Function Sheet

Extent shown:	
Blocks chosen:	ABK, APP, FB, FDEF, FW
System:	SG ME7.2
Project:	BMW 8-Zyl ME-7.2 M62LEV 3,5l und 4,4 l, variable Einl.-NW
Project code:	11/195;40
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MS 3.0 Engine control overview

FDEF MS 3.0 Function definition

ms-ms

ABK MS 3.0 Abbreviations

Variable	Source	Type	Description
B	MS	LOK	vector operating state conditions (only CU model)
B_E	MS	LOK	bit vector input variables
B_U	MS	LOK	bit vector manipulated variables
B_Y	MS	AUS	bit vector output variables
C	MS	LOK	vector controller state conditions (only CU model)
E	MS	LOK	Vector of error-flags
M	MS	LOK	vector engine variables physical (only CU model)
R	MS	LOK	vector computing base flags (only CU model)
S		EIN	vector switch flags (only CU model)
U	MS	LOK	revolution counter
W		EIN	vector converted input variables (only CU model)
Y	MS	AUS	vector of physical CU output variables

FB MS 3.0 Detailed description of function

The control unit model of the Motronic is made up of the following main parts:

EG Input variables: Processing and diagnosis of the sensor signals, derivation of further variables
SY System variables: Initializations, calculation cycles etc.
MSF Engine control functions: Contain the functional groups to calculate the setting variables, e.g. torque coordination, injection, ignition, idle control etc.
AS Output signals: Conversion of the setting variables into hardware-dependent setting signals
KO Communication: Representation of the interfaces to the fault code memory management, customer service, driver, application etc.

The structure of the SG functions has been revised. The aim is a modular and more comprehensible structure. Checking and data flows are separated to a great extent. Data and checking flows are represented by different lines. Transfer of the data on the upper structure levels is performed by vectors.

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APP MS 3.0 Application hint

ASCETBLK 1.0 Description of ASCET block library

FDEF ASCETBLK 1.0 Function definition

Funktionsdarstellung:

Bei der Darstellung von Funktionen wird zwischen physikalischen Informationen (Datenfluß) und digitaler Steuerinformation (Kontrollfluß) unterschieden.
Datenfluß: Lastsignal, Drehzahl, Regelfaktor
Kontrollfluß: Bedingung Leerlauf, Schalter Fahrstufe, Fehler Kat
Durchgezogene Linien markieren den Datenfluß, gestrichelte Linien den Kontrollfluß.

Grundblöcke (allgemeines):
- Bei Blöcken mit der Kennzeichnung "NOV" am Ausgang wird der Zustandswert des Blockes (Integratorinhalt, Flag, RAM-Zelle, etc.) im Dauer-RAM gespeichert (ansonsten im flüchtigen RAM). Im übrigen verhalten sich die Blöcke wie ihre Pendants ohne "NOV".
- Die Haupteingangs- und Hauptausgangswerte ("in" und "out") weisen im Block-Icon kein Symbol auf; sie sind mit 0.0 (float) bzw. FALSE (bool) vorbelegt, sofern nichts anderes angegeben ist.
- Nichtbeschaltete Eingänge sind mit 0.0 (float) bzw. FALSE (bool) vorbelegt, sofern nichts anderes angegeben ist.
- Bei einigen Blöcken kann an der linken oberen Ecke ein "Rastereingang" (default TRUE) angeschlossen werden, durch den die Berechnungshäufigkeit explizit festgelegt wird. Im folgenden bezeichnet "rasterZeit" den Abtand zwischen zwei Berechnungen.
- Eine Abweichung von der nachfolgenden Standardbelegung der Ein- und Ausgängen wird in der Beschreibung des Blockes angegeben.

	Kürzel im Icon	Default-Wert	Bezeichnung
EINGÄNGE:	E	TRUE	Berechnung des Blocks freigeben
	I	FALSE	Initialisierung auslösen
	IV	0.0	Initialisierungswert
	K	0.0	hier: Integrationsfaktor K
	MX	1E35	obere Begrenzung der Ausgangsgröße
	MN	-1E35	untere Begrenzung der Ausgangsgröße

ascetblk-teil0

ascetblk-teil0

Integrator K
neuer Integratorwert := alter Integratorwert + K * rasterZeit * in
EINGÄNGE: K Integrationsfaktor

Integrator T
neuer Integratorwert := alter Integratorwert + (rasterZeit / T) * in
Der Minimalwert von T wird auf rasterZeit begrenzt.
EINGÄNGE: T Integrationszeitkonstante

Rekursion
neuer Wert := alter Wert + m * (in - alter Wert)
EINGÄNGE: m Rekursionskonstante

Tiefpass
neuer Tiefpasswert := alter Tiefpasswert + (rasterZeit / T) * (in - alter Tiefpasswert)
Der Minimalwert von T wird auf rasterZeit begrenzt.
EINGÄNGE: T Zeitkonstante

Eingangs-UmschalterUnten
Das Icon zeigt die Ruhestellung des Schalters, nichtbeschaltete Eingänge sind mit 0.0 vorbelegt.

Exklusiv-ODER
Der Ausgang wird TRUE, wenn genau ein Eingang TRUE ist.

FlankeBi
Bei negativer oder positiver Flanke am Eingang, wird während dieses Simulationsschrittes am Ausgang TRUE ausgegeben. Sonst ist der Ausgang FALSE.

Maximum2
Am Ausgang liegt das Maximum der Eingangswerte an.
Der Ausgang i zeigt den Index des ersten Eingangs an, dessen Wert gleich dem ermittelten Maximum ist.

ascetblk-teil1

ascetblk-teil1

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Begrenzer
Am Ausgang wird der auf den Bereich [MN, MX] begrenzte Eingangswert ausgegeben.
Ist eine Begrenzung aktiv, so wird der Ausgang B := TRUE gesetzt; ansonsten ist dieser Ausgang FALSE.

Betrag
Am Ausgang liegt der Betrag des Eingangswertes an.

Hystrese
Der rechte und der linke Schaltpunkt der Hysterese ergibt sich aus der Beschaltung:

beschaltet	linker Schaltpkt	rechter Schaltpkt
LSP und delta	LSP	LSP + delta
LSP und RSP	LSP	RSP
delta und RSP	RSP - delta	RSP

Bei allen anderen Beschaltungen der Eingänge wird am Ausgang FALSE ausgegeben (fehlerhafte Beschaltung).

Signum
Ist der Eingangswert < 0.0, liegt am Ausgang der Wert -1.0, ansonsten der Wert 1.0 .

Akkumulator
Der Akkumulator wird um den Eingangswert additiv verändert und auf den Bereich [MN, MX] begrenzt.

FLAG
Nachbildung einer flüchtigen 1 Bit-Speicherzelle.

RAM
Nachbildung einer flüchtigen Speicherzelle.

ascetblk-teil2

ascetblk-teil2

RS-FlipFlop
Das RS-FlipFlop hat einen Set-Eingang S und einen Reset-Eingang R.
Am Ausgang !Q liegt immer der zu Q invertierte Wert. Reset ist gegenüber Set dominant.

VerzögerungRaster
Verzögerung des Signals um ein Raster, d.h. out(i) := in(i-1).
Am Ausgang liegt der jeweils um einen Rastertakt verzögerte Wert an.
Wenn der Rastereingang offen ist, wird um einen Simulationstakt verzögert.

Ausschalt-Verzögerung
Der Ausgang folgt dem Schalten des Eingangs von TRUE nach FALSE nach der Verzögerungszeit, die am Eingang DELAY anliegt. Schaltet während der Verzögerung der Eingang wieder nach TRUE, liegt auch am Ausgang sofort TRUE an.

Einschalt-Verzögerung
Der Ausgang folgt dem Schalten des Eingangs von FALSE nach TRUE nach der Verzögerungszeit, die am Eingang DELAY anliegt. Schaltet während der Verzögerung der Eingang wieder nach FALSE, liegt auch am Ausgang sofort FALSE an.

Timer
Eine positive Flanke am Eingang bewirkt, daß der Timer gestartet wird, d.h.
- der interne Timer wird auf den Wert (in Sekunden) gesetzt, der am Eingang SV anliegt,
- der Ausgang wird TRUE und bleibt TRUE bis der Timer abgelaufen ist.

Eine erneute positive Taktflanke am Eingang hat keine Auswirkung, solange der Timer noch nicht abgelaufen ist. Liegt an E FALSE, wird der Timer gestoppt, bis E wieder TRUE ist.

EINGÄNGE:	in	Starten des Timers
	SV	Timerzeit
AUSGÄNGE:	B	Timer läuft

Timer-Retrigger
Grundfunktion wie "Timer", jedoch: Eine erneute positive Taktflanke am Eingang bewirkt stets Neustart des Timers.

ascetblk-teil3

ascetblk-teil3

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ZeitZähler
TRUE am Eingang R setzt den Zeitzähler auf 0.0 zurück. Wird R = FALSE, beginnt der ZeitZähler zu laufen.
Liegt an E FALSE, so wird der Zeitzähler gestoppt. Der Zeitzähler zeigt die abgelaufene Zeit in Sekunden an.

EINGÄNGE:	R	Rücksetzen des ZeitZählers

Zähler
Dieser Block zählt in jedem Simulationsschritt um eins aufwärts bzw. abwärts. Startwert, Endwert und damit die Zählrichtung werden festgelegt, wenn am Eingang I TRUE anliegt.
Wenn der Wert von SV größer als der Wert von EV ist, dann wird abwärts (ansonsten aufwärts) gezählt, bis der Endwert erreicht ist. Das Erreichen des Endwertes wird durch ein TRUE am Ausgang B angezeigt.
Der Zähler kann mit dem Eingang E gestoppt werden.

EINGÄNGE:	SV	Startwert des Zählers
	EV	Endwert des Zählers
	I	Zähler starten
AUSGÄNGE:	B	Endwert erreicht

Zustandsautomat
Der Kontrollfluß wird durch logische Gatter und Zustandsautomaten dargestellt. In Zustandsautomaten wird der Funktionsablauf in graphischer Form mit Hilfe von "Zuständen" und "Übergängen" abgebildet.

Zustand: (Ellipse)	Innerhalb eines Zustandsautomaten ist jeweils genau ein Zustand aktiv, d.h. die zu diesem Zustand gehörenden Aktionen werden ausgeführt. Der Name des Zustandes ist innerhalb der Ellipse dargestellt.
Übergang: (Pfeil)	Der Übergang von einem Zustand zum anderen erfolgt, wenn die Übergangsbedingung erfüllt ist. Dabei werden diesem Übergang zugeordnete Aktionen ausgeführt. Die Bedingung, die erfüllt sein muß, damit ein Übergang stattfindet, steht neben dem jeweiligen Pfeil; ggf. steht nur ein logischer Name für die Bedingung und die ausfürliche Beschreibung ist dem nachfolgenden Text zu entnehmen. Bevorzugt wird die Bedingung mit der niedrigsten Nummer.

Für jeden Zustandsautomaten ist festgelegt, welcher Zustand beim Start des Automaten angenommen werden soll (S) und welcher Zustand bei erfüllter RESET-Bedingung (R).

ascetblk-teil4

ascetblk-teil4

ABK ASCETBLK 1.0 Abbreviations

Variable	Source	Type	Description
N		EIN	Engine speed

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FB ASCETBLK 1.0 Detailed description of function

APP ASCETBLK 1.0 Application hint

ASCETSDB 1.23 ASCET-SD descripton of block library

FDEF ASCETSDB 1.23 Function definition

Graphical presentation of basic elements

Basic elements are presented in the diagram as rectangular blocks. Communication between basic elements is displayed by connecting lines. The interfaces between basic elements are the pins at the block edges. Each block has return pin that outputs the result from the block. In addition to this, there are argument pins that provide the inputs into the block as well as method pins that are used for those methods without input arguments and without return values.

The methods call up functions in the block.

The process information and the computing sequence are given in the form: "/computing sequence/process", e.g. /10/100 ms: The tenth call-up in the 10-ms computing frame

Methods	Arguments	Return value
m1: out	-	Float
m2: compute	in, inmx, inmn	-
m3: reset	-	-

The example given above shows a block with 3 methods:
- The method m1 "out" has one return value
The method "out" is called up by the request for the return value from the subsequent block outy, that is in the tenth position in the computing sequence in the 100-ms computing frame.
- The method m2 "compute" has three arguments (in, inmn, inmx) yet no return value.
The method "compute" is called up at the fifth position in the computing sequence in the 10-ms computing frame.
- The method m3 "reset" has neither arguments nor a return value. This is therefore represented by the "method pin".
If B_reset is true, then the method "reset" is called up first (1/) in the computing sequence.

ascetsdb-e-beschrei

ascetsdb-e-beschrei

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Arithmetic operations

Equations can be described using arithmetic operations (addition, subtraction, multiplication and division). Equations are represented graphically such that the return value of an operation is the argument for the subsequent operation.

(a * b) + c

a * (b + c)

The arguments of primitive operations and their computing sequence are shown in the following:

a + b **a + b + c** **a+b+c+d** **a - b** **a / b**

Negation: b = - a

Amount: b = |a|

Maximum for input values: c = MAX(a,b)

Minimum for input values: c = MIN(a,b)

ascetsdb-e1-artihme

Variables

receive_message

Receive message are input variables of the function that are made available from another function.

send_receive_message

Send/Receive variables are output variables of the function that are used both within as well as outside of the function.

send_message

Send messages are output variables of the function and are available for the other functions.

local_varable

Local variables are only made available and used within the function.

ascetsdb-e2-variabl

ascetsdb-e1-artihme

ascetsdb-e2-variabl

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Arrays and matrices

Arrays and matrices have two methods for reading and writing access to the elements. The reading and writing can be independent of one another.

Array:
- The value to be written is connected to the left pin, the associated index to the lower left pin.
- The value to be read is connected to the right pin, the associated index to the lower right pin.

Matrix:
Matrices behave as arrays, whereby the methods here have two index arguments (x, y):
- The index x is connected to the lower left, the index y to the upper left pin for writing access.
- The index x is connected to the lower right, the index y to the upper right pin for reading access.

ascetsdb-e3-arrays-

1 -1.3 **Constants**

true false **Boolean Constants**

ascetsdb-e4-konstan

System constants

SY_ZYLZA

System constants are constants that are permanently anchored in the program and cannot be applied. System constants can switch functional positions conditionally on or off.

SY_TURBO

Example **SY_ZYLZA: Cylinder number**
SY_TURBO: Engine with or without turbo-charger

ascetsdb-e5-systemk

ascetsdb-e3-arrays-

ascetsdb-e4-konstan

ascetsdb-e5-systemk

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Fixed values, Characteristics, Maps, Group characteristics, Group maps and datapoint distribution

Fixed values are applicable parameters

Characteristics have one argument.
Maps have two arguments as the input.
Both have one return value

In the case of group characteristics and group maps, several characteristics and maps pick up the same datapoint distributions.
To this end, the current datapoint from the datapoint distribution, e.g. SNM07LRNM, is first computed from the dependent parameter e.g. nmot. The computation of the output value for the group characteristic or map then follows using this current datapoint.

ascetsdb-e6-kl-kf-g

ascetsdb-e6-kl-kf-g

Bit operations

E1 E2 → & → A **AND element:**

E1	E2	A
0	0	0
1	0	0
0	1	0
1	1	1

E1 E2 → ≥1 → A **OR element:**

E1	E2	A
0	0	0
1	0	1
0	1	1
1	1	1

E → ! → A **Negation**

E	A
0	1
1	0

E1 E2 → =1 (Exor) → A **Exklusive OR:**

E1	E2	A
0	0	0
1	0	1
0	1	1
1	1	0

ascetsdb-e7-bitoper

ascetsdb-e7-bitoper

Comparator

The comparator provides TRUE at the output if the comparison applies.
If the comparison is not fulfilled, then FALSE is given as the output.

Greater, greater than or equal to

Less, less than or equal to

Equal, unequal

Closed interval:
a <= x <= b

The comparison is always read from top to bottom (interval excepted):

If vfz is greater than VMAX, then the condition B_toofast is TRUE

B_ubok = true if UBMN <= ub <= UBMX

ascetsdb-e8-verglei

ascetsdb-e8-verglei

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Multiplex operator "Multiplexer", "Switch"

A multiplexer switches a value through to the output as a dependency of the input conditions.
The multiplexer icon is shown in the dormant position, i.e. if the input conditions are false.

Example "Simple multiplexer"
- if B_stend = false: nsoll = 1100
- if B_stend = true: nsoll = 800

An input condition is assigned to each value in the case of cascaded multiplexers.
The uppermost value, the input condition for which is true, is switched through.
If there is no input condition of true, then the lowest value is switched through.

Example "Mehrfach-Muxer":
- if B_1 = true: nsoll = value1
- if B_1 = false & B_2 = true: nsoll = value2
- if B_1 = false & B_2 = false: nsoll = value3

ascetsdb-e9-multipl

ascetsdb-e9-multipl

CASE operator

The CASE operator switches one of the remaining left inputs through to the output as a dependency of a top-applied discrete control value (1, 2, 3, ...).
If the control value 1 is the first value, then 2 is the second value and is switched through immediately.
If the value is outside of the range, then the lowest input (default) is switched through.

Example: Formation of the physical cylinder number onto the software cylinder number.

ascetsdb-e10-case-o

ascetsdb-e10-case-o

Switch

The SWITCH operator activates the matching control flows over the right-hand outputs as a dependency of an upper applied discrete control value (1, 2, 3, ...).
If there is no matching output existing, then the control flow is activated at the lower output.

Example:
One of the following operations is executed depending on zzyl:
- if zzyl = 0: a = memory
- if zzyl = 1: b = memory
- if zzyl = 2: c = memory
- if zzyl = 3: d = memory
- otherwise: error = memory

ascetsdb-e11-kontro

ascetsdb-e11-kontro

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If ..... then

The If .. Then operation analyzes a logic condition and activates all computing sequences for TRUE that are connected to the control flow. The computing sequence is defined by the numbering.

Example:
If B_stend changes to true, then tnst = 0 is set.

If

then **else**

The IF .. Then .. Else operation analyzes a logic condition and activates all computing sequences of the then control branch for TRUE, and all computing sequences of the else control branch for FALSE. The computing sequence at each control branch is defined by the numbering.

Example: If B_stend = true,
then tnst is incremented by 0.01 sec.
in the 10-ms time frame.
Otherwise (B_stend = false) tnst = 0 is set.

Mule bridge for IF:

I=True <-- IF **--> F=False**

ascetsdb-e12-kontro

While loop

The computing sequence within the control flow of the loop is executed for such a time as the input condition is fulfilled, i.e. is TRUE. The loop is aborted when the input condition is FALSE. The value for terminating the While loop is normally formed within the loop. This usually concerns a counter here that shall count up to a certain value.

Example:
The array wkr[i] is written with 0 for such a time as izzy < SY_ZYLZA. Each element of the array is initialized with 0 by the numerical variable izzyl at the index input of the array.

ascetsdb-e13-while

Break

The break operation prematurely interrupts a process, e.g. the functions component in a computing frame. All subsequent calculations of the function in the process with a higher number for the computing sequence are not then executed.

Break
0/-

Example:

In accordance with the computing sequence, a break is triggered after the operation b = a exactly then when B_stend = TRUE. The 100-ms process is started if a break occurs. The subsequent operation, c = memory, is no longer executed.

ascetsdb-e14-kontro

Hierarchy:

Hierarchy

The hierarchy is graphical possibility for structuring functions.
The hierarchy block is identified by a double border.
The corresponding hierarchy level is identified by the name, here "AND link".
The transfer element is only a designator for the links between both levels.

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Function in the graphical "AND link" hierarchy:

ascetsdb-and-link

ascetsdb-and-link

Example

The method "reset" of the integrator is executed in the 50-ms computing frame as long as the condition B_stend = FALSE. This method causes the internal memory cell of the integrator to initialized with the IV-value, i.e. 0.0. If the condition now becomes B_stend = TRUE, then the left-hand control flow is activated and the method "compute" has as the arguments time T and the input value. This depends on B_ll. The input value = 1.0 for B_ll = TRUE; the input value = -1.0 for B_ll = FALSE. The number in front of the computing frame indicates the computing sequence: The time constant T is computed in the 200-ms computing frame and the message wkltnm is stored in Send/Receive. The IF .. THEN .. ELSE query is first executed in the 50-ms computing frame. The integration value is written into the variable a in the second step.

ascetsdb-e-b-beispi

ascetsdb-e-b-beispi

ASCET-SD System Library

Comparators

ClosedInterval
`ClosedInterval` returns TRUE, if the value `x` is in the closed interval defined by A and B.

Methods	Characteristics	Arguments	Return Value
out	TRUE is returned, if `A <= x <= B`. Otherwise FALSE is returned.	x::continuous A::continuous B::continuous	TRUE or FALSE

LeftOpenInterval
`LeftOpenInterval` returns TRUE, if the value `x` is in the left open interval defined by A and B.

Methods	Characteristics	Arguments	Return Value
out	TRUE is returned `A < x <= B. Otherwise FALSE is returned`.	x::continuous A::continuous B::continuous	TRUE or FALSE

OpenInterval
`OpenInterval` returnes TRUE, if the value `x` is in the open interval defined by A and B .

Methods	Characteristics	Arguments	Return Value
out	TRUEis returned, if `A < x < B`. Otherwise FALSE is returned .	x::continuous A::continuous B::continuous	TRUE or FALSE

ascetsdb-etassyse1

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RightOpenInterval
`RightOpenInterval` returns TRUE, if the value `x` is in the right open interval defined by A and B.

Methods	Characteristics	Arguments	Return Value
out	TRUE is returned, if `A <= x < B`.Otherwise FALSE is returned.	x::continuous A::continuous B::continuous	TRUE or FALSE

GreaterZero
`GreaterZero` returns TRUE, if the value x is greater than zero.

Methods	Characteristics	Arguments	Return Value
out	TRUE is returned, if `x > 0.0`. otherwise FALSE is returned.	x:continuous	TRUE or FALSE

Counter & Timer

CountDown
CountDown decrements the counter and signals when the counter has reached zero.

Methods	Characteristics	Arguments	Return Value
start	The counter is set to the start value .	startValue::unsigned discrete	none
compute	The counter is decremented by one.	none	none
out	TRUE is returned if the counter is greater than zero. Otherwise FALSE is returned.	none	TRUE or FALSE

ascetsdb-etassyse2

ascetsdb-etassyse2

CountDownEnabled
CountDownEnabled dercrements the counter and signals when the counter has reached zero. This counter must be enabled explicitly.

Methods	Characteristics	Arguments	Return Value
start	The counter is set to start value.	startValue:: unsigned discrete	none
compute	If enable isTRUE, the counter is decremented by one.	enable::TRUE or FALSE	none
out	TRUE is returned if the counter is greater zero.Otherwise FALSE is returned.	none	TRUE or FALSE

Counter
Counter increments the couner by one.

Methods	Characteristics	Arguments	Return Value
reset	The counter is set to zero.	none	none
compute	The counter is incremented by one .	none	none
out	The counter value is returned .	none	unsigned discrete

CounterEnabled
CounterEnabled increments the counter by one. This counter must be enabled explicitly.

Methods	Characteristics	Arguments	Return Value
reset	If `initEnable is` TRUE, the counter is set to zero .	initEnable::TRUE or FALSE	none
compute	If `enable` is TRUE, the counter is incremented by one.	enable::TRUE orFALSE	none
out	The counter value is returned.	none	unsigned discrete

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StopWatch
StopWatch increments the time counter by one dT.

Methods	Characteristics	Arguments	Return Value
reset	The counter is set to zero.	none	none
compute	The time counter is inremented by dT.	none	none
out	The time counter value, i. e. the time elapsed since the last start, is returned .	none	continuous

StopWatchEnabled
StopWatchEnabled increments the time counter by one dT. Thies timer must be enabled explicitly.

Methods	Characteristics	Arguments	Return Value
reset	If `initEnable is` TRUE, the internal counter is set to zero.	initEnable::TRUE or FALSE	none
compute	If `enable` is TRUE, the time counter is incremented by dT .	enable::TRUE or FALSE	none
out	The time counter value, i.e. the time elapsed since the last start and while `enable` was TRUE is returned.	none	continuous

ascetsdb-etassyse4

ascetsdb-etassyse4

Timer
Timer decrements the time counter by dT and singals when the time counter has reached zero . Its not retriggerable.

Methods	Characteristics	Arguments	Return Value
start	The time counter is set to zero, if the time counter value was previously less than or equal to zero.	startTime::continuous	none
compute	The time counter is decremented by dT.	none	none
out	TRUE is returned, if the time counter is greater then zero. Otherwise FALSE is returned.	none	continuous

TimerEnabled
TimerEnabled decrements the time counter by dT and signals when the time counter reaches zero. It must be enabled explicitly.

Methods	Characteristics	Arguments	Return Value
compute	If `enable` is TRUE, `in` has a rising edge and the time counter value is less or equal zero, the timer is started, i.e. its counter value is set to the start time. Otherwise the time counter is decremented by dT. If `enable` is FALSE nothing happens.	enable::TRUE or FALSE in::TRUE or FALSE startTime::continuous	none
out	TRUE is returned, if the time counter value is greater than zero. Otherwise , FALSE is returned .	none	continuous

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TimerRetrigger
TimerRetrigger decrements the time counter by dT and signal when the time counter has reached zero.It can be retriggered.

Methods	Characteristics	Arguments	Return Value
start	The time counter is set to the start value	startTime::continuous	none
compute	The time counter is decremented by dT.	none	none
out	TRUE is returned, if the time counter value is greater than zero.Otherwise, FALSE is returned.	none	continuous

TimerRetriggerEnabled
TimerRetriggerEnabled decrements the time counter by dT and signals when time counter has reached zero. It can be retriggered and must be enabled explicitly.

Methods	Characteristics	Arguments	Return Value
compute	If `enable` is TRUE and it has a rising edge,the timer is started i.e. its counter value is set to the start value. Otherwise the time counter is decremented by dT (the time frame). If enable is FALSE nothing happens.	enable::TRUE or FALSE in::TRUE or FALSE startValue::continuous	none
out	TRUE is returned, if the time counter value is greater than zero. Otherwise FALSE is returned .	none	continuous

ascetsdb-etassyse6

ascetsdb-etassyse6

Delay

DelaySignal
DelaySignal delays its input signal by one evaluation step.

Methods	Characteristics	Arguments	Return Value
compute	The input signal is buffered	signal::TRUE or FALSE	none
out	The buffered signal is returned ,thus the input signal is delayed by one step.	none	TRUE or FALSE

DelaySignalEnabled
DelaySignalEnabled delays its input singal by one evaluation step. It must be enabled explicitly.

Methods	Characteristics	Arguments	Return Value
reset	If `initEnable` is TRUE, `initValue` is buffered	initEnable::TRUE or FALSE initValue::TRUE or FALSE	none
compute	If `enable` is TRUE, the input signal is buffered.	signal::TRUE or FALSE enable::TRUE or FALSE	none
out	The buffered signal is returned, thus the input signal is delayed by one step..	none	TRUE or FALSE

DelayValue
DelayValue delays its input value by one evaluation step.

Methods	Characteristics	Arguments	Return Value
compute	The input value is buffered .	value:continuous	none
out	The buffered value is returned, thus the input value is delayed by one step.	none	continuous

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DelayValueEnabled
DelaySignalEnabled delays its input value by one evaluation step. It must be enabled explicitly.

Methods	Characteristics	Arguments	Return Value
reset	If `initEnable` is TRUE,`initValue` is buffered.	initEnable::TRUE or FALSE initValue::continuous	none
compute	If `enable` is TRUE, the input value is buffered .	value::continuous enable::TRUE or FALSE	none
out	The buffered value is returned, thus the input value is delayed by one step	none	TRUE or FALSE

TurnOffDelay
TurnOffDelay delays a falling edge of the input signal .

Methods	Characteristics	Arguments	Return Value
compute	A fallling edge of the input signal is delayed. If the signal flips from TRUE to FALSE, a timer is started . On being FALSE the timer is incremented by dT and is compared to delayTime. If the input signal is TRUE, the timer is reset.	signal::TRUE or FALSE delayTime::continuous	none
out	TRUE is returned if the input signal is TRUE or the timer has not exceeded delayTime. Otherwise FALSE is returned.	none	TRUE or FALSE

TurnOnDelay
TurnOffDelay delays a rising edge of the input signal.

Methods	Characteristics	Arguments	Return Value
compute	A rising edge of the input signal is delayed. If the signal flips from FALSE to TRUE a timer is started. On being TRUE the timer is incremented by dT and is compared to delayTime. If the input signal is FALSE, the timer is reset.	signal::TRUE or FALSE delayTime::continuous	none

ascetsdb-etassyse8

ascetsdb-etassyse8

out	FALSE is returned if the input signal is FALSE, or the timer has not exceeded delayTime . Otherwise,TRUE is returned.	none	TRUE or FALSE

Memory

Accumulator
Accumulator adds up its input value.

Methods	Characteristics	Arguments	Return Value
reset	The accumulator is set to initValue.	initValue::continuous	none
compute	The accumulator is incremented by the input value, i.e. `accumulator (new) = accumulator (old) + input value`.	value::continuous	none
out	The accumulator value is returned.	none	continuous

AccumulatorEnabled
AccumulatorEnabled adds up its input value. It must be enabled explicitly and its accumulator value can be limited.

Methods	Characteristics	Arguments	Return Value
reset	If `initEnable` is TRUE, the accumulator value is set to `initValue`.	initValue:continuous initEnable::TRUE or FALSE	none
compute	If `enable` is TRUE, the accumulator is incremented by the input value, i.e. `accumulator(new) = accumulator(old) + input value`. Additionally, the accumulator value is limited by `mn` and `mx`.	value:continuous mn:continuous mx::continuous enable::TRUE or FALSE	none
out	The accumulator value is returned.	none	continuous

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AccumulatorLimited
AccumulatorLimited adds up its input value. Its accumulator value can be limited.

Methods	Characteristics	Arguments	Return Value
reset	The accumulator value is set to `initValue`.	initValue::continuous	none
compute	The accumulator is incremented by the input value, i.e. `accumulator(new) =accumulator(old) + input value`. Additionally, the accumulator value is limited by mn and mx.	value::continuous mn::continuous mx::continuous	none
out	The accumulator value is returned.	none	continuous

RSFlipFlop
RSFlipFlop is a flip flop with a reset and a set input, where the reset input dominates the set input.

Methods	Characteristics	Arguments	Return Value
compute	If `r` is TRUE the state of the flip flop is set to FALSE. Otherwise, if `s` is TRUE, the state is set to TRUE. If both `r` and `s`, are FALSE the state is left unchanged.	r::TRUE or FALSE s::TRUE or FALSE	none
q	The state of flip flop is returned .	none	TRUE or FALSE
nq	The negated value of the state is returned .	none	TRUE or FALSE

ascetsdb-etassyse10

ascetsdb-etassyse10

Miscellaneous

DeltaOneStep
DeltaOneStep returns the difference of the current input value and the last input value.

Methods	Characteristics	Arguments	Return Value
compute	The input value is subtracted from the previous input value.	value::continuous	none
out	The difference is returned.	none	continuous

DifferenceQuotient
DifferenceQuotient computes the difference quotient of the input value .

Methods	Characteristics	Arguments	Return Value
compute	The difference quotient (`value - previous value)/ dT` is computed.	value::continuous	none
out	The difference quotient is returned.	none	continuous

EdgeBi
EdgeBi detects a bidirectional edge of the logical input signal.

Methods	Characteristics	Arguments	Return Value
compute	The input signal is compared to the previous input signal.	signal::TRUE or FALSE	none
out	TRUE is returned, if the input signal differ. Otherwise, FALSE is returned.	none	TRUE or FALSE

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EdgeFalling
EdgeFalling detects a falling edge of the logical input signal.

Methods	Characteristics	Arguments	Return Value
compute	The input signal is compared to the previous input signal.	signal::TRUE oder FALSE	none
out	TRUE is returned, if the input signal is low and the previous input signal was high. Otherwise FALSE is returned.	none	TRUE or FALSE

EdgeRising
EdgeRising detects a rising edge of the logical input signal.

Methods	Characteristics	Arguments	Return Value
compute	The input signal is compared to the previous input signal.	signal::TRUE or FALSE	none
out	TRUE is returned, if the input signal is high and the previous input signal was low. Otherwise, FALSE is returned.	none	TRUE or FALSE

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Mux1of4
Mux1of4 switches between the four inputs values s0,... , s3 on the binary representation of their index.

Methods	Characteristics	Arguments	Return Value
out	The input value `si (index i)` is returned where `i = b0 + 2*b1` interpreting FALSE as 0 and TRUE as 1, i. e. the table: b0 b1 out FALSE FALSE s0 TRUE FALSE s1 FALSE TRUE s2 TRUE TRUE s3	b0::TRUE or FALSE b1::TRUE or FALSE s0::Float s1::Float s2::Float s3::Float	Float

Mux1of8
Mux1of8 Switches betwen the four input values `sIndex = s0,...,s7` on their binary representation of their index..

Methods	Characteristics	Arguments	Return Value
out	The input value `si (index i)` is returned, if `i = b0 + 2*b1 + 4*b2` interpreting FALSE as 0 and TRUE as 1 (see. Mux1of4).	b0::TRUE or FALSE b1::TRUE or FALSE b2::TRUE orFALSE s0::Float, s1::Float, s2::Float, s3::Float s4::Float, s5::Float, s6::Float, s7::Float	Float

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Hysteresis-Delta-RSP
Hysteresis-Delta-RSP is a hysteresis with a right switching piont and a delta offset.

Methods	Characteristics	Arguments	Return Value
out	TRUE is returned, if `x > rsp`. FALSE is returned, if `x < (rsp - delta)`. The returne value is unchanged, if `x` lies within the open interval `(rsp - delta) rsp`	x::continuous delta::continuous rsp::continuous	TRUE or FALSE

Hysteresis-LSP-Delta
Hysteresis-LSP-Delta is a hysteresis with a left switching point and a delta offset.

Methods	Characteristics	Arguments	Return Value
out	TRUE is returned,if `x > (lsp + delta)`. FALSE is returned,if `x < lsp`. The returne value is unchanged, ifx lies within the open interval `lsp and(lsp + delta)`.	x::continuous lsp:continuous delta:continuous	TRUE or FALSE

Hysteresis-LSP-RSP
Hysteresis-LSP-RSP is a hysteresis with both a left and a right switching point.

Methods	Characteristics	Arguments	Return Value
out	TRUE is returned,if `x > rsp`. FALSEis returned,if `x < lsp`. The return value is unchanged, if `x` lies within the open interval `lsp and rsp`.	x::continuous lsp::continuous rsp::continuous	TRUE or FALSE

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Hysteresis-MSP-DeltaHalf
Hysteresis-MSP-DeltaHalf is a hysteresis with a middle switching point and a delta/2 offset.

Methods	Characteristics	Arguments	Return Value
out	TRUE is returned, if `x > (msp + deltahalf)`. FALSE is returned `x < (msp - deltahalf)`. The return value is unchanged, if x is in the open interval`(msp - deltahalf)` and `(msp + deltahalf)`.	x::continuous msp::continuous deltahalf::continuous	TRUE or FALSE

Limiter
Limiter returns the input x limited by mn and mx.

Methods	Characteristics	Arguments	Return Value
out	The input `x` is limited by `mn` and `mx and is returned,` i.e. `max( min(x, mx),mn)`.There is no check if mn<= mx.	x::continuous mn::continuous mx::continuous	continuous

Signum
Signum returns the sign of the input.

Methods	Characteristics	Arguments	Return Value
out	1.0 is returned if `x >= 0.0`, otherwise -1.0 is returned .	x:continuous	continuous

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Transfer Function

DT1
DT1 is a time discrete differentiation transfer function with time constant T and grain constant K.

Methods	Characteristics	Arguments	Return Value
compute	The difference value is computed via a P-function and an I-function which is backcoupled.	in::continuous T::continuous K::continuous	none
out	The differentiation value is returned.	none	continuous

P
P is a time discrete proportional transfer function with grain constant K.

Methods	Characteristics	Arguments	Return Value
out	The differentiation value out = in * K is computed.	in::continuous K::continuous	continuous

PI
PI is a time discrete proportional integrator with time constant T and grain constant K.

Methods	Characteristics	Arguments	Return Value
reset	The integrator value is set to initValue.	initValue::continuous	none
compute	The value of the PI-function is computed as a sum of a P-Funktion and an I-function.	in::continuous T::continuous	none

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		K::continuous	
out	The value of the PI-function is returned.	none	continuous

PID
PID is a time discrete proportional integrator with differential part with time constants Tv and Tn and grain constant K.

Methods	Characteristics	Arguments	Return Value
reset	Der Integrator is set to initValue.	initValue:continuous	none
compute	The value of the PID-function is computed as a sum of a P-Funktion, a D-Funktion and an I-Funktion.	in::continuous Tv::continuous Tn::continuous K::continuous	none
out	The value of the PID-Funktion is returned.	none	continuous

PIDLimited
PIDLimited is a time discrete proportional integrator with differential part with time constants Tv and Tn and grain constant K. The value of the integrator is limited.

Methods	Characteristics	Arguments	Return Value
reset	Der Integrator is set to initValue.	initValue::continuous	none
compute	The value of the PID-Funktion is computed as a sum of a P-Funktion, a D-Funktion and an I-Funktion , where the integrator value of the I-fuction is limited by mn and mx.	in::continuous Tv::continuous Tn::continuous K::continuous mn::continuous mx::continuous	none
out	The value of the PID-Funktion is returned.	none	continuous

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PILimited
PILimited is a time discrete proportional integrator with time constant T and grain constant K. The value of the integrator limited.

Methods	Characteristics	Arguments	Return Value
reset	The value of th integrator is set to initValue.	initValue::continuous	none
compute	The value of the PI-function is computed as the sum of a P-function and an I-function,where the integrator value of the I-function is limited by mn and mx.	in::continuous T::continuous K::continuous mn::continuous mx:continuous	none
out	The value of the PI-function is returned.	none	continuous

PT1
PT1 is a time discrete low pass with time constant T and grain constant K.

Methods	Characteristics	Arguments	Return Value
reset	The value of th integrator is set to initValue.	initValue::continuous	none
compute	Thevalue of the PT1-function is computed via an I-function wich is backcoupled.	in::continuous T::continuous K::continuous	none
out	The value of the PT1-function is returned.	none	continuous

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PT2
PT2 is a time discrete delay function with time constant T, grain constant K, and damping d.

Methods	Characteristics	Arguments	Return Value
reset	The two integrator values are set to initValue.	initValue::continuous	none
compute	The value of the PT2-function is computed via two I-functions in row, wich are backcoupled by a cascade of two P-functions.	in::continuous T::continuous K::continuous d::continuous	none
out	The value of the PT2-function is returned.	none	continuous

Integrator

IntegratorK
IntegratorK is a time discrete integrator with grain constant K.

Methods	Characteristics	Arguments	Return Value
reset	The integrator value is set to initValue.	initValue::continuous	none
compute	The integrator value is computed via: `integrator (new) = integrator (old) + in * dT* K`	in::continuous K::continuous	none
out	The integrator value is returned.	none	continuous

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IntegratorKEnabled
IntegratorKEnabled is a time discrete integrator with grain constant K.It must be enabled explicitly and its Integrator value can be limited.

Methods	Characteristics	Arguments	Return Value
reset	If initEnable is TRUE, the integrator value is set to initValue.	initValue::continuous initEnable::TRUE or FALSE	none
compute	If enable is TRUE, the integrator value is computed via:`Integrator(new) = Integrator(old) + in * dT * K`	in::continuous K::continuous mn::continuous mx::continuous enable::TRUE or FALSE	none
out	The integrator value is returned.	none	continuous

IntegratorKLimited
IntegratorKLimited is a time discrete integrator with grain constant K. Its integrator value can be limited.

Methods	Characteristics	Arguments	Return Value
reset	The integrator value is set to initValue.	initValue::continuous	none
compute	The integrator value is computed via: `Integrator (new) = Integrator (old) + in * dT * K`	in::continuous K::continuous mn::continuous mx::continuous	none
out	The integrator value is returned.	none	continuous

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IntegratorT
IntegratorT is a discrete integrator with time constant T.

Methods	Characteristics	Arguments	Return Value
reset	The integrator value is set to initValue.	initValue::continuous	none
compute	The integrator value is computed via: `Integrator (new) = Integrator (old) + in * dT / T`	in:continuous T::continuous	none
out	The integrator value is returned.	none	continuous

IntegratorTEnabled
IntegratorTEnabled is a time discrete integrator with time constant T.It must be enabled explicitly and its integrator value can be limited.

Methods	Characteristics	Arguments	Return Value
reset	If initEnable is TRUE,the integrator value is set to initValue.	initValue:continuous initEnable::TRUE or FALSE	none
compute	If enable is TRUE, the integrator value is computed via: `Integrator(new) = Integrator(old) + in * dT / T`	in::continuous T::continuous mn::continuous mx::continuous enable::TRUE or FALSE	none
out	The integrator value is returned.	none	continuous

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IntegratorTLimited
IntegratorTLimited is a time discrete integrator with time constant T. Its integrator value can be limited.

Methods	Characteristics	Arguments	Return Value
reset	The integrator value is set to initValue.	initValue::continuous	none
compute	The integrator value is computed via: `Integrator (new) = Integrator (old) + in * dT / T`	in::continuous T::continuous mn::continuous mx::continuous	none
out	The integrator value is returned.	none	continuous

Lowpass

DigitalLowpass
DigitalLowpass recursively computes the mean value of the input value.

Methods	Characteristics	Arguments	Return Value
reset	The mean value is set to initValue.	initValue::continuous	none
compute	The mean value is computed via : `mean(new) = mean(old) + m * ( in - mean(old) )`	in::continuous m::continuous	none
out	The mean value is returned.	none	continuous

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LowpassK
LowpassK is a simplified PT1-function with grain constant K (low pass filter).

Methods	Characteristics	Arguments	Return Value
reset	The value is set to initValue.	initValue::continuous	none
compute	The lowpass is computed via: `val(new) = val(old) + (in - val(old) ) * dT * K.`	in::continuous K::continuous	none
out	The lowpass value is returned.	none	continuous

LowpassKEnabled
LowpassKEnabled is a simplified PT1-function with grain constant K (low pass filter). It must be enabled explicitly.

Methods	Characteristics	Arguments	Return Value
reset	If initEnable is TRUE, the lowpass value is set to initValue.	initValue:continuous initEnable::TRUE or FALSE	none
compute	If enable is TRUE, the lowpass is computed via: `val(new) = val(old) + (in - val(old) ) * dT * K.`	in::continuous K::continuous enable::TRUE or FALSE	none
out	The lowpass value is returned.	none	continuous

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LowpassT
LowpassT is a simplified PT1-function with time constant T (low pass filter) .

Methods	Characteristics	Arguments	Return Value
reset	The lowpass value is set to init value	initValue::continuous	none
compute	The lowpass is computed via: `val(new) = val(old) + (in - val(old) ) * dT / T.`	in::continuous T::continuous	none
out	The lowpass value is returned.	none	continuous

LowpassTEnabled
LowpassTEnabled is a simplified PT1-function with time constant T (low pass filter) . It must be enabled explicitly.

Methods	Characteristics	Arguments	Return Value
reset	If initEnable is TRUE , the lowpass value is set to initValue.	initValue::continuous initEnable::TRUE or FALSE	none
compute	If enable is TRUE, the lowpass is computed via: `val(new) = val(old) + (in - val(old) ) * dT / T.`	in::continuous T::continuous enable::TRUE or FALSE	none
out	The lowpass value is returned.	none	continuous

ascetsdb-etassyse24

ascetsdb-etassyse24

No text for FDEF available!

ABK ASCETSDB 1.23 Abbreviations

FB ASCETSDB 1.23 Detailed description of function

APP ASCETSDB 1.23 Application hint

SYABK 8.2 Symbols and abbreviations

FDEF SYABK 8.2 Function definition

SYMBOLE:

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MSF 9.10 Engine control functions

FDEF MSF 9.10 Function definition

msf-msf

ABK MSF 9.10 Abbreviations

Variable	Source	Type	Description
B_LL	MSF	AUS	Condition idle
B_NWS	MSF	AUS	Condition camshaft control
B_SAB	MSF	AUS	Condition fuel cut-off requested
B_VL	MSF	AUS	Condition for wide open throttle
DMAR_W	MSF	LOK	delta torque anti-jerk
DMLLR_W	MSF	LOK	desired torque change from the idle speed control (PD-)
DMRKH	MSF	LOK	torque reserve for catalyzer heating
DMRLLR	MSF	LOK	Torque reserve for idle speed control
ETAZAIST	MSF	LOK	actual cylinder masking effectiveness
ETAZWBM	MSF	LOK	mean ignition angle effectiveness of basic ignition angle
GANGI	BBGANG	EIN	Engaged gear
LAMBAS_W	MSF	LOK	lambda base value
LAMKH_W	MSF	LOK	Lambda engine nominal at catalyst heating (word)
MIASRL_W	CANASR	EIN	desired indicated torque from ASR for slow intervention
MIASRS_W	CANASR	EIN	desired indicated torque from ASR for quick intervention
MIBAS_W	MSF	LOK	indicated basic torque
MIBGR_W	MSF	LOK	Indicated desired torque for gear-dependent limiting of the clutch torque
MIFAL_W	MSF	LOK	Indicated driver's wish torque for torque coordination cylinder filling
MIFA_W	MSF	LOK	desired indicated engine torque
MIGES_W	MSF	LOK	desired indicated torque for transmission protection
MIGSRC_W	CANEGS	EIN	Torque reduction request transmission control (CAN message)
MIGS_W	MSF	LOK	desired indicated torque form GS for quick intervention
MIIST_W	MSF	AUS	indicated real engine torque
MILSOL_W	MSF	LOK	driver torque request for charge
MIMAX_W	MSF	LOK	maximum attainable indicated torque
MIMIN_W	MSF	LOK	Minimal engine torque
MIMSR_W	DASC	EIN	desired indicated torque from MSR
MINMX_W	MSF	LOK	indicated nominal torque for NMAX limiting
MIOPT_W	MSF	LOK	optimum indicated torque
MISOL_W	MSF	LOK	indicated resultant nominal torque
MISZUL_W	MSF	LOK	maximum permissible indicated torque
MITXU_W	CANTXU	EIN	Torque reduction request transmission control (CAN TXU message)
MIVMX_W	MSF	LOK	indicated nominal torque for VMAX control
MIZSOL_W	MSF	LOK	indicated resultant nominal torque for ignition angle intervention
MRFGR_W	MSF	LOK	relative torque demand from cruise control
MSTESOLL_W	MSF	AUS	desired purge mass flow
NMOT_W	BGNMOT	EIN	engine speed
REDIST	AEVAB	EIN	real cylinder cut-off step
RK2_W	MSF	AUS	relative fuel mass Bank2
RK_W	MSF	AUS	relative fuel mass
RL_W	EGFE	EIN	relative air charge (Word)
SZOUT	MSF	AUS	dwell time
VFGR_W	BGVFGR	EIN	cruise control vehicle speed
WDKS_W	MSF	AUS	desired throttle angle w.r.t. to lower mechanical stop
WPED_W	GGPED	EIN	normed angle acceleration pedal
ZWBAS	MSF	LOK	basic ignition angle
ZWIST	MSF	LOK	real ignition angle

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Variable	Source	Type	Description
ZWOPT	MSF	LOK	optimal ignition angle
ZWOUT	MSF	AUS	Ignition angle output value

FB MSF 9.10 Detailed description of function

The torque-based functional structure consists of a series of functions, which pose requests on the engine torque: Driver's request (MDFAW), minimum torque for start and idle control (MDMIN), exhaust gas/catalyst functions (AK), driving comfort functions such as anti-jerking (ARMD), external requirements of ASR, MSR coming in via CAN communication, transmission control and limiting functions for engine speed and driving speed (NMAXMD, VMAXMD).

The coordination of these requests takes place in the functions MDKOL for the air path and in MDKOG as total coordination. The chosen desired torques are converted to the setting variables throttle-valve position, injection period and ignition angle in the groups FE (charge interventions), GK (mixture check) and ZUE (ignition).

The function MDBAS makes available the basic variables of the torque model, such as e.g. optimum torque, optimum ignition angle and so on. MDIST calculates the actually set indicated torque.

APP MSF 9.10 Application hint

MDFAW 3.150 Calculation of vehicle-operator demand

FDEF MDFAW 3.150 Function definition

mdfaw-mdfaw

mdfaw-auswahl

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mdfaw-dmfabeg

Subfunction DMFABEG: torque requested by driver slope limitation

mdfaw-filsawe

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Subfunction FILSAWE: change limitation to or from fuel cut-off active

mdfaw-dashpot

Subfunction DASHPOT: change limitation of negative torque slope ("Dashpot")

mdfaw-lowra-dsh

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Subfunction DASHPOT-Daten: data selection by low range condition (B_lowra)

mdfaw-lsd

Subfunction LSD: change limitation of positive torque slope (Lastschlagdämpfung)

mdfaw-lowra-dat

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Subfunction LSD-Daten: data selction by low range condition

mdfaw-lowra-lsd

Subfunction LSD-Daten: data selction by low range of positive torque slope

mdfaw-lsd-on

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Subfunction LSD: condition of positive torque slope

mdfaw-pt2-fil

mdfaw-pt2-fil

Subfunction PT2_FIL: PT2-Filter

mdfaw-mi-to-mr

mdfaw-mi-to-mr

ABK MDFAW 3.150 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDMFAB			FW	code word software switch for slope limitation
DLSDHK			FW	Damping of PT2 filter in positive torque slope limitation for high clutch torque
DLSDHKLR			FW	Damping of PT2 in positive torque slope limitation for high clutch torque; Low e
DMDPUG	GANGI		KL	delta torque threshold end of dashpot
DMDPULRG	GANGI		KL	delta torque threshold end of dashpot, condition low range
DMIFSAWE			FW	threshold for resetting B_fil in case of mimin_w step
DMLSDUG	GANGI		KL	Delta torque for finishing positive slope limitation
DMLSDULR	GANGI		KL	Delta torque for finishing positive slope limitation in Low range
KDMLDOLR	GANGI	MKFANB_W	KF	Delta torque for starting positive slope limitation in Low range
KFDLSD	GANGI	NMOT_W	KF	Damping of PT2 filter in positive torque slope limitation
KFDLSDLR	GANGI	NMOT_W	KF	Damping of PT2 filter in positive torque slope limitation; Low range
KFDMDPLR	GANGI	MKFANB_W	KF	Delta torque for starting negative slope limitation, condition low range
KFDMDPO	GANGI	MKFANB_W	KF	Delta torque for starting negative slope limitation
KFDMLSDO	GANGI	MKFANB_W	KF	Delta torque for starting positive slope limitation
KFMILSD	GANGI	NMOT_W	KF	Initial value for positive torque slope limitation
KFMIMR	NMOT_W	MRFA_W	KF	Map for torque increase in the pedal overtravel
KFMRMI	NMOT_W	FMIL_W	KF	Map for torque increase in pedal overtravel relative in ind torque
KFPED	WPED_W	NMOT_W	KF	accelerator pedal characteristic
KFPEDU	WPED_W	NMOT_W	KF	accelerator pedal characteristic during low range
KFWPFGR	MRFGR_W	NMOT_W	KF	Inverse pedal characteristic for cruise mode
KFZDASH	GANGI	NMOT_W	KF	Time constant for negative torque slope limitation
KFZDSHLR	GANGI	NMOT_W	KF	Time constant for negative torque slope limitation in Low range
KFZLSD	GANGI	NMOT_W	KF	Time constant for positive torque slope limitation
KFZLSDLR	GANGI	NMOT_W	KF	Time constant for positive torque slope limitation in Low range

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Parameter	Source-X	Source-Y	Type	Description
KMILSDLR	GANGI	NMOT_W	KF	Initial value for positive torque slope limitation; Low range
MDIMX			FW	maximum limit indicated engine torque
MKLSDO			FW	Clutch torque threshold for switching parameters of positive slope limitation
MRFALLO			FW	Upper threshold of relative torque for idle detection
MRFALLU			FW	Lower threshold of relative torque for idle detection
MRFUEMXN	NMOT_W		KL	Characteristic for max. attainable driver-requested torque for pedal overtravel
NGFSAWE			FW	Threshold engine speed gradient for disabling filter for transition fuel cut-off
TDMFBSA			FW	Time constant PT1 filter for transition to fuel cut-off
TDMFBWE			FW	Time constant of PT1 filter for transition from fuel cut-off
TVFSAWE			FW	Time delay until resetting of B_fil
ZLSDHK			FW	Time constant PT2 filter of positive slope limitation for high clutch torque
ZLSDHKLR			FW	Time constant PT2 of positive slope limitation for high clutch torque; Low range

Variable	Source	Type	Description
B_AUTGET	CANEGS	EIN	condition automatic gearbox
B_DASH	MDFAW	AUS	condition: limitation of negative torque gradient active
B_DP	MDFAW	LOK	Condition: Start of negative torque slope limitation
B_EDP	MDFAW	LOK	Condition: activation of negative torque slope limitation possible
B_ELSD	MDFAW	LOK	Condition activation of positive torque slope limitation possible
B_FGR	MDFAW	AUS	condition: driver's set engine torque determined by cruise control
B_FGREN		EIN	condition: cruise control is active (enable)
B_FIL	MDFAW	LOK	condition: low pass filter for transition to or from fuel cut-off active
B_IFLSD	MDFAW	LOK	Condition : Initialisiation of Antijerking filter
B_KUPPL	GGEGAS	EIN	EGAS Condition cluch is disengaged
B_LL	MDFAW	AUS	Condition idle
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_LS	MDFAW	LOK	Condition: Start of positive torque slope limitation
B_LSD	MDFAW	LOK	condition: limitation of positive torque gradient active
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_SA	MDRED	EIN	Condition fuel cut-off
B_SAB	MSF	EIN	Condition fuel cut-off requested
B_SAVFGR		EIN	Condition: prohibited trailing throttle fuel cut-off by cruise control
B_STEND	BBSTT	EIN	condition end of start
B_VNULL	GGVFZG	EIN	condition vehicle at stillstand
B_WK	CANEGS	EIN	condition: converter lockup clutch closed
C_INI		EIN	ECU-condition for intialisation
DLSD_W	MDFAW	LOK	Damping of PT2 filter in positive torque slope limitation
DMDPO_W	MDFAW	LOK	delta torque start of dashpot
DMDPU_W	MDFAW	LOK	delta torque end of dashpot
DMLLRI_W	LLRRM	EIN	desired torque change from the idle speed control (I-)
DMLSDO_W	MDFAW	LOK	Delta torque for starting positive torque slope limitation
DMLSDU_W	MDFAW	LOK	Delta torque for finishing positive torque slope limitation
DMVERL_W	MDVER	EIN	Resistant torque after DT1-filter
FMIL_W	MDFAW	DOK	factor relative/indicated torque
GANGI	BBGANG	EIN	Engaged gear
IWFLSD_W	MDFAW	LOK	Initial value for filter in positive torque slope limitation
MDVERL_W	MDVER	EIN	Resistant torque of the engine
MIASRL_W	CANASR	EIN	desired indicated torque from ASR for slow intervention
MIBDP_W	MDFAW	LOK	desired indicated engine torque dashpot
MIBGR_W	MDIHGS	EIN	Indicated desired torque for gear-dependent limiting of the clutch torque
MIBLSD_W	MDFAW	LOK	Limited indicated torque of positive slope limitation
MIFA	MDFAW	AUS	desired indicated engine torque
MIFAL_W	MDFAW	AUS	Indicated driver's wish torque for torque coordination cylinder filling
MIFA_W	MDFAW	AUS	desired indicated engine torque
MIGEF_W	MDFAW	LOK	Filtered indicated torque for transition to or from fuel cut-off
MIGES_W	BGMIGS	EIN	desired indicated torque for transmission protection
MIIST_W	MSF	EIN	indicated real engine torque
MIL1_W	MDFAW	DOK	indicated torque from MINMAX selection
MIL2_W	MDFAW	DOK	indicated torque from MINMAX selection
MIMAX_W	MDMAX	EIN	maximum attainable indicated torque
MIMIN_W	MDMIN	EIN	Minimal engine torque
MIMS_W	MSMD	EIN	indicated torque for engine protection
MIMXL1_W	MDMAX	EIN	maximum optimal torque at lambda = 1
MINBEG_W	MDFAW	LOK	Indicated torque requested by driver after slope limitation
MINMX_W	NMAXMD	EIN	indicated nominal torque for NMAX limiting
MISZUL_W	MDZUL	EIN	maximum permissible indicated torque
MIVBEB_W	MDFAW	LOK	Indicated torque before slope limitation, limited to mimax_w
MIVBEG_W	MDFAW	LOK	Indicated torque requested by driver before slope limitation
MIVMX_W	VMAXMD	EIN	indicated nominal torque for VMAX control
MI_MR_W	MDFAW	DOK	indicated torque in relative torque
MKFANB_W	MDFAW	LOK	Clutch torque calculated from limited driver's request
MRFAMX_W	MDFAW	AUS	Relative torque request by driver maximum value
MRFAV_W	MDFAW	AUS	Relative torque request by driver without consideration of safety function
MRFA_W	MDFAW	LOK	relative driver request torque from cruise control and pedal, =0 in limp-home
MRFGR_W	FGRAUS	EIN	relative torque demand from cruise control
MRFUEMX_W	MDFAW	AUS	Max. attainable rel. driver-requested torque for pedal overtravel
MRFUE_W	MDFAW	AUS	Relative driver-requested torque in pedal overtravel
MRSTT_W	STMD	EIN	Relative starting torque
NGFIL_W	BGNG	EIN	filtered engine-speed gradient
NMOT_W	BGNMOT	EIN	engine speed
S_DP	MDFAW	LOK	Software switch negative slope limitation active

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Variable	Source	Type	Description
S_LS	MDFAW	LOK	Software switch positive slope limitation active
WPED_W	GGPED	EIN	normed angle acceleration pedal
WPFGR_W	MDFAW	AUS	Recalculated accelerator pedal position in cruise mode
ZDASH_W	MDFAW	LOK	time constant for dashpot
ZLSD_W	MDFAW	LOK	Time constant of filter in positive torque slope limitation

FB MDFAW 3.150 Detailed description of function

```
PT2_FIL
-------

Das PT2-Filter wird mit zwei Integratoren und Rückführungen gemäß Föllinger realisiert. Zusätzlich besteht die Möglichkeit, das
Filter mit einem bestimmten Wert zu initialisieren.
```

APP MDFAW 3.150 Application hint

```
Konfiguration über CWDMFAB
--------------------------

Bit 0    0:  Lastschlagdämpfung ausgeschaltet
         1:  Lastschlagdämpfung freigegeben

Bit 1    0:  Dashpot ausgeschaltet
         1:  Dashpot freigegeben

Bit 2    0:  Lastschlagdämpfung bei B_kuppl aktiv
         1:  Lastschlagdämpfung bei B_kuppl inaktiv

Bit 3    0:  Dashpot bei B_kuppl aktiv
         1:  Dashpot bei B_kuppl inaktiv

Bit 4    0:  SA/WE-Filter bei B_kuppl aktiv
         1:  SA/WE-Filter bei B_kuppl inaktiv

Bit 5    0:  B_ll unabhängig von B_savfgr
         1:  B_ll nur bei NOT B_savfgr

Wenn wdkugd und rlvmxn bei 95% der Maximalfüllung appliziert sind und KFPED bis 105% geht, könnte das Kennfeld KFMIMR
bei n=1000 1/min folgendermaßen appliziert sein:
mr_w    100     100.25  100.85  102.75  104.40  104.50
-------------------------------------------------------
FMIMR   100     103.00  104.50  104.75  104.75  105.00
```

BBVL 1.20 Operating Range Full Load

FDEF BBVL 1.20 Function definition

bbvl-bbvl

ABK BBVL 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
WDKVLN	NMOT		KL	Throttle valve angle threshold for full load detection

Variable	Source	Type	Description
B_DKUNB	GGDVE	EIN	condition: unknown throttle blade position
B_VL	BBVL	AUS	Condition for wide open throttle
NMOT	BGNMOT	EIN	engine speed
WDKBA	GGDVE	EIN	throttle angle

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FB BBVL 1.20 Detailed description of function

Das Bit Vollast wird in Abhängigkeit des Drosselklappenwinkels gebildet.
Bei erkanntem Fehler in %GGDVE mit B_dkunb = True (beide Poti sind unplausibel zu Ersatzsignal) wird B_vl = False.
Das System ist im Zustand Sicherheitskraftstoffabschaltung (SKA).

APP BBVL 1.20 Application hint

MDMAX 4.20 Calculation maximum torque

FDEF MDMAX 4.20 Function definition

mdmax-mdmax

ABK MDMAX 4.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FMIVL			FW	factor correction maximum torque full load
FRLVTM	TMOT		KL	correction volumetric flow with open throttle valve
KFMIOP	NMOT_W	RLUGD_W	KF	map optimum engine torque
RLVMXN	NMOT		KL	maximum volumetric flow with open throttle valve

Variable	Source	Type	Description
FHO_W	GGDSAS	EIN	correction factor: altitude
FTVDK	BGTEMPK	EIN	correction factor for temperature upstream of throttle valve
MIMAX_W	MDMAX	AUS	maximum attainable indicated torque
MIMXL1_W	MDMAX	AUS	maximum optimal torque at lambda = 1
MRFAMX_W	MDFAW	EIN	Relative torque request by driver maximum value
NMOT	BGNMOT	EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed
RLUGD_W	MDMAX	DOK	charge under unthrottled condition
TMOT	GGTFM	EIN	Engine temperature

FB MDMAX 4.20 Detailed description of function

APP MDMAX 4.20 Application hint

Determination of the characteristics RLVMXN and RLVSMXN: Measurement of rl at rpm map and open throttle valve. Conversion to corresponding rlv by division with the factors ftvdk and fpvdk_w (load detection must be already applied), entered in the corresponding characteristic. Application hint for characteristic KFMIOP, see %MDBAS.

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MDKOG 9.50 Coordination torque intervention

FDEF MDKOG 9.50 Function definition

mdkog-mdkog

Subfunction MDABWS: stalling protection

mdkog-mdabws

Subfunction BBMDEIN: condition of active torque intervention

mdkog-bbmdein

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Subfunction BBZWEIN: condition ignition angle intervention

mdkog-bbzwein

Subfunction MDBEG: condition torque limit

mdkog-mdbeg

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Subfunction ZWE : condition of fast external ignition angle intervention

mdkog-zwe

Subfunction ZWE by catalyst warming /-heating, TE-intervention :

mdkog-zwe-sub

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Subfunction MDBEG_DIAG: interface torque limitation and diagnosis

mdkog-mdbeg-diag

ABK MDKOG 9.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWMDKOG			FW	code word MDKOG: ignition timing adjusted to retard for limiting vacuum
CWTEZW			FW	code word: ignition angle intervention at test of canister-purge valve
CWZWE			FW	code word ignition-timing interventions active for MD structure
CWZWVMX			FW	code word: ignition-timing intervention for VMAX limiting
DMRKHO			FW	Upper hysteresis threshold of catalyst heating torque margin with ZW action
DMRKHU			FW	Lower hysteresis threshold of catalyst heating torque margin with ZW action
MDHYST			FW	Hysteresis for limitation of desired torque (monitoring concept, level 1)
MDIMX			FW	maximum limit indicated engine torque
NASNOT			FW	Speed threshold for ASR prohibited due to stalling protection
NKUPZWEO			FW	Upper engine speed hysteresis threshold for KUP-ZW actions
NKUPZWEU			FW	Lower engine speed hysteresis threshold for KUP-ZW actions
NLLZWEO			FW	Upper engine speed hysteresis threshold for LL-ZW actions
NLLZWEU			FW	Lower engine speed hysteresis threshold for LL-ZW actions
NLSDZWEO			FW	Upper engine speed hysteresis threshold for LSD-ZW actions
NLSDZWEU			FW	Lower engine speed hysteresis threshold for LSD-ZW actions
TMVER			FW	Debounce time: ETC torque limitation is activ for a longer time
TPNSMD			FW	Check time after end of start for diagnosis of torque limitation
VKUPZWEO			FW	Upper vfzg-hyteresis threshold for KUP-ZW actions
VKUPZWEU			FW	Lower vfzg-hyteresis threshold for KUP-ZW actions
VLLZWEO			FW	Upper vfzg-hyteresis threshold for LL-ZW actions
VLLZWEU			FW	Lower vfzg-hyteresis threshold for LL-ZW actions
VLSDZWEO			FW	Upper vfzg-hyteresis threshold for LSD-ZW actions
VLSDZWEU			FW	Lower vfzg-hyteresis threshold for LSD-ZW actions

Variable	Source	Type	Description
B_ALLZWE	MDKOG	LOK	Condition ignition timing by torque structure active (LL,DASH,LSD,KUP)
B_ASR	MDKOG	AUS	condition for ASR active
B_CLMDB		EIN	Flag for clearence: ETC torque limitation is activ
B_DASH	MDFAW	EIN	condition: limitation of negative torque gradient active
B_FIL		EIN	condition: low pass filter for transition to or from fuel cut-off active
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KHZWE	MDKOG	LOK	condition ignition angle during catalyst heating
B_KUPPL	GGEGAS	EIN	EGAS Condition cluch is disengaged
B_KW	BBKHZ	EIN	Condition catalyst warming
B_LL	MSF	EIN	Condition idle
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_LSD		EIN	condition: limitation of positive torque gradient active
B_MDEIN	MDKOG	AUS	Condition actions on the torque are active
B_MIBEG	MDKOG	AUS	condition torque limit active
B_MIBEGDAU	MDKOG	DOK	condition: ETC torque limitation is activ
B_MIZWE	MDKOG	LOK	condition adjusting ignition angle activ
B_MSR	MDKOG	AUS	Condition MSR
B_MXMDB	MDKOG	AUS	Fault type max.: ETC torque limitation is activ for a longer time
B_RLZWE	MDKOG	LOK	condition adjusting ignition angle because of torque intervention
B_STEND	BBSTT	EIN	condition end of start
B_ZWVS	MDKOG	AUS	condition for fast external ignition angle intervention of torque interface
B_ZWVZ	MDKOG	AUS	condition for ignition angle intervention of torque interface
C_FCMCLR		EIN	system state: reset fault memory

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Variable	Source	Type	Description
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DMAR_W	ARMD	EIN	delta torque anti-jerk
DMLLRZ_W	LLRRM	EIN	Demanded torque change of the LLR (PD-ignition part)
DMRKH	KHMD	EIN	torque reserve for catalyzer heating
DMRKT_W	MDTRIP	EIN	Torque reserve during quicktest
DMZMS_W	MDKOG	AUS	difference between internal nominal engine torque and permissible nominal torque
E_MDB	MDKOG	AUS	error flag: ETC torque limitation is active
MIASRL_W	CANASR	EIN	desired indicated torque from ASR for slow intervention
MIASRS_W	CANASR	EIN	desired indicated torque from ASR for quick intervention
MIBAS_W	MDBAS	EIN	indicated basic torque
MIBEG_W	MDKOG	LOK	limit torque
MIBGR_W	MDIHGS	EIN	Indicated desired torque for gear-dependent limiting of the clutch torque
MIEXTV_W	MDKOG	LOK	externally requested torque before stall protection
MIEXT_W	MDKOG	LOK	desired indicated torque outside (from ASR, GS, etc.)
MIFAB_W	MDKOG	AUS	limited desired indicated engine torque
MIFA_W	MDFAW	EIN	desired indicated engine torque
MIGS_W	BGMIGS	EIN	desired indicated torque form GS for quick intervention
MILRES_W		EIN	torque request for air path including all torque reserves
MIMAX_W	MDMAX	EIN	maximum attainable indicated torque
MIMSR_W	DASC	EIN	desired indicated torque from MSR
MINMX_W	NMAXMD	EIN	indicated nominal torque for NMAX limiting
MISOLV_W	MDKOG	LOK	indicated resultant nominal torque before torque limitation
MISOL_W		EIN	indicated resultant nominal torque
MISZUL_W	MDZUL	EIN	maximum permissible indicated torque
MITEBG_W	TEB	EIN	torque value for minimum charge canister purge
MIVMX_W	VMAXMD	EIN	indicated nominal torque for VMAX control
MIZSOLV_W	MDKOG	LOK	ind. torque for an ignition timing intervention before torque limiting
MIZSOL_W	MDKOG	AUS	indicated resultant nominal torque for ignition angle intervention
NMOT	BGNMOT	EIN	engine speed
RLMIN_W		EIN	minimum permissible rl
RLSOL_W	MDFUE	EIN	desired relative air charge
VFZG	GGVFZG	EIN	vehicle speed (km/h)
Z_MDB	MDKOG	AUS	Cycle flag: ETC torque limitation is active

FB MDKOG 9.50 Detailed description of function

APP MDKOG 9.50 Application hint

```
Typischer Wert:

MDIMX = 99.6%;
NASNOT = 800 U/min;
Die Drehzahl-Schwelle NASNOT darf nicht größer als 2550 U/min sein.
```

BGMDLM 1.70 Calculated variable: engine torque with torque interventions

FDEF BGMDLM 1.70 Function definition

bgmdlm-bgmdlm

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No text for FDEF available!
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ABK BGMDLM 1.70 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWZWVMX			FW	code word: ignition-timing intervention for VMAX limiting
REDMX			FW	maximal step number for disabled injectors (f.e. =2*number of cylinder)

Variable	Source	Type	Description
B_ALLZWE		EIN	Condition ignition timing by torque structure active (LL,DASH,LSD,KUP)
B_DASH	MDFAW	EIN	condition: limitation of negative torque gradient active
B_FIL		EIN	condition: low pass filter for transition to or from fuel cut-off active
B_INTZWV	BGMDLM	DOK	condition ignition-timing adjustment by MD structure active
B_MIEXT	BGMDLM	AUS	condition: external torque intervention
B_MSR	MDKOG	EIN	Condition MSR
DMAR_W	ARMD	EIN	delta torque anti-jerk
DMLLR_W	LLRRM	EIN	desired torque change from the idle speed control (PD-)
DMRKT_W	MDTRIP	EIN	Torque reserve during quicktest
ETAZABAS	BGMDLM	DOK	Actual cylinder cutout efficiency (without external deactivation request)
MDINDLM	BGMDLM	AUS	indicated real engine torque; egs interface
MIBAS_W	MDBAS	EIN	indicated basic torque
MIBGR_W	MDIHGS	EIN	Indicated desired torque for gear-dependent limiting of the clutch torque
MIEXT_W		EIN	desired indicated torque outside (from ASR, GS, etc.)
MIFA_W	MDFAW	EIN	desired indicated engine torque
MIINT1_W	BGMDLM	AUS	calculated indicated torque; with AR, LLR, MDBEG
MIINT2_W	BGMDLM	AUS	calculated indicated torque; mizwmn limitation
MIINT3_W	BGMDLM	AUS	calculated indicated torque; mibas, miszul limitation
MIINTV_W	BGMDLM	AUS	calculated indicated torque; without AR, LLR, MDBEG
MIINT_W	BGMDLM	AUS	calculated indicated torque
MIIST_W	MSF	EIN	indicated real engine torque
MIMS_W	MSMD	EIN	indicated torque for engine protection
MINMX_W	NMAXMD	EIN	indicated nominal torque for NMAX limiting
MISZUL_W	MDZUL	EIN	maximum permissible indicated torque
MIVMX_W	VMAXMD	EIN	indicated nominal torque for VMAX control
MIZSOL_W	MDKOG	EIN	indicated resultant nominal torque for ignition angle intervention
MIZWMN_W		EIN	indicated engine torque at the latest spark angle
REDBAS	AEVAB	EIN	Base cut-off step

FB BGMDLM 1.70 Detailed description of function

APP BGMDLM 1.70 Application hint

MDZUL 4.10 Calculation of maximum permitted set torque

FDEF MDZUL 4.10 Function definition

mdzul-mdzul

mdzul-mdzul

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mdzul-nsc

ABK MDZUL 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMIZUFIL	WPED	NMOT	KF	Maximum permitted indicated set torque for torque limitation before Filter
KFMIZUNS	WPED	NMOT	KF	Authorized torque for post-start torque increase
KFMIZUOF	MIZUVFIL	NMOT	KF	Maximum permitted indicated set torque for torque limitation
MDIMX			FW	maximum limit indicated engine torque
NSTART			FW	engine speed limit for low engine speed exit (for post-start torque increase)
NSTEND			FW	engine speed limit for start end (for post-start torque increase)
TANSMN			FW	intake air temperature limit (for post-start torque increase)
TFMIZU			FW	Time constant of low pass filter for permitted set torque
TMNSMN			FW	engine temperature limit (for post-start torque increase)
TNSC			FW	post-start monitoring time
TNSOF			FW	debounce time for turning off the post-start torque increase

Variable	Source	Type	Description
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_MSR	MDKOG	EIN	Condition MSR
B_MZNS	MDZUL	LOK	Post-start torque increase is active
B_MZNS_UM	UFNSC	EIN	afterstart torque increase of ETC-monitoring is active
B_NSAKT	MDZUL	LOK	post-start is active (for post-start torque increase)
B_NSEND	MDZUL	LOK	post-start monitoring time is over (for post-start torque increase)
C_INI		EIN	ECU-condition for intialisation
MISZUL_W	MDZUL	AUS	maximum permissible indicated torque
MIZUFIL_W	MDZUL	LOK	Indicated torque after filtering allowed
MIZUOFIL	MDZUL	LOK	Indicated torque without filtering
MIZUVFIL	MDZUL	LOK	Indicated torque before filtering
NMOT	BGNMOT	EIN	engine speed
TANS	GGTFA	EIN	Intake air temperature
TMOT	GGTFM	EIN	Engine temperature
WPED	GGPED	EIN	Standardized accelerator pedal angle

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FB MDZUL 4.10 Detailed description of function

This function calculates a maximum indicated torque miszul_w. This torque is used in the functions %mdkol and %mdkog of the torque coordination to limit the desired torque. Limiting the desired torque shall prevent an unjustified triggering of level 2 of the monitoring concept. In level 2 of the monitoring concept (overview section ufue) a roughly calculated actual torque is compared with a maximum permitted actual torque. A desired torque from the torque coordination, which is calculated too large would lead to a too large actual torque with a response of the actual torque monitoring in level 2.

The calculation of the maximum permitted desired torque miszul_w in the function %mdzul can be described in detail as follows:
The maximum torque request of the pedal, which is permitted at a certain engine speed is stored in two maps (KFMIZU = f(nmot, mizuvfil), KFMIZUFIL = f(nmot, wped)). In the process also an offset is taken into consideration, which comes from other torque-increasing functions, which will not be discussed in detail here (e.g. idle control).
The sum of the two maps (referred to as sum map of level 1 in the following) results in the permitted desired torque. In order to avoid an unjustified limiting of the desired torque (which is e.g. increased due to the dashpot function) in case of quick setpoint changes (due to negative pedal angle gradient) the value obtained from map KFMIZUFIL is filtered in a low pass. This filter, however, is only active in case of a negative gradient of the value obtained from the map.

By the distribution of the permitted torque in conjunction with the filter the following filter effect is obtained:
"- If the pedal value decreases at constant engine speed, then the change of the permitted torque resulting from this must be" filtered, since the reduction of the desired torque is also filtered.
"- If the engine speed increases at a pedal value of 0 (e.g. due to a fault in the torque coordination) then the decrease of" the permitted desired torque resulting from this may not be filtered, so that the actual torque does not increase further due to the reduction of the desired torque.

An after-start extension is performed in level 2 of the torque monitoring in dependency on the engine temperature and on the intake air temperature. The condition for the after-start extension is calculated there in the function %UFNSC. The actual after-start extension is performed in the function %UFMZUL. Level 1 may only perform an after-start extension (subfunction NSC) if an after-start extension is also performed in level 2.
This must be ensured by the entering of data.

APP MDZUL 4.10 Application hint

Starting point for the entering of data into the two maps is the permitted torque in dependency on pedal angle and engine speed. This maximum permitted torque (sum map of level 1) results among other from the idle demand and from the pedal map.

A complete deactivation of the function can be performed by the map KFMIZU (KFMIZU = 99,6% for all base points). A deactivation of the after-start extension can take place by entering data into the map KFMIZUNS. In the process the same data are entered into the map KFMIZUNS as into the map KFMIZUFIL. The value -48 C must be entered for the temperature thresholds TMNSMN and TANSMN. A deactivation of the function %mdzul with active torque monitoring can lead to a response of the torque monitoring (%ufmzul) in level 2 with the fault reaction safety fuel switch-off.

The counts of TNSOF and TNSC can be looked at in VS100 under tnsofCtr and tnscCtr.

While the offset was so far stored dependent on engine speed and pedal setpoint (KFMIZU) it is now stored dependent on permitted torque and engine speed (KFMIZUOF). The entered data can be changed as follows:
For a fixed engine speed and a fixed pedal setpoint an offset torque is obtained from the map KFMIZU. This offset is now entered into the map KFMDZOF for the corresponding engine speed base point and the torque base point, which results from the map KFMIUFIL (with same engine speed and same pedal angle).

KFMIZU:

The map KFMIZUOF is adjusted in the function %ufmzul following the map KFMDZOF_UM.

KFMIZUFIL:

The map KFMIZUFIL is adjusted in the function %ufmzul following the map KFMPED_UM.

The most important part of this map lies at an accelerator position of 0 and at an engine speed above 1000 rpm.

TFMIZU:

This filter shall take into consideration torque-increasing functions, e.g. dashpot.
The filter time constant of this filter lies between 100 ms and 2 seconds (slow filter). It is to be tuned to the filter in the torque monitoring (section ufmzf). A filter time constant of 0,3s has so far proved to be worthwhile.

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MDKOL 3.10 Coordination torque intervention air path

FDEF MDKOL 3.10 Function definition

mdkol-mdkol

ABK MDKOL 3.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
MDIMX			FW	maximum limit indicated engine torque
NASNOT			FW	Speed threshold for ASR prohibited due to stalling protection

Variable	Source	Type	Description
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_MIBEG	MDKOG	EIN	condition torque limit active
DMLLLMN_W	LLRMR	EIN	Reserve torque threshold for action on the air
DMLLR_W	LLRRM	EIN	desired torque change from the idle speed control (PD-)
DMRKH	KHMD	EIN	torque reserve for catalyzer heating
DMRKT_W	MDTRIP	EIN	Torque reserve during quicktest
DMRLLR	LLRMD	EIN	Torque reserve for idle speed control
ETAZWBM	MDBAS	EIN	mean ignition angle effectiveness of basic ignition angle
ETAZWMN	ZWMIN	EIN	minimum ignition angle effectiveness
MIASRL_W	CANASR	EIN	desired indicated torque from ASR for slow intervention
MIBGR_W	MDIHGS	EIN	Indicated desired torque for gear-dependent limiting of the clutch torque
MIFAFU_W	MDKOL	DOK	driver torque request for charge
MIFAL_W	MDFAW	EIN	Indicated driver's wish torque for torque coordination cylinder filling
MIFA_W	MDFAW	EIN	desired indicated engine torque
MIGES_W	BGMIGS	EIN	desired indicated torque for transmission protection
MILRES_W	MDKOL	DOK	torque request for air path including all torque reserves
MILSOL_W	MDKOL	AUS	driver torque request for charge
MIMSR_W	DASC	EIN	desired indicated torque from MSR
MIMS_W	MSMD	EIN	indicated torque for engine protection
MINMX_W	NMAXMD	EIN	indicated nominal torque for NMAX limiting
MISZUL_W	MDZUL	EIN	maximum permissible indicated torque
MITEBG_W	TEB	EIN	torque value for minimum charge canister purge
MIVMX_W	VMAXMD	EIN	indicated nominal torque for VMAX control
NMOT	BGNMOT	EIN	engine speed
VSDMR	VS_VERST	EIN	adjustable torque reserve via VSxy

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FB MDKOL 3.10 Detailed description of function

1. Calculation of increased air request milres, mechanism of torque reserve

The maximum torque reserve from catalyst heating, idle speed control and short trip is added to the driver air request mifal. Further increase is for application purpose is possible via VSxy by the interface vsdmr. Another minimal air request is given by mitebg of the tank ventilation. The resulting air request with all torque reserves is milres.
This increase of the charge torque automatically retards the ignition angle, since the driver request mifa can only be adjusted by retarding the ignition under an increased charge. The torque reserve always applies to the optimum ignition angle and not to the basic ignition angle, in order to allow non-ambiguous adjustment of the operating point.

2. Calculation of resulting driver air request mifafu concerning torque reserve and limits of efficiency

First the torque of the idle speed controller dmllr is added to the driver torque. The increased driver torque milres is limited to the torque that provides the minimum permissible ignition angle efficiency etazwmn. The value is then multiplied by the basic efficiency in order to arrive at the same reference point as the rest of the coordination torques. If the torque reserve is greater than the required torque because of the basic effectiveness, then the former is selected (taking the maximum between the driver request and the driver request with torque reserve). Result is the drivers torque request for the engine load mifafu.

3. Actual torque coordination

Maximum selection with torque request mimsr from MSR, then minimum selection with the torque of the rpm limiter minmx, the torque of the speed limiter mivmx, the torque from ASR and and the torque request in case of transmission protection or torque in case of overheated engine protection.
The last three torques are only considered in case of excceding a low engine speed to prevent engine stalling.

In case of limiting the torque by the safty concept (Level 1), the torque ist limited to miszul_w.

MDIST 10.2 Engine torque calculation

FDEF MDIST 10.2 Function definition

mdist-mdist

ABK MDIST 10.2 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ETADZW	DZWI		KL	ignition efficiency depending on delta ignition angle
REDMX			FW	maximal step number for disabled injectors (f.e. =2*number of cylinder)

Variable	Source	Type	Description
DZWI	MDIST	LOK	difference ignition angle (between zwopt and zwout)
ETAZAIST	MDIST	AUS	actual cylinder masking effectiveness
ETAZWIST	MDIST	AUS	actual ignition angle effectiveness
MDINDG_W	MDIST	LOK	indicated torque in the case of all cylinders firing
MIIST_W	MDIST	AUS	indicated real engine torque
MIOPT_W	MDBAS	EIN	optimum indicated torque
REDIST	AEVAB	EIN	real cylinder cut-off step
ZWIST	ZUE	EIN	real ignition angle
ZWOPT	MDBAS	EIN	optimal ignition angle

FB MDIST 10.2 Detailed description of function

This function supplies an indicated actual torque for all operating states of the engine.
From the difference dzwi between the optimum ignition angle zwopt and the actual ignition angle zwist the actual ignition-angle efficiency etazwist results over the ignition-angle efficiency characteristic ETADZW. The indicated engine torque miopt_w, at given Lambda and optimum ignition angle, is multiplied by the actual ignition-angle efficiency etazwist. The indicated actual engine torque miist_w is the indicated engine torque mdindg_w, which is reduced share-wise by the cut-out cylinders.

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APP MDIST 10.2 Application hint

Due to the multiple use of the parameter ETADZW in the functional extent, the working point indication in application aids is of no use for this table. The working point must be determined by a separate indication of the input dzwi.

MDBAS 4.30 Basic calculation for torque interface

FDEF MDBAS 4.30 Function definition

mdbas-mdbas

ABK MDBAS 4.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DZWNWSUE	WNWUE		KL	Delta ignition angle dependent on the camshaft overlap
DZWOAGR	AGRR		KL	AGR-rate-dependent offset of optimum ignition angle
DZWOLA	LAMBAS		KL	Lambda dependency of optimum ignition angle referred to Lambda 1
DZWOM	TMOT		KL	temperature-dependent offset of optimum ignition angle
ETADZW	DZWB		KL	ignition efficiency depending on delta ignition angle
ETALAM	LAMBAS		KL	Lambda effectiveness
KFMIOP	NMOT_W	RL_W	KF	map optimum engine torque
KFZWOP	NMOT_W	RL_W	KF	optimum ignition angle
KFZWOP2	NMOT_W	RL_W	KF	Optimum ignition angle, variant 2

Variable	Source	Type	Description
AGRR	BGSRM	EIN	exhaust gas recirculation rate
DZWOAG	MDBAS	AUS	exhaust recirculation rate-dependent correction of optimum ignition angle
DZWOL	MDBAS	AUS	Lambda-dependent correction of optimum ignition angle
DZWOTM	MDBAS	LOK	temperature-dependent correction of optimum ignition angle
ETALAB	MDBAS	AUS	Lambda effectiveness without intervention w.r.t. to optimum torque at Lambda=1
ETATRMN	MDBAS	AUS	minimum value in effectiveness drum
ETAZWB	MDBAS	AUS	ignition angle effectiveness of basic ignition angle
ETAZWBM	MDBAS	AUS	mean ignition angle effectiveness of basic ignition angle
FNWUE	WNWEIN	EIN	Weighting factor camshaft overlap
LAMBAS	LAMKO	EIN	basic Lambda
MIBAS_W	MDBAS	AUS	indicated basic torque
MIOPTL1_W	MDBAS	LOK	optimal torque at lambda = 1
MIOPT_W	MDBAS	AUS	optimum indicated torque
NMOT_W	BGNMOT	EIN	engine speed
RL_W	EGFE	EIN	relative air charge (Word)
R_SYN		EIN	Synchro schedule
SY_NWS	PROKON	EIN	system constant camshaft control: none, 2 point or continuous
TMOT	GGTFM	EIN	Engine temperature
WNWUE		EIN	camshaft overlap angle of inlet and outlet valve opening
ZWBAS	ZUE	EIN	basic ignition angle
ZWOPT	MDBAS	AUS	optimal ignition angle
ZWOPTL1	MDBAS	LOK	optimal ignition angle at lambda=1

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FB MDBAS 4.30 Detailed description of function

Calculation of the optimum torque mioptl1 at Lambda=1 with the aid of the map KFMIOP. Correction of this torque by the Lambda influence via multiplication by the Lambda effectiveness etalab. The Lambda effectiveness is calculated from the curve ETALAM. Multiplication by the ignition angle effectiveness gives the basic torque mibas. This corresponds to the indexed torque that stabilises if combustion occurs with the basic Lambda lambas and the basic ignition angle zwbas. Calculation of the optimum ignition angle via the map KFZWOP for Lambda=1. Additive corrections depending on Lambda, the exhaust recirculation rate agrr and the engine temperature, are included. The ignition angle zwopt thus obtained now forms the basis for calculation of the ignition angle effectiveness. The basic ignition angle effectiveness is calculated with the curve ETADZW, and the input variable is formed from the difference between zwopt and zwbas. The basic effectiveness values are then averaged over all cylinders to produce the basic effectiveness etazwbm.

APP MDBAS 4.30 Application hint

Exhaust recirculation inactive for all measurements!

The following measurements must be performed:

1. Lambda=1 operation:
Ignition angle loops on engine test stand at Lambda=1 at the following points with warm engine:
n=500,750,1000,1250,1500,2000,2500,3000,3500,4000,4500,5000,5500,6000,6500 (if possible) rpm
rl=10,20,30,40,50,60,70,80,90,100 %
The ignition angle loops start at the angle at which the maximum torque is obtained (if not driveable at the knock limit).
Ignition is now retarded in steps of 4.5 degrees CA until the latest possible ignition angle is reached.
The following data should be recorded for each measuring point: nmot, rl, lambda, clutch torque, ignition angle.

2. Lambda dependency
Ignition angle loops over lambda at measuring points:
n = 1000, 2000, 3000 rpm
rl= 30, 50, 70 %
Lambda= .8,.85,.9,.95,1,1.05,1.1,1.15,1.2
Measurements as above

3. Friction torque
The friction torque must be present for all measurements under 1. Measurement on test stand, engine off but warm.

4. Evaluation
Measurement results evaluated by K3/ESY4-Hes or -Zg.

MDMIN 5.10 Minimum engine torque coordination

FDEF MDMIN 5.10 Function definition

mdmin-mdmin

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ABK MDMIN 5.10 Abbreviations

Variable	Source	Type	Description
B_LL	MSF	EIN	Condition idle
B_LLREIN	MDMIN	LOK	Condition idle speed control is active
B_SAB	MDMIN	LOK	Condition fuel cut-off requested
DMLLRI_W	MDMIN	LOK	desired torque change from the idle speed control (I-)
DMLLR_W	MDMIN	AUS	desired torque change from the idle speed control (PD-)
DMRLLR_W	MDMIN	AUS	torque reserve for idle speed control
DMVAD_W	MDMIN	LOK	Delta resistant torque from resistant torque adaptation
DMVERL_W	MDMIN	AUS	Resistant torque after DT1-filter
FNSTAB_W	MDMIN	LOK	Factor for speed stabilization
MDVERB	MDMIN	LOK	Torque request of the accessories
MDVERF_W	MDMIN	LOK	Filtered charge torque
MDVERL_W	MDMIN	AUS	Resistant torque of the engine
MDWAN_W	MDMIN	LOK	Torque request of the torque converter
MILL_W	MDMIN	LOK	Indicated engine torque at idle
MIMIN_W	MDMIN	AUS	Minimal engine torque
MISTT	MDMIN	LOK	Starting torque
NMOT	BGNMOT	EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed
NSOL	MDMIN	LOK	idle reference speed
NSTAT	MDMIN	LOK	Stationary reference speed

FB MDMIN 5.10 Detailed description of function

During the readiness for fuel cutoff the torque 0 to be indicated at the minimum is outputted. Otherwise the torque to be indicated at the minimum is taken from a maximum selection. So as to achieve a self-stabilization the sum from mdverl_w and mdwan_w is weighted with the quotient nsol/nmotll. After the initialization the sum is weighted with 1 until the actual engine speed nmotll has reached the desired engine speed nsol (MDNSTAB).

APP MDMIN 5.10 Application hint

MDVERB 2.0 Torque demand by auxiliary systems (e.g. air conditioner, misc. consumers)

FDEF MDVERB 2.0 Function definition

mdverb-mdverb

ABK MDVERB 2.0 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DMDKOE	NMOT		KL	Start value of torque filter when AC is swiched on
KFMDKO	NMOT	KOPWM	KF	map for torque needed for air condition
KFMDKOG	NMOT	MDKOG	KF	map for torque needed for controlled air condition
MDSL			FW	Torque request of the power steering
ZKMDKO			FW	time constant A/C compressor-load decreasing

Variable	Source	Type	Description
B_ACRES	KOS	EIN	Condition for increasing the torque reserve by AC-stand-by
B_KOE	KOS	EIN	Condition for AC-compressor ON
B_KOGER	CANINS	EIN	Condition closed loop/open loop controlled A/C-compressor
B_SL		EIN	Condition power steering
DMRAC	MDVERB	AUS	Torque reserve for AC-compressor

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Variable	Source	Type	Description
KOPWM		EIN	air-condition information as PWM
MDKO	MDVERB	AUS	torque needed for air condition
MDKOG	CANINS	EIN	torque needed for air condition
MDVERB	MDVERB	AUS	Torque request of the accessories
NMOT	BGNMOT	EIN	engine speed

FB MDVERB 2.0 Detailed description of function

Torque demand of the Air-conditioner Compressor

The torque demand of the air-conditioner compressor is composed of the steady-state torque demand, which is formed from the map KFMDKO dependent on the engine speed nmot and the PWM signal kopwm, or from the map KFMDKOG for controlled compressor and of the dynamic component DMDKOE+KFMDKO*, which covers the additional torque demand when the air-conditioner compressor starts.

When the air-conditioner compressor is switched on the torque demand mdko = DMDKOE+KFMDKO* is outputted. This additional demand is filtered to the steady-state demand mdko = KFMDKO* with the time constant ZKMDKO. When the air-conditioner compressor is switched off, mdko = 0 is set.

The start-up torque of the air-conditioner compressor is simultaneously that torque, which is preset as torque margin. It is made available to the function LLRMR in form of dmrac.

Via the bit B_koger a selection is made, whether the pilot control of the steady-state torque is calculated from the map KFMDKO or KFMDKOG.

APP MDVERB 2.0 Application hint

MDVER 1.30 Loss in engine torque

FDEF MDVER 1.30 Function definition

mdver-mdver

mdver-mdver

ABK MDVER 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CNFMDVER			FW	Codeword to configure the function MDVER
DMDNSM	TMOT		KL	Torque offset for after cranking compensation
KFMDS	NMOT_W	RL_W	KF	map for engine drag torque
MDSM	TMOT		KL	temperatuer share of enginie friction torque
ZFMDVERL			FW	Time constant for filtering the resistant torque
ZMDNS			FW	time constant for decay of torque offset after cranking

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Variable	Source	Type	Description
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_SA	MDRED	EIN	Condition fuel cut-off
C_INI		EIN	ECU-condition for intialisation
DMVAD_W	MDVERAD	EIN	Delta resistant torque from resistant torque adaptation
DMVERL_W	MDVER	AUS	Resistant torque after DT1-filter
MDS_W	MDVER	DOK	engine drag torque
MDVERB	MDVERB	EIN	Torque request of the accessories
MDVERF_W	MDVER	AUS	Filtered charge torque
MDVERL_W	MDVER	AUS	Resistant torque of the engine
MDWAN_W	MDWAN	EIN	Torque request of the torque converter
NMOT_W	BGNMOT	EIN	engine speed
RL_W	EGFE	EIN	relative air charge (Word)
TMOT	GGTFM	EIN	Engine temperature

FB MDVER 1.30 Detailed description of function

The calculated engine resistant torque mdverl_w is the sum of the engine load torque mds, the adapted resistant torque dmvad_w and the torque request of the accessories mdverb.
The engine load torque mds is calculated from the load torque KFMDS depending of nmot and the relative cylinder filling rl and the engine coolant temperatur depending torque MDSM.
To compensate the higher resistant torque of the engine immediatly after engine start, an additional torque DMDNSM depending of temperature is taken into account. This additional torque ist reduced to zero by a filter with the time constant ZMDNS, beginning when B_llrein becomes equal to 1.
The for the clalculation of the driver’s wish needed change of dmverl_w includes mdverl_w and the converter torque mdwan_w.
The change is calculated in an hight-pass filter.

APP MDVER 1.30 Application hint

Calibration of KFMDS: KFMDS represents the resistant torque of the non-burning engine. It will be measured on a engine dyno where the engine can be crancked. The engine oil temperature mus be at least 80 °C. For several engine speed and load points note the resistant torque of the engine. This map ist automatically determined when the enigne caracteristic maps are determinated.

Calibration of MDSM: MDSM contains the temperature effects on the engine resistant torque. The main effect is the change of oil viscosity with temperature. The determination of the temeprature effects is done in the climatic chamber. Different engine warm-up with start temperature as low as possible are done with a constant engine speed. For different temperatures, the necessary engine torque mimin is measures. For a fully warmed up engine the value of mimin is equal to the corresponding map value of KFMDS. For lower temperatures the difference of mimin to the KFMDS-value is the temperature correction MDSM. It is important to have a mean value for DMSM measured on different engines with different oil qualities (old or new oil, viscosity range of the oil, ...) and different engine speeds. The values immediatly after the start should be ignored because the oil molecules polymerise when oil remains quiet at a constant temperature. Therefore the viscosity is higher immediatly after the engine start. While the engine is running, the oil will be depolymerised mechanically until it reaches his normal viscosity. Therefore a specific torque correction after start is necessary.

Calibration of DMDNSM: DMDNSM is the additional correction on the engine torque immediatly after the engine start. The oil is pumped trough the engine an depolymerises because of the mechanical efforts. The viscosity of the oil decreases towards it’s normal value.

Calibration of ZMDNS: With this time constant the torque correction DMDNSM is decreased towards zero after the engine start. To calibrate this time constant, observe for several engine starts the behaviour of the idle speed controller. In time the controller should not do any corrections but immediatly after the start there are corrections which should be done by the precontrol MDNSM and not by the controller. Therefore ajust the time constant ZMDNS to have no correction by the controller after engine start.

Calibration of ZFMDVERL: To avoid quick changes of the accelerator pedal caracteristic the minimal engine torque mimin mus be filtered. With the filter time constant ZFMDVERL the change of mimin is determined.

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MDVERAD 5.40 Adaptation of torque loss

FDEF MDVERAD 5.40 Function definition

mdverad-mdverad

Overview of the demand adaptation: The demand adaptation is divided into 4 ranges:
MADLL : Operation without air-conditioning compressor and without engaged drive driving position
MADKO : Operation with air-conditioning compressor and without engaged driving position
MADFS : Operation without air-conditioning compressor and with engaged driving position
MADFK : Operation with air-conditioning compressor and with engaged driving position

The choice of the current range is made in the BBLLRAD

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mdverad-bbllrad

BBLLRAD: Determination of the operating range and enabling of the adaptation in these ranges

mdverad-madll

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DMADLL :Adaptation for operation without air-conditioning system and without engaged driving position

mdverad-madko

DMADKO :Adaptation for operation with air-conditioning system and without engaged driving position

mdverad-madfs

DMADFS :Adaptation for operation without air-conditioning system and with engaged driving position

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mdverad-madfk

DMADFK :Adaptation for operation with air-conditioning system and with engaged driving position

ABK MDVERAD 5.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DMADFK			FW	maximum adaptable change of resistant torque during one idle cycle AT-drvie + AC
DMADFS			FW	maximum adaptable change of resistant torque during one idle cycle AT in drive
DMADKO			FW	maximum adaptable change of resistant torque during one idle cycle compressor on
DMADLL			FW	maximum adaptable change of resistant torque during one idle cycle loadless
DMADMNFK			FW	lower limit for torque adaptation At in drive + AC compressor on
DMADMNFS			FW	lower limit for torque adaptation At in drive
DMADMNKO			FW	lower limit for torque adaptation AC compressor on
DMADMNLL			FW	lower limit for torque adaptation loadless
DMADMXFK			FW	upper limit for torque adaptation AT in drive + AC compressor on
DMADMXFS			FW	upper limit for torque adaptation AT in drive
DMADMXKO			FW	upper limit for torque adaptation AC compresssor on
DMADMXLL			FW	upper limit for torque adaptation loadless
DMOFK			FW	LLR adaptation offset at FK
DMOFS			FW	LLR adaptation offset at FS
DMOKO			FW	LLR adaptation offset at KO
DMOLL			FW	LLR adaptation offset at LL
TMDMAD			FW	Engine temperature threshold to enable adaptation of resistant torque
TWDMAD			FW	Waiting time to enable adaptation of resistant torque
ZKDMADFK			FW	time constant for torque adaptation AT in drive and AC compressor on
ZKDMADFS			FW	time constant for torque adaptation AT in drive
ZKDMADKO			FW	time constant for torque adaptation AC compressor on
ZKDMADLL			FW	time constant for torque adaptation loadless

Variable	Source	Type	Description
B_ADWFK	MDVERAD	LOK	condition to use adaptation value for AT in drive and AC compressor on
B_ADWFS	MDVERAD	LOK	condition to use adaptation value for AT in drive
B_ADWKO	MDVERAD	LOK	condition to use adaptation value for AC compressor on
B_DKNOLU	SREAKT	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SREAKT	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_EEV	DEVE	EIN	condition injector fault (power stage)
B_EVLOC	AEVAB	EIN	Status: all injection valves are activated
B_FS	CANEGS	EIN	Condition driving state (automatic gear box)
B_KOE	KOS	EIN	Condition for AC-compressor ON
B_LLR	LLRBB	EIN	condition idle speed control
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_MADFK	MDVERAD	LOK	condition for torque adaptation AT in drive and AC compressor on
B_MADFS	MDVERAD	LOK	condition for torque adaptation AT in drive
B_MADKO	MDVERAD	LOK	condition for torque adaptation AC-compressor on
B_MADLL	MDVERAD	LOK	condition for torque adaptation loadless
B_MADSTP	MDVERAD	LOK	condition for torque adaptation stopped

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Variable	Source	Type	Description
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_VLLR	LLRBB	EIN	Condition vehicle is moving with engaged gear
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DMLLRI_W	LLRRM	EIN	desired torque change from the idle speed control (I-)
DMVADFK_W	MDVERAD	LOK	Delta resistant torque from resistant torque adaptation(B_fs=1 & B_ko=1)
DMVADFS_W	MDVERAD	LOK	Delta resistant torque from resistant torque adaptation(B_fs=1)
DMVADKO_W	MDVERAD	LOK	Delta resistant torque from resistant torque adaptation(B_ko=1)
DMVADLL_W	MDVERAD	LOK	Delta resistant torque from resistant torque adaptation(B_ll=1)
DMVAD_W	MDVERAD	AUS	Delta resistant torque from resistant torque adaptation
DMVAMNFK_W	MDVERAD	DOK	Lower limit of resistant torque adaptation (B_fs=1 & B_ko=1)
DMVAMNFS_W	MDVERAD	DOK	Lower limit of resistant torque adaptation (B_fs=1)
DMVAMNKO_W	MDVERAD	DOK	Lower limit of resistant torque adaptation (B_ko=1)
DMVAMNLL_W	MDVERAD	DOK	Lower limit of resistant torque adaptation (B_ll=1)
DMVAMXFK_W	MDVERAD	DOK	Upper limit of resistant torque adaptation (B_fs=1 & B_ko=1)
DMVAMXFS_W	MDVERAD	DOK	Upper limit of resistant torque adaptation (B_fs=1)
DMVAMXKO_W	MDVERAD	DOK	Upper limit of resistant torque adaptation (B_ko=1)
DMVAMXLL_W	MDVERAD	DOK	Upper limit of resistant torque adaptation (B_ll=1)
E_DK	GGDVE	EIN	Error flag: throttle position sensor
E_LLR	DLLR	EIN	Error flag: idle speed control
E_LM	DHFM	EIN	Error flag: main load sensor
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_UB	GGUB	EIN	error flag: power supply voltage UB
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
TMOT	GGTFM	EIN	Engine temperature

FB MDVERAD 5.40 Detailed description of function

The demand adaptation learns the different friction loss of the system engine+auxiliary aggregates. Included as auxiliary aggregates for the adaptation are only the compressor for the air-conditioning system and the converter for the automatic transmission. Since the engine is sometimes run without the air-conditioning compressor turned on, or with driving positions of the automatic transmission not engaged, the adaptation must take the different load states into account.

The adaptation MADLL is performed when idling without the air-conditioning compressor and without an engaged driving position (only for AT). In dmvadll_w, the change in the load torque of the engine alone is learned (basic change in the engine torque corresponds to a change in the internal friction of the engine by, e.g. wear or differences in viscosity).

The basic load change is retained when the air-conditioning compressor is switched on, new changes in the load are primarily attributable to the air-conditioning compressor. A further factor dmvadko_w is thus adapted to the basic load change dmvadll_w by addition.
This adaptation is as a rule more rapid than the basic load adaptation because the compressor load changes much quicker for regulated compressors (depending on the quality of the check-back signal from the compressor for the load) than the basic load of the engine (given by the mechanical friction and the viscosity).

A similar process takes place when the driving position (automatic transmission) is engaged, as for switching on the compressor.

In the event that the compressor and driving position take place as loads at the same time, then the adaptation only sees the sum of changes in load from the compressor and driving position. Hence in this case, the factors already learned for the den air-conditioning compressor and the driving position alone are included in the calculation. A new factor dmvadfk_w is adapted however.

As soon as one of the loads (air-conditioning compressor or driving position) is turned off again, the inclusion of dmvadk_w in the calculation and the corresponding factor dmvadko_w or dmvadfs_w are learned again and included in the computation.

APP MDVERAD 5.40 Application hint

MDNSTAB 1.10 Torque: engine-speed stabilization

FDEF MDNSTAB 1.10 Function definition

mdnstab-mdnstab

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ABK MDNSTAB 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FNSTABNV	NVER		KL	Factor for engine speed stabilisation by torque

Variable	Source	Type	Description
C_INI		EIN	ECU-condition for intialisation
FNSTAB_W	MDNSTAB	AUS	Factor for speed stabilization
NMOT_W	BGNMOT	EIN	engine speed
NSTAT		EIN	Stationary reference speed

FB MDNSTAB 1.10 Detailed description of function

In order to achieve a self-stabilization of the speed, the indicated torque is weighted with the factor fnstab_w. The factor fnstab-w is obtained from the characteristic FNSTABNV.
After the initialization the factor remains at 1 until the actual speed nmot has exceeded the desired speed nsol.

APP MDNSTAB 1.10 Application hint

Adjustment of FNSTABNV: The characteristic FNSTABNV makes it possible to achieve an arbitrary stabilization function for the speed. Dependent on the quotient of the desired speed and on the actual speed of the engine, it is possible to determine a weighting factor for the demanded torque.
The values for speed quotients greater than 1 must also be greater than 1, for quotients less than 1 they must also be less than 1. All characteristics belong to a group and they all intersect the point quotient=1 and fnstab_w=1. When the desired speed is reached, no correction is to be performed.
If the performance output of the engine is to be kept constant (opening cross-section of the throttle valve remains constant at over-critical pressure ratios), then data is to be entered into FNSTABNV as the first bisector. For example:

Quotient	= 0	1.0	2.0	3.0	4.0	5.0
FNSTABNV	= 0	1.0	2.0	3.0	4.0	5.0

By influencing the factors above and below 1, it is possible to improve the speed distribution around the desired speed. For this, however, an exact analysis of the speed distribution should be performed.
The above-mentioned characteristic should be used when starting the application.

STMD 4.10 Starting torque

FDEF STMD 4.10 Function definition

stmd-stmd

ABK STMD 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMDST	TMOT	QNST_W	KF	Starting torque

Variable	Source	Type	Description
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
MIMIN_W	MDMIN	EIN	Minimal engine torque
MIMXL1_W	MDMAX	EIN	maximum optimal torque at lambda = 1
MISTT	STMD	AUS	Starting torque
MRFAMX_W	MDFAW	EIN	Relative torque request by driver maximum value
MRSTT_W	STMD	AUS	Relative starting torque
NMOTLL		EIN	engine speed
NSST	LLRNS	EIN	Initialisation value for desired RPM during start
QNST_W	STMD	DOK	speed quotient during start
TMOT	GGTFM	EIN	Engine temperature

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FB STMD 4.10 Detailed description of function

Torque at Start:

For the engine speed run-up during start a certain clutch torque is necessary.
For this a relative engine torque (analogous to mrfa_w) is pre-controlled dependent on the quotient nmotll/nsst and the engine temperature. With mrstt_w it is possible to open the throttle valve in the range 0 to 100% via the torque structure up to wdkugd. In the range from mrstt_w >100% to mrfamx_w the throttle valve can be opened from wdkugd further up to wdks=100%. The effect of the pedal over-travel is thus expanded also into the start. A de-throttling as is necessary for a forceful starting procedure is possible with mrstt 100% especially at very low engine temperature.

In the %MDFAW, mrstt is included in a maximum selection of the rel. torques after the formation of B_ll.

The formation of mistt is necessary due to the %LLRBB and there for the formation of B_llrein.

Ignition timing during Start:

See %ZWSTT

APP STMD 4.10 Application hint

MDWAN 5.10 Torque of the AT-converter

FDEF MDWAN 5.10 Function definition

mdwan-mdwan

mdwan-mdwan

mdwan-nturb

mdwan-nturb

ABK MDWAN 5.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FABMDWA	QNTNS		KL	Factor to decrease the converter torque depending of nturb
FMDWAT	TWAN		KL	Factor to calculate the converter torque depending of oil temperature
FNRAD			FW	Factor between wheel speed and vehicle speed f(circumference)
TVFSAM	TWAN		KL	Delay time after DRIVE-position switch off

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Parameter	Source-X	Source-Y	Type	Description
TVFSEM	TWAN		KL	delay time after DRIVE-position switch on
TVFUE			FW	Delay for the cylinder filling
UEVERG	GANGI		KL	Gear ratio depending of the gear
ZKMDWA			FW	Time constant for converter torque change

Variable	Source	Type	Description
B_FS	CANEGS	EIN	Condition driving state (automatic gear box)
B_FSU	MDWAN	DOK	Condition: Gear selection, switchover
B_INI		EIN	Condition initialization
C_INI		EIN	ECU-condition for intialisation
DNTURB	MDWAN	LOK	Speed difference of the converter turbine
GANGI	BBGANG	EIN	Engaged gear
MDWAN_W	MDWAN	AUS	Torque request of the torque converter
NSOL	LLRNS	EIN	idle reference speed
NTURB	MDWAN	LOK	Converter turbine speed
NTURBV	MDWAN	LOK	Expected converter turbine speed
QNTNS	MDWAN	LOK	Quotient of turbine speed by target speed at idle
S_FS		EIN	Drive position selected
TWAN		EIN	Converter oil temperature
VFZG	GGVFZG	EIN	vehicle speed (km/h)

FB MDWAN 5.10 Detailed description of function

On a vehicle with automatic transmission, which is at standstill, with tight brake the engine must produce a torque against the immobilized turbine of the torque converter when in driving position in order to maintain the idle speed. The torque acceptance of the converter at idle resp. in a range close to idle can be calculated according to the following formula:

$$md = FMDWAT(twan) * FABMDWA(qntns)^2 * nsol$$

where twan = oil temperature of the converter and
qntns = nturbv / nsol, quotient from turbine speed to be expected and desired idle speed.

The turbine speed to be expected is formed as follows:

$$nturbv = nturb + \begin{cases} 0, & \text{if the turbine speed is constant or if it increases} \\ dnturb * TVFUE, & \text{if the turbine speed decreases.} \end{cases}$$

The turbine speed nturb can be calculated as follows:

nturb = UEVERG * nrad with nrad = FNRAD * vfzg.

where UEVERG = f(gangi) is the gear ratio in the current gear (e.g. transmission ratio * rear axle gear ratio) and FNRAD is a function of the wheel circumference.

If the driver lets the vehicle roll slowly the turbine turns as a result of the rotation of the drive wheel. When the turbine speed approaches the desired speed (nturb increases), the brake effect of the converter on the engine decreases and the stress of the engine due to the torque converter becomes less.

If the drive wheels are decelerated the turbine speed decreases and the stress of the engine increases (mdwan_w must become greater). So as to be able to fill the intake manifold faster the turbine speed is in this case corrected dependent on the delay time for the build-up of the charge and on the gradient of the turbine speed (see above).

An increase of the converter torque must take place unfiltered (torque must be available as fast as possible), the reduction of the converter torque can take place filtered (comfort).

Via the code word CWMDWAN > 0 it is possible to receive the torque acceptance of the converter also directly from the transmission control (via CAN).

APP MDWAN 5.10 Application hint

FABMDWA: The factor is 1, if qntns is 0. The factor lies between 1 and 0 if the turbine speed approaches the desired speed nsol, i.e. 0 < qntns < 1. The factor is 0, if qntns is 1.

FMDWAT: With colder oil the factor increases since the internal friction increases in the converter.

TVFUE: Delay time for the build-up of the charge, at idle speed and low load.

UEVERG: Example: Transmission ratio in 5th gear $= \frac{nTurbine}{nJointed\ Shaft} = 3.7$ and rear axle gear ratio $= \frac{nJointed\ Shaft}{nWheel} = 0.8$.
From this the entire gear ratio in 5th gear results UEVERG(5) = 3.7 * 0.8 = 2.96.

FNRAD: Example: With a wheel circumference of 2m, from nWheel = 1 rpm = 2 m/min = 120 m/h = 0.12 km/h = vfzg the following factor results

$$FNRAD = \frac{nWheel}{vfzg} = \frac{1\ rpm}{0.12\ km/h} = 8.33\ \frac{rpm}{km/h}.$$

TVFSAM:

TVFSEM:

ZKMDWA:

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ARMD 2.60 Torque based anti jerk function

FDEF ARMD 2.60 Function definition

armd-dmar

```
Berechnung alle 50ms
====================
```

Low-pass of the 2nd order

ndiff_w ——> ndfil_w(k)=(ndiff_w(k)*A0+ndiff_w(k-1)*A1+ndiff_w(k-2)*A2)-ndfil_w(k-1)*B1-ndfil_w(k-2)*B2 ——> ndfil_w

Caution: Index k is based on 50 ms

Initialization o fthe low-pass for B_iniar:
B_iniar = 1 ——> ndfil_w(k) = 0, ndfil_w(k-1) = 0, ndfil_w(k-2) = 0, ndiff_w(k-1) = 0, ndiff_w(k-2) = 0

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armd-armd-par

Gear-dependent parameters with differentiation between automatic transmission and manual gear-shifting
==========

armd-ar-activ

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```
Activation conditions
=====================
Note: Assignment of data from fixed values beforehand: TMAR = -48 deg. C; NARAO > nmax (due to ROM function)
```

armd-ar-ini

```
Conditions for initialization
=============================
```

Parameter	Source-X	Source-Y	Type	Description
DMDAROG	GANGI		KL	upper threshold for torque intervention
DMDARUG	GANGI		KL	lower threshold for torque intervention
DNARAO			FW	engine speed hysteresis for anti-jerk function active
DNFILO			FW	upper threshold of filter output gradient ndfil
DNIARNG	NGFAR_W		KL	Delta engine speed for nmod initialization of speed gradient
DVFZAR			FW	Hysteresis for vehicle speed limit during AR (Anti jerk)
FLRAG	GANGI		KL	amplification of load controller at AT
FLRAWG	GANGI		KL	amplification of load controller
FLRHG	GANGI		KL	amplification of load controller
FRARAG	GANGI		KL	amplification factor at AT
FRARAWG	GANGI		KL	amplification factor
FRARHG	GANGI		KL	amplification factor
KIFZGAG	GANGI		KL	amplification of vehicle model integrator at AT
KIFZGAWG	GANGI		KL	amplification of vehicle model integrator at AT
KIFZGHG	GANGI		KL	amplification of vehicle model integrator at AT
NARA			FW	engine speed threshold for anti surge function
NARASTG			FW	RPM threshold in higher gear for AR active
NARLL			FW	RPM threshold for AR during idle condition
NTAREIN	NMOT		KL	lockup time for anti-jerk funktion
TMARSTM	TMST		KL	Lower TMOT threshold for AR release
TZSPINI			FW	Resting time for filter initialisation
VARAU			FW	vehicle speed for anti-jerk active
ZNGAR			FW	Time constant for the engine speed gradient AR

Variable	Source	Type	Description
B_AR	ARMD	LOK	condition anti-jerk active
B_ASREXT	CANASR	EIN	condition for externe ASR
B_AUTGET	CANEGS	EIN	condition automatic gearbox
B_INIAR	ARMD	LOK	condition initialization of anti-jerk function
B_KUPPL	GGEGAS	EIN	EGAS Condition cluch is disengaged
B_KURN	ARMD	LOK	condition negative clutch slip
B_KURP	ARMD	LOK	condition positive clutch slip
B_LL	MSF	EIN	Condition idle
B_MIEXT	BGMDLM	EIN	condition: external torque intervention
B_MSREXT	CANASR	EIN	Condition external MSR demand
B_SA	MDRED	EIN	Condition fuel cut-off
B_STEND	BBSTT	EIN	condition end of start
B_TZARNI	ARMD	LOK	Condition waiting time after AR initialization has elapsed
B_WK	CANEGS	EIN	condition: converter lockup clutch closed
B_WKR	CANEGS	EIN	condition clutch controlled
C_INI		EIN	ECU-condition for intialisation

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Variable	Source	Type	Description
DMAR_W	ARMD	AUS	delta torque anti-jerk
DNIAR_W	ARMD	LOK	Delta desired speed at initialization of AR speed
FDAR	ARMD	LOK	amplification factor for anti-jerk intervention
FLRAR	ARMD	LOK	amplification factor for modelling of external load
GANGI	BBGANG	EIN	Engaged gear
KIFZ_W	ARMD	LOK	amplification of vehicle model
MDBES_W	ARMD	DOK	Acceleration torque
MDVERL_W	MDVER	EIN	Resistant torque of the engine
MIFA_W	MDFAW	EIN	desired indicated engine torque
MISOLV_W		EIN	indicated resultant nominal torque before torque limitation
MKAR_W	ARMD	DOK	calculated clutch torque for anti-jerk function
NDAR_W	ARMD	DOK	Difference RPM for torque control
NDFDIF_W	ARMD	LOK	Gradient from AR difference speed
NDFIL_W	ARMD	LOK	filtered engine speed difference
NDIFF_W	ARMD	DOK	engine speed difference for ISC amplification
NGAS_W	ARMD	LOK	engine speed gradient during one working cycle
NGFAR_W	ARMD	AUS	filtered engine-speed gradient AR function
NMOD_W	ARMD	DOK	engine speed from model
NMOT	BGNMOT	EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed
TMOT	GGTFM	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
VFZG	GGVFZG	EIN	vehicle speed (km/h)

FB ARMD 2.60 Detailed description of function

Function purpose

The anti-jerk function detects oscillations of the power train and smoothens them using phase correct torque interventions. The torque intervention is converted into ignition angle offset by the torque interface.

Desired phase position of the torque intervention

In order to smoothen the power train oscillation efficiently, the torque intervention should be counterwise to the engine speed oscillations. Therby the same effect is achieved, as if the attenuation coefficient of the drive shaft is increased.

Operation pattern of anti-jerk function

Basic idea: A reference speed without oscillation and corresponding to the desire of the driver is evaluated. The difference between desired and actual engine speed isolates the oscillation. A delta torque is conterset to this oscillation.
Realization: A simple vehicle model consisting of an integrator with the constant kifz_w. Input of this integrator is the difference between the calculated coupling torque mkar_w and the load torque mlast_w; output is the model engine speed nmod_w. The engine speed difference ndiff_w between model engine speed nmod_w and engine speed nmot_w serves now as basis for the torque intervention as well as for the calculation of the load torque. The load torque is evaluated proportional to the engine speed difference, the factor flrar is taken from the corresponding char. line. The engine speed difference ndiff_w contains besides the oscillation part another offset. This offset is filtered in 50 ms scan rate through a discrete low pass of 2nd order. (Coefficients of the nominator polynomial are denoted A0, A1 and A2, of the denominator polynomial 1, B1 and B2.
The filtered offset ndfil_w is substracted from the differential engine speed and gives the engine speed oscillation ndar_w. Proportionally to this engine speed and using the factor fdar, a delta torque as torque intervention is calculated. If this intervention lays between the limits DMDARU and DMDARO it is set to zero.

Activation conditions

The model is always active, just the intervention can be switched off.

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APP ARMD 2.60 Application hint

Conditions for calibration of anti-jerk

The basic calibration of the vehicle must have been done. This includes the compensation for transition (ÜK) and all functions for the torque interface.

1. Evaluation of the integer constant kifz_w and flrar
   Coarse application:
   Drive on the road (flat surface, no hills) with constant speed in respective gear with deactivated anti-jerk function (fdar=0). Then execute a change in load and register the calculated coupling torque mkar_w and the speed nmot_w.
   Evaluation of integrator constant as follows: at a load step the torque jump is approximately delta M (in %) and the speed approximately rises with constant gradient gradn (in RPM/s). kifz_w is then calculated from gradn/(delta M). A typical value for 2nd gear is 4.6*100/MDNORM [RPM/(s*%)].
   Fine application:
   Driving on flat surface. Setting of the product kifz_w*flrar on a fixed value (recommendation: 15). Realization of load jumps with registration of mkar_w, mlast_w, nmot_w, ndiff_w. Variation of the couple kifz_w, flrar (with constant product!) until ndiff_w stays approximately constant at load jump.
   In principle the following is valid for the amplification factor flrar: high factors cause a reduction of the offset ndfil_w, but also a big phase advance of ndiff_w.
2. Evaluation of filter parameters
   Low pass in 50 ms scan rate: transmission function has the form G(z) = Z(z)/N(z) with
   Z(z) = A0 + A1*z^(-1) + A2*z^(-2) N(z) = 1 + B1*z^(-1) + B2*z^(-2).
   Selection of one of the low pass below, according to the appearing jerk frequency:

TP No.	limit freq.	A0	A1	A2	B1	B2
1	0.67 Hz	.0095	.0191	.0095	-1.7056	.7437
2	0.8 Hz	.0134	.0267	.0134	-1.6475	.7009
3	1.0 Hz	.0201	.0402	.0201	-1.561	.6414

   Recommended is low pass No. 3. The attenuation of the jerk frequency is determined by the distance between jerk frequency and filter cut-off frequency. The bigger the filter cut-off frequency, the smaller the time the filter needs to stabilize.
   Attenuation: any modification of a single coefficient of G(z) is not allowed!
3. Evaluation of fdar
   Recommendation is fdar = .67*100/MDNORM (%/RPM. Increase of attenuation by enlargement of fdar, reduction of fdar decreases the attenuation.
4. Thresholds DMDARO and DMDARU
   In case the delta torque for the intervention is within these thresholds, it is set to zero. This avoids undesired instabilities of the ignition angle. Typical values: DMDARU=-5*100/MDNORM [%], DMDARO= 5*100/MDNORM [%].

BBKURU 1.10 Operation conditions of slip clutch

FDEF BBKURU 1.10 Function definition

bbkuru-bbkuru

ABK BBKURU 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
IKURUN	GANGI		KL	threshold of detection clutch slip negativ
IKURUP	GANGI		KL	threshold of detection clutch slip positiv
TVKURU			FW	delay time of difference calulation x seconds
ZKURU			FW	time constant detection of clutch slip

Variable	Source	Type	Description
B_KUPPL	GGEGAS	EIN	EGAS Condition cluch is disengaged
B_KURN	BBKURU	AUS	condition negative clutch slip
B_KURP	BBKURU	AUS	condition positive clutch slip
C_INI		EIN	ECU-condition for intialisation
DNVQUOTF_W	BBKURU	AUS	Filtered difference, speed/velocity quotient
DNVQUOT_W	BBKURU	AUS	Difference, speed/velocity quotient
GANGI	BBGANG	EIN	Engaged gear
NVQUOT_W	BBGANG	EIN	quotient engine speed nmot / vehicle speed vfzg

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FB BBKURU 1.10 Detailed description of function

On the basis of the nmot/vfzg gradient, the function recognizes that the clutch slips and disables the anti-jerk function by the bits B_kurn, B_kurp. Any undesirable intervention by the AR anti-jerk function is thus prevented by this during quick gear shifting.

APP BBKURU 1.10 Application hint

MDIHGS 1.60 Torque limiting as a function of the gear

FDEF MDIHGS 1.60 Function definition

mibgr_w-Regelung, falls die Füllung beim Begrenzen nicht ganz korrekt ist !

mdihgs-mdihgs

ABK MDIHGS 1.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FMIHGN	NMOT		KL	factor torque limitation of transmission protect
MDIMX			FW	maximum limit indicated engine torque
MIHGSLG	GANGI		KL	torque limiting for protection of manually shifted transmission
NGHGS			FW	Engine speed gradient during gear range torque limitation
ZMIBGR			FW	Time constant for factor for limiting gear-dependent torque
ZNGHGS			FW	time constant low pass for revolution gradient

Variable	Source	Type	Description
B_AUTGET	CANEGS	EIN	condition automatic gearbox
B_HGSNDY	MDIHGS	AUS	condition engine speed dynamic
B_MIBGR	MDIHGS	AUS	condition: control of gear-dependent torque limiting active
FMIBGRV_W	MDIHGS	AUS	control factor for correction of gear-dependent torque limiting before filtering
FMIBGR_W	MDIHGS	AUS	control factor for correction of gear-dependent torque limiting
GANGI	BBGANG	EIN	Engaged gear
MIBGRV_W	MDIHGS	AUS	indicated traget torque for gear-dependent torque limiting before regulation
MIBGR_W	MDIHGS	AUS	Indicated desired torque for gear-dependent limiting of the clutch torque
MIFAFU_W		EIN	driver torque request for charge
MIINT_W	BGMDLM	EIN	calculated indicated torque
MILSOL_W	MDKOL	EIN	driver torque request for charge
NGAS_W	BGNG	EIN	engine speed gradient during one working cycle
NGHGS_W	MDIHGS	LOK	filtered engine-speed gradient
NMOT	BGNMOT	EIN	engine speed
R_T10		EIN	Time schedule 10 ms
R_T50		EIN	Time schedule 50 ms

FB MDIHGS 1.60 Detailed description of function

The torque can be limited for each gear by means of the characteristic MIHGSLG and the weighting factor FMIHGN to protect manually shifted transmissions. The engine torque is ineffective for unsteady operation by engine speed dynamics.

A new rear-axle design (mechanically weaker) will be installed for the B35.
It is for this reason that the permissible torque must be limited in 1st and 2nd gear by mibrgr_w. In case the mibgr_w control demand is not correctly executed (setpoint charge too high, measurable feedback signal by mibas_w or miint_w), then the permissible torque mibgr_w is accordingly corrected by fmibgr_w (regulator).

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APP MDIHGS 1.60 Application hint

gangi	0	1	2	3	4	5	6
MIHGSLG B44	99.6094	99.6094	99.6094	99.6094	99.6094	99.6094	99.6094
MIHGSLG B35	70.3125	70.3125	99.6094	99.6094	99.6094	99.6094	99.6094

Weighting factor chracteristic (8 nmot datapoints) - initial assignment of data

nmot	1000	2000	3000	4000	4500	5000	5500	6000
FMIHGN	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

BGMIGS 1.10 Torque reduction automatic-transmission shift control request

FDEF BGMIGS 1.10 Function definition

bgmigs-bgmigs

bgmigs-bgmigs

No text for FDEF available!

ABK BGMIGS 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
MDIAGMX			FW	constant maximum engine torque during can timeout
MDIMX			FW	maximum limit indicated engine torque
MDITXUMX			FW	constant maximum engine torque during can TXU timeout

Variable	Source	Type	Description
B_AUTGET	CANEGS	EIN	condition automatic gearbox
B_GTS	CANEGS	EIN	Condition: Transmission protection
B_TXUGET	CANTXU	EIN	condition transfer gearbox TXU
E_CGE	DCGE	EIN	error flag: CAN-interface timeout EGS
E_CTXU	DCTXU	EIN	error flag: CAN-interface timeout TXU
MIGES_W	BGMIGS	AUS	desired indicated torque for transmission protection
MIGSRC_W	CANEGS	EIN	Torque reduction request transmission control (CAN message)
MIGS_W	BGMIGS	AUS	desired indicated torque form GS for quick intervention
MITXU_W	CANTXU	EIN	Torque reduction request transmission control (CAN TXU message)

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FB BGMIGS 1.10 Detailed description of function

APP BGMIGS 1.10 Application hint

BBGANG 16.20 Detection of actual gear

FDEF BBGANG 16.20 Function definition

bbgang-bbgang

```
Gear detection for manual shifting by evaluation of the quotient engine speed/vehicle speed.
The value 0 is outputted, i.e. gear not detected, for cases where the quotient or the fault detected is not plausible.

With automatic transmissions (B_autget is set) the gear gangauti received via CAN is passed on.
```

ABK BBGANG 16.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
IGESGA	GANGI		KL	Total transmission ratio
NGANGMIN			FW	minimum engine speed for gear detection
NVQUOT1O			FW	gear detection n/v 1. gear high
NVQUOT1U			FW	gear detection n/v 1. gear low
NVQUOT2O			FW	gear detection n/v 2. gear high
NVQUOT2U			FW	gear detection n/v 2. gear low
NVQUOT3O			FW	gear detection n/v 3. gear high
NVQUOT3U			FW	gear detection n/v 3. gear low
NVQUOT4O			FW	gear detection n/v 4. gear high
NVQUOT4U			FW	gear detection n/v 4. gear low
NVQUOT5O			FW	gear detection n/v 5. gear high
NVQUOT5U			FW	gear detection n/v 5. gear low
NVQUOT6O			FW	gear detection n/v 6. gear high
NVQUOT6U			FW	gear detection n/v 6. gear low

Variable	Source	Type	Description
B_AUTGET	CANEGS	EIN	condition automatic gearbox
B_GWHS	BBGANG	AUS	Condition gear change on manual transmission vehicle
B_VNULL	GGVFZG	EIN	condition vehicle at stillstand
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
GANGAUTI	CANEGS	EIN	current gear of automatic gearbox received by CAN
GANGI	BBGANG	AUS	Engaged gear
NMOT_W	BGNMOT	EIN	engine speed
NVQUOT_W	BBGANG	AUS	quotient engine speed nmot / vehicle speed vfzg
UEVGES	BBGANG	AUS	Transmission ratio total
VFZG_W	GGVFZG	EIN	Vehicle speed

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FB BBGANG 16.20 Detailed description of function

The quotient nmot_w/vfzg_w (corresponds to the current transmission ratio) is calculated and compared to the possible transmission ratios for the gear detection on manual transmissions. A sufficient tolerance range must be permitted due to drive shaft vibrations.

gangi = 1 results for NVQUOT1U < nmot_w/vfzg_w < NV1QUOT1O.
gangi = 2 results for NVQUOT2U < nmot_w/vfzg_w < NV1QUOT2O.
gangi = 3 results for NVQUOT3U < nmot_w/vfzg_w < NV1QUOT3O.
gangi = 4 results for NVQUOT4U < nmot_w/vfzg_w < NV1QUOT4O.
gangi = 5 results for NVQUOT5U < nmot_w/vfzg_w < NV1QUOT5O.
gangi = 6 results for NVQUOT6U < nmot_w/vfzg_w < NV1QUOT6O.

If the calculated quotient lies in neither of the ranges then gangi = 0 is set, i.e. gear not detected.

Since only the signals nmot_w and vfzg_w are available for the gear detection and since they can only take on positive values, reverse gear cannot be detected, especially since the transmission ratio of reverse gear usually only differs slightly from that of first gear.

Conditions for the setting of the actual gear:
In case E_vfz or B_vnull is set, gangi=0 is set, i.e. gear not detected. (These bits must have been debounced.)
In case nmot_w < NGANGMIN, gangi=3 is supplied. (Demand from FGR is to be checked for other applications.)
The bit B_kupstat is not taken into consideration since it is already set when the clutch is touched only slightly, although the power transmission is not yet interrupted then. It must be checked separately for the FGR.

The possible values of gangi have been taken from previous definitions and have the following meaning:

gangi	Physical Gear
0	On automatic transmission: P or N On manual transmission: Gear not detected, i.e. clutch is applied resp. vehicle is at standstill resp. unknown gear ratio (not plausible quotient nmot_w/vfzg_w)
1	On automatic transmission: 1st gear On manual transmission: 1st gear or reverse gear
2	2nd gear
3	3rd gear
4	4th gear
5	5th gear
6	6th gear
7	On automatic transmission: Reverse gear

Correction at low engine speeds for the FGR (= road speed control):
At certain operating points (low speeds in high gear) the engine speed strongly changes in case of abrupt throttle changes, although the vehicle speed remains constant. The drive shaft twists and n/v enters a not plausible range although the gear is engaged. Abrupt throttle changes can occur at exactly this operating point when the FGR is activated and then lead to deactivation due to non-plausibility of n/v.
Remedy: If gangi=0 (quotient n/v not plausible) is detected and the engine speed lies below a threshold, gangi = 3 is set.

The quotient nvquot_w = nmot_w / vfzg_w is made available for further processing.

APP BBGANG 16.20 Application hint

The engine speed value must be shifted suitably to the left, i.e. by 9 bits so as to ensure a sufficient resolution of the calculated quotient.

The range limits for the quotient n/v (10%) must be expanded especially in low gears, since due to twisting in the drive shaft distinctly higher quotation fluctuations were measured.
Due to tolerances (sensing, deceleration, slipping clutch, twisting in the drive shaft) a range of approx. 10% width is defined round the ideal gear ratio so as to be able to detect the respective gear, cf. application hints.
For the gear detection it is checked in which numerical range the quotient lies and gangi is set accordingly.
The program is designed to distinguish 6 forward gears.

BBSAWE 22.50 Conditions for fuel cut-off / cut-in

FDEF BBSAWE 22.50 Function definition

ABK BBSAWE 22.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DNSAH			FW	Delta n overrun cut-off high with reference to n reinstatement
DNSAL			FW	Delta n overrun cut-off low with reference to n reinstatement
DNSLL			FW	Overrun cut-off hysteresis for reinstatement at idle
DNVSA			FW	cut off engine speed increase at low vehicle speed
DNWEK			FW	Delta n for reinstatement with air conditioning
DVSA			FW	delta vehicle speed for cut off engine speed increase
ENASAG			FW	enabling fuel cut off dependent on gear
KFTVSA	NMOT	TMOT	KF	Retard time for overrun fuel cut-off
KFTVSALR	N	TMOT	KF	Retard time for overrun fuel cut-off with gear box in low-range
KFTVSAM	NMOT	TMOT	KF	delay time for overrun cutoff
KFTVSAMLR	NMOT	TMOT	KF	delay time for overrun cutoff with gear box in low range
NGDNSA			FW	Engine speed gradient during decreasing the cut-off hysteresis
NWEM	TMOT		KL	Fuel cut-in speed
NWENG	NGFIL		KL	Fuel cut-in engine speed
TKATSAN	NMOT		KL	Catalyst temperature threshold for fuel cut-off

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Parameter	Source-X	Source-Y	Type	Description
TVSATM	TMST		KL	delay time after cranking for fuel cut off
VSAA			FW	vehicle speed threshold for cut off engine speed increase

Variable	Source	Type	Description
B_CVT		EIN	Condition continuously variable transmission
B_DASH	MDFAW	EIN	condition: limitation of negative torque gradient active
B_DNSLL	BBSAWE	LOK	condition fuel cut off engine speed hysteresis DNSLL
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_FALLS		EIN	condition: requirement to change engine speed by tester
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KOE	KOS	EIN	Condition for AC-compressor ON
B_KUPPL	GGEGAS	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_SAB	BBSAWE	AUS	Condition fuel cut-off requested
B_SABT	BBSAWE	LOK	Condition fuel cut-off requested
B_SACVT		EIN	condition support of the fuel cut of for CVT-gearbox
B_SAVFGR		EIN	Condition: prohibited trailing throttle fuel cut-off by cruise control
B_STEND	BBSTT	EIN	condition end of start
C_INI		EIN	ECU-condition for intialisation
DNSA	BBSAWE	LOK	time depending overrun hysteresis
GANGI	BBGANG	EIN	Engaged gear
NGFIL	BGNG	EIN	filtered engine-speed gradient
NMOT	BGNMOT	EIN	engine speed
NSA	BBSAWE	LOK	Engine speed for fuel cut-off
NWE	BBSAWE	LOK	engine speed for fuel cut-in
TKATM	ATM	EIN	catalyst temperature (model)
TMOT	GGTFM	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
VFZG	GGVFZG	EIN	vehicle speed (km/h)

FB BBSAWE 22.50 Detailed description of function

1. Generating the fuel cut-off request

The following status is necessary to generate the condition of fuel cut-off request (B_sab = 1):

```
        The engine speed is higher than the threshold nwe + dnsa
and     the cranking is finished since at least the time TVSAM (as function of engine cranking temperature)
and     the catalyst temperature tkatm is lower than the threshold TKATSA
and     idle condition B_ll is set
and     dashpot condition B_dash is set
and     no disabling of fuel cut off by cruise control B_savfgr, no diagnosis of secondary air system and no catalyst heating
and     at actual gear fuel cut off is enabled or CVT-transmission enables fuel cut off.
```

B_sab is set when the abowe conditions are true after the time delay TVSAM.
This avoids fuel cut-off while changing gears.

B_sab is reset without time delay (B_sab = 0) when the above conditions are no longer valid.

2. Calculation of the speed thresholds

The engine speed for fuel cut-in nwe and the cut-in hysteresis dnsa are thresholds for cut-off and cut-in:
- nwe: if engine speed is lower, fuel cut-in has to occur.
- nwe + dnsa: if engien speed is higher, fuel cut-off is possible.

The cut-in engine speed depends on th engine temperature tmot and the engine speed gradient ngseg. This threshold is additionnally increased when switching on the AC-compressor (B_koe).
When leaving idle, the hysteresis is set to DNSAH and then decreased linearly towards DNSAL. The (negative) slope is defined by NGDNSA.
For slow vehicle speed (vfzg < VSAA) the hysteresis is additionnally increased by DNVSA. If the vehicle speed becomes higher than the threshold VSAA + DVSA, the hysteresis is reset to her normal value.

```
                 ^ n
nwe + DNSAH - -  | - - - - - - - - - - *
                 |                   * *     slope NGDNSA
nwe + DNSLL - -  | - - * * * * * * * *   *  /
                 |       *               *
nwe + DNSAL - -  | * * *                   * * * * * * *  nsa

        nwe      |------------------------------------------ nwe
            1    |        -------------                          ------>
       B_ll   0  |-------|             |--------------------- B_ll      time t
```

Timediagramm of the threshold nsa(t) depending on B_ll for constant cut-in speed mwe and without increase for slow vehicle speed.

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APP BBSAWE 22.50 Application hint

MDRED 11.10 Calculation reduction step from torque demand

FDEF MDRED 11.10 Function definition

mdred-mdred

Sub-function HYST: Hysteresis to prevent bouncing of the masking stage:

mdred-hyst

Sub-function BBRED: Operating conditions of torque intervention over injection masking:

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mdred-bbred

ABK MDRED 11.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CREDSTU			FW	code word for reduction step on/off
MDHYEZ			FW	torque-hysteresis for decision cylinder fuel cut-off
NSAUE1			FW	
NWEUE1			FW	
REDHYOC			FW	hysteresis of reduction step at bigger desired red. step than actual value
REDHYUC			FW	hysteresis of reduction step at smaller desired red. step than actual value
REDMX			FW	maximal step number for disabled injectors (f.e. =2*number of cylinder)
REDZEM	TMOT		KL	threshold between ignition intervention and injector disabling
WPUE1MX			FW	

Variable	Source	Type	Description
B_ASR	MDKOG	EIN	condition for ASR active
B_DKNOLU	SREAKT	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SREAKT	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_MDEE	MDRED	LOK	condition: torgue reduction by injection fade out is permited
B_MIBEG	MDKOG	EIN	condition torque limit active
B_MSR	MDKOG	EIN	Condition MSR
B_NMAX	NMAXMD	EIN	1 = maximum engine speed exceeded
B_SA	MDRED	AUS	Condition fuel cut-off
B_SAB	MSF	EIN	Condition fuel cut-off requested
B_SAUE1	MDRED	AUS	
ETAZWMN	ZWMIN	EIN	minimum ignition angle effectiveness
MIBAS_W	MDBAS	EIN	indicated basic torque
MIOPT_W	MDBAS	EIN	optimum indicated torque
MISOL_W		EIN	indicated resultant nominal torque
MIZWMN_W	MDRED	DOK	indicated engine torque at the latest spark angle
NMOT	BGNMOT	EIN	engine speed
REDHYST	MDRED	LOK	hysteresis for cylinder cut-off step
REDNEU	MDRED	LOK	new calculated cylinder cut-off step
REDSOL	MDRED	AUS	calculated desired cylinder cut-off step
REDZE	MDRED	DOK	threshold of cylinder cut-off step between two interventions
REDZST_W	MDRED	LOK	cylinder cut-off step without hysteresis and roundness
TMOT	GGTFM	EIN	Engine temperature
WPED	GGPED	EIN	Standardized accelerator pedal angle

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FB MDRED 11.10 Detailed description of function

This function provides the injection masking stages corresponding to the nominal torque request misol_w (referred to the indexed engine torque mibas_w, which results at the static ignition angle zwbase and basic Lambda lambas).
A hysteresis is used to ensure that no "bouncing" occurs in the selection of the reduction stages (cf. sub-function "HYST").
Cutting the decimal places ("Floor function") results in the new reduction stage. The sub-function "BBRED" determines whether injection masking is permitted (B_mdee) and whether deceleration cut-off occurs (B_sa).

The actual reduction stage redist results from a max selection between redbas (basic reduction stage due to bank shut-off or due to misfire detection) and the reduction stage redsol calculated from misol.

Sub-function HYST: Hysteresis to prevent bouncing of the masking stage

The hysteresis is determined by the difference between REDHYUC and REDHYOC and the offset of the hysteresis referred to the old value of redsol, divided by (1-REDHYOC). REDHYUC must always be greater than REDHYOC. If the calculated masking stage redzst exceeds the current value of redsol by more than 1-REDHYOC (if redzst_w>redsol(k-1)-REDHYOC)
or REDHYUC (if redzst_w <= redsol(k-1)-REDHYOC) stages,
then the next masking stage must be selected.

Sub-function BBRED: Operating conditions of torque intervention over injection masking

The characteristic REDZEM in relation to the engine temperature can be used to establish the reduction stage redze from which injection masking is actually permitted. If the calculated reduction stage redneu is less than the value specified in the characteristic REDZEM, ignition angle intervention is activated. Injection masking is only possible when redsol>=redze (see above) or when the requested torque misol_w is less than the possible torque mizwnm at the latest ignition angle and the condition such as B_ska, B_dknolu or B_nmax is set. At B_asr =1 cylinder masking is possible if in addition the 0th bit of CREDSTU is set to 1. Otherwise the injection angle intervention is limited to zwmin and no cylinder masking is possible.
If misol_w is less than mizwmn_w and B_sab is set, the condition B_sa is set and the nominal reduction stage redsol equals REDMX, so that deceleration cut-off occurs. In MSR intervention (B_msr = 1), deceleration cut-off is prohibited.

APP MDRED 11.10 Application hint

Typical value:

REDMX = No. of cylinders
REDHYOC = 0.5 (for simultaneous injection and ignition interventions)
REDHYUC = 0.6 (for simultaneous injection and ignition interventions)
MDHYEZ = 5 Nm
CREDSTU[0] = 0 (cylinder masking during ASR not possible)

Characteristic REDZEM (typical value, see diagram below)
This characteristic determines the threshold between injection masking and ignition intervention. According to the engine temperature it can be used to program the reduction stage from which injection masking no longer results in overheating of the catalytic converter.

Example for the calculation of REDHYUC, REDHYOC :

Target is a hysteresis of 0.1, at delta=(redzst-redsol(k-1)) >=0.5 a higher stage should be selected. From the equations
REDHYUC - REDHYOC = 0.1
delta = 1 - REDHYOC

we get:
REDHYOC = 0.5; REDHYUC = 0.6;

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NMAXMD 5.30 Torque calculation during maximum speed control

FDEF NMAXMD 5.30 Function definition

nmaxmd-nmaxmd

Calculation of the limiting torque at maximum speed

nmaxmd-nmaxd

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Calculation of differential speed for limiting torque

nmaxmd-initint

Calculation of the initialization values for

ABK NMAXMD 5.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DNMAXHG	GANGI		KL	hysteresis for hard rpm limiting (dependent on gear position)
DNMAXLR			FW	hysteresis for hard rpm limiting in low range
KFMIRED1	MIIST_W	GANGI	KF	Map of decreasing control torque for NMAX control
MDIMX			FW	maximum limit indicated engine torque
NMAX			FW	engine-speed limitation, transient limit
NMAXLR			FW	engine-speed limitation, transient limit in low range
NMAXPG	GANGI		KL	p-element in NMAX control (dependent on gear position)
NMAXPLR			FW	P-element in NMAX control in low range gear
NMXDAEF	WPED		KL	maximum permitted engine speed for throttle actuator substitute function
NMXDKPU			FW	Maximum permitted engine speed in case of unknown or wrong throttle position
TNMXPRG	GANGI		KL	rpm prediction horizon for NMAX control (dependent on gear position)
TNMXPRLR			FW	rpm prediction horizon for NMAX control in low range
UKWNMAXG	GANGI		KL	Gear-dependent camshaft revolution counter for NMAX control
UWNMAXLR			FW	camshaft revolution counter for NMAX control in low range
ZINMAXG	GANGI		KL	I-gradient for NMAX control (dependent on gear position)
ZINMAXLR			FW	I-gradient for NMAX control in low range

Variable	Source	Type	Description
ANZKWU_W	NMAXMD	DOK	Number of crankshaft revolutions
B_DKNOLU	SREAKT	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SREAKT	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_NMAX	NMAXMD	AUS	1 = maximum engine speed exceeded
B_NMAXD	NMAXMD	LOK	condition rpm limiting with injection masking
DMNMXI_W	NMAXMD	DOK	torque I-component for NMAX control
DMNMXP_W	NMAXMD	DOK	torque P-component for NMAX control
DNSI_W	NMAXMD	LOK	difference between nominal and actual engine speed
GANGI	BBGANG	EIN	Engaged gear
INMAX	NMAXMD	LOK	Initial value for integrator for NMAX regulation
MIFAB_W	MDKOG	EIN	limited desired indicated engine torque
MIIST_W	MSF	EIN	indicated real engine torque
MINMXS	NMAXMD	DOK	Indicated desired torque for integrator initialisation of NMAX control
MINMX_W	NMAXMD	AUS	indicated nominal torque for NMAX limiting
MIRED1	NMAXMD	DOK	Indicated torque reduction for NMAX regulation
NGFIL_W	BGNG	EIN	filtered engine-speed gradient
NMOTPR_W	NMAXMD	DOK	engine speed
NMOT_W	BGNMOT	EIN	engine speed
R_T10		EIN	Time schedule 10 ms
UZKW_W		EIN	revolution counter crankshaft
WPED	GGPED	EIN	Standardized accelerator pedal angle

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FB NMAXMD 5.30 Detailed description of function

A PI controller with speed prediction is used to limit the engine speed.

The round a time horizon TNMXPRG predicted actual engine speed (prediction only at positive gradient of the engine speed) is compared to the MAX engine speed NMAX. if the predicted actual engine speed nmotpr_w exceeds the maximum permitted value NMAX, then the delta torque events dmnmxp_w and dmnmxi_w are calculated via a PI controller and added together with the indicated driver's torque to minmxb_w so that the actual engine speed is limited to NMAX. The output variable minmxb_w is limited between the minimum value 0 and the maximum value MDIMX. If minmx_w(z-1) equals zero, the integrator of the PI controller is stopped. If the predicted actual engine speed is less than NMAX and if the torque minmx_w is greater or equal to the driver's torque mifab_w, the condition B_nmax is reset and the indicated torque minmx_w is switched to the default value MDIMX so that no further intervention will take place.
The condition B_nmax is set, if the engine speed exceeds the threshold NMAX. Thereby cylinder cutout is possible, if air and ignition-angle intervention is not sufficient (cf. %MDRED).
Once the engine speed exceeds the threshold NMAX+DNMAXHG, the condition B_nmaxd is set. Thereby minmx_w is set to zero for anzkwu_w (UKWNMAXG)!

APP NMAXMD 5.30 Application hint

The control parameters NMAXP, ZINMAX and TNMXPR should be programmed so that the transient recovery time or the overshoot of the engine speed does not exceed the requested values and the system remains stable.

Typical values:

NMAX = 6500 rpm, MDIMX = 99.6%; DNMAXH = 100 rpm

For ZINMAX, TNMXPR and NMAXP:
Assumption: The control path can be described by PT1 with a time constant T1 and an integrator.
Parameter assignment without overshoot, denominator of $1 + Ts + (1/3)*(Ts)^2 + (1/27)*(Ts)^3 = (1+Ts/3)^3$ must apply. Thus for T=3T1:

ZINMAX = T1; TNMXPR = 2 * T1; NMAXP = [1/(0.09549 * MDNORM / BETA)] / T1

where MDNORM = Normalisation variable for torque
BETA = Centrifugal mass

VMAXMD 3.30 Torque request of Vmax regulation

FDEF VMAXMD 3.30 Function definition

ABK VMAXMD 3.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDVMX			FW	code word SW-switch for integrator initialization during VMAX control
KFMIRED	RL_W	BFZGLF	KF	Map of decreasing control torque for VMAX control
KFMIRLR	RL_W	BFZGLF	KF	Map of decreasing control torque for VMAX control low range
MDIMX			FW	maximum limit indicated engine torque
NMINVMX			FW	Minimum engine speed threshold for the VMAX control
TVMXPR			FW	Speed prediction horizon for VMAX control
VABSCH			FW	Vmax controller shut-down threshold, variant-coded
VABSCHLR			FW	
VHYST			FW	Vmax hysteresis threshold, variant-coded
VHYSTLR			FW	
VMAXO			FW	Vmax limiting value (line with 16 variants)
VMAXOLR			FW	
VMAXP			FW	P element for VMAX control
VMAXPLR			FW	P element for VMAX control, active low range
VVORH			FW	Vmax guide threshold, variant-coded
VVORHLR			FW	
ZBFIL			FW	Time constant for acceleration filter
ZIVMAX			FW	I gradient for VMAX control
ZIVMAXLR			FW	I gradient for VMAX control, condition low range

Variable	Source	Type	Description
BFZGLF	VMAXMD	LOK	Vehicle acceleration , filtered
BFZGL_B	GGVFZG	EIN	Automobile acceleration in the longitudinal direction
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_VMAX	VMAXMD	AUS	flag VMAX limitation active
DMVMXI_W	VMAXMD	DOK	Torque value I-part during VMAX regulation
DMVMXP_W	VMAXMD	DOK	Torque value P-part during VMAX regulation
DVPRAE_W	VMAXMD	LOK	Predicted speed component
DVSI_W	VMAXMD	DOK	Difference between desired and predicted vehicle speed
IVMAX	VMAXMD	LOK	Initial value for integrator for Vmax regulation
MIFAB_W	MDKOG	EIN	limited desired indicated engine torque
MIIST_W	MSF	EIN	indicated real engine torque
MIRED	VMAXMD	DOK	Indicated torque reduction for VMAX regulation
MIVMXS	VMAXMD	DOK	Indicated desired torque for integrator initialisation of VMAX regulation
MIVMX_W	VMAXMD	AUS	indicated nominal torque for VMAX control
NMOT	BGNMOT	EIN	engine speed
RL_W	EGFE	EIN	relative air charge (Word)
SY_TVVR		EIN	system constant tester connection to vmax-control
VFGR_W	BGVFGR	EIN	cruise control vehicle speed
VFZGPR_W	VMAXMD	DOK	Predicted vehicle speed

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Variable	Source	Type	Description
VFZG_W	GGVFZG	EIN	Vehicle speed
VSTVVR		EIN	Speed offset for the VMAX control

FB VMAXMD 3.30 Detailed description of function

In order to limit the vehicle speed a PI controller with speed prediction and torque derivation is used.

The basis of this function is the vehicle speed vfzgpr_w, which is predicted in the partial function TVMXPR by a prediction horizon TVMXPR (prediction only with positive vehicle acceleration). If this predicted vehicle speed exceeds the threshold VVORH, then the VMAX control becomes active. The output B_vmax of the RS flip-flop is set to one. The initialization value IVMAX is pre-assigned into the integrator, the delta torques dmvmxp_w and dmvmxi_w are calculated in the controller and added to the indicated torque mifab_w.
If the engine speed falls short of a hysteresis threshold VHYST, then the integrator is stopped. Stopping the integrator shall prevent an escalation of the controller, which may occur due to decelerating and then accelerating again.
So as to prevent the engine from stopping while the clutch is operated and the engine speed having decreased, the VMAX control is is deactivated as from an engine speed threshold.
When the switch-off threshold VABSCH is undershot the controller becomes inactive, the output of the RS flip-flop B_vmax is reset to zero.

The value of the integrator is limited between -MDIMX and MDIMX.
The calculation of the initialization value of the integrator is performed in the partial function INITINT. Dependent on the filtered vehicle acceleration bfzglf and the relative charge rl_w a reduction torque is calculated from a characteristic map. This reduction torque contains the specific torque characteristics of the engine independent of the vehicle mass. By subtracting the reduction torque from the actual torque miist that torque is obtained, which is needed by the engine to maintain the maximum speed.

Via the interface vstvvr a minor change of the control speed is possible.

APP VMAXMD 3.30 Application hint

Hints regarding the initial application:

The controller parameters VMAXP and ZIVMAX are to be adjusted such that the stabilization time resp. the overshoot of the vehicle speed do not exceed the requested values and that the system remains stable.

When starting the control care must be taken at first that the speed signal and the acceleration signal have smooth signal profiles. For this at first the function GGVFZG needs to be adjusted.
For the initial application the prediction horizon TVMXPR should lie at 100 ms and the filter time constant ZBFIL at 500 ms.
The integrator initialization and the speed prediction shall improve the control quality with regard to the stabilization behaviour.
At high limiting speeds and small torque reserve of the engine at that speed an initialization of the integrator is not absolutely necessary.

The map KFMIRED is to be adjusted in the following way:
At first the speed VMAXO is to be reached by driving on a flat stretch of road with the controller being switched off. The actual torque misst (VMAXO, bfzgl=0) measured in the process serves as a basis for the further application. Now the speed threshold VMAXO is exceeded at different accelerations, while the controller is still deactivated. In the process the load rl and the actual torque miist (VMAXO, bfzgl <> 0) are measured. The reduction value, which corresponds to this rl and to this acceleration results with regard to

```
        mired (rl,bfzgl) = miist(VMAXO, bfzgl <> 0) - miist(VMAXO, bfzgl = 0)
```

For the controller adjustment the controller initialization can be switched off by means of the code word CWDVMX.

Typical application:

Example for a typical application

Version coding:
In order to obtain different vmax control speeds for different versions the following labels are activated via a version coding:

Vehicle dependency:

VMAXO
VHYST
VABSCH
VVORH
VMAXP
ZIVMAX
KFMIRED
NMINVMX

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MSMD 1.10 engine protection through torque reduction

FDEF MSMD 1.10 Function definition

msmd-msmd

No text for FDEF available!

ABK MSMD 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DTMABMS			FW	
FPMSTM	DTMUEMS		KL	p-element in engine overheated protection
FPMSTME	DTMUEMS		KL	p-element in engine overheated protection
MDIMX			FW	maximum limit indicated engine torque
MDMSMIN	NMOT_W		KL	
TMMSX			FW	Threshold for boiling prevention
TMSTKA	TKA		KL	Threshold for boiling prevention

Variable	Source	Type	Description
B_GOT	CANEGS	EIN	condition excess temperature gear box
B_MSMD	MSMD	AUS	Condition torque limitation for engine protection active
B_NTKW	CANINS	EIN	Condition request of low coolant temperature (heat-exchanger protection)
B_STEND	BBSTT	EIN	condition end of start
C_INI		EIN	ECU-condition for intialisation
DTMUEMS	MSMD	LOK	
MIMS_W	MSMD	AUS	indicated torque for engine protection
MIMXL1_W	MDMAX	EIN	maximum optimal torque at lambda = 1
NMOT_W	BGNMOT	EIN	engine speed
R_T200		EIN	Time schedule 200 ms
TKA	GGTKA	EIN	Temperature engine radiator outlet (coolant)
TMOT	GGTFM	EIN	Engine temperature

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FB MSMD 1.10 Detailed description of function

APP MSMD 1.10 Application hint

LLRBB 2.40 Operating conditions of idle speed control

FDEF LLRBB 2.40 Function definition

llrbb-llr-bed

Enable conditions for the idle speed control

llrbb-b-vllr

Recognistion of cluch disengaged

ABK LLRBB 2.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CNFKUPPL			FW	Configuration flag for the evaluation of the cluch switch in the ISC
DNLLR			FW	Engine speed range above nstat to enable the ISC
NMIN			FW	minimum engine speed
TVDK			FW	delay time after closing of the throttle
TVKUPPL			FW	Delay time for the cluch information
VLLR			FW	vehicle speed limit for idle speed control

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Variable	Source	Type	Description
B_DASH	MDFAW	EIN	condition: limitation of negative torque gradient active
B_FIL		EIN	condition: low pass filter for transition to or from fuel cut-off active
B_FS	CANEGS	EIN	Condition driving state (automatic gear box)
B_KUPPL	GGEGAS	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_LLR	LLRBB	AUS	condition idle speed control
B_LLREIN	LLRBB	AUS	Condition idle speed control is active
B_LLRI	LLRBB	AUS	Condition activation of I-part of idle speed control
B_LLRPD	LLRBB	AUS	Condition activation of PD-part of idle speed control
B_MDEIN	MDKOG	EIN	Condition actions on the torque are active
B_SA	MDRED	EIN	Condition fuel cut-off
B_SAB	MSF	EIN	Condition fuel cut-off requested
B_STEND	BBSTT	EIN	condition end of start
B_VLLR	LLRBB	AUS	Condition vehicle is moving with engaged gear
C_INI		EIN	ECU-condition for intialisation
DMLLRI_W	LLRRM	EIN	desired torque change from the idle speed control (I-)
DN		EIN	speed deviation at idle speed control
GANGI	BBGANG	EIN	Engaged gear
MILL_W		EIN	Indicated engine torque at idle
MISTT	STMD	EIN	Starting torque
NMOT	BGNMOT	EIN	engine speed
NSTAT		EIN	Stationary reference speed
VFZG	GGVFZG	EIN	vehicle speed (km/h)

FB LLRBB 2.40 Detailed description of function

This function block determines the enable conditions for the idle speed control.
The different conditions are:

B_llrein: Idle speed control enabled after crancking, when the start torque firstly becomes less than the sum of all torques issued from the idle speed control.
B_llrein is reset when the engine stalls (nmot < NMIN) or the sofware-initialisation accurs.

B_vllr: Condition that the vehicle is running with gear in: when a gear is engaged, the vehicle speed exceeds the threshold VLLR and the cluch is not disengaged, the bit B_vllr is set. Is no gear is engaged, the vehicle is at rest or the cluch is disengaged (B_kuppl = 1), the bit B_vllr is cleared.
ATTENTION: on several cars the clutch switch is not suitable to be used for detection the disengaged position of the cluch. Therefore it is possible to disable the information of the clutch switch by settiong the label CNFKUPPL greather than zero.

B_llr: Condition to activate the idle speed control: this bit indicates if the idle speed control is enabled (B_llr=1) or still disabled (B_llr=0).
The idle speed is enabled if the throttle is at idle position (B_ll=1), no fuel cut-off request is set (B_sab=0), no fuel cut-off is set (B_sa=0) and the time TVDK elapsed since the throttle reached its idle position or the engine speed is lower than the target speed, no torque filtering for fuel cut-off is active (B_fil=1).

B_llrpd: Condition to enable the P- and D- parts of the controller: the proportional and the differential parts of the controller are enabled when the engine speed is lower than the target speed or the ISC is enabled (B_llr=1) and B_llrein = 1 and there is no external torque action active (B_mdein=0).

B_llri: Condition to enable the I-part of the controller: the integral part of the controler is enabled if there is no action on the torque active (B_mdein=0) and the controller is active (B_llr=1) or the engine speed is lower than the target speed (dn>0), startend is reached and the engine speed is under the threshold given by nstat+DNLLR.

APP LLRBB 2.40 Application hint

Calibration of VLLR: VLLR should be as small as possible to detect as soon as possible the driving state of the car. This mus be ensured for driving at low idle speed in first gear. The speed threshold can be apprixmated as follows:

VLLR = (nsol_lowest_value - 200) * v1000 / 1000

where v1000 ist the car speed at an engine speed of 1000 rpm (typically VLLR has a value from 7 km/h to 10 km/h depending on the gear ratio an the tyre size)

Calibration of TVDK: This inhibition time should prevent the controller to work immediatly after having closed the thottle. After an acceleration to nearly the maximal engine speed of approx. 6000 rpm the throttle is closed and the time TVDK should stop the controller until the engine speed arrives at the dynamically followed target speed. Typically TVDK is a value between 0.5 an 1.0 second.
If TVDK is too small the controller becomes too negative an the engine speed would drop under the target speed.

Calibration of TVKUPPL: This time delay is necessary for the information of the cluch switch, because this switch reacts when the driver only touches the cluch pedal (without disengaging the cluch). So the point of disengaging the cluch occurs approximatly 100ms after the signal of the switch becomes equal to 1.

Calibration of DNLLR: According to the engone speed threshold for the dynamic target speed, the vaule of DNLLR should be equal to DNSNFX (see Function LLRNS).

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LLRMD 1.2 Torque-based idle-speed control

FDEF LLRMD 1.2 Function definition

llrmd-llrmd

ABK LLRMD 1.2 Abbreviations

Variable	Source	Type	Description
B_LLR	LLRMD	LOK	condition idle speed control
B_LLREIN	LLRMD	AUS	Condition idle speed control is active
B_LLRI	LLRMD	LOK	Condition activation of I-part of idle speed control
B_LLRPD	LLRMD	LOK	Condition activation of PD-part of idle speed control
B_VLLR	LLRMD	LOK	Condition vehicle is moving with engaged gear
DMLLRI_W	LLRMD	AUS	desired torque change from the idle speed control (I-)
DMLLR_W	LLRMD	AUS	desired torque change from the idle speed control (PD-)
DMRLLR	LLRMD	AUS	Torque reserve for idle speed control
DN	LLRMD	LOK	speed deviation at idle speed control
DNS	LLRMD	LOK	LLR: difference of idle speed precontrol
DN_W	LLRMD	LOK	speed deviation at idle speed control
MILL_W		EIN	Indicated engine torque at idle
MISTT	STMD	EIN	Starting torque
NMOTLL		EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed
NSOL	LLRMD	AUS	idle reference speed

FB LLRMD 1.2 Detailed description of function

The block LLRNS calculates the target speeed nsol, the dynamic speed difference dn_w (dn) ant the stationary speed difference dns.

The block LLRRM contains the idle speed controler.

The block LLRBB determines the operation conditions of the idle speed control.

The block LLRMR calculates the desired torque resverve for the idle speed control.

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APP LLRMD 1.2 Application hint

LLRNS 517.30 Idle control; Nominal engine speed for idle speed control

FDEF LLRNS 517.30 Function definition

llrns-llrns

llrns-nsllmn

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llrns-nsllmn

Determination of the minimal target speed for B_fs=1

llrns-nslbz

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Determination of the minimaln target speed when battery is discharged

llrns-llrnsnf

llrns-llrnsnf

Dynamic following of the target speed

ABK LLRNS 517.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DNSNFX			FW	Offset to determine the upper limit of target speed
FNSNF			FW	factor for desired engine-speed correction
FNSSTM	TMOT		KL	Faktor for taget engine speed during start
FTEDS			FW	threshold canister charge for switching to endless purging
KNSNF			FW	Engine speed follow-up inhibition band
NFHZ			FW	Idle speed increase during wind screen heating activ
NFHZFS			FW	Idle speed increase during wind screen heating activ and B_fs=1
NFSLRM	TMOT		KL	desired engine speed DRIVE-position and low range active
NFSM	TMOT		KL	desired engine speed DRIVE-position switch on
NGNSNF			FW	Threshold of speed gradient for starting dynamic taget idle sped calculation
NLLM	TMOT		KL	desired engine speed
NSAC			FW	desired engine speed with air conditioner on (S_AC = 1)
NSACFS			FW	desired engine speed with air conditioner on (S_AC = 1) and AT in Drive (S_fs=1)
NSLPP	PSL		KL	Target speed depending on the pump pressure of power steerung
NSLPPFS	PSL		KL	Target speed depending on the pump pressure of power steering with B_fs=1
NSLRM	TMOT		KL	desired engine speed for low range active
NSMNEGS			FW	Desired speed threshold for transmission control B_nsmin
NSNOT			FW	Target engine speed while B_nnot=1
NSNOT1			FW	Target engine speed while limp home
NSNOT1FS			FW	Target engine speed while limp home and B_fs
NSNOTFS			FW	Target engine speed while B_nnot=1 and B_fs
NTEB			FW	Increased target speed when canister is high loaded
NTEBFS			FW	Increased target speed when canister is high loaded and B_fs=1
ZKNS			FW	Time constant for target engine speed when changing target
ZNSM	TMOT		KL	time constant for decay of reference speed
ZNSUB			FW	time constant for desired engine speed at low voltage

Variable	Source	Type	Description
B_AUTGET	CANEGS	EIN	condition automatic gearbox
B_DKNOLU	SREAKT	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SREAKT	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_EGSCOK	CANEGS	EIN	Condition: CAN message of the gearbox is received
B_FALLS		EIN	condition: requirement to change engine speed by tester
B_FALLSA	LLRNS	AUS	Condition: requirement to change engine speed by tester
B_FHZ		EIN	Condition flag windshield heating
B_FS	CANEGS	EIN	Condition driving state (automatic gear box)
B_KUPPL	GGEGAS	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_NAC	KOS	EIN	condition for increased idle-speed at AC

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Variable	Source	Type	Description
B_NFTEV		EIN	Condition for increasing the target speed to have mor canister purging
B_NIVNS	LLRNS	AUS	condition lower idle speed
B_NNOT		EIN	Condition for increasing target speed during limp-home
B_NSUB	BGLBZ	EIN	condition to increase nominal engine speed at low battery-voltage
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_PN	CANEGS	EIN	condition: position P or N of automatic transmission selected
B_STEND	BBSTT	EIN	condition end of start
DNFSACMV		EIN	LLRNS: Delta desired speed of DS2 communicator, AC with FS
DNFSMV		EIN	LLRNS: Delta desired speed of DS2 communicator, with FS
DNLLMV		EIN	LLRNS: Delta desired speed of DS2 communicator
DNS	LLRNS	AUS	LLR: difference of idle speed precontrol
DNSACMV		EIN	LLRNS: Delta desired speed of DS2 communicator, AC without FS
DNSLBV		EIN	LLRNS: Delta desired speed of DS2 communicator, from LLRUB
FTEAD_W	TEB	EIN	charcoal canister charge
LLSSTAT	LLRNS	AUS	Functional status LLRNS when system check is requested
NFSKH	BBKHZ	EIN	Idling speed driving level for catalyzer heating
NGFIL	BGNG	EIN	filtered engine-speed gradient
NLLKH	BBKHZ	EIN	Idling speed for catalyzer heating
NMOTLL		EIN	engine speed
NSFSM	LLRNS	LOK	LLR: target speed depending on engine temperature during idling with S_fs=1
NSFSMN	LLRNS	LOK	LLR: minimal target speed for AT in drive
NSLB	BGLBZ	EIN	Nsoll correction from charge assessment battery
NSLBZ	LLRNS	LOK	Target engine speed dependin on lbz
NSLLM	LLRNS	LOK	LLR: target speed depending on engine temperature during idling
NSLLMN	LLRNS	LOK	LLR: minimal target speed during idling
NSNF	LLRNS	DOK	LLR: followed-up target speed
NSOL	LLRNS	AUS	idle reference speed
NSOLFA		EIN	Desired engine speed at idle, function request of the tester
NSST	LLRNS	AUS	Initialisation value for desired RPM during start
NSTAT		EIN	Stationary reference speed
PSL		EIN	Oil pressure of the power steering system
TMOT	GGTFM	EIN	Engine temperature
VSNS	VS_VERST	EIN	Change of target engine speed with calibrationg tool VSxy

FB LLRNS 517.30 Detailed description of function

Determination of the target engine speed
==========

Stationary target speed (nstat)

The stationary target speed depends principally of the engine coolant temperature. There is a difference between the target speed for manual transmission MT and automatic transmission (AT) in 'neutral' (B_fs=0) and AT in 'drive' (B_fs=1). For B_fs=0 the target speed is given by the caracetistic NLLM, for B_fs=1 it is given by NFSM.

Different comfort functions may change this target engine speed if there target is greather than nslllmn resp. nfskh.
The choice of the maximum for the case B_fs=0 is shown in the figure NSLLMN:

- Immediatly after start the catalyst heating function may increase the target speed to nllkh
- The battery charge monitoring lbz max increase the target speed.
- For AC use the target speed may be increased.

For B_fs=1 after start the target speed can be increased to heat the catalyst.

Follow-up of the target speed (nsnf)

To permit an earlier reaction of the controller when the engine speed falls from hight speed into the idle, the tartget speed follows the actual engine speed (follow-up). This dynamic target speed ist calculated from the actual engine speed nmotll multiplied with the factor FNSNF. The subtracted offset KNSNF ihibits a speed follow-up in a KNSNF large band above the stationary target speed. The dynamic following stops at the speed of NSNFX.

Target engine speed (nsol)

The controller tries to chage the actual engine speed until it is equal to the target speed. The target speed is the maximum of the filtered target speed nsnf and nstat. If the engine speed increases (ngfil > NGNSNF) and (nsnf > nsol) and (nsnf > nstat) the filter is reseted to its input value (no filtering occurs). The filter time constant depends of the engine coolant temperature.

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APP LLRNS 517.30 Application hint

Calibration of the function parameter
==========

Stationary target speed

NLLM : Normally the car manufacturer determines the target engine speed at idle. The following criteria may be taken into account. Often the resulting target speed is a compromise between the different requests:
- smoothness of the engine at idle (is also depending of the ignition timing, for late timing the smoothness increases because the engine turns with higher filling of the cylinders).
- fuel consumption at idle (urban driving cycle)
- vibrations of the body (resonnace)
- charging of the battery (rotating speed of the generator)
- power steering (oil flow trough the hydraulic pump)

NFSM : Self driving of the car with MT in 'drive' must be small

DNSLBZ: To assure the actual charge of the battery the target speed should be increased.
There are two possibilities to calibrate this function:

1. DNSLBZ=constant, 0 < LBZO1 < LBZO2 : if lbz > LBZO2 at idle, the target speed is increased filtered by ZNSUB toward its new value.
   If LBZO1 < lbz < LBZO2 the target speed is set to a higer value immedialtly when leaving the idle condition.
   The reset to zero of the speed increase et fullfilled when lbz < LBZU and B_ll=0 and n > NSLBZS.
   The change of the target speed occurs in one step.

2. DNLSBZ = line passing the origin, LBZO1=LBZO2=LBZU=0. the speed increase is directcly dependent of the values of DNSLBZ(lbz). The change of target speed occurs now continuously.

NSAC, NSACFS : Minimal target speed for AC
NFHZ, NFHZFS : Minimal target speed for wind screen heating
NSLPP, NSLPPFS: Minimal target speed depending on the oil pressur of the power steering
NTEB, NTEBFS : Minimal target speed for charget canister

Target speed follow-up

FNSNF : Determines how near the follow-up speed shoult come to the real speed. Normal value between 0.9 and 0.95.
KNSNF : Determines a speed zone abowe the stationary speed nstat where there is no speed follow-up.
DNSNFX: Upper limit for speed follow-up is given by nstat + offset DNSNFX.
ZNSM : Time constant for the decay of the target speed during falling actual speed. The decay of the target speed should be as quick as the speed of an loadless engine decays.
FNSSTM: Factor to increase the target engine speed during the start.So it is possible to control the behaviour of the speed-overshoot after the start. When the idle speed control is activated (B_llrein=1) the target speed is changed towards the stationnary value nstat with the time constant ZNSM.

The following picture illustrates schematically the behaviour of the engine and the target speed when increasing and decreasing the engine speeed.

LLRRM 7.20 Idle speed control: torque controller

FDEF LLRRM 7.20 Function definition

llrrm-llrrm

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Idle speed controller: PID-controller

llrrm-llrrmi

Subfunction LLRRMI: idle speed controller I-part

llrrm-libeg

Subfunction LIBEG: limitation of the I-part

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Subfunction LLRRMD(Z): idle speed controller D-part

llrrm-llrrmd

llrrm-llrrmdz

ABK LLRRM 7.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DMLLRIMXN	NMOT		KL	Safety concept: upper limit for dmllri
DMLLRMN			FW	Lower limit for dmllr_w
DMLLRMXN	NMOT		KL	Safety concept: upper limit for dmllr
DMLLRZMN			FW	Lower limitation for dmllrz_w
DMLLRZMXN	NMOT		KL	Upper limitation for dmllrz_w
DNMNI			FW	Lowest possible value for dn for the I-controller
DVNG	NGFIL		KL	LLR: D-gain depending of ngfil for vehicle at rest
DVNGV	NGFIL		KL	LLR: D-gain depending of ngfil for vehicle rolling
DVZNG	NGFIL		KL	LLR: D ignition component dependent on ngfil when vehicle is standing still
DVZNGV	NGFIL		KL	LLR: D ignition component dependent on ngfil when vehicle is rolling
FDDN	DNS		KL	LLR: weightning factor for D-amplification
FDDZN	DNS		KL	LLR: Weighting factor for D ignition part
IVDN	DN		KL	LLR: I-gain for vehicle at rest
IVDNV	DN		KL	LLR: I-gain for vehicle rolling
LIMN			FW	lower integrator limit for standing car
LIMNDLLR			FW	lower integrator limit for diagnostic of idle speed control
LIMNDTES			FW	lower integrator limit for DTES
LIMNV			FW	lower integrator limit for rolling car
LIMX			FW	upper integrator limit for standing car
LIMXV			FW	upper integrator limit for rolling car
LISTM	TMOT		KL	value of idle speed control integrator during start
LLRICNF			FW	Configuration byte for ISC integrator
NDSU			FW	difference engine speed for integrator reset
PVDN	DN		KL	LLR: P-gain for vehicle at rest
PVDNV	DN		KL	LLR: P-gain for vehicle rolling
PVDNVZ	DN		KL	LLR: P ignition component gain when vehicle is rolling
PVDNZ	DN		KL	LLR: P ignition component gain when vehicle is standing still
TVLISTUM	TMOT		KL	Prohibition time for negative integrator component after start
ZKLLRD			FW	Time constant for the decrease of the differential part of the controller
ZKLLRDZ			FW	Time constant for the decreasing control of the D ignition component
ZLIBG			FW	filter time constant for adjusting integrator limits

Variable	Source	Type	Description
B_DLLR	DLLR	EIN	Active diagnostic: ISC-actuator diagnostic
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_LLR	LLRBB	EIN	condition idle speed control
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_LLRI	LLRBB	EIN	Condition activation of I-part of idle speed control
B_LLRIMX	LLRRM	LOK	Condition dmllri has reached safety limit erreicht
B_LLRPD	LLRBB	EIN	Condition activation of PD-part of idle speed control

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Variable	Source	Type	Description
B_MDMIN		EIN	Condition minimal possible indicated torque reached
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_VLLR	LLRBB	EIN	Condition vehicle is moving with engaged gear
DMLLRDZ_W	LLRRM	LOK	Demanded torque change of the LLR (D ignition component)
DMLLRD_W	LLRRM	LOK	desired torque change from the idle speed control (D-part)
DMLLRI_W	LLRRM	AUS	desired torque change from the idle speed control (I-)
DMLLRPZ_W	LLRRM	DOK	torque changed demanded from idle-speed control (P ignition component)
DMLLRP_W	LLRRM	DOK	desired torque change from the idle speed control (P-part)
DMLLRZ_W	LLRRM	AUS	Demanded torque change of the LLR (PD-ignition part)
DMLLR_W	LLRRM	AUS	desired torque change from the idle speed control (PD-)
DN	LLRRM	LOK	speed deviation at idle speed control
DNS	LLRNS	EIN	LLR: difference of idle speed precontrol
DN_W		EIN	speed deviation at idle speed control
LIMAX_W	LLRRM	LOK	Idle speed control integrator upper limit
LIMIN_W	LLRRM	LOK	Idle speed control integrator lower limit
LIMNST	LLRRM	LOK	Idle speed control integrator lower limit during after start
NGFIL	BGNG	EIN	filtered engine-speed gradient
NMOT	BGNMOT	EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed
NSOL	LLRNS	EIN	idle reference speed
TMOT	GGTFM	EIN	Engine temperature

FB LLRRM 7.20 Detailed description of function

In the special case, when the diagnostic supposes a blocked idle speed control device the lower limit of the integral part is set to LIMNDLLR as long as B_dllr=1.

During the diagnosis of the canister purge system (B_dtes=1) a specific lower integrator limit LIMNDTES is active.

If the minimal possible indicated torque or the maximum limit of the I-Part DMLLRIMXN(nmot) is reached (B_mdmin or B_llrimx is true), the appropriate limit of the integrator is set to the actual integrator value. So the integrator can’t contiue to work in the torque limited direction.

APP LLRRM 7.20 Application hint

Before calibrating the controller for car at rest:

The following precautions have to be taken before calibrating the controller:

* switch off the D-part of the controller: caracteristic DVNG set to zero, caracteristic FDDN set to 1.

* switch off the P-part of the controller: caracteristic PVDN set to zero

* switch off the adaptation of torque requirement: set TMDMAD to a value greather than 120 °C.

* Be shure that the lowest target speed is selected. The engine must be warm, the torque reserve has to be determined. If it is not, set the torque reserve to a value between 3% and 4%.
  ATTENTION: For the calibration of the controller it is important to have a low engine speed with a low load because under these conditions the dead time of the system is at its maximum and the system tends to be instable..

* Calibrate a slow I-part of the controller to enable the system to reah exactly the low target speed.
  IVDN = 0.01 for all points of the caracteristic.
  Then, when the target speed is reached, set the gain of the integral part to zero. The controller is then stopped. The engine should turn with the target speed.

Calibrating the controller:

ATTENTION: The load of the engine mus be as low as possible to have a big dead time in the system. During the calibration resp. the evaluation of the results, no additional load (AC-compressor, electrical load like fans or the power steering) must be switched on. For engines with low internal friction it could be necessary to press the cluth pedal to reduce additionnaly the engine load.

Calibration of the P-part: Increase the proportional gain by increasing the values of PVDN. Make a perturbation by tipping-in or switching on and off a load like the AC-compressor or the power steering. Increase the P-gain until the engine speed oscillates stationnary with a constant amplitude after an exitation.
Now decrease progressivly the P-gain until the engine speed stops oscillating. Verify the behaviour of the engine speed withe a tip-in. The speed shoule reach the target value with at maximaum 2 or 3 oscillations.
The P-again is then calculated from:

PVDN = 0.5 * limit_gain (all values of the caracteristic must be the same).

Calibration of the I-part: The integral part is calibrated after having done the first calibration of the proportional part. The P-part remains active during the calibration of the I-part. The calibration is done in the same way as for the proportinal part. The limit gain where the engine just doen’t oscillate is searched.
The P-gain is the given by:

IVDN = 0.5 * limit_gain (all values of the caracteristic must be the same).

With this calibration of the PI-controller the switching on or off of load like the AC-compressor, the power steering or the electrical cooling fan should not result in a engine speed oscillation. The speed drop could of course still be too large. This can be now reduced using the differential part of the controller.

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Calibration of the D-part: The differential gain should be kept as small as possible to be shure that the system doesn't become nervous.

* In a dead zone of about ±20 rpm about the target speed, the D-part shoule stay at zero, to avoid a nervous idling. Therefore calibrate the caracteristic FDDN as follows:

dn	.....	-50	-20	20	50	...
FDDN	1.0	1.0	0	0	1.0	1.0

  In a range of 20 rpm above and below the target speed the D-part is zero, between 20 rmp and 50 rpm of deviation the D-part increases and reaches it's maximum for speed deviations of more than 50 rpm.

* Increase slowly the differential gain DVNG of the controller an observe the speed drop when using power steering (keep the steering wheel forced to the right or left buffer to keep the load konstant). There should be no speed overshoot. Increase the D-gain until the speed drop is minimal and the speed behaviour is correct.

* If the behaviour of the engine speed after cranking or after a tip-in leeds to an undershoot, ist is necessary to reduce te D-gain for engine speed above the target speed. In the caracteristic FDDN the values for negative dn have to be reduced (for example 0.5 or even less).

After these calibrations the controller normally gives good results. It is still possible that under specific conditions like driving avay without accelerating the reaction of the controller is insuffisant. The parameter of the controller have the to be optimized. For big speed deviations it is the necessary to increase the P- and I-gain. A limit for the gain is given by 75% of the limit gain mesaured preliminary.For small engines it is possible to increase the gain until the limit gain is reached. For these engines the gain for small speed deviations is more oriented towards the 75% of the limit gain.

The calibration of the gain for driving car have to be smaller like them for car at rest (tendence of stucking). As initial values take the values for car at rest (just calibrated). The gain should not excced 50% of the limit gain. In practice it would either be only 25%.

IMPORTANT REMARK: When judjing the speed behaviour after a tip-in it is important that the dynmical following of the target speed is well calibrated. When an engine returns to it's target speed without any external load the controller should'nt do any corrections. If necessary (I-part becomes too negative) increase the time TVDK to start the controller later after reaching the idle status (B_ll = 1).

LLRMR 4.40 Torque reserve for idle speed control

FDEF LLRMR 4.40 Function definition

llrmr-llrmr

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llrmr-dyn-mdres

ABK LLRMR 4.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWLLRMR			FW	code word for torque reserve in idle-speed control
DMRESFS			FW	LLR: reduction rate for increased torque reserve
DMRESLL			FW	LLR: reduction rate for increased torque reserve
DMRESLW	LWS_W		KL	Torque reserve for power steering
DNLLRES			FW	LLR: dn threshold for increasing the torque reserve at idle
KFMRES	DNS	TMOT	KF	LLR: torque reserve at idle and near-idle zone
KFMRESFS	DNS	TMOT	KF	LLR: torque reserve at idle and near-idle zone for B_fs=1
MRESFSM	TMOT		KL	LLR: increased torque reserve in idling after engaging gear selection
MRESLLM	TMOT		KL	LLR: increased torque reserve at idle after speed undershoot
MRESTEV			FW	torque reserve for canister-purge valve speed check
TDMRESLL			FW	Inhibition time for the increased torque reserve after engine start
TVLLRMRTEV			FW	Delay time MD reserve removal after canister-purge valve speed check
TVRESFS			FW	Hold time for increased torque reserve after engaging gear selection
TVRESLL			FW	Hold time for increased torque reserve after engine speed drop

Variable	Source	Type	Description
B_DTEBN		EIN	start of engine speed test-procedure
B_FS	CANEGS	EIN	Condition driving state (automatic gear box)
B_LL	MSF	EIN	Condition idle
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_STEND	BBSTT	EIN	condition end of start
DMDRESDTEV	LLRMR	LOK	delta torque reserve for canister purge speed check
DMDRESFS	LLRMR	LOK	dynamic delta torque after engaged gear selection
DMLLLMN_W	LLRMR	AUS	Reserve torque threshold for action on the air
DMRAC	MDVERB	EIN	Torque reserve for AC-compressor
DMRLLR_W	LLRMR	AUS	torque reserve for idle speed control
DNS	LLRNS	EIN	LLR: difference of idle speed precontrol
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
LWS_W	CANLWS	EIN	Steering angle
TMOT	GGTFM	EIN	Engine temperature

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FB LLRMR 4.40 Detailed description of function

The torque reserve deplaces the operationg point of the engine toward later ignition timing. It becomes possible with a jump of the ignition time to make a jump in the engine torque. This function determines the amount of the torque reserve needed.

Normally the torque reserve is given by the map KFMDRES (depending of dna and tmot). The torque reserve should be as less as possible to have an optimal efficiency.

If a speed drop occurs because the LLR was not able to compensate the load quickly enough by ignition, the torque reserve is increased to the new value MRESLL. In time this value is again decreased to the normal programmed value. The decreasing speed is given by the value DMRESLL (negative value!). This option is usefull with power steering when parking the car for example. The first action of the power steering will drop the engine speed under a threshold, for the following actions of the power steering the torque reserve is now high enough to avoid speed drops.

Before swiching on the AC-compressor, the torque reserve is increased to dmrac. The engine is now able to compensate the high torque demand to accelerate the compressor when swiching him on. This extra torque reserve is only present just before the compressor is swiched on.

For powersteering it is possible to increase the torque reserve to at least MRESSL when B_sl is true.

Only the largest requested torque reserve is taken into account.

APP LLRMR 4.40 Application hint

Calibration of KFMRES: KFMRES if the torque reserve in the region of the idle speed. Because the engine efficiency decreases with the torque reserve, it will be suitable to choose a reserve as small as possible. The reserve should be big enough to avoid a stall of the engine if a big load is suddenly switched on (Colling fan or power steering). The controller should be able to keep the engine speed in a defined zone below the target speed when switching the load on. For engine speeds below the target speed + 300 rpm the torque reserve should be in the order of 3% to 4%. Then it decreases to zero until it reaches the point target speed + 500 rpm. For greather engine speeds the torque reserve must be zero.

Calibration of DNLLRES, TVRESLL, MRESLL and DMRESLL:
DNRESLL: tolerated limit of speed drop when switching on a load. Typicall value 120 rpm. If the speed drops under this threshold the torque reserve is increased.
TVRESLL: time during which the increase of the torque reserve is active. This time should be long enough to permit the car driver to park his car (multiple use of full powersteering load). Typically 30 seconds.
MRESLL: Amound of increase of the torque reserve after speed drop under DNRESLL. Usually an increase of 4% should be enough.
DMRESLL: After the time TVRESLL the increase of the reserve is reduces to zero. This should be done in a time of 10 seconds. This can be influenced by DMRESLL. DMRESLL is a negative value.

DLLR 36.10 Diagnosis: idle speed control, recognising a blocked actuator

FDEF DLLR 36.10 Function definition

dllr-dllr

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General view of the idle speed control diagnosis

The diagnosis of the idle speed control is divided into three parts:
1. DLLRBB : conditions to activate the function
2. ERRCHK : error check of the idle speed control
3. ZEFLAG : management of the error and cycle flags

dllr-dllrbb

DLLRBB: conditions to activate the function

The function is activated when:
1. the EURO code sets the flag B_cdllr
2. other functions have no errors detected (upper OR-gatter)
3. the engine operates under predefined conditions (lower part of the figure)
The diagnosis is enabled when the flag B_lldia is true (set to 1).

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dllr-errchk

ERRCHK: error check of the idle speed control

This part of the function works only if B_lldia is set to 1 (see above).
In the upper part of the figure (upper AND-gatter) occurs the check for engine speed too low. If the engine speed remains more than DNDLLRO rpm under the target speed an the ISC-integrator reaches the upper limit DMLLRIDO for a time longer than TDLLRMN, the error-flag B_mnllr is set.
In the lower part of the figure the check for engine speed to high is made. If the integrator remains at its lower limit DMLLRIDU and the engine speed difference ist DNDLLRU the flag B_dllr is set after the time TDLLR. This causes the lower limit of the integrator to be changed to LIMNDLLR (see %LLRMD, LIBEG). If now the limit DMLLRIDU2 is reached for more than TDLLRMX seconds, the flag B_mxllr is set.
This flag is also set if during one continuous disgnosis phase (B_lldia set) the flag B_sa is set more than DASA times.
This is normally impossible vehicle at rest without opening the throttle.

dllr-zeflags

ZEFLAGS: management of the error and cycle flags

If the diagnosis worked one time completly, independently if an error occurded, the cycle flag is set.
If an error occured the error-flag is set additionnaly.

ABK DLLR 36.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DASA			FW	number of fuel cut-out phases to detect ISC-actuator error
DMLLRIDO			FW	Maximal integrator deviation (low speed) for diganostis of idle speed control
DMLLRIDU			FW	Maximal integrator deviation (high speed) for diganostis of idle speed control
DMLLRIDU2			FW	Maximal integrator deviation (high speed) for diganostis of ISC (2nd threshold)
DNDLLRO			FW	Maximal speed deviation (low speed) for diagnosis of idle speed control
DNDLLRU			FW	Maximal speed deviation (high speed) for diagnosis of idle speed control
FHDLLR			FW	altitude threshold for performing of ISC-actuator diagnosis
RLDLLR			FW	Cylinder filling threshold for ISC diagnosis
TADLLR			FW	intake air temperature threshold for ISC-actuator diagnosis
TDLLR			FW	Time delay for setting the condition diagnosis of ISC-actuator
TDLLRMN			FW	Time delay before storing error of closed ISC-actuator
TDLLRMX			FW	Time delay before storing the error ISC-actuator open

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Parameter	Source-X	Source-Y	Type	Description
TDLLRNF			FW	Time delay before storing ISC-actuator with no error
TFDLLRO			FW	Upper limit for time window for DLLR
TFDLLRU			FW	Lower limit for time window for DLLR
TMDLLR			FW	Engine temperature threshold for ISC-actuator diagnosis

Variable	Source	Type	Description
B_CDLLR	PROKON	EIN	function active per codeword CDLLR
B_CLLLR		EIN	condition clear failure path DLLR
B_DKNOLU	SREAKT	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SREAKT	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DLLR	DLLR	AUS	Active diagnostic: ISC-actuator diagnostic
B_DLLRA	DLLR	AUS	Condition DLLR request
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_LL	MSF	EIN	Condition idle
B_LLDIA	DLLR	LOK	Diagnosis of idle speed control released
B_LLR	LLRBB	EIN	condition idle speed control
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_MNLLR	DLLR	AUS	Error 'Idle speed too low'
B_MXLLR	DLLR	AUS	Error 'Idle speed too high'
B_NOLLRFLR	DLLR	LOK	Condition LLR-diagnosis finished with o.k. report
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_SA	MDRED	EIN	Condition fuel cut-off
B_ST	BBSTT	EIN	condition for start
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DMLLRI_W	LLRRM	EIN	desired torque change from the idle speed control (I-)
DNS	LLRNS	EIN	LLR: difference of idle speed precontrol
E_LLR	DLLR	AUS	Error flag: idle speed control
E_LM	DHFM	EIN	Error flag: main load sensor
E_TA	GGTFA	EIN	error flag: TANS
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
FHO	GGDSAS	EIN	Correction factor altitude
RL	EGFE	EIN	relative air charge
TANS	GGTFA	EIN	Intake air temperature
TMOT	GGTFM	EIN	Engine temperature
TNSE_W	BBSTT	EIN	time counter at end of start (16 bit)
VFZG	GGVFZG	EIN	vehicle speed (km/h)
Z_LLR	DLLR	AUS	cycle flag: diagnostic ISC-actuator
Z_TES	DTEVN	EIN	cycle flag of canister purge system

FB DLLR 36.10 Detailed description of function

The diagnosis of the idle speed control is enabled only if the flag B_lldia is set.

The DLLR-function controls the behaviour of the ISC-integrator dmllri_w in dependence of the engine speed.

If the engine speed difference is greather than DNDLLRO and the integrator is greather than DMLLRIDO the flag B_llrmn is set after waiting the time TDLLRMN.

If the engine speed difference is lower than DNDLLRU and the integrator dmllri_w is lower than DMLLRIDU the lower integrator limit is set to LIMNDLLR after the time TDLLR. If the integrator reaches the new limit DMLLRDIU2 and stays there for more than TDLLRMX seconds, the flag B_llrmx is set.

If the throttle stays too much opened (still with B_ll=1), the engine speed can rise until fuel cut-off occurs.
The speed oscillations and the fuel cut-off phases disable the integrator to reach a lower limit. Therefore the function monitors the times of apprearing of the flag B_sa. If this flag ist set and reset more than DASA times the flag B_mxllr is also set.

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APP DLLR 36.10 Application hint

The detection of an idle speed control error has to occure before other functions who need the ISC have theire diagnosis working. The time disponible for the DLLR during the FTP-cycle is only 26 seconds (this is the longest idle phase with warm engine at second 620).

TMDLLR: set to 80°C

RLDLLR: bigger than rl at idle. Is used to detect if the driver tries to hold his car at the hill using the clutch and having an engine speed under the target speed.

DNDLLRO: 100 rpm: engine speed more than 100 rpm under the target speed must be detected as an error.

DMLLRIDO: <= LIMX

DNDLLRU: 200 rpm: engine speed more than 200 rpm above the target speed must be detected as an error.

DMLLRIDU: >= LIMN

DASA: minimum equal to 2

DMDLLIDU2: approx. 5% lower than LIMN = LIMNDLLR

TDLLRNF: max. 20 sec.

TDLLRMX: TDLLRMX and the time needed by the integrator to reach the limit DMLLRIDO when engine speed is 100 rpm too low (depends of the integral gain of the controller) must be less than TDLLRNF.

TDLLRMN: TDLLRMN and the time needed by the integrator to reach its upper limit DMLLRIDU when engine speed is 200 rpm too high and
TDLLR: TDLLR, and the time the integrator needs to reach the new limit DMLLIDU2 when engine speed is still 200 rpm too high must be lower than TDLLRNF.

The available time during the FTP cycle is schematically the following:

```
B_lldia ____/                    <<— maximal time 26 seconds !! ——>>          \_____
            .                                                                  .
            .                                                                  .
1) Case n > nsol (engine speed to high)
========================================
            .                                                                  .
      1     .                                                                  /————
Z_llr 0 ————————————————————————————————————————————————————————————————————————
            .                                                                  .
            .                                                                  .
      1     .                                                                  /————
E_llr 0 ————————————————————————————————————————————————————————————————————————
            .                                                                  .
            .                                                                  .
dmllri_w ——                                                                    .
             —  .<————————TDLLR————————>.  .<————————TDLLRMN————————>.        .
            .  —.                        .  .                        .        .
DMLLRIDU    .    ————————————————————————  .                        .        .
            .    .                          —.                        .        .
DMLLRIDU2   .                                ————————————————————————————————
```

```
B_lldia ____/                                  <<— maximal time 26 seconds !! ——>>  \_____
            .                                  .                      .
            .                                  .                      .
2) Case n < nsol (engine speed too low)
========================================
            .                                  .                      .
      1     .                                  /————————————————————————————————
Z_llr 0 ————————————————————————————————————————————————————————————————————————
            .                                  .                      .
            .                                  .                      .
      1     .                                  /————————————————————————————————
E_llr 0 ————————————————————————————————————————————————————————————————————————
            .                                  .                      .
            .                                  .                      .
            .    .<————————TDLLRMX————————>.  .                      .
            .    .                          .                      .
DMLLIDO     .    ————————————————————————————————————————————————————————————
            .  —                                                      .
            .—                                                        .
dmlllri_w ——                                                          .
```

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BGLBZ 5.10 Calculated charge deficit of the battery

FDEF BGLBZ 5.10 Function definition

bglbz-bglbz

Formation of the desired engine speed in case of a deficit in the charge balance

bglbz-b-nsub

Formation of B_nsub for desired engine speed increase in case of a deficit in the charge balance

ABK BGLBZ 5.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DILBN	NMOTLL		KL	Delta integrator value battery charge assessment
DILBST			FW	Delta integrator value battery charge assessment during start
DITNS			FW	Delta integrator value battery charge assessment at night
ILBHYSO			FW	Integrator value battery charge assessment, upper hysteresis value
ILBHYSU			FW	Integrator value battery charge assessment, lower hysteresis value
ILBINI			FW	Integrator initialization value battery charge assessment

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Parameter	Source-X	Source-Y	Type	Description
ILBMN			FW	Minimum integrator value battery charge assessment
ILBMX			FW	Maximum integrator value battery charge assessment
KFDILU	TUMG	UB	KF	map delta integrator value battery-charging budget depending on amb. temp.
NSUBO			FW	nsoll for battery charge assessment too low
NSUBU			FW	nsoll for battery charge assessment OK

Variable	Source	Type	Description
B_FS	CANEGS	EIN	Condition driving state (automatic gear box)
B_KL15		EIN	condition ignition switch on
B_LL	MSF	EIN	Condition idle
B_NSUB	BGLBZ	AUS	condition to increase nominal engine speed at low battery-voltage
B_PWF		EIN	Condition for powerfail
B_STEND	BBSTT	EIN	condition end of start
B_TNS	CANINS	EIN	Condition from switch day/night illumination
DILB	BGLBZ	AUS	Integrator input value for charge assessment battery
E_UB	GGUB	EIN	error flag: power supply voltage UB
ILB	BGLBZ	AUS	Integrator output value for charge assessment battery
NMOTLL		EIN	engine speed
NSLB	BGLBZ	AUS	Nsoll correction from charge assessment battery
NSLLM		EIN	LLR: target speed depending on engine temperature during idling
TUMG	GGTFUMG	EIN	Ambient air temperature
UB	GGUB	EIN	battery voltage
VFZG	GGVFZG	EIN	vehicle speed (km/h)

FB BGLBZ 5.10 Detailed description of function

The function determines whether the current performance of the generator is sufficient to prevent a discharging of the battery.

The integrator ILB shall simulate the battery charge condition by means of the input values. The desired speed of the idle control is influenced dependent on the integrator value. The purpose being to ensure a uniform charge balance at an as low as possible idle speed. This function not only works at idle but in all operating ranges (incl. start).

The basic gradient DILBN (pos. and neg.) for the charge-balance integrator, which is dependent on the parameter "engine speed" shall represent the basic charge balance of the vehicle battery, so the charge balances without additional electric consumers.
This means, at a certain engine speed (at which charge and discharge current are equal) this gradient = 0;
at a lower engine speed it is negative and so on.

The map KFDILU acts as second gradient influence. It shall detect the level of the battery voltage.
Among others the battery stress at start shall also be detected via this map.
Furthermore this takes the electric consumption with KL15 ON and engine at standstill into consideration.

Bit informations on the switch state of strong electric consumers are read via CAN. When a consumer is switched on the gradient of the integrator is additionally influenced dependent on the power demand of the consumer.

The integrator value ILB is constantly transferred to a RAM-cell in the permanent RAM, so that its contents is available as integrator starting value during the next start, i.e. the prehistory of the battery is thus known for the next engine run phase.
In case power fail is detected, ILB starts for safety with ILBINI during the next start.

From the integrator value ILB an idle speed setpoint NSLB is formed with hysteresis ILBHYSO / ILBHYSU between NSUBU / NSUBO.
This value is included in the maximum selection as additional input value in the idle setpoint section %LLRNS.

In case other functions do not make a higher engine speed necessary, the idle speed can then be lowered as far as possible by means of NSLB with regard to the charge balance.

APP BGLBZ 5.10 Application hint

LLRABG 1.20 Idle-speed control - correction of nominal speed by tester

FDEF LLRABG 1.20 Function definition

The possibility is given by means of suitable diagnostic test equipment at end-of-line
testing as well as in the workshop of making corrections to the low-idle setpoint speed.

Three KWP2000* diagnostics blocks are defined for the desired iddle speed setting:
- Block 1: Read adjustment values
- Block 2: Default adjustment values
- Block 3: Program adjustment values

Requirement with KWP-2000* protocol:

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	Tester sends (request): Service ID		ECU responds:	Service ID	Contents / Cause
Block 1:	Read adjustment value	IOCBLI	Positive response message Adjustment value read	IOCBLIP CS_abc	dnxxxmv
			Negative response message Response code	IOCBLI RC_	Transmission error
Block 2:	Default adjustment value	IOCBLI	Positive response message Defaulted adjustment value	IOCBLIPR CS_abc	dnxxxmv
			Negative response message Response code	IOCBLI RC_	Transmission error Adjusting condition not fulfilled B_nsabg = False
Block 3:	Program adjustment value	IOCBLI	Positive response message Programmed adjustment value	IOCBLIPR CS_abc	dnxxxmv
			Negative response message Response code	NR RC_	Transmission error Adjusting condition not fulfilled B_nsabg = False

llrabg-llr-abg

llrabg-llr-abg

Overview of data handling with shadow ROM and saving the adjustment values in the EEPROM:

Take the EEPROM values only for (B_eepdif = FALSE and B_ndsav = TRUE), otherwise set 0 !

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llrabg-ns-eb

Execute conditions for enabling adjustment of the set speed:

llrabg-dns-ver

Calculation for correction of the set speed:

ABK LLRABG 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NFSACVMN			FW	adjustable nominal speed for AC and FS minimum
NFSACVMX			FW	adjustable nominal speed for AC and FS maximum
NFSMVMN			FW	adjustable nominal speed minimum for FS
NFSMVMX			FW	adjustable nominal speed maximum for FS
NLLMVMN			FW	adjustable nominal idling speed minimum
NLLMVMX			FW	adjustable nominal idling speed maximum
NSACMVMN			FW	adjustable nominal idling speed minimum for AC
NSACMVMX			FW	adjustable nominal idling speed maximum for AC
NSLBVMN			FW	adjustable nominal idling speed minimum for undervoltage
NSLBVMX			FW	Adjustable nominal idle speed maximum for undervoltage
TMLLRNS			FW	engine-temperature threshold for adjusting nominal speed by tester
TMNV			FW	temperature threshold for DS2 Nnom adjustment for FS = 0
TMNVFS			FW	temperature threshold for DS2 Nnom adjustment for FS = 1

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Variable	Source	Type	Description
B_LL	MSF	EIN	Condition idle
B_NDSAV	PROKON	EIN	Condition EEPROM emulation active
B_NSABG	LLRABG	LOK	condition adjustment of engine idle speed
B_PWF		EIN	Condition for powerfail
C_INI		EIN	ECU-condition for intialisation
DNFSACMV		EIN	LLRNS: Delta desired speed of DS2 communicator, AC with FS
DNFSMV		EIN	LLRNS: Delta desired speed of DS2 communicator, with FS
DNLLMV		EIN	LLRNS: Delta desired speed of DS2 communicator
DNSACMV		EIN	LLRNS: Delta desired speed of DS2 communicator, AC without FS
DNSLBV		EIN	LLRNS: Delta desired speed of DS2 communicator, from LLRUB
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
TMOT	GGTFM	EIN	Engine temperature

FB LLRABG 1.20 Detailed description of function

Adjustment routine

Adjustment of Nsoll when the conditions Engine Temperature > TMLLRNS,
vehicle idling and B_ndsav = TRUE.
All three conditions must be fulfilled at the same time.

Each of the setpoint speeds can be subsequently changed for the various states (Ko, Fs, ...) by means of a DS2 tool.
The adjustment routine only functions for fixed ECU’s. The function can be switched on and off in the version
here by the bit B_ndsav from CWNSABG.

The names for the adjustment data (RAM cells) are according to the description for the function:
dnllmv, dnsacmv, dnslbv, dnfsacmv und dnfsmv.

The adjustment routine is carried out in three steps:

1. Block "Read adjustment value":
This block can be executed in each operating state of the engine (engine on, engine off). The contents of the adjustments made to the low-idle setpoint speed are read out of the permanent RAM for output in a response block. Qualization of the values is as described above.

2. Block "Default adjustment value":
This block is only evaluated when the engine is in the idle state (condition LL = idle) and TMOT > TMLLRNS.
If this is not the case then the REJECT response block is transmitted and no adjustment is performed.
All 5 LL adjustment values are always sent !!! If the user wants to change only one (or some) of the LL adjustment values, then the tester has to transmit back those values for the other LL adjustment values that were received from reading all the LL adjustment values. No error message is generated if the tester sends a value that is outside of the range foreseen for the low-idle setpoint speed. In this case, the value is automatically limited to the maximum or minimum value set in the labels NLLMVMX, ...

After execution of the command "Default adjustment value", the new values for the low-idle setpoint speed are in the permanent RAM and these act accordingly on the engine. If the engine is turned off before the block "Program adjustment value" was transmitted, then the old adjustment values from the flash are loaded again.

3. Block "Program adjustment value":
This block is only evaluated when the engine is in the idle state (condition LL = idle) and TMOT > TMLLRNS.
If this is not the case then the REJECT response block is transmitted and no programming is performed.
A noting flag is set internally in the program. The adjustment values still in the permanent RAM are programmed into the flash as soon as the engine is turned off and the program runs through the hold phase for a set noting flag.

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APP LLRABG 1.20 Application hint

EGFE 2.0 Input variables for charging detection

FDEF EGFE 2.0 Function definition

egfe-egfe

ABK EGFE 2.0 Abbreviations

Variable	Source	Type	Description
AGRP	EGFE	LOK	EGR partial pressure
AGRP_W	EGFE	LOK	EGR partial pressure
AGRRAT	EGFE	LOK	EGR ratio
AGRR_W	EGFE	LOK	exhaust gas recirculation rate
B_EHFM	EGFE	LOK	condition: HFM error (without debounce)
B_HFM	EGFE	LOK	Condition: HFM ready to measure
B_LL	MSF	EIN	Condition idle
DRLROH_W	EGFE	AUS	delta air charge
E_DK	GGDVE	EIN	Error flag: throttle position sensor
E_HFM	EGFE	LOK	fault on HFM
E_LM	EGFE	LOK	Error flag: main load sensor
FHO_W	EGFE	LOK	correction factor: altitude
FPVDK_W	EGFE	AUS	correction factor for pressure upstream of throttle valve, 16-bit
FRHOL_W	EGFE	AUS	Factor: air density f(intake air temp., altitude), 16-bit
FTBR	EGFE	LOK	factor: temperature correction in combustion chamber
FTR_NW	EGFE	LOK	Transient factor for camshaft control -> correction of ign.and inj.
FTSR	EGFE	LOK	correction factor for air temperature in the manifold
FTU	EGFE	LOK	factor: ambient temperature
FTVDK	EGFE	LOK	correction factor for temperature upstream of throttle valve
FUPSRL_W	EGFE	AUS	factor system related transformation pressure to load (16-Bit)
ML	EGFE	LOK	air mass flow
ML_W	EGFE	AUS	air mass flow filtered (Word)
MSAGR	EGFE	LOK	EGR mass flow into intake manifold
MSHFM_W	EGFE	LOK	air-mass flow HFM
MSTE	EGFE	LOK	mass flow purge control into the manifold
MSTEO	EGFE	LOK	Air mass flow thru open canister purge valve
MSTEO_W	EGFE	LOK	Mass flow the 100 % opened TEV
MSTE_W	EGFE	LOK	mass flow purge control into the manifold
NMOT	BGNMOT	EIN	engine speed
PIRG_W	EGFE	AUS	partial pressure residual exhaust gas internal EGR (16-Bit)
PSFG	EGFE	LOK	Intake manifold pressure of fresh gas and intern rest gas without external EGR
PSFG_W	EGFE	LOK	fresh air partial pressure in manifold

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Variable	Source	Type	Description
PS_W	EGFE	AUS	intake manifold pressure (absolute) (Word)
PU_W	EGFE	LOK	Ambient pressure
PVDK_W	EGFE	AUS	pressure upstream of throttle valve, 16-bit
RFAGR	EGFE	LOK	relative load by external exhaust gas reduction
RFAGR_W	EGFE	AUS	relative load by external exhaust gas reduction
RFGES_W	EGFE	LOK	total relative charge (including EGR)
RL	EGFE	AUS	relative air charge
RLDVS	EGFE	LOK	Relative air charging thru throttle valves in intake manifold
RLDVS_W	EGFE	LOK	relative air charge through throttle valves on intake manifold
RLROH	EGFE	LOK	Relative air charging: Raw value from load sensor
RLROH_W	EGFE	LOK	relative air charge flowing into intake manifold
RL_W	EGFE	AUS	relative air charge (Word)
TAAGR		EIN	duty cycle EGR valve
TAGS	EGFE	LOK	EGR temperature at point of intake manifold inlet
TAGS_W	EGFE	LOK	EGR temperature on introduction into intake manifold
TANS	GGTFA	EIN	Intake air temperature
TATEIST		EIN	actual duty-cycle of the PCV
TMOT	GGTFM	EIN	Engine temperature
UHFM		EIN	HFM voltage
WDKBA	GGDVE	EIN	throttle angle
WNWUE		EIN	camshaft overlap angle of inlet and outlet valve opening
Z_HFM	EGFE	LOK	cycle flag HFM
Z_LM	EGFE	LOK	cycle flag:^load determination LMM/HLM/HFM

FB EGFE 2.0 Detailed description of function

APP EGFE 2.0 Application hint

GGHFM 53.50 Sensor signal, hot-film air-mass meter

FDEF GGHFM 53.50 Function definition

gghfm-gghfm

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gghfm-ggabt

gghfm-kfpu

ABK GGHFM 53.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFKHFM	NMOT	RL	KF	HFM-correction characteristic map
KFPU	NMOTKOR	WDKBA	KF	pulsation characteristic map
KFPU2SU	NMOTKOR	WDKBA	KF	pulsation characteristic map at active variable intake sytem by sumode=2
KFPU3SU	NMOTKOR	WDKBA	KF	pulsation characteristic map at active variable intake system by sumode=3
KFPUSU	NMOTKOR	WDKBA	KF	pulsation characteristic map at active variable intake system by sumode=1
MLHFM	UHFM_W		KL	air-mass meter characteristic line
MLOFS			FW	offset for characteristic line of air mass flow meter HFM 5
PUKANS	TANS		KL	correction of pulsation depending on intake air temperature

Variable	Source	Type	Description
FPUK	GGHFM	LOK	correction factor for HFM in pulsation range
MLHFMA_W	GGHFM	LOK	air mass scanning value of HFM 16-bit
MLHFMM_W	GGHFM	AUS	mean HFM air mass value 16-Bit
MSHFM_W	GGHFM	AUS	air-mass flow HFM
NMOT	BGNMOT	EIN	engine speed
NMOTKOR	GGHFM	LOK	engine speed correction
RL	EGFE	EIN	relative air charge
R_SYN		EIN	Synchro schedule
R_T1		EIN	Time schedule 1 ms
SUMODE		EIN	status of the intake manifold switch over
SY_TURBO	PROKON	EIN	system constant for turbocharged engine
TANS	GGTFA	EIN	Intake air temperature

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Variable	Source	Type	Description
UHFM_W		EIN	HFM voltage
WDKBA	GGDVE	EIN	throttle angle

FB GGHFM 53.50 Detailed description of function

The air mass sensor (HFM) is scanned every 1ms. The scanned voltage is first linearised (MLHFM). The characteristic contains only positive values, for further calculation of the air mass flow. For this reason, when using a HFM5 an offset (MLOFS) for the reverse flow range must be taken into account when calculating the values for MLHFM. The calculated air mass values are then added together via a segment in a memory. Once per segment, at the beginning of the charge calculation, the totalled value is arithmetically averaged via the preceding segment, i.e. it is divided by the number of scans of the last segment and then the characteristic offset MLOFS is deducted. The value is then multiplied by a pulsation correction value taken from the map KFPU. This air mass flow is delivered to the output as a 16-bit value mshfm_w and as an 8-bit value mshfm.

APP GGHFM 53.50 Application hint

Procedure in application:

Linearisation characteristic of the HFM

Input/check of the linearisation characteristic of the HFM
- Characteristic dependent on size and design (hybrid/sensor) of the HFM used
- HFM2: Characteristic with positive air masses and MLOFS = 0 !!
- HFM5: Use characteristic with reverse flow range, i.e. pos. and neg. air masses, and additional offset (MLOFS = 200 kg/h)
- Interpolation is the same for HFM2 and for HFM5

When using a plug-in sensor variant the characteristic must be checked in conjunction with the fitting position used.

Prerequisites for application of the pulsation map

- Adaptation of the battery voltage correction TVUB, poss. determined by way of fuel measuring

- Neutralisation of all enrichments, i.e. set pre-control to Lambda=1 (e.g. KFLF); Pulsation correction initially neutralised (set KFPU to 1); Deactivate or increase psmax limitation

Application of the pulsation map

The pulsation map is used to compensate pulsation errors of the HFM; it is not intended to correct errors in the reverse flow range.

Definition of pulsation range:
Voltage oszillation of air mass sensor HFM < 0.5V

Definition of reverse range:
Voltage of air mass sensor HFM < 1.0

Adaptation of the pulsation map:
- Definition of the pulsation range; poss. distribution of interpolation points of the pulsation map for better coverage of the pulsation range

In fuel systems without constant differencial pressure upstream of the injection valve (e.g. RLFS), i.e. where the pressure regulator does not operate against the intake manifold pressure as a reference pressure, this must be specially guaranteed for application of the pulsation map (connection of the pressure regulator to the intake manifold).

If this is not possible for technical reasons, the varying pressure differential upstream of the injection valve must be taken into account beforehand in a correction map (see note on RLFS systems).

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DHFM 63.20 Diagnosis; plausibility test hot film air flow sensor

FDEF DHFM 63.20 Function definition

dhfm-dhfm

```
"- (*1) Unlike the circuitry, this part is realized in the module %DFPM."
"- (*2) The activities triggered by C_[*] (identified in the figure by (*2)) are processed in the software by separate processors."


"- Maximum value of wdkba e.g. for 8-bit wdkba ——> FF Hex"


Error memory management:
_______________


Status error path LM: SFPLM
Error flag LM:        E_lm
Cycle flag LM:        Z_lm
Error type LM:        B_mxlm
                      B_mnlm



Delete error path:     C_fcmclr & B_cllm
Error path LM  :                  CDTLM
Error class LM:                   CLALM
Error severity LM:                TSFLM
CARB code LM:                     CDCLM
Environmental conditions LM:      FFTLM      Environmental conditions: Refer to %DFFT
```

ABK DHFM 63.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMLDMN	WDKBAED_W	NMOT_W	KF	air mass flow threshold for min. failure
KFMLDMX	WDKBAD_W	NMOT_W	KF	air mass flow threshold for max. failure
MLOFS			FW	offset for characteristic line of air mass flow meter HFM 5
TDMLMN			FW	debounce time for minimum fault detection air-mass meter
TDMLMX			FW	debounce tme for maximum fault detection air-mass metr
TDMLNF			FW	debounce time air-mass meter diagnosis with o.k. status
TDMLST			FW	debounce time fault detection air-mass meter during start
TDUBHFM			FW	time of HFM-diagnosis at u < UBHFM
UBHFM			FW	battery voltage threshold for switch to msdk
ZMLRO			FW	time constant for low-pass-filter air mass flow

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Variable	Source	Type	Description
B_CLLM		EIN	condition: clear fault path main load sensor
B_EHFM	DHFM	AUS	condition: HFM error (without debounce)
B_HFM	DHFM	AUS	Condition: HFM ready to measure
B_MNLM	DHFM	AUS	Condition: min-error main load sensor
B_MXLM	DHFM	AUS	Condition: max-error main load sensor
B_STEND	BBSTT	EIN	condition end of start
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF		EIN	ECU-condition powerfail initialisation
E_DK	GGDVE	EIN	Error flag: throttle position sensor
E_LM	DHFM	AUS	Error flag: main load sensor
MLHFMM_W	GGHFM	EIN	mean HFM air mass value 16-Bit
NMOT_W	BGNMOT	EIN	engine speed
UB	GGUB	EIN	battery voltage
WDKBA_W	GGDVE	EIN	throttle angle with respect to lower mechanical stop
Z_LM	DHFM	AUS	cycle flag:^load determination LMM/HLM/HFM

FB DHFM 63.20 Detailed description of function

The scope of the function covers the following partial ranges:

Afterstart stabilization

The diagnostic routine is enabled only following elapse of the debounce time TDMLST, in order to suppress erroneous signals after turning on the HFM2 (12 V peak, pre-heating fault when switching on).
The beginning of triggering the debounce time is executed by the condition B_stend.
The same condition for enabling the diagnostic routine also applies for minimum errors.

B_mnlm, e.g. cable fall-off or short to ground

B_mnlm is set if
(mlhfmm-MLOFS) is less than the threshold value KFMLDMN that is dependent on the speed
and
the throttle valve
and the delay time TDMLST is triggered by elapse of B_stend followed
by elapse of the
debounce time TDMLMN (delay time in error entry
for minimum error).
A MAX selection between (mlhfmm-MLOFS) and (mlhfmf-MLOFS) is made during the formation of B_mnlm (mlhfmm = unfiltered HFM mean value, mlhfmf = filtered HFM mean value).

B_mxlm, e.g. short to Ubatt

B_mxlm is set if
(mlhfmm-MLOFS) is greater than the threshold value KFMLDMX that dependent on the speed and the throttle valve
and
the delay time TDMLST is triggered by elapse of B_stend followed by
elapse of the
debounce time TDMLMN (delay time in error entry for minimum error).
A MIN selection between (mlhfmm-MLOFS) and (mlhfmf-MLOFS) is made during the formation of B_mnlm
(mlhfmm = unfiltered HFM mean value, mlhfmf = filtered HFM mean value).

In the case of a throttle-valve fault (for E_dk), KFMLDMX is addressed with maximum throttle-valve angle, whereby on the uppermost threshold values then apply.
In the case of a throttle-valve fault (for E_dk), KFMLDMN is addressed with maximum throttle-valve angle, whereby on the lowest threshold values then apply.

B_noflr

B_noflr is set if
no error is detected (Min-Max-Plaus) with
the debounce time TDMLNF

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E_lm

Error flag is set after the respective debounce time for
B_minflror B_maxflr

Z_lm

Cycle flag is set for
B_plausor B_minflror B_maxflror B_noflr

B_ehfm

This flag is set without debounce for a Min or a Max error, in order that a switchover can be made immediately to the standby signal in the
event of a fault.
If the battery voltage is less than 11 volts for HFM5, then no further statement is possibility with the DHFM regarding the plausibility of the HFM signals (reason: voltage level of 0.5 - 2.0 V for a short circuit between Ubat and Uref) and a switchover is made with B_ehfm = true to the standby filling signal.
UBHFM threshold is meaningless for HFM2 and must be assigned with data accordingly such that no switchover is made to the standby filling signal (i.e. UBHFM = 0).

B_hfm

The flag B_hfm is set at the end of start-up (B_stend) and subsequent elapse of TDMLST and signals
the readiness by the HFM for measuring and operation. Filling detection after start-up is switched over with the Flag B_hfm from the standby filling signal to the main filling signal.
In the afterrun, the flag B_hfm must be defined and set to FALSE.

Remarks:
- Malfunction lamp control : 2 subsequent driving cycles (E_lm & Z_lm)
- No fault diagnosed on the hardware side
- Refer also to %DFVL for error memory management
- C_ini for resetting the cycle flag is described in greater detail in %DFVL

APP DHFM 63.20 Application hint

Standby measures:

Switchover to auxiliary filling signal and standby value RLNOT for simultaneous throttle-valve error (is realized in the function %BGMSZS).

Different additional project-specific measures are possible (refer to cross-reference matrix):

Disable idle-speed adaptation, >
Disable idle-speed control characteristics and demand adaptation, > Current adaptation values valid in each case
Disable KR adaptation,
Tank ventilation in continuous operation (no ban for adaptation)

Stored environmental conditions for occurrence of the error

We recommend for the case that the freeze-frame cannot be read out using the service diagnostic tester, that the following environmental conditions be saved as well for an occurrence of fault.
1. Environment value nmot_u
2. Environment value tmot_u
If it is possible to read the freeze-frame out using the service diagnostic tester, we recommend that two additional environmental conditions (variables not included in the freeze-frame) are saved as well, e.g. tans_u,wdkba_u. (Refer to %DFFT for table of references).

Guiding values for first application :

TDMLMN	0.3 sec	Possible drop in speed for connector falling off during idling, yet without the vehicle stopping.
TDMLMX	0.3 sec	
TDMLNF	1.0 sec	Stabilization behavior of HFM following a short
TDMLST	0.3 sec	Depending on start-up with fallen-off cable
ZMLRO	approx. 0.3 sec	Time constant from manifold pipe
KFMLDMX		Design approx. 20 % above maximum possible air mass from the corresponding throttle-valve angle
KFMLDMN		Design approx. 60 % below minimum possible air mass from the corresponding throttle-valve angle

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BGMSZS 10.60 Calculation of mass flows into intake manifold

FDEF BGMSZS 10.60 Function definition

bgmszs-bgmszs

bgmszs-msdk

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bgmszs-system

bgmszs-msndko

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bgmszs-dabgl

bgmszs-lad

ABK BGMSZS 10.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DFKMSMN			FW	Delta FKMSDKMN for resetting of B_fkmsmn
DFKMSMX			FW	Delta FKMSDKMX for resetting of B_fkmsmx
DFKPVMN			FW	Delta FKPVDKMN for resetting of B_fkpvmn
DFKPVMX			FW	Delta FKPVDKMX for resetting of B_fkpvmx
FKMSDKMN			FW	low limit for slow mass-flow correction of throttle valve

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Parameter	Source-X	Source-Y	Type	Description
FKMSDKMX			FW	high limit for fast mass-flow correction of throttle valve
FKPVDKE			FW	initialization value for integrator correction factor for mass flow compensation
FKPVDKMN			FW	lower limit for mass-flow correction of throttle valve
FKPVDKMX			FW	high limit for mass-flow correction of throttle valve
KFMSNWDK	WDKBAB_W	NMOT_W	KF	Map for scaled mass flow over throttle valve
KIMSA			FW	Coefficient for idle-speed air-mass for exhaust gas
KIMSALL			FW	Correction value for idling air mass integrator for E gas
KLAF	PSPVDK_W		KL	characteristic of Saint-Venant
KUMSRL			FW	conversion constant from mass flow to relative air charge
KVLAD			FW	air charge correction caust by boost pressure dynamic
LADFIL			FW	boost pressure filtering for calculation of delta boost pressure
MLFKMSDK			FW	air flow threshold for multipl. adjustment of HFM and throttle air flow
MSALLMN			FW	Minimum idling air mass adaptation for E gas
MSALLMX			FW	Maximum idling air mass adaptation for E gas
MSLG			FW	Mass flow total leakage air
NMSNDKO			FW	engine speed threshold for enable integrator for adaption unmetered air
PSPVDKUGN	NMOT_W		KL	Ratio pspvdk not throttled
RLNOT	NMOT		KL	limp-home relative air charge rl in case of E_DK and E_LM
TIMSA			FW	Integrator increase for multiple adaptation
TIMSALL			FW	Integrator increase for multiple adaptation (slow)
TMFKMSDKA			FW	Engine temperature threshold for multiple adaptation
WDKFMAON	NMOT		KL	Min. threshold enable multiple adaptation
WDKFMAUN	NMOT		KL	Max. threshold enable multiple adaptation
WDKMSON	NMOT		KL	Min. threshold enable additive adaptation
ZKMSDK	PSPVDK_W		KL	integrator speed for fast constant mass-flow adaption

Variable	Source	Type	Description
B_DSLVH	BGMSZS	LOK	boost-pressure sensor is on the system
B_DSSV	BGMSZS	LOK	intake-manifold pressure sensor is mounted
B_FKMSMN	BGMSZS	AUS	Quick adaption of the mass flow fkmsdks at the lower arrester
B_FKMSMX	BGMSZS	AUS	Quick adaption of the mass flow fkmsdks at the upper arrester
B_FKPVMN	BGMSZS	AUS	Slow mass flow adaption fkpvdk at the lower arrester
B_FKPVMX	BGMSZS	AUS	Slow mass flow adaption fkpvdk at the upper arrester
B_HFM	DHFM	EIN	Condition: HFM ready to measure
B_HFMI	BGMSZS	LOK	condition HFM-intern
B_HFMV	BGMSZS	LOK	HFM is mounted
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_TIMSA	BGMSZS	DOK	condition integrator for multiple adaptation enabled
B_TIMSALL	BGMSZS	DOK	condition integrator for additive adaptation enabled
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DRLLAD_W	BGMSZS	LOK	dynamic part of relative air charge rl at turbo engine
E_DK	GGDVE	EIN	Error flag: throttle position sensor
E_DSL	GGDSAS	EIN	error flag: pressure sensor charging pressure
E_DSS		EIN	error flag: Manifold absolute pressure
E_DSSI	BGMSZS	LOK	Errorföag: intake manifold pressure sensor intern
E_LM	DHFM	EIN	Error flag: main load sensor
FKMSDKA_W	BGMSZS	LOK	Correction factor rapid mass-flow equalization
FKMSDKS_W	BGMSZS	LOK	correction factor for fast mass flow signal
FKMSDK_W	BGMSZS	LOK	correction factor for mass-flow substitute load signal
FPVDK	BGMSZS	AUS	correction factor for pressure upstreams throttle
FPVDKDS_W	GGDSAS	EIN	Factor pressure in front of throttle valve of pressure sensor (word)
FPVDK_W	BGMSZS	AUS	correction factor for pressure upstream of throttle valve, 16-bit
FRHODK_W	BGMSZS	AUS	factor correction air density for throttle valve flow f(intake air temp.,altit.)
FTVDK	BGTEMPK	EIN	correction factor for temperature upstream of throttle valve
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSDIF_W	BGMSZS	AUS	mass flow difference mshfm_w - msdk_w
MSDKALM_W	BGMSZS	AUS	Mass flow over throttle (balance with HFM signal)
MSDK_W	BGMSZS	AUS	air-mass flow through throttle valve
MSHFM_W	GGHFM	EIN	air-mass flow HFM
MSNDKO_W	BGMSZS	AUS	norm leakage air mass flow through throttle blade
MSNDK_W	BGMSZS	AUS	standardised air mass flow through throttle valve
MSS_W	BGMSZS	LOK	mass flow frm sensor (selection between mshfm_w and ml_w)
MSTE	BGTEV	EIN	mass flow purge control into the manifold
NMOT	BGNMOT	EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed
PSPVDB_W	BGMSZS	AUS	quotient:int.manif.press.divided by press.upstream of throttle valve limit
PSPVDK_W	BGMSZS	AUS	quotient: int.manif.pressure divided by pressure upstream of throttle valve
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PU_W	GGDSAS	EIN	Ambient pressure
PVDK	BGMSZS	AUS	pressure in front of throttle
PVDKDS_W	GGDSAS	EIN	Pressure in front of throttle valve of pressure sensor (word)
PVDK_W	BGMSZS	AUS	pressure upstream of throttle valve, 16-bit
RLDVS_W	BGMSZS	AUS	relative air charge through throttle valves on intake manifold
RLROH_W	BGMSZS	AUS	relative air charge flowing into intake manifold
R_SYN		EIN	Synchro schedule
R_T10		EIN	Time schedule 10 ms
R_T200		EIN	Time schedule 200 ms
SY_EGFE	PROKON	EIN	system characteristic input-value
SY_TURBO	PROKON	EIN	system constant for turbocharged engine
TMOT	GGTFM	EIN	Engine temperature

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Variable	Source	Type	Description
UMSRLN_W	BGMSZS	AUS	calculation factor load to mass flow
WDKBA	GGDVE	EIN	throttle angle
WDKBA_W	GGDVE	EIN	throttle angle with respect to lower mechanical stop
WDKUGD_W	FUEDK	EIN	Throttle valve angle during which 95% charge is reached

FB BGMSZS 10.60 Detailed description of function

Since adaptation of the throttle angle stop limit at closed throttle valve occurs too infrequently under actual operating conditions (char.15 = true & nmot=0 & t<= 30 sec), an adaptation is carried out by means of a comparison of the air mass flow measured with the HFM and the air mass flow calculated via the throttle valve equation. This "leakage air adaptation" only runs under condition B_ll and when the main charge signal (!E_lm) and secondary charge signal (!E_dk) are ok. With MSALLMX and MSALLMN the maximum and minimum air mass adaption ranges respectively are defined.
Via factor KIMSALL the "leakage air adaptation" speed is set.
The output of the leakage air adapttion is added to the leakage air MSLG at closed throttle valve (wdkba = 0) and stored in the variable msndko_w. If the corrected air mass flow through throttle valve msdk corresponds to the air mass flow measured by HFM mshfm, the leakage air adaptation has been completed successfully.

APP BGMSZS 10.60 Application hint

The standardised flow through throttle valve KLAF is specified by physics, and is stored as a 501 * 16 bit table in the Eprom. The fine stepping from value to value is particularly necessary in the subcritical operating range, since the intake manifold model tends to oscillate if the stepping is spread too coarsely.
The values table for the outflow characteristic KLAF can be requested as an EXCEL file from H.Pfitz K3/ESY5 Tel. 8502 if required.

!!!! The KLAF is stored only once for the entire project in the EPROM (FLASH), due to the available memory space.!!!!

The KLAF input value is calculated in the relevant modules and transferred in a RAM cell. Then the corresponding output value of the KLAF is calculated using the transfer value, and the KLAF value is used for further calculations in the relevant software modules.
Characteristic MSNWDK for the standard mass flow through the throttle valve, dependent on the throttle angle wdkba, will not always be supplied by the engine manufacturer. In this case the following measurement variables are required to determine the characteristic:
wdkba - Throttle angle referred to stop limit at closed throttle valve
tans - Fresh-air temperature upstream of throttle valve
pvdk - Pressure upstream of throttle valve = ambient pressure in induction engine
ps - intake manifold pressure
mshfm - Air mass flow at HFM

The measuring of the characteristic of throttle valve is described in E-Bericht K3/ESY 28/96.

there are the following relationships:

ECU term

$$MSNWDK = \frac{mshfm}{fpvk * ftvdk * KLAF(pspvdk)}$$

fpvdk = pvdk/ 1013hPa

E-Bericht term

$$= \frac{msd}{(pvd/p0) * (Wurzel(T0/Tvd)) * Psin}$$

= pvd/1013 hPa

ftvdk = sqrt(273/(tans+273)) -> Square root of the standard temperature 273 Kelvins divided by the intake air temperatur (Kelvin)

KLAF - The value of KLAF as function of the ratio between the intake manifold pressure and the pressure upstreams of throttle valve.

Values for initialize:

LADFIL = 0.25
KVLAD = 0.35 %/hPa
MSALLMN = 0 kg/h
MSALLMX = 12 kg/h
KIMSALL = .01
KLAF is specified by physic

MSNDK: during application there must be a measured actuator characteristic.
for production application a desired value for actuator characteristic MSNDK has to be specified.
the characteristic MSNDK has to be correctected, so that at closed throttle valve (wdkba = 0) the air mass flow through the valve is zero (MSNWDK = 0 kg/h).

MSLG: during application the leakage air mass flow at closed throttle valve is entered in MSLG.
for production application the leakage air mass flow specified in the TKU is entered in MSLG

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DEGFE 2.10 Diagnosis of input variables for charge detection

FDEF DEGFE 2.10 Function definition

degfe-main

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Initialization block

degfe-init

degfe-init

ABK DEGFE 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDEGFE			FW	code word for shutdown of the function %DEGFE
TDEGFEMN			FW	Time delay for setting the MIN fault
TDEGFEMX			FW	Time delay for setting the MAX fault
TDEGFENO			FW	Time delay for setting NO fault
TDEGFEST			FW	Time delay after start-up

Variable	Source	Type	Description
B_CLEGFE		EIN	condition clear fault path EGFE
B_FKMSMN	BGMSZS	EIN	Quick adaption of the mass flow fkmsdks at the lower arrester
B_FKMSMX	BGMSZS	EIN	Quick adaption of the mass flow fkmsdks at the upper arrester
B_FKPVMN	BGMSZS	EIN	Slow mass flow adaption fkpvdk at the lower arrester
B_FKPVMX	BGMSZS	EIN	Slow mass flow adaption fkpvdk at the upper arrester
B_MNEGFE	DEGFE	AUS	Condition: MIN fault input parameters charging detection
B_MXEGFE	DEGFE	AUS	Condition: MAX fault input parameters charging detection
B_PWF		EIN	Condition for powerfail
B_STEND	BBSTT	EIN	condition end of start
E_EGFE	DEGFE	AUS	Error flag: input parameters for charging detection
Z_EGFE	DEGFE	AUS	Cycle flag: Input variables for charging detection

FB DEGFE 2.10 Detailed description of function

The function %DEGFE serves the diagnosis of the input variables for the charging detection. The fundamental concept of the function is based on an evaluation of the factors fkmsdks_w (rapid equalization) and fkpvdk_w (slower equalization) from the function %BGMSZS.
The error bit E_egfe is then set if the integrators of the massflow equalization in der %BGMSZS have run either in their lower limits, i.e. the bits B_fkmsmn & B_fkpvmn are TRUE, or if the integrators of the massflow equalization in the %BGMSZS have run in their upper limits, i.e. the bits B_fkmsmx & B_fkpvmx are set.
A shutdown of the function is possible by the code word CWDEGFE. The code word must be assigned the value of 0 for this. CWDEGFE shall be assigned the value of 1 if the function is to be activated.

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APP DEGFE 2.10 Application hint

Prerequisite for putting the function into operation is the correct application of the charging detection.
Particular attention shall be paid to assignment of the correct data for the following labels in the %BGMSZS:
- FKMSDKMX, FKMSDKMN, FKPVDKMX, FKPVDKMN, MSALLMX, MSALLMN, MSLG, ZKMSDK and ZKPVDK
  (Refer to the application in the %BGMSZS for proposed values)

Guiding values for the first application:

TDEGFEMN	2 sec.
TDEGFEMX	2 sec.
TDEGFENO	2 sec.

BGSRM 9.10 Model of intake manif. for calc. relative air charge and intake manif. pressure

FDEF BGSRM 9.10 Function definition

bgsrm-bgsrm

bgsrm-brfges

bgsrm-brl

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bgsrm-bps

bgsrm-bps

bgsrm-bpirg

bgsrm-bpirg

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Calculation in 20ms task

bgsrm-bpirg1

bgsrm-bpirg1

Calculation in 20ms task

bgsrm-rlsu

bgsrm-rlsu

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Calculation in 20ms task

bgsrm-pirg

bgsrm-pirg

ABK BGSRM 9.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FPVMXN	NMOT_W		KL	factor for pressure ratio maximum
FPVMXN2	NMOT_W		KL	factor for pressure ratio maximum with secondary last sensor
KFPRG	NMOT_W	WNWUE_W	KF	internal partial exhaust gas pressure dependent on camshaft adjustment sumode=0
KFPRG2SU	NMOT_W	WNWUE_W	KF	internal partial exhaust gas pressure depent on camshaft adjustment sumode=2
KFPRG3SU	NMOT_W	WNWUE_W	KF	internal partial exhaust gas pressure dpent on camshaft adjustment sumode=3
KFPRGSU	NMOT_W	WNWUE_W	KF	internal partial exhaust gas pressure dependent on camshaft adjustment sumode=1
KFURL	NMOT_W	WNWUE_W	KF	conversion factor from ps->rl dependent on camshaft adjustment sumode=0
KFURL2SU	NMOT_W	WNWUE_W	KF	conversion factor from ps->rl dependent on camshaft adjustment sumode=2
KFURL3SU	NMOT_W	WNWUE_W	KF	conversion factor from ps->rl dependent on camshaft adjustment sumode=3
KFURLSU	NMOT_W	WNWUE_W	KF	conversion factor from ps->rl dependent on camshaft adjustment sumode=1
KISRM			FW	integrator speed constant for intake manifold model
KISRM2SU			FW	integrator speed constant for intake manifold model by sumode=2
KISRM3SU			FW	integrator speed constant for intake manifold model by sumode =3
KISRMSU			FW	integrator speed constant for intake manifold model by sumode=1
ZVTPRGSU			FW	time constant for low pass filtering by intake manifold flaps dynamic

Variable	Source	Type	Description
AGRR	BGSRM	AUS	exhaust gas recirculation rate
AGRR_W	BGSRM	AUS	exhaust gas recirculation rate
B_HFM	DHFM	EIN	Condition: HFM ready to measure
B_SUMOD1	BGSRM	LOK	condition variable intake manifold sumode=1
B_SUMOD2	BGSRM	LOK	condition variable intake manifold sumode=2
B_SUMOD3	BGSRM	LOK	condition variable intake manifold sumode=3
C_INI		EIN	ECU-condition for intialisation
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_PWF		EIN	ECU-condition powerfail initialisation
DPSFG_W	BGSRM	AUS	delta fresh air partial pressure in manifold
DRL_W	BGSRM	AUS	charge change (Word)
FHO_W	GGDSAS	EIN	correction factor: altitude
FTBR_W	BGTEMPK	EIN	factor: temperature correction in combustion chamber
FTSR	BGTEMPK	EIN	correction factor for air temperature in the manifold
FUPSRL_W	BGSRM	AUS	factor system related transformation pressure to load (16-Bit)
FVISRM_W	BGSRM	AUS	integrator amplifier factor intake manifold modell
ML	BGSRM	AUS	air mass flow
ML_W	BGSRM	AUS	air mass flow filtered (Word)
NMOT_W	BGNMOT	EIN	engine speed
PIRGRO_W	BGSRM	LOK	unfilter value for partial pressure residual gas internal EGR
PIRG_W	BGSRM	AUS	partial pressure residual exhaust gas internal EGR (16-Bit)
PSAGR_W		EIN	partial pressure EGR
PSFG_W	BGSRM	AUS	fresh air partial pressure in manifold
PSMX_W	BGSRM	AUS	maximum manifold pressure limitation for modeled manifold pressure
PSRLRO_W	BGSRM	LOK	factor for conversion pressure in cylinder filling
PS_W	BGSRM	AUS	intake manifold pressure (absolute) (Word)
PU_W	GGDSAS	EIN	Ambient pressure
PVDKDS_W	GGDSAS	EIN	Pressure in front of throttle valve of pressure sensor (word)
RFAGR_W	BGSRM	AUS	relative load by external exhaust gas reduction
RFGES_W	BGSRM	LOK	total relative charge (including EGR)
RL	BGSRM	AUS	relative air charge
RLROH_W	BGMSZS	EIN	relative air charge flowing into intake manifold
RL_W	BGSRM	AUS	relative air charge (Word)
R_SYN		EIN	Synchro schedule
R_T20		EIN	Time schedule 20 ms

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Variable	Source	Type	Description
SUMODE		EIN	status of the intake manifold switch over
UMSRLN_W	BGMSZS	EIN	calculation factor load to mass flow
WNWUE_W		EIN	camshaft overlap angle of inlet and outlet valve opening

FB BGSRM 9.10 Detailed description of function

Target of the Function:

The intake manifold model calculates from the air-mass flows flowing into the intake manifold the fresh gas charge of the combustion chamber.

Description:

An integrator simulates the storage behavior of the intake manifold. It integrates with the integrator gradient KISRM the difference between in-flowing relative charge rlroh_w and exhausted relative air charge rl_w and supplies - after correction with the manifold temperature per ftsr and the standard pressure 1013 hPa - the fresh gas partial pressure in the intake manifold. This integrator is calculated in the synchro cycle. Thus it is possible to describe the increase of the pump output of the engine with increasing speed without changing the parameters.
External AGR is taken into consideration by an addition of the residual exhaust-gas partial pressure in the intake manifold psagr_w (see %BGAGR). As a result a measurable variable, namely the manifold pressure ps_w is now available, which can be used for the adjustment of the model during the application phase.
The fresh-gas partial pressure in the intake manifold is now limited to such a maximum value that the total pressure in the intake manifold ps_w does not rise above psmx_w, so that also in the reverse-flow zone of the HFM the manifold pressure never stabilizes at too high values. By this the fresh-gas charge rl_w is indirectly limited by means of the manifold pressure model.

At charge cycles BDC there is an approximate pressure compensation between intake manifold and cylinder. This means that there is a linear relation between cylinder charge and manifold pressure.
The exhaust residual share in the cylinder must additionally be described, since exhaust gas remains in the cylinder after the exhaust procedure and some of the residual exhaust gas flows back into the intake manifold hence, however, is sucked in again.

The camshaft overlap angle wnwue characterizes the crank angle, during which intake valve as well as exhaust valve is open and it is therefore a (non-linear) measure for the mean cross-sectional area that is available for the cross-flow of the exhaust gas from the exhaust system into the intake manifold. Since the cross-flowing exhaust gas mass is also dependent on the time span, also the engine speed needs to be taken into account as input value to describe the effect.

From this a linear rl_w - ps_w relation with offset KFPIRG(nmot,wnwue) and gradient KFPSURL(nmot,wnwue) results. Since the exhaust residual share pirg and the gradient fupsrl are dependent on the manifold change-over, a switch to the respective map is performed dependent on the manifold position. So as not to obtain abrupt changes at the exhaust residual share pirg and at the gradient fupsrl when changing over the flap position they are filtered by a low pass with the time constant ZVTPRGSU. Since a low pass has reached 95% of its final value after about 3*time constant, it only needs to be calculated for this time.

With decreasing ambient pressure the exhaust gas pressure decreases and thus the exhaust residual share in the cylinder. The offset pirg_w is therefore corrected with the altitude factor fho_w; for the gradient fupsrl_w a correction according to the combustion chamber temperature ftbr takes place.

With external AGR the conversion from manifold pressure to cylinder charge supplies the total air charge of the cylinder rfges_w including AGR part. The share of the exhaust residual charge of the cylinder rfagr_w results as ratio of the residual exhaust gas partial pressure in the intake manifold psagr_w to the charge-effective manifold pressure psorgs_w. The remaining charge share describes the fresh-gas charge of the cylinder rl_w.
rl_w is the central variable for the inclusion of all charge-dependent influences and basic variable for the pre-control of the injection.
The exhausted fresh-gas mass flow ml_w is obtained from the product of rl_w, engine speed and the conversion factor umsrln_w.

In contrast to previous tl-filter applications the time constant of the rl stabilization procedure is now no longer explicitly adjusted via a characteristic but it results implicitly from the steady-state adjustment of the ps-model and the (computable) value of KISRM. The value for KISRM is also switched over in dependency on the intake manifold position.

A charge gradient is formed for knock and misfire detection over one working cycle in the partial function RLGAS.
For this, the current value of rl_w (STORE_RL) and the segment time tseg_w (STORE_TSEG) are entered segment-synchronous into a ring buffer. The pointer irspsyn points to the position of the latest entry in the ring buffer. The size of the ring buffer is SY_ZYLZA + 2 values.
The charge difference drlas_w for one working cycle is calculated in the time cycle. It results from the charge at that position in the ring buffer to which irspsyn points minus the charge prior to SY_ZYLZA working cycles.
The duration of a working cycle (time for 1 camshaft revolution) tas_w is calculated by adding the individual segment times starting from irspsyn for SY_ZYLZA working cycles.
By a division of charge change drlas_w by the time tas_w needed for this the charge gradient over one working cycle is obtained.

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APP BGSRM 9.10 Application hint

Preconditions:

"- Conversion of air mass flow into rl is adjusted (see %BGMSZS) "
"- Temperature compensation is adjusted (see %BGTEMPK)"

Application aid:

For steady-state adjustment of the ps-model:
"- Slow manifold pressure measurement in the intake plenum"

For dynamic comparison of ps-model to ps-measurement:
"- Throttle-valve servomotor"
"- Quick manifold pressure measurement in the intake plenum (time constant sensor < 10 ms, sampling rate < 4 ms)"

Presetting of the parameters:

"- Maximum permissible ratio manifold pressure/pressure upstream throttle valve FPVMXN = 1.20"
"- Internal residual exhaust gas partial pressure in the cylinder KFPRG "
50 hPa at smallest wnwue, 300 mbar at largest wnwue, smaller with increasing engine speed
"- Gradient rl(ps)-characteristic KFURL "
0.105 %/hPa at smallest wnwue, 0.142 %/hPa at largest wnwue, smaller with increasing engine speed
"- Gradient of manifold pressure integrator KISRM "

$$KISRM = \frac{zkorr}{Vs/VH * z}$$

z.....Cylinder number:.....4 - 8
VH.....Displacement of the entire engine
Vs.....Manifold volume of throttle valve up to intake valves...typ. 1.5 .. 3.0 * VH
zkorr...Correction factor for numeric stability.....0.90 at z = 4
0.92 at z = 5
0.95 at z = 6
1.00 at z > 6

e.g.: z = 4, Vs/VH = 2.2 ⟶ KISRM = 0.1023

Deactivating the function:

"- Manifold dynamics simulation from: KISRM = 1.0"

Procedure:

"- Stationary for each engine speed nmot and camshaft overlap wnwue:"
Determine approx. 4 - 5 points rl and measured manifold pressure, calculate straight line through these points, determine ps-offset KFPRG (when rl = 0) and straight line gradient KFURL.

"- The dynamic correctness of the air-charge model must be proven after performed steady-state application of the ps-model by " means of throttle jumps (e.g. rl = 26 % ⟶ 60 %) and by comparing the manifold pressure measured with the fast ps-sensor to the ps_w simulated in the ECU. Possibly existing small deviations can be corrected by minor changes of KISRM. The ps-dynamics and thus also the rl-dynamics should in fact be satisfactorily described with the calculated value of KISRM.

Influenced functions:

All functions that use the charge signal rl, so nearly all!

BGTEMPK 3.40 Calculation of temperature compensation for intake manifold model

FDEF BGTEMPK 3.40 Function definition

ABK BGTEMPK 3.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FDVANS	TANS		KL	Temperature factor for air at throttle valve
KFFWTBR	RL	NMOT	KF	Weighting factor for combustion chamber temperature model
ZBRT			FW	time constant for combustion chamber temp. model
ZTDAGR			FW	time constant for temperature dynamics for EGR add-on - shutdown
ZTMMBR			FW	time constant, engine temperature for combustion chamber temp. model

Variable	Source	Type	Description
AGRR_W	BGSRM	EIN	exhaust gas recirculation rate
C_INI		EIN	ECU-condition for intialisation
EVTMOD	BGTEMPK	AUS	modelled temperature at inlet valve
FTBR	BGTEMPK	AUS	factor: temperature correction in combustion chamber
FTBR_W	BGTEMPK	AUS	factor: temperature correction in combustion chamber
FTSR	BGTEMPK	AUS	correction factor for air temperature in the manifold
FTU	BGTEMPK	AUS	factor: ambient temperature
FTVDK	BGTEMPK	AUS	correction factor for temperature upstream of throttle valve
FTW	BGTEMPK	DOK	factor weighting of temperature tmot, tans
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_T100		EIN	Time schedule 100 ms

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Variable	Source	Type	Description
SY_TFA	PROKON	EIN	configuration of the fitting position of air temperature sensor
TAGS_W		EIN	EGR temperature on introduction into intake manifold
TANS	GGTFA	EIN	Intake air temperature
TMOT	GGTFM	EIN	Engine temperature
TSGES_W	BGTEMPK	DOK	intake mainfold temp. (after EGR introduction)

FB BGTEMPK 3.40 Detailed description of function

This temperature compensation delivers the factor temperature combustion chamber (ftbr) which is used to convert the intake manifold pressure into air mass. The generally gas equation p*V = m*R*T gives the relationship between the pressure p and the air mass m. V is the volume, R the property of the air (air correction value = isentropic exponential) and T corresponds to the air temperature.
The intake manifold temperature sensor is usually installed in the air filter box or in the intake manifold.
The system constant SY_TFA configures the function for the installed position of the air temperature sensor.

```
SY_TFA = false: position of air temperature sensore downstreams of the EGR induction point at intake manifold
                meaesured temperature is a mixture of air and EGR tempeature
SY_TFA = true:  position of air temperature sensore upstreams of the EGR induction point at intake manifold
                measured temperature is air temperature and must be corrected to a mixture temperature by EGR-rate
```

The correct temperature required for the calculation is the air temperature in the combustion chamber. The temperature model can only calculate a air temperatur which corresponds to a temperature near to the inlet valve.
The modelled temperature depends on the relative air charge rl and engine speed nmot. The value of model based air teperatur is always between engine temperatur and intake air temperature. A weighting of TANS/TMOT is set with the map KFFWTBR which depends on air charge an engine speed.
The low pass in the TMOT branch prevents too rapid an increase in the modelled air temperature during the warming up of the engine.
The setting of a new thermal balance (air temperature near to the inlet valve) at load alteration is in the regions of seconds
The second low pass with the time constant ZBRT takes this into account and prevents the modelled air temperature from changing suddenly during load alteration.
The third low pass calibrated with ZTDAGR fits the dynamic behaviour from the modelled EGR-inlet temperature to the real temperature.
The modelled intake air temperature is converted into Kelvin. With a standardization to 273 Kelvin (0 degrees Celsius), a temperature compensation factor (ftbr) for other functions is calculated.
The temperature factor ftsr is used for the conversion of air mass into intake manifold pressure.
The temperature factor ftu converts the charged air mass into charged pressure for the charged pressure control.
A root tnorm/tans value for the calculation of the mass flows at the throttle is made available in the characteristic FDVANS.

APP BGTEMPK 3.40 Application hint

The intake manifold must be fitted with a thermocouple near to the inlet valve for the application of the temperature model. This is necessary in order to equalize the model temperature at the outlet of the low pass filter with the time constant ZBRT to the temperature measured at the intake manifold. It shall be observed thereby that the thermocouple tip is installed in the cross section of the intake manifold in order to prevent radiation heat from the intake manifold wall from falsifying the measurement results.
The map KFFWTBR is changed for different relative air charges rl and different engine speed, such that the model temperature agrees with the temperature measured with the thermocouple. Therefore the engine has to be at operating temperatur.

The time constant shall be selected such that for a change in the load, the new model temperature to be set changes at the same time as the suction air temperature as measured with the thermocouple. In practice measurements shall be thereby made at different jumps in the load and at several speeds. A mean value shall be selected for ZBRT from the time constants thereby determined.
The time constant ZTMMBR can only be checked when the engine is in warm up cycle, whereby the time constants shall be determined such that the model temperature agrees with the air temperature actually measured (thermocouple) for a previously matched weighting characteristic KFFWTBR. Several warm-run trials are usually needed for matching the time constant.
The time constant ZTDAGR has to apply in such manner, that the modell EGR-inlet temperatur has the same dynamic behaviour as the real EGR-inlet near plenum (measured with a thermo couple).

Initial value for application

KFFWTBR	Turbo engine 0, inducton engine 0.2
ZTMMBR	approx. 300 sec
ZBRT	approx. 2-5 sec
FDVANS	see table below
ZTDAGR	approx. 10 sec

The intake air temperature correction is stored as a factor in the characteristic FDVANS and addressed with tans [°C].
This characteristic is required to correct the specific air mass density at air mass flow through throttling valves.

$$FDVANS = V \frac{T0[k]}{TANS[K]}$$

Basis temperature T0 is 0°C = 273K i.e. ftans (0°C) = 1.0

Characteristic to be used with 8 set points for suction air temperature:

TANS	-40	-20	0	20	30	40	50	80
FDVANS	1,0824	1,0388	1.0	0.9653	0.9492	0.9339	0.9194	0.8794

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BGRLP 3.20 Calculation variable rlp: predicted air charge

FDEF BGRLP 3.20 Function definition

BGRLP: Overview load prediction

bgrlp-bgrlp

ENANSP: Activation conditions

bgrlp-enansp

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BWPR: Calculation of prediction angle wpr

bgrlp-bwpr

BPSMP: 1. Extrapolation manifold pressure

bgrlp-bpsmp

BRLP: Calculation of predicted air charge rlp_w

bgrlp-brlp

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BPSP: Calculation of predicted manifold pressure psp_w

bgrlp-bpsp

bgrlp-bpsp

BRLROHMP: Air mass flowing into the intake manifold at psmp_w

bgrlp-brlrohmp

bgrlp-brlrohmp

BRLMP: Air mass flowing out of the intake manifold at psmp_w

bgrlp-brlmp

bgrlp-brlmp

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BDPSMP: Gradient of manifold pressure at psmp_w

bgrlp-bdpsmp

bgrlp-bdpsmp

BDPSDVS: Gradient of manifold pressure at ps_w

bgrlp-bdpsdvs

bgrlp-bdpsdvs

BPSPMV: Calculation of predicted manifold pressure with the mean value of dps_w and dpsmp_w

bgrlp-bpspmv

bgrlp-bpspmv

ABK BGRLP 3.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CBGRLP			FW	Code word configuration function BGRLP
DRLDYNU			FW	drl threshold value for te post injection/reduction
DTEPRU			FW	delta-te threshold for post injection/ti-reduction detected
GRDWRT			FW	on hold - programmed reference-mark angle -> GDWRT
KFMSNWDK	WDKBAPB_W	NMOT_W	KF	Map for scaled mass flow over throttle valve
KLAF	PSMPPVDK_W		KL	characteristic of Saint-Venant
PSPVDKUGN	NMOT_W		KL	Ratio pspvdk not throttled
TNSURLP			FW	Time rl prediction suppression in post-start
WESBM			FW	angle intake closes before software reference mark (tR)

Variable	Source	Type	Description
B_LL	MSF	EIN	Condition idle
B_NSP	BGRLP	AUS	condition for post-injection
B_NSWO2	PROKON	EIN	condition engine speed > NSWO2
B_RLP	BGRLP	LOK	condition for load prediction
B_RLPNS	BGRLP	LOK	Enable condition load prediction after cranking
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_TIRED	BGRLP	AUS	Condition reduction of active injections
C_INI		EIN	ECU-condition for intialisation
DPSDVS_W	BGRLP	LOK	Delta intake manifold pressure from throttle valves (Word)
DPSFG_W	BGSRM	EIN	delta fresh air partial pressure in manifold
DPSMP_W	BGRLP	LOK	delta extrapolated intake manifold pressure (Word)
DRLP_W	BGRLP	AUS	delta predicted load for injection time calculation (word)
DRL_W	BGSRM	EIN	charge change (Word)
E_DK	GGDVE	EIN	Error flag: throttle position sensor
FRHODK_W	BGMSZS	EIN	factor correction air density for throttle valve flow f(intake air temp.,altit.)
FRHOLK_W	BGRLP	LOK	Factor: air density correction f(intake air temp., altitude) 16-Bit
FUPSRL_W	EGFE	EIN	factor system related transformation pressure to load (16-Bit)
FVISRM_W	BGSRM	EIN	integrator amplifier factor intake manifold modell
FWPRS_W	BGRLP	LOK	Factor prediction angle with respect to segment

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Variable	Source	Type	Description
MSNDKO_W	BGMSZS	EIN	norm leakage air mass flow through throttle blade
MSNDKPK_W	BGRLP	LOK	normalized predicted corrected mass flow over throttle (word)
MSTE	BGTEV	EIN	mass flow purge control into the manifold
NMOT_W	BGNMOT	EIN	engine speed
PIRG_W	EGFE	EIN	partial pressure residual exhaust gas internal EGR (16-Bit)
PSMP_W	BGRLP	LOK	extrapolated intake manifold pressure (Word)
PSMX_W	BGSRM	EIN	maximum manifold pressure limitation for modeled manifold pressure
PSP_W	BGRLP	LOK	predicted intake manifold pressure (Word)
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PVDK_W	EGFE	EIN	pressure upstream of throttle valve, 16-bit
RFAGR_W	EGFE	EIN	relative load by external exhaust gas reduction
RLDVS_W	BGMSZS	EIN	relative air charge through throttle valves on intake manifold
RLMP_W	BGRLP	LOK	rel. extrapolated air charge (Word)
RLP	BGRLP	AUS	rel. air charge predicted for injection calculation
RLP_W	BGRLP	AUS	rel. air charge predicted for injection calculation (Word)
RLROHMP_W	BGRLP	LOK	Relative air filling intake manifold flow for intake manifold pres. psmp_w(Word)
RL_W	EGFE	EIN	relative air charge (Word)
R_SYN		EIN	Synchro schedule
R_T10		EIN	Time schedule 10 ms
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
TE_W		EIN	effective injection time (word)
TVU_W		EIN	supply of voltage correction
UMSRLN_W	BGMSZS	EIN	calculation factor load to mass flow
VWKW	BGRLP	DOK	crankshaft angular speed
WDKBAP_W	BGWDKM	EIN	predicted throttle angle wdkbl for ti-calculation (Word)
WDKUGD_W	FUEDK	EIN	Throttle valve angle during which 95% charge is reached
WEA	EA	EIN	anglemark injection break off
WEE	EA	EIN	angle injection-end in normal operation
WPR	BGRLP	LOK	Calculated injection angle for load prediction
WPRNSP	BGRLP	LOK	Calculated injection angle for load prediction for behind injection

FB BGRLP 3.20 Detailed description of function

Prediction of the load of the injection-period calculation:

The charge cycle (LW) BDC determines the air charge of the cylinder, largely independent of the camshaft control times, since here a pressure compensation between intake manifold and cylinder is performed.
The load signal rl_w is based on the current manifold pressure ps_w and describes the air charge of the currently aspirating cylinder. Since it still takes a certain time until the LW-BDC of the cylinder belonging to currently calculated ti is reached, the manifold pressure can still change immensely.
By taking a future throttle-actual-angle wdkbap_w and the knowledge of the differential crank angle until LW-BDC (prediction angle wpr) as basis, the manifold pressure at LW-BDC psp_w can now be calculated in advance.

The entire prediction of the load of the injection-period calculation can be switched off by means of CBGRLP[bit 0 = 0].

1. Normal case without enabling of post-/asynchronous injection or of ti reduction

The crank angle from tr-mark until ignition TDC (GRDWRT) here is 108 ° crankshaft (KW)

```
                                                                LW-TDC            LW-BDC
    tr                tr                tr                tr       inlet opens       inlet closes
|——*——————————|——*——————————|——*——————————|——*——————————|——*——————————|——*——————————|
                      ^
                      |           |<——— ti(old) ———>|<————————— wee —————————>|—|   angle ti-beginning before tr-mark
               ti-calculation                                                   WESBM

                      |<- 1ms ->|                                          ——>|   |<—— (180°KW - GRDWRT)

                      |<——————————— wpr ————————————————————————————>|       prediction angle wpr
```

At first, the crank angle which lies between the current load /ti calculation in the synchro at a tr-mark and the charge cycle BDC of the corresponding cylinder is calculated (——> prediction angle wpr).
The 1. step here is to determine the angle between tr-mark and ti start + 1ms (= estimated calculation time synchro).
The angle is rounded to complete segments (720°KW/SY_ZYLZA); and thus the number of complete segments between ti calculation and tr-mark of the regarded cylinder is obtained.
Averaging the air mass across 1 segment means that rl_ can be temporally directly assigned to the tr-mark. However, 180°KW - GRDWRT (tr-mark prior to ignition TDC) must still be subtracted, in order to obtain the angle difference from the moment of load determination until LW-BDC (= prediction angle wpr).

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2. With enabling of post-/ asynchronous injection

```
                                                                  LW-TDC            LW-BDC
    tr                tr                tr                tr      inlet opens       inlet closes
|---*----------------|---*----------------|---*----------------|---*----------------|---*----------------|
                      ^
                      |                                   |<---------------- wee ---------------->|--|
                ti-calculation                                                                     WESBM
                                                          |<- DTEPRU ->|        |<-- wea ->|

                                                          |<----- wprnsp ------------------->|       prediction angle wprnsp

                                                          XXXXX                                     post-injections
```

If the predicted load rlp_w is distinctly larger than the current load rl_w (--> DRLDYNU), then the asynchronous /post-injection mechanism of the CIFI is enabled (B_nsp = 1).
Since now a prolongation of injections which are already taking place or of additional post-injections is allowed, the KW between the last updating possibility on a tr-mark and the inlet-closes-KW of the corresponding cylinder is used as prediction angle.
It is assumed, that the ti for a cylinder can still be updated if at least a time of DTEPRU (typical 5 ms) remains from the end of the ti calculation until the angle injection abort wea (see %EA), so that a sensible asynchronous injection duration is still possible.
This special treatment of the prediction angle wpr with B_nsp =1 can be prevented by means of CBGRLP[bit 1 = 0].

3. With ti reduction enabling:

```
                                                                  LW-TDC            LW-BDC
    tr                tr                tr                tr      inlet opens       inlet closes
|---*----------------|---*----------------|---*----------------|---*----------------|---*----------------|
                      ^
                      |           |<------ ti(old) ------>|<---------------- wee ---------------->|--|
                ti-calculation                                                                     WESBM
                                          |<- DTEPRU ->|

                                          |<-------- wpr ------------------------------------->|       prediction angle wpr
```

If the predicted load rlp_w is distinctly smaller than the current load rl_w (--> DRLDYNU), then the ti reduction mechanism of the CIFI is enabled (B_tired = 1).
Since now a ti reduction of injections which are already taking place is allowed, the KW between the last updating possibility on a tr-mark during still running ti and the inlet-closes-KW of the corresponding cylinder is used as prediction angle wprnsp.
The selection of the last updating possibility is made such that at least one (to be shortened) injection time of DTEPRU (typical 5 ms) remains.
This special treatment of the prediction angle wpr with B_tired = 1 can be avoided by means of CBGRLP[bit 2 = 0].

During start, during transition from start to after-start and shortly after end of start, rlp_w is supplied with the direct main load signal rl_w. In addition, the entire prediction can be deactivated by means of CBGRLP[bit 0 = 0].

APP BGRLP 3.20 Application hint

Preconditions:
- Main load sensing steady-state correct
- Secondary load sensing correct, that means msdk_w must comply to mshfm_w
- Load sensing dynamically correct, that means ps_w complies to the manifold pressure course measured during steady-state and during dynamics

- Pre-injection angle as late as possible (fuel flight time prior to inlet opens = about 8ms for usual injector mounting)
- Angle injection-abort as late as possible (approx. fuel flight time prior to charge cycle BDC)
- Distance of pre-injection angle to angle injection-abort so large that asynchronous/post-injections still have enough time also in case of N-dynamics (>= 4ms); otherwise the CIFI cannot give out any post-injection!!

- Throttle valve prediction correctly adjusted (see %BGWDKM)
- NSWO2-thresholds in %PROKON >= 4500 rpm

Presetting of the parameters:
- Threshold for post-injection / ti reduction enabling DRLDYNU = 5 %
- Threshold for minimum time post-injection / ti reduction DTEPRU = 5 ms
- Time for suppression of prediction during after-start TNSURLP = 5 s
- Configuration CBGRLP = 3 that means prediction on, ti post-injection enabled!!

Deactivating the function:
- Configuration CBGRLP = 2 that means prediction off, ti post-injection enabled

Procedure:
- The development of this function was aimed at minimizing the extent of the application, therefore nothing else needs to be done!!

Influenced functions:
- Transient control
  Since the prediction corrects the updating error of the load sensing of the injection-period calculation load sensing and in addition, also controls the reduction of the post-injection and of the ti of the CIFI, the application of the transient control is strongly influenced. For this reason it is necessary to adjust the load prediction prior to the transient control.

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GGDSAS 4.50 Sensor variable for pressure sensors outside the manifold pipe

FDEF GGDSAS 4.50 Function definition

Bit2: charge pressure sensor

ggdsas-ggdsas

ggdsas-ggdsas

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Bit2: charge pressure sensor

ggdsas-bgplsds

ggdsas-bgplsds

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voltage pressure sensor udsl_w [V]

ggdsas-ggdsl

ggdsas-ggdsl

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ggdsas-ddsl

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ggdsas-ggdsu

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ggdsas-ddsu

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ggdsas-init

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ggdsas-fcmclr

ggdsas-fcmclr

```
For partial function GGDSU:
"- (*1) deviant from the circuit this part is realized in the module %DFPM."
"- (*2) The actions triggered by C_[*] (marked in the picture by (*2)) are processed individually in the software."

Fault Code Memory Management:
-----------------------------

Status fault path DSU: SFPDSU
Error flag DSU:        E_dsu
Cycle flag DSU:        Z_dsu
Fault type DSU:        B_mxdsu
                       B_mndsu

Clear fault path:       C_fcmclr & B_cldsu
Fault path DSU  :                  CDTDSU
Fault class DSU:                   CLADSU
Fault severity DSU:                TSFDSU
Carb Code DSU:                     CDCDSU                                          Ambient: U1DSU nmot_u
Ambient conditions DSU:            FFTDSU     Ambient conditions see %DFFT                 U2DSU rl_u



For partial function GGDSL:
"- (*1) deviant from the circuit this part is realized in the module %DFPM."
"- (*2) The actions triggered by C_[*] (marked in the picture by (*2)) are processed individually in the software."

Fault Code Memory Management:
-----------------------------

Status fault path DSL: SFPDSL
Error flag DSL:        E_dsl
Cycle flag DSL:        Z_dsl
Fault type DSL:        B_mxdsl
                       B_mndsl

Clear fault path:       C_fcmclr & B_cldsl
Fault path DSL  :                  CDTDSL
Fault class DSL:                   CLADSL
Fault severity DSL:                TSFDSL
Carb Code DSL:                     CDCDSL
Ambient conditions DSL:            FFTDSL     Ambient conditions see %DFFT
```

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```
For partial function BGPLSDS:
"- (*1) deviant from the circuit this part is realized in the module %DFPM."
"- (*2) The actions triggered by C_[*] (marked in the picture by (*2)) are processed individually in the software."

Fault Code Memory Management:
_____________________________

Status fault path DSVLU: SFPDSVLU
Error flag DSVLU:        E_dsvlu
Cycle flag DSVLU:        Z_dsvlu
Fault type DSVLU:        ___
                         ___


Clear fault path:       C_fcmclr & B_clplsds
Fault path   DSVLU:                CDTDSVLU
Fault class DSVLU:                 CLADSVLU
Fault severity DSVLU:              TSFDSVLU
Carb Code DSVLU:                   CDCDSVLU                                                  Ambient: U1DSVLU nmot_u
Ambient conditions DSVLU:          FFTDSVLU     Ambient conditions see %DFFT                          U2DSVLU rl_u
```

ABK GGDSAS 4.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DPDSVLU			FW	delta pressure for signal comparison load-pressure with ambient pressure
DPUPVDK	ML_W		KL	pressure difference pu-pvdk
DSLGRAD			FW	gradient for turbo charge pressure sensor
DSLOFS			FW	offset for turbo charge pressure sensor
DSUGRAD			FW	gradient for ambient air pressure sensor
DSUOFS			FW	offset for ambient air pressure sensor
FHOE			FW	default value for altitude in case of sensor failure
KFLDFK	NMOT_W	PSSPVDKD_W	KF	constant for filtering air charge pressure
NDSVLO			FW	lower engine speed threshold for signal comparison load- with ambient pressure
NDSVLU			FW	engine speed threshold for signal comparison load-pressure with ambient pressure
PUE			FW	substitute value for ambient pressure in case of sensor failure
PUMN			FW	Ambient pressure limitation minimum
PUMX			FW	Ambient pressure limitation maximum
PUSPSMX			FW	Max. deviation of ambient pressure and manifold pressure
PVDKMN			FW	low limit of pvdk for failure detection of air charge pressure sensor
PVDKMX	NMOT_W		KL	load air pressure limit for diagnosis max. failure
PVDKPSMX			FW	Max. deviation of manifold pressure and pressure upstream throttle valve
SY_AGR_DSS			SYS (REF)	system constant
SY_EGFE			SYS (REF)	system constant input variable for charge detection
SY_TURBO			SYS (REF)	system constant for exhaust-gas turbocharger
TDDFL			FW	debounce time for error entry, boost pressure sensor
TDDFLUGD			FW	debounce time for error entry, boost pressure sensor
TDDFU			FW	dechatter time for ambient pressure sensor fault recognization
TDDFUUGD			FW	dechatter time for ambient pressure sensor fault recognization
UADPLMN			FW	min. voltage for diagnosis, boost pressure sensor
UADPLMX			FW	max. voltage for diagnosis, boost pressure sensor
UADPUMN			FW	minimum input voltage for pressure sensor diagnosis
UADPUMX			FW	maximum input voltage for pressure sensor diagnosis
WDKDSVLU	NMOT		KL	throttle plate threshold for pressure sensor plausibilisation
ZDSU			FW	time constant for filtering pu, fho

Variable	Source	Type	Description
ANZUDSL_W	GGDSAS	LOK	number of samples from boost pressure during one segment (long)
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_BEDSL	GGDSAS	AUS	condition DSL request
B_BEDSU	GGDSAS	AUS	condition DSU request
B_BEDSVLU	GGDSAS	AUS	condition DSVLU request
B_BKDSL	GGDSAS	AUS	Condition: charge pressure sensor active
B_BKDSU	GGDSAS	AUS	Condition: ambient pressure sensor
B_BKDSVLU	GGDSAS	AUS	Condition: pressure sensor comparision (load-/ambient pressure)
B_CLDSL		EIN	condition: clear fault path load pressure sensor
B_CLDSU		EIN	condition: clear fault path ambient pressure sensor
B_CLDSVLU		EIN	condition: clear fault pressure sensor comparision ambient- load pressure sensor
B_EDSL	GGDSAS	AUS	condition error in charging-pressure sensor
B_EDSUU	GGDSAS	LOK	condition error ambient pressure sensor not debounced
B_FTDSL	GGDSAS	AUS	Condition fault entry by tester for DSL
B_FTDSU	GGDSAS	AUS	Condition fault entry by tester for DSU
B_FTDSVLU	GGDSAS	AUS	Condition fault entry by tester for DSVLU
B_HAG	GGDSAS	AUS	condition altitude adaptation valid
B_MNDSL	GGDSAS	AUS	condition min. failure load pressure sensor
B_MNDSU	GGDSAS	AUS	Condition: min-error ambient pressure sensor
B_MNDSVLU	GGDSAS	AUS	codition: min. error pressure sensor comparision (load-/ambient pressure)
B_MXDSL	GGDSAS	AUS	condition max. failure load pressure sensor
B_MXDSU	GGDSAS	AUS	Condition: max-error ambient pressure sensor
B_MXDSVLU	GGDSAS	AUS	condition fault type 'maximum value' detected:pressure sensor comparision
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_NPDSL	GGDSAS	AUS	Condition: Boost-pressure sensor not plausible
B_NPDSU	GGDSAS	AUS	Condition: Ambient pressure sensor not plausible
B_NPDSVLU	GGDSAS	AUS	condition: pressure sensor comparison non plausible (load-/ambient pressure)

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Variable	Source	Type	Description
B_PWF		EIN	Condition for powerfail
B_SIDSL	GGDSAS	AUS	Condition signal fault of boost-pressure sensor
B_SIDSU	GGDSAS	AUS	error type: ambient pressure sensor
B_SIDSVLU	GGDSAS	AUS	error type: pressure sensor comparision (load-/ambient pressure)
DFP_DK	GGDSAS	DOK	ECU int. fault path no.: clear error throttle potentiometer
DFP_DSL	GGDSAS	DOK	internal failure path number: diagnosis load pressure sensor
DFP_DSU	GGDSAS	DOK	ECU int. fault path no.: ambient pressure sensor
DFP_DSVLU	GGDSAS	DOK	ECU int. fault path no.: pressure sensor comparision (load-/ambient pressure)
DFP_LM	GGDSAS	DOK	ECU-internal fault path no.: main-load sensor
DPVDKSPU_W	GGDSAS	AUS	delta between pressure upstreams throttle and ambient pressure
E_DK	GGDVE	EIN	Error flag: throttle position sensor
E_DSL	GGDSAS	AUS	error flag: pressure sensor charging pressure
E_DSU	GGDSAS	AUS	error flag: Pressure Sensor Ambient
E_DSVLU	GGDSAS	AUS	error flag: pressure sensor comparison (load-/ambient pressure)
E_LM	DHFM	EIN	Error flag: main load sensor
FHO	GGDSAS	AUS	Correction factor altitude
FHO_W	GGDSAS	AUS	correction factor: altitude
FPVDKDS	GGDSAS	AUS	Factor pressure in front of throttle valve of pressure sensor
FPVDKDSL_W	GGDSAS	AUS	Factor pressure in front of throttle valve of air charge pressure sensor (word)
FPVDKDSU_W	GGDSAS	AUS	Factor pressure in front of throttle valve of ambient pressure sensor (word)
FPVDKDS_W	GGDSAS	AUS	Factor pressure in front of throttle valve of pressure sensor (word)
FRHOL_W	GGDSAS	AUS	Factor: air density f(intake air temp., altitude), 16-bit
FTU	BGTEMPK	EIN	factor: ambient temperature
LDFKI_W	GGDSAS	AUS	map output of filter constant for filtering air charge pressure sensor signal
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	BGNMOT	EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed
PLSOL_W	FUEDK	EIN	Reference boost pressure
PSDSS_W		EIN	Intake manifold pressure measured with pressure sensor at manifold (DS-S)
PSSOL_W	FUEDK	EIN	Set intake manifold pressure
PSSPVDKD_W	GGDSAS	LOK	ratio set intake manifold pres/front of throttle valve of pressure sensor (word)
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PU	GGDSAS	AUS	Ambient pressure
PUS_W	GGDSAS	AUS	Ambient pressure without substitution on sensor error
PU_W	GGDSAS	AUS	Ambient pressure
PVDKDS	GGDSAS	AUS	Pressure in front of throttle valve of pressure sensor
PVDKDSL_W	GGDSAS	AUS	Pressure in front of throttle valve of air charge pressure sensor (word)
PVDKDSU_W	GGDSAS	AUS	Pressure in front of throttle valve of ambient pressure sensor (word)
PVDKDS_W	GGDSAS	AUS	Pressure in front of throttle valve of pressure sensor (word)
PVDKMX_W	GGDSAS	LOK	max. pressure upstream of throttle valve, initial value from characteristic P
PVDKSPUD	GGDSAS	AUS	Difference between ambient pressure and pressure upstream throttle valve
PVDKS_W	GGDSAS	AUS	pressure upstreams throttle without substitution on sensor error
SFPDSL	GGDSAS	AUS	status fault path: pressure sensor charging pressure
SFPDSU	GGDSAS	AUS	status fault path: ambient pressure sensor
SFPDSVLU	GGDSAS	AUS	status fault path: pressure sensor comparision (load-/ambiant pressure)
UDSLSUM_L	GGDSAS	LOK	signal voltage, boost pressure sensor summation during one segment (long)
UDSL_W		EIN	signal voltage, boost pressure sensor
UDSU_W		EIN	signal voltage, ambient pressure sensor (10-bit word of ADC)
WDKBA	GGDVE	EIN	throttle angle
Z_DSL	GGDSAS	AUS	cycle flag: pressure sensor charging pressure
Z_DSU	GGDSAS	AUS	cycle flag: Pressure Sensor Ambient
Z_DSVLU	GGDSAS	AUS	cycle flag: pressure sensor comparison (load-/ambient pressure)

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FB GGDSAS 4.50 Detailed description of function

Generally the following applies:
The section can be used for an aspirating or turbo engine as well as for an HFM-system. The necessary functionality of each system is determined by the system constant SY_EGFE, which is defined in the section %PROKON.
The system constant SY_EGFE states whether HFM, ambient pressure sensor, intake manifold sensor and pressure sensor upstream throttle valve exist. The system constant SY_EGFE is then defined as follows:

```
SY_EGFE     ->  Bit0: HFM exists (B_hfmv)
                Bit1: Pressure sensor downstream throttle valve (B_dssv)
                Bit2: Pressure sensor upstream throttle valve (B_dslvh)
                Bit3: Ambient pressure sensor; Pu-sensor (B_dsuv)

Example:     System with HFM and ambient pressure sensor       BIT         3   2       1       0
                                                                                       1   0       0       1     -
> SY_EGFE = 9
```

Partial function GGDSU:
In this function the voltage from an ambient pressure sensor is converted to an ambient pressure. Here the characteristic of the pressure sensor is assumed to be a straight line and can thus be converted from voltage to an ambient pressure by taking into account the offset DSUOFS and the gradient DSUGRAD. The ambient pressure is made available as output value pu. By dividing the ambient pressure by the standard pressure (1013 hPa) the altitude factor fho is calculated. The ambient pressure pu and the altitude factor fho are filtered with the time constant ZDSU. In order to obtain the pressure upstream the throttle valve pvdk, the pressure drop across the air filter is subtracted from the ambient pressure pu (only for aspirating engines). By dividing the pressure upstream the throttle valve pvdk by the standard pressure (1013 hPa) the factor pressure upstream throttle valve fpvdk is calculated (only for aspirating engines).
A simple signal plausibility check is performed in the partial function DDSU. This means an inquiry is made on the electrical plausibility thresholds UADPUMN and UADPUMX. The pressure sensor signal is plausible within the range UADPSMN <= udsu <= UADPSMX and PUMN <= pus_w <= PUMX. If the sensor voltage does not lie within the plausible range then after the time TDDFU an ambient pressure sensor fault is detected and E_dsu = true. Thereby a switch-over is performed from the given pressure pu resp. pvdk to the default value PUE, the altitude factor fho resp. fpvdk takes on the default value FHOE in case of a fault.
The air density, which lessens with increasing altitude is proportional to the ambient pressure pu. By multiplying the ambient temperature factor ftu by the altitude fho a density correction factor frhol is calculated. This factor is made available to other modules as a service. The altitude factor decreases by 0.1/1000m with increasing altitude.
The secondary air diagnosis and the AGR diagnosis are enabled with the bit B_hag = true (inverted E_dsu flag).

For partial function GGDSL:
The voltage udsl coming from the boost-pressure sensor is scanned dependent on the system constants SY_DSL10MS and SY_DSL2MS in the 2ms- resp. 10ms-cycle and converted to a boost pressure via the gradient factor DSLGRAD as well as the offset value DSLOFS.

The thus calculated boost pressure is filtered in dependency on the pressure ratio psspvdkd. A pressure fluctuation when opening the recirculation valve is thereby to be dampened at the supercharger. For measurements, e.g. by the workshop tester, the filtered pressure signal pvdks_w is available. The variable pvdks_w is not switched to default value.
A division by the standard pressure 1013 hPa provides the factor pressure upstream throttle valve, which is used in other functions (e.g. BGMSZS).

The pressure sensor signal is plausible within the range UADPLMN <= udsl <= UADPLMX and when PVDKMN < pvdk < PVDKMX.

If the sensor voltage or pvdk are not plausible for the time TDDFL then the fault E_dsl is detected and a switch-over to plsol_w, as default value pressure upstream throttle valve is performed.
For fault healing the pressure pvdk must be within the plausible range for the time TDDFL prior to the fault E_dsl being reset.

The characteristic of the pressure sensor for the boost pressure is assumed to be a straight line with an offset.

Partial function BGPLSDS:
In the partial function BGPLSDS a plausibility check of the ambient pressure sensor (DS-U) is performed on the turbo engine with the boost-pressure sensor (DS-L). By forming the difference of boost pressure pvdks_w minus ambient pressure pus_w and by subsequently forming the absolute value a sign-neutral difference of the pressure sensors (DS-L DS-U) is obtained. When the speed threshold NDSVLU is reached and when simultaneously the speed is less than NDSVLO the difference of the two pressure values is compared to the value DPDSVLU. If the difference of the two pressure values is greater than DPDSVLU, the error flag E_dsvlu is set. In the process the error flag is set with the delay time TDDSVLU. On aspirating engines with ambient pressure sensor and manifold pressure sensor (HFM- as main charge sensor with pressure sensor in the intake manifold for the AGR valve diagnosis) a signal plausibility check of the two pressure sensor signals is also performed when the speed threshold NDSVLU is exceeded (and if the speed is simultaneously less than NDSVLO). On aspirating engines without manifold pressure sensor the pressure signal difference is preset with 0 by means of B_turbo, thereby the result of the plausibility check is always false.
In order to detect the pressure sensor fault of the not plausible pressure sensor pair (DS-U/DS-L) resp. (DS-U/DS-S), the boost pressure sensor DS-L is compared - on the turbo engine in the boost pressure diagnosis DDSL at not plausible pressure sensor pair DS-U/DS-L - to the modeled manifold pressure from the manifold model at unthrottled operation (wdkba > WDKDSVLU). If the delay time TDDFLUGD has elapsed and the absolute value pvdks - ps_w is outside of the tolerance range PVDKPSMX, the boost-pressure sensor is defective. This check can only be performed if no E_dk is given.
The reversed conclusion that when the tolerance range PVDKPSMX is not exceeded the ambient pressure sensor is defective, is not automatically permissible due to the worst case tolerances of boost pressure and modeled manifold pressure.
With not plausible DS-U/DS-L at start and without error boost pressure (E_dsl) during unthrottled operation, the suspected defective ambient pressure sensor must be verified via a workshop tester by reading the ambient pressure and by making it plausible with regard to the current ambient pressure (see service hint).
On the aspirating engine with manifold pressure sensor the ambient pressure sensor DS-U at unthrottled operation (wdkba > WDKDSVLU) is compared - with not plausible pressure sensor pair (DS-U/DS-S) in the ambient pressure diagnosis DDSU - to the modeled manifold pressure from the manifold model. If the difference is outside of a certain tolerance range PUSPSMX, a fault of the ambient pressure sensor exists. This check can only be performed is no E_dk is given.

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APP GGDSAS 4.50 Application hint

For partial function GGDSU
The factor fho = 1.0 can be adjusted by a simulated fault: FHOE=1 and UADPSMN = 5V and UADPSMX = 5V.
(Check whether E_dsu=true, then a switch-over to FHOE=1 is performed.)

With error E_dsu a switch-over to the pressure default value PUE and to the altitude default value FHOE is performed.
Guidance values: FHOE = 1.0 thus no enleanment to sea-level possible.
PUE = 700 hPa complies to approx. 3000m altitude, thus no overboost by the turbo at high altitude.

Stored ambient conditions when the fault occurs

In case the freeze-frame cannot be read via the service diagnosis tester, we recommend to also store the following ambient conditions should the fault occur:
1. Ambient value nmot_u
2. Ambient value tmot_u
If the freeze-frame can be read via the service diagnosis tester, we recommend to store two further values (variables not contained in the freeze-frame) as ambient conditions, e.g. tans_u,wdkba_u. (reference table see %DFFT).

Basic values for initial application for partial function GGDSU:

DPUPVDK : starting at ml = 0 enter the value 0 with maximum ml approx. 40 hPa should be entered
The final data of this characteristic must be determined on the engine with production air filters and with final intake tract. Only applies for aspirating engines. For turbo engines this characteristic is not active.

```
PUE     =    700 hPa for turbo engines    1000 hPa for aspiration engines
FHOE    =      1.0
TDDFU   =    200 ms
ZDSU    =      5 sec
UADPUMN =    0.200 Volt
UADPUMX =    4.88 Volt
PUMX    =    1200 hPa
PUMN    =     400 hPa
DSUGRAD =    see calculation example
DSUOFS  =    see calculation example
TDDFUUGD=     1.0 sec    (guidance value factor 2 manifold time constant)
WDKDSVLU=    Preset speed-dependent angle such, that pressure drop of pressure upstream and downstream throttle valve < 5%
             Basic data to be entered: as WDKUGDN
PUSPSMX=     200 hPa  ambient pressure sensor tolerance plus tolerance modeled manifold pressure plus 50 hPa safety margin
                      Only active on aspirating engines with pressure sensor in the manifold and ambient pressure sensor
             By entering 100 % into the entire characteristic it is ensured in case of E_dsvlu (not plausible pressure
             values DS-U/DS-L resp. DS-S/DS-U) that no error E_dsl on turbo resp. E_dsu on aspirating engine is set.
```

Calculation example of DSUGRAD (gradient) and DSUOFS (offset) of the ambient pressure sensor characteristic

assumed values of the ambient pressure sensor characteristic 600 hPa = 2.37 V
1150 hPa = 4.54 V

1.) $$DSUGRAD = \frac{\text{delta y}}{\text{delta x}} \longrightarrow \frac{(1150\ \text{hPa} - 600\ \text{hPa})}{(4.54\ \text{Volt} - 2.37\ \text{Volt})} = \underline{253\ \text{hPa/Volt}}$$

2.) pu = DSUGRAD * Upu (at 2.37 Volt) + P_offset ——> P_offset = pu 600hPa(at 2.37V) - 2.37V * DSUGRAD

DSUOFS = 600 hPa - (2.37V * 253 hPa/Volt) = 0 hPa

For partial function GGDSL:

Basic values for initial application:

```
TDDFL   =    200 ms
UADPLMN =    0.200 Volt
UADPLMX =    4.88 Volt
DSLGRAD =    see calculation example
DSLOFS  =    see calculation example
PVDKPSMX=    210 hPa      Boost-pressure sensor tolerance plus tolerance modeled manifold pressure plus safety margin
TDDFLUGD=    1.0 sec      choose such that ps_w and pvdks have stabilized after B_ugd=true has been reached
WDKDSVLU=    see partial function GGDSU
```

Calculation example of DSLGRAD (gradient) and DSLOFS (offset) of the boost-pressure sensor characteristic

assumed values of the boost-pressure sensor characteristic 200 hPa at 0.4 V
2500 hPa at 4.65V

1.) $$DSLGRAD = \frac{\text{delta y}}{\text{delta x}} \longrightarrow \frac{(2500\ \text{hPa} - 200\ \text{hPa})}{(4.65\ \text{Volt} - 0.4\ \text{Volt})} = \underline{541\ \text{hPa/Volt}}$$

2.) pvdkds = udsl(200hPa)*DSLGRAD + DSLOFS ——>

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DSLOFS = pvdkds(0.4V) - udsl(200hPa) * DSLGRAD = 200 hPa - 0.4 V * 541 hPa/V = -16.4 hPa

Map KFLDFK: Base points nmot_w——> 3000 4000 5000 6000

psspvdkd_w					
0.8	0.01	0.01	0.01	0.01	0.01 = Filter off
0.9	0.01	0.01	0.01	0.01	
0.96	0.04	0.06	0.07	0.08	
1.0	0.05	0.07	0.08	0.09	
1.05	0.04	0.06	0.07	0.08	
1.15	0.03	0.03	0.03	0.03	

Fixed value PVDKMN : 370 hPa (ambient pressure at maximum altitude minus tolerances DSL)
The value is to be adjusted such that at maximum operating altitude of the vehicle and defective supercharger (no compression by supercharger) no sensor fault is detected.

!!! Attention application engineers: When incorrect data are entered into PVDKMX, the engine resp. turbo charger may be damaged !!!

Characteristic PVDKMX: Base points nmot 600 920 1200 1520 rpm
1350 1400 1800 2559,95 hPa
(FFFF Hex)

Above the response speed of the turbo charger (usually 1500 .. 1750 rpm) the max-fault detection must be deactivated by setting PVDKMX to 2559,96 hPa (FFFF Hex), since otherwise the incorrect default measure may possibly be started, the consequence of which could be an engine failure.
The deactivation above the response pressure of the turbo charger is absolutely necessary since based on the boost-pressure information pvdks it is not possible to distinguish between pressure sensor faults and overboost faults (E.g. waste-gate is jamming at closed position or pipe is disconnected at waste-gate pressure box).

For partial function BGPLSDS: PVDKMX
Basic values for initial application

NDSVLU: 50 rpm
NDSVLO: 300 rpm
DPDSVLU: 220 hPa

If the engine speed is within the thresholds NDSVLU and NDSVLO, the pressure sensor comparison is performed between DSL and DSU
Add worst case sensor tolerances DS-U and DS-L + safety margin
(must be greater than PVDKPSMX)

BGTEV 1.60 Calculation variable, mass flow TEV

FDEF BGTEV 1.60 Function definition

BGTEV: Function BGTEV:

bgtev-bgtev

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TATEISTB: Function part TATEISTB - Calculation of the actual duty cycle:

bgtev-tateistb

MSTEB: Function part MSTEB - Calculation of the PCV mass flow:

bgtev-msteb

ABK BGTEV 1.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FUMRMV			FW	factor for density of the air
FUMSTEK			FW	factor for switching over to map-calculation of the mass-flow through the PCV
KFAFTE	NMOT	WDKBA	KF	map flow-characteristic of PCV (incl. PCV carcoal-canister line)
KLAFTE	PSPVDK_W		KL	characteristic of Saint-Venant of purge control valve an line AKF-TEV
MSNTATE	TATEIST		KL	Characteristic standardized mass flow through TEV
NOVZTE			FW	code word for desired duty cycle not delay

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Variable	Source	Type	Description
B_DTEAA		EIN	Condition diagnosis CPV by opening the CPV active
C_INI		EIN	ECU-condition for intialisation
E_LM	DHFM	EIN	Error flag: main load sensor
FAFTEKF	BGTEV	LOK	factor flow through PCV: value from characteristic map
FAFTE_W	BGTEV	LOK	factor flow through PCV
FHO_W	GGDSAS	EIN	correction factor: altitude
FTHO_W	BGTEV	LOK	factor temperature and altitude depending correction of mass flow
FTVDK	BGTEMPK	EIN	correction factor for temperature upstream of throttle valve
MSNTETEV_W	BGTEV	LOK	normalized mass flow PCV (16 bit)
MSNTEVO_W	BGTEV	AUS	normalized mass flow through the complete open PCV
MSTE	BGTEV	AUS	mass flow purge control into the manifold
MSTEDTE	BGTEV	AUS	purge mass flow for DTEV
MSTEO_W	BGTEV	AUS	Mass flow the 100 % opened TEV
MSTETEV_W	BGTEV	LOK	mass flow through the purge control valve
MSTE_W	BGTEV	AUS	mass flow purge control into the manifold
NMOT	BGNMOT	EIN	engine speed
PSPVDK_W	BGMSZS	EIN	quotient: int.manif.pressure divided by pressure upstream of throttle valve
R_T20		EIN	Time schedule 20 ms
TATEIST	BGTEV	LOK	actual duty-cycle of the PCV
TATESLO1	BGTEV	LOK	desired durty cycle of the PVC (delay of one calculation frame)
TATESLO2	BGTEV	LOK	desired durty cycle of the PVC (delay of two calculation frames)
TATESLO3	BGTEV	LOK	desired durty cycle of the PVC (delay of three calculation frames)
TATESOLL	GKRA	EIN	desired duty cycle of the PCV
TEVPER	ATEV	EIN	periode time of purge control valve
TEVPERO1	BGTEV	LOK	periode time of purge control valve delay of one calculation frame
TEVPERO2	BGTEV	LOK	periode time of purge control valve delay of two calculation frames
TEVPERO3	BGTEV	LOK	periode time of purge control valve delay of three calculation frames
TEVPERVZ	BGTEV	LOK	delayed period time of the PCV
VREGDIA_W	BGTEV	AUS	gas volume flow through the purge control valve: for fuel tank diagnosis
WDKBA	GGDVE	EIN	throttle angle

FB BGTEV 1.60 Detailed description of function

Introduction:

The section BGTEV calculates the mass flow (mste resp. mste_w) which flows into the intake manifold via the purge control valve (PCV). Mste is included in the calculation in the load acquisition as additional air charge. In the canister purge control function mste_w is needed for the later calculation of the ti-correction (rkte_w). Furthermore the possible volume flow through a fully opened valve is needed (msteo_w) for the canister purge control function.

For the canister diagnosis a value of the volume flow PCV is needed which is independent of HFM tolerances. This value is also formed in BGTEV (vregdia_w). Vregdia_w is the product from the standardized mass flow PCV in the over-critical (msntetev) with the output value of a characteristic map over engine speed and throttle valve angle (KFAFTE) divided by the density of air (FUMRMV).

It is assumed that pure air flows through the PCV. In case of charged activated carbon filter, therefore, the HC molecules which flow through the PCV are considered just like air molecules. The thus resulting charge error can, however, be neglected when taking into consideration that at the max. only approx. 1/46 of the entire volume flow flowing into the intake manifold can consist of fuel particles. So in the extreme case (HC-conc. = 1) a charge error of approx. 2% at 50% fuel proportion canister purge control is obtained.

Calculation of the actual duty cycle on the PCV (tateist):

For the calcualtion of the mass flow through the purge control valve at first the "current, actual" duty cycle at the PCV must be calculated. For this it is assumed that the PCV-timer takes over the desired duty cycle in the mean delayed by half a period. With the thus delayed duty cycle (tateist) the current mass flow mste_w is calculated.

Example: The PCV closes (resp. opens) e.g. at decreasing load (increasing load) with a period of 120 ms in the mean 60 ms later than is demanded by the requirement (tatesoll). By the delay by 60 ms tateist takes into consideration the mean "retarding" of the PCV.

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Example for the calculated delay of the signal tateist and for the actually given out duty cycle Tatesoll

The calculation of tateist in detail:

The duty cycle tatesoll as well as the period are stored delayed up to 3-times (in the 20 ms grid) as a RAM-cell.

Remark: Apart from values for the duty cycle also values for the period need to be stored in order to be able to take into consideration that the PCV-timer each time processes the period transfered in the past and thus a change from a large period to a small period can only be taken over after the large period has passed.

The variable delayed period (tevpervz) is inquired upon:
- if tevpervz < 60 ms then the value of tevper (tevper(-1)) delayed by only one calculation cycle is used
- if tevpervz >= 60 ms but also <= 100 ms then the value of tevper (tevper(-2)) delayed by two calculation cycles is used
- if tevpervz >= 100 ms and at the same time also tevper(-3) >= 100 ms then tevper(-3) is used.
  This additional And-inquiry is necessary so that in case of a period jump from e.g. tevper = 30 ms to tevper = 120 ms at first after one calculation cycle the 120 ms, but then again the 30 ms are given for a calculation cycle as delayed duty cycle tevpervz.

For the calculation of the delayed duty cycle it is now only necessary to give the selection conditions for the period also to the switches for the selection of the corresponding 1-,2-,3-times delayed duty cycle. Thus the value for tateist can be obtained from tatesoll.
Important: The switch is operated only after the calculation of tateist.

With the codeword "NOVZTE" the delay of tatesoll can be switched off.

Calculation of the mass flow into the intake manifold (mste_w):

Principally two different calculation types for the mass flow through the purge control valve must be distinguished:

a) The calculation derived from the KLAFTE - characteristic line
b) The calculation derived from a characteristic map KFAFTE over the engine speed and the throttle valve angle

to a) The mass flow through a valve depends on the quotient of the pressures ps_w/pvdk_w = pspvdk_w. Because of the long pipes there is needed a special KLAFTE for the PCV flow.

to b) It cannot be ruled out that while being at full load ps_w/pvdk_w is silghtly wrong. That causes big deviations in mste_w if the KLAFTE is still used for calculation. Furthermore local small vacuums can occur (Bernoulli) due to flow effects on the PCV. Here it may be necesseray to switch-over to an adjusted characteristic map value. In the characterisic map KFAFTE (characteristic map outflow purge control valve) the actually measured values of the mass flow through the PCV (incl. pipe) must be stored pressure- and altitude-corrected and divided by MSNTATE. So to speak KFAFTE contains the individual flow rate characteristics for PCV and pipe. KFAFTE has just as KLAF values between 0 and 1.0. So as to obtain a harmonic quantization with fafte_w the value range, however, is [0... < 2].

Remark: The mass flow at given external temperature and at given pressure can be measured by means of a "mass flow meter". With this and from the determined characteristic line (MSNTATE) the values of the individual flow rate function PCV + pipe can be calculated.

KFAFTE = mstetev_measured / MSNTATE / (ftho_w)

- ftho_w = correction temperature = SQRT (273 K / tans) and correction pressure = pu / 1013 hPa

The change-over from the value determined under a) and the value determined under b) is performed as soon as the KLAFTE as well as once the characteristic map value from KFAFTE lies below the threshold FUMSTEK.

Thus it is achieved that close to full load the characteristic map value is given out. However, in case of lower intake manifold pressures the value calculated from the HFM-signal which is also correct with regard to dynamics is used.

With B_dteaa = TRUE the mass flow mste_w is set Zero to switch off the consideration of the purge mass flow in the complete system. (load detection, throttle activation, purge control function). This is important for the diagnosis of the purge valve, because the effect of valve opening should cause a reaction in the system (idle control closes the throttle, Lambda controller corrects Lambda deviation).

Examples from the application (MSNTATE and KLAFTE) - Taking into consideration the flow resistance of the pipe "ACF-PCV":

Duty cycle-dependent correction:

By the freely adjustable opening characteristic MSNTATE any PCV-characteristic line can be taken into consideration. In addition it can be considered that with a high flow resistance of the pipes and of the ACF also in case of a linear characteristic of the PCV a curved characteristic line msntetev_w = f(tate) is obtained.

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Example for MSNTATE for a PCV with mass flow 5.5 kg/h (without pipe, without ACF) and 3.5 kg/h with ACF and pipe

```
    MSNTATE
       ^
  5.5  |                                    -
       |
5 kg/h+
       |                              -
       |
       |                           -
                                                        ———   characteristic line PCV with pipe and PCV
4 kg/h -                      -                         ———   characteristic line only PCV
       |
  3.5  |                    -              +
       |                              +
3 kg/h -                 -        +
       |                     +
       |              -    +
       |                +
2 kg/h -            -  +
       |           +
       |        +
       |      +
1 kg/h -    +
       |
       |  +
       |____________________________________________>  tateist
       0      20      40      60      80      100%
```

Example of a characteristic line MSNTATE (correction is dependent on duty cycle).
Characteristic line measured at very low intake manifold pressure (ps/pu < 0.3)

From this example it becomes obvious:

- The pipe upstream of the PCV and the ACF markedly reduce the mass flow (5.5 kg/h -> 3.5 kg/h)
- The linear characteristic line over the duty cycle becomes curved.

Example for the KLAFTE:

```
    KLAFTE
       ^
       |
       |
       |                                                ———  KLAFTE short line, normal PCV
1.00   |—*# + # + # + # + #  + #                         ****  KLAFTE long line, normal PCV
       |            *         +   #                     ####  KLAFTE short line, Laval-PCV
       |                 *            #
       |                         +
0.75   -                     *
       |                              #
       |                              +
       |                         *
0.50   -                              #
       |                        xxxxxxxxxxx    <- lower application limit of KLAFTE: 0.45  !!!!
       |                                          for higher pspvdk_w the map KFAFTE is used => FUMSTEK = 0.46 !!
       |                          *     #
0.25   -
       |                              *  +
       |
       |                                 *
       |_____________________________________________>  pspvdk_w
       0      0.2             0.6             1.0
```

After having selected the best value of the flow rate characteristic (faftekf or fafte_w) for the corresponding operating state the selected value is corrected with regard to altitude and pressure (multiplication by ftho_w). The thus corrected value is multiplied by msntetev_w. The duty cycle-dependent mass flow through the PCV is obtained.

In a later version of the BGTEV also the pipe PCV-intake manifold can be taken into consideration (storage effect).

In this BGTEV mstetev_w is identical to the output value mste_w.

Apart from the current flow rate also the flow rate through the fully opened PCV is needed in the TEB. Msteo_w is calculated from MSTATE if 100% (resp. 99.61% = FF HEX) is assumed as input.

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APP BGTEV 1.60 Application hint

Values for the "initial application":

- FUMSTEK = 0.46
- FUMRMV = 1.3
- MSNTATE - base points/ values

0	11.1	22.2	33.3	44.4	55.5	66.6	77.7	88.8	100	[%]
0	0.634	1.269	1.903	2.537	3.1718	3.80664	4.441	5.07500	5.72	[kg/h]

KFAFTE:

wdkba / nmot	600	800	1000	1400	1800	2400	3000	3500	4000	5000 rpm
4%	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10%										
16%	0.60	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00
24%										
34%	0.20	0.50	0.80	0.95	1.00	1.00	1.00	1.00	1.00	1.00
45%										
55%	0.05	0.1	0.40	0.60	0.85	0.90	0.95	1.00	1.00	1.00
65%										
80%	0.01	0.02	0.08	0.15	0.40	0.50	0.60	0.70	0.75	0.80
99.61%	0.01	0.01	0.04	0.08	0.20	0.25	0.30	0.35	0.40	0.45

KLAFTE see under %FB.

MDFUE 9.20 Nominal-value input from nominal torque for airmass

FDEF MDFUE 9.20 Function definition

mdfue-mdfue

ABK MDFUE 9.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMIRL	NMOT_W	MILSOL_W	KF	map for calculation of nominal charge
RLMNN	NMOT		KL	characteristic minimum charge
RLMNSAN	NMOT		KL	characteristic minimum charge in overrun
ZETABASN	NMOT		KL	Low-pass filter time constant for etabas_w

Variable	Source	Type	Description
B_SA	MDRED	EIN	Condition fuel cut-off
C_INI		EIN	ECU-condition for intialisation
DRLSOL_W	MDFUE	AUS	change of nominal charge
ETABASF_W	MDFUE	DOK	filtered etabas_w
ETABAS_W	MDFUE	DOK	multiplied ignition timing and efficiency
ETALAB	MDBAS	EIN	Lambda effectiveness without intervention w.r.t. to optimum torque at Lambda=1
ETAZWBM	MDBAS	EIN	mean ignition angle effectiveness of basic ignition angle
MILSOL_W	MDKOL	EIN	driver torque request for charge
MISOPL1_W	MDFUE	DOK	nominal air torque, recalculated for Lambda=1 and zwopt
NMOT	BGNMOT	EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed
RLMAX_W		EIN	maximum attainable charge with turbo
RLMIN_W	MDFUE	DOK	minimum permissible rl
RLSOL_W	MDFUE	AUS	desired relative air charge
R_T10		EIN	Time schedule 10 ms

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FB MDFUE 9.20 Detailed description of function

The torque milsol_W, which is to be set via the charge path at the basic ignition angle and effectiveness, is converted into the torque misopl1_w, which corresponds to the optimum torque at Lambda=1. With the aid of the map KFMIRL the charge belonging to this operating point is calculated. This charge is limited to the minimum permissible value rlmin_w. In the case of a turbocharger, it is limited to the maximum permissible charge rlmax_w. The result is the nominal charge rlsol_w.

APP MDFUE 9.20 Application hint

The map KFMIRL is inverse to the map KFMIOP in the section %MDBAS. Application hint, see %MDBAS.

FUEDK 6.20 Charge control (calculation of nominal throttle-valve angle)

FDEF FUEDK 6.20 Function definition

FUEDK: Übersicht

fuedk-fuedk

fuedk-fuedk

UMPSPI: Berechnung Referenzdruck vor Drosselklappe beim Turbo

fuedk-umpspi

fuedk-umpspi

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BWDKSGV: Sollwert Dk-Winkel

fuedk-bwdksgv

fuedk-bwdksgv

BMLDKNS: Sollwert normierter Luftmassenstrom ueber Drosselklappe

fuedk-bmldkns

fuedk-bmldkns

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WDK_APPL: Applikations-Schnittstelle

fuedk-wdk-appl

VERZWDKS: Dk-Soll Totzeit

fuedk-verzwdks

BPSSOL: Sollwert Saugrohrdruck

fuedk-bpssol

ABK FUEDK 6.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DPUPS			FW	delta pressure threshold for switching of reference pressure upstreams throttle
FPWDKAPP	WPED_W		KL	throttle angle dependent on accelerator pedal position, only for calibration
FUEPMLD	LDITV_W		KL	Factor for gliding transition average pressure (reference pressure turbo)
KFWDKMSN	MLWDKNS_W	NMOT_W	KF	Map for the desired throttle blade angle
KLAF	PSSPVDK_W		KL	characteristic of Saint-Venant
KUMSRL			FW	conversion constant from mass flow to relative air charge
NRLMN			FW	lowest engine speed for calculation of umsrln
TFUPI			FW	filter time delay for switching of reference pressure to actual pressure
TFUPS			FW	filter time delay for switching of reference pressure to set boost pressure
TVWDKS			FW	delay time for desired throttle angle
TWDKSV	PSPVMIN_W		KL	time constant for filtering of reference throttle blade position
WDKSAPP			FW	throttle angle for calibration tasks
WDKUGDN	NMOT_W		KL	throttle angle necessary for 95 % of the maximum possible air charge

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Variable	Source	Type	Description
B_FPWDKAP	PROKON	EIN	throttle-valve control by accelerator pedal
B_LDRUGD	FUEDK	AUS	Condition unthrottled, Eneable from LDR
B_UGD	FUEDK	AUS	condition: throttle angle greater or equal wdkugd
B_UGDB	FUEDK	LOK	Condition readiness unthrottled
B_UGDS	FUEDK	AUS	set value throttle angle near full load
B_UGDSET	FUEDK	LOK	Enable set value throttle angle full load turbo
B_WDKSAP	PROKON	EIN	throttle-blade contol by fixed value, bit 1 has priority
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DPDK		EIN	pressure difference at throttle
DRLFUE_W		EIN	correction offset by air mass controller
DWDKS_W	FUEDK	AUS	modification of desired throttle angle
FKMSDK_W		EIN	correction factor for mass-flow substitute load signal
FRHODKR_W	FUEDK	LOK	factor correction air density for throttle blade correction
FRHODK_W	BGMSZS	EIN	factor correction air density for throttle valve flow f(intake air temp.,altit.)
FTVDK	BGTEMPK	EIN	correction factor for temperature upstream of throttle valve
FUPSRL_W	EGFE	EIN	factor system related transformation pressure to load (16-Bit)
LDITV_W		EIN	I-quota (on/off ratio) for boost control
MLDKNS_W	FUEDK	AUS	normed set air mass flow through throttling valve
MLDKS_W	FUEDK	DOK	set air mass flow through throttling valve
MLSOL_W	FUEDK	AUS	set air mass flow
MLWDKNS_W	FUEDK	LOK	normed air mass flow for desired value of throttle blade
MRFUEMX_W	MDFAW	EIN	Max. attainable rel. driver-requested torque for pedal overtravel
MRFUE_W	MDFAW	EIN	Relative driver-requested torque in pedal overtravel
MSNDKO_W	BGMSZS	EIN	norm leakage air mass flow through throttle blade
MSTE_W	BGTEV	EIN	mass flow purge control into the manifold
NMOT	BGNMOT	EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed
PDPLD		EIN	predicted delta pressure (overswing pressure)
PIRG_W	EGFE	EIN	partial pressure residual exhaust gas internal EGR (16-Bit)
PLSOL	FUEDK	AUS	Reference boost pressure
PLSOL_W	FUEDK	AUS	Reference boost pressure
PSPVDK_W	BGMSZS	EIN	quotient: int.manif.pressure divided by pressure upstream of throttle valve
PSPVMIN_W	FUEDK	LOK	selection (minimum) from pspvdk and psspvdk
PSSOL_W	FUEDK	AUS	Set intake manifold pressure
PU_W	GGDSAS	EIN	Ambient pressure
PVDKR_W	FUEDK	LOK	reference pressure upstreams throttle
PVDK_W	EGFE	EIN	pressure upstream of throttle valve, 16-bit
RFAGR_W	EGFE	EIN	relative load by external exhaust gas reduction
RLSOLK_W	FUEDK	LOK	corrected relative air charge
RLSOL_W	MDFUE	EIN	desired relative air charge
R_T10		EIN	Time schedule 10 ms
SY_TURBO	PROKON	EIN	system constant for turbocharged engine
TFWDKS_W	FUEDK	LOK	time constant of wdks filtering
UMSRLN_W	BGMSZS	EIN	calculation factor load to mass flow
WDKS	FUEDK	AUS	desired throttle angle w.r.t. to lower mechanical stop
WDKSGV_W	FUEDK	LOK	desired throttle blade before application interface(filtered)
WDKSP_W	FUEDK	AUS	predicted desired throttle angle
WDKSV_W	FUEDK	LOK	desired throttle angle before application interface (unfiltered)
WDKS_W	FUEDK	AUS	desired throttle angle w.r.t. to lower mechanical stop
WDKUGD_W	FUEDK	AUS	Throttle valve angle during which 95% charge is reached
WPED_W	GGPED	EIN	normed angle acceleration pedal

FB FUEDK 6.20 Detailed description of function

The function’s task is the calculation of the desired throttle angle for a turbo engine. The main inputs are the desired relative air charge and the correction offset generated by the air mass controller. Several other values, like correction factors for pressure and temperature or information about offset of air mass flow at closed throttle blade (umsrln_w),purge control and exhaust gas reduction, are taken from the manifold model in the engine load calculation. For that reason, there is a close connection between the calculation of the desired throttle angle and the calculation of engine load.

The set manifold pressure calculated in FUEDK is also used for the boost control.

To ensure the stability of the air charge control (consisting of boost control and throttle blade control), the reference pressure upstreams throttle is switched to the set boost pressure in case of a positive step of the set air charge. To compensate the time delay of the turbo charger by opening the throttle blade, a PT1 filter is used additionally.

The characteristic curve WDKMSN is the inverse of MSNWDK. It is throttle actuator specific and only valid for a normed ambient air density and an air stream at sonic speed. Other conditions are covered by the characteristic of Saint-Venant (KLAF) and air density correction factors.

The condition B_ugd is set if the actual air charge is higher or equal the maximum possible air charge at the actual engine speed. In this case, the air mass controller is disabled (see section FUEREG).

The calibration interface allows to disable the normal calculation of the desired throttle angle which requires the functionality of the torque interface. Instead, the desired throttle angle is only dependent on the accelerator pedal position or even equals a constant.

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APP FUEDK 6.20 Application hint

```
KLAF: see calculation of engine load
KFWDKMSN:  inverse of KFMSNWDK

Initial Values:

CWMDAPP=       wdksp_w=
   0              wdksgv_w, sofern nmot>0
   2              FPWDKAPP(wped_w)
   4              WDKSAPP, sofern nmot>0

FPWDKAPP wped_w [%]     1.5  6.25  11.0   15.63  23.43  31.25  39.0  46.87  54.69  62.5  70.3  78.13  82 86  85.94  89.84  93.75
         wdksv_w [%]    1.7  7.1   11.16  15.25  2.0    31.0   39.0  47.0   55.0   62.0  70.0  78.0   82.00  86.0   90.0   99.9

WDKSAPP 2 %
WDKUGDN 100% for disable the function.
Application: throttle blade angle at begin ps/pvdk >= 0.95.    ps = intake manifold pressure
                                                               pvdk = pressure upstreams of throttle blade
TFUPS: 0 s
TFUPI: 2 s
DPUPS: >=250 hPa

TWDKSV: psspvdk_w       0.990   0.992   0.996   0.998   1.0     1.02
                        0.01    0.1     0.15    0.2     0.25    0.0
NDRLS: -500%/s

WDKUGDN so applizieren, daß  PSPVDKUG = ps/pvdk = 0.95  (siehe BGMSZS)

TVWDKS: legt die Totzeit zwischen wdksp_w und wdks_w fest
        0: keine Verzögerung; 1: 10 ms; 2: 20 ms; ...; 5 oder mehr: 50 ms Verzögerung
```

BGWDKM 1.0 Calculation of throttle angle model

FDEF BGWDKM 1.0 Function definition

bgwdkm-bgwdkm

ABK BGWDKM 1.0 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ZWDKM1			FW	1. time constant throttle angle model
ZWDKM2			FW	2. time constant throttle angle model

Variable	Source	Type	Description
C_INI		EIN	ECU-condition for intialisation
R_T10		EIN	Time schedule 10 ms
WDKBAP_L	BGWDKM	LOK	predicted throttle angle wdkbl for ti-calculation (Long)
WDKBAP_W	BGWDKM	AUS	predicted throttle angle wdkbl for ti-calculation (Word)
WDKSP_W	FUEDK	EIN	predicted desired throttle angle

FB BGWDKM 1.0 Detailed description of function

```
Task of the function:
_____________________

Calculation of an advancing Dk actual angle wdkbap_w from the advancing Dk nominal angle wdksp_w.

Benefits:
_________

By knowing the future Dk actual angle, very rapid changes in the air filling can be calculated despite an unavoidable dead time
between load detection and the actual air filling of the cylinders;
combustion misfiring is thereby avoided for extreme dynamics (see %BGRLP).

Realization:
____________

The dynamics of the Dk actuator (without overshoot) are simulated by 2 PT1 members connected in series;
the model Dk actual angle corresponds to the stationary nominal value for the Dk angle.
```

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APP BGWDKM 1.0 Application hint

Prerequisites:

- Dk position regulator applied and stable (i.e. no overshoot in the Dk actual angle !);
  An overshoot of the Dk actual angle cannot be simulated !!

Application tools:

- VS100

Pre-assignment of parameters:

- Time constants Dk angle model: ZWDKM1 = 0.01 s, ZWDKM2 = 0.03 s
- Dead time in the Dk nominal value path (see %FUEDK) TVWDKS = 0.02 s

Shutdown of the function:

- TVWDKS (see %FUEDK) = 0.0 s
- ZWDKM1 = ZWDKM2 = 0.0 s,
  i.e. simulated Dk actual value corresponds to the Dk nominal value

Method of proceeding:

- Dead time in the Dk nominal value path (see %FUEDK) TVWDKS = 0.0 s

- Perform Dk nominal value jumps
  Possibility a: by applying a voltage to the pedal input
  Possibility b: by switching over in %FUEDK to Dk nominal value requirement using code word CWMDAPP and WDKSAPP; different Dk nominal values can be realized by paging in the VS100 measurements menu

- Comparison of measured Dk actual value wdkba_w with the estimated Dk actual value wdkbap_w;
  Optimization in the agreement by adaptation of ZWDKM1 and ZWDKM2

- Reset the dead time in Dk nominal value path back to the original value (see %FUEDK) TVWDKS = 0.02 s).

BGTABST 3.60 Calculated variable: cut-off time

FDEF BGTABST 3.60 Function definition

bgtabst-bgtabst

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bgtabst-absttm

Subfunction ABSTTM: Soak time determination from engine cooling

bgtabst-abstnl

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Subfunction ABSTNL: Soak time determination with ECM-afterrunning

bgtabst-uhrrmin

Subfunction UHRRMIN: Soak time determination with relative minute counter

bgtabst-uhrrsec

Subfunction UHRRSEC: Soak time determination with relative second counter

ABK BGTABST 3.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DTABUNPL			FW	threshold soak time unplausible
DTUMTA			FW	offset intake-air temperature -> ambient temperature
IMTUMTA			FW	threshold integrated air mass for determination ambient temperature
LNXQTM	XQTM_W		KL	natural logarithm from temperature quotient
NTUMTA			FW	threshold engine speed for determination ambient temperature
TNLSGM	TMOTAB		KL	Delay time for ECU shut-off
TPLUHRR			FW	diagnostic time relativ timecounter unplausibel
TUMTAI			FW	initial value of ambient temperature
VTUMTA			FW	threshold velocity for determination ambient temperature
ZKTABTU	TUM_EIN		KL	time constant for engine cooling

Variable	Source	Type	Description
B_ABSTNL	PROKON	EIN	condition soak time calculation via ECM-afterrun
B_ETUM	GGTFUMG	EIN	Condition fault in ambient temperature
B_INS2COK	CANINS	EIN	condition: CAN-message INSTR2 received
B_INS3COK	CANINS	EIN	Condition CAN message INST3 present
B_NLWST	BGTABST	LOK	Request for ECM afterrun for recognition of re-start
B_NMIN		EIN	condition lower speed: n < NMIN
B_PLTAB	BGTABST	LOK	condition plausibility check soak time possible
B_PWF		EIN	Condition for powerfail
B_STEND	BBSTT	EIN	condition end of start
B_TABUNPL	BGTABST	LOK	condition soak time unplausible
B_TFU	PROKON	EIN	condition ambient temperature sensor exists
B_UHRRMIN	PROKON	EIN	Condition clock with a relative counter of minutes
B_UHRRNPL		EIN	Condition clock with a relative counter of minutes unplaus.
B_UHRRSEC	PROKON	EIN	Condition clock with a relative counter of seconds
B_VBEMG	ESSTT	EIN	condition detection of combustion possible
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF		EIN	ECU-condition powerfail initialisation
E_CINS	DCINS	EIN	Error flag: CAN interface, timeout instrument
E_TA	GGTFA	EIN	error flag: TANS
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
IMLATM	ATM	EIN	integrated air mass flow from engine start to maximum value
NMOT	BGNMOT	EIN	engine speed
R_T1S		EIN	Time schedule 1 s
R_T50		EIN	Time schedule 50 ms
TABSMN_W	BGTABST	LOK	soak time from relative counter of minutes

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Variable	Source	Type	Description
TABSNL_W	BGTABST	LOK	soak time from ECM-afterrunning
TABSSC_W	BGTABST	LOK	soak time from relative counter of seconds
TABSTM_W	BGTABST	LOK	soak time from engine cooling
TABST_W	BGTABST	AUS	soak time
TANS	GGTFA	EIN	Intake air temperature
TMOTAB	GGTFM	EIN	engine coolant temperature at engine stop or cut-off cranking
TMST	GGTFM	EIN	engine temperature at start
TNST_W	BBSTT	EIN	time after end of start
TRMINAUS_W	BGTABST	LOK	relative time of engine shut-off in minutes
TRMINEIN_W	BGTABST	LOK	relative time of engine start in minutes
TRMIN_W	CANINS	EIN	relative time in minutes
TUMG	GGTFUMG	EIN	Ambient air temperature
TUMTA	BGTABST	LOK	ambient temperature from intake-air temperature
TUM_EIN	BGTABST	LOK	ambient temperature for soak time calculation
VFZG	GGVFZG	EIN	vehicle speed (km/h)
XQTM_W	BGTABST	LOK	temperature quotient

FB BGTABST 3.60 Detailed description of function

The soak time tabst_w can be determined by different methods depending on the given surroundings.
These are defined by the codeword CWUHR. The following methods are distinguished:

1. Soak time determination with relative second counter: A relative second counter is required, that is available either ECM-internal and works permanent, or ECM-external, which works permanent and communication between ECM and counter is possible throughout ECM operation (i.e. via CAN). If these requirements are fulfilled B_uhrrsec = 1 (bit 1 of CWUHR).

2. Soak time determination with relative minute counter: A relative minute counter is required, that is available either ECM-internal and works permanent, or ECM-external, which works permanent and communication between ECM and counter is possible throughout ECM operation (i.e. via CAN). If these requirements are fulfilled B_uhrrmin = 1 (bit 0 of CWUHR).

3. Soak time determination with ECM-afterrunning:
   B_abstnl = 1 (bit 2 of CWUHR) if ECM-afterrunning is available for determination of short soak times.
   After the engine is stalled or shut-off a time counter is started at the beginning of ECM-afterrunning.
   The necessary (permissible) duration of ECM-afterrunning for re-start detection is given in characteristic TNLSGM depending on engine temperature. If the engine is not started within the duration of ECM-afterrunning the time counting will be stopped at the end of afterrunning and the minimum soak time stored in tabsnl_w. Longer soak time is then detected as described in 5. .
   If ignition is switched on again within the duration of afterrunning tabsnl_w is stored and updated until end of start.

4. Soak time determination with relative minute counter and ECM-afterrunning:
   Combination of 2. and 3.: B_uhrrmin = 1 and B_abstnl = 1 (bits 0 and 2 of CWUHR).

5. Soak time determination from engine cooling:
   If neither relative second counter nor relative minute counter are available for soak time determination longer soak times are determined from engine cooling. Therefor xqtm_w = (tmotab - tumta)/(tmst - tumta) is calculated. Characteristic LNXQTM contains values for the natural logarithm ln(xqtm_w). Soak time tabstm_w is then obtained by multiplication of ln(xqtm_w) and time constant ZKTABTU = f(tumta).

APP BGTABST 3.60 Application hint

1. Soak time determination with relative second counter:
   This method of soak time determination is the most precise and therefor should be preferred. If plausibility test is desired subfunction ABSTTM and threshold for plausibility check DTABUNPL must be applicated (see 5.). If no plausibility check within %BGTABST is desired DTABUNPL must be set on its maximum value 65535.

2. Soak time determination with relative minute counter:
   Application like 1. . If ECM-afterrunning is available, see 4. .

3. Soak time determination with ECM-afterrunning:
   This method of soak time determination is suitable for detecting short soak times up to 4 minutes. A combination with a relative minute counter (see 4.) or evaluation of engine cooling (see 5.) is necessary to detect longer soak time. Characteristic TNLSGM in subfunction ABSTNL must contain the desired or permitted duration of ECM-afterrunning in seconds for re-start detection depending on engine temperature

4. Soak time determination with combination of relative minute counter and ECM-afterrunning:
   With this method it is possible to determine soak time with a resolution of 1 s during afterrunning and with a resolution of 1 min after that. For application of subfunction ABSTNL see 3. .

5. Soak time determination from engine cooling:
   This method is less precise than the above described and should be used only if the hardware requirements for these are not fulfilled. Soak time is calculated as multiplication of time constant (depending on ambient temperature) ZKTABTU and natural logarithm of xqtm_w. The logarithm is calculated via characteristic LNXQTM.

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data for LNXQTM:

xqtm	1,000	1,102	1,199	1,352	1,551	1,750	2,000	2,801	4,200	6,000	9,999	16,00
LNXQTM	0,0000	0,0967	0,1816	0,3012	0,4387	0,5596	0,6931	1,0298	1,4348	1,7917	2,3025	2,7725

Time constant ZKTABTU must be applicated for four ambient temperatures, i.e. Tu = -20°C, 0°C, 20°C und 40°C.
Therefor measurements of engine temperature after engine is stalled at T1 = tmotab = 80°C are required. The second temperature T2 = tmot must be determined after soak time dt for that highest accuracy is desired (i.e. 1800 s).

ZKTABTU = dt / ln((T1 - Tu)/(T2 - Tu)) .

B_tfu = 1 (bit 0 of CWTF, see %PROKON) if ambient temperature can be measured directly with a separate sensor. In this case the measured ambient temperature is used for the calculation of soak time. If no sensor for measurement of ambient temperature is available ambient temperature tumta is calculated from intake-air temperature. For initialization of tumta TUMTAI = 20°C is suggested.

GK 3.40 Overview, mixture control

FDEF GK 3.40 Function definition

gk-gk

ABK GK 3.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFBS	RL	NMOT	KF	bank-selective mixture factor

Variable	Source	Type	Description
FGRU	GK	LOK	factor: basic pilot control
FKS	GK	LOK	factor knock protection
FNS	GK	LOK	afterstart factor
FR2_W	GK	LOK	Lambda controller output (word)
FRA2_W	GK	LOK	multiplicative correction of the mixture adaptation (word)
FRA_W	GK	LOK	multiplicative correction of the mixture adaptation (word)
FR_W	GK	LOK	Lambda controller output (word)
FST_W	GK	LOK	start-injection factor
FVST_W	GK	DOK	factor: pilot control
FWE	GK	LOK	reinjection factor
FWL	GK	LOK	warm up factor
FWNW	GK	LOK	Mixture factor camshaft position
LALGF	GK	LOK	lambda limit ”rich”
LALGM	GK	LOK	lambda limit ”lean”
LAMNSWL_W	GK	LOK	lambda engine nominal at afterstart and warming up
LAMSBG2_W	GK	LOK	required lambda limitation Bank2
LAMSBG_W	GK	LOK	Desired Lambda limitation (word)
LAMSONS2_W	GK	LOK	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	GK	LOK	required lambda referred to lambda sensor fitting location
NMOT	BGNMOT	EIN	engine speed

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Variable	Source	Type	Description
RK2_W	GK	AUS	relative fuel mass Bank2
RKA2_W	GK	LOK	additive adaptive correction of the relative fuel amount bank 2
RKACO_W	GK	LOK	Additive correction of the rel. fuel mass for setting idle-speed CO
RKA_W	GK	LOK	additive adaptive correction of the relative fuel amount
RKKVA2_W	GK	AUS	Relative fuel mass (for fuel consumption indicator, Bank 2)
RKKVA_W	GK	AUS	Relative fuel mass (for fuel consumption indicator, Bank 1)
RKTE_W	GK	LOK	relative fuel part of the purge control
RKUKG_W	GK	LOK	rel. fuel mass transition compensation
RK_W	GK	AUS	relative fuel mass
RL	EGFE	EIN	relative air charge
RLP_W	BGRLP	EIN	rel. air charge predicted for injection calculation (Word)

FB GK 3.40 Detailed description of function

The function for mixture control, GK, calculates the relative quantity of fuel, rk_w, for the relative (anticipated) air filling rlp_w of a cylinder for a combustion at lambda = 1.0. Standardization of both the variables rl_w and rk_w has been chosen such that for a 100 % air filling, 100 % fuel is required as well for combustion for an engine at its running temperature and lambda = 1.0. The stoichiometric ratio of air mass to fuel mass in the cylinder is designated as the lambda combustion compartment.

The function injection precontrol, ESVST provides the precontrol values for lambda combustion compartment = 1.0

This lambda combustion compartment can be shifted for engine-running reasons (engine protection, lean running limit) or exhaust-gas requirements by the function lambda coordination LAMKO towards "rich" or "lean".

The function mixture control, lambda control and adaptation, GRKA, includes mixture adaptation, tank ventilation, diagnostics of tank ventilation and lambda control.
On a bank-selective basis, continuous lambda control regulates to the signal nominal lambda sensor (lamsons_w, lamsons2_w), that is formed in the function for secondary-air control, SLS.
On the other hand, the two-point lambda control regulates to lambda combustion compartment = 1.0 irrespective of lamsons.

The nominal value set for the lambda at the sensor deviates from the lambda combustion compartment during the time secondary-air is in operation.

Calculation of the relative fuel mass rk_w:

The factors fgru, fst_w, fns, fwl, ... are multiplied by one another and are available for the application as the RAM cell factor precontrol (fvst_w). The value for the precontrol is obtained by multiplying this precontrol factor for the relative fuel mass that leads to a lambda combustion compartment = 1.0, by the relative air filling rl.
A difference in the charging for two-bank systems is corrected by multiplication using the bank-selective correction KFBS.
Positive values in KFBS mean an "enrichment" of bank 1 and an "enleanment" by the same amount of bank 2 at the same time, since the filling of both banks is made up of the total filling that is measured by the hot-film air-mass sensor, HFM.

The additive component rka_w from the mixture control GKRA should correct for any air leaks that may be present in order that there is precontrol to lambda combustion compartment = 1.0 in this case as well.

Precontrol for variants without lambda control by CO-compensation in idling is also by means of the additive component rka_co to both cylinder banks (not bank-selective up to now).

These precontrol values are now corrected on a bank-selective basis to the lambda given by the lambda coordination LAMKO (lamsbg_w, lamsbg2_w), in that the respective bank is divided by the corresponding limited lambda setpoint lamsbg_w. Continuous lambda control regulates to this prescribed lambda and corrects any possible deviation by means of the factor controllers fr_w, fr2_w on a bank-selective basis. The controller is switched off (fr_w = 1.0) for lambda setpoint # 1.0 in the case of two-point lambda control and lambda setpoint # 1.0 is precontrolled.

The transition compensation corrects any dynamics effects for the suction-pipe wall film by means of the additive intervention rkukg_w.

Long-term deviations (faults dominating in the fuel path) from nominal lambda are adapted in the factor controller adaptation fra_w, fra2_w and on a bank-selective basis as well. These are included in the calculations by multiplication.

Finally, the fuel component introduced in the suction pipe by tank ventilation is subtracted from this relative fuel requirement that has been
calculated for lambda nominal (lamsbg_w), and this is then made available for output as rk_w, rk2_w.

This relative and bank-selective fuel mass rk_w, rk2_w is subsequently weighted in the function for output injection, AES, on a cylinder-specific basis and corrected by the resumption excess rkwe(z)_w following an Ev shutdown.

Both rk-paths are calculated for a one-bank system as well. The bank-selective ti is outputted only for the actual injection output in ACIFI because of the Ev-bank arrangement. All Ev’s are assigned to bank 1 for one-bank systems.

APP GK 3.40 Application hint

KFBS: Neutral value id 0.
Factor 1.0 corresponds to 10 % enrichment at bank 1 and to a 10 % enleanment at bank 2 at the same time.

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ESVST 5.10 Fuel injection pre-control

FDEF ESVST 5.10 Function definition

esvst-esvst

ABK ESVST 5.10 Abbreviations

Variable	Source	Type	Description
B_HST	ESVST	LOK	condition hot start
B_NSP	ESVST	LOK	condition for post-injection
B_STAA	ESVST	LOK	starting fuel adaptation active at afterstart
B_TIRED	ESVST	LOK	Condition reduction of active injections
B_UKG	ESVST	LOK	condition transient control activated
B_WKS	ESVST	LOK	Condition cold restart
FGRU	ESVST	AUS	factor: basic pilot control
FKS	ESVST	AUS	factor knock protection
FNS	ESVST	AUS	afterstart factor
FST_W	ESVST	AUS	start-injection factor
FWE	ESVST	AUS	reinjection factor
FWL	ESVST	AUS	warm up factor
FWNW	ESVST	AUS	Mixture factor camshaft position
KSTAA	ESVST	LOK	currently used start mixture adaptation factor
LALGF	ESVST	AUS	lambda limit ”rich”
LALGM	ESVST	AUS	lambda limit ”lean”
NSACTR	ESVST	LOK	afterstart counter/filter
NSACTR_W	ESVST	LOK	afterstart counter 16-bit
RKUKG_W	ESVST	AUS	rel. fuel mass transition compensation
RKWE(Z)_W	ESVST	AUS	additional relative fuel mass at fuel cut in (Z) = Cylinder 1...

FB ESVST 5.10 Detailed description of function

The function ESVST presents an overview of the injection advance control for a combustion compartment lambda of 1 and is made up of the basic injection factor fgru, the start injection factor fst_w, the post-start factor fns, the warm-run factor fwl and the enrichment factor fks (catalyzer protection.
The transition compensation UKSEFI dynamically corrects wall film effects via the additive additional or lesser quantity rkukg_w and additional quantities for restoring shut-down cylinders by the additive additional quantity rkwe(z)_w.

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APP ESVST 5.10 Application hint

ESGRU 32.10 Basic function injection

FDEF ESGRU 32.10 Function definition

esgru-esgru

ABK ESGRU 32.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FRKAP			FW	factor, relative fuel mass for application
KFANS	ML	TANS	KF	characteristic map for lambda factor
KFLF	NMOT	RL	KF	lambda characteristic map at part load

Variable	Source	Type	Description
FGRU	ESGRU	AUS	factor: basic pilot control
ML	BGSRM	EIN	air mass flow
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_T200		EIN	Time schedule 200 ms
TANS	GGTFA	EIN	Intake air temperature
VSFRK	VS_VERST	EIN	Correction of the relative fuel mass by adjusting systems

FB ESGRU 32.10 Detailed description of function

The KFLF, KFANS map should not be used for intervening in the mixture, because the relative air charge rl must be balanced to the engine demand via the pulsation map KFPU. If rl is corrected by KFPU faktor fgru has to be 1.0
The two interventions vsfrk and FRKAP are multiplying interventions via application devices. FRKAP is changed by VS100 adjustment; vsfrk by VS20 or via the serial interface. These two interventions must be set to neutral during definition after start of production

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APP ESGRU 32.10 Application hint

ESSTT 16.30 Injection duration at start

FDEF ESSTT 16.30 Function definition

esstt-esstt

esstt-bbesstt

Ermittlung der Motorlaufzeit, beim Startversuch und beim erfolgreichem Start

esstt-motor-lz

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Injections during start-up:

The function is made up of cold/warm start-up and a hot start-up. Effects from hot gasoline (leaning) can be balanced out during a hot start-up up to a certain temperature by a higher open-loop control.
The function permits individual start-up adaptation of the starting factor and regulation of start-up delivery.
A uniform wall-film build-up and a homogeneous starting mixture can be achieved for all cylinders by the anzti-dependent weighting regulation. The conditions of hot start-up and repeated cold start-up are also transmitted to the post-start function %ESNST.

Hot start-up: The objective is certain hot start-up detection. Hot start-up conditions are present when the engine temperature tmst is high and the fuel system has been able to heat up (detection by an increase in temperature of the intake air between turning the engine off and starting again). A reset is only then meaningful after the engine has cooled down again, or has been running for a certain period of time, such that the fuel delivery system has been purged. The reset path must therefore be calculated outside of the of the start-up phase for a hot start-up. If hot start-up conditions are still prevailing when the engine is turned off, then B_hst will be set once again for the subsequent start-up phase if the engine's starting-up temperature, tmst, is greater than or equal to TMSG.

Repeat start: After turning off the engine, combustion-compartment temperature and engine temperature (cooling water) are only the same again after elapse of a certain period of time. If the engine is started up again within this time (repeat start), then a leaner mixture is required with respect to tmot in order to make allowance for the high temperature conditions prevailing in the combustion compartment.

Two criteria that are independent of one another play a role in the condition repeat start. These are for the repeat-start condition that the stored shutdown time, tabst_w, has to be below the threshold TWSTT (B_wst1 = 1) as well as that the number of detected combustions during the preceding start-up phase or attempted start-up, zburnsum, has exceeded the threshold ZBURNLIM, i.e. B_wst0 = 1 (warming the combustion compartment). B_wst1 may only be described when B_st is reset. This can be the case both when the end of the start-up phase is reached as well as if the start-up is aborted.

If the shutdown time, tabst_w, has been determined only by an ECU afterrun, then attention has to be paid to conformity of the characteristics TWSTT and TNLSGM (refer to %BGTABST). B_wst1 is formed between the beginning of initialization and the detection of start-up (B_st = 1) because the shutdown time tabst_w is formed during this period of time. B_wst1 is established for engine running when B_st is set.

The condition combustion possible, B_vbmg, is formed for detection of combustion by a comparison of tistzyl and zzyl. It is also possible to detection combustion one synchronization later and this is expressed by the condition combustion possible B_vbemg. The combustion counter is clocked with R_syn as soon as B_vbemg is set. Combustion is detected by the presence of a speed increase, dnmot_w, that is greater than DN10BURN. The condition B_vbemg is also used for adaptation of the start-up quantity.

If B_wst = 1 and tmst < TMK apply during the start-up phase, i.e. B_wks = 1, then the start-up factor is weighted by KFWKSTAB. KFWKSTAB depends on the shutdown time tabst_w and the engine temperature tmst. The conditions B_wks and B_hst are used for the repeat post-start as well.

ABK ESSTT 16.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZTIWS			FW	Number of injections for repeated start detection
CWESSTT			FW	code word setting B_vbemg and B_wks
FHSTT	TANS		KL	factor hot start
FKSTT	TMST		KL	factor cold start
IMLHS			FW	integrated flow of air-mass at hot start
KFFWST	TMLAUF_W	TMOTAB	KF	Factor for re-start
KFWHSTT	TANS	ANZTIST	KF	map weighting of hot start factor
KFWKSTN	TMST	NMOT	KF	map weighting of factor cold start
KFWKSTT	TMST	ANZTIST	KF	map weighting of factor cold start
KLFWST	TABST_W		KL	Factor repeated start
TANDT	TANSAB		KL	threshold difference intake air temperature for hot start
TMH			FW	engine-temperature - threshold warm
TMHSG			FW	engine temp. hot-start limit

Variable	Source	Type	Description
ANZTIST	ESSTT	DOK	ti-counter at start
ANZTI_W	CIFINA	EIN	injection counter
B_HST	ESSTT	AUS	condition hot start
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_VBEMG	ESSTT	AUS	condition detection of combustion possible
B_VBMG	ESSTT	DOK	condition combustion possible
B_WKS	ESSTT	AUS	Condition cold restart
B_WST	ESSTT	AUS	condition for re-start
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
FST0_W	ESSTT	DOK	precontrolled start factor 16 bit
FST_W	ESSTT	AUS	start-injection factor
IMLATM	ATM	EIN	integrated air mass flow from engine start to maximum value
KSTAA		EIN	currently used start mixture adaptation factor
NMOT	BGNMOT	EIN	engine speed

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Variable	Source	Type	Description
R_SYN		EIN	Synchro schedule
TABST_W	BGTABST	EIN	soak time
TANS	GGTFA	EIN	Intake air temperature
TANSAB	GGTFA	EIN	Intake air temperature when engine is shut-off
TISTZYL	CIFINA	EIN	cylinder number of first injection and ignition
TMLAUF_W		EIN	Engine operating time prior to parking
TMOTAB	GGTFM	EIN	engine coolant temperature at engine stop or cut-off cranking
TMST	GGTFM	EIN	engine temperature at start
TNSE_W	BBSTT	EIN	time counter at end of start (16 bit)
TSTLAUF_W	ESSTT	DOK	time since B_st at 1
ZZYL		EIN	SW-cylinder counter

FB ESSTT 16.30 Detailed description of function

APP ESSTT 16.30 Application hint

Prerequisites:

- Torque coordination applied, torque loss in particular
- Basic adaptation applied for a warm engine
- Entire charging detection applied
- LLR idle-speed regulation adapted to a warm engine
- Basic ignition timing, ignition time defined in start-up and post-start, as well as torque reserves
- Start-up torque adapated to a warm engine.

Preparatory work:

- Specify fuel and oil for carrying out the application
- Shu down adaptation of the start-up quantity %STADAP (——> kstaa = 1.0)
- Disconnect canister-purge valve and turn the tank-ventilation function off
- Turn off lambda control and lambda adaptation
- Turn off the catalyst heating function
- Shut down the torque-loss adaptation
- Set KFLANSWL(.../...) = 1.0 (in %ESWL)
- Check running limits in %ESWL (lalgm > 1, lalgf < 1)
- Define pre-storage and type of injection (%EA, %EASTT)
- Execute a powerfail to reset the learned values.

KFFWST:

```
                ^
 tmotab [ °C]   |   0.1  .............  0.0
                |    .                   .
                |    .                   .
                |   0.6  .............  0.3
                |------------------------------------>
                                          tmlauf_w [s]
```

KLFWST:

```
                ^
 1              |  +
                |            +
                |                        +
                |                            +
 0              |------------------------------------>
                                                tmabst_w  [s]
```

Cold / warm start-up:

The start-up factor is saved in FKSTT and is weighted with the values KFWKSTT and KFWKSTN (regulated). There is no interpolation in KFWKSTT. Instead the value for the first datapoint is included in the calculations until the next datapoint is reached. The anzti datapoints shall be selected as whole-number multiples of the number of cylinders. A uniform wall-film build-up over all cylinders is thus possible by this. The rl-dependency is however to be observed when considering the injection times (ti).

Example: 4-cylinder ——> Datapoints: 0, 4, 8, 12, 16, 20
6-cylinder ——> Datapoints: 0, 6, 12, 18, 24, 30

Proposal for tmst datapoints:
-30 / -25 / -20 / -15 / -7 / 0 / 15 / 20 / 25 / 40 / 60 / 90 deg. C

Adaptation of the first injection per cylinder: The amount of fuel for the first injections per cylinder should be sufficiently large that combustion will result from ignition (to be detected by the increase in speed after each firing). The value 1.0 is entered in KFWKSTT for anzti = 0 for all temperature datapoints to do this, and the necessary enrichment factor is written in KFSTT.

The start-up quantity can be (greatly) reduced after the first large injections have been made. This is because a wall film has already built up and the combustion compartment has since warmed up from from the first combustions. It is advisable to design the downwards regulation to be sufficiently steep such that any "flooding" of the engine is ruled out after approx. 3 injections have been made per cylinder. It is assured by this that the engine can be started with certainty even for a repeat start-up. The appropriate values for this shall be entered on a temperature-specific basis in KFWSTT. An assessment of the data that have been selected can be made based on the course of the engine speed.

In addition to the downwards regulation of the start-up enrichment, the start-up factor can also be reduced by anzti where KFWKSTN = f (tmst, nmot). This map can simplify the transfer of data from earlier projects with downwards speed regulation of the start-up factor. New applications should always be assigned with KFWKSTN = 1.0 wherever possible.

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Repeat cold start-up:

The condition repeat cold start-up, B_wks, is fulfilled when the condition B_wst is fulfilled and the engine temperature in the start-up phase is lower than the threshold TMK (e.g. 20 °C). The condition repeat start-up, B_wst, is in turn made up of the sub-conditions B_wst0 and B_wst1. B_wst0 is fulfilled when more than a minimum number of combustions ZBURNLIM (e.g. 2) was detected during the preceding start-up phase or attempted start-up, and it can hence be assumed that the combustion chamber is warmer than the coolant temperature. This condition is stored as a non-voltile condition and is thus always available for the subsequent start-up phase or start-up attempt. B_wst1 is fulfilled when the shutdown time for the engine has not yet exceeded the threshold TWSTT = f (tmotab) (refer also to %BGTABST for this). The duration is to be entered in TWSTT. This is the time for which repeat-start conditions prevail after turning off or stalling the engine.

Hot start-up:

Hot start-up conditions apply when the fuel system has heated up considerably (especially in the region around the injection valves). Injection valves with a temperature-measuring point in the vicinity of the injection valves shall be installed for clear recognition of hot start-up conditions.

The threshold for the engine temperature, tmot, as of which hot start-up conditions can apply, shall be entered in TMH. A heating-up of the fuel system can be deduced from a consideration of the increase in the intake-air temperature since turning off the engine (tansab). If the increase in temperature exceeds the threshold TANDT = f (tansab), then this can be an indication for hot-start conditions.

Hot start-up conditions no longer prevail if:

a) The engine has been operated for a considerable period of time and hence the fuel-supply system has been purged. This can be recognized by an assessment of the airmass integral imlatm. That value for the integrated airmass shall be entered in IMLHS as of which adequate purging has taken place. The subsequent start-up phase can be another hot start-up if the setting conditions are fulfilled.

b) The engine under hot start-up conditions (B_hst set) has been turned off for such a time that the fuel system was able to cool down again. The corresponding engine temperature for this shall is to be entered in TMHSG. During start-up, B_hst is still reset to before the first ti-output.

FHSTT and KFWHSTT shall be applied analogous to a cold-start adaptation if hot start-up conditions are prevailing (B_hst set), though this as a dependency of the intake-air temperature tans rather than as a function of the engine temperature tmst. The start-up data for tmst = tans from the warm adaptation from FKSTT and KFWKSTT shall be taken first for the application (e.g. tmst = 90 °C). B_hst shall be blocked by TMH = 143.25 °C. The next step is to check tmst, tans, tansab and the injection-valve peak temperatures as of which hot start-up problems occur (to be recognized by, amongst others, the course of the speed and the course for lambda). Setting conditions can thus be specified by this and the start-up data in FHSTT and KFWHSTT can be accordingly corrected based on the course of lambda (LSU lambda sensor unit, pre-heated).

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ESNST 3.90 Afterstart enrichment

FDEF ESNST 3.90 Function definition

esnst-esnst

esnst-nst-abr1

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esnst-nst-abr2

esnst-nst-abr2

esnst-anztibeg

esnst-anztibeg

The afterstart factor needs not be calculated when "fktns" has converged on zero and B_stend is set. Especially when cranking without complete initialization is possible, it has to be made sure that after a new start "fns" is calculated again. For that "fktns" has to be initialized with 1.0 during C_ini or when B_st is set.

Only one of the subfunctions NST_ABR1 or NST_ABR2 has to be calculated (depending on B_staa).

In projects with no service device interaction SY_TFNS must be false. In projects with continuous A/F control a service device interaction is not allowed, so SY_TFNS has to be false (see %ESWL)!

KFLANS needs only to be calculated, when B_lamnse = false. This Bit is false while anzti_w < ANZTIBMX.

ABK ESNST 3.90 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZTIBMX			FW	limit of injection counter ”anztib_w”
FNSA	TANS		KL	after start increase
FNSSM	TMST		KL	after start increase
FWSTAA1	KSTAA		KL	afterstart correction
FWSTAA2	KSTAA		KL	correction of threshold for afterstart
FWSTAA3	KSTAA		KL	weighting afterstart decrease range 1
FWSTAA4	KSTAA		KL	weighting afterstart decrease range 2
FZANSSA1	TANS		KL	factor for ign. sync. decreasing of afterstart enrichment at hot start range 1
FZANSSA2	TANS		KL	factor for ign. sync. decreasing of afterstart enrichment at hot start range 2
FZANSSM1	TMST		KL	factor for ign. sync. decreasing of afterstart enrichment above SZANSSM
FZANSSM2	TMST		KL	factor for ign. sync. decreasing of afterstart enrichment below SZANSSM
KFLANS	ANZTIB_W	TMST	KF	map lambda engine during afterstart
KFNSWRL	TMST	RL	KF	weighting of afterstart enrichment
KFWWNS	TMST	TABST_W	KF	repeated start time factor
SZANSSM	TMST		KL	switching level of afterstart enrichment

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Parameter	Source-X	Source-Y	Type	Description
ZDGZA1			FW	Number of ignitions for decrease in range 1
ZDGZA2			FW	Number of ignitions for decrease in range 2

Variable	Source	Type	Description
ANZTIB_W	ESNST	AUS	injection counter with limit
ANZTI_W	CIFINA	EIN	injection counter
B_HST	ESSTT	EIN	condition hot start
B_LAMNSE	ESNST	AUS	condition end of lamns_w calculation
B_ST	BBSTT	EIN	condition for start
B_STAA		EIN	starting fuel adaptation active at afterstart
B_STEND	BBSTT	EIN	condition end of start
B_WKS	ESSTT	EIN	Condition cold restart
C_INI		EIN	ECU-condition for intialisation
FKTNS	ESNST	LOK	after start enrichment
FNS	ESNST	AUS	afterstart factor
FZANS1	ESNST	LOK	factor decrease of afterstart
FZANS2	ESNST	LOK	factor decrease of afterstart
KSTAA		EIN	currently used start mixture adaptation factor
LAMNS_W	ESNST	AUS	lambda engine nominal during afterstart
NSACTR	ESNST	LOK	afterstart counter/filter
NSACTR1	ESNST	LOK	afterstart counter with starting fuel adaptation not active
NSACTR2	ESNST	LOK	afterstart counter with starting fuel adaptation active
RL	EGFE	EIN	relative air charge
R_SYN		EIN	Synchro schedule
SY_TFNS		EIN	system constant service device intervention afterstart factor
TABST_W	BGTABST	EIN	soak time
TANS	GGTFA	EIN	Intake air temperature
TMST	GGTFM	EIN	engine temperature at start
VSTFNS		EIN	adjustment factor afterstart (service device interface)

FB ESNST 3.90 Detailed description of function

Basic description:

During afterstart losses due to blow-by and wall-wetting must be compensated. This function allows a compensation by mixture enrichment depending on engine coolant temperature at start. The afterstart factor is decreased depending on engine coolant temperature at start and starting fuel adaptation factor.

To take wall-wetting into consideration, the after start enrichment can be weighted depending on load and ECT at start.

As defined in %LAMKO the engine has to be pre-controlled for lambda= 1.0. For that a lambda nominal value for afterstart gives the enrichment. This deviation from lambda = 1.0 can be mapped depending on the number of injections since start and ECT at start.

In case of cold re-afterstart the afterstart enrichment can be reduced (KFWWNS). Condition cold re-start is defined in %ESSTT.

With hot afterstart, hot fuel effects can also be compensated up to a certain degree by mixture enrichment. Condition hot start is defined in %ESSTT.

A different afterstart application is needed for critical fuel qualities. The afterstart mixture can be modified with the help of the starting fuel adaptation factor from %STADAP.

Details:
The weighting factors FWSTAA1-FWSTAA4 can be defined depending on "kstaa". The afterstart enrichment is influenced by them when B_staa = true (only then subfunction NST_ABR2 is active).

B_staa is build in %STADAP. The influence of %STADAP is limited by TMLIM. When ECT > TMLIM "kstaa" has no influence on the afterstart enrichment.

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APP ESNST 3.90 Application hint

Presupposition:

s. %ESSTT

Preparation:

s. %ESSTT
- set KFLANS to "1" for first application of fst_w, fns and fwl. Then this map is neutral.
- make sure that all lambda nominal values in %LAMKO are = "1".

Notes:

- %ESSTT, %ESNST ans %ESWL can not be applicated independent on each other. For that reason,try to get the nominal value for lambda from the "rich" side.

- lambda nominal for afterstart (lamns_w) has to describe the enrichment from lambda = 1, released from the pre-control factors fst_w and fns. This description is used for a correction of the injection timing in %GK. Now factor fvst_w is valid for lambda = "1", how it is defined in %LAMKO. Because a description can not be exact, the application of the pre-control should be done in the way, that the engine really runs in a short time at lambda ="1" and with that "lamns_w" gets neutral.

- enrichment in the cause of serial variance, drivability or running smoothness shall be done with the lambda nominal value for warming up "lamwl_w" (s. %ESWL).

- the application of the subfunction NST_ABR2(T) has to be done after application of %STADAP.

Application:

Afterstart application for cold start:

- set KFNSWRL (.../...) temporary to "1". This map can be used to compensate changings in load by transition from cranking to idle. If there are values for after start enrichment over 3 necessary (very cold temperatures), this can be realized with values from 1.0 to 1.5 in KFNSWRL (FNSSM has already the maximum value).

- the afterstart factor FNSSM and its decrease have to be adjusted so that lambda=1 results as fast as possible. Applicate FNSSM to get a lambda curve from the necessary enrichment to lambda = 1.0 without steps.

- the decrease is done by multiplication with nsactr. nsactr is calculated as follows:
  nsactr_new = nsactr_old * (1 - fzans)

- the decrease can be executed in two phases. So it is possible to reduce "fns" strongly in the first phase (FZANSSM1). In the second phase with FZANSSM1 > FZANSSM2 a weak reduction from "fns" can be realized.

- the characteristic line SZANSSM = f(tmst) gives the threshold for switching from "phase one" of deactivation to "phase two". For example FZANSSM1 is valid, when nsactr > 0.3, when the threshold SZANSSM is 0.3, for smaller values of "nsactr" FZANSSM2 is valid.

- for both decrease phases "synchro" intervals, in which the afterstart counter "nsactr" is calculated, can be defined with ZDGZA1 and ZDGZA2. Proposal for ZDGZA1 is the number of cylinders, for ZDGZA2 it is 2 * number of cylinders.

- the first phase of decrease is mainly to compensate lost fuel while the warming-up of the engine parts near to the combustion chamber is dominant. The second phase can be used to get a slight transition to fully warming-up. When the physical range for FZANSSM2 is not sufficient, a correction of ZDGZA2 to greater values allows a slower decrease.

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Afterstart application for cold re-start:

- at cold re-start only a reduced amount of fuel is needed. This is mainly caused by the higher temperature in the combustion chamber compared with the ECT. The afterstart enrichment therefore can be reduced by KFWWNS depending on tabst_w and tmst.

Afterstart application for hot start:

- The afterstart factor FNSA = f(tans) has to be adjusted to get lambda = 1.0 as fast as possible. Approach like in %ESSTT described.

Application of lambda engine nominal for post start:

- after the application of fst_w, fns and fwl the measured lambda curve (LSU) for the valid ECT at start is mapped in KFLANS depending on anztib_w. You have to map the lambda curve until the engine is really running with lambda = 1.0. A later adjustment of the pre-control factors, causing a deviation of lambda, has to be considered in KFLANS again. Also the delay time of the measured signal has to be considered by changing KFLANS. When the oxygen sensor is out of range, you will have to map the value 0.77.
  (For a fast adjustment in the range of catalyzer heating it could be useful to follow a short-term strategy to save time. Therefore "lamns_w" can be verified by the load who is given by the moment reserve for catalyzer heating. But then "lamns_w" is only valid for this operating point!!! For this "short way" you have to activate the function for catalyzer heating, set lambda nominal for catalyzer heating to "1.0" and deactivate the secondary-air pump.)

- ANZTIBMX is used to limit the range of "anztib_w". When anztib_w is reaching its limit ANZTIBMX, anztib_w is held to prevent an overflow. Depending on "anztib_w" there is a transition in %ESWL from "lamns_w" to "Lamwl_w". This transition is defined with the treshold ATISLATM as a function of ECT at start. This is to make sure, that in every case ATISLATM < ANZTIBMX.

Afterstart application for critical fuel qualities:

- for the entire cold application, fuel qualities must be defined. RB-recommendation:
  Fuel A: approximately in the middle of DIN EN 228, for low temperatures (<10 degr. C) winter specification,
  for higher temperatures summer specification.
  Fuel B: "worst case" fuel that will be expected, i.e. RFG.

  The application for start, afterstart and warm-up is done using fuel A. Optimum application does not contain any security addition. After that, fuel B is used. %STADAP learns during start. Now the afterstart enrichment must be modified so that lambda=1 results again.

- for application, activate subfunction NST_ABR2(T) with TMLIM in %STADAP (B_staa is set).

- now the factors FWSTAA1 - FWSTAA4 have an influence on the basic application. For initial start-up the factors should be set to "1". Then the curve of the after start enrichment factor "fns" is identical to the subfunction NST_ABR1.

- by definition of the setpoint values in FWSTAAi (SKS06ESUB), you have to recognize that "kstaa" has a range from 1.0 to 2.0. One set point with the value 1.0 is required.

- at kstaa = 1 the factors FWSTAA1 - FWSTAA4 must have the value "1". Only then the adjusted afterstart enrichment is the same as in NST_ABR1 (without %STADAP).

- FWSTAA1 influences the afterstart enrichment in general. For a stronger enrichment at kstaa > 1.0, use greater values in FWSTAA1.

- FWSTAA2 has an effect on the switch to the second phase. If you want to switch later to the second phase (if kstaa>1.0), use values < 1.0 in FWSTAA2.

- FWSTAA3 and FWSTAA4 are used to correct the speed of the decrease in the both phases. A fast deactivation for kstaa > 1.0 is realized with values > 1.0.

Proposal for tmot/tmst-setpoints:

-30 / -25 / -20 / -15 / -7 / 0 / 15 / 20 / 25 / 40 / 60 / 90 degr. C

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ESWL 7.50 Injection for warm-up

FDEF ESWL 7.50 Function definition

eswl-eswl

ABK ESWL 7.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ATISLATM	TMST		KL	threshold number of ti to switch from lamns_w to lamwl_w
KFFWL	TMOT	TMST	KF	map warm-up factor
KFFWLW	NMOT	RL	KF	map weighting warm-up factor
KFLASWLR	TMOT	TMST	KF	map lambda engine nominal at warming up with active A/F control
LASWLTM	TMOT		KL	offset lambda engine nominal with inactive A/F control
ZKLANSWL			FW	time constant filter lamnswl_w

Variable	Source	Type	Description
ANZTIB_W	ESNST	EIN	injection counter with limit
B_LRNDA	LREB	EIN	lambda control bank 1 active by conditions : B_Jrpspa & B_Jrkasn & !E_obdlr
B_LRNDA2	LREB	EIN	lambda control bank 2 active by conditions : B_Jrpspa & B_Jrkasn & !E_obdlr
B_STEND	BBSTT	EIN	condition end of start
FWL	ESWL	AUS	warm up factor
LAMNSWL_W	ESWL	AUS	lambda engine nominal at afterstart and warming up
LAMNS_W	ESNST	EIN	lambda engine nominal during afterstart
LAMWL_W	ESWL	LOK	lambda engine nominal at warming up
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_T10		EIN	Time schedule 10 ms
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
SY_TFWL	PROKON	EIN	system constant service device intervention warm-up factor
TMOT	GGTFM	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
VSTFWL		EIN	adjustment factor warm-up (service device interface)

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FB ESWL 7.50 Detailed description of function

During engine warm-up, wall-wetting in the intake manifold and combustion chamber as well as blow-by losses must be compensated for by mixture enrichment. Therefore warm-up factors depending on speed, load and engine temperature are pre-controlled (see %GK).

As defined in %LAMKO, the engine must be pre-controlled for lambda = 1.0. For that, a nominal value for lambda "lamns_w" describes the enrichment during afterstart (s.%ESNST). When the afterstart enrichment is deactivated, the nominal value for lambda can be changed with the map KFLASWLR = f(ECT at start, ECT). The transition is dependent on the threshold ATISLATM = f(anztib_w). Its time constant is ZKLANSWL. With KFLASWLR the lambda nominal value for warm-up "lamwl_w" can be defined from "rich" to 1.0 depending on ECT. While the A/F control is not ready, you can define an offset to the nominal value for lambda in the characteristic line LASWLTM = f(ECT). So there is the possibility to give a stronger enrichment while the A/F control is not active.

Service device interaction:

For projects without service device interaction SY_TFWL must be false. In projects with continuous A/F control the service device interaction must not be active, because this interaction only affects the pre-control factors but not the nominal lambda values. The lambda nominal value description "lamns_w" still depends on the basic application. With active A/F control and vstfwl

1.0, offsets in the A/F controller output might occur (see also %ESNST).

APP ESWL 7.50 Application hint

Proceedings:

1. Proposal for tmot/tmst-setpoints:
   -30 / -25 / -20 / -15 / -7 / 0 / 15 / 20 / 25 / 40 / 60 / 90 degr. C

2. Warm-up factor (KFFWL) and weighting have to be laid out for lambda=1. Therefore the desired lambda of other functions must be set to 1 (Control: lamsbg_w and lamsbg2_w=1.0). For first application at minimum load in KFFWLW (compare "rlmin") a value of 0.3 seems to be a good choice. So for very cold conditions large values for the warm-up factor can be realized and at higher temperatures there are no problems with the quantization. Adjust KFFWL at the lowest possible load (idle without catalyst heating). The weighting KFFWLW depends on load and engine speed. Map it in the same way as in former projects by cold departures or by several warm-ups with different loads. In a limited range you can effect the load with the torque reserve for idle speed control (see %LLRMR). Also the engine speed can be influenced with the idle speed control in %LLRNS. The final application of KFFWL is done in the climatic chamber with torque and speed demanded from the idle speed control for final dataset.

3. Lambda value for warm-up:
   LASWLTM is set neutral (to zero) in the first step. This characteristic line is used to define an offset of the lambda nominal while the A/F control is not active. In KFLASWLR you can map the wanted lambda curve depending on ECT for every setpoint of ECT at start. The transition from lambda nominal with/without A/F control is described with the time constant ZKLANSWL (it is the same for transition from "lamns_w" to "lamwl_w"). For projects with conventional A/F control, the controller can be activated by setting the values of KFLASWLR to 1.0 beginning at the desired ECT-setpoint.

ESKS 1.20 Knock protection injection

FDEF ESKS 1.20 Function definition

esks-esks

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esks-zwout-gem

esks-zwout-gem

ABK ESKS 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FKKSN	NMOT		KL	knock protection injection factor
FVKKSN	NMOT		KL	knock protection injection factor during full load
KFZWKS	NMOT	RL	KF	ignition angle map for knock protection
TMKS			FW	engine temperature threshold for knockprotection-injection-timing
TVKS			FW	delay time for knockprotection-injection-timing
WKSVN	NMOT		KL	ignition angle limit for knock control fuel correction at WOT
ZYLZA			FW	number of cylinders

Variable	Source	Type	Description
B_KSE	ESKS	AUS	condition enrichment at knock protect
B_VL	MSF	EIN	Condition for wide open throttle
FKS	ESKS	AUS	factor knock protection
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_SYN		EIN	Synchro schedule
TMOT	GGTFM	EIN	Engine temperature
ZWOUT	ZUE	EIN	Ignition angle output value
ZWOUTM	ESKS	LOK	mean value of ignition output angle

FB ESKS 1.20 Detailed description of function

APP ESKS 1.20 Application hint

```
Die Funktion dient als Katalysatorschutz vor Übertemperatur durch zu
späte Zündwinkel aus der Klopfregelung.
Damit die Funktion im Warmlauf (->Zündwinkelspätziehung) nicht wirkt,
muß der Wert TMKS entsprechend gesetzt werden.
Die Verzugszeit läuft nach jedem 0->1 Sprung der "und-Verknüpfung" ab.
Diese Entprellung verhindert ein häufiges Zu-/Abschalten der Lambdaregelung,
wenn knapp an der Eingriffsgrenze gefahren wird.
Bei der Applikation der Zündwinkelgrenzwerte für VL und TL ist zu beachten, daß im
ZWOUT der Phasengang WPHN eingerechnet ist.
Die Grenzzündwinkel für Klopfschutzeinspritzung sind im Vergleich zu den normalen
Zündwinkelvorsteuerwerten um den Betrag
von WPHN größer zu applizieren!
```

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ESNWS 1.0 Camshaft control for mixture correction

FDEF ESNWS 1.0 Function definition

esnws-vanossum

ABK ESNWS 1.0 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DTWNWS			FW	Delta time for Camshaft nomonal angle late switch over
KFFWNW	WNWUE	TMOT	KF	Correction factor with camshaft control
TWNWS			FW	Time for camshaft nominal angle late switchover
ZKWNW			FW	Time constant correction factor camshaft switch-over

Variable	Source	Type	Description
B_ESNWS	ESNWS	AUS	Condition mixture factor with camshaft adjustment
B_LL	MSF	EIN	Condition idle
B_STEND	BBSTT	EIN	condition end of start
B_WNWS		EIN	Condition for camshaft nominal value
C_INI		EIN	ECU-condition for intialisation
FWNW	ESNWS	AUS	Mixture factor camshaft position
TMOT	GGTFM	EIN	Engine temperature
WNWUE		EIN	camshaft overlap angle of inlet and outlet valve opening

FB ESNWS 1.0 Detailed description of function

APP ESNWS 1.0 Application hint

ESWE 1.10 Injection, resumption of overrun fuel cut-off

FDEF ESWE 1.10 Function definition

```
Block diagram see %EA

1. If B_sa = 1 (see %BBSAWE), then no further injection valves are opened;
                              injections in progress are not terminated

2. If B_sa = 1 --> 0 , then the injection pulses start again.
   The factor fwe influences the injection duration.

   When B_ll = 0, fwe = FIMHU (strong enrichment)
   When B_ll = 1, fwe = FIMWU (weaker enrichment)

 fwe is calculated in the main program
```

ABK ESWE 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FIMHU	U		KL	Factor pulse abrupt
FIMWU	U		KL	Factor pulse smooth

Variable	Source	Type	Description
B_LL	MSF	EIN	Condition idle
B_SA	MDRED	EIN	Condition fuel cut-off
FWE	ESWE	AUS	reinjection factor

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FB ESWE 1.10 Detailed description of function

1. When deceleration cut-off active (B_sa - see %BBSAWE): No further injection pulses are output; injections in progress are not terminated.

2. When they start again (B_sa changes from 1 ——> 0) the first injection pulses can be enriched via a characteristic in relation to the number of camshaft revolutions after the re-start. The condition B_ll is used to select between 2 factors (depending on the number of camshaft revolutions since the re-start):
   - For soft re-starts (B_ll = 1) the characteristic FIMWU applies
   - For hard re-starts (B_ll = 0) the characteristic FIMHU applies

APP ESWE 1.10 Application hint

ESUK 2.60 Injection: transient compensation

FDEF ESUK 2.60 Function definition

Overview Transient Compensation

esuk-esuk

UKENA: transient compensation enable

esuk-ukena

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UKWF: calculation of wall wetting amount

esuk-ukwf

UKAU: wall wetting share factor

esuk-ukau

UKKSP: short term memory

esuk-ukksp

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UKLSP: long term memory

esuk-uklsp

UKABST: memory adjustment enable

esuk-ukabst

UKKORR: short+long term correction, post cranking, transient compensation adaptation

esuk-ukkorr

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UKBAUS: state bits

esuk-ukbaus

ABK ESUK 2.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DUKK			FW	threshold for short term portion
FUKNSTM	TMST		KL	initial value of transient control post cranking factor
FVANST			FW	weighting factor of deceleration during post-cranking
FWFN			FW	wall wetting factor influence of rpm
KFABAK	NMOT	TMOT	KF	share factor wall wetting for acceleration enrichment
KFAVAK	NMOT	TMOT	KF	share factor wall wetting for deceleration enleanment
KFBAKL	NMOT	TMOT	KF	factor accel. enrichment (short- and long-time part)
KFVAKL	NMOT	TMOT	KF	factor decel. enleanment (short- and long-time part)
RKBAU			FW	rk-threshold for acceleration enrichment display
RKUKKLU			FW	threshold sum of long-/short term
RKVAU			FW	rk-threshold for deceleration enleanment display
TNSUUK			FW	disabling time of transient control during post-cranking
WFRL	RLP_W		KL	fuel wall hang.up
ZBALM	TMOT		KL	reduction factor L-memory (tmot) for accel. enrichment
ZUKK			FW	reduction factor K-memory
ZUKNST			FW	time constant of transient control post cranking factor
ZVALM	TMOT		KL	reduction factor L-memory (tmot) for decel. enleanment

Variable	Source	Type	Description
ABAK	ESUK	LOK	share factor wall wetting for acceleration enrichment
ANZTI	CIFINA	EIN	injection counter
AUKK	ESUK	DOK	partition factor for fuel film amount
AVAK	ESUK	LOK	share factor wall wetting for deceleration enleanment
B_BA	ESUK	AUS	Condition acceleration enrichment (display)
B_BAG	ESUK	AUS	Condition large accel. enrichment
B_LL	MSF	EIN	Condition idle
B_NSWO2	PROKON	EIN	condition engine speed > NSWO2
B_REDKL	ESUK	LOK	Enable reduction of K- and L-Memory
B_SA	MDRED	EIN	Condition fuel cut-off
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_UK1	ESUK	LOK	Enable condition for transient control
B_UKG	ESUK	AUS	condition transient control activated
B_UKNS	ESUK	LOK	Enable condition transient contr. after cranking
B_VA	ESUK	AUS	Condition deceleration enleanment (display)
B_VAAU	ESUK	LOK	Condition decel. enleanment for partition of fuel film
B_VAG	ESUK	AUS	Condition large deceleration enleanment
B_VAKL	ESUK	LOK	Condition decel. enleanment L- and K-part
B_WF	ESUK	LOK	Condition wall wetting calculation
C_INI		EIN	ECU-condition for intialisation
DRLP_W	BGRLP	EIN	delta predicted load for injection time calculation (word)
DWFK_W	ESUK	LOK	delta wall wetting quantity short term
DWFL_W	ESUK	LOK	delta wall wetting quantity long term
DWF_W	ESUK	LOK	Delta wall hang-up quantity
FBAKL_W	ESUK	LOK	factor short/long time part of trans.control during acceleration
FBANS	ESUK	LOK	post cranking factor of transient control during acceleration
FBANS_W	ESUK	LOK	post cranking factor of transient control during acceleration
FUKA		EIN	factor adaptive transient control
FUKKL_W	ESUK	DOK	factor short/long time part of transient control
FVAKL_W	ESUK	LOK	factor short/long-time part of trans.control at deceleration
FVANS	ESUK	LOK	post cranking factor of transient control during deceleration
NMOT	BGNMOT	EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed

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Variable	Source	Type	Description
RKUKG_W	ESUK	AUS	rel. fuel mass transition compensation
RKUKKL_W	ESUK	LOK	sum of short and long term parts of transient control
RKUKK_W	ESUK	AUS	rk short term part of transient control
RKUKL_W	ESUK	LOK	rk long term part of transient control
RLP_W	BGRLP	EIN	rel. air charge predicted for injection calculation (Word)
R_SYN		EIN	Synchro schedule
R_T100		EIN	Time schedule 100 ms
SDWFK_W	ESUK	LOK	memory content of the wall wetting difference for short term portion
SDWFL_W	ESUK	LOK	memory content of the wall wetting difference for long term portion
SY_TFBA		EIN	system constant service device intervention accel. enrichment
SY_TFVA		EIN	system constant service device intervention decel. enleanment
TMOT	GGTFM	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
VSTFBA		EIN	factor acceleration enrichment (service device interface)
VSTFVA		EIN	factor deceleration enleanment (service device interface)
WF_W	ESUK	LOK	wall wetting quantity
ZBALE	ESUK	LOK	reduction factor during acceleration
ZVALE	ESUK	LOK	reduction factor during deceleration enleanment

FB ESUK 2.60 Detailed description of function

The transient control determines the required additional or reduced injected fuel during a change in load to compensate for wall wetting.

The transient control consists of three different portions:

- Long term portion rkukl_w
  serves to compensate slow wall wetting effects. Based on predicted load signal rlp_w and engine speed. Calculation is performed segment synchroneously.

- Short term portion rkukk_w
  serves to compensate fast wall wetting effects. Based on predicted load signal rlp_w and engine speed. Calculation is performed segment synchroneously.

The wall wetting characteristic line WFRL contains that fuel quantity, which is stored in the wall wetting for the appropriate load at steady-state conditions. If the load is changing during one segment by the value drlp_w = rlp_w(s) - rlp_w(s-1), then the wall wetting difference dwf_w = WFRL(rlp_w(s)) - WFRL(rlp_w(s-1)) has to be injected as additional fuel amount, in order to compensate the increase of wall wetting.

This additional quantity has to be distributed over time, so that Lambda remains constant during the transient. For this, the additional quantity is divided into a short time and a long time portion by means of the partition factor aukkn and accumulated in the corresponding memorys (sdwfl_w, long term memory resp. sdwfk_w, short term memory).

For each segment the fuel quantity sdwfl_w * ZBALM (for acceleration) resp. sdwfl_w * ZVALM (for deceleration) is taken from the long term memory. It represents the long time portion rkukl_w of rkukkl_w. Afterwards the long term memory is decremented by the same value rkukl_w, if the current value of rlukl_w has been used at least for one injection (B_redkl = 1). The reduction factors ZBALM and ZVALM depend on engine temperature, since the evaporation of fuel film is much slower during warm up than at hot engine.
Equivalently, the fuel quantity sdwfk_w * ZUKK - DUKK, i.e. the amount that exceeds the threshold DUKK, is taken from the short term memory as short term portion rkukk_w. The reduction factor of the short term portion ZUKK is equal for both increasing and decreasing load. The short term memory is decremented by rkukk_w as soon as the current value rkukk_w has been used at least for one injection (B_redkl = 1).
By means of this it is ensured, that the additionally injected fuel amount (due to the load change drlp_w = rlp_w(s) - rlp_w(s-1)) corresponds exactly to the difference of the wall wetting quantities dwf_w = WFRL(rlp_w(s)) - WFRL(rlp_w(s-1)).

The sum rkukkl_w of the two portions rkukl_w (from long term memory) and rkukk_w (from short term memory) is weighted by the factor KFBAKL (for acceleration) resp. KFVAKL (for deceleration), a post cranking factor and the correction factor from adaptation of transient control (see later).

During cranking at a determined coolant temperature the wall of intake manifold is much cooler as if it would be during warming at the same coolant temperature (cranking at a lower temperature). That is the reason why the transient control is weighted with the factor fbans resp. fvans during post cranking. This factor is initialized with FUKNSTM during cranking and then reduced exponentially towards 1. At deceleration an additional factor FVANST is used.

The differentiation between acceleration and deceleration for the segment synchroneous portions is realized as dependence on drlp_w (share factor aukkn) resp. on sdwfl_w (reduction factor zukl).
For the change over between fbakl/fvakl the sum of the short term/long term portion rkukkl_w is used.

The transient control is not determined during cranking and for engine speeds above a speed limit (B_nswo=1).
Besides the calculation of the segment synchronous part of the transient control is turned off for an additional cycle after the the engine speed falls short of the treshold again, since the value WFRL(s-1) which is required for the calculation of the change dwf_w is not yet defined.

After transition from cranking to post cranking the transient control can be disabled during the time TNSUUK in order to prevent that errors in measured load do trigger an acceleration enrichment or a deceleration enleanment;
so it is possible to calibrate the post cranking phase independent of transient control. This time will be finished at once, when idling status is left.

If the absolute value of rkukkl_w exceeds RKUKKLU, bit B_ukg will be set to indicate high dynamics;
this information as well as Bits B_bag/B_vag are used to disable other functions.
B_ba and B_va are used to show the acceleration or decelaration state, e.g. on a calibration tool like VS20.

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APP ESUK 2.60 Application hint

Requirements:

- steady state calibration to Lambda = 1
- injection advance angle calibrated, so that the fuel is just not yet injected into the open inlet valve (flight time of fuel (approx. 8 ms considered), i.e. the ti-end must advance for increasing engine speed; this results in a minimized actualization error and low HC-emission
- creation of load signal rl_w proportional to intake manifold pressure
- load prediction calibrated

Application aids:

- Lambda-test procedure with a sample rate of < 20 ms. If a sensor LSM11 and a Lambda display LA1/LA2 is employed, the engine can be tuned for steady state condition to a Lambda value of 1.05. With it, the more accurate "lean"-branch of the LSM11 characteristic is used and the problems during rich-lean transients at Lambda = 1.0 are avoided.
- throttle actuator for defined load jumps during constant engine speed

Presetting of the parameters:

- preset of all setpoints of n resp. tmot-dependent characteristic lines or maps to i d e n t i c a l values

- wall wetting characteristic line WFRL: lower base point: WFRL = 0.0 %, upper base point: WFRL = 1300 %;
  gradient around idle area approx. 1/3 of the gradient for WOT
- factor wall wetting influence of engine speed FWFN = 0.0 %/(1/min)
- reduction factor ZUKK = 0.25
- threshold short time part DUKK = 0.0 ms
- reduction factors ZBALM = ZVALM = 0.015 (4-cylinder engine) for temperatures between 100 °C .. 40 °C
  = 0.008 (6-cylinder)
  = 0.006 (8-cylinder)
  should be reduced at lower temperatures
- share factors KFABAK = KFAVAK = 0.25 (for all engine speeds)
- engine temperature factors KFBAKL, KFVAKL = 0.8 for tmot = 100°C and all engine speeds
  KFBAKL, KFVAKL = 1.0 for tmot = 90 °C and all engine speeds
  KFBAKL, KFVAKL = 1.2 for tmot = 80 °C and all engine speeds
  KFBAKL, KFVAKL = 6.0 for tmot = 20 °C und N = 1500 rpm,
  KFBAKL, KFVAKL = 2.0 for tmot = 20 °C und N = 4000 rpm

- time Uk disabled after cranking TNSUUK = 2 s
- threshold disable of other functions RKUKKLU = 30 %, RKBAU = 300 %, RKVAU = -300 %
- transient control post cranking factor FUKNSTM = 2.0 (for tmot < 80 °C, neutral value = 1.0), FVANST = 1.0
- time constant of transient control post cranking factor ZUKNST = 22 s

Switch off transient control:

switch off load dependent part: KFBAKL = 0; KFVAKL = 0

Procedure:

For calibration of the transient control, the Lambda closed loop control must be turned off. Transient control adaptation (see %ESUKA resp. %ESUKAS) must be disabled and the correction factor of transient control must be set to its initial value of 1.0 .

1) Calibration of the hot engine at low engine speed

Prefereably, the calibration should be carried out on an externally driven chassis dynamometer or engine dyno.
In case the calibration is carried out with the vehicle, then a manual transmission is required. If not available, the torque converter of the automatic transmission must be locked, so that the engine can be operated with variable load at constant engine speed. For vehicle calibration, the fuel evaporation must be sucked off. Appropriate tire equipment must be provided (the stress on tires is comparable to engine mapping).

At first the wall wetting characteristic line WFRL, the share of KFABAK, KFAVAK and the reduction factors ZUKK, ZBALM, and ZVALM are determined for the short and long term portion at a relatively low engine speed (approx. 1400 RPM).
For this, fast load changes at constant speed are performed between neighbouring rlp_w setpoints of the wall wetting characteristic WFRL (throttle plate adjustment within approx. 100 ... 200 ms). For practical reasons, the engine load and Lambda characteristic during the load change is simultaneously displayed (with oscilloscope) and recorded. Waiting time between two consecutive load steps: approx. 10 ... 20 s.

In the following the procedure, recommended for correcting the transient parameters, is explained, based on various Lambda traces occuring during acceleration.
The following load setpoints of the wall wetting characteristic are assumed:

rlp_w = ... 24 % / 36 & / 48 % / 60 % .....

At first the calibration is carried out at low load, e.g., with a load step from rlp_w = 24 % ——> 36 % ——> 24 %.

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```
 rlp  ^
      |
36 %  | - - - - - -  ***********************************************************************
      |              **
      |             **
      |            *
24 %  | **********
      |___________|___________|___________|___________|___________|___________|___________|___________|---> Time / ms
                  0         500       1000       1500       2000       2500       3000       3500
```

```
      ^
Lambda |             **           Characteristic A:
 1.1   | - - - - - -  **  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
       |             *  *
       |             *  *
 1.0   | *************   ******     ************************************************************
       |                      *****
 0.9   | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
       |___________|___________|___________|___________|___________|___________|___________|___________|---> Time / ms
                   0         500       1000       1500       2000       2500       3000       3500
```

```
      ^
Lambda |                          Characteristic B:
 1.1   | - - - - - -  **  ***  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
       |             *  **   **********
       |             *                 **********************
 1.0   | *************   - - - - - - - - - - - - - - - - - -  ************************************
       |
 0.9   | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
       |___________|___________|___________|___________|___________|___________|___________|___________|---> Time / ms
                   0         500       1000       1500       2000       2500       3000       3500
```

```
      ^
Lambda |                          Characteristic C:
 1.1   | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
       |                         ***********
       |             **          **           *****************
 1.0   | ************  *       **    - - - - - - - - - - - -   ***********************************
       |                *    **
       |                 *  *
 0.9   | - - - - - - - -  **   - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
       |___________|___________|___________|___________|___________|___________|___________|___________|---> Time/ ms
                   0         500       1000       1500       2000       2500       3000       3500
```

The Lambda characteristic B indicates insufficient transient compensation for all portions. In this case the wall wetting amount WFRL should be increased. Since only the differences between consecutive calculations are used for evaluation of the wall wetting characteristic WFRL, the gradient of the wall wetting characteristic between the setpoints rlp_w = 24 % and rlp_w = 36 % must be increased. In this case the total characteristic WFRL for rlp_w = 36 % must be upshifted in a parallel direction (therefore, the characteristic of the function in the load range rlp_w > 36 % remains constant).

On an average, line C shows a desired Lambda characteristic. However, the split-up into short term and long term portion is considered insufficient. By reducing the split factor KFABAK, the total injected additional amount of fuel is shifted from the short term to the long term portion. By this, both the mixture deviation to the rich at t = 400 ms and the following lean-out is reduced.

For negative load steps above procedure is applied accordingly. In this case, however, the opposite reaction of the transient compensation parameters must be obeyed:
Mixture lean-out after load reduction is caused by excessive deceleration lean-out, i.e., in contrary to the acceleration lean-out, the transient compensation must be reduced.

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Since the wall wetting characteristic WFRL is applied to increasing and decreasing load, the acceleration as well as the deceleration parameters for a specific load range must always be optimized. In below example a significant enrichment occurs during deceleration. Accordingly, the gradient of the wall wetting characteristic WFRL for the range 24 % < rlp_w < 36 % must be significantly increased. This change can be implemented, although there is no significant lean-out during acceleration.
An insufficient amount of wall wetting results in significantly less mixture deviation during increasing load, since this insufficient additional amount of fuel is related to a higher load, compared to the appropriate deceleration. Therefore, it is expected that, by applying a steeper wall wetting characteristic WFRL in the range 24 % < rlp_w < 36 %, at first only the deceleration enrichment will be compensated, not necessarily resulting in mixture enrichment during acceleration.

```
   rl   ^
        |
 36 %   | - - -  ****************************************
        |      *                                        *
        |     *                                          *
        |    *                                            *
 24 %   | ****    - - - - - - - - - - - - - - - - - - - -   ****************************************
        |____|____________________|____________________|____________________|____________________|____________>  Time / s
             0                    5                    10                   15                   20
```

```
        ^
Lambda  |
 1.1    | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        |
        |         **************
 1.0    | ********              *************************  - - - - - -  *************************
        |                                                 *       *******
        |                                                  *   ***
 0.9    | - - - - - - - - - - - - - - - - - - - - - - - - - *** - - - - - - - - - - - - - - - - - - - - - -
        |____|____________________|____________________|____________________|____________________|____________>  Time / s
             0                    5                    10                   15                   20
```

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For the "decrease factors" ZUKK, ZBALM and ZVALM for the short and long term portion, generally the given pilot values are sufficient. Possible indicators for improperly chosen "decrease factors" are:

- remaining Lambda deviation after the long term portion has elapsed (in this case the long term portion must be increased, i.e., ZBALM or ZVALM must be reduced). This effect is frequently experienced with cold engine.

- short lean-out during acceleration (approx. 1 s) after load step, in the case when an increased short term portion results in an enrichment p r i o r to the lean-out, and increased long term portion leads to an enrichment a f t e r the lean-out. In this case there is obviously a gap between the short term and long term portion.

When varying the "decrease factors", the ratio ZUKK/ZBALM or ZUKK/ZVALM should not fall short of 8 ... 10. Otherwise, both portions are dynamically too similar in order to influence the mixture characteristic by means of the short and long term portion.

Note: When calibrating the wall wetting characteristic WFRL, make sure to obtain a "plausible" characteristic (flat parabolic curve, no edges!).
As soon as all load intervals 24 % <——> 36 %, 36 % <——> 48 %, 48 % <——> 60 % etc. have been calibrated, larger load changes are applied and the Lambda characteristic is then evaluated. In case there are unacceptable Lambda deviations, at first the "small" load steps should be again verified at the appropriate area. Frequently, the deviations, occuring at large load steps, are also experienced with small load steps (smaller magnitude), however, they were yet accepted in these areas.
Short term portions KFABAK or KFAVAK exceeding 60 % are frequently caused by a dynamic error in load signal (too slow). In this case both the rl and the manifold pressure characteristic during load variation should again be compared.

Remaining Lambda deviations for load steps close to full load may indicate insufficient steady state calibration in this area. In this case the pulsation compensation and the psmax-limitation must again be verified.

2. Calibration with hot engine for the entire engine speed range

Initial calibration is performed at the speed setpoint of approx. 1400 rpm. Then, the remaining speed setpoints are calibrated as well. At first the setpoints in the idle area should be calibrated, since, in some cases, improperly chosen "decrease factors" ZUKK, ZBALM, ZVALM may be discovered, resulting in verification of the speeds which have already been calibrated. If possible, neither the "decrease factors" nor the wall wetting characteristic WFRL should be changed, because there is no degree-of-freedom for different engine speed.
For significant deviations of the entire wall wetting amount, the correction should be carried out via the speed dependency in the look-up tables KFBAKL and KFVAKL.

Note: The time for build-up and reduction of wall wetting decreases at higher engine speed. This effect must be considered when choosing the parameters, compensating for Lambda deviations. At 1000 rpm, the Lambda deviation, occuring approx. 1 s after a load step, is rather allocated to the short term portion, at 3000rpm, however, the deviation is mainly influenced by the long term portion.

Time for calibration: Approx. 1 day for each speed setpoint.

3. Conversion engine dyno ——> vehicle

If the calibration of the hot engine is performed on the engine dyno, all transient compensation data must be reduced by 10 - 20 %, since the manifold temperatures for vehicle installation are slightly increased.
In order to obtain proper conversion to the vehicle, the configuration of all engine components (manifold design, camshaft, etc.) must be identical for dyno and vehicle testing. Aging conditions (intake valve deposits) should be comparable as well. If not ensured, the conversion of data must be verified, after one or two speed setpoints have been calibrated.

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4. Warm-up calibration

The correspondence between engine dyno and vehicle is not ensured for the cold engine. Therefore, the warm-up calibration of the transients (accel, decel) should be performed on the chassis dyno. For this purpose, alternating acceleration and deceleration events are carried out at a constant engine speed (lower load point corresponding to approx. 400 mbar, upper load point at approx. 800 - 900 mbar manifold pressure) and the parameters: load, injection time, coolant temperature and Lambda are recorded (on-line calibration not possible!). Then, the factors KFBAKL and KFVAKL for the appropriate speed and temperature range are increased or decreased, depending on the Lambda characteristic (10 %-steps each, based on the previous value, e.g., increase KFBAKL from 5.0 to 5.5, if there is an accel lean-out in the relevant temperature range).

In order to minimize the time required for adjusting the desired speed and load points (undesired engine heat-up), the chassis dyno adjustment, and the variation of the throttle angle are determined prior to testing (with hot engine).
Note: With cold engine (coolant 20 deg C), the air flow for the same throttle position is approx. 10 - 15 % higher than with hot engine (increased desired idle airflow and cylinder charge with cold engine). Prior to testing, the Lambda sensor must be pre-heated (approx. 5 min).

For the temperature range > 0 deg C, a soak time of 7 to 8 hours (if possible in the cold chamber) is sufficient, allowing two measurements daily. Cooling down the engine by means of a blower (2 ..3 hours) is not recommended. In this case, the manifold would have cooled down, however, the coolant temperature, used for determining the transient compensation (TC) maps, would increase quickly due to the relatively warm engine block, causing insufficient TC calibration.
Time for calibration: Three to four warm-up cycles required for each speed setpoint.
Since the speed dependency shows a smooth characteristic, it is considered sufficient to calibrate 3 to 4 setpoints in the range 800 to 4000 rpm.

In many cases the long term portion must be increased at <= 20 deg C (ZBALM and ZVALM to be reduced at the appropriate temperature range). When increasing the temperature dependent factors during load reduction, it must be ensured that the injection time during transients exceeds the te-minimum value. With cold engine, in general a significant speed dependency of the wall wetting is experienced (wall wetting decreasing with increasing speed).

5. Calibration of the post cranking factor

In case the calibration of the TC is performed according to section 4, e.g., TC at 20 deg C with a start temperature of 0 deg C, then a significant undercompensation is experienced, when the engine is started at 20 deg C (poor acceleration immediately after cranking, partly misfiring at fast acceleration).
Cause: Shortly after coldstart the temperatures of the manifold and intake valves are significantly lower compared to the temperatures occuring based on a significantly lower start temperature. This temperature effect can be compensated with the post cranking factors FUKNSTM and FVANST. In this case the post cranking factor FUKNSTM at the appropriate start temperature is increased (starting at 1.0) until satisfactory driving conditions for the warm-up stage have been obtained.

Due to high HC concentrations, Lambda measurements are very critical if carried out right after start.
If fast gas analyzers are available, then "Lambda = constant" can also be calibrated during post cranking conditions.

Influenced functions:

- Idle speed control: The wall wetting compensation, which is also effective during idle condition, leads to a faster increase of engine torque for opening of the idle speed actuator. This could result in cyclic speed oscillations ("sawing").

EASTT 3.1 Injection at start

FDEF EASTT 3.1 Function definition

No text for FDEF available!

ABK EASTT 3.1 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
WEESTM	TMOT		KL	correction of pretiming of injection during start
WEESTN	N		KL	end of injection angle during start
WEESTS			FW	limit for end of injection angle during start
WESBM			FW	angle intake closes before software reference mark (tR)
ZTPREL			FW	number of teeth during start recognition

Variable	Source	Type	Description
B_START		EIN	Cranking condition
WEEST	EASTT	LOK	angle injection-end at start

FB EASTT 3.1 Detailed description of function

APP EASTT 3.1 Application hint

EA 139.10 Mode of injection

FDEF EA 139.10 Function definition

CIFI injection

1. Calculation of the pretiming angle:
   In normal operation the end of injection is specified by the pretiming angle wee (in deg. CA, referred to WESBM + wnwem)
   Calculation of wee:

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#

#

The pretiming angle is calculated in the main program; number of ignitions is stored in ZZWEETM

2. ti resolution:
The start-of-injection angle is calculated from ti duration, engine speed and pretiming angle, and ti output is started at the corresponding negative tooth flank. Calculation of injection duration ti and calculation of start of injection occur at each tR mark.

3. Post-injections:
Post-injections for one or more cylinders are output at the last two tR marks before the reference mark specified by WESBM (time k=k0 for the first and k=k1 for the second post-injection). The position of the last tR mark relevant for output of a post-injection can be selected via a system constant.

The first post-injection at time k0 is triggered when the difference between the already injected tiz and the current calculated tiz(k0) exceeds an absolute threshold:
The post-injection output occurs only if the condition B_nsp is set.

$$tiz(k0) - tiz > DTIABS$$

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The second post-injection at time k1 is triggered when the difference between the already injected tiz including any first post-injection and the current calculated tiz(k1) exceeds a relative threshold:

$$\frac{tiz(k1) - tiz(k0)}{tiz(k0)} > DTIREL$$

If a post-injection overlaps the tiz output for the relevant cylinder or the other post-injection, then it is appended

The magnitude of the post-injection is calculated from the tiz difference:

$$tinsp1 = tiz(k0) - tiz$$

$$tinsp2 = tiz(k1) - (tiz + tinsp1)$$

4. Spontaneous triggering:
Spontaneous triggering of the injection at a tR mark is triggered if a ti calculation at the tR mark ascertains that the calculated start of injection for the injection pulse to be output has already passed. In this case the specified end of injection is not maintained.

5. Decision about ti output:
On the decision about ti output see %ESUE. When these conditions take effect, no further injections are output injections in progress are not terminated.

For the 8-cyl.:

SSSSS	Sequential injection at start
ZZZZZ	Additional simultaneous injections at start,
=====	Desired injection point from Weer map
nnnnn	Post-injection
#####	Spontaneous triggering

NNNNN Sequential injection in normal operation

Remarks: - Spontaneous triggering for IV6 example only (reason: e.g. altered pretiming angle)

For the 6-/12-cylinder:

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NNNNN	Sequential injection in normal operation
=====	Desired injection point from Weer map
nnnnn	Post-injection
#####	Spontaneous triggering

ABK EA 139.10 Abbreviations

WESBM	Angle, inlet closes (Es) before reference mark (BM)
wee	Angle, end of injection in normal operation
weer	Angle, resultant end of injection
tinsp1	ti post-injection 1
tinsp2	ti post-injection 2
Es	Control time, inlet closes
LWOT	Load change TDC
ZOT	Ignition TDC
UTH	BDC vefore high-pressure process (ZOT)

Switching conditions

B_nmin	Condition minimum engine speed not attained
B_vl	Full-throttle condition

Parameter	Source-X	Source-Y	Type	Description
DTIABS			FW	Dti threshold value for first post-injection
DTIREL			FW	Dti threshold value for second post-injection
KFWEE	NMOT	RL	KF	characteristic map angle end of injection
KFWEEK	NMOT	RL	KF	map for end of injection angle (cold parameters)
WEAN	NMOT		KL	angle injection break off
WEEM	TMOT		KL	correction of prestorage angle
WEESTM	TMOT		KL	correction of pretiming of injection during start
WEESTN	NMOT		KL	end of injection angle during start
WEESTS			FW	limit for end of injection angle during start
WEEVLN	NMOT		KL	angle end of injection at WOT
WESBM			FW	angle intake closes before software reference mark (tR)
ZTPREL			FW	number of teeth during start recognition
ZZWEETM	TMST		KL	Switchover threshold pattern angle

Variable	Source	Type	Description
B_NSP	EA	LOK	condition for post-injection
B_STEND	BBSTT	EIN	condition end of start
B_VL	MSF	EIN	Condition for wide open throttle
NMOT	BGNMOT	EIN	engine speed
WEA	EA	AUS	anglemark injection break off
WEE	EA	AUS	angle injection-end in normal operation
WEENWCNT	EA	LOK	counter of crankshaft revolutions
WNWEM		EIN	Camshaft angle intake (average value)

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FB EA 139.10 Detailed description of function

In cylinder-individual fuel injection (CIFI) the fuel injection quantity is calculated separately for each cylinder.
The time for each fuel injection is calculated indivudally for each bank.

APP EA 139.10 Application hint

WESBM:

Angle WESBM is the angle between the last useful post-injection and the corresponding tR mark of the relevant cylinder
The corresponding tR mark is the last tR mark before the relevant ignition TDC when viewed in the direction of rotation

The value for WESBM is stored as a constant in DAMOS (in conversion formula) when the database is created. This angle must therefore be stated with the project request. WESBM must be adapted accordingly when the inlet timing and MB position is changed. The values are stored in the pretiming maps in 0CA before inlet closes.

The value is calculated from the Es timing and the distance GDWRT of reference mark BM and the ignition TDC (ZOT) as follows

WESBM (0CA) = 180 (0CA) - Es (0CA after UTH) - (GDWRT (0CA) - 60CA)

Remark: The valve timings apply for the start of opening and end of closing of the valve, i.e. for a valve stroke of 0 mm or valve play.

Position of injection:

When configuring the end of injection the following aspects should be taken into account:

- The start of injection should not precede inlet closes of the previous cycle
- The greater the pretiming angle, the less up-to-date the ti calculation (dynamics, jerking, l-control)
- The fuel flight times must be taken into account (depending on fuel pressure, speed of air flow and fuel jet preparation)

Start of injection in normal operation:

In many engines injection in front of the closed inlet valve is desirable to prevent flooding of the spark plugs.
In engines where the spark position is not critical it may well be an advantage to inject into the opening inlet valve in order to obtain improved mixture preparation thanks to the air flow.

To provide reliable fuel feed even under maximum engine speed dynamics and to prevent injection into the open inlet valve, the injection position is established relative to the engine speed with a dynamic lead. The injection should occur at the earliest immediately after inlet closes of the preceding induction cycle. Too great a pretiming angle should also be avoided so as to ensure a ti calculation that is as up-to-date as possible.

Re. the 2nd pretiming map KFWEEK:
With a warm engine / intake manifold a large pretiming angle can be used (utilization of the thermal preparation of the fuel)
The warming is relative to the energy throughput since engine start and thus occurs in relation to the reading of the ignition counter zzkh (when it exceeds a threshold value ZZWEETM).

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AES 1.50 Overview calculation of injection time

FDEF AES 1.50 Function definition

aes-aes

ABK AES 1.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWPKAPP			FW	code word application of reference pressure for fuel-pressure controller
FRLFSDP	DPUS_W		KL	injection correction for RLFS
KRKTE			FW	conversion from relative fuel mass rk into effective injection time te
PSAPES			FW	intake manifold pressure to applicate injection
TVUB	UB		KL	voltage correction

Variable	Source	Type	Description
B_BEVAB	AES	AUS	condition: Inj. valve cut off on Bank/Bank1
B_BEVAB2	AES	AUS	condition: Inj. valve cut off on Bank2
B_EVASEL	AES	AUS	Status:all local injector relevant to DASE are switched on
B_EVLOC	AES	AUS	Status: all injection valves are activated
B_FAEVZ		EIN	condition cylinder fade out by tester
B_SA	AES	AUS	Condition fuel cut-off
C_INI		EIN	ECU-condition for intialisation
DEVOFF		EIN	injector fade out pattern at tester requirement
DPUS_W	AES	AUS	delta between ambient and intake manifold pressure
ETAZWMN	ZWMIN	EIN	minimum ignition angle effectiveness
ETAZWMN_W	AES	LOK	minimum ignition angle effectiveness
EVZ_AGS	AES	LOK	injection cut off pattern total of one or two ECU
EVZ_AUS	AES	LOK	injection cut off pattern
EVZ_AUSTOT	AES	LOK	injection cut off pattern total
FLGTIAB	DMDMIL	EIN	state flag ti turn-of by catalyst damaging misfiring rates
FRKTE	AES	LOK	factor: conversion rel. fuel mass rk into effect. injection time te
MIBAS_W	MDBAS	EIN	indicated basic torque
MIOPT_W	MDBAS	EIN	optimum indicated torque
MISOL_W		EIN	indicated resultant nominal torque
PSES_W	AES	LOK	intake manifold pressure corrected bei application system
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PU	GGDSAS	EIN	Ambient pressure
REDBAS	AES	AUS	Base cut-off step
REDIST	AES	AUS	real cylinder cut-off step
REDSOL	AES	LOK	calculated desired cylinder cut-off step
RK2_W	MSF	EIN	relative fuel mass Bank2
RK_W	MSF	EIN	relative fuel mass
TI_B1	AES	LOK	injection time for valves on bank1
TI_B2	AES	LOK	injection time for valves on Bank2
TI_EV0	AES	AUS	injection time 1. cylinder in firing sequence
TI_EV1	AES	LOK	injection time 2. cylinder in firing sequence
TI_EV7	AES	AUS	injection time 8th cylinder in firing sequence
TI_EV8	AES	LOK	injection time 9th cylinder in firing sequence
TI_TVU_W	AES	LOK	injection time correction as function of battery voltage ECU-quantization
TVU_W	AES	LOK	supply of voltage correction
UB	GGUB	EIN	battery voltage
VSFPSES	VS_VERST	EIN	factor for modifying intake manifold pressure during Application injection

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Variable	Source	Type	Description
WEA	AES	AUS	anglemark injection break off
WEE	AES	AUS	angle injection-end in normal operation
WEER	AES	LOK	resulting crankshaft angle for end of injection
WEESTZ	AES	LOK	angle injection-end for triggering simultanious injection at start

FB AES 1.50 Detailed description of function

The function AES shows the calculation of the injection time (injection valve control time) from the relative fuel mass rk_w, rk2_w.
The injection time is calculated bank-selectively and results as:

```
ti_b1 = rk_w *frkte + tvu_w
ti_b2 = rk2_w *frkte + tvu_w
```

wherein

ti_b1, ti_b2	bank-selective injection time
rk_w, rk2_w	relative fuel mass, bank-selective
frkte	correction for returnless fuel systems (FRLSDP) and translation of relative fuel mass rk into effective injection time te (KRKTE).
tvu_w	battery voltage compensation of the injection valves (response delay with differing battery voltage)
FRLFSDP	correction of injection fuel mass at returnless fuel systems

In the AEVAB function, a valve cutoff pattern ev_zaustot is formed from the fixed valve cutoff patterns of the misfire flag DASE (flgtiab), the tester specification for cutoff of an injection valve for tests at the end of line assembly (devoff) where B_faevz = true, the error of injection valves E_ev and from the reduction stage redsol specified by the torque reduction.

Based on the valve cutoff pattern the information bits B_bevab, B_bevab2 are formed, indicating the bank on which injection valves are shut off.

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APP AES 1.50 Application hint

Calculation of constant KRKTE:

$$\text{KRKTE [ms/\%]} = \frac{\text{rho0Air [g/dm^3]} * \text{Vhzyl[dm^3]}}{\text{100[\%]} * \text{Lst} * \text{Normmk[min/ms]} * 1.05 * \text{Qstat[g/min]}}$$

KRKTE = 50.2624 * Vh / Qstat

where

rho0Air	= 1.293	g/dm^3	(0°C and 1013hPa)
Vhzyl	=	dm^3	Displacement of a cylinder in dm^3
Qstat	=	g/min	Valve constant with n-Heptane
	1.05		Valve correction for petrol/n-Heptane
Lst	= 14.7		Air/fuel ratio for Lambda = 1.0
Normmk	= 0.00001667	min/ms	Adaptation of units

Calculation of the correction for returnless fuel systems:

$$\text{FRLFSDP} = \sqrt{\text{pdr_evmes}/(\text{pdr_akt}+(\text{pu-ps}))}$$

Wherein pdr_evmes = absolute pressure in the fuel circulation upstream of the injection valve at measuring Qstat (3000 hPa)
pdr_akt = actuell system pressure in fuel circulation
pu = ambient pressure
ps = intake manifold pressure

At systems with reference pressure at intake manifold pu - ps = 0.
The correction for the complete characteristic a this one is:

$$\text{FRLFSDP} = \sqrt{\text{pdr_evmes}/\text{pdr_akt}}$$

For a fuel pressure of 3000 hPa the result for FRLFSDP is:
Wherein dpus = pu - ps

Induction engine 3000 hPa /3500 hPa			Turbo engine:		
dpus [hPa]	FRLFSDP		dpus [hPa]	FRLFSDP	
0	1.0	1.0	-1200	1.299	pBoostPress = 1800 hPa, pu = 600 hPa
100	0.9837	0.9860	-1000	1.2247	
200	0.9682	0.9726	-800	1.1678	
300	0.9535	0.9597	-600	1.1180	
400	0.9393	0.9473	-400	1.0742	
500	0.9258	0.9354	-200	1.0351	
600	0.9129	0.9240	0	1.0	
700	0.9005	0.9129	200	0.9682	
800	0.8885	0.9022	400	0.9393	
			600	0.9129	
			800	0.8885	

There are 11 interpolation points implemented for induction and turbo engine.

during application air charge measuring, the modelled intake manifold pressure is not correct.
At returnless fuel systems the intake manifold pressure can be set by
the application system VS100 with parameter PSAPES. Therefore bit 0 at CWPKAPP must be set.
The init value for PSAPES is 1013 hPa. The VS20 application System can correct the pressure PSAPES by the factor vsfpses
with a range of 0 ... 2. The corrected pressure for calculation dpus_w is pses_w.

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RKTI 1.60 Calculation of injection time ti from relative fuel mass rk

FDEF RKTI 1.60 Function definition

rkti-rkti

ABK RKTI 1.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FKKVS	NMOT	TEVFA2_W	KF	Factor to correct fuel delivery system
TEMIN			FW	minimum effective injection time

Variable	Source	Type	Description
B_STEND	BBSTT	EIN	condition end of start
B_TEMIN	RKTI	AUS	Condition: TEMIN-limitation active, bench 1
B_TEMIN2	RKTI	AUS	Condition: TEMIN-limitation active, bench 2
C_INI		EIN	ECU-condition for intialisation
FRKTE		EIN	factor: conversion rel. fuel mass rk into effect. injection time te
NMOT	BGNMOT	EIN	engine speed
RK2_W	MSF	EIN	relative fuel mass Bank2
RK_W	MSF	EIN	relative fuel mass
R_SYN		EIN	Synchro schedule
R_T100		EIN	Time schedule 100 ms
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TI2_W	RKTI	AUS	injection time cylinder 2 (word)
TI_B1	RKTI	AUS	injection time for valves on bank1
TI_B2	RKTI	AUS	injection time for valves on Bank2
TI_TVU_W	RKTI	AUS	injection time correction as function of battery voltage ECU-quantization
TI_W	RKTI	AUS	injection time
TVU_W		EIN	supply of voltage correction

FB RKTI 1.60 Detailed description of function

The function calculates the effective injection time tevfa from the relative fuel mass rk_w,rk2_w and the factor frkte.
At an ideal fuel system there will be Lambda combustion chamber 1.0 with ti = tefva + tvu. A real fuel system has to be corrected by the map FKKVS for pulsations in returnless fuel systems, nonlinearitis of injection valves ... .
The injection time ti_b1, ti_b2 is calculated by addition of the battery voltage correction and the corrected effective injection time te_w, te2_w.
The CIFI controls the relevant injection valves with times ti_b1 and ti_b2.

In a single-bank system (SY_stervk = false) the injection time of Bank1 is passed as ti_b1 and ti_b2 to the CIFI.

To implement the large injection times occurring during starting, the ti_b1, ti_b2, ti_tvu_w quantisation is increased by a factor of 8 during starting, and the values range thus extended to 1677.696ms. The interface to cifi is so realized by a 16-Bit RAM, also during start.

ti_w is calculated selective to cylinder bank and shows the correct VS100-measured value during start and normal operating with constant resolution of 16 us.

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APP RKTI 1.60 Application hint

```
Init values:

        FKKVS: Interpol. points nmot_w   800  1400 2000 2600 3200 3800 4400 5000 5600 6200 1/min
                                tevfa_w  1.5   2.5  3.5  4.5  5.5  6.5  7.5  8.5  9.5 10.5 ms
               Values                    1.0   1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
the map FKKVS corrects errors in fuel system, especially pulsation at returnless fuel systems.
        TEMIN: 1 ms

ti-resolution:  start:  ti_b1, ti_b2            25.6 us         real value = VS100-measured value * 8 during start
                        ti_tvu_w                25.6 us           "
                        ti_w, ti2_w             16 us
                        te_w, te2_w             not available

                normal: ti_b1, ti_b2            3.2 us
                        ti_tvu_w                3.2 us
                        ti_w, ti2_w             16 us
                        te_w, te2_w             3.2 us
```

COSA 6.20 Idle CO adjustment

FDEF COSA 6.20 Function definition

The possibility is given using a suitable diagnostic tester at the end-of-the line as well as in the workshop to perform idle-speed CO-tuning for vehicles not fitted with a catlytic converter.

Three KWR2000* diagnostic blocks are defined for the LL idle-speed CO-tuning:

- Block 1: Read CO tuning value
- Block 2: Define CO tuning value
- Block 3: Program CO tuning value

Requirement with KWP-2000* protocol:

	Tester sends (Request):	Service ID		ECU replies:	Service ID	Content / Cause
Block 1:	Read CO tuning value	IOCBLI	——>	Positive Response message Tuning value read	IOCBLIP CS_abc	co_pot
				Negative response message ResponseCode	IOCBLI RC_	Transmission error
Block 2:	Prescribe CO tuning value	IOCBLI	——>	Positive Response message Tuning value prescribed	IOCBLIPR CS_abc	co_pot
				Negative response message ResponseCode	IOCBLI RC_	Transmission error Tuning condition not fulfilled B_cotrim = False
Block 3:	Program CO tuning value	IOCBLI	——>	Positive Response message Tuning value programmed	IOCBLIPR CS_abc	co_pot
				Negative response message ResponseCode	NR RC_	Transmission error Tuning condition not fulfilled B_cotrim = False

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cosa-cosa

Overview of data handling with EEPROM:

```
Only take EEPROM value for co_pot if !B_eepdif && B_ndsav otherwise 0
B_cotrim = B_ll && (tmot>=TLLCO) && !E_tm && B_ndsav && B_nokatfz
```

cosa-co-eb

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Condition for enabling LL idle-speed CO tuning

cosa-es-rkaco

cosa-es-rkaco

Calculation rkco_w :

ABK COSA 6.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
N0			FW	conversion constant for calculation the mixture correction rkat
NRKAB			FW	minumum engine speed for limitation rkat correction
RKACOMN			FW	lower threshold of additive correction per time
RKACOMX			FW	upper threshold of additive correction per time
TLLCO			FW	coolant temp. threshold for CO-correction
TVCO	CO_POT		KL	idle-speed potentiometer correction

Variable	Source	Type	Description
B_COTRIM	COSA	LOK	condition enable LL-CO tuning
B_LL	MSF	EIN	Condition idle
B_NDSAV	PROKON	EIN	Condition EEPROM emulation active
B_NOKATFZ	KATV	EIN	condition: no cat vehicle
CO_POT	COSA	LOK	idle CO adjusting potmeter
C_INI		EIN	ECU-condition for intialisation
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
NMOT	BGNMOT	EIN	engine speed
RKACO_W	COSA	AUS	Additive correction of the rel. fuel mass for setting idle-speed CO
TMOT	GGTFM	EIN	Engine temperature

FB COSA 6.20 Detailed description of function

Tuning procedure

LL idle-speed CO-tuning only when the conditions of engine temperature > TLLCO, no TMOT error present, vehicle is idling and B_nokatfz = TRUE are fulfilled.
All conditions must be met at the same time.

The LL idle-speed CO-tuning is adjusted using suitable test equipment during the compensation phase in the ECU's RAM. It then acts immediately on the injection quantity and the desired tuning value can be determined by measuring the exhaust-gas emissions.

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APP COSA 6.20 Application hint

AEVAB 2.10 Output injection valve cut off

FDEF AEVAB 2.10 Function definition

aevab-aevab

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aevab-abm

ABK AEVAB 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NMXSKA			FW	Maximum permitted engine speed in case of unknown throttle position -> cut off
REDABM	EVRBGN_ONE	REDSOL_ONE	KF	fuel cut-off table for torque reduction

Variable	Source	Type	Description
ABMF	AEVAB	LOK	injection cut off pattern at fixed position
B_2SG		EIN	System consists of 2 ECU, connected via CAN
B_BEVAB	AEVAB	AUS	condition: Inj. valve cut off on Bank/Bank1
B_BEVAB2	AEVAB	AUS	condition: Inj. valve cut off on Bank2
B_DKNOLU	SREAKT	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SREAKT	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DKUEVAB	AEVAB	DOK	Injection valve cut off by throttle blade uncorrect
B_DVEADA	BGDVE	EIN	condition: disabling injection during DV-E-adaptation
B_ECULOCK		EIN	Locking request immobilyzer
B_EVASEL	AEVAB	AUS	Status:all local injector relevant to DASE are switched on
B_EVLOC	AEVAB	AUS	Status: all injection valves are activated
B_FAEVZ		EIN	condition cylinder fade out by tester
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_NMAXD		EIN	condition rpm limiting with injection masking
B_SGA		EIN	ECU select condition
B_SKAEVAB	AEVAB	DOK	Fuel cutoff by safety fuel shut-down
C_INI		EIN	ECU-condition for intialisation
DEVOFF		EIN	injector fade out pattern at tester requirement
EEVX	AEVAB	LOK	Injection valve Errorbyte
EVRBGN	AEVAB	LOK	ev.nr. at begin of cylinder cut-off
EVRBGN_ONE	AEVAB	LOK	ev.nr. -1 at begin of cylinder cut-off for REDABM
EVZ_AGS	AEVAB	AUS	injection cut off pattern total of one or two ECU
EVZ_AUS	AEVAB	AUS	injection cut off pattern
EVZ_AUSTOT	AEVAB	AUS	injection cut off pattern total
E_EV1	DEVE	EIN	error flag: injection valve of cyl. 1
E_EV2	DEVE	EIN	error flag: injection valve of cyl. 2
E_EV3	DEVE	EIN	error flag: injection valve of cyl. 3
E_EV4	DEVE	EIN	error flag: injection valve of cyl. 4
E_EV5	DEVE	EIN	error flag: injection valve of cyl. 5
E_EV6	DEVE	EIN	error flag: injection valve of cyl. 6
E_EV7	DEVE	EIN	error flag: injection valve of cyl. 7
E_EV8	DEVE	EIN	error flag: injection valve of cyl. 8

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Variable	Source	Type	Description
FLGTIAB	DMDMIL	EIN	state flag ti turn-of by catalyst damaging misfiring rates
NMOT	BGNMOT	EIN	engine speed
REDBAS	AEVAB	AUS	Base cut-off step
REDIST	AEVAB	AUS	real cylinder cut-off step
REDSOL	MDRED	EIN	calculated desired cylinder cut-off step
REDSOLR	AEVAB	LOK	realized cylinder cut-off step
REDSOL_ONE	AEVAB	LOK	calculated desired cylinder cut-off step -1 for REDABM
SY_2SG	PROKON	EIN	system constant 2 motronic systems
SY_DVEADA	PROKON	EIN	system constant BGVE: disabling injection and ignition during DV-E-adaptation
SY_REDMX	PROKON	EIN	system constant: max. cylinder cutoff step
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
SY_ZZBANK	PROKON	EIN	system constant cylinder assignment bank1/bank2, 0 bank1, 1 b.2, binary value
TVRNR	AEVAB	LOK	delay time from end of fuel cut of to normal combustion
ZZBANK	AEVAB	LOK	cylinder allocation to injection banks
ZZYL		EIN	SW-cylinder counter

FB AEVAB 2.10 Detailed description of function

The function output injector shutoff AEVAB determines the injectors to be shut off from the fixed injector shutoff pattern of the misfire detection DASE (flgtiab), from the input of an injector shutoff by the workshop tester (devoff), from the injector output stage faults eevx as well as from the torque reduction via the reducing stage redsol. The operating mode is described by means of a state machine. In the process the function is always within one of the sketched states. The transitions from one state to another state are always performed in the direction of the arrow.
Fixed injector shutoff patterns are such patterns, at which a particular injector needs to be shut off e.g. in case of fault.
In contrast to that the next possible injector is always to be shut off in case of a torque reduction.

The injector shutoff via fixed injector shutoff patterns is displayed in the RAM-cell abmf. The basic reduction redbas is calculated from this.

The entire injector shutoff pattern via reducing stage and fixed injector shutoff pattern is displayed in the RAM-cell evz_ags with 1ECU and 2ECU concepts.
With 2ECU concepts this pattern evz_ags is distributed to both ECUs ranged right in evz_aus, B_sga = false && B_2sg = true
 ——> High nibble (bit 4 .. bit7) from evz_ags to evz_aus from left ECU, Low nibble to evz_aus right ECU.
With 1ECU concepts: evz_aus = evz_ags.

Also refer to APP-hint in this FDEF.

Description of the individual states:

Initialization: State Init

This state is only run through during the ECU start-up.

No injector shutoff effective: State No_evab

The function is in this state if no injector shutoff is requested.

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Torque reduction: State MOMEVAB

If only the torque reduction is active then redsol pre-selects the number of injectors, which are to be shut off.

The injector shutoff starts with the injector with the number evrbgn = zzyl+1+SY_ZYLZAL/2; zzyl-counting mode (0 ... SY_ZYLZA-1) injector counting mode (1 ... SY_ZYLZA).
Here zzyl is that cylinder, which shall just fire. Since, however, fuel was already injected for the next cylinders to fire, the injector for the next cylinder cannot be shut off, but a subsequent one. This subsequent injector is defined with the offset SY_ZYLZAL/2. This definition is no compromise, since the number of the next injector to be triggered does not exit in the current version of the CIFI. Thus an injector is shut off at the latest after one crankshaft revolution. The injector shutoff pattern evz_ags is determined from the fixed map REDABM with the value evrbgn_one = evrbgn-1 and the value redsol_one = redsol-1.
The pattern evz_ags is the injector shutoff pattern for the entire engine for 1 ECU concepts as well as for 2 ECU concepts.
This pattern is distributed to both ECUs with 2ECU concepts and there it is always realized as evz_aus with ranged right injector shutoff pattern. The actually realized reduction redist is formed from the total pattern evz_ags in each ECU as a feedback for the actual torque calculation.
In this case the basic reduction redbas is 0, since it is only formed from the shut off injectors of the fixed injector shutoff pattern.

Deactivation via fixed injector shutoff patterns: State FEST_EVAB

The fixed injector shutoff patterns flgtiab, devoff, eevx are "OR" and are available as bit pattern abmf for injector shutoff.

Since only injector shutoff via fixed shutoff pattern will take place in this state, evz_ags = abmf and evz_aus = abmf is set.
The actual reduction redist is calculated from evz_ags. Since only reduction from fixed injector shutoff pattern, redbas = redist will result.

Deactivation via fixed injector shutoff and torque reduction: State Mom_fest_evab

The injector shutoff pattern evz_ags to be realized is formed by an OR logic of the fixed deactivation patterns devoff, flgtiab, eevx and the shutoff pattern of the torque reduction REDABM.
abmf = devoff OR flgtiab OR eevx
evz_ags = abmf OR REDABM

For the start of the shutoff evrbgn via the torque reduction the same applies as mentioned in the state MOM_EVAB.

From evz_ags the number of the actually shut off injectors is determined and displayed to the torque coordination via redist.
The number of shut off injectors for the basic reduction is formed from the OR logic abmf.

State Warten_2_NWU:

The conditions B_bevab, B_bevab2 are set to false when this state is entered. The injections, which are again enabled as from here are calculated with the "normal pre-controlled Lambda" and not any more with LASOAB.
Then two camshaft revolutions are waited for in this state until the misfire detection via B_evasel = true or e.g. the Lambda control via B_evloc = true is again enabled.

The following applies in all states:

From the actually realized deactivation pattern evz_ags that bank is determined, at which one or several injectors are shut off.
B_bevab = true: at least one injector of bank1 is shut off.
B_bevab2 = true: at least one injector of bank2 is shut off.
The shutoff of an arbitrary injector, is displayed in B_evloc, just as an injector output stage fault.
The following applies to injector shut off or output stage fault: B_evloc = false
A blocking of the misfire detection is performed with cylinder cutout by a tester and with torque reduction by the setting of B_evasel = false.

Shutoff request	shutoff condition	shutoff information	misfire detection	
Tester	devoff > 0 & B_faevz = TRUE	-> B_evloc = false	-> B_evasel = false	misfire detection blocked
Torque reduction	redsol > 0	-> B_evloc = false	-> B_evasel = false	misfire detection blocked
Outp.stage fault diag.	eevx > 0	-> B_evloc = false	-> B_evasel = true	misfire detection active
Misfire detection	flgtiab > 0	-> B_evloc = false	-> B_evasel = true	misfire detection active, search for further faults.

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Description of the transition conditions of the function AEVAB:

```
State: Init ------------------------------------------------------------------------------------------

Transition:------------------------------------------------------------------------------------------
      End of Init:     ---
                       C_ini = FALSE
                       ---                                                 -- End of the initialization

State: No_evab ---------------------------------------------------------------------------------------

Transition:------------------------------------------------------------------------------------------
     Start of Fest_evab:
                       ---
                       (((devoff >0) and (B_faevz = TRUE)) or (flgtiab > 0 ) or (eevx > 0)) and (redsol = 0 )
                       ---                                                 -- Start of an injector shutoff by a fixed defined
                                                                              injector pattern by misfire detection flgtiab,
                                                                              injector output stage fault eevx or tester
                                                                              request devoff.
Transition:------------------------------------------------------------------------------------------
     Start of Mom_evab:
                       ---
                       redsol > 0
                       ---                                                 -- --- Start of injector shutoff by torque reduction
                                                                              --- via the reduction stage redsol
State: Mom_evab --------------------------------------------------------------------------------------
Transition:------------------------------------------------------------------------------------------
      add. Fest_evab:
                       ---
                       ((devoff >0) and (B_faevz = TRUE)) or (flgtiab > 0) or (eevx > 0)
                       ---                                                 -- --- Tester injector output stage diagnosis or misfire
                                                                                  detection also request injector shutoff
                                                                                  in addition to the torque reduction
State:  Fest_evab -------------------------------------------------------------------------------------
Transition:------------------------------------------------------------------------------------------
      add. Mom_evab:   ---
                       redsol > 0
                       ---                                                 -- --- In addition to injector shutoff from misfire
                                                                              --- detection, injector output stage diagnosis or
                                                                                 tester also injector shutoff from torque reduction
Transition:------------------------------------------------------------------------------------------
     End of Fest_evab:
                       ---
                       ((devoff=0) and (B_faevz = FALSE)) and (flgtiab = 0) and (eevx = 0)
                       ---                                                 -- --- As from now injector shutoff by tester
                                                                              --- request, injector diagnosis or misfire
                                                                                  detection is no longer given

State:  Mom_fest_evab ---------------------------------------------------------------------------------
Transition:------------------------------------------------------------------------------------------
     Only Mom_evab:                                                     --- End of the injector shutoff by
                                                                        --- misfire detection or tester request

                       ((devoff=0) and (B_faevz = FALSE)) and (flgtiab = 0) and (eevx = 0)
                       ---
Transition:------------------------------------------------------------------------------------------
     Only Fest_evab:                                                    --- End of the injector shutoff by
                                                                        --- torque reduction
                       redsol = 0
                       ---
State: Warten_2nwu -----------------------------------------------------------------------------------
Transition:------------------------------------------------------------------------------------------
    End of evab:       ---
                       tvrnr >= (2*SY_ZYLZA)                               -- --- End of the injector shutoff, each cylinder was
                                                                              --- ignited once, i.e. normal operating is
                                                                              --- ensured.
```

Interventions for the injector shutoff by the DV-E-stop adaptation and the monitoring concept:

If the system detects an actuator exchange then at first a stop adaptation needs to be performed.
During this time a complete injector shutoff is demanded via B_dveada. This intervention is not fed back to the torque structure, just as an intervention via safety fuel deactivation.
With DV-E-default operation (B_dknolu,B_dkpu) a complete injector shutoff is demanded by redsol = SY_REDMX above the engine speed threshold NMXSKA. This request is reported to the torque structure via the regular injector shutoff.

Since the RAM-cell evz_aus only contains SY_ZYLZA injectors to be shut off, a cylinder-independent mask with the value FF or 225 is defined for the entire injector shutoff by the watchdog functions. In case of interventions this mask is entered into the RAM-cell evz_austot by the monitoring concept. This RAM-cell is used in the CIFI as RAM-cell EVZ_AUS for the real shutoff.

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APP AEVAB 2.10 Application hint

Example 8-cylinder

Definition of the system variables is to be performed project-specifically in the function PROKON:

The following description shows the meaning:

SY_2SG = 0 ——> 1 SG mounted
SY_2SG = 1 ——> 2 SG mounted ——> 4 cylinders per ECU

SY_ZYLZA = 8 with SY_2SG = 0
SY_ZYLZA = 4 with SY_2SG = 1 Each ECU supplies half of the cylinders

SY_REDMX = 8 (all cylinders of an engine)

SY_ZZBANK specifies the assignment of the injectors to bank 1 resp. bank 2.
Bit position 0 corresponds to injector 1
Bit position 7 corresponds to injector 8

Bit = 0 ——> injector is assigned to bank 1
Bit = 1 ——> injector is assigned to bank 2

With SY_2SG = 1 four injectors are assigned to bank 1 in each ECU: SY_ZZBANK = 00001111.

The actual deactivation pattern is stored in the fixed map REDABM = f(evrbgn_one, redsol_one)
The access to this map is performed in dependency on the currently firing cylinder zzyl and on the reducing stage redsol requested by the torque reduction.

The first injector to be shut off is specified by evrbgn = zzyl + 1 + SY_ZYLZA/2, since the injectors that immediately follow the current cylinder have already pre-injected their fuel and therefore a shutoff is no longer possible.
The characteristic REDABM starts with Index 0, therefore a conversion is performed for the indicated access:

evrbgn_one = evrbgn - 1
redsol_one = redsol - 1

The assignments ignition order, injection sequence, bank assignment of the injectors, assignment deactivation pattern REDABM to injectors are described below.

```
                        longitudinally mounted front engine cylinder layout
                                    ^
                                    | direction of travel
                                5       1
                bank2           6       2       bank1
                                7       3
                                8       4
                                    XX
                                clutch side

Cylinder No.                    1 5 4 8 6 3 7 2 <—— ignition order in direction of arrow, cylinder no. engine counting mode
Injector No.                    8 7 6 5 4 3 2 1 <—— injection sequence in direction of arrow counting mode 1 ... SY_ZYLZA
Injector No.                    7 6 5 4 3 2 1 0 <—— injection sequence in direc. of arrow ECU-internal counting mode 0..SY_ZYLZA-1
                                | | | | | | | |      corresponds to zzyl counting mode
SY_ZZBANK = zzbank = 90 dec     0 1 0 1 1 0 1 0      cylinder assignment to bank        Bit = false (0) injector belongs to bank 1,
                                | | | | | | | |                                         Bit = true (1) injector belongs to bank 2
REDABM bit position             7 6 5 4 3 2 1 0
deactivation pattern    REDABM                          evrbgn_one: 0
        redsol_one:     0       0 0 0 0 0 0 0 1         01 dec  redsol_one = redsol -1, if redsol  > 0
                      | 1       0 0 0 1 0 0 0 1         17
                      | 2       0 0 0 1 0 1 0 1         21
                      | 3       0 1 0 1 0 1 0 1         85
                      | 4       0 1 0 1 0 1 1 1         87
                      | 5       0 1 1 1 0 1 1 1         119
                      | 6       0 1 1 1 1 1 1 1         127
                    v 7       1 1 1 1 1 1 1 1         255
```

The pattern with evrbgn_one = 1 is generated by a single logic rotation to the left, i.e. a 1 that drops out on the left is entered again on the right.

```
                                                        evrbgn_one: 1
        redsol_one:     0       0 0 0 0 0 0 1 0         02 dec
                        1       0 0 1 0 0 0 1 0         34
                        2       0 0 1 0 1 0 1 0         42
                        3       1 0 1 0 1 0 1 0         170
                        4       1 0 1 0 1 0 1 1         171
                        5       1 0 1 1 1 0 1 1         187
                        6       1 0 1 1 1 1 1 1         191
                        7       1 1 1 1 1 1 1 1         255

        .
        .               Rotation of each previous pattern
        .
                                                        evrbgn_one = SY_ZYLZA-1 last pattern
```

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Formation of the actual deactivation pattern by an OR logic of REDABM and fixed injector shutoff patterns:

```
Fixed shutoff patterns: eevx     output stage fault
                        flgtiab  cylinder with combustion misses, which were detected by the function misfire detection
                        devoff   injectors to be shut off by tester

        abmf = eevx OR flgtiab OR devoff
```

Total injector shutoff pattern:

```
        evz_ags = abmf OR REDABM ( evr_bgn_one, redsol_one)
```

Calculation of the realized reduction:

```
        redist = No. of shut off injectors in evz_ags

        redbas = No. of shut off injectors in  abmf
```

The actual injector shutoff takes place in the CIFI via the bit pattern in the RAM-cell evz_aus.

With SY_2SG = 0 (only 1 ECU exists):

```
        evz_aus = evz_ags
```

With SY_2SG = 1 (2 ECUs exit) only 4 injectors are shut off in each ECU:

```
        evz_aus = evz_ags & 0F  ECU1 bit 0 .. bit 3  of evz_ags

        evz_aus = (evz_ags & F0) >> 4   ECU2 Bit 4 ... bit 7 of evz_ags ranged right
```

Example

```
SY_2SG = 0:
        evz_ags                 xxxx yyyy
        evz_aus                 xxxx yyyy

SY_2SG = 1:
        evz_ags                 xxxx yyyy       The fixed map REDABM is subdivided into 2 halves for the 2 ECUs
                                                with SY_2SG = 1
        evz_aus ECU 1   0000 yyyy
        evz_aus ECU 2   0000 xxxx
```

For the definition of the injector shutoff pattern various criteria exist:

```
 -- for projects with one ECU an injector is always shut off alternately of each bank with increasing reducing stage
 -- here, always the next injector of the ignition order may be used or an injector with constant firing interval, in order to
 -- prevent greater engine roughness if 2 subsequent injectors are shut off.
 -- On projects with 2 ECU’s at first the injectors of one half (master half) are shut off and in case of further reduction
 -- the injectors of the second half.
```

The patterns shifted via evrbgn are normally formed by a logic rotation to the left from the pattern of evrbn-1.

The start of the injector shutoff is synchronized to the currently firing cylinder, i.e. an injector would at the earliest be shut off after 2 crankshaft revolutions. This start can be set to an earlier moment by means of the fixed offset SY_ZYLZA/2, so that the first injector shuts off after 1 crankshaft revolution.

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ACIFI 6.10 Output for cylinder-individual injection

FDEF ACIFI 6.10 Function definition

acifi-ticalc

ABK ACIFI 6.10 Abbreviations

FB ACIFI 6.10 Detailed description of function

APP ACIFI 6.10 Application hint

CIFINA 1.30 CIFI new parts ME7

FDEF CIFINA 1.30 Function definition

see FB: detailed describtion of function

ABK CIFINA 1.30 Abbreviations

Variable	Source	Type	Description
ANZTI	CIFINA	AUS	injection counter
ANZTI_W	CIFINA	AUS	injection counter
TISTZYL	CIFINA	AUS	cylinder number of first injection and ignition

FB CIFINA 1.30 Detailed description of function

```
   tistzyl is the number of the cylinder with the first combustion.
   If C_inisyn = true: tistzyl = $FF, at first ignition (B_ZESYNC)=TRUE: tistzyl = ZUEN_BEG.

   The free running counter anzti or anzti_w counts the injections: anzti = LO-Byte of TI_CNT.
   anzti = LO-Byte of TI_CNT
   anzti_w = TI_CNT. Initvalue: 0 at C_inisyn

cylinderindividual faktors (schematic)

   nmot_w ———> FZNx ———————————  x = 1 ... 12 (Zündreihenfolge)
                                |
                                |
   ti_b1, ti_b2 ———o———————— * ———o———> ti_ev(x-1)
                  - ^           ^ +
   ti_tvu_w ———————————————————————
```

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APP CIFINA 1.30 Application hint

AEKP 4.10 EKP control

FDEF AEKP 4.10 Function definition

aekp-aekp

aekp-ekpvl

Subfunction EKPVL(T)

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Electric fuel pump (EKP) control with lead time and suppression of interference during start

Signals may interfere the speed sensor (DG) line caused by operation of electric consumers during engine stop. These signals can exceed the switching threshold of the DG-preparation circuit and might be recognized as toothed disk pulses. This can lead to a false switch-on of the EKP. Monitoring of tooth speed and battery voltage during start can prevent this.

1. B_ekpubn: Monitoring of battery voltage, EKP-start control

```
speed signal:       ------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---
battery voltage:                                                    |<-------TZMIN  ---->|
 -schedule         ------------|--------------------|----------------|---|---|---|---|---|-----------------------------------
 -course          ----------------------------------------------|          __/-------------------------------------------
                                                                |        __/
                                                                |      _/
                                                                |    _/
                                                                |__/
```

test of condition: dekpub = ub_old - ub_act > UBSTS and next tooth signal within TZMIN

```
                  1 : On                                          ----------------------------------------------------
        B_ekpubn: 0 : Off-----------------------------------------------|
```

2. B_ekpn: Speed calculation, EKP-start control (if 1. not recognized)

B_ekpn is set if B_nmin is not set.

3. B_ekpvl: EKP-lead time

The decision if EKP-lead time is necessary or desired can be reached in two different manners. If precise information about soak time is available EKP-lead time is released only when tabst_w > TAPVLTM. The characteristic line TAPVLTM contains the maximum soak time in minutes up to that no lead time is necessary depending on the engine temperature when the engine is stopped. If no precise information about soak time is available (B_uhrrsec = 0) EKP-lead time is released when number of ignition=on——>off without reaching end of start is less than ZNOSTMX. No lead time if ignition is switched on during ECM-afterrun (B_nachlend=0) and when tnachl_w <TNLEKPVL. This ensures that lead time is available at the next start even when the ignition is switched on once again after the engine is stopped i.e. to close windows (power-windows).

4. B_kstebf: Initial fuelling

If SY_TEBF=true the EKP can be activated for TEBF seconds for initial fuelling of the fuel system. For further information see %TKMWL if available.

ABK AEKP 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TAPVLTM	TMOTAB		KL	threshold soak time for EKP-lead time
TEBF			FW	EKP operation for initial fuelling
TNLEKPVL			FW	threshold ECM-afterrun for EKP-lead time
TPVL			FW	time for fuel pump precontrol
TZMIN			FW	timeframe for recognition of teeth after battery voltage drop
UBSTS			FW	threshold for recognition of battery voltage drop
ZNOSTMX			FW	number of ignition=on without reaching end of start for no EKP-lead time

Variable	Source	Type	Description
B_AIRBAG	GGAIRB	EIN	condition airbag activated
B_EKP	AEKP	AUS	Release of EKP-supply
B_EKPD	AEKP	LOK	condition EKP continuos duty
B_EKPN	AEKP	LOK	EKP starting condition engine speed
B_EKPUBN	AEKP	LOK	EKP starting condition speed sensor signal within TZMIN
B_EKPVL	AEKP	LOK	condition EKP lead time
B_KSTEBF		EIN	condition initial fuelling
B_NACHLEND	MOTAUS	EIN	conditon ECU switch off delay regularly finished
B_NMIN		EIN	condition lower speed: n < NMIN
B_PVL1	AEKP	LOK	condition EKP-lead time for systems with clock
B_PVL2	AEKP	LOK	condition EKP-lead time for systems without clock
B_PVLNL	AEKP	LOK	condition EKP-lead time from ECM-afterrun duration
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_TPVL	AEKP	LOK	condition EKP-lead time for TPVL seconds
B_UHRRSEC	PROKON	EIN	Condition clock with a relative counter of seconds
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
DEKPUB	AEKP	LOK	change in battery voltage between two following measurements
R_NBM		EIN	Schedule of tooth signal
R_T10		EIN	Time schedule 10 ms
R_T1S		EIN	Time schedule 1 s
SY_AIRBAG		EIN	system constant airbag-signal present
SY_TEBF		EIN	system constant initial filling fuel system (service device)
TABST_W	BGTABST	EIN	soak time

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Variable	Source	Type	Description
TMOTAB	GGTFM	EIN	engine coolant temperature at engine stop or cut-off cranking
TNACHL_W	MOTAUS	EIN	time of ECU switch off delay
UB	GGUB	EIN	battery voltage
ZNOSTEND	AEKP	LOK	Number ignition on without reaching end of start

FB AEKP 4.10 Detailed description of function

EKP-supply may not be released with B_ekp = 0. For additional security, the EKP-supply may be locked by crash-sensor or signal from airbag-ECU.

APP AEKP 4.10 Application hint

EKP-lead time is essential to obtain short starting time. TNLEKPVL should always be less than TNLSGMX (%MOTAUS).

ZUE 258.100 Basic function - ignition

FDEF ZUE 258.100 Function definition

zue-zue

ABK ZUE 258.100 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
WPHN	NMOT		KL	phase correction
ZWAPPL			FW	Applications interface ignition angle adjustment

Variable	Source	Type	Description
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_NOZWE	ZUE	LOK	condition no ignition angle intervention of torque structure
B_SA	MDRED	EIN	Condition fuel cut-off
B_ZWAPPL	PROKON	EIN	Condition ignition-timing applications without torque intervention
B_ZWKRA	ZUE	LOK	condition: ignition angle of the KC is active
DWKRZ	ZUE	LOK	cyl.-spec. ignition-timing retardation with retardation for dynamics
DZWWL	ZUE	LOK	delta ignition angle from warm-up
MISOLZ_W	ZUE	LOK	indicated resultant nominal torque for ignition angle intervention
MIZSOL_W	MDKOG	EIN	indicated resultant nominal torque for ignition angle intervention
NMOT	BGNMOT	EIN	engine speed
REDIST	AEVAB	EIN	real cylinder cut-off step
SY_REDMX	PROKON	EIN	system constant: max. cylinder cutoff step
SY_WMAX	PROKON	EIN	System constant earliest ignition timing that can be outputed
SY_WMIN	PROKON	EIN	System constant latest ignition timing that can be outputed
SZOUT_W	ZUE	AUS	dwell time
VSZW	VS_VERST	EIN	Ignition-timing correction by adjusting system
WPHG	ZUE	DOK	ignition angle DG phase correction
ZWBAS	ZUE	AUS	basic ignition angle
ZWGRU	ZUE	LOK	basic ignition angle
ZWIST	ZUE	AUS	real ignition angle
ZWOUT	ZUE	AUS	Ignition angle output value
ZWOUTCPL	ZUE	AUS	Single complement of the ignition angle for function monitoring
ZWSOL	ZUE	LOK	desired ignition angle from torque intervention

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Variable	Source	Type	Description
ZWSPAE	ZUE	LOK	retarded ignition angle
ZWSTT	ZUE	LOK	Ignition angle during start
ZWZYL1	ZUE	AUS	ignition angle cylinder 1

FB ZUE 258.100 Detailed description of function

The ignition timing zwgru from the basic ignition-timing calculation is corrected by the timing dzwwl for the warming-up run and the cylinder-specific timing dwkrz of the knocking control. The basic ignition timing zwbas is given that is identical to the most advanced ignition timing that is possible.
This ignition timing forms the input for the torque implementation MDZW that supplies the ignition timing zwsol as the output. # This ignition timing is limited to the most advanced or most retarded ignition timing that is possible.

In the case of active torque interventions (B_nozwe = B_zwappl = B_sa = 0), the ignition timing thereby obtained is used for zwist.

If the torque interventions have been deactivated (B_nozwe or B_zwappl = 1), then the basis ignition timing zwbas is used; for trailing throttle fuel cutoff, the most retarded ignition timing that is possible zwspae.

zwist is finally corrected by the phase error and limited to the values that can be outputted by the system. The output ignition timing zwout is given.

The single component of zwout is formed for safeguarding the ignition timing as the input variable of function surveillance and saved in zwoutcpl.

APP ZUE 258.100 Application hint

Three interfaces are foreseen for the application. The RAM cell vszw and the fixed value ZWAPPL enable adjustment of the ignition timing by means of application tools. The intervention by torque functions is shut down by the code word CWMDAPP (bit 0) such that the applied ignition timing zwbas can be run directly.

ZUESZ 2.10 Ignition, calculation of coil closing time

FDEF ZUESZ 2.10 Function definition

zuesz-zuesz

ABK ZUESZ 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TSUB	UB		KL	dwell period

Variable	Source	Type	Description
SZOUT_W	ZUESZ	AUS	dwell time
UB	GGUB	EIN	battery voltage

FB ZUESZ 2.10 Detailed description of function

1. Introduction:

So that the spark plug can ignite the mixture sufficient ignition energy needs to be made available. This can be achieved by closing the primary circuit of the ignition coil in time, so that the coil can charge itself sufficiently.
The dwell period may on the other hand not become too long, since otherwise the ignition output stages may overheat (especially critical with internal output stages).
The primary current i rises exponentially over time after the closing. The period from the closing of the primary circuit until the opening (firing) is called dwell period.

For the energy stored in the magnetic field the following results:

W = 1/2 * L * i^2 (L: inductance, i: current, which is flowing in the primary circuit at the moment of the opening)

2. Calculation of the dwell period:

The dwell period szout is calculated from a battery voltage dependent characteristic.
The RAM-cell szout_w cannot be measured with VS100.

3. Dependencies of the dwell period:

ub: The primary current i flows through the primary winding of the coil. It is determined by the battery voltage ub and by the resistance of the coil.

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APP ZUESZ 2.10 Application hint

If the dwell period is too short then the ignition energy is not sufficient to ignite the mixture.
A too long dwell period can endanger the ignition output stages.

BLOCK ANM

TEXT/ANF

RAM-cell	Physical Range	Quantization	Cal. Frequ.	Init Value	Remarks
szout_w	0...6553,5ms	16 bit, 0.1ms	20 ms	0	

In the SW module szout_w is converted reps. re-quantized to the corresponding timer quantization.
Furthermore a minimum value limitation of szout_w to 0,3 ms is performed, i.e. szout_w is always > 0,3 ms.

Parameter	Physical Range	Perm. Range	Quantization	Cal. Frequ.	Remarks
TSUB	0...25.5ms		8 bit, 0.1ms	20ms	

ZWGRU 18.20 Basic ignition angle

FDEF ZWGRU 18.20 Function definition

zwgru-zwgru

zwgru-zwgru

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zwgru-wkor

ABK ZWGRU 18.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFZW1	NMOT	RL	KF	ignition map part load variant 1
KFZW2	NMOT	RL	KF	Ignition angle performance characteristics variant 2
KFZWVL	NMOT	RL	KF	full-load ignition characteristic map
NKLO			FW	engine speed - knock protection threshold
RLKL			FW	load signal rl knock-protection threshold
SNM16ZUUB	NMOT		SV	datapoint distribution engine speed, 16 datapoints
SRL10ZUUB	RL		SV	Base point distribution relative charge, 10 base pts.
WKORA	TANS		KL	ign. angle correction factor

Variable	Source	Type	Description
B_KR	KRRA	EIN	condition for knock control active
B_KRDWS	EGKE	EIN	condition knock control safety ignition retarding
B_STEND	BBSTT	EIN	condition end of start
B_VL	MSF	EIN	Condition for wide open throttle
B_WKORA	ZWGRU	LOK	Condition ignition timing correction knock protection
DZWOAG	MDBAS	EIN	exhaust recirculation rate-dependent correction of optimum ignition angle
DZWOL	MDBAS	EIN	Lambda-dependent correction of optimum ignition angle
FNWUE	WNWEIN	EIN	Weighting factor camshaft overlap
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
TANS	GGTFA	EIN	Intake air temperature
ZWGRU	ZWGRU	AUS	basic ignition angle
ZWKS	ZWKS	EIN	abs. ignition angle from %KS_W

FB ZWGRU 18.20 Detailed description of function

Provision of the basic ignition angle from the performance characteristic KFZW1 and ~2, as a dependency on the camshaft position set.
The NWS overlap is coded in the factor fnwue, the performance characteristics can always be switched over by this.
For the full load condition B_vl the basic ignition angle is made available from the performance characteristics KFZWVL.
The basic ignition angle is corrected via the suction air at B_wkora as knocking protection.
Performance of the same additive ignition angle corrections as in the calculation of the optimum ignition angle (see %MDBAS), i.e. taking the dependency of AGR and lambda into consideration. The temperature dependency is taken into account is a separate function (%ZWWL).

APP ZWGRU 18.20 Application hint

The performance characteristics KFZW1, ~2 are applied for a running-warm engine for the respective NWS position, AGR inactive, lambda=1.
Entry of the optimum ignition angle in case the engine does not knock. Entry of the knocking limit for an engine which knocks.

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ZWSTT 4.10 Igniton at start

FDEF ZWSTT 4.10 Function definition

zwstt-zwstt

ABK ZWSTT 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DZWSTTA	TANS		KL	Delta ignition angle during start
FZWSTNM	NMOT		KL	Ignition angle during start
FZWSTTM	TMST		KL	Ignition angle during start

Variable	Source	Type	Description
B_STEND	BBSTT	EIN	condition end of start
C_INI		EIN	ECU-condition for intialisation
NMOT	BGNMOT	EIN	engine speed
R_T10		EIN	Time schedule 10 ms
TANS	GGTFA	EIN	Intake air temperature
TMST	GGTFM	EIN	engine temperature at start
ZWSTT	ZWSTT	AUS	Ignition angle during start

FB ZWSTT 4.10 Detailed description of function

```
At start the ignition angle output value zwout is the result of zwstt and the ignition angle DG phase correction wphg (see %Zue).
The ignition angle during start zwstt is calculated until B_stend is true and it is still valid until B_llrein is active.
```

APP ZWSTT 4.10 Application hint

ZWWL 4.10 Ignition during warm-up

FDEF ZWWL 4.10 Function definition

zwwl-zwwl

ABK ZWWL 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFZWWLNM	NMOT	TANS	KF	Delta ignition sparc advance during engine warm up phase
KFZWWLTM	TMOT	TMST	KF	Delta ignition sparc advance during engine warm up phase

Variable	Source	Type	Description
DZWWL	ZWWL	AUS	delta ignition angle from warm-up
NMOT	BGNMOT	EIN	engine speed
TANS	GGTFA	EIN	Intake air temperature
TMOT	GGTFM	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start

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FB ZWWL 4.10 Detailed description of function

The function offers the possibility to modify the basic ignition sparc advance zwbas by an additive value dzwwl. This offset is dependent on engine start temperature, intake air temperature and engine speed.

APP ZWWL 4.10 Application hint

MDZW 1.90 Calculation of torque in nominal ignition timing

FDEF MDZW 1.90 Function definition

mdzw-mdzw

mdzw-mdzw

ABK MDZW 1.90 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DMAUFN	NMOT_W		KL	delta torque rise after torque intervention
DZWETA	ETAZWS		KL	delta ignition angle from efficiency

Variable	Source	Type	Description
B_NOZWE	MDZW	AUS	condition no ignition angle intervention of torque structure
B_ZWVS	MDKOG	EIN	condition for fast external ignition angle intervention of torque interface
B_ZWVZ	MDKOG	EIN	condition for ignition angle intervention of torque interface
DMAUFR_W	MDZW	LOK	delta torque rise
DZWS	MDZW	LOK	difference ignition timing (between zwopt and zwsol)
ETAZAIST	MDIST	EIN	actual cylinder masking effectiveness
ETAZWS	MDZW	LOK	nominal ignition angle effectiveness
MIBAS_W	MDBAS	EIN	indicated basic torque
MIOPT_W	MDBAS	EIN	optimum indicated torque
MISOL_W		EIN	indicated resultant nominal torque
MIZSOL_W	MDKOG	EIN	indicated resultant nominal torque for ignition angle intervention
MIZWMN_W		EIN	indicated engine torque at the latest spark angle
NMOT_W	BGNMOT	EIN	engine speed
R_SYN		EIN	Synchro schedule
ZWOPT	MDBAS	EIN	optimal ignition angle
ZWSOL	MDZW	AUS	desired ignition angle from torque intervention

FB MDZW 1.90 Detailed description of function

The torque request mizsol_w is converted to the nominal ignition angle effectiveness etazws. This occurs through division by the optimum torque, which is calculated by multiplying miopt_w by the effectiveness etazaist.

Ignition angle intervention by the torque structure does not occur if the the nominal torque of the air path milsol_w equals the global nominal torque misol_w and the deviation of the load rl_w from the nominal load rl_w is below the threshold DRLZWE. This prevents ignition angle interventions in stationary operation without intervention in the air path.

In this case, the nominal effectiveness etazws is converted to a delta ignition angle dzws by the inverse ignition angle effectiveness characteristic DZWETA. The nominal ignition angle results from the difference between the optimum ignition angle zwopt and dzsw.

Otherwise the nominal ignition angle is set equal to the basic ignition angle (B_nozwe = true).

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APP MDZW 1.90 Application hint

The characteristic DZWETA is the inverse of the characteristic ETADZW.

ZWKS 1.10 Ignition timing knock protection

FDEF ZWKS 1.10 Function definition

zwks-zwks

ABK ZWKS 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFFWK	NMOT	RL	KF	factors - characteristic map for KFWK
KFKSZW	NMOT	RL	KF	ignition angle map for knock protection
KFWK	TMOT	TANS	KF	spark-advance-angle characteristic map for knock-protection function
KSZWE			FW	Knock protection ignition angle default value with E_ta v E_tm

Variable	Source	Type	Description
DZWKS	ZWKS	AUS	Delta ignition angle knock protection
E_TA	GGTFA	EIN	error flag: TANS
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
TANS	GGTFA	EIN	Intake air temperature
TMOT	GGTFM	EIN	Engine temperature
ZWKS	ZWKS	AUS	abs. ignition angle from %KS_W

FB ZWKS 1.10 Detailed description of function

Switch-over from KFWK to KSZWE with E_ta or E_tm for the purpose of engine protection. Reason:
With E_ta resp. E_tm considerably higher intake resp. engine temperatures can result than are covered by possible default values for E_ta resp. E_tm.

APP ZWKS 1.10 Application hint

Due to the introduction of the switch-over of zwgru to zwks during knock protection, 0 must be entered into KRDWSN from %KRRA.

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ZWMIN 1.50 Calculation of maximum retarded spark limitation

FDEF ZWMIN 1.50 Function definition

zwmin-zwmin

ABK ZWMIN 1.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DZWSPM	TMOT		KL	delta latest ignition angle relative to engine temperature
ETADZW	DZWSPAE		KL	ignition efficiency depending on delta ignition angle
KFZWMN	NMOT	RL	KF	Map for minimal ignition angle
KFZWMNST	NMOT	RL	KF	minimal ignition spark advance for engine start and after start
ZZWMNST			FW	time constant for decreasing ignition angle limitation during after start

Variable	Source	Type	Description
B_ST	BBSTT	EIN	condition for start
B_ZWMNSTE	ZWMIN	LOK	Condition for latest ignition angle limitation decresing fulfilled
DZWSPAE	ZWMIN	LOK	correction ignition angle for latest permissible ignition angle
ETAZWMN	ZWMIN	AUS	minimum ignition angle effectiveness
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
TMOT	GGTFM	EIN	Engine temperature
ZWOPT	MDBAS	EIN	optimal ignition angle
ZWSPAE	ZWMIN	AUS	retarded ignition angle

FB ZWMIN 1.50 Detailed description of function

This function provides the latest possible ignition angle zwspae and the latest ignition angle effectiveness etazwmn for ignition angle limiting. The latest possible angle for a warm engine is calculated from the load- and rpm-dependent map KFZWSP. By addition with the temperature-dependent correction ignition angle DZWSPM, the latest ignition angle zwspae is calculated.

APP ZWMIN 1.50 Application hint

The map KFZWSP and characteristic DZWSPM should be applied so that no misfire occurs at the latest possible ignition angle in the relevant operating condition.

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RUV 42.0 Distributorless ignition

FDEF RUV 42.0 Function definition

For 4-cylinder engines

For V6 engines:

ABK RUV 42.0 Abbreviations

swb = Angle between TR mark and start of closure
sw = Dwell angle
GDWRT = Programmed reference mark angle
wout = Output ignition angle

Parameter	Source-X	Source-Y	Type	Description
GDWRT			FW	programmed reference-mark angle

FB RUV 42.0 Detailed description of function

The ignition angle wout calculated according to %ZUE is converted into an angle swb (= angle between tr mark and start of closure) taking into account the dwell angle sw. The primary circuit is then closed until the dwell angle has elapsed.
The resolution of sw and swb is 0.75 degrees CA.

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APP RUV 42.0 Application hint

ZNDAUS 8.10 Ignition: requirements for suppression

FDEF ZNDAUS 8.10 Function definition

zndaus-zndaus

ABK ZNDAUS 8.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANWFOZA			FW	No. camshaft revolutions for ignition suppression for fuel-off adaptation

Variable	Source	Type	Description
B_FOF_M		EIN	monitor, condition fuel-off adapation active
B_SA	MDRED	EIN	Condition fuel cut-off
B_ZNDAUS	ZNDAUS	AUS	condition ignition suppression active

FB ZNDAUS 8.10 Detailed description of function

For fuel-off adaptation B_fof_m and B_sa, the ignition output shall be disabled with a delay of ANWFOZA camshaft revolutions.
Reason: HC might enter the combustion compartment in the event of defective canister-purge valve in the open position and be ignited. The fuel-off adaptation would then learn incorrect values that have nothing to do with the mechanical tolerances of the pulse-generating wheel in such a case.
B_zndaus is set to 0 during initilaization, i.e. ignition output is possible.

APP ZNDAUS 8.10 Application hint

B_fof_m is bit 6 from the flag byte flg_m.
Select ANWFOZA > ANWFOST. ANWFOST is from the DMDFON.

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EGKE 1.1 Input variables for knocking detection

FDEF EGKE 1.1 Function definition

KUE: overview knock control
==========

condition for doing synchro part of KRRA and KRDY

egke-kue

egke-kue

EGKE: input variables
==========

egke-egke

egke-egke

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ABK EGKE 1.1 Abbreviations

Variable	Source	Type	Description
B_C95_G0	KRKE	EIN	signal for control of CC195's amplifier stage (pin G0)
B_C95_G1	KRKE	EIN	signal for control of CC195's amplifier stage (pin G1)
B_C95_G2	KRKE	EIN	signal for control of CC195's amplifier stage (pin G2)
B_KL	EGKE	AUS	condition for knocking
B_KR	KRRA	EIN	condition for knock control active
B_KRDWS	EGKE	AUS	condition knock control safety ignition retarding
B_KRLDY	KRDY	EIN	Condition load dynamics for knock detection active
B_KRNDY	KRDY	EIN	condition speed dynamics for knock detection active
B_MF	EGKE	AUS	condition: measure window
B_TMKR	KRRA	EIN	Condition temperature (tmot) for knock control achieved
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_KRNT	EGKE	LOK	error flag: knock control zero test
E_KROF	EGKE	LOK	Errorflag: knock control offset
E_KRTP	EGKE	LOK	error flag: knock control test puls
E_KS1	EGKE	LOK	error flag: knock sensor 1
E_KS2	EGKE	LOK	error flag: knock sensor 2
E_KS3	EGKE	LOK	error flag: knock sensor 3
E_KS4	EGKE	LOK	error flag: knock sensor 4
IGOKR_W	EGKE	LOK	integrator gradient for offset correction knock control (word)
IKR	EGKE	LOK	integrator value with offset correction
IKRMA	EGKE	LOK	integrator value at start of measurement window, knock control
IKRME	EGKE	LOK	integrator value at end of measurement window, knock control
IKRMET	EGKE	LOK	integrator value at end of measurement window, knock control test pulse
KEK	EGKE	AUS	knock detection threshold corrected
RKR	EGKE	LOK	reference level knock control
TPNT_AKTIV	EGKE	AUS	activation of kc-functions
UADKI	EGKE	LOK	current integrator value
VIRKR	EGKE	AUS	Ratio: integrator / reference level knock control
VKR	EGKE	LOK	amplification stage knock control
XZSKRNT	EGKE	LOK	safety counter for knock control zero test
XZSKROF	EGKE	LOK	safety counter for knock control offset
XZSKRTP	EGKE	LOK	Timer knock control error flag E_krtp
ZZYLKR	EGKE	AUS	cylinder counter KC
Z_KRNT	EGKE	LOK	cycle flag: knock control zero test
Z_KROF	EGKE	LOK	cycle flag: knock control offset
Z_KRTP	EGKE	LOK	cycle flag: knock control test pulse
Z_KS1	EGKE	LOK	cycle flag:ˆknock sensor 1
Z_KS2	EGKE	LOK	cycle flag: knock sensor 2
Z_KS3	EGKE	LOK	cycle flag: knock sensor 3
Z_KS4	EGKE	LOK	cycle flag: knock sensor 4

FB EGKE 1.1 Detailed description of function

```
EGKE: input variables
=====================

The function group EGKE describes the co-operation of the following functions:
        GGKS    control of IC CC195 and signal processing of A/D-converted knock integral uadki         s. %GGKS 2.*
        KRKE    knock detection by using the signal processed by GGKS                                   s. %KRKE 10.*
        DKRNT   diagnosis of IC CC195 - test with no signal ("zero") and integrator reset value         s. %DKRNT 4.*
        DKRTP   diagnosis of IC CC195 - test with puls                                                  s. %DKRTP 6.*
        DKRS    diagnosis of knock sensors and signal path sensor - CC195                               s. %DKRS 9.*


KUE: kock control overview
==========================
```

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```
KUE describes the co-operation of EGKE with KRRA and KRDY:
        KRRA    control and stationary adaptation of ignition timing retard                          s. %KRRA 10.*
        KRDY    detection of load and speed dynamics, adaptation of dynamics ignition timing retard     s. %KRDY 10.*
```

GGKS 7.10 Sensor signal for knocking detection

FDEF GGKS 7.10 Function definition

No text for FDEF available!

ABK GGKS 7.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDKRTP			FW	code word: kc-diagnosis testpulse
CWDKRNT			FW	code word: kc-diagnosis integrator gradient
CWDKROF			FW	code word: kc-diagnosis reset value
CWDKRTP			FW	code word: kc-diagnosis testpulse
DKROKMX			FW	maximum offset-compensation value
DKROKO			FW	upper rpm-limit for determination of offset-compensation-value
FMFKR			FW	mean frequency for knock control filter
GDWRT			FW	programmed reference-mark angle
KEMLN	NMOT		KL	length of the sampling window for knock control
KFMAKR	NMOT	RL	KF	map for starting measuring window knock control
KRFHT			FW	error frequency, test pulse
SENZZYL0			FW	knock sensor for sw-cylinder counter 0
SENZZYL1			FW	knock sensor for sw-cylinder counter 1
SENZZYL2			FW	knock sensor for sw-cylinder counter 2
SENZZYL3			FW	knock sensor for sw-cylinder counter 3
TMKR			FW	engine-temperature threshold to enable knock control

Variable	Source	Type	Description
B_C95BF0	GGKS	LOK	signal for control of CC195's filter frequency (pin BF0)
B_C95BF1	GGKS	LOK	signal for control of CC195's filter frequency (pin BF1)
B_C95BF2	GGKS	LOK	signal for control of CC195's filter frequency (pin BF2)
B_C95BF3	GGKS	LOK	signal for control of CC195's filter frequency (pin BF3)
B_C95KS1	GGKS	LOK	signal for control of knock-sensor signal's path (pin KSA1)
B_C95KS2	GGKS	LOK	signal for control of knock-sensor signal's path (pin KSA2)
B_C95KS3	GGKS	LOK	signal for control of the zero test of the CC195
B_C95KTI	GGKS	LOK	signal for control of the testimpulse of the CC195
B_C95_G0	KRKE	EIN	signal for control of CC195's amplifier stage (pin G0)
B_C95_G1	KRKE	EIN	signal for control of CC195's amplifier stage (pin G1)
B_C95_G2	KRKE	EIN	signal for control of CC195's amplifier stage (pin G2)
B_DNT	GGKS	LOK	condition for active diagnosis: knock control zero test
B_DNTB	GGKS	LOK	condition : ready for knock control zero test (execution: next measure window)
B_DTP	GGKS	LOK	condition : knock control test pulse active
B_DTPB	GGKS	LOK	condition: ready for knock control test pulse(execution: next mesurement window)
B_KR	KRRA	EIN	condition for knock control active
B_KRLDY	KRDY	EIN	Condition load dynamics for knock detection active
B_KRNDY	KRDY	EIN	condition speed dynamics for knock detection active
B_MF	GGKS	AUS	condition: measure window
B_NTINI	GGKS	LOK	kc: condition initialization zero test
B_STEND	BBSTT	EIN	condition end of start
B_TMKR	KRRA	EIN	Condition temperature (tmot) for knock control achieved
B_TPNT_AW	GGKS	LOK	KC: selection zerotest or testimpulse

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Variable	Source	Type	Description
B_TPNT_E	GGKS	LOK	KC: zero test/ testimpulse enable
C_INI		EIN	ECU-condition for intialisation
IGOD_W	GGKS	AUS	integrator gradient for zero test diagnosis knock control
IGOKR_W	GGKS	LOK	integrator gradient for offset correction knock control (word)
IKR	GGKS	AUS	integrator value with offset correction
IKRMA	GGKS	AUS	integrator value at start of measurement window, knock control
IKRME	GGKS	AUS	integrator value at end of measurement window, knock control
IKRMEN	GGKS	AUS	integrator value at end of measurement window, knock control zero test
IKRMET	GGKS	AUS	integrator value at end of measurement window, knock control test pulse
IKR_TST	GGKS	LOK	integrator value with offset correction updated with cyl.counter
IOKKR	GGKS	AUS	correction of integrator‘s offset, knock control
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_SYN		EIN	Synchro schedule
R_T100		EIN	Time schedule 100 ms
R_T20		EIN	Time schedule 20 ms
SY_GRDWRT	PROKON	EIN	System constant basic value, space between SW reference mark to OT in teeth
SY_KS1	PROKON	EIN	system constant: input of the CC195 onto which knock sensor 1 is connected
SY_KS2	PROKON	EIN	system constant: input of the CC195 onto which knock sensor 2 is connected
SY_KS3	PROKON	EIN	system constant: input of the CC195 onto which knock sensor 3 is connected
SY_KS4	PROKON	EIN	system constant: input of the CC195 onto which knock sensor 4 is connected
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
TMFA_W	GGKS	LOK	beginning of measurement window knock control
TMFLN_W	GGKS	AUS	duration of measurement window knock control zero test
TMFL_W	GGKS	LOK	duration of measurement window
TMOT	GGTFM	EIN	Engine temperature
TN	GGDG	EIN	segment time
TPNT_AKTIV	GGKS	AUS	activation of kc-functions
UADKI		EIN	current integrator value
WMFA	GGKS	LOK	beginning of measurement window in degree crank angle
WMFL	GGKS	LOK	duration of measurement window in degree crank angle
XZSKRNT	DKRNT	EIN	safety counter for knock control zero test
XZSKROF	DKRNT	EIN	safety counter for knock control offset
XZSKRTP	DKRTP	EIN	Timer knock control error flag E_krtp
ZFLZ		EIN	tooth edge counter
ZTPTN_A	GGKS	LOK	KC: counter for release of zero test or test pulse
ZZYL		EIN	SW-cylinder counter
ZZYLKR	GGKS	AUS	cylinder counter KC

FB GGKS 7.10 Detailed description of function

APP GGKS 7.10 Application hint

KRKE 10.12 Knocking detection

FDEF KRKE 10.12 Function definition

```
KRKE: Knock detection
=====================
(Condition for execution: B_kr && tpnt_aktiv == 0)
```

krke-krke

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K-Schw: Determining the corrected knock detection thresholds
==========

krke-k-schw

REFPEGEL: Follow-up of reference level
==========
(Condition for execution: tpnt_aktiv == 0)

krke-refpegel

VERST: Change-over of amplification stage
==========
(Condition for execution: tpnt_aktiv == 0)

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krke-verst

VERST-ANST: Triggering of amplification stage CC195
==========

krke-verst-anst

ABK KRKE 10.12 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FKELDY			FW	correction factor for knock detection threshold during load dynamics
FKENDY			FW	correction factor for knock detection threshold with engine-speed dynamics
KE1N	NMOT		KL	knock detection threshold at cylindertimer 1
KE2N	NMOT		KL	knock detection threshold at cylindertimer 2
KE3N	NMOT		KL	knock detection threshold at cylindertimer 3
KE4N	NMOT		KL	knock detection threshold at cylindertimer 4
KRFTP1			FW	low pass characteristic normal
KRFTP2			FW	low pass characteristic at engine speed dynamics
KRFTP3			FW	low pass characteristic at load dynamic
KRKFKS			FW	selected knock detection threshold, if missing cylinder one detection
KRVST			FW	gain after cranking
KSZA			FW	number of knock sensor
REFINI			FW	initial value for reference level if knock control enabled
RKRMX1N	NMOT		KL	Maximum of reference level for knock detection threshold cylinder group 1
RKRMX2N	NMOT		KL	maximum of reference level for knock detection threshold cylinder group 2
ZYRKR			FW	cylinder selective reference level limitation

Variable	Source	Type	Description
B_C95_G0	KRKE	AUS	signal for control of CC195's amplifier stage (pin G0)
B_C95_G1	KRKE	AUS	signal for control of CC195's amplifier stage (pin G1)
B_C95_G2	KRKE	AUS	signal for control of CC195's amplifier stage (pin G2)
B_KL	KRKE	AUS	condition for knocking

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Variable	Source	Type	Description
B_KR	KRRA	EIN	condition for knock control active
B_KRLDY	KRDY	EIN	Condition load dynamics for knock detection active
B_KRNDY	KRDY	EIN	condition speed dynamics for knock detection active
B_MF	GGKS	EIN	condition: measure window
B_STEND	BBSTT	EIN	condition end of start
B_SYNPH		EIN	condition synchronization phase
IKR	GGKS	EIN	integrator value with offset correction
IKRMA	GGKS	EIN	integrator value at start of measurement window, knock control
IKRME	GGKS	EIN	integrator value at end of measurement window, knock control
KE1W	KRKE	LOK	instantaneous value of characteristic KE1N
KE2W	KRKE	LOK	instantaneous value of characteristic KE2N
KE3W	KRKE	LOK	instantaneous value of characteristic KE3N
KE4W	KRKE	LOK	instantaneous value of characteristic KE4N
KEK	KRKE	AUS	knock detection threshold corrected
KEK_1	KRKE	LOK	corrected knock detection threshold for cyl. 1
KEK_2	KRKE	LOK	corrected knock detection threshold for cyl. 2
KEK_3	KRKE	LOK	corrected knock detection threshold for cyl. 3
KEK_4	KRKE	LOK	corrected knock detection threshold for cyl. 4
KEK_TST	KRKE	LOK	knock detection threshold corrected updated with cyl.counter
NMOT	BGNMOT	EIN	engine speed
RKR	KRKE	AUS	reference level knock control
RKRMX	KRKE	LOK	reference level limited upwards
RKRMX1W	KRKE	LOK	instantaneous value of chracteristic RKRMX1N
RKRMX2W	KRKE	LOK	instantaneous value of characteristic RKRMX2N
RKRTP	KRKE	LOK	reference level behind low pass knock control
RKR_TST	KRKE	LOK	reference level knock control updated with cyl.counter
R_T100		EIN	Time schedule 100 ms
VIRKR	KRKE	AUS	Ratio: integrator / reference level knock control
VKR	KRKE	AUS	amplification stage knock control
VKRC95	KRKE	LOK	amplification stage for input amplification stage of knock-IC
VKR_TST	KRKE	LOK	amplification stage knock control updated with cyl.counter
VSKE	VS_VERST	EIN	adjustable offset for knock detection threshold via VS20
ZZYLKR	GGKS	EIN	cylinder counter KC

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FB KRKE 10.12 Detailed description of function

Knock detection (KRKE)
==========

For the knock detection the oscillations characteristic of knocking are transformed into electrical signals by one or more knock sensors and passed on to the Electronic Control Unit. The evaluation circuit in the ECU mainly consists of a BOSCH-IC, the CC195, which processes the sensor signals, i.e. amplifies, filters, rectifies and integrates them within a measuring window.
In the process the uC cylinder-individually controls the amplification stages in the CC195 and starts and stops the integration in the CC195. The integrator values are read into the uC via the A/D-converter. As can be taken from %GGKS an offset correction of the integrator values takes place in the micro-computer.
Knocking is detected if the following conditions are met:

```
B_kl:     ikr(i) / rkrmx >= kek(i)  or  ikrme(i) - ikrma >= 3,7 V
          with rkrmx = min ( rkr(i), rkrmx1/2w * 2^(vkr(i)-6))
```

during which the cylinder-individual reference level rkr(i) is limited to the maximum value rkrmx1/2w * 2^(vkr(i)-6). (The standardized reference level from the characteristic lines RKRMX1/2N is calculated to a cylinder-individual absolute limit value with the aid of the cylinder-individual amplification stage.) Thus a knock detection is still made possible even in case of an unusually strong increase in engine noise (for example due to a beginning engine trouble)

The cylinders are assigned to the characteristic lines RKRMX1N and RKRMX2N by the label ZYRKR (grouping into "loud" and "quiet" cylinders)

```
Switch logic: bit = 0  =>  RKRMX1N
              bit = 1  =>  RKRMX2N
```

Examples:

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	bit	7	6	5	4	3	2	1	0		
	cyl.counter(zzylkr)	-	-	-	-	4	3	2	1		
4-cylinder	ignition order	-	-	-	-	2	4	3	1		cyl. 2 a. 3 ==> RKRMX1N
	bit pattern	-	-	-	-	0	1	0	1	==> ZYRKR = 0101 B = 05 Hex	" 1 a. 4 ==> RKRMX2N
	cyl.counter(zzylkr)	-	-	6	5	4	3	2	1		
6-cylinder	ignition order	-	-	5	2	6	3	4	1		cyl. 1, 3, 4, 5 ==> RKRMX1N
	bit pattern	-	-	0	1	1	0	0	0	==> ZYRKR = 011000 B = 18 Hex	" 2, 6 ==> RKRMX2N
	cyl.counter(zzylkr)	8	7	6	5	4	3	2	1		
8-cylinder	ignition order	8	2	7	4	5	3	6	1		1, 4, 5, 8 ==> RKRMX1N
	bit pattern	0	1	1	0	0	1	1	0	==> ZYRKR = 01100110 B = 66 Hex	2, 3, 6, 7 ==> RKRMX2N

zzylkr = 1 ... SY_ZYLZA ASCET-model
zzylkr = 0 ... SY_ZYLZA -1 ECU-code

Knock detection threshold (K-Schw)

The knock detection thresholds are stored in characteristic lines over the engine speed. In connection with a cylinder-1-detection a characteristic line KE(i)N is assigned to each cylinder i. In case of a loss of the cylinder-1-detection (!B_synph) a cylinder-individual control continues to be performed on systems with one knock sensor (KSZA = 1). Here the knock detection for all cylinders is then based on the knock detection threshold characteristic line determined by KRFKS. On systems with more than one knock sensor (KSZA > 1) a safety retarding B_krdws takes place in case of !B_synph (s. %DKRS).
If the motronic has an increment system with reference mark for the engine speed acquisition and no cylinder-1-detection on the 4-cylinder engine the cylinder groups 1 + 4 resp. 2 + 3 get a knock detection threshold characteristic line each.
If load resp. engine speed dynamic response exists the knock detection thresholds ke(i)w determined from the characteristic lines are corrected by multiplication with the labels FKELDY resp. FKENDY. The thus obtained corrected final values in the RAM kek(i) then form the knock detection thresholds for the corresponding cylinders.

relation between ignition order, characteristic line KEiN and sw-cylinder counter zzylkr (ex. V6):

io	1	4	3	6	2	5
zzylkr	0	1	2	3	4	5
KEiN	KE1N	KE2N	KE3N	KE4N	KE5N	KE6N

Calculation of reference level (RefPegel)

The calculation of the reference level (rkr(i)) is performed cylinder-individually and contains the background noise for the knock-free operating. By means of a low-pass filter this reference level is followed-up to the current integrator value. If kocking is detected not the high integrator value but the integrator value divided by the corrected knock detection factor (ikr(i) / kek(i)) and in case of virkr > 2,5 && !B_kl && !B_krldy && !B_krndy the halved integrator value is used for the calculation. Thus it is ensured that also in case of constant knocking a knock detection is maintained. Since the basic noise of the engine changes faster in case of load and engine speed dynamic response than during quasi-steady-state operation the reference levels are followed-up quicker in order to prevent misdetections.
For engine speed dynamic response this is done with KRFTP2 and for load dynamic response with KRFTP3.

Formula for low-pass: rkr(i,k+1) = (1 - 1/KRFTP) * rkr(i,k) + 1/KRFTP * ikr(i,k+1) k: working cycles engine
i: SW cylinder counter
= rkr(i,k) + 1/KRFTP * (ikr(i,k+1) - rkr(i,k))

After the engine start (!B_stend ——> B_stend) the calculation of the reference level for rkr(i) begins with the starting value REFINI. For the largest amplification stage (vkr=6) the minimum reference level is limited to 260 mV.
The calculation of the reference level is also continued in the KC-not-active-range and if the error flag of the the KC (B_krdws) is set.

Change-over of amplification stages (Verst)

Since the available integrator lift range without offset correction is limited to 3,8 V the reference level must be limited to 1.0 V for usual knock detection factors up to approx. 3,3. This becomes possible by the 7 stages of the input amplifier of the CC195.
If rkr(i) exceeds the upper change-over threshold (1 V) the amplification stage (vkr(i)) for this cylinder is reduced by one and the reference level (rkr(i)) is halved. If the lower change-over threshold (0,3 V) is undershot then the cylinder-individual amplification stage (vkr(i)) is increased by one and the reference level is doubled. The change-over each time takes place up to the largest resp. to the smallest amplification stage.
After the engine start the cylinder-individual amplification stages vkr(i) begin with the starting value KRVST.

The following cylinder-individual amplification stages exist and they can be indicated with the aid of application devices:

amplification stage CC195 = vkr(i)	6	5	4	3	2	1	0
input amplification factor 2^vkr	64	32	16	8	4	2	1
amplification factor incl. filter factor 2^vkr *2	128	64	32	16	8	4	2

——————————>
increase of basic engine noise
idle speed — nominal engine speed

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APP KRKE 10.12 Application hint

For the application the following typical values are suggested:
==========

```
FKELDY  =       approx. 1,1
FKENDY  =       approx. 1,1
KEiN    =       cylinder-specific and dependent on the dectection quality, standard is 2 - 3, see following description
KRFTP1  =       16
KRFTP2  =       4
KRFTP3  =       4
KRVST   =       input amplification stage = 4
REFINI  =       980 mV (just below the upper change-over threshold)
RKRMX1/2N =     maximum value during the application (limitation is not effective), exact explanation see below
ZYRKR   =       see RKRMX1/2N
```

The following sequence is useful:

1. Determine and check the knock sensor assignment as described in %GGKS (measuring window, phase and multiplexed knock sensor signal to be observed by oscilloscope, test of varying knock sensor assignments)

2. Determine the beginning and the length of the measuring window (MF) for the entire engine speed range (oscilloscope).
   For each base point the MF must be stipulated during full load and partial load. Experience has shown that only in case of large differences in ignition angle between full load and partial load an earlier beginning of the measuring window is necessary during partial load.
   The sum of MF-beginning and MF-length (in deg. crankshaft (° KW)) must be smaller than the segment length (720° KW / amount of cylinders, s.a. %GGKS).
   Both values must each be chosen different from 0.
   Generally the MF-lengths and positions must be adjusted in such a way that the main emphasis of the knock occurrence, represented by the knock sensor raw signal from the original mounting place, lies within the MF. Corresponding to the MF-characteristic line base points at first the best compromise for one engine speed regarding the MF-beginning should be found. Here medium and a little heavier knocking during full load and during partial load have to be considered. The beginning of the knocking should each time lie within the MF. Thereafter the MF-length is chosen such that in case of medium knocking the knock occurrence lies within the MF and in case of a little heavier knocking the dying-out oscillations of the knock occurrence are cut off. The adjustment of the MF must be especially optimal for light and medium knocking.
   Heavy knocking as a rule always fills out the entire MF and therefore it is no problem to detect it.
   This procedure now is to be repeated for the remaining engine speed base points.
   It is also important that the generated knocking for the selection of the MF is carried out with normal basic ignition angles. Therefore it is absolutely necessary to operate the engine with REGULAR UNLEADED fuel.

   If the engine has disturbing noises then this should be taken into consideration when selecting the MF as follows:
   - continuous disturbing noises may lie in the MF (here too it would, however, be better if they would lie outside the MF)
   - pulsating disturbing noises must lie outside the MF

   In any case the customer needs to be informed about existing disturbing noises.

3. Adjustment of the filter center frequency (VS100, knock intensity detector: KID)
   The filter center frequency must be chosen such that for all operating points the best possible detection is obtained. In this case the behaviour during high load and high engine speed is decisive for the selection of the frequency. The frequency which guarantees the best detection in this range must be selected.

4. Taking over of the above data listing

5. Fixing the knock detection thresholds KE1N , KE2N ... (VS100, KID)
   Now it is useful to decide on the knock detection (KD) thresholds for the individual cylinders. Especially recommendable in this case is the use of combustion chamber pressure sensors in order to be able to measure the pressure amplitudes in the combustion chamber during the knock occurrence. Should the engine not have bore holes for the pressure sensor in the cylinder head then also spark plugs with integrated pressure sensor can be used. If no exact details were given by the customer then the KD thresholds for the individual cylinders are to be fixed in such a way that knock occurrences whose amplitude exceed the following thresholds are detected 100 %.

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```
n <= 1 800 rpm  press.amplitude — 0,5 - 1 bar  Here not the engine durabilty is decisive but the audibility threshold in
                                               the vehicle. In connection with knock control the knocking which is
                                               audible in the engine test bench
n = 3 000 rpm  press.amplitude  — 2 - 2,5 bar  room or during open bonnet must also be detected. The knocking occurring
                                               during active knock control, however, may not be audible later on in the
                                               interior of the vehicle.

n = 4 000 rpm  press.amplitude — 3 - 3,5 bar

n = 5 000 rpm  press.amplitude ┌ 5,0 bar       Now the engine durabiltiy is decisive. In case of this high engine speed
n = 6 000 rpm  press.amplitude └ 5,5 bar       the engine noise is so loud that the knocking is no longer audible.

Attention!!! For characteristic lines with 16 engine speed base points only every 2. engine speed base point is to be
             adjusted (delta 800 RPM).
```

Thereafter the misdetection thresholds (retarding at control limit) for each cylinder and for each engine speed are to be determined by reducing the above-determined KD thresholds. Up to 5000 rpm these misdetection thresholds should be for at least 0,5 below the above-determined KD thresholds. Above this engine speed the distance to misdetection may be a little smaller.

These measurements also have to be performed with REGULAR UNLEADED fuel.
Standard are knock detection thresholds of 2 - 3. The value 3,3 may under no circumstances be exceeded during steady-state operation. The determined knock thresholds must then be confirmed at an early stage by the customer in an engine endurance test.

6. Fixing of the maximum permitted reference level for the knock detection RKRMX1/2N (VS100)
So that also in case of very loud background noise of the engine or of a cylinder a knock detection keeps on being possible the reference level rkr(i) is limited to the maximum with RKRMX1/2N only for the calculation of the knock condition B_kl (see picture in FDEF).
For the characteristic lines RKRMX1N and RKRMX2N the following concept is recommended:

- equip the engine with normal noise behaviour with max-KS (upper limit of the tolerance range)
- by means of the RAM-contents of rkr(i) and vkr(i) on the engine speed base points of the characteristic lines RKRMX1/2N the standardized reference levels rkrn(i) are to be determined with the formula rkr(i) * 64 / (2^vkr(i)) cylinder-specific for all cylinders or they are to be measured directly (s.a. %DKRS).
- divide cylinders into loud and quiet groups, e. g. 4-cyl. and 1 KS ==> cyl. 2+3 loud a. cyl. 1+4 quiet
  in case of 2-cyl./KS a grouping is usually not necessary
  Via a corresponding bit pattern in the label ZYRKR the reference level is limited cylinder-specifically to RKRMX1N or RKRMX2N just as in the KS assignment.
  bit = 0 => RKRMX1N
  bit = 1 => RKRMX2N (see function description earlier on)
- Approx. the following values are to be stored in RKRMX1N and RKRMX2N:
  # if n = 2 000 rpm approx. 1,5 * mean value of rkrn(i) for the loud resp. quiet cylinder groups
  # if n = 4 000 " approx. 1,3 * " " " " " " " " " " " "
  # if n = 6 000 " approx. 1,2 * " " " " " " " " " " " "

  Especially rkrmx must be adjusted in such a way that also when using min-KS a definite detection of heavy knocking is possible that means ikr(heavy knocking) > rkrmx * kek. In order to cover the characteristic line RKRMX1/2N it should be checked with min-KS whether the knock detection for heavy knocking is still at all possible with the above-determined knock thresholds (rkrmx * kek) if rkr is limited by rkrmx1/2w. So as to simulate this case the knock detection threshold KEiN must be increased since the reference levels cannot be influenced. Thus rkr can (e.g. if light knocking occurs since it is no longer detected as such) be limited by rkrmx1/2w which makes it possible to check whether following heavy knocking is definitely being detected.

For the knock detection the following grades are now obtained:

- normal engine noise: rkr(i) < RKRMX1/2N * (2^vkr(i)) / 64 ==> knock detection with rkrmx = rkr(i)
- loud engine: RKRMX1/2N * (2^vkr(i)) / 64 < rkr(i) < UDKSNO * (2^vkr(i)) / 64 ==> knock detection with rkrmx = RKRMX1/2N * (2^vkr(i)) / 64 , since rkr(i) to large
- very loud engine: rkr(i) > UDKSNO (see %DKRS) ==> B_krdws = safety retarding

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KRRA 16.80 Adaptive knock control

FDEF KRRA 16.80 Function definition

KRRA: Adaptive knock control - overview
==========

krra-krra

STKRA: Detection load- engine speed ranges
==========
(Execution in every 10 ms-grid)

krra-stkra

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BBKR: Enabling knock control and adaptation
==========
(Execution in every 10 ms-grid)

krra-bbkr

BBKR: Enabling knock control and adaptation
==========
(Execution in every 10 ms-grid)

krra-bbtmkr

KR_ADAP: Adaptation of the retarding
==========
(Condition for execution: B_kra && !B_krdws && tpnt_aktiv == 0)

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krra-kr-adap

```
WKRBER: Calculation of the ignition angle retarding
===================================================
(Condition for execution of the block incl. sub-blocks: B_kr && !B_krdws && tpnt_aktiv == 0)
```

krra-wkrber

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WKRI: Calculation of the medium ignition angle retarding
==========

krra-wkri

FRUEHVERST: Enabling advancing
==========

krra-fruehverst

VSWKR: Ignition angle timing with VS2x
==========

krra-vswkr

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ABK KRRA 16.80 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DWKRMSN	NMOT		KL	delta ignition angle knock control distance from mean retarding
KFKRMX	NMOT	RL	KF	maximum ignition retardation due to knock
KRAL1N	NMOT		KL	load range for adaption maps 1
KRAL2N	NMOT		KL	load range dor adaption maps 2
KRALH			FW	load hysterisis for adaptation maps
KRAN1			FW	speed range for adaption maps, Stützstelle 1
KRAN2			FW	speed range for adaption maps, Stützstelle 2
KRAN3			FW	speed range for adaption maps, Stützstelle 3
KRAN4			FW	speed range for adaption maps, Stützstelle 4
KRANH			FW	n hysterisis for adaptation maps
KRDWA			FW	knock control difference current ignition angle to adaption map
KRDWSN	NMOT		KL	knock control delta angle safety
KRFKN	NMOT		KL	retard step knock occurrence
KRLMDY			FW	Read if change of load range: always or only if dynamic active
KRNMDY			FW	Read if change of speed range: allways or only if dynamic active
KRVFN	NMOT		KL	number of firings/cyl. or time for ignition advancing
KRVFSN	NMOT		KL	number of firings/cyl. or delay-time during fast ignition advancing of the KC
KRWKRUM			FW	storing at knocking: value before or after knocking
LKRN	NMOT		KL	load-signal threshold knock control
NKRF			FW	engine speed threshold to enable knock control
NKRFA			FW	engine speed threshold to enable knock control adaption
STKRLDY			FW	tL support-points for KR-adaptation
STKRNDY			FW	engine speed support-points for KR-adaptation
TMKR			FW	engine-temperature threshold to enable knock control
TMKRAN	NMOT		KL	engine temperature threshold for adaptive knock control

Variable	Source	Type	Description
B_KL	KRKE	EIN	condition for knocking
B_KR	KRRA	AUS	condition for knock control active
B_KRA	KRRA	LOK	condition for aktive KR-adaptation
B_KRDWS	EGKE	EIN	condition knock control safety ignition retarding
B_KRFV	KRRA	LOK	condition ignition advance
B_KRLDY	KRDY	EIN	Condition load dynamics for knock detection active
B_KRLDYA	KRDY	EIN	Condition load dynamics retard and dynamics adaptation active
B_KRNDY	KRDY	EIN	condition speed dynamics for knock detection active
B_KRVF	KRRA	LOK	condition for adjustment of kc-ignition timing to a less retarded value
B_MF	GGKS	EIN	condition: measure window
B_STEND	BBSTT	EIN	condition end of start
B_TMKR	KRRA	AUS	Condition temperature (tmot) for knock control achieved
B_VL	MSF	EIN	Condition for wide open throttle
B_WKRAL	KRRA	LOK	Condition wkr from knock control adaption map read
B_ZWKRAA	KRRA	AUS	condition ignition angle of the KC is given
B_ZWKRUM	KRRA	LOK	flag: fast ignition advance KC
C_PWF		EIN	ECU-condition powerfail initialisation
DWKR	KRRA	AUS	cylinder-specific ignition-timing retardation
DWKRMSW	KRRA	DOK	current value for mean value limitation of the retarding
KRAL1W	KRRA	DOK	current value load adaptation range 1
KRAL2W	KRRA	DOK	current value load adaptation range 2
KRDWSW	KRRA	DOK	momentan characteristic-value for safety retard
KRFKW	KRRA	AUS	current value of KRFKN
KRMXW	KRRA	DOK	current value for retard limitation of the retarding
KRVFSW	KRRA	DOK	initialization value for quick advancing
KRVFW	KRRA	DOK	initialization value for normal advancing
LKRW	KRRA	DOK	current value of the load threshold knock control
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
STKRLX	KRRA	LOK	load range adaption map KC
STKRNX	KRRA	AUS	speed range adaption map KC
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
TMOT	GGTFM	EIN	Engine temperature
VSZWKR	KRRA	LOK	cylinder individual adjustment of ignition angle by VS2x
VSZWM	KRRA	LOK	mean value of adjustment ignition angle with VS2x
WKR	KRRA	LOK	cylinderindividual ignition retarding value knock control
WKRA	KRRA	LOK	adaption map of wkr, speed- and load-dependent
WKRATST	KRRA	DOK	wkra updated with synchro
WKRDY	KRDY	EIN	ignition retard during dyn-function of knock control
WKRM	KRRA	LOK	average value of individual ignition retarting by knocking
WKRMA	KRRA	AUS	Average value of ignition retarding by KC, generally(limpe home with safety)
WKR_TST	KRRA	DOK	cylinder-individual ignition angle retarding, druming
ZWKRAFLD		EIN	bit pattern of the cylinder-individually stored B_zwkra
ZZYLKR	GGKS	EIN	cylinder counter KC
ZZYLKRAL	KRRA	LOK	counter: reading of the apdaption map knock control

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```
Hint:   The cylinder-individual values wkr, dwkrz, wkra, zkrvf are indicated in the following description by a control variable (i)
        - like in the ECU-code - for example wkr(i). The corresponding RAM-cell which can be read via VS100 is marked by _i, for
        example wkr_i.
        The KC cylinder counter zzylkr serves as control variable (apart for wkra). The following applies to it:
          zzylkr = 1 ... SY_ZYLZA    ASCET-model
          zzylkr = 0 ... SY_ZYLZA-1  ECU-code
      s.a. application hints
```

FB KRRA 16.80 Detailed description of function

```
Function of the knock control
============================
The function KRRA comprises the calculation of the cylinder-individual change of ignition angle of the knock control. It includes
the adaptive calculation of the cylinder-individual retarding wkr(i)  (WKRBER) and the storage in an adaptation characteristic map
wkra(i) (KR_ADAP). The input values of the adaptation map are current cylinder number, engine speed and load (STKRA).
The value of the retarding dwkrz(i) which is passed on to the ignition comes to dependent on the operating condition (BBKC):
        1. B_kr & !B_krdws      dwkrz(i) = wkr(i) + wkrdy       wkrdy - dynamic response derivation s. %KRDY
        2. B_kr & B_krdws       dwkrz(i) = krdwsw               KRDWS - safety retarding s. %DKRS, %DKRNT, %DKRTP
        3. !B_kr & (!)B_krdws   dwkrz(i) = 0

Condition KC active   :       B_kr         : (( rl > LKRN ) v B_krldy ) & ( tmot > TMKR ) & B_stend
Condition adaptation active : B_kra        : B_kr & ( tmot > TMKRAN )


Coordination of ignition angle for the torque management
========================================================
In case of active knock control the earliest cylinder-individual ignition angle results with regard to:
        KFZW + dwkrz(i)
Two cases of control behaviour are distinguished:
        1. output ignition angle = KFZW | dwkrz(i)      ==> B_zwkraa = 1 ==> knock control algorithm remains unchanged
        2. output ignition angle < KFZW | dwkrz(i)      ==> B_zwkraa = 0 ==> advancing algorithm of wkr(i) is frozen and
                                                                             KC-adaptation is blocked. ( due to exhaust gas
                                                                             reasons, ASR-operation, LL, a.s.o. )

        In %ZUE the bit B_zwkra is formed synchronous to the ignition angle output and it is then stored in correspondent position
        in a bit array zwkrafld. B_zwkraa is then determined from zwkrafld as follows:

        SW cyl. counter
        (zzylkr)        5  4  3  2  1  0

        B_zwkra         1  1  0  1  0  0  ==> zwkrafld = 2^5 + 2^4 + 2^2 = 52
                                 ^
                                 |
        B_zwkraa (zzylkr=3)------|   = 0 (= false)

Please note:    Signs of the ignition angle (in deg. crankshaft (° KW)) according to mathematical convention.
                KFZW > 0 ° (with DTC as point of reference, ignition "before" DTC means mathematically positive angles KFZW)
                dwkrz(i) <= 0 ° ("retard"timing with regard to the basis ignition angle means mathematically negative dwkrz(i) )


Retarding of the ignition angle without adaptation (WKRBER)
===========================================================
If B_kr and !B_kra are set the knock control operates as follows:
If a knocking combustion (B_kl) is detected in %KRKE then the ignition angle of the corresponding cylinder i is adjusted by
retarding it by an amount KRFKN per knocking occurrence. This cylinder-individual retarding is added load- and engine speed-
independent in the RAM-area wkr(i).
For engine smoothness reasons and in order to avoid misfire misdetections the retarding is limited in each calculation to a range
around the mean value wkrm of the latest given SY_ZYLZA retardings wkr(i), given by wkrm plus/minus a freely selectable threshold.
This threshold DWKRMSN is a characteristic line over the engine speed.
Additionally the retarding is limited in wkr(i) towards retard to KFKRMX and towards advance to 0°.
```

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wkr is a RAM-area in which a RAM-cell is reserved for each cylinder.

```
^    wkr(i)
|
|
|   _
| - | | -          -
| - | - | . . . | - |
cylinder
 1 2 3         Z
```

If the KC-active operating range of the engine is left (!B_kr) then the latest present retarding remains stored in wkr(i) until the KC-active range is entered again. The same applies for wkrm.
In the KC-not-active range of the engine zero is passed on to %ZUE as adjustment value dwkrz(i).
In case of ignition off the retardings in wkr(i) are set equal to zero.

Advancing of the ignition angle (WKRBER & FRUEHVERST)
==========
The retardings from wkr(i) are taken back cylinder-individually if B_kr is set and if a cylinder-individual advancing counter zkrvf(i) has reached zero.
During each knock occurrence B_kl the cylinder-individual counter zkrvf(i) is loaded with the value KRVFN. Each not knocking combustion of the cylinder i for which in addition B_zwkraa = 1 applies (i.e. the given ignition angle was limited by the KC) decrements zkrvf(i) by 1. When zkrvf(i) = 0 is reached the retarding in wkr(i) assigned to the corresponding cylinder is decremented by one quantization step and the counter is again loaded with KRVFN.
During each timing towards advance the wkr(i) are limited to the mean value wkrm of the latest given retarding SY-ZYLZA minus a freely selectable threshold DWKRMSN or to the value zero.

If the KC-active operating range of the engine is left (!B_kr) the latest available counter values remain stored in zkrvf(i) until the KC-active range is entered again.
In case of ignition off the counter values in zkrvf(i) are set equal to zero.

If changed operating conditions of the engine lead to a lesser knock tendency a quicker advancing of the wkr(i) is performed until the first knocking occurs after the beginning of the quick advancing. For this the counters zkrvf(i) are started by means of KRVFSN < KRVFN. Condition for the start of the quick advancing is the transition from !B_kra to B_kra resp. a change of the load or engine speed range in the adaptation characteristic map which leads to the adjusted values wkra(i) being read.

Retarding of the ignition angle with adaptation (KR_ADAP)
==========
Besides the above-described retarding the retardings are under certain circumstances written into or read from an adaptation map during active adaptation.
By the adaptation it is ensured that also for strongly map-dependent varying retardings the knock frequency does not increase in case of quick changes of the map ranges.

In the adaptation map wkra a RAM-cell is reserved for each load and engine speed range per cylinder. The range limits for load and engine speed are taken from adjustable labels (KRAL1N, KRAL2N resp. KRAN1 -4). The values which are stored there shall be used as limit values in case of increasing load or engine speed.
In case of decreasing load or engine speed an adjustable hysteresis (KRALH, KRANH) is deducted from these values.
In case of full load (B_vl) the Vl-line is addressed load-independently.
The current load range is stored in stkrlx, the engine speed range in stkrnx.
After ignition off all values remain stored in wkra. If the supply voltage of the ECU is disconnected the values are lost.
After the supply voltage of the ECU has been reconnected all values are set to 0.

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For the indexing of the wkra(i) - RAM-cells the following specification is used in the SW:

i = zzylkr + 8 * stkrnx + 40 * stkrlx zzylkr = 0...7, so at the max. 8 cylinders can be represented
stkrnx = 0...4, 5 engine speed ranges
stkrlx = 0...3, 4 load ranges
^
—— deviant from the ASCET-model !

Storage:
3 conditions for the updating of the adaptation map are distinguished:

1. During each knock occurrence the retarding of the corresponding cylinder is stored in the current load/engine speed range of the adaptation map immediately after knocking has occured if this retarding is later than that stored in wkra. By means of KRWKRUM it is decided whether the retarding which led to the knock occurrence (=knock border) is stored or whether the current retarding after the knock occurrence (retarded by KRFKN) is stored. KRWKRUM=0 ignition angle after the knock occurrence; KRWKRUM=1 ignition angle before the knock occurrence.

2. If the current retarding wkr(i) is earlier by at least KRDWA than the latest value stored in the adaptation map and if the advancing counter zkrvf(i) = 0 then the retarding is changed by KRDWA towards advance in the adaptation map.

3. If wkra(i) + KRDWA > 0, if the current retarding wkr(i) = 0 and if the advancing counter zkrvf(i)=0, then wkra(i) is set to wkr(i) = 0.

The adaptation of the characteristic map is only performed during steady-state and during not active safety retarding (B_krdws=0). The adaptation does not take place if the ignition angle is drawn further towards retard by the torque management than would be necessary for the KC (B_zwkraa = 0).

Reading:
During active adaptation the retarding of all cylinders wkr(i) is overwritten by the values from wkra(i) if one of the following conditions is fulfilled:

1. Transition from !B_kra to B_kra

2. Load range changes
   It is possible to choose via label whether during the change of the load adaptation range without dynamic response the value wkr(i) from the just left range is kept or whether it is taken over from the new range wkra(i). The change-over is performed via the fixed value KRLMDY:
   KRLMDY=0 take-over of wkr(i) from wkra(i) always during load range changes
   KRLMDY=1 take-over of wkr(i) from wkra(i) only during load range changes with dynamic response.

3. Engine speed changes
   It is possible to choose via label whether during the change of the engine speed adaptation range without dynamic response the value wkr(i) from the just left range is kept or whether it is taken over from the new range wkra(i). The change-over is performed via the fixed value KRNMDY:
   KRNMDY=0 take-over of wkr(i) from wkra(i) always during engine speed range changes
   KRNMDY=1 take-over of wkr(i) from wkra(i) only during engine speed range changes with dynamic response.

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Knock control in case of active dynamic response (KRRA, KR_ADAP, BBKR)
==========
In case of active dynamic response (B_krldy, B_krldya, B_krndy, s. %KRDY) the further adaptation of the steady-state values wkra(i) is blocked. A change of the adaptation ranges leads to an updating of wkr(i) with the values adjusted in wkra(i).
Each knocking combustion (B_kl), like so far, leads to a retarding by KRFKN and is therefore added to the cylinder-individual retarding in wkr(i).
For B_krldya additionally an adaptive dynamic response derivation wkrdy (s. %KRDY) is added.

Safety retarding during active knock control (KRRA)
==========
If the safety flag of the KC, B_krdws, is set (see %DKRS, %DKRNT, %DKRTP), dwkrz(i) and wkrma are overwritten by KRDWS if the knock control is active.
wkra(i), wkr(i) and wkrm are not updated as long as B_krdws is set.
If B_krdws is again reset dwkrz(i) is overwritten by wkr(i), wkrma by wkrm.

APP KRRA 16.80 Application hint

Cylinder-individual and load/engine speed range-dependent values are marked by (i) in the description corresponding to their realization in the ECU-code, e.g. wkr(i). The corresponding RAM-cell which can be read via VS100 is indicated in the ASCET-picture by _i, e.g. wkr_i.
The cylinder counter zzylkr generated in the %GGKS serves as control variable for the index i of the cylinder-individual RAM-cells (wkr(i), dwkrz(i), zkrvf(i), with the exception of wkra(i), s.b.).

The knock control can be switched off via the label TMKR: TMKR > tmot ==> !B_kr

For the application the following typical values are suggested:
==========

KRFKN -3 ° KW is a value for the retarding of the ignition angle. Experience shows that it is a sufficient value to safely run the engine at the knock border with stabilized adaptation.

KFKRMX -12 ° KW is a value which is sufficient for most applications. When fixing this characteristic line it must be noted though that the engine can be operated absolutely knock-free with the programmed value under worst-case conditions (tmot, tans, fuel with lowest octane number).
In the process attention must be paid to the maximum permitted exhaust gas temperature.

KRVFN approx. 4 sec/°KW advancing is a typical value. The control speed of the KC during quasi-steady-state engine running results from this characteristic line in connection with KRFKN. The aim here is to determine a time constant which is larger than the thermic time constant of the engine so as to avoid a thermic strain.
When adjusting KRVFN it must be taken into consideration that the thermic strain of the engine increases with increasing engine speed so that a larger period should be chosen for higher engine speeds.
KRVFN = 1 Inc. * n / (120 * x) with 1 Inc. in ° KW
n in rpm
x in ° KW / sec - "speed" for the advance adjustment

KRVFSN to be adjusted dependent of KRWKRUM in order to enable a quick advancing of the adaptation map values in case of changed operating conditions without provoking an increased knock frequency.
KRWKRUM = 0: approx. 1 sec/°KW advancing or approx. 1/4 * KRVFN
KRWKRUM = 1: approx. 2 sec/°KW advancing or approx. 1/2 * KRVFN

KRWKRUM = 0 ==> Adaptation of the knock border + retarding KRFKN
= 1 ==> Adaptation of the knock border

TMKR approx. 40 °C is the value during which on many engines knocking combustions can already occur.

TMKRAN: Below an engine temperature threshold tmkra f(nmot) it is not useful to update wkra since experience has shown that within this operating range the knock tendency of the engine is very low. If adaptation would be permitted the necessary values learned in the normal operating range would be lost which means that the knock frequency is again increased when this operating range is reached again.
Usually this engine temperature threshold lies at TMKRAN = 80 ° C.

LKRN approx. 30% rl is a typical value. The lowest load threshold during which knocking combustions can occur is stored in this characteristic line.

KRDWA approx. 2,25 ° KW (3 increments) is a typical value.

DWKRMSN approx. -3 ° KW is a typical value to maintain the engine smoothness and to avoid misfire misdetection; if the values get smaller the cylinder-individual character of the knock control is increasingly lost.

KRLMDY = 0: reading of the adaptation map in case of load range changes is always performed (independent of dynamic response)

KRNMDY = 1: reading of the adaptation map in case of engine speed range changes is only perfomed during simultanious dynamic response

KRDWSN approx. -12 ° KW, knocking must definitely be avoided under worst-case conditions

KRALH In order to avoid a jitter at the range limits a hysteresis was introduced for decreasing load.
Typical value for KRALH 3 %.

KRANH In order to avoid a jitter at the range limits a hysteresis was introduced for decreasing engine speed.
Typical value for KRANH 120 RPM.

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When determining the ignition characteristic map special attention must be paid to the knowledge in which range an enrichment function (lambda < 1)) is active since the knock border shifts due to the enrichment.
So as not to endanger a stable knock control the determination of the ignition angles and the enrichment function must be adjusted such that in the entire operating range of the engine a constant distance is kept to the knock border(<3 ° KW).

Hints regarding load

The load is given in percent.

Needed measured values:

- B_kl
- B_kr
- B_kra
- B_krldy _krldya _krndy
- B_zwkraa
- B_zwkrum
- stkrlx
- stkrnx
- wkr_0 - x
- wkra_0 - x
- wkrdy_0 - x
- zkrvf_0 - x

The existence of some values/RAMs is determined by the representation in ASCET (block hierarchy, course of control). They are not realized in the SW resp. they cannot be measured definitely by means of VS100 due to their special realization:
- B_wkral cannot be measured definitely
- B_krvf not realized
- zkrvf(i)=0 cannot be measured, this state can only be detected indirectly via the performed RESET of the counter from zkrvf(i) = 1 to zkrvf(i) = KRVF(S)N
- zzylkral not realized

Distinction wkrm/wkrma

wkrm represents the mean value of the each time SY_ZYLZA latest calculated wkr(i) (possibly incl. mean value vswzm) while wkrma represents the mean value of the dwkrz(i) (without wkrdy) which was passed on to the ignition during the SY_ZYLZA latest combustions.

Adaptation characteristic map wkra

When choosing the map values a compromise has to be found between the possibly varying knock tendency of the engine at different load and engine speed ranges and the time by which the characteristic map is updated during normal driving.
If the adaptation map wkra is chosen to large (i.e. many rl-nmot-ranges) a longer period is needed in order to update all ranges. Thus in case of changed operating conditions which lead to a larger knock tendency it is inevitable that the knock frequency increases.

Generally a characteristic map with 3 load and 5 engine speed ranges is sufficient for wkra. In this map a RAM-cell is provided for each load/ engine speed range per cylinder.
(Example 4-cylinder-engine: 3 x 5 x 4 = 60 RAM-cells for wkra)
For the indexing of the wkra(i) - RAM-cells the following specification is used in the SW:
i = zzylkr + 8 * stkrnx + 40 * stkrlx (zzylkr = 0...7, so at the max. 8 cylinders can be represented)

In case of special customers need the number of adaptation ranges can be varied but at the maximum to 4 x 8 load/engine speed ranges (change of above-mentioned indexing may possibly be necessary).

Cylinder-individual ignition angle timing with VS20

By means of VS20 a cylinder-individual additional timing vszw(i) can be performed (s.a. %VS_VERST) so that the following applies:
dwkrz(i) = wkr(i) + wkrdy + vszwkr(i) if B_kr & !B_krdws

Label	timing range	quantization	initialization/neutral value
vszwkr_1	see %VS_VERST		
vszwkr_8	see %VS_VERST		

==========

Attention: 1. No automatic limitation of vszwkr(i) is performed - please observe engine and catalyst protection during the timing!

2. The earliest possible ignition angle is under all circumstance determined by the knock control, i.e. it is possible that the minimum permitted (due to temperature reasons) ignition angle may be undershot (s. %ZUE, %ZWMIN). Please observe engine and catalyst protection !

==========

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KRDY 19.10 Knock control for load dynamics

FDEF KRDY 19.10 Function definition

KRDY: Overview KC-dynamic response
==========

krdy-krdy

krdy-krdy

BB_DYN: Detection load and engine speed dynamic response, Enabling adaptation
==========

krdy-bb-dyn

krdy-bb-dyn

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DYN_ADAP: Adaptation of the dynamic response derivation
==========

krdy-dyn-adap

krdy-dyn-adap

ABK KRDY 19.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
AZKRLDYN	NMOT		KL	number of ignition per cyl. during knock control load dynamic
AZKRNDYN	NMOT		KL	number of ignition for knock control engine speed dynamic
CWKR			FW	code word kc
DYADMX			FW	max. value of dynamic response derivation
DYAMNV			FW	min. value of dynamic response derivation
DYAVF			FW	deactivation period for dynamics retardation
DYESN	NMOT		KL	dynamic derivative action detection threshold
DYESOFN	NMOT		KL	offset for dynamic derivative action detection threshold
FKELDYA			FW	Corrective factor for knock detection threshold for adaptation of load dynamic
KFDYES	NMOT_W	WDKBA_W	KF	Threshold for dynamic presetting values
KFDYESOF	NMOT_W	WDKBA_W	KF	Offset threshold for dynamic presetting values
NKRUM			FW	revolution threshold for change of delta load signal for load dynamics
PZWKRA			FW	percentage frequency of ignition angle output by KC during dyn. adaption
TMDYNA			FW	engine temperature threshold to enable load dynamic adaptation
TMKR			FW	engine-temperature threshold to enable knock control

Variable	Source	Type	Description
B_KL	KRKE	EIN	condition for knocking
B_KLDYNRM	KRDY	DOK	Condition normal knocking with adapted load dynamic
B_KLDYSTK	KRDY	DOK	Condition heavy knocking with adapted load dynamic
B_KRLDY	KRDY	AUS	Condition load dynamics for knock detection active
B_KRLDYA	KRDY	AUS	Condition load dynamics retard and dynamics adaptation active
B_KRLDYF	KRDY	LOK	condition adaptation load dynamics retard towards advance released
B_KRNDY	KRDY	AUS	condition speed dynamics for knock detection active
B_LL	MSF	EIN	Condition idle
B_MF	GGKS	EIN	condition: measure window
B_TMKR	KRRA	EIN	Condition temperature (tmot) for knock control achieved
B_ZWKRAA	KRRA	EIN	condition ignition angle of the KC is given
C_PWF		EIN	ECU-condition powerfail initialisation
DNKRDYV	KRDY	DOK	current value of engine speed dynamic response detection threshold
DRLKRDY	KRDY	LOK	load gradient for activating kc load dynamics
DRLP_W	BGRLP	EIN	delta predicted load for injection time calculation (word)
DRL_W	BGSRM	EIN	charge change (Word)
DYESOFV	KRDY	DOK	current value offset for load dynamic response detection threshold
DYESV	KRDY	DOK	current value of load dynamic response detection threshold
KEK	KRKE	EIN	knock detection threshold corrected
KRFKW	KRRA	EIN	current value of KRFKN
LKRNEW	KRDY	LOK	value of load at time t
LKROLD	KRDY	LOK	value of load at time t-dt
NGFIL	BGNG	EIN	filtered engine-speed gradient
NMOT	BGNMOT	EIN	engine speed
RLP_W	BGRLP	EIN	rel. air charge predicted for injection calculation (Word)
RL_W	EGFE	EIN	relative air charge (Word)
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
STKRNX	KRRA	EIN	speed range adaption map KC

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Variable	Source	Type	Description
TMOT	GGTFM	EIN	Engine temperature
VIRKR	KRKE	EIN	Ratio: integrator / reference level knock control
WKRDY	KRDY	AUS	ignition retard during dyn-function of knock control
WKRDYA	KRDY	LOK	Adapted ignition timing for KC dynamic
ZALDY	KRDY	LOK	Ignition counter for deactivation of load dynamics
ZLDY	KRDY	LOK	Ignition counter for load dynamic
ZNDY	KRDY	LOK	ignition counter for rpm-dynamics
ZZWDYKR	KRDY	LOK	ignition counter for KC with bit B_zwkra=1 set during KC dynamic
ZZWDYMD	KRDY	LOK	ignition counter for KC with bit B_zwkra=0 not set during KC dynamic
ZZYLKR	GGKS	EIN	cylinder counter KC

FB KRDY 19.10 Detailed description of function

```
Load dynamic response
=====================
The load dynamic response is marked by two phenomena:
        - increased knock tendency (in case of corresponding temperature)
        - quick noise increase
which are responded to by an additional ignition retarding (dynamic response derivation wkrdy) resp. by a quicker following-up of
the reference level and increased knock detection threshold (s. %KRKE).


Detection load dynamic response and enabling of the dynamic response adaptation (BB_DYN)
==========================================================================================
When introducing countermeasures two temperature ranges are distinguished:
Temperature range 1: (TMKR < tmot < TMDYNA): knock control load dynamic response without adaptation of ignition angle ——>
                                             B_krldy & !B_krldya
Temperature range 2: (tmot > TMDYNA):        knock control load dynamic response with adaptation of ignition angle ——>
                                             B_krldy & B_krldya

In both ranges the load dynamic response B_krldy is triggered via the positive load difference between equidistant instants (=load
gradient). If during an acceleration the difference drlkrdy of the nominal load signal between two consecutive scannings in the
10ms-grid is larger than the 1. dynamic response detection threshold KFDYES then the timer zldy is set to the starting value
AZKRLDYN. As soon as drlkrdy < KFDYES,  zldy is decremented by 1 increment per ignition until zldy = 0 is reached. As long as
zldy > 0 and TMKR < tmot <= TMDYNA, only the condition B_krldy=1 applies. For zldy > 0 and tmot > TMDYNA the condition B_krldya=1
additionally applies and this is done until wkrdy is completely controlled back to 0. The starting value for the timer
AZKRLDYN is engine speed-dependent and taken from a fixed characteristic line.
During idling (B_ll) no dynamic response may be detected (e.g. due to LLR). In additon B_ll=1 analogous to zldy=0 leads to the
dynamic phase being stopped.

Triggering conditions for load dynamic response:  Temperature range 1 ——>  (TMKR < tmot < TMDYNA) & (drlkrdy > KFDYES) & !B_ll
                                                  Temperature range 2 ——>  (tmot > TMDYNA) & (drlkrdy > KFDYES) & !B_ll
```

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```
for temperature range 1 without adaptation of the ignition angle as long as zldy > 0:  B_krldy & !B_krldya applies
                                 .                                        .
  B_krldy  ^                     .                                        .
           |                     .----------------------------------------.
           |                     |                                        |
           ------------------------------------------------------------------------------------------------>
  B_krldya ^                     .                                        .                          ignitions
           |                     .                                        .
           |                     .                                        .
           ------------------------------------------------------------------------------------------------>
                                 .                                        .                          ignitions
                                 .                                        .
                                 .                                        .
for temperature range 2 with adaptation of the ignition angle as long as zldy > 0 & !B_ll:  B_krldy & B_krldya applies
                                 .                                        .
  B_krldy  ^                     .<-- KFDYES+KFDYESOF > drlkrdy > KFDYES            .<-- zldy=0 or B_ll
           |                     .----------------------------------------.
           |                     |                                        |
           ------------------------------------------------------------------------------------------------>
                                 .        .                               .
  B_krldyf ^                     .        .<-- drlkrdy > KFDYES+KFDYESOF            .
           |                     .        .                               .
           |                     .        .-------------------------------.
           |                     |        |                               |
           ------------------------------------------------------------------------------------------------>
                                 .                                        .
  B_krldya ^                     .  tmot > TMDYNA                         .<-- wkrdy < 0                ignitions
           |                     .----------------------------------------------------------.
           |                     |                                        |                 |
           ------------------------------------------------------------------------------------<-- wkrdy = 0
                                                                                                          ignitions
                                 .                                        .
   DYAMNV  |------------------------------------------------------------------------------------------------>
                        ^        |                                        .                          ignitions
                        |        |                                        .                 .
  wkrdy                 |        |                                        .                 .  |
                        |        |                                        .                 .  v
                        v        |                                        .   - - - - - - - - - -
       wkrdya           - - - -  |                                        - - - - - - - - - - - - - 1 incr.
   DYADMX  |------------------------------------------------------------------------------------------------
           v
```

Ermittlung des Lastgradienten drlkrdy (DLast)
==========

Zur Ermittlung des Lastgradienten wird das in der Füllungserfassung generierte Lastsignal (rl bzw. drl) bzw. ein prädiziertes Lastsignal (rlp bzw. drlp) verwandt. Zur Umschaltung zwischen tatsächlichem und prädiziertem Lastsignal dient das Bit 0 des Codeworts CWKR.
Lastdynamik muß im 10 ms-Raster erkannt und ausgelöst werden. Die zur Verfügung stehenden Lastsignale werden im synchro berechnet. Die applizierbare Drehzahlschwelle NKRUM beschreibt den Grenzbereich, ab dem das synchro-Raster kürzer als das 10 ms-Raster wird. Unterhalb der Drehzahlschwelle NKRUM ergibt sich drlkrdy aus den im synchro gebildeten Delta-Lastsignalen der Last-erfassung bzw. -prädiktion (drl bzw. drlp), oberhalb NKRUM wird drlkrdy als Differenz des im 10 ms-Raster abgetasteten Lastsignals rl bzw. rlp gebildet. Durch diese Umschaltung wird eine Überabtastung von rl bzw. rlp im Bereich unterhalb NKRUM vermieden.

Influence of load dynamic response on knock detection and control
==========

When triggering load dynamic response the following functions become effective independent of the temperature range (TMKR < tmot <= TMDYNA or tmot > TMDYNA):

1. The cylinder-selective reference level calculations are performed by means of the label KRFTP3 (see %KRKE) => quicker following-up of reference level.

2. The knock detection thresholds ke(i)w are increased by the factor FKELDY. Corrected knock detection thresholds kek(i) result (see %KRKE).

3. For each detected knocking combustion the ignition angle is retarded by the value KRFKN cylinder-selectively (see % KRRA). For enabled steady-state adaptation the stored retardings are read from the each time current adaptation map range in case of range changes. Writing access to the characteristic map of the steady-state adaptation is, however, forbidden (see %KRRA).

In temperature range 1 (TMKR < tmot <= TMDYNA) n o additional dynamic response retarding of the ignition angle is performed !!

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Load dynamic response adaptation (DYN_ADAP)
==========
If load dynamic response is triggered in temperature range 2 (tmot > TMDYNA ==> B_krldya) the following functions additionally become effective:

4. Adaptive dynamic response retarding of the ignition angle for a l l cylinders (KRDY and %KRRA).
   In addition to the steady-state cylinder-selective KC retarding the ignition angle for a l l cylinders is retarded by wkrdy for the time zldy > 0 if dynamic response was detected. Here wkrdy is read engine speed-dependent from the RAM-area wkrdya. If zldy = 0 this additional dynamic response retarding wkrdy is reduced by 1 increment per DYAVF combustions.

5.1 If load dynamic response is triggered without exceeding of the 2. dynamic response threshold (KFDYES < drlkrdy < KFDYES+KFDYESOF ==> B_krldy & B_krldya), then the enabling of the adaptation to retard (BB_DYN)is performed for the starting value of the dynamic response retarding wkrdy. That means that by strong knocking B_kldystk a new adaptation of wkrdya is performed for the next dynamic procedure (wkrdya(new) = wkrdya(old) + DYADS, limited to DYADMX).
   In case of exclusively normal knocking B_kldynrm the adaptation value remains unchanged and also if no knocking occurs (DYN_ADAP).

5.2 If the 2. dynamic response threshold is also exceeded (drlkrdy > KFDYES + KFDYESOF ==> B_krldyf) then in additon to the measures from 4 and 5.1 also the adaptation of the dynamic response retarding is enabled to advance (BB_DYN).
   During the active dynamic phase (B_krldyf = 1) two counters zzwdykr and zzwdymd are started. For each set bit B_zwkraa = 1 (i.e. ignition angle of the KC was given out) zzwdykr is incremented, for each not set bit B_zwkraa = 0 (i.e. ignition angle of the torque management was given out) zzwdymd is incremented. At the end of the dynamic phase (B_krldyf = 0) the ratio zzwdykr / (zzwdykr + zzwdymd) is determined, the two counters zzwdykr and zzwdymd are thereafter reset to 0 (DYN_ADAP).
   If no knocking combustion occurs during the active dynamic phase (B_krldyf = 1) which is detected by the knock detection threshold kek (s. %KRKE) and if zzwdykr / (zzwdykr + zzwdymd) >= PZWKRA (adjustable fixed value) then the adaptive dynamic response derivation starting value wkrdya is adjusted towards advance by 1 increment, however, in the process it is limited to the value DYAMNV.

The RAM-area wkrdya is subdivided into 5 engine speed ranges stkrnx.

```
stkrnx =    0           1           2           3           4
        wkrdya  |           |           |           |           |
                |           |           |           |           |
engine speed base points KRAN1       KRAN2       KRAN3       KRAN4
                            <———————                ———————————> nmot (rpm)
                           hysteresis KRANH
```

The engine speed ranges are identical to those of the steady-state adaptation map (s. %KRRA). The engine speed limits apply directly with rising engine speed. The engine speed hysteresis KRANH is only deducted with decreasing engine speed (identical to %KRRA).

The dynamic response derivation calculated again each time is written into the RAM-area wkrdya and there into the engine speed range which is valid at the time of the triggering of the dynamic response (!B_krldya ==> B_krldya). It is then available as wkrdy for the next dynamic procedure which starts in this engine speed range.

With 'ignition off' all retardings are preserved in the RAM-area wkrdya until the engine is started again.
After a 'disconnection of the voltage supply' the RAM-area wkrdya is initialized by DYAMNV.

Engine speed dynamic response
==========
If the engine temperature tmot > TMKR and the engine speed gradient ngkrf_w are lager than the engine speed dynamic response detection threshold DNKRDYSN then the timer zndy is set to the starting value AZKRNDYN.
If ngkrf_w < DNKRDYSN, zndy is decremented up to zero for each ignition. The condition B_krndy=1 applies until zndy > 0 & !B_ll. In the case of idling B_ll = 1 no engine speed dynamic response is detected.

As long as B_krndy=1 the following applies:
1. The cylinder-selective reference level calculations are performed with the label KRFTP2 (see %KRKE) => quicker following-up of reference level.

2. The knock detection thresholds ke(i)w are increased by the factor FKENDY. Corrected knock detection thresholds kek(i) result (see %KRKE).

3. For each detected knocking combustion the ignition angle is retarded by the value KRFKN cylinder-selectively (see % KRRA).
   For enabled steady-state adaptation the stored retardings are read from the each time current adaptation map range in case of range changes. Writing access to the characteristic map of the steady-state adaptation is, however, forbidden (see %KRRA).

The triggering of the load dynamic response may also take place during engine speed dynamic response active and vice versa. It is decided in %KRKE resp. %KRRA which of the then introduced measures takes priority.

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APP KRDY 19.10 Application hint

Application aim load dynamic response: Adjustment so that perfomance is optimized but no audible "dynamic knocking" in the vehicle. The adjustment should be performed resp. checked under "worst-case conditions" (summer test, fuel with lowest enabled octane number).
The following values taken from experience can be used for a rough adjustment:

```
TMKR      approx. 40 degrees C
TMDYNA    approx. 80 degrees C
KFDYES    no values have yet been gained
KFDYESOF  no values have yet been gained, tough demand: KFDYES + KFDYESOF <= 767 % for all base points nmot !
          For load dynamic it became necessary to use a map for the threshold, due to variation in the exhaust gas back
          flow rate (variable camshaft timing) steps in rl could appear, which should not trigger any load dynamic.
AZKRLDYN  should be chosen in such a way that the dynamic conditon approx. 300-600 ms applies.
          Guidance values are: 2-5 working cycles (AS) at 1000 rpm and 15-25 working cycles at 6000 rpm.
DYADS     -2.25 ...-1.5 ° KW; the value will be different to KRFKN, due to lower temperature in the combustion chamber
          during dynamic events.
DYADMX    approx. -8 ... -10 degrees crankshaft (°KW)
FKELDYA   1.2 - 1.3
DYAVF     should be chosen such that during each working cycle adjustment to advance is perfomed by approx. 4 increments at most
          (so DYAVF must be equal to or exceed no. of cylinders / 4, DYAVF is an integer and DYAVF > 0 is demanded!)
CWKR      BIT   7  6  5  4  3  2  1  0
                *  *  *  *  *  *  *  1  if load prediction is not available or not stable, then use actual load
                *  *  *  *  *  *  *  0  load prediction will be used
NKRUM     = 4000 rpm for SY_ZYLZA = 3
          = 3000 rpm for SY_ZYLZA = 4
          = 2400 rpm for SY_ZYLZA = 5
          = 2000 rpm for SY_ZYLZA = 6
          = 1500 rpm for SY_ZYLZA = 8
          = 1200 rpm for SY_ZYLZA = 10
          = 1000 rpm for SY_ZYLZA = 12
```

Application aim engine speed dynamic response: Avoiding of misdetections due to a very fast increase in engine speed and a thus resulting abrupt noise increase (especially critical: gear shifting on powerful vehicles with automatic gearbox)

```
DNKRDYSN  approx. 500 - 1000 rpm/s;
AZKRNDYN  should be chosen such that the dynamic response condition approx. 300-600 ms applies.
          Guidance values are: 2-5 working cycles at 1000 rpm and 15-25 working cycles at 6000 rpm.
```

DKRS 28.10 Diagnosis; knock sensor

FDEF DKRS 28.10 Function definition

dkrs-dkrs

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dkrs-sendia

dkrs-senzyk

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dkrs-ks

In block diagrams error type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the error path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external error paths which occur as inputs access methods are available which read these informations directly from the error path status managed in the DFPM.

```
For each error path the following values are defined:
        status error path ks*:                  sfpks*
                error flag ks*:                 E_ks*
                cycle flag ks*:                 Z_ks*
                error type ks*:                 TYPks*
                                                   B_mxks*
                                                   B_mnks*
                delete error path:              B_clks*
        error path code ks*:                    CDTks*
        error class ks*:                        CLAks*
        error intensity ks*:                    TSFks*
        CARB code ks*:                          CDCks*
        table of the environmental cond. ks*:   FFTks*
        error intensity ks*:                    TSFks*
        CARB code ks*:                          CDCks*
        table of the environmental cond. ks*:   FFTks*

 * is a wildcard and stands here for the number of the knock sensor.

In this function definition (FDEF) the following error paths are treated:

        knock sensor 1  ks1
        knock sensor 2  ks2
        knock sensor 3  ks3
        knock sensor 4  ks4


Substitute measures if E_ks(KS):        - Instead of the current cylinder-specific retardings the safety retarding is given
                                          out with KRDWS in the range "knock control active"
                                        - KC adaptation not active (the adjusted values remain stored)
                                        - knock detection algorithm remains active for the error healing
                                        - In the range 'knock control not active' no retarding is performed
```

ABK DKRS 28.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDKS1			FW	code word: knock sensor diagnosis, sensor 1
CDKS2			FW	code word: knock sensor diagnosis,sensor2
CDKS3			FW	code word: knock sensor diagnosis, sensor3
CDKS4			FW	code word: knock sensor diagnosis, sensor 4
KRFHKS			FW	fault frequency - knock sensors
KSZA			FW	number of knock sensor
NDKS			FW	engine-speed threshold for diagnosis knock sensors
SENZZYL0			FW	knock sensor for sw-cylinder counter 0
SENZZYL1			FW	knock sensor for sw-cylinder counter 1
SENZZYL2			FW	knock sensor for sw-cylinder counter 2

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Parameter	Source-X	Source-Y	Type	Description
SENZZYL3			FW	knock sensor for sw-cylinder counter 3
SENZZYL4			FW	knock sensor for sw-cylinder counter 4
SENZZYL5			FW	knock sensor for sw-cylinder counter 5
UDKSNO	NMOT		KL	upper reference voltage threshold for diagnosis knock sensors
UDKSNU	NMOT		KL	lower reference voltage threshold for diagnosis knock sensors

Variable	Source	Type	Description
B_CLKS1		EIN	condition clear fault path knock sensor 1
B_CLKS2		EIN	condition clear fault path knock sensor 2
B_CLKS3		EIN	condition clear fault path knock sensor 3
B_CLKS4		EIN	condition clear fault path knock sensor 4
B_DSI	DKRS	LOK	condition for active diagnosis: knock sensor i test
B_KRDWS	DKRS	AUS	condition knock control safety ignition retarding
B_KRLDY	KRDY	EIN	Condition load dynamics for knock detection active
B_KRNDY	KRDY	EIN	condition speed dynamics for knock detection active
B_MNKS1	DKRS	AUS	condition: min-error knock sensor 1
B_MNKS2	DKRS	AUS	condition: min-error knock sensor 2
B_MNKS3	DKRS	AUS	condition: min-error knock sensor 3
B_MNKS4	DKRS	AUS	condition: min-error knock sensor 4
B_MXKS1	DKRS	AUS	condition: max-error knock sensor 1
B_MXKS2	DKRS	AUS	condition: max-error knock sensor 2
B_MXKS3	DKRS	AUS	condition: max-error knock sensor 3
B_MXKS4	DKRS	AUS	condition: max-error knock sensor 4
B_SYNPH		EIN	condition synchronization phase
B_TMKR	KRRA	EIN	Condition temperature (tmot) for knock control achieved
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_KRNT	DKRNT	EIN	error flag: knock control zero test
E_KROF	DKRNT	EIN	Errorflag: knock control offset
E_KRTP	DKRTP	EIN	error flag: knock control test puls
E_KS1	DKRS	AUS	error flag: knock sensor 1
E_KS2	DKRS	AUS	error flag: knock sensor 2
E_KS3	DKRS	AUS	error flag: knock sensor 3
E_KS4	DKRS	AUS	error flag: knock sensor 4
NMOT	BGNMOT	EIN	engine speed
RKR	KRKE	EIN	reference level knock control
R_T100		EIN	Time schedule 100 ms
VKR	KRKE	EIN	amplification stage knock control
XZKRZS1	DKRS	DOK	counter knock control cycle flag Z_ks1
XZKRZS2	DKRS	DOK	counter knock control cycle flag Z_ks2
XZKRZS3	DKRS	DOK	counter knock control cycle flag Z_ks3
XZSEN1	DKRS	DOK	safety counter knock sensor 1
XZSEN2	DKRS	DOK	safety counter knock sensor 2
XZSEN3	DKRS	DOK	safety counter knock sensor 3
Z_KS1	DKRS	AUS	cycle flag:ˆknock sensor 1
Z_KS2	DKRS	AUS	cycle flag: knock sensor 2
Z_KS3	DKRS	AUS	cycle flag: knock sensor 3
Z_KS4	DKRS	AUS	cycle flag: knock sensor 4

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FB DKRS 28.10 Detailed description of function

By means of the diagnosis knock sensor drop off a disconnection of the wiring to the knock sensor (e.g. not plugged sensor) as well as a short circuit to U_Batt or ground can be detected. Furthermore it can point to a defect engine if an error is detected (e.g. increased noise level due to expanded piston groove).

The decisive signal for these tests is the normalized reference level rkrn(i) obtained from the reference level rkr and the amplification stages vkr of each cylinder. The calculation of the normalized reference level rkrn(i) for the test UDKSNO > rkrn > UDKSNU is performed according to:

rkrn(i) = (1/ (2^vkr(i))) * rkr(i) * 2^6

The assignment of the knock sensors to the normalized refence levels is performed via SENZZYL which is described in %GGKS. In this case the normalized reference level rkrn_0 belongs to SENZZYL0, i.e rkrn_0 belongs to the error path of the knock sensor entered into SENZZYL0.

In order not to assign a defect knock sensor wrongly if the cylinder assignment was lost (!B_synph) the knock sensor diagnosis is not performed in case of detected phase sensor error and a system with more than one knock sensor (==> safety retarding). The amount available knock sensors must be set in the fixed value KSZA. The diagnosis is also blocked if there is a detected IC-error (E_krof, E_krnt s.% DKRNT , E_krtp s. %DKRTP).

If the current reference level - in case of tmot > TMKR (B_tmkr) and engine speeds greater than NDKS and no phase sensor error (B_synph) and not detected dynamic response (! B_krndy and ! B_krldy) - undershoots resp. exceeds the reference level thresholds UDKSNU resp. UDKSNO which are stored in the engine speed-dependent characteristic lines for KRFHKS successive tests (i.e. an error which lies in between and is not detected means reset of the error counter) then a knock sensor drop off E_ks(KS) is detected and the above-described substitution measures are taken.

The error check is performed once per 100 ms grid for the normalized reference levels of all cylinders, i.e. each knock sensor path is checked several times in the process. An error is detected if a normalized reference level of the knock sensor path lies outside the limits during the check. No error is only detected if all normalized reference levels of the knock sensor path lie within the limits.

The safety measures are lifted again if the current reference level lies again within the range defined by the reference voltage thresholds UDKSNO and UDKSNU for KRFHKS successive checks (i.e. an error check which lies in between means reset of the counter). The transition from safety retarding back to normal operating is performed immediately after determined error healing.

The cycle flags Z_ks(KS) are set after an each time (2*KRFHKS)-times diagnosis check (counter xzkrzs(KS-1)) or if an error is definitely dedected or healed. Thus it is ensured that e.g. after the repair in a workshop the error diagnosis is at least run through with the debouncing frequency KRFHKS in order to reliably determine the error clearance.
During the initialization with C_ini the cycle flags Z_ks(KS) as well as the counters xzkrzs(KS-1) are reset.

The sensor diagnosis can be switched off for each knock sensor individually by setting CDKS(KS) = 0. (The corresponding cycle flags are then set to 1 and the error flags to 0). The activation or deactivation may only take place during the ECU reset so as to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means all CDKS(i) must be set to a value > 0).

The calculation of the normalized reference level and the evaluation of the path for the change-over to safety retarding are not switched off by the switches.

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APP DKRS 28.10 Application hint

The characteristic lines UDKSNU and UDKSNO must be adjusted such that there is a sufficient safety margin to normal operating and that a deplugged knock sensor is detected just as a short circuit to ground or U_Batt. The application of the characteristic lines UDKSNU and UDKSNO must be performed with max.- and min.-sensors. Thereby a safety margin of at least factor 2 is to be kept to.

In order to ensure that the application engine with its noise behaviour lies within the tolerance of the mass production the normalized reference levels should be checked every 500 rpm on all engines available during the application and on at least one pilot vehicle.
These measurements are performed with mass production knock sensors. The measured normalized reference levels must lie within the limits determined with min.- and max.-sensors (safety margin of at least factor 2 to the characteristic lines UDKSNU and UDKSNO).

Should no sufficient safety margin be guaranteed in some parts of the range (an intact, connected knock sensor may under no circumstances lead to the error lamp being switched on) then it has to be done without the possibility of diagnosis in these partial ranges (fix threshold in such a way that the diagnosis does not react).
The customer must be informed about these partial ranges.

When load or engine speed dynamic response is triggered the normalized reference levels can possibly exceed the characteristic line UDKSNO for a short time. For this reason the diagnosis is not performed in case of detected dynamic response (B_krldy oder B_krndy).
Nevertheless a check of the debouncing period is recommendable in this case because the refence levels have not yet again stabilized after the end of the dynamic response.

With low engine speeds there may be ranges in which an error detection is not possible. Therefore an engine speed threshold NDKS was introduced below which the diagnosis is blocked. The threshold must be adjusted such that errors which were detected during higher engine speeds are not falsely healed again in the lower range.

The initialization of the reference level with REFINI during the starting phase or during the transition from KC not active to KC active can possibly lead to a wrong error detection or error healing.
When fixing the initialization values for the amplification and for the reference level attention must be paid that the normalized reference level has stabilized prior to the end of the debouncing time (error frequency counter), that means the debouncing period must be large enough so that wrong error detections or healings are ruled out.

The sensor diagnosis can be switched off for each knock sensor individually by setting CDKS(KS) = 0. (The corresponding cycle flags are then set to 1 and the error flags to 0). The activation or deactivation may only take place during the ECU reset so as to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means all CDKS(i) must be set to a value > 0).

The values B_ds*, E_hks* contained in the ASCET pictures are only aid values for the representation and they cannot be measured.

The following guidance values are recommended:
KRFHKS > 20 (KRFHKS = 0 is inadmissible)
NDKS > 2000 rpm
CDKS1 = 1
CDKS2 = 1
CDKS3 = 1
CDKS4 = 1

Needed measured values:
- E_ks1 - x
- Z_ks - x
- B_krdws
- nmot
- rkrn_w0 - x
- xzkrzs0 - x
- xzsen0 - x

DKRNT 11.10 Diagnosis; Knock-control, zero-test (OBDII)

FDEF DKRNT 11.10 Function definition

dkrnt-dkrnt

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dkrnt-resetwnt

dkrnt-nulltest

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In block diagrams error type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the error path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external error paths which occur as inputs access methods are available which read these informations directly from the error path status managed in the DFPM.

For each error path the following values are defined:

```
        status error path krof:                 sfpkrof
                error flag krof:                E_krof
                cycle flag krof:                Z_krof
                error type krof:                TYPkrof
                                                   B_npkrof
                delete error path:              B_clkrof
        error path code krof:                   CDTkrof
        error class krof:                       CLAkrof
        error intensity krof:                   TSFkrof
        CARB code krof:                         CDCkrof
        table of environmental cond. krof:      FFTkrof

        status error path krnt:                 sfpkrnt
                error flag krnt:                E_krnt
                cycle flag krnt:                Z_krnt
                error type krnt:                TYPks(i)
                                                   B_npkrnt
                delete error path:              B_clkrnt
        error path code krnt:                   CDTkrnt
        error class krnt:                       CLAkrnt
        error intensity krnt                    TSFkrnt
        CARB code krnt:                         CDCkrnt
        table of environmental cond. krnt:      FFTkrnt
```

In this function definition (FDEF) the following error paths are treated:

```
        integrator reset value (offset)         krof
        integrator gradient (zero test)         krnt
```

```
Substitute measures     :       - Instead of the current cylinder-specific retardings the safety retarding is given
                                  out with KRDWS in the range "knock control active"
                                - KC adaptation not active (the adjusted values remain stored)
                                - knock detection algorithm remains active for the error healing
                                - In the range 'knock control not active' no safety retarding is performed
```

ABK DKRNT 11.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCKRNT	BLOKNR		KL	code word CARB: knock control zero test pulse
CDCKROF	BLOKNR		KL	codeword CARB: knock control offset
CDTKRNT			FW	code word tester: knock control zero test pulse [220]
CDTKROF			FW	code word tester: knock control offset
CLAKRNT			FW	fault class: knock control zero test
CLAKROF			FW	fault class: knock control offset
CWDKRNT			FW	code word: kc-diagnosis integrator gradient
CWDKROF			FW	code word: kc-diagnosis reset value
DKROFN	TMFLN_W		KL	limit of integrator rise for zero test
DKROKD			FW	upper rpm-limit for zero test diagnosis (knock control)
DKROKU			FW	lower rpm-limit for determination of offset-compensation-value
FFTKRNT	BLOKNR		KL	freeze frame table: knock control zero test
FFTKROF	BLOKNR		KL	freeze frame table: knock control offset
KRFHT			FW	error frequency, test pulse
TSFKRNT			FW	fault active time: knock control zero test
TSFKROF			FW	fault active time: knockcontrol offset
UDKRGOFS			FW	voltage threshold for DIA/KR basic offset amplifier

Variable	Source	Type	Description
B_CLKRNT		EIN	condition clear fault path kc-diagnosis integrator gradient
B_CLKROF		EIN	condition clear fault path kc-diagnosis reset value
B_NPKRNT	DKRNT	AUS	condition plausibility error of kc-diagnosis intgrator gradient
B_NPKROF	DKRNT	AUS	condition plausibility error of kc-diagnosis reset value
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_KRNT	DKRNT	AUS	error flag: knock control zero test
E_KROF	DKRNT	AUS	Errorflag: knock control offset
IGOD_W	GGKS	EIN	integrator gradient for zero test diagnosis knock control
IKRMA	GGKS	EIN	integrator value at start of measurement window, knock control
NMOT	BGNMOT	EIN	engine speed
SFPKRNT	DKRNT	AUS	status fault path: knock control zero test
SFPKROF	DKRNT	AUS	status fault path: knock control offset
TMFLN_W	GGKS	EIN	duration of measurement window knock control zero test
TPNT_AKTIV	GGKS	EIN	activation of kc-functions
XZKRZNT	DKRNT	LOK	counter for knock control cycle flag Z_krnt
XZKRZOF	DKRNT	LOK	counter for knock control cycle flag Z_krof
XZSKRNT	DKRNT	AUS	safety counter for knock control zero test
XZSKROF	DKRNT	AUS	safety counter for knock control offset

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Variable	Source	Type	Description
Z_KRNT	DKRNT	AUS	cycle flag: knock control zero test
Z_KROF	DKRNT	AUS	cycle flag: knock control offset

FB DKRNT 11.10 Detailed description of function

The zero test serves for the determination of the integrator offset and for the checking of the KC-evaluation-IC CC195 with regard to

- keeping to the valid limits for the starting value of the integrator (integrator reset value)
- keeping to the admissible integrator offsets
- the function of the multiplexer regarding 'open switch'

During the zero test all multiplexer switches are brought into the position 'open' (deactivate signal sources). The amplitude of the integrator is watched in a measuring window. Then the plausibility of the reset value and the integrator offset is checked. If the integration result lies within the limits of the permitted offset then the determined value is used for the offset compensation. If the integration result is markedly larger than the permitted offset then it can be assumed that the switch of the multiplexer is stuck in the position 'closed'.

1) Reset values ==> Checking of the integrator value at the beginning of the measuring window (picture RESETWNT):

The plausibility of the integrator voltage ikrma at the beginning of the measuring window and with deactivated signal sources is checked. In this case the following must apply: | ikrma - 715 mV | < UDKRGOFS.

The counters xzskrof, xzkrzof and the flags E_krof and Z_krof are part of this diagnosis (error path offset).

2) Zero test ==> Checking of the integrator gradient igod_w (picture NULLTEST):

The integrator gradient (integrator value at end of measuring window minus integrator at beginning of measuring window with open multiplexer switch divided by the current measuring window length) is checked for plausibility. The following must apply: | igod_w | < DKROFN(tmfln_w).

DKROFN is a characteristic line over the zero test measuring window length. While using the characteristic line the diagnosis is active in a great speed range.

The value igod_w determined in %GGKS may not be used for the diagnosis of stuck MUX-switches if the measuring window lengths are > 5 ms since in this case a definite distinction between permitted integrator offset and stuck MUX-switch is not possible (in case of 10 ms measuring window lengths the permitted integrator offset is 300 mV and it thus lies within the normal integral range between 300 and 1000 mV ==> double safety results in a max. measuring window lengths of 5 ms). This is achieved by the threshold DKROKU. When the lower engine speed threshold DKROKU is undershot the integrator gradient igod_w is determined but no diagnosis with regard to DKROFN(tmfln_w) (stuck MUX-switch) is performed.

The diagnosis can be swtiched off with an upper engine speed threshold. In this case the diagnosis is not performed. This is achieved by the upper engine speed threshold DKROKD. The diagnosis of the integrator gradient is frozen above the engine speed threshold.
Application hints see below

The counters xzskrnt, xzkrznt and the flags E_krnt and Z_krnt are part of this diagnosis (error path zero test).

3) Conditions for the execution of the zero test (s %GGKS):

The diagnosis zero test (DKRNT) and test pulse (DKRTP) are normally triggered alternately approx. every 255 working cycles (i.e. DKRNT, after 255 working cycles DKRTP, after further 255 again DKRNT etc.)
The zero test is performed if the knock control is active (i.e. B_kr=1). In case the KC is not active while the zero test is to be performed the state is frozen and a zero test is performed at the next transition from !B_kr to B_kr.

In case of suspected error of a diagnosis, i.e. the error counter of the corresponding diagnosis does not have the value KRFHT, zero test and test pulse are no longer performed alternately. Instead the diagnosis which generated the suspected error is carried out at approx. 120 working cycles until the error is definitely detected or healed. Thereafter a change back to the normal state is performed. This applies analogous for the healing.

In order to obtain reasonable starting values for the offset correction the values for ikrma and igokr are determined but not diagnosed if tmot > TMKR-5°C and if the KC is not yet active.

4) Amplification during zero test

The amplification during zero test must be equal to the current amplification of the current measuring window. (Theoretically also larger amplifications are possible and sensible in order to increase the reliability of detecting a stuck multiplex switch. However, these can cause additional problems if a disturbance noise from the printed board in the CC195 exists ==> falsely a stuck multiplex switch is then detected). For the adjustment of the amplification see %GGKS resp. %KRKE.

5) Error healing and error management

If the respective checks result in inadmissible values then the corresponding error counter xzskrxx is decremented. An error entry into the error memory (E_krof resp. E_krnt) and a reset of the respective error counter to KRFHT are performed for the detected error after KRFHT-times consecutive error checks (i.e. an error which lies in between and is not detected means reset of the respective error counter)
After KRFHT-times consecutive healing checks (i.e. an error check which lies in between means reset of the counter) error healing and a reset of the error counter to KRFHT are performed.

So that no jumps in the ignition angle (torque) occur during the error healing the transition from safety retarding back to normal operating is performed only in the first "KC-not-active-phase" after error healing was determined (s. %DKRS).

The cycle flags Z_krof and Z_krnt are set after (2*KRFHT)-times diagnosis checks (counters xzkrzof and xzkrznt) or if an error is definitely detected or healed. Thus it is ensured that, e.g. after the repair in a workshop, the error diagnosis must be at least run through with the debouncing frequency KRFHT in order to reliably determine the error clearance (Z_krtp = 1 &

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E_krtp = 0).
During the initialization with C_ini the cycle flags Z_krof and Z_krnt as well as the cycle and error flags are reset.

The diagnosis of the integrator gradient can be switched off by CWDKRNT=0 and the diagnosis of the starting value can be switched off by CWDKROF=0. (The corresponding cycle flags are then set to 1 and the error flags are set to 0).
Through deactivation of the diagnosis only the evaluation is suppressed. The zero test is still performed since the values are needed for the offset correction.
The activation or deactivation may only take place during the ECU reset in order to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means CWDKRNT and CWDKROF must be set to a value > 0.)

APP DKRNT 11.10 Application hint

The limit value for the tolerance of the reset value is 100 mV according to the specification of the CC195 for the reset value.
The limit value for the intergrator gradient - according to the specification of the CC195 - is dependent on the internal pulse frequency of the CC195.

Frequency	100 kHz	110 kHz	120 kHz	130 kHz	140 kHz	150 kHz
Limit value f. integrator gradient acc. to specification o.the CC195	— 30 mV/ms	— 36 mV/ms	— 42 mV/ms	— 48 mV/ms	— 54 mV/ms	— 60 mV/ms

(specification values as at September 1996)

However, when using these limits it has shown that disturbance noises from the printed board in the CC195 or disturbances of the supply voltage of the CC195 can easily lead to a diagnosis misdetection. Due to this reason it may be necessary to broaden these limits. This must be checked in each individual case. For this measurements need to be performed.
Generally it should obviously be ensured that no disturbance noises occur into the CC195! (Layout updating!)

The diagnosis threshold UDKRGOFS = 220 mV is recommended for the reset value.

The following is recommended for the integrator gardient threshold DKROFN (internal pulse Frequency of CC195: 100 kHz)

measuring window length	tmfln_w > 3 ms	3 ms > tmfln_w > 2 ms	2 ms > tmfln_w > 1,5 ms	1,5 ms > tmfln_w > 1 ms
DKROFN	40 mV/ms	45 mV/ms	50 mV/ms	60 mV/ms

DKROKU must set to a value, so that the zero test measuring window length is < 5 ms describtion s. 2)).

The diagnosis can be switched off via the upper engine speed threshold DKROKD, so that in case of short measuring window lengths the diagnosis-threshold DKROFN is not too great. DKROKD has to be greater then DKROKO (s.%GGKS).

The protection of the ECU-dependent value is absolutely necessary.

In case a broadening of the recommended values is necessary it should be discussed with the function application or with the function development first.

The error frequency of the functions DKRNT and DKRTP (master functions) is identical. Both use the label KRFHT.

The diagnosis of the integrator gradient can be switched off by CWDKRNT=0 and the diagnosis of the starting value can be switched off by CWDKROF=0. (The corresponding cycle flags are then set to 1 and the error flags are set to 0).
Through deactivation of the diagnosis only the evaluation is suppressed. The zero test is still performed since the values are needed for the offset correction.
The activation or deactivation may only take place during the ECU reset in order to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means CWDKRNT and CWDKROF must be set to a value > 0.)

The values tpnt_aktiv and B_diag cannot be measured with VS100.

The following guidance values are recommended:
KRFHT > 2 (KRFHT = 0 inadmissible)
UDKRGOFS = 220 mV
DKROKU ca. 2000 rpm (measuring window > 5 ms)
CWDKRNT = 1
CWDKROF = 1

Needed measured values:
- B_dnt
- B_kr
- E_krnt
- E_krof
- igod_w
- ikrma
- nmot
- xzkrznt
- xzkrzof
- xzskrnt
- xzskrof
- Z_krnt
- Z_krof

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DKRTP 11.10 Diagnosis of knock control, test pulse for OBDII

FDEF DKRTP 11.10 Function definition

dkrtp-dkrtp

In block diagrams error type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the error path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external error paths which occur as inputs access methods are available which read these informations directly from the error path status managed in the DFPM.

For each error path the following values are defined:

status error path krtp:	sfpkrtp
error flag krtp:	E_krtp
cycle flag krtp:	Z_krtp
error type krtp:	TYPkrtp B_npkrtp
delete error path:	B_clkrtp
error path code krtp:	CDTkrtp
error class krtp:	CLAkrtp
error intensity krtp:	TSFkrtp
CARB code krtp:	CDCkrtp
table of the environmental cond. krtp:	FFTkrtp

In this function definition (FDEF) the following error paths are treated:

test pulse krtp

Substitute measures in case of E_krtp:
- Instead of the current cylinder-specific retardings the safety retarding is given out with KRDWS in the range "knock control active"
- KC adaptation not active (the adjusted values remain stored)
- knock detection algorithm remains active for the error healing
- In the range 'knock control not active' no retarding is performed

ABK DKRTP 11.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCKRTP	BLOKNR		KL	code word CARB: knock control test pulse
CDTKRTP			FW	code word tester: knock control test pulse
CLAKRTP			FW	fault class: knock control test pulse
CWDKRTP			FW	code word: kc-diagnosis testpulse
FFTKRTP	BLOKNR		KL	freeze frame table: knock control test pulse
KRFHT			FW	error frequency, test pulse
TSFKRTP			FW	fault active time: knock control test pulse
UDKRTP			FW	integr.volt.thresh. f.diagn. knock eval.circ. test pulse

Variable	Source	Type	Description
B_CLKRTP		EIN	condition clear fault path kc-diagnosis test pulse
B_NPKRTP	DKRTP	AUS	condition plausibility error fo kc-diagnosis test pulse
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation

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Variable	Source	Type	Description
E_KRTP	DKRTP	AUS	error flag: knock control test puls
IKRMA	GGKS	EIN	integrator value at start of measurement window, knock control
IKRMET	GGKS	EIN	integrator value at end of measurement window, knock control test pulse
SFPKRTP	DKRTP	AUS	status fault path: knock control test pulse
TPNT_AKTIV	GGKS	EIN	activation of kc-functions
XZKRZTP	DKRTP	LOK	Timer knock control cycle flag Z_krtp
XZSKRTP	DKRTP	AUS	Timer knock control error flag E_krtp
Z_KRTP	DKRTP	AUS	cycle flag: knock control test pulse

FB DKRTP 11.10 Detailed description of function

The test pulse serves for the checking of the knock evaluation circuit CC195. By the test pulse an error localization (knock sensor - evaluation circuit) is made possible.

If the raw integral value (ikrmet - ikrma), i.e. without offset compensation (s. GGKS) undershoots the value UDKRTP then the error counter xzskrtp is decremented. After KRFHT-times, consecutive error checks (i.e. an error which lies in between and was not detected means reset of the error counter) an error entry into the error memory (E_krtp = 1) and a reset of the error counter to KRFHT is performed. In the following tests a checking of whether the error state was healed is carried out.
After KRFHT-times consecutive checks of the healing (i.e. an error which lies in between and is detected means reset of the counter) the error healing (E_krtp = 0) and a reset of the error counter to KRFHT is performed.

The diagnosis zero test (DKRNT) and test pulse (DKRTP) are normally triggered alternately approx. every 255 working cycles (i.e. DKRNT, after 255 working cycles DKRTP, after further 255 again DKRNT etc.)
The test pulse is performed if the temperature threshold for the KC was exceeded (i.e. B_tmkr=1 fulfilled).

In case of suspected error, i.e. the error counter of a diagnosis does not have the value KRFHT, the diagnosis are no longer performed alternately. Instead the diagnosis which generated the suspected error is carried out at approx. 120 working cycles until the error is definitely detected or healed. Thereafter a change back to the normal state is performed. This applies analogous for the healing (s. %GGKS)

The test pulse must be performed at a random distribution so that all knock sensor paths are checked in a statistically uniform distribution. By omitting a combustion evaluation the test pulse is carried out in a normal measuring window.
The amplification of the knock evaluation circuit is set to 2^3 (medium amplification). Thus it is ensured that also in case of short measuring windows the integrator is fully activated. The frequency of the test pulse is adjusted to the filter center frequency of the band pass.

So that no jumps in the ignition angle (torque) occur during the error healing the transition from safety retarding back to normal operating is performed only in the first "KC-not-active-phase" after error healing was determined (see %DKRS).

The cycle flag Z_krtp is set after (2*KRFHT)-times diagnosis checks (counter xzkrztp) or if an error is definitely dedected or healed. Thus it is ensured that e.g. after the repair in a workshop the error diagnosis must be at least run through with the debouncing frequency KRFHT in order to reliably determine the error clearance (Z_krtp = 1 & E_krtp = 0).
During the initialization with C_ini the cycle flag Z_krtp and the counter xzkrztp are reset.

The diagnosis can be switched off by CWDKRTP=0. (The cycle flag is set to 1 and the error flag is set to 0).
Through deactivation of the diagnosis the evaluation and the triggering of the CC195 are suppressed (s. %GGKS). The activation or deactivation may only take place during the ECU reset so as to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means CWDKRTP must be set to a value > 0.)

APP DKRTP 11.10 Application hint

The error frequency of the functions DKRNT and DKRTP (master functions) is identical. Both use the label KRFHT.

The diagnosis can be switched off by CWDKRTP=0. (The cycle flag is set to 1 and the error flag is set to 0).
Through deactivation of the diagnosis the evaluation and the triggering of the CC195 are suppressed (s. %GGKS). The activation or deactivation may only take place during the ECU reset so as to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means CWDKRTP must be set to a value > 0.)

The value tpnt_aktiv cannot be measured with VS100.

The following guidance values are recommended:
UDKRTP = 3,7 V
KRFHT > 2 (KRFHT = 0 inadmissible)
CWDKRTP = 1

Needed measured values:
- ikrma
- ikrmet
- xzkrztp
- xzskrtp
- B_dtp
- E_krtp
- Z_krtp

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WNWEIN 5.30 Nominal camshaft angle for intake camshaft position regulation

FDEF WNWEIN 5.30 Function definition

wnwein-wnws

calculation Sollwinkel Einlaß-Nockenwelle

wnwein-bed-wnws

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condition Sollwinkelverstellung Einlaß-Nockenwelle

Begrenzung des Sollwinkels:

Ausgabe des mittleren Winkels der Auslass-Seite

Setzen und Rücksetzen Faktor fnwue bei Nockenwellenspätanschlag und wnw < Schwelle:

wnwein-begr-wnws

wnwein-begr-wnws

ABK WNWEIN 5.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DWNWEB			FW	WNW-threshold for fnwue-switch over
KFWNLLK	NMOT	RL	KF	Nominal angle for camshaft in idling mode for cold engine
KFWNLLW	NMOT	RL	KF	Nominal angle for camshaft in idling mode for warm engine
KFWNSL	NMOT	TMOT	KF	NW nominal angle for SLP operation
KFWNWK	NMOT	RL	KF	Nominal angle for camshaft at partial load for cold engine
KFWNWW	NMOT	RL	KF	Nominal angle for camshaft at partial load for warm engine
KFWNWWK	TNST	TMOT	KF	Weighting performance characteristica for NW nominal angle warm/cold in TL / LL
NEVFZG			FW	Speed threshold for speedometer signal error
NNWMAX			FW	Speed threshold for switch off camshaft closed loop controller
NWNWS			FW	Speed threshold for camshaft nominal angle late switchover
TANW			FW	Suction air temperature threshold for camshaft adjustment
TMNW			FW	Engine temperature threshold for camshaft adjustment
TWNWS			FW	Time for camshaft nominal angle late switchover
WNWAIMN2			FW	
WNWFVMN			FW	Min. nominal angle limiting for error in the velocity signal
WNWMN			FW	Minimum camshaft nominal angle
WNWMX			FW	Maximum camshaft nominal angle
WNWV	VFZG		KL	Nominal angle for camshaft dependent on the vehicle velocity
WNWVLN	NMOT		KL	Nominal angle for camshaft at full load

Variable	Source	Type	Description
B_FANWTST	WNWTST	EIN	Condition for testing purpose (system test)
B_KL15		EIN	condition ignition switch on
B_LL	MSF	EIN	Condition idle
B_NNWMX	WNWEIN	AUS	Engine speed over threshold for camshaft closed loop controller
B_SLP	SLS	EIN	condition for secondary air pump
B_VL	MSF	EIN	Condition for wide open throttle
B_WNWMXBE	WNWEIN	AUS	
B_WNWS		EIN	Condition for camshaft nominal value
E_NWS	DNWS	EIN	error flag: camshaft control
E_NWS2	DNWS	EIN	error flag: camshaft control bank 2
E_PH	DPH	EIN	error flag: phase sensor
E_PH2	DPH	EIN	error flag: phase sensor 2
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
FNWUE	WNWEIN	AUS	Weighting factor camshaft overlap
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
TANS	GGTFA	EIN	Intake air temperature
TMOT	GGTFM	EIN	Engine temperature
TNST		EIN	time after end of start
TNST_W	BBSTT	EIN	time after end of start

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Variable	Source	Type	Description
VFZG	GGVFZG	EIN	vehicle speed (km/h)
VSWNWS	VS_VERST	EIN	Change of the variable camshaft angle by adjusting system VSxy
WNW		EIN	Advance control value for camshaft angle
WNWAM	WNWEIN	AUS	Camshaft angle output (average value)
WNWKOR_W		EIN	Current correction value for camshaft signal
WNWS	WNWEIN	AUS	Nominal angle for camshaft
WNWSMX	WNWEIN	LOK	
WNWSP_W_0		EIN	Flank individual offset of camshaft position control, flank 0
WNWSP_W_1		EIN	Flank individual offset of camshaft position control, flank 1
WNWSP_W_2		EIN	Flank individual offset of camshaft position control, flank 2
WNWSP_W_3		EIN	Flank individual offset of camshaft position control, flank 3
WNWSP_W_4		EIN	Flank individual offset of camshaft position control, flank 4
WNWSP_W_5		EIN	Flank individual offset of camshaft position control, flank 5
WNWSP_W_6		EIN	Flank individual offset of camshaft position control, flank 6
WNWSP_W_7		EIN	Flank individual offset of camshaft position control, flank 7
WNWSTST		EIN	Nominal angle for camshaft for testing purpose
Z_NWS	DNWS	EIN	cycle flag: camshaft control
Z_NWS2	DNWS	EIN	cycle flag: camshaft control bank 2

FB WNWEIN 5.30 Detailed description of function

Nominal angle for adjustment of the intake camshaft.
The camshaft nominal angle wnws is given in the idling mode by the characteristic WNWLLN, at full load by the characteristic WNWVLN, at a partial load with KFWNWK - [(KFWNWK - KFWNWW) * KFWNWK].

The possibility is given with the characteristic WNWV to adjust the intake camshaft to early as dependency on the velocity and thereby cause a soft velocity limitation.
The camshaft angle 0 deg. KW is given for B_WNWS, i.e. the intake camshaft is in the late limit position.
For an error in the velocity signal VFZG, the nominal angle is limited for n > NEVFZG by WNWFVMN in the late direction.
The nominal angle is limited by WNWMN and WNWMX to the angle which can be set mechanically.

The factor camshaft overlap fnwue is formed as dependency on the condition B_wnws. The setting and resetting is only possible for a requested camshaft angle wnw = 0.

This calculation of the nominal angle for the intake shaft(s) fits to non-adjustable output shaft(s). The center position of the output shafts wnwam is set here to "0" accordingly.

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APP WNWEIN 5.30 Application hint

WANWKW 11.50 Angle adaptation of alignment between camshaft and crankshaft

FDEF WANWKW 11.50 Function definition

Signal assignment, crankshaft (CKS) - camshaft (CMS)

```
CKS signal:
                              | SW-ref.m. cyl.1
                              v
 ___ ___ ___ ___        ___ ___ ___ ___ ___                2*(60-2) teeth = 1 CMS revolution
"__ ___ ___ ___ _________ ___ ___ ___ ___ __"
                              .
                              .
                              .
                              .
CMS signal (in retarded position; adaptation is terminated: CMS actual value wnwi=0):
                              .
                       ______________________________________|___________|___________________________|___________
                              .                                .                                .
                              .                                .                                .
                              .                                .                                .
                              |________wnwkw_w (1. edge)_______>|                                .
                              |__WNWSPS(1)+wnwsp_w(1)+wnwkor_w__>|                                .
                              .                                .                                .
                              .                                .                                .
                              |_______ wnwkw_w (2. edge) ____________________________________________>|
                              |_____________________________ WNWSPS(2) + wnwsp_w(2) + wnwkor_w _____>|
                              .                                .                                .
                              .                                .                                .
                              .                                .                                .
                              .                                .                                .
CMS signal (adjustment in the direction advanced; CMS actual value wnwi > 0):                  .
                              .                                .                                .
                  ___________________________________|_________|___________________________|___________
                              .                                .                                .
                              .                                .                                .
                              .                                .                                .
                              |___wnwkw_w (1. egde)___>|<-wnwi_w-|                                .
                              |__WNWSPS(1)+wnwsp_w(1)+wnwkor_w__>|                                .
                              .                                .                                .
                              .                                .                                .
                              |_______ wnwkw_w (2. edge) ____________________________________>|<-wnwi_w-|
                              |_____________________________ WNWSPS(2) + wnwsp_w(2) + wnwkor_w _____>|
```

Determination of actual value of CMS position and adaptation of retard position (in the CMS interrupt)

```
 B_nowff >____________________________________________________________________________________________
                 |_____________>0 [ & ]_____________________________________________________>> B_nwi
 B_nwaf >_____________>[ v ]_____>|
 jnwfl >___>[ = 0 ]___>|
                 |_____|_____________|
                 v                                                                   [ 0 ]___0 ^
"                / -                                                   [ WNWIMX ]          "
 wnwkw_w >_____0   0_____>0_____________________>0_____________>0->|  ________  |_____________0___0___> wnwi_w
                          ^                      ^                   | WNWIMN / |
 wnwkor_w >_____________|          [ WNWSPS(i) ]_____|  wnwsp_w(i) >|__________|
                                                 ^i                 ^i
 jnwfl >_____________________________________________________________|
                 |
                 0
 B_nwads >_____> \
                 0
                 |                                  |_____________________________|
"                |  ________                        v+      |  ________________  |  "
                 |___[ FNWADS ]_____________>0_____|       | WNWASMX |          |_____________> wnwsp_w(i)
                                              -       |  ________  |                                ^
                                                      | WNWASMN / |                                |i
 jnwfl >_____________________________________________|____________|_____________________________|
```

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Making ckeck values available (in the background)

Calculation of the edge-independent correction of the CMS position (in the background)

ABK WANWKW 11.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANWFLMX			FW	Number of edges of camshaft signal per camshaft revolution
BNWPOL			FW	Polarity of camshaft signal edges
FNWADS			FW	Factor for adaptation of camshaft late position
NNWAFMX			FW	Upper n-limit f. evaluation of all NW flanks
NNWHYS			FW	Hysteresis width for switchover to 1 NW flank for each NW revolution
TAWSP			FW	Disable time until adaptation late limit permitted
TAWSPE			FW	Time until adaptation late limit finished
WNWASMN			FW	lower camshaft adaptation limit of the retarded end position(advanced direction)
WNWASMX			FW	upper camshaft adaptation limit of the retarded end position(retarded direction)
WNWIMN			FW	Lower Limit of camshaft position
WNWIMX			FW	upper limit of camshaft position
WNWKM	TMOT		KL	Correction angle camshaft over engine temperature
WNWKN	N		KL	Correction angle camshaft over speed
WNWSPS			FW	setangle of the camshaft in the retarded end position

Variable	Source	Type	Description
B_NOADV	WANWKW	AUS	No adaptation adjustment rate
B_NWADS	WANWKW	LOK	Release adaptation of camshaft late position
B_NWAF	WANWKW	AUS	Flag for evaluating all flanks
B_NWI	WANWKW	AUS	Current camshaft interrupt has to be utilized
B_NWOFF		EIN	Switch off camshaft closed loop controller
B_STEND	BBSTT	EIN	condition end of start
JNWFL		EIN	Number of current edge of camshaft signal
T1NWI_W		EIN	Time of camshaft signal edge
WNWI_W	WANWKW	AUS	actual shifting angle of the camshaft (word)
WNWKOR_W	WANWKW	LOK	Current correction value for camshaft signal
WNWKW_W		EIN	Angle of camshaft edges relativ to crankshaft
WNWS	WNWEIN	EIN	Nominal angle for camshaft
WNWSP_W	WANWKW	LOK	Adaptation angle of the camshaft in retarded end position

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FB WANWKW 11.50 Detailed description of function

Angle detection of alignment between crankshaft and camshaft

In the case of CMS interrupt (negative or positive edge from the camshaft wheel signal) the angle wnwkw_w is determined relative to the SW reference mark for cylinder 1. For the determination of the CMS actual value wnwi_w the following is considered:

- WNWSPS (i) : The values given by the sensor wheel geometric, which define the setpoint position of the edges in the retard position
- wnwsp_w (i): Deviations of the edges from the setpoint position due to mounting tolerances (are adapted in the retard position)
- wnwkor_w : Correction of the edges in dependence on the engine speed and on the engine temperature

In case of nmot>NNWAFMX the detection of the CMS position is performed only by means of one edge. The switch-over is performed with the hysteresis of the width 2*NNWHYS. If the engine speed is within the hysteresis the flag B_noadv is set which forbids the adaptation of the adjustment rate in the controller, see %WNWR.

Each adaptation of the CMS position wnwsp_w(i) in the retard position is performed in the CMS interrupt, provided that the setpoint wnws=0 is given for at least the time TAWSP and that the engine speed lies below the threshold NNWAFMX.
In the retard position the CMS actual value should be "0". An occurring deviation is used for the adaptation by multiplying the the value in the corresponding CMS interrupt by the factor FNWADS and by correcting the adaptation value wnwsp with this result. Here a limitation of wnwsp (i) to the limit values WNWASMN and WNWASMX is performed.
Wnwsp is stored in the permanent RAM. In the event of powerfail the RAM-cell wnwsp is initialized with the value "0".

The uneveness of the 4-toothed wheel on the camshaft is taken into consideration by the adaptation being performed individually for each edge (wnwsp_w(i), in which case i = 1...no. of the CMS edges).

Realization for 2 CMS signals

The signals of the two CMS sensors are evaluated independently. The following values must thus be given twice:

B_nwi	CMS interrupt to be evaluated is present
jnwfl	Number of the current CMS edge
t1nwi_w	Time during which the CMS edge occurs
wnwi_w	Actual angle for camshaft
wnwkw_w	Angle of the CMS edges relative to the crankshaft
wnwsp_w(i)	Adaptation angle CMS retard position (for the edges of each CMS signal)
BNWPOL	Polarity of the edges of the CMS signal
WNWSPS(i)	Desired angle of camshaft in the retard position (for the edges of each CMS signal)

A differentiation between the values is done in the application system by attaching a "0" (1. signal) resp. a "1" (2.signal).
Example: "wnwi_w0" and "wnwi_w1".

APP WANWKW 11.50 Application hint

The first (electric) CMS edge after the SW reference mark cyl. 1 must always be activated by the same edge on the CMS sensor wheel. That means the CMS sensor must be arranged such that also in case of an adjustment of the CMS no edge travels past the SW reference mark cyl. 1.

Here the following must be taken into consideration:

- The time offset between electrical and mechanical edge
- The mounting tolerances rel. to CMS sensor wheel, CMS sensor, CKS sensor
- Tolerances in the CMS drive (length and vibrations of chain etc.)

Guidance values for initial application:

ANWFLMX	No. of edges on the CMS sensor wheel on which the CMS interrupt shall be activated
BNWPOL	Polarity of the edges on the CMS sensor wheel on which the CMS interrup shall be activated (0 - neg. edge (el.); 1 - pos. edge (el.)
FNWADS	0.2
NNWAFMX	4000 rpm
NNWHYS	40 rpm
TAWSP	10 s
TAWSPE	10 s
WNWASMN	-10 deg, CKS
WNWASMX	10 deg. CKS
WNWKM (,)	0 deg. CKS
WNWKN (,)	0 deg. CKS
WNWIMN	-127 deg. CKS
WNWIMX	+127 deg. CKS

Application instruction

1. Fixing of the angle values in dependence on the CMS sensor wheel (at the desk)

   ANWFLMX No. of edges on the sensor wheel on which the CMS interrupt shall be activated

   BNWPOL Polarity of the edges on the CMS sensor wheel (0 - neg. electrical edge; 1 - pos. electrical edge)

   WNWSPS Here for each edge on which a CMS interrupt is to be activated the distance to the SW reference mark for the cylinder "0" is entered.

   For the determination of the position of the CMS sensor wheel it must be noted: The first egde after the SW

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reference mark cyl.0 may not travel past the reference mark as a result of an adjustment. A safety margin of 15 deg. CKS is to be adhered to. Thus values in the range of 15 to 720 deg. CKS are obtained. In case of an adjustment in the direction "advanced" the distance of the first edge from the SW reference mark is to be increased by the adjustment range.

WNWASMN This value must be fixed dependent on the distance of the first edge to the SW ref. mark. If only the above-mentioned safety margin of 15 deg. is kept to, here a value of -5 deg. CKS is entered. If the distance is greater the value may be increased accordingly (e.g. - 10 deg. CKS).

WNWASMX This value must be fixed dependent on the distance of the last edge from the SW ref. mark since it may also not travel past the ref. mark. If the distance is, e.g. 20 deg., a value of max. 15 deg. can be entered for WNWASMX.

2. Fixing of times, time constants etc.

TAWSP The time must be sufficiently long so that the retard position is definitely reached:
- Determine max. time for an adjustment from the advanced to the retarded position (low engine speed, high temperature)
- At least double the determined time

FNWADS By the suggested value of 0.2 it is achieved that the remaining error is reduced to approx. 10% of the original error within 10 CMS revolutions. That means when mounting the CMS sensor wheel wrongly by 5 deg. CKS an error of 0.5 deg. CKS remains. At an engine speed of 600 rmp this corresponds to a time of 2 s.

TAWSPE The time must be sufficiently long so that the retard position adaptation was definitely terminated. For a value of 0.2 for FNWADS a time of 10 s will definitely be sufficient.

3. Determination of the angle corrections

At first the setpoint wnws is to be adjusted to "0": WNWMN = WNWMX = 0. The correction values WNWKM and WNWKN are set to "0". With a reference engine temperature (e.g. 85 deg. C) and a reference engine speed (e.g. idling speed) the termination of the adaptation is waited on and the mean value of the adapted values wnwsp_w(i) is recorded.

WNWKM The temperature values must cover the range in which a control is to be allowed, i.e. the range above TMNW (compare %WNWEIN). The intended temperature values are approached and the mean value of the adaptation values wnwsp_w(i) is recorded. After all temperatures were approached the recorded mean values are transfered to the characteristic line WNWKM.

WNWKN The engine speeds must cover that range in which a control is to be allowed, i.e. the range above NWNWS (compare. %WNWEIN). The intended engine speeds are approached and the mean value of the adaptation values wnwsp_w(i) is recorded. After all engines speeds were approached the recorded mean values are transfered to the characteristic line WNWKN.

4. Fixing of the engine speed thresholds

NNWAFMX This value can only be fixed in connection with the quality of the control, i.e. it must be ensured that at engine speeds above this value the taking into consideration of only one edge per CMS revolution is sufficient for the demanded control quality.

Once all edges on the CMS sensor wheel have the same distance to the each time following DTC the following initial value is to be set:

NNWAFMX = nmot_idling * ANWFLMX (max. 4000 rpm)

If not all edges on the CMS sensor wheel have the same distance to the each time following DTC the fixing must be performed according to other criteria. In this case NNWAFMX should lie as low as possible so that a good control quality with one edge is still definitely reached. The value can, therefore, only be fixed finally after an adjustment of the controller (compare %WNWR). The initial value to be set is:

NNWAFMX = 1200 rpm.

NNWHYS This value is of minor relevance. As a rule a small value of, e.g. 40 rpm is suitable.

NNWMAX See %WNWEIN.

appropiate physical limitation of wnwi_w

WNWIMN lower limit of wnwi_w. It must be lower zero to allow adaption of wnwsp_w(i) !

WNWIMX Upper limit of wnwi_w

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WNWR 4.40 Camshaft position control with adaptations

FDEF WNWR 4.40 Function definition

Determination of the control deviation (in the TV interrupt, if B_nwoff=false and B_fanwhst = false; reset wnwgs_w in the CMS interrupt)

Determination of the duty cycle to be given out (in the TV interrupt)

Determination of the valid final adjustment rate (in the TV interrupt, if B_nwoff=false and B_fanwhst=false)

B_wnws0 = (wnws==0) & (wnwgsend_w<wsnw)

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Adaptation hold duty cycle (in the TV interrupt, if B_nwoff=false and B_fanwhst=false)

determination of B_fanwhst (for testing purpose) (in the TV Interrupt, if B_nwoff=false)

Adaptation adjustment rate (in the CMS interrupt, if B_nwi=1 and B_fanwhst=false)

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Output of the CMS position for other functions (10ms grid)

Determination whether CMS setpoint is constant (in the background)

Calculation of intermediate values of shifting speed (in the background)

Determine switch off of the closed loop controller (in the background)

ABK WNWR 4.40 Abbreviations

TNWTAPER - Period of the PWM signal (= 4 ms; not adjustable)

FB WNWR 4.40 Detailed description of function

1. System overview: Variable camshaft spreading

The following goals are aimed for by a variable camshaft spreading:
- Improvement of the emissions
- Reduction of fuel consumption
- Improved smoothness during idling

The variable spreading is achieved by a continuous adjustment of the camshaft (s) by means of position control.

The adjustment is performed by changing the relative angle position of the camshaft to the crankshaft. The direction of adjustment and the adjustment rate of the inlet camshaft are determined by a proportional valve, the throughput of which is controlled by different duty cycles.

The valve is operated at three working points:
- Adjustment in the direction advanced, duty cycle close to 0% corresponding to a current for the adjustment unit close to Imax
- Hold position; duty cycle approx. 50%
- Adjustment in the direction retarded; duty cycle close to 100% corresponding to a current close to "0".

A CMS angle wnwi, wnws etc. with the value "0" corresponds to the retard position. Adjustments in the direction "advanced" correspond to positive CMS angle values (e.g. wnwi_w=20 deg: adjustment of 20 deg. in the direction "advanced").

2. Position control inlet camshaft

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The position control is performed by a three-point-controller with integrated observer (BID controller). At the neutral point of the controller a proportional component is activated. The major characteristic of the observer is that not only the present state variable is observed (position of the CMS) but additionally it is taken into consideration which changes this state variable will be subject to, if no further adjustment request is made. By this consideration of the low pass filter response of the adjustment unit a stable control is also possible if high adjustment rates and a large time constant are present.

The position control is performed by comparing the setpoint wnws with the the estimated value wnwgsend_w (wnwgsend_w indicates the position of the CMS, which is reached if hold TV is given with immediate effect). If the deviation dwnw_w lies outside of the tolerance range, which was defined by WSNW, then an adjustment is caused by the output of the duty cycle for advanced adjustment TANWRF or for retarded adjustment TANWRS. Otherwise the hold duty cycle tanwrhf is given out so that the position of the CMS remains unchanged (see also 4.).
If a control error occurs in the hold range, then the hold duty cycle is corrected by a value which results from the multiplication of the control error by the factor FNWTAP.

wnwgsend_w not only takes the current position wnwgs_w into account but also that adjustment, which although requested, was not implemented due to the low pass response of the adjustment unit. Thus an adjustment is terminated prior to the setpoint being reached. If the assumed time constant XZNWVENT corresponds to the actual time constant of the adjusment unit the CMS position will reach the setpoint exactly. XZNWVENT is calculated dependent on the engine temperature from the characteristic line ZNWVENTM.

The measurement of the current position wnwi_w is performed dependent on the engine speed either 4 times or once per CMS revolution (see %WANWKW). In order to obtain information continuously the position is estimated in between measurements: The adjustment rates for retard position vnwads_w and for advanced position vnwadf_w are known (see also 3.).
Due to the given duty cycle it is known which adjustment is performed, so that when taking the low pass response of the adjustment unit XZNWVENT into consideration the current position of the CMS wnwgs_w can be estimated.

In case of an output of the hold duty cycle it is assumed that no adjustment is performed. The condition ‘no adjustment’ is also fulfilled if the setpoint wnws is equal to 0 and if the estimated CMS position wnwgsend_w lies within the tolerance range WSNW (retard position has been reached).

Since the adjustment rates are dependent on the engine speed the adapted values of the adjustment rate vnwadf_w and vnwads_w are multiplied by the characteristic line KLFVGNWF prior to their inclusion in the calculation.

If the setpoint wnws was given the value 0, the control is switched off and the duty cycle for the retard adjustment TANWSP is given out.

3.Adaptation of the adjustment rate

The adaptation of an adjustment rate is performed, if the retard resp. the advanced position was not reached, i.e. it must apply that wnwi_w>WSNWAS resp. wnwi_w<WSNWAF. If both preconditions are fulfilled the adaptation is performed by using the difference between the measured value wnwi_w and the estimated value wnwgs_w, provided that the actual value of adjustment rate has reached the value to be adapted to a certain amount (FLNWVAD). The adaptation is performed by means of a change of the active adjustment rate (advanced or retarded) by the value resulting from the difference between actual value wnwi_w and estimated value wnwgs_w multiplied by the factor FNWVAD.

The adapted adjustment rates are limited to VGNWMN and VGNWMX.

Under certain preconditions the adaptation of the adjustment rate is no longer meaningfully possible, e.g. in the engine speed range in which a switch-over is performed during the evaluation of 4 CMS edges to one CMS edge. In this case the flag B_noadv is set (see %WANWKW) and the adaptation is hence prohibited.

4. Adaptation of the hold duty cycle

The adaptation of the hold duty cycle is performed if the setpoint wnws has remained constant for the time tznwco and if the the hold duty cycle was given out at least once. Thereafter the time TNWCOMN is waited for to elapse and then the number of TV periods of advanced resp. retarded position are evaluated.

5. Realization for 2 CMS signals

The signals of the two CMS sensors are evaluated independently of each other. The following values must therefore exist twice:

B_nwi	CMS interrupt to be evaluated is present
B_adhtv	Adaptation of the hold TV is enabled
B_wnws0	CMS setpoint=0 is reached
B_*tv	Point at which the controller is currently written into
B_fanwhst	Testing system
anwws	Number of retarded duty cycles minus number of advanced duty cycles with stationary CMS setpoint
t1nwi_w	Time during which the CMS edge occurs
t1tvi_w	Time during which the TV interrupt occurs
tanwp	TV prop. control error
tanwr	TV to be given out
tznwco	Time with stationary setpoint since hold TV
vnwadf_w	Adapted CMS adjustment rate advanced
vnwads_w	Adapted CMS adjustment rate retarded
vnwadta_w	Adjustment rate with respect to duty cycle (proportional component)
vnwgs_w	Estimated CMS adjustment rate
vnwgsend_w	Estimated final value of CMS adjustment rate
wnwgs_w	Estimated CMS angle
wnwgsend_w	Estimated final value of CMS angle (for output of hold TV)
wnwi_w	Actual angle for camshaft

In the application system the values are distinguished by attaching a "0" (1. signal) resp. a "1" (2.signal).
Example: "wnwi_w0" und "wnwi_w1".

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APP WNWR 4.40 Application hint

Guidance values for the initial application:

ANWWSS	4
FNWTAP	5 %/deg.
FLNWVAD	50 %
FNWVAD	5 1/s
FNWVTA	0.01 deg./s/%
ITANWHFM	50 %
KLFVGNWF	1.0
TANWF	5 %
TANWSP	95 %
TAWSP	10 s
TWNWS	5 s
TNWCOMN	100 ms
VGNWFM	180 deg./s
VGNWMN	30 deg./s
VGNWMX	300 deg./s
VGNWSM	-180 deg./s
WSNW	1.5 deg.
WSNWAF	Advanced position - 2 deg.
WSNWAS	2 deg.
WSNWS	1 deg.
ZNWVENTM	40 ms

Application instruction

The data of the function %WNWR should be adjusted after the data of the function %WANWKW.

1. Fixing of the angle values for the determination of the overlap

WNWEOA, WNWASA: The CMS angle values of the controller (wnwem, wnwi, wnwgs, ...) are related to the retarded position. That means if the CMS is in the retarded position these values are "0". An adjustment in the direction advanced results in positive angle values. For the calculation of the intersection wnwue additionally the absolute angle values are necessary, which indicate at which angle value the inlet opens (WNWEOA) and the outlet closes (WNWASA). Both values are given for the retarded position. In case of an CMS adjustment of the outlet shaft the adjustment value wnwam is added to WNWASA.
The overlap is then calculated as follows:

wnwue = WNWEOA + wnwem - (WNWASA + wnwam)

2. Fixing of the duty cycles and of the limits of the adaptation ranges

TANWF: The duty cycle for the advancing should lie as close as possible to 0%. This complies to the maximum current and thus enables a maximum adjustment rate.

TANWSP: The duty cycle for the retarding should lie as close as possible to 100%. This complies to the minimum current and thus enables a maximum adjustment rate.

WSNWAS: The maximum permissible value for an overshoot of the controller is entered here

WSNWAF: The mechanical advanced position minus WSNWAS. If the mechanical advanced position is not known or if the control range shall markedly lie below it, also the "advanced" limit of the control range can be entered here.

3. Adjustment of hold TV (incl. adaptation)

- A constant setpoint wnws is entered, with a distance of at least 5 deg. from both positons.
- The proportional component in the neutral range is deactivated: FNWTAP = 0

WSNWS: Enter maximum permissible control deviation.

TNWCOMN: Enter the maximum temporal distance between 2 CMS edges which are used for the control.
Ex.: 4 edges per CMS rev. with a min. engine speed of 600 rpm: 50 ms (stipulated by idling speed)
1 edge per CMS rev. with a min. engine speed of 1200 rpm: 100 ms (adjusted by NNWAFMX=1200 rpm)
=> TNWCOMN = 100 ms

ANWWSS: Usually the recommended value "4" will be suitable. If it is recognizable that the adaptation of the hold TV
- is performed too quickly: increase value /
- is performed too slowly: decrease value.

ITANWHFM: The adaptation of the hold TV is performed for the entire relevant temperature range. The adapted values are entered into the characteristic line ITANWHFM.

4. Adjustment of the control parameters and of the parameters for the adaptation of the adjustment rate

- For the adjustment of the following parameters usually jumps of the setpoint wnws at constant engine speed and constant temperature are performed. For this the data of the function %WNWEIN are adjusted as follows:
  - WNWV = 0
  - KFWNWWK = 1.0 (=> only characteristic map KFWNWW acts independent of the temperature)
  - KFWNWW: At a load, for which B_ll=B_vl=.false., which can be executed at any engine speed, two load base points with a minimum distance are entered.
    - For all values in the upper load range CMS values with a distance of 5 deg. to the advanced position are entered.
    - For all values in the lower load range CMS values of 5 deg. are entered.

  Setpoint jumps are performed by increasing the load above the threshold.

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- Measurements need to be performed at two engine speeds at least: A value n1 below NNWAFMX and a value n2 above it:
  n1 = 0.5 * (nmot_idling + NNWAFMX)
  n2 = 1.5 * NNWFAMX (max. 4500 rpm)

FNWTAP The proportional component in the neutral range is at first deactivated: FNWTAP = 0.

WSNW At first half the value of the maximum permissible control deviation is entered here.

ZNWVENTM
- Perform setpoint jumps until the adapted adjustment rates vnwadf and vnwads remain approximately constant.
- In case of jumps into both directions record vnwadf and vnwads. Keep on increasing ZNWVENTM until the the absolut value of the adjustment rates is no longer decreased during the jumps.
- This must apply for engine speeds below and above NNWAFMX.

At first the same values are entered for all temperatures. If the controller was completely adjusted for one temperature other temperatures are entered and the corresponding values are corrected individually.

- If ZNWVENTM was adjusted the control should always be stable, i.e. only occasional overshoots occur and in case of a constant setpoint a stable state is definitely achieved (possibly after a few control oscillations). If this is not so, WSNW is temporarily increased until the controller has stabilized.

FLNWVAD Decrease this factor, if the adaptation of the adjustment rate is too slow or does not take place at all. Increase this factor, if there is an adaptation even in a stable situation with a constant value of the demand camshaft position, where it is not necessary.

FNWVAD Influences how fast the adjustment rate is adapted. The value is of minor relevance, a value of approx. 5 1/s is in general suitable.

FNWTAP Factor for the P-component in the neutral range of the 3-point-controller. Keep on increasing this value until the control deviation with constant setpoint is reduced sufficiently quick. The stability of the controller may under no circumstances be worsened, if necessary WSNW is to be increased at the same time.

FNWVTA
- Adjust constant setpoint
- Measure a phase, in which the controller stays in the neutral range, i.e. in which only hold TV is given out (if necessary WSNW can be increased temporarily for this); record wnwi and wnwgs.
- Increase the value if the the change of wnwgs is less than the change of wnwi (from edge to edge)
- Decrease the value if the change of wnwgs is greater than the change of wnwi (from edge to edge)

WSNW, FNWTAP If the control quality is not yet satisfactory a further optimization can be performed by changing these 2 values. An increase of WSNW as a tendency leads to a stabilization of the controller. Each increase of WSWN must be balanced by an increase of FNWTAP, in order to keep the stationary control error small. An anew adjustment of ZNWVENTM may possibly be necessary.

NNWAFMX Two engine speed ranges are separated by the value NNWAFMX: below NNWAFMX: Evaluation of all edges
above NNWAFMX: Evaluation of only one edge

- Adjust engine speed just below NNWAFMX-2*NNWHYS: If the control quality is not sufficient: Decrease NNWAFMX.
- Adjust engine speed just above NNWAFMX-2*NNWHYS: If the control quality is not sufficient: Increase NNWAFMX.

The optimum adjustment of NNWAFMX is especially important in case not all edges have the same distance to the DTC: The control quality should be assessed for the entire relevant temperature range. This assessment should if possible be checked on several engines.

For run time reasons NNWAFMX should be adjusted as low as possible.

KLFVGNWF
- Use two base points which lie just below resp. just above NNWAFMX, but which lie outside the hysteresis range NNWHYS.
- Adjust engine speeds in the entire engine speed range (especially the two above-mentioned base points):
  - Perform setpoint jumps until the adapted adjustment rates vnwadf and vnwads remain approximately constant.
  - Record the adapted adjustment rates vnwadf and vnwads
  - The reference engine speed nmot_ref is that engine speed with the maximum values of the adjustment rate (typically the maximum engine speed)
  - The correction factors for all other engine speeds are calculated:
    (vnwadf(nmot) - vnwads(nmot)) / (vnwadf(nmot_ref) - vnwads(nmot_ref)) (vnwads < 0)
  - The correction factors are entered into KLFVGNWF.

VGNWFM, VGNWSM
- Perform setpoint jumps at an engine speed (e.g. n2) until the adapted adjustment rates vnwadf and vnwads remain approximately constant.
- Enter the adapted values for each temperature
- Since the temperature in the adjustment unit does not equal engine temperature tmot, it is better for stability reasons to enter slightly higher values for the shifting speed

VGNWMN - 75 % of the absolute value of the smallest value of VGNWFM and VGNWSM

VGNWMX - 125 % of the absolute value of the largest value of VGNWFM and VGNWSM

5. Remaining values

TWNWS After a cold start a not controlled vibration of the CMS may possibly occur since the oil chambers have not yet been filled. The duration during which this vibration occurs is to be entered here.

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DNWS 12.30 Diagnosis camshaft control

FDEF DNWS 12.30 Function definition

No text for FDEF available!

ABK DNWS 12.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANWFLMX			FW	Number of edges of camshaft signal per camshaft revolution
ASIDNWS			FW	max. number of signal faults
ASIDNWSMX			FW	Upper limitation of the signal fault counter
KTDWNWS	TMOT	TMST	KF	debouncing time DNWS plaus-fault
TDNWS			FW	debouncing time for set of the fault flag
TDNWSNOSI			FW	debouncing time for initialization of the signal fault counter
TDWNW			FW	delay time for healing of the fault flag or set of the cycle flag
WNWAIMN			FW	minimum value for the induvidual adaption of the camshaft retard limit stop
WNWAIMX			FW	Maximum value for the individual adaption of the camshaft retard limit stop

Variable	Source	Type	Description
B_CDNWS	PROKON	EIN	function active per codeword CDNWS
B_CDNWS2	PROKON	EIN	function active per codeword CDNWS
B_CLNWS		EIN	condition clear fault path camshaft control
B_ENWS	DNWS	AUS	condition error camshaft control
B_FTV		EIN	Advance duty cycle at active camshaft control
B_FTV2		EIN	Advance duty cycle at active camshaft control of bank 2
B_MNNWS	DNWS	AUS	fault type: camshaft control advanced position not reached
B_MNNWS2	DNWS	AUS	fault type: camshaft control 2 advanced position not reached
B_NPNWS	DNWS	AUS	fault type camshaft control undefined position
B_NPNWS2	DNWS	AUS	fault type camshaft control 2 undefined position
B_PHAD		EIN	adaptation crankshaft/camshaft performed
B_SINWS	DNWS	AUS	Error Type: signal fault of camshaft sensor
B_SINWS2	DNWS	AUS	Error type: signal fault of camshaft sensor bank 2
B_STEND	BBSTT	EIN	condition end of start
B_STV		EIN	Late pulse duty factor NW position control is/was active
B_STV2		EIN	Late pulse duty factor NW position control active of bank 2
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_NWS	DNWS	AUS	error flag: camshaft control
E_NWS2	DNWS	AUS	error flag: camshaft control bank 2
E_NWSE	DNWSE	EIN	error flag: power stage of camshaft control valve
E_NWSE2		EIN	error flag: driver stage bank 2 of camshaft control valve
E_PH	DPH	EIN	error flag: phase sensor
E_PH2	DPH	EIN	error flag: phase sensor 2
JNWFL_0		EIN	
JNWFL_1		EIN	
TMOT	GGTFM	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
WNWS	WNWEIN	EIN	Nominal angle for camshaft
WNWSP_W_0		EIN	Flank individual offset of camshaft position control, flank 0
WNWSP_W_1		EIN	Flank individual offset of camshaft position control, flank 1
WNWSP_W_2		EIN	Flank individual offset of camshaft position control, flank 2
WNWSP_W_3		EIN	Flank individual offset of camshaft position control, flank 3
WNWSP_W_4		EIN	Flank individual offset of camshaft position control, flank 4
WNWSP_W_5		EIN	Flank individual offset of camshaft position control, flank 5
WNWSP_W_6		EIN	Flank individual offset of camshaft position control, flank 6
WNWSP_W_7		EIN	Flank individual offset of camshaft position control, flank 7
ZZYL		EIN	SW-cylinder counter
Z_NWS	DNWS	AUS	cycle flag: camshaft control
Z_NWS2	DNWS	AUS	cycle flag: camshaft control bank 2

FB DNWS 12.30 Detailed description of function

APP DNWS 12.30 Application hint

WNWTST 1.10 system diagnosis request of camshaft controller

FDEF WNWTST 1.10 Function definition

No text for FDEF available!

ABK WNWTST 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
WSNW			FW	Threshold camshaft angle (insensitivity range)

Variable	Source	Type	Description
B_FANWH	WNWTST	AUS	Demand for system test
B_FANWHST		EIN	system test
B_FANWHST2		EIN	system test

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Variable	Source	Type	Description
B_FANWS		EIN	condition general function request for diagnosis camshaft control
B_FANWSD		EIN	
B_FANWTST	WNWTST	AUS	Condition for testing purpose (system test)
B_FTV		EIN	Advance duty cycle at active camshaft control
B_FTV2		EIN	Advance duty cycle at active camshaft control of bank 2
B_PHAD		EIN	adaptation crankshaft/camshaft performed
NWSDSTAT	WNWTST	AUS	
NWSDSTAT2	WNWTST	AUS	
NWSSTAT	WNWTST	AUS	
NWSSTAT2	WNWTST	AUS	
TNWSFI	WNWTST	AUS	
TNWSFI2	WNWTST	AUS	
TNWSSI	WNWTST	AUS	
TNWSSI2	WNWTST	AUS	
WNWI2_W		EIN	actual shifting angle of the camshaft 2 (word)
WNWI_W	WANWKW	EIN	actual shifting angle of the camshaft (word)
WNWSTST		EIN	Nominal angle for camshaft for testing purpose

FB WNWTST 1.10 Detailed description of function

APP WNWTST 1.10 Application hint

LAMKO 3.140 Lambda coordination

FDEF LAMKO 3.140 Function definition

lamko-lamko

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subfunction selection of lambda at bank1: LAMSEL

lamko-lamsel

subfunction selection of lambda at bank2: LAMSEL2

lamko-lamsel2

subfunction correction of nominal Lambda for lambdasensor bank1: LSS1KOR

lamko-lss1kor

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subfunction correction of nominal Lambda for lambdasensor bank2: LSS2KOR

lamko-lss2kor

ABK LAMKO 3.140 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
LAMLGF			FW	lambda limit ”rich”
LAMLGMTM	TMOT		KL	lambda limit ”lean”
LAMSOSOF			FW	Lambda sensor upper limit for 1.0
LAMSOSUF			FW	Lambda sensor lower limit for 1.0
LASOAB			FW	target lambda value for bank shutdown

Variable	Source	Type	Description
B_BEVAB	AEVAB	EIN	condition: Inj. valve cut off on Bank/Bank1
B_BEVAB2	AEVAB	EIN	condition: Inj. valve cut off on Bank2
B_DSLA	DSLSLR	EIN	adaption phase: calculation of secondary air mass
B_FALSH		EIN	condition function request downstream oxygen sensor diagnosis
B_FALSH2		EIN	condition function request downstream oxygen sensor diagnosis bank2
B_FASLA	SLS	EIN	Condition: external request of SAI system aktiv
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_LALGF	LAMKO	AUS	condition lambda limit ”rich” active
B_LALGF2	LAMKO	AUS	condition lambda limit ”rich” active
B_LAMBTS	LAMKO	LOK	lambda for component protection is active
B_LAMBTS2	LAMKO	LOK	lambda for component protection is active (bank 2)
B_LAMKA	LAMKO	LOK	lambda for Katalyst oxygen purge is active
B_LAMKA2	LAMKO	LOK	lambda for Katalyst oxygen purge is active
B_LAMLASH		EIN	Condition for enleanment in %LAMKO
B_LAMLASH2		EIN	Condition for enleanment in %LAMKO bank2
B_LAMNSE	ESNST	EIN	condition end of lamns_w calculation
B_LAMNSWL	LAMKO	LOK	lambda engine nominal at post start and warming up active
B_LAMSDEF	LAMKO	AUS	Condition: defined desired air/fuel ratio value
B_LDEF	LAMKO	LOK	Condition: defined desired value of the lambda (bank1)
B_LDEF2	LAMKO	LOK	Condition: defined desired value of the lambda (bank2)
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
C_INI		EIN	ECU-condition for intialisation
DLAMATR2_W		EIN	desired delta lambda of exhaust temperature control bank 2
DLAMATR_W		EIN	desired delta lambda of exhaust temperature control
FLAMKH	BBKHZ	EIN	factor setting up lambda engine nominal at catalyst heating
FLAMSL2_W	SLS	EIN	Factor lambda change by secondary air, bank 2
FLAMSL_W	SLS	EIN	Factor lambda change by secondary air
LAMBAS	LAMKO	AUS	basic Lambda
LAMBTS_W		EIN	lambda for component protection
LAMELSH2_W	DLSH	EIN	desired lambda for electrical sensor diagnosis behind catalyst (short trip)
LAMELSH_W	DLSH	EIN	desired lambda for electrical sensor diagnosis behind catalyst (short trip)
LAMFA_W	LAMFAW	EIN	required lambda, driver request
LAMKA2_W	LRKA	EIN	Lambdasetpoint catalyst clean out, bank2
LAMKA_W	LRKA	EIN	Lambdasetpoint catalyst o2 purge function
LAMKH2_W	LAKH	EIN	Lambda engine nominal at catalyst heating, bank 2 (word)
LAMKHE2_W	LAMKO	LOK	lambda engine nominal at catalyst heating, actual, bank 2
LAMKHE_W	LAMKO	LOK	lambda engine nominal at catalyst heating, actual
LAMKH_W	LAKH	EIN	Lambda engine nominal at catalyst heating (word)
LAMLASH2_W	DLSAHK	EIN	Desired Lambda for test oscillation check downstream catalyst bank2
LAMLASH_W	DLSAHK	EIN	Desired Lambda for test oscillation check downstream catalyst
LAMLGM	LAMKO	LOK	lambda limit ”lean”
LAMNSWL_W	ESWL	EIN	lambda engine nominal at afterstart and warming up
LAMS2_W	LAMKO	LOK	Lambda nominal (word)
LAMSBG2_W	LAMKO	AUS	required lambda limitation Bank2
LAMSBG_W	LAMKO	AUS	Desired Lambda limitation (word)
LAMSONS2_W	LAMKO	AUS	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMKO	AUS	required lambda referred to lambda sensor fitting location
LAMSOS2_W	LAMKO	LOK	required lambda referred to lambda sensor fitting location bank2
LAMSOS_W	LAMKO	LOK	required lambda referred to lambda sensor fitting location
LAMSUBG2_W	LAMKO	LOK	Lambda nominal unlimited (word)
LAMSUBG_W	LAMKO	LOK	Lambda nominal unlimited (word)
LAMS_W	LAMKO	LOK	Lambda nominal (word)
LAMVOA2_W	LAMKO	AUS	lambda pilot control without additive parts

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Variable	Source	Type	Description
LAMVOA_W	LAMKO	AUS	lambda pilot control without additive parts
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SY_ATR	PROKON	EIN	system constant exhaust-gas temperatur controller built in
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TMOT	GGTFM	EIN	Engine temperature

FB LAMKO 3.140 Detailed description of function

Lambda = 1.0 is set in the combustion chamber by the precontrol of the injection ESVST.
The function Lambda coordination LAMKO defines that operating point of the engine at which the engine is run at combustion chamber Lambda # 1.0.
The position of the switches is a dimension for the selection priority of lambda.
The priorities of lambdaselection are catalyst protection, component protection, catalyst heating by secondary air.
Lambda for catalyst protection is LASOAB.
Component protection for manifold, exhaust valves, supercharger, catalyzer is realized by means of the input lambts_w.

For projects with exhaust emission temperature control by exhaust emission sensors, the control correction is included in the computation by the additive component dlamatr_w.
From post-start until end of warm up of the engine lamnswl_w is active, if there is no katalyst heating.

The transition is made at the beginning of catalyzer heating from Lambda post-start/warm up (lamnswl_w) by means of the factor flakh from %LAKH to Lambda for catalyzer heating lamnswl_w. Return to lamnswl_w is made by means of flakh for an abort of the catalyzer heating. For systems with secondary air injection (B_slsfz), the nominal lambda given at the Lambda sensor lamsons_w is calculated from the Lambda engine (lamsbg_w) by dilution of the secondary air by multiplication with the auxiliary air dilution factor flamsl_w.
The Lambda requirements is given by the fixed value LASOB for injection valve cut off (B_evab,Bevab2 = true). It can realized by this, that there is no excess HC occuring in the corresponding exhaust emission train for cylinders which have been cut off if the entire bank is operated at "lean", e.g. with LASOAB = 1.05.

The average value from both banks is provided as the basic Lambda lambas for calculation of the engine torque.

If there is no further need for higher Lambda dynamics outside of the warm up, catalyzer heating range (B_lamnswle = true), then a switchover is made from the 10 ms to the 100 ms computation frame.

The lambda set by the driver request, engine protection or catalyzer heating is limited by both of the Lambda thresholds for the engine-running limit "rich" (lalgf_w) and "lean" (lalgm_w).

APP LAMKO 3.140 Application hint

Initialisation Parameters for Applikation:
LASOAB = 1.05
LAMLGF = 0.77
LAMLGMTM: tmot interpolation points are the same one as the tmot points in function ESWL.
values of LAMLGMTM = 1.2
LAMSOSUF = 0.998779
LAMSOSOF = 1.001221 means 5 inc difference from 1.0

The inputs lamka_w , lamka2_w are inactive if its value is >= 2.0. The Function katalyst purge set this value to 8.0 if there is no activity.
Outside warm-up and catalyst heating, at reduced lambda dynamic requirement (B_lamnswle = true), the calculation timing is switched from 10 ms to 100 ms.

LAMFAW 3.30 Lambda vehicle-operator demand

FDEF LAMFAW 3.30 Function definition

lamfaw-lamfaw

lamfaw-lamfaw

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ABK LAMFAW 3.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFLAMFA	NMOT	RL	KF	Map Lambda driver's request
LAMFAVL	NMOT		KL	Lambda request full load
TLAFA			FW	delay time for activation of lambda demand by driver
TMVL			FW	engine temperature threshold for full load recognition

Variable	Source	Type	Description
B_VL	MSF	EIN	Condition for wide open throttle
C_INI		EIN	ECU-condition for intialisation
LAMFA_W	LAMFAW	AUS	required lambda, driver request
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
TMOT	GGTFM	EIN	Engine temperature

FB LAMFAW 3.30 Detailed description of function

Enrichment at full load is realized via the characteristic LAMFAVL. KFLAMFA may not contain any full load enrichment. The intervention via lamfa_w on the mixture can be delayed via the delay time TLAFA.

APP LAMFAW 3.30 Application hint

Neutralization of the function by data:

KFLAMFA = 1.0 and LAMFAVL = 1.0 ——> then lamfa_w is 1.0

LAKH 3.20 Lambda coordination for catalyst heating

FDEF LAKH 3.20 Function definition

lakh-lakh

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Changing to lambda-exhaust at secondary air:

lakh-blasdyn

ABK LAKH 3.20 Abbreviations

Variable	Source	Type	Description
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
C_INI		EIN	ECU-condition for intialisation
FLAKH	BBKHZ	EIN	Factor control lambda at catalyst heating
FLAMSL2_W	SLS	EIN	Factor lambda change by secondary air, bank 2
FLAMSL_W	SLS	EIN	Factor lambda change by secondary air
FLASKH	LAKH	LOK	Factor change to lambda-exhaust at secondary air
FLMSSL	SLS	EIN	Factor lambda engine by secondary air
FLMSSLKH	LAKH	LOK	Factor lambda engine by secondary air, resulting
FMSLDYN		EIN	Factor dynamic behavior secondary air
FSLPDYN	SLS	EIN	Factor dynamic behavior secondary air pump
FSLSDYN	LAKH	LOK	Factor dynamic behavior of secondary air system
IMLPR	BBKHZ	EIN	relative amount of integrated air mass flow at catalyst heating
LAMKH2_W	LAKH	AUS	Lambda engine nominal at catalyst heating, bank 2 (word)
LAMKHR2_W	LAKH	LOK	Lambda engine result at catalyst heating, bank 2 (word)
LAMKHR_W	LAKH	LOK	Lambda engine result at catalyst heating (word)
LAMKH_W	LAKH	AUS	Lambda engine nominal at catalyst heating (word)
LANSKH_W	LAKH	LOK	lambda engine nominal during afterstart at catalyst heating
LASDSL_W	LAKH	LOK	Lambda exhaust nominal at secondary air diagnosis
LASKH_W	LAKH	LOK	Lambda exhaust nominal at catalyst heating (word)
LMSKH_W	LAKH	LOK	Lambda engine nominal at catalyst heating (word)
LMSSL2_W	LAKH	LOK	Lambda engine nominal caused by secondary air, bank 2
LMSSL_W	LAKH	LOK	Lambda engine nominal caused by secondary air (word)
ML	BGSRM	EIN	air mass flow
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_T100		EIN	Time schedule 100 ms
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
SY_STETLR	PROKON	EIN	System constant condition continuous Lambda control present
TMOT	GGTFM	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start

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FB LAKH 3.20 Detailed description of function

For exhaust gas reasons the engine is operated after cold start in such a way that an accelerated catalyst warm-up takes place. The quantity of heat necessary for this can be mainly supplied by thermal exhaust gas energy (exhaust gas temperature, exhaust gas mass flow), during which the engine must be operated as lean as possible, in order to minimize the raw emissions ("lean warm-up"). A further possible catalyst heating source uses thermal exhaust gas energy ("rich warm-up"). For this, the engine is operated with an excess of fuel. In combination with secondary air the rich exhaust gas reacts inside the manifold or inside the catalyst. The heat produced by this oxidation process is used for the heating of the catalyst.

An excess of air in the exhaust gas is necessary for both catalyst heating concepts.

For concepts with lean warm-up the lean Lambda engine set point lmskh (due to flmssl = 0) from the characteristic map KFLMSKH is preassigned and made available as Lambda set point lamkh. The "control" is performed by the evaluation to Lambda = 1 by flakh from %BBKHZ. In the Lambda coordination %LAMKO the transition from lamnswl (Lambda after-start warm-up) to lamkh and the limitation to the actual Lambda combustion chamber lamsbg is performed by the evaluation factor flamkh from %BBKHZ. In addition the Lambda set point lamsons for the Lambda control is calculated.

For concepts with secondary air injection (B_slsfz = 1, code word CWKONABG from %PROKON) the setpoint for Lambda engine is determined for flmssl = 0.9961 from the setpoint for Lambda exhaust gas laskh by the relation of lmssl = laskh / flamsl with the secondary air dilution factor flamsl = (1 + msl / ml) from %SLS.

By the weight factor flmssl from the secondary air control %SLS the resulting Lambda setpoint lamkhr is then obtained from:

lamkhr = lmskh + flmssl * (lmssl - lmskh).

Here flmssl = 0 - in spite of secondary air - complies to the setpoint input for Lambda engine of a concept with lean warm-up. The limit flmssl = 0.9961 then complies to the setpoint default selection with thermal reaction in combination with secondary air. The default selection of fmssl takes place in the secondary air control %SLS.

The setpoint for Lambda catalyst heating lamkhr resulting from this, also evaluated by flakh, is controlled by flamkh in %LAMKO and is made available as actual Lambda combustion chamber lamsbg. In %LAMKO the correspondent Lambda setpoint lamsons for the Lambda control is calculated by:

lamsons = lamsbg * flamsl.

Both catalyst heating concepts ("lean warm-up", "secondary air injection") have in common, that the starting procedure must be performed with minimum raw emissions and minimum exhaust gas mass flow, that means idling of the engine must be adjusted such that maximum heat is produced in the exhaust pipe, whilst the starting procedure must take place at the lean warm-up limit with an ignition angle of optimum efficiency. As a result, the Lambda in the engine is defined by the lean limit "lalgm" from %ESWL, especially at start of driving. For concepts with a large excess of secondary air during idling Lambda engine is additionally determined by the rich limit lalgf from %WL. For this also see %LAMKO.

During afterstart the lambda-request lanskh_w from map KFLANSKH, depending on anztib_w and tmst can be defined. This is possibly necessary at catalyst heating concepts with thermal reactor without changes of the normal afterstart enrichment.

Depending on the imlpr-threshold IMLLASKH the change from lambda-engine to lambda-exhaust, with filter constant ZFLASKH, can be defined. By this, it is possible e.g at ECE driving cycle, to delay the start of the thermal reaction.

Secondary air adaptation/quick test:
For the secondary air diagnosis (%DLSLR or %DSLSLRS) it is possible to again activate the secondary air by B_dsla or also by the quick test request B_fasla. The Lambda input selection is performed dependent on the secondary air diagnosis, based on the used Lambda control:
Two-state controller -> secondary air diagnosis DSLSLR:
Control to Lambda exhaust gas = 1 with input selection of the necessary engine enrichment due to the secondary air dilution factor flamsl_w.
At engine operation points, at which a too rich engine operation would be reached due to the little intake air mass, the Lambda exhaust gas input selection lasdsl_w can be corrected in the direction lean depending on the intake air mass. An adaptation of the secondary air mass then, however, is no longer possible due to lamsons_w, since the "measuring window" has been left. (Regarding this see %DSLSLR.)

Continuous Lambda control -> secondary air diagnosis DSLSLRS:
Input selection of Lambda engine = 1 and calculation of the desired Lambda exhaust gas (lamsons_w) from the secondary air dilution factor. In case of quicktrip request (B_fasla) the diagnosis is performed in combination with active control analogous to the secondary air diagnosis during catalyst heating. During the adaptation phase (B_dsla) the secondary air diagnosis in comparison is performed by measuring and evaluating the Lambda sensor voltage lamsoni_w at controlled operation. (Regarding this see %DSLSLRS.)

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APP LAKH 3.20 Application hint

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Precondition:   Application mixture check (%GK), injection pilot control (%ESVST), secondary air control (%SLS),
                Application %WL in combination with catalyst heating.

Default selection:
By the bit B_slsfz from CWKONABG the catalyst heating concept without / with secondary air system becomes compatible:

B_slsfz =  | 0: no secondary air system, lean catalyst heating operation of the engine
           | 1: with secondary air system, rich catalyst heating operation of the engine
                Further possible secondary air variations are described in %SLS.

Lean warm-up:   Default selection KFLMSKH with 1,05, transition to 1,0 resp. richer dependent on load (rl) when starting from rest
                and adjustment to the lean performance limit (lalgm) from %ESWL, as described in %LAMKO.

Rich warm-up :  Default selection KFLASKH with 1,1 to 1,2, transition to > 1,3 when starting from rest and adjustment to the lean
                performance limit (lalgm) from %ESWL, as described in %LAMKO. Also see %BBKHZ.

or              Lambda engine default selection by code word CWSLS in %SLS analogues to lean warm-up.

The base point distribution of KFLMSKH, KFLASKH is to be chosen such that the "catalyst heating idle range" is sufficiently covered
with regard to engine speed and load at idle and that a steady transition by interpolation to partial load can be performed.

Default selection in %ESWL such that "lalgm" does not limit lalgf during catalyst heating.

Switching off:
No catalyst heating with MLSUS = 0 in %BBKHZ
No Lambda action during lean warm-up: KFLMSKH = 1
                  with secondary air: MSLUB = 0 in %SLS and KFLASKH = 1.0
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SLS 91.20 Secondary air control

FDEF SLS 91.20 Function definition

sls-sls

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BMSL: Calculation of secondary air mass

sls-bmsl

BSLPDYN: Description of the dynamic of the secondary air pump

sls-bslpdyn

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BSLSOFF: Description of secondary air dynamic inside exhaust system

sls-bslsoff

BFMLSSL: Calculation of secondary air enrichment

sls-bfmlssl

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BKT: Secondary air adaption/short test

sls-bkt

ABK SLS 91.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWFASL			FW	code word: tester intervention in secondary-air diagnosis
CWSLS			FW	Code word for secondary-air system
CWSLSOF			FW	Codeword secondary air system; configuration
DPSLV			FW	Threshold minimal pressure drop for opening secondary air valve
FMSL			FW	Factor correction secondary air mass
FMSL2			FW	Factor correction secondary air mass, bank 2
FMSLOFF			FW	Threshold removing secondary air finished
FMSRHOL	FRHOL_W		KL	density correction of secondary air mass
FMSTMOT	TMOT		KL	tmot- correction of secondary air mass
IMLSLMN			FW	Min. ratio factor psum_w/mlsu for SLS switch-on
IMLSLMX			FW	Max. ration factor psum_w/mlsu for SLS switch-on
IMLSLSA			FW	threshold air mass integral starting secondary air inside exhaust
IMLSLSE			FW	threshold air mass integral removing secondary air inside exhaust
KFFMSML	NMOT	RL	KF	Exhaust back pressure correction of SAI- mass flow
MLSLMX			FW	max. engine air flow for secondary air
MSLUB	UBF		KL	Secondary air mass depending on battery voltage
TASLSO			FW	max. air temperature for secondary air system
TASLSU			FW	min. air temperature for secondary air system
TDDSLA			FW	duration of secondary air at adaption phase
TDSLKT			FW	Duration of secondary air short test, measure of secondary air mass
TLMSSLAB			FW	delay time switching off secondary air enrichment
TLMSSLMX			FW	maximum time for secondary air enrichment at idle
TMFASLMN			FW	Engine temperature threshold tester demand secondary air diagnosis
TMSSLO			FW	upper start temperature threshold for secondary air
TMSSLSTO			FW	upper temperature threshold for secondary air at cranking
TMSSLSTU			FW	lower temperature threshold for secondary air at cranking
TMSSLU			FW	lower start temperature threshold for secondary air
TSLABB			FW	delay time, switching off secondary air
TSLPMN			FW	minimum switch on time of secondary air pump
TSLUBST			FW	delay time, switching off secondary air at start bei UBSLSTMN
TVDSLOFF			FW	Delay time switch off secondary air valve at adaption/short test
TVSLVOFF			FW	Delay time switch off secondary air valve
TVSLVON			FW	Delay time switch on secondary air valve
UBSLMN			FW	min. voltage for switch on secondary air
UBSLMX			FW	max. voltage for switch on secondary air
UBSLSTMN			FW	min. voltage for switch on secondary air at start
VSLS			FW	vehicle speed threshold for secondary air
ZFLMSSL			FW	time constant enrichement secondary air
ZKSLPOFF			FW	Time constant switch off secondary air pump
ZKSLPON			FW	Time constant switch on secondary air pump
ZKSLSOFF			FW	Time constant removing secondary air after shut off valve closed
ZKSLSON			FW	Time constant starting secondary air after shut off valve open

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Variable	Source	Type	Description
B_ATMTPL	ATM	EIN	condition temperature downstream catalyst exceeds dew-point (last trip)
B_BREMS	GGEGAS	EIN	condition: brake operated
B_DSLFA	DSLSLR	EIN	Condition: Request start of SAI- system for short trip
B_DSLRESET	SLS	LOK	condition: reset secondary air adaption/short test
B_DSLSET	SLS	LOK	condition: set secondary air adaption/short test
B_DSLSP4	DSLSLR	EIN	Condition: Request start of SAI for adaptation/additional diagnosis
B_DSPE	DSLSLR	EIN	condition diagnosis secondary air on
B_FA		EIN	condition general function request
B_FASLA	SLS	AUS	Condition: external request of SAI system aktiv
B_FASLARQ	SLS	AUS	Condition: local request tostart test of SAI system
B_FASLS		EIN	condition for external request of SAI system
B_FS	CANEGS	EIN	Condition driving state (automatic gear box)
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KHA	BBKHZ	EIN	request of activated catalyst heating
B_KHAB	BBKHZ	EIN	condition catalyst heating terminating
B_KUPPL	GGEGAS	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_LMSSLOF	SLS	AUS	condition lambda engine by secondary air, off
B_MSLMN	DSLSLR	EIN	condition secondary air mass too few
B_MSLOFF	SLS	AUS	Condition secondary air mass flow removed after switch off
B_MSLON	SLS	LOK	Condition secondary air mass flow stable after start of secondary air
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_SLDSL4	SLS	LOK	Condition: secondary air enabled for diagnosis phase 4
B_SLKHOF	SLS	AUS	condition shut down secondary air pump caused by imlpr threshold
B_SLKT	SLS	LOK	Condition: secondary air enabled at short test
B_SLP	SLS	AUS	condition for secondary air pump
B_SLPENA	SLS	LOK	condition to start secondary air pump
B_SLPOFF	SLS	AUS	Condition secondary air pump switched of
B_SLPOFST	SLS	LOK	condition to set flip flop B_slpoff
B_SLS	SLS	AUS	Condition for active secondary air
B_SLSADAP	SLS	AUS	Condition: adaption of secondary air mass
B_SLSDIS	SLS	LOK	condition to shut down secondary air pump
B_SLSERR	SLS	LOK	condition to lock start of secondary air pump
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
B_SLSINHI	SLS	LOK	condition to disable bit B_sls
B_SLSOFF	SLS	AUS	Condition end of secondary air after removing secondary air
B_SLV	SLS	AUS	condition for secondary air valve
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
E_SLPE	DSLPE	EIN	error flag: secondary air pump (power stage)
E_SLVE	DSLVE	EIN	error flag: secondary air valve (power stage)
FLAMSL2_W	SLS	AUS	Factor lambda change by secondary air, bank 2
FLAMSL_W	SLS	AUS	Factor lambda change by secondary air
FLMSSL	SLS	AUS	Factor lambda engine by secondary air
FMSAGD	SLS	LOK	correction factor exhaust back pressure of secondary air mass
FMSLA	DSLSLR	EIN	correction factor secondary air mass, adaptive
FMSLA2	DSLSLR	EIN	correction factor secondary air mass, adapative, bank 2
FMSLDYN	SLS	LOK	Factor dynamic behavior secondary air
FMSLRHO	SLS	LOK	density correction of secondary air mass flow
FMSLTM	SLS	LOK	tmot correction of secondary air mass flow
FRHOL_W	GGDSAS	EIN	Factor: air density f(intake air temp., altitude), 16-bit
FSLPDYN	SLS	AUS	Factor dynamic behavior secondary air pump
IMLPR	BBKHZ	EIN	relative amount of integrated air mass flow at catalyst heating
IMLSLA_W	SLS	LOK	air mass integral starting secondary air
IMLSLE_W	SLS	LOK	air mass integral removing secondary air inside exhaust
ML	BGSRM	EIN	air mass flow
MLBB2_W	BGMSABG	EIN	air mass flow filtered (Word), bank2 related
MLBB_W	BGMSABG	EIN	air mass flow filtered (Word), Bank1 related
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSL	SLS	AUS	secondary air mass flow
MSL2	SLS	AUS	secondary air mass, bank 2
MSLPUB	SLS	LOK	secondary air mass flow, depending on battery voltage
MSLSTAT	SLS	AUS	static secondary air mass flow
NMOT	BGNMOT	EIN	engine speed
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PU	GGDSAS	EIN	Ambient pressure
RL	EGFE	EIN	relative air charge
R_T100		EIN	Time schedule 100 ms
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TANS	GGTFA	EIN	Intake air temperature
TMOT	GGTFM	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
TNST_W	BBSTT	EIN	time after end of start
UBF	BGUBF	EIN	filtered battery voltage for charge control
VFZG	GGVFZG	EIN	vehicle speed (km/h)
Z_SLS	DSLSLR	EIN	cycle flag: secondary air system

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FB SLS 91.20 Detailed description of function

The secondary air control is coordinated by the catalyst heating function %BBKHZ and consists of the following partial functions:

Switch-on conditions:
The secondary air (B_SLS=B_SLV = 1, B_slp = 1) is activated by B_kh = 1 and by the imlpr threshold IMLSLMN being exceeded, if the starting temperature of the engine tmst is inside the window TMSSLU < tmst < TMSSLO and the intake air temperature tans is inside the window TASLU < tans < TASLO. Through this it is possible to restrict the temperature range for the switching on of the secondary air system with regard to catalyst heating, so as to e.g. avoid an overheating of the secondary air pump or a switching on of the freezed secondary air system. In the restricted temperature window TMSSLSTU < tmst < TMSSLST the secondary air can already be activated during the start by setting the bit 0 from the code word CWSLS, so as to e.g. ensure the self-ignition already during engine start for concepts with thermal reactor. Precondition, however, is that this is compatible to the voltage of the electrical system, i.e. that the battery voltage is > UBSLSTMN.
By bit 1 it is alternatively possible to activate the secondary air only at starting up when the speed threshold VSLS is exceeded. This is adequate for secondary air concepts on which the exothermic reaction is ignited only by the catalyst.
The control of the secondary air pump relay is performed by B_slp = 1 with the minimum hold time TSLPMN in order to avoid an opening of the relay during the pump starting flow. The opening of the secondary air valve (B_slv =1) can be delayed by the time TVSLON with regard to the pump. If the secondary air valve is open, B_sls = 1 is set. For diagnosis purposes the control of the pump and of the secondary air valve can additionally be performed by the flags B_dspe and B_dslfa, B_dslp4.

Switch-off and abort conditions:
The secondary air injection is terminated if the threshold IMLSLMX is exceeded (B_slpoff = 1). A debounced abort of the function by TSLABB can take place as from end of start (B_stend = 1), if the air mass threshold MLSLMX is exceeded, if the pressure difference DPSLV for keeping the vacuum-dependent secondary air valve open is too small, if there is too little battery voltage UBSLMN, if there is a power stage error E_slpe, E_slve or with an abort of the catalyst heating (B_khab = 1). The secondary air is not at all activated if the power stage errors or a too high electrical system voltage, e.g. due to a booster start, are already detected when starting the vehicle. After the secondary air pump was switched off it is possible that the closing of the secondary air valve is delayed by the time TVSLOFF.
This may be necessary for engine concepts on which the secondary air leads to a charge improvement in the combustion chamber. By the later closing of the secondary air valve this boost effect can then be rounded by the decreasing secondary air during the stopping of the pump. Attention: On concepts with valve test from the secondary air diagnosis a delayed switch-off of the secondary air valve is not permitted, since here the pump has to work against the closed secondary air valve.
After the switch-off the secondary air function remains blocked until the initialization (C_ini) is started again.

Description of the secondary air mass:
The secondary air mass msl is specified in the characteristic line MSLUB dependent on the electrical system voltage and corrected dependent on the engine running point, by the map KFFMSML and on the air density (characteristic line FMSRHOL). At hot engine, e.g. at adaptation or separate diagnosis, the secondary air mass flow can be corrected by the characteristic line FMSTMOT. The starting and stopping of the pump is described by the dynamic factor fslpdyn. On two-bank concepts (SY_STERVK) the secondary air is divided in half and it can be corrected bank-specifically (FMSL, -2). By means of bit 6 from the code word CWSLS (= B_slsadap) the secondary air adaptation factor fmsla, -2, which is determined by the secondary air diagnosis can be included in the calculation. From the secondary air mass msl finally the secondary air dilution factor flamsl is calculated for the mixture control. The purging of the secondary air is described by the factor fslsoff after the secondary air valve has closed. The end is indicated by B_slsoff dependent on the necessary intake air mass IMLSLSE. At opening and closing of the secondary air valve, the dynamic of the secondary air mass flow is described by the factor fmsldyn with the time constants ZKSLON, ZKLOFF, after the integral air mass IMLSLA, IMLSLE is sucked through the engine. The purge of the secondary air after closing the valve is indicated by B_slsoff.

Calculation of the enrichment due to secondary air:
Dependent on bit 3 of the code word CWSLS it is established whether the default selection for engine Lambda during secondary air injection shall take place by the characteristic map KFLMSKH (see %LAKH) (flmssl = 0) or whether an automatic calculation of the necessary Lambda engine, by taking into consideration the secondary air dilution factor flamsl, shall take place by means of the default selection of Lambda exhaust gas including secondary air (flmssl = 1) in KFLASKH from %LAKH. On concepts with Lambda exhaust gas default selection the transition to Lambda engine can be realized by a filter with the time constant ZFLMSSL, after a debounced exiting of the idling (dependent on bit 4) or after shifting into gear (bit 5).

Secondary air adaptation/short trip:
The secondary air adaptation is requested by B_dslfa from the secondary air diagnosis and it switches the secondary air on for the time TDDSLA (B_sldsl4). In combination with the default selection for Lambda catalyst heating the secondary air mass adaptation resp. the diagnosis in the diagnosis phases 4, 5 is then performed (also see description of the secondary air diagnosis in DSLSLR or DLSLRS).

The short trip is requested by B_fa and B_fasls if tmot > TMFASLMN and it switches the secondary air on for the time TDSLKT (B_slkt), after the readiness of the diagnosis is announced by the flag B_dslfa. Additionally idling speed and torque margins can be preset, in order to adjust an engine operation point capable of diagnosis. This is especially necessary in combination with the diagnosis DSLSLR for the two-level Lambda control, so that the engine with Lambda = 1-control during the secondary air is not operated at the rich running limit. By the code word CWFASL, bit 0 it is possible to activate the abort criterions B_brems, B_kuppl, B_fs, speed threshold for the abort of the quicktest.

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APP SLS 91.20 Application hint

Suggestion for the initial parameterization:

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Overview of the variation coding by CWSLS:
Bit 0:  0: Secondary air with B_kh                      1: Secondary air already during start in the tmot-window
Bit 1:  0: Secondary air with B_kh                      1: Secondary air only as from road speed >= threshold
Bit 2:  0: free                                         1:
Bit 3:  0: Default selection Lambda engine              1: Default selection Lambda exhaust gas (= secondary air enrichment)
Bit 4:  0: Lambda def. select. the same in LL/TL        1: Transition to Lambda engine during partial load
Bit 5:  0: Lambda def.sel. the same w/w.out drive       1: Transition to Lambda engine when in gear
Bit 6:  0: without secondary air adaptation             1: with secondary air adaptation
Bit 7:  0: KFLASKH def. selection with B_atmtpl         1: KFLASKH def. selection without B_atmtpl, Attention: set only for
                                                           application phase!!

Secondary air concept with thermal reactor in the exhaust manifold:
CWSLS.0 = true   second. air already during start causes a quick start of the second. reaction in the FTP-tmst range.
                 Att.: stress of electrical system!!
CWSLS.3 = true   def. select. Lambda exhaust gas -> automatic calculation of Lambda engine from secondary air dilution flamsl_w
CWSLS.4 = true   transition to Lambda engine when idling is exited, since secondary reaction stops anyhow
CWSLS.5 = true   transition to Lambda engine when shifting into gear, since  "
CWSLS.6 = false  no secondary air adaptation
CWSLS.7 = false  default selection KFLASKH only with B_atmtpl = true

Secondary air concept with secondary reaction in the catalyst:
CWSLS.0 = false no secondary air during start
CWSLS.1 = true/false dependent on the beginning of a partial light-off in the catalyst (catalyst position)
CWSLS.3 = false default selection Lambda engine during secondary air
CWSLS.6 = false no secondary air adaptation

Partial picture SLS:
IMLSLMN  0       secondary air at the same time as B_kh
IMLSLMX  0.9961  secondary air during entire catalyst heating
TMSSLSTU 15deg.C secondary air as from tmst > 15 deg. C already during start with CWSLS.0 = true
TMSSLSTO 35deg.C secondary air until tmst < 35 deg C "
TMSSLU   15 "    secondary air with B_kh for tmst > 15 deg. C
TMSSLO   35 "    secondary air with B_kh for tmst < 35 deg. C
TASLSU   15 "    secondary air with B_kh for tans > 15 deg. C
TASLSO   35 "    secondary air with B_kh for tans < 35 deg. C
VSLS     10 km/h secondary air only for vfzg > 10 km/h with CWSLS.1 = true
MLSLMX   200kg/h abort threshold for ml > 200 kg/h
DPSLV    0 hPa   abort threshold of differential pressure for opening of secondary air valve
UBSLMN   9 V     minimum battery voltage for sufficient secondary air mass
TSLABB   1 sec   debouncing time for stop of secondary air after engine start (B_stend)
UBSLMX   16V     fan protection in case of booster start
TSLPMN   500 ms  minimum hold time of the SLP relay for protection of relay
TVSLVON  0.1 sec SLV opens at the same time as SLP-start
TVSLVOFF 0 sec   SLV closes at the same time as SLP-stop
TVDSLOFF 2 s     SLV closes 2 s after quicktrip/adaptation
UBSLSTMN 8 V     B_sls during start for ub > 8 V
TSLUBST  2 s     debouncing ub during start

Partial picture BMSL:
MSLUB = f(ub)   from laboratory measurements of the fan with 100 mbar back-pressure, checking in the vehicle necessary!
KFFMSML = f(nmot,rl)
FMSRHOL         everywhere factor = 1, at first no density correction
FMSTMOT = f(tmot) everywhere = 1, at first no correction
FMSL,-2 1       no single-bank correction

Partial picture BSLPDYN:
ZKSLPON  1 s    starting of SAI-pump
ZKSLPOFF 1 s    stopping of SAI-pump

Partial picture BSLSOFF:
IMLSLSA  3,5 g
IMLSLSE  3   g  air mass to be put through for the purging of the secondary air
ZKSLSON  0,5 s
ZKSLSOFF 0,5 s

Partial picture BFMLSSL:
TLMSSLMX 60 s   abort of the thermal reaction (default selection Lambda exhaust gas) after 60 s during LL
TLMSSLAB 1 s    debouncing of the detection "exit LL"
ZFLMSSL  1 s    time constant for transition Lambda exhaust gas -> Lambda engine

Partial picture BKT:
CWFASL 0
TMFASLMN 60 deg. C
TDDSLA   25 s
TDSLKT   10 s
```

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BGUBF 1.10 Calculated variable: ub filtered

FDEF BGUBF 1.10 Function definition

bgubf-bgubf

bgubf-bgubf

The function calculates the filtered value of the battery voltage.

ABK BGUBF 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ZKFUB			FW	time constant for filtering the battery voltage

Variable	Source	Type	Description
C_INI		EIN	ECU-condition for intialisation
UB	GGUB	EIN	battery voltage
UBF	BGUBF	AUS	filtered battery voltage for charge control

FB BGUBF 1.10 Detailed description of function

APP BGUBF 1.10 Application hint

ZKFUB = 2s

BBKHZ 17.60 Control of catalyst heating

FDEF BBKHZ 17.60 Function definition

bbkhz-bbkhz

BFLAKH: calculation lambda feed forward

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bbkhz-bflakh

BNKH: calculation of idle speed at catalyst heating, catalyst warming

bbkhz-bnkh

ABK BBKHZ 17.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
BTRKHTMS	TMST		KL	Characteristic enabling flag B_trkh
CWKHZ			FW	code word for catalyzer heating control
DTKATMN			FW	Hysteresis catalyst temperature control threshold for catalyst warming
DTKH			FW	absolute value difference (tans -tmst) for catalyst heating
DTMABKH			FW	Temperature difference of engine stall and restart for activating cat. heating
FHOKH			FW	minimum altitude threshold to enable catalyst heating
FKHABMN			FW	threshold terminating factor catalyst heating
FKHLA	IMLPR_W		KL	Weighting factor Lambda nominal for catalyzer heating
FKHLA2	IMLPR_W		KL	Weighting factor Lambda nominal for cars without catalyst
FKHMD	IMLPR		KL	Weighting factor torque reserve for catalyzer heating
FTMLAKH	TMOT		KL	tmot-correction of lambda-weighting at catalyst heating
IMLKHMX			FW	Max. ration factor psum_w/mlsu for switch-on catalyst heating
IMLKHTMS	TMST		KL	imlpr-threshold, changing to lambda catalyst heating
KTNDMRKH			FW	Int.-constant for request of torque reserve catalyst heating
MLKHMX			FW	max. air flow for catalyst heating

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Parameter	Source-X	Source-Y	Type	Description
MLSUS	TMST		KL	reference of air mass flow integral
MLSUS2	TMST		KL	reference of air mass flow integral for cars without catalyst
NFSKHM	TMOT		KL	LL nominal speed with driving graduations and catalyzer heating
NFSKHM2	TMOT		KL	LL nominal speed with driving graduations for cars without catalyst
NLLKHM	TMOT		KL	Nominal idling speed during catalyzer heating
NLLKHM2	TMOT		KL	Nominal idling speed for cars without catalyst
NLLKT			FW	Nominal idle speed at short test of SAI-system
TABSTKH			FW	Minimum soak time for release of catalyst heating
TKATMN			FW	Catalyst temperature control threshold for catalyst warming
TKATW			FW	Catalyst temperature threshold for catalyst warming
TKHABB			FW	delay time switching off catalyst heating
TKHFSAB			FW	delay time switching to idle speed at drive at catalyst heating
TKHLL			FW	cancelling time catalyst heating idle speed
TKHLLAB			FW	delay time switching off increased idle speed at catalyst heating
TKHLLMX			FW	Maximum time for increased catalyst heating idle speed
TKHLLMX2			FW	Maximum time for increased catalyst heating idle speed
TKHMX			FW	maximum time for active catalyst heating
TMSLOF			FW	threshold of engine temperature for disabled secondary air
TNSDMRKH			FW	Time after start for torque reserve catalyst heating
ZKHABB			FW	Time constant for abort low-pass catalyzer heating
ZKLAMKH			FW	time constant lambda engine nominal at catalyst heating
ZKLAMKH2			FW	time constant lambda engine nominal for cars without catalyst

Variable	Source	Type	Description
B_DSLA	DSLSLR	EIN	adaption phase: calculation of secondary air mass
B_FA		EIN	condition general function request
B_FASLA	SLS	EIN	Condition: external request of SAI system aktiv
B_FS	CANEGS	EIN	Condition driving state (automatic gear box)
B_HAG	GGDSAS	EIN	condition altitude adaptation valid
B_IMLPRINI	BBKHZ	LOK	Initialisation imlpr/imlpr_w
B_KATFZ	PROKON	EIN	condition: cat fitted in vehicle
B_KH	BBKHZ	AUS	condition catalyst heating activated
B_KHA	BBKHZ	AUS	request of activated catalyst heating
B_KHAB	BBKHZ	AUS	condition catalyst heating terminating
B_KHARES	BBKHZ	LOK	condition reset bit B_kha
B_KHASET	BBKHZ	LOK	condition set bit B_kha
B_KHERR	BBKHZ	LOK	error caused disable condition for bit B_kh
B_KHLL	BBKHZ	LOK	condition catalyst heating idle speed (cancelling condition)
B_KHLLE	BBKHZ	LOK	condition idle at cactalyst heating quitted
B_KHLLMX	BBKHZ	LOK	condition max. catalyst heating time reached
B_KHN	BBKHZ	LOK	condition catalyst heating idle speed
B_KHRES	BBKHZ	LOK	condition reset bit B_kh
B_KHSET	BBKHZ	LOK	condition set bit B_kh
B_KHSTC	BBKHZ	LOK	Release of catalyst heating condition depending on temperature or soak time
B_KW	BBKHZ	AUS	Condition catalyst warming
B_LL	MSF	EIN	Condition idle
B_LMSSLOF	SLS	EIN	condition lambda engine by secondary air, off
B_MLSU	BBKHZ	LOK	condition mlsu not greater 0
B_MSLOFF	SLS	EIN	Condition secondary air mass flow removed after switch off
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_NOKATFZ	KATV	EIN	condition: no cat vehicle
B_SLKHOF	SLS	EIN	condition shut down secondary air pump caused by imlpr threshold
B_SLPOFF	SLS	EIN	Condition secondary air pump switched of
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_TRKH	BBKHZ	AUS	Flag for catalyst fast heating
B_WST	ESSTT	EIN	condition for re-start
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
E_LM	DHFM	EIN	Error flag: main load sensor
E_TA	GGTFA	EIN	error flag: TANS
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
FHO_W	GGDSAS	EIN	correction factor: altitude
FKHAB	BBKHZ	AUS	terminating factor catalyst heating
FLAKH	BBKHZ	AUS	Factor control lambda at catalyst heating
FLAMKH	BBKHZ	AUS	factor setting up lambda engine nominal at catalyst heating
FMDKH	BBKHZ	AUS	Weighting factor torque reserve for catalyst heating
FMDKHTNS	BBKHZ	DOK	Time control torque reserve for catalyst heating after start
IMLATM_W	ATM	EIN	integrated air mass flow from engine start to max. value (word)
IMLPR	BBKHZ	AUS	relative amount of integrated air mass flow at catalyst heating
IMLPR_W	BBKHZ	AUS	relative amount of integrated air mass at catalyst heating (word)
ML	BGSRM	EIN	air mass flow
MLSU	BBKHZ	LOK	nominal air mass for catalyst heating
NFSKH	BBKHZ	AUS	Idling speed driving level for catalyzer heating
NLLKH	BBKHZ	AUS	Idling speed for catalyzer heating
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
TABST_W	BGTABST	EIN	soak time
TANS	GGTFA	EIN	Intake air temperature
TKATM	ATM	EIN	catalyst temperature (model)

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Variable	Source	Type	Description
TMOT	GGTFM	EIN	Engine temperature
TMOTAB	GGTFM	EIN	engine coolant temperature at engine stop or cut-off cranking
TMST	GGTFM	EIN	engine temperature at start
TNST		EIN	time after end of start
TNST_W	BBSTT	EIN	time after end of start

FB BBKHZ 17.60 Detailed description of function

Die Katheizfunktion koordiniert die Eingriffe:

* KHMD:Drehmomentenreserve zur gezielten Erhöhung der Abgastemperatur durch Spätzündung,
* LAKH, LAMKO: Gemischsteuerung,
* Leerlauf-Soll-Drehzahl und
* SLS: Sekundärlufteinblasung

zur beschleunigten Aufheizung des Katalysators nach Start des Motors.

Ein-, Ausschaltbedingung:
Die Katheizfunktion wird nur bei Bedingung B_katfz = 1 aus %Prokon freigegeben und durch Vorgabe der Soll-Ansaugluftmasse mlsu > 0 abhängig von der Startmotortemperatur tmst ab Startende aktiviert (B_kh = 1). Die Ansaugluftmasse beschreibt hierbei die zur Katalysatorerwärmung notwendige Wärmemenge im Abgasstrang.
Die Steuerung erfolgt durch den prozentualen Heizfortschritt imlpr durch Bezug der ab Startende (B_stend) durchgesetzten Luftmasse imlatm_w auf die Soll-Luftmasse mlsu.
Zusätzlich muß die Ansaugluftemperatur tans wegen (tmst - tans) < DTKH in der Nähe der Startmotortemperatur liegen.
Die notwendige Wärmemenge zur Katalysatorerwärmung ist aufgebracht, wenn die Solluftmasse durch den Motor durchgesetzt wurde und imlpr = 0.9999 erreicht ist.
Im Wiederholstartfall (B_wst =1) bei einer Startmotortemperatur tmst < TMLOF wird Katheizen gesperrt, um kein unerwünschtes Einschalten des eventuell noch eingefrorenen Sekundärluftsystems zu bewirken.

Drehmomentenreserve:
Abhängig von imlpr wird die Drehmomentenreserve durch fmdkh aus der Kennlinie FKHMD bewertet. Die Aufsteuerung erfolgt von 0 auf 0.9961 abhängig von imlpr. Durch eine verzögerte Aufsteuerung der Drehmomentenreserve nach Startende durch eine geeignete Festlegung der imlpr-Stützstellen und des Bewertungsfaktors ist ggf. sicherzustellen, daß ein ausreichender Unterdruckaufbau des Unterdrucksystems, Bremskraftverstärkers erfolgt. Die Absteuerung erfolgt durch die Bewertung mit 0 an der Stützstelle imlpr = 0.9999.

Gemischsteuerung:
Die Gemischsteuerung erfolgt durch den Bewertungsfaktor flakh aus der Kennlinie FLAKH durch Aufsteuerung von 0 -> 0.9961 und Absteuerung zu 0 abhängig von imlpr, analog zur Drehmomentenreserve. Zusätzlich kann das Lambda- Katheizgewicht flakh tmot-abhängig durch FTMLAKH bewertet werden. Die gefilterte Aufsteuerung von lamkh erfolgt dann in der Lambda-Koordination %LAMKO durch flamkh mit der Zeitkonstanten ZKLAMKH, um eine Ankoppelung an die Nachstartgemischsteuerung zu erzielen. Ein Katheizabbruch führt zur Lambda-Nachstart-Warmlauf-Vorgabe lamnswl zurück.
Zur Sekundärluftdiagnose kann durch B_dsla = 1 der Gemischeingriff erneut angefordert werden.

Leerlauf-Soll-Drehzahl:
Die Leerlauf-Soll-Drehzahl erfolgt durch Vorgabe in der tmot-abhängigen Kennlinie NLLKHM und NFSKHM bei eingelegter Fahrstufe bei Automatikgetrieben. Aus Komfortgründen wird durch Einlegen der Fahrstufe unumkehrbar auf die Vorgabe aus NFSKHM umgeschaltet. Zusätzlich kann durch das Codewort CWKHZ, Bit 0 die erhöhte Katheizdrehzahl nach Anfahren und Überschreiten der Zeit TKHLLMX beendet werden.

Sekundärluftsteuerung:
Die Sekundärluftsteuerung erfolgt durch Auswertung von imlpr in der separaten Sekundärluftsteuerung. Durch das Bit B_kha kann die Sekundärluft, abhängig vom Bordnetz, bereits im Start aktiviert werden, wie in der Sekundärluftsteuerung beschrieben ist. Ein Sekundärluftabbruch B_slpoff = 1 führt auch zu einem Katheizabbruch.

Katheizabbruch:
Katheizabbruch (B_khab = 1) erfolgt durch entprelltes Überschreiten der max. Ansaugluftmasse MLKHMX, bei Fehler des Hauptlastsignals E_lm, bei Fehler Motor-, Ansaugluftemperatursensor E_tm, E_ta oder falls die zulässige Katheizdauer TKHMX überschritten ist. (Bei Sekundärluftsystemen entspricht dies der zulässigen Einschaltdauer der Sekundärluftpumpe.) Die Abbruch-bedingung B_slpoff =1 aus %SLS bricht Katheizen ebenfalls ab (optional: abhängig von CWKHZ.6). Bei Katheizabbruch wird der prozentuale Heizfortschritt imlpr eingefroren. Die Katheizeingriffe werden durch den Abregelfaktor fkhab mit der Zeitkonstanten ZKHABB abgeregelt. Bei Erreichen der Schwelle FKHABMN wird die Katheizfunktion beendet (B_kh = 0). Bei ununterbrochenem Leerlauf seit Motorstart wird nach Erreichen der Zeit TKHLL ebenfalls das Katheizen beendet.

Kat warmhalten:
Bei warmem Katalysator kann, abhängig von der Katalysatortemperatur tkatm nach einmaligem Überschreiten der Temperaturschwelle TKATW der Modus "Kat warmhalten, temporär" (B_kw = 1) appliziert werden. Hierzu wird zwischen TKATMN und TKATMN + DTKATMN die Solldrehzahl nllkh aus NLLKHM auch bei höheren Motortemperaturen angehoben. Die Drehzahlanhebung bei eingelegter Fahrstufe nfskh wird durch die Kennlinie NFSKHM vorgegeben. (Achtung: Bei Fahrzeugen mit Automatikgetrieben ist die Drehzahlerhöhung in NFSKHM vorsichtig zu applizieren, um kein unbeabsichtigtes Wegrollen des Fahrzeugs z.B. bei unzureichender Betätigung der Feststellbremse zu bewirken.) Zusätzlich kann zur Erhöhung der Verlustleistung im Abgasstrang eine eigene Drehmomentenreserve aus KFKWTMP akti-viert werden.

Sekundärluftadaption/Kurztrip:
Durch B_dsla aus der Sekundärluftdiagnose oder B_fasla aus %SLS wird die Sekundärluftadaptionsphase bzw. der Kurztest angefordert. In der Lambdavorgabe BFLAKH wird dann der Bewertungsfaktor flamkh auf 1, d.h. Lambda-Katheizvorgabe lamkh in %LAKH geschaltet. Durch B_fasla aus der Testeranfordeung wird zusätzlich die Drehzahlvorgabe NLLKT geschaltet.

Notiz:
Das Bit B_khlle wird auch außerhalb Katheizen generiert, hat aber nur während Katheizen (B_kh = 1) Bedeutung.

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APP BBKHZ 17.60 Application hint

```
Voraussetzungen:        Applikation Gemischkontrolle(%GK), Drehmomentenkoordination(%MDUE)

Vorschlag zur Vorbelegung:
BBKHZ*****************************************************************************************
MLSUS:  2 .. 5 kg im gewünschten Startmotortemperaturbereich, =0 kg zum Ausschalten Katheizung
DTKH:   10 grd C
MLKHMX: 200 kg/h
TKHABB: 1 s, Entprellzeit für Katheizabbruch
TKHLL:  120 s, maximale Katheizdauer bei ununterbrochenem Leerlauf ab Motorstart
TKHMX:  180 s, z.B. zulässige max. Einschaltdauer der Sekundärluftpumpe
TKHMW:  255 s, LL-Drehzahlabsenkung nach 255 s
ZKHABB: 2 s
FKHABMN: 0,2
FKHMD: von 0 nach 0.9961 nach 0 abhängig von 0, stetige Abregelung nahe imlpr = 0.9961
(Die Stützstellenverteilung von imlpr ist so zu wählen, daß eine stetige Abregelung auf 0 erreicht wird.)
TMSLOF: -10 grdC
FHOKH: 0.8
BFLAKH****************************************************************************************
FKHLA: analog zu FKHMD
FTMLAKH: 0.9961, zunächst keine tmot-Abhängigkeit, da Katheizdauer =f(tmst) in MLSUS
IMLKHTMS: 0, Übergang auf lamkh bereits ab B_stend
ZKLAMKH: 0,01 s, schneller Übergang auf imlpr_w- Steuerung
BNKH******************************************************************************************
TKATW:  1000 grd C, kein Modus Kat warmhalten
TKATMN: 300 grd C,
DTKATMN: 100 K
TKHFSAB: 0,3 s, Entprellung für Einlegen der Fahrstufe
TKHLLAB: 1 s, Entprellzeit für Verlassen Leerlauf
NLLKHM: 1200 1/min bei tmot 20 ... 40 grd C, normale Solldrehzahl bei warmem Motor
NFSKHM:  800 1/min      "                  , normale Solldrehzahl bei warmem Motor
BTRKHTMS: = 0, -> verringerte Sondenheizleistung bei geringfügigen Katheizmaßnahmen,
          > 0 -> maximale Sondenheizleistung nur in Verbindung mit intensiven Katheizmaßnahmem (Thermoreaktor)
 CWKHZ: 0, keine Drehzahlabsenkung nach Zeit TKHLLMX, B_trkh wird bei Störung resetiert
 Achtung: Bit 7 nur für Applikationszwecke setzen!
          Bit 7 setzt B_trkh hart -> keine Verringerung der Sondenheizleistung -> Gefährdung der Sonde möglich.
KT*******************************************************************************************
TDDSLA: 10s
TDSLKT: 5s
```

BGMSABG 2.10 Calculation of exhaust emission mass flow - bank-dependent

FDEF BGMSABG 2.10 Function definition

Provision for exhaust emission flow quantity:

In the basic version, the air mass ml is distributed throughout the active exhaust emission banks.

ABK BGMSABG 2.10 Abbreviations

Variable	Source	Type	Description
ML	BGSRM	EIN	air mass flow
MLBB	BGMSABG	AUS	air mass flow filtered (Byte), bank1 related
MLBB2	BGMSABG	AUS	air mass flow filtered (Byte), bank2 related
MLBB2_W	BGMSABG	AUS	air mass flow filtered (Word), bank2 related
MLBB_W	BGMSABG	AUS	air mass flow filtered (Word), Bank1 related

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Variable	Source	Type	Description
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSABG	BGMSABG	AUS	exhaust gas mass flow filtered, bank 1
MSABG2	BGMSABG	AUS	exhaust gas mass flow filtered, bank 2
MSABG2_W	BGMSABG	AUS	exhaust gas mass flow filtered (Word), bank 2
MSABG_W	BGMSABG	AUS	exhaust gas mass flow filtered (Word), bank 1
MSL	SLS	EIN	secondary air mass flow
MSL2	SLS	EIN	secondary air mass, bank 2

FB BGMSABG 2.10 Detailed description of function

APP BGMSABG 2.10 Application hint

KHMD 2.20 Calculation of torque reserve for heating catalytic converter

FDEF KHMD 2.20 Function definition

khmd-khmd

ABK KHMD 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWKHMD			FW	code word for torque reserve in catalyzer heating
FMDKHFH	FHO_W		KL	altitude correction of torque reserve for catalyst heating
FMDKHFH2	FHO_W		KL	altitude correction of torque reserve witout catalyst
FMDKHTM	TMOT		KL	tmot-correction of torque reserve for catalyst heating
FMDKHTM2	TMOT		KL	tmot-correction of torque reserve
KFKWTMP	NMOT_W	MIFAKH_W	KF	Characteristic torque reserve for keeping catalyst warm, temporary
KFMDDSLA	NMOT_W	MIFAKH_W	KF	Map torque reserve at tester demand of SAI-diagnosis short test
KFMDKH	NMOT_W	MIFAKH_W	KF	Characteristic torque reserve for catalyst heating
KFMDKH2	NMOT_W	MIFAKH_W	KF	characteristic torque reserve without catalyst

Variable	Source	Type	Description
B_FASLA	SLS	EIN	Condition: external request of SAI system aktiv
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KW	BBKHZ	EIN	Condition catalyst warming
B_NOKATFZ	KATV	EIN	condition: no cat vehicle
DMLLRI_W	LLRRM	EIN	desired torque change from the idle speed control (I-)
DMRDSLS_W	KHMD	AUS	Torque reserve for SAI- diagnosis
DMRKH	KHMD	AUS	torque reserve for catalyzer heating
DMRKHZ_W	KHMD	LOK	Torque reserve for catalyst heating
DMRKH_W	KHMD	AUS	Torque reserve for catalyst heating
DRKWTMP_W	KHMD	LOK	Torque for keeping catalyst warm, temporary
FHO_W	GGDSAS	EIN	correction factor: altitude
FMDKH	BBKHZ	EIN	Weighting factor torque reserve for catalyst heating
FMKHFHO_W	KHMD	LOK	Altitude correction of torque reserve at catalyst heating
FMKHTM	KHMD	LOK	tmot-correction of torque reserve at catalyst heating
MIFAKH_W	KHMD	LOK	desired indicated engine torque at catalyst heating

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Variable	Source	Type	Description
MIFA_W	MDFAW	EIN	desired indicated engine torque
NMOT_W	BGNMOT	EIN	engine speed
TMOT	GGTFM	EIN	Engine temperature

FB KHMD 2.20 Detailed description of function

So as to heat up the catalyst quicker resp. to keep it warm, the engine performance is deliberately reduced and thus the exhaust gas temperature is increased.
For this the torque margin dmrkh is included in the function %MDKOL, which causes the charge to be increased and the ignition angle to be retarded.

A distinction is made between "catalyst heating" dmrkhz and "keeping catalyst warm, temporary" drkwtmp:

Catalyst heating:
The torque margin dmrkhz only has an effect while catalyst heating (B_kh = 1) is active. The control is performed from %BBKHZ by fmdkh. In order to ensure the performance at altitudes and the build-up of a vacuum for the break the torque margin can be evaluated altitude-dependent (FMDKHFH). The build-up of a vacuum during the start of the engine is to be ensured by an increasing control of fmdkh 0 -> 1 in %BBKHZ. So as to enlarge the catalyst heating range a tmot-dependent evaluation of the torque margin is possible.

Keeping the catalyst warm:
A temporary "keeping catalyst warm, temporary" (B_kw) can be realized by the temporary torque margin drkwtmp from the characteristic map KFKWTMP dependent on the catalyst temperature tkatm from %ATM.

The resulting torque margin dmrkh_w is obtained by a max-selection from dmrkhz_w and drkwtmp.

By the code word CWKHMD, bit 0 it is possible to optionally deactivate the idle intervention dmllri_w in the addressing of the torque margin by mifakh_w = (mifa_w - dmrllri_w), e.g. with steep gradients within KFMDKH in the idle region.

Quick-trip for the secondary air diagnosis:
By an input selection of the torque margin KFMDDSLA in case of tester intervention (B_fasla) it is possible to adjust the desired intake air mass for the secondary air diagnosis. (Also see %SLS.) From the map KFMDDSLA the necessary torque margin dmrdsls_w is passed on to %MDTRIP for this.

Vehicles with and without catalyst are distinguished by means of B_nokatfz.

APP KHMD 2.20 Application hint

Preconditions: Application torque margin coordination (%MDUE)
Suggestion for presetting:

KFMDKH: Base point distribution for intended catalyst heating operating range, decreasing control of the torque margin with increasing driver’s request mifa, in order to start from rest most efficiently.
Preset with 0, application of the torque margin e.g. from the necessary power loss for catalyst heating.

FMDKHFH: Altitude-dependent evaluation of the torque margin, preset with 1.0

FMDKHTM: tmot- dependent evaluation of the torque margin, preset with 1.0

KFKWTMP: Base point distribution for idle and operating ranges close to idle, in which the catalyst cools down when being in these ranges for longer. Preset with 0.

KFMDDSLA: Base point distribution for secondary air diagnosis in case of tester intervention. Preset with 0.

CWKHMD: 0

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DSLSLR 2.30 Diagnosis secondary air system with two-step Lambda control

FDEF DSLSLR 2.30 Function definition

DSLSLR : Gesamtübersicht

dslslr-dslslr

BBDSLSLR: Betriebsbedingungen der Diagnose

dslslr-bbdslslr

dslslr-bbdslslr

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DSLSERR: Sammel-Bit sperrende Fehler

dslslr-dslserr

BDSLS: Diagnosefreigabe

dslslr-bdsls

LROFF: Bildung internes SLS-Fehler-Bit aus Ventilundichtheit

dslslr-lroff

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MEASURE: Freigabe Meßfenster

dslslr-measure

PHASES: Übersicht der Diagnosephasen

dslslr-phases

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PHASE1: Sekundärluftmasse

dslslr-phase1

PHASE2: Sekundärluftventildichtheit

dslslr-phase2

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PHASE3: Offset Sekundärluftmasse

dslslr-phase3

BSLA: Bedarfsanforderung der Adaption

dslslr-bsla

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ADAPTION: Sekundärluftmassenadaption bei Lambda Abgas = 1

dslslr-adaption

DSLSB1: Messung Sekundärluft und Bewertung, Bank 1

dslslr-dslsb1

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MMSL: Messung Sekundärluft

dslslr-mmsl

MFMSL: Berechnung relative Sekundärluftmasse

dslslr-mfmsl

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ESLS: Bewertung und Schnittstelle zur Fehlerspeicherverwaltung

dslslr-esls

BBASLA: Anforderung Sekundärluft-Adaption

dslslr-bbasla

FASLA_STAT: Bildung Funktionsstatus bei System-Kurztest Anforderung über Tester

dslslr-fasla-stat

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AMOD6: Schnittstelle Mode 6

dslslr-amod6

DSLSB2: Messung Sekundärluft und Bewertung, Bank 2

dslslr-dslsb2

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Fehlerspeicherverwaltung:

	Bank 1	Bank 2	Bank 1	Bank 2
Status Fehlerpfad:	sfpsls	sfpsls2	sfpslv	sfpslv2
Errorflag:	E_sls	E_sls2	E_slv	E_slv2
Zyklusflag:	Z_sls	Z_sls2	Z_slv	Z_slv2
Fehlerart:	B_mnsls	B_mnsls2	- - -	- - -
	- - -	- - -	B_mxslv	B_mxslv2
	- - -	- - -	- - -	- - -
Löschen Fehlerpfad:	C_fcmclr & B_clsls	C_fcmclr & B_clsls2	C_fcmclr & B_clslv	C_fcmclr & B_clslv2
Fehlerpfadcode:	CDTSLS	CDTSLS2	CDTSLV	CDTSLV2
Fehlerklasse:	CLASLS	CLASLS2	CLASLV	CLASLV2
Fehlerschwere:	TSFSLS	TSFSLS2	TSFSLV	TSFSLV2
CARB Code:	CDCSLS	CDCSLS2	CDCSLV	CDCSLV2
Tabelle Umweltbedingungen:	FFTSLS	FFTSLS2	FFTSLV	FFTSLV2

ABK DSLSLR 2.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCSLS	BLOKNR		KL	code word CARB: secondary air system
CDCSLS2	BLOKNR		KL	code word CARB: secondary air system
CDCSLV	BLOKNR		KL	code word CARB: sec. air valve
CDCSLV2	BLOKNR		KL	Code word CARB: Secondary Air Injection Valve bank 2
CDTSLS			FW	Code word tester: Secondary air system
CDTSLS2			FW	Code word tester: Secondary air system, bank 2
CDTSLV			FW	code word tester: secondary air valve
CDTSLV2			FW	code word tester: secondary air valve, bank 2
CLASLS			FW	error class: Secondary air system
CLASLS2			FW	error class: secondary air system
CLASLV			FW	error class: secondary air valve
CLASLV2			FW	error class: secondary air injection valve bank 2
CWDSLSY			FW	code word in diagnostics of secondary-air system
FFTSLS	BLOKNR		KL	Freeze frame table: Secondary air system
FFTSLS2	BLOKNR		KL	freeze frame table: secondary air system
FFTSLV	BLOKNR		KL	Freeze frame table: secondary air valve
FFTSLV2	BLOKNR		KL	Freeze Frame table: secondary air injection valve bank 2
FHODSL			FW	minimum altitude threshold to enable DSLS
FMSLAMN			FW	min. adaptation factor of SAI- mass flow
FMSLAMX			FW	max. adaptation factor of SAI- mass flow
IMLATDSL			FW	min. amount of air flow for adaptation/additional diagnosis
IMLATDSLK			FW	min. amount of air flow for short diagnosis
IMLDSL			FW	Minimum flow of air mass
IMSLADAP			FW	Threshold air-mass integral for repeated adaptation
MLDSLAMN			FW	min. air mass flow for condition adapation/add. diagnosis
MLDSLAMX			FW	max. air mass flow for condition adaptation/add. diagnosis
MLDSLKMN			FW	Min. air mass for condition diagnosis short test
MLDSLKMX			FW	Max. air mass for condition diagnosis short test
MLDSLMN			FW	Min. air mass for condition diagnostic function
MLDSLMX			FW	Max. air mass for condition diagnostic function
MSLBAS			FW	Ini.- secondary air mass
MSLOFMX			FW	Diagnostic threshold for test of offset value auxiliary air mass
MSLVMX			FW	Diagnostic threshold for valve tightness testing
MSLVMX2			FW	Diagnostic threshold for valve tightness testing, Bank 2
RMSLADA			FW	Diagnoseis threshold for adaptation
RMSLMN			FW	Diagnostic threshold: reduce SAI- mass flow
RMSLMN2			FW	Diagnostic threshold: reduced SAI- mass flow, bank 2
RMSLPMN			FW	Diagnostic threshold: error SAI- pump, only pulse air
RMSLSUMN			FW	Diagnostic threshold: reduce SAI- mass flow; summary value
RMSLTMN			FW	Threshold: hardly reduced SAI- mass flow without offset correction
TABGMSLAD			FW	Exhaust-gas temperature threshold for triggering adaptation
TANDSLMN			FW	min. air temperature for SAI- diagnostics
TANDSLMX			FW	min. air temperature for SAI- diagnostics
TC6CSL			FW	mode 6 code word ID for check secondary air system
TC6CSL2			FW	mode 6 code word ID for secondary air check, bank 2
TC6CSLN			FW	mode 6 code word ID for check min. SAI-flow
TC6CSLN2			FW	mode 6 code word ID for check min. SAI-flow, bank 2
TC6CSLV			FW	mode 6 code word ID for tightness check of SAI-valve
TC6CSLV2			FW	mode 6 code word ID for tightness check of SAI-valve, bank 2
TDMSLMN1			FW	Minimal time for secondary air mass measurement, phase 1
TDMSLMN4			FW	Minimal time for secondary air mass measurement, phase 4
TDMSLMNK			FW	min. required time of SAI- measure of phase 1 at short trip
TDMSLO			FW	min. measuring time for calculation including SAI-mass-offset
TDMSLOF3			FW	Measuring time offset secondary air mass, phase 3
TDMSLOF5			FW	Measuring time offset secondary air mass, phase 5
TDMSLOFK			FW	Measure time SAI- offset of phase 3 at short trip
TDMSLOK			FW	min. measuring time for calculation including SAI-mass-offset at short test
TDMSLV			FW	Measuring time for valve tightness testing
TDMSLVK			FW	Measure time of SAI- valve tightness at short trip
TDSLMVBA			FW	Switch on delay of BA-/VA-lock at calculation of B_dslmes

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Parameter	Source-X	Source-Y	Type	Description
TFIMSLI			FW	Time constant of msli- and msln- filter
TFIMSLIK			FW	Time constant of msli- and msln- filter at short trip
TFIMSLO			FW	Time constant of mslo- filter
TFIMSLOK			FW	Time constant of mslo- filter at short test
TFIMSLV			FW	Time constant of mslv- filter
TFIMSLVK			FW	Time constant of mslv- filter at short trip
TKATDSL			FW	max. catalyst temperature for enable SAI- diagnosis
TMDSLAMN			FW	min. engine temperature for additional diagnosis
TMDSLMN			FW	min. engine temperature for DSLS
TMDSLMX			FW	max. engine temperature for DSLS
TNOMF2			FW	allowable time outside measuring window, phase 2
TNOMF3			FW	allowable time outside measuring window, phase 3
TNOMF5			FW	allowable time outside measuring window, phase 5
TSFSLS			FW	fault active time: secondary air system
TSFSLS2			FW	fault active time: secundary air system, bank 2
TSFSLV			FW	fault active time: secondary air valve
TSFSLV2			FW	Fault active time: secondary air injection valve bank 2
TWHLSLP			FW	Delay time switching on SAI- pump
TWMLFE			FW	Min. time for ml inside diagnosis area
TWMSLMIN			FW	Debouncing time for error reporting B_mslmin

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_ASLA	DSLSLR	LOK	Demand seondary air adaption bank 1
B_ASLA2	DSLSLR	LOK	Demand secondary air adaption bank 2
B_BAG	ESUK	EIN	Condition large accel. enrichment
B_CDSLS	PROKON	EIN	function active per codeword CDSLS
B_CLSLS		EIN	condition: clear error secondary air system
B_CLSLS2		EIN	condition: clear error secondary air system (bank 2)
B_CLSLV		EIN	condition: clear error secondary air valve
B_CLSLV2		EIN	condition: clear error secondary air valve (bank 2)
B_CWDSLT	DSLSLR	LOK	Condition: enable valve tightness
B_CWSLA		EIN	Condition: enable of adaptation phase/additional diagnosis
B_DSL	DSLSLR	AUS	Condition request of diagnosis
B_DSL1	DSLSLR	LOK	Diagnosis phase 1: secondary air mass
B_DSL1AB	DSLSLR	LOK	Diagnosis phase 1: disable phase 1
B_DSL1E	DSLSLR	LOK	Diagnostics phase 1, enable secondary air mass flow measure
B_DSL2	DSLSLR	LOK	Diagnosis phase 2: valve tightness
B_DSL2AB	DSLSLR	LOK	Diagnosis phase 2: disable phase 2
B_DSL2E	DSLSLR	LOK	Diagnosis phase 2: enable measurement
B_DSL3	DSLSLR	LOK	Diagnostics phase 3: determination of offset value auxiliary air mass
B_DSL3AB	DSLSLR	LOK	diagnostics phase 3: dissable
B_DSL3E	DSLSLR	LOK	diagnostics phase 3: enable measurement
B_DSL4	DSLSLR	LOK	Condition phase 4: secondary air mass adaptation/ add. diagnosis
B_DSL4AB	DSLSLR	LOK	Condition: disable phase 4
B_DSL4E	DSLSLR	LOK	Condition: phase 4 enable measurement
B_DSL5	DSLSLR	LOK	Diagnostics phase 5: secondary air mass offset
B_DSL5AB	DSLSLR	LOK	Diagnostics phase 5: disable
B_DSL5E	DSLSLR	LOK	Diagnostics phase 5: enable measurement
B_DSLA	DSLSLR	AUS	adaption phase: calculation of secondary air mass
B_DSLERR	DSLSLR	LOK	Summary dissable features diagnostic secondary air system
B_DSLFA	DSLSLR	AUS	Condition: Request start of SAI- system for short trip
B_DSLM	DSLSLR	LOK	diagnostics secondary air mass
B_DSLMAB	DSLSLR	LOK	diagnostics secondary air mass, dissable measurement
B_DSLME	DSLSLR	LOK	diagnostis secondary air mass, enable measurement
B_DSLMES	DSLSLR	LOK	condition: enable measurement window
B_DSLO	DSLSLR	LOK	diagnostics secondary air mass offset value
B_DSLOAB	DSLSLR	LOK	diagnostics secondary air offset, dissable measurement
B_DSLOE	DSLSLR	LOK	diagnostics secondary air offset value, enable measurement
B_DSLS	DSLSLR	AUS	condition for active diagnosis of secondary air system
B_DSLSP4	DSLSLR	AUS	Condition: Request start of SAI for adaptation/additional diagnosis
B_DSLT	DSLSLR	LOK	diagnostics tightness secondary air valve
B_DSLTAB	DSLSLR	LOK	diagnostics valve tightness, dissable measurement
B_DSLTE	DSLSLR	LOK	diagnostics valve tightness, enable measurement
B_DSPE	DSLSLR	AUS	condition diagnosis secondary air on
B_DSPER	DSLSLR	LOK	condition reset secondary air pump on
B_DSPES	DSLSLR	LOK	condition set secondary air pump on
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_ENWS	DNWS	EIN	condition error camshaft control
B_ERROFS	DSLSLR	LOK	Condition: max. allowed secondary air mass offset crossed
B_ERROFS2	DSLSLR	LOK	Condition: max. allowed offset value crossed, bank 2
B_ESLS	DSLSLR	AUS	Condition secondary air fault by wrong air mass flow
B_EVLOC	AEVAB	EIN	Status: all injection valves are activated
B_FASLA	SLS	EIN	Condition: external request of SAI system aktiv
B_FASLARQ	SLS	EIN	Condition: local request tostart test of SAI system
B_FASLS		EIN	condition for external request of SAI system
B_HAG	GGDSAS	EIN	condition altitude adaptation valid
B_KHA	BBKHZ	EIN	request of activated catalyst heating
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_LRNDA	LREB	EIN	lambda control bank 1 active by conditions : B_Jrpspa & B_Jrkasn & !E_obdlr

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Variable	Source	Type	Description
B_LRNDA2	LREB	EIN	lambda control bank 2 active by conditions : B_Jrpspa & B_Jrkasn & !E_obdlr
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_MNSLS	DSLSLR	AUS	error type: secondary air mass too low
B_MNSLS2	DSLSLR	AUS	error type: secondary air mass too low, Bank 2
B_MSLMIN	DSLSLR	LOK	Condition nearly zero SAI-mass from SAI- measure phase
B_MSLMIN2	DSLSLR	LOK	Condition nearly zero SAI-mass flow from SAI-measure phase (bank 2)
B_MSLMN	DSLSLR	AUS	condition secondary air mass too few
B_MSLOFS	DSLSLR	LOK	condition calculation with secondary air mass offset value
B_MSLOFS2	DSLSLR	LOK	condition calculation with secondary air mass offset value, bank 2
B_MSLPMN	DSLSLR	AUS	Error condition: no SAI-pump, only pulse air
B_MSLPMN2	DSLSLR	AUS	Error condition: no SAI- pump, only pulse air, bank 2
B_MXSLV	DSLSLR	AUS	Fault type: auxiliary air mass for valve tightness test too large
B_MXSLV2	DSLSLR	AUS	Fault type: auxiliary air mass for valve tightness test too large
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_SLA	DSLSLR	LOK	demand of secondary air adaption phase
B_SLAR	DSLSLR	LOK	dissable demand of secondary air adaption phase
B_SLAS	DSLSLR	LOK	enable demand of secondary air adaption phase
B_SLP	SLS	EIN	condition for secondary air pump
B_SLS	SLS	EIN	Condition for active secondary air
B_SLSADAP	SLS	EIN	Condition: adaption of secondary air mass
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
B_SLSOFF	SLS	EIN	Condition end of secondary air after removing secondary air
B_SZSLS		EIN	Condition diagnostic secondary air system performed, result
B_TE	TEBEB	EIN	Condition canister purge active
B_VAG	ESUK	EIN	Condition large deceleration enleanment
B_ZSLS	DSLSLR	LOK	Condition diagnostic secondary air system performed
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_LATP	DLSA	EIN	error flag: lambda sensor aging tp
E_LATP2	DLSA	EIN	error flag: lambda sensor aging tp (cylinder row 2)
E_LATV	DLSA	EIN	error flag: lambda sensor aging tv
E_LATV2	DLSA	EIN	error flag: lambda sensor aging tv (cylinder row 2)
E_LM	DHFM	EIN	Error flag: main load sensor
E_SLPE	DSLPE	EIN	error flag: secondary air pump (power stage)
E_SLS	DSLSLR	AUS	error flag: secondary air system
E_SLS2	DSLSLR	AUS	error flag: secondary air system, cylinder row 2
E_SLV	DSLSLR	AUS	error flag: secondary air valve
E_SLV2	DSLSLR	AUS	Error flag: Auxiliary air valve Bank 2
E_SLVE	DSLVE	EIN	error flag: secondary air valve (power stage)
E_TA	GGTFA	EIN	error flag: TANS
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_UB	GGUB	EIN	error flag: power supply voltage UB
FHO_W	GGDSAS	EIN	correction factor: altitude
FMSLA	DSLSLR	AUS	correction factor secondary air mass, adaptive
FMSLA2	DSLSLR	AUS	correction factor secondary air mass, adapative, bank 2
FMSLAV	DSLSLR	LOK	Adaptation factor secondary air mass
FMSLAV2	DSLSLR	LOK	Adaptation factor secondary air mass, bank 2
FRM2_W	LR	EIN	fast mean value of lambda control factor bank 2(word)
FRM_W	LR	EIN	fast mean value of lambda control factor (word)
IMLATM_W	ATM	EIN	integrated air mass flow from engine start to max. value (word)
IMLPR	BBKHZ	EIN	relative amount of integrated air mass flow at catalyst heating
LAMSONS2_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location
M6AMSL	DSLSLR	AUS	Mode 6 - memory: number of value blocks of SAI- test
M6CMSL	DSLSLR	AUS	Mode 6 - memory: Component ID for SAI- mass test
M6CMSL2	DSLSLR	AUS	Mode 6 - memory: Component ID for SAI- mass test, bank 2
M6CMSLV	DSLSLR	AUS	Mode 6 - memory: Component ID for SAI- tightness test
M6CMSLV2	DSLSLR	AUS	Mode 6 - memory: Component ID for SAI- tightness test, bank 2
M6SMSL2_W	DSLSLR	AUS	Mode 6 - memory: Threshold value for test of auxiliary air mass, Bank 2
M6SMSLV2_W	DSLSLR	AUS	Mode 6 - memory: Threshold value for valve tightness testing, Bank 2
M6SMSLV_W	DSLSLR	AUS	Mode 6 - memory: Threshold value for valve tightness testing
M6SMSL_W	DSLSLR	AUS	Mode 6 - memory: Threshold value for test of auxiliary air mass
M6WMSL2_W	DSLSLR	AUS	Mode 6 - memory: Measurement value of SAI- mass flow, bank 2
M6WMSLV2_W	DSLSLR	AUS	Mode 6 - memory: Measurement value tightness, bank 2
M6WMSLV_W	DSLSLR	AUS	Mode 6 - memory: Measurement value valve tightness
M6WMSL_W	DSLSLR	AUS	Mode 6 - memory: Measurement value of SAI- mass flow
MLBB2_W	BGMSABG	EIN	air mass flow filtered (Word), bank2 related
MLBB_W	BGMSABG	EIN	air mass flow filtered (Word), Bank1 related
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSABG2_W	BGMSABG	EIN	exhaust gas mass flow filtered (Word), bank 2
MSABG_W	BGMSABG	EIN	exhaust gas mass flow filtered (Word), bank 1
MSL	SLS	EIN	secondary air mass flow
MSL2	SLS	EIN	secondary air mass, bank 2
MSLIF	DSLSLR	LOK	Actual value of secondary air mass, filtered
MSLIFT	DSLSLR	LOK	Actual value of secondary air mass, filtered, temporary
MSLIFT2	DSLSLR	LOK	Actual value of secondary air mass, filtered, temporary (Bank 2)
MSLIFT2_L	DSLSLR	DOK	Actual value of secondary air mass, filtered (bank 2)
MSLIFT_L	DSLSLR	DOK	Actual value of secondary air mass, filtered
MSLNENN	DSLSLR	LOK	Nominal value of secondary air mass

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Variable	Source	Type	Description
MSLNENN2	DSLSLR	LOK	Nominal value of secondary air mass, bank 2
MSLNF	DSLSLR	LOK	Nominal value of secondary air mass, filtered
MSLNF2	DSLSLR	LOK	Nominal value of secondary air mass, filtered, bank 2
MSLNF2_W	DSLSLR	DOK	Filter for mslnf, bank 2
MSLNF_W	DSLSLR	DOK	Filter for mslnf
MSLNT	DSLSLR	LOK	Nominal value of secondary air mass, temporary
MSLNT2	DSLSLR	LOK	Nominal value of secondary air mass, temporary, bank 2
MSLOFS	DSLSLR	LOK	Offset value SAI- mass
MSLOFS2	DSLSLR	LOK	Offset value SAI- mass, bank 2
MSLOFS2_⊥	DSLSLR	DOK	Offset value auxiliary air mass, filtered (bank 2)
MSLOFS_⊥	DSLSLR	DOK	Offset value auxiliary air mass, filtered
MSLT2_W	DSLSLR	LOK	Temporary value of SAI- mass, bank 2
MSLT_W	DSLSLR	LOK	Temporary value of SAI- mass
MSLV	DSLSLR	LOK	SAI- mass of valve tightness test
MSLV2	DSLSLR	LOK	SAI- mass of valve tightness test, bank 2
MSLVF	DSLSLR	LOK	Secondary air valve tightness, filtered
MSLVF2	DSLSLR	LOK	Temporary auxiliary air mass valve, filtered, Bank 2
MSLVFT	DSLSLR	LOK	Secondary air valve tightness, filtered, temporary
MSLVFT2	DSLSLR	LOK	Secondary air valve tightness, filtered, temporary (bank 2)
MSLVFT2_⊥	DSLSLR	DOK	Temporary auxiliary air mass valve, filtered (bank 2)
MSLVFT_⊥	DSLSLR	DOK	Temporary auxiliary air mass valve, filtered
MSLVT2_W	DSLSLR	LOK	Temporary air mass of valve tightness, Bank 2
MSLVT_W	DSLSLR	LOK	Temporary air mass of valve tightness
RMSL	DSLSLR	LOK	relative SAI- mass flow
RMSL2	DSLSLR	LOK	relative SAI- mass flow, bank 2
RMSLT	DSLSLR	LOK	relative SAI- mass flow without offset correction
RMSLT2	DSLSLR	LOK	relative SAI- mass flow without offset correction, bank 2
R_T100		EIN	Time schedule 100 ms
SFPSLS	DSLSLR	AUS	Status error path: Diagnosis of SAI- system
SFPSLS2	DSLSLR	AUS	Status error path: Diagnosis of SAI- system, bank 2
SFPSLV	DSLSLR	AUS	Status error path: Diagnosis SAI- valve
SFPSLV2	DSLSLR	AUS	Status error path: Diagnosis SAI- valve, bank 2
SLSSTAT	DSLSLR	AUS	
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TANS	GGTFA	EIN	Intake air temperature
TKATM	ATM	EIN	catalyst temperature (model)
TMOT	GGTFM	EIN	Engine temperature
Z_SLS	DSLSLR	AUS	cycle flag: secondary air system
Z_SLS2	DSLSLR	AUS	cycle flag: secondary air system bank 2
Z_SLV	DSLSLR	AUS	cycle flag: secondary air valve
Z_SLV2	DSLSLR	AUS	cycle flag: secondary air valve, bank 2

FB DSLSLR 2.30 Detailed description of function

APP DSLSLR 2.30 Application hint

MDTRIP 2.10 Calculation of torque reserve for short trip

FDEF MDTRIP 2.10 Function definition

mdtrip-mdtrip

ABK MDTRIP 2.10 Abbreviations

Variable	Source	Type	Description
DMRDSLS_W	KHMD	EIN	Torque reserve for SAI- diagnosis
DMRKT_W	MDTRIP	AUS	Torque reserve during quicktest
DMRLASH_W	DLSAHK	EIN	torque reserve for lambda sensor ageing diagnosis downstream cat
DMRLSH_W	DLSH	EIN	torque reserve for lambda sensor diagnosis downstream cat

FB MDTRIP 2.10 Detailed description of function

The torque reserve dmrkt_w is acquired by a max.-selection from the torque reserves of the individual short-trip requirements.

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APP MDTRIP 2.10 Application hint

ATM 21.40 Exhaust temperature model

FDEF ATM 21.40 Function definition

atm-atm

ATM_B1 Model overview

atm-atm-b1

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TMP_STAT Temperature correction at fuel cutoff, intake air, catalyst heating warming, ignition angle, lambda and cold engine

atm-tmp-stat

DYNAMIK Temperature-dynamics of exhaust gas, pipe-wall and catalyst

atm-dynamik

TMP_START Calculation of exhaust gas - and pipe-wall temperature at engine start

atm-tmp-start

TPE_LOGIK Calculation of exceed dew-point for lambdasensor upstream and downstream

atm-tpe-logik

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SP_NACHL Store exceed dew-point flag and temperature tabgm, tkatm at switch off delay

atm-sp-nachl

atm-sp-nachl

TMP_UMGM If there is no ambient-air-sensor, calculation of the ambient tempereature from tans (intake air temperature)

atm-tmp-umgm

atm-tmp-umgm

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MEAN etazwist-mean-value

atm-mean

ABK ATM 21.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ATMABKA	TABST_W		KL	factor reduction of exhaust gas temperature = f(soak time)
ATMABKK	TABST_W		KL	factor reduction for catalyst temperature = f(soak time)
ATMTANS	TATU		KL	temperature correction of the exhaust model temperature
DTUMTAT			FW	offset intake-air temperatur -> ambient temperature
FATMRML	ML		KL	divide factor exhaust-/exhaust-pipe temperature
FATMRML2	ML		KL	divide factor exhaust-/exhaust-pipe temperature bank2
FATMVM	VFZG		KL	change of exhaust gas temperature vehicle speed depending
FWMABGW			FW	factor heat quantity upstream when dew-point end not reached last trip
FWMABGW2			FW	factor heat quantity upstream when dew-point end not reached last trip bank2
FWMKATW			FW	factor heat quantity downstream when dew-point end not reached last trip
FWMKATW2			FW	factor heat quantity downstream when dew-point end not reached last trip bank2
IMTUMTAT			FW	threshold integrated air mass for determination ambient temp. (from TANS)
KFATMLA	ML	LAMSONS_W	KF	map exhaust gas temperature correction = f(lambda)
KFATMLA2	ML	LAMSONS2_W	KF	map exhaust gas temperature correction = f(lambda) bank2
KFATMLAE	ML	LAMSONS_W	KF	Map catalyzer exotherms for catalyzer temperature = f(Lambda)
KFATMLAE2	ML	LAMSONS2_W	KF	map catalyzer exotherms for catalyzer temperature = f(lambda) bank2
KFATMZW	ML	ETAZWIMT	KF	map exhaust gas temperature correktion = f(ignition-variation)
KFATMZW2	ML	ETAZWIMT	KF	map exhaust gas temperature correktion = f(ignition) bank2
KFATMZWE	ML	ETAZWIMT	KF	Map catalyzer exotherms for catalyzer temperature = f(etazwist)
KFTATM	NMOT	RL	KF	map exhaust gas temperature f(nmot,rl)
KFTATM2	NMOT	RL	KF	map exhaus gas temperature f(nmot,rl) bank2
KFWMABG	TABGMST	TMST	KF	map for heat-quantity threshold dew-point end upstream bank1
KFWMABG2	TABGMST2	TMST	KF	map for heat-quantity threshold dew-point end upstream bank2
KFWMKAT	TKATMST	TMST	KF	map for heat quantity threshold dew-point end downstream
KFWMKAT2	TKATMST2	TMST	KF	map for heat quantity threshold dew-point end downstream bank 2
NTUMTAT			FW	threshold engine speed for determination ambient temperature (from TANS)
TABGMEX			FW	Exhaust-gas temperature below the catalyzer light-off temperature
TASTBFA			FW	modelled-temperature exhaust gas start value at B_faatm-condition function
TATMKH			FW	exhaust gas temperature correction at catalyst heating
TATMKH2			FW	exhaust gas temperature correction at catalyst heating bank2
TATMKW			FW	exhaust gas temperature correction at catalyst warming
TATMSA			FW	exhaust gas temperature at fuel cut off
TATMSTI			FW	initial value tabgm, tkatm at power fail
TATMTMOT			FW	engine temperature warmed up engine, for temperature correction cold engine
TATMTP			FW	exhaust temperature at dew point
TATMWMK			FW	Temperature offset for heat-quantity calculation
TKSTBFA			FW	modelled-temp. catalyst start value at B_faatm-cond.(short dew-point end time)
TUMTAIT			FW	inital value of ambient temperature (from TANS)
VTUMTAT			FW	threshold velocity for determination ambient temperature from TANS
WMABGKH			FW	factor for heat-quantity-correction at catalyst heating for dew-point end
WMABGKH2			FW	factor for heat-quantity-correction at catalyst heating for dewpoint-end bank2
ZATMAML	ML		KL	time constant for exhaust gas temperature model
ZATMAML2	ML		KL	time constant for exhaust gas temperature model bank2
ZATMKML	ML		KL	time constant for catalyst temperature model tkatm
ZATMKML2	ML		KL	time constant for catalyst temperature model bank2
ZATMRML	ML		KL	time constant for exhaust model temperature - pipe temperature
ZATMRML2	ML		KL	time constant for exhaust model temperature - pipe temperature bank2

Variable	Source	Type	Description
B_ATMST	ATM	LOK	Flag start-value tabgmst, tkatmst calculated
B_ATMST2	ATM	LOK	Flag start-value tabgmst, tkatmst calculated bank 2
B_ATMTPA	ATM	AUS	condition temperature upstream catalyst exceeds dew-point
B_ATMTPA2	ATM	AUS	condition temperature upstream catalyst exceeds dew-point2
B_ATMTPF	ATM	AUS	condition dew-point exceeds upstream (last trip)
B_ATMTPF2	ATM	AUS	condition dew-point exceeds upstream (last trip) bank2
B_ATMTPK	ATM	AUS	condition temperature downstream catalyst exceeds dew-point
B_ATMTPK2	ATM	AUS	condition temperature downstream catalyst exceeds dew-point2
B_ATMTPL	ATM	AUS	condition temperature downstream catalyst exceeds dew-point (last trip)
B_ATMTPL2	ATM	AUS	condition temperature downstream catalyst exceeds dew-point (last trip) bank2
B_ETUM	GGTFUMG	EIN	Condition fault in ambient temperature
B_FAATM		EIN	condition function request short dew-point end time
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KW	BBKHZ	EIN	Condition catalyst warming
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_SA	MDRED	EIN	Condition fuel cut-off
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start

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Variable	Source	Type	Description
B_STNDNL	ATM	AUS	condition start of ECU-after run or end of start (1->0)
B_TFU	PROKON	EIN	condition ambient temperature sensor exists
B_TRKH	BBKHZ	EIN	Flag for catalyst fast heating
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF		EIN	ECU-condition powerfail initialisation
ETAZWIMT	ATM	LOK	mean efficiency at actual ignition angle (200 ms)
ETAZWIST	MDIST	EIN	actual ignition angle effectiveness
E_TA	GGTFA	EIN	error flag: TANS
E_TUM	GGTFUMG	EIN	Error Flag: ambient (air) temperature tumg
IMLATM	ATM	AUS	integrated air mass flow from engine start to maximum value
IMLATM_W	ATM	AUS	integrated air mass flow from engine start to max. value (word)
IWMATM2_W	ATM	AUS	heat quantity to dew-point end
IWMATM_W	ATM	AUS	heat quantity to dew-point end
LAMSONS2_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location
ML	BGSRM	EIN	air mass flow
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_T10		EIN	Time schedule 10 ms
R_T200		EIN	Time schedule 200 ms
TABGM	ATM	AUS	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	AUS	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TABGM2_W	ATM	AUS	Exhaust gas temperature in front of the catalyzer from model (Word) bank2
TABGMAB	ATM	LOK	exhaust gas temperature (modelled) at switch off
TABGMAB2	ATM	LOK	exhaust gas temperature (modelled) at switch off
TABGMST	ATM	LOK	Exhaust gas temperature at engine start
TABGMST2	ATM	LOK	Exhaust gas temperature at engine start bank2
TABGM_W	ATM	AUS	Exhaust gas temperature in front of the catalyzer from model (Word)
TABST_W	BGTABST	EIN	soak time
TANS	GGTFA	EIN	Intake air temperature
TATMKF	ATM	DOK	exhaust gas temperature-modelled from map KFTATM
TATMKF2	ATM	DOK	exhaust gas temperature-modelled from map KFTAMT bank2
TATMSTA	ATM	LOK	exhaust gas temperature-modelled steady-stade
TATMSTA2	ATM	LOK	exhaust gas temperature-modelles steady-stade
TATU	ATM	LOK	intake air or ambient temperature
TKATM	ATM	AUS	catalyst temperature (model)
TKATM2	ATM	AUS	catalyst temperature (model), bank2
TKATM2_W	ATM	AUS	catalyst temperature modelled (word) bank2
TKATMAB	ATM	LOK	exhaust gas temperature downstream cat.(modelled) at switch off
TKATMAB2	ATM	LOK	exhaust gas temperature downstream cat.(modelled) at switch off bank 2
TKATMST	ATM	LOK	catalyst temperature modelled start value = f(last value, soak time)
TKATMST2	ATM	LOK	catalyst temperature modelled start value = f(last value, soak time) bank 2
TKATM_W	ATM	AUS	catalyst temperature modelled (word)
TMOT	GGTFM	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
TUMG	GGTFUMG	EIN	Ambient air temperature
VFZG	GGVFZG	EIN	vehicle speed (km/h)
ZWMATM	ATM	AUS	counter for dew-point end not reached for heat quantity threshold
ZWMATM2	ATM	AUS	counter for dew-point end not reached for heat quantity threshold
ZWMATMF	ATM	AUS	counter for dew-point end not reached for heat quantity threshold upstream
ZWMATMF2	ATM	AUS	counter for dew-point end not reached for heat quantity threshold upstream

FB ATM 21.40 Detailed description of function

```
The simulated exhaust and catalyst temperature is used:

  1.  For catalyst monitoring: If the catalyst temperature falls short of its light-off temperature, then this catalyst could
                               erroneously be detected as defective.

  2.  For the downstream Lambda control:  The downstream Lambda controller is activated after cranking, but only, if the catalyst
                                          has exceeded its light-off temperature.

  3.  For sensor heater control after engine start: If the simulated dew point temperature has been exceeded, then the sensor
                                                    heater can be completely turned on.

  4.  For sensor heater control monitoring:         If the exhaust temperature exceeds a given threshold (e.g. 800 deg C), then
                                                    the sensor heater is turned off (in order to avoid overheating of the sensor).

  5. For engine fan control:                        Activation of engine fan during power latch when tabgm > TABGLF and other
                                                    conditions (see %MLS).

  6. For switch-on protection of components by mixture enrichment

By introducing this function, only approximations of the exhaust and catalyst temperature are obtained. For application
especially the  monitoring areas
        - dew point characteristic of the exhaust
        - catalyst monitoring
        - activation and deactivation of the sensor heater
        - switch-on protection of components
        must be critically observed.
```

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1. Base function temperature tatmsta

The steady state exhaust gas temperature upstream catalyst is determined by the nmot/rl dependent characteristic map KFTATM.
This temperature is corrected by
- ambient temperature (ATMTANS)
- fuel cutoff (TATMSA)
- catalyst heating or - warming (TATMKH, TATMKW)
- ingnition angle (KFATMZW temperature = f(ML, ETAZWIST)
- lambda nominal value (KFATMLA temperature = f(ML, LAMSBG_W)
- cold engine temperature (TMOT - TATMTMOT ; TATMTMOT = 90 °C)

The temporal influence of the exhaust gas temperataure upstream and downstream of the catalyst:
This function is simulated with filter for exhaust gas, pipe-wall and catalyst. The "heat transport" is approx. proportional to the air massflow. Therefore, the filter time constants are depending on airflow and determined by a characteristic line. The appropriate filter values reflect the exhaust gas temperature upstream of catalyst (ZATMAML), pipe-wall (ZATMRML) and downstream of catalyst (ZATMKML).
Correction of exhaust gas temperature with time characteristic of the pipe wall temperature.
If the exhaust gas temperature in the manifold increases 'in jumps', initially with a small time constant (5-15s) the exhaust gas temperature upstream of the cat. increases by a specific (smaller) amount. Then the exhaust gas temperature increases further as a result of the heating up of the exhaust pipe, with a larger time constant (50-200s).
This pipe wall temperature effect is especially necessary in more precise exhaust gas temperature simulation.
The pipe wall temperature effect is shown by a filter (with high time constant) which is calculated parallel to the filter for the exhaust gas temperature. Splitting of the two effects is dependent on air-mass. At low air-mass flow the pipe wall temperature effect is significantly greater than at higher air-mass flow. The filter value for the exhaust gas temperature is multiplied directly by the splitting factor (FATMRML), while the filter value for the pipe wall temperature is multiplied by a factor (1-FATMRML).
The two corrected filter values are added together and produce the exhaust gas temperature.

During extended fuel cutoff conditions with low exhaust gas temperatures, the catalyst may fall short of the light-off temperature. For these operating conditions, the exhaust temperature at the filter input is switched to the constant value TATMSA.
During catalyst heating (B_kh = 1) temperature TATMKH is added to TATMML characteristic line.

As long as condensation in the exhaust system is detected by the "Dewpoint end" detecting logic, then the almost constant temperatures tabgmst or tkatmst are simulated by switching (B_atmtpa, B_atmtpk) the filters to this values.
The "Dewpoint end" set time must always be longer then the condensed water in the wall near the lambdasensor.

At low tatu tkabgm and tkatm are corrected with the curve ATMTANS.

2. "Dewpoint end"-detection

Temperature tabgmst and tkatmst at engine start.
At switch off delay (C_nachl = 1) the modelled temperatures tabgm and tkatm are stored.
At engine start the start-temperature tabgmst is calculated as a function of stored temperature tabgm and stop-time (tabst_w) as a charcteristic curve ATMABKA (cooling down factor) corrected with ambient temperature.
The calcualtion for tkatmst is similar to the calculation of tabgmst.

Integrated heat quantity iwmatm_w
The exceed dew-point time is nearly proportional to the integrated heat quantity after engine start.
Heat quantity is the integral of temperature (tatmsta) * ml * cp (nearly 1 kJ /(kg*k))

Exceed dew-point time for the lambdasensor upstream flag B_atmtpa and lambdasensor downstream flag B_atmtpk
The calculated start-temperature tabgmst should be the pipe-wall-temperature at engine start.
If the temperature tabgmst is lower than 60 °C then condensation water could be in the pipe. At the map KFWMABG the threshold values for the heat quantity can be set.
The higher the air massflow and the temperature tatmsta get after cranking, the shorter are the "dewpoint end" times.

Extention of the "dewpoint end" times
In case the condensation has not completely evaporated after the last start (due to short engine operation), and in the meantime the exhaust system has cooled off, then even more condensation must evaporate during the following engine run.
If the "dewpoint end" time for the catalyst temperature has not been reached (B_atmtpk) after the last engine start, then a counter is incremented. The higher the number of those starts the higher is the factor to increae the threshold value of the map KFWMABG-values.
If the integrator (iwmatm_w) reaches the thresholds, then the appropriate conditions B_atmtpa resp. B_atmtpk = 1 are set.

3. Temperature changes on ignition retard and fuel enrichment.
As the engine efficiency falls due to ignition retard the exhaust gas temperature increases. The temperature changes can be set at the map KFATMZW. (etazwimt is the mean value over 200ms of the etazwist-value)
With fuel enrichment the exhaust gas temperature falls. The temperature correction is set in the map KFATMLA.

APP ATM 21.40 Application hint

1. Installation locations of temperature measuring sensors for application purposes (listed in direction of exhaust flow)

- For sensor installation upstream of catalyst
  1. Exhaust gas temperature (center of pipe) for high temperatures at high load for sensor heating shut-off
  2. Pipe wall temperature for determining the "dewpoint end" times (protection from condensation)

- upstream of catalyst
  3. Exhaust gas temperature (center of pipe) for determining the light-off temperature of the catalyst

- in catalyst
  4. Ceramic temperature in catalyst (in the last third of catalyst or touching the end of monolith) for determining the airflow dependent time constants

- downstream of catalyst
  5. Pipe wall temperature at the Lambda sensor location for determining the "dewpoint end" time

The temperature measuring point 3 may not be necessary if the distance from sensor to catalyst is less than 30 cm. In this case, the temperature difference from sensor location to catalyst may be neglected.

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2. Characteristic map KFTATM

   The steady state exhaust gas temperature upstream catalyst depends on nmot and rl. The values of the charcteristic map could be set at driving on a roller test bench.Better values have to be set at driving on road conditions.

3. Characteristic line ZATMAML, ZATMKML, ZATMRML, FATMRML

   The air massflow dependent time constants ZATMAML (temperature measuring points 1 and 3), as well as ZATMKML (temperature measuring point 4) can be determined by means of "load jumps", or more accurately of "airflow jumps". In this case, full load and especially fuel cutoff conditions are to be avoided at "airflow jumps".

   Example: For an airflow jump from 30 kg/h to 80 kg/h, the measured time constant is referred to 80 kg/h.

4. The "dewpoint end" times for exhaust gas temperatures (exhaust pipe center) and pipe wall are very different. For "dewpoint end" times, the pipe wall temperatures upstream of catalyst (measuring point 2) resp. downstream of catalyst (temperature measuring point 5) should be used. In case, these times are too long (concerning delayed readiness for operation of the Lambda control), then the temperature characteristics at the sensor location must be evaluated in more detail. In order to avoid sensor damaging due to condensation, the maximum sensor heating may only be applied, when the dewpoint temperature has been exceeded or the "dewpoint end" time has been detected, and therefore, condensation can no longer occur.

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Typical values:

KFTATM  [grd C]   nmot [1/min]  800   1200  1800  2400  3000  4000   5000   6000
            rl[-]       15      380   400    420   450   480   520    550    580
            22      400   420    450   480   520   550    580    610
            30      420   450    480   520   550   580    610    650
            50      450   480    520   550   580   610    650    700
                70      470   520    550   580   610   660    700    750
           100      490   550    580   610   650   700    750    790
               120      510   560    610   650   700   750    790    840
               140      530   580    650   700   750   790    840    900

KFATMZW [grd C]     ML [kg/h]    20    40     80   150   250   400
         ETAZWIST[-]     1.0      0     0      0     0     0     0
                         0.95    15    40     50    60    70    75
                         0.90    15    60     80   100   125   140
                         0.80    20    80    120   150   180   200
                         0.70    25   100    150   190   210   220
                         0.60    30   115    175   210   230   245

KFATMLA [grd C]     ML [kg/h]    20    40     80   150   250   400
          LAMSBG_W[-]   1.15      5    10     30    50    60    70
                        1.0       0     0      0     0     0     0
                        0.95     5     10     20    30    40    45
                        0.90     15    25     40    50    60    75
                        0.80     30    40     60    70    85   100
                        0.70     40    60     80    90   100  120

KFWMABG [kJ]      tabgmst [Grad C]      -40     0       15       25       50
              tmst [Grad C]  -40     200       160     150      140      100
                              0         180       150     120      110       80
                             15         160       140      60       55       30
                             25         140       120      30       30       15
                             60         120        30      15       10        5
   KFWMKAG   the values correspond to  KFWMABG * 5

   ZATMAML  ml   [kg/h], Zeitkonst. [sek]    10,  30  ;  20,  20  ;  40, 13  ;  80,   5  ; 180,  4   ; 400,  3  ;
   ZATMKML  ml   [kg/h], Zeitkonst. [sek]    10, 150  ;  20,  60  ;  40, 35  ;  80,  20  ; 180, 10   ; 400,  7  ;
   ZATMRML  ml   [kg/h], Zeitkonst. [sek]    10, 300  ;  20,  80  ;  40, 55  ;  80,  30  ; 180, 20   ; 400, 10  ;
   FATMRML  ml   [kg/h], Zeitkonst. [sek]    10, 0.5  ;  20,  0.6 ;  40, 0.7 ;  80,  0.8 ; 180, 0.95 ; 400,0.95 ;
   TATMTP   Temp [Grad C]                    50

   ATMABKA  tabst [s]  , Faktor              10, 0.95 ;  50,  0.7 ; 180, 0.5 ; 360, 0.3  ; 600, 0.15 ; 1000, 0  ;
   ATMABKK  tabst [s]  , Faktor              10, 0.90 ;  50,  0.6 ; 180, 0.4 ; 360, 0.25 ; 600, 0.15 ; 1000, 0  ;

   ATMTANS  TANS [°C], Temp [Grad C]        -40, 60   ; -10, 20   ;  20,  0  ;

   TATMSA   Temp [Grad C]                  100
   TATMKH   Temp [Grad C]                  200
   TATMKW   Temp [Grad C]                  100
   TATMTMOT Temp [Grad C]                   90

   TUMTAIT  Temp [Grad C]                   20
   TASTBFA  Temp [Grad C]                   40
   TKSTBFA  Temp [Grad C]                   40

   TATMWMK  Temp [Grad C]                 - 80
   WMABGKH  Faktor                         0.3
   FWMABGW  Faktor            0.25
   FWMKATW  Faktor                 0.25

   DTUMTAT  temperature [°C]                20
   VTUMTAT  velocity  [km/h]                40
   NTUMTAT  engine speed [1/min]          1800
   IMTUMTAT air mass [kg]                    1
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DKAT 59.30 Diagnosis; catalyst conversion

FDEF DKAT 59.30 Function definition

DKAT : Katalysatorüberwachungsfunktion Bank 1 und 2

dkat-dkat

DKATKB : Katalysatorüberwachungsfunktion Bank 1

dkat-dkatkb

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DKATINI : Initialisierung Bank 1

dkat-dkatini

AKATB : Aufbereitung des Katbelastungssignales Bank 1

dkat-akatb

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AHKATS : Amplitudenaufbereitung in Abhängigkeit von der Sondenspannung Bank 1

dkat-ahkats

AHKATB : Amplitudenaufbereitung in Abhängigkeit vom Katbelastungssignal Bank 1

dkat-ahkatb

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DKATST : Aufbereitung der Stoppbedingung Bank 1

dkat-dkatst

dkat-dkatst

DKATSTP : Physikalische Stoppkriterien Bank 1

dkat-dkatstp

dkat-dkatstp

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DKATSTB : Bankspezifische Stoppkriterien Bank 1

dkat-dkatstb

dkat-dkatstb

DKATAW : Signalauswertung Bank 1

dkat-dkataw

dkat-dkataw

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DKATEL : Setzen der Error- und Zyklusflags Bank 1

dkat-dkatel

dkat-dkatel

dkat-dkatlrp

dkat-dkatlrp

DKATLRP: Parmeter zur Umschaltung der Lambdaregelungsamplitude

ABK DKAT 59.30 Abbreviations

The following values are "describing values" i.e. they are no RAM cells.

B_erdkt ... catalyst diagnosis error detected (bank1)
B_erdkt2... catalyst diagnosis error detected (bank2)

Parameter	Source-X	Source-Y	Type	Description
ADKATNF			FW	scaling factor for signal amplitude of the sensor resp. of the catalyst stress
AHKATKM	KMSTAND		KL	
AHKATMN			FW	threshold value catalyst good, AHKAT < AHKATMN
AHKATMX			FW	threshold value catalyst defect, AHKAT > AHKATMX
AHKATS			FW	threshold value for sum AHKAT,AHKAT2 (stereo)

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Parameter	Source-X	Source-Y	Type	Description
AHKATSB			FW	threshold value for error of adding range (stereo)
AHKTTSW			FW	setting value for timer in signal evaluation
APEKTDX			FW	max. number of tests with error result
AVKATFS			FW	setting value for AVKATF in case of powerfail
CDKATLK			FW	code word for B_lrka active
DKATCW			FW	single run resp. initialization of the DKAT function
DMRKTD			FW	torque reserve for catalyst monitoring
DRLKTDP			FW	Threshold for engine load change
FALRKTD			FW	amplification factor for amplitude of lambda controller
FALRKTT			FW	amplification factor for amplitude of lambda controller at tester mode
KATBFML	ML		KL	filter time constant for signal attenuation in catalyst stress
KATBFMN			FW	threshold value for small catalyst stress
KATBFN			FW	standardized mean value of the sensor amplitude
KATBFNM			FW	scaling factor multiplicative for catalyst stress
KATBFNP			FW	scaling factor additive for catalyst stress
KATBFSX			FW	maximum integrator value for stop condition
KATBFXM	ML		KL	max. catalyst load threshold for stop condition
KATBSG			FW	catalyst storage value for catalyst stress
KATBSH			FW	offset for lambda control slightly in the rich area
KATBSHF			FW	amplification factor for difference of mean values of the O2/S
KATBSHG			FW	limitation factor of model lambda-offset due to sensor mean values
NDKTSO			FW	upper engine speed limit for DKAT-active
NDKTSOT			FW	upper engine speed limit for function request
NDKTSU			FW	lower engine speed limit for DKAT-active
NDKTSUT			FW	lower engine speed limit for function request
NKTDX			FW	Maximum speed for DKAT calculation
RLDKTOT			FW	upper load limit for function request
RLDKTSO	NMOT		KL	upper load characteristic line for DKAT-active
RLDKTSU	NMOT		KL	lower load characteristic line for DKAT-active
RLDKTUT			FW	lower load limit for function request
TDKATAKT			FW	threshold value cycle finished if active monitoring time > TDKATAKT
TDKATATT			FW	threshold value cycle finished for function request
TMINKAT			FW	minimum catalyst temperature for monitoring
TMNKATT			FW	minimum catalyst temperature for monitoring during tester mode
TVDKAT			FW	
TWDKATST			FW	waiting time after stop condition for filter and integrator
TWKTDLP			FW	delay time after parameter switch over in lambda control
ZDKATAD			FW	filter time constant of the differentiator for signal amplitude
ZDKATAF			FW	time constant ”absolute value filter” for signal amplitude
ZDKATSH			FW	time constant low pass filter, mean sensor values
ZDKTBD			FW	time constant of the differentiator for RF-alternating component
ZDKTBF			FW	time constant for gas mixing procedure in front of catalyst
ZKTDRL			FW	time constant low pass filter, engine load

Variable	Source	Type	Description
AHKAT	DKAT	LOK	mean value of the amplitude sensor signal behind catalyst corrected by KB
AHKAT2	DKAT	LOK	mean value of the amplitude sensor signal behind catalyst corr. by KB (2.bank)
AHKATN	DKAT	LOK	amplitude sensor signal behind catalyst standardized
AHKATN2	DKAT	LOK	amplitude sensor signal behind catalyst standardized
AHKTKI2_W	DKAT	DOK	amplitude sensor signal behind catalyst corrected and integrated
AHKTKI_W	DKAT	DOK	amplitude sensor signal behind catalyst corrected and integrated
AHKTNK	DKAT	DOK	corrected sensor signal amplitude standardized
AHKTNK2	DKAT	DOK	corrected sensor signal amplitude standardized (sterio 2.bank)
AKATBN	DKAT	LOK	amplitude of the catalyst stress signal
AKATBN2	DKAT	LOK	amplitude of the catalyst stress signal (stereo 2.bank)
APEDKT	DKAT	LOK	number of tests with error-result
APEDKT2	DKAT	LOK	number of tests with error-result (bank2)
AVKATF	DKAT	AUS	amplitude ratio laafh/laafv strained
AVKATF2	DKAT	AUS	amplitude ratio laafh/laafv strained bank2
B_CDKAT	DKAT	LOK	function active per codeword CDKAT
B_CLKAT	DKAT	LOK	condition clear fault path DKAT
B_CLKAT2	DKAT	LOK	condition clear failure path DKAT (stereo)
B_DKINI	DKAT	LOK	condition for initialize DKAT function
B_DKINI2	DKAT	LOK	condition for initialize DKAT function (stereo 2.bank)
B_DKLPI	DKAT	LOK	internal request of param. switch over in lambda control
B_DKLPI2	DKAT	LOK	internal request of param. switch over in lambda control, bank2
B_DKTEN	DKAT	DOK	DKAT no longer active for this trip
B_DKTEN2	DKAT	DOK	DKAT no longer active for this trip (bank2)
B_DKTLP	DKAT	AUS	Request of parameter switch over in lambda control
B_DKTNR	DKAT	LOK	speed-/load range left
B_DKTNR2	DKAT	LOK	speed-/load range left, bank2
B_DKTSB	DKAT	LOK	bank-specific stop condition
B_DKTSB2	DKAT	LOK	bank-specific stop condition (stereo 2.bank)
B_DKTSP	DKAT	LOK	physical stop condition
B_DKTSP2	DKAT	LOK	physical stop condition (stereo 2.bank)
B_DKTST	DKAT	LOK	DKAT function is stopped (B_dktst=FALSE)
B_DKTST2	DKAT	LOK	DKAT function is stopped (B_dktst=FALSE, stereo 2.bank)
B_DKTT	DKAT	LOK	DKAT active time over
B_DKTT2	DKAT	LOK	DKAT active time over, bank2
B_EKATS	DKAT	DOK	added-up error for MODE 6
B_EKATS2	DKAT	DOK	added-up error for MODE 6 (stereo 2.bank)

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Variable	Source	Type	Description
B_ENWS	DNWS	EIN	condition error camshaft control
B_ERDKT	DKAT	LOK	Internal faul at catalyst diagnosis
B_ERDKT2	DKAT	LOK	Internal faul at catalyst diagnosis (bank2)
B_FA	DKAT	LOK	condition general function request
B_FAKAT	DKAT	LOK	condition function request catalyst monitoring
B_FAKAT2	DKAT	LOK	condition funktion request catalyst monitoring (stereo 2.Bank)
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_MDKAT	DMDMIL	EIN	cat. damaging misfire rate exceeded (for deactivation of other functions)
B_MXKAT	DKAT	AUS	condition upper plausibility threshold exceeded
B_MXKAT2	DKAT	AUS	condition upper plausibility threshold exceeded (stereo)
B_PWF	DKAT	LOK	Condition for powerfail
B_SZKAT	DKAT	LOK	cycle time and error one bank run out
B_SZKAT2	DKAT	LOK	cycle time and error bank2 run out
B_TVDKAT	DKAT	LOK	
B_ZKATB	DKAT	DOK	bank-specific cycle time for MODE 6
B_ZKATB2	DKAT	DOK	bank-specific cycle time for MODE 6 (stereo 2.bank)
B_ZKATS	DKAT	LOK	cycle time for one bank run out
B_ZKATS2	DKAT	LOK	cycle time for 2. bank run out
B_ZKATZ	DKAT	DOK	condition for added-up error in MODE 6
B_ZKATZ2	DKAT	DOK	condition for added-up error in MODE 6 (stereo 2.bank)
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
DKATAKT2_W	DKAT	LOK	active monitoring time for DKAT (stereo 2.bank)
DKATAKT_W	DKAT	LOK	active monitoring time for DKAT
DMRDKT_W	DKAT	AUS	torque reserve for catalyst monitoring
E_KAT	DKAT	AUS	error flag: catalyst conversion
E_KAT2	DKAT	AUS	error flag: catalyst conversion (cylinder row 2)
E_LATP	DLSA	EIN	error flag: lambda sensor aging tp
E_LATP2	DLSA	EIN	error flag: lambda sensor aging tp (cylinder row 2)
E_MD	DMDMIL	EIN	Error flag: misfire, multiple
FAHKATKM_W	DKAT	AUS	
FALRDKT	DKAT	AUS	Request form cat monitoring: modify lambda controller amplitude
FR2_W	LR	EIN	Lambda controller output (word)
FR_W	LR	EIN	Lambda controller output (word)
KATBF	DKAT	LOK	signal after memory standardized comparable to ushk
KATBF2	DKAT	LOK	signal donstream of accumulator, standardized, comp. with ushk2 (stereo, bank 2)
KATBFI2_W	DKAT	LOK	amount of oxygen upstream of accumulator (catalyzer model, stereo, bank 2)
KATBFI_W	DKAT	LOK	amount of oxygen upstream of accumulator (catalyzer model)
KATBFS	DKAT	LOK	signal downstream of accumulator (catalyzer model)
KATBFS2	DKAT	LOK	signal downstream of accumulator (catalyzer model, stereo, bank 2)
KATBFTP	DKAT	LOK	signal downstream of accumulator, standardized, low-pass filtered
KATBFTP2	DKAT	LOK	signal downstream of accumulator, standardized, low-pass filtered (bank 2)
KATBSHD2_W	DKAT	LOK	signal for rich-shift of the catalyst model (bank2)
KATBSHD_W	DKAT	LOK	signal for rich-shift of the catalyst model
KBDKT2_W	DKAT	LOK	catalyst load signal, bank2
KBDKT_W	DKAT	LOK	catalyst load signal
KMSTAND	CANINS	EIN	Route of the vehicle as information via CAN
ML	DKAT	LOK	air mass flow
ML_W	DKAT	LOK	air mass flow filtered (Word)
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
RLDKTHP	DKAT	DOK	High pass filteres engine load signal
RLDKTHP2	DKAT	DOK	High pass filteres engine load signal, bank2
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
TKATM	DKAT	LOK	catalyst temperature (model)
TKATM2	DKAT	LOK	catalyst temperature (model), bank2
TNSE_W	BBSTT	EIN	time counter at end of start (16 bit)
URDDKTP	DKAT	LOK	difference of sensor mean values, low pass filtered
URDDKTP2	DKAT	LOK	difference of sensor mean values, low pass filtered, bank2
USHDKTP	DKAT	DOK	output voltage oxygen sensor downstream catatalyst, low pass filtered
USHDKTP2	DKAT	DOK	output voltage oxygen sensor downstream catatalyst2,low pass filtered
USHK	DKAT	LOK	output voltage oxygen sensor downstream catalyst
USHK2	DKAT	LOK	output voltage oxygen sensor downstream catalyst 2
Z_KAT	DKAT	AUS	cycle flag of catalyst conversion
Z_KAT2	DKAT	AUS	cycle flag: catalyst conversion (2nd bank)
Z_LATP	DLSA	EIN	cycle flag of lambda sensor aging tp
Z_LATP2	DLSA	EIN	cycle flag of lambda sensor aging tp (cylinder row 2)

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FB DKAT 59.30 Detailed description of function

Introduction :

The catalyst has the characteristics of storing oxygen. The oxygen stored during the lean phase is either completely or partially used during the rich phase. Due to aging or due to environmental influences the storage capability of the catalyst is reduced. In case of this aging the HC convertion is also reduced. According to OBDII requirements the HC emission in the FTP test may not exceed a given limit. The task of the catalyst monitoring function is to make a statement from the oxygen storage capability of the catalyst about the the HC convertion in the FTP-test. By means of this procedure the oxygen storage capability is determined from the amplitude of the lambda sensor behind the catalyst. Since during non-steady state drive the storage capacity of the catalyst is at times taken up completely the function shall be protected against wrong conclusions by means of adequate measures.

The catalyst conversion monitoring:

The amplitude of the lambda sensor behind the catalyst is strongly dependent on the alternating stress of the oxygen (deficiency / excess) in the catalyst. This catalyst stress may vary in different load ranges. So as to consider the working point influences a correcting function apart from the various stop criteria is introduced. The task of this function is, dependent on the manipulated variable of the lambda controller (fr-signal), to form an expectancy signal for the amplitude of the lambda sensor. The difference between the expectancy signal and the lambda sensor amplitude is integrated and standardized to the time. The standardized signal is a dimension for the aging of the catalyst. The monitoring is carried out in a single load-engine speed range. The structure of bank one and two is identical. Due to this only one bank was described. The differing signals were designated with index 2 for the second bank. The following blocks DKATAW2, DKATSTB2, DKATSTP2, DKATST2, AHKATB2, AHKTS2, AKATB2 are the same as those of bank 1 except for the index 2. So as to increase the overview these block diagrams were therefore omitted.

The catalyst conversion monitoring consists of the following blocks:

Partial function block AKATB:

The task of this partial function is, dependent on the manipulated variable of the lambda controller and of the air mass throughput, to calculate a catalyst stress signal. For this the change of the fr-signal from the neutral position (phys. 1.0) is filtered with a high pass (formed from the low-pass filter and subtraction). This filtering is necessary to be independent of the position of the fr-signal. The high-pass filtered signal is multiplied by the air mass throughput ml, which was converted to g/s. Thereafter it is filtered with a low pass. The low-pass filter is used for the gas mixing procedure. The output of the low-pass filter is added to the offset KATBSH and standardized to the catalyst storage value. This signal (katbfi_w) is used for application purposes and for the formation of the stop criteria. The offset KATBSH is dependent on the control threshold of the pilot control and KATBSG is dependent on the catalyst volume of the borderline catalyst.

The catalyst was designed as integrator with limitation. The limitation was standardized to ——1. After the katbfi_w-signal was integrated it is filtered through an air mass throughput-dependent low pass and standardized to the lambda sensor amplitude by means of a multiplying and an adding factor. The standardized signal katbf has a similar course to ushk. The output of the intergrator is called katbfs and it is used for the formation of the physical stop criteria and for application purposes.

The time constant of the high-pass filter ZDKTBD should be chosen such that only the direct component of the fr-signal is filtered. The time constant of the gas mixing filter ZDKTBF lies between 0.05..0.2 sec. By this time constant the threshold values of the stop conditions are influenced.
The air mass-dependent time constant of the low-pass filter is realized via the characteristic line KATBFML. In case of very small air masses this filter generally has a larger time constant. For the given base points the time constants shall be adjusted so that the standardized katbf-signal shows the best possible match with the lambda sensor amplitude for the the designed borderline catalyst.

All filters and the integrator are reset to zero by B_dkini=TRUE.

Partial function block AHKATS :

By means of this function the alternating components of the ushk-signal are calculated by a high-pass filter (formed from low-pass filter and subtraction). Via the sum and the subsequent filtering the rectified mean value of the alternating components is obtained. The low-pass filter is stopped by the bit B_dktst = FALSE. The output of the low-pass filter is multiplied by the factor ADKATNF so that on very old catalysts (washcoat only) ahkatn becomes = 1. The standardized signal ahkatn then complies to the avkat-signal from the filter procedure carried out so far.

Both filters are set to ZERO by the bit B_dkini=TRUE.

The mean value of the oxygen sensors after catalyst is taken into aacount. This is performed by creating "katbshd" from the difference of the values of the rear sensor and the modelled rear sensor signal. This "katbshd" impacts the catalyst model.

Partial function block AHKATB :

By means of this function the alternating components of the katbf-signal are calculated by a high-pass filter (formed from low-pass filter and subtraction). Via the sum and the subsequent filtering the rectified mean value of the alternating components is obtained. The low-pass filter is stopped by the bit B_dktst = FALSE. The output of the low-pass filter is multiplied by the factor ADKATNF. The standardized signal akatbn is used as expectancy signal (set point).

Both filters are set to ZERO by the bit B_dkini=TRUE.

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Partial function block DKATAW :

From the two signals ahkatn and akatbn a correcting signal ahktnk is formed for the evaluation of the catalyst conversion. For this the difference between the ahkatn-signal and the akatbn-signal is formed. The difference is corrected by means of a straight line with a gradient of one. The straight line has the point of intersection KATBFN with the y-axis. The correcting signal ahktnk is integrated and thereafter divided by the time. The result (ahkat-signal) takes up a value between ZERO and one. The integrator and the timer are definedly set during the initialization (B_dkini=TRUE). The setting values (avkatf*AHKTTSW and AHKTTSW)
are necessary so that in the beginning no division by ZERO or no high value occurs. The integrator and the timer are stopped if
- B_dktst is equal to FALSE.
- akatbn is smaller than KATBFMN.
- the integrator or the timer have reached the limit.

The output of the timer (dkatakt_w) supplies the active monitoring time. The ahktki_w-signal supplies the actual integration value. These two signals are needed for application purposes.

Partial function block DKATST:

Stop criteria :

The catalyst conversion monitoring is not always active The conditions leading to an interruption of the monitoring may either be derived physicaly or they are caused by the errors of other functions in the motronic. Due to this reason the two stop types are seperated from each other.

a) physical stop criteria (partial function DKATSTP)
- The catalyst monitoring is only active within one load-engine speed range. The engine speed range lies between a lower (NDKTSU) and an upper (NDKTSO) threshold. The load range is limited by two engine speed-dependent characteristic lines (RLDKATSO, RLDKATSU). The engine speed base points are identical on both characteristic lines.

- During low temperature (start temperatur) the HC conversion decreases and the amplitudes of the lambda sensor behind the catalyst increase. Therefore a monitoring during this temperatur is excluded.
  The catalyst temperature tkatm is reformed in the function ATM. The catalyst diagnosis is only active if the temperature tkatm is larger than TMINKAT.

- The katbfs- resp. katbfi_w-signals gained from the partial function AKATB are used for the formation of the physical stop criteria. Cut-off limits for the katbfs-signal (KATBFSX) and for the katbfi_w-signal (KATBFXM) are fixed.
  The catalyst conversion monitoring is stopped if the katbfi- resp. the katbfs-signal at the same time exceed resp. fall short of the limits (KATBFXM, KATBFSX).
  By these limiting values resp. by chosing the load-engine speed range it is possible to influence the active monitoring time in the FTP-test.
- Stop criteria if a tester requests a function:
  If a tester requests a function (B_fakat = TRUE) a special load-engine speed range is defined. Thus it is ensured that the request can only be triggered for the intended working point. The engine speed nmot can vary between the limits (NDKTSUT, NDKTSOT) and the load rl can vary between the limits (RLDKTUT, RLDKTOT). Out of these ranges the function is stopped.

b) non-physical stop criteria (partial function DKATSTB)
  The monitoring of the catalyst conversion can only take place during undisturbed functioning of the lambda controller. At the same time the sensors in front of and behind the catalyst must be fully available. This includes the results of the heating diagnosis and of the monitoring of the aging. The condition B_lr indicates the normal operating of the lambda controller especially no fuel cut-off and readiness of the front sensor. A high charging of the activated carbon filter can disturb the monitoring and is therefore considered as a ban.
  This also applies for quick load changes which require a considerable correction in the transient control (B_ukg).
  Furthermore misfires, AGR-errors, TES-errors as well as general errors in the load sensing are used as exclusion criteria.

  Test modes:
  - Permanent testing (DKATCW=0, APEKTDX=255, for application purpose only)
    The function will be initialized (B_dikini), as soon as the diagnosis has finished on both banks (see chapter DKATINI).
    The function will be stopped for this trip (B_dkten=TRUE), as soon as fault counter apedtk exceeds APEKTDX.
    The fault counter will be increased at the event of a fault at bank1 and bank2 respectively.
    In case of o.k.-testresult the diagnosis will be repeated for ever, in case of a fault it sill be repeated 255 times.
  - One healing test (DKATCW=1, APEKTDX=2, for series application)
    In case of an detected fault the diagnosis wil be stopped when the fault counter exceeds the threshold "2". I.e. max. one healing test is possible.
    If in the first test no fault is detected (Z_kat,-2=TRUE, E_kat,-2=FALSE), the diagnosis will be stopped as well (B_dkten=TRUE).
  - Single test (DKATCW=2, APEKTDX > 0).
    The diagnosis will be stopped after the first run-through (B_szkat=TRUE and hence B_dkten=TRUE).

From the two stop types the bit B_dktst is generated by connecting the OR function. After the stop condition has ended the waiting time TWDKATST is still waited for until the filters resp. the integrators are again enabled.

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Partial function block DKATEL :

For the setting of the error and cycle flags the following considerations were laid down:

1.) An individual error exists that means in one bank after the active monitoring time (TDKATAKT) has run out ahkat is larger than the maximum limit (AHKATMX). In this case E_kat and Z_kat are immediately set to TRUE (individual error has high priority).
2.) An added-up error exists that means that after the active monitoring time has run out the sum of the ahkat-signals of the two banks exceed the preselected border AHKATS. In this case the catalyst which shows a larger ahkat-signal is detected as defective. For this purpose a lower limit (AHKATMN) is defined which may not be undershot. Furthermore the active monitoring time of the two banks must have run out and in none of the banks no individual error may exist.
By forming the flag (B_zkats) three conditions are fixed. Firstly that in one bank the time has run out, secondly that no individual errors have occured and thirdly that the ahkat-signal of the concerned bank does not lie below AHKATMN.
3.) An error of the adding range exists that means after the active monitoring time has run out an added-up error exists if the ahkat-signal is not larger than AHKATSB. The meaning of this being that in case of an added-up error both catalysts will be detected as being defective if they do not differ largely in the state of their age.

Z_kat is set to FALSE by B_dkini = TRUE. The cycle flag is not set until the monitoring end of the lambda sensor period is reported by the setting of the cycle flag Z_latp=TRUE. By setting B_fakat = TRUE the border for the active monitoring time is changed from TDKATAKT to TDKATATT.
The E_kat(2) and the Z_kat(2) are set to FALSE in case of B_pwf =TRUE resp. B_clkat=TRUE. For the European version "CDKAT=0" E_kat (2) is set to FALSE, Z_kat(2) is set to TRUE and thus the function is stopped.
In case of E_kat(2) = TRUE B_mxkat(2) = TRUE is set. B_mxkat(2) is used in the error memory management.

Partial function block DKATINI:

The catalyst conversion monitoring is initialized in case of the following conditions:
a) If the bit B_ini = TRUE
b) If the bits B_szkat resp. B_szkat2 = TRUE were set
c) If the fault code storage is cleared
d) If the diagnosis is started via tester request (B_fakat)

The initialization means that all filters are set to ZERO, the integrators are either set to ZERO or to the setting values, the timer is set to the value AHKTTSW and Z_kat is set to False.

After a single run of the monitoring function (cycle bit was set) it is possible to stop the catalyst conversion via the code word DKATCW bit no. ONE = TRUE.

Due to a historical reason ahkat is stored in a battery-backed RAM-cell with the edge of the Z_kat-signal for the function %LC under the name avkatf. The avkatf-signal is set to the value AVKATFS in case of powerfail = TRUE.

Subfunction block DKATLRP:

In order to amplify the downstream sensor signal, it can be useful to enlarge the lambda pertubations.
The parameter switch over for this performance is requested by B_dktlp, falrdkt is the wanted value for amplification factor of the amplitude of the lambda pertubation.
B_dktlp is set when DKAT is active (dkatakt_w > AHKTTSW) and is cleared when the speed/load-range is left (B_dktnr) or the DKAT-time is elapsed (B_dktt) or the load oscillations are too rough.

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APP DKAT 59.30 Application hint

A p p l i c a t i o n p r o c e s s :

The application of DKAT can be started usefully only if the application of the lambda controller and of the transient enrichment/ lean-out has been completed and the FTP-results of the vehicle lie close to the target value. Only in this case it is possible to to select a borderline catalyst. During application always a "mid-range" lambda sensor should be used to avoid the influences of sensor characteristics on FTP-results and on DKAT.
The condition B_dktst indicates whether the function is actually active at the moment (B_dktst = TRUE) or whether it is blocked.
The application is largely carried out off-line. For this an evaluation software is available. Although the application must be carried out for the entire operating range, in this case an attempt is made to give corresponding suggestions for the determination of the individual application values for each individual block.

The results of th catalyst diagnosis can be improved by activating the lambda control after catalyst (rear control, trim control).

- Application of AKATB-block :

A p p l i c a t i o n v a l u e s

ZDKTBD	filter time constant for differentiator	[0,5....1,0.....1,5] sec
ZDKTBF	filter time constant for low pass	[0,05...0,15....0,2] sec
KATBSH	offset for lambda control threshold	[0,0.....47....80,0] mg/sec
KATBSG	memory value	[2,0....55,0...160] g
KATBFNM	scaling factor multiplicative for KB	[0,0....0.30....1,0] Volt
KATBFNP	scaling factor additive for KB	[0,0....0.40....1,0] Volt
KATBFML	filter time constant for sensor signal attenuation	characteristic line over ml

Characteristic line KATBFML

ml/(kg/h)	12	25	50	80	130
time constant/sec	[0,1..2,0..4,0]	[0,1..1,0..2,0]	[0,01..0,15..1,0]	[0,01..0,14..0,9]	[0,01..0,08,..0,3]

The values indicated in the middle are to be understood as reference values.

Determination of the two scaling factors KATBFNP and KATBFNM by the conformal mapping:
With these two factors the output signal of the low-pass filter for the sensor signal attenuation of —1 is mapped onto the sensor signal threshold. The mapping is implemented by a straight line (y = a * X + b).
Example:
If the sensor signal has the values 0.7 volt during rich phase and 0.1 volt during lean phase then the factors are to be deteremined by the following equation.

0.7 = KATBFNM * 1 + KATBFNP
0.1 = KATBFNM * (-1) + KATBFNP

The conclusion from this is KATBFNM = 0.3 volt and KATBFNP = 0.4 volt

Determination of the air mass throughput-dependent time constant KATBFML :

The time constant generally drops with increasing air mass throughput. For differing air mass the ushk-signal is compared with the katbf-signal. If the katbf-signal is attenuated compared to ushk the time constant is decreased. The time constant may not rise during increasing air mass. Whether the characteristic line was adjusted correctly can easily be read by comparing the katbfs-signal with the ushk-signal. Because if katbfs takes a similar course to ushk but katbf does not then the characteristic line was adjusted incorrectly. The precondition for a comparision between the ushk- and the katbf-signal is good conformance of the two signals ahkatn and akatbn.

Determination of the time constants ZDKTBD and ZDKTBF :

The time constant ZDKTBD should be chosen in such a way that only the direct component of the fr-signal is filtered. Here it is possible to determine the period of the fr-signal during idling and to calculate the time constant as follows.

ZDKTBD = [1,5...2,0] * Tp/6 sec (Tp is the period during idling)

The time constant ZDKTBF should be chosen in such a way that the area filtered of (fr-1.0)*ml approximately equals the area lambda * ml. Lambda may either be measured by a LSU-sensor or it may be determined by linearization of the LSH-sensor. If this time constant is chosen too large then the katbfi_w-signal is very attenuated and the katbfs-signal has no ushk-similiar course. Since katbfi_w is used for the physical stop condition the attenuation has a direct influence on the selection of the two application values KATBFIO, KATBFIU. (See application instruction of DKATSTP)

Determination of the two application values KATBSH and KATBSG :

A conformance of the two signals ahkatn and akatbn can mainly be obtained by the correct selection of the KATBSG-values. Both signals are shown during the entire measurement. If akatbn is smaller than ahkatn then the value of KATBSG is too large. Should no conformance be achieved by reduction of the KATBSG then at first ZDKTBF should be checked whether it was not chosen too large and then the characteristic line KATBFML should be changed. Here katbfs shall be similar to ushk.

If the two signals ahkatn and akatbn chiefly correspond the signals ahktki_w and ahkat shall be monitored during the entire measurement range. For this at first the constant KATBFN must be set to ZERO so that it has no influence on the ahktnk-signal during integration.

If the fluctuations of the ahktki_w-signal are smaller than 5 to 10 % and if ahkat fluctuates around zero then KATBSH and KATBSG are adjusted correctly. Should ahkat be positive then KATBSH is too large. If the fluctuations are greater than 10 % then the application of the block should be repeated.

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Application of AHKATB and AHKATS :

A p p l i c a t i o n v a l u e s

ZDKATAD	time constant differentiated signal amplitude	[0,3...0,8...1,0] Sec
ZDKATAF	time constant "absolute value filter" signal amplitude	[2,0...2,5...3,0] Sec
ADKATNF	scaling factor for signal amplitude	[2,0...4,0...8,0] 1/Volt

The values indicated in the middle are reference values

The task of these two blocks is to disconnect the alternating components and to form the rectified mean value of these alternating components.

The ADKATNF factor is introduced due to the comparison of ahkat with avkat from the filter procedure. For this the rectified mean value of the avkat-signal is compared to the rectified mean value of the akatbn-signal after the application of the AKATB-block. The scaling factor results from:

$$\text{ADKATNF} = \frac{\text{mean value of the avkat-signal}}{\text{mean value of the akatbn-signal}} \quad [1/\text{volt}]$$

ADKATNF can also be determined with a washcoat only catalyst such that ahkatn becomes = 1 (ADKATNF*ahkatn = 1).
Should no washcoat only catalyst be present it is possible to take into consideration the sensor voltage in front of the catalyst as output signal.

When selecting the time constant attention should be paid that the output signal is not too attenuated and that the input signal is not filtered too quickly. In principal the reference values should be used.

Compensation of mean value of the rear sensor:

ZDKATSH	Time constant difference mean values	[1...3 ...10] Sec
KATBSHF	weighing factor mean value difference	[1...12...30]
KATBSHG	limitation ahkatn-impact	[0.05...0,2...0,5]

KATBSHF to be chosen so low that no oscillation of %DKAT occurs.

Application of the DKATSTP block:

A p p l i c a t i o n v a l u e s

KATBFSX	limit catalyst stress signal	[0,85.....0,9....1,0] 1/sec
KATBFXM	limit gradient of the KB	[3,0.....6,0....9,0]
TMINKAT	lower limit for temperature	[350.....350....450] °C
NDKTSU	lower limit engine speed range	[640.....720...1000] rpm
NDKTSO	upper limit engine speed range	[1500....2540...4000] rpm
NDKTSUT	lower engine speed function request	[640.....740....1000] rpm
NDKTSOT	upper engine speed function request	[1500....2500...4000] rpm
RLDKTUT	lower load function request	[18.....20.....22] %
RLDKTOT	upper load function request	[27.....30.....53] %
RLDKTSO	upper limit for rl-characteristic line over nmot	[20.....70] %
RLDKTSU	lower limit for rl-characteristic line over nmot	[10.....30] %

nmot / rpm	640	1200	1600	2000	2500
RLDKTSO / %	27	27	42	53	47
RLDKTSU / %	22	20	20	18	22

The values indicated in the middle are reference values. The characteristic lines must be adjusted. The above-mentioned characteristic line values may be used as reference values.

TMINKAT shall guarantee the definate operating readiness of the borderline catalyst.

By means of KATBFXM, KATBFSX an evaluation of the lambda sensor amplitude is refrained from during steady-state operation as well as during non-steady state operation with high catalyst stress. Thus the absolute value filters from the partial function blocks AHKATS, AHKATB and the integrator from the partial function block DKATAW are kept on the old value.

By these factors it is possible to influence the active monitoring time in the FTP test. If they are set to the indicated minimum limits and if the active time is smaller than 90 sec in the FTP test then they must be increased very carefully. In the FTP test a monitoring time in CT-phase of 150 sec is sufficient.

The evaluation time may be influenced by the evaluation range. In this case a compromise between load- engine speed range and the stopping with deactivation factors has to be found. The factors are, however, mainly intended for the stopping during non-steady-state drives or for high catalyst stress.

Application of the evaluation range:

The catalyst conversion monitoring works within one load-engine speed range only. The range is limited by two characteristic lines (rl-characteristic lines) and by two limits (engine speed limits). The range should be surrounded by NDKTSU, NDKTSO, RLDKTSO, RLDKTSU. The largest range is adjusted as follows.

-a) Application of RLDKTSO :
The characteristic line shall be adjusted for high load such that during small engine speed ranges high loads are excluded. In the FTP test in high hills the accelerations are excluded. Very large air masses (approx. 150 kg/h) at higher engine speeds are not to occur in the evaluation range. Thus the main points of the RLDKTSO characteristic line are fixed.

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-b) Application of RLDKTSU
The characteristic line is adjusted for low loads. During low engine speeds small air masses (approx. 12 kg/h) shall not occur in the evaluation range. During higher engine speeds ranges close to the fuel cut-off are to be excluded. Thus the main points of the RLDKTSU characteristic line are fixed.

-c) Application of the NDKTSU and the NDKTSO values
NDKTSU can be set equal to the idle speed. NDKTSO can be limited to the medium engine speed range.

The excluded area should be made as large as possible. In the middle of the area ahkatn shall be approx. 50 % of the maximum value.

Application of the DKATSTB block :

A p p l i c a t i o n v a l u e s

CDKATLK	Codeword stop DKAT while B_lrka	0 ... diagnosis conducted during B_lrka > 0 ... diagnosis topped with B_lrka
DKATCW	Codeword testing mode	0 ... permanent test (—>APEKTDX=255), for application phase only 1 ... one healing test (—>APEKTDX=2) 2 ... single test(—>APEKTDX > 0)
APEKTDX	Max. number of test with an error-result (see DKATCW)	

Application of the DKATAW block:

A p p l i c a t i o n v a l u e s

AHKTTSW	timer setting value	1,0 Sec
KATBFMN	lower threshold for KB-amplitude	[0,1...0,2...0,3]
KATBFN	standardized correction for signal amplitude	[0,1...0,5...1,0]

After the ahkatn-signal and the akatbn-signal have been adjusted so that the ahktki_w-fluctuations are smaller than 10 % and ahkat is approximately zero KATBFN shall be adjusted to the mean value of the ahkatn-signal. This correction works like a straight line with a gradient of one. It intersects with the y-axis at KATBFN. The KATBFN summand enables a comparison between ahkat and avkat.

In case of very small amplitudes it is impossible to differentiate between the borderline catalyst and a catalyst which is to be detected as "good". Due to this reason the integrator and the timer are stopped in case of such amplitudes. This lower limit should be 20 % of the KB-amplitude at the maximum otherwise no DKAT is possible while driving in small load-engine speed ranges.

Application of the DKATEL block:

A p p l i c a t i o n v a l u e s

AHKATMX	threshold value catalyst defect	[0,1....0,5....1,0]
AHKATMN	threshold value catalyst good	[0,1....0,3....1,0]
AHKATS	added-up threshold value (stereo 1. and 2.bank)	[0,2....1,1....2,0]
AHKATSB	adding range threshold value (stereo)	[0,2....1,1....2,0]
TDKATAKT	threshold for active monitoring time	[30.....100....400] sec
TDKATATT	time threshold function request	[10.....30.....50] sec

The values indicated in the middle are reference values.

The threshold for the active monitoring time should be chosen as large as possible in the FTP test so that the standardized integration (ahkat-signal) can stabalize. Due to the quantization the time should, however, not exceed 400 sec.

The AHKATS-value should be at least double that of AHKATMN, AHKATSB must be larger than AHKATMN.

Application of AVKATFS :

AVKATFS	AVKATF setting value	[0,1...0,5...1,0]

AVKATFS is adjusted for a bad catalyst.

TEXT/ANF
Application of speed threshold NKTDX
==========
Above the speed of NKTDX rpm the diagnosis calculation will be stopped due to ECU computation time saving.

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```
  NKTDX       rpm-threshold for calculation inhibit      [3000...4000...5000]  rpm
```

Application of the DKATLRP block :

```
 A p p l i c a t i o n  v a l u e s

  DRLKTDP       Threshold load-transients                       [1....5....20 %]
  ZKTDRL        Time constant rl-low pass                       [0,5....2....4] s
  FALRKTD       Ampl. factor of lambda controller amplitude     [1...1...3]
```

Default-Application: DLRKTDP = -2% (switch off the feature to impact the lambda controller amplitude, because many other moinitoring functions are disturbed).
Recommendation: Switch off this feature of incluencing the lambda controller amplitude.

KATV 1.20 Variant recognition (vehicle with/without cat. converter and lambda sensors)

FDEF KATV 1.20 Function definition

katv-katv

ABK KATV 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDHSV			FW	code word heating diagnose upstr. Kat (CDHSV = 0 => no diagnosis)
UHDMX			FW	Threshold for not powerded heater power stage

Variable	Source	Type	Description
B_CLKATFZ		EIN	condition: reset variant recognittion (with delete adaptation values)
B_NOKATFZ	KATV	AUS	condition: no cat vehicle
C_PWF		EIN	ECU-condition powerfail initialisation
UHSV		EIN	Voltage at the heater output stage upstream of the catalyzer
UHSV2		EIN	Voltage at the heater output stage 2 upstream of the catalyzer

FB KATV 1.20 Detailed description of function

The function KATV recognizes the vehicle variant (with/without catalytic converter and lamda sensors) on the basis of the signals from heating the lambda sensors. The information is stored in the permanent RAM in B_nokatfz (whereby B_nokatfz = 1 denotes a vehicle without catalytic converter).
The vehicle can be programmed by the codeword CDHSV (bit 0 = 1) as a permanent catalytic-converter variant (variant recognition is turned off). If variant recognition is activated by CDHSV (bit 0 = 0), then the variant is set to Vehicle without catalytic converter after each power failure and when the adaptation values are erased.
Vehicle with catalytic converter is recognized as soon as the heater voltage exceeds the threshold UHDMX for a lambda sensor upstream of the catalytic converter, and the bit B_nokatfz is set to False (the label UHDMX is also used in %DHLS !).
The enable bits must be switched in %PROKON by B_nokatfz for diverse functions (DHLS, DKAT, LR ...) such that there are no corresponding entries made in the fault memory for a "Vehicle without catalytic converter".

Diagram for lambda-sensor heating:

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uhsv if no lambda sensor installed
2.5 V (switch open) to 2 V (switch closed)

uhsv if lambda sensor installed
4.2 V (switch open) to 2 V (switch closed)

APP KATV 1.20 Application hint
Übernahme UHDMX aus der %DHLS.

GKEB 3.0 Operating condition mixture control overview

FDEF GKEB 3.0 Function definition

Mixture Control, Adaptation - Activation Conditions:

gkeb-gkeb

ABK GKEB 3.0 Abbreviations

Variable	Source	Type	Description
B_DTEST		EIN	condition for start of TEV opening
B_GAE	DKVS	EIN	condition for adaptive Lambda pilot control successful
B_GAE2		EIN	condition for adaptive lambda pilot control 2 successful
B_GAP	GKEB	AUS	condition mixture adaptation phase active
B_GASP	GKEB	LOK	condition for basic mixture adaptation disabled
B_LR	GKEB	AUS	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	GKEB	AUS	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRA	GKEB	AUS	condition for basic mixture adaptation enabled
B_LRA2	GKEB	AUS	condition for basic mixture adaption 2 enabled
B_LRND	GKEB	AUS	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_LRND2	GKEB	AUS	set control bit LR activ; request for ”NORMAL” or ”DIAGNOSIS”

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Variable	Source	Type	Description
B_MLRSA	GKEB	AUS	LRSEB: Air mass based switch off Lambda Control during and after fuel cut off
B_RLRAB	GKEB	AUS	condition LR off due to high load
B_TE	GKEB	AUS	Condition canister purge active
B_TEABB	TEB	EIN	Condition purge canister function ready to finish
B_TEF	GKEB	AUS	Condition canister purge function principally released
B_TEI	GKEB	AUS	Internal condition: canister purge function active
B_TEP	GKEB	AUS	Condition canister purge phase active
LAMSONS2_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location
TATESOLL	GKRA	EIN	desired duty cycle of the PCV

FB GKEB 3.0 Detailed description of function

```
Functional group, mixture control, switch-on conditions (%GKEB)

Only for 2-point lambda control !!!!!!!

This functional group includes the following functions:

 %LREB    -   Switch-on conditions for 2-point lambda control
 %LRAEB   -   Switch-on conditions for mixture adaptation
 %TEBEB   -   Switch-on conditions for the loading-dependent tank venting
 %BBTEGA  -   Phase control tank venting / mixture adaptation
              (The term "phase control" designates a device which actuates the
              change between a mixture adaptation phase and a tank venting phase)

 Remark: the switch-on conditions for the control after the catalyzer are described in the function "Control after the catalyzer"
         and not in %LREB.

 %LREB   -    Switch-on conditions for 2-point lambda control
              - A number of conditions must be fulfilled for activation of the lambda control.
              - The lambda control must remain disabled (B_lr = FALSE) in particular for OBDII faults which have a strong
                influence on the mixture at the probe
              - Specific conditions must also be fulfilled however.  The most important of these are, e.g.
                - B_sbbvk (readiness for operation by the probe in front of the catalyzer)
                - B_evloc (all EV's triggered)

 %LRAEB   -   Switch-on conditions for mixture adaptation
              - The mixture adaptation has specific switch-on conditions.  A number of OBDII faults thereby disable the mixture
                adaptation.
              - A prerequisite for activation of the mixture adaptation is B_lr
              - The mixture adaptation is furthermore only then activated when there is no tank venting active (B_gap = 1)

 %TEBEB   -   Switch-on conditions for the loading-dependent tank venting
              - The tank venting valve is opened during a tank venting phase (B_tep)
              - Furthermore, certain conditions must be fulfilled in order that the tank venting can be activated.
                (e.g. engine temp. > threshold).  The TEV can only be opened if the bit B_tef (condition for release of tank
                venting) is TRUE.
              - Furthermore, it is differentiated between controlled tank venting (e.g. the probe is defective) and regulated tank
                venting.  A regulated tank venting (loading-dependent) is only activated for B_tei.  To the extent that
                B_tef = TRUE, the TEV can also be opened for B_tei = FALSE by controlled performance characteristics (emergency
                run TE).
              - The bit B_te indicates that the TEV is still opened for "normal TEB" (regulated TE).  B_te is only the reset
                if the TEV is completely closed, e.g. following a TE phase.

 %BBTEGA  -   Phase control tank venting / mixture adaptation
              The phase control brings about the change mixture adaptation / tank venting and shall meet OBDII requirements in
              particular.  Hence switchover to long tank venting phase is only then made after an established mixture adaptation
              (B_gae = TRUE). Tank venting can be terminated intentionally by means of a customer servicing tester and the mixture
              adaptation activated for diagnosis purposes.
```

APP GKEB 3.0 Application hint

Not applicable here as all parameters are described in the appropriate functions.

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GKRA 3.0 Mixture control and adaptive pilot control

FDEF GKRA 3.0 Function definition

Overview Mixture Control and Adaptation:

gkra-gkra

ABK GKRA 3.0 Abbreviations

Variable	Source	Type	Description
B_DLDPTE	GKRA	AUS	request from evap system monitoring to shut down PCV
B_DTEAAV	GKRA	AUS	canister vent valve closed
B_DTEFRR	GKRA	AUS	condition of lambda controller reset
B_DTES	GKRA	AUS	Condition for active diagnosis of canister purge system
B_FRINI	GKRA	LOK	Condition control factor fr initialize
B_LL	MSF	EIN	Condition idle
B_LR	GKRA	LOK	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	GKRA	LOK	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRA	GKRA	LOK	condition for basic mixture adaptation enabled
B_LRA2	GKRA	LOK	condition for basic mixture adaption 2 enabled
B_LRKA	GKRA	LOK	condition for neutralization of catalyst oxygen storage
B_LRKA2	GKRA	LOK	condition for neutralization of catalyst oxygen storage, cylinder row 2
B_LRND	GKRA	LOK	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_LRND2	GKRA	LOK	set control bit LR activ; request for ”NORMAL” or ”DIAGNOSIS”
B_TE	GKRA	LOK	Condition canister purge active
DFRKA2_W	GKRA	LOK	delta-fr for open loop catalyst oxygen neutralization, bank 2
DFRKA_W	GKRA	LOK	delta-fr for open loop catalyst oxygen neutralization
DTVKA	GKRA	LOK	delta-tv for catalyst oxygen neutralization
DTVKA2	GKRA	LOK	delta-tv for catalyst oxygen neutralization for 2nd bank of stereo lambda contr.
E_FRA	GKRA	AUS	error flag: multiplicative mixture adaptation factor fra
E_FRA2	GKRA	AUS	error flag: multiplicative mixture adaption factor fra2
FR	GKRA	LOK	Lambda controller output
FR2_W	GKRA	AUS	Lambda controller output (word)
FRA	GKRA	LOK	multiplicative mixture adaptation factor
FRA2_W	GKRA	AUS	multiplicative correction of the mixture adaptation (word)
FRAO2_W	GKRA	LOK	multipl. mixture adaptation factor higher load bank 2 (Word)
FRAO_W	GKRA	LOK	multipl. mixture adaptation factor higher load (word)
FRAU2_W	GKRA	LOK	multipl. mixture adaptation factor of the lower mult. section of bank 2 (Word)
FRAU_W	GKRA	LOK	multipl. mixture adaptation factor of the lower mult. section (Word)
FRA_W	GKRA	AUS	multiplicative correction of the mixture adaptation (word)
FRDTER_W	GKRA	LOK	lambda control factor as reference value for CPV diagnosis
FRINI_W	GKRA	LOK	Initialisation value for control factor lambda control
FRM2_W	GKRA	LOK	fast mean value of lambda control factor bank 2(word)
FRM_W	GKRA	LOK	fast mean value of lambda control factor (word)
FR_W	GKRA	AUS	Lambda controller output (word)
LAMSONS2_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location
MIFA_W	MDFAW	EIN	desired indicated engine torque
MITEBG_W	GKRA	AUS	torque value for minimum charge canister purge
MSTE_W	BGTEV	EIN	mass flow purge control into the manifold
PTE		EIN	tank pressure (from ADC)
RKA2_W	GKRA	AUS	additive adaptive correction of the relative fuel amount bank 2
RKAT2_W	GKRA	LOK	additive correction (per time) of the mixture adaptation bank 2 (Word)
RKAT_W	GKRA	LOK	additive correction (per time) of the mixture adaptation (Word)
RKAZ2_W	GKRA	LOK	additive corretion (per ignition) of the mixture adaptatition Bank 2 (Word)

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Variable	Source	Type	Description
RKAZ_W	GKRA	LOK	additive correction (per ignition) of the mixture adaptation
RKA_W	GKRA	AUS	additive adaptive correction of the relative fuel amount
RKTE_W	GKRA	AUS	relative fuel part of the purge control
TADTEA	GKRA	LOK	TEV duty cycle from canister purge diagnosis
TATESOLL	GKRA	AUS	desired duty cycle of the PCV
TVLRH	GKRA	LOK	LRHK: correction value for delayed controller switch tv
TVLRH2	GKRA	LOK	LRHK: correction value for delayed controller switch tv 2
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USVK2_W	GGLSV	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst 2
USVK_W	GGLSV	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst
Z_FRA	GKRA	AUS	cycle flag of mixture adaption factor fra
Z_FRA2	GKRA	AUS	cycle flag:ˆLambda adaptation multiplicative (bank 2)

FB GKRA 3.0 Detailed description of function

Only for 2-step Lambda control !!!

Overview of Lambda control, mixture adaptation, purge control, tank diagnosis including the activation conditions.
Also contains the phase control mixture adaptation / purge control (%BBTEGA in %GKEB).

APP GKRA 3.0 Application hint

LREB 123.60 Activation conditions for lambda closed loop control

FDEF LREB 123.60 Function definition

Activation conditions Lambda control upstream catalyst total overview

lreb-lreb

B_lr shows for all sections, which evaluate this bit, the state of the Lambda control (B_lr = TRUE means Lambda control is active).
B_lrnd is activated in addition to B_lr as soon as the Lambda control, e.g. for diagnostic purposes, is necessary the controller factor fr_w, however, would lie in non-plausible ranges or in case a lean engine operation is to be prevented for lamsons < 1 or a rich engine operation is to be prevented for lamsons > 1.
Two paths during the formation of B_lr and B_lrnd ensure this:

- For lamsons <> 1 B_lr is set to FALSE, lean/rich protection is activated by B_lrnd = TRUE.
- LC is blocked during SLS/DSLS, with lamsons >1 rich protection is activated during DSLS if necessary
- LC By B_vag = TRUE OR B_bag = TRUE (from UKSEFI) B_lr is set to FALSE for an adjustable time.
  Lean protection is activated via B_lrnd = TRUE if necessary.

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LREB100MS: Activation conditions for control upstream catalyst determined in the 100 ms cycle

lreb-lreb100ms

LREBRLLR: Evaluation of load threshold

lreb-lrebrllr

LREBPSPWL: Warm-up specific activation conditions for control upstream catalyst

lreb-lrebpspwl

Activation / deactivation: - If the hot start condition TMST > TMSHS and TANSST > TASHS is fulfilled during start, the delay time TLRHS is set. TLRHS operates as of end of start and accordingly delays the start of the Lambda control upstream catalyst.

Via the local bit B_tarau it is possible to alternatively define another temperature threshold for the activation of the Lambda control. This may e.g. be necessary on systems with an evaluation of the intake air temperature.

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LREBTMLR: TMOT- and TANS-dependent activation conditions for control upstream catalyst

lreb-lrebtmlr

LREBBAVA: Evaluation of lean and rich protection condition and of transient control bits B_vag/B_bag

lreb-lrebbava

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LREBPSPA: Project-specific deactivation conditions for control upstream catalyst
==========

lreb-lrebpspa

LROBD: OBDII deactivation conditions
==========

lreb-lrobd

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LREBLERICN: Evaluation of lean and rich protection condition

lreb-lreblericn

LREBLEANPR: Subfunction lean protection

lreb-lrebleanpr

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LREBRICHPR: Subfunction rich protection
==========

lreb-lrebrichpr

Conditions for lean / rich protection (only active during DSLS-operation)
==========

The lean protection monitoring is activated by lamsons_w < 1.

The lean protection function is triggered by the condition

((usvk = "lean") AND (fr_w = 1)) OR (fr_w >1)

The lean protection function is reset by the condition

((usvk = "rich") AND (fr_w = 1))

((B_mslr = TRUE & blocking conditions = FALSE) ——> B_lrnd = TRUE and B_lr = FALSE)

The rich protection monitoring is activated by lamsons_w > 1.

The rich protection function is triggered by the condition

((usvk = "rich") AND (fr_w = 1)) OR (fr_w <1)

The rich protection function is reset by the condition

((usvk = "lean") UND (fr_w = 1))

((B_fslr = TRUE & blocking conditions = FALSE) ——> B_lrnd = TRUE and B_lr = FALSE)

LREBMLSA: Checking on air mass integral after fuel cut-off
==========

lreb-lrebmlsa

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LREBVK: Formation of the bits B_lr and B_lrnd

lreb-lrebvk

LREBFRZ1: CARB Freeze Frame - status byte of the LC, at stereo LC for bank 1 (flglrs)

lreb-lrebfrz1

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LREBFRZ2: CARB Freeze Frame - status byte of the LC, at stereo LC for bank 2 (flglrs2)

lreb-lrebfrz2

Remark: The bits should be checked upon in above-mentioned order. If one of the bits Bit0, Bit1, Bit2 or Bit3 is set to TRUE, no further checking is to be performed. By the thus given priority of the evaluation it is ensured that 2 bits cannot be set simultaneously in the freeze frame byte.

ABK LREB 123.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CLRZWTMS			FW	Codeword for hard activation of LR according to CARB
DTMR			FW	hysteresis for cut-in threshold
DTMTMRW			FW	temperature difference thresh. for detection of hard LC-switch on
IMLSALR			FW	thresh.value integr.air mass for activ.delay of lambda contr.after fuel cut-off
NLRSHB			FW	eng.speed thesh.,turn-off lamb.cont.during overrun,in connec.with idle a.TLLRSHB
RLLRSHB			FW	load thresh.,turn-off lambda contr.during sec. air,in connect.with idle a.NLRSHB
RLLRUN	NMOT		KL	char.line above nmot,lower rL control limit for controller in front of catalyst
RLRAN	NMOT		KL	load threshold lambda closed-loop control
RLRVAO			FW	Upper rl-threshold for trigger of LR stopped during transient VA
TARAU			FW	air temperature threshold for closed loop lambda - control switching on
TASHS			FW	threshold intake air temp.for trigg.of TLRHS-blocking time LC during hot start
TLRBAM	TMOT		KL	blocking time for activation LC after BA
TLRHS			FW	blocking time LC during hot start, triggered via thresholds TASHS and TMSHS
TLRTMS	TMST		KL	lock time for CL lambda control after start, depending on engine start temperatu
TLRVAM	TMOT		KL	blocking time for activation LC after VA
TLRZWTMS	TMST		KL	Time until hard LC switch on after start (CARB)
TMRA1			FW	cut-out condition (idle-speed switch = 0)
TMRA2			FW	cut-out condition (idle-speed switch = 1)
TMRAK			FW	cut-out threshold of lambda closed-loop control at low starting temperature
TMSHS			FW	threshold engine temp.for triggering of TLRHS-blocking time LC during hot start
TRAB			FW	monitoring time for load threshold lambda closed-loop control
TRAU			FW	monitoring time for lower load limit of lambda closed-loop control
TSBBVTMS	TMST		KL	time delay control readiness after sensor readiness
USR			FW	controller theshold for lambda control upstream catalyst

Variable	Source	Type	Description
B_BAG	ESUK	EIN	Condition large accel. enrichment
B_BLKMD	DMDMIL	EIN	MIL-trigger blinking controlled by misfire detection
B_BVDEL	LREB	LOK	OR-logic interconnection for the stop condition B_bag / B_vag
B_CRAUS		EIN	Tested by LREB: Workshop bit to stop LR
B_DSL	DSLSLR	EIN	Condition request of diagnosis
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_DSLSK		EIN	COndition secondary air diagnosis short trip
B_EEV	DEVE	EIN	condition injector fault (power stage)
B_EOBDLR	LREB	LOK	error flag:^OBDII summary fault, disables lambda control
B_EOBDLR2	LREB	LOK	error flag:^OBDII summary fault, disables lambda control, bank 2
B_ESLS	DSLSLR	EIN	Condition secondary air fault by wrong air mass flow
B_EVLOC	AEVAB	EIN	Status: all injection valves are activated

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Variable	Source	Type	Description
B_FALR		EIN	condition: requirement open loop
B_FSLR	LREB	LOK	Condition LR activ/inactiv during rich open loop (lamsons_w < 1.0)
B_FSLR2	LREB	LOK	Condition LR activ/inactiv during rich open loop (lamsons_w < 1.0) bank 2
B_KSE	ESKS	EIN	condition enrichment at knock protect
B_LL	MSF	EIN	Condition idle
B_LR	LREB	AUS	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	AUS	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LR2S	LREB	LOK	CARB freeze frame, cyl.row 1 bit 1, LR:closed loop operating with two sensors
B_LR2S2	LREB	LOK	CARB freeze frame, cyl.row 2 bit 1, LR:closed loop operating with two sensors
B_LREB100	LREB	LOK	Collection bit of stop condition during a 100ms-slot
B_LREBLE	LREB	LOK	Condition LR inactiv during lean out and lambda sensor indicates ”rich”
B_LREBLE2	LREB	LOK	Condition LR inactiv during lean out and lambda sensor indicats ”rich” bank 2
B_LREBPR		EIN	Condition LR inactiv during enrichment and lambda sensor indicates ”lean”
B_LREBPR2		EIN	Condition LR inactiv during enrichment and lambda sensor indicates ”lean”
B_LREBRI	LREB	LOK	cond. lambda control inact. while open loop: lamsons_w < 1, B_vl, B_vag or B_bag
B_LREBRI2	LREB	LOK	cond. lambda control inact. while open loop: lamsons_w < 1, B_vl, B_vag or B_bag
B_LRKAST		EIN	condition for neutralization of catalyst oxygen storage, open loop
B_LRKAST2		EIN	condition for neutralization of catalyst oxygen storage,open loop,bank 2
B_LRND	LREB	AUS	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_LRND2	LREB	AUS	set control bit LR activ; request for ”NORMAL” or ”DIAGNOSIS”
B_LRNDA	LREB	AUS	lambda control bank 1 active by conditions : B_lrpspa & B_lrkasn & !E_obdlr
B_LRNDA2	LREB	AUS	lambda control bank 2 active by conditions : B_lrpspa & B_lrkasn & !E_obdlr
B_LRPSPA	LREB	LOK	LREB: Project specific condition for lambda closed loop control upstream cat.
B_LRRL	LREB	LOK	LREB: Load dependend condition for lambda closed loop control upstream catalyst
B_LRVK	LREB	LOK	CARB freeze frame,cyl.row 1 bit 4,LR:closed loop contr. with one sensor (upstr.)
B_LRVK2	LREB	LOK	CARB freeze frame,cyl.row 2 bit 4,LR:closed loop contr. with one sensor (upstr.)
B_LRWLA	LREB	LOK	lambda control active by conditions : B_lrrl & B_tmlr & B_pspwl & B_stend
B_LSVVSP	DLSVV	EIN	condition for exchange lambda sensor; lambda control stopped
B_MLRSA	LREB	AUS	LRSEB: Air mass based switch off Lambda Control during and after fuel cut off
B_MSFSLR	LREB	LOK	Condition LR activ/ inactivduring rich/lean protection
B_MSFSLR2	LREB	LOK	Condition LR activ/ inactivduring rich/lean protection, bank 2
B_MSLR	LREB	LOK	Condition LR activ/inactiv during rich/lean protection
B_MSLR2	LREB	LOK	Condition LR activ/ inactiv during rich/lean protection
B_NOLRB	LREB	LOK	CARB freeze frame, cyl.row 1 bit 2, LR:open loop operating by operating condit.
B_NOLRB2	LREB	LOK	CARB FREEZE FRAME, bank2 Bit 2, LR: open loop control by operation condition
B_NOLRE	LREB	LOK	CARB freeze frame, cyl.row 1 bit 3, LR:open loop operating by system fault
B_NOLRE2	LREB	LOK	CARB FREEZE FRAME, bank2 bit 3, LR: open loop after system error
B_NOLRW	LREB	LOK	CARB freeze frame,cyl.row 1 bit 0,LR:open loop opera.,start cond.not yet fulfil.
B_NOLRW2	LREB	LOK	CARB FREEZE FRAME, bank2 bit 0, LR: open loop,start condition not fullfilled
B_PSPAUS	LREB	LOK	condition lambda control inactive by project spezific off-condition
B_PSPWL	LREB	LOK	condition lambda control inactive by project spezific warmup condition
B_SA	MDRED	EIN	Condition fuel cut-off
B_SBBVK	DLSV	EIN	condition for lambda sensor upstream cat ready for operation
B_SBBVK2	DLSV	EIN	condition oxygen sensor upstream cat. bank2 ready for operation
B_SLS	SLS	EIN	Condition for active secondary air
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
B_SLSOFF	SLS	EIN	Condition end of secondary air after removing secondary air
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_TARAU	LREB	LOK	LREB: condition start for low intake air temperatures
B_TEMIN	RKTI	EIN	Condition: TEMIN-limitation active, bench 1
B_TEMIN2	RKTI	EIN	Condition: TEMIN-limitation active, bench 2
B_TMLR	LREB	AUS	LREB: Engine Temperature dependend condition for lambda closed loop control u.C.
B_VAG	ESUK	EIN	Condition large deceleration enleanment
C_INI		EIN	ECU-condition for intialisation
E_LSV	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_LSV2	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_SLPE	DSLPE	EIN	error flag: secondary air pump (power stage)
E_SLVE	DSLVE	EIN	error flag: secondary air valve (power stage)
FLGLRS	LREB	AUS	CARB FREEZE FRAME byte, bank 1, for lambda control
FLGLRS2	LREB	AUS	CARB FREEZE FRAME byte, bank 2, for lambda control
FR2_W	LR	EIN	Lambda controller output (word)
FR_W	LR	EIN	Lambda controller output (word)
IMLRSA_W	LREB	DOK	air mass after fuel cut-off for continuous lambda control
LAMSONS2_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_T10		EIN	Time schedule 10 ms
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TANS	GGTFA	EIN	Intake air temperature
TANSST	LREB	DOK	Intake air temperature at cranking
TMOT	GGTFM	EIN	Engine temperature
TMOTLIN	GGTFM	EIN	Engine coolant temperature, linearised and calculated
TMRW	GGTFM	EIN	model-based reference value for plausibility check of engine temperature signal
TMST	GGTFM	EIN	engine temperature at start
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2

Label for stereo LC

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FB LREB 123.60 Detailed description of function

1.1 Activation / deactivation via temperature thresholds TMRA1 (partial load) TMRA2 (idle) TMRAK (no emission test)

1.1.1 Activation at Tmot > TMRAx + DTMR
Deactivation at Tmot < TMRAx
1.1.2 If the condition Tmot > TMSHS and Tans > TASHS is fulfilled at start, then activate as from end of start after a delay time t > TLRHS.
1.1.3 Activate as from end of start after a delay time TLRTMS dependent on the engine temperature at start.

1.2 Sensor operating readiness

Activation / deactivation when flag B_sbbvk from %DLSV is set / not set.

1.3 Switch-over to open-loop control under certain conditions, hence switch-over to closed-loop control

Switch-over to open-loop control:

1.3.1 at start
1.3.2 at fuel cut-off (B_sa = 1); until throughput of air mass IMLSALR after transition from (B_sa : 1 ——> 0)
1.3.3 while UKSEFI status B_bag = 1 OR while UKSEFI status B_vag = 1
1.3.4 when exceeding a load threshold rl > RLLRUN(nmot) after a delay time t > TRAB
1.3.5 Lambda setpoint lamsons_w <> 1.0
1.3.6 at idle, if (B_ll = 1) & tl >= TLLRSHB & n >= NLRSHB
1.3.7 while function secondary air is active (B_sls = 1), is achieved indirectly by lamsons_w > 1
1.3.8 Lambda control is blocked after function secondary air until the bit B_slsoff (from %DSLS) has been set
Checking of bit B_slsoff is blocked as long as bit B_sls is TRUE
1.3.9 while the function "open-loop controlled catalyst purging" is active

Switch-over to closed-loop control:

1.3.10 at full load and ready control sensor OR while UKSEFI-status B_bag = 1 OR while UKSEFI-status B_vag = 1,
and under the following conditions:
((lean mixture, usvk < USR) AND (fr >= 1.0)) OR ((rich mixture, i.e. usvk) > (USR fr > 1.0)
independent of temperature-dependent activation conditions

1.4 Switch-over to open-loop control during OBDII fault detection

Switch-over to open-loop control:

1.4.1 at fault injector output stage
1.4.2 at detected catalyst-damaging misfires with B_blkmd
1.4.3 with fault secondary air system (leakage air)
1.4.4 with fault of SLV/SLP output stage

1.5 Switch-over to open-loop control under further project-specific deactivation conditions

Switch-over to open-loop control project-specifically:

1.5.1 as soon as B_evloc := 0; the following applies to the following conditions

1.5.1.1 at active engine speed limitation
1.5.1.3 at speed limitation

1.5.2 As soon as bit B_craus is set; mode basic setting:
Permits open-loop controlled operating of the engine by the workshop
for diagnostic purposes

2.1 Switch-over to closed-loop control at forced activation (according to CARB requirement)

2.1.1 CLRZWTMS > 0
Switch-over to closed-loop control at forced activation after tmot-fault was suspected as soon as the difference between the model engine temperature tmrw and the engine temperature raw value is greater than the threshold DTMTMRW, the LC is activated forcibly after the time TLRZWTMS = f(tms).

2.1.2 CLRZWTMS = 0
Switch-over to closed-loop control at forced activation
The LC is activated forcibly after the time TLRZWTMS = f(tms)

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APP LREB 123.60 Application hint

LR 74.50 Lambda closed loop control

FDEF LR 74.50 Function definition

Changes with regard to previous version:
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1. The Lambda shift during catalyst drainage is in future controlled via the Lambda coordination. The inputs dfrka_w and dfrka2_W are thereby dropped.
2. The bit B_lrsp became active for each P step change in the previous version. The behavior of the bit was adjusted to the original meaning (sensor step change identifier). The fr step change is controlled by the new B_frsp.
3. Single large symmetrical deviations of the control factor fr (quotient tfrn/tfrp lies within the band) are not included in the calculation when forming the filtered amplitudes dfrst_w/dfrst2_w. Short interferences are thereby masked during the determination of the amplitudes.
4. The DKAT can modify the amplitude of the Lambda control via the bit B_dktlp and the factor falrdkt. For this, falrdkt acts on the integrator gradient as well as on the height of the P step change.
5. If the sensor heating is clocked after engine start, the sensor will react with a distinctly increased reaction time. With not changed integrator gradient this leadsto an increased amplitude of fr_w with a negative influence on the performance of the engine. The integrator speed is therefore reduced by multiplication in dependency on the engine temperature at start. The sensor is heated with maximum performance once end of dew point is reached. The increasing dynamics of the sensor is realized via a PT1 actuator by an increasing control of the integrator gradient to the full value.
6. The effect of the characteristic FLRM is changed. The factor now only has an effect on the output of KFRI.

In the section function definition the function extent of the Lambda control is described. The representation is illustrated by means of hierarchically structured block diagrams:

Bank 1 and bank 2

1. Lambda controller bank1 and bank2 with global functions I selection and tv-calculation

1.1 Lambda controller formation of total tv-time for bank1 and bank2
1.2 Lambda controller formation of function-specific integrator gradient,
P step change value and fr limitation for bank1 and bank2
1.2.1 Lambda controller formation of bank-specific integrator gradient, P step change value

Bank 1

2. Lambda controller basic structure with state machine, fr integrator and monitor block

2.1 Lambda controller state machine for control of integrating, P step change and tv-time
2.2 Lambda controller formation of the internal control factor frint_w

Bank 2

3. Lambda controller basic structure with state machine, fr integrator and monitor block

Monitor functions to Lambda control bank 1

4. Lambda controller overview of basic blocks for determination of steady-state condition,
fr mean value frm_w and period

4.1 Lambda controller determination of time-based steady-state condition
4.2 Lambda controller calculation of period of fr
4.3 Lambda controller formation of current control lift dfrps_W
4.4 Lambda controller formation of fr mean value frm_w
4.4.1 Lambda controller formation of fr mean value, state machine
4.5 Lambda controller determination of amplitude-based steady-state condition, adaptation controller lift
4.6 Lambda controller detection of exceeding of amplitude
4.7 Lambda controller output of state valid period and steady-state condition time/amplitude

1. Lambda controller bank1 and bank2 with global functions I selection and tv-calculation

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lr-lr

1.1 Lambda controller formation of total tv-time

lr-tvlr

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1.2 Lambda controller formation of function-specific integrator gradient, P step change value and fr limitation

lr-lripxsel

1.2.1 Lambda controller formation of bank-specific integrator gradient, P step change value

lr-lrip

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1.2.2 Lambda controller formation of the bank-specific integrator gradient after engine start

lr-lrfrimst

2. Lambda controller basic structure bank 1

lr-lrbank1

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2.1 Lambda controller state machine for the controlling of integrating, P step change and tv-time

lr-lrza

2.2 Lambda controller formation of the internal control factor frint_w

lr-frint

3. Lambda controller basic structure bank 2

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lr-lrbank2

4. Lambda controller overview of the basic blocks for determination of steady-state condition, fr mean value frm_w and period

lr-lrmonit

4.1 Lambda controller determination of time-based steady-state condition

lr-bb-quot

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4.2 Lambda controller calculation of period of fr

lr-lr-tp

4.3 Lambda controller formation of current control lift dfrps_W

lr-lr-dfrsp

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4.4 Lambda controller formation of fr mean value frm_w

lr-lr-frm

4.4.1 Lambda controller formation of fr mean value, state machine

lr-frm-aut

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4.5 Lambda controller determination of amplitude-based steady-state condition, adaptation controller lift

lr-lr-hub

4.6 Lambda controller detection of exceeding of amplitude

lr-bb-amplue

4.7 Lambda controller output of status valid period and steady-state condition time/amplitude

lr-bb-stat

ABK LR 74.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CFRA			FW	code word for adaptation of control amplitude
DFRMN			FW	min. lambda deviation for steady state cond. and adaptation of transient contrl.
DFRSPS			FW	stroke of A/F ratio controller signal (standard value)
FFRITMS	TMST		KL	tmst dependent factor to modify I-dynamic of lambda control
FLRFKATE	FKATEI		KL	Rating of factor fkatei from %TEB to optimize the regulation parameter
FLRM	TMOT		KL	Engine temperature dependent factor to modify I-dynamic of lambda control
FRIPTES			FW	Factor adjustment of fri and frp at fault ”open TEV pinch”
FRMAX			FW	upper limit of control range
FRMIN			FW	lower limit of control range
FRTEMX			FW	upper limit of control range on error ”cannister purge valve open”
KFRI	NMOT	RL	KF	I characteristic map

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Parameter	Source-X	Source-Y	Type	Description
KFRI2	NMOT	RL	KF	LR-I-Map for bank 2
KFRP	NMOT	RL	KF	P characteristic map
KFRP2	NMOT	RL	KF	LR-P MAP for bank 2
KFRTV	NMOT	RL	KF	delay time characteristic map
KFRTV2	NMOT	RL	KF	delay time characteristic map
QUFRMN			FW	lower limit for static condition of lambda controller
QUFRMX			FW	upper limit for static condition of lambda controller
TSPERN	NMOT		KL	lock time for p-offset after lambda sensor voltage jump
TSPERN2	NMOT		KL	lock time for p-offset after lambda sensor voltage jump, bank 2
USR			FW	controller theshold for lambda control upstream catalyst
ZDFR			FW	filter constant for calc. of A/F ratio contr. stroke mean value
ZLRFRI			FW	Time constant for ingreasing of tmst depending weighting factor FFRITMS

Variable	Source	Type	Description
B_ATMTPA	ATM	EIN	condition temperature upstream catalyst exceeds dew-point
B_ATMTPA2	ATM	EIN	condition temperature upstream catalyst exceeds dew-point2
B_DFRF	LR	AUS	rich deviation by %LR detected
B_DFRF2	LR	AUS	rich deviation by %LR detected, bank2
B_DFRM	LR	AUS	lean deviation by %LR detected
B_DFRM2	LR	AUS	lean deviation by %LR detected, bank2
B_DKTLP	DKAT	EIN	Request of parameter switch over in lambda control
B_FRAB	LR	AUS	condition fr outside adapted controller range
B_FRAB2	LR	AUS	condition fr outside adapted controller range, bank 2
B_FRINI	LRINI	EIN	Condition control factor fr initialize
B_FRINI2	LRINI	EIN	Condition control factor fr initialize, bank 2
B_FRMAX	LR	AUS	lambda control sets bit when lambda controller reaches its limit FRMAX
B_FRMAX2	LR	AUS	lambda control sets bit when lambda control reaches it limit FRMAX, bank2
B_FRMIN	LR	AUS	lambda control sets bit when lambda controller reaches its limit FRMIN
B_FRMIN2	LR	AUS	lambda control sets bit when lambda control reaches its limit FRMIN,bank2
B_FRMINI	LR	LOK	condition for initialize frm
B_FRMINI2	LR	LOK	condition for initialize frm bank 2
B_FRSP	LR	LOK	Flag controller factor fr is jumping
B_FRSP2	LR	LOK	Flag controller factor fr is jumping, Bank 2
B_INIFRM	LR	LOK	Condition for the choixe of initial value of frm_w
B_INIFRM2	LR	LOK	Condition for the choixe of initial value of frm_w , bank 2
B_INT	LR	LOK	LR: Condition Intregation allowed
B_INT2	LR	LOK	LR: Condition Intregation allowed , bank 2
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRND	LREB	EIN	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_LRND2	LREB	EIN	set control bit LR activ; request for ”NORMAL” or ”DIAGNOSIS”
B_LRSP	LR	AUS	Flag ’O2 sensor voltage crosses threshold detected’
B_LRSP2	LR	AUS	condition for sensor signal bounce cylinderbench 2
B_LRSTAT	LR	AUS	static condition for lambda controller
B_LRSTAT2	LR	AUS	static condition for lambda controller, bank2
B_LRSTTA	LR	AUS	static condition for lambda controller, time and amplitude
B_LRSTTA2	LR	AUS	static condition for lambda controller, time and amplitude, bank2
B_LRTPP	LR	AUS	Periodic time valid, static cond. for %LR (amplitude/periodic time) = TRUE
B_LRTPP2	LR	AUS	static condition for lambda controller (amplitude/periodic time) bank2
B_PWF		EIN	Condition for powerfail
B_SGNALT	LR	LOK	Indication of rich / lean mixture pre cat, 1 slot retarded
B_SGNALT2	LR	LOK	Indication of rich / lean mixture pre cat, 1 slot retarded
B_SGNLR	LR	AUS	calculation sign for mixture upsteam cat (Bool)
B_SGNLR2	LR	AUS	calculation sign for mixture upsteam cat (Bool), bank 2
B_SGNRA	LR	LOK	Indication of rich / lean mixture pre cat due to delay time control
B_SGNRA2	LR	LOK	Indication of rich / lean mixture pre cat due to delay time control bank2
B_TE	TEBEB	EIN	Condition canister purge active
B_TEHBX	TEB	EIN	Condition load integrator ftead at max. limit
B_TSPER	LR	LOK	LR: Condition Start of delay time
B_TSPER2	LR	LOK	LR: Condition Start of delay time, bank 2
B_TSPON	LR	LOK	Condition of start of delay time in LR for signal interference elimination
B_TSPON2	LR	LOK	Condition of start of delay time in LR for signal interference elimination,bank2
C_INI		EIN	ECU-condition for intialisation
DFRSP2_W	LR	AUS	delta peak value lambda control factor frsp bank 2
DFRSP_W	LR	AUS	delta peak value lambda control factor frsp
DFRST2_W	LR	AUS	A/F ratio controller output stroke in steady-state condition (cylinderbench 2)
DFRSTGA2_W	LR	LOK	controller output stroke in steady-state condition (basic adaptation), bank 2
DFRSTGA_W	LR	LOK	controller output stroke in steady-state condition (basic adaptation)
DFRSTTE2_W	LR	LOK	controller output stroke in steady-state condition (canister purge), bank 2
DFRSTTE_W	LR	LOK	controller output stroke in steady-state condition (canister purge)
DFRST_W	LR	AUS	A/F ratio controller output stroke (steady-state condition)
DTVKA	LRKA	EIN	delta-tv for catalyst oxygen neutralization
DTVKA2	LRKA	EIN	delta-tv for catalyst oxygen neutralization for 2nd bank of stereo lambda contr.
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
FALRDKT	DKAT	EIN	Request form cat monitoring: modify lambda controller amplitude
FFRI	LR	LOK	LR with integrator stop: weighing factor I-Slope to compensate slow sensor
FFRI2	LR	LOK	LR with integrator stop: weighing factor I-Slope to compensate slow sensor,bank2
FKATEI	TEB	EIN	factor fuel part purge control (actuel value)
FLR_AP		EIN	LR: rich shift by TV-adjustable via VS23
FR2_W	LR	AUS	Lambda controller output (word)
FRBAND2_W	LR	LOK	Close loop regulation frm calculation local variable Bank2

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Variable	Source	Type	Description
FRBAND_W	LR	LOK	Close loop regulation frm calculation local variable Bank2
FRI	LR	LOK	LR with integrator stop: gradient from KFRI(n,tL) or corresp. to DSLS
FRI2	LR	LOK	bank2: LR with integrator stop: gradient from KFRI(n,tL) or corresp. to DSLS
FRIBAND2_W	LR	LOK	Close loop regulation frm calculation local variable Bank2
FRIBAND_W	LR	LOK	Close loop regulation frm calculation local variable
FRIINT	LR	LOK	gradient from KFRI(nmot,rL) or corresp. to DSLS, local use
FRIINT2	LR	LOK	gradient from KFRI(nmot,rL) or corresp. to DSLS, local use, bank 2
FRINI2_W	LRINI	EIN	Initialisation value for control factor lambda control, bank 2
FRINI_W	LRINI	EIN	Initialisation value for control factor lambda control
FRINT2_W	LR	LOK	Close loop lambda coltrol regulation factor Bank 2 Integrator value
FRINT_W	LR	LOK	Close loop lambda coltrol regulation factor Integrator value
FRM2_W	LR	AUS	fast mean value of lambda control factor bank 2(word)
FRMN2_W	LR	AUS	lambda regulator output min., bank 2
FRMN_W	LR	AUS	lambda regulator output min.
FRMX2_W	LR	AUS	LR bank 2: Maximum limit. of integrator fr;FRMAX increased by DSLS
FRMX_W	LR	AUS	LR with integrator stop:Maximum limit. of integrator fr;FRMAX increased by DSLS
FRM_W	LR	AUS	fast mean value of lambda control factor (word)
FRP	LR	LOK	LR with integrator stop; P-jump from KFRP(n,tL), or DSLS enabled
FRP2	LR	LOK	bank2: LR with integrator stop; P-jump from KFRP(n,tL), or DSLS enabled
FRPINT	LR	LOK	P-part from KFRP(nmot,rL) or corresp. to DSLS, local use
FRPINT2	LR	LOK	P-part from KFRP(nmot,rL) or corresp. to DSLS, local use, bank 2
FRSP2_W	LR	LOK	Lambda close loop control: Regulation factor fr before p-jump bank2/min-value)
FRSP_W	LR	LOK	Lambda close loop control: Regulation factor fr before p-jump
FRTV	LR	LOK	integrator stop from KFRTV(nmot,rL) or corresp. to DSLS
FRTV2	LR	LOK	integrator stop from KFRTV(nmot,rL) or corresp. to DSLS, bank 2
FR_W	LR	AUS	Lambda controller output (word)
LRFRMZ	LR	LOK	Condition byte, Creation of fr-mean value frm_w
LRFRMZ2	LR	LOK	Condition byte of calculation Fr-meam value frm_w, Bank2
LRFRZ	LR	LOK	Condition byte of LR-machine
LRFRZ2	LR	LOK	Condition byte of LR-machine , bank2
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_T100		EIN	Time schedule 100 ms
SY_STERSY	PROKON	EIN	system constant condition stereo lambda control symmetrical
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
SY_TLR		EIN	system constant service device intervention LR, modif. of integrator stop time
TFRN2_W	LR	LOK	time duration lambda controller negativ slope, bank 2
TFRNINT2_W	LR	LOK	counter to measure time duration lambda controller negativ slope, bank 2
TFRNINT_W	LR	LOK	counter to measure time duration lambda controller negativ slope
TFRN_W	LR	LOK	time duration lambda controller negativ slope
TFRP2_W	LR	LOK	time duration lambda controller positiv slope, bank 2
TFRPINT2_W	LR	LOK	counter to measure the time duration lambda controller positiv slope, bank 2
TFRPINT_W	LR	LOK	counter to measure the time duration lambda controller positiv slope
TFRP_W	LR	LOK	time duration lambda controller positiv slope
TMOT	GGTFM	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
TPLRVK2_W	LR	AUS	cycle duration of sensor upstream cat, calculated by %LR, bank 2
TPLRVK_W	LR	AUS	cycle duration of sensor upstream cat, calculated by %LR
TSPERR	LR	LOK	Stop time for lambda close loop system
TSPERR2	LR	LOK	Stop time for lambda close loop system, bank2
TV	LR	LOK	LR: counter for delayed controller switch tv / ES: supply of voltage correction
TV2	LR	LOK	LR bank2: count. for delayed contr. switch tv / ES: supply of voltage correction
TVLR	LR	LOK	LR: total value for delayed controller switch tv
TVLR2	LR	LOK	LR: total value for delayed controller switch tv 2
TVLRH	LRHK	EIN	LRHK: correction value for delayed controller switch tv
TVLRH2	LRHK	EIN	LRHK: correction value for delayed controller switch tv 2
TVLRHI	LRHK	EIN	weighted I-part for delayed controller switching tv
TVLRHI2	LRHK	EIN	Bank2: weighted I-part for delayed controller switching tv
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2
VSTLR		EIN	adjustment integrator stop time tv (service device interface)

FB LR 74.50 Detailed description of function

The Lambda control with the sensor upstream of the catalyst is designed as two-step control with a single-sided delay in switch-over (delay time tv) and an integrator stop during active delay time. The control with the sensor downstream of the catalyst superimposes it (%LRHK). The only control interaction on the control upstream catalyst is the tv correction value tvlrh.

In addition the control position is shifted to rich for a certain time by the function catalyst drainage %LRKA after fuel cut-off, in order to purge the oxygen stored in the catalyst. For this the section %LRKA makes available dtvka in case of the close-loop controlled drainage (drainage-tV), resp. dfrka in case of the open-loop controlled drainage (delta-fr-drainage).
The sum of the map value KFRTV, of the controller output of the superimposed controller (tvlrh), of the drainage tV (dtvka) and of the value flr_ap pre-assigned by the tester, results in the acting delay time tvlr.
During end of production line or workshop test the bit B_falsh is set for testing of the Lambda sensor downstream of the catalyst. The Lambda control reacts by an output of the maximum possible positive tv-time. This in turn leads to the maximum possible shift into the direction rich. The Lambda sensor downstream of the catalyst shows a voltage > 600 mV, which corresponds to the rich controller position, however, only if the system is O.K.

Control upstream catalyst:

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The two-step behavior of the control upstream the catalyst is created because only the plus and minus sign of the controller difference is considered. A constant oscillation with an amplitude develops which results from the integrator gradient KFRI and the system dead time.
This dead time is load and engine speed dependent. In order to achieve a steady amplitude, the integrator gradient KFRI needs to be load and engine speed dependent.

So as to reduce the oscillation period, the control factor fr is shifted abruptly by the value sgnlr*KFRP during the mixture change from rich to lean resp. from lean to rich. If this step change is equal to the amplitude which is generated by the integrator, then the oscillation period can be reduced down to twice the dead time.
The values KFRP may also be stored load and engine speed dependent in a map, just like the KFRI values.

By means of a one-side delayed switch-over of the controller (delay time tv) an asymmetrical controller oscillation is created which allows for a much greater Lambda shift than would be possible with an asymmetrical P step change.

The load/engine speed dependent delay time (tvlr) is considered as rich shift, if the sum of
- map value KFRTV
- controller output of the superimposed controller (tvlrh)
- catalyst drainage time (dtvka)
- application value (flr_ap)

is greater than 0. Values less than 0 will cause a lean shift.

The result of this kind of tv-calculation is that a delay can always only be performed after a step change into one direction; e.g. with a rich shift only the lean -> rich step is delayed, the controller reacts without delay in case of a rich -> lean step (see signal response of fr).

If a step change of the sensor voltage according to rich/lean shift occurs and a tv-time is triggered then this tV-time is entered into a tV-time counter which is hence started. While the counter is in operation the fr integrator is stopped.
Once the delay time is over a step change of fr by sgnlr*KFRP takes place.
Simultaneously, the value TSPERN is entered into a blocking time counter after each step change. The reaction to sensor step changes is blocked while this counter is in operation. Thus false reactions due to chemical noise are suppressed.
The system starts to react to step changes of the sensor voltage again, only once the time TSPERN or the tV_time have elapsed.

In case of a sign change of the control difference the flag B_lrsp is set in order to mark the sensor step change (if the blocking time TSPERN resp. the tv-delay time has not elapsed since the last sensor step change).

The upper function chart FDEF %LR and the corresponding signal responses explain the function of the Lambda control upstream of the catalyst.

Every 10ms the control factor counter is incremented by the value KFRI (two step controller output = +1, B_sgnra = 1) resp. it is decremented (controller output = -1, B_sgnra = 0). This corresponds to an I controller. At integrator stop the count is not changed.

After the delay time has completely elapsed a P step takes place. This function corresponds to a P controller.
For aiding reasons a mean value is formed from the control factor fr_w from the functions diagnosis canister purge control (section %DTEV), LC adaptation (section %LRA) and the canister purge control (section %TEB). This mean value is made available under the designation frm_w.

By means of the output limiter, fr_w is limited around 1 in a plausible range (FRMIN/FRMAX). A limitation by FRMAX is signaled by the bit B_frmax, a limitation by FRMIN is signaled by the bit B_frmin.

Certain switch-on conditions apply for the Lambda control upstream catalyst (see %LREB). If all switch-on conditions are fulfilled then the flag B_lrnd is set. If the Lambda control is switched off then the fr counter and hence fr_w is set to the neutral value 1. Thus it is ensured that fr starts at 1, e.g. after fuel cut-off on deceleration.

Determination of state steady-state operation by amplitude conditions and I operating times

Formation of steady-state condition from the ratio of the positive/negative I operating times

The steady-state condition B_lrstat is set, if the ratio qufr of positive (tfrp_w) and negative (tfrn_w) I operating time lies within the window, which is formed by QUFRMX and QUFRMN.

Determination of control lift:

The fr control lift can change distinctly between two sensor step changes compared to the original state, e.g. due to sensor aging. The control lift must, therefore, be constantly learned during the undisturbed state. For this, the absolute value of the determined control lift dfrsp_w is filtered by means of a low-pass. A calculation step of the low-pass filter is, however, only performed during a sensor step change, if the steady-state condition B_lrstat is fulfilled. Here, each control lift is determined separately for the purging phase of the canister purging as well as for the basic adaptation phase, in order to take into consideration a possibly occurring switch-over of the parameter during active canister purging. The learned control lift dfrstga (for basic adaptation phase) and dfrstte (for canister purging phase) are stored in the permanent RAM.

The starting value for the formation of the mean value must be adjusted by means of fixed value DFRSPS. This value must correspond to the control lift in accordance to the application in the original state (typically 6 %). A resetting to this value is possible by means of the code word CFRA (bit 1 = 0).

Calculation of mixture deviation ——> amplitude condition

The control lift dfrsp_w (change of the control factor between two sensor step changes) is calculated and compared to the expected

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set point dfrst_w. If the deviation of the control lift from the set point exceeds the adjustable threshold DFRMN (typically 2 %), then the flag B_drfr for enrichment resp. B_dfrm for enleanment is set, dependent on the direction of the deviation. The determined control shift dfrsp_w is made available to the adaptation of the control lift.

Formation of the quick Lambda controller mean value frm_w by the fr_w of the two-step Lambda control:
==========

The output value of the Lambda controller is needed in many functions (LRA, TEB...).
Frequently, however, only the temporal mean value of the Lambda controller is needed. So far the fr_w was simply low-pass filtered for this. The formation of the mean value in case of sensor step changes is better than a low-pass filtering.

During each sensor step change the mean value is formed by the last two fr values prior to a sensor step change (B_lrsp resp. B_sonsp).

Exceptions:
- If no sensor step change occurs for a long time, the mean value follows the fr with the corresponding offset as soon as the fr has left the normal range (width e.g. 6% = 0.06).
- During the first sensor step change after inactive Lambda control (B_lr = FALSE) no mean value may be formed
- In case of a fr limit stop (fr = FRMIN resp. FRMAX), as well as in case of B_lr = FALSE the mean value is set to the current value of fr.

Remark: With the introduction of the continuous Lambda control, the two-step Lambda control as well as the continuous Lambda control must both supply this mean value frm, so that the modules of the LRA or the TEB are compatible to both types of Lambda control.

Execution:

The mean value frm_w is the output of a summing unit. This summing unit has three different operating modes:
a) Initialization value (IV) is taken over in the 10 ms grid if I = TRUE
b) In the 10 ms grid the input is added to the current value
c) Enabling of the summing unit (in order to avoid a summing up)
Operating mode a) is needed when forming a mean value during "normal fr response" from the values of the fr just prior to the last two sensor step changes.
Operating mode b) is needed to correct the frm_w to the fr_w when leaving the normal fr range (e.g. +/- 3%).
In case of this type of correction a distinction must be made between:
i) Calculation of the distance from the range border after leaving the range
(fr change in less than 10 ms)
ii) Calculation of the fr change within the last 10 ms

Operating mode c) is needed so that the mean value remains unchanged after a longer fr deviation during the first fr step change.

Explanation of the ASCET picture:

The input values are:

fr_w: 16 bit value of the factor Lambda control
B_lrsp: Condition sensor step change (which is not suppressed) and which thus leads to a following P step.
R_t10: 10 ms grid (same grid in which the Lambda control is calculated)
B_frmax: Condition factor control at maximum limit stop
B_frmin: Condition factor control at minimum limit stop
dfrst_w: Adapted controller lift of the Lambda control
B_lr: Condition Lambda control active

The output values are:

frm_w: 16 bit value of the desired mean value
B_frab: Condition fr not within the normal limitation range resp. fr_w has changed by more than 6% since just before the last sensor step change.

Demanded signal response of the frm_w:

Special case: fr_w is just about to leave the normal range with a higher resolution:

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```
                                  |
                        ___^______|
                        |  |      |
_______________________ |__v______|____
                        |         |
    ________________    |         |
___|                    |         |
10 ms-grid          10 ms-grid          10 ms-grid
                                            *****


                      ****^****************
                          |
************************  v
```

When exceeding the normal range frm_w is only increased by that absolute value by which fr_w has deviated from the normal range. frm_w is incremented by the delta of the Lambda integrator only during the next calculation step.

Calculations:

The following values of the fr_w are needed:
- fralt_w : fr_w of the last 10 ms grid (output is delayed by one R_t10)
- frbsp_w : fr_w just prior to the last sensor step change
- frbspalt_w: fr_w just prior to the penultimate sensor step change

The fralt_w is needed so as to calculate the changes of the factor control when leaving the normal control range. With this change the mean value is then corrected to the fr in the 10 ms grid.

When the range is exceeded for the first time frm_w, however, must only be changed by that absolute value by which fr_w has deviated from the normal range. For this the difference between fr_w and frbsp_w is formed. The absolute value is then obtained from it. If the desired control lift (e.g. 6 %) is subtracted, then the absolute value by which the normal range was exceeded results (exception: first sensor step change after B_lr = FALSE => see below). Now frm_w must be increased during the first calculation step after the range was left, if the current fr_w is greater than the fr_w value of the last sensor step change. If the current fr_w is less than the fr_w value of the last sensor step change then frm_w must be decreased by the absolute value by which the range was exceeded (switch-over after multiplication by -1).

During the next sensor step change each change of the fr_w from one calculation step to the next is summed up in the counter.

During the first sensor step change after such a "fr tracing phase" the counter is blocked (counting is no longer performed). With the negative edge of B_frab, however, also the initialization of the counter to the mean value of the last two sensor step changes is prevented.

During operation in the normal range (B_frab = FALSE and B_frab has no neg. edge) the mean value of the last two sensor step changes is entered into the counter during each sensor step change.

The mean value may not be taken over during the first sensor step change after overrun on fuel cut-off or after engine start. Here, an initialization of the counter to the mean value is prevented by the AND logic with four inputs (bottom input).

If after B_lr = FALSE no sensor step change has so far occurred then the range of the normal control lift (e.g. 6 %) must be reduced to halve. By doing so, the distance between frm_w and fr_w is limited to approx. 3 %, also after B_lr = FALSE.

If either B_lr = FALSE or (B_frmax or B_frmin = TRUE) the current value of the fr_w is entered into the counter.

So that the mean value is set to the current value of fr in case of a fr limit stop (fr = FRMIN resp. FRMAX) as well as in case of B_lr = FALSE, the counter is initialized with fr_w.

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APP LR 74.50 Application hint

```
Control upstream catalyst:
_________________________

- USR     = 450 mV
- FRMAX   = 1.25
- FRMIN   = 0.75
- The base points of the maps KFRI, KFRP and KFRTV should be identical:
  7 * nmot-base points: range 800 rpm  —— 3000 or 3500 rpm
  6 * rl-base points: range 15% ... 80%

- adjust pilot control, KFRI, KFRP (amplitude fr approx. 3%, P step change 2.7%)



On systems with a two sensor control the characteristic map KFRTV can be measured according to the application hint given
in % LRHK. On one sensor concepts the tv map must be measured on the test bench in view of an optimum emission behavior.
In case of a NOx tendency a rich reserve must possibly be adjusted.

- The base points of the characteristic line TSPERN are to be adjusted according to the dead time behavior of the
  controlled system.
  Choose values of approx. 1/4 to 1/3 of the dead time.
  4 * nmot-base points: range e.g. 800 rpm ... 5000 rpm
```

LRINI 1.0 Coordination initializing lambda controller

FDEF LRINI 1.0 Function definition

```
Funktion LRINI: Koordinationn der Initialisierung der Lambdaregelung
====================================================================
```

lrini-lrini

ABK LRINI 1.0 Abbreviations

Variable	Source	Type	Description
B_DTEFRR	GKRA	EIN	condition of lambda controller reset
B_FRINI	LRINI	AUS	Condition control factor fr initialize
B_FRINI2	LRINI	AUS	Condition control factor fr initialize, bank 2
B_LRND	LREB	EIN	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_LRND2	LREB	EIN	set control bit LR activ; request for ”NORMAL” or ”DIAGNOSIS”
B_STERVK		EIN	condition Stereo Lambda control before catalyst
FRDTER_W		EIN	lambda control factor as reference value for CPV diagnosis
FRINI2_W	LRINI	AUS	Initialisation value for control factor lambda control, bank 2
FRINI_W	LRINI	AUS	Initialisation value for control factor lambda control

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FB LRINI 1.0 Detailed description of function

APP LRINI 1.0 Application hint

LRKA 15.10 Two Sensor Lambda Control: Oxygen Clear Out Function

FDEF LRKA 15.10 Function definition

Changes from previous versions:
==========

Functional change:

The major extension in the present version of the LRKA is the measurement of the oxygen intake into the catalyzer as a function of lamsons_w (the equivalent airmass is calculated).
The trigger condition for clearing out the catalyzer is re-formulated to do this:
The condition bit B_evloc is substituted by the bank-specific bits B_bevab/B_bevab2. For a correct computation of the oxygen intake during B_sa, lamsons_w must be switched locally to 16.0 (to infinity so-to-speak). By this, B_sa must also be evaluated as a condition.

If the input condition for clearing out the catalyzer is fulfilled, then the voltages of the sensors upstream of the catalyzer are checked during the test time TSAKAMX. Measurement of the oxygen intake is commenced if usvk lies below USVKAMX. The oxygen equivalent ilmlka_w is calculated according to:

$$ilmlka_w = ml * (1 - 1/lamsnka_w).$$

lamsnka_w is the local parameter for the lambda specified at the sensor. Normally lamsnka_w = lamsons_w. It is only for B_sa = TRUE that lamsnka_w is set to 16.0 as described above.
The oxygen intake is measured until an abort of lean running or until a lean voltage is detected at the sensor downstrean of the catalyzer.
The mass of oxygen thereby determined is then used as the threshold for the "enriched area" during clear-out of the catalyzer.
If the voltage condition for the sensor downstream of catalyzer detects that the catalyzer has been fully charged with oxygen, the integral of the oxygen taken is a measure for the oxygen storage capacity. The bit B_ilmlkat is set for identification of the status that the measurement is OK and the magnitude of the oxygen storage is made available in the RAM cell ilmlkat_w.

The tkatm dependency of the oxygen storage is automatically taken into account when the oxygen taken in by the catalyzer is measured.

Changed parameters:

A new parameter FLMLKAPR is introduced in order to weight the measured oxygen intake for the clearing-out phase.

Functions block LRKA: Functions structure for bank 1 and bank 2
==========

lrka-lrka

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Sub-functions block LRKABED: Condition for clearing out the catalyzer for bank 1 and bank 2
==========

lrka-lrkabed

Sub-functions block LRKAKONF: Parameter selection for bank 1 and bank 2
==========

lrka-lrkakonf

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Sub-functions block LRKAB1: Clearing out the catalyzer regulated/controlled for bank 1
==========

lrka-lrkab1

Selection of the alternative functions of regulated/controlled clearing-out the catalyzer is made using the code word CLRKA.
CLRKA bit 0 = FALSE (decimal CLRKA = 0) disables clearing out the catalyzer
CLRKA bit 0 = TRUE and CLRKA Bit 1 = FALSE (decimal CLRKA = 1) provides regulated clearing-out of the catalyzer
CLRKA bit 0 = TRUE, CLRKA bit 1 = TRUE, CLRKA bit 2 = FALSE, CLRKA bit 3 = FALSE (decimal CLRKA = 3) provides controlled clearing-out of the catalyzer Without evaluation of the condition lamsons
CLRKA bit 0 = TRUE, CLRKA bit 1 = TRUE, CLRKA bit 2 = TRUE, CLRKA bit 3 = FALSE (decimal CLRKA = 7) provided controlled clearing-out of the catalyzer With evaluation of the condition lamsons, Condition B_sls Disables lamsons condition
CLRKA bit 0 = TRUE, CLRKA bit 1 = TRUE, CLRKA bit 2 = TRUE, CLRKA bit 3 = TRUE (decimal CLRKA = 15) provides controlled clearing-out of the catalyzer With evaluation of the condition lamsons when B_sls is active as well

Sub-functions block LRKAS: Controlled O2-removal, bank 1
==========

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lrka-lrkas

```
State machine  ALRKAGST: Controlled O2-removal, bank 1
=======================================================
```

lrka-alrkagst

```
State machine description ALRKAGST: Controlled O2-removal, bank 1
=================================================================
```

S t a t e s

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The states of the state machine can be read out from the status byte lrkaz.
The byte lrkaz2 is available for stereo lambda control systems.

State	Status byte	Description	Activity
A_Normal	lrkaz = 0	Output states for normal running	B_lrkaa := false
A_Schubd	lrkaz = 1	Measurement of a minimum duration Lean mixture upstream and downstream of the catalyzer	tsaka := tsaka + dt
A_measur	lrkaz = 2	Measurement of the oxygen intake Waiting for end of lean condition or for "catalyzer is full" condition	B_lrkaa := false Operating integrator oxygen intake ilmlka_w := ilmlka_w + (1-1/lamsnka_w)* ml * dt
A_Warten	lrkaz = 3	Waiting for end of lean condition and measure intake of oxygen taken in in main catalyzer with maximum limit	B_lrkaa := false ilmlkam_w := ilmlkam_w + (1-1/lamsnka_w)* ml * dt Measurement is aborted for ilmlkam_w > ilmlkat_w*FLMLKAMA
A_o2vor	lrkaz = 4	Clearing out the primary catalyzer is active Abort condition enriched area or Sensor downstream of catalyzer	B_lrkaa := true, enriching active operate enriched-area integrator ilmlka := ilmlka + (1/lamka_w -1)* ml * dt
A_o2haupt	lrkaz = 5	Clearing out the main catalyzer is active Abort condition proportional to enriched area	B_lrkaa := true, enriching is active Operate enriched-area integrator ilmlka := ilmlka + (1/lamka_w -1)* ml * dt

Notes: The enrichment by lamka_w acts as a pre-control factor by the LAMKO after controlled clearing-out the catalyzer has been triggered.

T r a n s i t i o n s

Transition	from ——> to	Priority	Description
U_wlrka	A_Normal -> A_Schubd	1	B_evloc = False (e.g. trailing throttle) OR lamsons_w > 1 AND nmot < NLRKA The time counter tsaka is reset by a transition!
U_nwaits	A_Schubd -> A_Normal	1	Abort of lean conditions before elapse of minimum trailing-throttle duration TSAKMN Conditions for clearing out the catalyzer are thus not fulfilled
U_waits	A_Schubd -> A_Measur	2	The condition "lean upstream of catalyzer" is fulfilled (tsaka > TSAKAMN) AND (usvk < USVKAMX) Start of measuring the oxygen intake Parameters: TSAKAMN - Minimum duration for lean running USVKAMX - Lean-threshold sensor upstream of the catalyzer
U_measmx	A_measur -> A_waitka	1	catalyzer is fully charged with oxygen (ilmlka_w > ilmlkax_w) OR ((ushk < USHKAMN) AND B_sbbhk) Parameters: USHKAMN - Lean-threshold sensor downstream of the catalyzer
U_kaena	A_measur -> A_o2vor	2	End of lean condition before catalyzer fully charged with oxygen NOT B_blrka corresponds to lamsons_w = 1.0 AND B_sa = FALSE AND B_bevab = TRUE The transition to the conditions for clearing out the catalyzer follows this The "proportional enriched area" is calculated to do this according to ilmlkav_w = ilmlka_w * FLMLKAPR
U_kaena	A_Waitka -> A_o2vor	1	Lean running has finished NOT B_blrka corresponds to lamsons_w = 1.0 AND B_sa = FALSE AND B_bevab = TRUE The integrator ilmlka is reset by the transition! and the "proportional enriched area" is calculated according to ilmlkav_w = ilmlka_w * FLMLKAPR
U_ilmlkavor	A_o2vor -> A_o2haupt	1	(ushk > USHKAMX AND B_sbbhk AND (B_ilmlkat OR CLRKA.Bit2)) OR (ilmlka_w > ilmlkav_w) OR (NOT B_lrkaei) detailed: (ushk above the threshold USHKAMX AND sensor downstream of the catalyzer is ready (B_sbbhk = TRUE) AND (catalyzer fully charged with oxygen (can be activated by bit 2 in CLRKA)) OR threshold "maximum enriched area" ilmlkav_w exceeded

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```
                                                  OR immediate abort if condition B_lrkaei is no longer fulfilled
                                                  The integrator ilmlka is reset by the transition!
                                                  and the "proportional enriched area" is calculated
                                                       according to ilmlkah_w = ilmlka_w * FLMLKAMA
                                                  Parameters:
                                                  FLMLKAMA  - Proportional factor for clearing out the primary/main
                                                  catalyzer Action of the bit B_lrkaei:
                                                  The condition lamkai < 1.0 is included in the condition B_lrkaei
                                                  lamkai < 1.0 means that there is no entry made in the  enriched
                                                  area-integral ilmlka_w.
                                                  By this, the abort criterion has not been fulfilled and the
                                                  lambda control remains disabled.

U_wlrka          A_o2vor -> A_Schubd          2   controlled clearing-out is retriggered
                                                  B_sa = TRUE  OR B_bevab = FALSE OR lamsons_w > 1
                                                             AND nmot < NLRKA
                                                  The time counter tsaka is reset by the transition!

U_ilmlkahaupt    A_o2haupt -> A_Normal        1   threshold "proportional enriched area" ilmlkav_w  exceeded
                                                  OR immediate abort in case condition B_lrkaei is no longer fulfilled

U_wlrka          A_o2haupt -> A_Schubd        2   controlled clearing-out is re-triggered
                                                  B_sa = TRUE  OR B_bevab = FALSE OR lamsons_w > 1
                                                             AND nmot < NLRKA
                                                  The time counter tsaka is reset by the transition!


The priority determines the order when inquiring the transition conditions.
 Sub-functions block LAMKAB: Controlled increase/decrease of the O2 removal terms, bank 1
 ==========================================================================================
```

Irka-lamkab

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Sub-functions block LRKAR: Regulated 02-removal, bank 1
==========

lrka-lrkar

Status analyzer ALRKAREG: Regulated 02-removal, bank 1
==========

lrka-alrkareg

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Analyzer description ALRKAREG: Regulated 02-removal, bank 1
==========

S t a t e s

The states of the analyzer can be read out by the status byte lrkaz.
The byte lrkaz2 is available for this for stereo lambda control systems.

State	Status byte	Description	Action
A_Normal	lrkaz = 0	Initial state in normal operation Reset state after B_st	B_lrkaa := false
A_Schubd	lrkaz = 1	Measurement of a minimum duration Lean mixture upstream downstream of the catalyzer	tsaka := tsaka + dt
A_Warten	lrkaz = 2	Waiting for the end of the lean condition	B_lrkaa := false
A_o2vor	lrkaz = 3	Clearing out primary catalyzer is active Abort condition airmass or Sensor downstream of the catalyzer	B_lrkaa := true, enriching active actuation of airmass integrator imlka := imlka + ml * dt
A_o2haupt	lrkaz = 4	Clearing out the main catalyzer is active Abort condition "proportional airmass"	B_lrkaa := true, enriching is active Actuation of airmass integrator imlka := imlka + ml * dt

Notes: The enrichment by dtvka is only active for an active lambda control.
dtvka acts in the lambda control (additive) in addition to the current tv time.
B_lrka disables the guidance control %LRHK.

T r a n s i t i o n s

From ——> to	Priority	Description
A_Normal -> A_Schubd	1	B_evloc = False (e.g. trailing throttle) OR lamsons_w > 1 AND nmot < NLRKA The time counter tsaka is reset by the transition!
A_Schubd -> A_Normal	1	Abort of lean conditions before elapse of the minimum trailing throttle period TSAKMN Conditions for clearing out the catalyzer are thus not fulfilled
A_Schubd -> A_Warten	2	The condition "lean upstream and downstream of catalyzer" is fulfilled (tsaka > TSAKAMN) AND (usvk < USVKAMX) AND ((ushk < USHKAMN) OR (NOT B_sbbhk)) Parameters: TSAKAMN - Minimum duration for lean operation USVKAMX - Lean-threshold upstream of the catalyzer USHKAMN - Lean-threshold sensor downstream of the catalyzer
A_Warten -> A_o2vor	1	Lean operation finished lamsons_w = 1 AND B_evloc = TRUE The integrator imlka is reset by the transition!
A_o2vor -> A_o2haupt	1	(ushk above the threshold USHKAMX AND sensor downstream of the catalyzer is ready (B_sbbhk = TRUE) OR threshold "maximum air mass IMLKAMX = f(tkatm)" exceeded The integrator imlka is reset by the transition! and the "proportional air mass" calculated according to imlkav_w = imlka_w * FMLKAMA Parameters: IMLKAMX - Threshold-airmass for abort of clearing out the catalyzer FMLKAMA - Proportional factor for clearing out the primary/main catalyzer
A_o2vor -> A_Schubd	2	Regulated clearing-out is re-triggered B_evloc = False (e.g. trailing throttle) OR lamsons_w > 1 AND nmot < NLRKA The time counter tsaka is reset by the transition!
A_o2haupt -> A_Normal	1	Threshold "proportional airmass" ilmlkav_w exceeded
A_o2haupt -> A_Schubd	2	Regulated clearing-out is re-triggered B_evloc = False (e.g. trailing throttle) OR lamsons_w > 1 AND nmot < NLRKA The time counter tsaka is reset by the transition!

The priority determines the order when inquiring the transition conditions.

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Sub-functions block LRKAOUT: Output for bank 2 according to stereo/mono/symmetry

Irka-Irkaout

ABK LRKA 15.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CLRKA			FW	code word for catalyst O2 purge funktion
DTVKAML	ML		KL	delta-tv for cat oxygen neutralization (air mass dependent)
DTVKAML2	ML		KL	delta-tv for cat oxygen neutralization (air mass dependent) bank2
FFWEKA			FW	Weighting factor for inclusion of resumption factor fwe in calc.of enriched area
FKAXAVKAT	AVKATF		KL	weighting factor for oxygen capacity depending on avkatf
FLMLKAMA			FW	Factor for evaluation of threshold of richness to interrupt cat evacuation
FLMLKAPR			FW	Factor for weighing of the measured stored oxygen
FMLKAMA			FW	factor for threshold correc. of integrated air mass for stop of cat clear out
ILMLKAXTK	TKATM_W		KL	Threshold of richness area of O2 purging after fuel cat off, funct. of cat-temp
ILMLKAXTK2	TKATM2_W		KL	Thresh. of richness area of O2 purging after fuel cut off, funct. of cat-temp.
IMLKAXTK	TKATM_W		KL	integr. air mass threshold f(tkatm) for cancelation of cat oxygen neutralization
IMLKAXTK2	TKATM2_W		KL	integr. air mass threshold f(tkatm2) for cancelation of cat oxygen neutral.
LAMKAML	ML		KL	lambda setpoint for catylyst deoxidation (dependent on air mass)
LAMKAML2	ML		KL	lambdasetpoint for catalyst deoxidation (air mass dependent), bank 2
NLRKA			FW	Speed threshold for suppression of controlling emptying of the catalyzer
TDFRKAD			FW	Control-down time for controlled emptying of the catalyzer
TDFRKAU			FW	Control-up time for controlled emptying of the catalyzer
TSAKAMN			FW	minimum duration of fuel cut-off for catalyst oxygen neutralization
USHKAMN			FW	downstream sensor voltage for detection of cat has compl. stored oxygen
USHKAMX			FW	downstream sensor voltage for cancelation of cat oxygen neutralization
USVKAMX			FW	upstream sensor voltage for detection of lean cond. of cat oxygen neutralization

Variable	Source	Type	Description
AVKATF	DKAT	EIN	amplitude ratio Iaafh/Iaafv strained
B_BEVAB	AEVAB	EIN	condition: Inj. valve cut off on Bank/Bank1
B_BEVAB2	AEVAB	EIN	condition: Inj. valve cut off on Bank2
B_BLRKA	LRKA	LOK	Condition controlled oxygen purging of catalyzer requested
B_BLRKA2	LRKA	LOK	Condition controlled oxygen purging of catalyzer requested, bank 2
B_ILMLKAT	LRKA	AUS	Condition: valid measurement of oxygen storage
B_ILMLKAT2	LRKA	AUS	Condition: valid measurement of oxygen storage, bank 2
B_KAWE	LRKA	LOK	Factor fwe active during catalyzer clear-out, Bank 1
B_KAWE2	LRKA	LOK	Factor fwe active during catalyzer clear-out, Bank 2
B_LRKA	LRKA	AUS	condition for neutralization of catalyst oxygen storage
B_LRKA2	LRKA	AUS	condition for neutralization of catalyst oxygen storage, cylinder row 2
B_LRKAA	LRKA	LOK	condition for turning on/ turning off the neutralization of cat. oxygen storage
B_LRKAA2	LRKA	LOK	condition for turning on/off the neutralization of cat. oxygen storage, bank 2
B_LRKAE	LRKA	LOK	Condition open loop oxygen purging of catalyst possible
B_LRKAE2	LRKA	LOK	Condition open loop oxygen purging of catalyst possible
B_LRKAEI	LRKA	LOK	Condition open loop oxygen purging of catalyist possible (ALRKAGST)
B_LRKAEI2	LRKA	LOK	Condition open loop oxygen purging of catalyst possible (ALRKAGST2), bank 2
B_LRKAON	LRKA	LOK	Status catalyst clearing stopped due to new trigger of function
B_LRKARG	LRKA	LOK	condition for neutralization of catalyst oxygen storage, closed loop
B_LRKARG2	LRKA	LOK	condition for neutralization of catalyst oxygen storage, closed loop, bank 2
B_LRKAST	LRKA	LOK	condition for neutralization of catalyst oxygen storage, open loop
B_LRKAST2	LRKA	LOK	condition for neutralization of catalyst oxygen storage,open loop,bank 2
B_SA	MDRED	EIN	Condition fuel cut-off
B_SBBHK	DLSH	EIN	condition for lambda sensor downstream cat ready for operation

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Variable	Source	Type	Description
B_SBBHK2	DLSH	EIN	condition for lambda sensor downstream cat ready for operation bank2
B_SLS	SLS	EIN	Condition for active secondary air
C_INI		EIN	ECU-condition for intialisation
DTVKA	LRKA	AUS	delta-tv for catalyst oxygen neutralization
DTVKA2	LRKA	AUS	delta-tv for catalyst oxygen neutralization for 2nd bank of stereo lambda contr.
DTVKAI	LRKA	LOK	delta-tv for catalyst oxygen neutralization, internal use
DTVKAI2	LRKA	LOK	delta-tv for catalyst oxygen neutralization, internal use, bank 2
FAVKATMX	LRKA	LOK	Evaluation factor for oxigen capacity of avkatf
FWE	ESWE	EIN	reinjection factor
ILMLKA2_W	LRKA	LOK	(air mass times delta fr)-integrator for cat oxygen neutralization, bank 2
ILMLKAH2_W	LRKA	LOK	Integrator, rich area for catalyst purging of main cat, bank 2
ILMLKAH_W	LRKA	LOK	Integrator, rich area for catalyst purging of main cat,
ILMLKAM_W	LRKA	LOK	Weighted integrator of oxigen input in main catalyst
ILMLKAT2_W	LRKA	AUS	Valid value of oxygen storage, bank 2
ILMLKAT_W	LRKA	AUS	Valid value of oxygen storage
ILMLKAV2_W	LRKA	LOK	Integrator, rich area after catalyst purge pre cat, Bank2
ILMLKAV_W	LRKA	LOK	Integrator, rich area after catalyst purge pre cat,
ILMLKAX2_W	LRKA	LOK	Rich area limit for controlled catalyst purge f(tkatm2), bank 2
ILMLKAX_W	LRKA	LOK	Rich area limit for controlled catalyst purge f(tkatm2), bank 1 |
ILMLKA_W	LRKA	LOK	(air mass times delta fr)-integrator for cat oxygen neutralization
IMLKA2_W	LRKA	LOK	air mass integrator for cat oxygen neutralization for 2nd bank of stereo control
IMLKAV2_W	LRKA	LOK	weighted integrator air-mass at end of deoxidation of precatalyst, bank2
IMLKAV_W	LRKA	LOK	weighted integrator air-mass at end of deoxidation of precatalyst
IMLKAX2_W	LRKA	LOK	Air mass threshold for regulated (KAT ausräumen) f(tkatm2), bank 2
IMLKAX_W	LRKA	LOK	Air mass threshold for regulated (KAT ausräumen) f(tkatm), bank 1
IMLKA_W	LRKA	LOK	air mass integrator for cat oxygen neutralization
LAMKA2_W	LRKA	AUS	Lambdasetpoint catalyst clean out, bank2
LAMKAI2_W	LRKA	LOK	Lambdasetpoint catalyst O2 purge function, bank 2
LAMKAII2_W	LRKA	LOK	Lambdasetpoint catalyst o2 purge function, local intermediate value, bank 2
LAMKAII_W	LRKA	LOK	Lambdasetpoint catalyst o2 purge function, local intermediate value
LAMKAI_W	LRKA	LOK	Lambdasetpoint catalyst O2 purge function
LAMKA_W	LRKA	AUS	Lambdasetpoint catalyst o2 purge function
LAMSNKA2_W	LRKA	LOK	required lambda for internal use by function LRKA, bank 2
LAMSNKA_W	LRKA	LOK	required lambda for internal use by function LRKA
LAMSONS2_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location
LRKAZ	LRKA	LOK	flagbyte of the catalyst oxygen neutralization
LRKAZ2	LRKA	LOK	status byte of the cat O2 neutralization for 2nd bank of stereo lambda control
ML	BGSRM	EIN	air mass flow
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	BGNMOT	EIN	engine speed
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERSY	PROKON	EIN	system constant condition stereo lambda control symmetrical
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TKATM2_W	ATM	EIN	catalyst temperature modelled (word) bank2
TKATM_W	ATM	EIN	catalyst temperature modelled (word)
TSAKA	LRKA	LOK	timer fuel cut-off duration for cat oxygen neutralization
TSAKA2	LRKA	LOK	timer fuel cut-off duration for cat O2 neutralization 2nd bank stereo control
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2

FB LRKA 15.10 Detailed description of function

```
The function of clearing out the catalytic converter has the task of removing the oxygen from the catalytic converter as quickly
as possible following lean engine-running.
It is only then that the normal operating conditions for guiding control of the catalytic converter are attained again.
Clearing out the catalyzer is activated if the minimum trailing-throttle period TSAKAMN is exceeded (timer tsaka) and at the same
time, both lambda sensors, i.e. upstream and downstream of the catalyzer, indicate a lean mixture. The state of waiting is
maintained until the end of the lean phase.

There are two alternative procedures available for clearing out the catalyzer:

  Regulated clearing-out
  ======================

  For this alternative, the lambda control position is shifted by an airmass-dependent value (from DTVKAML) towards "rich". The
  action of tv that depends on the operating point is taken into account by the airmass dependency.
  The function of clearing out the catalyzer is controlled by an analyzing status that checks any additional minimum or maximum
  requirements (refer to the analyzer description for details).

  The enrichment is carried out in two steps. In the first step, the oxygen level is correctly set in the primary catalyzer. This
  step remains active until the sensor voltage downstream of catalytic converter exceeds a certain value (USHKAMX) or the airmass
  integral imlka_w reaches a threshold IMLKAXKT = f(tkatm). The airmass throughput up to this point in time (final value of the
  integrator imlka_w) is multiplied by the factor FMLKAMA to give the threshold imlkav_w.
  An enrichment phase then follows by which the oxygen stored in the primary catalytic converter shall be neutralized. The
  duration for the enrichment in the second step is thereby proportional to the duration in step 1. The threshold value determined
  in step 1 is used as the abort condition for this.
  If the entire catalytic converter system is being monitored, then the 2nd step in clearing out the catalyzer can be deactivated
  by setting the proportional factor FMLKAMA to zero.
```

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Controlled clearing-out
==========

The pre-control by the LAMKO is shifted by am airmass-dependent pre-control value (LAMKAML) towards "rich" to do this.
The lambda control is disabled by the thereby resulting lamsons_w < 1.0 and the neutral value fr = 1 is outputted.
Any possible enriching action that depends on the operating point is taken into account by the airmass dependency.

As for a regulated clearing-out of the catalyzer, the controlled version is a two-stage process as well. The airmass integral imlka_w is however substituted by the enriched-area integral ilmlka_w. The corresponding enriched-area threshold is ILMLKAXKT = f(tkatm).

The change in the O2 storage capacity can be
described in terms of the operating temperature by the tkatm dependency of the airmass threshold and the enriched-area threshold.

The enrichment is only activated if the speed is below the threshold NLRKA.

The following provides an example of the course over time for lamka_w for controlled clearing-out of the catalyzer:

APP LRKA 15.10 Application hint

T y p i c a l v a l u e s (strong catalyzer dependency)
==========

The parameters of the function LRKA are determined to a large extent by the characteristics of the catalytic converter. The application values given in the following can therefore only serve as a proposal for the magnitude of these. The actual parameters must be determined in each case on a project-specific basis.

Controlled version
Typical values, configuration-dependent

Control sensor downstream of catalyzer is downstream of the entire catalytic converter system
==========

TSAKAMN	Minimum duration for lean running	0.5 s
USVKAMX	Voltage from the sensor upstream of the catalyzer for "lean detection"	0.15 V
ILMLKAXKT	Threshold value integrator enriched area for abort Product := ml * (1/lasnka_w -1) * dT	200 - 1000 g
FLMLKAMA	Volume ratio primary/main catalyzer determines the proportional threshold for clearing out the catalyzer	0.0 (shutdown stage 2)

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```
                Main catalyzer
USHKAMN         Sensor voltage for condition catalyzer with O2 abort is                        0.08 V
                charged
USHKAMX         Sensor voltage for abort                                                       0.2 V
LAMKAML         Lambda   for clearing out the catalyzer                                        0.97 - 0.85 depending on ml
TDFRKAU         Controlled-increase time for lamka_w                                           0.0 - 0.5 s
TDFRKAD         Controlled-decrease time for lamka_w                                           0.0 - 0.5 s
                LAMKAML - characteristic over the airmass
                datapoints typical for an engine with ml full load: 800 kg/h

                    ml      :  9.6   28.8   86.4    200   400  kg/h
                    LAMKAML :  0.78   0.78   0.84  0.88   0.93


                ILMLKAXKT  -  characteristic over tkatm
                Typical datapoint distribution

                    tkatm      :  200    250    300    450    900 Deg. C
                    ILMLKAXKT       0    1.0    2.5    3.0    3.5 g

Control sensor downstream of catalyzer is after the primary catalyzer
=====================================================================

TSAKAMN         Minimum duration of lean running                                               0.2 s
USVKAMX         Voltage of the sensor upstream of the catalyzer for "lean detection"           0.15 V

ILMLKAXKT       Threshold value integrator enriched area for abort                             100 - 500 g
                Product :=  ml * (1/lasnka_w -1) * dT
FLMLKAMA        Volume ratio primary/main catalyzer  The volume ratio
                determines the proportional threshold for clearing out the
                main catalyzer
USHKAMN         Sensor voltage for condition catalyzer with O2 abort is                        0.08 V
                charged
USHKAMX         Sensor voltage for abort                                                       0.3 V
LAMKAML         Lambda  for clearing out the catalyzer                                         0.97 - 0.85 depending on ml
TDFRKAU         Controlled-increase time for lamka_w                                           0.0 - 0.5 s
TDFRKAD         Controlled increase time for lamka_w                                           0.0 - 0.5 s


                DFRKAML - characteristic over the airmass
                Typical datapoints for engine with ml full load: 800 kg/h

                    ml      :  9.6   28.8   86.4    200   400  kg/h
                    LAMKAML :  0.80   0.80   0.84  0.88   0.93

                ILMLKAXKT  -  characteristic over tkatm
                Typical datapoint distribution

                    tkatm      :  200    250    300    450    900 Deg. C
                    ILMLKAXKT       0    1.0    2.5    3.0    3.5 g

Regulated version
Typical values, configuration-dependent
 ____________________________________


Control sensor downstream of catalyzer is after the entire catalytic converter system
=====================================================================================

TSAKAMN         Minimum duration for lean running                                              0.5 s
USVKAMX         Voltage of the sensor upstream of the catalyzer for "lean detection"           0.15 V
IMLKAXKT        Threshold value integrator airmass for abort                                   200 - 1000 g
FMLKAMA         Volume ratio primary/main catalyzer                                            0.0     (shutdown stage 2)
                determines the proportional threshold for clearing out the
                main catalyzer
USHKAMN         Sensor voltage for condition catalyzer with O2 abort                           0.08 V
                charged
USHKAMX         Sensor voltage for abort                                                       0.3 V
DTVKAML         Delta tv for clearing out the catalyzer                                        400 ms  [100 to 600]
                                                                                                       depending on ml
                DTVKAML - characteristic over the airmass in s.
                Datapoints typical for engine with ml full load: 450 kg/h

                    ml      :  9.6   28.8   86.4   200  400  kg/h
                    DTVKAML :  0.4    0.4    0.3   0.2  0.1  s


                 IMLKAXKT  -  characteristic over tkatm
                 Typical datapoint distribution

                    tkatm      :  200    250    300    450    900 Deg. C
                    IMLKAXKT        0    350    600    700   1000  g

Control sensor downstream of catalyzer is after the entire catalytic converter system
=====================================================================================
```

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TSAKAMN	Minimum duration for lean running	0.5 s
USVKAMX	Voltage for sensor upstream of the catalyzer for "lean detection"	0.15 V
IMLKAXKT	Threshold value integrator airmass for abort	600 g
FMLKAMA	Volume ratio primary/main catalyzer determines the proportional threshold for clearing out the main catalyzer	according to volume ratio
USHKAMN	Sensor voltage for condition catalyzer is charged with O2 abort	0.08 V
USHKAMX	Sensor voltage for abort	0.3 V
DTVKAML	Delta tv for clearing out the catalyzer	400 ms [100 to 600] depending on ml

DTVKAML - characteristic over the airmass in s.
Datapoints typical for engine with ml full load: 450 kg/h

ml :	9.6	28.8	86.4	200	400	kg/h
DTVKAML :	0.4	0.4	0.3	0.2	0.1	s

IMLKAXKT - characteristic over tkatm
Typical datapoint distribution

tkatm :	200	250	300	450	900	Deg. C
IMLKAXKT	0	350	600	700	1000	g

Response of the function LRKA for the case of sensor ready is FALSE:

The state of clearing out the primary catalyzer is aborted immediately if there is no readiness for operation by the sensor. This state is thus exited with the value imlka = 0 and hence with the threshold value imlkav = 0. It is for this reason that stage 2 is also aborted immediately in the function LRKA.

LRHK 33.10 Lambda closed loop control downstream catalyst (OBDII)

FDEF LRHK 33.10 Function definition

Two sensor control - global control structure:

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Effect of corrections tvlrh and dtvka:

The blocking of the effect of tvlr by the bit B_dslalr is only necessary during the diagnosis of the secondary air system.
At projects without secondary air this bit has to be preset.

Closed loop control downstream catalyst - control structure:

Those labels, which exist twice in case of a stereo lambda control, are marked.

Those labels, which exist twice in case of a stereo lambda control, are marked.

Determination of the lower control limits by NLRHU and TLLRHU.
The upper control limits are to be determined by NLRHO and the characteristic line TLRHON.

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ABK LRHK 33.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ATVINI			FW	Initial value for control factor atv, set according to code word NOATV
ATVINI2			FW	Initial value for control factor atv, bank 2, set according to code word NOATV
ATVMN			FW	lower limit of control range of factor atv
ATVMX			FW	upper limit of control range of factor atv
CLRHK			FW	code word for lambda closed-loop control downstream catalyst on/off
KDLASHKI	IDLASHKM_W		KL	evaluation factor of I-part of LRHK, f(dlashkm)
KDLASHKI2	DLASHKM2_W		KL	evaluation factor of I-part of LRHK, f(dlashkm), bank 2
KDLASHKP	IDLASHKM_W		KL	evaluation factor of P-part of LRHK, f(dlashkm)
KDLASHKP2	DLASHKM2_W		KL	evaluation factor of P-part of LRHK, f(dlashkm), bank 2
KFFTV	NMOT	RL	KF	weighting map for TVLRH
KFFTV2	NMOT	RL	KF	weighting map for TVLRH bank 2
KFUSHK	NMOT	RL	KF	lambda sensor reference value for lambda control downstream of catalyst
KFUSHK2	NMOT	RL	KF	lambda sensor reference value for lambda control downstream of catalyst bank2
LALIUSH	USHK_W		KL	lambda linearization, sensor behind catalyst
LALIUSH2	USHK2_W		KL	lambda linearization, sensor behind catalyst, bank 2
LALIUSRH	USRHK		KL	lambda linearization, sensor behind catalyst
LALIUSRH2	USRHK2		KL	lambda linearization, sensor behind catalyst
LASHKAB			FW	initial value for dynamic increase of desired value (lamsolh) in the LRHK
MLNKAX			FW	air mass threshold for activation readiness LRSHK I-part
NLRHO			FW	upper engine speed threshold for lambda control downstream cat
NLRHU			FW	lower engine speed threshold for lambda control downstream cat
PLRHAV	IAVKATF		KL	Weighting factor of P-part LRHK depending on catalyst age
PLRHAV2	AVKATF2		KL	Weighting factor of P-part LRHK depending on catalyst age range 2
PLRHML	ML		KL	p-part of LRHK, f(dushk)
PLRHML2	ML		KL	Partie p. dans LRHK, agit avec la difference de tension de sonde aval cata banc2
RLLRHON	NMOT		KL	char. line on nmot, upper rl control threshold for downstream lambda control
RLLRHUN	NMOT		KL	char. line on nmot, lower control threshold rl for downstream lambda control
TBLRH			FW	lock per. f. c.-loop contr.downstr.cat after rel.by c.-loop contr.upstr.cat
TBLRH2			FW	lock per. f. c.-loop contr.downstr.cat after rel.by c.-loop contr.upstr.cat b2
TKATMLRH			FW	lower catalyst temperature threshold for lambda control downstream cat
TKATMLRH2			FW	lower catalyst temperature threshold for lambda control downstream cat, bank 2
ZLASHKAB			FW	time const.for decrease of the dynamic set point increase (dlasohkab)in the LRHK
ZLASOHML	ML_W		KL	time constant for PT1-filter of the pseude lambda behind catalyst
ZLASOHML2	ML_W		KL	Time constant for PT1-filter of pseudo lambda post cat, bank 2
ZLRHML	ML		KL	time constant of lambda control integrator downstream catalyst
ZLRHML2	ML		KL	time constant of lambda control integrator downstream catalyst bank 2

Variable	Source	Type	Description
ATV	LRHK	AUS	current integrator value of lambda control downstream cat
ATV2	LRHK	AUS	current integrator value of lambda control downstream cat 2
ATVINII	LRHK	LOK	Initialisation value for integrator atv
ATVINII2	LRHK	LOK	Initialisation value for integrator atv, bank 2
AVKATF	DKAT	EIN	amplitude ratio laafh/laafv strained
AVKATF2	DKAT	EIN	amplitude ratio laafh/laafv strained bank2
B_ATVINI	LRHK	LOK	Condition integrator atv be initialized
B_ATVINI2	LRHK	LOK	Condition integrator atv be initialized, Bank 2
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_FALSH		EIN	condition function request downstream oxygen sensor diagnosis
B_FALSH2		EIN	condition function request downstream oxygen sensor diagnosis bank2
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRHK	LRHK	AUS	condition for lambda closed loop control downstream cat
B_LRHK2	LRHK	AUS	condition for lambda closed loop control downstream cat (bank 2)
B_LRHKB	LRHK	LOK	LRHK: condition lambda control behind catalyst, bank-specific parameter bank 1
B_LRHKB2	LRHK	LOK	LRHK: condition lambda control behind catalyst, bank-specific parameter bank 2
B_LRHKG	LRHK	LOK	LRHK: bank-independent condition lambda control behind catalyst
B_LRHKGI	LRHK	LOK	LRHK: bank-independent condition I-part lambda control behind catalyst
B_LRHKP	LRHK	LOK	LRHK: condition for P-part lambda closed loop control downstream cat (bank 1)
B_LRHKP2	LRHK	LOK	LRHK bank2: condition for P-part lambda closed loop control downstream cat
B_LRKA	LRKA	EIN	condition for neutralization of catalyst oxygen storage
B_LRKA2	LRKA	EIN	condition for neutralization of catalyst oxygen storage, cylinder row 2
B_LRSP	LR	EIN	Flag 'O2 sensor voltage crosses threshold detected'
B_LRSP2	LR	EIN	condition for sensor signal bounce cylinderbench 2
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_SBBHK	DLSH	EIN	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	EIN	condition for lambda sensor downstream cat ready for operation bank2
B_ST	BBSTT	EIN	condition for start
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DLAHKAB2_W	LRHK	LOK	dynamic overshoot of the pseudo lambda set point value behind catalyst, bank2
DLAHKAB_W	LRHK	LOK	dynamic overshoot of the pseudo lambda set point value behind catalyst
DLASHKI2_W	LRHK	LOK	delta lambda weighted for I-component LRSHK, bank2
DLASHKI_W	LRHK	LOK	delta lambda weighted for I-component LRSHK
DLASHKM2_W	LRHK	LOK	delta lambda of lambda contr.behind cat.(actual value averaged fr-synchr.),bank2
DLASHKM_W	LRHK	LOK	delta lambda of lambda contr.behind cat.(actual value averaged fr-synchr.)
DLASHKP2_W	LRHK	LOK	delta lambda weighted for P-component LRSHK5.30, Bank2
DLASHKP_W	LRHK	LOK	delta lambda weighted for P-component LRSHK5.30

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Variable	Source	Type	Description
E_HSH	DHLS	EIN	error flag: lambda sensor heating downstream cat
E_HSH2	DHLS	EIN	error flag: lambda sensor heating downstream cat on the right
E_HSV	DHLS	EIN	error flag: lambda sensor heating upstream cat
E_HSV2	DHLS	EIN	error flag: lambda sensor heating upstream cat on the right
E_KAT	DKAT	EIN	error flag: catalyst conversion
E_KAT2	DKAT	EIN	error flag: catalyst conversion (cylinder row 2)
E_LASH	DLSAHK	EIN	error flag: lambda sensor aging downstream cat
E_LASH2	DLSAHK	EIN	error flag: lambda sensor aging downstream cat (cylinder row 2)
E_LATV	DLSA	EIN	error flag: lambda sensor aging tv
E_LATV2	DLSA	EIN	error flag: lambda sensor aging tv (cylinder row 2)
E_LM	DHFM	EIN	Error flag: main load sensor
E_SLS	DSLSLR	EIN	error flag: secondary air system
E_SLS2	DSLSLR	EIN	error flag: secondary air system, cylinder row 2
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TEVE2		EIN	error flag: canister purge valve power stage
FTV	LRHK	LOK	factor weighting tv-correction of downstream lambda control
FTV2	LRHK	LOK	factor weighting tv-correction of downstream lambda control, bank 2
IAVKATF	LRHK	DOK	Char. Line source: amplitude relatio of catalyst downstream/upstream
IDLASHKM_W	LRHK	DOK	KL-Source: Delta-lambda from close loop regulation post cat,(actuell value of fr
LAHKMZ	LRHK	LOK	status byte of the machine: avera.of pseudo-lambda beh.cat. fr-synchr.
LAHKMZ2	LRHK	LOK	status byte of the machine: avera.of pseudo-lambda beh.cat. fr-synchr.; bank 2
LAMHF2_W	LRHK	LOK	pseudo-linearized lambda downstream, filtered by PT1, bank2
LAMHF_W	LRHK	LOK	pseudo-linearized lambda downstream, filtered with PT1
LAMHM2_W	LRHK	LOK	fr-synchronized mean-value of pseudo-lambda downstream, bank2
LAMHM_W	LRHK	LOK	fr-synchronized mean-value of pseudo-lambda downstream
LAMSOLH2_W	LRHK	AUS	pseudo lambda set point behind catalyst, bank2
LAMSOLH_W	LRHK	AUS	pseudo lambda set point behind catalyst
LAMSONH2_W	LRHK	AUS	pseudo-lambda, measured with Nernst-sensor downstream
LAMSONH_W	LRHK	AUS	pseudo-lambda,measured with Nernst-sensor downstream
ML	BGSRM	EIN	air mass flow
MLNKA2_W	LRHK	DOK	air mass after catalyst oxygen neutralization, bank 2
MLNKA_W	LRHK	DOK	air mass after catalyst oxygen neutralization
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	BGNMOT	EIN	engine speed
PERCNT2_W	LRHK	LOK	counter 10-ms-steps for fr-synchronous lamsolh averaging, bank 2
PERCNT_W	LRHK	LOK	counter 10-ms-steps for fr-synchronous lamsolh averaging
PTV	LRHK	LOK	LRHK: unweighted p-part for delayed controller switching tv
PTV2	LRHK	LOK	Bank2: unweighted p-part for delayed controller switching tv
RL	EGFE	EIN	relative air charge
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERSY	PROKON	EIN	system constant condition stereo lambda control symmetrical
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TKATM	ATM	EIN	catalyst temperature (model)
TKATM2	ATM	EIN	catalyst temperature (model), bank2
TVLRH	LRHK	AUS	LRHK: correction value for delayed controller switch tv
TVLRH2	LRHK	AUS	LRHK: correction value for delayed controller switch tv 2
TVLRHI	LRHK	AUS	weighted I-part for delayed controller switching tv
TVLRHI2	LRHK	AUS	Bank2: weighted I-part for delayed controller switching tv
TVLRHP	LRHK	LOK	weighted P-part for delayed controller switching tv
TVLRHP2	LRHK	LOK	Bank2: weighted p-part for delayed controller switching tv
USHK2_W	GGLSH	EIN	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst 2
USHK_W	GGLSH	EIN	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst
USRHK	LRHK	AUS	momentary control threshold for downstream lambda control
USRHK2	LRHK	AUS	momentary control threshold for downstream lambda control, bank2
ZATV	LRHK	LOK	Integration speed I-part, close loop regulation post cat.
ZATV2	LRHK	LOK	Integration speed I-part, close loop regulation post cat, Bank2
Z_LASH	DLSAHK	EIN	cycle flag of lambda sensor aging downstream cat
Z_LASH2	DLSAHK	EIN	cycle flag of lambda sensor aging downstream cat, cylinder row 2

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FB LRHK 33.10 Detailed description of function

The lambda controller for the sensor downstream catalyst is superimposed to the upstream control. The only intervention on the upstream lambda control is performed by the tv-correction tvlrh.

Lambda control downstream catalyst:

Deactivated by inserting zeros into the map KFFTV and setting the turn-on threshold TKATMLRH to a high value.

The lambda control downstream catalyst is considered a slow "ON-OFF" controller with a clear I-behavior. The controller ensures to a large extent compensation of emission deterioration, caused by a shift of the static sensor characteristic and possible unsymmetrical increase of the response time of the sensor upstream the catalyst.

The controller downstream converter interferes with the upstream controller only via an additional tv-shift (tvlrh). The magnitude of the change is a measure for the aging of the sensor and is used for the self diagnosis function "sensor aging". A symmetrical increase of the sensor response time cannot be detected via tvlrh.

The momentary integrator value of the downstream control is generally weighted with a factor from the map KFFTV. By means of a multiplication of the integrator value with a weighting factor a load/speed dependent weighting of the controller correction over the whole load/speed area is possible. The tv - correction for the controller downstream catalyst (tvlrh) is derived from the product of the integrator content and the value KFFTV. This correction is added to the appropriate value from the tv-pilot control map KFRTV.

If the downstream sensor indicates an e.g. lean mixture, then the integrator content and therefore the complete tv-shift is increasing. As consequence, the mixture is enriched until ushk exceeds the threshold downstream catalyst again. In contrast to the controller upstream catalyst, there is a map designated for the downstream control threshold. By varying this threshold, a marginal load/speed dependent lambda shift is obtained. The control rate of the superimposed controller is to be selected as significantly slower than the controller upstream catalyst. Due to the fact, that in case of small air flow (low load/speed point) the downstream sensor voltage usually shows a poorer run and corresponding undershootings should be less rated, the time constant of the downstream control has to be chosen depending on the air flow ml (characteristic line ZLRHML). With high air flow the integration speed is usually to be chosen higher.

For the downstream controller specific "Turn-On" conditions (B_lrhk) apply. E.g., the integrator inputs are enabled only within the control area (NLRHU <= n <= NLRHO and TLLRHU <= tL <= TLRHON(n)) and only after the blocking time TBLRH after reactivation of the upstream control (B_lr) has elapsed.

The characteristic line TLRHON allows to define the tL-limit of the control area depending on the engine speed. With it, the control area (which showed a tL-/n-rectangle at former function definitions) can be defined, so that the operating range, which results in higher exhaust gas temperatures, is excluded. Higher exhaust gas temperatures and therefore higher lambda sensor temperatures leads to a partial healing of sensor effects, which would result in a misadaption.

After fuel cut-off the catalyst is satuarated with oxygen. The sensor voltage downstream catalyst will remain for a certain time on small, "lean" values. After fuel cut-off the downstream control is forbidden by the section %LRKA using the bit B_lrka. After finishing the oxygen neutralisation lambda sensor voltage downstream is overshooting the threshold of 600 mV for appr. 2..10 s. For avoiding enleanment by downstream lambda control it is stopped until air mass threshold MLLRH is exceeded.

Additionally the downstream lambda control will only be enabled, if a certain catalyst temperature threshold (tkatm > TKATMLRH) is exceeded and after the downstream oxygen sensor readyness (B_sbbhk) has been detected. The downstream control is also blocked by a whole string of diagnosis faults.

Remark: So far as a secondary air system is existing, B_lrhk must be blocked during secondary air diagnosis (B_dsls = 1). B_lrhk is additionally disabled during active secondary air (B_sls = 1) by B_lr = 0 (section LREB).

Outside of the control area, the value of the integrator is also considered, even it is frozen.

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APP LRHK 33.10 Application hint

Procedure for application of %LR and %LRHK:

- calibrate pilot control, KFRI, KFRP (amplitude fr approx. 3 %, P-jump 2.5 %)
- The base points of the characteristic line TSPERN are to be calibrated in accordance with the dead time behaviour of the control plant. Choose the values to about 2/3 of the dead time.
  3 * n-base points: range e.g. 800 rpm ... 5000 rpm
- The base points of KFFTV should be chosen like those of KFRI (7*n, 6*tl) , set all values of KFFTV priliminary to 1. Should the situation arise, that a weighting is necessary outside of the control area, it can be constructed by the map KFFTV. Please note, that the weighting factor within the control area must be definitely chosen to 1! If other values than 1 are applied, the integration speed of the downstream controller varies!
- 4 * 4 base points are to be provided for the map KFUSHK

  Proposal:

n:	1000,	1800,	2400,	3000	rpm
tl:	2	3	4	5	ms

- lower control limit e.g. NLRHU = 1200 rpm, TLLRHU = 2.0 ms
- upper control limit e.g. NLRHO = 3000 rpm,
  characteristic line TLRHON depending on n
  For the characteristic line there are no experiences available. However, four base points should be sufficient, placed between NLRHU and NLRHO.
  The introduction of the characteristic line is based on the experience, that sensor faults show less effect with high temperatures. By means of the characteristic line the learning area is to be limited, so that no critical temperatures occur during learning.
- Choose TKATMLRH so that closed loop control is activated at approx. 300 deg C. In the meanwhile a catalyst temperature model is available including a physical conversion of the catalyst temperature tkatm.
- TBLRH should be min. 1 s.
- ZLRHML- characteristic line depending on the air flow [kg/h].
  base points exemplary for an engine with ml(WOT): 450 kg/h

ml:	9.6	28.8	86.4	200	400	kg/h
ZLRHML:	0.6	1.2	1.8	2.4	3.0	ms/s

- Set values in KFRTV to 0.
- Set control threshold downstream catalyst to 550,600 or 650 mV; then operate the engine at all KFRTV and KFRI map points of and determine the resulting tvlrh values for each single mapping point. Afterwards, these values must be carried over into the map KFRTV.
  Remark: tvlrh values from lower load/speed points (n < 1200 rpm, tl < 2 ms) can strongly deviate from the other values and are not necessarily to be adopted (carry out an extrapolation based on neighbouring points).
- Perform FTP 75 with various voltage thresholds downstream catalyst and the appropriate KFRTV map values, determined in advance under steady state conditions
- Which is the best test?

Application of MLLRH:
Overshooting of sensor voltage after finishing oxygen neutralisation is specific phenomena of every project. LRHK shall be stopped until air mass threshold MLLRH is exceeded.

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BBTEGA 3.40 Operating contitions for purge canister control / fuel adaption

FDEF BBTEGA 3.40 Function definition

bbtega-main

forced TE-Stop:

bbtega-forcedte-s

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TE-GA-AUTO: Statemachine for phase control between canister purge (TE) and mixture adaptation (GA)

bbtega-te-ga-auto

bbtega-te-ga-auto

bbtega-statemachi

bbtega-statemachi

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bbtega-a-tteini

bbtega-a-tteini

bbtega-a-tgaini

bbtega-a-tgaini

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bbtega-a-tte

bbtega-a-tte

bbtega-a-ttemn

bbtega-a-ttemn

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bbtega-a-tteae

bbtega-a-tteae

bbtega-a-tga

bbtega-a-tga

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ABK BBTEGA 3.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DFTEDS			FW	hysteresis width on canister charge for switching to endless purging
FTEADZU			FW	threshold canister charge for interruption of the purge phase
FTEDS			FW	threshold canister charge for switching to endless purging
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
TATELL			FW	tans-threshold for canister purge control with B_ll = 1
TMSNOGA			FW	threshold tms for endless purge control, if mixture adaptation without error
TTE			FW	time for canister purge phase
TTEAE			FW	duration of canister purge phase with completed mixture adaptation
TTEBSTP			FW	maximum time for purge stop at idle if the cycle flags are not set
TTEGA			FW	time during canister purge for basic adaptation
TTEGAI			FW	Duration of the first mixture adaptation phase
TTEGAZO			FW	Time for canister purge stop for lambda adaptation, upper threshold
TTEGAZU			FW	Time for canister purge stop for lambda adaptation, lower threshold
TTEINI			FW	Duration of the first purge phase
TTEMN			FW	time for canister purge phase minimum
TTEPRIO			FW	time after start for switching to endless purging
TTEZAO			FW	Time for permanent canister purge, upper threshold
TTEZAU			FW	Time for permanent canister purge, lower threshold

Variable	Source	Type	Description
B_DLDPTE	GKRA	EIN	request from evap system monitoring to shut down PCV
B_DMTLTZ	DDMTL	EIN	Condition TEV should be closed
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_FRAO	LRA	EIN	condition for enabling adaption of frao
B_FRAOAN	BBTEGA	AUS	demand CPV quickly closing for activtion of mixture adaptation
B_GAE	DKVS	EIN	condition for adaptive Lambda pilot control successful
B_GAEFRA	DKVS	EIN	condition for fra portion of adaptive Lambda pilot control successful
B_GAEFRA2	DKVS	EIN	condition for fra2 portion of adaptive lambda pilot control successful
B_GAP	BBTEGA	AUS	condition mixture adaptation phase active
B_GASP	LRAEB	EIN	condition for basic mixture adaptation disabled
B_GRDST		EIN	condition basic attitude
B_LL	MSF	EIN	Condition idle
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_TE	TEBEB	EIN	Condition canister purge active
B_TEABB	TEB	EIN	Condition purge canister function ready to finish
B_TEHBX	TEB	EIN	Condition load integrator ftead at max. limit
B_TEHBXF	BBTEGA	LOK	Condition load integrator ftead at max. limit, filtered
B_TEP	BBTEGA	AUS	Condition canister purge phase active
B_TEPI	BBTEGA	LOK	Condition canister purge phase active internal
B_TEPZUS	BBTEGA	LOK	condition additional canister purge phase
B_TEZA		EIN	Condition forced activation of the purge control function
B_TEZSTP	BBTEGA	LOK	condition canister purge forced stop
B_TTEAE	BBTEGA	LOK	condition switch over to long purge phase
FTEAD_W	TEB	EIN	charcoal canister charge
TANS	GGTFA	EIN	Intake air temperature
TEPHC	BBTEGA	LOK	phase counter mixture adaptation / canister purge
TMST	GGTFM	EIN	engine temperature at start
TNSE_W	BBSTT	EIN	time counter at end of start (16 bit)
Z_FRAO	DKVS	EIN	cycle flag of mixture adaption factor frao
Z_FRAO2	DKVS	EIN	cycle flag of mixture adaption factor frao2 (bank 2)

FB BBTEGA 3.40 Detailed description of function

```
Remarks on stereo lambda control:
---------------------------------
- The FDEF below is intended for systems with stereo and mono lambda control but there is no stereo variable necessary because
  in DKVS B_gae represents the both sides.


Description of phase control, mixture adaptation / canister purge  (function BBTEGA):
-------------------------------------------------------------------------------------
Output variables:
 - Mixture adaptation phase active: B_gap (B_gap = TRUE does not necessarily mean that LRA is really active)
 - Canister purge phase active: B_tep (B_tep = TRUE does not necessarily mean that TEB is really active)
   Remark: With inactive lambda control (e.g. defective probe), the system switches to controlled purge operation.
           The canister purge valve is opened even in a "mixture phase". The LRA is then disabled.
```

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Input variables:
- Flags of the DKVS (B_gae, B_gaefra/2). The flag B_gae corresponds to the cycle bit of DKVS. When LRA is not complete, there is greater need of adaptation at idle.
- Load ftead for PCV closing, if
  - in idle speed the mixture adaptation has not stablizied (B_gae = FALSE) and multiplicative adaptation has stablized (B_gaefra=TRUE).
  - upper multiplicative range is active, the cycle bit Z_frao(2) = FALSE and the lambda control is active (B_lr(2) = TRUE).
- Request bits of the diagnosis functions that can only run at idle speed (B_dldpte, B_dtes, B_dmtltz)
- Request bits for a quickly test: B_grdst
- The bit B_nmot (engine speed plausible) for initialisation of counters in the phase control
- The bits B_teabb (purge ready to finish), B_gasp (mixture adaptation disabled) and B_tehbx (load at max. limit) for influencing the phase control
- The Bit B_te from the TEB for detecting whether the purge valve is closed
- tans : No canister purge control in idle speed, if manifold air temperature less then threshold TATELL
- time since end of start tnse_w for time controlled canister purge and mixture adaptation

Purpose of phase control:
- Coordination of the changeover between mixture adaptation and canister purge with the following aims:
  a) Maximising the flush volume (in emission test and in the field) especially at high loads => activate TEB
  b) Quickest possible detection of a DKVS fault (sufficiently long and frequent activation of mixture adaptation on faults) => activate LRA
  c) Quickly closing of the purge valve and LRA (activate upper multiplicative range) at low load
  d) Quickest possible activation of diagnosis functions that only run at idle speed => Initiation of reset of the purge valve at B_ll (idle switch only) and low load
  e) Reset of the purge valve on request by DKVS (B_gae = FALSE and multiplicative adaptation correction is completed), DLDP (B_dldpte), and tester (B_grdst)
  f) Activation of TEB, if from DLDP desired (B_teza)
  g) Long canister purge, if the time after start greater then TTEPRIO or B_gae = TRUE or a hotstart withught a fault in feul supply system (starttempeture higher then TMSNOGA and B_edkvs(2) = FALSE).
  h) Endless canister purge by high load of cainster purge (ftead >= FTEDS), B_tehbx = FALSE and long caniter purge is actived (B_tteae = TRUE).
  i) No canister purge control in idle speed, if manifold air temperature less then threshold TATELL

Implementation of phase control:
- The core is a statemachine. The output of this statemachine is the bit B_tepi (internal purge phase). The main internal variable is the RAM cell tephc - phase counter for canister purge/mixture adaptation. It is set to an initial value at the start of each phase. The phase counter is decremented in each state. At zero the system generally switches to the other state.

  The following process control is integrated into this statemachine:
  - Start with a purge phase (B_tepi = TRUE) of length TTEINI, which cannot be aborted (state A_tteini)
  - Switching to state A_tgaini: first mixture adaptation phase -> B_tepi = FALSE
  - Depending on bit B_tteae (long purge phase) transition to state A_tteae (long purge phase with TTEAE) if B_tteae = TRUE, else short purge phase with TTE if B_tteae = FALSE. Both states may be exited prematurely if the remaining time is greater than TTEMN (tephc < TTEMN) and the bit B_teabb (purge ready to finish) is set. => Transition to state A_ttemn. Otherwise when the phase counter has elapsed, transition to mixture adaptation (A_tga).
  - After the adaptation phase, transition to either long or short purge phase.

- Two conditions result in switching to endless canister purge (OR condition with B_tepi):
  A) B_gasp - mixture adaptation disabled
  B) Load greater than threshold FTEDS (hysteresis to prevent toggeling of activation of endless canister purge) and load was not at maximum limit (this condition is reset once when time TTEPRIO after start ist elapsed) and
     - time TTEPRIO after start elapsed, or
     - mixture adaptation complete or
     - the starttemperature is higher then threshold TMSNOTGA and any faults are in diagnosis fuel supply system.

- However, some conditions produce a "dominant" switching (activation) of mixture adaptation:
  A) If the DKVS (additive correction) that is active at idle speed" has not yet finished running (B_gae = FALSE) and the canister load is less than a threshold (FTEADZU) with the idle switch closed.
  B) If B_frao = TRUE, and Z_frao is not set, the system also switches to a mixture adaptation phase at low canister load. The purge valve is there closed quickly.
  C) A "diagnosis function active at idle speed" forces a purge phase: B_dldpte, B_dtes, B_dmtltz
  D) Short test via tester: B_grdst = TRUE
  E) by low manifold air temperature in idle speed for a quiet operation the canister purge control is switched off.
  F) time controled mixture adaptation phase starting at time TTEGAZU and ending at time TTEGAZO

- Actiavation of TE-phase with highest priority at the following conditions.
  A) activation from the DLDP by B_teza
  B) time controlled canister purge phase starting at time TTEZAU and ending at Time TTEZAO

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APP BBTEGA 3.40 Application hint

```
TTEINI  : 220 s
TTEMN   :  30 s
TTEGAI  : 130 s
TTE     :  60 s
TTEGA   :  60 s
TTEPRIO : 700 s
TTEBSTP :  40 s

TTEZAU  : FTP: 900s   DTEV assured in idle phas at  1000 s after start
TTEZAO  : FTP: 1020s

TTEZAU  : ECE: 610 s DTEV has 3 chances; if only one chance needed: TTEZAU = 750 s
TTEZAO  : ECE: 840 s

TMSNOGA : 50 °C

FTEDS   : 20
DFTEDS  :  5
FTEADZU :  5 kg/m^3
MSTEOZU :  0.1 kg/h
```

TEBEB 9.10 Switch-on conditions for purge control

FDEF TEBEB 9.10 Function definition

tebeb-main

ABK TEBEB 9.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TMTE			FW	engine-temperature threshold for canister purge
TTEAUS			FW	Delay time after engine start for activating the purge control valve

Variable	Source	Type	Description
B_ATMTPA	ATM	EIN	condition temperature upstream catalyst exceeds dew-point
B_DLDPTE	GKRA	EIN	request from evap system monitoring to shut down PCV
B_DLLRA	DLLR	EIN	Condition DLLR request
B_DMMTEV	DDMMVE	EIN	close canister purge valve for power stage test DMTL-solenoid

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Variable	Source	Type	Description
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_DTEAA		EIN	Condition diagnosis CPV by opening the CPV active
B_EOBDLR		EIN	error flag:^OBDII summary fault, disables lambda control
B_FRAOAN	BBTEGA	EIN	demand CPV quickly closing for activtion of mixture adaptation
B_FTEDAB		EIN	Condition decrease purge rate for diagnosis CPV
B_LAMKA		EIN	lambda for Katalyst oxygen purge is active
B_LAMKA2		EIN	lambda for Katalyst oxygen purge is active
B_LAMSDEF	LAMKO	EIN	Condition: defined desired air/fuel ratio value
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRSSA		EIN	LRSEB: switch onLambda after fuel cut off with slow sensor
B_LRSSA2		EIN	switch onLambda after fuel cut off with slow sensor, bank2
B_MLRSA	LREB	EIN	LRSEB: Air mass based switch off Lambda Control during and after fuel cut off
B_QTEDAB	TEBEB	AUS	condition fast decrementation of purge rate
B_SBBVK	DLSV	EIN	condition for lambda sensor upstream cat ready for operation
B_SBBVK2	DLSV	EIN	condition oxygen sensor upstream cat. bank2 ready for operation
B_SLS	SLS	EIN	Condition for active secondary air
B_TE	TEBEB	AUS	Condition canister purge active
B_TEF	TEBEB	AUS	Condition canister purge function principally released
B_TEI	TEBEB	AUS	Internal condition: canister purge function active
B_TEN	TEBEB	AUS	condition open loop purging
B_TEP	GKEB	EIN	Condition canister purge phase active
DFP_DK	TEBEB	DOK	ECU int. fault path no.: clear error throttle potentiometer
DFP_LDPE	TEBEB	DOK	ECU int. fault path no.: leakage detection pump power stage
DFP_TEVE	TEBEB	DOK	Internal fault path number: canister purge valve power stage
E_DK	GGDVE	EIN	Error flag: throttle position sensor
E_LDPE	DLDPE	EIN	error flag: leakage detection pump power stage
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
LAMSONS_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location
TATESOLL	GKRA	EIN	desired duty cycle of the PCV
TMOT	GGTFM	EIN	Engine temperature

FB TEBEB 9.10 Detailed description of function

```
The function TEBEB contains the activation conditions for the purge control function (TEB)
There is closed loop (B_tei) and open loop purge control (B_ten)
 - Closed loop only if B_tep = TRUE
 - Open loop purge control can also be activated if B_tep = FALSE if no Lambda sensors is ready.

The TEBEB has the following output values:
 - B_tef: principle acivation of purge control
 - B_tei: closed loop purge control active
 - B_te : purge control activ (PCV not closed)
 - B_ten: open loop purge control (no lambda regulator active)
 - B_qtedab : quickly closing of CPV for diagnosis function


Input values:
  - tmot: engine temperature. It should be higher than TMTE to activate the purge control
  - B_atmpta:(dew-point end) after end of the time TTEAUS, after this there is not condensation in exhaust and the Lambda-sensor
    could be fuel, the canister purge is enabled.
  - B_dteaa : The learning of load canister purge is avoid during diagnosis of purge canister valve
  - Stop purging if one of the following conditions is TRUE:
    - B_sls  : Secondary air active
    - B_dsls : Diagnosis of secondary air system active
    - B_ftedab : Diagnosis of the purge system
    - B_fraoan : by not learnt adaptation in FRAO range
    - E_teve : Electrical Error PCV stage
    - E_dk   : Error throttle potentiometer
    - E_ldpe : Error Power stage LDP
    - B_dldpe: Condition leak detection pump active
    - B_dllra: Condition PCV closed when idle speed actuator diagnosis is active
    - B_lamsdef : For diagnosis Lambda sensor the Lambda control is stopped and a test function is started. In this case should be
      prohibited open loop purge control too. The PCV is not closed during katalyst oxygen purgeing (B_lamka = TRUE).
    - B_lrssa(2): switch on condition of lambda control after feul cut off with slow sensor
    - B_dmmtev: Condition PCV closed when power stage diagnosis DM-TL valve is active (test pulse)


  B_tei is only TRUE if at the same time, B_tep, B_tef and  B_lr or B_lr2 (Stereo-LR) is activ.
  B_te is TRUE with B_tei = TRUE and, if tatesoll > 0.
  B_ten is only TRUE, if the following conditions are fullfilled:
  - Either Lambda sensor 1 nor Lambda sensor 2 are ready  !(B_sbbvk V B_sbbvk) or no Lambda controller is active (bank1 or bank2)
    an TEB-phase is TRUE (B_tep) and lamsons_w is unequal 1.0, or by OBDII summary fault, which disables the lambda control.
  - B_tef is TRUE
  - After fuel cut off enough air was sucked in to activate the Lambda control (B_mlrsa = FALSE).
```

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APP TEBEB 9.10 Application hint

```
engine temperature threshold:- TMTE
 * the lower, the more can be purged in the FTP Test
 * the higher, the less are the influences on the emissions
 => compromise: TMTE  40 - 50 ° C

Time for TEB switched off after start: TTEAUS
 * reason: after a hot start, the TEB should not be switched on early after start (ftead_w misslearning because of
   hot fuel in the fuel-rail.
 => proposed values: TTEAUS: 10s - 20s
```

TEB 95.10 Purge canister function

FDEF TEB 95.10 Function definition

Overview of TEB:

teb-teb

Calculation of Lambda control signals (frmxa, frmit_w and B_gwrte) and of the quotient: qtetemin = MIN(te_w, te2_w) / TEMIN:

teb-frteaufb

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Calculation of the desired value of purge mass flow (mstesoll_w) and of the purge rate (ftefva_w):

teb-fteber

teb-fteber

Limitation of the purge rate (signal ftefvamx_w):

teb-ftefxber

teb-ftefxber

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The two integrators: ftefsoll_w and mstesoll_w:

teb-ftefint

teb-ftefint

Adaptation of the HC-concentration of the purge flow:

teb-fteadber

teb-fteadber

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Calculation of the mixture correction signal "rkte_w":

teb-rkteber

Calculation of the Bits derived from "Canister Charge - ftead_w":

teb-hbelber

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Interaction on engine torque:

teb-miteber

ABK TEB 95.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DFTEAHB			FW	threshold fuel rate for switching the bit B_tebh to TRUE
DMSTES	MSTESOLL		KL	characteristic line maximum increase of purge mass flow
DSTEMIN			FW	minimum value for transportation distance in delay-time block
FBTEB	FTEFVAB		KL	factor ftefvab-depending limitation of the canister charge adaptation speed
FBTEVA	FTEFVA		KL	factor ftefva-depending canister charge adaptation speed
FETATEBN	NMOT		KL	characteristic line: reduction of engine efficiency as f(nmot)
FKATEB	QTETEMIN		KL	Characteristic line fuel portion depending on te / TEMIN
FQTEFR	FRMXA		KL	characteristic line: purge rate reduction with big frm-deviation
FQTEPT	PTE		KL	characteristic line: for fuel-tank underpressure limitation
FQTEVA	FTEFVA		KL	progression of purge rate controller
FRHB			FW	limit for lambda controller to reset Bit ”High HC-canister charge”
FSRFTEF			FW	factor: control speed of purge rate controller
FTEADAB			FW	Canister charge threshold for interruption of the purge phase
FTEADMX			FW	Maximum value of the canister charge (ftead)
FTEFHB			FW	Limit for flow rate of purge system to detect high concentration
FTEHB			FW	Limit for purge factor to detect high concentration
FTEINIX	IMSTEINI		KL	characteristic line for max. purge rate = F(integral purge flow after TE-Stop)
FUMRBRK			FW	factor calculation of canister charge (ftead) from HC-concentration
FVERMN	NMOT		KL	characteristic line: filter factor for purge flow in the manifold with fresh air
FVERZTE			FW	factor delay of purge flow in the manifold
KFETATE	FTEADF	QTETEMIN	KF	characteristic map for efficency at active purging when te is near TEMIN
KFFTEAN	NMOT	WDKBA	KF	characteristic map for limitation of the purge rate with no Lambda control
KFFTEAX	ML	TANS	KF	Characteristic map for limitation of the purge rate
KFQTE	ML	FRMIT	KF	Map for purge rate increase / decrease
KFTATX	NMOT	PSPU	KF	map for max. duty cycle
KFTEKA	NMOT	RL	KF	characteristic map of desired fuel portion purge control
KHCTEMN			FW	minimum value of HC concentration in purge flow
KHCTEMX			FW	maximum value of HC concentration in purge flow
KUMSRL			FW	conversion constant from mass flow to relative air charge
NOBELSTP			FW	Lerning of canister purge load enable
TEMIN			FW	minimum effective injection time
TFTEINI			FW	Time for detection of purge stop
TQTEAB			FW	time for decrementation of the purge rate
TQTEDAB			FW	time for fast decrementation of the purge rate
TVSATEM	TMOT		KL	delay time for closing of the PCV after readyness for fuel cut off
ZBTEML	ML		KL	integration speed for canister charge adaptation
ZETATE			FW	changing speed of engine efficiency because of purge control
ZKFTEAD			FW	time constant filtered factor load scavening air at tank ventilation

Variable	Source	Type	Description
B_EVLOC	AEVAB	EIN	Status: all injection valves are activated
B_FRMAX	LR	EIN	lambda control sets bit when lambda controller reaches its limit FRMAX

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Variable	Source	Type	Description
B_FRMAX2	LR	EIN	lambda control sets bit when lambda control reaches it limit FRMAX, bank2
B_FRMIN	LR	EIN	lambda control sets bit when lambda controller reaches its limit FRMIN
B_FRMIN2	LR	EIN	lambda control sets bit when lambda control reaches its limit FRMIN,bank2
B_GWRTE	TEB	LOK	condition: purge rate reduction because of fr-controller deviations
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRAR	TEB	AUS	condition for reducted correction ranges at LRA
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_QTEDAB	TEBEB	EIN	condition fast decrementation of purge rate
B_SAB	MSF	EIN	Condition fuel cut-off requested
B_TE	TEBEB	EIN	Condition canister purge active
B_TEABB	TEB	AUS	Condition purge canister function ready to finish
B_TEAKT	TEB	LOK	condition purge control active (open loop or closed loop)
B_TEF	TEBEB	EIN	Condition canister purge function principally released
B_TEHB	TEB	AUS	condition for canister purge system with high canister load
B_TEHBX	TEB	AUS	Condition load integrator ftead at max. limit
B_TEI	TEBEB	EIN	Internal condition: canister purge function active
B_TEN	TEBEB	EIN	condition open loop purging
B_TEP	GKEB	EIN	Condition canister purge phase active
C_INI		EIN	ECU-condition for intialisation
DFTEF_W	TEB	LOK	input purge rate integrator
DKATEFRG	TEB	LOK	deviation actual fuel rate purge control from desired value
DKHC_W	TEB	LOK	input integrator for learning HC-concentration of purge control
ETATE	TEB	AUS	engine efficiency when purging with high vapour concentration
ETATEINT	TEB	LOK	integrator engine efficiency while purging
ETATESOL	TEB	LOK	desired engine efficiency when purging (depending on HC-vapor concentration)
E_LSV	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_LSV2	DLSV	EIN	error flag: lambda sensor upstream catalyst
FBETATE	TEB	LOK	desired engine efficiency as f(nmot) at purge control to avoid te/TEMIN<=1
FBKATE	TEB	LOK	factor fuel portion of purge flow depending on te / TEMIN
FGWRTE	TEB	LOK	value: purge rate reduction because of fr-controller deviations
FKATEAPP	TEB	LOK	factor calibrated fuel portion of purge flow
FKATEFRG	TEB	LOK	factor fuel rate purge control at desired purge rate
FKATEI	TEB	AUS	factor fuel part purge control (actuel value)
FKATES	TEB	LOK	factor fuel part purge control (desired value)
FNGWRTE	TEB	LOK	factor purge rate control after fr-controller reduction
FREGFTE	TEB	LOK	factor purge rate control before fr-controller reduction
FRM2_W	LR	EIN	fast mean value of lambda control factor bank 2(word)
FRMIT	TEB	LOK	Mean value of fr and fr2
FRMIT_W	TEB	AUS	mean value of fr and fr2 (16 bit)
FRMXA	TEB	LOK	fr value (out of fr and fr2) which is the farest away from 1.0
FRMXAOLD_W	TEB	LOK	mean value fr-controller - old value (16 bit)
FRMXA_W	TEB	AUS	fr value (out of fr aund fr2) wich is the farest away from 1 (16bit)
FRM_W	LR	EIN	fast mean value of lambda control factor (word)
FTEADF	TEB	AUS	filtered factor load scavening air at tank ventilation
FTEADF_W	TEB	LOK	filtered factor load scavening air at tank ventilation (16 bit)
FTEAD_W	TEB	AUS	charcoal canister charge
FTEFSOLD_W	TEB	LOK	last desired canister purge rate before closing the PCV
FTEFSOLL_W	TEB	LOK	desired canister purge rate
FTEFVA	TEB	LOK	canister purge rate
FTEFVAB	TEB	LOK	actual limit of the purge rate
FTEFVAMX_W	TEB	LOK	max. purge rate (16 bit value)
FTEFVA_W	TEB	AUS	purge rate of the purge control function
FTEML	TEB	LOK	input purge rate integrator
FVERMTE_W	TEB	LOK	factor filtering purge low in the manifold
IMSTEINI	TEB	LOK	integral of purge mass flow after a longer purge stop
KHC_W	TEB	LOK	adapted HC-concentration of the purge flow
KTEEV_W	TEB	LOK	concentration purge flow in the manifold at the injection valve
KTETEV_W	TEB	LOK	concentration purge flow in the manifold at the PCV
MIFA	MDFAW	EIN	desired indicated engine torque
MIFA_W	MDFAW	EIN	desired indicated engine torque
MIOPT_W	MDBAS	EIN	optimum indicated torque
MITEBG_W	TEB	AUS	torque value for minimum charge canister purge
ML	BGSRM	EIN	air mass flow
MLSOL_W	FUEDK	EIN	set air mass flow
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSDKALM_W	BGMSZS	EIN	Mass flow over throttle (balance with HFM signal)
MSSGIN_W	TEB	LOK	mass flow into manifold (through throttle and PCV)
MSTE	BGTEV	EIN	mass flow purge control into the manifold
MSTEEV_W	TEB	LOK	purge mass flow at the injection valve
MSTEO_W	BGTEV	EIN	Mass flow the 100 % opened TEV
MSTESMX_W	TEB	LOK	max. possible desired purge mass flow
MSTESOLL_W	TEB	AUS	desired purge mass flow
MSTE_W	BGTEV	EIN	mass flow purge control into the manifold
NMOT	BGNMOT	EIN	engine speed
NMOT_W	BGNMOT	EIN	engine speed
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PTE		EIN	tank pressure (from ADC)
PU	GGDSAS	EIN	Ambient pressure
QTETEMIN	TEB	LOK	quotient: te / TEMIN for BDE teh_w/teminh_w resp. tes_w/temins_w
RKTE_W	TEB	AUS	relative fuel part of the purge control

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Variable	Source	Type	Description
RL	EGFE	EIN	relative air charge
RLTEEV_W	TEB	LOK	relative cylinder air amount because of purging
R_T100		EIN	Time schedule 100 ms
R_T20		EIN	Time schedule 20 ms
SY_EGAS	PROKON	EIN	system constant E-GAS present
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TANS	GGTFA	EIN	Intake air temperature
TE2_W		EIN	effective injection time bank 2 (word)
TE_W		EIN	effective injection time (word)
TMOT	GGTFM	EIN	Engine temperature
WDKBA	GGDVE	EIN	throttle angle

FB TEB 95.10 Detailed description of function

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Introduction:
=============
The new "loading-dependent purge control" is subdivided into several functions:
> %TEB     - core of the function
> %TEBEB   - activation conditions
> %ATEV    - output of the duty cycle to the PCV
> %BGTEV   - calculation of the mass flows PCV (separate functions for aspirating engines and for turbo charger engines)


Short description of the function purge control:
================================================
> A desired mass flow scavenge gas is determined  (mstesoll_w)
> From this the pulse duty cycle PCV is calculated (tateout)
> The actual scavenging flow purge control into intake manifold is calculated (mste_w)
> The concentration of scavenge gas in the intake manifold at the level of the PCV is calculated (ktetev_w)
> The transport and mixing through the intake manifold are taken into consideration (ktetev_w -> kteev_w)
> The mass flow of scavenge gas at the level of the intake valve of the engine (msteev_w) is calculated
> The relative charge in the cylinder due to scavenge gas (rlteev_w) is calculated.
> From the deviations of the Lambda controller from 1.0 the HC concentration directly upstream the PCV (khc_w)
  is adapted and directly from this the variable loading (ftead_w) is calculated.
> The needed relative fuel correction is calculated (rkte_w = relative charge * loading).

Remark: All mass flows (so also scavenging flows) refer to pure air. A possible "loading" with hydrocarbons (HC) is only taken
        into consideration during the mixture correction (rkte_w).
        The system constant SY_EGAS distinguishes the system-specific versions with/without electronic accelerator (EGAS)

List of the most important values for purge control (turbo charge engine + aspirating engine):
==============================================================================================
Mass flows:
-----------

> Air masses flowing into and out of the intake manifold (msdkalm_w, ml_w)
> Scavenge gas masses flowing into and out of the intake manifold (mste_w, msteev_w)
=> thus resulting scavenge gas concentrations (ktetev_w - at the level of throttle valve, kteev_w)

Physical values (only for description):
---------------------------------------

> HC concentrations (mass of HC particles / mass of air particles) in the monitored gas flow
  - khc_tev: directly upstream PCV
    (no motronic value, however, adapted value "HC conc. upstream PCV" exists in motronic: khc_w )
  - khc_einl.: at the level of the intake valve of the engine (no motronic value)

Special motronic values for PCV triggering and mixture correction:
------------------------------------------------------------------

> tateout  : Output duty cycle PCV (contains pickup delay PCV)
> rkte_w   : Mixture correction for injection (is subtracted from the injection volume needed without purge control)
> khc_w    : Adapted HC concentration of the scavenge gas flow directly upstream the PCV
> rlteev_w : Relative charge in the cylinder due to scavenge gas
> ftead_w  : Value obtained from khc_w only by conversion (re-normalization) (rkte_w = ftead_w * rlteev_w)
```

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Intake manifold models (separate for aspirating engines and turbo charger engines), complete list of all values:

Aspirating engine:

Mass flows:

mshfm_w.....: Mass flow of air flowing through HFM
msdkalm_w.....: Mass flow through throttle valve equalized with air mass meter signal (on the aspirating engine msdkalm_w = mshfm_w, on the turbo charger engine the balance air mass turbo charger is added)
mstetev_w.....: On the aspirating engine: mass flow PCV (intake downstream throttle valve)
mste_w.....: Total flow purge control ("currently flowing at the level of the throttle valve")
msteev_w.....: Total (compared to throttle valve) timewise delayed and "smoothed out mass flow purge control" msteev_w is only used for the mixture correction (the charge sensing calculates with mste).
mssgin_w.....: mssgin_w = msdkalm_w + mste_w: total gas mass flow flowing into intake manifold (air throttle valve + TE scavenge gas). EGR is not taken into consideration
ml_w.....: Total air mass flow siphoned from the engine (in ml_w also scavenge gas is contained)

Pressures:

ps_w.....: Manifold pressure in hPa
pu.....: Ambient pressure in hPa
pvdk.....: Pressure upstream throttle valve

HC concentrations:

khc_tev.....: Concentration HC at PCV
khc_einl.....: Concentration HC at the level of the intake valves

Concentrations of scavenge gas in air, which is taken in through the throttle valve (not illustrated in above diagrams) :

ktetev.....: Concentration of scavenge gas in the intake manifold immediately after scavenge gas has mixed with air
kteev.....: Concentration of scavenge gas at intake valve
Remark: Conc. of scavenge gas is not equal to concentration of HC but only indicates how many gas particles from the TE-system have currently mixed with the gas particles of the air.
ktetev = mste / (msdkalm + mste) ktete
kteev = msteev / ml

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Turbo engine:
==========

Mass flows:

mshfm_w.....:	Air mass flow flowing through HFM
msdkalm_w.....:	Mass flow through throttle valve equalized by air mass meter signal (on the aspirating engine msdkalm_w = mshfm_w, on the turbo charger engine the balance air mass turbo charger is added)
mstevl_w.....:	Only turbo engine: portion of mass flow PCV which is led in upstream of the turbo charger
mstehl_w.....:	Only turbo engine: mass flow purge control currently flowing into the intake manifold from the turbo charger
mstesg_w.....:	Only turbo engine: the mass flow purge control currently flowing into the manifold via the intake position of the manifold
mstetev_w.....:	On the turbo engine: the mass flow PCV which is led in upstream throttle valve
mste_w.....:	Total flow purge control ("currently flowing at the level of the throttle valve")
msteev_w.....:	Total (compared to throttle valve) timewise delayed and "smoothed out mass flow purge control" msteev_w is only used for the mixture correction (the charge sensing calculates with mste).
mssgin_w.....:	mssgin_w = msdkalm_w + mste_w: total gas mass flow flowing into intake manifold (air throttle valve + TE scavenge gas). EGR is not taken into consideration
ml_w.....:	Total air mass flow siphoned from the engine (in ml_w also scavenge gas is contained)

Pressures:

ps_w.....:	Manifold pressure in hPa
pu.....:	Ambient pressure in hPa
pvl.....:	Only turbo engine: Pressure upstream the turbo charger (little below external pressure due to flow resistance)
pvdk.....:	Pressure upstream throttle valve

HC concentrations:

khc_tev.....:	Concentration HC at PCV
khc_einl.....:	Concentration HC at the level of the intake valves

Concentrations of scavenge gas in air, which is sucked in through the throttle valve (not illustrated in above diagrams) :

ktetev.....:	Concentration of scavenge gas in the intake manifold immediately after scavenge gas has mixed with air
kteev.....:	Concentration of scavenge gas at intake valve

Remark: Conc. of scavenge gas is not equal to concentration of HC but only indicates how many gas particles from the TE-system have currently mixed with the gas particles of the air.
ktetev = mste / (msdkalm + mste) ktete
kteev = msteev / ml

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Statements and physical regularities:
==========

> For the purge control at first the entire mass flow of scavenge gas which flows in at the level of the throttle valve is of interest (mste_w). On the aspirating engine there is only one intake downstream throttle valve. Due to the intake manifold vacuum, regenerating gas flows into the intake manifold. On the turbo charger two intake positions are to be provided (1. downstream throttle valve, 2. upstream the turbo charger) In case of low manifold pressure the scavenging flow will flow in downstream throttle valve. In the charging area the flow resistance of the air filter causes a minor vacuum upstream the turbo charger. Then the scavenge gas will flow upstream the turbo charger. A check valve prevents that air from the intake manifold will flow upstream the turbo charger.

> On the aspirating engine and also on the turbo charger engine the entire purge flow at throttle valve is calculated (mste_w) - important common intermediate value.
=> Mste_w is thus then the input value for %TEB. Mste_w calculation for aspirating engines and for turbo engines, however, in separate versions %BGTEV
Remarks: Mste_w at first does not take into consideration that also HC particles are contained in the flow. Additionally also a HC concentration must be learned (adapted) (khc_w resp. ftead_w). Mste_w is related to pure air !
Storage effects in the pipe PCV-intake manifold and in the turbo charger can (in later versions) be taken into consideration in mste_w. For this the values mstetev_w (aspirating engine, turbo engine) and mstevl_w, mstehl_w (additionally only for turbo engine) were introduced.

> The HC flow led in at the PCV needs a certain time until it reaches the intake valve (position of the intake valve).

> Steep edges of concentration differences at the position of the PCV are smoothed by diffusion in the intake manifold. Generally it can be said that the longer a gas particle is in the intake manifold the more diffused become the concentration jumps.
A concentration progress in form of a rectangle (0->1 jump) smoothes out and results in a concentration progress in form of a -S- at the intake valve of the engine.

> The time spend by a particle in the intake manifold is approx. inversely proportional to the engine speed during steady-state engine operation.

> If the PCV does not open resp. close at exactly the same time or to exactly the same degree as the throttle valve then load changes cause strong HC concentration changes in the intake manifold. For example in case of a constantly open PCV the opening of the throttle valve will result in a temporarily very low scavenge gas concentration (air shoots into the intake manifold, PCV flow remains the same or reduces).
> However, if the PCV is opened resp. closed at exactly the same time as the throttle valve then the scavenge gas concentration in the intake manifold remains at a constant level. Unfortunately this mode of operation is not possible. As a rule the PCV timer enables the closing of the PCV only 120 ms after the throttle valve has closed. A throttle valve synchronous opening is also only to be passed on to the PCV delayed by the same time.
In order to obtain an as constant as possible HC concentration of the scavenge gas flow it is furthermore recommendable to open the PCV only slowly also in case of quick positive load changes (e.g. double the opening within 5 s to 10 s). This prohibits a throttle valve synchronous activation of the PCV.

=> With load changes the dilution of the scavenge gas flow in the intake manifold changes very quickly with the inflowing air.
This must be taken into consideration for the injection correction.

Advantages of the new charge sensing for the purge control function:
==========

> The new charge sensing performs a "particle balance" in the intake manifold. All gas particles flowing in are determined and from this the outflowing particles are calculated. Thus an exact knowledge of the manifold pressure is obtained. By means of the manifold pressure and of the external pressure the gas particles flowing in can then again be calculated in the next step.
The only factors which must be known are the opening areas (resp. the mass flow led off from them in the over-critical under standard conditions) to the intake manifold.

> The consequences for the purge control are:

The following values are known:

a) Aspirating engine (see e.g. BGTEV1.20):
- one intake position downstream throttle valve
ps_w - manifold pressure
pu_w - ambient pressure
=> from this the current mass flow through the PCV (mste_w = KLAFTE(ps_w/pu_w))
and the mass flow with open PCV (msteo_w) can be derived.
Remark: Additional characteristic KLAFTE (and not KLAF) to take into consideration the flow resistance of the pipe ACF-PCV or the flow characteristic of a Laval PCV changed with regard to the throttle valve.

Exceptions: close to full load and full load. Here a map value (KFAFTE = f(nmot, wdkba)) instead of the HFM-signal is used due to steady-state accuracy reasons.

b) Turbo engine (see e.g. BGTEV2.10):
- as shown above as a rule two intake positions are provided here
- The quotient ps_w/pu is taken from the charge sensin for the intake downstream throttle valve.
- For the intake upstream the turbo charger the characteristic DPVLMS (pressure drop upstream turbo charger due to air filter) is used.
- Also an own outflow characteristic is defined (KLAFTE). Deviations from the normal characteristic may be necessary in order to:
a) take into consideration the flow resistance of a long pipe ACF-PCV.
b) take into consideration another PCV characteristic (Laval nozzle)

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Summary for application compared to previous TEB:

> On the aspirating engine the map "factor outflow (KFAFTE)" instead of the map "volume flow open PCV (KFVOBL)" is adjusted
> The PCV mass flow (vacuum side) over the outflow characteristic (KLAF) is calculated for the turbo and for the aspirating engine. The mass flow in the loading range is adjusted via the differential pressure characteristic (DPVLMS).
  Remark: The map KFVOBL used for the previous purge control was very inaccurate for the turbo engine.
> In case of long pipes ACF-PCV an engine-specific correction characteristic MSNTATE (previously KORTATE) is still needed. So as to take into consideration the different flow rate characteristics (throttle valve <-> PCV + pipe, resp. flow rate characteristic Laval-PCV) an own flow rate characteristic (KLAFTE) is provided.

Remarks to dynamic response:
> With the new functions %BGTEV an exact temporal course of the mass flow (mste_w) flowing into the intake manifold in case of load changes can be calculated for the aspirating engine as well as for the turbo engine !!
> The vrego used so far was only dependent on nmot and wdkba !!! The dynamic response was not taken into consideration.
> With the new purge control the mixture correction during dynamic engine operation can be calculated much better than before.

Example: Course of the mass flow (mste_w) through the open PCV after a negative load change at nmot = 1000 rpm:

Subdivision of the new purge control into subfunctions %TEBEB, %BGTEV, %ATEV and %TEB (rough block diagram):

Basic ideas and consequences of the new "loading-dependent purge control" especially in comparison to the previous function are:

> Volume flows (in previous TEB) are substituted by mass flows. When calculating the mass flows through the PCV it is assumed that pure air is coming.

  Remark: Consequence of the calculation of mass flows compared to volume flows of the previous TEB:
  => The values "loading" (ftead_w) and "purge rate" (ftefva_w) no longer have units !!

> A distinction is made between a desired pulse duty cycle (tatesoll) and the actual pulse duty cycle (tateist). Tatesoll is calculated in %ATEV from mstesoll_w for the activation of the PCV (activation value tateout), tateist is used for the calculation of the scavenge gas flow flowing into the intake manifold (%BGTEV). Thus the simultaneous use of the purge rate ftefva_w for the calculation of the pulse duty cycle and of the mixture correction was dropped for the first time !! The splitting-up into tatesoll and tateist is also important so as to take into consideration the delayed activation of the PCV.

> The PCV volume flow (mste) is taken into consideration in the charge sensing. Here too, it is assumed that pure air is coming. The thus made fault is (for 50% fuel portion and highest loading) at the maximum 50% / 21 = 2.4%.
  The division by 21 indicates that with HC vapor the Lambda deviation is approx. 21-times greater than with air.
  Remark: Factor 21 = 15 * root(2) ! According to the theory, the mass flow HC through a valve is only root 2-times greater than the mass flow air due to the density of HC gas being approx. double. In addition the maximum of the flow rate function for HC gas differs slightly from the maximum for air. This is to be neglected here.
  Even though it showed: At 100 % HC concentration, HC vapor causes a 30-times greater Lambda deviation than air!

> Attention new value, re-normalization: A value "concentration HC in the scavenge gas" (khc_w) was introduced.
  The value range lies between 0.. 1.
  The old value "loading - ftead_w", however, was maintained. It is generated by multiplication by 30 (FUMRBRK). The loading thus has the physically plausible value range [0... 30] !!
  By taking the ambient pressure and the ambient temperature into consideration during the calculation of mste the maximum value of the loading is in future no longer altitude- and temperature-dependent !!!

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Several other statements and calculations follow, some of which were also valid for the previous TEB:

> Dependent on the total air mass currently flowing into the intake manifold and on the HC concentration of the gas flow (also called loading in the following) the purge control valve is triggered by the activated carbon filter. The aim is to obtain a certain fuel portion from the purge control.

> For the calculation of the pulse duty cycle it is important to know the maximum possible air mass flow through the PCV (msteo_w). It can be calculated from the corresponding load state of the engine and from ambient conditions (pressure, temperature).
Remark: msteo_w is the gas mass flowing into the intake manifold at fully opened PCV provided pure air is coming.
In case of an air-fuel mixture the actual gas mass flow is greater (since fuel vapor is denser), the air mass flow, however, is less, since the HC particles reduce the cross section of the valve, which is effective for air.

> Mste_w is the gas mass flow PCV currently flowing into the intake manifold (related to air). In mste (calculated in %BGTEV) the delay of the PCV timer is already taken into consideration.

> The quotient from: "gas mass flow PCV (related to air) / total air mass flowing into the intake manifold" is called purge rate.
Remark: In the purge rate control a distinction is made between desired purge rate (ftefsoll_w) and the currently realized purge rate ftefva_w. Reason for the splitting-up into two values: It must be possible to limit the change of the desired volume flow through the PCV (mstesoll).

> The purge control function adapts the HC concentration of the scavenge gas flow (khc_w) flowing through the PCV. This concentration is multiplied by FUMRBRK and the value loading ftead_w is obtained. By this conversion it is achieved that khc_w has the plausible value range [0..1].

> The additive mixture correction (ti-correction with rkte_w) is obtained from the relative charge with scavenge gas particles currently flowing into the cylinders (rlteev_w) multiplied by the loading ftead_w. Rlteev_w is a value related to pure air. Transport and mixing in the intake manifold are already taken into consideration in rlteev_w.

> For the calculation of rlteev_w at first the desired pulse duty cycle, by which the PCV power stage is activated, is transferred to a simulation of the PCV timer. Here a pulse duty cycle course is calculated which comes quite close to the actual mechanical pulse duty cycle by which the PCV adjusts (as delay of the PCV timer approx. half of the current cycle duration is assumed).

> With the pulse duty cycle "tateist" calculated from this, the mass flow (mste_w) currently flowing through the PCV into the intake manifold is calculated without temporal cycle offset (important!!!) from the actual pulse duty cycle, from the ambient temperature, from the ambient pressure as well as from the manifold pressure. This is done in %BGTEV. Mste_w is the mass flow, provided pure air would come from the PCV.

> In the TEB the transport time and the mixing in the intake manifold to which the scavenge gas particles are subject to is then taken into consideration. The mass flow scavenge gas msteev_w currently being siphoned from the intake manifold is obtained (still provided pure air is coming). Finally the relative charge purge control rlteev_w, i.e. the relative charge in the cylinder which was caused by regenerating gas is obtained by a division by nmot_w and by a re-normalization (KUMSRL).

> With rlteev_w on its own no mixture correction can be performed. The needed mixture correction is dependent on the HC concentration in the scavenging flow. In case of pure air the mixture correction is zero since the mass flow flowing through the PCV is already included in the calculation in the charge sensing.
The necessary mixture correction rkte_w is obtained from the product of the loading (ftead_w) by rlteev_w.
The loading ftead_w is calculated from the HC concentration khc_w which in turn is continuously learned from the deviations of the mean value of the Lambda controller. The re-normalization factor khc_w
-> ftead_w is calculated related to 20,7 = 14.7 * 1.4142 :
* 14,7.....: stoichiometric ratio "air mass / fuel mass"
* 1.4142...: = root (roh_fuel / roh_air) assuming that fuel vapor is double as dense as air

It was neglected that the maximum of the flow rate function PSI for HC gas is slightly different to the maximum of air.
Remark: Law for mass flow flowing through restrictor dependent on ambient temperature and ambient pressure:
mp(rohu, pu) = mp = u * Aa * PSI * SQRT (2 * pu * rohu)
In practice a factor 30 results!! => FUMRBRK = 30 !

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Block diagram of all functions assigned to the purge control (without adhering to the function subdivision in the ASCET pictures)

The following block diagrams describe the function principle. Here the term desired purge rate (ftefsoll_w) appears.
The desired purge rate is the quotient: Desired mass flow through the PCV (mstesoll_w) / mass flow currently flowing into the intake manifold (mssgin). During the mass balance at first it is assumed that pure air goes through the PCV.
The purge rate does not have a unit. Ftefsoll_w = 0.01 means e.g. that per taken in mass flow (msdkalm_w + mste_w) of 1 kg/h a scavenge gas mass flow (mstesoll_w) of 10 g/h should get into the intake manifold via the PCV (provided pure air is coming).

Calculation of desired mass flow, desired cycle duty cycle

- mstesoll_w is the desired gas mass flow through the PCV
- provided pure air is coming: msdkalm_w + mste_w is the total air mass flow currently flowing into the intake manifold.
- mlsol_w desired air mass flow from the throttle valve triggering (%FUEDK). The MIN- selection causes an as fast as possible closing of the PCV with a negative load change.

Calculation of actual mass flow purge control into the intake manifold, mixture correction:

Remarks to diagram shown above:

1) In %BGTEV (calculation of mste_w) a "re-correction" of the characteristic rotation of the PCV adjusted in TATEMSN is performed (MSNTATE). The characteristic TATEMSN in %ATEV is the inverse characteristic to MSNTATE => please pay attention during application !!

2) rlteev_w is the current relative charge of the cylinder with scavenge gas particles (pure air through the PCV provided). Transport and mixing in the intake manifold have already been taken into consideration.

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Formulas:

Volume flow and mass flow through the PCV in dependency on ambient pressure and temperature:
Siphoned volume flow (thus with pu and Tu)
vp = u * Aa * PSI * SQRT(2 * pu/rohu)

Siphoned mass flow:
mp = u * Aa * PSI * SQRT (2 * pu * rohu)

Ratio mass / volume:
mp = vp * rohu

Normalization to temperature T_o and pressure p_o:
rohu = roh_o * pu/p_o * T_o/Tu

=> vp = vp_o * PSI * SQRT (Tu / T_o)
=> mp = mp_o * PSI + pu/p_o * SQRT (T_o/Tu)

Fuel mass flow through a PCV (pure fuel vapor provided) at known mass flow air:
mktev = mltev * SQRT (roh_Kraftst./roh_Luft) = mltev * 1.4142

Through a PCV the 1.4142-fold fuel mass passes referred to air !!!
Reason: Stoichometric ratio mass portions air / mass portions fuel = 14.7
Density fuel / density air = 2 (assumed to be constant for the sake of simplification)
Mass flow through PCV, however, only SQRT(2) times that of air

=> If the PCV is open so wide that in ml 1% air flow through PCV is contained this PCV opening at the same load-/engine speed point would cause a Lambda deviation of 20.7% with fuel vapor.

This value is independent of the altitude and the temperature since mste_w is supplied density- and altitude-corrected from %BGTEV.

Description of the ASCET block diagram of the function %TEB:
==========

The function is subdivided into the following subfunctions:
> FRTEAUFB - Processing of the Lambda controller values and formation of quotient qtetemin
> FTEBER - Calculation purge rate and desired mass flow
> FTEFXBER - Subfunction for the calculation of the maximum of the purge rate
> FTEFINT - Integrator purge rate and integrator mass flow purge control valve
> FTEADBER - Calculation of HC concentration of the scavenge gas flow, of the loading and of a filtered value of the loading
> RKTEBER - Calculation of the relative fuel portion purge control
> HBELBER - Calculation of the bit B_lrar at high loading and of other bits
> MITEBER - Calculation of requested minimum torque purge control

> FRTEAUFB - Formation quotient: qtetemin and processing of the Lambda controller values

> Formation of the quotient qtetemin
- The minimum value of te_w and te2_w is used
- With mono Lambda control (SY_STERVK = FALSE) automatically te_w is used.
- After division by TEMIN the variable qtetemin is formed. It indicates how far the smallest te is still away from the minimum value TEMIN. Qtetemin is needed in the purge rate control FTEBER.

> Formation of frmxa_w (frmxa) (maximum deflection of fr_w and fr2_w)
- the absolute value of the deviation of frm_w and frm2_w from 1.0 is formed.
- via a transfer switch frmxa_w is determined with respect to the value frm_w or frm2_w, which has the greater absolute value of the deviation from 1.0
- For mono Lambda control (SY_STERVK = FALSE) automatically frmxa_w = frm_w.

> Formation of frmit_w (mean value related to fr_w and fr2_w)
- if B_lr and B_lr2 = TRUE the mean value frmit_w is formed with respect to (frm_w + frm2_w) / 2
- if only B_lr2 = FALSE the frm_w is used for the mean value frmit_w
- if only B_lr2 = TRUE, but B_lr = FALSE the frm2_w is used for the mean value

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> Formation of the bit B_gwrte (limiting value control in operation)
  - The limiting value control shall only be in operation if
    a) the frmxa_w has a sufficient distance to its neutral position
    b) the frmxa_w keeps on moving away from the neutral position. If frmxa returns, the limiting value control shall immediately become inactive. In order to detect this the bit B_gwrte is needed.
       For the formation of B_gwrte the last value of frmxa_w (frmxaold_w) is stored.
       B_gwrte is set if
       - the new value frmxa_w is greater than or equal to the old value frmxaold_w and if frmxa_w is greater than 1.0
       - the new value frmxa_w is less than or equal to the old value frmxaold_w and if frmxa_w is less than 1.0
       - one of the two Lambda controllers fr_w or fr2_w is at the minimum or maximum limit.

> FTEBER - Calculation purge rate and desired mass flow

> Contains characteristics and maps for the calculation of the increasing and decreasing control speed of the desired purge rate (ftefsoll_w) as well as the limiting value control via Lambda controller and canister pressure
> Contains the subfunction FTEINIX for the limitation of the purge rate
> Contains the subfunction FTEFINT with the integrators desired purge rate (ftefsoll_w) and desired mass flow PCV (mstesoll_w)

Formation of desired fuel portion purge control:

Description of the subfunction FTEBER:
- The purge rate (ftefsoll_w) is controlled such that a fuel portion defined in KFTEKA should be reached.
  The fuel portion is calculated with respect to: ftead_w * ftefsoll_w. However, if the injection time te lies close to TEMIN only a small fuel portion can be realized.
  Via the controller amplification FSRFTEF the control behaviour at ftead_w * ftefsoll_w can be adjusted approx. equal to KFTEKA.
  The smaller FSRFTEF, the "softer" the control characteristic.
- Via the limiting value action (FQTEFR (frmxa) as well as FQTEPT (pte)) the purge rate is controlled down in case of large fr-deviations and in case of an unpermissibly high canister vacuum.
- Via the characteristic FQTEVA the increasing control can be made increasingly quicker with increasing purge rate.
- The speed of the increasing control is given in the map KFQTE dependent on ml and on the deviation of the frmit from 1.
- Subfunction FTEFXBER:
  - The max. purge rate is limited by a number of characteristics / maps:
    - KFFTEAN: Purge rate in case of TEB without Lambda control (limp-home purge rate)
    - KFFTEAX: Limitation of purge rate in dependency on ml and tans
    - KFTATX: Max. PCV volume flow reduced by map in percent to the maximum flow rate through the open PCV
    - FTEINIX: Characteristic purge rate limitation dependent on the integral mass flow PCV after purge break

    Remarks to the initial limitation of the purge rate (FTEINIX):
    On vehicles on which the ACF is "engine distant" the pipe ACF-PCV often has a length of over 3 m.
    If now, e.g. in case of a fully loaded ACF, the purge rate is activated after a long deactivation phase at first pure air flows through the PCV into the intake manifold. Only once this air has completely been siphoned the HC concentration suddenly increases immensely. So that the purge rate cannot increase too much until then and so that no too strong enrichment occurs the purge rate can be limited dependent on the integral of the air taken in after a purge break. Only once more scavenge gas was taken in than can remain in the the pipe ACF-PCV, shall the purge rate be able to increase to higher values.

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The following principle diagram is for the understanding of the purge rate and desired mass flow calculation by means of the subfunction FTEFINT:

The integrators for desired purge rate and for desired air mass are in the subfunction FTEFINT. This separation was made in order to be able to adjust a maximum increase of the mass flow PCV separately from the purge rate control. Via DMSTES the mass flow increase can be chosen dependent on the current mass flow purge control. Choosing the minimum (mssgin_w / mlsol_w * fafteptk_w) has the effect that just before the throttle valve is closed already the new smaller pulse duty cycle is passed on to the PCV timer. This prevents mixture faults in case of neg. load changes.
The system constant SY_EGAS decides whether mlsol_w is to be used for the comparison or whether mssgin_w is used directly.
A quickly closing of CPV for diagnosis function can be make with B_qtedab = TRUE. In this case is switched of closing time TQTEDAB

> FTEADBER - Calculation of the HC concentration of the scavenge gas flow (loading) and of a filtered value of the loading

- The HC concentration is calculated from the integral of the deviation of the frmit_w (mean value from frm and frm2) if B_te = TRUE.
- Apart from depending on ml (ZBTEML) the integration speed also depends on a value from the characteristics FBTEB and FBTEVA determined by the chosen minimum.
  - FBTEB serves for the reduction of the integration speed in case of a limitation to very small purge rates.
  - FBTEVA servers to avoid an oscillation tendency fr (resp. frm) towards rkte.

- From the HC concentration the loading ftead_w is calculated (multiplication by FUMRBRK = 30)
- The TEB also provides a filtered value of the loading (fteadf). The low pass filter is necessary so that short-termed oscillations of ftead_w are not taken into account. This value is needed e.g. to reduce the engine performance in case of long-termed high loading (see below) and so as to increase the idle speed.

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> RKTEBER - Calculation of the relative fuel portion purge control

This subfunction at first calculates the mass flow purge control (msteev_w) flowing to the combustion chamber from the mass flow purge control (mste_w) which flows into the intake manifold at the level of the throttle valve.
After a division by nmot_w and by the conversion constant KUMSRL the relative charge purge control at the level of the intake valve (rlteev_w) is obtained. After a multiplication by the loading ftead_w the relative fuel portion purge control rkte_w is obtained. In order to maintain the injection time at the intake valve, rkte_w is subtracted from the value rk_w without purge control during the injection calculation => "additive action in the TEB" .

So in the subfunction RKTEBER the transport and the mixing in the intake manifold are also described.
> The mass flow mste_w led in at the PCV is at first converted to a concentration "scavenge gas purge control in air" (ktetev_w).
> After delay (variable lag element) and after mixing (filtering 2 * PT1 with the same time constant) the concentration of scavenge gas purge control at the intake valve (kteev_w) is calculated.
> By a multiplication by ml_w the mass flow purge control at the intake valve of the engine (msteev_w) is obtained.
Attention: msteev_w refers to pure air as scavenge gas !

Calculation of delay and mixing in the intake manifold

> HBELBER - Calculation of the bit B_lrar "mixture adaptation reduced range" at high loading as well as of the bit loading at maximum limit stop (B_tehbx).

> In case of a high fuel concentration in the scavenging flow the Lambda controller frequency may possibly change due to an uneven distribution of the scavenge gas to the individual cylinders. OBDII functions which evaluate the Lambda controller (DLSA, DKAT) must be blocked. - A high loading is an indication for hot fuel. There is a risk of vapor blisters occurring in the intake valve. The diagnostic fuel supply system evaluates the adaptation factors of the LRA. They are limited via B_lrar to a lift lower than the fault thresholds.
> In case of C_ini the flip-flop is always set: If the purge rate exceeds the value FTEHB or if the frmit_w exceeds the threshold FRHB (if B_tei = 1) and if at the same time the loading is less or greater than FTEHB, then the flip-flop is reset.
If ftead_w rises above FTEHB or if ftea falls below FTEAHB, then the flip-flop is set again.
> If the loading undershoots the value FTEADAB an error in the fuel supply system is assumed and the flag " canister purge control ready for abort" (B_teabb) is set.
> An indication for a pilot control fault (pilot control too rich) or for a leaking PCV is the dead stop of the loading integrator at the maximum value FTEADMX. The bit B_tehbx can be used e.g. for the switch-over of the controller speed of the fr and of the maximum fr-lift.

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> MITEBER - Calculation of the demanded minimum torque purge control

Calculation of a minimum torque (mitebg) for the torque management for the increase of the purge rate at high loading.

From the filtered value of the loading fteadf (see above) and from the driver's request torque mifa_w a desired engine performance for engine operation with purge control is derived, which is corrected by an engine speed dependent evaluation factor fbetate.
It is e.g. possible to increase the air charge of the engine with long-lasting high loading and with a low induced driver's request torque, so as to increase the purged quantity. The torque coordination ensures that the driver will not notice this while at the same time the ignition angle is retarded and thus the engine performance is worsened.

For the determination of the torque mifafu_w (torque driver's request for charge) the value mitebg is included in a maximum selection.

- etate is the desired engine performance with purge control. A desired low engine performance is only reached if mitebg_w is not high-limited to zero by etate = 100%.
- mifa is the torque requested by the driver. The charge resulting from it assumes an engine performance of 100%.

The calculation of etate:
> The desired engine performance is stored in the map KFETATE dependent on fteadf and on mifa_w.
By means of this map very small injection times te with high fuel portions purge control can be avoided.
By reducing the engine performance the small te-values are no longer reached.
> In the characteristic FETATEBN an evaluation factor is stored dependent on nmot, which corrects the etatesoll change of 100%.
> The core of this subfunction is an integrator whose output gives the currently desired engine performance. At the beginning of the purge control phase the input value is adjusted to - ZETATE, so that the integrator integrates down to 0 starting from 100%. Once the integrator reaches its minimum, it is stopped.
> For non E-Gas systems the performance etate is set to 100% by means of the system constant SY_EGAS.

APP TEB 95.10 Application hint

Instruction for the application of the entire purge control:
==========

Concerns sections: TEBEB, BGTEV, ATEV, TEB, (BBTEGA)

Preliminary remark: Apart from this APP. hint also a detailed APP. standard with measurement reports and diagrams exists. This APP. hint can be obtained until the end of 1996 only directly from Mr. Mallebrein, dep. K3/ESY4. Later on (approx. from beginning of 1997) it will also be available in the APS. In case of differences the data should be taken from the detailed APP. hint. If necessary call Tel.: 811/8432

The following must be dealt with prior to an application:
> Throttle valve activation (%FUEDK): The throttle valve may have no considerable over-, undershoot, it may not flutter.
> The charge sensing must have been adjusted (adjustment of the pilot control (rl) to +/- 3%-4%, so that the adaptation of the HC concentration is not performed incorrectly, adjustment of ps_w on the turbo charger stationary as exact as possible).
> Application of all time constants of the charge sensing, of all temperature models especially on the turbo charger so that the intermediate value manifold pressure (ps_w) is sufficiently accurate. The manifold pressure is needed in BGTEV for the turbo charger in order to calculate the mass flow PCV.
> Application of the engine warm-up so that the HC-concentration does not stop learning itself there.
> The transient control must be adjusted in order to be reliably able to learn a HC-concentration from the fr-course and so as to avoid the limiting value control being erroneously activated.
> Application of the Lambda control (incl. all activation conditions). If no exhaust gas test has yet been performed the control downstream catalyst must not necessarily be adjusted (resp. active).

Application of the BBTEGA and of the TEBEB:
> In BBTEGA the time for the purge control can be adjusted. Make TTEINI, TTE, TTEAE as long as possible, make TTEGAI, TTEGA as short as possible (only for application phase, for FTP-test see values in BBTEGA).
> Adjust TEBEB according to specifications in the section

Application of the sections BGTEV, ATEV:
> The main work of a purge control application will have to be done in BGTEV (turbo resp. aspirating engine version) !!!
BGTEV must definitely be adjusted prior to a test on the engine test bench reps. chassis test bench ! See in BGTEV !
> ATEV is also to be adjusted according to the suggestion in the section ATEV.

Actual core function TEB:
> Most of the data are general and not vehicle-specific !! - The values shown below are to be used.
> However, KFQTE, ZBTEML, KFTATX, FVERZTE, FVERMN and DMSTES are engine-specific ! For the initial entering of data the data given below can be used.
- KFQTE, ZBTEML depend on the delay time of the Lambda control - the larger the delay time the smaller the values.
- KFTATX must especially be adjusted on the turbo engine, so that in the range where the turbo charger sets in (ps_w/pu around 1.0) the PCV is opened less especially at low engine speeds.
- FVERZTE and FVERMN depend on the design of the intake manifold, on the PCV intake position and on the ratio of intake manifold volume to lift volume. The variables are to be determined by performing jumps while scavenge gas is taken in.
- DMSTES is to be determined after the application of KFQTE and ZBTEML. For a not buffered ACF the increasing control speed (PCV mass flow increase) must be distinctly smaller than for a buffered ACF.

The data, which follow now, are for an initial entry. Depending on the engine size possibly ml base points need to be shifted a little. The data are only guidance values and were thought up by the function developer without having been tested on the vehicle. They do not represent an application state on an actually existing vehicle.

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Data for the initial entry of all parameters of the TEB:
==========

Subfunction FRTEAUFB:

> TEMIN: see injection calculation

Subfunction FTEBER:

FQTEPT: Limiting value control for the limitation of canister vacuum unit [-]

- 32.00	-28.00	-25.00	-20.00	-15.00	0	pte [hPa]
15.75	4	2	1	0	0	factor

FQTEFR: Limiting value control to avoid uncontrolled Lambda controller deviations unit [-]

0.75	0.80	0.86	0.92	1.08	1.14	1.20	1.25	fr
12	4	2	0	0	2	4	12	factor

KFFTEAN: Map maximum purge rate for limp-home purge control unit purge rate [-]

nmot[rpm]	600	800	1000	1400	1800	2400	3000	3500	4000	5000
wdkba[%]										
4	0.005	0.005	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007
10	0.005	0.005	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
16	0.005	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
24	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
34	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
45	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
55	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
65	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
80	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
100	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007

KFFTEAX : Map maximum purge rate for normal operating unit purge rate [-]

ml [kg/h]	10	20	50	100	500
tans [°C]					
-30	0.02	0.02	0.03	0.03	0.03
0	0.04	0.04	0.06	0.06	0.08
20	0.10	0.10	0.10	0.10	0.10
80	0.10	0.10	0.10	0.10	0.10

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KFTATX: Map maximum pulse duty cycle unit pulse duty cycle [%]
(Recommendation for turbo engine - pspu around 1.0 the pulse duty cycle is reduced especially at low engine speeds - on an aspirating engine here no reduction needs to be performed)

nmot[rpm]	600	800	1000	1400	1800	2400	3000	3500	4000	5000
pspu										
0.30	60.00	60.00	70.00	80.00	80.00	99.61	99.61	99.61	99.61	99.61
0.90	60.00	60.00	70.00	80.00	80.00	99.61	99.61	99.61	99.61	99.61
0.95	10.00	15.00	20.00	25.00	30.00	40.00	50.00	65.00	80.00	99.61
1.05	10.00	15.00	20.00	25.00	30.00	40.00	50.00	65.00	80.00	99.61
1.10	80.00	80.00	80.00	90.00	99.61	99.61	99.61	99.61	99.61	99.61
1.70	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61

KFTEKA : Map maximum fuel portion purge control unit fuel portion [-]

nmot [rpm]	1000	2000	4000
rl [%]			
10	0.0	0.0	0.0
20	0.3	0.3	0.3
50	0.4	0.4	0.4
100	0.5	0.5	0.5

Please note that te_w each time remains greater than TEMIN.

FKATEB : Characteristic evaluation factor for fuel portion in dependency on qtemin

qtetemin []	1.0	1.1	1.2	1.5	2
fbkate	0.0	0.5	1.0	1.0	1.0

FTEINIX : Characteristic maximum purge rate in dependency on the integral air mass after purge break unit purge rate [-]
The example data apply for a pipe ACF-PCV of 4 m length with an internal diameter of 6 mm.
V = 4 m * Pi * 0.006 m * 0.006 m / 4 = 113 E-6 m^3 = 113 cm^3 => 150 E-6 kg
Application recommendation: At first (for small values of imsteini) the purge rate may rise to high values. However, after exactly that mass scavenge gas was taken in, which was in the pipe as a precaution the purge rate is at first reduced to 0.01. Then it can be increased to 0.1.

imsteini [kg]	0.00005	0.00010	0.00015	0.00020	0.00025
Output	0.1	0.02	0.01	0.02	0.1

TFTEINI [s]: Time for detection of purge break: 30 s (in any case shorter than TTEGA)

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KFQTE: Increasing control speed desired purge rate unit [1/s]

ml [kg/h]	10	20	50	100	200	500
frmit						
0.7	0.0006	0.0010	0.0020	0.0040	0.0060	0.0100
0.9	0.0002	0.0003	0.0005	0.0010	0.0016	0.0026
1.0	0.0006	0.0010	0.0020	0.0040	0.0060	0.0100
1.1	0.0002	0.0003	0.0005	0.0010	0.0016	0.0026
1.3	0.0006	0.0010	0.0020	0.0040	0.0060	0.0100

FSRFTEF: Factor steepness purge rate controller 20 [-]

FQTEVA: Increasing control progression desired purge rate unit [-]

0.002	0.006	0.012	0.020	0.040	0.100	ftefva [-]
1.00	2.00	3.00	4.00	6.00	8.00	factor progression [-]

TVSATEM: Delay time for PCV closed after fuel cut-off readiness unit [s]

-30	-10	20	40	70	90	tmot [°C]
3	2	1.5	1.0	0.8	0.8	delay time [s]

TQTEAB: Decreasing control time PCV at the end of a purge control phase TQTEAB: 10 s
TQTEDAB: Quickly decreasing control time PCV at the end of a purge control phase TQTEDAB: 2 s

DMSTES: Increase of mass flow PCV

0.005	0.02	0.08	0.32	1.28	5.12	mstesoll_w [kg/h]
25.6	51.2	204.8	819. 2	2048	5120	output DMSTES [kg/h]

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Subfunction FTEABER:

ZBTEML: Learning speed loading unit [1/s]

10	20	50	100	200	500	ml [kg/h]
0.30	0.50	0.80	1.2	2.0	3.0	learning speed [1/s]

FBTEB: Unlearning brake loading with limitation to small purge rates unit [-]

0.00024	0.00061	0.00122	0.00244	0.00610	0.0122	ftefvab [-]
0	0.0	0.1	0.2	0.5	0.9961	factor learning speed [-]

FBTEVA: Purge rate dependent learning speed of the loading unit [-]

0.000	0.005	0.01	0.020	0.050	0.100	ftefva [-]
0.4	0.9961	0.9961	0.5	0.2	0.1	factor learning speed [-]

KHCTEMX: Maximum fuel concentration scavenge gas: 1.3 [-]

KHCTEMN: Minimum fuel concentration scavenge gas: -0.3 [-]

FUMRBRK: Factor conversion loading / HC conc.: 30 [-]

ZKFTEAD: Time constant filtering of the loading: 100 [s]

Subfunction RKTEBER:

FVERZTE: Factor delay time scavenge gas in the intake manifold: 5.E-5 [min]
=> continued transport at 1000 rpm: 1000 rpm * 2 * 5E-5 min = 0.100 => delay = 20 ms / 0.1 = 200 ms

FVERMN: Characteristic factor mixing in the intake manifold []

800	1200	1800	2600	3600	5000	nmot [rpm]
0.15	0.20	0.30	0.35	0.40	0.45	factor mixing [-]

KUMSRL: see charge sensing: V_Hub [l] / 2578

DSTEMIN 0.01 []

Subfunction MITEBER:

KFETATE : Map desired performance with te close to TEMIN unit performance [%]

mifa [%]	8	16	32	60	100
fteadf					
12	90	100	100	100	100
20	80	90	95	100	100
30	70	80	90	95	100

FETATEBN: Characteristic evaluation factor for desired engine performance dependent on the engine speed

600	1200	2000	3000	5000	nmot [rpm]
1	1	0.5	0	0	evaluation factor

ZETATE: Ramp steepness change of engine performance 1 [%/s]

Subfunction HBELBER:

DFTEAHB: Fuel portion detection high loading: 0.3 [-]

FTEHB: Loading threshold for detection high loading: 5 [-]

FTEFHB: Minimum purge rate for resetting high loading: 0.01 [-]

FRHB: fr threshold to prevent resetting high loading 1.24 [-]

FTEADAB: Threshold for setting B_teabb -4 [-]

FTEADMX: Threshold for setting B_tebhx 25 [-]
NOBELSTP : stopp the learning of loading 0 [-]

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ATEV 2.0 Purge valve drive (duty cycle)

FDEF ATEV 2.0 Function definition

atev-atev

ABK ATEV 2.0 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFTEVP	NMOT	TATESOLL	KF	Characteristic map for period time of the PCV
TATEGMX			FW	Maximum PCV duty cycle for pulsed PCV activation
TATEMSN	MSNTEV_W		KL	characteristic line of the PCV duty-cycle depending on the desired mass-flow
TTEVUB	UB		KL	Battery-voltage depending delay time of canister purge valve

Variable	Source	Type	Description
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_EVLOC	AEVAB	EIN	Status: all injection valves are activated
MSNTEVO_W	BGTEV	EIN	normalized mass flow through the complete open PCV
MSTEO_W	BGTEV	EIN	Mass flow the 100 % opened TEV
MSTESOLL_W	TEB	EIN	desired purge mass flow
NMOT	BGNMOT	EIN	engine speed
TADTEA		EIN	TEV duty cycle from canister purge diagnosis
TATEOUT	ATEV	AUS	output duty cycle for canister purge valve
TATESOLL	ATEV	AUS	desired duty cycle of the PCV
TEVPER	ATEV	AUS	periode time of purge control valve
UB	GGUB	EIN	battery voltage

FB ATEV 2.0 Detailed description of function

```
The function ATEV calculates the desired duty-cycle of the PCV (tatesoll) for further treatment in BGTEV and also the
output sources for the PCV-timer tateout (duty cycle) and tevper (period time).

Tatesoll is calculated from the folowing sources:

mstesoll_w          = desired purge mass flow through the PCV
msteo_w             = purge mass flow through the complete open PCV
msntevo_w           = normalized overcritical purge mass flow through the complete open PCV
Kennlinie TATEMSN   = characteristic line for the PCV duty-cycle depending on the desired normalized overcritical purge mass flow

Normalized overcritical purge mass flow PCV: msntev_w  = mstesoll_w / msteo_w * msntevo

Output PCV duty-cycle: Tateout = tatesoll + delay time of PCV / Period time * 100%
Remarks:
  - As tatesoll = 0%,  tateout = 0% too.
  - Tateout ist limited to 99.61 %  begrenzt (max. value HEX is FF => PCV timer should activate the PCV all the time.

Further features:
 - Switching tateout to 99.61% if tateout >= TATEGMX
 - As tateout = 99.61% tevper is set to 5 ms => a fast closing of the PCV is possible, because the PCV timer can change
   it's duty-cycle every 5 ms.
```

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APP ATEV 2.0 Application hint

TTEVUB: Delay time of the PCV depending on the battery voltage

7 V	9 V	11 V	13 V	15 V	17 V
11 ms	9.5 ms	7 ms	5.5 ms	4.5 ms	3.5 ms

KFTEVP: Characteristic map for the period time of the PCV

Values in ms:

	800	1200	2000	3000	4500	1/min
0%	128	110	100	80	60	
10%	110	100	80	70	50	
20%	80	80	60	50	40	
30%	70	60	50	40	30	
50%	60	40	30	30	30	
70%	60	40	40	40	40	
80%	80	80	80	80	80	<= if TEV delay is higher than 7 ms (at ubat > 11V)
90%	120	120	120	120	120	choose higher period times to avoid tateout = 99.61% at tatesoll < 90%
100%	120	120	120	120	120	

TATEGMX: 97% - Explanation: up to tateout = 97% there is continuous dosing. Then tateout and tatesoll jump to 99.61% !
Reason: Above a max. duty cycle the purge control valve current does not fall to zero.

TATEMSN: Characteristic line for the PCV duty-cycle depending on the desired normalized overcritical purge mass flow

TATEMSN ist exactly the inverse characteristic line to MSNTATE ! Please consider when calibrating !

Example for first calibration:
(small TEV2)

0	0.488	0.976	1.464	1.952	2.440	2.928	3.416	3.904	4.400	[kg/h]
0	11.1	22.2	33.3	44.4	55.5	66.6	77.7	88.8	100	[%]

(big TEV2)

0	0.634	0.1.27	1.903	2.5375	3.172	3.8066	4.441	5.075	5.72	[kg/h]
0	11.1	22.2	33.3	44.4	55.5	66.6	77.7	88.8	100	[%]

DTEVN 22.100 Diagnosis of canister purge valve (OBDII)

FDEF DTEVN 22.100 Function definition

ABK DTEVN 22.100 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
AIODTEX			FW	maximum number of correct checks at canister purge system diagnostic
APDTEX			FW	maximum number of checks at TE diagnosis
FTETEDF			FW	threshold charge factor rich mixture for purge system o.k. test
FTETEDM			FW	threshold charge factor lean mixture for purge system o.k. test
HTEDU			FW	lower altitude threshold for performing of canister purge diagnosis
TBTEVIO			FW	Delay time for saturation test PCV O.K. detection
TMTED			FW	engine temp threshold for evap system monitoring
TNODTEV			FW	time after engine start prohibition of TE diagnosis
TNODTEVT			FW	time for prohibition of TE diagnosis at tester operation
TTEGAI			FW	Duration of the first mixture adaptation phase
TTEINI			FW	Duration of the first purge phase
TWKODTE			FW	delay time after compressor switch on/off

Variable	Source	Type	Description
B_CDTES	PROKON	EIN	function active per codeword CDTES
B_DMTLTZ	DDMTL	EIN	Condition TEV should be closed
B_DRUCK		EIN	Condition unpressurized test fulfilled, system unpressurized
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_DTEAA	DTEVN	LOK	Condition diagnosis CPV by opening the CPV active
B_DTEABR	DTEVN	LOK	condition for interruption of TE diagnosis because of interference sources
B_DTEBEL	DTEVN	LOK	input conditions for charge test fulfilled
B_DTEBN	DTEVN	LOK	start of engine speed test-procedure
B_DTES	DTEVN	LOK	Condition for active diagnosis of canister purge system
B_DTEVIO	DTEVN	LOK	condition canister purge valve ok (description variable)
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_ENWS	DNWS	EIN	condition error camshaft control
B_FA		EIN	condition general function request
B_FATES		EIN	condition leak detection request
B_FRAO	LRA	EIN	condition for enabling adaption of frao
B_FRAU	LRA	EIN	condition enable adaptation of frau
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KO	CANINS	EIN	condition AC compressor authorised
B_KW	BBKHZ	EIN	Condition catalyst warming
B_LL	MSF	EIN	Condition idle

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Variable	Source	Type	Description
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_RKAT	LRA	EIN	condition adaptation area rkat active
B_RKAZ	LRA	EIN	condition adaptation area rkaz active
B_STEND	BBSTT	EIN	condition end of start
B_TEI	DTEVN	LOK	Internal condition: canister purge function active
DTEVPHC	DTEVN	LOK	counter for prohibition of TEV diagnosis after engine start
E_DK	GGDVE	EIN	Error flag: throttle position sensor
E_FPP	GGPED	EIN	Error flag drive pedal potentiometer
E_LDP	DLDP	EIN	error flag: leakage detection pump
E_LM	DHFM	EIN	Error flag: main load sensor
E_TA	GGTFA	EIN	error flag: TANS
E_TES	DTEVN	AUS	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_UB	GGUB	EIN	error flag: power supply voltage UB
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
FHO	GGDSAS	EIN	Correction factor altitude
FTEAD_W	TEB	EIN	charcoal canister charge
MSTESOLL_W	TEB	EIN	desired purge mass flow
TESSTAT	DTEVN	AUS	Functional status DTES when system check is requested
TMOT	GGTFM	EIN	Engine temperature
VFZG	GGVFZG	EIN	vehicle speed (km/h)
ZDTEIO	DTEVN	LOK	i.o. counter for canister purge diagnosis
ZDTEV	DTEVN	LOK	test counter for TEV diagnosis
Z_TES	DTEVN	AUS	cycle flag of canister purge system

FB DTEVN 22.100 Detailed description of function

APP DTEVN 22.100 Application hint

DLDP 16.31 Diagnosis of Tank Leakage with DLDP Module

FDEF DLDP 16.31 Function definition

No text for FDEF available!

ABK DLDP 16.31 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANSWPUK			FW	
CWDTLECK			FW	
DHAKTIV			FW	
DPUBABMX			FW	Maximum threshold delta ambient pressure for downhill recognition
DPUKORDH			FW	
DTMLDP			FW	Difference engine stopping temperature - TMOT at starting
FDKHLDP			FW	
FSALULDP			FW	
FTEADLDP			FW	
KLDTPLDP	TIMTP		KL	
KLWZTLDP	TIMTP		KL	
MLDPKD			FW	
PSLDPMX			FW	
RLLDPRU			FW	threshold intake temperature monitor activ
TALDPMX			FW	
TALDPO			FW	Upper suction temperature threshold for leakage diagnosis module
TALDPRO			FW	
TALDPRU			FW	
TALDPU			FW	Lower suction temperature threshold for leakage diagnosis module
TDHAKT			FW	time down hill detection active
TLDPEIN			FW	
TLDPFL			FW	
TLDPFP			FW	
TLDPFTE			FW	
TLDPLRMX			FW	
TLDPMN			FW	Waiting time after starting for release leakage diagnosis
TLDPNF			FW	
TLDPONMX			FW	
TLDPREF			FW	
TLDPRKL			FW	Time for 'Reed-contact closed'-recognition closed check
TLDPRKO			FW	Time for "Reed-contact open"-recognition at leakage diagn. module
TLDPRKZ			FW	
TLDPSD			FW	
TLDPST1			FW	
TLDPTD			FW	
TLDPVL			FW	
TLDPWAB			FW	
TMLDPO			FW	Upper engine temperature threshold for leakage diagnosis module
TMLDPU			FW	Lower engine temperature threshold for leakage diagnosis module
TULDPRO			FW	

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Parameter	Source-X	Source-Y	Type	Description
TULDPRU			FW	
UBLDPMX			FW	
VLDPMX			FW	
VLDPRU			FW	
VMAXLDP			FW	
WLDPAB			FW	
WZCTCMX			FW	
WZLDPRO			FW	Max. number of repeated tests Reed-switch close to open check
WZSTLMX			FW	

Variable	Source	Type	Description
BSSP	DLDP	LOK	storage value signal acceleration sensor
B_BERGAB	DLDP	LOK	condition downhill driving detected
B_BT		EIN	condition general actuator request
B_BTLDP		EIN	condition actuator request; leak detection pump
B_CLLDP	DLDP	LOK	condition: clear fault path leak detection pump function
B_CLTESB	DLDP	LOK	condition: clear error TESB
B_CLTESK	DLDP	LOK	condition: clear error ”smallest leak”
B_CTCCKA	DLDP	LOK	
B_CTCCKE	DLDP	LOK	
B_CTOCKA	DLDP	LOK	
B_CTOCKE	DLDP	LOK	
B_DLDP	DLDP	LOK	active diagnosis: leak detection modul
B_DLDPTE	DLDP	LOK	request from evap system monitoring to shut down PCV
B_DPUABB	DLDP	LOK	
B_DRUCK	DLDP	LOK	Condition unpressurized test fulfilled, system unpressurized
B_DTEBEL	DLDP	LOK	input conditions for charge test fulfilled
B_DTEBN	DLDP	LOK	start of engine speed test-procedure
B_DTEVIO		EIN	condition canister purge valve ok (description variable)
B_EGGLDP	DLDP	LOK	error condition in DLDP-sensors
B_EINLDP	DLDP	LOK	condition leak detection pump on
B_EOBDLR	DLDP	LOK	error flag:^OBDII summary fault, disables lambda control
B_ESTLDP	DLDP	LOK	error condition stopped leak detection modul
B_FA	DLDP	LOK	condition general function request
B_FADLDP		EIN	
B_FBLDP		EIN	
B_FBLDPW		EIN	
B_FPULS	DLDP	LOK	
B_FRZDH		EIN	
B_GA	DLDP	LOK	condition for basic mixture adaptation (canister purge valve closed)
B_GAE	DLDP	LOK	condition for adaptive Lambda pilot control successful
B_GAP	DLDP	LOK	condition mixture adaptation phase active
B_LDPABB	DLDP	LOK	flag abort of DLDP
B_LDPEIN	DLDP	LOK	
B_LDPENA	DLDP	LOK	
B_LDPF1	DLDP	LOK	error fault 1
B_LDPF2	DLDP	LOK	error fault 2
B_LDPF3	DLDP	LOK	error fault 3
B_LDPF4	DLDP	LOK	error fault 4
B_LDPF5	DLDP	LOK	error fault 5
B_LDPF6	DLDP	LOK	error fault 6
B_LDPP		EIN	
B_LDPSTP	DLDP	LOK	
B_MAXFLR	DLDP	LOK	Condition for fault type ”maximum value” detected
B_MESSE	DLDP	LOK	flag period measurement (stage 5) terminated
B_MINFLR	DLDP	LOK	Condition for fault type ”minimum value” detected
B_MNLDP	DLDP	LOK	condition for fault type ”minimum value” detected (reed switch not open)
B_MNTESB	DLDP	LOK	condition for fault type ”minimum value” detected
B_MNTESK	DLDP	LOK	condition for fault type ”minimum value” detected (smallest leak)
B_MXLDP	DLDP	LOK	condition for fault type ”max0mum value” detected (reed switch open)
B_MXTESB	DLDP	LOK	condition for fault type ”maximum value” detected
B_MXTESK	DLDP	LOK	condition for fault type ”maximum value” detected (smallest leak)
B_NOLDP		EIN	
B_NPLDP	DLDP	LOK	condition for fault type ”not plausible” detected (reed switch not closed)
B_NPTESB	DLDP	LOK	condition for fault type ”unplausible signal” detected
B_NPTESK	DLDP	LOK	condition for fault type ”unplausible signal” detected (smallest leak)
B_PLAUS	DLDP	LOK	Condition fault type ”value not plausible” detected
B_PUERR	BGPUK	EIN	Condition error corrected ambient-pressure for downhill-drive detection
B_READS		EIN	
B_SILDP	DLDP	LOK	error type: leakage detection pump
B_SITESK	DLDP	LOK	error type: smallest leak
B_STEND	BBSTT	EIN	condition end of start
B_STLDP	DLDP	LOK	
B_STLDPV	DLDP	LOK	
B_TAAKT	DLDP	LOK	
B_TAREF	DLDP	LOK	
B_TE	TEBEB	EIN	Condition canister purge active
B_TEABB	DLDP	LOK	Condition purge canister function ready to finish
B_TIMRS	DLDP	LOK	
B_TLABLP	DLDP	LOK	
B_TLXLDP	DLDP	LOK	
B_TMABS	DLDP	DOK	

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Variable	Source	Type	Description
C_FCMCLR	DLDP	LOK	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DPUBAB_W	DLDP	AUS	
E_CGE	DLDP	LOK	error flag: CAN-interface timeout EGS
E_DK	GGDVE	EIN	Error flag: throttle position sensor
E_FRAO	DLDP	LOK	error flag: upper multiplicative mixture adaption factor frao
E_FRAO2	DLDP	LOK	error flag: upper multiplicative mixture adaption factor frao2
E_FRAU	DLDP	LOK	error flag: lower multiplicative mixture adaption factor frao
E_FRAU2	DLDP	LOK	error flag: lower multiplicative mixture adaption factor frao2
E_LDP	DLDP	AUS	error flag: leakage detection pump
E_LDPE	DLDPE	EIN	error flag: leakage detection pump power stage
E_LLR	DLDP	LOK	Error flag: idle speed control
E_LM	DHFM	EIN	Error flag: main load sensor
E_LSV	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_LSV2	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_LSVV	DLSVV	EIN	error flag: exchanged lambda sensors upstream catalyst
E_RKAT	DLDP	LOK	error flag DKVS (additive correction per unit of time)
E_RKAT2	DLDP	LOK	error flag DKVS (additive correction per unit of time, bank 2)
E_RKAZ	DLDP	LOK	error flag DKVS (additive correction per ignition)
E_RKAZ2	DLDP	LOK	error flag DKVS (additive correction per ignition, bank 2)
E_TA	GGTFA	EIN	error flag: TANS
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TESB	DLDP	AUS	
E_TESK	DLDP	AUS	error flag: evap system monitoring - smallest leak
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
FHO_W	GGDSAS	EIN	correction factor: altitude
FSP_CL	DLDP	LOK	clear fault memory
FTEAD	DLDP	LOK	factor HC-charge of purge flow
FTEFVA_W	TEB	EIN	purge rate of the purge control function
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	BGNMOT	EIN	engine speed
PSPVDK_W	BGMSZS	EIN	quotient: int.manif.pressure divided by pressure upstream of throttle valve
PUKORFRZ	DLDP	LOK	
PUKORF_W	DLDP	LOK	Ambient-pressure values following filtered additive backpressure correction
PUKOR_W	DLDP	LOK	Ambient-pressure values following additive backpressure correction
RL	EGFE	EIN	relative air charge
R_T1000		EIN	Time schedule 1000 ms
STPTR		EIN	state pointer of the DLSP
STPTRW	DLDP	LOK	
TALDPREF	DLDP	LOK	
TANS	GGTFA	EIN	Intake air temperature
TC6LDPC	DLDP	AUS	Output of code SCAN-Tool Mode 6 from LDP-diagnosis
TC6LDPS	DLDP	AUS	Output of threshold value SCAN-Tool Mode 6 from LDP-diagnosis
TC6LDPW	DLDP	AUS	Output of test value SCAN-Tool Mode 6 from LDP-diagnosis
TIMFP	DLDP	LOK	timer for duration of fast pulse
TIMRS	DLDP	LOK	timer for Reed switch closed check
TIMTP	DLDP	LOK	
TIMVLDP	DLDP	LOK	
TMABSLDP		EIN	
TMOT	GGTFM	EIN	Engine temperature
TNST_W	BBSTT	EIN	time after end of start
TPLDP	DLDP	LOK	
TPLDPE	DLDP	LOK	
TUMG	GGTFUMG	EIN	Ambient air temperature
UB	GGUB	EIN	battery voltage
VFZG	GGVFZG	EIN	vehicle speed (km/h)
W	DLDP	LOK	vector converted input variables (only CU model)
WZCTC	DLDP	LOK	
WZCTO	DLDP	LOK	counter of repeated attempts of close to open check
Z_LDP	DLDP	AUS	cycle flag of leakage detection pump
Z_TESB	DLDP	AUS	
Z_TESK	DLDP	AUS	cycle flag of evap system monitoring - smallest leak

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FB DLDP 16.31 Detailed description of function

APP DLDP 16.31 Application hint

BGPUK 1.10 Calculation and correction of value ambient pressure (detection down hill)

FDEF BGPUK 1.10 Function definition

bgpuk-bgpuk

bgpuk-pulim

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bgpuk-pumean

ABK BGPUK 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DIFFMAX			FW	Max. permissible change in pressure during 100 ms
PUKORRV	VFZG_W		KL	Ambient-pressure correction depending on vehicle speed
PUSMAX			FW	Maximum plausible ambient-pressure threshold
PUSMIN			FW	Minimum plausible ambient-pressure threshold
TPUKOR			FW	Filter time for PUKORF

Variable	Source	Type	Description
B_ADD	BGPUK	LOK	Condition plausibility and difference condition fulfilled for current PUS_W
B_PUERR	BGPUK	AUS	Condition error corrected ambient-pressure for downhill-drive detection
C_INI		EIN	ECU-condition for intialisation
E_DSU	GGDSAS	EIN	error flag: Pressure Sensor Ambient
E_VFZG		EIN	error flag: vehicle speed signal
PUKORF_W	BGPUK	AUS	Ambient-pressure values following filtered additive backpressure correction
PUKOR_W	BGPUK	AUS	Ambient-pressure values following additive backpressure correction
PUMEAN_W	BGPUK	LOK	Ambient-press. val. for the plausible ambient-press. val. (freak-value filter)
PUS_W	GGDSAS	EIN	Ambient pressure without substitution on sensor error
R_T100		EIN	Time schedule 100 ms
R_T1000		EIN	Time schedule 1000 ms
VFZG_W	GGVFZG	EIN	Vehicle speed

FB BGPUK 1.10 Detailed description of function

The function filters the values for ambient pressure presented in physical units (%GGDSU) such that the output signal represents the change in the ambient pressure on the basis of the change in altitude.
The influence of the vehicle speed is corrected.
The successive values PUS_W in the 100-ms time frame are checked for physical plausibility. The subsequent check performed with the plausible values of the changes in the pressure occurring during the 100 ms is intended to establish a causal relationship with the change in altitude of the vehicle.
If a difference pus_w(n) - pus_w(n-1) occurs that cannot be explained by change in the altitude, then the current value pus_w is rejected (B_add = false). If the difference can be explained by a change in the altitude, then pus_w(n) is declared as being valid (B_add = true) and is added to pumean_w. The next value pus_w (n+1) is subsequently processed. The check for the difference from pus_w(n+1) is performed in case pus_w(n) has been declared as being valid.
Otherwise pus_w(n+1) is taken following a check for physical plausibility yet without checking the difference.
The output of the mean value formed from the valid pressure values follows after one second. To do this, pumean_w is divided by number of values taken. A vehicle-speed-specific correction for the backpressure is added to the average value thereby resulting, and is outputted without filtering as pukor_w. Furthermore, pukor_w is made available over a low-pass filter of the first order with the filter fixed value TPUKOR as pukorf_w as the output value.
The output signal of the function is valid if the unfiltered ambient pressure and the vehicle speed are valid (B_puerr = false).

APP BGPUK 1.10 Application hint

Guiding values for the first application:

```
DIFFMAX :    2 hPa
PUSMAX  : 1150 hPa
PUSMIN  :  450 hPa
PUKORRV : These values must be determined in the vehicle - (ambient pressure and specific to the installation).
          If the ambient pressure is influenced as a dependency of the vehicle speed (backpressure), then this incorrect value for
          the ambient pressure can be corrected with PUKORRV.
```

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DLDPE 4.30 Driver diagnosis; overpressure pump of fuel tank leckage diagnosis

FDEF DLDPE 4.30 Function definition

Diagnosis CJ400, resp. CJ 920 see %DECJ

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Substitution measures: non

Error memory management:

Status error path ldpe:	SFPLDPE
Error flag LDPE:	E_ldpe
Cycle flag LDPE:	Z_ldpe
Error type LDPE:	B_mnldpe B_mxldpe B_sildpe
Delete error path:	C_fcmclr & B_clldpe
Error path LDPE:	CDTLDPE
Error class LDPE:	CLALDPE
Error intensity LDPE:	TSFLDPE
Carb code LDPE:	CDCLDPE
Environmental conditions LDPE:	FFTLDPE

ABK DLDPE 4.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCLDPE	BLOKNR		KL	code word CARB: driver stage of diagnosis leak pump
CDTLDPE			FW	code word tester: driver stage of diagnosis leak pump
CLALDPE			FW	fault class: leak detection pump power stage
FFTLDPE	BLOKNR		KL	freeze frame table: power stage of leak detection pump
FLCLDPE			FW	fault set debouncing: driver stage of diagnosis leak pump
HLCLDPE			FW	fault reset debouncing: driver stage of leak diagnosis pump

Variable	Source	Type	Description
B_CLLDPE		EIN	condition: clear fault path leak detection pump power stage
B_DESEE	DLDPE	LOK	Diagnosis power stage: entry conditions fulfilled
B_DLDP		EIN	active diagnosis: leak detection modul
B_MNLDPE	DLDPE	AUS	Error type: short circuit to ground ldp power stage
B_MXLDPE	DLDPE	AUS	error type: short circuit to Ubat ldp power stage
B_SILDPE	DLDPE	AUS	error type: cable disconnection of leak detection pump power stage

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Variable	Source	Type	Description
C_INI		EIN	ECU-condition for intialisation
E_LDPE	DLDPE	AUS	error flag: leakage detection pump power stage
Z_LDPE	DLDPE	AUS	cycle flag: leakage detection pump power stage

FB DLDPE 4.30 Detailed description of function

Together with the CJ400/CJ920 diagnosis %DECJ the leak pump power stage diagnosis forms a function unit.
The diagnosis describes the forming of the error bit E_ldpe and of the cycle bit Z_ldpe.

The setting of the cycle flag is performed for one via an error entry and for the other via a definitely checked not to be due error. This definitate check is given if both switch states of the power stage, i.e. an on-state and an off-state were reached once. If an error is detected an error verification is activated in %DECJ which is performed independent of the external power stage request and which is definitely terminated after approx. 500 ms. Thereafter the the cycle flag is set in case no error occured.

APP DLDPE 4.30 Application hint

GGDMTL 3.10 Signal DM-TL pump current output

FDEF GGDMTL 3.10 Function definition

ggdmtl-main

ggdmtl-main

No text for FDEF available!

ABK GGDMTL 3.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
RPTES			FW	resistance measurement of pump current of DM-TL

Variable	Source	Type	Description
B_CDDMTL	PROKON	EIN	function enabled per codeword
IPTES_W	GGDMTL	AUS	pump motor current of leakage detection
UPTES_W	GGDMTL	AUS	voltage of pump motor current of leakage detection
UUPTES_W_0		EIN	ADC-voltage of pump motor current of leakage detection (Buffer 0)
UUPTES_W_1		EIN	ADC-voltage of pump motor current of leakage detection (Buffer 1)
UUPTES_W_2		EIN	ADC-voltage of pump motor current of leakage detection (Buffer 2)
UUPTES_W_3		EIN	ADC-voltage of pump motor current of leakage detection (Buffer 3)
UUPTES_W_4		EIN	ADC-voltage of pump motor current of leakage detection (Buffer 4)

FB GGDMTL 3.10 Detailed description of function

Goal:
Calculation of a hardware-independent value of DMTL-motor current for diagnosis of tank leak

Solution:
The voltage over the measuring resistance of electric DMTL-pump is calculated by the A/D-converter routine.
It is sampled every 2ms and stored as uuptes_w_x. Every 10 ms the mean value of the recent 5 sampled values is calculated and stored as uptes_w.

The voltage uptes_w is divided by the measuring resistance RPTES to get the pump-current iptes_w by Ohm's law.

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APP GGDMTL 3.10 Application hint

```
Requirements:
 - DMTL-pump connected to ECU

Default Parameters:
 - measuring resistance for DMTL-motor current RPTES = 33.8 Ohm (33.3 Ohm shunt, 0.5 Ohm power-stage resistance)

Approach:
 - adjust label RPTES to the measuring resistance used in the ECU-hardware

Influenced functions:
 - diagnosis of tank leak DDMTL
```

DDMTL 1.112 Diagnosis of Tank Leakage with DM-TL Module

FDEF DDMTL 1.112 Function definition

ddmtl-ddmtl

```
CONTROL: Central Sequential Control and Error Output
```

ddmtl-control

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TIMCONTR: Central Sequential Control

ddmtl-timcontr

IPFILTER: Filtering of Pump Motor Current

ddmtl-ipfilter

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BGFIPTES: Correction of Pump Motor Current

ddmtl-bgfiptes

BBDIPRFO: Abort in case of current fluctuation

ddmtl-bbdiprfo

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ENABLE: Function Release

ddmtl-enable

BBDMTLHE: Main Function Release

ddmtl-bbdmtlhe

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BDMTLHE: Haupteinschaltbedingungen

ddmtl-bdmtlhe

BDMTLFE: Sperrung bei Endstufenfehlern

ddmtl-bdmtlfe

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ENACLDIA: Release of Rough-Leak Check

ddmtl-enacldia

BBDTEGEN: Release of Rough-Leak Check

ddmtl-bbdtegen

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BBFLUCTG: Release of Rough-Leak Check in case of current fluctuation

ddmtl-bbfluctg

ddmtl-bbfluctg

BDTEG: Anforderung Grobleckprüfung OBD

ddmtl-bdteg

ddmtl-bdteg

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BDTEGTD: Anforderung Grobleckprüfung wegen Check Filler Cap

ddmtl-bdtegtd

ddmtl-bdtegtd

ENAFLDIA: Release of Smallest Leak Check

ddmtl-enafldia

ddmtl-enafldia

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BBFLUCTF: Release of Smallest Leak Check in case of current fluctuation

ddmtl-bbfluctf

BBFLDIA: Release of Smallest Leak Check

ddmtl-bbfldia

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BBTANKE: Release of Smallest Leak Check after Refueling

ddmtl-bbtanke

ddmtl-bbtanke

BFEDMTL: Power Stage Function Request

ddmtl-bfedmtl

ddmtl-bfedmtl

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REFUEL: Detection of Tank Cap Removal and Refueling

ddmtl-refuel

BBMNDMTG: Rough Leak Error from Supposed Rough Leak

ddmtl-bbmndmtg

BGLVNM: Vermuteter Grobleckfehler generiert keinen Fehlereintrag

ddmtl-bglvnm

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BBTANKD: Kombi-Anzeige "Check Filler Cap" aktivieren

ddmtl-bbtankd

ddmtl-bbtankd

ERROR: Output of Error Flags

ddmtl-error

ddmtl-error

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BEDMTL: Output of Error Flag DMTL

ddmtl-bedmtl

MXDMTL: Max-Error DMTL

ddmtl-mxdmtl

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MNDMTL: Min-Error DMTL

ddmtl-mndmtl

NPDMTL: Np-Error DMTL

ddmtl-npdmtl

SIDMTL: Signal-Error DMTL

ddmtl-sidmtl

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EDMTL: Error DMTL

ddmtl-edmtl

BEDMTK: Output Error Flag DMTK

ddmtl-bedmtk

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BEDMTKNM: Output Error Flag Small leak (no MIL)

ddmtl-bedmtknm

MODE6: Output of Mode 6 Values

ddmtl-mode6

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MODE6: Mode 6 Value

ddmtl-m6w

MODE6: Mode 6 Threshold

ddmtl-m6s

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MODE6: Mode 6 CID

ddmtl-m6cid

```
Zustand
|    Übergangsname     ┌─ Übergangsbedingung
|    |    Aktionen     ├─ Aktions-Code
|    |    |            |
V    V    V            V
```

```
A_start                 Reset-Bedingung: B_admtls OR (NOT B_dmtge)          ── Dies ist der Reset-Zustand, er wird aus allen
                                                                               Zuständen angesprungen, wenn die Reset-Bedingung
                                                                               erfüllt ist.

            Entry:                                                          ── time slot of state machine is 100 ms
                        isadmtl     := 0;                                   ── state-number
                        B_admtll    := false;                               ── diagnosis not active (nv)
                        B_dmtpm     := false;                               ── pump motor off
                        B_dmtmv     := false;                               ── valve solenoid off
                        B_dmtlpe    := false;                               ── module diag not finished
                        B_zdmtgv    := false;                               ── rough leak diag not finished
                        B_zdmtk     := false;                               ── smallest leak diag not finished
                        B_dmtrfm    := false;                               ── no reference leak diag
                        B_dmtglm    := false;                               ── no rough leak diag
                        B_dmtklm    := false;                               ── no smallest leak diag
                        B_rfmgv     := false;

                        IF (B_sidmtl) THEN
                            B_refu      := false;
                            B_refo      := false;
                            B_sumv      := false;
                        ENDIF;

                        IF(C_pwf) THEN
                            isadmtl     := 0;                               ── nv
                            tdmstba_w   := 0;                               ── nv
                            tdmrfa_w    := 0;                               ── nv
                            tdmlka      := 0;                               ── nv
                            iptrefr_w   := 0;                               ── nv
                            iptglmn_w   := 0;                               ── nv
                            iptvgl_w    := 0;                               ── nv
                            iptref      := 0;                               ── nv
                            iptgl       := 0;                               ── nv
                            iptkl       := 0;                               ── nv
                            iptumv      := 0;                               ── nv
                            diptgl_w    := 0;                               ── nv

                            B_refu      := false;                           ── non volatile
                            B_refo      := false;                           ── non volatile
                            B_sumv      := false;                           ── non volatile
```

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```
                    B_dmtlpe    := false;                       -- non volatile
                    B_edmtk     := false;                       -- non volatile
                    B_zdmtk     := false;                       -- non volatile
                    B_dmtgv     := false;                       -- non volatile
                    B_zdmtgv    := false;                       -- non volatile
                    B_dmtrfm    := false;                       -- nv
                    B_dmtglm    := false;                       -- nv
                    B_dmtklm    := false;                       -- nv
                    B_admtll    := false;                       -- diagnosis not active (nv)
                    B_dmtpm     := false;                       -- nv
                    B_dmtmv     := false;                       -- nv

                    iptref_w    := 0;                           -- reference current (non volatile)
                    iptumv_w    := 0;                           -- non volatile
                    iptsumv_w   := 0;                           -- non volatile
                    iptgl_w     := 0;                           -- current at end of rough leak check (non volatile)
                    iptsgl_w    := 0;                           -- threshold current (non volatile)
                    iptkl_w     := 0;                           -- current at end of smallest leak check (nv)
                    tdmlka_w    := 0;                           -- time of leak check (non volatile)
                ENDIF;
                IF (NOT B_cddmtl) THEN
                    B_refu      := false;                       -- no error found
                    B_refo      := false;
                    B_sumv      := false;
                    B_dmtlpe    := false;                       -- module diag not finished
                    B_edmtk     := false;
                    B_zdmtk     := false;                       -- smallest leak diag not finished
                    B_dmtgv     := false;
                    B_zdmtgv    := false;
                ENDIF;

                IF (C_fcmclr AND B_cldmtl) THEN
                    B_refu      := false;                       -- no error found
                    B_refo      := false;
                    B_sumv      := false;
                    B_dmtlpe    := false;
                ENDIF;
                IF (C_fcmclr AND B_cldmtk) THEN
                    B_dmtgv     := false;                       -- no error found
                    B_zdmtgv    := false;
                    B_edmtk     := false;                       -- no error found
                    B_zdmtk     := false;
                ENDIF;
        Exit:   B_admtll    := true;                            -- diagnosis now active
    B_dmtge:    B_dmtge
```

```
A_refdia1
        Entry:  isadmtl     := 1;
                tdmrfa_w    := 0;
                iptref_w    := 0;
                iptref      := 0;
                B_dmtglmv   := false;                           -- reset extended rough-leak
                B_dmtrfm    := true;                            -- start of reference meas.
                B_dmtpm     := true;                            -- pump motor on
        Action: tdmrfa_w    := tdmrfa_w + dT;
                iptrefr_w   := ipteskf_w;
                iptref_w    := iptrefr_w + DIPTREF;
                iptref      := iptref_w;
        Exit:   B_dmtrfm    := false;                           -- end of reference meas.
                B_dmtglmv   := false;
    iptref>IPTREFO:
                (tdmrfa_w > TDMTREF) AND (iptref_w > IPTREFO)
        Action: B_refo      := true;                            -- max-error
                B_refu      := false;                           -- no min-error
                B_sumv      := false;                           -- no plaus-error
                B_dmtlpe    := true;                            -- module diag finished
    iptref<IPTREFU:
                (tdmrfa_w > TDMTREF) AND (iptref_w < IPTREFU)
        Action: B_refo      := false;                           -- no max-error
                B_refu      := true;                            -- min-error
                B_sumv      := false;                           -- no plaus-error
                B_dmtlpe    := true;                            -- module diag finished
    tdmrfa>TDMTREF:
                tdmrfa_w > TDMTREF
```

```
A_rleakdia
        Entry:  isadmtl     := 2;
                tdmlka_w    := 0;
                tdmlka      := 0;
                B_dmtglm    := true;                            -- start of rough leak detection
                B_dmtmv     := true;                            -- valve solenoid on
                iptglmn_w   := ipteskf_w;                       -- minimum current
                iptgh_w     := iptref_w - iptglmn_w;
                iptgh       := iptgh_w;
                iptgl_w     := ipteskf_w;                       -- rough leak current
                iptgl       := iptgl_w;
```

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```
                    iptsgl_w    := iptglmn_w | FIPTGL * iptgh_w;        -- threshold
                    iptsumv_w   := iptrefr_w | DIPTUMVU;                -- threshold change over valve
                    iptumv_w    := iptglmn_w;
                    iptumv      := iptumv_w;
        Action:     tdmlka_w    := tdmlka_w + dT;
                    tdmlka      := tdmlka_w;
                    iptgl_w     := ipteskf_w;                           -- rough leak current
                    iptgl       := iptgl_w;
                    IF (ipteskf_w < iptglmn_w) THEN
                        iptglmn_w   := ipteskf_w;                       -- minimum current
                        iptgh_w     := iptref_w - iptglmn_w;
                        iptgh       := iptgh_w;
                        iptsgl_w    := iptglmn_w + FIPTGL * iptgh_w;    -- threshold
                        iptumv_w    := iptglmn_w;
                        iptumv      := iptumv_w;
                    ENDIF;
    iptumv>=iptsumv:
                    (tdmlka_w > TIPTPAMN) AND (tdmlka_w < TIPTPAMX) AND
                    (iptumv_w >= iptsumv_w)
        Action:     B_refo      := false;                               -- no max-error
                    B_refu      := false;                               -- no min-error
                    B_sumv      := true;                                -- plaus-error
                    B_dmtlpe    := true;                                -- module diag finished
    iptgl<iptsgl:   (tdmlka_w > tdmgl_w) AND (iptgl_w < iptsgl_w)
    iptgl>=iptsgl:  (tdmlka_w > TDMTGLR) AND (iptgl_w >= iptsgl_w)
```

```
A_rleakv
        Entry:      isadmtl     := 3;
                    B_dmtglm    := true;                                -- start of rough leak detection
                    B_dmtglmv   := true;                                -- start of rough leak detection
                    B_dmtmv     := true;                                -- valve solenoid on
                    iptsglv_w   := iptref_w - iptgh_w * FIPTGLR;
                    iptglv_w    := ipteskf_w;
        Action:     tdmlka_w    := tdmlka_w + dT;
                    tdmlka      := tdmlka_w;
                    iptglv_w    := ipteskf_w;
                    IF (ipteskf_w < iptglmn_w) THEN
                        iptglmn_w   := ipteskf_w;                       -- minimum current
                        iptgh_w     := iptref_w - iptglmn_w;
                        iptgh       := iptgh_w;
                        iptsglv_w   := iptref_w - iptgh_w * FIPTGLR;    -- threshold
                    ENDIF;
        Exit:       B_dmtglm    := false;                               -- end of rough leak detection
    iptglv>=iptsglv:
                    iptglv_w >= iptsglv_w
    iptglv<iptsglv:
                    (iptglv_w < iptsglv_w) AND (tdmlka_w > tdmkl_w)
                    B_rfmgv     := true;
```

```
A_rleakend
        Entry:      isadmtl     := 4;
                    B_dmtglm    := false;                               -- end of rough leak detection
                    B_dmtgv     := false;                               -- no rough leak
                    B_zdmtgv    := true;                                -- module diag finished
    NOT B_dmtke:    B_dmtke = false
        Action:     B_refo      := false;                               -- no max-error
                    B_refu      := false;                               -- no min-error
                    B_sumv      := false;                               -- no plaus-error
                    B_dmtlpe    := true;                                -- module diag finished
    B_dmtke:        B_dmtke = true
        Action:     B_dmtglmv   := false;
```

```
A_sleakdia
        Entry:      isadmtl     := 5;
                    tdmstba_w   := 0;
                    diptgl_w    := 0;
                    iptvgl_w    := ipteskf_w;
                    B_zdmtgv    := false;
                    B_dmtmv     := true;                                -- valve solenoid on
                    B_dmtklm    := true;                                -- start of smallest leak detection
        Action:     tdmstba_w   := tdmstba_w + dT;
                    diptgl_w    := abs(ipteskf_w - iptvgl_w);
                    tdmlka_w    := tdmlka_w + dT;                       -- total time of tank mode
                    tdmlka      := tdmlka_w;
    ipteskf>iptref:
                    (ipteskf_w > iptref_w)
        Action:     iptkl_w     := ipteskf_w;                           -- smallest leak current
                    B_dmtklm    := false;                               -- end of small leak
                    B_refo      := false;                               -- no max-error
                    B_refu      := false;                               -- no min-error
                    B_sumv      := false;                               -- no plaus-error
                    B_dmtlpe    := true;                                -- module diag finished
    diptgl>DIPTSTAB:
                    diptgl_w >= DIPTSTAB
    tdmstba>tdmstth:
                    (tdmstba_w > tdmstth_w) AND (tdmlka_w > tdmkl_w)
```

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```
          Action:     iptvgl_w    := ipteskf_w;
```

```
A_sleakv
          Entry:      isadmtl     := 6;
                      diptgl_w    := 0.0;
                      tdmstba_w   := 0.0;
                      iptvglv_w   := ipteskf_w;
                      B_dmtklmv   := true;
          Action:     tdmstba_w   := tdmstba_w + dT;
                      tdmlka_w    := tdmlka_w + dT;
                      tdmlka      := tdmlka_w;
                      diptgl_w    := abs(ipteskf_w - iptvglv_w);
          Exit:       B_dmtklmv   := false;
     diptgl>DIPSTAB:
                      diptgl_w > DIPTSTAB
     tdmstba>tdmstth:
                      tdmstba_w > tdmstth_w * FIP2STAB
          Action:     iptgl_w     := ipteskf_w;
                      iptgl       := iptgl_w;
                      B_dmtklm    := false;                              -- end of small leak
```

```
A_refdia2
          Entry:      isadmtl     := 7;
                      tdmrfa_w    := 0;
                      iptref_w    := 0;
                      iptref      := 0;
                      B_dmtmv     := false;
                      B_dmtrfm    := true;                               -- start of reference measurement
                      B_dmtlpe    := false;
          Action:     tdmrfa_w    := tdmrfa_w + dT;
                      iptrefr_w   := ipteskf_w;
                      iptref_w    := iptrefr_w + DIPTREF;                -- reference current
                      iptref      := iptref_w;
                      iptglmn_w   := iptref_w - iptgh_w;                 -- new min current
                      iptsgl_w    := iptglmn_w + iptgh_w * FIPTGL;       -- new threshold
                      iptsglv_w   := iptref_w - iptgh_w * FIPTGLR;
          Exit:       B_dmtrfm    := false;                              -- end of reference measurement
     iptref>IPTREFO:
                      (tdmrfa_w > TDMTREFW) AND (iptref_w > IPTREFO)
          Action:     B_refo      := true;                               -- max-error
                      B_refu      := false;                              -- no min-error
                      B_sumv      := false;                              -- no plaus-error
                      B_dmtlpe    := true;                               -- module diag finished
     iptref<IPTREFU:
                      (tdmrfa_w > TDMTREFW) AND (iptref_w < IPTREFU)
          Action:     B_refo      := false;                              -- no max-error
                      B_refu      := true;                               -- min-error
                      B_sumv      := false;                              -- no plaus-error
                      B_dmtlpe    := true;                               -- module diag finished
     iptglv<iptsglv:
                      (tdmrfa_w > TDMTREFW) AND (iptglv_w < iptsglv_w) AND (B_dmtglmv)
                      OR
                      (tdmrfa_w > TDMTREFW) AND (iptgl_w < iptsgl_w) AND (NOT B_dmtglmv)

          Action:     B_refo      := false;                              -- no max-error
                      B_refu      := false;                              -- no min-error
                      B_sumv      := false;                              -- no plaus-error
                      B_dmtlpe    := true;                               -- module diag finished
     iptglv>=iptsglv:
                      (tdmrfa_w > TDMTREFW) AND (iptglv_w >= iptsglv_w) AND (B_rfmgv)

          Action:     B_rfmgv     := false;
                      tdmlka_w    :=0;                                   -- reset total time of tank mode
                      tdmlka      :=0;
     iptvgl<=iptref:
                      (tdmrfa_w > TDMTREFW) AND (iptvgl_w <= iptref_w) AND (NOT B_rfmgv)

          Action:     iptkl_w     := iptvgl_w;                           -- smallest leak current
                      B_refo      := false;                              -- no max-error
                      B_refu      := false;                              -- no min-error
                      B_sumv      := false;                              -- no plaus-error
                      B_dmtlpe    := true;                               -- module diag finished
     iptvgl>iptref:   (tdmrfa_w > TDMTREFW) AND (iptvgl_w > iptref_w) AND (NOT B_rfmgv)

          Action:     iptkl_w     := iptvgl_w;                           -- smallest leak current
                      B_refo      := false;                              -- no max-error
                      B_refu      := false;                              -- no min-error
                      B_sumv      := false;                              -- no plaus-error
                      B_dmtlpe    := true;                               -- module diag finished
```

```
A_tight
          Entry:      isadmtl     := 8;
                      B_edmtk     := false;                              -- no smallest leak detected
                      B_zdmtk     := true;                               -- smallest leak diag finished
     true:            true
```

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```
A_sleak
          Entry:      isadmtl     := 9;
                      B_edmtk     := true;                          -- smallest leak detected
                      B_zdmtk     := true;                          -- smallest leak diag finished
     true:            true
-------------------------------------------------------------------------------------------------
A_rleak
          Entry:      isadmtl     := 10;
                      B_dmtgv     := true;                          -- rough leak supposed
                      B_zdmtgv    := true;                          -- rough leak diag finished
     true:            true
-------------------------------------------------------------------------------------------------
A_dmtlerr
          Entry:      isadmtl     := 11;
     true:            true
-------------------------------------------------------------------------------------------------
A_end
          Entry:      isadmtl     := 12;                            -- state number
                      B_dmtpm     := false;                         -- pump motor off
                      B_dmtmv     := false;                         -- valve solenoid off
                      B_dmtrfm    := false;                         -- no reference measurement
                      B_dmtglm    := false;                         -- no rough leak diagnosis
                      B_dmtklm    := false;                         -- no smallest leak diagnosis
                      B_admtll    := false;                         -- diagnosis finished
     true:            true
=================================================================================================
Lokale Variablen:
     Float tdmrfa_w    := 0; -- non volatile
     Float tdmlka_w    := 0; -- non volatile
     Float tdmlka      := 0; -- nv
     Float tdmstba_w   := 0; -- nv
     Float iptglmn_w   := 0; -- nv
     Float iptgh       := 0; -- nv
     Float iptvgl_w    := 0; -- nv
     Float iptvglv_w   := 0; -- nv
     Float diptgl_w    := 0; -- nv
     Float iptrefr_w   := 0; -- nv
     Float iptref      := 0; -- nv
     Float iptumv      := 0; -- nv
     Float iptgl       := 0; -- nv
     Float iptkl       := 0; -- nv
     Int   isadmtl     := 0; -- nv
     Bool  B_rfmgv     := false;
     Bool  B_dmtklmv   := false;
```

ABK DDMTL 1.112 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDDMTL			FW	code word for function DDMTL
CWDDMTL2			FW	code word for function DDMTL
DIPRFO			FW	upper threshold delta pump reference current
DIPTREF			FW	offset reference pump current
DIPTSTAB			FW	delta pump current for stabilized pump current
DIPTUMVU			FW	offset pump current at ambient pressure
DITEDTD			FW	threshold change of pump current for fuel cap detection
DITEDTK			FW	threshold change of pump current for refueling detection
DPSF			FW	threshold decrasing current during measuring
DUBTES			FW	delta ub-threshold for evap leakage diagnosis
FIP2STAB			FW	Factor for 2 stabilisation time
FIPTGL	IPTGH_W		KL	factor delta pump current for rough leak detection
FIPTGLR	IPTGH_W		KL	factor delta pump current for rough leak detection in refer to reference
FIPTUBF	UBTESF_W		KL	factor pump current
HOTEDU			FW	lower altitude threshold for performing of leak diagnosis
IPTREFO			FW	upper limit of pump current during reference measurement
IPTREFU			FW	lower limit of pump current during reference measurement
KFTDSTAB	IPTGH_W	GVTAF_W	KF	time for pump current stabilasation
NGLMHEMX			FW	max. number enable fulfilled for rough leak test
NGLMTKMX			FW	max. number rough leak tests for smallest leak test
NGLTDA			FW	max. number of aborted check filler cap detections
NGLTDW			FW	max. number check filler cap detections
NKLDIPFMX			FW	upper limit of stop smallest leak detection in case of motor current fluctuation
NKLMTKMX			FW	max. number of smallest leak tests after refueling
SDMGLVU			FW	lower threshold of driving distance from refueling to supposed rough leak
SFTEDA			FW	max. threshold of HC-charge for allowed leak diagnose
TABTESMN			FW	minimum key off time for evap leakage diagnosis
TANKDBE			FW	turn on delay combi
TANKDD			FW	turn off delay combi
TDDPSF			FW	delaytime for detection of decrease of current
TDMGLGTF	GVTAF_W		KL	time for rough leak detection
TDMKLGTF	GVTAF_W		KL	time for small leak detection
TDMTGL			FW	time for rough leak detection
TDMTGLR			FW	time for reference test at rough leak detection
TDMTKL			FW	time for small leak detection
TDMTLMX			FW	max. measuring time for tank leakage diagnosis

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Parameter	Source-X	Source-Y	Type	Description
TDMTREF			FW	time for reference leakage measurement
TDMTREFW			FW	time for additional reference leakage measurement
TDMTSTAB			FW	time for stabilized pump current
TFEDMMX			FW	max. time for function request of DM-TL power stages
TIPTPAMN			FW	minimum time for test of pump current during rough leak test
TIPTPAMX			FW	maximum time for test of pump current during rough leak test
TMSDMTLU			FW	lower threshold of start temperature of DDMTL
TNSTESMN			FW	minimum post cranking time for evap leakage diagnosis
TTEDUBV			FW	time delay for Ubat monitoring
TUMTESO			FW	max. ambient temp. threshold for leak detection
TUMTESU			FW	min. ambient temp. threshold for leak detection
TWKL15IP			FW	delay after power on for evaluation of pump motor current
TWTEDTA			FW	waiting time for detection of refueling
TWTEMV			FW	waiting time after switching of solenoid
TWTESNL			FW	key off waiting time until start of tank leakage detection
UBTEDFAO			FW	maximum battery voltage for diagnosis in case of request by tester
UBTEDFAU			FW	minimum battery voltage for diagnosis in case of request by tester
UBTEDO			FW	maximum battery voltage for diagnosis
UBTEDU			FW	minimum battery voltage for evap leakage diagnosis
VDMTLO			FW	upper threshold of velocity of DDMTL
VFZTANKD			FW	vehicle speed for display ”check filler cap”
ZIPTESB			FW	time constant for start of iptes-filtering
ZIPTESN			FW	time constant for iptes-filtering
ZIPTKTKN			FW	time constant for iptes-filtering
ZUBTESB			FW	time constant for start of ub-filtering
ZUBTESN			FW	time constant for ub-filtering

Variable	Source	Type	Description
B_ADMTLL	DDMTL	LOK	Condition DDMTL-state machine running
B_ADMTLS	DDMTL	LOK	Condition DDMTL-state machine should stop
B_ADMTPM	DDMTL	AUS	condition DMTL-pump-motor turned on
B_AIRBAG	GGAIRB	EIN	condition airbag activated
B_CDDMTL	PROKON	EIN	function enabled per codeword
B_CLDMTK		EIN	condition: clear error smallest leak
B_CLDMTL		EIN	condition: clear error DMTL-module
B_CRDMTL		EIN	supposed CRash output to disable DMTL diagnosis
B_DIPRFO	DDMTL	LOK	Condition delta reference current exceeded
B_DMDIPTGE	DDMTL	LOK	condition roughleak detection enabled after current fluctuation
B_DMDIPTKE	DDMTL	LOK	condition smallest leak detection enabled after current fluctuation
B_DMGLTD	DDMTL	LOK	condition only enable of rough leak detection becuase of check filler cap
B_DMKL15	DDMTL	AUS	Condition power on during smallest leak check
B_DMKTKE	DDMTL	LOK	condition smallest leak detection enabled after refueling
B_DMKTKR	DDMTL	LOK	condition smallest leak detection reset after refueling
B_DMKTKS	DDMTL	LOK	condition smallest leak detection set after refueling
B_DMMVET		EIN	condition power stage test DMTL-solenoid turned on
B_DMPMET		EIN	condition power stage test DMTL-pump-motor turned on
B_DMTDC	DDMTL	LOK	condition check filler cap
B_DMTETE	DDMTL	LOK	condition enable function request DM-TL power stages
B_DMTGE	DDMTL	LOK	condition enable of rough leak detection
B_DMTGLM	DDMTL	LOK	condition rough leak measurement running
B_DMTGLMV	DDMTL	LOK	condition extended rough leak measurement
B_DMTGTZ	DDMTL	LOK	Condition TEV should be closed
B_DMTGV		EIN	canister purge system diagnosis - supposed rough leak
B_DMTGVS	DDMTL	LOK	canister purge system diagnosis - supposed rough leak
B_DMTKE	DDMTL	LOK	condition enable of smallest leak detection
B_DMTKEE	DDMTL	LOK	condition end of enable of smallest leak detection
B_DMTKLM	DDMTL	LOK	condition smallest leak measurement running
B_DMTKLMV	DDMTL	LOK	condition extended smallest leak measurement running
B_DMTKTZ	DDMTL	LOK	Condition TEV should be closed
B_DMTLFE	DDMTL	LOK	condition enable function request rough and smallest leak detection
B_DMTLHE	DDMTL	LOK	condition main enable of rough and smallest leak detection
B_DMTLMV	DDMTL	AUS	condition DMTL-solenoid turned on
B_DMTLPE	DDMTL	LOK	limit-check of motor current valid
B_DMTLTDE	DDMTL	LOK	condition main enable of check filler cap
B_DMTLTZ	DDMTL	AUS	Condition TEV should be closed
B_DMTMV	DDMTL	LOK	condition DMTL-solenoid turned on
B_DMTNGE		EIN	condition only enable of rough leak detection
B_DMTPM	DDMTL	LOK	condition DMTL-pump-motor turned on
B_DMTRFM	DDMTL	LOK	condition reference leak measurement running
B_DPSF	DDMTL	LOK	condition decreasing current during measuring
B_DTEG	DDMTL	LOK	no small leak detection due to HC-charge
B_DTEGEN	DDMTL	LOK	Condition enable of rough leak test
B_DTEGFA	DDMTL	LOK	Condition function request of rough leak test
B_DTEGTR	DDMTL	LOK	Condition no more rough leak checks in actual trip
B_DTEKEN	DDMTL	DOK	condition smallest leak check enabled
B_DTEKFA	DDMTL	DOK	Condition function request for smallest leak check
B_DTEKTR	DDMTL	LOK	Condition no more smallest leak checks in actual trip
B_DTETD	DDMTL	LOK	Condition refueling recognized
B_DTETK	DDMTL	LOK	Condition refueling recognized
B_DUBTES	DDMTL	LOK	condition big battery voltage fluctuations during tank leakage diagnosis
B_EDMTG	DDMTL	LOK	canister purge system diagnosis - rough leak

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Variable	Source	Type	Description
B_EDMTK	DDMTL	LOK	evap system monitoring - smallest leak
B_EDMTKS	DDMTL	LOK	non healed smallest leak fault
B_EDMTKSNM	DDMTL	AUS	non healed smallest leak fault in case error path not used for MIL on
B_ESDMTE	DDMTL	AUS	Condition DDMTL enabled due to power stage faults
B_FA		EIN	condition general function request
B_FADMET		EIN	condition DMTL-power stage diagnostic tool control
B_FADMTL	T2DMTL	EIN	condition leak detection request
B_FEDMMV	DDMTL	LOK	condition DMTL-solenoid turned on with function request
B_FEDMPM	DDMTL	LOK	condition DMTL-pump-motor turned on with function request
B_FEDMTL	DDMTL	LOK	condition power stage of leak detection request
B_FEDMTZ	DDMTL	LOK	Condition TEV should be closed
B_FSTDMN	GGFSTT	EIN	condition minimum fuel level for diagnostic function
B_FSTDMX	GGFSTT	EIN	condition maximum fuel level for diagnostic function
B_FSTTG	GGFSTT	EIN	fuel level valid (even during control unit run on)
B_GLVNM	DDMTL	LOK	no MIL in case rough leak
B_HAG	GGDSAS	EIN	condition altitude adaptation valid
B_KL15		EIN	condition ignition switch on
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_MIRDMTK		EIN	Condition MIL on caused by E_dmtk
B_MNDMTK	DDMTL	LOK	condition for fault type ”minimum value” detected (smallest leak)
B_MNDMTKNM	DDMTL	LOK	condition for fault type ”minimum value” detected (smallest leak; no MIL on)
B_MNDMTL		EIN	condition for fault type ”minimum value” detected (DMTL-module)
B_MXDMTK	DDMTL	LOK	condition for fault type ”maximum value” detected (rough leak)
B_MXDMTL	DDMTL	AUS	condition for fault type ”maximum value” detected (DMTL-module)
B_NACHL	MOTAUS	EIN	ECU control for ECU switch off delay
B_NGLMTR	DDMTL	LOK	condition: rough leak enable during actual trip
B_NKFL	DDMTL	AUS	upper limit of not ended smallest leak in case of fluctuations reached
B_NKFLG	DDMTL	AUS	current-fluctuation-check of component valid
B_NLDTE	DDMTL	AUS	request for ECM afterrun from leak detection
B_NLDTEG	DDMTL	LOK	request for ECM afterrun from rough leak test
B_NLDTEK	DDMTL	LOK	request for ECM afterrun from smallest leak test
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_NOMILKL	DDMTL	LOK	no MIL on in case of smallest leak
B_NPDMTL		EIN	condition for fault type ”unplausible signal” detected (DM-TL module)
B_REFO	DDMTL	LOK	upper limit of pump current during reference measurement reached
B_REFU	DDMTL	LOK	lower limit of pump current during reference measurement reached
B_RFMGV	DDMTL	LOK	condition second reference measuring in cas of supposed raough leak
B_RSDMTG	DDMTL	DOK	condition disable smallest leak diagnosis
B_RSNGL	DDMTL	LOK	condition reset Counter nglmhe
B_SDMGLV	DDMTL	LOK	condition driving distance for rough leak verification enabled
B_SIDMTL		EIN	condition for fault type ”signal” detected (DMTL-module)
B_STEND	BBSTT	EIN	condition end of start
B_SUMV	DDMTL	LOK	pump motor current threshold at DM-TL valve check reached
B_TANK	DFSTT	EIN	condition refuelling
B_TANKD	DDMTL	AUS	condition for closed filler cap
B_TANKDO	DDMTL	LOK	filler cap open
B_TANKG	DFSTT	EIN	condition refuelling bit valid
B_TANKS	DDMTL	LOK	condition refuelling
B_TEVZU	DDMTL	LOK	Condition TEV closed
B_TWDMNL	DDMTL	LOK	delay start of DM-TL finished
B_TXDMTS	DDMTL	LOK	Condition DDMTL stopped due to max time
B_ZDMTG	DDMTL	LOK	cycle flag of evap system monitoring - rough leak
B_ZDMTGV		EIN	cycle flag of evap system monitoring - supposed rough leak
B_ZDMTK	DDMTL	LOK	cycle flag of evap system monitoring - smallest leak
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DIPTGL_W	DDMTL	LOK	difference of pump motor current
E_DMMVE		EIN	error flag: DM-TL change-over valve (power stage)
E_DMPME	DDMPME	EIN	error flag: DM-TL pump motor (power stage)
E_DMTK	DDMTL	AUS	error flag: evap system monitoring - smallest leak
E_DMTKNM	DDMTL	AUS	error flag: evap system monitoring - smallest leak (not MIL on)
E_DMTL	DDMTL	AUS	error flag: DMTL-module
E_FST	DFSTT	EIN	error flag: fuel level
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
FHO_W	GGDSAS	EIN	correction factor: altitude
FIPTES_W	DDMTL	LOK	factor of pump motor current
FSP_CL		EIN	clear fault memory
FTEADF	TEB	EIN	filtered factor load scavening air at tank ventilation
GVTAF_W	GGFSTT	EIN	free gas capacity in fuel tank
IPRFMN_W	DDMTL	LOK	minimum pump motor reference current
IPRFMX_W	DDMTL	LOK	maximum pump motor reference current
IPTESKFH_W	DDMTL	LOK	highpass filtered corrected pump motor current of leakage detection
IPTESKFM_W	DDMTL	LOK	max. filtered corrected pump motor current of leakage detection during measuring
IPTESKF_	DDMTL	DOK	filtered corrected pump motor current of leakage detection
IPTESKF_W	DDMTL	LOK	filtered corrected pump motor current of leakage detection
IPTESK_W	DDMTL	LOK	corrected pump motor current of leakage detection
IPTES_W	GGDMTL	EIN	pump motor current of leakage detection
IPTGH	DDMTL	LOK	difference pump motor current between reference and min at rough leak

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Variable	Source	Type	Description
IPTGH_W	DDMTL	LOK	difference pump motor current between reference and min at rough leak
IPTGL	DDMTL	LOK	pump motor current at the end of rough leak detection
IPTGLMN_W	DDMTL	LOK	minimum pump motor current at rough leakage detection
IPTGLV_W	DDMTL	LOK	pump motor current at the end of extended rough leak detection
IPTGL_W	DDMTL	LOK	pump motor current at the end of rough leak detection
IPTKF_⊥	DDMTL	DOK	filtered corrected pump motor current of leakage detection
IPTKF_W	DDMTL	LOK	filtered corrected pump motor current of leakage detection
IPTKL	DDMTL	LOK	pump motor current at the end of smallest leak detection
IPTKL_W	DDMTL	LOK	pump motor current at the end of smallest leak detection
IPTKTKF_⊥	DDMTL	DOK	filtered pump motor current of leakage detection for refueling
IPTKTKF_W	DDMTL	LOK	filtered pump motor current of leakage detection for refueling
IPTREF	DDMTL	LOK	pump motor current with reference leak
IPTREFR_W	DDMTL	LOK	pump motor current with reference leak
IPTREF_W	DDMTL	LOK	pump motor current with reference leak
IPTSGLV_W	DDMTL	LOK	pump motor current threshold at extended rough leak detection
IPTSGL_W	DDMTL	LOK	pump motor current threshold at rough leak detection
IPTSUMV_W	DDMTL	LOK	pump motor current threshold at DM-TL valve check
IPTUMV	DDMTL	LOK	pump motor current at DM-TL valve check
IPTUMV_W	DDMTL	LOK	pump motor current at DM-TL valve check
IPTVGLV_W	DDMTL	LOK	pump motor current for comparison at extended fine leak check
IPTVGL_W	DDMTL	LOK	pump motor current for comparison at rough leak check
ISADMTL	DDMTL	LOK	state number of DMTL-state machine
M6CDDMTL	DDMTL	AUS	Mode 6 - memory: component ID for DM-TL tank leakage detection
M6SDDMTL_W	DDMTL	AUS	Mode 6 - memory: Threshold value for DM-TL tank leakage detection
M6WDDMTL_W	DDMTL	AUS	Mode 6 - memory: Measured value for DM-TL tank leakage detection
MSTEDTE	BGTEV	EIN	purge mass flow for DTEV
NADMTLL_W	DDMTL	AUS	number of startet leak measurements
NDIPRFO_W	DDMTL	AUS	number of not ended leak detection in case of current fluctuations
NGLMHE	DDMTL	LOK	number of rough leak enables after latest rough leak test
NGLMTK	DDMTL	LOK	number of rough leak tests after latest refueling
NGLTDCA	DDMTL	DOK	number of aborted check filler cap detections
NGLTDCW	DDMTL	DOK	number of check filler cap detections
NKFL	DDMTL	AUS	number of not ended smallest leak in case of fluctuations (limited)
NKLMTK	DDMTL	LOK	number of smallest leak tests after refueling
NTGLM_W	DDMTL	LOK	total number of rough leak checks
NTKLM_W	DDMTL	LOK	total number of smallest leak checks
SDMGLVA_W	DDMTL	LOK	driven distance since rough leak recognized
TABST_W	BGTABST	EIN	soak time
TDMGL_W	DDMTL	LOK	time of rough leak measurement
TDMKL_W	DDMTL	LOK	time of small leak measurement
TDMLKA	DDMTL	LOK	actual time leak test
TDMLKA_W	DDMTL	LOK	actual time leak test
TDMRFA_W	DDMTL	LOK	actual time reference leakage measurement
TDMSTBA_W	DDMTL	LOK	actual time stabilized pump current
TDMSTTH_W	DDMTL	LOK	threshold for actual time stabilized pump current
TMST	GGTFM	EIN	engine temperature at start
TNSE_W	BBSTT	EIN	time counter at end of start (16 bit)
TUMG	GGTFUMG	EIN	Ambient air temperature
UBSQ_W	GGUB	EIN	battery voltage (on board), conversed to standard quantization
UBTESF_⊥	DDMTL	DOK	filtered battery voltage
UBTESF_W	DDMTL	LOK	filtered battery voltage
UBTREF_W	DDMTL	LOK	battery voltage at reference measurement
VFZG_W	GGVFZG	EIN	Vehicle speed
Z_DMTK	DDMTL	AUS	cycle flag of evap system monitoring - smallest leak
Z_DMTKNM	DDMTL	AUS	cycle flag of evap system monitoring - smallest leak (no MIL on)
Z_DMTL	DDMTL	AUS	cycle flag: DMTL-module

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FB DDMTL 1.112 Detailed description of function

Task:
On board diagnosis (OBDII) of a smallest leak (diameter > 0.5 mm) resp. of a rough leak (diameter > 1.0 mm) in the canister system of a vehicle.

Method:
Mounting of a canister diagnostic module (DM-TL) on the air connection of the activated carbon filter, closing of the purge control valve and of a switch-over valve in the diagnostic module, building-up of an excess pressure of about 25 hPa in the canister by means of an electric pump present in the diagnostic module. The current input of the pump is a measure for the excess pressure in the canister and allows for a statement on the tightness of the canister system by a comparison with the current input at a defined reference leak in the module.

Solution:
The function is principally enabled via the bit B_cddmtl from the central configuration.
Controlling of the diagnostic procedure is performed via the machine TIMCONTROL. It receives from the block ENABLE the enabling B_dmtke for the smallest leak detection and B_dmtnge for the rough-leak detection. The machine thereupon starts a reference-leak measurement (state A_refdia1, B_admtpm = true for pump motor on); after the time TDMTREF the transition to the rough-leak diagnosis takes place (state A_rleakdia), unless the current monitoring detects a module fault (state A_dmtlerr), or the diagnosis is aborted due to detected humidity B_diprfo.

Grobleckverdacht besteht (Zustand A_rleak), wenn sich innerhalb der Zeit tdmgl_w der Pumpenstrom die Schwelle iptsgl_w nicht übersteigt und nach der Verlängerungszeit tdmkl_w der Pumpstrom die Schwelle iptsglv_w nicht erreicht.

A rough leak is suspected (state A_rleak), if the pump current rises by less than DIPTGL within the time tdmgl_w.
In case of suspected rough leak a second reference measurement is performed, by the result of which the final decision on suspected rough leak is made (new calculation of rough-leak threshold and comparison with the latest stored pump current).
Thereafter the transition to the micro-leak diagnosis is performed (state A_sleakdia). The canister system is detected to be tight (state A_tight), if the pump current exceeds the reference current iptref_w. If the pump current is detected as having stabilized (for two times) after the time tdmkl_w (pump current change < DIPTSTAB within time tdmstth), another reference measurement is performed (state A_refdia2). If the current rises in the process, a smallest leak is diagnosed (state A_sleak), if the current drops the canister system is detected as being tight (state A_tight).
At the end of the diagnosis (state A_end) the pump motor is switched off (B_admtpm = false) and the switch-over valve is switched back to the regenerating position again (B_dmtlmv = false).
The errors are signalized by the bits E_dmtl for module error, E_dmtk for leak error (MIL-relevant) and E_dmtknm (not MIL-relevant).

The bit B_admtll indicates an active diagnosis; an abort of the diagnosis is requested via B_admtls.

Abort is performed when the fuel cap is detected to be open (B_dtetd), when starting to refuel (B_dtetk), at too high fluctuation of the battery voltage during the diagnosis (B_dubtes), at dropping pump current during the measuring phase (B_dpsf) or at detected short-circuit of the pump output stage (B_dmpme).
The function is terminated without result during the reference phase in case of detected humidity (B_diprfo).

The pump current iptes_w is filtered in the block IPFILTER after a conversion to a standard voltage of 12 V (ipteskf_w).
In the process a smaller time constant is used (ZIPTESB instead of ZIPTESN) at the beginning of the reference measurement (B_dmtrfm) and at the beginning of the rough-leak measurement (B_dmtglm), so as to enable a quicker stabilization of the filter.
Furthermore, the filtered battery voltage is scanned at the end of the reference measurement (ubtref_w) and the change in the subsequent rough-/smallest leak measurement is monitored for threshold DUBTES, result is B_dubtes, which leads to an abort of the diagnosis, if it is TRUE. Current fluctuations are paid attention to during the reference phase (B_diprfo), which can lead to the diagnosis being aborted.

Block REFUEL differentiates the corrected pump current and checks for a positive threshold DITEDTK being exceeded, so on rising pump current for refueling detection (B_dtetk), since the canister pressure and thus the pump current rises during refueling.
When the fuel cap is opened the canister pressure breaks down, thus the pump current decreases. When the negative threshold DITEDTD is undershot, the bit B_dtetd is set to indicate that the fuel cap is open. A slow drop of the pump current by DPSF leads to the diagnosis being aborted via the bit B_dpsf (detected humidity during pump phase).

Block ERROR serves to generate the error (E_..) and cycle flags(Z_..) from the fault types B_mn.., B_mx.. resp. B_no.. (information test has been performed, no fault was found). Fault paths can also be cleared individually by tester interventions (B_cl..).

Block ENABLE calculates the enabling of the function.

The smallest leak diagnosis is triggered during the after-run, below a certain altitude (HOTEDU), when the vehicle is at rest, at not too high degree of saturation of the ACF (SFTEDA), ambient temperature within range (TUMTESU, TUMTESO), battery voltage within range (UBTESU, UBTESO) and closed PCV (mstedte = 0 kg/h).
Block ENAFLDIA additionally checks the time since engine start (TNSTESMN), the engine off-time (TABTESMN) and the not existing engine speed.
B_nldte prevents the deactivation of the main relay during after-run until the diagnosis is terminated, B_dmtktz resp. B_dmtltz demand the closing of the PCV.
The time TWTESNL is a threshold to delay the beginning of the smallest leak diagnosis after engine OFF.
Bit B_dtektr = true means that the diagnosis was executed once during this trip, this blocks a further start of the diagnosis.
By the code word CWDDMTL (bit 0 = true) the start of the smallest leak diagnosis can be forced manually during the after-run.

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APP DDMTL 1.112 Application hint

```
Preconditions:
 - To prevent wrong results of diagnosis on account of humditiy (drizzel, condensation), reffering to fitting condition in
   latest TCI
 - Influence of humditiy after long time driving in line while drizzel is checked
 - DMTL module connected to ACF, electrical connections checked
 - Sensor value %GGDMTL adjusted
 - Diagnosis of pump motor output stage %DDMPME adjusted
 - Diagnosis of solenoid valve output stage %DDMMVE adjusted
 - Set B_cddmtl to true in %PROKON to activate %DDMTL (usually in code word CDDMTL)
 - In %MOTAUS, set maximum time for ECU after-run > maximum duration for DM-TL diagnosis
```

CWDDMTL				
Bit	Dez	Beschreibung	Wert	Wert-Bedeutung
0	1	Kleinstleckdiagnose erzwingen (manuell)		
1	2	Durchschalten B_dmtlfe nach B_dtegfa		
2	4	B_rsdmtg, Feinleckdiagnose deaktiviert		
3	8	B_rsngl, Reset Zähler: Grobleckenables seit letzter Grobleckmessung		
4	16	Heilung wenn E_dmtk (1 = enable, 0 = disable)	1	Heilung möglich
5	32	Freigabe Endstufentest für Pumpe und Ventil (siehe Bit 6,7)		
6	64	Endstufenansteuerung Pumpe		
7	128	Endstufenansteuerung Ventil		

CWDDMTL2				
Bit	Dez	Beschreibung	Wert	Wert-Bedeutung
0	1			
1	2	Aktivierung Request bei erkannter Feuchte (Freischalten B_dpsf oder B_diprfo)	0	aktiv
2	4	Freischalten B_dpsf (Grobleck)	0	disable
3	8	Freischalten B_dpsf (Feinleck) (bis Version 1.90)		
4	16	keine MIL-Ansteuerung bei Feinleckerkennung	1	keine MIL
5	32	Heilungsprüfung mit bzw. ohne Abstellzeit: Umschalten zw. B_dmtkee und tabst_w	0	B_dmtkee
6	64	Deaktivierung: Check Filler Cap (ab Version 1.110)	0	Check Filler Cap inaktiv
7	128	Vermeidung Grobleckeintrag außerh. Spezifikation (ab Vers. 1.110); Motorlaufzeit	0	inaktiv

ddmtl-cwlist

ddmtl-cwlist

```
Presetting of the Parameters:
 - Code word CWDDMTL = 16  (error healing possibility on in case of leak)
 - Code word CWDDMTL2 = 12 (abort of diagnosis, if the pump current drops by DPSF during measuring phase)
 - Max. duration of canister leak diagnosis TDMTLMX = 490 s
 - Max. duration of output-stage triggering TFEDMMX = 600 s
 - Minimum duration for rough-leak test TDMTLGLR = 3.5 s  ( > TIPTPAMX)
 - Factor delta pump current for rough-leak detection FIPTGL:
                    2 mA       0.365
                    3 mA       0.243
                    4 mA       0.222
                    5 mA       0.209
                    6 mA       0.200
                    7 mA       0.196
                    8 mA       0.189
                    9 mA       0.168
 - Factor delta pump current for rough-leak detection FIPTGLR:
                    2 mA       0.400
                    3 mA       0.600
                    4 mA       0.600
                    5 mA       0.600
                    6 mA       0.600
                    7 mA       0.600
                    8 mA       0.600
                    9 mA       0.650
 - Delta pump current for pump current stable DIPTSTAB = 0.5 mA
 - Threshold pump-current change for canister cap detection DITEDTD = - 1.5 mA
 - Threshold pump-current change for refueling detection DITEDTK = + 1.5 mA
 - Delta-ub threshold DUBTES = 0.5 V
 - Difference of pump current at external pressure to reference leak DIPTUMVU = -2 mA
 - Correction of reference mean position DIPTREF = 0.0 mA
 - Deactivation of diagnosis at decreasing current during measurement DPSF = 0.75 mA
 - Waiting time at decreasing current TDDPSF = 3.0 sec
 - Altitude threshold HOTEDU = 0.73
 - Upper reference pump-current threshold IPTREFO = 40 mA
 - Lower reference pump-current threshold IPTREFU = 15 mA
```

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```
 - Threshold for ACF saturation SFTEDA = 3
 - Minimum off-time TABTESMN = 18000 s (= 5 h)
 - Time for reference leak measurement TDMTREF = 15 s
 - Time for reference leak measurement in case of prolongation TDMTREFV = 15 s
 - Time for reference leak measurement TDMTREFW = 10 s
 - Time for pump current stable TDMTSTAB min. 20 s
 - Time for pump current stable KFTDSTAB (iptgh_w, gvatf_w) min. 20 s (for complete map)
 - Factor time for pump current stable FIP2STAB = 0.5
 - Start of pump-current test in rough-leak phase TIPTPAMN = 2.0 s ( > TWTEMV )
 - End of pump-current test in rough-leak phase TIPTPAMX = 2.5 s   ( > TIPTPAMN )
 - Minimum post-start waiting time TNSTESMN = 1200 s
 - Time delay for ub monitoring TTEDUBV = 0.5 s
 - Upper ambient temperature threshold TUMTESO = 35 C
 - Lower ambient temperature threshold TUMTESU = 4 C
 - Lower engine-start temperature threshold TMSDMTLU = 4 C
 - After-run waiting time TWTESNL = 3 s
 - Lower ub-threshold UBTEDU = 11.5 V
 - Upper ub-threshold UBTEDO = 14.5 V  ( <= ub-threshold in %DDMPME and %DDMMVE)
 - Lower ub-threshold UBTEFADU by function request due to tester = 11.5 V
 - Upper ub-threshold UBTEFADO by function request due to tester = 14.5 V  ( <= ub-threshold in %DDMPME and %DDMMVE)
 - Time constant for start ipteskf-filtering ZIPTESB = 0.2 s (Attention: critical due to iptesk_w oscillation)
 - Time constant for normal ipteskf-filtering ZIPTESN = 1.5 s
 - Time constant for iptktkf-filtering at refueling ZIPTKTKN = 2.0 s
 - Waiting time for refueling detection TWTEDTA = 2.5 s (dependent on ZIPTESB, > TWTEMV)
 - Waiting time after switch-over of solenoid valve TWTEMV = 1.5 s (> 7*ZIPTESB)
 - Time constant for start of ub-filtering ZUBTESB = 0.2 s
 - Time constant for normal ub-filtering ZUBTESN = 0.4 s
 - ub-correction of pump current FIPTUBF (C1 pattern, vehicle measurement):
                   (10.0V  1.19531)
                   10.5V   1.14063
                   11.0V   1.09375
                   11.5V   1.04688
                   12.0V   1.00000
                   12.5V   0.95313
                   13.0V   0.92188
                   13.5V   0.89060
                   14.0V   0.84375
                   14.5V   0.7923 ?
 - Max. mileage between refueling and suspected rough leak SDMGLVU = 200 m
 - Max. number of fulfilled activation conditions without rough-leak test NGLMHEMX = 2
 - Max. number of rough-leak tests without refueling to force micro-leak test NGLMTKMX = 14
 - Max. number of micro-leak test starts after refueling NKLMTKMX = 3
 - Max. number of aborts at current fluctuations NKLDIPFMX = 255
 - max. Anzahl Check Filler Cap Prüfungen NGLTDW = 1
 - max. Anzahl abgebrochener Check Filler Cap Prüfungen NGLTDA = 1
 - Zeitpuntk einschalten Kombi-Anzeige "check filler cap" nach Kl15 TANKDBE = 2s
 - Dauer einschalten Kombi-Anzeige "check filler cap" nach Kl15 TANKDD = 5s
 - Change of reference current DIPRFO = 0.5 mA
 - Hold time iptesk_w after terminal 15 ON TWKL15IP = 0.35 s
 - Rough-leak measuring time TDMGLGTF:
                   10 l    6 s
                   30 l    17 s
                   50 l    30 s
                   70 l    40 s
                   100 l   60 s
 - Rough-leak measuring time at defective fuel-level sensor TDMTGL = 60 s

 - Minimum pump time at fine-leak test TDMKLGTF:
                   10 l    50  s
                   30 l    100 s
                   50 l    125 s
                   70 l    175 s
                   100 l   250 s
 - Minimum pump time at defective fuel-level sensor TDMTGL = 250 s

Deactivation of the Function:
 - Bit B_cddmtl = false by setting of the code word in function %PROKON

Influenced Functions:
 - Function %MOTAUS, since ECU after-run is maintained by bit B_nldte until the DDMTL diagnosis is terminated.


Manual Start of Leak Test:
 - Only rough-leak test:
   in code word CWDDMTL: at first bit 1 = false, then bit 1 = true (rising edge) ——> Start of rough-leak test, if
   activation condition B_dmtlfe = true
   Attention: Activate the function only during the after-run due to output stage diagnosis

 - Entire Diagnosis (Rough-Leak Test + Smallest Leak Test):
   in code word CWDDMTL: at first bit 0 = false, then Bit 0 = true (rising edge) ——> Start of entire diagnosis, if
   - ECU is in the after-run
   - activation condition B_dmtlfe = true

Manual Triggering of Output Stages:
  - DM-TL pump motor:  Code word CWDDMTL: Bit 5 = true, Bit 6 = true
  - DM-TL solenoid valve: Code word CWDDMTL: Bit 5 = true, Bit 7 = true
```

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Procedure:

1. Checking of the tightness of the purge control system:
   Since the diagnosis evaluates the sum of all leaks of the purge control system, attention must be paid prior to the application of the %DDMTL being performed that the purge control system is tight right up to the ACF. The following procedure is useful to check the tightness: Tightly seal off the system between ACF and DM-TL and apply an excessive pressure of about 25hPA - 50hPa at an appropriate position (service port, canister cap with pipe connection). Then watch the pressure drop in the purge control system by means of a pressure sensor (Careful: Pay attention to max. pressure range). As rule of thumb the following applies: A system is then (sufficiently) tight, if the pressure drop amounts to less than 1hPa within 240s.

   Please note: Once the excess pressure was applied, adjustment events take place dependent on the pressure level, on how fast the pressure is built up and dependent on the canister (geometry, material), which must in any case be waited for (for 70 L plastic-coated canister about 60s)! The pressure sensor is not absolutely necessary for the further application.

2. Application of the reference measurement:
   The reference measurement is part of each diagnosis and is performed in any case once the diagnosis was started. Precondition for the reference measurement to be performed correctly is the correct application of the values for the min/max permissible reference current, IPTREFU and IPTREFO, of the current fluctuation monitoring DIPRFO as well as the correct setting of the filter-time constants for the pump current, ZIPTESB and ZIPTESN, and of the switch-over time TWTEMV (suggested values see above). The values IPTREFU and IPTREFO must be set such that the reference current iptref_w lies within the two limits with a sufficient safety margin at minimum and maximum battery voltage. Monitoring of the current fluctuations (DIPRFO) may not be chosen too narrow to avoid a deactivation of the function under "dry" conditions. The pump current should have stabilized by the end of the measuring time for the reference measurement TDMTREF.

3. Application of the rough-leak detection:
   The rough-leak detection can be started manually as described above via the code word CWDDMTL (0 ——> 2). Precondition for the diagnosis to be executed is B_dmtlhe = true, i.e. that the main activation conditions are fulfilled and that the counter for the number of repeated measurements during this trip, nglmtr, is less than 3.

   At first the reference measurement is performed (B_dmtrfm=1, B_dmtlpm=1), and the reference current iptref_w as well as the battery voltage ubtref_w measured at this instant are stored. Shortly after the start of the reference measurement (TWTEMV) the current fluctuation monitoring starts. For this, the difference between minimum and maximum value is formed. If this difference exceeds the threshold value DIPRFO, humidity is detected and the diagnosis is aborted. Thereafter the current is applied to the solenoid valve (B_dmtlmv=1) and the rough-leak measurement is started (B_dmtglm=1, B_dmtge=1).

   Once the solenoid valve has been activated, the pump current ipteskf_w will at first drop immensely. In the time window [TIPTPAMN,TIPTPAMX] it is checked, whether the current value has dropped by at least DIPTUMVU compared to the reference value - the solenoid valve has then actually been activated (suggested values see above).

   Then the pump-current minimum iptglmn_w is searched for. Once the time tdmgl_w has elapsed it is check, whether the given current value ipteskf_w has risen by less than iptsgl_w compared to the detected minimum iptglmn_w (——> rough leak). The measuring time for the rough-leak test tdmgl_w and the threshold iptsgl_w need to be set such that at empty canister (no degassing!) and with a 1.0mm leak installed at the canister (e.g. canister cap) the threshold is still exceeded within TDMTGL.

   If the pump current exceeds the rough-leak threshold iptsgl_w during the rough-leak measurement once the time TDMTGLR has elapsed, the diagnosis ends with a tight message. This time must be adjusted such that at max. canister level (full canister) and tight system, TDMTGLR is less than the time until the reference current iptref_w is reached but greater than TIPTPAMX (otherwise there is a risk that a not activated solenoid valve is not detected).

   If the pump current undershoots the rough-leak threshold, a second reference measurement is performed. In the process the rough-leak threshold is calculated anew. At the end of the reference measurement, the latest value of the current from the rough-leak measurement is compared with the new threshold and thereby a decision is made, whether it is a rough leak.

4. Application of the smallest leak detection:
   The smallest leak detection (B_dmtklm=1, B_dmtke=1) takes place subsequent to the rough-leak measurement. If the reference current iptref_w measured at the beginning is no longer reached, another reference measurement is performed (B_dmtrfm=1), the result of which then finally decides on the tightness of the purge control system. If the reference current is exceeded during the smallest leak diagnosis, the system is regarded as being tight.

   The smallest leak diagnosis can be started manually via the code word CWDDMTL (0 ——> 1) or via ignition resp. engine on/off (CWDDMTL=0). Precondition for the smallest leak diagnosis to be executed is B_dmtlfe = true (manual start, ignition on, no speed), or B_dmtlhe = true (B_dmtfe = true) and TNSTESMN = 0 and TABTESMN = 0 at start of diagnosis via ignition on/off.

   During the smallest leak measurement the following stability criterion is used for the pump-current curve (ipteskf_w):
   If the current ipteskf_w rises by less than DIPTSTAB within the (stability) time TDMTSTAB after the minimum pump time tdmkl_w, the current curve is seen as sufficiently stabilized and the smallest leak measurement is terminated. When the time tdmstba_w is started, the given current value is stored in iptvgl_w. The difference diptgl_w := (ipteskf_w - iptvgl_w) is constantly calculated and compared with the threshold DIPTSTAB. When this threshold is exceeded, the value of iptvgl_w is set to the given current value ipteskf_w and the time tdmstba_w is started anew.

   The minimum pump time must be chosen such that dependent on canister level the final pressure is reliably reached in the canister in case of a 0.5mm leak. During the application of the values for DIPTSTAB, KFTDSTAB and TDMTSTAB, attention needs to be paid that a 0.5mm leak independent of the leak position (canister cap, PCV), independent of the canister level (empty canister, full canister, 50% level) is detected, while a 0.4mm leak is still to be detected as tight system. Here, DIPTSTAB should at least be 2 increments (e.g. 0.3mA). Furthermore it must be ensured that at high temperatures as of a certain degassing of HC in the canister the diagnosis is reliably prevented from taking place and that below this threshold (SFTEDA) a 0.5mm leak can still be detected at above-mentioned conditions.

   (For the reference measurement the same settings apply as with the first one.)

5. Detection of refueling

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The refueling detection consists of two parts: a) Opening of the canister cap (prior to refueling), b) Entering fuel into the canister (actual refueling process). For this, the high-pass filtered pump current ipteskfh_w is examined. The filter time constants ZIPTKTKN and ZIPTESB must have been adjusted accordingly useful for this (suggested values see above). The waiting time TWTEDTA, after which the refueling detection is active, prevents the strong current drop after the switch-over of the valve from already being detected as opening of the canister cap (suggested value see above).

At correct application of the time constant ZIPTKTKN, the high-pass filtered pump current lies within a symmetrical range around 0mA, typically]-1,1[. For application of the thresholds "canister cap open" (DITEDTD, negative value) resp. "refueling" (DITEDTA, positive value) the minimum and the maximum of the high-pass filtered pump current ipteskfh_w of an aged module is determined at idle. The thresholds are now adjusted such that at max. deviation of ipteskfh_w both thresholds are not reached (suggested values see above).

Checking of the thresholds (DITEDTD, DITEDTA) and filter time constant (ZIPTKTKN):
a) When the canister cap is opened during the diagnosis at an excess pressure greater than about 5hPa, the diagnosis is stopped and B_dtetd is set.
b) For the actual refueling detection during the diagnosis, refuel with various volumetric flows (15L/min, 45L/min) starting with empty canister up to full canister. Attention must be paid that at high and low volumetric flow, refueling is detected sufficiently fast and that the fuel nozzle does not switch off!

The maximum pump current is constantly stored during the rough-leak and the fine-leak phase. If the given current drops by DPSF below the maximum current, then the diagnosis is aborted due to detected humidity during the measuring phase. Small fluctuations must be suppressed by entering according data into DPSF. The waiting time TDDPSF must be waited for, since it could be an opening of the canister cap.

DHDMTE 2.10 power stage diagnosis heater DM-TL

FDEF DHDMTE 2.10 Function definition

Diagnosis CJ 940

*) Diagnose CJ400, bzw. CJ920 siehe %DECJ

dhdmte-dhdmte

dhdmte-puls

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(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

The following variables are defined for the fault path of this diagnostic function:

Fault memory management:

Status fault path DHDMTE: SFPDHDMTE
Error flag DHDMTE: E_dhdmte
Cycle flag DHDMTE: Z_dhdmte
Fault type DHDMTE: B_mxdhdmte
B_mndhdmte
B_sidhdmte

Reset fault path: C_fcmclr & B_cldhdmte
Fault path DHDMTE : CDTDHDMTE
Fault class DHDMTE: CLADHDMTE
Fault rate DHDMTE: TSFDHDMTE
Carb Code DHDMTE: CDCDHDMTE
Freeze frame table DHDMTE: FFTDHDMTE

ABK DHDMTE 2.10 Abbreviations

Variable	Source	Type	Description
B_CLDHDMTE		EIN	condition clear fault path DHDMTE
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_FADMTL	T2DMTL	EIN	condition leak detection request
B_FADMTLP	DHDMTE	LOK	generate puls for heater DM-TL in case of start DDMTL by tester
B_HDMTL	HDMTL	EIN	Condition heating DM-TL
B_HDMTTP	DHDMTE	LOK	condition power stage test DMTL-heater turned on
B_MNDHDMTE		EIN	error type: short circuit ground DM-TL heater (power stage)
B_MXDHDMTE		EIN	error type: short circuit Ubat DM-TL heater (power stage)
B_SIDHDMTE		EIN	error type: cable disconnection DM-TL heater (power stage)
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_DHDMTE	DHDMTE	AUS	error flag: DM-TL heater (power stage)
FSP_CLP	DHDMTE	LOK	generate puls for heater DM-TL after clear fault memory
Z_DHDMTE	DHDMTE	AUS	cycle flag: DM-TL heater (power stage)

FB DHDMTE 2.10 Detailed description of function

Together with the CJ400/CJ920 diagnosis %DECJ the heater power stage diagnosis forms a function unit.
The diagnosis describes the forming of the error bit E_dhdmte and of the cycle bit Z_dhdmte.

The setting of the cycle flag is performed for one via an error entry and for the other via a definitely checked not to be due error. This definitate check is given if both switch states of the power stage, i.e. an on-state and an off-state were reached once. If an error is detected an error verification is activated in %DECJ which is performed independent of the external power stage request and which is definitely terminated after approx. 500 ms. Thereafter the the cycle flag is set in case no error occured.

By end of line-test and by clear fault memory a checkpuls is generated to reach on-state for full power satge diagnosis.

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APP DHDMTE 2.10 Application hint

HDMTL 1.20 Heating DM-TL

FDEF HDMTL 1.20 Function definition

hdmtl-main

hdmtl-main

No text for FDEF available!

ABK HDMTL 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWHDMTL			FW	code word for function HDMTL
NGLMHEMX			FW	max. number enable fulfilled for rough leak test
TABTESMN			FW	minimum key off time for evap leakage diagnosis
TMSDMTLU			FW	lower threshold of start temperature of DDMTL

Variable	Source	Type	Description
B_CDDMTL	PROKON	EIN	function enabled per codeword
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_DMDIPTGE		EIN	condition roughleak detection enabled after current fluctuation
B_DMDIPTKE		EIN	condition smallest leak detection enabled after current fluctuation
B_DMKTKE		EIN	condition smallest leak detection enabled after refueling
B_FSTDMN	GGFSTT	EIN	condition minimum fuel level for diagnostic function
B_FSTTG	GGFSTT	EIN	fuel level valid (even during control unit run on)
B_HDMTL	HDMTL	AUS	Condition heating DM-TL
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_STEND	BBSTT	EIN	condition end of start
NGLMHE		EIN	number of rough leak enables after latest rough leak test
TABST_W	BGTABST	EIN	soak time
TMST	GGTFM	EIN	engine temperature at start

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FB HDMTL 1.20 Detailed description of function

APP HDMTL 1.20 Application hint

GGFSTT 1.40 Sensor variable fluid level sensor tank

FDEF GGFSTT 1.40 Function definition

Overview of the function: GGFSTT

ggfstt-main

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Read fuel level: FSTIN

ggfstt-fstin

fuel level quantization

ggfstt-qfstt

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Filling level validation: FSTVAL

ggfstt-fstval

Conditions for tank filling level: BBFST

ggfstt-bbfst

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ABK GGFSTT 1.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
AFSTB			FW	debounce counter fuel tank conditions
CWGGFST			FW	codeword fuel level sensor
FQFSTT			FW	factor quantization fuel level
FSTDMN			FW	minimum fuel level for diagnostic functions
FSTDMX			FW	maximum fuel level for diagnostic functions
FSTDTOL			FW	tolerance fuel level dynamic
FSTHYS			FW	Hysteresis for fuel level tresholds
FSTTAL			FW	Low-fuel level threshold
FSTTAL1			FW	Low-fuel level treshold tank 1
FSTTAV			FW	high level threshold
FSTTEW			FW	fuel level replacement value
FSTTMX			FW	maximum fuel tank capacity
GVTMX			FW	maximum gas capacity fuel tank
TVHALT			FW	delay time after vehicle halt
TVKL15			FW	delay time terminal 15
ZKDFST			FW	time constant fuel level difference-filter
ZKFSTV	VFZG		KL	characteristiv line time constant fuel level filter

Variable	Source	Type	Description
B_FSTDMN	GGFSTT	AUS	condition minimum fuel level for diagnostic function
B_FSTDMX	GGFSTT	AUS	condition maximum fuel level for diagnostic function
B_FSTDY	GGFSTT	LOK	condition dynamic fuel level
B_FSTSTA	GGFSTT	LOK	Condition fuel level after start
B_FSTTEW	GGFSTT	LOK	condition fuel level replacement value
B_FSTTG	GGFSTT	AUS	fuel level valid (even during control unit run on)
B_FSTTSH	GGFSTT	AUS	condition sample/hold fuel level
B_FSTTVAL	GGFSTT	AUS	condition fuel level valid
B_KL15		EIN	condition ignition switch on
B_MNFST	DFSTT	EIN	error type: short circuit to ground fuel level sensor
B_MXFST	DFSTT	EIN	error type: short circuit to Ubat fuel level sensor
B_NPFST	DFSTT	EIN	error type: Fuel level sensor signal not plausibel
B_PWF		EIN	Condition for powerfail
B_SIFST	DFSTT	EIN	Faulttyp: fuel level sensor signal not okay
B_TAL	GGFSTT	AUS	Condition tank empty or reserve
B_TALCAN	CANINS	EIN	condition: tank empty from CAN
B_TALVAL	GGFSTT	AUS	condition ; bit empty tank valid
B_TAV	GGFSTT	AUS	condition fuel tank full
E_FST	DFSTT	EIN	error flag: fuel level
FSTADF_W	GGFSTT	LOK	differential filtered fuel level
FSTT	GGFSTT	AUS	fuel level
FSTTAF_W	GGFSTT	LOK	filtered fuel level
FSTTVAL_W	GGFSTT	LOK	valid fuel level
FSTT_W	GGFSTT	AUS	fuel level
GVTAF_W	GGFSTT	AUS	free gas capacity in fuel tank
RFSTT	GGFSTT	AUS	relative fuel level
RGVTAF	GGFSTT	AUS	relative free gas capacity in fuel tank
TFST	CANINS	EIN	Tank level
TFST2		EIN	fuel level tank 2
TFST2NQ_W	GGFSTT	LOK	fuel level tank2 in standard quantization
TFST2_DEZ	GGFSTT	LOK	dezimal value of fuel level tank 1
TFSTNF_W	GGFSTT	LOK	fuel level after lowpass
TFSTNQ_DEZ	GGFSTT	LOK	
TFSTNQ_W	GGFSTT	LOK	fuel level in standard quantization
TFST_DEZ	GGFSTT	LOK	dezimal value of fuel level tank 1
TFST_W	GGFSTT	LOK	Tank level
VFZG	GGVFZG	EIN	vehicle speed (km/h)
ZKFSTF	GGFSTT	LOK	time constant fuel level filter

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FB GGFSTT 1.40 Detailed description of function

Task:
=======
Provision of the fluid level in the fuel tank and the conditions that depend on this fluid level.

Overview of FSTIN:
==========
The function blocks and the tasks of these are as follows:

- FSTIN: read in the fuel level signal
- QFSTT: requantizytion to the platform quantizytion
- FSTVAL: Calculation of the Sample/Hold conditions as well as provision of a validation bits
- BBFST: Provision of the fluid-level conditions

Explanatory notes on GGFSTT:
The lowpass filtering to which a time constant depending on the vehicle’s speed has been applied, ensure the first smoothing of the fluid-level signal. This is only necessary, if there is no adequate filtering executed by the dashboard.
The lowpass filtering is deactivated by using Codeword CWGGFST(bit 1).

In case of an CAN fault the B_fsttew bit switchs over the fuel level to a replacement value. The fault bit E_fst switchs over the fuel level state bits B_fsttval and B_fsttsh and all other fuel level bits (B_fstdmn, B_fstdmx, B_tal, B_tav) to the state "false". Because of this it is sure that all diagnostic functions are executed though there is a fuel level fault.

ATTENTION:
==========
The fuel level signal - which is available on the CAN - must not be calculated or modified with the fuel consumption.
The typ of calculation of the fuel level must be known.
==========

Explanatory notes on QFSTT:
This subfunctions task is to produce independece of customer CAN quantizytions. The label FQFSTT contains the incoming quantizytion and tfst_dez is the number of the increments with builds together with this quantizytion the physical value tfst (e.g. tfst = 10 Liter with FQFSTT = 0.5 L/inc. ==> tfst_dez = 20).
Hence tfstnq_dez is the number of increments witch builds together with the platform quantizytion (0.1 L/inc.) the physical value of tfst (e.g. 0.5/0.1 = 5 ==> tfstnq_dez = 20 * 5 = 100).
After multiplication with the platform quantizytion 0.1 L/inc. there is the result tfstnq_w = 10 L. The application is easy to prove: tfst and tfstnq_w must be equal.

Explanatory notes on FSTVAL:
Changes in the fluid level that are caused during the start-up process, by the driving dynamics, or similar circumstances shall be suppressed by a Sample and Hold procedure. To this end, the signal already filtered by the lowpass is supplied to further DT1 filtering.
If a change in the fluid level is detected that is greater than the applicable threshold FSTDOL, then the fluid level magnitude is held at the last value by using the condition (B_fsttsh = false).
If the change in the fluid level falls below the threshold FSTDTOL (B_fsttsh = true) depending on the DT1 time constant applied by using the factor FZKDFST, then transfer of the fluid-level value in the 100-ms time frame is permissible.
The lowpass filtering is activated by using Codeword CWGGFST(bit 2).

The tank fluid level is principally only valid following elapse of a waiting time after TVKL15 has turned on the power supply.
This makes allowance for any oscillations in the fluid-level sensor signal. The validation bit B_fstval is "cancelled" by a switchover to the standby value and is only reset again for a "rectified" signal fault and once the fluid level has stabilized again.

Explanatory notes on BBFST:
The fluid level is compared with the applicable thresholds for "Tank full" FSTTAV, "Tank empty" FSTTAL, as well as with the thresholds for the diagnostic functions FSTDMX and FSTDMN.
The results from the comparison are not debounced according to the time but rather by counters that can only then change their counter values when the fluid-level signal is sampled (B_fsttsh = true).
Evaluation of a signal "held" over a longer period of time is prevented by this.

Overview of codeword CWGGFST:

```
| 7 | 6 | 5 | 4 | 3 | 2 | 1 |  0 |

                                  = "1" Changeover to two-tank-system
                                = "1":  Lowpass filtering of the incoming signal
                              = "1": DT1-filterfng and sample and hold of the signals

                            = "1": Changeover to  CAN-Message "tank empty"
                          ="1": Changeover to B_talval and B_tal processed with tfst
```

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APP GGFSTT 1.40 Application hint

```
Prerequites
================
fuel - level in CAN-Message present
%DFSTT: E_fst

Pre-assignment of parameters:
==========================
Codeword:(If the signal is adequately processed by the instrument cluster)
                CWGGFST(1) = "0"
                CWGGFST(2) = "0"

Chracteristic:ZKFSTV
                vfzg    0     5     10      300  [km/h]
                zkfstf  2    10     50       50  [s]

Standby value:FSTTEW
                FSTTEW = 0.0 [L]

Time constant DT1-filter: ZKDFST
                ZKDFST = 20 [s]

Tolerance in sampling:
                FSTDTOL = 0.2 [L/dt]
Waiting time terminal 15
                TVKL15 = 5.0 [s]
Hysteresis
                FSTHYS = 1.5 [L]

other Labels:
AFSTB = 20
FSTTMX = depends on vehicle typ
GVTMX = depends on vehicle typ
FSTDMN = 15% max. volume fuel canister
FSTDMX = 85% max. volume fuel canister
FSTTAL = customer demand
FSTTAV = customer demand
FSTTAL1 = customer demand
FQFSTT = depends on prefunction


Method of proceeding:
=====================
The fuel level signal should be monitoring during different driving, vehicle halt and refuelling situations.
Particularly pay attention to the behaviour of the fuel level signal in the upper and lower fueltank filling.
PT1/DT1 - filtering
The filteralgorithm of the function only should be used, if there is no filtering executed by the instrument.
Delay-times:
TVHALT:
After this delay time the DT1-filter switches to the faster time constant of the PT1-filter.
This makes sure, that there is a shorter sample time but still only stanionary fuel levels are used.
TVKL15:
Particularly pay attention to the fuel level signal executed by the instrument. After this time the fuel level signal and all CAN
bits must be in a validated state.


Functions influenced:
=========================
%DFSTT: Diagnostics for fluid level in the tank
```

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DFSTT 1.40 Diagnostics for fluid level sensor tank

FDEF DFSTT 1.40 Function definition

Overview: DFSTT

dfstt-main

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Initialize diagnosis: DFSTTINI

dfstt-dfsttini

distance debounce for low range: LOWR

dfstt-lowr

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detect refuelling:TANKERK

dfstt-tankerk

detect refuelling during ignition on: IGNON

dfstt-ignon

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read fuel level if vehicle halts:LEVELIN

dfstt-levelin

dfstt-levelin

detect refuelling after ignition off: IGNOFF

dfstt-ignoff

dfstt-ignoff

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set refuelling flag: SETFLAG

dfstt-setflag

dfstt-setflag

Diagnosis fuel level sensor: DFSTKV

dfstt-dfstkv

dfstt-dfstkv

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Enable diagnosis and output fault path: DFSTEN

dfstt-dfsten

electrical fault path: DFSTTSIG

dfstt-dfsttsig

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ABK DFSTT 1.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWFSTD			FW	codeword fuel level diagnostic
DFSKVO			FW	fuel level sensor diagnostic high threshold
DFSKVU			FW	fuel level sensor diagnostic low threshold
DKVBD			FW	consumed fuel diagnostic threshold
SLOWRMX			FW	maximum distance since low range active
TANKABN			FW	minimum fuel level decrease for refuelling diagnostic
TANKMN			FW	minimum fuel in for refuelling diagnostic
TFSTNP			FW	fuel level plausible treshold
TVFSTD			FW	delay time fuel level sensor diagnostic
TVHATA			FW	delay time before refuelling - cycle

Variable	Source	Type	Description
B_CDFST	PROKON	EIN	fuel level sensor diagnostic enable
B_DFSKVO	DFSTT	LOK	condition fuel level diagnostic high threshold
B_DFSKVU	DFSTT	LOK	condition fuel level diagnostic low threshold
B_DTANKM	DFSTT	LOK	condition refuelling possible
B_FSTCANOK	CANINS	EIN	CAN: Condition fuel level message okay
B_FSTCLR	DFSTT	LOK	condition clear fuel level diagnostic
B_FSTDAKT	DFSTT	LOK	condition fuel sensor rationality check enable
B_FSTINI	DFSTT	LOK	condition fuel level diagnostic initialize
B_FSTLOWR	DFSTT	LOK	condition fuel level diagnostic interrupt cause of low range
B_FSTSIGF	DFSTT	LOK	condition fuel level signal error
B_FSTTAB	DFSTT	LOK	condition fuel level decrease while ignition on
B_FSTTD	DFSTT	AUS	condition fuel level sensor diagnostic active
B_FSTTDEN	DFSTT	LOK	condition fuel level sensor diagnostic enable
B_FSTTIN	DFSTT	AUS	condition read fuel level
B_FSTTSH	GGFSTT	EIN	condition sample/hold fuel level
B_FSTTVAL	GGFSTT	EIN	condition fuel level valid
B_FSTTZU	DFSTT	LOK	condition fuel level increases while ignition on
B_KVBD	DFSTT	LOK	condition consumed fuel threshold for diagnostic
B_KVTA	BGKV	EIN	condition consumed fuel larger then tank capacity
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_MNFST	DFSTT	AUS	error type: short circuit to ground fuel level sensor
B_MXFST	DFSTT	AUS	error type: short circuit to Ubat fuel level sensor
B_NPFST	DFSTT	AUS	error type: Fuel level sensor signal not plausibel
B_PWF		EIN	Condition for powerfail
B_SIFST	DFSTT	AUS	Faulttyp: fuel level sensor signal not okay
B_TANK	DFSTT	AUS	condition refuelling
B_TANKAB	DFSTT	LOK	condition fuel level decrease
B_TANKDY	DFSTT	LOK	condition fuel level dynamic during refuelling
B_TANKEND	DFSTT	LOK	condition refuelling end
B_TANKG	DFSTT	AUS	condition refuelling bit valid
B_TANKZU	DFSTT	LOK	condition fuel level increase
B_TFST2OK		EIN	CAN: fuel level signal sensor 2 okay
B_TFSTOK		EIN	CAN: fuel level signal sensor 1 okay
DFSKV_W	DFSTT	LOK	difference consumed fuel - fuel level difference
DFSTIGOF_W	DFSTT	LOK	difference fuel levels after restart
DFSTIGO_W	DFSTT	LOK	difference fuel lvels during vehicle halts
DFSTT_W	DFSTT	LOK	difference fuel levels
DKVBIGO_W	DFSTT	LOK	fuel consumption during vehicle halts
DKVB_W	DFSTT	LOK	difference consumed fuel
E_FST	DFSTT	AUS	error flag: fuel level
FSTAKT_W	DFSTT	LOK	current fuel level
FSTALT_W	DFSTT	LOK	last fuel level before ignition off
FSTHIN_W	DFSTT	LOK	fuel level during vehicle stops
FSTNEU_W	DFSTT	LOK	first fuel level after ignition
FSTTIN_W	DFSTT	LOK	fuel level initialized for diagnostic
FSTT_W	GGFSTT	EIN	fuel level
KVBADD_W	DFSTT	LOK	consumed fuel in last driving cycle
KVBAKT_W	DFSTT	LOK	current consumed fuel
KVBRES_W	DFSTT	LOK	consumed fuel at diagnostic reset
KVB_W	BGKV	EIN	consumed fuel
SLOWR_W	DFSTT	LOK	driven distance since low range active
TFST	CANINS	EIN	Tank level
VFZG	GGVFZG	EIN	vehicle speed (km/h)
Z_FST	DFSTT	AUS	cycle flag of fuel level

FB DFSTT 1.40 Detailed description of function

```
Motivation:
===========
A plausibility check of the tank fluid-level signal is necessary for various number of diagnostic functions as well as detection of
the tank-fuelling process.

Task:
=======
The function %DFSTT has the following tasks:
                        - Detection of tank-filling tasks (both when the ignition is turned as well as when this switched on again)
                        - Plausibility check of the fluid-level signal by means of a fuel consumption calculation
                        - Diagnosis of the fluid-level signals for electrical faults
Overview:
```

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==========
The function %DFSTT is made up of the following sub-functions:
- DFSTTINI: Initialization of the diagnostics variables depending on each state (refuelling process, etc.)
- TANKERK : Detection of tank-fuelling processes for a power supply permanently on (IGNON) and after a power supply has been switched on again for the fluid-level sensor (IGNOFF).
- DFSTKV : Plausibility check of the fluid-level sensor signal by using the calculation variable: "consumed fuel" kvb_w
- DFSTEN : Diagnostics enable and description of the fluid-level sensor fault path by the result of the plausibility check
- DFSTTSIG: Description of the fault path by the result of the electrical-signal diagnosis
- FCMCLR : Initialization of the diagnostics memorys on "clear fault path memory"
- INITIALIZE: Initialization of all variables on controller initialization or power fail

Principle of refuelling detection:
==========
Refuelling when the ignition is on:
==========
For a stationary vehicle, the possibility must principally be taken into consideration that a tank-fuelling process can take place. The bit B_dtankm is set to this end when the vehicle speed equals zero following elapse of a waiting time (TVHATA) and the fluid level in the tank has been validated. When setting the fuelling possibility, the fluid level is read (fsthin_w) and after this time continually compared with the current fluid level (fstakt_w).
The fuel level from the beginning of the monitoring (fsthin_w) is continually being corrected with the fuel consumption till this point. If the difference between this corrected starting fluid level (fsthin_w) and the actually fluid level (fstakt_w) exceeds the applicable threshold TANKMN, then a fuelling process is concluded and the bit B_tankdy is set. The plausibility check is blocked when this condition is set. If the fuel is tanking off during vehicle standing, this state is displayed by comparing the fluid level with the treshold TANKABN and setting the refuelling bit B_tankdy.

If the vehicle is set in motion, the bit B_tankdy is set and if the fliud level has been detected as being valid, then the bit B_tankende ist set in order to initialize the plausibility check for the fluid-level sensor again. The bit for the end of refuelling is cancelled the next time the vehicle is at a halt.

No statemant about a vehicle halt can be make if a vehicle-speed error is detected. Because of this the bit B_tankdy and the fuel level ram is setting back to zero. In this case the function is stoped by the bit B_fsttden, too.

Fuelling when the ignition is off:
==========
Basic principle for a diagnostic routine when the ignition is off is the fluid level fstalt_w described in the continuously running permanent RAM.
The last fluid level of the driving cycle is contained in this variable when the ignition is switched off. If the fluid level has been validated for the first time when the ignition is switched on again, then this new value (fstneu_w) is compared with the value stored in the permanent RAM.
The refuelling bit B_tank is set if the difference lies above an applicable threshold (TANKMN).
This refuelling detection may not be executed in the event of B_pwf and the presence of a fault previously set for the A/D signal.
The removal of fuel is indicated by B_tankab.
In the case of "delete error fault path" - demand the ramcells fstneu_w and fstalt_w are written at the same time with the fuel level. Therefore the refuelling detection is suppressed.

The refuelling bit is set as well if the fuel consumption calculated in the function (%BGKV) exceeds the volume of the tank.
It must be assumed in this case that the fuelling process has not been detected on account of smaller refuelling quantities or for similar reasons.

Principle: Plausibility check of the fluid-level sensor signal on the basis of the fuel consumed
==========
Initialization of diagnostics parameters (DFSTTINI):
The fuel consumption given from the fluid level values is compared with the calculated fuel consumption for the plausibility check of the fluid-level signal.
An fluid level must be read in for initialization of this comparison routine and the integration of the consumption must be reset to zero at the same time.
Reading in the new value (fsttin_w) and the resetting of the consumption integration (kvbres_w) must taken place if

- refuelled	(B_tankzu)
- fuel has been removed from the tank	(B_tankab)
- for refuelling when the engine was running	(B_tankende)
- a power fail was present	(B_pwf)
- there was an electrical failure	(B_fstsigf)
- the fuel consumed is greater than the tank volume	(B_kvta)
- the consumption diagnostic mark was been reached	(B_kvbd)
- Clear error path demanded	(B_clfst)

Is one these states true, then the diagnostic value of the fuel consumption (kvbakt_w) is setting to zero because of the difference with kvbres_w. The consumption integration is initialized with the value determined for the fuel consumed (kvbadd_w) during the last driving cycle when the power supply is switched on.
The quantity of fuel must be stored (kvbadd_w) for short trips where the amount of fuel consumed is not sufficient for reading out the diagnosis, and this value is taken as the initial value for consumption integration for the next drive.
Hence the plausibility check of the tank fluid-level signal using the fuel consumed can extend over several drives.
The bits B_clfst and B_kvta can be setting true while the fuel level is not valitated or is not sampled. Hence the initializing of the plausibility check must waiting for setting the Flipflop B_fstclr, because of sampling the fuel level B_fsttsh.

Plausibility check (DFSTKV):
If the calculated fuel consumption (kvbakt_w) reaches an applicable threshold DKVBD, then - in case the fluid level is sampled and there is no fuelling process - the difference between the calculated fuel consumption and the fluid-level difference is compared with the thresholds DFSKVU and DFSKVO.
The difference between both consumption values may exhibit a certain tolerance (DFSKVU < dfskv_w < DFSKVO).
This tolerance is due to
- circumstances that apparently change the fluid level (e.g. vehicle position at an inclination, hill drives)
- the resolution and tolerance of the fluid-level signals (incl. fluid level characteristic)
- Tolerances in the fuel consumption calculations.

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The tolerances within which the diagnostic parameter dfskv_w may move, must of course be smaller than the consumption threshold DKVBD.
It is assured by this selection of the consumption threshold that the fluid-level sensor indicates a smaller value at the point in time of the diagnosis than at the start of the diagnostic routine.

The consumption integration is restarted following completion of this comparison (see above), and the diagnostic routine starts again from the beginning.

Principle diagram:

```
              Liter
                 |
                 |****                        |
                 |    *****                   |
                 |         *****              |  fuel consumption from fluid level as follows: dfstt(t1) = fstt(t0) - fstt(t1)
                 |              *********     |                  |
                 |                       ***  |                  |
                 |                            |                  |
                 |                            |                  |
                 |                            |                  |——>  kvbakt(t1) - dfstt(t1) = dfskv(t1)
                 |                            |                  |     Compare: DFSKVU < dfskv(t1) < DFSKVO
                 |                            |                  |
                 |                   ———————  |                  |
                 |         ————————————       |  Calculated fuel consumption:  kvbakt_w(t1)= DKVB + x
                 |  ———————                   |
                 |+---------------------------|-----------------------
                 t0                           t1                      Time

                 , whereby the point in time t1 is determined by the quantity of fuel that is consumed
```

The plausibility check must be activated by the code word CWFSTD (bit 0 = "1").
==========

DFSTEN:
========
If there is no electrical signal fault present, then the fault path FST (signal not plausible) is described by detection of a sensor fault. The cycle bit of the fault path is otherwise set when the diagnostic mark for the consumption is reached.
The diagnostic routine can be aborted (B_cdfst = false) by the enable condition B_cdfst; all faults are reset and the cycle bit for the fault path is set.
Fault type:
B_npfst : fuel level sensor is noz plausible
internal fault type:
B_dfskvo: dkvb_w - dfstt_w > DFSKVO
Example: fuel consumption dkvb_w = 12.1 Liter, threshold DFSKVO = 10.0 Liter
==> fuel level sensor must be moved down at least 2.1 Liter
==> error if dfstt_w < 2.1 Liter
B_dfskvu: dkvb_w - dfstt_w < DFSKVU
Example: fuel consumption dkvb_w = 12.1 Liter, threshold DFSKVU = -10.0 Liter
==> fuel level sensor must be moved down at most 22.1 Liter
==> error if dfstt_w > 22.1 Liter

Set cycle flag with:
B_fsttd

Debounced with:
consumption threshold DKVBD

DFSTTSIG:
========
The fault signals are - following a debounce time - switched to the corresponding types of faults.
It is to be noted that the electrical diagnosis sets the cycle flag only in case of CWFSTD = false or an electrical error.
Fault type:
B_mnfst : fault in fuel level signal tank2
B_mxfst : fault in fuel level signal tank1
B_sifst : fault in CAN message
Set cycle flag with:
- B_fsttd, if there is CAN-fault and the codeword CWFSTD(0) is true
- the ufst_w comparison, if there is a CAN-fault or there is a CAN-fault and the codeword CWFSTD(0) is false
Debounced with:
time TVFSTD

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APP DFSTT 1.40 Application hint

Prerequisites:
==========
- Function: Calculation parameter consumed fuel %BGKV
- Function: Sensor parameter fluid level tank %GGFSTT
- Knowing the maximum deviation by the fluid-level parameter from the actual fluid level for inclined positions of the vehicle about the longitudinal and traverse axes
- Knowing the minimum resolvable fluid-level differences resulting from a fuelling process in all (!) fluid-level ranges for the tank.

Pre-assignment of the parameters:
==========
Knowing the maximum deviations in the fluid level of the tank resulting from an inclined position of the vehicle and/or vehicle dynamics, serves to specify the tolerance limits for the plausibility check of the sensor signal. If the limits for the tolerances are selected to be too close together, then an inclined position of the vehicle can be interpreted as a fault in the fluid-level sensor or as a fuelling process.
If the tolerance limits are selected to be too large, then the consumption threshold must also be selected to be very large as well as a result of this.
In certain cases, the consumption threshold is close to the maximum volume of the tank and hence a plausibility check is never possible in certain circumstances.

	Parameter	value to be pre-assigned
Enabling the diagnostic routine	CDEFST	1 in %Prokon

Switch on the plausibility check:
codeword CWFSTD:

7	6	5	4	3	2	1	0

- 0: = "1" : Switch on plusibility check
- 1: = "1" : use CAN-bit B_tfstok
- 2: = "1" : use CAN-bit B_tfst2ok
- 3: ="1" use tfst: fuel level signal ok.

at least	CWFSTD(0):	1
	SLOWRMX	20 [m]

Plausibility-check tolerances	DFSKVU:	less than -10 [L]
	DFSKVO:	greater than 10 [L]
	DKVBD:	greater than the maximum of |DFSKVU| and DFSKVO

Fuelling tolerances:	TANKABN	-5	[L]
	TANKMN	5	[L]
	TVFSTD	5	[s]
	TVHATA	10	[s]

Method of proceeding:
==========
On the one hand it must be avoid, that the refuelling bit is set to often and on the other hand a refuelling must bei certainly detected.
Before starting up the function, the following special cases are to check:
- refuelling with ignition on with a spare canister
- monitoring the fuel level in extrem inclined vehicle positions
- refuelling with ignition on and switch off ignition during the refuelling

Functions influences:
==========
Not yet clarified.

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BGKV 1.20 Calculation variable consumed fuel

FDEF BGKV 1.20 Function definition

Overview of the function: BGKV

bgkv-main

ABK BGKV 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FSTTMX			FW	maximum fuel tank capacity
KUMSRL			FW	conversion constant from mass flow to relative air charge
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
SY_ZYLZA			SYS (REF)	system constant number of cylinders

Variable	Source	Type	Description
ANZTI	CIFINA	EIN	injection counter
ANZTID	BGKV	LOK	difference between injection counters in the calculation matrix
B_KVTA	BGKV	AUS	condition consumed fuel larger then tank capacity
KVB_W	BGKV	AUS	consumed fuel
RK2_W	MSF	EIN	relative fuel mass Bank2
RKTE_W	TEB	EIN	relative fuel part of the purge control
RK_W	MSF	EIN	relative fuel mass
VSKS_W	BGKV	AUS	fuel volume flow

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FB BGKV 1.20 Detailed description of function

Motivation:
==========
The quantity of fuel used up is needed for diagnosis of the fluid-level sensor in the tank with respect to the consumption.
The value for the amount of fuel consumed can also be used as consumption information for the driver.

Task:
=======
Calculation of the fuel consumed, whereby the integration can only then be reset when the quantity of fuel consumed is the same as the tank contents.

Principle:
==========
The relative quantity of fuel injected rk_w is totaled together with the quantity of fuel from the tank ventilation rkte_w following a conversion of this into a volume.
The total of the fuel masses rk_w and rk2_w calculated in synchronization is carried out in the 100-ms time frame. To do this, the difference is formed from the injection counter anzti from the last 100-ms mark and multiplied by the current value from rk_w.
For a two-bank system, the fuel consumed is calculated from the mean value from both of the relative fuel masses rk_w and rk2_w.

The conversion of the relative fuel mass rk_w to the magnitude of the fuel consumed kvb_w is realized by multiplication of a constant conversion factor (0.00300342) and KUMSRL/cylinder number.

Physical relationship of the conversion factor:
==========
Initially it applies that:
KUMSRL = VH [dm^3] / 2578 = engine displacement volume / 2578

The conversion factor is then given from the definition for rk_w:

$$\text{kvb_w / rk_w} = \text{Fuel consumed / rel. fuel mass} = \frac{\text{Air density * Cylinder displacement volume}}{\text{Fuel density * A/F ratio lambda 1.0 * 100\%}} =$$

$$\frac{\text{rho0air [g/dm^3] * KUMSRL[dm^3]/cylinder no. * 2578}}{\text{rho0KS [g/dm^3] * LST * 100 [\%]}}$$

using the values:
rho0air = 1.293 [g/dm^3]
rho0KS = 755.0 [g/dm^3]
LST = 14.7
it is given that: rk_w[%] * 0.00300342[1/%] * KUMSRL [L] /ZYLZA = kvb_w [L]

A value in liters should be given as the output variable of the function for the fuel consumed during the current driving cycle.
The totalizer shall not overrun and is only then reset when an applicable mark KVBMX is reached.
FSTTMX is thereby the maximum possible volume of fuel consumed during a driving cycled. This maximum volume should be the maximum tank quantity.

Remarks on ASCET-SD diagram
==========
a)
The function with the remark "delta one step" realizes the following function in accordance with the name assigned for this:
anztid(t) = anzti(t) - anzti(t-1)
if t is discrete time variable.
b)
The switching design according to "delta one step" shall support the overrun function of the anzti counter.

APP BGKV 1.20 Application hint

For the application,
- the maximum tank quantity must be entered in FSTTMX

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LRAEB 5.40 Conditions adaptive pilot control

FDEF LRAEB 5.40 Function definition

lraeb-lraeb

ABK LRAEB 5.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TARA			FW	temperature threshold intake air
TMRAA			FW	cut-in temperature adaptive precontrol for lambda closed-loop control
TVLRA			FW	delay time for activation of the lambda adaption after lambda control active
WDKARN	NMOT		KL	threshold throttle angle for activation of the mixture adaptation

Variable	Source	Type	Description
B_AUAKT	PROKON	EIN	condition emission check active
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_DTEST		EIN	condition for start of TEV opening
B_ESNWS	ESNWS	EIN	Condition mixture factor with camshaft adjustment
B_FA		EIN	condition general function request
B_FAKVS		EIN	condition function request diagnoses fuel supply system
B_FALRA		EIN	condition: requirement adaption open loop
B_GAP	GKEB	EIN	condition mixture adaptation phase active
B_GASP	LRAEB	AUS	condition for basic mixture adaptation disabled
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRA	LRAEB	AUS	condition for basic mixture adaptation enabled
B_LRA2	LRAEB	AUS	condition for basic mixture adaption 2 enabled
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_SLS	SLS	EIN	Condition for active secondary air
B_TE	TEBEB	EIN	Condition canister purge active
B_UKG	ESUK	EIN	condition transient control activated
B_VL	MSF	EIN	Condition for wide open throttle
E_BM	DDG	EIN	error flag: reference mark sensor
E_DK	GGDVE	EIN	Error flag: throttle position sensor
E_DVEU	BGDVE	EIN	Error flag: DV-E cause of failure: UMA-learning
E_LM	DHFM	EIN	Error flag: main load sensor
E_TA	GGTFA	EIN	error flag: TANS
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_UB	GGUB	EIN	error flag: power supply voltage UB
NMOT	BGNMOT	EIN	engine speed
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TANS	GGTFA	EIN	Intake air temperature
TMOT	GGTFM	EIN	Engine temperature
WDKBA	GGDVE	EIN	throttle angle

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FB LRAEB 5.40 Detailed description of function

Remarks concerning stereo lambda control:

- This FDEF is intended for systems with stereo lambda control.
- The stereo variables are identified by the suffix 2 (e.g. B_lra -> B_lra2).
- The FDEF is also fully applicable for mono systems. In this case B_lr2 = FALSE. And thus B_LRA2 = FALSE.
- At a Mono system (SY_STERVK) = FALSE B_lra2 is automatically set to FALSE.

Description of the function LRAEB:

- The function LRAEB provides the cut-in conditions for adaptations and the bit "mixture adaptation disabled" (B_gasp).
- For stereo systems the cut-in conditions are separate for each bank (B_lra, B_lra2).

Bit B_gasp:
A series of OBDII errors prohibit mixture adaptation (E_...) . Adaptation is also prohibited at high intake air temperatures (tans>=TARA) . These disable conditions are compiled in the flag B_gasp. When B_gasp = true the system should switch to permanent purging. This is taken into account in the relevant phase control or canister purge module.

Other cut-in conditions:
As long as B_gasp = false, mixture adaptation is only ever enabled if for the time TVLRA the engine temperature was above the threshold TMRAA; lambda control with closed TEV (B_te = FASLE) was uninterrputed active, (B_lr/B_lr2 = true & NOT B_te); the basic adaptation phase was there (B_gap = true); no condition low range (B_lowra = true); no full load (B_vl = false) and no function / diagnosis function was running to prohibit adaptation (e.g. secondary air injection (B_sls), secondary air diagnosis (B_dsls) or canister purge diagnosis (B_dtest)).

The learning of the mixture adaptation is prohibited by B_ukg = TRUE at least for the time TVLRA in order to avoid an error in diagnosis %DKVS due to a strong effect from transient control.

If an off-bord tuning of the exhaust emission occur, the LRA should be stopped.

If the throttle valve is fully, or almost fully open, no adaptation may occur. In this case the load signal may be falsified by pulsations. Above the throttle valve threshold WDKARN adaptation is disabled for this reason. WDKARN is an engine-speed-dependent characteristic.

By a function request of diagnosis supply system is stopped the LRA. The output of integrators is set to netraul value (see %LRA).

APP LRAEB 5.40 Application hint

TMRAA: Cut-in threshold for engine temperature. LRA must always be able to be active in the large peak (FTP75). Warm running must be controlled. TMRAA: 50 - 70 ° C
TARA: Cut-off threshold for high intake air temperatures: project-specific: above 60 - 100 °C
TVLRA: Cut-in delay after tatei = 0 and B_lr (B_lr2) = TRUE. Avoids erroneous adaptations when idle control not yet stabilised, e.g. after purge operation or deceleration cut-off. Value: 1 - 4 s
WDKARN: Erroneous adaptations in the pulsation range must be avoided at all costs. Set WDKARN a few percent below the pulsation range.
Remark: The threshold TLWARN (or TLARN) familiar from earlier FDEFs can be converted into WDKARN.

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LRA 117.10 Lambda closed loop control; Adaptive pilot control

FDEF LRA 117.10 Function definition

LRA : Calculation of the adaptation corrections and of their activation and reset conditions (bank 1 and 2)

lra-lra

BBLRA : Definition of the learning ranges, calculation of the activation and reset conditions

lra-bblra

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LRAINT : Calculation of the adaptation corrections frao_w, frau_w, rkat_w and rkaz_w

lra-lraint

lra-lraint

INTFRAU : Calculation of the lower multiplicative adaptation correction frau_w

lra-intfrau

lra-intfrau

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INTRKAT : Calculation of the additive adaptation correction per time rkat_w

lra-intrkat

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INTRKAZ : Calculation of the additive adaptation correction per ignition rkaz_w

lra-intrkaz

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INTFRAO : Calculation of the upper multiplicative adaptation correction frao_w

lra-intfrao

ABK LRA 117.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FRAOMN			FW	lower limit of correction factor frao
FRAOMX			FW	upper limit of correction factor frao
FRAORN			FW	reduced lower threshold for frao correction
FRAORX			FW	reduced upper threshold for trao correction
FRAUMN			FW	lower limit of correction factor frau
FRAUMX			FW	upper limit of correction factor frau
FRAURN			FW	reduced lower threshold for frau correction
FRAURX			FW	reduced upper threshold fpr frau correction
MLO1			FW	upper air-quantity threshold range 1
MLO2			FW	upper air-quantity threshold range 2
MLO3			FW	upper air-quantity threshold range 3
MLU2			FW	lower air-quantity threshold range 2
MLU4			FW	lower air-quantity threshold range 4
N0			FW	conversion constant for calculation the mixture correction rkat
NO1			FW	upper engine-speed threshold range 1
NOLRA			FW	codeword for release of adaptation
NRKAB			FW	minumum engine speed for limitation rkat correction
NU3			FW	lower engine-speed threshold range 3
RKATMN			FW	lower threshold of additive correction per time
RKATMX			FW	upper threshold of additive correction per time
RKATRN			FW	reduced lower threshold of additive correction per time
RKATRX			FW	reduced upper threshold of additive correction per time
RKAZMN			FW	lower threshold of additive correction per ignition
RKAZMX			FW	upper threshold of additive correction per ignition
RKAZRN			FW	reduced lower threshold of additive correction per ignition
RKAZRX			FW	reduced upper threshold of additive correction per ignition
RLO2			FW	upper load threshold of range 2
RLO3			FW	upper load-signal threshold range 3
RLU2			FW	lower load-signal threshold range 2
RLU3			FW	lower load-signal threshold range 3
RLU4			FW	lower load threshold of the upper multiplicative section
ZKFRAOA	ABO		KL	time constant for frao-integrator, f(number of starts with fuel in oil)
ZKFRAUA	ABO		KL	time constant for frau-integrator, f(number of starts with

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Parameter	Source-X	Source-Y	Type	Description
ZKRKATA	ABO		KL	integration speed integrator rkat, f(abo)
ZKRKAZ			FW	integration speed integrator rkaz

Variable	Source	Type	Description
ABO	BBBO	EIN	numbers of starts with fuel in oil
B_ABOR	BBBO	EIN	condition numbers of starts with fuel in oil for reduced adaptive lambda control
B_CLFRAO		EIN	condition clear failure path FRAO (upper multipl. section)
B_CLFRAO2		EIN	condition clear failure path FRAO2 (stereo)
B_CLFRAU		EIN	condition clear failure path FRAU (lower multipl. section)
B_CLFRAU2		EIN	condition clear failure path FRAU2 (stereo)
B_CLRKAT		EIN	condition clear failure path RKAT (add. per time)
B_CLRKAT2		EIN	condition clear failure RKAT2 (stereo)
B_CLRKAZ		EIN	condition clear failure RKATZ (add. per ingnition)
B_CLRKAZ2		EIN	condition clear failure path RKAZ2 (stereo)
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_FA		EIN	condition general function request
B_FAKVS		EIN	condition function request diagnoses fuel supply system
B_FRAO	LRA	AUS	condition for enabling adaption of frao
B_FRAOR	LRA	AUS	condition frao-integrator outside reduced thresholds
B_FRAOR2	LRA	AUS	condition frao2-integrator outside reduced thresholds
B_FRAU	LRA	AUS	condition enable adaptation of frau
B_FRAUR	LRA	AUS	condition frau-integrator outside reduced thresholds
B_FRAUR2	LRA	AUS	condition frau2-integrator outside reduced thresholds
B_LRA	LRAEB	EIN	condition for basic mixture adaptation enabled
B_LRA2	LRAEB	EIN	condition for basic mixture adaption 2 enabled
B_LRAR	TEB	EIN	condition for reducted correction ranges at LRA
B_LRARE	LRA	AUS	condition reset of mixture adaptation
B_LRARE2	LRA	AUS	condition reset of mixture adaptation bank 2
B_LRAREB	LRA	LOK	condition reset readiness of mixture adaptation
B_LSVVSP	DLSVV	EIN	condition for exchange lambda sensor; lambda control stopped
B_NOFRA	LRA	AUS	condition no fra adaptation active
B_NORKAT	LRA	AUS	condition additive correction of the mixture adaptation switched off
B_NORKAZ	LRA	AUS	condition additive correction of the mixture adaptation switched off
B_RKAT	LRA	AUS	condition adaptation area rkat active
B_RKATR	LRA	AUS	condition rkat-integrator outside reduced thresholds
B_RKATR2	LRA	AUS	condition rkat2-integrator outside reduced thresholds
B_RKAZ	LRA	AUS	condition adaptation area rkaz active
B_RKAZR	LRA	AUS	condition rkaz-integrator outside reduced thresholds
B_RKAZR2	LRA	AUS	condition rkaz2-integrator outside reduced thresholds
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DFRM2_W	LRA	LOK	deviation of fast lambda controller mean value from 1.0 (Word), bank 2
DFRM_W	LRA	LOK	deviation of fast lambda controller mean value from 1.0 (Word)
FRA2_W	LRA	AUS	multiplicative correction of the mixture adaptation (word)
FRAO2_W	LRA	AUS	multipl. mixture adaptation factor higher load bank 2 (Word)
FRAO_W	LRA	AUS	multipl. mixture adaptation factor higher load (word)
FRAU2_W	LRA	AUS	multipl. mixture adaptation factor of the lower mult. section of bank 2 (Word)
FRAU_W	LRA	AUS	multipl. mixture adaptation factor of the lower mult. section (Word)
FRA_W	LRA	AUS	multiplicative correction of the mixture adaptation (word)
FRM2_W	LR	EIN	fast mean value of lambda control factor bank 2(word)
FRM_W	LR	EIN	fast mean value of lambda control factor (word)
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	BGNMOT	EIN	engine speed
RKA2_W	LRA	AUS	additive adaptive correction of the relative fuel amount bank 2
RKAT2_W	LRA	AUS	additive correction (per time) of the mixture adaptation bank 2 (Word)
RKAT_W	LRA	AUS	additive correction (per time) of the mixture adaptation (Word)
RKAZ2_W	LRA	AUS	additive corretion (per ignition) of the mixture adaptatition Bank 2 (Word)
RKAZ_W	LRA	AUS	additive correction (per ignition) of the mixture adaptation
RKA_W	LRA	AUS	additive adaptive correction of the relative fuel amount
RL	EGFE	EIN	relative air charge
R_T200		EIN	Time schedule 200 ms
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat

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FB LRA 117.10 Detailed description of function

Principle:
==========
The fuel pilot control is adjusted by the mixture adaptation multiplicative and additive such that the Lambda controller corrections become minimal and that the desired Lambda is also obtained during open-loop controlled operation (e.g. B_vl = 1 or tmot < activation temperature threshold of the Lambda control). The correction variables multiplicative (fra_w) and additive (rka_w)are included in the calculation on the mixture side, i.e. the load signal rl is not corrected (see %GK).

The method of the LRA is based on the following assumptions:
1. Due to the service life and by manufacturing tolerances mainly three fault types occur:
   multiplicative faults, additive faults per time unit (leakage air) and additive faults per injection (injector pickup delay).
2. During idling the leakage air fault dominates (low air flow-rate, low engine speed), with high air flow-rate the multiplicative fault dominates and at high engine speed and low load the injector fault dominates.
3. An arbitrary fault combination of multiplicative and additive kind is correctly compensated if a correction variable each is adapted in its corresponding dominating range. Precondition is a repeated switching from one range to another during the driving cycle. Learning ranges are defined for individual adaptation variables. Only during engine operation within a learning range is the corresponding integrator activated. The adaptation variables are however included global in the calculation according to their physical effect (fra_w multiplicative - everywhere equally strong, rkat_w additive per time decreases according to the engine speed nmot).

Remark: In addition to the above-mentioned fault types the mixture adaptation should also correct characteristic deviations of the HFM. In order to adapt "a curved HFM fault characteristic" the multiplicative range was subdivided into two ranges (FRAU and FRAO).

Remarks regarding Stereo Lambda control:
==========
- This FDEF is designed for a system with stereo Lambda control.
- The stereo variables are distinguished by attaching a (2) (fra_w(2) means fra_w for bank 1 and fra2_w for bank 2).
- The FDEF is, however, also completely suitable for a mono-system. In this case B_lra2 = FALSE.
  Additionally B_lrare2 = TRUE (reset of the integrators), so that the integrators of bank 2 are set to their neutral values.
- Provided they exist in duplicate the ASCET pictures only show the function of bank 1.

Description of the overview representation:
==========
The LRA is part of the %GKRA (mixture check, controls, adaptations). It makes available the multiplicative and additive adaptation variables of the DKVS (for the diagnosis of the fuel supply system) and the mixture check GK (for the ti calculation).
The LRA contains the following partial functions:
- BBLRA (determination of the learning ranges of the adaptation variables and calculation of the reset and deactivation conditions for the integrators)
  Remark: The learning ranges (over nmot, rl and ml) of the two banks are identical.
- LRAINT (calculation of the adaptation variables for bank 1 resp mono Lambda control)
- LRAINT2 (calculation of the adaptation variables for bank 2 with stereo Lambda control)

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a) Description of the partial function BBLRA:

Four learning ranges are defined, in each of which a learning integrator is active.

1. FRAU : lower multiplicative learning range for the adaptation of multiplicative faults and HFM deviations with mean air masses

2. FRAO : upper multiplicative learning range for the adaptation of multiplicative faults and HFM deviations with large air masses

3. RKAZ : additive adaptation variable for the learning of faults additive per ignition

4. RKAT : additive adaptation variable for the learning of faults additive per time

The learning ranges should each time be chosen such that the effect of the assigned fault is at its maximum.

Calculation of the activation conditions of the ranges:

The multiplicative adaptation variable of the lower learning range is activated via the bit B_frau = TRUE. The range is limited by a lower air mass threshold (ml >= MLU2) and a lower relative load threshold (rl >= RLU2) as well as by an upper air mass threshold (ml <= MLO2) and an upper load threshold (rl <= RLO2).

The multiplicative adaptation variable of the upper learning range is activated via the bit B_frao = TRUE. The range is limited by a lower air mass threshold (ml >= MLU4) and a lower relative load threshold (rl >= RLU4).

If the air mass ml <= MLO3, the engine speed nmot >= NU3 and the relative load lie between RLU3 and RLO3, then the bit B_rkaz is set to TRUE and thereby the learning range for additive adaptation correction per injection is chosen.

The learning range for the additive adaptation variable per time unit (range 1) is chosen by the engine speed nmot <= NO1 and by the air mass ml <= MLO1.

Remark: If the throttle valve is completely open (HFM pulsations) learning must be prohibited: -> see threshold WDKARN in %LRAEB. The general activation condition B_lra(2) is reset here. The above-mentioned learning conditions remain unchanged from this.

Calculation of the reset conditions for the integrators in LRAINT(2):

There are several conditions, for which the adaptation integrators should be set to neutral values.

They are furthermore generally reset:

a) After detected power fail (C_pwf)
   If the voltage supply is interrupted, then this is detected by a power fail test. (A stored test word then no longer corresponds to the value, which is also stored in the EPROM). In this case the adaptation is started with neutral values.
b) During the initialization C_ini = TRUE,
   1. If one of the integrator values (frau_w, frau2_w or frao_w, frao2_w) is outside of the absolute limit
   2. With detected fault E_dpl

Deactivation of individual integrators:

The status byte NOLRA is a simple possibility to deactivate individual adaptation ranges.
This should also then happen if the respective range is not entered.

a) Bit 0 in NOLRA resets the RKAT-integrator in LRAINT(2)	B_norkat
b) Bit 1 in NOLRA resets the FRAU and the FRAO-integrator in LRAINT(2)	B_nofra
c) Bit 2 in NOLRA resets the RKAZ-integrator in LRAINT(2)	B_norkaz

In case of exchanged Lambda sensor plugs (B_lsvvsp = TRUE) all adaptation values are reset to their neutral values.

Remark: It is not useful to only deactivate one of the two multiplicative integrators. Therefore a separate reset of FRAO and FRAU was abstained from.

For the clearing of the individual fault path the bit reset readiness B_lrareb is made available. The bit B_lrareb is set to TRUE,
a) if bit 3 of NOLRA = FALSE or
b) if bit 4 of NOLRA = FALSE and B_edkvs or B_edkvs2 = TRUE.

B_edkvs(2) is set as soon as a fault threshold of the DKVS is exceeded. If bit 3 was set to TRUE and bit 4 was set to FALSE then the individual adaptation variables are only reset in case of clear fault path if a fault of the DKVS occurred.

Attention:
==========
In the series production version the adaptation must at least then be reset at clear fault memory if a fault of the DKVS occurred.
A general resetting is, however, recommended.
==> NOLRA bit 4 must be FALSE in any case, it is also recommendable to set NORLA bit 3 to FALSE.

NOLRA bit 3 and NOLRA bit 4 may only both be TRUE during the application phase.

If SY_STERVK = FALSE all integrators in LRAINT2 are reset (B_lrare2 = TRUE). Thus all integrators of the LRAINT2 are at their neutral values with a mono-system. In the software bank 2 is not processed and no program codes are generated.

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b) Description of the partial functions LRAINT(2):

Since the two partial functions LRAINT and LRAINT2 (for 2. bank) are designed similarly, the description of LRAINT2 is abstained from here. Where stereo labels exist, it is mentioned explicitly (e.g. frm_w(2) means frm_w for bank 1 and frm2_w for bank 2).

LRAINT(2) consists of:
- Calculation of dfrm_w(2): The frm_w(2) (mean value of the Lambda controller from continuous or 2-step Lambda control) serves as input value
- Calculation of fra_w: Interpolation between frau_w(2) and frao_w(2) over the air mass ml_w
- Calculation of rka_w(2) from rkat_w(2), rkaz_w(2) and nmot
- The following partial functions:
  INTFRAU(2): Integrating of the frm_w(2) deviation for the lower multiplicative fault correction and for the calculation of the condition "frau_w(2) outside the reduced range" B_fraur(2)
  INTFRAO(2): Integrating of the frm_w(2) deviation for the upper multiplicative fault correction and for the calculation of the condition "frao_w(2) outside the reduced range" B_fraor(2)
  INTRKAT(2): Integrating of the frm_w(2) deviation for the additive fault correction per time and for the calculation of the condition "rkat_w(2) outside the reduced range" B_rkatr(2)
  INTRKAZ(2): Integrating of the frm_w(2) deviation for the additive fault correction per ignition and for the calculation of the condition "rkaz_w(2) outside the reduced range" B_rkazr(2)

Calculation of dfrm_w(2):

dfrm_w(2) is only calculated if the condition B_lra(2) = TRUE, otherwise dfrm_w(2) equals zero.

Calculation of fra_w(2): Interpolation between frau_w(2) and frao_w(2) over the air mass ml_w

Between the learning ranges a linear interpolation over ml_w from frau_w(2) and frao_w(2) is to be performed for the multiplicative correction variable. If ml_w has a value within one of the learning ranges FRAU resp. FRAO, then fra_w(2) to frau_w(2) resp. frao_w(2) shall be chosen.

The interpolation takes place as follows:
- Formation of the difference from the current ml and the upper threshold of the lower multiplicative range (MLO2).
- Formation of the difference from the lower ML threshold of the upper multiplicative range (MLU4) and of the upper ml threshold multiplicative range (MLO2)
- Formation of the ratio of both values calculated above -> Norm_Wert_ml = (ml - MLO2)/ (MLU4-MLO2)
  thus a normalized value between 0 and 1 is obtained for the current air mass ml_w. For air masses less than MLO2 an extrapolation to frau_w is performed and for air masses greater than MLU4 an extrapolation to frao_w is performed. For air masses between MLO2 and MLU4 a linear interpolation between frau_w and frao_w is performed.

  fra_w = frau_w * (1 - Norm_Wert_ml) + frao_w * Norm_Wert_ml = Norm_Wert_ml * (frao_w - frau_w) + frau_w

Calculation of rka_w(2):

The additive correction per time rkat_w(2) calculated by the partial function INTRKAT(2) is multiplied by the factor N0/nmot (value N0=640 rpm) and added to the additive correction per injection calculated by the partial function INTRKAZ(2) and then it is passed on to the injection-period calculation (see mixture check %GK) as additive correction rka_w(2).
By a maximum selection of nmot with NRKAB it is ensured that the additive correction per time, which was included in the calculation does not become too large in case of very low engine speeds (stalling).

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Description of the partial functions INTFRAU(2), INTFRAO(2), INTRKAT(2) and INTRKAZ(2)

Partial function INTFRAU(2):

The lower multiplicative adaptation factor frau_w(2) is adjusted with the integration speed ZKFRAUA, if the condition B_frau(2) is fulfilled. If this condition is not fulfilled, then the integration input is set to zero.

The integrator is initialized with the value 1.0, if one of the following conditions is fulfilled: B_nofra (deactivate FRA range by bit 1 in NOLRA = TRUE), B_lrare(2) (reset mixture adaptation during the initialization phase) or clear fault path FRAU (if B_lrareb=TRUE reset readiness). The output of the integrator is set to 1.0, if the functional request is signalized to be equal to TRUE by B_fa and B_fakvs. The output of the integrator is limited by the absolute threshold FRAUMX resp. FRAUMN, which may by no means be exceeded. In order to rule out the incorrect messages of the DKVS (see diagnosis; fuel supply system) due to hot gasoline problems, additionally the reduced threshold FRAURX resp. FRAURN were introduced. The reduced thresholds apply, if the condition B_lrar was set to TRUE by the partial function HOHE BEL. (high saturation in TEB). In case the integrator value is already outside of the reduced thresholds with B_lrar = TRUE, only a reversed integration to the neutral position is still possible otherwise the integrator will be held at the present value. This behavior is forced by MINi-, MAXi-operators (resp. MAXi, MINi with lower limit), which are connected in series. The reduced thresholds are activated just as when high oil dilution B_abor=TRUE is detected.

If frau_w(2) is greater than or equal to FRAURX or less than or equal to FRAURN, the condition B_fraur(2) = TRUE is set. B_fraur(2) is needed in the DKVS to prevent an erroneous setting of the bit B_gaefra(2) (multiplicative adaptation factor stabilized) and of B_gaeing(2) (mixture adaptation bank 1 resp. bank 2 stabilized).

Partial function INTFRAO(2):

The facts mentioned regarding INTFRAU(2) apply analogous apart from the following differences:
- The thresholds can be adjusted separately (labels FRAOMX, FRAOMN, FRAORX, FRAORN)
- The time constant can be adjusted separately ZKFRAOA f(abo)
- B_fraor(2) is not needed for the formation of B_gaefra(2)
- The FRAO integrator is reset to the neutral value by clear fault path FRAO (if reset readiness is given).

Partial function INTRKAT(2):

The additive adaptation variable per time rkat_w(2) is adjusted with the integration speed ZKRKATA f(abo), if the condition B_rkat(2) is fulfilled.

The integrator is initialized with the value 0.0, if one of the following conditions is fulfilled: B_norkat (bit no. 0 in NOLRA), B_lrare(2) or clear fault path RKAT. The output of the integrator is set to 0.0 if the functional request is signalized to be equal to TRUE by B_fa and B_fakvs. The integrator is limited by the absolute thresholds (RKATMX, RKATMN).

Analogous to the FRAU and the FRAO integrator there are also reduced thresholds (RKATRN and RKATRX). These thresholds apply as soon as B_lrar(2) or B_abor is set. If, however, rkat_w(2) has exceeded or undershot these thresholds then only a reversed integration resp. a hold at momentary value is possible.
If rkat_w(2) is outside of the reduced thresholds, then the condition B_rkatr(2) = TRUE is set. B_rkatr(2) is needed in the DKVS to prevent an erroneous setting of the bit B_gaeing(2) (mixture adaptation bank 1 resp. bank 2 stabilized).

Partial function INTRKAZ(2):

The additive adaptation factor per ignition rkaz_w(2) is adjusted with the integration speed ZKRKAZ, if the condition B_rkaz(2) is fulfilled. If this condition is not fulfilled, then the integration input is set to zero. The integrator is initialized with the value 0.0, if one of the following conditions is fulfilled: B_norkaz (bit no. 2 in NOLRA),B_lrare(2) or clear fault path RKAZ. The output of the integrator is set to 0.0 if the functional request is signalized to be equal to TRUE by B_fa and B_fakvs. The integrator is limited by the absolute thresholds RKAZMX resp. RKAZMN.

Analogous to the RKAT integrator there are also reduced thresholds(RKAZRN and RKAZRX). These thresholds apply as soon as B_lrar is set. If, however, rkaz_w(2) has exceeded or undershot these thresholds then only a reversed integration resp. a hold at momentary value is possible.
If rkaz_w(2) is outside of the reduced thresholds, then the condition B_rkazr(2) = TRUE is set. B_rkazr(2) is needed in the DKVS to prevent an erroneous setting of the bit B_gaeing(2) (mixture adaptation bank 1 resp. bank 2 stabilized).
It must be taken into account that only one of the two integrators RKAT resp. RKAZ is checked for stabilization in the DKVS (see %DKVS code word CPLRA). It is recommendable, here, to stop that integrator, which is not needed via the code word NORLA.

Remark:
The adaptive corrections are included in the injection-period calculation during all operating states outside of start and they are stored in the RAM with permanent voltage supply (permanent RAM), so that they are not lost when the engine is turned off.

APP LRA 117.10 Application hint

P r o c e d u r e :

The application of the DKVS should usefully only be started once the application of the following functions has been terminated: Lambda controller, transient control, charge sensing, torque structure and idle controller. The characteristic WDKARN in LRAEB should be adjusted.

Application of the partial function BBLRA:

A p p l i c a t i o n v a r i a b l e s

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```
NO1     upper engine speed threshold range 1  (RKAT)    rl                                  WDKRAN
MLO1    upper air mass threshold range 1      (RKAT)    ^                              *____________________
                                                        |   *___________*RLO2     *          FRAO        |
MLU2    lower air mass threshold range 2      (FRAU)    |     *  (B 2)     *         *                  |
MLO2    upper air mass threshold range 2      (FRAU)    |       *   FRAU    *           *       (B 4)      |
RLU2    lower rl-threshold range 2            (FRAU)    |         *          *        MLU4*                |
RLO2    upper rl-threshold range 2            (FRAU)    |       MLU2*          *              *            |
                                                        |              *        *MLO2        *______________RLU4
NU3     lower engine speed threshold 3        (RKAZ)    *                *          *
MLO3    upper air mass threshold range 3      (RKAZ)    |  *MLO1              *________*RLU2
RLU3    lower rl-threshold range 3            (RKAZ)    |      *            RLO3
RLO3    upper rl-threshold range 3            (RKAZ)    |          *     ___v___*
                                                        | RKAT    |     | RKAZ        *MLO3
MLU4    lower air mass threshold range 4      (FRAO)    | (B 1)   |     |_____________________* RLU3
RLU4    upper rl-threshold range 4            (FRAO)    |_____________________________________________|------> nmot
                                                          NO1   NU3                                NMAX
NOLRA   Code word deactivate adaptation ranges
```

Selection of the adaptation ranges:

1) Leakage air at idle: choose N01 about 1000 rpm.
choose ML01 to air needed at idling in case all consumers are connected (air conditioner, rear window, fan, lights).

2) Multipl. fault : choose MLU2 about twice as large as MLO1.
choose MLO2 about 1/3 of the max. possible air mass (120 kg/h).
(lower range) choose RLU2 to that rl, which results at nmot = 2000 rpm with the air need ml = MLU2.
choose RLO2 such that adaptation is blocked in pulsation range. Possibly enough if only WDKARN acts.
Remarks: The deactivation threshold WDKARN is defined in LRAEB. The adaptation can be blocked in the pulsation range by this.
Selection of MLO2 together with MLU4 (see below) according to HFM fault characteristic.

3) Injector fault : For the quicker stabilization of the two other ranges it is recommended to shut this range down by means of NOLRA (bit no. 2 equal to TRUE e.g. NOLRA = 4 HFM systems).
For P-systems and for test purposes:
: choose ML03 between MLO1 and MLU2
choose NU3 about 1600 rpm
choose RLU3 about 16 %
choose RLO3 about 32 %

4) Multipl. fault : choose MLU4 about 40-60 kg/h above MLO2.
(upper range) choose RLU4 about 20 -30% above RLU2
Remarks: The deactivation threshold WDKARN is defined in LRAEB. The adaptation can be blocked in the pulsation range by this.
Selection of MLO2 together with MLU4 (see below) according to HFM fault characteristic.

- NOLRA: For OBDII series with HFM : NOLRA = 4 (bit 2 is the only one which is set) -> shut down RKAZ range, reset in case of clear fault memory active. For Europe also recommended: NOLRA: 4

I m p o r t a n t :
Attention must be paid that the ranges do not overlap each other!!

Application of the partial function INTFRAU and INTFRAO:

A p p l i c a t i o n v a r i a b l e s

FRAUMX	upper limitation of the correction factor FRAU	[1,2....1,25....1,3]
FRAUMN	lower limitation of the correction factor FRAU	[0,7....0,75....0,8]
FRAURX	upper reduced limitation of the correction factor FRAU	[1,2....1,25....1,3]
FRAURN	lower reduced limitation of the correction factor FRAU	[0,7....0,75....0,8]
FRAOMX	upper limitation of the correction factor FRAO	[1,2....1,25....1,3]
FRAOMN	lower limitation of the correction factor FRAO	[0,7....0,75....0,8]
FRAORX	upper reduced limitation of the correction factor FRAO	[1,2....1,25....1,3]
FRAORN	lower reduced limitation of the correction factor FRAO	[0,7....0,75....0,8]
ZKFRAUA	integration speed integrator FRAU	[0,025..0,025..0,0125] 1/sec
ZKFRAOA	integration speed integrator FRAO	[0,025..0,025..0,0125] 1/sec

The values indicated in the middle are reference values.

Time constants, which result with feedback (via engine and Lambda control):
Time constant for FRAU/FRAO integrator : 40 to 80 s (integration gradient ZKFRAU: 0.025/s to 0.0125/s)

Example for fra integration gradient ZKFRAU:
A frm deviation of 0.1 (step change from 1.0 to 1.1) causes a ti increase of 10 percent. The output of the integrator must therefore increase from 1.0 to 1.1, so that the frm will fall back to 1.0. If the integrator output shall reach the value 1.1 after 40 s, the integration gradient then has the value
ZKFRAU = 1/40s = 0.025/s .

Adaptation limits: FRAURX = FRAORX = FRAUMX; no reduction of the fra range, so that DKVS is successful also with high saturation
(restricted) FRAURN = FRAORN = FRAUMN; no reduction of the fra range

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Application of the partial function INTRKAT and INTRKAZ:

A p p l i c a t i o n v a r i a b l e s

RKATMX	upper limitation of the correction factor RKAT	[7,0....9,0...11,0] %
RKATMN	lower limitation of the correction factor RKAT	[-11,0..-9,0..-7,0] %
RKATRX	upper reduced limitation of the correction factor RKAT	[7,0....9,0...11,0] %
RKATRN	lower reduced limitation of the correction factor RKAT	[-9,0..-7,0...-5,0] %
RKAZMX	upper limitation of the correction factor RKAZ	[7,0....9,0...11,0] %
RKAZMN	lower limitation of the correction factor RKAZ	[-11,0..-9,0..-7,0] %
RKAZRX	upper reduced limitation of the correction factor RKAZ	[7,0....9,0...11,0] %
RKAZRN	lower reduced limitation of the correction factor RKAZ	[-11,0..-9,0..-7,0] %
ZKRKATA	integration speed integrator RKAT	[0,5...0,5...0,25] %/sec
ZKRKAZ	integration speed integrator RKAZ	[0,5...0,5...0,25] %/sec

The values indicated in the middle are reference values.

Background of the above values -> a rl of 30% was assumed during idling.
Choose RKATMX such that during idling 25% to 30% rk-correction is possible
Choose RKATMN such that during idling -25% to -30% rk-correction is possible
(Choose RKAZMX such that with typ. rl in range three +25% rk- correction is possible
Choose RKAZMN such that with typ. rl in range three -25% rk- correction is possible)

RKATRX =RKATMX; no upward reduction of the rkat
RKATRN: about 2% to 3% (related to idle rl) above diagnostic threshold RKATDN
Remark: For OBDII with running losses no reduction at all RKATRX = RKATMX
(RKAZRX : about 2% to 3% (related to typ. rl in RKAZ range) below diagnostic threshold RKAZDX
RKAZRN : about 2% to 3% (related to typ. rl in rkaz range) above diagnostic threshold RKAZDN)

Time constants, which result with feedback (via engine and Lambda control):

Time constant for RKAT integrator : 40 to 80 s (ZKRKAT 0.5 %/s to 0.25 %/s) Att.: oscillation tendency with frm!!
Time constant for RKAZ integrator : 40 to 80 s (ZKRKAZ 0.5 %/s to 0.25 %/s)

Example for rkat integration gradient ZKRAKTA:
A frm deviation of 0.1 causes a ti increase of 10 percent. This constitutes a 2% rl change as related to rl = 20%.
The engine speed is to be 800 rpm during idling. If these 2% have to be controlled within 50s, so that the frm reaches the value 1.0, then the integration gradient for RKAT integrator is the same
ZKRKATA = (800 rpm * 2%)/(640 rpm * 0.1 * 50 s) = 0.5 %/s .

Example for rkaz integration gradient ZKRAKZ:
A frm deviation of 0.1 causes a ti increase of 10 percent. This constitutes a 2% rl change as related to rl = 20%.
If these 2% have to be controlled within 40s, so that the frm deviation of one becomes zero again, then the integration gradient is the same
ZKRKAZ = 2% /(40 s * 0.1) = 0.5 %/s .

An oscillation tendency of the LRA with the frm is definitely to be ruled out during the application of the time constants. The most critical case is given here during idling without consumers. The integrator gradient of the frm is at its lowest here. The integration speed of the rkat must be chosen distinctly slower than that speed, at which an oscillation tendency could be provoked. Otherwise the system will oscillate after excitation (large frm deviations).

Application of the partial function LRAINT:

A p p l i c a t i o n v a r i a b l e s

NRKEB	minimum engine speed for limitation control action rkat	[400...400...500] rpm
N0	conversion constant for inclusion mixture correction rkat	[640...640...800] rpm

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BBBO 2.10 Start operating range with fuel in oil

FDEF BBBO 2.10 Function definition

bbbo-bbbo

ABK BBBO 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ABOLRAR			FW	threshold numbers of starts with fuel in oil for reduction LRA
ABOMX			FW	max. numbers of starts for recognation of fuel in oil
IMLKS			FW	threshold integrated air mass for detection fuel in oil
TMSKS			FW	engine temperature threshold for detection fuel in oil

Variable	Source	Type	Description
ABO	BBBO	AUS	numbers of starts with fuel in oil
B_ABOR	BBBO	AUS	condition numbers of starts with fuel in oil for reduced adaptive lambda control
B_STEND	BBSTT	EIN	condition end of start
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
IMLBBO	BBBO	AUS	integration air mass for recognizing fuel in oil
ML_W	EGFE	EIN	air mass flow filtered (Word)
TMST	GGTFM	EIN	engine temperature at start

FB BBBO 2.10 Detailed description of function

Fuel can get into the engine oil during cold start. The engine oil gets warm during continued driving. The fuel evaporates. The fuel vapor is delivered to the combustion via the crankcase ventilation. The mixture deviation occurring in the process can amount to up to 30% at idle. The Lambda control corrects this. The mixture adaptation stores this correction as long-term effect. If the values of the mixture adaptation exceed certain values, the error lamp may be triggered. Furthermore the subsequent start may fail, since the starting mixture has become too lean, however, during the start no degassing of the fuel in the oil takes place.

By means of a counter abo the feeding of fuel into oil is simulated. The counter is incremented by one if a start below the temperature threshold TMSKS takes place. This can be the engine and or the intake or the transmission oil temperature of the vehicle.
The counter is decremented if it is ensured that the oil temperature has remained above a threshold for long enough. Then it is ensured that the fuel has degassed again. The air mass flow integrated during a drive or the transmission oil temperature can serve as measure for high oil temperature. When this variable exceeds a threshold the counter is decremented again. In the process zero may not be undershot.

Realization: The air mass ml is integrated in imlbbo. If the integrator value imlbbo is greater than IMLKS the counter abo is decremented and the integrator value imlbbo is reset.
Thereby the counter can be decremented several times during an engine run. The counter abo is stored in the permanent RAM.

By the count of the counter abo, which can be limited to a maximum value, the learning speed of the mixture adaptation is varied.

If the counter is greater than the threshold ABOLRAR the condition B_abor is set, which enables the reduced adaptation ranges in the function %LRA.

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APP BBBO 2.10 Application hint

DKVS 17.60 Diagnosis; plausibility test fuel supply system

FDEF DKVS 17.60 Function definition

DKVS : Plausibility test fuel supply systems

dkvs-dkvs1

DKVSB1 :Formation of the cycle and error flags and checking on whether the basic adaptation stabilizes

dkvs-dkvsb1

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DKVSGAE :Checking on whether the basic adaptation stabilizes

dkvs-dkvsgae

DKVSZYK : Setting of the cycle flag and checking on whether it is active for a minimum time

dkvs-dkvszyk

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DKVSES : By tank empty error disenable

dkvs-dkvses

dkvs-dkvses

DKVSERR :Formation of the error flag for FRAO, FRAO, RKAT and RKAZ

dkvs-dkvserr

dkvs-dkvserr

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RKATERR : Checking of the additive adaptation correction per time RKAT for error

dkvs-rkaterr

FRAUERR : Checking of the lower multiplicative adaptation correction FRAU for error

dkvs-frauerr

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FRAOERR : Checking of the upper multiplicative adaptation correction FRAO for error

dkvs-fraoerr

RKAZERR : Checking of the additive adaptation correction per ignition RKAZ for error

dkvs-rkazerr

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DKVSST : Short Test

dkvs-dkvsst

In block diagrams error type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the error path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external error paths which occur as inputs access methods are available which read these informations directly from the error path status managed in the DFPM.

For each error path xyz of this diagnosis function the following values are defined:

```
Status error path xyz                sfpxyz
   Error flag xyz :                     E_xyz
   Cycle flag xyz :                     Z_xyz
   Error type xyz :                     TYP_xyz :(B_mxxyz, B_mnxyz, B_sixyz, B_npxyz)
   Delete error path:                   B_clxyz
   Substitution value active :          B_bkxyz (optional)
Error path code xyz:                 CDTxyz
Error class     xyz:                 CLAxyz
Error intensity xyz:                 TSFxyz
CARB code       xyz:                 CDCxyz
Table of environm. cond.xyz:         FFTxyz
```

In this function definition (FDEF) the following error paths xyz are treated:

```
Error path name                                      used abbreviation (substitutes ,,xyz‘‘)

upper multiplicative correction FRAO                 frao
upper multiplicative correction FRAO2                frao2
lower multiplicative correction FRAU                 frau
lower multiplicative correction FRAU2                frau2
additive correction per time RKAT                    rkat
additive correction per time RKAT2                   rkat2
additive correction per ignition RKAZ                rkaz
additive correction per ignition RKAZ2               rkaz2

Error path name  for short test                                  used abbreviation (substitutes ,,xyz‘‘)

short test Lambda control deviation                  frst
short test Lambda control deviation                  frst2
```

ABK DKVS 17.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCFRAO	BLOKNR		KL	code word CARB: mixture adaptation factor frao
CDCFRAO2	BLOKNR		KL	code word CARB: mixture adaptation factor frao bank 2
CDCFRAU	BLOKNR		KL	code word CARB: mixture adaptation factor frau
CDCFRAU2	BLOKNR		KL	code word CARB: mixture adaptation factor frau bank 2
CDCFRST	BLOKNR		KL	code word CARB: deiation of lambda loop control
CDCFRST2	BLOKNR		KL	code worde : deviation of lambda loop control bank 2
CDCRKAT	BLOKNR		KL	code word CARB: additive adaptive mixture correction rkat
CDCRKAT2	BLOKNR		KL	code word CARB: additive adaptive mixture correction rkat bank 2
CDCRKAZ	BLOKNR		KL	code word CARB: additive adaptive mixture correction rkaz
CDCRKAZ2	BLOKNR		KL	code word CARB: additive adaptive mixture correction rkaz bank 2
CDLFRAO	BLOKNR		KL	code word lamp : LR-Adaptation multiplicative upper threshold
CDLFRAO2	BLOKNR		KL	code word lamp : LR-Adaptation multiplicative upper threshold bank 2

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Parameter	Source-X	Source-Y	Type	Description
CDLFRAU	BLOKNR		KL	code word lamp: LR-Adaptation multiplicative lower threshold
CDLFRAU2	BLOKNR		KL	code word lamp: LR-Adaptation multiplicative lower threshold bank 2
CDLFRST	BLOKNR		KL	code word lamp: feul supply system short test
CDLFRST2	BLOKNR		KL	code word lamp: feul supply system short test bank 2
CDLRKAT	BLOKNR		KL	code word lamp : LR-Adaptation additive per time
CDLRKAT2	BLOKNR		KL	code word lamp : LR-Adaptation additive per time bank 2
CDLRKAZ	BLOKNR		KL	code word lamp : LR-Adaptation additive per ingnition
CDLRKAZ2	BLOKNR		KL	code word lamp : LR-Adaptation additive per ingnition bank 2
CPLRA			FW	Code word for switching DKVS from HFM- to pressure controlled system
DFRMST			FW	delta frm threshold for detection of successful basic mixt. adaptation
FRAE			FW	delta-fra-threshold for detection of successful basic mixture adaptation
FRAODN			FW	lower diagnostic threshold of frao correction
FRAODX			FW	upper diagnostic threshold of frao correction
FRAUDN			FW	lower diagnostic threshold of correction frau
FRAUDX			FW	upper diagnostic threshold of correction frau
FRMSTDN			FW	lower threshold for diagnosis (short test)
FRMSTDX			FW	upper threshold for diagnosis (short test)
IMLKVSMX			FW	maximum integration threshold for error enabled in DKVS (empty tank)
MLDKVSF			FW	Air mass threshold for error enable in DKVS (empty tank)
MLDKVSG			FW	air mass threshold for error enable empty tank
RKAE			FW	delta rkat- rkaz threshold for detection of successful basic mixt. adaptation
RKATDN			FW	lower threshold for diagnosis of additive correction per time
RKATDX			FW	upper threshold for diagnosis of additive correction per time
RKAZDN			FW	lower threshold for diagnosis of additive correction per ignition
RKAZDX			FW	upper threshold for diagnosis of additive correction per ignition
TFRA			FW	monitoring duration FRA
TFRAOZ			FW	duration of stay in FRAO for cycle flag with not successful adaptation
TFRAUZ			FW	duration of stay in FRAU for cycle flag with not successful adaptation
TFRMST			FW	monitoring duration frm sufficient
TFRMZST			FW	duration of stay for unplausible frm-signal (short test)
TRKA			FW	monitoring duration rkat, rkaz sufficient
TRKATZ			FW	activation duration rkat for setting the cycle-flag if B_gae = FALSE
TRKAZZ			FW	activation duration rkaz for setting the cycle-flag if B_gae = FALSE
ZFRMST			FW	time constant for frm-filter (short test)

Variable	Source	Type	Description
B_CDKVS	PROKON	EIN	function active per codeword CDKVS
B_CLFRAO		EIN	condition clear failure path FRAO (upper multipl. section)
B_CLFRAO2		EIN	condition clear failure path FRAO2 (stereo)
B_CLFRAU		EIN	condition clear failure path FRAU (lower multipl. section)
B_CLFRAU2		EIN	condition clear failure path FRAU2 (stereo)
B_CLFRST		EIN	condition clear failure path FRST (short test)
B_CLFRST2		EIN	condition clear failure path FRST (short test bank 2)
B_CLRKAT		EIN	condition clear failure path RKAT (add. per time)
B_CLRKAT2		EIN	condition clear failure RKAT2 (stereo)
B_CLRKAZ		EIN	condition clear failure RKATZ (add. per ingnition)
B_CLRKAZ2		EIN	condition clear failure path RKAZ2 (stereo)
B_DKVSF	DKVS	AUS	condition: enabled of error
B_DKVSFM	DKVS	LOK	condition: enabled of error (filpflop output)
B_DKVSTR	DKVS	AUS	condition: integrator reset by tank empty
B_EDKVS	DKVS	AUS	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	AUS	condition for adaption fault thresholds bank 2 momentarily exceeded
B_EFRAO	DKVS	LOK	Condition: diagnostic thresholds of upper multipl. correction actually exceeded
B_EFRAO2	DKVS	LOK	Condition: diagnostic thresholds (bank 2) of upper multipl. correction exceeded
B_EFRAU	DKVS	LOK	Condition diagnostic thresholds of lower multipl. correction actually exceeded
B_EFRAU2	DKVS	LOK	Condition diagnostic thresholds (bank 2) of lower multipl. correction exceeded
B_ERKAT	DKVS	LOK	Condition diagnostic thresholds of additive correction per time actually exeeded
B_ERKAT2	DKVS	LOK	Condition diagnostic thresholds (bank2) of additive correction per time exceeded
B_ERKAZ	DKVS	LOK	Condition: diagnostic thresholds of add. correction per inj. actually exceeded
B_ERKAZ2	DKVS	LOK	Condition: diagnostic thresholds (bank2) of add. correction per inj. exceeded
B_FA		EIN	condition general function request
B_FAKVS		EIN	condition function request diagnoses fuel supply system
B_FRAO	LRA	EIN	condition for enabling adaption of frao
B_FRAU	LRA	EIN	condition enable adaptation of frau
B_FRAUR	LRA	EIN	condition frau-integrator outside reduced thresholds
B_FRAUR2	LRA	EIN	condition frau2-integrator outside reduced thresholds
B_FRSTE	DKVS	LOK	condition frm stabilized (short test)
B_FRSTE2	DKVS	LOK	condition frm2_w stabilized (short test 2. bank)
B_GAE	DKVS	AUS	condition for adaptive Lambda pilot control successful
B_GAEFRA	DKVS	AUS	condition for fra portion of adaptive Lambda pilot control successful
B_GAEFRA2	DKVS	AUS	condition for fra2 portion of adaptive lambda pilot control successful
B_GAEING	DKVS	LOK	condition basic adaption Bank 1 steady state
B_GAEING2	DKVS	LOK	condition for adaptive lambda pilot control 2 successful
B_IMLKVSE	DKVS	LOK	condition air mass integrator reset
B_KVSFFL	DKVS	LOK	condition: enable of error in spite of empty tank
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRA	LRAEB	EIN	condition for basic mixture adaptation enabled
B_LRA2	LRAEB	EIN	condition for basic mixture adaption 2 enabled
B_LRARE	LRA	EIN	condition reset of mixture adaptation
B_LRARE2	LRA	EIN	condition reset of mixture adaptation bank 2

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Variable	Source	Type	Description
B_MNFRAO	DKVS	LOK	condition below low plausibility threshold (upper multipl. section)
B_MNFRAO2	DKVS	LOK	condition below low plausibility threshold (stereo)
B_MNFRAU	DKVS	LOK	condition below low plausibility threshold (lower multipl. section)
B_MNFRAU2	DKVS	LOK	condition below low plausibility threshold (stereo)
B_MNFRST	DKVS	LOK	condition below low plausibility threshold (short test)
B_MNFRST2	DKVS	LOK	condition below low plausibility threshold (short test stereo
B_MNRKAT	DKVS	LOK	condition below low plausibility threshold (add. per time)
B_MNRKAT2	DKVS	LOK	condition below low plausibilitiy threshold (stereo)
B_MNRKAZ	DKVS	LOK	condition below low plausibility threshold (add. per ingnition)
B_MNRKAZ2	DKVS	LOK	condition below low plausibility threshold (stereo)
B_MXFRAO	DKVS	LOK	Condition: upper plausible value exceeded (frao)
B_MXFRAO2	DKVS	LOK	Condition: upper plausible value exceeded (bank 2) (frao2)
B_MXFRAU	DKVS	LOK	Condition: upper plausible value exceeded (frau)
B_MXFRAU2	DKVS	LOK	Condition: upper plausible value exceeded (multiplicative 2. bank)
B_MXFRST	DKVS	LOK	Condition: upper plausible value exceeded (short test)
B_MXFRST2	DKVS	LOK	Condition: upper plausible value exceeded (short test stereo)
B_MXRKAT	DKVS	LOK	Condition: upper plausible value exceeded (rkat)
B_MXRKAT2	DKVS	LOK	Condition: upper plausible value exceeded (Bank 2) (rkat2)
B_MXRKAZ	DKVS	LOK	Condition: upper plausible value exceeded (rkaz)
B_MXRKAZ2	DKVS	LOK	Condition: upper plausible value exceeded (bank 2) (rkaz)
B_NOFRA	LRA	EIN	condition no fra adaptation active
B_NORKAM	DKVS	LOK	condition additive correction of the mixture adaptation switched off
B_NORKAT	LRA	EIN	condition additive correction of the mixture adaptation switched off
B_NORKAZ	LRA	EIN	condition additive correction of the mixture adaptation switched off
B_NPFRST	DKVS	LOK	condition for fault type ”unplausible signal” detected (DKVS short test)
B_NPFRST2	DKVS	LOK	condition for fault type ”unplausible signal” detected (DKVS short test bank 2)
B_PLRA	DKVS	LOK	Condition: Switch over from HFM to pressure controlled system
B_RKAM	DKVS	LOK	Condition: One of both additive LRA sections is active
B_RKAMR	DKVS	LOK	Condition: rkaz or rkat has exceeded it’s thresholds
B_RKAMR2	DKVS	LOK	Condition: rkaz2 or rkat2 has exceeded it’s thresholds
B_RKAT	LRA	EIN	condition adaptation area rkat active
B_RKATR	LRA	EIN	condition rkat-integrator outside reduced thresholds
B_RKATR2	LRA	EIN	condition rkat2-integrator outside reduced thresholds
B_RKAZ	LRA	EIN	condition adaptation area rkaz active
B_RKAZR	LRA	EIN	condition rkaz-integrator outside reduced thresholds
B_RKAZR2	LRA	EIN	condition rkaz2-integrator outside reduced thresholds
B_SA	MDRED	EIN	Condition fuel cut-off
B_TAL	GGFSTT	EIN	Condition tank empty or reserve
B_TALVAL	GGFSTT	EIN	condition ; bit empty tank valid
B_TE	TEBEB	EIN	Condition canister purge active
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_FRAO	DKVS	AUS	error flag: upper multiplicative mixture adaption factor frao
E_FRAO2	DKVS	AUS	error flag: upper multiplicative mixture adaption factor frao2
E_FRAU	DKVS	AUS	error flag: lower multiplicative mixture adaption factor frao
E_FRAU2	DKVS	AUS	error flag: lower multiplicative mixture adaption factor frao2
E_FRST	DKVS	AUS	error flag: fuel supply system (short test)
E_FRST2	DKVS	AUS	error flag: fuel supply system (short test bank 2)
E_RKAT	DKVS	AUS	error flag DKVS (additive correction per unit of time)
E_RKAT2	DKVS	AUS	error flag DKVS (additive correction per unit of time, bank 2)
E_RKAZ	DKVS	AUS	error flag DKVS (additive correction per ignition)
E_RKAZ2	DKVS	AUS	error flag DKVS (additive correction per ignition, bank 2)
FRAO2_W	LRA	EIN	multipl. mixture adaptation factor higher load bank 2 (Word)
FRAO_W	LRA	EIN	multipl. mixture adaptation factor higher load (word)
FRAU2_W	LRA	EIN	multipl. mixture adaptation factor of the lower mult. section of bank 2 (Word)
FRAUZS2_W	DKVS	LOK	multipl. mixture adaptation factor of the lower mult. section (stereo)
FRAUZS_W	DKVS	LOK	multipl. mixture adaptation factor of the lower section (old value)
FRAU_W	LRA	EIN	multipl. mixture adaptation factor of the lower mult. section (Word)
FRM2_W	LR	EIN	fast mean value of lambda control factor bank 2(word)
FRM_W	LR	EIN	fast mean value of lambda control factor (word)
IMLKVSZS_W	DKVS	LOK	strored value:air mass after DKVS fault with empty fuel tank
IMLKVS_W	DKVS	LOK	air mass after DKVS fault with empty fuel tank
ML	BGSRM	EIN	air mass flow
RKAM2_W	DKVS	LOK	Selection of additive correction of the mixture adaptation for calc. of B_gae2
RKAMZS2_W	DKVS	LOK	correction additive (per time or ingnition) bank 2 (old value)
RKAMZS_W	DKVS	LOK	correction additive (per time or ingnition); old value
RKAM_W	DKVS	LOK	Selection of additive correction of the mixture adaptation for calc. of B_gae
RKAT2_W	LRA	EIN	additive correction (per time) of the mixture adaptation bank 2 (Word)
RKAT_W	LRA	EIN	additive correction (per time) of the mixture adaptation (Word)
RKAZ2_W	LRA	EIN	additive corretion (per ignition) of the mixture adaptatition Bank 2 (Word)
RKAZ_W	LRA	EIN	additive correction (per ignition) of the mixture adaptation
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
Z_FRAO	DKVS	AUS	cycle flag of mixture adaption factor frao
Z_FRAO2	DKVS	AUS	cycle flag of mixture adaption factor frao2 (bank 2)
Z_FRAU	DKVS	AUS	cycle flag of mixture adaption factor frau
Z_FRAU2	DKVS	AUS	cycle flag of mixture adaption factor frau2 (bank 2)
Z_FRST	DKVS	AUS	cycle flag: fuel supply system (short test)
Z_FRST2	DKVS	AUS	cycle flag: fuel supply system (short test bank 2)
Z_RKAT	DKVS	AUS	cycle flag of additive adaptive mixture correction per time
Z_RKAT2	DKVS	AUS	cycle flag of additive adaptive mixture correction per time (bank 2)

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Variable	Source	Type	Description
Z_RKAZ	DKVS	AUS	cycle flag of additive adaptive mixture correction rkaz
Z_RKAZ2	DKVS	AUS	cycle flag of additive adaptive mixture correction rkaz (bank 2)

FB DKVS 17.60 Detailed description of function

Introduction:

The OBD II legislation requires monitoring of the fuel supply system. A defective fuel supply system leads to deviations in the pilot mixture control. As a result, the average control factor (frm) will deviate from factor 1.0.

The mixture adaptation (LRA) will try to "learn" such errors in order to correct the error even during dynamic engine operation in the best possible way. The best result is obtained for errors with a specifically assigned LRA integrator. Examples are:
- rkat in case of an additive error per time (leakage air)
- frau, frao in case of a multiplicative error (pressure controller tolerance or fluctuating fuel density)
- rkaz in case of an additive error per ignition (injection valve-delay time TVUB wrong)

Within certain limits (+/- 25% multiplicative and +/- 25% additive) the mixture adaptation is capable of correcting such an error with only little impact on emissions. Errors, however, which deviate from the above-mentioned characteristics cause continuously activated integrators. In this case only part of the error can be compensated and a residual error remains which must constantly be compensated by the Lambda controller dependent on the load and engine speed point. In this case the legal emission limits may be exceeded by factor 1.5 even in case of small deviations of the LRA integrators from the neutral value. This must be taken into consideration when selecting the diagnosis thresholds.

The diagnosis thresholds of the LRA adaptation values are to be determined such that the emissions do not exceed the defined limits with respect to the factor 1.5 (see block APP).

The DKVS is closely connected to the mixture adaptation (LRA) and it evaluates the following integrators of the mixture adaptation:

- RKAT...: additive error per time (e.g. leakage air)
- FRAU...: multiplicative error (at average air masses - lower mulitplicative range)
- FRAO...: multiplicative error (at high air masses - upper multiplicative range)
- RKAZ...: additive error per ignition (e.g. wrongly adjusted valve delay time TVUB)

Apart from the error flags (E_xyz) and the corresponding cycle flags (Z_xyz) the DKVS also provides the information "basic adaptation stabilized" (B_gae). Once the adaptation has stabilized an early switch-over to long canister purge phases can be performed (see phase control %BBTEGA).

Apart from the integrator values (rkat_w, frau_w, frao_w and rkaz_w) and the conditions B_rkat, B_frau, B_rkaz and B_frao, the DKVS also needs the information from the mixture adaptation whether the corresponding integrator has reached resp. exceeded one of the reduced thresholds.

- B_rkatr: a reduced threshold of rkat reached resp. exceeded
- B_fraur: a reduced threshold of frau reached resp. exceeded
- B_fraor: is not needed since frao is not checked for stabilization
- B_rkazr: a reduced threshold of rkaz reached resp. exceeded

As soon as the reduced thresholds are reached resp. exceeded the bit "mixture adaptation stabilized" (B_gae) can no longer be set.

The reduced thresholds were introduced in order to avoid possible error messages which mistakenly occur under certain conditions (e.g. high charge of the activated carbon filter).

The banks 1 and 2 have the same structure. Where bank-specific signals occur an index (2) is given for the second bank. Example: frau_w(2) means frau_w for bank 1 and frau2_w for bank 2.

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The diagnosis fuel supply systems (DKVS) consists of the following partial functions :

Partial function block DKVSGAE(2) :

In this partial function it is checked whether the basic adaptation has stabilized (B_gaeing(2) = TRUE). It only monitores the adaptation stabilization of 2 LRA integrators. One of these integrators is the FRAU. The other is either the RKAT (HFM-systems) or the RKAZ (P-load acquisition). The switch-over is performed outside of this partial function via the code word CPLRA. If CPLRA > 0 then the RKAZ (adaptive correction per ignition) is monitored for stabilization and if CPLRA = 0 the RKAT (adaptive correction per time) is monitored. It is recommendable to always deactivate the integrator not needed in the LRA (B_norkaz = TRUE with HFM load acquisition or B_norkat = TRUE with P-load acquisition) => see %LRA - partial function BBLRA.

If frau, frao ist stopped by B_nofra, B_gaefra is set.
If rkat ist stopped by B_norkat and CPLRA = 0 the Flip-Flop for B_gaeing is set.
If rkaz ist stopped by B_norkaz and CPLRA = 1 the Flip-Flop for B_gaeing is set.
With this method "B_gae can be set TRUE" also if one range is stopped!

The bit "basic adaptation stabilized" is needed:
- for a quick switch-over to long canister purge phases (TTE -> TTEAE) in the function %BBTEGA
- for a quick setting of the cycle flags of the DKVS (Z_rkat(2), Z_frau(2), Z_frao(2) and Z_rkaz(2)).
- as an information for other diagnosis functions

Generally it can be assumed that an integrator of the LRA has stabilized if the corresponding integrator changed only little during the time in which it was active.

However, if only a fixed load / engine speed point (e.g. idle speed) is entered an intergrator (e.g. RKAT) may stabilize even though it falsely learned a mixture error (e.g. multiplicative error) which does not belong in this range. In order to avoid a too early setting of the bit B_gaeing(2) the check on stabilization in the additive range (RKAM = RKAT resp. RKAZ) is only performed after FRAU has stabilized (B_gaefra(2) = TRUE). The basic adaptation stabilizes only once both monitored integrators have stabilized (B_gaeing(2) = TRUE).

The check in detail:
At the beginning of the check (e.g. from start for FRAU, resp. after FRAU has stabilized for RKAM) the adaptation value frau_w is temporarily stored in frauzs_w resp. rkam_w in rkamzs_w. Then the time during which the condition for the adaptation of the variables FRAU resp. RKAM were fulfilled is measured starting from the beginning.
The time counter is only active if frau_w (rkam_w) has not already reached or undershot resp. exceeded one of the reduced thresholds FRAURX resp. FRAURN(RKATRX resp. RKATRN or RKAZRX resp. RKAZRN) and the Bit B_dkvsf is set to TRUE.
Reason: A forced limitation on the reduced threshold may not be interpreted as stabilized state.

After the time TFRA (TRKA) has passed an inquiry is made whether the adapation has deviated by more than FRAE (RKAE) from the starting value. If this is not so then the FRAU- resp. the RKAM-adaptation has stabilized and the flags B_gaefra(2) and B_gaeing(2) are set.

The flags B_gaefra(2) and B_gaeing(2) are set to FALSE under the following conditions :
- in case of start (C_ini = TRUE)
- reset of all integrators of the LRA during the initialization phase (B_lrare(2) = TRUE, this bit is formed in %LRA)
- individual error path deletion:
  - deleting of the error path FRAO(2) or FRAU(2) i.e.. B_clfrao(2) or B_clfrau(2) equal TRUE and C_fcmclr = TRUE
    => B_gaefra(2) and B_gaeing(2) = FALSE
  - deleting of the error path RKAT(2) or RKAZ(2) => o n l y B_gaeing(2) = FALSE is set.
- the additive corrections of the mixture adaptation RKAT or RKAZ are switched off with B_norkat resp. B_norkaz (selecting via codeword CPLRA => B_norkam = TRUE)

B_gaefra(2) and B_gaeing(2) are set to TRUE if B_cdkvs was set to FALSE by the bit no. ZERO of the code word CDKVS (in %PROKON). In this case this block is not calculated. They are also set TRUE, if the range, that is needed for a TRUE is stopped by B_noxxx.

On the stereo version the adaptation has stabilized once both banks have stabilized (B_gaeing and B_gaeing2 equal TRUE).

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Partial function block DKVSZYK(2) :

The task of this partial function is the formation of the cycle flags (Z_rkat(2), Z_rkaz(2), Z_frau(2) and Z_frao(2)).

- The cycle flag Z_frau(2) is set if
  a) the accompanying integrator has stabilized in LRA. The stabilization of the FRAU(2)-integrators is signaled by the bit B_gaefra(2) from the partial function DKVSGAE.
  b) the time during which the adaptation is active in the FRAU range is larger than a defined threshold (TFRAUZ). This setting of the cycle flag is described as "forced setting".

- The cycle flag Z_frao(2) is set if the passed time during active Lambda control in the FRAO range is larger than the adjustable threshold TFRAOZ.

- The cycle flag Z_rkaz(2) is set if
  a) in case of the set bit B_plra the accompanying integrator RKAZ(2) has stabilized in the LRA. The stabilization of the RKAZ(2) integrator is signaled by the bit B_gaeing(2) = TRUE from the partial function DKVSGAE.
  b) in case of the not set bit B_plra the time during which the adaptation is active in the RKAZ range is larger than TKRAZZ. In this case the cycle flag Z_frau must be set beforehand.

- The cycle flag Z_rkat(2) is set if
  a) in case of the not set bit B_plra the accompanying integrator has stabilized in the LRA. The stabilization of the RKAT(2) integrator is signaled by the bit B_gaeing(2) = TRUE from the partial function DKVSGAE.
  b) in case of the set bit B_plra the time during which the adaptation is active in the RKAT range is larger than TKRATZ. In this case the cycle flag Z_frau must be set beforehand.

The cycle flags Z_frau(2), Z_frao(2), Z_rkaz(2) and Z_rkat(2) are set to TRUE if B_cdkvs = FALSE. In this case the function is not calculated. They are also set TRUE, if the range is stopped by B_noxxx.

The timers and thus the cycle flags are reset under the following conditions:
a) in case of start (C_ini = TRUE)
b) in case of delete error path FRAO(2) or delete FRAU(2)
c) in case of delete error path RKAT(2) or RKAZ(2) only the cycle flags Z_rkat(2) and Z_rkaz(2) are set to FALSE by the resetting of the accompanying timers.

The resetting of all cycle flags in case of condition b) is necessary because the stabilization of the integrators RKAZ resp. RKAT is only checked for after the FRAU integrator has stabilized. The condition c) is permitted because after the RKAT resp. the RKAZ integrators were deleted only the stabilization behaviour of the RKAT resp. the RKAZ integrator is observed for the setting of the bit B_gaeing(2).

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Partial function block DKVSES :

In order to avoid an error diagnosis in DKVS (fuel supply system) due to an empty tank, the sitting of error flag is prohibited for a difinite time (if one of the threshold diagnosis is exceeded or undershot). Because for the reasion the air mass throughput is integrated so much that, the threshold MLDKVSF is exceeded. In fuel cut off the integrator is stopped. The Integrator is initializated with the value Zero and then stopped, if after enable in next driving,
a) the air mass integrator is integrated at least MLDKVSG (imlkvs - imlkvszs > MLDKVSG)
b) The integrator has reached his maximum. Remark: The integrator is limited to maximal value IMLKVSMX.

The bit B_dkvsf by the make ones debut of error with an empty tank is set to FALSE und as a result, the DKVS is deactived against the error diagnosis.

The bit B_dkvsf is set to TRUE und so error identify is enabled, if
a) the integrator is exceeded the value MLDKVSF(B_kvsffl=TRUE).
b) in case of start (C_ini=TRUE) if the bit B_imlkvse is set to FALSE

Partial function block DKVSERR(2) :

This partial function consists of four further partial functions (RKATERR(2), FRAUERR(2), FRAOERR(2), RKAZERR(2)). The task of each partial function is the formation of the error bit E_xyz(2) and the formation of the flag error type (B_mnxyz(2), B_mxxyz(2)). Since these partial functions all show the same structure here only the partial function FRAUERR is described.

Description of the partial function FRAUERR:

- Formation of the flags E_frau, B_mxfrau and B_mnfrau

If in case of set cycle flag the adaptation value frau_w reaches resp. exceeds the upper diagnosis threshold FRAUDX resp. the lower diagnosis threshold FRAUDN and the bit tank empty is enabled then E_frau is set to TRUE. When the cycle flag Z-frau is set the error type B_mxfrau is detected if frau_w is greater than or equal to the diagnosis threshold FRAUDX and the errors B_mnfrau are detected if the adapation value frau_w is less than or equal to the diagnosis threshold FRAUDN.

In addition to the error flag E_frau a quick error message for the blocking of other diagnosis functions in case of an error is needed. In this case the error bit B_efrau is set to TRUE when an error threshold is exceeded. The bit B_efrau is not directly available to other diagnosis functions but the bit B_edkvs(2) is formed by an OR operation of the four error bits B_efrau(2), B_efrao(2), B_erkat(2) and B_erkaz(2).

The error flag is again reset during a drive while the cycle flag is set if frau_w is in the permitted diagnosis range. This means that the error flag can be set and again reset as often as desired during a drive.
The error flag (E_xyz) and the fault type (B_mnxyz, B_mxxyz) are set to FALSE with B_noxyz = TRUE.

Partial function block DKVSST(2) :

This subfunction is needed for a short test. If low pass filtered frm_w(2)-signal has stabilized, the error flags E_frst(2), B_mxfrst(2) (max. permissible frm_w(2)-value) oder B_mnfrst(2) (min permissible frm_w(2)-value) are set in relatet of diagnosis thershold FRMSTDX resp. FRMSTDN.
The frm_w(2) signal has stabilized, if the time TFRMST is passed and the change of frm_w(2) is less then DFRMST. If the time TFRMZST is passed and the change of frm_w(2) ist not less then DFRMST, the error flags E_frst(2), B_npfrst(2) (für unplausible signal) and the cycle flag Z_frst are set of TRUE.

The time counter and the low pass filter are enabled, if
- canister purge is not active (B_te = FALSE).
- lambda closed loop control is active (B_lr(2) = TRUE).
- the function request will be actived by the tester (B_fa and B_fakvs are TRUE).
- condition clear failure path FRST (B_clfrst(2) = TRUE and C_fcmclr) are not set

With cancel of the function request the cycle flag, the error flag, und the error type flags are unchanged (Z_frst(2), E_frst(2), B_mxfrst(2), B_mnfrst(2) and B_npfrst(2)). A reset of the cycle flag is done at engine start (C_ini).

If there is no error detected a Reset of the error flag is possible if the thresholds are not exceeded while the positive slope of B_frste is detected.

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APP DKVS 17.60 Application hint

A p p l i c a t i o n p r o c e s s :

It is sensible to start the application of the DKVS only once the application of the Lambda controller, of the transient control, of the charge acquistion, of the torque management and of the idle speed control has been terminated. In the mixture adaptation especially adapation speeds (ZKFRAU,...) and the adaptation ranges (MLU2,...) shall be determined. In the LRA reduced thresholds shall be set to maximum thresholds (FRAURX = FRAUMX, FRAURN = FRAUMN, RKATRX = RKATMX, RKAZRN = RKAZMN, a.s.o.).

An exception is RKATRN.

Application of the partial function DKVSGAE :

A p p l i c a t i o n v a l u e s

TFRA	Detection time for stabilized basic adaptation of FRAU	[8..10..12] sec
TRKA	Detection time for stabilized basic adaptation of RKAT or RKAZ	[4...6...8] sec
FRAE	Delta-FRAU for detection of the stabilized adaptation value FRAU	[0,01..0,03..0,05]
RKAE	Delta-RKAT resp. RKAZ for detection of the stabilized adaptation value RKAT resp. RKAZ	[0,2..0,6..1,0] %

The values indicated in the middle are reference values

By means of the partial function DKVSGAE the adaptation values FRAU and alternative RKAT (HFM system) or RKAZ (P-load acquistion) are checked for stabilization.

Frau_w is the lower multiplicative adaptation correction. A multiplicative error only differs significantely from an additive error if air masses >> idle speed air mass. For this reason the application values TFRA and FRAE should be chosen such that the bit B_gaefra can be set in the FTP75 in the large hill.

The choice of the value FRAE is directly dependent on the adaptation speed ZKFRAU. It should be chosen such that in case of a frm_w deviation from the neutral value 1.0 by 3% to 7% B_gaefra(2) is just not set. A multiplicative error can be simulated e.g. by an adjustable pressure controller. It should be possible to adjust the pressure between 1 and 6 bar so that a delta Lambda of — 25 % can be adjusted. In future the CARB also allows an error simulation by manipulation of the ECU (e.g. multiplication of the injection time by a factor).

RKAZ resp. RKAT are the additive adaptation correction values and they act significantely in the low load range respectively load / engine speed range. The application values TRKA and RKAE should be chosen such that the bit B_gaeing(2) can be set in the FTP75 during idling after the big hill. Here again the value RKAE depends on the adaptation speed ZKRKAZ resp. ZKRKAT. It should be chosen in such a way that in case of a frm deviation by more than 3% - 7% no stabilization is detected.
Via the code word CPLRA it is possible to switch from the detection of RKAT having stabilized to RKAZ having stabilized. It is recommendable to deactivate the integrator in %LRA which was not checked for stabilization via the code word NOLRA. An additive error can be simulated by a leakage after the HFM in the intake manifold. A leakage of 3-4 mm diameter proofed itself useful for a certification on a 2.4 l engine. With lager holes it may happen that the engine no longer starts. Leakage air can also be simulated by a drop-off of the crankcase purge pipe (if there is one).

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Application of the partial function DKVSZYK :

A p p l i c a t i o n v a l u e s

TFRAUZ	Waiting time for the forced setting of the adaption correction FRAU	[20..30..50] sec
TFRAOZ	Waiting time for the forced setting of the adaption correction FRAO	[20..30..50] sec
TRKATZ	Waiting time for the forced setting of the adaption correction RKAT	[20..30..50] sec
TRKAZZ	Waiting time for the forced setting of the adaption correction RKAZ	[20..30..50] sec

The values indicated in the middle are reference values

By means of the partial function DKVSZYK the cycle flags for all adaptation ranges are set. The cycle flag is either set by the bit B_gaefra for FRAU and B_gaeing for RKAT resp. RKAZ or after an adjustable time has passed.

The cycle flags Z_rkat and Z_rkaz may only be set during a drive once a mixture error can reliably be detected by the integrator (RKAT resp. RKAZ) assigned to it. It must for example be definately ruled out that a multiplicative error after engine start and long idling leads to an error message in the additive range.
Such false messages can be ruled out if the demand is made that the adaptation first must be active in the frau range for a certain time (TFRAUZ) before it then is active for another time in the RKAT resp. RKAZ range (TRKATZ,TRKAZZ).
For the FTP-72 test without error in the fuel supply system the times TRKATZ and TFRAUZ are too long. A quicker setting is necessary. For this the information basic adaptation stabilized (B_gaefra resp. B_gaeing) can be used.

Application of block DKVS enable:

Application values :

MLDKVSF : Air mass threshold for fault enable [8....10....15] Kg
MLDKVSF is to choose graeter then the air mas value, which could be sucked in only after first low fat e.g. by not straight standing auto until finally auto standstill by e.g. straight auto position.

MLDKVSG : air mas threshold for intergrator to set of zero [10....20....30] Kg
MLDKVSG is the air mas, which must flow in motor for verification of fil up. After this the DKVS is free for closing by repeated fault with empty tank. MLDKVSG must be not to less, so that by a real error DKVS with toggelbehavior of bit B_edkvs it dose not occur an erroneously closing.

IMLKVSMX: air mas threshold for integrator to set of zero [50....80...100] Kg
IMLKVSMX is introduced, with them a reset of integrator occurs anyway. IMLKVSMX is to choose higher then air mass, which in 2 FTP75 tests could be sucked in.

Remark : The Values indicated in the middle are recommend reference values.

Application of the partial function DKVSERR :

A p p l i c a t i o n v a l u e s

FRAUDX	upper diagnosis threshold FRAU	[1,2...1,23...1,25]
FRAUDN	lower diagnosis threshold FRAU	[0,75..0,77...0,80]
FRAODX	upper diagnosis threshold FRAO	[1,2...1,23...1,25]
FRAODN	lower diagnosis threshold FRAO	[0,75..0,77...0,80]
RKATDX	upper diagnosis threshold RKAT	[7.....8,5....10,0] %
RKATDN	lower diagnosis threshold RKAT	[-10..-8,5....-7,0] %
RKAZDX	upper diagnosis threshold RKAZ	[7.....8,5....10,0] %
RKAZDN	lower diagnosis threshold RKAZ	[-10..-8,5....-7,0] %

The values indicated in the middle are reference values.

The diagnosis thresholds must be entered into the permissible adaptation range (lift). The thresholds are to be determined such that an error fitted in the fuel supply system which results in the emission limit being exceeded by more than factor 1.5 definitely causes the error threshold to be reached in the FTP72 test. The diagnosis threshold should be adjusted in such a way that if the crankcase purge pipe drops off a leakage air error is detected (new CARB requirement).

In order to avoid undesired error messages under certain conditions (hot fuel, very high intake air temperature) reduced adaptation limits were introduced in the LRA, of which, however, only RKATRN shall be used.
These adaptation limits are to be adjusted to the determined diagnosis thresholds. The following conditions shall apply:

set FRAURX = FRAUMX and FRAURN = FRAUMN; i.e. no reduced threshold for FRAU
set FRAORX = FRAOMX and FRAORN = FRAOMN; i.e. no reduced threshold for FRAO

set RKATRX = RKATMX.
RKATRN approx. 2% - 3% Delta Lambda (related to rl during idling) above diagnosis threshold RKATDN

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The 2% - 3% Delta Lambda must be maintained, so that "further adaptation into the wrong direction" for a short time after the next cranking (where the extended correction thresholds are again released) cannot lead to an error message.

set RKAZRX = RKAZMX and RKAZRN = RKAZMN; i.e. no reduced threshold for RKAZ

Maximum resp. minimum limits (FRAUMX,...,FRAOMN,...) should lie approx. 2% - 3% Delta-Lambda above resp. below the diagnosis thresholds.

```
- - - - - - - - - - - - - FRAUMX = FRAURX (upper adaptation limit)
_____________________ FRAUDX          (upper diagnosis threshold)

-.-.-.-.-.-.-.-.- FRAUDN          (lower diagnosis threshold)
_.._.._.._.._.._ FRAUMN = FRAURN (lower adaptation limit)
```

Application of the partial function DKVSST :

A p p l i c a t i o n v a l u e s

ZFRMST	Low pass time constant für frm_w(2)-signal	[3,0...5,0....10,0] sec
TFRMST	Detection time for stabilized of frm_w(2)-signal	[3,0...15,0...30,0] sec
TFRMZST	Waiting time for the unplausible frm_w(2)-signal	[20,0..50,0...50,0] sec
DFRMST	Delta-frm for detection of the stabilized frm_w(2)-signal	[0,01..0,03...0,05]
FRMSTDX	upper diagnosis threshold for frm_w(2)-signal short test	[1,2...1,23...1,25]
FRMSTDN	lower diagnosis threshold for frm_w(2)-signal short test	[0,75..0,77...0,80]

The values indicated in the middle are reference values.

The detection time for stabilized frm_w(2)-signal TFRMST should be choosen laset 3 time of low pass time constans.
The diagnositc thresholds (FRMSTDX and FRMSTDN) must be entered into the permissible control range (lift) and less then diagnositc threshold of FRAU. The thresholds are so to define, such that a fitted error in the fuel supply system, which in stationary state exceeds the error threshold of FRAU, with certainty reachs the error threshold (FRMSTDX resp. FRMSTDN).
The time threshold TFRMZST should be greater then time threshold TFRMST.

GGMFL 1.70 Sensor variable for multi-function steering wheel

FGRUE 2.10 Overview of vehicle-speed controller

FDEF FGRUE 2.10 Function definition

fgrue-fgrue

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ABK FGRUE 2.10 Abbreviations

FB FGRUE 2.10 Detailed description of function

Functionality of the road speed controller

The task of the road speed controller (FGR) is to keep the speed of the vehicle at a constant level, independent of the travelling resistance, without an accelerator pedal having to be operated. Apart from maintaining the current speed (cruise) it is also possible to approach a stored target speed (resume), to accelerate and to decelerate as well as to increase or decrease the desired speed in small steps (tip-up and tip-down) and to adopt the current vehicle speed as desired speed (set).

The control of the FGR by the driver takes place by means of a special actuator which has switches for the functions set, resume, accelerate and decelerate. Dependent on the layout of the actuator more than one function can be assigned to a switch (e.g. one function key for set/decelerate and one for resume/accelerate), since it can be definitely told from the state of the FGR and from the duration for which the switch is operated which function shall be performed. The functions tip-up resp. tip-down are activated by a quick operating of the accelerate resp. decelerate switches.

Apart from the function switches the actuator optionally has a main switch and a switch by which to switch the FGR off. Characteristic of the main switch is that is must be switched on so that operating of the the function switches is at all registered. If the main switch is turned off a desired speed which was previously stored is lost. Apart from by the main switch, the FGR can also be switched off by using the break or the clutch.

If the FGR is switched on the driver can adjust a higher engine performance by operating the accelerator and thus speed up the vehicle (override). In the meantime the FGR remains active in the background and re-adjusts the previously set desired speed once the driver releases the accelerator.

Adaptive Cruise Control (ACC)

As an alternative to the normal FGR also an externally realized adaptive cruise control (ACC) can be used which communicates with the ME via CAN. The CAN module automatically detects the presence of an ACC Electronic Control Unit and it is indicated by the setting of B_acc. In this case the ME-FGR is deactivated, however, the enabling and cut-out of the torque-increasing intervention of the ACC control unit is still monitored by means of the actuator signals as well as by the break and clutch switch.

Program structure

The described functionality is realized by the functions shown in the overview diagram. It fulfills the following tasks:

GGFGRH: Conditioning of the actuator signals and conversion of the information to the standardized interface;
BBFGR: Monitoring of the enabling and cut-out conditions;
FGRMD: Function logic and control algorithm;
FGRAUS: Limitation of the FGR actuating signal dependent on enabling and cut-out conditions and realization of the switch-off ramp.

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APP FGRUE 2.10 Application hint

BBFGR 3.60 Switch-on and switch-off conditions for vehicle-speed controller

FDEF BBFGR 3.60 Function definition

bbfgr-bbfgr

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bbfgr-einsch

EINSCH: Switch-on conditions

bbfgr-ab-rev-l

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AB_REV_L: Reversible switch-off conditions (slow switch-off)

bbfgr-ab-rev-s

bbfgr-ab-rev-s

AB_REV_S: Reversible switch-off conditions (quick switch-off)

bbfgr-ab-rv-ext

bbfgr-ab-rv-ext

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AB_REV_S: Reversible switch-off conditions (quick switch-off) during ASC / DSC /ABS

bbfgr-ab-irr

AB_IRR: Irreversible switch-off conditions

bbfgr-ab-e2

AB_E2: Switch-off condition for level 2

ABK BBFGR 3.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
BFGRO			FW	upper limit for acceleration while cruise control is active
BFGRU			FW	lower limit for acceleration while cruise control is active
CWBBFGR			FW	code for BBFGR
CWBFGROF			FW	code word for BBFGR for external shutdown demands
DVAQUGMX			FW	max. permitted velocity difference during aquaplaning and high speed
DVAQUKMX			FW	max. permitted velocity difference during aquaplaning and low speed
DVFGREO			FW	delta-velocity for upper velocity to switch on cruise control
DVFGREU			FW	delta-velocity for lower velocity to switch on cruise control
DVIVZMX			FW	max. permitted deviation between actual speed and target speed in cruising mode

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Parameter	Source-X	Source-Y	Type	Description
DVZVIMX			FW	max. permitted deviation between target speed and actual speed in cruising mode
GAFGRO			FW	max. permitted gear during active cruise control
GAFGRU			FW	min. permitted gear during cruise control is active
NFGRMAX			FW	max. permitted speed during cruise control ist active
TDVIVZ			FW	tolerance time of high deviation between actual and target velocity
TDVZVI			FW	tolerance time of high deviation between target and actual velocity
TFGRAQU			FW	tolerance time for aquaplaning detection during cruise control
TFGRARLG	GANGI		KL	ramp running time during CC slow switch off
TFGRASCOF			FW	switch off time cruise control on ASC active
TFGRBREOF			FW	switch off time cruise control during brake intervention
TFGRDSCOF			FW	switch off time cruise control on DSC active
TFGRUEOB			FW	tolerance time for violation of upper acceleration threshold
TFGRUM			FW	Tolerance time for detection of FGR-mode in function monitoring
TFGRUNUB			FW	tolerance time for violation of lower acceleration threshold
VBGFGRAQ			FW	speed range during aquaplaning detection
VFGRMAX			FW	max. permitted velocity during active cruise control
VFGRMIN			FW	Minimum permissible speed during FGR-operation
VREGLMAX			FW	max. permitted desired speed for cruise control
VREGLMIN			FW	min. permitted desired speed for cruise control

Variable	Source	Type	Description
BFZGLFGR	BGVFGR	EIN	Automobile acceleration in the longitudinal direction
B_ACC	CANACC	EIN	Condition: ACC-control unit exists
B_ASC_REG	CANASR	EIN	CAN-message: ASC in action (with break intervention)
B_ASR	MDKOG	EIN	condition for ASR active
B_ASREXT	CANASR	EIN	condition for externe ASR
B_BREMS	GGEGAS	EIN	condition: brake operated
B_DKNOLU	SREAKT	EIN	condition: power supply of throttle actuator cut off
B_DKPIU	SREAKT	EIN	Condition: irreversible SKA
B_DSC_REG	CANASR	EIN	CAN message: DSC controls (engine and braking interventions)
B_EVFZGV1	CANASR	EIN	Condition error in speed signal V1 (via CAN)
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_FGRAB	BBFGR	AUS	CC/ACC shut-off from the function
B_FGRABZ	BGVFGR	EIN	Condition additional FGR shutdown
B_FGRAEXT	BBFGR	LOK	condition: cruise control switch off on ASC/DSC
B_FGRAI	BBFGR	AUS	condition: cruise control deactivation is not reversible
B_FGRAL	BBFGR	LOK	condition: cruise control slow switch off
B_FGRARS	BBFGR	LOK	condition: reversible cruise control fast switch off
B_FGRAS	BBFGR	AUS	condition: cruise control fast switch off
B_FGRAT	GGMFL	EIN	condition: tip-switch off CC lever control
B_FGREN		EIN	condition: cruise control is active (enable)
B_FGRENV	BBFGR	AUS	Condition: preliminary FGR-control active (Enable)
B_FGRES	BBFGR	LOK	condition: cruise control is switched on
B_FGRESV	BBFGR	AUS	Condition: FGR-switching on condition reached
B_FGRHE	GGMFL	EIN	condition: CC-lever fault
B_FGRHSA	GGMFL	EIN	condition: CC main switch off
B_FGRKF		EIN	condition: cruise control in cruising mode
B_FGRTBE	GGMFL	EIN	condition: Cruise control button ACCELERATE
B_FGRTSE	GGMFL	EIN	condition: CC button (+ or -) set
B_FGRTVE	GGMFL	EIN	condition: Cruise control button DECELERATE
B_FGRTWA	GGMFL	EIN	condition: Cruise control button RESUME
B_FGR_UM	UFUE	EIN	CC/ACC torque intervention in function monitoring permitted
B_GWHS	BBGANG	EIN	Condition gear change on manual transmission vehicle
B_HDC	CANASR	EIN	Condition hill desent control active
B_KUPPL	GGEGAS	EIN	EGAS Condition cluch is disengaged
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_MSREXT	CANASR	EIN	Condition external MSR demand
B_PWGNOTFR	GGPED	EIN	FR error reaction pedal-travel sensor limphome
C_INI		EIN	ECU-condition for intialisation
E_BREMS	GGEGAS	EIN	error flag: brake pedal signal
E_CAS	DCAS	EIN	errorflag: CAN-interface, timeout ASC
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
GANGI	BBGANG	EIN	Engaged gear
NMOT	BGNMOT	EIN	engine speed
VFGRRF_W	BGVFGR	EIN	cruise control reference vehicle speed
VFGR_W	BGVFGR	EIN	cruise control vehicle speed
VZIEL_W	FGRMD	EIN	target velocity cruise control

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FB BBFGR 3.60 Detailed description of function

The function controls the enabling and switch-off of the road speed controller (FGR). If a switch-off conditon is fulfilled the FGR cannot be activated. When switching off the active FGR a distinction is made between comfort switch-off and quick switch-off as well as between reversible and irreversible switch-off. With the comfort switch-off the controller output is made to reach zero via a ramp with gear-dependent running time, whereas with the quick switch-off the controller output is immediately set to zero. Reversible switch-off means that the FGR can be reactivated during the current driving cycle while with irreversible switch-off a reactivation is not possible during the current driving cycle. Certain switch-off conditions are ineffective if an ACC Electronic Control Unit exists so as not to impair the ACC functionality.

EINSCH

Checking of the switch-on condition:

o positive edge on one of the function keys of the actuator
o vehicle speed within the permitted range (ineffective with ACC)

AB_REV_L

Checking of the switch-off conditions which lead to a reversible comfort switch-off:

o main switch on actuator off
o OFF button on actuator operated
o vehicle speed exceeds the target speed during cruising for longer than TDVIVZ by more than DVIVZMX (ineffective with ACC)
* vehicle speed undershoots the target speed during cruising for longer than TDVZVI by more than DVZVIMX (ineffective with ACC)

AB_REV_S

Checking of the switch-off conditions which lead to a revesible quick switch-off:

o break or clutch operated
o engine speed greater than NFGRMAX
o gear not in permitted range (GAFGRU up to GAFGRO)
o ASR-interaction active (only if bit 0 is not set in CWBBFGR, ineffective with ACC)
o Aquaplaning detected due to a non-plausiblity between the speed signal from the driven axle and from the non-driven axle (only if bit 1 is set in CWBBFGR, ineffective with ACC)
o vehicle speed less than VFGRMIN or greater than VFGRMAX (ineffective with ACC)

AB_IRR

Checking of the switch-off conditions which lead to an irreversible quick switch-off:

o PWG default operation (only if bit 2 is set in CWBBFGR)
o DK drive default operation
o engine speed limitation via injection deactivation due to DK error
o error during plausibility check of the stop lights switch
o error during speed recording
o error on the FGR actuator
o vehicle acceleration less than BFGRU for longer than TFGRUNUB (ineffective with ACC)
o vehicle acceleration greater than BFGRO for longer than TFGRUEOB and no override occurring (ineffective with ACC)

AB_E2

For the watchdog function the information that a switch-off condition is fulfilled is made available. In case of a comfort switch-off the message is passed on to the watchdog function only once the ramp running time has elapsed. Since the watchdog function is performed in the 40 ms grid the switch-off information B_fgrab is kept for a sufficiently long time so that it will definitely be registered in the watchdog function.

APP BBFGR 3.60 Application hint

Configuration via CWBBFGR

Bit 0
0: FGR switch-off in case of ASR interaction
1: No FGR switch-off in case of ASR interaction

Bit 1
0: No detection of aquaplaning
1: Detection of aquaplaning with 2. V signal

Bit 2
0: FGR operation possible with PWG limp home
1: Irreversible FGR is forbidden with PWG limp home

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BGVFGR 1.20 Calculated speed for vehicle-speed controller

FDEF BGVFGR 1.20 Function definition

bgvfgr-bgvfgr

ABK BGVFGR 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ZFMVRV			FW	time constant for filter vehicle speed signal

Variable	Source	Type	Description
BFZGLFGR	BGVFGR	AUS	Automobile acceleration in the longitudinal direction
B_ASC1COK	CANASR	EIN	condition CAN-ASC1 message with o.k. status
B_EVFZGV1	CANASR	EIN	Condition error in speed signal V1 (via CAN)
B_FGRABZ	BGVFGR	AUS	Condition additional FGR shutdown
C_INI		EIN	ECU-condition for intialisation
E_KUPPL	DKUPPL	EIN	error flag: clutch pedal signal
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
R_T20		EIN	Time schedule 20 ms
VFGRRF_W	BGVFGR	AUS	cruise control reference vehicle speed
VFGR_W	BGVFGR	AUS	cruise control vehicle speed
VFZGV1_W	CANASR	EIN	Vehicle speed, CAN signal
VFZG_W	GGVFZG	EIN	Vehicle speed
VFZV1F_W	BGVFGR	LOK	vehicle speed, CAN signal v1 filtered

FB BGVFGR 1.20 Detailed description of function

The function computes the output variables vfgr_w and vfgrrf_w for the functions "vehicle-speed controller". Input variable is the average speed from the front wheels as computed by the TCR (traction control system) ECU. The vfzgv1_w signal made available in the CAN module is filtered by the time constant (intermediate variable vfzv1f_w) and made available as the output variable vfzgv1_w. The variable vfzg_w is calculated and made available as a substitute value in the event of an interruption in CAN by E_cas or a vfzgv1 signal incorrectly identified by B_evfzgv1 = TRUE. Besides the vehicle speed, bfzgfgr is formed for the vehicle acceleration in the longitudinal direction and is also used by the vehicle-speed controller as an imput variable.

vfzg_w is computed from the driven wheel and is used as the reference speed vfgrrf_w for the vehicle-speed controller. Switchover to vfgr_w is made by E_vfz in the event of a fault.

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APP BGVFGR 1.20 Application hint

FGRMD 4.10 Function logic and control algorithm of vehicle-speed controller

FDEF FGRMD 4.10 Function definition

fgrmd-fgrmd

fgrmd-fktanf

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FKTANF: Function requests from key signals

fgrmd-egzstaut

fgrmd-egzstaut

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EGZSTAUT: Input values for state machine

fgrmd-statemachi

STATEMACHI: State machine for FGR control

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```
State
|     Transition name   ┌─ Transition condition
|     |     Actions     ├─ Action code
|     |     |           |
V     V     V           V
```

```
Off                     Reset condition: NOT B_fgrenv                    ── This is the reset state, it is entered from all
                                                                            states if the reset condition is
                                                                            fulfilled.

          Entry:        B_fgrakt:= false;
                        B_fgrra:= false;
          Action:       B_uebvau:= false;
          Exit:         B_uebvau:= false;
     Off_Res:           B_twap AND vziel_w > vfgr_w AND B_fgresv
     Off_Cru:           (B_tsent OR B_tsenh OR (B_twap AND (vziel_w > 0 OR CWFGRMD & 4 > 0))) AND B_fgresv
          Action:       if (B_twap AND vziel_w > 0) then
                            B_wavo:= true;
                        endif;
     Off_Acc:           B_tbeph AND B_fgresv
     Off_Coa:           B_tveph AND CWFGRMD & 8 > 0 AND B_fgresv
```

```
Cruise
          Entry:        B_fgrkfm:= true;
                        B_fgrakt:= true;
                        B_fgrra:= false;
          Action:       B_uebrkf:= false;
                        if (B_tsent) then
                            B_kfnb:= false;
                            B_kfnv:= false;
                        endif;
                        B_wavo:= false;
          Exit:         B_fgrkfm:= false;
                        B_kfnb:= false;
                        B_kfnv:= false;
                        B_uebrkf:= false;
                        B_wavo:= false;
     Cru_Acc:           B_tbeph OR (B_tbep AND B_tpuerl)
     Cru_Coa:           B_tveph OR (B_tvep AND B_tpderl)
     Cru_Res:           vziel_w - vfgr_w > DVZVIWA
```

```
Resume
          Entry:        B_fgrakt:= true;
                        B_fgrra:= true;
                        B_wiauf:= true;
          Exit:         B_wiauf:= false;
     Res_Acc:           B_tbeph AND (NOT (CWFGRMD & 1 > 0))
     Res_Coa:           B_tveph AND (NOT (CWFGRMD & 2 > 0))
     Res_Cru:           B_tsent OR vfgr_w >= vziel_w
          Action:       if (NOT B_tsent) then
                            B_uebrkf:= true;
                        endif;
```

```
Accel
          Entry:        B_fgrakt:= true;
                        B_fgrra:= true;
                        B_besch:= true;
          Exit:         B_besch:= false;
                        if (NOT B_fgrenv) then
                            B_uebvau:= true;
                        endif;
     Acc_Cru:           B_tbenh OR vfgr_w >= vrbemx_w
          Action:       B_kfnb:= true;
     Acc_Tpu:           B_tbent
          Action:       B_uebetu:= true;
```

```
Tipup
          Entry:        B_fgrakt:= true;
                        B_fgrra:= true;
                        B_tpup:= true;
          Action:       B_uebetu:= false;
          Exit:         B_uebetu:= false;
                        B_tpup:= false;
     Tpu_Acc:           B_tbeph OR (B_tbep AND B_tpuerl AND anztpup < ANZTPMX)
     Tpu_Coa:           B_tveph OR (B_tvep AND B_tpderl)
     Tpu_Cru:           vregl_w >= vziel_w
          Action:       B_uebrkf:= true;
```

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```
Coast
          Entry:      B_fgrvem:= true;
                      B_fgrakt:= false;
                      B_fgrra:= false;
          Exit:       B_fgrvem:= false;
                      if (NOT B_fgrenv) then
                          B_uebvau:= true;
                      endif;
     Coa_Cru:         B_tvenh OR vfgr_w <= vrvemn_w
          Action:     B_kfnv:= true;
     Coa_Tpd:         B_tvent
          Action:     B_uevztd:= true;
```

```
Tipdown
          Entry:      B_fgrakt:= true;
                      B_fgrra:= true;
                      B_tpdn:= true;
          Action:     B_uevztd:= false;
          Exit:       B_uevztd:= false;
                      B_tpdn:= false;
     Tpd_Acc:         B_tbeph OR (B_tbep AND B_tpuerl)
     Tpd_Coa:         B_tveph OR (B_tvep AND B_tpderl AND anztpdn < ANZTPMX)
     Tpd_Cru:         vregl_w <= vziel_w
          Action:     B_uebrkf:= true;
```

fgrmd-tip-zaehl

fgrmd-tip-zaehl

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TIP_ZAEHL: Tip-counter

fgrmd-bed

BED: Conditions for FGR controller

fgrmd-vregl

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VREGL: Calculation of the desired speed for FGR controller

fgrmd-ramp

RAMP: Acceleration and coast ramps

fgrmd-vziel

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VZIEL: Calculation of the target speed

fgrmd-fgregl

fgrmd-fgregl

FGREGL: Control algorithm

fgrmd-fgrpara

fgrmd-fgrpara

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FGRPARA: Parameter for FGR controller

fgrmd-voffs

VOFFS: Calculation of the offset speed

fgrmd-antisr

ANTISR: Antijerking function

ABK FGRMD 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZTPMX			FW	maximum number of tips (one after the other)
BRABEVI	VFGR_W		KL	acceleration at accelerating ramp
BRATD			FW	acceleration (amount) at tip-down ramp
BRATU			FW	acceleration at tip-up ramp
BRAWA1GA	VFGR_W		KL	acceleration resuming ramp in Lande-mode range 1
BRAWA2GA	VFGR_W		KL	acceleration resuming ramp in Lande-mode range 2
BRAWA3GA	VFGR_W		KL	acceleration resuming ramp in Lande-mode range 3
BRAWAVI	VFGR_W		KL	acceleration resuming ramp
CWFGRMD			FW	code for FGRMD
DVIVZTMX			FW	maximum delta between actual and target speed for tip permission

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Parameter	Source-X	Source-Y	Type	Description
DVSAVO			FW	delta velocity to set prohibited trailing throttle fuel cutoff
DVSAVU			FW	delta velocity to remove prohibited trailing throttle fuel cutoff
DVSKNBGA	GANGI		KL	delta velocity for set value correction after acceleration
DVSKNVGA	GANGI		KL	delta velocity for set value correction after deceleration
DVTIPUD			FW	changing actual speed at tip-up or tip-down
DVZVITMX			FW	maximum delta between target and actual speed for tip permission
DVZVIWA			FW	delta between target and actual speed for transition cruising to resuming
DVZVRWA1			FW	delta between target and actual speed for transition in WA-Lande-mode range 1
DVZVRWA2			FW	delta between traget and actual speed for transiton in WA-Lande mode range 2
DVZVRWA3			FW	delta between target and actual speed for transition in WA-Lande mode range 3
KFVOFFS	VZIEL_W	GANGI	KF	velocity offset for cruise control
KKFFGRGA	GANGI		KL	amplification rate during cruising for cruise control
KRAFGRGA	GANGI		KL	amplification rate at ramp for cruise control
MRFGRMAX			FW	maximum value for relative torque request from cruise control
MRFGRMR	MRREGL_W		KL	FGR correction characteristic
MRFGRSTA			FW	starting value for relativ torque at active cruise control
MRMRFGR	MRFGRI_W		KL	Inverse FGR correction characteristic
TFGRTP			FW	time for tip detection for cruise control buttons
TN2FGRGA	GANGI		KL	double denominator time constant for cruise control
TSWKNBGA	GANGI		KL	time to set value correction after acceleration finished
TSWKNVGA	GANGI		KL	time to set value correction after deceleration finished
TVLADV	DVZVI_W		KL	Integrator time constant at vlast-calculation
TZ2FGRGA	GANGI		KL	double numerator time constant for cruise control
VFGRMAX			FW	max. permitted velocity during active cruise control
VFGRMIN			FW	Minimum permissible speed during FGR-operation
VLMXVZ	VZIEL_W		KL	Max. value for vlast_w
VREGLMAX			FW	max. permitted desired speed for cruise control
VREGLMIN			FW	min. permitted desired speed for cruise control

Variable	Source	Type	Description
ANZTPDN	FGRMD	LOK	number of Tip-Downs (one after the other)
ANZTPUP	FGRMD	LOK	number of Tip-Ups (one after the other)
B_BESCH	FGRMD	LOK	condition: cruise control in acceleration mode
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_FGRAKT	FGRMD	LOK	condition: cruise control is active
B_FGRDVI	FGRMD	LOK	condition: CC initialization of the saved system deviation
B_FGRENE	FGRMD	AUS	Condition: FGR-controller active (enable) extended
B_FGRENV	BBFGR	EIN	Condition: preliminary FGR-control active (Enable)
B_FGRESV	BBFGR	EIN	Condition: FGR-switching on condition reached
B_FGRHSA	GGMFL	EIN	condition: CC main switch off
B_FGRKFM	FGRMD	AUS	condition: cruise control in cruising mode (ME)
B_FGRRA	FGRMD	LOK	condition: cruise control ramp
B_FGRTBE	GGMFL	EIN	condition: Cruise control button ACCELERATE
B_FGRTSE	GGMFL	EIN	condition: CC button (+ or -) set
B_FGRTVE	GGMFL	EIN	condition: Cruise control button DECELERATE
B_FGRTWA	GGMFL	EIN	condition: Cruise control button RESUME
B_FGRVEM	FGRMD	AUS	condition: cruise control in decelerating mode (ME)
B_KFNB	FGRMD	LOK	condition: cruising after acceleration
B_KFNV	FGRMD	LOK	condition: cruising after deceleration
B_SAVM	FGRMD	AUS	condition: prohibited trailing throttle fuel cutoff of cruise control (from ME)
B_SWKNB	FGRMD	LOK	condition: set value correction after acceleration
B_SWKNV	FGRMD	LOK	condition: set value correction after deceleration
B_TBENH	FGRMD	LOK	condition: button ACCELERATE negative edge after holding
B_TBENT	FGRMD	LOK	condition: button ACCELERATE negative edge after tip
B_TBEP	FGRMD	LOK	condition: button ACCELERATE positive flank
B_TBEPH	FGRMD	LOK	condition: button ACCELERATE positive flanl hold
B_TPDERL	FGRMD	LOK	condition: tip-down permitted
B_TPDN	FGRMD	AUS	condition: cruise control in tip-down mode
B_TPUERL	FGRMD	LOK	condition: tip-up permitted
B_TPUP	FGRMD	AUS	condition: cruise control in tip-up mode
B_TSENH	FGRMD	LOK	condition: set button negative edge after holding
B_TSENT	FGRMD	LOK	condition: set button negative edge after tip
B_TVENH	FGRMD	LOK	condition: button decelerate negative edge after holding
B_TVENT	FGRMD	LOK	condition: button decelerate negative edge after tip
B_TVEP	FGRMD	LOK	condition: button decelerate positive flank
B_TVEPH	FGRMD	LOK	condition: button decelerate positive flank hold
B_TWAP	FGRMD	LOK	condition: resume button positive flank
B_UEBETU	FGRMD	LOK	condition: transition from acceleration to tip-up
B_UEBRKF	FGRMD	LOK	condition: transition from limiting ramp to cruising mode is effected
B_UEBVAU	FGRMD	LOK	condition: transition acceleration or deceleration to switch off is effected
B_UEVZTD	FGRMD	LOK	condition: transition from deceleration to tip-down is effected
B_WAVO	FGRMD	LOK	Condition: resume from above
B_WIAUF	FGRMD	AUS	condition: cruise control in resuming mode
DVRABE_W	FGRMD	LOK	delta velocity at acceleration ramp
DVRAVE_W	FGRMD	LOK	delta velocity at deceleration ramp
DVZVI_W	FGRMD	LOK	Difference between target- and actual velocity
GANGI	BBGANG	EIN	Engaged gear
KFGR_W	FGRMD	LOK	Amplification factor FGR-controller
MRFGRI_W	FGRMD	LOK	Relative torque initialization value for FGR-controller
MRFGRM_W	FGRMD	AUS	relativ torque request from cruise control (from ME)
MRFGR_W	FGRAUS	EIN	relative torque demand from cruise control

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Variable	Source	Type	Description
MRPED_W		EIN	Relative torque request by accelerator pedal
MRREGL_W	FGRMD	DOK	relative torque controller output FGR
MRRGLI_W	FGRMD	LOK	Initialization value relative torque for FGR controller
TN2FGR_W	FGRMD	LOK	double denominator time constant cruise control
TZ2FGR_W	FGRMD	LOK	double numerator time constant cruise control
VFGR_W	BGVFGR	EIN	cruise control vehicle speed
VLAST_W	FGRMD	LOK	Additional offset of the velocity for FGR-controller at higher load
VOFFS_W	FGRMD	LOK	offset velocity for cruise control
VRBEMX_W	FGRMD	LOK	maximum value for vregl_w during acceleration
VREGL_W	FGRMD	LOK	desired speed for cruise control
VRVEMN_W	FGRMD	LOK	minimum value for vregl_w during deceleration
VZIEL_W	FGRMD	AUS	target velocity cruise control

FB FGRMD 4.10 Detailed description of function

The function contains the function logic and the control algorithm for the road speed controller (FGR).

FKTANF

In this partial function the key signals from the evaluation of the actuator are processed for the FGR function control. With the function keys on the FGR actuator a distinction is made between an operation for shorter than TFGRTP (tip) and an operation for longer than TFGRTP (hold). When starting to operate a function key <xyz>, B_t<xyz>p is set for one calculation step. If the function key is continuously operated then after the time TFGRTP, B_t<xyz>ph is set for one calculation step. Dependent on whether the key was operated for longer or for shorter than TFGRTP either B_t<xyz>nh or B_t<xyz>nt is set for one calculation step, once the key is no longer operated. Only those bits are made available which are actually needed in the FGR function control.

<xyz> = se, be, wa, ve

EGZSTAUT

Here, some input values are made available to the FGR function control. The functions tip-up and tip-down are only permitted if there is no override and if the actual speed does not differ too much from the target speed. In addition tip-up is only performed if the controller output is less than the maximum value. Tip-down is only possible if the controller output is greater zero.

Even when the function key is kept on being operated, accelerating and coasting are terminated shortly before the minimum resp. maximum desired speed is reached. No transition to cruising takes place. The abort speeds are formed by taking into consideration the gear-dependent set-value correction.

STATEMACHI

The function logic of the FGR is realized with a state machine. The states OFF, cruise, accelerate, coast, resume, tip-up and tip-down are distinguished. The transitions from one state to another take place dependent on the processed actuator signals, the actual, desired and target speed as well as some additional conditions. For the following calculation of the desired and target speed the information, which state the FGR is in and whether certain transitions were performed is made available.

TIP_ZAEHL

If several tip-ups or tip-downs are performed in succession prior to the corresponding target speed having been reached then the corresponding counters are incremented. This way further tip-ups resp. tip-downs can be prohibited as soon as a maximum permissible amount is exceeded. The counters are reset as soon as the new target speed is reached after a tip-up resp. tip-down.

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BED

For the formation of the desired speed and of the control algorithm the following conditions are calculated:

o Set-value correction after acceleration occurs after a gear-dependent time after transition from accelerating to cruising
o Set-value correction after coast occurs after a gear-dependent time after transition from coasting to cruising
o Re-initialization of the old control deviation to avoid jumps at the controller output takes place, if the controller is activated, at the beginning and at the end of a ramp (resume, accelerate, tip-up, tip-down), in case of setting during cruising as well as in case of corrections of the set value

The information, whether the FGR is active or not is made available as additional output.

VREGL

The desired speed for the controller is changed in the following cases:

o Set-value correction after accelerating: Increase by gear-dependent offset
o Set-value correction after coasting: Decrease by gear-dependent offset
o Acceleration ramp (resume, accelerate, tip-up): Increase by delta according to ramp gradient
o Tip-down ramp: Decrease by delta according to ramp gradient
o Transition from limited ramp (resume, tip-up, tip-down) to cruising or resuming from the top: Set to target speed

In most cases the new desired speed is dependent on the old desired speed. Instead of the old value of the desired speed the actual speed is used in the following cases:

o Setting during cruising
o Beginning of cruising after accelerating
o Activation of the controller
o Beginning of resume

RAMP

For the calculation of the increase resp. decrease of the desired speed per calculation step on accelerating and coasting ramps the corresponding valid value is chosen and converted from the unit m/s^2 into km/h per 20 ms. The desired acceleration with resuming and accelerating is dependent on the actual speed. Here, however, the desired acceleration is reduced in three stages in the landing mode of resuming. For the tip-up and the tip-down ramp there is a corresponding constant desired acceleration. The ramps are stopped if the controller output reaches the maximum resp. the minimum value.

VZIEL

The target speed is changed in the following cases:

o Cruising: Set to the desired speed for the controller
o Main switch off or abort of accelerating or coasting set at bit 5 in CWFGRMD: Set to zero
o Abort of accelerating or coasting not set at bit 5 in CWFGRMD: Set to actual speed
o Transition from accelerating to tip-up ramp: Increase by DVTIPUD (if bit 4 is set in CWFGRMD, set to actual speed plus DVTIPUD)
o Transition from coasting to tip-down ramp: Decrease by DVTIPUD (if bit 4 is set in CWFGRMD, set to actual speed minus DVTIPUD)

FGREGL

A PDT1-controller is used as road speed controller. It has the following transfer function:

$$G(s) = K \frac{1 + T_Z s}{1 + T_N s}$$

For the discrete realization the following recursive formula results:

$$y(i) = \frac{1}{2T_N + dT} \left[K \left[(2T_Z + dT)\, x(i) - (2T_Z - dT)\, x(i-1) \right] + (2T_N - dT)\, y(i-1) \right]$$

x: Control deviation (delta speed)
y: Controller output (relative torque)
dT: Scanning time (20 ms)
i: Calculation step

When activating the controller the old controller output is initialized with the maximum from old controller output, relative torque from the pedal and a fixed value. If the controller is not active (off or coasting) the controller output is set to zero. The used PDT1-controller is not steady-state exact. Therefore the control deviation is additionally increased by a speed- and gear-dependent offset.

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FGRPARA

The following parameters are made available to the controller:

o Gear-dependent numerator time constant
o Gear-dependent denominator time constant that is set equal to the numerator time constant on ramps (switch-over to P-controller)
o Gear-dependent controller amplification, different for cruising and for ramps
o Offset for the control deviation, separated into two parts, of which one is always active and the other only at higher load

VOFFS

During cruising voffs_w is calculated dependent on gear and target speed. As soon as a ramp is started, voffs_w is initialized to a value, at which the controller output does not drop. voffs_w then remains constant in the further course of the ramp.
In order to avoid too large control deviations, vlast_w is calculated as additional offset for the control deviation by using an integrator with varying time constant.

ANTISR

For comfort reasons fuel cut-off during FGR-operation is only allowed if the actual speed exceeds the target speed by a certain amount. The fuel cut-off release is reset by means of hysteresis. During coasting fuel cut-off is allowed in any case.

APP FGRMD 4.10 Application hint

Configuration via CWFGRMD

Bit 0
0: Transition from resume to accelerate possible
1: Transition from resume to accelerate not possible

Bit 1
0: Transition from resume to coast possible
1: Transition from resume to coast not possible

Bit 2
0: Setting during uncontrolled driving not possible with resume key when vziel = 0
1: Setting during uncontrolled driving possible with resume key when vziel = 0

Bit 3
0: Transition from uncontrolled driving to coast not possible
1: Transition from uncontrolled driving to coast possible

Bit 4
0: Set tips to vziel_w
1: Set tips to vfgr_w

Bit 5
0: vziel_w = vfgr_w with deactivation condition during accelerating or coasting ramp
1: vziel_w = 0 with deactivation condition during accelerating or coasting ramp

Bit 6
0: vlast_w can take on values greater than 0
1: vlast_w = 0

Data must always be entered into MRMRFGR inverse to MRFGRMR.

FGRAUS 1.0 Cut-out by vehicle-speed controller

FDEF FGRAUS 1.0 Function definition

fgraus-fgraus

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fgraus-abschra

ABSCHRA: Switch-off ramp

ABK FGRAUS 1.0 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DMRFGRAL			FW	relative delta torque at slow CC switch off
MRFGRMAX			FW	maximum value for relative torque request from cruise control
TFGRARLG	GANGI		KL	ramp running time during CC slow switch off

Variable	Source	Type	Description
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_FGRARI	FGRAUS	LOK	condition: initializing cruise control deactivation ramp
B_FGRAS	BBFGR	EIN	condition: cruise control fast switch off
B_FGREN		EIN	condition: cruise control is active (enable)
B_FGRVER		EIN	condition: cruise control in decelerating mode
DMRAR_W	FGRAUS	LOK	relative delta torque at cruise control deactivation ramp
GANGI	BBGANG	EIN	Engaged gear
MRFGRU_W	FGRAUS	LOK	lower limit for relative torque from cruise control
MRFGRV_W		EIN	relative torque demand from cruise control without limiting
MRFGR_W	FGRAUS	AUS	relative torque demand from cruise control

FB FGRAUS 1.0 Detailed description of function

The task of the function is to limit the controller output of the FGR dependent on enabling and switch-off conditions. With enabled FGR (B_fgren is set) a high limiting to MRFGRMAX and a low limiting to mrfgru_w is performed. Otherwise (B_fgren is not set) a switch-over to mrfgru_w occurs.

ABSCHRA

In case of comfort switch-off or during transition to deceleration the switch-off ramp is started. It starts out from the last mrfgr_w reduced by DMRFGRAL and reaches the value 0 after the gear-dependent time TFGRARLG. The ramp is stopped early if override occurs, if the FGR is activated again or if a condition for quick switch-off is fulfilled. If no switch-off ramp is active then mrfgru_w is 0.

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APP FGRAUS 1.0 Application hint

GGPED 1.50 Sensor variable for accelerator pedal

FDEF GGPED 1.50 Function definition

ggped-ggped

ggped-pwg-plaus

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PWG_PLAUS: Plausibility Check of the two Pedal Sensor (PWG) Poti Voltages

ggped-fehl-bed

FEHL_BED: Generating the Fault Conditions

ggped-fehl-ausw

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FEHL_AUSW: Fault Evaluation

ggped-gleichl-pr

GLEICHL_PR: Synchro Check

ggped-bew-erk

BEW_ERK: Movement Detection

ggped-beweg-aus

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BEWEG_AUS: Evaluation of the Movement Detection

ggped-hop

HOP: High-resistance Check at Idle

ggped-entjit

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ENTJIT: De-jittering of the PWG Poti Voltage

ggped-ped-norm

PED_NORM: Conversion of Poti Voltage to Pedal Value

ggped-pwg-notfa

PWG_NOTFA: Limitation of the Pedal Value during PWG Limp-home

ggped-pwg-diag

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PWG_DIAG: Diagnosis for PWG

ggped-diag-fpp

PWG_DIAG: Diagnosis for PWG

ggped-diag-bwf

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DIAG_BWF: Diagnosis PWG Movement Detection

ggped-diag-fp1p

DIAG_FP1P: Diagnosis for PWG Poti 1

ggped-diag-fp2p

DIAG_FP2P: Diagnosis for PWG Poti 2

ABK GGPED 1.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWBWEEN			FW	Code word for deactivation of movement detection
DUPW12			FW	Permissible voltage deviation between PWG potentiometer 1 and 2
DUPW12BE			FW	Necessary voltage path of poti 2 for the movement detection
DUPW12TG			FW	Permitted voltage deviation between PWG poti 1 and 2 during part. throttle range
DUPW12VG			FW	Permissible volt. deviation between PWG potentiometer 1 and 2 in full gas range
DUPWGHY			FW	Voltage hysteresis for dejittering the PWG voltage
DWPMXNOT			FW	Max. permissible increase in pedal travel per calc. step in PWG standby mode

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Parameter	Source-X	Source-Y	Type	Description
TFPWG2			FW	Filter time for filtering potentiometer 2 during movement detection
THOPP1			FW	Fault time for high resistance test potentiometer 1
THOPP2			FW	Fault time for high resistance test potentiometer 2
TPNSE			FW	Test time after start end for DVE diagnostic routine
TUPWBWV			FW	Time delay for storing a new potentiometer-2 value
TUPWG12			FW	Fault time during comparison of PWG potentiometer 1 and 2
TUPWG1O			FW	Fault time for upper violation of range by PWG potentiometer 1
TUPWG1U			FW	Fault time for lower violation of range by PWG potentiometer 1
TUPWG2O			FW	Fault time for upper violation of range by PWG potentiometer 2
TUPWG2U			FW	Fault time for lower violation of range by PWG potentiometer 2
UPW1LLMX			FW	Maximum voltage of potentiometer 1 at no-throttle point
UPWG12U			FW	Lower limit for PWG potentiometer volt. before comparison potentiometer 1 and 2
UPWG1O			FW	Upper barrier for PWG potentiometer-1 voltage
UPWG1U			FW	Lower barrier for PWG potentiometer-1 voltage
UPWG2O			FW	Upper barrier for PWG potentiometer-2 voltage
UPWG2U			FW	Lower barrier for PWG potentiometer-2 voltage
UPWGKDO			FW	Upper hyst. switching point for kick-down detection from potentiometer voltage
UPWGKDU			FW	Lower hyst. switching point for kick-down detection from potentiometer voltage
UPWGO			FW	Upper PWG voltage value for re-scaling to pedal value
UPWGTG			FW	PWG voltage threshold for partial throttle range
UPWGTL			FW	Partial load threshold of the PWG voltage in high resistance testing
UPWGU			FW	Lower PWG voltage value for re-scaling to standard value
UPWGUBF			FW	Lower voltage value for the re-scaling for detected movement fault
UPWGVG			FW	PWG voltage threshold for full-throttle range
WPMXNOT			FW	Max. permissible pedal travel in PWG limp-home
ZBWF			FW	Counter status for movement-detection fault entry

Variable	Source	Type	Description
B_BREMS	GGEGAS	EIN	condition: brake operated
B_BWF	GGPED	LOK	Condition: movement detection has detected fault
B_BWUNPL	GGPED	LOK	Condition non-plausibility during movement detection
B_CLBWF		EIN	Flag for clearance: pedal moving detection
B_CLFP1P		EIN	Flag for clearing measures: accelerator pedal potentiometer 1
B_CLFP2P		EIN	Flag for clearing measures: accelerator pedal potentiometer 2
B_CLFPP		EIN	Delete condition fault path FPP (drive pedal potentiometer)
B_DUPW	GGPED	LOK	Condition deviation between potentiometer 1 and 2 too large
B_DUPW12	GGPED	LOK	Condition permissible deviation between PWG potentiometers 1 and 2 exceeded
B_GLF	GGPED	LOK	Condition synchronization between potentiometers 1 and 2 violated
B_HOLP1	GGPED	LOK	Condition high resistance in idling at PWG potentiometer 1 detected
B_HOLP1A	GGPED	LOK	Cond. high resistance in idling at PWG potentiometer 1 in current drive cycle
B_HOLP1L	GGPED	LOK	Cond. high resistance in idling at PWG potentiometer 1 in previous drive cycle
B_HOLP2	GGPED	LOK	Condition high resistance in idling at PWG potentiometer 2 detected
B_HOLP2A	GGPED	LOK	Cond. high resistance in idling at PWG potentiometer 2 in current drive cycle
B_HOLP2L	GGPED	LOK	Cond. high resistance in idling at PWG potentiometer 2 in previous drive cycle
B_HOP1MN	GGPED	LOK	Condition lower violation of range at potentiometer 1 in high resistance testing
B_HOP2MN	GGPED	LOK	Condition lower violation of range at potentiometer 2 in high resistance testing
B_HOPAKT	GGPED	LOK	Condition high resistance testing active
B_KD	GGPED	AUS	Condition: kick-down
B_MNFP1P	GGPED	LOK	Fault type min.: accelerator pedal potentiometer 1
B_MNFP2P	GGPED	LOK	Fault type min.: Pedal 2. poti
B_MXFP1P	GGPED	LOK	Fault type max.: Pedal 1. poti
B_MXFP2P	GGPED	LOK	Fault type max.: Pedal 2. poti
B_NPBWF	GGPED	LOK	Fault type not plausible: movement by pedal-travel sensor
B_NPFP1P	GGPED	LOK	Fault type not plausible: accelerator pedal potentiometer 1
B_NPFP2P	GGPED	LOK	Fault type unplaus.: Pedal 2. poti
B_NPFPP	GGPED	LOK	Condition potentiometer signals from drive pedal not plausible
B_PWGBWF	GGPED	LOK	Condition pedal-travel sensor movement fault
B_PWGNOTFR	GGPED	AUS	FR error reaction pedal-travel sensor limphome
B_PWGNOTUM	URADCC	EIN	= b_pwgnot_um function monitoring fault response PWG idling (= b_pwgnot_sr)
B_SP1S	GGPED	AUS	message to SR: SP1S is command variable
B_SP2S	GGPED	AUS	SP2S is valid set value for PWG failure driving
B_SPSMIN	GGPED	AUS	message to SR: '1' = pedal-travel sensor limphome with SPSMIN
B_STEND	BBSTT	EIN	condition end of start
B_UBPVG	ADVE	EIN	condition: battery voltage sufficient for 5-V potentiometer supply
B_UPW12E	GGPED	LOK	Cond.: Fault during comparison of both standardized PWG potentiometer voltages
B_UPW1MN	GGPED	LOK	Condition: Voltage PWG potentiometer 1 below minimum value
B_UPW1MX	GGPED	LOK	Condition: Voltage PWG potentiometer 1 above maximum value
B_UPW2MN	GGPED	LOK	Condition: Voltage PWG potentiometer 2 below minimum value
B_UPW2MX	GGPED	LOK	Condition: Voltage PWG potentiometer 2 above maximum value
B_UPWG1O	GGPED	LOK	Condition upper violation of range at PWG potentiometer 1
B_UPWG1U	GGPED	LOK	Condition lower violation of range at PWG potentiometer 1
B_UPWG2O	GGPED	LOK	Condition upper violation of range at PWG potentiometer 2
B_UPWG2U	GGPED	LOK	Condition lower violation of range at PWG potentiometer 2
CTRBWF	GGPED	AUS	Fault counter movement detection
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF		EIN	ECU-condition powerfail initialisation
DWPED	GGPED	AUS	gradient of the standardized accelerator pedal angle
DWPED_W	GGPED	AUS	gradient of the standardized accelerator pedal angle
E_BWF	GGPED	AUS	Error flag: pedal moving detection

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Variable	Source	Type	Description
E_FP1P	GGPED	AUS	Error flag: accelerator pedal potentiometer 1
E_FP2P	GGPED	AUS	Error flag: accelerator pedal potentiometer 2
E_FPP	GGPED	AUS	Error flag drive pedal potentiometer
UPW2LL_W	GGPED	LOK	Value for voltage from pedal-travel sensor potentiometer 2 before movement
UPWG1_W	GGPEDV	EIN	Voltage PWG potentiometer 1 (word)
UPWG2D_W	GGPED	LOK	Doubled PWG potentiometer-2 voltage (word)
UPWG2FIL_W	GGPED	LOK	Filtered potentiometer 2 voltage
UPWG2_W	GGPEDV	EIN	Voltage PWG potentiometer 2 (word)
UPWGEJ_W	GGPED	LOK	De-jittered PWG potentiometer voltage
UPWG_W	GGPED	LOK	Resulting PWG potentiometer voltage following plausibility check
WPED	GGPED	AUS	Standardized accelerator pedal angle
WPEDV_W	GGPED	AUS	Standardized drive pedal angle prior to allowance for limiting in standby drive
WPED_W	GGPED	AUS	normed angle acceleration pedal
Z_BWF	GGPED	LOK	Cycle flag: pedal moving detection
Z_FP1P	GGPED	LOK	Cycle flag: Pedal 1. poti
Z_FP2P	GGPED	LOK	Cycle flag: Pedal 2. poti
Z_FPP	GGPED	LOK	Cycle flag drive pedal potentiometer

FB GGPED 1.50 Detailed description of function

The function calculates the standardized accelerator angle wped from the poti voltage of the pedal sensor (PWG). The PWG has two potentiometers, which are independently supplied with 5V from the control unit. Poti 2 possesses an additional resistor of the size of the track resistor, so that its characteristic displays only half the gradient as compared to that of poti 1. By various plausibility checks (voltage range, synchronization etc.) it is ensured that due to a single fault wped cannot take up higher values than corresponds to the accelerator position. In addition to the component monitoring for the PWG realized here, further parts of the PWG monitoring are contained in the functions %UFSPSC (watchdog function for %GGPED) and %URADCC (watchdog function of the A/D-converter).

Apart from wped further variables are made available:
o The pedal value gradient dwped,
o the kick-down information B_kd, which is transferred to the transmission control via CAN on vehicles with automatic transmission,
o if needed several fault code memory entries (FP1P, FP2P, FPP, BWF) as well as
o informations on the PWG limp-home operation (B_pwgnotfr, B_spsmin, B_sp1s, B_sp2s) for the watchdog function.

PWG_PLAUS
=========

Dependent on the result of the plausibility check the resulting poti voltage upwg is selected, which is thereafter used for the calculation of the pedal value. During normal operation (B_pwgnotfr = 0, B_spsmin = 0) upwg1, the signal of poti 1, is used for the calculation of the pedal value. With undervoltage (B_ubpvg = 0), with a fault detection in the watchdog function (B_pwgnot_um = 1) and with a range violation of the remaining poti during PWG limp-home operation, upwg is set to the smallest possible lower standard limit UPWGUR (s. partial function PED_NORM), which leads to wped = 0. In case of a range violation of poti 1, upwg is set to upwg2d, the signal of poti 2. Inversely, upwg is set to upwg1 in case of a range violation of poti 2.
With a synchronization fault (B_upw12e = 1) upwg equals the minimum of poti 1 and poti 2.

FEHL_BED
========

From the individual fault conditions, which indicate upper or lower range violations for both potis and synchro faults, the conditions for the selection of the resulting poti voltage upwg are generated. B_pwgnotfr is set if a range violation or a synchro fault is detected. B_spsmin is set in case of undervoltage, with a faulted detected in the watchdog function as well as in case of range violation of both potis and in case of a range violation of the used poti after a synchro fault. B_sp1s is set if a range violation of poti 2 but no range violation of poti 1 is given. Analogous B_sp2s is set, if a range violation of poti 1 but no range violation of poti 2 is given.

FEHL_AUSW
=========

The calculation of the fault conditions is only active if there is sufficient battery voltage to supply the potis (B_ubpvg = 1). All fault conditions are only set once the respective fault tolerance time has elapsed, then, however, they remain set for the entire current driving cycle. At first an upper range check is performed for upwg1 and upwg2d. If necessary B_upw1mx or b_upw2mx is set. If no fault arises during the upper range check the synchro check is performed during normal operation (see partial function GLEICHL_PR). If in the process a fault is detected a lower range check of both potis takes place. If no non-plausibility resulted in the process or if in the current or the previous driving cycle a high-resistance during idle was detected, b_upw12e is set. Otherwise the fault condition for the lower range violation (B_upw1mn or B_upw2mn) is set. If no upper range violation and no synchro fault is given the high-resistance check at idle is performed during normal operation (see partial function HOP).

GLEICHL_PR
==========

During the synchro check of the two potis the deviation of upwg1 and upwg2d is compared with the synchro tolerance. If the deviation is large, B_glf is set. After the specification of the PWG very large transition resistances can occur in the idle range. For this reason, upwg1 and upwg2d are low-limited to UPWG12U prior to the calculation of the deviation. A transition resistance at idle thus does not lead to a synchro fault. Since possible transition resistances may have varying effects in different ranges of the poti track the synchro tolerance is switched dependent on the range between DUPW12 (idle), DUPW12TG (partial throttle) and DUPW12VG (full throttle).

BEW_ERK

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=======

The movement detection ensures that a safety-relevant power increase of the engine will only take place if the two potis have moved away from their idle position. A slight drift of poti 1, which cannot be detected by the synchro check is thereby intercepted. The movement detection is only executed during normal operation with sufficient poti voltage supply and it can be deactivated via the code word CWBWEEN.

If poti 1 exits the idle range, after it was there for the time TUPWBWV beforehand, then the latest value of poti 2 is stored. The time condition is important so that in case of short-termed interferences no erroneous storage will be performed. The signal of poti 2 is filtered at upward movement, so that in case of short-termed interferences no too high value of poti 2 will be stored. If poti 1 exceeds the threshold UPWGU, poti 2 must have moved by at least DUPW12BE as compared to the stored value upw211. Otherwise B_bwunpl is set.

BEWEG_AUS
=========

If a non-plausibility was detected during the movement detection (B_bwunpl = 1), the lower standard limit is switched to UPWGUBF in the partial function PED_NORM by the setting of B_bwf. UPWGUBF lies so high that when it is exceeded a synchro fault occurs. In case of a drifting poti 1, wped remains at zero until the synchro check responds. B_bwf is reset when poti 1 undershoots the threshold UPW1LLMX.

If the accelerator is operated while B_bwf is set, so that poti 1 exceeds the threshold UPWGUBF, the fault counter ctrbwf is incremented. ctrbwf is decremented, if B_bwf was reset and thereafter by operating the accelerator poti 1 exceeds the threshold UPWGU. B_pwgbwf is set if the fault counter ctrbwf reaches the value ZBWF, and a fault code memory entry is performed (see partial function DIAG_BWF).

HOP
===

The high-resistance check at idle serves to increase the availability when the signal lead of a poti is disconnected. With synchro fault and detected lower range violation of this poti it is possible to use - instead of the minimum of both potis, which would permanently lead to wped = 0 - the other poti for the calculation of the pedal value, provided no high-resistance was detected in the current and in the previous driving cycle.

The high-resistance check is only performed during normal operation if neither an upper range violation nor a synchro fault is given. Should a poti in this state show a lower range violation for a certain time, this is stored (B_hop1mn or B_hop2mn). If both potis again exceed the threshold UPWGTL in the same driving cycle, high-resistance at idle is stored for the concerned poti (B_holp1a or B_holp2a). The two bits are stored in the non-volatile memory for the use in the next driving cycle.

ENTJIT
======

So as to avoid a jittering of the pedal value especially with aged PWG the resulting poti voltage upwg is smoothed as follows: If the new value does not deviate by more than DUPWGHY from the old value then the old value is maintained. If the deviation from the old value lies between DUPWGHY and 2*DUPWGHY, the new de-jittered value results by an increase resp. decrease of the old value by DUPWGHY. Only once a deviation of more than 2*DUPWGHY is given is the new value accepted without filtering.

The kick-down information B_kd is calculated from the de-jittered PWG voltage upwgej (see overview GGPED). During normal operation (B_pwgnotfr = 0) B_kd is set, if upwgej exceeds the threshold UPWGKDO and it is reset, if upwgej undershoots the threshold UPWGKDU. During PWG limp-home operation (B_pwgnotfr = 1) B_kd is always not set.

PED_NORM
========

For the conversion of the de-jittered poti voltage to a temporary pedal value the voltage range between lower and upper standard limit is linearly imaged to the range 0 to 100%. The upper standard limit is UPWGO. As lower standard limit UPWGUR , the maximum possible voltage value of poti 1 at idle, is used during normal operation. During PWG limp-home operation UPWGU is used, the maximum possible voltage value of poti 2 at idle. With detected movement fault during normal operation standardization is only performed as of UPWGUBF, which lies higher by the value of the synchro tolerance than UPWGU.

PWG_NOTFA
=========

During PWG limp-home operation the pedal value is immediately set to zero when the brake is applied (B_brems = 1) for safety reasons. When the brake is not applied the pedal value is high-limited to DWPMXNOT and an increasing limitation is performed, where DWPMXNOT defines the maximum permissible pedal value increase from one calculation step to the next, so within 10 ms.

PWG_DIAG
========

The fault code memory entries FP1P (accelerator 1. poti), FP2P (accelerator 2. poti), BWF (movement detection) and FPP (accelerator poti) are generated in this partial function. The fault path FPP is redundant and can be dropped as soon as E_fpp is no longer scanned in any other function. In case of a synchro fault, for which it cannot be decided which poti is defective (B_upw12e = 1), E_fp1p and E_fp2p are set.

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APP GGPED 1.50 Application hint

The parameters used in this function result from the tolerance calculation for the PWG.
UPWG12U is to be set less or equal to UPWGU.

GGPEDV 1.10 conditioning input signals of accelerator pedal

FDEF GGPEDV 1.10 Function definition

ABK GGPEDV 1.10 Abbreviations

Variable	Source	Type	Description
IUREFSP1_W		EIN	adc value incl. channel number, 5 V reference voltage
IUREFSP2_W		EIN	adc value incl. channel number, 5 V reference voltage
IUSPOTI1_W		EIN	adc value incl. channel number potentiometer 1
IUSPOTI2_W		EIN	adc value incl. channel number potentiometer 2
UPWG1_W	GGPEDV	AUS	Voltage PWG potentiometer 1 (word)
UPWG2_W	GGPEDV	AUS	Voltage PWG potentiometer 2 (word)

FB GGPEDV 1.10 Detailed description of function

Mit dieser Funktion werden die AD-Werte des Pedalwertgebers um eventuell vorhandene Toleranzen/Schwankungen der 5-Volt Referenz-spannnung korrigiert und dann als korrigierte Werte der Funktion %GGPED (Gebergröße Fahrpedal) übergeben.

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APP GGPEDV 1.10 Application hint

DVEUE 1.0 Overview of DV-E-control

FDEF DVEUE 1.0 Function definition

overview
throttle control, command signals

dveue-dve-ans0

ABK DVEUE 1.0 Abbreviations

FB DVEUE 1.0 Detailed description of function

```
The trigger of the throttle adjustment device is sectionalized in following parts:

  block ADC:   actual value with 10 Bit analog-digital converter
  FDEF GGDVE:  standardization and check of actual value
               diagnosis
  FDEF BGDVE:  learning of the lower mechanical DK limit stop (UMA learning)
               gain adjustment, offset and gradient
               learning and checking of the DV-E air at limphome position (NLP learning)
               DV-E return spring check
               diagnosis
  FDEF ADVE:   digital position controller (DLR)
               coordination of the DV-E power stage release (disable/enable)
               monitoring of the DK position (DK at air in limphome position and DK setpoint/actual value)
               monitoring of the DLR setting range
               monitoring of battery voltage
               diagnosis

Parts of above-mentioned functions are implemented in the initialization or run after of the control device.
```

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APP DVEUE 1.0 Application hint

GGDVE 1.51 Sensor variables for throttle-valve actuator

FDEF GGDVE 1.51 Function definition

ggdve-ggdve

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ggdve-umr

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UMR: Conversion of Poti Voltage into Throttle Angle

ggdve-plaus

ggdve-plaus

PLAUS: Plausibility Check for Throttle Angle

```
 —— Plausibility Check of Throttle Position Signals
if (NOT B_dkpu AND B_ubpvg) then
   if (B_dknot) then
      —— substitute operation
      if (E_lm) then
         B_dkp1e := TRUE;
         B_dkp2e := TRUE;
      else
         rlvppl := rl / (fpvdkds * ftvdk);
         wdk3 := KFWDKPP(nmot, rlvppl);
         rlvppmx := RLVPPMXN(nmot);
         if (rlvppl > rlvppmx) then
            B_rlvugd:= TRUE;
         else
            B_rlvugd:= FALSE;
         endif;
         if (B_dkpaw) then
            —— choice of correct poti for substitute operation
            if (wdk3 - wdk1_w <= DWDK13O AND (B_rlvugd OR wdk1_w - wdk3 <= DWDK13O)) then
               if (z1aw >= TVAWDKP1) then
                  B_dkp2np := TRUE;
                  B_dkp2e := TRUE;
                  B_dkpaw := FALSE;
               else
                  z1aw:= z1aw + 1;
               endif;
            else
               z1aw := 0;
               if (wdk3 - wdk2_w <= DWDK23O AND (B_rlvugd OR wdk2_w - wdk3 <= DWDK23O)) then
                  if (z2aw >= TVAWDKP2) then
                     B_dkp1np := TRUE;
                     B_dkp1e := TRUE;
                     B_dkpaw := FALSE;
                  else
                     z2aw:= z2aw + 1;
                  endif;
               else
```

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```
                z2aw := 0;
                if (zawf >= TVAWF12) then
                   B_dkp1np := TRUE;
                   B_dkp1e := TRUE;
                   B_dkp2np := TRUE;
                   B_dkp2e := TRUE;
                   B_dkpaw := FALSE;
                else
                   zawf:= zawf + 1;
                endif;
             endif;
          endif;
       else
          if (B_dkp2e) then
             -- substitute operation with poti 1
             if (udkp1_w > UDKP1O) then
                if (z1mx >= TVPDKP1) then
                   B_dkp1mx := TRUE;
                   B_dkp1e := TRUE;
                else
                   z1mx := z1mx + 1;
                endif;
             else
                z1mx := 0;
                if (udkp1_w < UDKP1U) then
                   if (z1mn >= TVPDKP1) then
                      B_dkp1mn := TRUE;
                      B_dkp1e := TRUE;
                   else
                      z1mn := z1mn + 1;
                   endif;
                else
                   z1mn := 0;
                   if (wdk3 - wdk1_w > DWDK13O OR NOT B_rlvugd AND wdk1_w - wdk3 > DWDK13O) then
                      if (z13 >= TVPWDK13) then
                         B_dkp1np := TRUE;
                         B_dkp1e := TRUE;
                      else
                         z13 := z13 + 1;
                      endif;
                   else
                      z13 := 0;
                   endif;
                endif;
             endif;
          else
             -- substitute operation with poti 2
             if (udkp2_w > UDKP2O) then
                if (z2mx >= TVPDKP2) then
                   B_dkp2mx := TRUE;
                   B_dkp2e := TRUE;
                else
                   z2mx := z2mx + 1;
                endif;
             else
                z2mx := 0;
                if (udkp2_w < UDKP2U) then
                   if (z2mn >= TVPDKP2) then
                      B_dkp2mn := TRUE;
                      B_dkp2e := TRUE;
                   else
                      z2mn := z2mn + 1;
                   endif;
                else
                   z2mn := 0;
                   if (wdk3 - wdk2_w > DWDK23O OR NOT B_rlvugd AND wdk2_w - wdk3 > DWDK23O) then
                      if (z23 >= TVPWDK23) then
                         B_dkp2np := TRUE;
                         B_dkp2e := TRUE;
                      else
                         z23 := z23 + 1;
                      endif;
                   else
                      z23 := 0;
                   endif;
                endif;
             endif;
          endif;
       endif;
    endif;
 else
    -- normal operation
    if (udkp1_w > UDKP1O) then
       if (z1mx >= TVPDKP1) then
          B_dkp1mx := TRUE;
          B_dkp1e := TRUE;
```

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```
         endif;
         z1mx := z1mx + 1;
      else
         z1mx := 0;
         if (udkp1_w < UDKP1U) then
            if (z1mn >= TVPDKP1) then
               B_dkp1mn := TRUE;
               B_dkp1e := TRUE;
            endif;
            z1mn := z1mn + 1;
         else
            z1mn := 0;
         endif;
      endif;
      if (nmot > NDKPPU) then
         if (udkp2_w > UDKP2O) then
            if (z2mx >= TVPDKP2) then
               B_dkp2mx := TRUE;
               B_dkp2e := TRUE;
            else
               z2mx := z2mx + 1;
            endif;
         else
            z2mx := 0;
            if (udkp2_w < UDKP2U) then
               if (z2mn >= TVPDKP2) then
                  B_dkp2mn := TRUE;
                  B_dkp2e := TRUE;
               else
                  z2mn := z2mn + 1;
               endif;
            else
               z2mn := 0;
               if (z1mx = 0 AND z1mn = 0) then
                  if ((wdk1_w - wdk2_w) > DWDK12O OR (wdk2_w - wdk1_w) > DWDK12O) then
                     if (z12 >= TVPWDK12) then
                        B_dkpaw := TRUE;
                     else
                        z12 := z12 + 1;
                     endif;
                  else
                     z12 := 0;
                  endif;
               endif;
            endif;
         endif;
      endif;
   endif;
   B_dkunb := B_dkp1e AND B_dkp2e;
   B_dknot := (B_dkp1e

 B_dkp2e) OR B_dkpaw;
   B_wdk2sel := B_dkp1e AND B_dknot;
endif;
```

ggdve-diag

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DIAG: Diagnosis for Throttle Valve Potentiometer

ggdve-diag-dk

DIAG_DK: Fault Path DK

ggdve-diag-dk1p

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DIAG_DK1P: Fault Path DK1P

ggdve-diag-dk2p

DIAG_DK2P: Fault Path DK2P

ABK GGDVE 1.51 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DUDKP1HY			FW	offset of hysteresis for switching to amplified throttle poti 1 signal
DWDK12O			FW	max. permissible difference between throttle-valve angles from pot's 1 and 2
DWDK13O			FW	max. permissible difference between throttle-valve angles from pot's 1 and 3
DWDK23O			FW	max. permissible difference between throttle-valve angles from pot's 2 and 3
KFWDKPP	NMOT	RLVPPL	KF	throttle blade position dependent on air charge signal
NDKPPU			FW	lower limit of engine speed for throttle poti plausibility check
RLVPPMXN	NMOT		KL	maximum relative air charge for throttle poti plausibility check
TPNSE			FW	Test time after start end for DVE diagnostic routine
TVAWDKP1			FW	Delay time for selection of throttle valve poti 1 during substitute operation
TVAWDKP2			FW	Delay time for selection of throttle valve poti 2 during substitute operation
TVAWF12			FW	Fault time during throttle valve poti selection for substitute operation
TVPDKP1			FW	delay time for recognition of implausible signal from throttle potentiometer 1
TVPDKP2			FW	delay time for recognition of implausible signal from throttle potentiometer 2
TVPWDK12			FW	Fault-tolerance time for checking synchronouso operation of DK potentiometers
TVPWDK13			FW	fault-tol. time checking sync.-operation pot. 1 and subs. value from charging
TVPWDK23			FW	fault-tol. time checking sync. operation DK-pot. 2 and subs. value from charging
UBVDKPO			FW	batt. voltage threshold for using amplified signal from DK-potentiometer 1
UBVDKPU			FW	batt. voltage threshold for using non-amplified signal from DK-potentiometer 1
UDKP1O			FW	maximum permissible voltage from throttle potentiometer 1
UDKP1U			FW	minimum permissible voltage from throttle potentiometer 1
UDKP2O			FW	maximum permissible voltage from throttle potentiometer 2
UDKP2U			FW	minimum permissible voltage from throttle potentiometer 2

Variable	Source	Type	Description
B_CLDK		EIN	condition: clear error throttle potentiometer
B_CLDK1P		EIN	Flag for clearing measures: throttle valve (DK) potentiometer 1
B_CLDK2P		EIN	Flag for clearing measures: throttle valve (DK) potentiometer 2
B_DKNOT	GGDVE	AUS	condition: continued operation with a single remaining throttle actuator poti
B_DKP1E	GGDVE	LOK	condition: defect in throttle actuator potentiometer 1
B_DKP1MN	GGDVE	LOK	Condition lower-range violation DK potentiometer 1
B_DKP1MX	GGDVE	LOK	Condition upper-range violation DK potentiometer 1
B_DKP1NP	GGDVE	LOK	Condition signal DK potentiometer 1 not plausible
B_DKP2E	GGDVE	LOK	condition: defect in throttle actuator potentiometer 2
B_DKP2MN	GGDVE	LOK	Condition: lower-range violation DK potentiometer 2
B_DKP2MX	GGDVE	LOK	Condition: upper-range violation DK potentiometer 2
B_DKP2NP	GGDVE	LOK	Condition: signal DK potentiometer 2 not plausible
B_DKPAW	GGDVE	LOK	Condition DK-potentiometer selection for DK-sensor standby operation
B_DKPU	SREAKT	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DKUNB	GGDVE	AUS	condition: unknown throttle blade position
B_MNDK1P	GGDVE	LOK	Fault type min.: Throttle valve 1. Poti
B_MNDK2P	GGDVE	LOK	Fault type min.: Throttle valve 2. Poti
B_MXDK1P	GGDVE	LOK	Fault type max.: Throttle valve 1. Poti

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Variable	Source	Type	Description
B_MXDK2P	GGDVE	LOK	Fault type max.: Throttle valve 2. Poti
B_NPDK	GGDVE	LOK	Condition potentiometer signals from throttle valve not plausible
B_NPDK1P	GGDVE	LOK	Fault type not plausible: Throttle valve 1. Poti
B_NPDK2P	GGDVE	LOK	Fault type not plausible: Throttle valve 2. Poti
B_RLVUGD	GGDVE	LOK	condition: air charge out of range suited for throttle poti plausibility check
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_UBPVG	ADVE	EIN	condition: battery voltage sufficient for 5-V potentiometer supply
B_WDK1V	GGDVE	AUS	Condition: amplified signal from potentiometer 1 used to calc. throttle angle
B_WDK2SEL	GGDVE	AUS	Condition: DV-E position control is performed with actual-value-poti 2
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DKPSTG_W	BGDVE	EIN	slope of throttle potentiometer (% DK / V)
DWDKBA_W	GGDVE	AUS	gradient of actual throttle blade position
E_DK	GGDVE	AUS	Error flag: throttle position sensor
E_DK1P	GGDVE	AUS	Error flag: Throttle valve 1. Poti
E_DK2P	GGDVE	AUS	Error flag: Throttle valve 2. Poti
E_LM	DHFM	EIN	Error flag: main load sensor
FPVDKDS	GGDSAS	EIN	Factor pressure in front of throttle valve of pressure sensor
FTVDK	BGTEMPK	EIN	correction factor for temperature upstream of throttle valve
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
RLVPPL	GGDVE	LOK	relative density-corrected air charge for calc. throttle-angle standby value
RLVPPMX	GGDVE	LOK	maximum relative air charge for throttle poti plausibility check
UB	GGUB	EIN	battery voltage
UDKP1A_W	BGDVE	EIN	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop (word)
UDKP1SV	BGDVE	EIN	Max. DK potentiometer-1 value for using amplified signal
UDKP1VO_W	BGDVE	EIN	voltage offset of DK potentiometer 1 amplification charcteristic
UDKP1VV_W	BGDVE	EIN	amplification of throttle potentiometer 1
UDKP1V_W		EIN	amplified sensor voltage throttle potentiometer 1
UDKP1_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UDKP2A_W	BGDVE	EIN	sensor voltage throttle potentiometer 2 at (lower) mechanical stop
UDKP2_W		EIN	sensor voltage from throttle potentiometer 2 (word)
WDK1_W	GGDVE	LOK	throttle blade position dependent on poti 1
WDK2_W	GGDVE	LOK	throttle blade position dependent on poti 2
WDK3	GGDVE	LOK	throttle blade position dependent on air charge signal
WDKBA	GGDVE	AUS	throttle angle
WDKBA_W	GGDVE	AUS	throttle angle with respect to lower mechanical stop
Z_DK	GGDVE	LOK	cycle flag: throttle position potentiometer
Z_DK1P	GGDVE	LOK	Cycle flag: Throttle valve 1. Poti
Z_DK2P	GGDVE	LOK	Cycle flag: Throttle valve 2. Poti

FB GGDVE 1.51 Detailed description of function

Task of the function is the calculation of the actual throttle angle in dependency on the momentary poti voltage and learned poti voltage at the lower mechanical limit stop. A plausibility check is also performed so as to ensure that the calculation is correct. In case the two poti-signals do not agree, the relative air charge is consulted so as to decide, which poti is the correct one.

Poti 1 at the throttle actuator possesses a rising characteristic, poti 2 a falling one. In order to achieve a higher resolution of the throttle angle in the idle range the voltage of poti 1 is amplified by means of an analog circuit. The throttle angle is then calculated dependent on the amplified signal.

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Darstellung von Winkel und Spannung am DV-E5

Exemplarisch wurde eine Drosselklappe (DK) mit 68 mm Durchmesser gewählt

ggdve-dvewink

```
Explanations:
   UMA:    Lower mechanical throttle valve (DK) limit stop (leakage air <= 4,8 kg/h)
   UEA:    Lower electrical DK limit stop (leakage air approx. 7,2 kg/h)
           UDKPAOFF:    Standard setting 25,6 mV -> 0,538 deg. DK
   OEA:    Upper electrical DK limit stop
   OMA:    Upper mechanical DK limit stop
   UIP:    Voltage of actual-value poti in % of 5 Volt
   udkp1:  Voltage of actual-value poti in Volt
   wdkba:  DK actual angle in % of the maximum opening, related to the UEA
```

APP GGDVE 1.51 Application hint

KFWDKPP and RLVPPMXN need to be adjusted.
The other parameters result from a throttle actuator-specific tolerance calculation.

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BGDVE 2.50 Values for DV-E control from the learning and checking routines

FDEF BGDVE 2.50 Function definition

bgdve-bgdve

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bgdve-mainpart

bgdve-check

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these informations directly from the fault path status managed in the DFPM.

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bgdve-spring

```
(*1):   deviant from the description this part is realized in the module %DFPM
(*2):   The actions triggered by C_(*) are implemented in the SW in individual
        processes

For each fault path DVEF of this diagnosis function the following values are defined:

    Status fault path DVEF:       sfpdvef
       Error flag dvef:             E_dvef
       Cycle flag dvef:             Z_dvef
       Fault type dvef:             TYP_dvef: (B_mxdvef, B_mndvef, B_sidvef, B_npdvef)
       Clear fault path:              B_cldvef
       Default value active:          B_bkdvef (optional)
    Fault path code dvef:         CDTDVEF
    Fault class dvef:             CLADVEF
    Fault intensity dvef:         TSFDVEF
    CARB code dvef:               CDCDVEF
    Table of ambient cond. dvef:  FFTDVEF
```

bgdve-nlp

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```
(*1):   deviant from the description this part is realized in the module %DFPM
(*2):   The actions triggered by C_(*) are implemented in the SW in individual
        processes
```

For each fault path DVEN of this diagnosis function the following values are defined:

```
Status fault path DVEN:       sfpdven
   Error flag dven:             E_dven
   Cycle flag dven:             Z_dven
   Fault type dven:             TYP_dven: (B_mxdven, B_mndven, B_sidven, B_npdven)
   Clear fault path:              B_cldven
   Default value active:          B_bkdven (optional)
Fault path code dven:         CDTDVEN
Fault class dven:             CLADVEN
Fault intensity dven:         TSFDVEN
CARB code dven:               CDCDVEN
Table of ambient cond. dven:  FFTDVEN
```

bgdve-amplifier

```
(*1):   deviant from the description this part is realized in the module %DFPM
(*2):   The actions triggered by C_(*) are implemented in the SW in individual
        processes
```

For each fault path DVEV of this diagnosis function the following values are defined:

```
Status fault path DVEV:       sfpdvev
   Error flag dvev:             E_dvev
   Cycle flag dvev:             Z_dvev
   Fault type dvev:             TYP_dvev: (B_mxdvev, B_mndvev, B_sidvev, B_npdvev)
   Clear fault path:              B_cldvev
   Default value active:          B_bkdvev (optional)
Fault path code dvev:         CDTDVEV
Fault class dvev:             CLADVEV
Fault intensity dvev:         TSFDVEV
CARB code dvev:               CDCDVEV
Table of ambient cond. dvev:  FFTDVEV
```

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bgdve-uma

```
(*1):   deviant from the description this part is realized in the module %DFPM
(*2):   The actions triggered by C_(*) are implemented in the SW in individual
        processes

For each fault path DVEU of this diagnosis function the following values are defined:

    Status fault path DVEU:       sfpdveu
       Error flag dveu:             E_dveu
       Cycle flag dveu:             Z_dveu
       Fault type dveu:             TYP_dveu: (B_mxdveu, B_mndveu, B_sidveu, B_npdveu)
       Clear fault path:              B_cldveu
       Default value active:          B_bkdveu (optional)
    Fault path code dveu:         CDTDVEU
    Fault class dveu:             CLADVEU
    Fault intensity dveu:         TSFDVEU
    CARB code dveu:               CDCDVEU
    Table of ambient cond. dveu:  FFTDVEU
```

ABK BGDVE 2.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCDVEF	BLOKNR		KL	Code word CARB: DV-E cause of failure: spring check
CDCDVEN	BLOKNR		KL	Code word CARB: DV-E cause of failure: limphome position
CDCDVEU	BLOKNR		KL	Code word CARB: DV-E cause of failure: UMA-learning
CDCDVEV	BLOKNR		KL	Code word CARB: DV-E cause of failure: amplifier adjustment
CDKDVEF			FW	Code word customer: DV-E cause of failure: spring check
CDKDVEN			FW	Code word customer: DV-E cause of failure: limphome position
CDKDVEU			FW	Code word customer: DV-E cause of failure: UMA-learning
CDKDVEV			FW	Code word customer: DV-E cause of failure: amplifier adjustment
CDTDVEF			FW	Code word tester: DV-E cause of failure: spring check
CDTDVEN			FW	Code word tester: DV-E cause of failure: limphome position
CDTDVEU			FW	Code word tester: DV-E cause of failure: UMA-learning
CDTDVEV			FW	Code word tester: DV-E cause of failure: amplifier adjustment
CLADVEF			FW	Fault class: DV-E cause of failure: spring check
CLADVEN			FW	Fault class: DV-E cause of failure: limphome position
CLADVEU			FW	Fault class: DV-E cause of failure: UMA-learning
CLADVEV			FW	Fault class: DV-E cause of failure: amplifier adjustment
DKPSTGMIN			FW	Min. gradient of the DK poti for conversion abs. to rel. angle in the worst case
DLRPIDSTMN			FW	Min. threshold for PWM pulse duty factor of the DLR with temp. UMA adapt.
DUDKNLPO			FW	Tolerance range for NLP upward (incl. Rü)
DUDKNLPU			FW	Tolerance range for NLP downward
DUDKP1HY			FW	offset of hysteresis for switching to amplified throttle poti 1 signal
DUDKPTMP			FW	Delta of a ramp-step during the temp. UMA adaptation
FFTDVEF	BLOKNR		KL	Freeze frame table: DV-E cause of failure: spring check
FFTDVEN	BLOKNR		KL	Freeze frame table: DV-E cause of failure: limphome position
FFTDVEU	BLOKNR		KL	Freeze frame table: DV-E cause of failure: UMA-learning
FFTDVEV	BLOKNR		KL	Freeze frame table: DV-E cause of failure: amplifier adjustment
FPRAT			FW	Inlet air temperature threshold for DV-E spring check
FPRMT			FW	Engine temperature threshold for DV-E spring check
FPRNMAX			FW	Engine speed threshold for DV-E spring check
FPRTIM1_T			FW	DV-E spring check, waiting time in check step 1

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Parameter	Source-X	Source-Y	Type	Description
FPRTIM2_T			FW	DV-E spring check, waiting time in check step 2
LRNST1_T			FW	Waiting time during learning step 1
LRNST3_T			FW	Waiting time during learning step 3
LRNST7_T			FW	Waiting time during learning step 7
LRNST9_T			FW	Waiting time during learning step 9
LRNVB_T			FW	Time during which learning is forbidden for ‘normal learning’
LRNVB_TDI			FW	Time during which learning is forbidden for ‘learning by means of diagnosis’
NLPST1T			FW	Waiting time 1 in the NLP learning
NLPST2T			FW	Waiting time 2 in the NLP learning
TDKNLPE			FW	time until zero current DK stabilizes in NLP
TDLRPIDMX			FW	Max. time for PWM pulse duty factor of the DLR at temp. UMA adapt.
TMSUTMUMA			FW	Lower Tmot threshold for temporary UMA adapation
TSFDVEF			FW	Fault active time: DV-E cause of failure: spring check
TSFDVEN			FW	Fault active time: DV-E cause of failure: limphome position
TSFDVEU			FW	Fault active time: DV-E cause of failure: UMA-learning
TSFDVEV			FW	Fault active time: DV-E cause of failure: amplifier adjustment
TTMUMASTA			FW	Time for steady-state during temp. UMA adaptation
UANAUFRP			FW	Step width for OPEN ramp
UANNMAX			FW	Engine speed threshold for the release of the UMA learning and gain adjustment
UANPEDMAX			FW	Pedal threshold for UMA learning allowed
UANPIDMIN			FW	Abort threshold PID-sum for CLOSE ramp
UANPIDMINA			FW	Abort threshold PID-sum for OPEN ramp
UANUATS			FW	Lower inlet air temperature threshold for release of learning
UANZURP			FW	Step width for CLOSE ramp
UAN_O_MT			FW	upper engine temperature threshold for stop limit
UAN_STORE			FW	Threshold for storage of new learning values
UAN_U_MT			FW	lower engine temperature threshold for stop limit
UB_UANL			FW	Battery voltage threshold for release of learning
UDKNLP1N			FW	Nominal value voltage DK-Poti 1 in NLP-position
UDKNLP2N			FW	Nominal value voltage DK-Poti 2 in NLP-position
UDKP1AMAX			FW	Max. voltage DK-Poti 1 at lower DK limit stop
UDKP1AMIN			FW	Min. voltage DK-Poti 1 at lower DK limit stop
UDKP1AURI			FW	Voltage DK-poti 1 at the lower DK limit stop, initial. value
UDKP1DUS			FW	Nominal switch-over threshold for DK-Poti-1 switch-over
UDKP1NHUB			FW	Rated travel of the throttle valve in the DV-E, (poti 1)
UDKP1VID			FW	Nominal amplification for DK-Poti 1
UDKP1VOMA			FW	Max. offset error for DK-Poti-1-amplifier
UDKP1VOMI			FW	Min. offset error for DK-Poti-1-amplifier
UDKP1VOSC			FW	Lower limit for upper adjust.pt. DK-Poti 1
UDKP1VUSC			FW	Upper limit for lower adjust.pt. DK-Poti 1
UDKP1VVMA			FW	Upper value amplification error for amplifier
UDKP1VVMI			FW	Lower value amplification error for amplifier
UDKP2AMAX			FW	Max. voltage DK-Poti 2 at lower DK limit stop
UDKP2AMIN			FW	Min. voltage DK-Poti 2 at lower DK limit stop
UDKP2AURI			FW	Voltage DK-poti 2 at the lower DK limit stop, initial. value
UDKPALOS			FW	Voltage offset for detection of the breakaway
UDKPAOFF			FW	Voltage offset at lower limit stop
UDKPATMX			FW	Max. possible offset of the temp. UMA adaptation
UPVGNENN			FW	Nominal value for DV-E poti supply voltage
WDKFPRZ1			FW	Deactivation threshold DK actual value for DV-E return spring check
WDKFPRZ2			FW	Checking threshold DK actual value for DV-E return spring check
WDKNLPMA			FW	Upper allowed setpoint for NLP-position
WDKNLPMI			FW	Lower allowed setpoint for NLP-position
WDKSFPR			FW	DK setpoint for DV-E return spring check
WDKSTMUMA			FW	DK angle threshold for temporary UMA adaptation

Variable	Source	Type	Description
B_ABGLE	BGDVE	LOK	Condition: Error during amplifier adjustment
B_BKDVEN	BGDVE	LOK	Backup value activated: DV-E limphome air position
B_BKDVEU	BGDVE	LOK	Backup value activated: DV-E UMA-learning
B_BKDVEV	BGDVE	LOK	Backup value activated: DV-E amplifier adjustment
B_CLDVEF		EIN	Flag for clearance: DV-E cause of failure: spring check
B_CLDVEN		EIN	Flag for clearance: DV-E cause of failure: limphome air position
B_CLDVEU		EIN	Flag for clearance: DV-E cause of failure: UMA-learning
B_CLDVEV		EIN	Flag for clearance: DV-E cause of failure: amplifier adjustment
B_DCDISFR	ADVE	EIN	Condition: Disable DV-E power stage by means of the funct. processor
B_DCDISR	BGDVE	AUS	Condition: DV-E power stage deactivation is requested
B_DKADEN	BGDVE	AUS	Condition: Use DK setpoint from DK adaptation and DK check
B_DKNOLU	SREAKT	EIN	condition: power supply of throttle actuator cut off
B_DKNOT	GGDVE	EIN	condition: continued operation with a single remaining throttle actuator poti
B_DKPIU	SREAKT	EIN	Condition: irreversible SKA
B_DLRSPID	ADVE	EIN	Condition: DLR, sign of sum of the PID-components, = 1: positiv, =0: negative
B_DVEADA	BGDVE	AUS	condition: disabling injection during DV-E-adaptation
B_FPRAKT	BGDVE	LOK	Throttle return spring check active
B_FPRRDY	BGDVE	LOK	throttle return spring check ended
B_FPRZAB	BGDVE	AUS	Condition: Abort of DV-E return spring check, spring does not close
B_FPRZE	BGDVE	LOK	Condition: Error in the DV-E return spring check
B_FPRZOK	BGDVE	LOK	Condition: DV-E return spring check o.k.
B_FPRZVB	BGDVE	LOK	Condition: DV-E return spring check forbidden
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_LRNAKT	BGDVE	LOK	learning active bit

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Variable	Source	Type	Description
B_LRNDIA		EIN	Condition: DV-E adaptations and checks activated by means of diagnosis tester
B_LRNERF	BGDVE	LOK	learning success bit
B_LRNFG	BGDVE	LOK	learning enable bit
B_LRNRDY	BGDVE	AUS	learning complete
B_LRNTESA	BGDVE	LOK	Condition: UMA learning a.gain adj. activated due to tester request
B_LRNVB	BGDVE	LOK	learning prohibition bit
B_LRNWS	BGDVE	LOK	learned value save bit
B_MXDVEF	BGDVE	LOK	Fault typ max.: DV-E cause of failure: spring return check
B_NLPE	BGDVE	LOK	Condition: Error in NLP-check and learning
B_NLPERF	BGDVE	LOK	Permanent RAM, condition: NLP acquisition successful
B_NLPERFT	BGDVE	LOK	Permanent RAM, condition: NLP acquisition successful, temp. stage
B_NLPNEW	BGDVE	LOK	Condition: NLP position not yet known
B_NLPREQ	BGDVE	LOK	Condition: Request NLP learning
B_NPDVEN	BGDVE	LOK	Fault type npt plausible: DV-E fault in checking the limp-home air position
B_NPDVEU	BGDVE	LOK	Fault type not plausible: DV-E failure during UMA learning
B_NPDVEV	BGDVE	LOK	Fault type not plausible: DV-E failure during amplifier adjustment
B_PWF		EIN	Condition for powerfail
B_UMAE	BGDVE	LOK	Condition: Error during UMA learning
B_UMAERF	BGDVE	LOK	Condition: UMA learning successful
B_UMARDR	BGDVE	LOK	Condition: UMA learning value transfered to permanent RAM
B_UMAUAB	BGDVE	AUS	Condition: UMA learning stopped during first initialization (SKA)
B_WDK2SEL	GGDVE	EIN	Condition: DV-E position control is performed with actual-value-poti 2
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF		EIN	ECU-condition powerfail initialisation
DKPSTG_W	BGDVE	AUS	slope of throttle potentiometer (% DK / V)
DLRMXT	BGDVE	LOK	Timer for DLR in the UMA within the limit
DLRSPID_W	ADVE	EIN	DLR for DV-E: Sum of the PID-components
E_DVEF	BGDVE	AUS	Error flag: DV-E cause of failure: spring check
E_DVEN	BGDVE	AUS	Error flag: DV-E cause of failure: limphome air position
E_DVEU	BGDVE	AUS	Error flag: DV-E cause of failure: UMA-learning
E_DVEV	BGDVE	AUS	Error flag: DV-E cause of failure: amplifier adjustment
FPRSTEP_C	BGDVE	LOK	step counter throttle return spring check
FPRTIM_C	BGDVE	LOK	time counter throttle return spring check
LRNSTEP_C	BGDVE	LOK	counter for learning time for a learning step
LRNTIM_C	BGDVE	LOK	Time counter for the waiting time in the learning steps
LRNVB_C	BGDVE	LOK	Learning prohibition counter (wait time)
LRNVB_ZT	BGDVE	LOK	Target value of the learning prohibition time
NLP1TIM	BGDVE	LOK	Time counter for the waiting time 1 in the NLP learning
NLP2TIM	BGDVE	LOK	Time counter for the waiting time 2 in the NLP learning
NMOTLL		EIN	engine speed
R_T200		EIN	Time schedule 200 ms
SFPDVEF	BGDVE	LOK	Status word: DV-E cause of failure: spring check
SFPDVEN	BGDVE	LOK	Status word: DV-E cause of failure: limphome air position
SFPDVEU	BGDVE	LOK	Status word: DV-E cause of failure: UMA-learning
SFPDVEV	BGDVE	LOK	Status word: DV-E cause of failure: amplifier adjustment
TANS	GGTFA	EIN	Intake air temperature
TLOOP	BGDVE	LOK	Ring counter for time difference measurement
TMOT	GGTFM	EIN	Engine temperature
TMPUMAST	BGDVE	LOK	Status for temporary UMA adaptation
TNACHL_W	MOTAUS	EIN	time of ECU switch off delay
TTMUMAD	BGDVE	LOK	time difference for temporary UMA adaptation
TYP_DVEF	BGDVE	LOK	Fault type: DV-E fault during spring check
TYP_DVEN	BGDVE	LOK	Fault type: DV-E fault during check of air in limphome position
TYP_DVEU	BGDVE	LOK	Fault type: DV-E fault during UMA learning
TYP_DVEV	BGDVE	LOK	Fault type: DV-E fault during gain adjustment
UB	GGUB	EIN	battery voltage
UDKNLP1	BGDVE	LOK	Voltage DK-Poti 1 at the NLP
UDKNLP1R	BGDVE	LOK	Permanent RAM: Voltage DK-Poti 1 at the NLP
UDKNLP2	BGDVE	LOK	Voltage DK-Poti 2 at the NLP
UDKNLP2R	BGDVE	LOK	Permanent RAM: Voltage DK-Poti 2 at the NLP
UDKP1A	BGDVE	AUS	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop
UDKP1AALT	BGDVE	LOK	Temp. voltage DK-poti 1 at the lower DK limit stop
UDKP1ASR_W	BGDVE	LOK	Permanent RAM: Voltage DK-Poti 1 at lower DK limit stop, stationary value
UDKP1AS_W	BGDVE	LOK	Voltage DK-poti 1 at the lower limit stop, steady-state part
UDKP1A_W	BGDVE	AUS	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop (word)
UDKP1ROB	BGDVE	LOK	Real DK-poti-1-value at the upper adjustment point
UDKP1RUN	BGDVE	LOK	Real DK-poti-1-value at the lower adjustment point
UDKP1SV	BGDVE	AUS	Max. DK potentiometer-1 value for using amplified signal
UDKP1VOR	BGDVE	LOK	Permanent RAM: Voltage offset at DK-Poti-1-amplification
UDKP1VOU	BGDVE	AUS	Diagnosis: 8 bit copy of udkp1vo_w as ambient value
UDKP1VO_W	BGDVE	AUS	voltage offset of DK potentiometer 1 amplification charcteristic
UDKP1VROB	BGDVE	LOK	Real amplified DK-poti-1-value at the upper adjustment point
UDKP1VRUN	BGDVE	LOK	Real amplified DK-poti-1-value at the lower adjustment point
UDKP1VV	BGDVE	AUS	Diagnosis: 8 bit copy of udkp1vv_w as ambient value
UDKP1VVR	BGDVE	LOK	Permanent RAM: Amplification at DK-Poti-1-amplification
UDKP1VV_W	BGDVE	AUS	amplification of throttle potentiometer 1
UDKP1V_W		EIN	amplified sensor voltage throttle potentiometer 1
UDKP1_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UDKP2A	BGDVE	AUS	sensor voltage poti 2 of throttle actuator at (lower) mechanical stop
UDKP2AALT	BGDVE	LOK	Temp. voltage DK-poti 2 at the lower DK limit stop

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Variable	Source	Type	Description
UDKP2ASR_W	BGDVE	LOK	Permanent RAM: Voltage DK-Poti 2 at lower DK limit stop, stationary value
UDKP2AS_W	BGDVE	LOK	voltage DK-poti 2 at the lower limit stop, steady-state part
UDKP2A_W	BGDVE	AUS	sensor voltage throttle potentiometer 2 at (lower) mechanical stop
UDKP2_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UDKPAT_W	BGDVE	LOK	Temporary UEA offset of the DK-poti
VFZG	GGVFZG	EIN	vehicle speed (km/h)
WDKADA_W	BGDVE	AUS	Setpoint DK-angle, from DV-E adaptation function and check function
WDKBA_W	GGDVE	EIN	throttle angle with respect to lower mechanical stop
WDKNLP	BGDVE	AUS	Diagnosis: 8 bit copy of wdknlp_w as ambient value
WDKNLPR	BGDVE	AUS	Diagnosis: 8 bit copy of wdknlpr_w as ambient value
WDKNLPR_W	BGDVE	LOK	Permanent RAM: Setpoint throttle angle in NLP-position, related to UMA
WDKNLP_W	BGDVE	AUS	throttle angle in the limphome air position
WDKS_W	MSF	EIN	desired throttle angle w.r.t. to lower mechanical stop
WDKVABOB	BGDVE	LOK	DK setpoint for upper adjustment point
WDKVABUB	BGDVE	LOK	DK setpoint for lower adjustment point
WPED	GGPED	EIN	Standardized accelerator pedal angle
Z_DVEF	BGDVE	AUS	Cycle flag: DV-E cause of failure: spring check
Z_DVEN	BGDVE	AUS	Cycle flag: DV-E cause of failure: limphome air position
Z_DVEU	BGDVE	AUS	Cycle flag: DV-E cause of failure: UMA-learning
Z_DVEV	BGDVE	AUS	Cycle flag: DV-E cause of failure: amplifier adjustment

FB BGDVE 2.50 Detailed description of function

```
0.     Overview
===============

       1.    Introduction
       2.    Initialization
       3.    NLP learning (DV-E exchange detection)
       4.    DV-E spring check
       4.1      Return spring check
       4.1.1       Overview
       4.1.2       Detailed order of events
       5.    DV-E adaptation
       5.1     Steady-state part
       5.1.1       Overview
       5.1.2       Detailed order of events
       5.2     Temporary part
       5.3     Resulting part
       6.    Diagnosis
       7.    Blocking of the injection
       8.    DV-E adaptation via tester request
       9.    Storage in permanent RAM and in EEPROM

1.     Introduction
===================

Since there is no adjustment between the actual value acquisition by the potentiometer
and the mechanical throttle valve position (DK) for the throttle adjustment device
DV_E5, an adaptation needs to be performed in the ME. During the adaptation the lower
mechanical DK limit stop (UMA) and the air in the limphome position (NLP) of the DV-E5
are learned and an adjustment of the actual value potentiometer gain is performed. The
learned values are stored in the permanent RAM resp. in the EEPROM. In addition the
springs of the DV-E5 are checked. With ignition ON this adaptation may under certain
input conditions take place again.

Therefore the following partial functions are realized in the BGDVE:

   - Learning and checking of the DV-E air at limphome position (NLP learning) with
     DV-E exchange detection
   - DV-E return spring check
   - Learning of the lower mechanical DK limit stop (UMA learning)
   - Gain adjustment, offset and gradient

A 'first initialization' was performed only if all mentioned partial functions are
successfully executed during an initial start. The variables must then be given the
following values:

B_lrnws = 1, B_lrnerf = 1, B_nlperf = 1, B_fprzok = 1 and lrnstep_c = 9

2.     Initialization
=====================

The initialization phase consists of three parts.

"- Part 1: Copy EEPROM values into the permanent RAM"
          B_lrnws, B_nlperf, udknlp1r, udknlp2r, udkp1asr_w,
          udkp2asr_w, udkp1vor, udkp1vvr and wdknlpr_w
"- Part 2: Copy permanent RAM values into the RAM"
          udkp1asr -> udkp1as_w, udkp1asr_w -> udkp1a
          udkp2asr -> udkp2as_w, udkp2asr_w -> udkp2a
          udkp1vor -> udkp1vo_w, udkp1vvr -> udkp1vv_w
          wdknlpr_w -> wdknlp_w
```

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```
"- Part 3: Calculate ini-values and write them into RAM"
          Poti gradient dkpstg_w := 100.0 %DK / UDKP1NHUB
          Switch-over threshold udkp1sv := UPVGNENN / udkp1vv_w - UDKP1DUS
```

If the EEPROM was cleared or if it is defective, fixed values are written into the permanent RAM in part 1. The assignment is as follows:

```
          udkp1asr_w := UDKP1AURI
          udkp2asr_w := UDIP2AURI
          udkp1vor   := 0.0
          udkp1vvr   := UDKP1VID
          B_lrnws    := false
          B_nlperf   := false
          udknlp1r   := UDKNLP1N
          udknlp2r   := UDKNLP2N
          wdknlpr_w  := WDKNLPMA
```

Furthermore the following plausibility checks are performed in part 3:

```
          if (udkp1asr_w < UDKP1AMIN)  OR  (udkp1asr_w > UDKP1AMAX)  OR
             (udkp2asr_w < UDKP2AMIN)  OR  (udkp2asr_w > UDKP2AMAX)
          then
              B_lrnws    := false
              udkp1asr_w := UDKP1AURI
              udkp2asr_w := UDKP2AURI
              udkp1as_w  := UDKP1AURI
              udkp1a     := UDKP1AURI
              udkp2as_w  := UDKP2AURI
              udkp2a     := UDKP2AURI
          endif

          if (udkp1vo_w < UDKP1VOMI)  OR  (udkp1vo_w > UDKP1VOMA)  OR
             (udkp1vv_w < UDKP1VVMI)  OR  (udkp1vv_w > UDKP1VVMA)
          then
              B_abgle := true
              udkp1vo_w := 0.0
              udkp1vv_w := UDKP1VID
          endif
```

Plausibilisierung gespeicherter Wert für Notluftpunkt wdknlp_w:

```
          if (wdknlp_w < WDKNLPMI)  OR  (wdknlp_w > WDKNLPMA)
          then
              B_lrnerf := false
              wdknlp_w := WDKNLPMA
          endif
```

3. NLP learning (DV-E exchange detection)

The NLP is needed for the digital position controller (DLR) for one and for the other for the detection of a DV-E adaptation need, e.g. in case of actuator exchange.
At ignition ON the NLP is read via the actual value potentiometers, as long as the DV-E is still at zero current (result in udknlp1 and ukdnlp2) and it is then checked for plausibility with the values stored in the memory (udknlp1r and udknlp2r). If the values differ, adaptation need is detected and after the return spring was checked in checking step 3 (fprstep_c = 3) the NLP is learned. The NLP is made available to the DLR in the ADVE as wdknlp_w.

In order to avoid an incorrect DV-E exchange detection in case of a quick change from ignition ON -> OFF -> ON the DV-E exchange detection is only permitted after a time tnachl_w > TDKNLPE in the ECU initialization. Thus it is ensured that the DK can definitely stabilize into the NLP while it is at zero current.

Also see chapter 7, blocking of the injection.

4. DV-E spring check

4.1 Return spring check

4.1.1 Overview

By an opening of the DK from the NLP into the direction DK OPEN and by a subsequent switching off of the DV-E power stage (DV-E-ES) the return motion forced by the return spring is checked. In case of a fault the DK drive default function (previously driving with DK limphome air) is requested. The course of events can be observed by means of the checking step counter fprstep_c.
The check is only performed once by it being locked via the check ready bit B_fprrdy.

The check is performed only if the following preconditions are fulfilled:

```
    (B_dkpiu = 0)       AND
    (B_dknolu = 0)      AND
```

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```
    (B_i_ska_um = 0)    AND
    (B_wdk2sel = 0)     AND
    (vfzg = 0 km/h)     AND
    (nmotll <= FPRNMAX) AND
    (tmot >= FPRMT)     AND
    (tans >= FPRAT)
```

4.1.2 Detailed order of events

Spring check step 0 (B_fprakt = 0 -> 1 AND fprstep_c = 0):

Entry of the desired angle WDKAFPR for original position, starting of the spring check timer fprtim_c and switching over of the DV-E triggering to 'setpoint selection by adaptation' (B_dkaden = 1).

Spring check step 1 (fprstep_c = 1):

If the DK actual angle reaches the threshold of the original position (udkp1_w > UDKPFPRZ1) within a max. time (fprtim_c <= FPRTIM1_T) a DV-E power stage switch-off is requested by B_dcdisr = 1. If the max. time is exceeded or if the check threshold is not reached, then the internal check fault B_fprze = 1 is set and the DV-E return spring check is aborted.

Spring check step 2 (fprstep_c = 2):

As a result of the DV-E power stage switch-off the DK returns into the direction NLP due to the return spring. If the DK actual angle reaches the threshold of the original position (udkp1_w < UDKPFPRZ2) within a max. time (fprtim_c <= FPRTIM2_T), the check is detected to be O.K., the check bit B_fprzok = 1 and 'spring check active' are reset B_fprakt = 0. If the max. time is exceeded or if the lower check threshold is not reached, it means that the return spring has not set the DK back within the necessary time or that the return spring can no longer perform a return. In case this fault occurs the DK drive default function (previously driving with DK limphome air) is requested via B_fprzab = 1.
Furthermore it is checked whether a learning of the NLP was requested (B_nlpreq = 1) or whether a NLP learning has not yet been completely terminated (B_nlperft = 1). If B_nlpreq = B_nlperft, then the check step counter is set to 4, otherwise the check step counter is set to 3.

Spring check step 3 (fprstep_c = 3):

Learning of the DK-NLP while the DK is in a zero current state. After a waiting time (nlp1tim > NLPST1T), during which the DK has stabilized into the NLP, both DK actual value potentiometers udkp1_w and udkp2_w are read until a certain time nlp2tim >= NLPST2T has elapsed. During this measuring time the absolute NLP of the DK (udknlp1 and udknlp2) is determined by means of a floating mean value formation.

Spring check step 4 (fprstep_c = 4):

Check is terminated; request of the DV-E power stage switch-off is taken back (B_dcdisr = 0), check terminated is set (B_fprrdy = 1) and DV-E triggering is enabled for the normal operation (B_dkaden = 0).

5. DV-E adaptation

5.1 Steady-state part

5.1.1 Overview

The steady-state part of the DV-E adaptation includes the UMA learning and the adjustment of the actual value potentiometer gain. In principle the steady-state part only needs to be performed once during the startup of a new control unit resp. when exchanging a DV-E. The possibility of a renewed adaptation at ignition ON can be controlled by means of the prohibition time for learning LRNVB_T. The shorter this time is the more likely it becomes that the adaptation is performed once more.

During the learning of the UMA the DK is moved in steps from the max. possible UMA to the UMA. By monitoring the actual value potentiometer it is detected, that the DK no longer moves. The corresponding value is read and increased by an offset UDKPAOFF it is checked for plausibility as lower electrical DK limit stop (UEA) and stored in the permanent RAM resp. EEPROM. The UEA udkp1as_w and udkp2as_w are made available to the function GGDVE. When adjusting the gain the offset and the gains of the OP loop are determined by taking up two measuring positions with the DK. The calculated values udkp1vo_w and udkp1vv_w are made available to the function GGDVE. The adjustment is performed after the UMA learning.

If a fault occurs during the first initialization resp. with not set learning value memory bit (B_lrnws = 0), an irreversible safety fuel deactivation (SKA) is requested via B_umauab = 1. The course of the adaptaption can be observed by means of the learning step counter lrnstep_c.

The adaptation can also be started by a tester. See chapter 8.

In adaptation step 0 ... 4 the UMA is learned

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```
                    5       the rel. NLP is calculated
                    6 ... 9 the gain is adjusted
```

5.1.2 Detailed order of events
==========

Starting conditions:

The adaptation will only take place, if the spring check has been terminated (B_fprrdy = 1) and if the following input conditions are fulfilled:

```
    (B_dkpiu = 0)         AND
    (B_i_ska_um = 0)      AND
    (B_dknolu = 0)        AND
    (B_dknot = 0)         AND
    *)
    (vfzg = 0 km/h)       AND
    (nmotll <= UANNMAX)   AND
    (wped < UANPEDMAX)    AND
    (ub > UB_UANL)        AND
    (tmot >= UAN_U_MT)    AND
    (tmot <= UAN_O_MT)    AND
    (tans >= UANUATS)

    *): The conditions to follow are only tested, if
                          (lrnvb_c >= lrnvb_zt) OR
                          (B_pwf = 1)           OR
                          (B_lrnws = 0)         OR
                          (B_lrnerf = 0)
        in which the adaptation prohibition time LRNVB_T is contained in lrnvb_zt in
        the normal case, and in case the tester has requested the adaptation the delay
        time LRNVB_TDI is contained.
```

If all input conditions are fulfilled, the adaptation is enabled (B_lrnfg = 1), if one of the conditions is violated the adaptation is prohibited (B_lrnvb = 1).

Adaptation step 0 (B_lrnfg = 0 -> 1 AND lrnstep_c = 0):

Initialization of the DV-E adaptation. Switch-over of the DV-E triggering to 'setpoint of the BGDVE' (B_dkaden = 1) and entering the worst case values into the UMA values (udkp1as_w = UDKP1AMAX and udkp2as_w = UDKP2AMIN).

Adaptation step 1 (lrnstep_c = 1):

The DK is made to approach the UMA via a ramp by reducing udkp1as_w (step width UAN-ZURP). As soon as the position controller output undershoots a min-threshold (conditon: B_dlrspid = 0 AND dlrspid_w > UANPIDMIN) a waiting time counter (lrntim_c) is started. During this time the learning value is formed by means of a floating mean value formation in udkp1aalt and udkp2aalt. After the waiting time (lrntim_c >= LRNST1_T) the determined values udkp1as_w and udkp2as_w are checked for the permitted value range (UDKP1AMIN and UDKP2AMAX). In case of a fault the learning fault is set (B_umae = 1) and the UMA abort function is executed.

Adaptation step 2 (lrnstep_c = 2):

The learned UMA, stored in the previous step in udkp1as_w and udkp2as_w, is increased by the offset (UDKPAOFF) and it thus becomes UEA. The UEA values are subsequently checked for the permitted value range (UDKP1AMAX and UDKP2AMIN). In case of a fault the learning fault is set (B_umae = 1) and the UMA abort function is executed.

Adaptation step 3 (lrnstep_c = 3):

In this step a ramp with the step width UANAUFRP is passed to the DK via the setpoint wdkada_w until the position controller output again exceeds the min-threshold (condition: B_dlrspid = 0 AND dlrspid_w <= UANPIDMINA). As soon as the threshold was exceeded, it is checked - after a waiting time (lrntim_c >= LRNST3_T) - on whether the DK has detached from the UMA (udkp1_w > udkp1aalt) resp. on whether it is not more than one delta away from UEA (udkp1_w <= udkp1as_w + UDKPALOS). In case of a fault the learning fault is set (B_umae = 1) and the UMA abort function is executed.

Adaptation step 4 (lrnstep_c = 4):

Part 1 of the adaptation, the UMA learning has successfully been terminated; the bit learning value storage is set (B_lrnws = 1). If the following conditions are fulfil-led, the currently learned UEA are entered into the permanent RAM (udkp1asr_w and udkp2asr_w)and 'learning value in the permanent RAM is set (B_umardr = 1).

```
Conditions:       (|udkp1as_w - udkp1asr_w| > UAN_STORE)  OR
                  (B_pwf = 1)                             OR
                  (B_lrnerf = 0)                          OR
                  (B_lrntesa = 1)
```

Adaptation step 5 (lrnstep_c = 5):

The value for the absolute NLP determined during the spring check is converted to a relative value (wdknlp_w). The calculated value is checked for plausibility with the

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NLP tolerance range permitted for the DV-E (WDKNLPMI and WDKNLPMA). If the tolerance range is adhered to, the temp. NLP learning success is set (B_nlperft = 1) and NLP-new is reset (B_nlpnew = 0). If the value is not within the tolerance range, the NLP learning success is reset (B_nlperf = 0) and NLP-fault is set (B_nlpe = 1). If the UEA values were passed on to the permanent RAM (B_umardr = 1), the NLP values are also passed on to the permanent RAM (udknlp1r, udknlp2r and wdknlpr_w).

Adaptation step 6 (lrnstep_c = 6):

Initialization for the gain adjustment (gain adj.). Calculation of the adjustment points (wdkvabub and wdkvabob), change control to non-amplified poti (udkp1sv = 0) and enter setpoint for upper adjustment point (wdkada_w = wdkvabob).

Adaptation step 7 (lrnstep_c = 7):

After a waiting time (lrntim_c >= LRNST7_T) the actual values are read in the upper adjustment point (udkp1rob and udkp1vrob). The amplified actual value is checked for plausibility (UDKP1VOSC). In case of a fault the gain adj. abort function is executed.

Adaptation step 8 (lrnstep_c = 8):

Enter setpoint for lower adjustment point (wdkada_w = wdkvabub).

Adaptation step 9 (lrnstep_c = 9):

After a waiting time (lrntim_c >= LRNST9_T) the actual values are read in the lower adjustment point (udkp1run and udkp1vrun). The amplified actual value is checked for plausibility (UDKP1VUSC). Thereafter the gain and the offset are calculated (udkp1vo_w and udkp1vv_w) and checked for plausibility (UDKP1VOMI, UDKP1VOMA, UDKP1VVMI and UDKP1VVMA). To finish off, the NLP learning success is finally set in adaptation step 9 (B_nlperf = 1 and B_nlperft = 0), if the temp. NLP learning success was set (B_nlperft =1), the switch-over threshold was updated (udkp1sv), gain and offset were written into the permanent RAM (udkp1vor and ukdp1vvr), the DV-E triggering for the normal operation was again enabled (B_dkaden = 0), the learning success was set (B_lrnerf = 1), the injection was again enabled (B_dveada = 0) and end of learning was set (B_lrnrdy = 1 and B_lrnakt = 0).

In case any fault occurs the gain adj. abort function is executed.

UMA abort function:

If no 'initial adaptation' has yet been performed(B_lrnws = 0), irreversible SKA is outputted (B_umauab = 1). If an initial adaptation was performed, a basic initialization is performed (udkp1asr_w = UDKP1AURI, udkp2asr_w = UDKP2AURI and dkpstg_w = DKPSTGMIN) in case of detected actuator exchange (B_nlpnew = 1). The permanent RAM values are continued to be transferred to the RAM (udkp1asr_w and ukdp2ar_w) and the settings for the adaptation are reset (B_dkaden, B_dveada, B_lrnrdy and B_lrnakt).

Gain adj. abort function:

Setting of the adjustment fault (B_abgle = 1), prohibit operation with amplified poti signal (udkp1sv = 0) and reset the settings for the adaptation (B_dkaden, B_dveada, B_lrnrdy and B_lrnakt).

5.2 Temporary part

On the DV-E on which the DK enters the bore, the UMA is influenced by the temperature. That means that in case of a setpoint entry << 1 %DK the DK can reach the UMA and that it can therefore be switched to zero current via the DLR range monitoring of the DV-E resp. the idle control (LLR) can no longer control the idling speed.
For this reason the UMA is increased in steps resp. decreased again to the learned value.

The offset formation is only permitted, if the engine temperature (tmot) has exceeded a threshold () and if the setpoint entry (wdks_w) has undershot a threshold ().

A temp. offset is built up, if the DLR output (dlrspid_w with B_dlrspid) exceeds the value DLRPIDSTMN for a time (dlrmxt >= TDLRPIDMX). The offset (udkpat_w) is increased by a delta (DUDKPTMP) in each calculation cycle (50 ms). The maximum possible offset is . As soon as the offset is so large that the DLR is no longer at the limit stop (DLRPIDSTMN), a time difference measurement is started (ttmumad).

If the offset is no longer built up for at least a time (TTMUMASTA), the temporary offset is reduced again. The delta per calculation cycle is DUDKPTMP/4.

As soon as the temp. offset is > 0, the gradient of the actual value potentiometer (dkpstg_w) is corrected, in order to avoid the DK from reaching the upper mechanical limit stop (OMA) when entering a setpoint of 100 %DK. The maximum position the DK reaches is the upper electrical DK limit stop (OEA).

The state of the temp. offset is indicated in tmpumast.

tmpumast = 0: no offset formation, resp. offset (udkpat_w) = 0

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```
                 1:  offset for UEA is increased, resp. is > 0
                 2:  offset for UEA is decreased

5.3    Resulting part
====================

The resulting UEA is formed from the steady-state UEA and the temporary UEA offset.
The following applies:  udkp1a_w := ukdp1as_w + udkpat_w
                        udkp2a_w := udkp2as_w - udkpat_w
                        udkp1a   := udkp1a_w
                        udkp2a   := udkp2a_w

6.     Diagnosis
================

For the workshop and CARB diagnosis four fault paths have been defined.

    - Path 'DVEF': indicates that the DV-E return spring check was not performed
                   correctly. B_mxdvef = 1.
    - Path 'DVEV': indicates that the gain adjustment was not performed correctly.
    - Path 'DVEN': indicates that an actuator exchange was detected via the NLP check
                   and that the DV-E basic adaptation which was subsequently started
                   was not performed, resp. that the detected air for the limphome
                   position is incorrect.
    - Path 'DVEU': indicates that the UMA learning was performed incorrectly.

7.     Blocking of the injection
================================

By means of the system constant SY_DVEADA it is possible to adjust whether the in-
jection in case of adaptation need can be blocked or not by the BGDVE. If blocking is
desired, then B_dveada = 1. Via the blocking request (B_dveada = 1) it can be ensured
that an adaptation requested via the DV-E exchange detection can definitely be perfor-
med by the system in spite of a starting attempt.

8.     DV-E adaptation by tester request
========================================

The learning of the NLP, UMA and of the gain adjustment can in addition be triggered
by a tester request. For this the B_lrndia must be set to 1. During a SG-cycle ON it
is allowed, that the DV-E adaption can be started repeatedly.

Also see chapter 7. 'Blocking of the injection'.

9.     Permanent RAM and EEPROM storage
=======================================

The following RAM-cells are stored in the permanent RAM and in the EEPROM:

      RAM          Permanent RAM    EEPROM
      ------------------------------------
      B_lrnerf     B_lrnerf          ——
      B_lrnws      B_lrnws           yes
      B_nlperf     B_nlperf          yes
      B_nlperft    B_nlperft         ——
      tnachl_w     tnachl_w          ——
      udknlp1      udknlp1r          yes
      udknlp2      udknlp2r          yes
      udkp1as_w    udkp1asr_w        yes
      udkp1vo_w    udkp1vor          yes
      udkp1vv_w    udkp1vvr          yes
      udkp2as_w    udkp2asr_w        yes
      wdknlp_w     wdknlpr_w         yes
```

APP BGDVE 2.50 Application hint

```
1.  Deactivation of parts of the function
=========================================

When switching off the following parts of the functions it must be noted that an in-
itial adaptation cannot be performed correctly.

    Label     Passive value   deactivated ...
    ---------------------------------------------
    DUDKNLPO      5 V         NLP check and learning (DV-E exchange detection)
    DUDKNLPU      5 V          "     "    "     "              "
    FPRAT       143,25  C     DV-E return spring check
    UAN_U_MT    143,25  C     UMA learning and gain adjustment
    TMSUTMUMA   143,25  C     temp. UEA adaptation
    WDKSTMUMA     0 %DK         "    "     "

2.  Function-oriented selection of the diagnosis labels in the VS100
====================================================================

Fault memory relevant values of the diagnosis function xyz are assigned to the functi-
on DFPM_xyz in the function-oriented selection.
```

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3. Check of the DV-E return spring
==========

The engine speed threshold FPRNMAX should be adjusted such that when turning the starter the threshold is not exceeded without injection. Thus it is ensured that in case of DV-E exchange detection and simultaneous prohibition of the injection, see chapter 6 of the function description, the DV-E adaptation is performed correctly.

4. Learning of the UMA and gain adj.
==========

The engine speed threshold UANNMAX should be adjusted such that when turning the starter the threshold is not exceeded without injection. Thus it is ensured that in case of DV-E exchange detection and simultaneous prohibition of the injection, see chapter 6 of the function description, the DV-E adaptation is performed correctly.

5. Temporary UEA adaptation
==========

An increase of the offset must take place so quickly that the DV-E-ES does not come into the temperature deactivation. The decrease of the offset is performed slower by a factor of 4. This value cannot be adjusted. That means that the ramp-step may not be less than 4 increments, complies to 4,884 mV. The maximum permitted offset is determined by means of the parameter calculation program (see ANM). The time, after which a decrease of the offset is permitted (TTMUMASTA), should be roughly adjusted to the cooling behaviour of the DV-E. The value is preset to 2 minutes.

6. DV-E exchange detection
==========

The time TDKNLPE to avoid an incorrect DV-E exchange detection in case of a quick change of the ignition ON -> OFF -> ON should be adjusted such that during this time the throttle valve can definitely stabilize in the NLP. When using a DV-E5 this time should not be less than 2 s. It must be ensured that the min. ECU after-run time TNLSGMN in the function MOTAUS is greater than TDKNLPE.

7. Air for the limphome position (NLP) of the DV-E
==========

The data made available by the DCM file assume a DV-E with a standard NLP of 5 DK over UMA. If the NLP diameter is changed the parameters DUDKNLPU, DUDKNLPO, UDKPFPRZ1, UDKPFPRZ2, WDKNLPMI and WDKNLPMA need to be adjusted. For the adjustment the 'calculation of the tolerances and of the system parameters for EGAS in the ME7' EGAToxx.xls should be used. This Excel document calculates above-mentioned parameters automatically, once corresponding basic data have been entered.

8. Blocking of the injection
==========

So that a complete DV-E adaptation is performed when a DV-E exchange is detected with the ignition ON, the system constant SY_DVEADA should generally be set = 1. If the injection is not prohibited with detected DV-E exchange, no DV-E basic adaptation is performed when the engine is started and therefore initialization values are loaded for the continued trip. ——> idle speed fluctuations are possible.

9. Other
==========

With changes of the DV-E dynamics, such as e.g. shortened setting times, the functions DV-E spring check, UMA learning and the gain adjustment need to be checked.
Please also pay attention to the block ANM!

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ADVE 2.12 Activation of the DV-E by means of the DLR

FDEF ADVE 2.12 Function definition

adve-adve

adve-dlr

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adve-i-ant-mani

monitoring and diagnosis

adve-check

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these informations directly from the fault path status managed in the DFPM.

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adve-diag1

For each fault path DVEL of this diagnosis function the following values are defined:

```
    Status fault path DVEL:       sfpdvel
       Error flag dvel:             E_dvel
       Cycle flag dvel:             Z_dvel
       Fault type dvel:             TYP_dvel: (B_mxdvel, B_mndvel, B_sidvel, B_npdvel)
       Clear fault path:              B_cldvel
       Default value active:          B_bkdvel (optional)
    Fault path code dvel:         CDTDVEL
    Fault class dvel:             CLADVEL
    Fault intensity dvel:         TSFDVEL
    CARB code dvel:               CDCDVEL
    Table of ambient cond. dvel:  FFTDVEL
```

adve-diag2

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(*1): deviant from the description this part is realized in the module %DFPM
(*2): The actions triggered by C_(*) are implemented in the SW in individual processes

For each fault path DVEE of this diagnosis function the following values are defined:

```
Status fault path DVEE:       sfpdvee
   Error flag dvee:             E_dvee
   Cycle flag dvee:             Z_dvee
   Fault type dvee:             TYP_dvee: (B_mxdvee, B_mndvee, B_sidvee, B_npdvee)
   Clear fault path:              B_cldvee
   Default value active:          B_bkdvee (optional)
Fault path code dvee:         CDTDVEE
Fault class dvee:             CLADVEE
Fault intensity dvee:         TSFDVEE
CARB code dvee:               CDCDVEE
Table of ambient cond. dvee:  FFTDVEE
```

adve-diag3

(*1): deviant from the description this part is realized in the module %DFPM
(*2): The actions triggered by C_(*) are implemented in the SW in individual processes

For each fault path DVER of this diagnosis function the following values are defined:

```
Status fault path DVER:       sfpdver
   Error flag dver:             E_dver
   Cycle flag dver:             Z_dver
   Fault type dver:             TYP_dver: (B_mxdver, B_mndver, B_sidver, B_npdver)
   Clear fault path:              B_cldver
   Default value active:          B_bkdver (optional)
Fault path code dver:         CDTDVER
Fault class dver:             CLADVER
Fault intensity dver:         TSFDVER
CARB code dver:               CDCDVER
Table of ambient cond. dver:  FFTDVER
```

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monitoring of position
from throttle blade

adve-dk-lage

adve-dk-lage

```
-- Code of block DK-Lageüb

   -- monitoring of position from throttle blade
   -- task rate: 20 ms
   if ((B_dkpiu = false) AND (B_i_ska_um = false) AND B_ubdve)
   then
      if (B_dknolu)
      then
         -- Überwachung der DK-NLP währende der DK-Antriebersatzfunktion
         -- (ehemals DK-Notluftfahren)
         if (wdkba_w > (wdknlp_w + WDKNLPTOL))
         then
            -- reversibel SKA anfordern
            B_nlpne := true;
         else
            -- reversibel SKA zurücknehmen
            B_nlpne := false;
         endif;
      else
         -- Überwachung von DK-Soll-/Istwert
         if (B_dkaden = false)
         then
            -- Sollwertänderung aus der FUEDK übernehmen und
            -- den Betrag bilden.
            -- ACHTUNG: Bereich dwdks_w von -50 .. 0 .. +50 %DK
            dwdks_kge := abs(dwdks_w);
            -- erlaubte Abweichung bestimmen
            -- Wert aus einer Tabelle ermitteln, ohne Interpolation
            dwdksimx := DWDKSBAMX(dwdks_kge);
            if (abs(wdksfi_w - wdkba_w) > dwdksimx)
            then
               if (dklagerc > DKLAGERT)
               then
                  -- Fehlerreaktionszeit ist abgelaufen, d.h.
                  -- Fehlerflag setzen, um Notluftfahren anzufordern
                  B_wdksive := true;
               else
                  -- Fehlerzähler inkrementieren
                  dklagerc := dklagerc + 20 ms;
               endif;
            else
               -- Fehlerzähler dekrementieren
               dklagerc := dklagerc - TDKLAGDE;
               -- und im SG auf min 0 begrenzen
               dklagerc := limit(0,dklagerc,DKLAGERT+20ms);
            endif;
            -- DK-Sollwert zur Prädiktion des DK-Istwertes
            -- mit PT1 filtern. Filterwert aber erst im
            -- nächsten Rechenraster verwenden, damit DK-An-
            -- laufverhalten berücksichtigt wird (PT2)
            wdksfi_w := wdksfi_w + (wdks_w - wdksfi_w) * ZKWDKSPT1;
         endif;
      endif;
   endif;
```

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monitoring of PID-setting range
of DV-E-power-stage status

adve-dlr-bereic

adve-dlr-bereic

```
-- Code of block DLR-Stellber

    -- monitoring of PID setting range
    -- calculation cycle: 10 ms
    if ((B_dknolu = false) AND (B_dkpiu = false))
    then
       if (B_ubdve AND(B_lrnakt = false))
       then
          if ((dlrspid_w > DLRPIDMAX) AND B_dlrspid)
          then
             -- range is exceeded
             FKT_DLRBER-test();
          else
             if ((dlrspid_w > DLRPIDMIN) AND (B_dlrspid = false))
             then
                -- range is exceeded
                FKT_DLRBER-test();
             else
                -- take back rev. SKA
                B_dlrbe := false;
                -- reset fault counter
                dlrpidc := 0;
                -- reset debouncing counter
                dveesc := 0;
             endif;
          endif;
       endif;
    else
       -- reset fault counter
       dlrpidc := 0;
       -- reset debouncing counter
       dveesc := 0;
    endif;

-- function FKT_DLRBER-test()

    if (dlrpidc > DLRPID2T)
    then
       -- The HW port to be scanned in the following
       -- P_dveeson, illustrates the state of the status
       -- flag of the DV-E power stage port.
       -- E.g. status flag at P3.15,
       -- for the DV-E power stage CJ220 the state = ok applies,
       -- if the line is at 'high'.
       -- That means P_dveeson = P3.15 applies
       if (P_dveeson = false)
       then
          -- set DV-E power stage fault
          B_dveese := true;
       endif;
       -- set fault 'DLR setting range at the limit stop',
       -- and thus signal the reaction request
       -- drive with DK limphome air
       B_dlrpide := true;
    else
       if (dlrpidc > DLRPID1T)
       then
          -- request reversible SKA
          B_dlrbe := true;
       endif;
       -- increment fault counter
       dlrpidc := dlrpidc + 10 ms;
       if (P_dveeson = false)
       then
          -- DV-E power stage restart test
          if (dveesc >= DVEEST)
          then
             -- take back deactivation request for DV-E power stage.
             -- By this a neg. edge is created, which can again
```

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```
            -- activate the power stage.
            B_dveesh := false;
         else
            -- increment debouncing counter
            dveesc := dveesc + 10 ms;
            if (dveesc >= DVEEST)
            then
               -- set deactivation request for DV-E power stage,
               -- in order to be able to create a neg. edge for the
               -- activation of the power stage by a subsequent taking
               -- back of the deactivation request.
               B_dveesh := true;
            endif;
         endif;
      else
         -- reset debouncing counter
         dveesc := 0;
      endif;
   endif;
```

adve-ubatt

ABK ADVE 2.12 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCDVEE	BLOKNR		KL	Code word CARB: DV-E power stage
CDCDVEL	BLOKNR		KL	Code word CARB: DV-E position deviation
CDCDVER	BLOKNR		KL	Code word CARB: DV-E control range
CDKDVEE			FW	Code word customer: DV-E power stage
CDKDVEL			FW	Code word customer: DV-E position deviation
CDKDVER			FW	Code word customer: DV-E control range
CDTDVEE			FW	Code word tester: DV-E power stage
CDTDVEL			FW	Code word tester: DV-E position deviation
CDTDVER			FW	Code word tester: DV-E control range
CLADVEE			FW	Fault class: DV-E power stage
CLADVEL			FW	Fault class: DV-E position deviation
CLADVER			FW	Fault class: DV-E control range
DANTGESWNV			FW	Threshold for activation of D component (speed) in the non-amplified range
DANTGESWV			FW	Threshold for activation of D component (speed) in the amplified range
DANTSCHWNV			FW	Threshold for activation of D component (deviation) in the non-amplified range
DANTSCHWV			FW	Threshold for activation of D component (deviation) in the amplified range
DKLAGERT			FW	Permissible fault time for DK setpoint/actual comparison
DLRDWDKSS1			FW	DLR, upper limit for the parameter switch-over
DLRDWDKSS2			FW	DLR, lower limit for the parameter switch-over
DLRIAMAXA			FW	Maximum permissible I-component
DLRIKLPAR			FW	DLR, I small parameter
DLRININI			FW	I-component during init for ramp passing through NLP
DLRKDONLP0			FW	DLR, D parameter above NLP
DLRKDUNLP0			FW	DLR, D parameter below NLP (weak)
DLRKDUNLP1			FW	DLR, D parameter below NLP (medium)
DLRKDUNLP2			FW	DLR, D parameter below NLP (strong)
DLRKIONLP0	DWDKDLR_W		KL	I component as f(abs(dwdkdlr_w)), above NLP
DLRKIUNLP0	DWDKDLR_W		KL	I component as f(abs(dwdkdlr_w)), below NLP (weak)
DLRKIUNLP1	DWDKDLR_W		KL	I component as f(abs(dwdkdlr_w)), below NLP (medium)
DLRKIUNLP2	DWDKDLR_W		KL	I component as f(abs(dwdkdlr_w)), below NLP (strong)
DLRKPONLP0			FW	DLR, P parameter above NLP
DLRKPUNLP0			FW	DLR, P parameter below NLP (weak)
DLRKPUNLP1			FW	DLR, P parameter below NLP (medium)
DLRKPUNLP2			FW	DLR, P parameter below NLP (strong)
DLRKREIS			FW	DLR, factor loop gain
DLRKREISST			FW	DLR, factor loop gain at the time of the engine start
DLRNLPD			FW	Fuzzy range of DK in limphome air position
DLRPID1T			FW	Permissible fault time 1 for DLR setting range at the limit stop
DLRPID2T			FW	Permissible fault time 2 for DLR setting range at the limit stop
DLRPIDMAX			FW	Max. permissible PWM pulse duty factor for DLR
DLRPIDMIN			FW	Min. permissible PWM pulse duty factor for DLR
DLRUBSOLL			FW	DLR, battery standard voltage
DLRUMABAND			FW	Range of uncertainty during the step change out of the UMA range
DLRUMAIINI			FW	Default value of the I component during the step change out of the UMA range

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Parameter	Source-X	Source-Y	Type	Description
DVEEST			FW	Time for the healing attempt of the DV-E-power stage
DWDKSBAMX	DWDKS_KGE		KL	Max. setpoint/actual DK angle deviation as f(dwdks)
DWDKSIKLS			FW	Threshold for the activation of the I small component
FFTDVEE	BLOKNR		KL	Freeze frame table: DV-E power stage
FFTDVEL	BLOKNR		KL	Freeze frame table: DV-E position deviation
FFTDVER	BLOKNR		KL	Freeze frame table: DV-E control range
KDLRIDDVE			FW	Identification of the DLR parameter block regarding DV-E type
TDKLAGDE			FW	Time delta for clearing of fault counter with DK setpoint/actual comparison
TSFDVEE			FW	Fault sum time: DV-E power stage
TSFDVEL			FW	Fault sum time: DV-E position deviation
TSFDVER			FW	Fault sum time: DV-E control range
WDKBEWS			FW	Threshold for the DK movement detection (I-small)
WDKNLPTOL			FW	Permissible DK angle tolerance of the NLP
WDKREIB			FW	Frictional component of the DK I small
WDKSTFEIN			FW	Threshold for detection of steady-state (amplified range)
WDKSTGROB			FW	Threshold for detection of steady-state (non-amplified range)
ZKUBDLR			FW	DLR, time constant for filtering of Ubatt
ZKWDKSPT1			FW	Time constant for prediction of DK angle from setpoint

Variable	Source	Type	Description
B_CLDVEE		EIN	Flag for clearing measures: DV-E power stage
B_CLDVEL		EIN	Flag for clearing measures: DV-E position deviation
B_CLDVER		EIN	Flag for clearing measures: DV-E deviation
B_DCDISFR	ADVE	AUS	Condition: Disable DV-E power stage by means of the funct. processor
B_DCDISR	BGDVE	EIN	Condition: DV-E power stage deactivation is requested
B_DKADEN	BGDVE	EIN	Condition: Use DK setpoint from DK adaptation and DK check
B_DKNOLU	SREAKT	EIN	condition: power supply of throttle actuator cut off
B_DKPIU	SREAKT	EIN	Condition: irreversible SKA
B_DLRBE	ADVE	LOK	Condition: DLR correction range exceeded
B_DLRBEW	ADVE	DOK	
B_DLRIKLA	ADVE	DOK	Condition: DLR, I-small active
B_DLRIKLST	ADVE	DOK	Condition: First run of I-small after start
B_DLRPARC	ADVE	LOK	Condition: desired value step change is about to happen
B_DLRPIDE	ADVE	LOK	Condition: Fault, DLR correction range at limit
B_DLRSPID	ADVE	AUS	Condition: DLR, sign of sum of the PID-components, = 1: positiv, =0: negative
B_DLRUMZU	ADVE	LOK	Condition: NLP reloading is permitted
B_DVEESE	ADVE	LOK	Condition: DV-E power stage fault
B_DVEESH	ADVE	LOK	Condition: DV-E power stage healing
B_IKLREST	ADVE	DOK	Condition: Re-triggering of I-small
B_IKLSTAR	ADVE	DOK	Condition: I-small shall start
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_KL15		EIN	condition ignition switch on
B_LRNRDY	BGDVE	EIN	learning complete
B_MNDVER	ADVE	LOK	Fault type min.: DV-E control range, exceeded for a short time
B_MXDVER	ADVE	LOK	Fault type max.: DV-E control range, violation for a long time
B_NLPE	ADVE	AUS	Condition: Error in NLP-check and learning
B_NPDVEE	ADVE	LOK	Fault type not plausible: DV-E power stage
B_NPDVEL	ADVE	LOK	Fault type not plausible: DV-E position deviation
B_PWF		EIN	Condition for powerfail
B_ST	BBSTT	EIN	condition for start
B_UBDVE	ADVE	AUS	Condition: Battery voltage for DV-E control OK
B_UBPVG	ADVE	AUS	condition: battery voltage sufficient for 5-V potentiometer supply
B_UB_OK	ADVE	AUS	Battery voltage o.k.
B_WDK1V	GGDVE	EIN	Condition: amplified signal from potentiometer 1 used to calc. throttle angle
B_WDKSAUF	ADVE	DOK	Condition: DLR, desired jump into direction OPEN
B_WDKSIVE	ADVE	LOK	Condition: Fault in comparing DK angle nominal value/actual value
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF		EIN	ECU-condition powerfail initialisation
DKLAGERC	ADVE	LOK	Fault counter DK position monitoring
DLRBATKP_W	ADVE	DOK	Compensation factor for fluctuation UBatt
DLRD	ADVE	DOK	DLR, D-parameter
DLRDANT_W	ADVE	DOK	D component
DLRDSV_W	ADVE	DOK	Threshold for activation of D component (speed)
DLRDSW_W	ADVE	DOK	Threshold for activation of D component (deviation)
DLRI	ADVE	DOK	DLR, I-parameter
DLRIAMAX	ADVE	LOK	DLR, maximum possible I-component
DLRIANT_L	ADVE	LOK	DLR, I component
DLRIANT_W	ADVE	LOK	DLR, I-component, high word of dlriant_l
DLRIKLST_W	ADVE	LOK	Input value i small component
DLRIKL_W	ADVE	LOK	DLR, I small component
DLRKOMP	ADVE	LOK	DLR, factor loop gain
DLRNDIF_W	ADVE	DOK	Actual value current - actual value latest for D component of the DLR
DLRP	ADVE	DOK	DLR, P-parameter
DLRPANT_L	ADVE	DOK	DLR, P component
DLRPIDC	ADVE	LOK	Fault counter DLR setting range monitoring
DLRRAST	ADVE	DOK	DLR task counter
DLRSPID_W	ADVE	AUS	DLR for DV-E: Sum of the PID-components
DVEESC	ADVE	LOK	Debouncing counter for DV-E power stage
DWDKDLRA_W	ADVE	DOK	DLR, value for detection of VZ change at I-small

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Variable	Source	Type	Description
DWDKDLR_W	ADVE	LOK	Difference-DK-angle setpoint - act. value (wdkdlr_w - wdkba_w)
DWDKSIMX	ADVE	DOK	Max. permissible deviation between desired throttle angle and actual angle
DWDKS_KGE	ADVE	LOK	Change of the throttle valve setpoint angle,absol.value for charact.line input
DWDKS_W	FUEDK	EIN	modification of desired throttle angle
E_DVEE	ADVE	LOK	Error flag: DV-E power stage
E_DVEL	ADVE	LOK	Error flag: DV-E position deviation
E_DVER	ADVE	LOK	Error flag: DV-E control range
P_DVEESON	ADVE	LOK	HW port: DV-E-powen stage is switched on (= HW status flag)
R_T100		EIN	Time schedule 100 ms
R_T200		EIN	Time schedule 200 ms
SFPDVEE	ADVE	LOK	Status word: DV-E power stage
SFPDVEL	ADVE	LOK	Status word: DV-E position deviation
SFPDVER	ADVE	LOK	Status word: DV-E control range
SY_UBDEDIS	PROKON	EIN	Ubatt threshold for disabling the DV-E output stage
SY_UBDEEN	PROKON	EIN	Ubatt threshold for enabling the DV-E output stage
UB	GGUB	EIN	battery voltage
WDKADA_W	BGDVE	EIN	Setpoint DK-angle, from DV-E adaptation function and check function
WDKBAALT_W	ADVE	DOK	Old Throttle valve actual value to determine the D component
WDKBAS_W	ADVE	DOK	Throttle valve actual value for the movement detection for I-small
WDKBA_W	GGDVE	EIN	throttle angle with respect to lower mechanical stop
WDKDLR_W	ADVE	LOK	Setpoint DK-Angle in 12 Bit-Resolution
WDKNLP_W	BGDVE	EIN	throttle angle in the limphome air position
WDKSFI_W	ADVE	LOK	Predicted DK angle from wdks_w
WDKSSTSW_W	ADVE	DOK	Threshold for steady-state detection for I-small
WDKS_W	MSF	EIN	desired throttle angle w.r.t. to lower mechanical stop
Z_DVEE	ADVE	LOK	Cycle flag: DV-E power stage
Z_DVEL	ADVE	LOK	Cycle flag: DV-E position deviation
Z_DVER	ADVE	LOK	Cycle flag: DV-E control range

FB ADVE 2.12 Detailed description of function

```
0.   Overview
=============

     1.   Introduction
     2.   Initialization
     3.   DK position control
     3.1     DK setpoint and DK actual value
     3.2     Pre-control of the I component
     3.3     Compensating the battery voltage fluctuations
     3.4     Digital PID controller
     4.   DV-E power stage triggering
     5.   Coordination of the DV-E power stage release
     6.   Monitoring of battery voltage
     7.   Monitoring of the DK position
     7.1     Monitoring of the DK at air in limphome position
     7.2     Monitoring of the DK setpoint/actual value
     8.   Monitoring of the DLR setting range
     9.   Diagnosis

1.   Introduction
=================

The task of the function is to trigger the throttle adjustment device (DV-E) and to
diagnose faults in the triggering circuit. The position of the throttle blade (DK) is
controlled by a digital position controller (DLR), which transfers a PMW pulse duty
factor and a directional bit to the DV-E power stage (DV-E-ES). The DV-E-ES is de-
signed as an integrated H-bridge with internal current limitation. The input values
are for one the DK setpoint (wdks_w), which is generated in the function FUEDK and for
the other the DK actual value (wdkba_w), which is formed in the function GGDVE.

Furthermore the position control loop is monitored for non-permissible desired / actu-
al deviations (wdks_w to wdkba_w), for the setting signal exceeding the range
(dlrspid_w with B_dlrspid) and for the operating state of the DV-E-ES (P_dveeson).

2.   Initialization
===================

During the initialization fixed values are written into the following RAM-cells:

     B_dlrpar   := true
     B_dlrumzu  := true
     dlrbatkp_w := 1.0
     dlrkomp    := DLRKREIS
     dlrd       := DLRKDONLP0
     dlri       := 1.0
     dlrp       := DLRKPONLP0

3.   DK position control
=========================
3.1  DK setpoint and DK actual value
====================================
```

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The setpoint for the DK position control is supplied by the FUEDK as a 16 bit value (wdks_w). Since the DK actual value (wdkba_w) is given with a maximum resolution of 0,0244 %DK (100 %DK / (2e12 - 1)) in the amplified and of 0,0978 %DK (100 %DK / (2e10 - 1)) in the remaining (non-amplified) range, the setpoint must be matched to the actual value. At first the setpoint is shifted to the right by 4 bit positions, this complies with a resolution of 12 bit. For the non-amplified range (B_wdk1v = false) the setpoint is additionally combined by an AND with the bit mask 0x0FFCh so that the resolution is 10 bit.

The DK actual value wdkba_w must have been updated by the GGDVE for the 1 ms - cycle of the DLR prior to the call-up of the DLR. The max. dead time between AD conversion and output of the DLR pulse duty factor may not exceed 0,5 ms. The shorter this dead time, the better it is for the control behaviour.

3.2 Pre-control of the I component

Due to the strongly non-linear control system the I component is manipulated by a pre-control in case of a DK movement through the limphome air point (NLP) and out of the UMA range.

If the DK is in the vicinity of the UMA then the I component will increase to large negative values due to the strongly increased friction. For this reason the I component is set to the smaller default value DLRUMAIINI, if the DK setpoint rises above the threshold DLRUMABAND and if the I component has increased to more than DLRUMAIINI.

In case of a movement of the DK through the NLP a torque step change with a reversal of direction of movement takes place there. This step change is compensated with a delta I component DLRININI. The sequence of this pre-control is described below:

Code of block pre-control of I component at air in the limphome position

```
—— for closing direction
if (wdkdlr_w < (wdknlp_w - DLRNLPD) AND B_dlrumzu)
then
   if (abs(wdkba_w - wdknlp_w) > DLRNLPD)
   then
      (highword)dlriant_l := (highword)dlriant_l - DLRININI
   endif
   —— turn reversal of movement of direction
   B_dlrumzu = false
endif
—— for opening direction
if (wdkdlr_w > (wdknlp_w + DLRNLPD) AND (B_dlrumzu = false))
then
   if (abs(wdkba_w - wdknlp_w) > DLRNLPD)
   then
      (highword)dlriant_l := (highword)dlriant_l + DLRININI
   endif
   —— turn reversal of movement of direction
   B_dlrumzu = true
endif
```

The highword of dlriant_l is available in dlriant_w for measurements with the VS100.

3.3 Compensation of the battery voltage fluctuation

Since a fluctuation of the battery voltage has a direct proportional effect on the loop gain of the DLR, this effect was compensated via a function. The battery voltage ub is filtered via a PT1 with the constant ZKUBDLR. The compensation, however, does have its limits in case of start. The starter can lower the battery voltage with a weak battery so far that in spite of compensation the DK can be stimulated to vibrate. In order to diffuse this case, a switch-over to an individual loop gain DLRKREISST is performed during the start (B_st = true). The therefore a little slower DK movement does not influence the starting behaviour.

3.4 Digital PID controller

The control structure consists of a PID controller, however, here the D component is only formed with the actual value. The non-linearities of the system are taken into consideration in the characteristic lines for the I component as well as in the range-dependent parameters. A moving of the DK through the NLP of the DV-E is supported by reloading the I component, see chapter 3.2.

The controller is processed in a 1 ms basic cycle and in a 1 ms cycle transposed 3 times (corresponds to a 3 ms cycle).

The control deviation dwdkdlr_w, the D component, the sum of all control components (dlriant_l, dlrikl_w, dlrpant_l and dlrdant_w) and the PWM signal (absolute value dlrspid_w and sign B_dlrspid) are calculated in the 1 ms cycle (see picture DLR in the block FDEF). The D component is limited to +/- 1000 %PWM. In addition the value (dlrkomp) resulting from the compensation and from the changed loop gain is included in the calculation prior to the PMW signal being made available. The PMW signal is limited to +/- 100 %PWM.

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In the 3 ms cycle the individual cycles are processed in the counting mode 2 1 0 2 1 ... In cycle 2 the I small component dlrikl_w is calculated. The I small component is used to tear away the DK from the static friction. This I small component is limited to +/- 100 %PWM. In cycle 1 the control parameters in dependency on the DK position (above/below NLP with wdkba_w) and below the NLP (wdkba_w < wdknlp_w) in dependency on the steepness of the step change of the DK setpoint (dwdks_w) are determined. Furthermore, here the I component dlriant_l is calculated and limited to +/- dlriamax. In cycle 0 the P component is calculated and limited to +/- 1000 %PWM.

4. DV-E power stage triggering

The setting signal given by the DLR is converted into a PWM signal with absolute value (dlrspid_w) and direction signal (B_dlrspid) and transferred to the DV-E power stage (DV-E-ES) via the functional processor (FR). The PWM frequency is 2000 Hz.

5. Coordination of the DV-E power stage release

Here the deactivation requests from various functions are combined in a resulting bit B_dcdisfr. This bit supplies the port of the FR, which supplies the disable line of the DV-E-ES. Representation in the block FDEF in the overview diagram part coordination of the DV-E power stage release

6. Monitoring of the battery voltage

For a faultless operation of the DV-E with the DV-E-ES a minimum supply voltage is required. So that the DV-E-ES does not constantly switch ON / OFF in case of undervoltage, the ES is therefore switched by means of a hysteresis (SY_UBDEEN and SY_UBDEDIS) via the bit B_ubdve. Furthermore a bit Bit B_ubpvg is supplied with this undervoltage detection, which blocks resp. enables the plausibility check of the potentiometer actual values of the PWG and the DV-E. See picture check of battery voltage in the block FDEF.

7. Monitoring of DK position

Representation in the block FDEF in the picture monitoring of position of throttle blade.

7.1 Monitoring of the DK with air at limphome position

In case of the DK drive default function (B_dknolu = 1) it is checked whether the DK is not further above the DK-NLP than the range permits (wdkba_w <= (wdknlp_w + WDKNLPTOL)). As long as the DK has not reached the DK-NLP during the transition from normal operating to the DK drive default function, reversible safety fuel deactivation (rev. SKA) is requested.

7.2 Monitoring of DK setpoint and DK actual value

During normal operating the deviation between DK setpoint and DK actual value is compared with a permissible deviation and if it is exceeded the DK drive default function is requested. The deviation is calculated from the difference between the DK setpoint filtered with a PT1 and delayed by one calculation cycle (wdksfi_w, rough prediction) and the DK actual value. The permissible deviation is given in a characteristic line (DWDKSBAMX) as a function of the DK setpoint gradient (dwdks_kge).

If the permissible deviation is violated a fault counter (dklagerc) is incremented, which can be counted back again by TDKLAGDE in case of healing.

8. Monitoring of the DLR setting range

In order to avoid overheating of the DV-E or of the DV-E-ES due to a tight DK the DLR setting range is monitored. Additionally an attempt is made to switch the ES on again, if the DV-E-ES has switched off automatically for hardware reasons. This switch-on attempt is performed via 2 cycles (2 x 10 ms).

In case of a fault the rev. SKA resp. the DK drive default function is requested.

Representation in the block FDEF in the picture monitoring of PID setting range and monitoring of DV-E power stage status.

9. Diagnosis

For the workshop and CARB diagnosis 3 fault paths were defined.

- Path 'DVEL': indicates that the DK of the DV-E will not reach the desired position any more
- Path 'DVEE': indicates that the DV-E power stage has switched off, e.g. due to too high temperature, too high current or too low voltage.

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- Path 'DVER': indicates that the DLR lies outside the valid control range.

APP ADVE 2.12 Application hint

1. Identification of the DLR version

For the identification of the DLR parameter records the following identification byte is used:

```
KDLRIDDVE = 1:  DV-E5 longitudinal construction and double-entry
            2:  Standard DV-E5
            x:  ...
```

2. Switch-off of function parts

Label	passive value	deactivated ...
DLRININI	0 %PWM	Reload I component via NLP in case of step change
WDKNLPTOL	100 %DK	Monitoring of the DK drive default function (driving with DK at limphome air)
SY_UBDEDIS	0 Volt	Monitoring of the battery voltage
DLRUMAIINI	0 %PWM	Default selection of the I component in case of a step change out of the UMA range
DLRIKLPAR	0 %PWM	I small component
DWDKSBAMX	100 %DK	Monitoring DK setpoint / actual value
DLRPIDMAX	100 %PWM	Monitoring of DLR setting range
DLRPIDMIN	-100 %PWM	" " "

3. Function-oriented selection of the diagnosis labels in the VS100

Fault memory relevant values of the diagnosis function xyz are assigned to the function DFPM-xyz in the function-oriented selection.

4. DK position control

An adjustment of the PID controller directly in the vehicle by means of a VS100 is not possible. The adjustment must be performed in the corresponding ASCET-model and HW in the loop at the labor desk (also see block ANM chapter 4.). Only via the loop gain DLRKREIS can an adjustment be performed in the vehicle with regard to special conditions. For the start (B_st = true) the loop gain factor DLRKREISST applies (also see block FB chapter 3.3). During the adjustment via the loop gain DLRKREIS for a certain project the parameter KDLRIDDVE is to be adjusted according to above-mentioned table resp. a value is to be completed for a quicker identification.

5. Monitoring of the battery voltage

The smaller the deactivation threshold SY_UBDEDIS is chosen, the greater the hysteresis must be chosen, since the performance curve of a car battery drops off at a steeper angle with decreasing voltage upon stress. That means the activation threshold SY_UBDEEN = SY_UBDEDIS + hysteresis. The chosen settings are to be checked in the vehicle with an according battery or at the labor desk with a suitable simulation. The DV-E-ES may not wobble between activation and deactivation.

6. Monitoring

If the DLR is adjusted anew, then the filter time constant ZKWDKSPT1 is to be adjusted to the DK position monitoring. For the determination the Excel document DKNBPT20.XLS can be used.

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GGEGAS 8.20 Sensor variable for brake and clutch switches

FDEF GGEGAS 8.20 Function definition

ggegas-ggegas

ABK GGEGAS 8.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWGGEGAS			FW	code word for GGEGAS
TSTAEBR			FW	Time to detect fallen-off connector, brake
TVERBR			FW	Delay time for brake-switch plausibility check
TVKUP			FW	Delay time for B_kupplv
ZERBR			FW	Fault counter status for brake-switch implausibility

Variable	Source	Type	Description
B_AUTGET	CANEGS	EIN	condition automatic gearbox
B_BL	GGEGAS	LOK	Brake lights switch info: brakes operated
B_BR	GGEGAS	LOK	Brakes switch info: brakes operated
B_BR2K	GGEGAS	AUS	Condition brakes actuated 2-channel detection
B_BREMS	GGEGAS	AUS	condition: brake operated
B_CLBREMS		EIN	condition: clear fault-path BREMS (brake pedal signal)
B_ERBR	GGEGAS	LOK	Condition break switch signals differ
B_KUPPL	GGEGAS	AUS	EGAS Condition cluch is disengaged
B_KUPPLV	GGEGAS	AUS	Condition clutch delayed
B_NPBREMS	GGEGAS	AUS	fault type BREMS: test result not plausible
B_STAEBR	GGEGAS	DOK	condition: detection of connector plug fallen off, brakes
CTRERBR	GGEGAS	AUS	Error counter for break switch plausibility check
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_BREMS	GGEGAS	AUS	error flag: brake pedal signal
E_KUPPL	DKUPPL	EIN	error flag: clutch pedal signal
R_T100		EIN	Time schedule 100 ms
S_BLS		EIN	brake light switch (true=activated pedal)
S_BRS		EIN	Switch for brake
S_KUPP		EIN	Clutch switch
Z_BREMS	GGEGAS	AUS	cycle flag: brake pedal signal

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FB GGEGAS 8.20 Detailed description of function

```
- Connection:
  S_BRS: Switch opens, if brake is applied. Switch is connected to terminal 15.
  S_BLS: Switch closes, if brake is applied. Switch is connected to terminal 30.

  Switching sequence is not defined

  On automatic vehicles the input S_kupp is omitted, evaluation then does not need to be calculated.
  With defective clutch switch (E_kuppl = TRUE), B_kuppl is set to FALSE.

  If it is detected with both switches that the brake is applied and if no fault is given, then B_br2k is set.

- Diagnostic part:
  The two pieces of brake information B_br and B_bl may differ at the maximum for the time TVERBR.
  When this time is exceeded, the fault counter is incremented. As of the adjustable count ZERBR the brake fault is set.
  Fault entry is then also performed, if the two pieces of brake information are not plausible to each other for longer than
  TSTAEBR.
  The fault counter is reset, if braking and not braking were clearly detected one after the other.
```

APP GGEGAS 8.20 Application hint

```
CWGGEGAS
--------

Bit 0
       0: Detection of plug disconnection inactive
       1: Detection of plug disconnection active
```

DKUPPL 1.40 Diagnosis of clutch switch

FDEF DKUPPL 1.40 Function definition

dkuppl-dkuppl

Fault memory management:

```
Status fault path KUPPL : sfpkuppl                 Clear fault path         : C_fcmclr & B_clkuppl
Error flag KUPPL        : E_kuppl                  Fault path KUPPL         : CDTKUPPL
Cycle flag KUPPL        : Z_kuppl                  Fault class KUPPL        : CLAKUPPL
Fault type KUPPL        : B_sikuppl                Fault intensity KUPPL    : TSFKUPPL
                                                   Carb-Code KUPPL          : CDCKUPPL
                                                   Ambient conditions KUPPL : FFTKUPPL     Ambient conditions see %DFFT
```

The function detects a defective clutch switch if a certain number of gear changes occurred without a clutch operation having been detected. In order to definitely detect a gear change (detection only in the 1s cycle), the gear change detection is deactivated for braking procedures and for vfzg < threshold!
The detection is also deactivated if e.g. the driver accelerates while the vehicle is rolling and while the clutch is operated and thus creates gangi jumps. The gear detection is blocked after a detected gear change for TDKUPNOG seconds by means of a timer.

On vehicles with automatic transmission the Z-kuppl is set to true by means of the bit B_autget and the formation of the error bit E_kuppl is prohibited. The information gangi is formed by means of the quotient nmot_w/vfzg_w (on the manual transmission). On the automatic transmission gangi is read from the CAN-bus. Fault healing is performed if anzkupplb > AKUPPLB.

ABK DKUPPL 1.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
AGANGW			FW	Number of gear changes for diagnosis clutch switch
AKUPPLB			FW	Number of times clutch is operated for diagnosis clutch switch

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Parameter	Source-X	Source-Y	Type	Description
TDKUPNOG			FW	Delay time after gear change until another gear change detection is possible
VDKUPPLMN			FW	min. vfzg-threshold for diagnosis clutch switch

Variable	Source	Type	Description
ANZGANGW	DKUPPL	AUS	Number of gear changes detected
ANZKUPPLB	DKUPPL	AUS	Number of clutch operations detected
B_AUTGET	CANEGS	EIN	condition automatic gearbox
B_BREMS	GGEGAS	EIN	condition: brake operated
B_CLKUPPL		EIN	condition: clear fault-path KUPPL (clutch pedal signal)
B_GANGOK	DKUPPL	LOK	Condition gear change detection allowed in principle
B_SIKUPPL	DKUPPL	AUS	fault type KUPPL: signal inactive
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_KUPPL	DKUPPL	AUS	error flag: clutch pedal signal
GANGI	BBGANG	EIN	Engaged gear
R_T1000		EIN	Time schedule 1000 ms
S_KUPP		EIN	Clutch switch
VFZG	GGVFZG	EIN	vehicle speed (km/h)
Z_KUPPL	DKUPPL	AUS	cycle flag: clutch pedal signal

FB DKUPPL 1.40 Detailed description of function

APP DKUPPL 1.40 Application hint

```
Suggestion for initial data to be entered:
AGANGW = 20
AKUPPLB = 2
TDKUPNOG = 15 s
VDKUPPLMN = 50 km/h
```

GGDG 1.5 Pickup variables: speed pickup and reference mark pickup

FDEF GGDG 1.5 Function definition

Processing of the Signals of Speed Sensor (DG) and Phase Sensor (PG) for the 4-Cylinder Engine

```
Explanation:
B_zyl1     next cylinder to be fired is cyl. 1, not cyl. 6 on the 6-cyl. engine or cyl. 4 on the 4-cyl. engine.
GDWRT      programmed reference mark angle = 60 deg. KW on the 6-cyl. and 72 deg. KW on the 4-cyl. (system constant)
TPRELL     tooth debouncing time during the initialization (system constant)
ZZINI      number of teeth of the tooth debouncing (system constant)
```

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The following operations take place in the control unit:

Condition 1: !E_ddg & !E_dbm & debouncing time "TPRELL" not elapsed

Operation: During the time "TPRELL" negative tooth edges are ignored

Condition 2: !E_ddg & !E_dbm & debouncing time "TPRELL" elapsed

Operation: For a number of "ZZINI" teeth the search for the gap of the 60-2-toothed wheel is suppressed.

Synchronization during Quick Start:

Regarding the synchronization during quick start and the formation of the tn-signal during quick start see %ALE and %EASTT.

ABK GGDG 1.5 Abbreviations

Variable	Source	Type	Description
NIST	GGDG	AUS	actual engine speed (25 RPM)
TN	GGDG	AUS	segment time

FB GGDG 1.5 Detailed description of function

To condition 1: Procedure at the first detected tooth edges (start of the engine)

Refer to FDEF

To condition 2: Normal operation

Signal assignment on the four-cylinder engine (sketch not to scale)

- For the sensing of the engine speed a speed sensor (DG) scans an increment wheel with 60-2 teeth (circumference is subdivided into 60 teeth, 2 teeth are omitted). The distance between two negative tooth edges thus is 6 degrees. The position of the gap is defined by the value "GDWRT". "GDWRT" marks the distance of the 1st negative tooth edge after the gap to TDC of cylinder 1 resp. cylinder 4 ("GDWRT" = 72 deg KW).
- For the synchronization of the cylinder-individual injection and of the static high-voltage distribution a camshaft reference mark is sensed. For this a phase sensor (PG) scans a camshaft segment of 24 deg. width (corresponds to 48 deg KW).

To 2a. For the triggering of the ignition-synchronous calculations a signal is formed on the 2nd negative edge of the 60-2 toothed wheel. For the measurement of engine speed and ignition angle by means of external measuring devices (application service) a tn-signal is additionally created as follows:
The tn-signal changes at each tr-mark from ’high’ to ’low’, the feedback edge follows 48 deg. KW later.

To 2b. Engine speed calculation
For all other engine speed dependent characteristics and maps the engine speed calculated from the distance of the tn-marks is used.

To 2c. cylinder 1 -detection:
At the 2nd negative tooth edge after the gap the signal of the phase sensor is scanned:
- Phase sensor signal = high --> next ignition is performed in cylinder 2
- Phase sensor signal = low --> next ignition is performed in cylinder 1

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APP GGDG 1.5 Application hint

Synchronization of the DG and PG signals (and thus cyl.1-detection) is performed once per crankshaft (KW) revolution.
It therefore takes place on the high as well as on the low level of the phase sensor signal.

When the quasi-steady sensor PG3 is used the correct phase position is not detected if the PG is above the mark of the camshaft wheel while the engine is in the standstill position.
By a selection of the variable "ZZINI" it must be ensured that the search for the reference mark is suppressed for at least until a secure phase detection is possible. The chosen "ZZINI" value is dependent on the length of the camshaft segment. For a segment length of 24 deg. camshaft "ZZINI" = 2 results (additional to the 3 teeth, which are at least necessary for the gap detection).

BGNMOT 4.10 Calculated variable: engine speed

FDEF BGNMOT 4.10 Function definition

bgnmot-bgnmot

During synchronisation (C_bmsuch) the engine speed nmot_w is calculated from the tooth period time tnbm_w. In synchronised operation (C_syn) the engine speed nmot_w is calculated at the SW reference marks (R_syn, tr-marks) from the internal segment time tseg_w.

ABK BGNMOT 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ZYLZA			FW	number of cylinders

Variable	Source	Type	Description
B_NMIN		EIN	condition lower speed: n < NMIN
B_NMOT	BGNMOT	AUS	condition engine speed: n > NMIN
C_BMSUCH		EIN	ECU-condition: searching for reference mark
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_NSUCH		EIN	ECU-conditon: searching for engine speed signal
C_SYN		EIN	ECU-condition angle synchronization available
NMOT	BGNMOT	AUS	engine speed
NMOT_W	BGNMOT	AUS	engine speed
R_NBM		EIN	Schedule of tooth signal
R_SYN		EIN	Synchro schedule
R_T10		EIN	Time schedule 10 ms

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Variable	Source	Type	Description
T		EIN	time
TNBM_W		EIN	tooth periode of the last NBM signal
TSEG_W	BGNMOT	AUS	segment cycle time

FB BGNMOT 4.10 Detailed description of function

```
In each calculation schedule the individual variables are re-quantised as follows:
        - nmot_w is updated in synchro schedule and is quantised with 0.25 rpm.
        - nmot is updated from nmot_w in 10 ms schedule and is quantised with 40 rpm.
```

APP BGNMOT 4.10 Application hint

BGNG 7.10 Calculated variable: engine-speed gradient

FDEF BGNG 7.10 Function definition

```
Die Funktion %BGNG liefert folgende Größen:
        - dnmot_w:      Die Differenzdrehzahl dnmot_w wird im Synchro-Raster über jeweils ein Segment gebildet:
                                dnmot_w = nmot(iact) - nmot(iact-1)
        - dnmotas_w:    Die Drehzahländerung über ein Arbeitsspiel wird im 10 ms -Raster gerechnet:
                                dnmotas_w = nmot_w(iact) - nmot_w(iact-SY_ZYLZA).
                        Die hierzu notwendigen Drehzahlwerte nmot_w(i) werden im Synchro-Raster in einer Trommel
                        abgespeichert.
        - tsas_w:       Die Zeit über ein Arbeitsspiel mit:
                                tsas_w = Summe(tseg_w(i), i=1, SY_ZYLZA).
                        Die hierzu notwendigen Segmentzeiten tseg_w(i) werden im Synchro-Raster in einer Trommel
                        abgespeichert.
        - ngas_w:       Der Drehzahlgradient über ein Arbeitsspiel ergibt sich im 10 ms-Raster mit:
                                ngas_w = dnmotas_w / tsas_w.
        - ngfil_w:      Gefilterter Drehzahlgradient aus ngas_w mit der Zeitkonstante ZNGFIL.


        Drehzahlgradienten bei 4-Zylindermotor: SY_ZYLZA = 4

                            :<--------- tsas_w --------->:
                            :<tseg_w->:                  :
        R_syn: |            |         |      |     |    |    |    |   |  |  |  |  |  |  |   |    |    |    |     |       |
                            :         :                  :
     nmot_w ^               :         :                  :
            |               :         :                  :
            |               :         :                  :                 *******
            |               :         :                  :          ***                    ****
            |               :         :                  :    **
            |               :         :                  **  ----------------- nmot(iact)            **
            |               :         :             **                   ^                                  **
            |               :         :        **                        |                                       ***
            |               :         :   **                             |
            |               :         ** ------------------          dnmotas_w
            |               :      **                  ^                |
            |               :   **                  dnmot_w             |
            |                 *                       v                  v
            |               * ------------------------------------------- nmot(iact-SY_ZYLZA)
            |            *
            |         *
            ------------------------------------------------------------------------------------------> t
```

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Übersicht Berechnung Drehzahlgradient:

bgng-bgng

Pointer für die Drehzahl- und Segmentzeit-Trommel:

Die Trommel enthält SY_INGASOS = SY_ZYLZA + 2 Elemente um ein Überschreiben während der Berechnung im 10 ms Raster durch einen Synchro-Interrupt zu verhindern. Die B_ngasok liefert die Freigabebedingung für die Berechnung der Werte über ein Arbeitsspiel.

bgng-pointer

Einträge in die Segmentzeit-Trommel im Synchro-Raster:

Die Trommel wird abhängig von SY_ZYLZA mit maximal SY_INGASOS Elementen befüllt.

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bgng-store-tseg

Einträge in die Drehzahl-Trommel im Synchro-Raster:

Die Trommel wird abhängig von SY_ZYLZA mit maximal SY_INGASOS Elementen befüllt.

bgng-store-nmot

ABK BGNG 7.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ZNGFIL			FW	time constant for engine gradient filter

Variable	Source	Type	Description
B_NGASOK	BGNG	AUS	condition memory array for ngas calculation valid
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_SYN		EIN	ECU-condition angle synchronization available
DNMOTAS_W	BGNG	AUS	engine speed difference during one working cycle
DNMOT_W	BGNG	AUS	engine speed difference between two following segments

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Variable	Source	Type	Description
INGAS	BGNG	LOK	Memory array pointer for engine speed gradient calculation over the engine cycle
IRSPSYN	BGNG	AUS	index to address memory of tsegrsp_w, nmotrsp_w, rlsp_w
NGAS_W	BGNG	AUS	engine speed gradient during one working cycle
NGFIL	BGNG	AUS	filtered engine-speed gradient
NGFIL_W	BGNG	AUS	filtered engine-speed gradient
NMOTRSP_W	BGNG	AUS	Start Ring buffer for rpm value
NMOT_W	BGNMOT	EIN	engine speed
R_SYN		EIN	Synchro schedule
R_T10		EIN	Time schedule 10 ms
SY_JNGASOS	BGNG	LOK	system constant size of the memory array for engine speed gradient calculation
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
TSEGRSP_W	BGNG	AUS	Begin of ring buffer for segment time
TSEG_W	BGNMOT	EIN	segment cycle time

FB BGNG 7.10 Detailed description of function

APP BGNG 7.10 Application hint

Recommendation for first application:

ZNGFIL = 50 ms

DDG 11.10 Diagnosis: engine speed sensor

FDEF DDG 11.10 Function definition

DDG 11.10 vom 12.12.1997

ddg-ddg

The section DDG describes the diagnosis of the engine speed sensor (DG) at the camshaft.
The diagnosis uses the following signals/events:

- DG diagnosis by monitoring the phase sensors (PG and PG2) level changes below minimum speed
- DG diagnosis by monitoring the reference gap

The counter nsyn_ctr is used to monitor the loss of the reference gap. The content of the counter is buffered during C_inisyn and compaired with the previous initialization. At a change of the counter, a re-synchronization by a loss of the gap occured. This function requires a free running counter, resetting itself at an overflow.

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Fault memory management:

Status fault path:	SFPN	Status fault path BM:	SFPBM
Error flag N:	E_n	Error flag BM:	E_bm
Cycle flag N:	Z_n	Cycle flag BM:	Z_bm
Fault type N:	B_sin	Fault type BM:	B_plaus

Delete fault path:	C_fcmclr & B_cln	Delete fault path:	C_fcmclr & B_clbm
Fault path N:	CDTN	Fault path BM:	CDTBM
Fault class N:	CLAN	Fault class BM:	CLABM
Fault intensity N:	TSFN	Fault intensity BM:	TSFBM
Carb code N:	CDCN	Carb code BM:	CDCBM
Environmental cond. N:	FFTN	Environmental cond. BM:	FFTBM

Fault	Fault type	Description
E_n	B_sin	during engine speed search no DG-signal (PGFLWA PG-phase level changes during B_nmin = 1 ==> no DG-signal)
E_bm	B_plaus	multiple losses of the reference gap or tooth corrections in synchronized condition (counter value = BMFMX)

ABK DDG 11.10 Abbreviations

DG	engine speed sensor at the crankshaft
PG	phase sensor
PG2	optional 2. phase sensor
PH	phase sensor signal from the camshaft
BM	reference gap

Parameter	Source-X	Source-Y	Type	Description
BMFA			FW	Numbers of BM-errors (initial value of counter)
BMFMX			FW	Counter maximale value for BM-errors
PGFLWA			FW	Number of edges of phase signal for error B_signal of the engine speed sensor
ZIDFBM			FW	counter increments on tooth correction at BM-check
ZIDNOBM			FW	counter increments after a loss of the reference gap

Variable	Source	Type	Description
B_CLBM		EIN	condition clear fault path reference mark sensor
B_CLN		EIN	condition clear fault path engine speed sensor
B_FBM		EIN	condition reference mark error => at least 1 tooth too few/many
B_NMIN		EIN	condition lower speed: n < NMIN
B_PLAUS	DDG	AUS	Condition fault type ”value not plausible” detected
B_SIN	DDG	AUS	Fault type: no signal from the crankshaft position sensor
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_PWF		EIN	ECU-condition powerfail initialisation
E_BM	DDG	AUS	error flag: reference mark sensor
E_N	DDG	AUS	error flag: engine speed sensor
NSYN_CTR		EIN	counter (byte) re-synchronizations due to a loss of the reference gap
R_SYNPH		EIN	synchro schedule for phase scan
R_T100		EIN	Time schedule 100 ms
SY_PHTWIN	PROKON	EIN	system constant 1/2 phase sensing system (sensor, wheel)
ZRPH		EIN	counter schedule of phase signal
ZRPH2		EIN	counter schedule of phase signal 2
Z_BM	DDG	AUS	cycle flag: reference mark sensor
Z_N	DDG	AUS	cycle flag: engine speed sensor

FB DDG 11.10 Detailed description of function

The input signals of the DDG are built in the sections %GGDPG, %SYSCON und %SYSYNC gebildet.

Fault E_n: The diagnosis of the DG is made as follows:

Monitoring the phase level changes below minimum engine speed:
The PG-signal is used as a referenz. When getting some phase interrupts R_ph without detecting an engine speed signal, then the speed sensor is faulty. To detect this, the number of phase interrupts are checked via the phase interrupt counter zrph below minimum engine speed (B_nmin). The error flag E_n and the fault type B_sin is set, as soon as PGFLWA number of phase level changes during B_nmin are monitored.
The error is resetted as soon as engine speed is detected.

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Fault E_bm: The diagnosis of the DG is made as follows:

In synchronized condition the reference gap is checked in %GGDPG in each synchro after the gap. A loss of the gap causes a re-synchronization (B_bm 1 -> 0) which increases a counter (nsyn_ctr). In case the gap is wrong by one tooth, a gap correction will be made and the flag B_fbm will be set. The diagnosis uses this information. At a gap loss a counter is increased by ZIDNOBM. At a gap correction the counter is increased by ZIDFBM. If the gap is found correctly, the couner is decreased by 1. As soon as the counter reaches BMFMX the error B_plaus is set. The error is reseted as soon as the counter has counted down to 0.

APP DDG 11.10 Application hint

Recommendation for first application:

PGFLWA:	8, depending on the number of phase signal per cam rotation, minimum 8 rotations should be used until the error is set		
ZIDFBM:	150		
ZIDNOBM:	1200		
BMFA:	1000		
BMFMX:	4000		
CDTN:	110	CDTBM:	111
CLAN:	3	CLABM:	6
TSFN:	255	TSFBM:	255
CDCN:	824,823,821,822d	CDCBM:	824,823,821,822d
FFTN:	ub, tmot	FFTBM:	ub, tmot

Function test:

1. Measurment of the following signals with VS100-VSO:
   - RAM cells: nmot, B_nmin, zrph, E_n, E_bm, Z_n, Z_bm, B_sin, B_fbm, nsyn_ctr, B_plaus
   - Label: PGFLWA, ZIDFBM, ZIDNOBM, BMFA, BMFMX

2. Check, with correct working DG:
   ignition on: B_nmin = true, zrph = 0, E_n = false, Z_n = false, E_bm = false, Z_bm = true
   start engine: B_nmin = false, Z_n = true, zrph is incremented, nmot plausible, E_n = false

3. Check not connected DG (disconnect DG sensor or disconnect both DG signal wires at the ECU adaptor)
   ignition on: B_nmin = true, zrph = 0, E_n = false, Z_n = false
   apply starter, engine does not start: B_nmin = true, Z_n = false, zrph is incremented;
   as soon as zrph > PGFLWA: E_ n =true and Z_n = true, B_sin = true;

4. Reset error flag: Reconnect the DG sensor / wires
   ignition on: B_nmin = true, zrph = 0, E_n = true, Z_n = false
   start engine: B_nmin = false -> E_n = false, Z_n = true

5. At systems with 2. phase sensor, disconnect PG and repeat steps 1 to 4 by monitoring zrph2 instead of zrph

6. Test intermittend contact:
   Connect DG, start engine and wait untill Z_bm = true. Afterwards monitor the counter bmfz_w and disconnect intermittend the DG wires. Reconnect the DG wires correctly as soon as the error is detected (E_bm = 1) and wait until the error disappears (E_bm = 0).

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DPH 20.20 Diagnosis; plausibility test phase sensor

FDEF DPH 20.20 Function definition

The section DPH describes the diagnosis of the phase sensor / of the phase sensors (PG) at the camshaft (CMS).

For the diagnosis the level of the PG signal is inquired upon for each synchro grid for phase inquiry. During normal operating of the PG the level changes alternately (01010101). If it does not change then a PG fault is assumed.

dph-dph

If a system has two PGs (SY_PHTWIN > 0), they are diagnosed separately. In case of only one PG (SY_PHTWIN = 0) the corresponding flags (e. g. E_ph2, Z_ph2, B_phsok2) get default values.

DPH_BANK1: Diagnosis phase sensor bank 1

dph-dph-bank

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DPH_BANK2: Diagnosis phase sensor bank 2

dph-dph-bank2

Fault memory management:

Status fault path PH:	sfpph	Status fault path PH2:	sfpph2
Error flag PH:	E_ph	Error flag PH2:	E_ph2
Cycle flag PH:	Z_ph	Cycle flag PH2:	Z_ph2
Fault type PH:	B_mxph	Fault type PH2:	B_mxph2
	B_mnph		B_mnph2
	B_npph		B_npph2

Delete fault path:	C_fcmclr & B_clph	Delete fault path:	C_fcmclr & B_clph2
Fault path PH:	CDTPH	Fault path PH2:	CDTPH2
Fault class PH:	CLAPH	Fault class PH2:	CLAPH2
Fault intensity PH:	TSFPH	Fault intensity PH2:	TSFPH2
Carb code PH:	CDCPH	Carb code PH2:	CDCPH2
Envirnonmental cond. PH:	FFTPH	Environmental cond. PH2:	FFTPH2

ABK DPH 20.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCPH	BLOKNR		KL	code word CARB: phase sensor
CDCPH2	BLOKNR		KL	code word CARB: phase sensor 2
CDTPH			FW	code word tester: phase sensor
CDTPH2			FW	code word tester: phase sensor 2
CLAPH			FW	fault class: phase sensor
CLAPH2			FW	fault class: phase sensor 2
FFTPH	BLOKNR		KL	freeze frame table: phase sensor
FFTPH2	BLOKNR		KL	freeze frame table: phase sensor
PHNOKA			FW	start value for counter phase signal not ok
TSFPH			FW	fault active time: phase sensor
TSFPH2			FW	fault active time: phase sensor 2

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_CLPH		EIN	condition clear fault path PH
B_CLPH2		EIN	condition clear fault path Phase sensor 2
B_MNPH	DPH	AUS	error type: short circuit ground of phase sensor
B_MNPH2	DPH	AUS	error type: short circuit ground of phase sensor 2
B_MXPH	DPH	AUS	error type: short circuit Ubat phase sensor
B_MXPH2	DPH	AUS	error type: short circuit Ubat phase sensor 2
B_NPPH	DPH	AUS	condition signal of camshaft sensor not plausible (ph)
B_NPPH2	DPH	AUS	condition signal of camshaft sensor not plausible (ph2)
B_PHAS2		EIN	Condition phase 2 low/high
B_PHASE		EIN	Condition phase low/high
B_PHSOK	DPH	AUS	Condition phase signal ok
B_PHSOK2	DPH	AUS	Condition phase signal 2 ok
B_ST	BBSTT	EIN	condition for start
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_PWF		EIN	ECU-condition powerfail initialisation

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Variable	Source	Type	Description
E_PH	DPH	AUS	error flag: phase sensor
E_PH2	DPH	AUS	error flag: phase sensor 2
PHPW	DPH	LOK	Slopes of phase signal (8 bit shifting)
PHPW2	DPH	LOK	Slopes of phase signal 2 (8 bit shifting)
R	DPH	LOK	vector computing base flags (only CU model)
R_SYN1		EIN	first schedule synchro
R_SYNPH		EIN	synchro schedule for phase scan
R_SYNPH2		EIN	synchro schedule for phase scan 2
R_T100		EIN	Time schedule 100 ms
SFPPH	DPH	AUS	status fault path: phase sensor
SFPPH2	DPH	AUS	status fault path: phase sensor
SY_PHTWIN	PROKON	EIN	system constant 1/2 phase sensing system (sensor, wheel)
ZPHNOK	DPH	LOK	Counter fault of phase signal
ZPHNOK2	DPH	LOK	Counter fault of phase signal 2
Z_PH	DPH	AUS	cycle flag: phase sensor
Z_PH2	DPH	AUS	cycle flag: phase sensor 2

FB DPH 20.20 Detailed description of function

The current level of the PG is entered into a shift register (phpw, phpw2) in the synchro grid for phase inquiry (R_synph*). During the next R_synph run the contents of the register is shifted and the new PG level is recorded.

Thus, under normal conditions, the 8-bit register is allocated with 01010101 or 10101010.
If this register allocation is not given a PG fault exists:

```
        Register contents                       Fault

        1111 1111                       ->      B_mx***       Max fault (e. g. short circuit to UB)
        0000 0000                       ->      B_mn***       Min fault (e. g. short circuit to ground)
        not equal to 0101 0101  or
        not equal to 1010 1010          ->      B_np***       Plausibility fault (e. g. loose contact)

        0101 0101 =  85d                ->      no fault
        1010 1010 = 170d                ->      no fault
```

At the same time the number of fault occurrences are counted (zphnok, zphnok2), during which no change of level is detectable in the synchro grid for phase inquiry (R_synph). If the downward counter zphnok resp. zphnok2 reaches the value 0 then in connection with the above-described fault type a fault is set (E_** = 1, Z_** = 1, B_**** =1).

In the initialization (C_inisyn) the fault counter (zphnok, zphnok2) gets the starting value PHNOKA.

During the start of the engine it is important to obtain informations about the functioning of the PG as quickly as possible (prior to the entire shift register having been filled). B_phsok (phase sensor OK) is always set during cranking if no E_ph from the preceding operating cycle exists. This condition is reset as soon as the first missing phase change is detected.

For the setting of B_phsok the last two entries of the shift register are used. In order to guarantee the correct setting of B_phsok the shift register must be initialized dependent on the current level (while the engine starts / during the first R_syn).

Case example for B_phsok:

Case 1: No fault entry is yet made in E_ph:

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```
Case 2: A fault entry is made in E_ph:
                                                   1   2   3   4   5   6   7   8
R_synph:    _|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___|___

Phase fault: 1
              0  ______________|____________________|___________________________________________________________________________

zphnok:          ______________|                    .            PHNOKA ---->                                  |
                                |___                 .                                                          |
                                    |___             .                                                          |
                                        |___         .                                                          |
                                            |___     .                                                          |
                                                |___ <= 0                                                       |
                 0 . . . . . . . . . . . . . . . . . |_____________________________________________________|
                                                     .
E_ph:     1                                          |_____________________________________________________|
          0      ___________________________________|                    .                                  |___________________
                                                                          .
                                                                          .
error-   1       ______________|                                          .                                  |
free      0                    |____________________________________________________________________________|
if B_st = 0 or =1:                                                                                          .
B_phsok:  1      ______________|                                                                             |
          0                    |____________________________________________________________________________|

error-free => 1 means: Contents of the shift register is 01010101 or 10101010
           => 0 otherwise
```

APP DPH 20.20 Application hint

```
PHNOKA:   12    ( > 7, so that the correct fault type is entered in B_mx**, B_mn**, B_np**.

Function test:
```

```
1. Measurement values:
        digital values:         B_phase , B_phsok, B_st, E_ph, Z_ph, B_npph, B_mnph, B_mxph
                                phpw.0 (bit 0), phpw.1 (bit 1), ..
        analog values:          zphnok (0..20), zzyl (0..20), phpw (0..260), nmot (0..2000),
                                if required: PH and NBM via analog card (VADI)
        Measurement grid:       10 ms

2. Measurement sequence:
2.1 Test of signal position:
        procedure: start engine, during engine operation connect the phase signal as follows:
        - Disconnection of the phase signal at the ECU-adapter:
        - Phase short circuit to ground:                --> B_phase=0, E_ph=1, B_mnph=1, phpw=0
        - Phase short circuit to UB/cable drop-off:     --> B_phase=1, E_ph=1, B_mxph=1, phpw=255
        - Phase loose contact:                          --> B_phase=*, E_ph=1, B_npph=1, 0 < phpw < 255
        - Phase ok:                                     --> B_phase=alternating, E_ph=0, phpw=85 V phpw=170
                                                        --> phpw.0=B_phase

2.2 Fault entry, fault healing:
        - Engine operation with phase ok: --> B_phsok=1, E_ph=0
        - Engine stop/start (phase ok): --> B_phsok=1, E_ph=0
        - Transition from phase ok to "not ok": --> B_phsok=0, if zphnok=0: E_ph=1
        - Engine stop/start (phase not ok): --> B_phsok=0, E_ph=1
        - Transition from phase "not ok" to ok: --> after 8 alternating entries in phpw: E_ph=0, B_phsok=1
        - Engine stop/start (phase ok): --> B_phsok=1, E_ph=0
        - Transition from phase ok to "not ok": --> B_phsok=0, if zphnok=0: E_ph=1
        - Engine stop, after KL15 off: phase ok
        - Engine start (phase ok): --> B_phsok=0, E_ph=1
          after 8 alternating entries in phpw: E_ph=0, B_phsok=1
```

BBNMIN 1.1 Lower engine speed limit

FDEF BBNMIN 1.1 Function definition

No text for FDEF available!

ABK BBNMIN 1.1 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NMIN			FW	minimum engine speed

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FB BBNMIN 1.1 Detailed description of function

APP BBNMIN 1.1 Application hint

BBSTT 11.20 Condition Engine start

FDEF BBSTT 11.20 Function definition

bbstt-bbstt

bbstt-timecount

Start condition B_st: - B_st is set if after KL15 On the start detection is completed and the engine is cranking (!B_nmin).
- B_st is reset when the start end speed NSTNM is exceeded. The start condition applies again if the engine speed drops below NNSTA.

Time after start tnst_w: At the end of start, the post-start time tnst_w is initiated. As soon as the maximum value of tnst_w is reached, tnst_w is limited to this value (dito tnse_w).

ABK BBSTT 11.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NNSTA	TANS		KL	engine-speed transition normal -> start
NSTNM	TMOT		KL	transition start -> normal

Variable	Source	Type	Description
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_ST	BBSTT	AUS	condition for start
B_STEND	BBSTT	AUS	condition end of start
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
NMOT	BGNMOT	EIN	engine speed
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
TANS	GGTFA	EIN	Intake air temperature
TMOT	GGTFM	EIN	Engine temperature
TNSE_W	BBSTT	AUS	time counter at end of start (16 bit)
TNST_W	BBSTT	AUS	time after end of start

FB BBSTT 11.20 Detailed description of function

1. Transition from initialization to start: start process (overview):

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```
KL15 on:                    speed          |————————.... BM search ....————————————————————————————>|<——Syncro-
 |C_ini                     debouncing                                                                |   nization
      rpm search ————————>|   & nmot > NMIN |B_nmin =0                                                |   occurs
     (n-interrupt)          |<————————————>|                                                          v
rpm signal:
                                                |——>
                                                 B_st=1
```

After initialization the tooth interrupt is enabled and the system is waiting for the first rpm signal. With the first rpm signal the speed debouncing is initiated. After the rpm signal is debounced and the minimum engine speed is exceeded, the start condition is set.

2. Transition from start to post-start:

```
B_st=1————————————————>->—┐
                          |          |
                          ^          v
                          |          |
                          |<-<————————————————  B_st=0
————————————.————————————.————————————————————> nmot
            NNSTA        NSTNM
```

APP BBSTT 11.20 Application hint

```
Speed   ^                                                  * *
        |                                          *     ******.....********
        |                                        *                      *
        |                NSTNM  ————————>   *                              *
        |                                    *                NNSTA ————————>   *
        |                              *                                     *
        |                        ****************                                    *
        |                    *                                                           *
        |                *                                                                   *
      0 |*****————————————————————————————————————————————————————————————————————————******——>  t
B_nmin  ————————————————————————————————————————————————.....————————————————————————————————————
B_st    ————————————————————————————————————————————————.....————————————————————————————————————
B_stend ————————————————————————————————————————————————.....————————————————————————————————————
                                                 0                    |FFFFh                        0
tnst_w                                           ——>->->->->->->->->->->->————————————————————————
```

MOTAUS 12.10 Engine switch-off

FDEF MOTAUS 12.10 Function definition

The function %MOTAUS describes the switch-off behaviour of the engine electronic control unit which is activated via S_KL15 (see %SYSCON) once the driver's desire to switch off the engine was detected and which is initiated by the setting of the condition B_kl15:

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motaus-motaus

ABK MOTAUS 12.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TNLSGMN			FW	minimum time for ECM-switch-off delay
TNLSGMX			FW	maximum time for ECM-switch-off delay
UBNLMN			FW	Lower limit for Batterey target voltage

Variable	Source	Type	Description
B_AIRBAG	GGAIRB	EIN	condition airbag activated
B_KL15		EIN	condition ignition switch on
B_NACHL	MOTAUS	AUS	ECU control for ECU switch off delay
B_NACHLEND	MOTAUS	AUS	conditon ECU switch off delay regularly finished
B_NACHLRAM	MOTAUS	AUS	Condition ECU switch off with system check
B_NLACLS		EIN	request for ECM afterrun from the AC-fan-control
B_NLALE		EIN	request for ECM afterrun from the function ALE
B_NLDSC	BGNLDSC	EIN	extended power down time request for DSC
B_NLDTE	DDMTL	EIN	request for ECM afterrun from leak detection
B_NLEEPR		EIN	Condition write of EEPROM during afterrun
B_NLMLS		EIN	request for ECM afterrun from the engine-fan-control
B_NLOBD	DFPMNL	EIN	request for ECM afterrun from OBD
B_NLSGLS		EIN	request for ECM afterrun from the ECM-fan-control
B_NLSIKO		EIN	Condition monitoring of EGAS during afterrun
B_NLWST		EIN	Request for ECM afterrun for recognition of re-start
B_NMIN		EIN	condition lower speed: n < NMIN
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_NORM		EIN	ECU-condition normal engine management operation
C_PWF		EIN	ECU-condition powerfail initialisation
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
TNACHL_W	MOTAUS	AUS	time of ECU switch off delay
UB	GGUB	EIN	battery voltage

FB MOTAUS 12.10 Detailed description of function

After the ignition key (B_kl15=0) was switched off the condition B_nachl is set during normal operation for the transition to the ECU-switch-off delay. Once the ECU-switch-off delay is terminated the condition B_nachl is reset. Via this the end of the ECU-switch-off delay is started in the system state control.

With the beginn of switch-off delay the time tnachl_w is started which gives the current time of the ECU-switch-off delay.

The switching off of the ECU-switch-off delay is activated,
- if no further requests come from the different functions during the switch-off delay, i.e. all B_nl* = false, and if the minimum switch-off delay time (TNLSGMN) has passed,

or - if the maximum switch-off delay time (TNLSGMX) was reached.

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If the ECU-switch-off delay is executed correctly, i.e. the ECU is only switched off once all requests were taken back, then this is documented in the condition B_nachlend (permanent RAM) by true. If the condition B_nachlend is false this indicates an abort of the ECU-switch-off delay by reset, by the ignition key being switched on again or by the maximum switch-off delay time TNSGLMX having been reached.

APP MOTAUS 12.10 Application hint

Data for initial application:
TNLSGMN = 5 sec
TNLSGMX = 25.6 sec

BGNLDSC 1.10 DSC Extended Power Down Request

FDEF BGNLDSC 1.10 Function definition

bgnldsc-bgnldsc

Additionel ECU power-down delay required as safety feature for DSC control of electrical steering lock.
Condition B_nldsc is input to ECU switch off delay function.

ABK BGNLDSC 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TNLDSCMX			FW	maximum allowed DSC request power down delay time
VDSCMN			FW	Minimum vehicle speed threshold for extended DSC request power down

Variable	Source	Type	Description
B_KL15		EIN	condition ignition switch on
B_NLDSC	BGNLDSC	AUS	extended power down time request for DSC
B_PN	CANEGS	EIN	condition: position P or N of automatic transmission selected
E_AS	DASC	EIN	errorflag: ASR-intervention
E_CAS	DCAS	EIN	errorflag: CAN-interface, timeout ASC
E_CGE	DCGE	EIN	error flag: CAN-interface timeout EGS
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
VFZG_W	GGVFZG	EIN	Vehicle speed

FB BGNLDSC 1.10 Detailed description of function

APP BGNLDSC 1.10 Application hint

AMUENE 1.20 Monitoring counter for maximum engine speed

FDEF AMUENE 1.20 Function definition

No text for FDEF available!

ABK AMUENE 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NUEMAX			FW	Limiting value for engine overspeed

Variable	Source	Type	Description
ANZNMAX	AMUENE	AUS	Number of times NMAX exceeded
C_PWF		EIN	ECU-condition powerfail initialisation
KMSTAND	CANINS	EIN	Route of the vehicle as information via CAN
KMSTNMAX	AMUENE	AUS	mileage counter reference mark

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Variable	Source	Type	Description
NMAX_W	AMUENE	AUS	Actual maxi engine speed
NMOT_W	BGNMOT	EIN	engine speed

FB AMUENE 1.20 Detailed description of function

APP AMUENE 1.20 Application hint

BBPEDBR 1.20 plausibility check PWG - brake pedal

FDEF BBPEDBR 1.20 Function definition

bbpedbr-bbpedbr

No text for FDEF available!

ABK BBPEDBR 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TWPEDBR			FW	
WPEDFMX			FW	

Variable	Source	Type	Description
ANZPBR_W	BBPEDBR	AUS	number of PWG-pedal plausibility checks
B_BL		EIN	Brake lights switch info: brakes operated
B_BR		EIN	Brakes switch info: brakes operated
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
C_PWF		EIN	ECU-condition powerfail initialisation
E_BREMS	GGEGAS	EIN	error flag: brake pedal signal
KMSTAND	CANINS	EIN	Route of the vehicle as information via CAN
KMSTPBR_W	BBPEDBR	AUS	
WPED_W	GGPED	EIN	normed angle acceleration pedal

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FB BBPEDBR 1.20 Detailed description of function

APP BBPEDBR 1.20 Application hint

GGVFZG 10.20 Input signal: vehicle speed

FDEF GGVFZG 10.20 Function definition

ggvfzg-ggvfzg

ABK GGVFZG 10.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
AIMV			FW	number of speedpulses for calibration of vehicle speed signal
DVFZBEG			FW	Delta speed for change limitation
TFGRVRAB			FW	FGR: Time speed shutdown by vroh = 0
VFZMN			FW	Detection of driving-standing
VRFGRMN			FW	Lower threshold vroh_w for FGR shutdown by vfzg_w = 0
ZFV			FW	time constant for filter vehicle speed signal

Variable	Source	Type	Description
BFZGL_B	GGVFZG	AUS	Automobile acceleration in the longitudinal direction
B_VNULL	GGVFZG	AUS	condition vehicle at stillstand
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
VFIL_W	GGVFZG	LOK	Filtered speed (16-bit)
VFZG	GGVFZG	AUS	vehicle speed (km/h)
VFZG_W	GGVFZG	AUS	Vehicle speed
VFZROH_W	GGVFZG	AUS	vehicle speed output value to scan tool
VROH_W		EIN	Vehicle speed

FB GGVFZG 10.20 Detailed description of function

The motronic receives the signal conditioned by the trip computer with 4 impulses per revolution transmission wheel. This approx. complies to a frequency of 1 Hz per km/h. (Exact adjustment is performed by means of data; see signal conditioning AIMV).

In the 10 ms grid a raw speed VROH is conditioned from the time difference between the two latest time entries delta-T = [t(n-1) - t(n)], to which the fixed value AIMV is subject to:

vroh_w [km/h] = constant / AIMV [Imp./km] / delta-T [s]

This value vroh_w is limited into positive and negative direction by the change limitation DVFZBEG and stored in the RAM-cell vfzroh_w.
If delta-T becomes greater than 1 s, then vroh_w is set to 0.

With V > 0, vfzroh_w is valid after 2 V-impulses.
In the hold phase (KL 15 off) a V-acquisition is no longer performed, the V-value acquired last is preserved.

For FGR-function vfzroh_w is smoothed by a PT1-filter. The vehicle acceleration is calculated from the filtered speed signal.

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APP GGVFZG 10.20 Application hint

DVFZ 21.10 Diagnosis; plausibility test vehicle speed

FDEF DVFZ 21.10 Function definition

dvfz-dvfz

ABK DVFZ 21.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NDV			FW	error detection vehicle speed signal / minimum threshold for engine speed
NDVO			FW	error detection vehicle speed signal, maximum threshold for engine speed
TDV			FW	error detection tachometer signal / time for interrogation
TMDV			FW	motor temperature threshold for release of vehicle speed diagnosis
VDMN			FW	vehicle speed threshold; fault detection vhehicle speed signal

Variable	Source	Type	Description
B_CLVFZ		EIN	condition: delete error path VFZ (Vehicle speed)
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_SA	MDRED	EIN	Condition fuel cut-off
B_SIVFZ	DVFZ	AUS	Condition missing signal vehicle speed
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_VFZ	DVFZ	AUS	Error flag: vehicle speed signal
NMOT	BGNMOT	EIN	engine speed
TMOT	GGTFM	EIN	Engine temperature
VFZROH_W	GGVFZG	EIN	vehicle speed output value to scan tool
Z_VFZ	DVFZ	AUS	cycle flag: vehicle speed signal

FB DVFZ 21.10 Detailed description of function

The function shall enable the diagnosis of the V signal during a FTP75 test also on vehicles with automatic gearbox with "soft" converter. For this the SAS-flag is checked within an engine speed range: if it is fulfilled within the range for a certain amount of time the vehicle must be in motion and thus V > VDMN must be fulfilled, otherwise the error is stored.

```
Devault measures:  Block the demand adaptation of the LLR
                   Block gear detection and thus compression control (see %KOS)
                   LLR active, if B_LL detected
                   Deactivate the antijerking function

In case BBNMAX exists: switch-over speed limiter/enginge speed limiter.
```

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APP DVFZ 21.10 Application hint

HLS 16.20 Lambda sensor heater

FDEF HLS 16.20 Function definition

hls-hls

hls-hls

hls-restart

hls-restart

hls-hlsvk

hls-hlsvk

hls-ub-korr1

hls-ub-korr1

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hls-hlsvk2

hls-ub-korr2

hls-hlshk

hls-ub-korr3

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hls-hlshk2

hls-ub-korr4

ABK HLS 16.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
THEH			FW	Time for maximal lambda sensor heating post cat after engine start
THEV			FW	Time for maximal lambda sensor heating after start , pre cat
THHA			FW	off time to reduce heater power of oxygen sensor downstream cat at 13Volt
THHA2			FW	off time to reduce heater power of oxygen sensor2 downstream cat at 13Volt
THHAWU			FW	Switch OFF time during power reduction of sensor heating post cat
THSHKTK	TKATM		KL	Line for switch off time of lambda sensor heating post cat dep. on temp
THSHKTK2	TKATM2		KL	ine for switch off time of lambda sensor heating 2 post cat dep. on temp
THSVKTA	TABGM		KL	Line of switching off time for lambda sensor heating depending on exh.gas temp
THSVKTA2	TABGM2		KL	Line of switching off time for lambda sensor heating depending on exh.gas temp 2
THVA			FW	off time to reduce heater power of oxygen sensor upstream cat at 13 Volt
THVA2			FW	off time to reduce heater power of oxygen sensor2 upstream cat at 13 Volt
THVAWU			FW	Switch OFF time during power reduction of sensor heating pre cat
TMOHSMN			FW	Minimum engine temperature for lambda sensor heating
TVHSH			FW	delay time for sensor heater downstream cut
TVHSV			FW	delay time for sensor heater upstream cut
UBHS			FW	battery voltage threshold for switching off oxygen sensor heater
UHSN			FW	Nominal battery voltage for lambda sensor heating

Variable	Source	Type	Description
B_ATMTPA	ATM	EIN	condition temperature upstream catalyst exceeds dew-point
B_ATMTPA2	ATM	EIN	condition temperature upstream catalyst exceeds dew-point2
B_ATMTPK	ATM	EIN	condition temperature downstream catalyst exceeds dew-point
B_ATMTPK2	ATM	EIN	condition temperature downstream catalyst exceeds dew-point2
B_HSHE	HLS	AUS	condition for lambda sensor heating-switch downstream cat on
B_HSHE2	HLS	AUS	condition for lambda sensor2 heating-switch downstream cat on
B_HSHMX	HLS	LOK	Condition maximal power of lambda sensor heating post cat
B_HSHMX2	HLS	LOK	Condition maximal power of lambda sensor heating 2 post cat
B_HSVE	HLS	AUS	condition for lambda sensor heating-switch upstream cat on
B_HSVE2	HLS	AUS	condition for lambda sensor2 heating-switch upstream cat on
B_HSVMX	HLS	LOK	Condition maximal power of lambda sensor heating pre cat
B_HSVMX2	HLS	LOK	Condition maximal power of lambda sensor heating 2 pre cat
B_REHS	HLS	LOK	Restart Lambda sensor heating
B_SBBHK	DLSH	EIN	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	EIN	condition for lambda sensor downstream cat ready for operation bank2
B_SBBVK	DLSV	EIN	condition for lambda sensor upstream cat ready for operation
B_SBBVK2	DLSV	EIN	condition oxygen sensor upstream cat. bank2 ready for operation
B_STEND	BBSTT	EIN	condition end of start
C_INI		EIN	ECU-condition for intialisation
PHLSNH	HLS	AUS	Standardized heating power of the Lambda sensor downstream of the catalyzer
PHLSNH2	HLS	AUS	Standardized heating power of the Lambda sensor 2 downstream of the catalyzer
PHLSNV	HLS	AUS	normalized heating power of lambda sensor upstream of catalyst
PHLSNV2	HLS	AUS	normalized heating power of lambda sensor 2 upstream of catalyst
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst

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Variable	Source	Type	Description
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
THHAIST	HLS	LOK	”Off”-duration for sensor heating downstream catalyst
THHAIST2	HLS	LOK	”Off”-duration for sensor heating2 downstream catalyst
THHAT	HLS	LOK	Uncorrected switch off time for lambda senor heating post cat
THHAT2	HLS	LOK	Uncorrected switch off time for lambda senor heating 2 post cat
THVAIST	HLS	LOK	”Off”-duration for sensor heating upstream catalyst
THVAIST2	HLS	LOK	”Off”-duration for sensor heating2 upstream catalyst
THVAT	HLS	LOK	Uncorrected switch off time for lambda senor heating pre cat
THVAT2	HLS	LOK	Uncorrected switch off time for lambda senor heating 2 pre cat
TKATM	ATM	EIN	catalyst temperature (model)
TKATM2	ATM	EIN	catalyst temperature (model), bank2
TMOT	GGTFM	EIN	Engine temperature
UB	GGUB	EIN	battery voltage

FB HLS 16.20 Detailed description of function

This heater control is suitable also for power stages without current measuring shunt. The heating of the Lambda sensor is controlled such that independent of the ambient conditions (condensate, exhaust gas temperature, battery voltage) the Lambda sensor is not damaged. The heater power stage is short-circuit-proof and switches off automatically in case of too high current.
Via a port, B_hsve triggers the heater power stage, that means B_hsve=1 ==> sensor is heated.
The port must be inverted for integrated power stages CJ920. It must be operated within 10ms after B_hsve.
The output signal phlsnv represents the standardized heating performance of the sensor heating. With nominal voltage (UHSN = 13 Volt) the output shows the value 1,0 if the heating is not reduced.
If the battery voltage is greater than UHSN then the sensor heating is clocked such that phlsnv = 1.

Function of the heater control after start:

1. Ceramic protection (avoiding ceramic stress)
   During the time TVHSV after end of start the heating performance is reduced (dependent on THVAWU) so as to limit the temperature gradient of the sensor ceramic.

2. maximum heating
   Maximum heating (phlsnv > 1) is performed during the time THEV, in order to reach the sensor operating readiness as quickly as possible.
   If the operating readiness stops again due to too little heating performance, maximum heating is again performed during THEV.
   If maximum heating is not allowed (downstream catalyst) then the time must be set to the value zero.

3. Ceramic protection (avoiding thermal shock)
   After the time THEV has elapsed or in case of sensor ready for operating the heating performance is reduced dependent on THVA until dew point end is reached. In addition the heating performance is corrected dependent on the battery voltage (ceramic protection during condensate phase).

4. Temperature control
   After end of dew point the heating performance can be controlled dependent on the exhaust gas temperature (characteristic line THSVKTA) so that the ceramic temperature is e.g. 750°C.

5. Power stage protection
   With high battery voltage (booster start) the heating must be switched off (threshold UBHS).

6. Power stage diagnosis
   For the diagnosis of the power stage the heating is switched off periodically every 10s for 100ms. A power stage switched off due to short-circuit or overloading is activated again by this (block restart).

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APP HLS 16.20 Application hint

1.Determination of THVA/2, THHA/2

Set point ceramic temperature: upstr. cat 300 to 350°C, downstr. cat 200 to 250°C

During the condensate phase the ceramic temperature of the sensors must be limited. For this, the necessary mean heater voltage is determined. The heater voltage is measured at an exhaust pipe wall temperature of 60°C. Above 60°C condensate no longer occurs. So as to reach 300 to 350°C on the ceramic, e.g. a heater voltage UHM of 7.5V is necessary on the LSH25-PL (vehicle-specific). With Te = 100ms the following times result for THVA from the below-mentioned formula.

LSH25P	LSH25PL	LSH25PL	LSF4.7	LSF4.7
u.cat	u.cat	d.cat	u.cat	d.cat
0.16s	0.20s	0.58s	0.24s	0.62s

The ceramic temperature must definitely be checked by means of a measuring sensor! After each change (engine, exhaust system, engine control), at the latest just prior to the release the ceramic temperature must be checked again!

********* Permitted ceramic temperature of the measuring sensor with condensate 350°C, after end of dew point approx. 650°C.********

Determination of the mean heater voltage UHM:

a) Mount a measuring sensor instead of the Lambda sensor for the ceramic temperature (from K3-LS/ESV).
   The measuring sensor should be of the same type (heating performance, protection pipe) as the sensor to be substituted.

b) Supply the sensor heating via an external constant-voltage source and adjust the voltage UHM such that the desired ceramic temperature (see above) is reached.
c) Start the vehicle (tmot < 70°C), operate at idling and correct UHM such that the demanded temperature is reached.
   The value UHM is valid at an exhaust pipe wall temperature of 55 to 60°C.
   The measurement should be terminated before the exhaust pipe wall temperature at the location where the sensor is mounted exceeds 60°C.

d) Calculate the off-time from UHM with the formula given below.

$$THVA = Te * \left(\frac{13V * 13V}{UHM * UHM} - 1 \right)$$

UHM = mean heater voltage for the demanded ceramic temperature
Te = on-time (0.10s)

Checking of the ceramic temperature:

The exhaust gas temperature model must already have been adjusted. Especially the values in %ATM for end of dew point must be adjusted correctly. In case of too early end of dew point (B_atmtpa=1) cracking of the ceramic may result!

a1) Connect measuring sensor to the vehicle wiring harness.
b1) Start vehicle (tmot < 70°C, exhaust pipe wall temperature < 50°C), operate at idling, record the ceramic temperature and the exhaust pipe wall temperature (VS100, thermoscanner).
    (attach the measuring position of pipe wall temperature just in front of the location where the sensor is mounted to the exhaust pipe by a conduit clip)
c1) In case of deviations of the ceramic temperature from the set point (moment: pipe wall exceeds 60°C) THVA must be corrected.
    Ceramic temperature too high ===> increase THVA resp. THHA!
    Should the bit end of dew point already have been set prior to this moment, then the %ATM application must be checked.
d1) After each correction of the off-time the course of the temperature must be checked again in case of a new start.

Hint: The control behaviour of the Lambda control is not good with the temperature-measuring sensor, i.e. the control readiness (B_sbbvk = 1) can be reset during the condensate phase. The control is OK with a normal sensor.

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2. UBHS:

UBHS = 15.5V

With very high battery voltage (booster start) and extremely cold sensor it is possible that the power stage switches off due to too high heating performance at it. By means of the threshold UBHS the possible heating performance is limited and a switch-off is avoided. The value of UBHS should be around 15 to 16V.

3. TVHSV, TVHSH

LSH25PL	LSF4.7
0s	4s

Time to reduce heating after start.

4. THVAWU THHAWU

	LSH25P u.Kat	LSH25PL u.Kat	LSH25PL d.Kat	LSF4.7 u.Kat	LSF4.7 d.Kat
THVAWU	0s	0s	-	0.03s	-
THHAWU	-	-	0s	-	0.10s

In order to avoid ceramic stress the heating is clocked after the start during the time TVHSV/H on the LSF4.7.

5. THEV, THEH:

	LSH25 u.Kat	LSH25 d.Kat	LSF4.7 u.Kat	LSF4.7 d.Kat
THEV	50s	-	20s	-
THEH	-	0s	-	0s

After the start the heating can constantly be switched on for the time THEV resp. THEH also during the condensate phase (until the sensor becomes ready for operation, only permissible for upstream sensor!).
Advantage: Maximum heating is again performed if the operating readiness is reset during the condensate phase.

6. THSVKTA/2, THSHKTK/2

tabgm, tkatm	100°C	200°C	300°C	400°C	500°C	600°C	700°C	800°C
LSH25P	0	0	0	0	0	0	0	2.55s
LSH25PL	0	0	0	0	0	0	0	2.55s
LSF4.7	0.03	0	0	0	0	0	0	2.55s

The heating performance of the sensor can be adjusted by this characteristic lines such that a constant ceramic temperature is achieved independent of the exh. gas temp.
The values THSVKTA/TK are dependent on the sensor type. So as to simplify the application the heating performance is reduced only above 700°C. The LSF4.7 is operated at 100°C tabgm with only about 80% heating performance (lesser ceramic stress after end of dew point).

7. TMOHSMN

TMOHSMN = -10°C

If the engine temperature is less than the threshold TMOHSMN only a reduced sensor heating is performed.

8. UHSN

UHSN = 13.0V

If the battery voltage is greater than UHSN the heater voltage is clocked, i.e. the heating performance remains constant.

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GGLSV 2.30 Sensorsignal lambda upstream catalyst

FDEF GGLSV 2.30 Function definition

GGLSV: Enable sensor function by configuration bit

gglsv-gglsv

GGLSVSYS: Overview and description of registration from sensor voltage

gglsv-gglsvsys

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GGLSVIMPTP: Generating pumping time intervals for bank1 und bank2

gglsv-gglsvimptb

GGLSERFV: Measuring the unloaded and the loaded sensor voltage into 1 ms-time frame, bank1

gglsv-gglserfv

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GGLSFV: Transfer of the measuered values unloaded and loaded after pumping into 100 ms-time frame, bank 1

gglsv-gglsfv

GGLSRIENV: Enabling of Ri-measurement, bank 1:

gglsv-gglsrienv

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GGLSVRIBER: Ri-calculation and statistical evaluation, bank 1

gglsv-gglsvriber

GGLSVENTS: Additional interference suppression of Ri-measurement and formation of enable for the Ri-filter, bank1

gglsv-gglsvents

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GGLSERFV2 : Measuring the unloaded and the loaded sensor voltage into 1 ms-time frame, bank2

gglsv-gglserfv2

GGLSFV2 : Transfer of the measuered values unloaded and loaded after pumping into 100 ms-time frame, bank 2

gglsv-gglsfv2

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GGLSRIENV2: Enabling of Ri-measurement, bank 2

gglsv-gglsrienv2

GGLSVRIBE2: Ri-calculation and statistical evaluation, bank 2

gglsv-gglsvribe2

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GGLSVENTS2: Additional interference suppression of Ri-measurement and formation of enable for the Ri-filter, bank 2

gglsv-gglsvents2

ABK GGLSV 2.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZRIBEV			FW	Amount of Ri calculation pre cat
CWGGLSV			FW	Code word for Ri-measurement for O2sensor pre cat (not fully heated)
DUSRIV			FW	Delta sensor voltage pre cat between new and old value for Ri measurement
DUSSPV			FW	Delta sensor volt.front cat between new and old val. for sensor jump knowledge
FRINOF			FW	Factor for validation of old Ri-value without filter
RINVMX			FW	Internal resistor Ri of nernst sensor limited to maximal value
TGGLS			FW	Time needed for ADC after interrupt in the function calculator (Asic)
THSRIV			FW	Ready condition, time delay,of Ri measurement after sensor heating on pre cat
TRIAKTV			FW	Time for Ri calculation actuel pre cat
TRIIMPV			FW	Time for pump impulse for both banks pre cat
TUSBELV			FW	Time for holding of O2 sensor voltage after Impuls charge
USRIMINV			FW	Minimum voltage threshold for Ri-mesurement of the sensor upstream cat
USRIOV			FW	Upper voltage threshold for Ri-measurement of the sensor upstream cat
USRIUV			FW	Lower voltage threshold for Ri-measurement of the sensor upstream cat
ZFRIV			FW	Reduction factor for internal resistor Ri-Nernst filter pre cat

Variable	Source	Type	Description
B_ENRINV	GGLSV	LOK	Condition enable for Ri-Nernst wit filter pre cat
B_ENRINV2	GGLSV	LOK	Condition enable for Ri-Nernst wit filter pre cat bank 2
B_ERINOFV	GGLSV	LOK	Condition enable for Ri-Nernst without filter pre cat
B_ERINOFV2	GGLSV	LOK	Condition enable for Ri-Nernst without filter pre cat bank 2
B_LSV	PROKON	EIN	Cond. lambda sensor inst. upstr. of the cat., 1. sensor downst. of outlet(Bank1)
B_LSV2	PROKON	EIN	Cond. lambda sensor inst. upstr. of the cat., 1. sensor downst. of outlet(Bank2)
B_PRIPV	GGLSV	AUS	Condition switch port for pump impuls upstream catalyst
B_PRIPV2	GGLSV	AUS	Condition switch port for pump impuls upstream cat bank2
B_RIAKV	GGLSV	LOK	Condition for pumping current updated upstream catalyst
B_RIAKV2	GGLSV	LOK	Condition for pumping current updated upstream catalyst, bank 2
B_RIBEV	GGLSV	LOK	Condition calculate internal resistance Ri for sensor upstream cat
B_RIBEV2	GGLSV	LOK	Condition calculate internal resistance Ri for sensor upstream cat , bank 2
B_RIIBV	GGLSV	LOK	Cond. sensor volt. in the perm. range for pump. current upstream cat
B_RIIBV2	GGLSV	LOK	Cond. sensor volt. in the perm. range for pump. current upstream cat , bank2
B_RIIMPV	GGLSV	LOK	Condition impuls for pumping current upstream catalyst
B_RIMV	GGLSV	LOK	Cond. (adc-trigger) for measuring of loaded sensor voltage upstream cat
B_RIMV2	GGLSV	LOK	Cond. (adc-trigger) for measuring of loaded sensor voltage upstrean cat, bank2
B_RINV	GGLSV	AUS	Condition: Internal resistance Ri of O2 sensor activ,pre cat
B_RINV2	GGLSV	AUS	Condition: Internal resistance Ri of O2 sensor activ,pre cat bank 2
B_RIPUV	GGLSV	LOK	Condition pumping current for sensor upstream catalyst
B_RIPUV2	GGLSV	LOK	Condition pumping current for sensor upstream catalyst bank2
B_RIREV	GGLSV	LOK	Condition result for internal resistance Ri for sensor upstream cat
B_RIREV2	GGLSV	LOK	Condition result for internal resistance Ri for sensor upstream cat , bank2
B_SA	MDRED	EIN	Condition fuel cut-off
B_SHUERF		EIN	Condition sensor voltage post cat measured
B_SHUERF2		EIN	Condition sensor voltage post cat measured bank 2
B_SVUERF	GGLSV	LOK	Condition sensor voltage pre cat measured
B_SVUERF2	GGLSV	LOK	Condition sensor voltage pre cat measured bank 2
B_TTBMH		EIN	condition theoretical lambda sensor operation readyness with heating
B_TTBMH2		EIN	condition theoretical lambda sensor operation readyness with heating bank2
B_USBEV	GGLSV	LOK	Condition for time counter for deactivation of the sensor load upstream cat
B_USBEV2	GGLSV	LOK	Condition for time counter for deactivation of the sensor load upstream cat ban2
C_INI		EIN	ECU-condition for intialisation
RINOFV2_W	GGLSV	AUS	Internal resistor (word) Ri Nernst without filter , pre cat, bank 2
RINOFVA2_W	GGLSV	LOK	Internal resistor (word) Ri Nernst (old value) without filter , pre cat bank2
RINOFVA_W	GGLSV	LOK	Internal resistor (word) Ri Nernst (old value) without filter , pre cat
RINOFV_W	GGLSV	AUS	Internal resistor (word) Ri Nernst without filter , pre cat
RINV2_W	GGLSV	AUS	Actuel value of internal resistance of lambda sensor 2, pre ca
RINV_W	GGLSV	AUS	Actuel value of internal resistance of lambda sensor,pre cat (word)

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Variable	Source	Type	Description
R_T1		EIN	Time schedule 1 ms
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
SY_STETLR	PROKON	EIN	System constant condition continuous Lambda control present
USBEV2_W	GGLSV	LOK	Voltage (word) lambda sensor loaded with resistance upstream cat, bank 2
USBEV_W	GGLSV	LOK	Voltage (word) lambda sensor loaded with resistance upstream cat
USOBV2_W	GGLSV	LOK	Voltage (word) lambda sensor without load upstream catalyst bank 2
USOBV_W	GGLSV	LOK	Voltage (word) lambda sensor without load upstream catalyst
USVK	GGLSV	AUS	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	AUS	output voltage oxygen sensor upstream catalyst 2
USVK2_W	GGLSV	AUS	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst 2
USVKR2_W	GGLSV	LOK	Voltage (word) O2-sensor in raw value, pre cat , bank 2
USVKR_W	GGLSV	LOK	Voltage (word) O2-sensor in raw value, pre cat
USVK_W	GGLSV	AUS	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst
USVMB2_W	GGLSV	LOK	Voltage (word, 10 ms time slot) sensor with resistor loaded, upstream cat, bank2
USVMB_W	GGLSV	LOK	Voltage (word, 10 ms-time slot) O2-sensor with resistor loaded , upstream cat
USVOB2_W	GGLSV	LOK	Voltage (word, 10 ms time slot) sensor, unloaded, upstream cat, bank 2
USVOB_W	GGLSV	LOK	Voltage (word 10 ms-time slot) sensor, unloaded, upstream cat
UUSVK2_W	GGLSV	LOK	ADC voltage for lambda sensor upstream of catalyzer 2 (Word)
UUSVK_W	GGLSV	LOK	ADC voltage for lambda sensor upstream of catalyzer (Word)
UUSVMB2_W	GGLSV	LOK	Voltage (word, 1 ms-time slot) sensor with resistor loaded, upstream cat bank2
UUSVMB_W	GGLSV	LOK	Voltage (word, 1 ms-time slot) O2-sensor with resistor loaded , upstream cat
UUSVOB2_W	GGLSV	LOK	ADC voltage (word, 1 ms-time slot) O2-sensor unloaded upstream cat bank2
UUSVOB_W	GGLSV	LOK	ADC voltage (word, 1 ms-time slot) O2-sensor unloaded upstream cat
ZRIBERV	GGLSV	LOK	Ri calculation counter after engine start pre cat
ZRIBERV2	GGLSV	LOK	Ri calculation counter after engine start pre cat, bank 2
ZRINV2_W	GGLSV	LOK	Time counter for preparation of the actuel condition Ri-Nernst pre cat bank 2
ZRINV_W	GGLSV	LOK	Time counter for preparation of the actuel condition Ri-Nernst pre cat

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FB GGLSV 2.30 Detailed description of function

1. Introduction:

The sensor function GGLSV serves for the acquisition and the quantization of the sensor voltage upstream catalyst as well as for the generating of a pump current while at the same time the internal resistance Ri of the Nernst sensor is determined.

In this sensor function the sensor voltage is perodically pulsed by means of a pump current (0.5 mA for 10 ms) so that the sensors LSH and LSF4 are completely compatible. Thus no sensor diagnosis need to be changed.
The sensors LSH and LSF4 have an air reference and would not need a pump current. However, if a pulsed pump current is used on these sensors then the internal resistance Ri can be determined. By the internal restistance an indirect check is performed in the heater diagnosis DHLS on whether the sensor heater is o.k. In case of defect sensor heating or strongly reduced heating performance at low exhaust gas temperatures the internal resistance increases markedly.

2. Enable sensor function by configuration bit (GGLSV):

The sensor function can be enabled by the code word CWKONLS, provided the corresponding bits for the sensor installed upstream of the catalyst have been set. Bank1 can be enabled by means of bit 0 and with B_lsv = 1 and Bank1 enabled by bit 4 with B_lsv2 = 1 (sum = 17).
If the universal sensor LSU is installed upstream of the catalyst, then th e above condition must also be set by this code word as recognition for the sensor installed upstream of catalyst. SY_STETLR must be set so that this sensor function will not be active for the Nernst sensor.

3. Generation of pump impulse (current impulse) GGLSRIENV:

An instable multi-vibrator with the output B_riimpv serves to generate a pump impulse. The multi-vibrator supplies an impulse with the duration of 10 ms after an adjustable timer TRIIMPV has passed. This impuls B_riimpv sets the flip-flop B_riakv, i.e. the pumping current is updated. One timer only is used for both banks.

A pumping current with the condition B_ripuv = 1 can be performed if the sensor voltage lies within the permitted permissible voltage ranges (B_riibv = 1) and if the condition B_ttbmh = 1 from %DLSV was continuously active for a time longer than THSRIV.
The condition B_ttbmh from %DLSV can be disabled by the codeword CWGGLSV in order that Ri can be measured for application purpose even befor end of dewpoint (refer to Application Note).

A permitted voltage range for permissible pumping current exists if the sensor voltage usvkr_w
"- is greater than USRIOV in the rich range"
"- lies between USRIMINV and USRIUV in the lean range"
"- the gradient of the sensor voltage (difference between new value and old value (i-1) in the 10 ms grid) is less than the " threshold value DUSRIV

After the pumping current was enabled B_ripuv = 1 the flip-flop B_riakv is reset in the next 10 ms grid (i-1) so that the period for pumping current is exactly 10 ms.

To maintain a correct current balance for the sensor LSF8, a timer TRIIMPV (B_riimpv =1, i.e. pump impulse is necessary) has passed and if at the same time sensor voltages occur in the not permitted voltage range (USRIUV < usvkr_w < USRIOV) the triggering of the pump impulse is at first forbidden and stored as information in the flip-flop B_riakv. Only once the non permitted voltage range is left immediately afterwards B_ripuv = 1 is set in the permitted voltage range and by doing so the pump impulse is triggered.

There must be a definite relationship between unloaded and loaded sensor voltage for a sensor in the 10 ms grid. This requirement is met by only one sensor being allowed to be pumped in the 10 ms grid.
B_ripuv canot be used to pump current if the sensor voltage at bank2 upstream of catalyst, or the voltages downstream of catalyst are momentarily being detected by B_svuerf2, or B_shuerf and B_shuerf2 respectively.
Via B_ripuv a port is switched with the bit B_pripv = 1 so that a pump current of 0,5 mA can flow for 10 ms from the 5V voltage supply and through a fixed defined resistor RBEL.

Hardware:

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4. Transfer of the sensor voltage measured values (unloaded and loaded) into the 100 ms grid for the Ri-calculation

For the calcualtion of the internal resistance Ri of the sensor it is important that the unloaded and the loaded sensor voltages are read within a time grid of 10 ms. This can be achieved if prior to the on-load impulse the unloaded sensor voltage uusvk_w is read via the ADC and if during the on-load impulse (10 ms) after approx. 3 ms the loaded sensor voltage uusvb_w is read via the ADC.
After the pump impulse was triggered B_ripuv = 1 the sensor voltage ushkr_w is held at the old value via a timer TUSBELH during the following 10 ms grid (i-1) so that the increased loaded sensor voltage cannot have an effect.

4.1 Measuring the loaded and unloaded sensor voltage in the 1 ms time frame (GGLSERFV):

The ADC value of the sensor voltage is sampled in the 1 ms-time frame and is stored as the word uusvk_w in the RAM.
If a permissible pump impulse B_ripuv follows, then the unloaded voltage uusvob_w is stored by setting the timer TGGLS with a positive edge. After elapse of the time TGGLS, the loaded sensor voltage uusvob_w is stored is then retained in the 1 ms time frame with the negative edge. Setting the pump impulse B_ripuv will also set the Flip-Flop B_svuerf in the 1 ms frame, i.e. for the sensor upstream of the catalyst at bank1, the requirement is set that only the the sensor voltage will be measured here. TGGLS is reset following elapse of the timer by the negative edge of this detection Flip-Flop B_svuerf.
It must be ensured that the order of the bank calculation is observed (first bank1 and then bank2).

4.2 Transfer of loaded and unloaded sensor voltage from the 1 ms time frame in 10 ms and 100 ms time frames (GGLSFV):

The condition B_rimv is set by resetting the Flip_Flop B_svuerf with the negative edge. The Flip-Flop B_ribev is set by B_rimv for transfer to the 10 ms and 100 ms time frames. The unloaded sensor voltage uusvob_w and the loaded sensor voltage uusvmb_w are transfered into a RAM in the 10 ms time frame with the positive edge of this Flip-Flop. The increase from sensor grounding, SY_USOFF, that is specific to the control unit, is sutracted from the unloaded sensor voltage uusvob_w or loaded sensor voltage uusvmb_w and then receives the unloaded sensor voltage usvob_w and the loaded sensor voltage usvmb_w in the 10 ms time. These are then transferred in the 100 ms time frame to the RAM, usobv_w and usbev_w respectively.
The increase in the sensor grounding, SY_USOFF, that is specific to the control unit is then also subtracded in the 1 ms-time frame from the ADC voltage and stored in the 10 ms-time frame as the raw value in the RAM usvkr_w (word). This 16 bit sensor voltage usvkr_w is converded to the 8 bit format (usvk) for additional use in sensor diagnostics and lamda control.

Ri-calculation (rinofv_w)

The internal resistance Ri’ of the sensor is calculated from:

$$Ri' = \frac{usbev_w - usobv_w}{5V - usbev_w} * RBEL$$

Corrected by the counter-resistance RKSP in the hardware Ri becomes:

$$Ri = \frac{Ri' * RKSP}{RKSP - Ri'} = rinofv_w$$

This RI value is given in the 100 ms-time frame by setting the Flip-Flop B_ribev = 1 and is limited to RINVMX.
The following measures are performed in order to prevent the loaded sensor voltage from being used in a jump of the sensor voltage during the 10 ms-impulse:

a) If, primarily the rich tolean jump, the difference between the loaded sensor voltage usbev__w and the unloaded sensor voltage usobv_w is less than zero, then the B_erinofv is not set and Ri is not comuted.

b) If, primarily during the lesn to rich jump, it is determined following elapse of the timer that the magnitude from the difference of the sensor voltage from the new-old value in the 10 ms time frame is grater than DUSSPV and hence Ri is not calculated.

Thereafter rinofv_w is filtered through an event filter with the attenuation factor ZFRIV so that the filtered internal resistance rinh_w of the sensor is obtained. ———> Event filter : y[k] = y[k-1] + ZFRIV(x[k] + y[k-1])

After the calculation of the internal resistance a flag is set in the 10 ms grid via B_rireh = 1 (Ri-calculation terminated) and the flip-flop B_ribev is reset.

4.3 Additional interference suppression of Ri measurements and formation of enable for the Ri filter (GGLSVENTS):

In the new unfiltered new value of Ri (rinofv_w) is greater by a factor FRINOF than the old Ri value rioffv_w, then B_enrinv is not set and hence the calculated value is transferred to the filter. In order than an increase in the internal resistance Ri is possible during sensor cooling (new Ri value is greater than the old value vby the factor FRINOF), the transfer of rinofv_w to the filter is enabled by B_enrinv = 1 after measuring 2 Ri values.

The Ri-calculations B_ribev are added-up by means of a counter zriberv. If the number of Ri-calculations is greater than ANZRIBEV then a flip-flop B_rinv is set, which indicates to the heater diagnosis the state that the calculation of the internal resistance is active and up to date. ANZRIBEV = 3/ZFRIV is chosen.
As soon as the counter starts a retriggerable timer zrinv_w is triggered, whose timer time is chosen at TRIAKTV = 4*TRIMPV.
Once the timer has passed zrinv_w = 0 the flip-flop B_rinv is reset (resitance value rinv_w is not updated). If within the period TRIAKTV again current Ri-calculations are performed (B_ribev =1), then this timer zrinv_w is continuously started again so that the condition B_rinv is currently active.

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Course of the ADC-sequence:

APP GGLSV 2.30 Application hint

SY_USOFF

The fixed value voltage difference between sensor ground and electronic ground can adjustable with a system constant SY_USOFF and it must be adjusted ECU-specific by the software.
Example: If the voltage between sensor grond and electronic ground is 0.268V the SY_USOFF must be adjusted to 0.268V.

Corresponding to the hardware design SY_USOFF becomes 0V; 0,268V or 0,714V.

Typical application values:

```
THSRIV   = 10 s
TUSBELV  = 30 ms
TRIIMPV  = 2 s
TRIAKTHV = 4*TRIMPV = 8 s
ZFRIV    = 0.3
ANZRIBEV = 3/ZFRIV = 10
RBEL     = 8.45 KOhm
RKSP     = 51 KOhm
RINVMX   = 100 KOhm
USRIOV   = 550 mV
USRIUV   = 250 mV
USRIMINV  = 60 mV
DUSRIV   = 25 mV
UBDLS    > 11 V
TGGLS    = 3 ms
FRINOF   = 1.5
CWGGLSV = 0   ————> Code word = 0 : Ri is only calculaded after end of dewpoint for full heating power (series)
                    = 1 : Ri can be measured as high-resistance for application purposes during phase of dewpoint

CWKONLS :  ————————>  Code word in % PROKON : Sensors present upstream of the catalyst  ——> Bank1: B_lsv by Bit  0 = 1
                                                                                              Bank2: B_lsv2 by Bit 4 = 16
                                                                                              (gives 17 as the sum)

                                              Sensors present downstream of the catalyst ——> Bank1: B_lsh by bit 1  = 2
                                                                                              Bank2: B_lsh2 by bit 5 = 32
                                                                                              (gives 34 as the sum)

                                              For all 4 installed seensors: CWKONLS = 51
```

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GGLSH 3.30 Sensor variable for lambda sensor downstream of catalytic converter

FDEF GGLSH 3.30 Function definition

GGLSH: Analysis of configuration bit

gglsh-gglsh

GGLSHSYS: Overview and description sensor voltage detection, bank1 and bank2

gglsh-gglshsys

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GGLSHIMPTP: Generating pumping time intervals for bank1 and bank2

gglsh-gglshimptb

GGLSERFH: Measuring the sensor voltage in the 1 ms cycle with and without load, bank1

gglsh-gglserfh

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GGLSFH: Transfer of the measured values without load after pumping into 100 ms cycle, bank 1

gglsh-gglsfh

GGLSRIENH: Enabling of Ri-measurement, bank 1

gglsh-gglsrienh

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GGLSHRIBER: Calculation of Ri and statistical evaluation, bank 1

gglsh-gglshriber

GGLSHENTS: Additional interference suppression of Ri-measurement and formation of enable for the Ri-filter, bank1

gglsh-gglshents

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GGLSERFH2: : Measuring the sensor voltage in the 1 ms cycle with and without load, bank2

gglsh-gglserfh2

GGLSFH2: Transfer of the measured values without load after pumping into 100 ms cycle, bank 2

gglsh-gglsfh2

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GGLSRIENH2: Enabling of Ri-measurement, bank 2

gglsh-gglsrienh2

GGLSHRIBE2: Calculation of Ri and statistical evaluation, bank 2

gglsh-gglshribe2

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GGLSHENTS2: Additional interference suppression of Ri-measurement and formation of enable for the Ri-filter, bank2

gglsh-gglshents2

ABK GGLSH 3.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZRIBEH			FW	Number of Ri.calculations downstream catalyst
CWGGLSH			FW	code word for Ri-evaluation for sensor downstr. of cat (not full heating)
DUSRIH			FW	Delta sensor volt. downstream cat betw. new and old value in grid for Ri-measur.
DUSSPH			FW	Delta sensor volt. rear cat between new and 2 old val. for sensor jump knowledge
FRINOF			FW	Factor for validation of old Ri-value without filter
RBEL			FW	On-load resistance for pump current generation
RINHMX			FW	Limit internal resistance Ri of the Nernst sensor downstream cat to max. value
RKSP			FW	Resistance between congruent voltage and sensor signal
TGGLS			FW	Time needed for ADC after interrupt in the function calculator (Asic)
THSRIH			FW	Time del. readiness of Ri-measure. after switched on sensor heat. downstream cat
TRIAKTH			FW	Time needed for Ri-calculation up to date downstream catalyst
TRIIMPH			FW	Time needed for pump impulse for both banks downstream catalyst
TUSBELH			FW	Time for holding of the sensor voltage after on-load impulse downstream catalyst
USRIMINH			FW	Minimum voltage threshold for Ri-mesurement of the sensor downstream catalyst
USRIOH			FW	Upper voltage threshold for Ri-measurement of the sensor downstream catalyst
USRIUH			FW	Lower voltage threshold for Ri-measurement of the sensor downstream catalyst
ZFRIH			FW	Attenuation factor for the internal resistance Ri Nernst filter downstream cat

Variable	Source	Type	Description
B_ENRINH	GGLSH	LOK	Condition enable for Ri-Nernst with filter post cat
B_ENRINH2	GGLSH	LOK	Condition enable for Ri-Nernst with filter post cat bank 2
B_ERINOFH	GGLSH	LOK	Condition enable for Ri-Nernst without filter post cat
B_ERINOFH2	GGLSH	LOK	Condition enable for Ri-Nernst without filter post cat bank 2
B_LSH	PROKON	EIN	Cond. lambda sensor inst. downstr. of cat., 2. sensor downst. of outlet (Bank1)
B_LSH2	PROKON	EIN	Cond. lambda sensor inst. downstr. of cat., 2. sensor downst. of outlet (Bank2)
B_PRIPH	GGLSH	AUS	Condition switch port for pump impulse downstream catalyst
B_PRIPH2	GGLSH	AUS	Condition switch port for pump impulse downstream catalyst bank2
B_RIBEH	GGLSH	LOK	Condition calculate internal resistance Ri for sensor downstream catalyst
B_RIBEH2	GGLSH	LOK	Condition calculate internal resistance Ri for sensor downstream cat. bank2
B_RIIMPH	GGLSH	LOK	Condition impuls for pumping current downstream catalyst
B_RIMH	GGLSH	LOK	Cond. (adc-trigger) for measuring of loaded sensor voltage downstream catalyst
B_RIMH2	GGLSH	LOK	Cond. (adc-trigger) for measuring of loaded sensor voltage downstream cat. bank2
B_RINH	GGLSH	AUS	Condition internal resistance of Ri-measur. of sensor active downstream cat.
B_RINH2	GGLSH	AUS	Condition internal resist. of Ri-meas. sensor active downstream cat. bank2
B_RIPUH	GGLSH	LOK	Condition pumping current for sensor downstream catalyst
B_RIPUH2	GGLSH	LOK	Condition pumping current for sensor downstream catalyst bank2
B_RIREH	GGLSH	LOK	Condition result for internal resistance Ri for sensor downsteam catalyst
B_RIREH2	GGLSH	LOK	Condition result for internal resistance Ri for sensor downstream catalyst bank2
B_SA	MDRED	EIN	Condition fuel cut-off
B_SHUERF	GGLSH	LOK	Condition sensor voltage post cat measured
B_SHUERF2	GGLSH	LOK	Condition sensor voltage post cat measured bank 2
B_SVUERF		EIN	Condition sensor voltage pre cat measured
B_SVUERF2		EIN	Condition sensor voltage pre cat measured bank 2
B_TTBMHH		EIN	cond. theoretical lambda sensor operation readyness downstr. cat with heating
B_TTBMHH2		EIN	cond. theoretical lambda sens. operat. readyness downstr. cat with heating bank2
C_INI		EIN	ECU-condition for intialisation
RINH2_W	GGLSH	AUS	Act. value (word) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH_W	GGLSH	AUS	Actual value (word) internal res. Ri-Nernst cell lambda sensor downstream cat
RINOFH2_W	GGLSH	LOK	Internal resistance (word) Ri Nernst without filtering downstream cat bank2
RINOFH_W	GGLSH	LOK	Internal resistance (word) Ri Nernst without filtering downstream catalyst
R_T1		EIN	Time schedule 1 ms
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms

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Variable	Source	Type	Description
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
USBEH2_W	GGLSH	LOK	Voltage (word) lambda sensor loaded with resistance downstream catalyst bank2
USBEH_W	GGLSH	LOK	Voltage (word) lambda sensor loaded with resistance downstream catalyst
USHK	GGLSH	AUS	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	AUS	output voltage oxygen sensor downstream catalyst 2
USHK2_W	GGLSH	AUS	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst 2
USHKR2_W	GGLSH	LOK	Voltage (word) lambda sensor raw value downstream catalyst bank2
USHKR_W	GGLSH	LOK	Voltage (word) lambda sensor raw value downstream catalyst bank2
USHK_W	GGLSH	AUS	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst
USOBH2_W	GGLSH	LOK	Voltage (word) lambda sensor without load downstream catalyst bank2
USOBH_W	GGLSH	LOK	Voltage (word) lambda sensor without load downstream catalyst
UUSHK2_W	GGLSH	LOK	ADC-voltage lambda sensor downstream catalyst bank2 (word)
UUSHK_W	GGLSH	LOK	ADC-voltage lambda sensor downstream catalyst (word)
UUSHMB2_W	GGLSH	LOK	Voltage (word,1 ms-time slot) sensor with resistor loaded, downstream cat bank2
UUSHMB_W	GGLSH	LOK	Voltage (word, 1 ms-time slot) O2-sensor with resistor loaded, downstream cat
UUSHOB2_W	GGLSH	LOK	ADC voltage (word, 1 ms-time slot) O2-sensor unloaded downstream cat bank2
UUSHOB_W	GGLSH	LOK	ADC voltage (word, 1 ms-time slot) O2-sensor unloaded downstream cat

FB GGLSH 3.30 Detailed description of function

1. Introduction:

The sensor function GGLSH is used to detect and quantitize the sensor voltage downstream catalyst, and to generate a pump current while at the same time the internal resistance Ri of the Nernst sensor is determined.

The LSF8 sensor is not equipped with a reference air volume and therefore, it requires a constant pump current which transports oxygen towards the reference electrode. In the present sensor function, the sensor voltage is perodically pulsed by means of a pump current (0.5 mA for 10 ms)
so that the sensors LSF8 sensor is fully compatible to the sensors LSH and LSF4. Thus the sensor diagnosis' do not need to be changed. The sensors LSH and LSF4 have an air reference and actualally do not need a pump current. However, if a pulsed pump current is used on these sensors, the internal resistance Ri can be determined. By the internal restistance an indirect check is performed in the heater diagnosis DHLS on whether the sensor heater is o.k. In case of defect sensor heating or strongly reduced heating performance at low exhaust gas temperatures the internal resistance increases markedly.

2. Enable sensor function by configuration bit (GGLSH):

The sensor function can be enabled by means of the code word CWKONLS, provided the corresponding bits for the sensor installed upstream of
the catalyst have been set. Bank1 can be enabled by means of bit 1 if B_lsh = 1; Bank2 is enabled enabled via bit 5 if B_lsh2 = 1 (sum = 34).

3. Generation of pump pulse (current impulse) GGLSRIENH:

An instable multi-vibrator with the output B_riimph is used to generate a pump impulse. The multi-vibrator supplies an impulse with the duration of 10 ms after an adjustable timer TRIIMPH has passed. This impuls B_riimph sets the flip-flop B_riakh, i.e. the pumping current is updated. One timer only is used for both banks.

A pumping current with the condition B_ripuh = 1 can be performed if the sensor voltage lies within the permitted permissible voltage ranges (B_riibh = 1) and if the condition B_ttbmhh = 1 from %DLSV was continuously active for a time longer than THSRIH. The condition B_ttbmhh from %DLSH can be disabled by the codeword CWGGLSH in order that Ri can be measured for application purpose even befor end of dewpoint (refer to Application Note).

A permitted voltage range for permissible pumping current exists if the sensor voltage usvkr_w
"- is greater than USRIOH in the rich range"
"- lies between USRIMINH and USRIUH in the lean range"
"- the gradient of the sensor voltage (difference between new value and old value (i-1) in the 10 ms cycle) is less than the "
threshold value DUSRIH

After the pumping current was enabled B_ripuh = 1 the flip-flop B_riakh is reset in the next 10 ms grid (i-1) so that the period for pumping current is exactly 10 ms.

To maintain a correct current balance for the sensor LSF8, a timer TRIIMPH (B_riimph =1, i.e. pump impulse is necessary) has passed and if at the same time sensor voltages occur in the not permitted voltage range (USRIUH < ushkr_w < USRIOH) the triggering of the pump impulse is at first forbidden and stored as information in the flip-flop B_riakh. Only once the non permitted voltage range is left immediately afterwards B_ripuh = 1 is set in the permitted voltage range and by doing so the pump impulse is triggered.

There must be a definite relationship between unloaded and loaded sensor voltage for a sensor in the 10 ms grid. This requirement is met by only one sensor being allowed to be pumped in the 10 ms grid.
B_ripuh canot be used to pump current if the sensor voltage at bank2 upstream of catalyst, or the voltages downstream of catalyst are momentarily being detected by B_shuerf2, or B_svuerf and B_svuerf2 respectively.
Via B_ripuh a port is switched with the bit B_priph = 1 so that a pump current of 0,5 mA can flow for 10 ms from the 5V voltage supply and through a fixed defined resistor RBEL.

Hardware:

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4. Transfer of the sensor voltage measured values (with and without load) into the 100 ms cycle for the Calculation of Ri

It is important for the calcualtion of the internal resistance Ri of the sensor that the sensor voltages with load and without load are read within one 10 ms cycle. This can be achieved if prior to the on-load impulse the unloaded sensor voltage uushk_w is read via the ADC and if during the on-load impulse (10 ms) after approx. 3 ms the loaded sensor voltage uushb_w is read via the ADC.
After the pump impulse was triggered B_ripuh = 1 the sensor voltage ushkr_w is held at the old value via a timer TUSBELH during the following 10 ms grid (i-1) so that the increased loaded sensor voltage cannot have an effect.

4.1 Measuring the loaded and unloaded sensor voltage in the 1 ms time frame (GGLSERFH):

The ADC value of the sensor voltage is sampled in the 1 ms-time frame and is stored as the word uushk_w in the RAM.
If a permissible pump impulse B_ripuh follows, then the unloaded voltage uusvob_w is stored by setting the timer TGGLS with a positive edge. After elapse of the time TGGLS, the loaded sensor voltage uusvob_w is stored is then retained in the 1 ms time frame with the negative edge. Setting the pump impulse B_ripuh will also set the Flip-Flop B_shuerf in the 1 ms frame, i.e. for the sensor upstream of the catalyst at bank1, the requirement is set that only the the sensor voltage will be measured here. TGGLS is reset following elapse of the timer by the negative edge of this detection Flip-Flop B_shuerf.
It must be ensured that the order of the bank calculation is observed (first bank1 and then bank2).

4.2 Transfer of loaded and unloaded sensor voltage from the 1 ms time frame in 10 ms and 100 ms time frames (GGLSFH):

The condition B_rimh is set by resetting the Flip_Flop B_shuerf with the negative edge. The Flip-Flop B_ribeh is set by B_rimh for transfer to the 10 ms and 100 ms time frames. The unloaded sensor voltage uushob_w and the loaded sensor voltage uushmb_w are transfered into a RAM in the 10 ms time frame with the positive edge of this Flip-Flop. The increase from sensor grounding, SY_USOFF, that is specific to the control unit, is sutracted from the unloaded sensor voltage uushob_w or loaded sensor voltage uushmb_w and then receives the unloaded sensor voltage ushob_w and the loaded sensor voltage ushmb_w in the 10 ms time. These are then transferred in the 100 ms time frame to the RAM, usobh_w and usbeh_w respectively.
The increase in the sensor grounding, SY_USOFF, that is specific to the control unit is then also subtracded in the 1 ms-time frame from the ADC voltage and stored in the 10 ms-time frame as the raw value in the RAM ushkr_w (word). This 16 bit sensor voltage ushkr_w is converded to the 8 bit format (ushk) for additional use in sensor diagnostics and lamda control.

Ri-calculation (rinofh_w)

The internal resistance Ri’ of the sensor is calculated from:

$$Ri' = \frac{usbeh_w - usobh_w}{5V - usbeh_w} * RBEL$$

Corrected by the counter-resistance RKSP in the hardware Ri results:

$$Ri = \frac{Ri' * RKSP}{RKSP - Ri'} = rinofh_w$$

This Ri value is given in the 100 ms-time frame by setting the Flip-Flop B_ribeh = 1 and is limited to RINHMX.
The following measures are performed in order to prevent the loaded sensor voltage from being used during a jump of the sensor voltage
in the 10 ms-impulse:

a) If, especially during the rich-to-lean jump, the difference between the sensor voltage usbeh__w (with load) and the sensor voltage usobh_w (without load) is less than zero, then the B_erinofh is not set and Ri is not comuted.

b) If, especially during the lean-to-rich jump, the absolute value of the difference between old and new sensor voltage exceeds DUSSPH after the timer TUSBELH has elapsed in the 10 ms cycle, then the flop-flop B_ribeh is reset prematurely; this causes Ri not to be calculated.

Thereafter rinofh_w is filtered through an event filter with the attenuation factor ZFRIH so that the filtered internal resistance rinh_w of the sensor is obtained. ———> Event filter : y[k] = y[k-1] + ZFRIH(x[k] + y[k-1])

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After the calculation of the internal resistance a flag is set in the 10 ms grid via B_rireh = 1 (Ri-calculation terminated) and the flip-flop B_ribeh is reset.

4.3 Additional interference suppression of Ri measurements and formation of enable for the Ri filter (GGLSHENTS):

In the new unfiltered new value of Ri (rinofh_w) is greater by a factor FRINOF than the old Ri value rioffh_w, then B_enrinh is not set and hence the calculated value is transferred to the filter. In order than an increase in the internal resistance Ri is possible during sensor cooling (new Ri value is greater than the old value vby the factor FRINOF), the transfer of rinofh_w to the filter is enabled by B_enrinh = 1 after measuring 2 Ri values.

The Ri-calculations B_ribeh are added-up by means of a counter zriberh. If the number of Ri-calculations is greater than ANZRIBEH then a flip-flop B_rinh is set, which indicates to the heater diagnosis the state that the calculation of the internal resistance is active and up to date. ANZRIBEH = 3/ZFRIH is chosen.
As soon as the counter starts a retriggerable timer zrinh_w is triggered, whose timer time is chosen at TRIAKTH = 4*TRIMPH.
Once the timer has passed zrinh_w = 0 the flip-flop B_rinh is reset (resitance value rinh_w is not updated). If within the period TRIAKTV again current Ri-calculations are performed (B_ribeh =1), then this timer zrinh_w is continoosly started again so that the condition B_rinh is currently active.

Course of the ADC-sequence:

APP GGLSH 3.30 Application hint

SY_USOFF

The fixed value voltage difference between sensor ground and electronic ground can adjustable with a system constant SY_USOFF and it must be adjusted ECU-specific by the software.
Example: If the voltage between sensor grond and electronic ground is 0.268V the SY_USOFF must be adjusted to 0.268V.

Corresponding to the hardware design SY_USOFF becomes 0V; 0,268V or 0,714V.

Typical application values:

```
THSRIH   = 10 s
TUSBELH  = 60 ms
TRIIMPH  = 2 s
TRIAKTHH = 4*TRIMPH = 8 s
ZFRIH    = 0.3
ANZRIBEH = 3/ZFRIH = 10
RBEL     = 8.45 KOhm
RKSP     = 51 KOhm
RINHMX   = 100 KOhm
USRIOH   = 490 mV
USRIUH   = 410 mV
USRIMIN  = 60 mV
DUSRIH   = 25 mV
UBDLS    > 11 V
DUSSPH   = 200 mV
TGGLS    = 3 ms
FRINOF   = 1.5
CWGGLSH = 0   ————> Code word = 0 : Ri is only calculaded after end of dewpoint for full heating power (series)
                              = 1 : Ri can be measured as high-resistance for application during the phase of dewpoint

CWKONLS :  ————————>  Code word in % PROKON : Sensors present upstream of the catalyst  ——> Bank1: B_lsv by Bit  0 = 1
                                                                                             Bank2: B_lsv2 by Bit 4 = 16
                                                                                             (gives 17 as the sum)

                                              Sensors present downstream of the catalyst ——> Bank1: B_lsh by bit 1  = 2
                                                                                             Bank2: B_lsh2 by bit 5 = 32
                                                                                             (gives 34 as the sum)

                                              For all 4 installed seensors: CWKONLS = 51
```

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DLSV 36.10 Diagnosis; Readiness for operation of sensor upstream catalyst

FDEF DLSV 36.10 Function definition

MAIN: Overview of electric wiring faults diagnosis of the Lambda sensor

dlsv-main

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DLSV: diagnostic function

dlsv-dlsv

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ADDE: detection of short circuit or defective sensor with limited voltage amplitude

dlsv-adde

ZWGEFLR: counter value of mixture fault

dlsv-zwgeflr

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LSFET: detection of sensor voltage current leakage to battery voltage

dlsv-lsfet

WRBRKV: detection of wiring interruption or common lambda sensor ground open

dlsv-wrbrkv

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LSVN: generating of condition cold lambda senor and condition leakage resistance at cold lambda sensor

dlsv-lsvn

dlsv-lsvn

DFPM: fault path manager electrical diagnosis for lambda sensor upstream cat

E_lsv = 1 if B_mxlsv or B_siglsv or B_nplsv is set
E_lsv = 0 if B_nolsv is set

Z_lsv = 1 if B_nolsv or B_mxlsv or B_siglsv or B_nplsv is set

dlsv-dfpm

dlsv-dfpm

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DLSV2: diagnostic function bank 2

dlsv-dlsv2

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ADDE2: detection of short circuit or defective sensor with limited voltage amplitude bank 2

dlsv-adde2

ZWGEFLR2: counter value of mixture fault bank 2

dlsv-zwgeflr2

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LSFET2: detection of sensor voltage current leakage to battery voltage bank 2

dlsv-lsfet2

WRBRKV2: detection of wiring interruption or common lambda sensor ground open bank 2

dlsv-wrbrkv2

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LSVN: generating of condition cold lambda senor and condition leakage resistance at cold lambda sensor

dlsv-lsvn2

dlsv-lsvn2

BreakBank2: SY_STERVK system constant condition: stereo exhaust system upstream of cat

dlsv-breakbank2

dlsv-breakbank2

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DFPM2: fault path manager electrical diagnosis for lambda sensor upstream cat bank 2

E_lsv2 = 1 if B_mxlsv2 or B_siglsv2 or B_nplsv2 is set
E_lsv2 = 0 if B_nolsv2 is set

Z_lsv2 = 1 if B_nolsv2 or B_mxlsv2 or B_siglsv2 or B_nplsv2 is set

dlsv-dfpm2

dlsv-dfpm2

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FCMCLR: clear fault path

dlsv-fcmclr

BRKDLSV: condition of active diagnosis function; see codeword CDLSV

Bei B_cdlsv = 0 wird Funktion DLSV nicht gerechnet

dlsv-brkdlsv

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these informations directly from the fault path status managed in the DFPM.

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For each fault path "lsv" of this diagnosis function the following values are defined:

	Bank 1	Bank 2
Status fault path lsv:	sfplsv	sfplsv2
Error flag xyz:	E_lsv	E_lsv2
Cycle flag xyz:	Z_lsv	Z_lsv2
Fault type xyz:	TYP_lsv: (B_mxlsv, B_silsv,B_nplsv)	TYP_lsv2: (B_mxlsv2, B_silsv2,B_nplsv2)
Clear fault path:	B_cllsv	B_cllsv2
Default value active:	B_bklsv (optional)	B_bklsv2 (optional)
Fault path code lsv:	CDTlsv	CDTlsv2
Fault class lsv:	CLAlsv	CLAlsv2
Fault intensity lsv:	TSFlsv	TSFlsv2
CARB CODE lsv:	CDClsv	CDClsv2
Table of ambient cond. lsv:	FFTlsv	FFTlsv2

ABK DLSV 36.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ABGMSIGV			FW	threshold for exhaust temp. for wiring-interruption with Ri-diagnosis upstr. cat
ANZGEM			FW	number of mixture fault
CDKLSV2			FW	code word customer: lambda sensor downstream cat
CDTLSV2			FW	code word tester: lambda sensor 2 upstream catalyst [018]
CLALSV2			FW	fault class: O2 sensor bank 2 pre cat
DRISIGV			FW	diagnosis threshold for Ri sensor for signal disconnection pre cat
RISIGRESV			FW	threshold for reset wiring-interruption with Ri-diagnosis upstr. cat
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
TABGMCSD			FW (REF)	threshold for exhaust temperature for measuring CSD
TASIG			FW (REF)	Time for the deactiv.of interf. peaks outside of range for det.of signal interr.
TMASO			FW	time after fuel cut off for commen open sensor ground
TMNEB			FW	Engine temprerature threshold for measurement of sensor shunt pre cat
TMSV			FW	engine temp. threshold for recognition cold start for measuring sensor upstream
TMSVA			FW	threshold for engine switch-off temp. for measuring cooling sensor upstream cat
TNSTDN			FW	time after start for diagnosis shunt resistance fault (monoflop)
TRSA			FW	monitoring time closed-loop control (upstream CAT) -> sensor off
TRSE			FW (REF)	monitoring time -> closed-loop control on
TSFLSV2			FW	fault active time: lambda sensor catalyst upstream, bank 2
TTBMH			FW (REF)	period for theoretical operation readiness of sensor with heating
TUSDU			FW	time delay for detec. intercore short circ. and sensor with limit. volt. up.cat
TUSDUC			FW	delay time code for detec. wire-to-wire sh. circ. of the oxyg. sens. upstr. cat
TUSEINV			FW	Delay time for condition Lambda sensor ready bit
TUSFETT			FW	time delay for detec. current leakage to Ubatt upstream cat
TUSKS			FW (REF)	delay time for short circuit detection on the oxygen sensor
TUSMAX			FW (REF)	monitoring time for Usmax
UBDLS			FW (REF)	battery voltage threshold for release the sensor diagnosis
USDBO			FW	upper limit wire-to-wire detection and defective O2-sensor limited voltage range
USDBU			FW	lower limit wire-to-wire detection and defective O2-sensor limited voltage range
USFHK			FW	sensor voltage threshold for detection 'rich' downstream cat
USMASO			FW	sensor voltage threshold for commen open sensor ground
USMAX			FW (REF)	threshold for short circuit of sensor to Ubat
USMHK			FW	sensor voltage threshold for detection 'rich' downstream cat
USMIN			FW (REF)	threshold for short circuit of sensor to ground
USREF			FW	threshold for operation readiness of sensor at rich mixture (upstream CAT)
USREM			FW	threshold for operation readiness of sensor at lean mixture (upstream CAT)

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_ADCSD	DLSV	LOK	condition for test of short-circuit and CSD
B_ADCSD2	DLSV	LOK	condition for test of short-circuit and CSD bank2
B_ADDE	DLSV	LOK	condition short circuit or defective sensor with limited voltage amplitude
B_ADDE2	DLSV	LOK	condition short circuit or defective sensor bank2 with limited voltage amplitude
B_ADSVB	DLSV	LOK	prohibition operating readiness because of SC wire-to-wire
B_ADSVB2	DLSV	LOK	prohibition operating readiness because of SC wire-to-wire bank2
B_ATMTPA	ATM	EIN	condition temperature upstream catalyst exceeds dew-point
B_ATMTPA2	ATM	EIN	condition temperature upstream catalyst exceeds dew-point2
B_BELSV	DLSV	AUS	Condition: function request for elctr. diag. sensor voltage upstream cat
B_BELSV2	DLSV	AUS	Condition: function request for elctr. diag. sensor voltage upstream cat bank2
B_BKLSV	DLSV	AUS	Condition: lambda sensor upstream cat. active
B_BKLSV2	DLSV	AUS	Condition: lambda sensor upstream cat. active bank2
B_CDLSH	PROKON	EIN	function active per codeword CDLSH
B_CDLSV	PROKON	EIN	function active per codeword CDLSV
B_CLLSV		EIN	Delete fault path in DLSV.
B_CLLSV2		EIN	Delete fault path in DLSV. Bank2
B_DMASO	DLSV	LOK	condition common lamda sensor ground open "dynamic"
B_DMASO2	DLSV	LOK	condition common lambda sensor ground open "dynamic" bank2
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_DSVEN	DLSV	AUS	condition enable sensor diagnosis upstream catalyst
B_DSVEN2	DLSV	AUS	condition enable sensor diagnosis upstream catalyst bank2
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_ESLS	DSLSLR	EIN	Condition secondary air fault by wrong air mass flow
B_FTLSV	DLSV	AUS	Condition fault entry by tester for lambda sensor upstream cat
B_FTLSV2	DLSV	AUS	Condition fault entry by tester for lambda sensor upstream cat bank2

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Variable	Source	Type	Description
B_HSVE	HLS	EIN	condition for lambda sensor heating-switch upstream cat on
B_HSVE2	HLS	EIN	condition for lambda sensor2 heating-switch upstream cat on
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LSADS	DLSV	LOK	condition for lambda sensor upstream cat SC wire to wire
B_LSADS2	DLSV	LOK	condition for Lambda sensor upstream cat wire to wire bank2
B_LSFET	DLSV	LOK	condition for sensor voltage current leakage to UBatt upstream cat
B_LSFET2	DLSV	LOK	condition for sensor voltage current leakage to UBatt upstream cat bank2
B_LSHUB	DLSV	LOK	condition for lambda sensor upstream cat with restricted signal amplitude
B_LSHUB2	DLSV	LOK	condition for lambda sensor upstream cat with restricted sensor voltage bank 2
B_LSVKLT	DLSV	LOK	condition cold oxygen sensor upstream catalyst
B_LSVKLT2	DLSV	LOK	condition cold oxygen sensor upstream catalyst bank2
B_LSVN	DLSV	LOK	condition leakage resistance at cold oxygen sensor upstream catalyst
B_LSVN2	DLSV	LOK	Condition leakage resistance at cold sensor upstream catalyst
B_MASO	DLSV	LOK	condition common lamda sensor ground open
B_MASO2	DLSV	LOK	condition common lambda sensor ground open on bank 2
B_MAXFLSV	DLSV	LOK	Short circiut to battery voltage at O2 sensor pre cat
B_MAXFLSV2	DLSV	LOK	Short circiut to battery voltage at O2 sensor pre cat Bank 2
B_MNLSV	DLSV	AUS	Condition for fault type ”minimum value” upstream cat detected
B_MNLSV2	DLSV	AUS	Condition for fault type ”minimum value” upstream cat detected bank2
B_MXLSV	DLSV	AUS	Condition for fault type ”maximum value” upstream cat detected
B_MXLSV2	DLSV	AUS	Condition for fault type ”maximum value” upstream cat detected bank2
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_NOLSV	DLSV	LOK	Condition diagnosis finished with o.k. upstream cat report
B_NOLSV2	DLSV	LOK	Condition diagnosis finished with o.k. upstream cat report bank2
B_NPLFLSV	DLSV	LOK	Short circuit between cables at O2 sensor pre cat
B_NPLFLSV2	DLSV	LOK	Short circuit between cables at O2 sensor pre cat bank 2
B_NPLSV	DLSV	AUS	Condition fault type ”value not plausible” detected
B_NPLSV2	DLSV	AUS	Condition fault type ”value not plausible” detected bank2
B_PWF		EIN	Condition for powerfail
B_REFMAX	DLSV	LOK	Condition O2-sensor voltage in plausible area between USREF and USMAX,pre cat
B_REFMAX2	DLSV	LOK	Condition O2-sensor voltage in plausible area between USREF and USMAX ,bank2
B_RISIGV	DLSV	LOK	Condition signal disconnection of sensor ground with Ri-diagnosis
B_RISIGV2	DLSV	LOK	Condition signal disconnection of sensor ground with Ri-diagnosis, bank 2
B_SA	MDRED	EIN	Condition fuel cut-off
B_SBBVK	DLSV	AUS	condition for lambda sensor upstream cat ready for operation
B_SBBVK2	DLSV	AUS	condition oxygen sensor upstream cat. bank2 ready for operation
B_SIGFLSV	DLSV	LOK	Signal interruption at O2 sensor upstream cat
B_SIGFLSV2	DLSV	LOK	Signal interruption at O2 sensor upstream cat bank 2
B_SILSV	DLSV	AUS	condition for fault type 'signal missing' upstream cat detected
B_SILSV2	DLSV	AUS	condition for fault type 'signal missing' upstream cat detected bank2
B_SLS	SLS	EIN	Condition for active secondary air
B_ST	BBSTT	EIN	condition for start
B_TRSA	DLSV	LOK	Condition wiring interruption for sensor upsteam catalyst
B_TRSA2	DLSV	LOK	Condition wiring interruption for sensor downstream catalyst bank 2
B_TTBMH	DLSV	LOK	condition theoretical lambda sensor operation readyness with heating
B_TTBMH2	DLSV	LOK	condition theoretical lambda sensor operation readyness with heating bank2
B_UEINV	DLSV	LOK	Condition: preparation of setting the O2 sensor ready condition
B_UEINV2	DLSV	LOK	Condition: preparation of setting the O2 sensor ready condition bank 2
B_UVSIG	DLSV	LOK	Condition O2 sensor voltage pre cat in voltage band for signal interruption
B_UVSIG2	DLSV	LOK	Condition O2 sensor voltage pre cat in voltage band for signal interruption ba.2
B_VADGE	DLSV	LOK	condition suspect for short circuit or mixture failure
B_VADGE2	DLSV	LOK	condition suspect of short-circuit or mixture failure on bank 2
B_VGEFLR	DLSV	LOK	condition suspicion of mixture fault
B_VGEFLR2	DLSV	LOK	condition suspicion of mixture fault bank 2
DFP_LSV	DLSV	DOK	ECU int. fault path no.: electrical diagnosis for lambda sensor upstream cat.
DFP_LSV2	DLSV	DOK	ECU int. fault path no.: electr. diagnos. for lambda sensor upstream cat. bank 2
DFP_TES	DLSV	DOK	Internal error path number evap system monitoring, pcv Struck open
DFP_TEVE	DLSV	DOK	Internal fault path number: canister purge valve power stage
DFP_TM	DLSV	DOK	Internal fault path number: engine temperature
E_LSV	DLSV	AUS	error flag: lambda sensor upstream catalyst
E_LSV2	DLSV	AUS	error flag: lambda sensor upstream catalyst
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
LAMSONS2_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location
RINV2_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor 2, pre ca
RINV_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor,pre cat (word)
SFPLSV	DLSV	AUS	status fault path: diagnosis of lambda sensor upstream of catalyzer
SFPLSV2	DLSV	AUS	status fault path:
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TMOT	GGTFM	EIN	Engine temperature
TMOTAB	GGTFM	EIN	engine coolant temperature at engine stop or cut-off cranking
UB	GGUB	EIN	battery voltage
USHK2_W	GGLSH	EIN	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst 2
USHK_W	GGLSH	EIN	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst
USVK2_W	GGLSV	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst 2
USVK_W	GGLSV	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst
ZWGEFLR	DLSV	AUS	counter value of mixture fault

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Variable	Source	Type	Description
ZWGEFLR2	DLSV	AUS	counter value of mixture fault bank 2
Z_LSV	DLSV	AUS	cycle flag: lambda sensor upstream of catalyst
Z_LSV2	DLSV	AUS	cycle flag: 2nd lambda sensor upstream of catalyst

Abbreviations and terminology

CSD 'chemical shift down' lowered sensor characteristic line due to poisoning
ECU,SG Electronic control unit
SC,KS Short circuit

Abbreviations for cross coupling matrix:

Partial function sensor operating readiness - outputs: SB=sensor operating readiness

- Inputs: S/SB=block/sensor operating readiness

Partial function sensor diagnosis - Outputs: SD=sensor diagnosis
F/SD=flip-flop sensor diagnosis

- Inputs: S/SD=block/sensor diagnosis
B/SD=condition/sensor diagnosis

FB DLSV 36.10 Detailed description of function

Introduction:

The diagnosis function serves the purpose to detect all possible wiring faults of the Lambda sensor. Output signals are: the fault bit E_lsv, the cycle bit Z_lsv and the sensor operating readiness bit B_sbbvk.
The following fault types are transferred to the fault management logic: (B_maxflsv (KS_UBat), B_sigflsv (wiring interruption, sensor heating defective), B_nplflsv (wire-to-wire SC or O2 sensor with limited voltage amplitude). B_minflsv is not transferred since a short-circuit to electronic ground is tantamount to wire-to-wire SC.
These fault types are stored in a flip-flop in the permanent RAM and they are transferred to the fault memory as B_mxlsv (SC-UBat), B_mnlsv (0), B_silsv (wiring interruption); B_nplsv (wire-to-wire SC).
Generally, a transfer to the fault management can only take place (B_dsven = 1) if the dew point end B_atmtpa = 1 is exceeded and thus the sensor heating is switched on with B_hsve =1 and if a sensor-specific time TUSEINV has elapsed and hence was permanently switched on for at least the time TTBMH (that means especially not dutycycled). At the same time the battery voltage ub may not lie below the threshold UBDLS, lamsons_w must be equal to 1 and the exhaust gas temperature from the model must be less than the threshold TABGMCSD. With the bit B_cdlsv = 0 the entire diagnosis function DLSV is switched off.

Requirements for a properly working diagnosis function:

The described diagnosis and detection of operating readiness of the sensor can only be performed, if a potential-free sensor, a sensor evaluation circuit with reverse voltage source and a two-level Lambda control is used.
The function can only be used in combination with the function %HLS.

Operating readiness:

The internal resistance of the the cold sensor is very high so that the voltage of the sensor evaluation circuit always remains within a given range (independent of the mixture), determined by the reverse-voltage source (USREM < usvk_w < USREF).
With increasing sensor temperature, the internal resistance decreases and the sensor voltage dominates the reverse voltage source. Due to the steep sensor characteristic, the sensor voltage is always different to the reverse voltage, so that the voltage of the evaluation circuit leaves the range USREM < usvk_w < USREF. The operating readiness of the sensor is not only, like so far, switched on via the sensor parameters. Only once the time TUSEINV has elapsed the operating readiness can be detected, if the following applies permanently for at least the time t = TRSE to the voltage usvk:
USREF <= usvk_w <= USMAX or usvk <= USREM. During the time TUSEINV all interferences which cause an early turn-on are suppressed. Furthermore, the faults 'wire-to-wire SC' as well as 'defective sensor with limited voltage amplitude' (B_nplsv) may not exist in the lower lean turn-on range.

If the time TUSEINV is adjusted towards zero then a too early turn-on is prevented, like so far, by means of the current leak detection, if with a highly restrictive current leak to U_Bat or to ECU ground the Lambda control is erroneously activated (formation of B_lsvn see below: "+/- detection current leakage for cold sensor"). Readiness for operation can only be set, if either the sensor voltage is outside of the window USREM < usvk_w < USREF and there is no current leak or if the sensor has been heated for a sufficient time.
In this second case, operating readiness is only set if the sensor heating has been turned on for the time TTBMH without any interruption.
The operating readiness of the sensor is reset in case of all detected faults of the sensor upstream catalyst. In case of initialization (C_ini = 1) the operating readiness is generally reset.

Possible faults:

If the sensor heating has been turned on (B_hsve = 1) without any interruption for the time TTBMH, then it can be assumed that, with properly working sensor heating, the sensor has a low impedance (high impedance shunt does not affect sensor signal) and, theoretically, the sensor should therefore be ready for operation.
If the sensor voltage usvk remains within the voltage range USREM < usvk_w < USREF, the flip-flop B_uvsig is set. When leaving this voltage range this flip-flop B_uvsig is again reset. The reset is performed after a delay by the time TASIG.
If influence peaks (e.g. clocked heating), which lie outside the voltage range, take place on the sensor voltage in case of wiring interruption (sensor voltage within the range), then they are deactivated by the time TASIG and the flip-flop B_uvsig is not reset.
If the flip-flop B_uvsig remains set for longer than the time TRSAH (sensor voltage within the range), then a wiring interruption or a defective sensor heating is assumed. The fault (B_silsv) is reported.

In case of an interruption of the common sensor ground (sensor grounds of the individual sensors are, however, connected) an

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undefined sensor voltage in the plausible voltage range is obtained, so that a Lambda control is no longer possible. This interruption can be detected with warm sensor (the time TTMBH has elapsed) during fuel cut-off (B_sa = 1) after the time TMASO, if the sensor voltages usvk and ushk exceed the threshold value USMASO. After the interference suppression time TUSKS a flip-flop B_maso is set and the operating readiness B_sbbvk is switched off. The fault (B_silsvl) is set via the trigger B_dmaso. During the next trip B-sbbvk remains switched off and E_lsv is set in the fault management, since the B_nolsv cannot be reset via B_maso in the permanent RAM. Only during the next check in the fuel cut-off phase B_sa the fault "open sensor ground" is either confirmed again or reset in case of healing B_maso, if the sensor voltages usvk and ushk are less than USMASO for the time TMASO. By resetting B_maso, B_nolsv = 1 and thus the E_lsv is reset. The cycle flag Z-lsv is only then set again.
By means of B_dmaso it is prevented that the MIL lamp is triggered prior to the check "open sensor ground" during the 2. trip.

If the voltage of the evaluation circuit permanently exceeds the value USMAX for longer than the time TUSKS then there is a short circuit of the sensor signal lead to the supply voltage. The operation readiness B-sbbvk is reset after the time TUSKS. Once the time TUSMAX has elapsed the fault B_mxlsv is reported.

If the voltage of the evaluation circuit lies permanently longer than the time TUSFETT between the voltage range USREF <= usvk_w <= USMAX with defined low-resistance current leak 2...3 kOhm and with active control B_lr = 1, and if also the sensor voltage ushk downstream of catalyst lies below the threshold USMHK, then with not turned on Euro code bit (Euro version) B_cdlsh = 1, the flip-flop B_lsfet is set in the permanent RAM and the operation readiness B_sbbvk is reset. The fault B_nplsv is set.
Only once the sensor voltage usvk lies outside of the voltage range USREF <= usvk_w <= USMAX, is the flip-flop B_lsfet reset and the fault B_nplsv is cleared via B_nolsv = 1.

A defective sensor with limited voltage amplitude is indicated (B_lshup=1) if the evaluation voltage in case of B_adcsd=1 lies within the limits USDBU <= usvk < USDBO for the time TUSDU (without any interruption) and if in addition the sensor voltage downstream of catalyst (ushk_w) in the rich range lies above the threshold USFHK. The fault B_nplsv is set in the permanent RAM via the flip-flop B_lshub and via B_adde and the operation readiness B_sbbvk is reset.
In addition the setting of the operation readiness (B_sbbvk) is prevented in the lower lean turn-on range.
Only once the sensor voltage usvk leaves the window USDBU <= usvk_w < USDBO, this flip-flop is reset again.
In case of a defective sensor downstream catalyst it is not possible to detect a defective sensor upstream catalyst.
A simultaneously occurring fault of the upstream and downstream sensor is not assumed.

Generating a cold bit (B_lsvklt)

With sufficient cooling down of the exhaust system the sensor is cold, so that in case of start the evaluation voltage is determined by the reverse voltage. Such a start is definitely given, if during the starting procedure the engine temperature lies below the threshold TMSV and if in addition the engine was turned off at a temperature above TMSVA. Additionally no tmot-fault may exist.

If all above-mentioned conditions are fulfilled then the monoflop TNSTDN is triggered with the start bit.
The duration of the cold bit is determined with the adjustable time TNSTDN.

On the Euro version there is no sensor downstream catalyst. With the code word CDLSH = 0 (Euro version) the time TUSDU is switched to a marginally greater time TUSDUC, and checking of the threshold USFHK is set to "1" via an OR gate.
The time TUSDUC may not be chosen too high, since otherwise the mixture adaptation controller will deviate too much in case of a defective sensor.

With a short circuit between sensor signal and ground or with a defective fuel supply system (e.g. reduced system pressure, leakage), the sensor voltage upstream catalyst (usvk) lies around 0 Volt below the lean threshold USMIN.
In order to distinguish these two faults the evaluation is performed by means of 2 flip-flops in the Euro Version.

Detection of wire-to-wire SC with OBD II version:

If the sensor voltage upstream catalyst lies below the lean threshold USMIN and the sensor voltage downstream catalyst does not lie above the threshold USFHK with above-mentioned fault, then a mixture fault is assumed, that means the operating readiness of the sensor is not switched off and the mixture adaptation has a chance to compensate for this fault. If the mixture adaptation controller in the process reaches the limit then, consequently, this fault will be reported by the mixture adaptation.

A wire-to-wire SC between sensor signal and ground lead is detected, if the following applies:
The evaluation voltage for B_adcsd=1, i.e. for active Lambda control (B_lr =1) and switched off secondary air (B_sls = 0) and secondary air diagnosis (B_dsls = 0 or B_esls), as well as the "not set" error flags of the secondary air pump (E_slpe = 0; E_slp = 0), and the "not set" error flags of the canister purge control (E_tes = 0; E_teve = 0), lies below the limits of the threshold USMIN without interruption, while at the same time the sensor voltage downstream catalyst (ushk) remains in the rich area above the threshold USFHK for the time TUSDU. Via a flip-flop B_lsads in the permanent RAM and via B_adde the operating readiness upstream catalyst (B_sbbvk) is reset and in the lower lean turn-on band the setting of the operating readiness is prevented. The fault B_nplsv is set.
A wire-to-wire SC is also immediately detected, if during start with cold sensor (B_lsvklt = 1), the sensor voltage lies below the threshold USMIN. The flip-flop B_lsads in the permanent RAM is set and once the time TTBMH has elapsed the fault B_plaus is indicated. Only once the sensor voltage usvk lies above the threshold USMIN, this flip-flop is reset.
Thus an additional information on whether a mixture fault or a wire-to-wire SC is present can be obtained during the start with cold sensor.

Detection of wire-to-wire SC with Europe version:

On the Europe version the sensor downstream catalyst is not installed. With the code word CDLSH = 0 (Euro version) a switch from the time TUSDU to the marginally greater time TUSDUC is performed and the inquiry on the threshold USFHK is set to the value = 1 by means of an OR-gate.
A wire-to-wire SC during start with cold sensor (B_lsvklt = 1) is immediately detected, if the sensor voltage lies below the threshold USMIN.
In the process the sensor operating readiness is blocked via the flip-flop (B_lsads=1) and B_adde and the fault B_plaus is set once the time TTBMH has elapsed.
If the sensor voltage lies below the threshold USMIN for longer than the time TUSDUC without interruption, with active Lambda control (B_lr = 1) and switched off secondary air (B_sls = 0) and secondary air diagnosis (B_dsls = 0; B_esls), as well as with the "not set" error flags of the secondary air pump (E_slpe = 0; E_slp = 0) and the "not set" error flags of the canister purge control (E_tes = 0; E_teve = 0), then the flip-flop B_adsvb=1 is set in the permanent RAM, the operating readiness upstream catalyst (B_sbbvk) is reset via B_vadge and the setting of the operating readiness is prevented in the lower lean turn-on band.
Simultaneously the flip-flop B_vgeflr=1 is set in the permanent RAM.
At first the operating readiness is only blocked on suspicion and no fault is indicated, since it is not yet known whether there

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is a wire-to-wire SC or a mixture fault.
However, if during the next cold start (B_lsvklt=1) the sensor voltage of the cold sensor does not lie below ULSMIN, but at the reverse voltage 450 mV, then a mixture fault is assumed. The two flip-flops with B_adsvb and B_lsads are reset, however, the flip-flop in the permanent RAM with B_vgeflr remains set. The event counter zwgeflr is incremented by 1, by a delay of one operating step once the cold bit B_lsvklt=1 has elapsed. Thereafter the flip-flop B_vgeflr is reset after the delay of one operating step.
The given mixture fault is incremented by 1 after each cold start and the quantity is compared to ANZGEM. Once the quantity of measured mixture faults is reached, B_vadge=0 and thus the operating readiness B_sbbvk of the sensor is no longer reset.
For the mixture adaptation control %LRA it is now possible to correct the mixture fault. This mixture fault can then possibly be indicated via %DKVS.
For the healing (B_vgeflr is not set) the event counter is each time incremented by 1, if during cold start B_lsvklt=1 there is no mixture fault.

Early detection of current leakage with a cold sensor

A high impedance current leakage must be detected in order to:
- prevent a premature turn-on of the Lambda control (formation of B_lsvn)
- provide maximum heating current after start without interruption for high impedance current leakage.

A detected current leakage is stored in a permanent RAM, buffered with a flip-flop (current leakage => B_lsvn = 1).
It is set, if with a cold sensor (B_lsvklt=1), the voltage is outside the band USREF <= usvk_w <= USREM longer than for the debouncing time TUSKS. It is reset accordingly at a following cold start if the voltage is again within the window.
Operating readiness of the upstream sensor is only released if either no current leakage has been detected, or the sensor heating has been turned on for longer than TTBMH without interruption. In the second case, high impedance current leakage does not affect the sensor voltage.
The current leakage detection can be switched off during the emission test if the engine temperature threshold TMNEB is chosen > 50°C.
Thereafter only the turn-on delay TUSEINV has an effect, i.e. if the sensor voltage lies outside of the window USREF <=usvk <=USREM during this time, then no turn-on of the operating readiness takes place.
If TMNEB is chosen < 20°C then the current leakage detection is fully effective during the emission test, i.e. with detected current leakage the operation readiness B_sbbvk is turned on only once the time TTBMH has elapsed.

Fault healed:

If the sensor heating is permanently on for longer than the time TTBMH and if the operation readiness B_sbbvk is set, then, most likely, there is no fault.

Fault management:

From the three fault types the fault flag and the cycle flag is created. The cycle flag, however, is also set after each no-fault resp. healing-trigger and it is reset after each ECU initialization C_ini. If an error is detected as having been healed (B_nolsv = 1), then the fault flag is reset. By the fault management logic the CARB lamp is only triggered if after 2 trips the cycle flag and the fault flag are each set.

APP DLSV 36.10 Application hint

```
Guidance values:        TUSKS  : 100 ms
                        TNSTDN : 1 s
                        TRSE   : 200 ms
                        TRSA   : 5 s
                        TUSDU  : 10 s
                        TUSFETT: 10 s
                        TASIG  : 60 ms
                        TUSDUC : 20 s
                        TMASO  : 3 s
                        TUSMAX : 5 s
                        USFHK  : 500 mV
                        USMHK  : 100 mV
                        TTBMH  : 90 s
                        TMSPV  : 40 deg. C
                        TMSPVA : 60 deg. C
                        TABGMCSD: 800 deg. C
                        ANZGEM : 4
                        UBDLS  : 11 V

               TUSEINV : less than the turn-on time of the operation readiness by a factor of 0.7 if USREF or USREM
                         are exceeded resp. undershot (5 ...20s).
               TMNEB  : -->   > 50 °C: Current leakage detection is switched off. During the time TUSEINV a current
                                       leakage is suppressed. (Use on the planar sensor LSF4.7)
                        -->   < 20 °C: Current leakage detection is fully effective during the emission test, i.e. in case of a
                                       detected current leakage, the operation readiness is turned on only after the time TTBMH.
```

The voltage band is briefly summarized in the following diagram.

Practical numerical values are indicated

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DLSVV 3.30 diagnosis; detection of exchange lambda sensors upstream catalyst

FDEF DLSVV 3.30 Function definition

Bei Codewort CDLSVV = 0 (Abschaltung) gilt:

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Ersatzmassnahmen: Lambdaregelung sperren; Gemisch-Adaptionswerte neutral setzen, TEB auf Steuerung

Fehlerspeicherverwaltung:

Status Fehlerpfad :	SFPLSVV	Löschen Fehlerpfad:	C_fcmclr & B_cllsvv
Errorflag :	E_lsvv	Fehlerpfad :	CDTLSVV
Zyklusflag :	Z_lsvv	Fehlerklasse :	CLALSVV
Fehlerart :	B_nplsvv	Fehlerschwere :	TSFLSVV
		Carb-Code :	CDCLSVV
		Umweltbedingungen :	FFTLSVV

Lastenheftforderung für Umweltbedingungen: Motordrehzahl, Last, Motortemperatur

ABK DLSVV 3.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FRDO			FW	upper diagnostic threshold for lambda controller
FRDU			FW	lower diagnostic threshold for lambda controller
TDLSVV			FW	debouncing time for detection lambda sensor exchange
TDWLSVV			FW	waiting time for setting cycle-bit diagnostic lambda sensor exchange

Variable	Source	Type	Description
B_CLLSVV		EIN	condition clear fault path exchanged lambda sensors
B_ENWS	DNWS	EIN	condition error camshaft control
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LSVVSP	DLSVV	AUS	condition for exchange lambda sensor; lambda control stopped
B_NPLSVV	DLSVV	AUS	not plausible error: exchanged lambda sensors upstream cat
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_LSVV	DLSVV	AUS	error flag: exchanged lambda sensors upstream catalyst
FR2_W	LR	EIN	Lambda controller output (word)
FR_W	LR	EIN	Lambda controller output (word)
Z_LSVV	DLSVV	AUS	cycle flag: exchanged lambda sensors upstream of catalyst

FB DLSVV 3.30 Detailed description of function

Bei vertauschten Anschlußstecker der Lambdasonden vor Kat (Regelsonden) am Kabelbaum laufen die Lambdaregler nach Freigabe der Lambdaregelung B_lr/B_lr2 gegenläufig nach Anfetten bzw. Abmagrrn bis zu den Regelgrenzen FRMAX bzw. FRMIN. Überschreiten die Lambdaregler gegenläüfig die Erkennungsschwellwerte FRDO und FRDU wird ein Zeitzähler mit TDLSVV gestartet. Verweilen die Lambdaregler länger als TDLSVV über den Schwellwerten wird auf Fehler erkannt und die Bedingung B_lsvvsp gesetzt. B_lsvvsp = 1 sperrt in %LREB die Lambdaregelung.
Für den weiteren Motorlauf wird zusätzlich die Gemischadaption gesperrt, Adaptionswerte auf Neutralwert gesetzt und auf Tankentlüftungssteuerung geschaltet.
Fehlerheilung mit Freigabe der Lambdaregelung ist nur nach Motor-Neustart oder ’Löschen Fehlerspeicher’ möglich.
Nach Ablauf der Heilungszeit TDWLSVV und nicht vorliegendem Fehler, wird E_lsvv zurückgesetz bzw. kann das Zyklusflag gesetzt werden.
Der Zeitzähler für TDLSVV ist als Retriggerbarer Zähler realisiert, d.h. bei FRDU < fr < FRDO wird der Zeitzähler mit TDLSVV neu geladen. Der Zeitzähler TDWLSVV ist als Summenzähler dargestellt.

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APP DLSVV 3.30 Application hint

DLSH 29.10 Diagnosis; Readiness for operation of sensor downstream catalyst

FDEF DLSH 29.10 Function definition

dlsh-dlsh-en1

dlsh-dlsh-en1

enable conditions diagnostic lambda sensor downstream, bank1 (B_dshen)

dlsh-dlsh-en2

dlsh-dlsh-en2

enable conditions diagnostic bank2 (B_dshen2)

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Detection wire-to-wire)

With STEREO-control additionally the following labels apply for bank2: ushk2; B_lrhk2; B_sbbhk2; Z_lsh2; E_lsh2; B_dshen2; B_usrhk2; B_ueinh2; B_adsh2; B_adshs2; B_acsdh2; lamsons2_w; tkatm2; B_uhsig2; B_trsah2; B_falsh2, lamelsh2_w rinh2_w; B_atmpk2; B_hshe2;

Momenten-Reserve für Kurztriptest

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Wire-interruption of sensor ground (planar sensor)

Fault management for DLSH:

(Bank1)

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Fault types in the fault memory:

For code word CDLSH = 0 (B_cdlsh = 0) (switch-off:

For Mono with bit switch-over SY_STERHK = 0:

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these informations directly from the fault path status managed in the DFPM.

For each fault path "lsh" of this diagnosis the following values are defined:

	Bank 1	Bank 2
Status fault path lsh:	sfplsh	sfplsh2
Error flag lsh:	E_lsh	E_lsh2
Cycle flag lsh:	Z_lsh	Z_lsh2
Fault type lsh:	TYP_lsh: (B_mxlsh, B_silsh,B_nplsh)	TYP_lsh2: (B_mxlsh2, B_silsh2,B_nplsh2)
Clear fault path:	B_cllsh	B_cllsh2
Default value active:	B_bklsh (optional)	B_bklsh2 (optional)
Fault path code lsh:	CDTlsh	CDTlsh2
Fault class lsh:	CLAlsh	CLAlsh2
Fault intensity lsh:	TSFlsh	TSFlsh2
CARB CODE lsh:	CDClsh	CDClsh2
Table of ambient cond. lsh:	FFTlsh	FFTlsh2

ABK DLSH 29.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ABGMSIGH			FW	threshold for exh. temp. for wiring-interruption with Ri-diagnosis downstr. cat
CDCLSH	BLOKNR		KL	code word CARB: lambda sensor downstream catalyst
CDCLSH2	BLOKNR		KL	code word CARB: lambda sensor downstream catalyst
CDTLSH			FW	code word tester: lambda sensor downstream catalyst [012]
CDTLSH2			FW	code word tester: lambda sensor 2 downstream catalyst, cyl.row 2 [020]
CLALSH			FW	fault class: O2 sensor post cat
CLALSH2			FW	fault class:
DLAMELSH			FW	Delta Lamda setpoint for electrical sensor diagnosis downstr. catal. (quicktrip)
DMRLSH			FW	torque reserve for diagnosis lambdasensor downstream cat
DRISIGH			FW	diagnosis threshold for Ri sensor for signal disconnection post cat
FFTLSH	BLOKNR		KL	Table of ambient conditions Lambda sensor downstream catalyst
FFTLSH2	BLOKNR		KL	Table of ambient conditions Lambda sensor downstream catalyst bank 2

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Parameter	Source-X	Source-Y	Type	Description
PHLSNHMN			FW	Heating power for adequate sensor heating
RISIGRESH			FW	threshold for reset wiring-interruption with Ri-diagnosis downstr. cat
TABGMCSD			FW	threshold for exhaust temperature for measuring CSD
TASIG			FW	Time for the deactiv.of interf. peaks outside of range for det.of signal interr.
TKATMSHU			FW	catalyst temperature for adequate sensor heating
TRSAFA			FW	monitoring time closed-loop control (downstream CAT) funct. requ. for Short trip
TRSAH			FW	monitoring time closed-loop control (downstream CAT) -> sensor off
TRSE			FW	monitoring time -> closed-loop control on
TSFLSH			FW	fault active time: lambda sensor catalyst downstream
TSFLSH2			FW	fault active time: lambda sensor catalyst downstream, bank 2
TTBMH			FW	period for theoretical operation readiness of sensor with heating
TUSDUFA			FW	time delay for detec. interc. short circuit sens. downstr.(func. rec.short-trip)
TUSDUH			FW	time delay for detection intercore short circuit l. sensor downstr. cat.
TUSEINH			FW	Delay time for turn-on of readiness for operation by sensor downstream of cat.
TUSKS			FW	delay time for short circuit detection on the oxygen sensor
TUSMAX			FW	monitoring time for Usmax
TUSTAL			FW	Delay for detection'wire to wire connection' after 'empty fuel tank for O2 po.ct
UBDLS			FW	battery voltage threshold for release the sensor diagnosis
USMAX			FW	threshold for short circuit of sensor to Ubat
USMIN			FW	threshold for short circuit of sensor to ground
USREFH			FW	threshold for operation readiness of sensor downstream CAT at rich mixture
USREMH			FW	threshold for operation readiness of sensor downstream CAT at lean mixture

Variable	Source	Type	Description
B_ACSDH	DLSH	LOK	condition for test of short-circuit and CSD catalyst downstream
B_ACSDH2	DLSH	LOK	condition for test of short-circuit and CSD catalyst downstream bank 2
B_ADSH	DLSH	LOK	condition for short-circuit downstream sensor
B_ADSH2	DLSH	LOK	condition for short-circuit for downstream sensor bank 2
B_ADSHS	DLSH	LOK	condition for short-circuit "set" downstream sensor
B_ADSHS2	DLSH	LOK	condition for short-circuit "set" downstream sensor bank 2
B_ATMTPK	DLSH	LOK	condition temperature downstream catalyst exceeds dew-point
B_ATMTPK2	DLSH	LOK	condition temperature downstream catalyst exceeds dew-point2
B_CDLSH	PROKON	EIN	function active per codeword CDLSH
B_CLLSH		EIN	Clear fault path in DLSH
B_CLLSH2		EIN	Clear fault path in DLSH, bank 2
B_DSHEN	DLSH	LOK	condition enable sensor diagnosis downstream catalyst
B_DSHEN2	DLSH	LOK	condition enable sensor diagnosis downstream catalyst bank2
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_ESLS	DSLSLR	EIN	Condition secondary air fault by wrong air mass flow
B_FA		EIN	condition general function request
B_FALSH	DLSH	LOK	condition function request downstream oxygen sensor diagnosis
B_FALSH2		EIN	condition function request downstream oxygen sensor diagnosis bank2
B_HSHE	DLSH	LOK	condition for lambda sensor heating-switch downstream cat on
B_HSHE2	DLSH	LOK	condition for lambda sensor2 heating-switch downstream cat on
B_LOWRA	DLSH	LOK	condition gear box in low range
B_LRHK	LRHK	EIN	condition for lambda closed loop control downstream cat
B_LRHK2	LRHK	EIN	condition for lambda closed loop control downstream cat (bank 2)
B_MAXFLSH	DLSH	LOK	Short-circuit to UBatt on sensor downstream catalyst detected
B_MAXFLSH2	DLSH	LOK	Short-circuit to UBatt on sensor downstream catalyst detected, bank 2
B_MXLSH	DLSH	AUS	Condition for fault type "maximum value" downstream cat detected
B_MXLSH2	DLSH	AUS	Condition for fault type "maximum value" downstream cat detected bank2
B_NMOT	DLSH	LOK	condition engine speed: n > NMIN
B_NOLSH	DLSH	AUS	Condition diagnosis finished with o.k. downstream cat report
B_NOLSH2	DLSH	AUS	Condition diagnosis finished with o.k. downstream cat report bank2
B_NPLFLSH	DLSH	LOK	Wire-to-wire SC on sensor downstream catalyst detected
B_NPLFLSH2	DLSH	AUS	Wire-to-wire SC on sensor downstream catalyst detected bank 2
B_RISIGH	DLSH	LOK	Condition signal disconnection of sensor ground with Ri-diagnosis, post cat
B_RISIGH2	DLSH	LOK	Condition signal disconnection of sensor ground with Ri-diagnosis post cat Bank2
B_SBBHK	DLSH	AUS	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	AUS	condition for lambda sensor downstream cat ready for operation bank2
B_SIGFLSH	DLSH	LOK	Signal interruption (wiring interruption) on sensor downstream catalyst detectet
B_SIGFLSH2	DLSH	LOK	Signal interruption (wiring interruption) on sensor downstr.cat.detectet bank 2
B_SILSH	DLSH	AUS	condition for fault type 'signal missing' downstream cat detected
B_SILSH2	DLSH	AUS	condition for fault type 'signal missing' downstream cat detected bank2
B_SLS	SLS	EIN	Condition for active secondary air
B_STERHK		EIN	condition Stereo Lambda control behind catalyst
B_TAL	GGFSTT	EIN	Condition tank empty or reserve
B_TALVAL	GGFSTT	EIN	condition ; bit empty tank valid
B_TRSAH	DLSH	LOK	Condition wiring interruption for sensor downstream catalyst
B_TRSAH2	DLSH	LOK	Condition wiring interruption for sensor downstream catalyst, bank 2
B_TTBMHH	DLSH	LOK	cond. theoretical lambda sensor operation readyness downstr. cat with heating
B_TTBMHH2	DLSH	LOK	cond. theoretical lambda sens. operat. readyness downstr. cat with heating bank2
B_UEINH	DLSH	AUS	Cond.: Prepar. to turn on the sensor readiness for operation downstream of cat.
B_UEINH2	DLSH	AUS	Cond.: Prepar. to turn on the sensor readiness for operat. downstr. of cat.Bank2
B_UHSIG	DLSH	LOK	Con.sensor voltage downstr.cat.in the voltage range for signal interrupt.
B_UHSIG2	DLSH	LOK	Con.sensor voltage downstr.cat.in the voltage range for signal interrupt., bank2
C_FCMCLR		EIN	system state: reset fault memory
C_INI	DLSH	LOK	ECU-condition for intialisation
DMRLSH_W	DLSH	AUS	torque reserve for lambda sensor diagnosis downstream cat
E_LSH	DLSH	AUS	error flag: lambda sensor downstream cat

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Variable	Source	Type	Description
E_LSH2	DLSH	AUS	Errorflag: Lambda-Sensor downstream bank2
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
LAMELSH2_W	DLSH	AUS	desired lambda for electrical sensor diagnosis behind catalyst (short trip)
LAMELSH_W	DLSH	AUS	desired lambda for electrical sensor diagnosis behind catalyst (short trip)
LAMSONS2_W	DLSH	LOK	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	DLSH	LOK	required lambda referred to lambda sensor fitting location
PHLSNH	DLSH	LOK	Standardized heating power of the Lambda sensor downstream of the catalyzer
PHLSNH2	DLSH	LOK	Standardized heating power of the Lambda sensor 2 downstream of the catalyzer
RINH2_W	GGLSH	EIN	Act. value (word) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH_W	GGLSH	EIN	Actual value (word) internal res. Ri-Nernst cell lambda sensor downstream cat
SFPLSH	DLSH	AUS	status fault path:
SFPLSH2	DLSH	AUS	status fault path:
TKATM	DLSH	LOK	catalyst temperature (model)
TKATM2	DLSH	LOK	catalyst temperature (model), bank2
TYP_LSH	DLSH	AUS	Fault type: lambda sensor 1 downstream
TYP_LSH2	DLSH	AUS	Fault type: lambda sensor 2 downstream
UB	DLSH	LOK	battery voltage
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
Z_LSH	DLSH	AUS	cycle-flag: lambda sensor downstream cat
Z_LSH2	DLSH	AUS	cycle-Flag: Lambda-sensor downstream cat bank2

Abbreviations and terminology

```
CSD             'chemical shift down' lowered sensor characteristic line due to poisoning
ECU,SG          Electronic Control Unit
SC,KS           Short-circuit
```

Abbreviations for cross coupling matrix:

```
Partial function sensor operating readiness - outputs: SB=sensor operating readiness

                                            - inputs: S/SB=block/sensor operating readiness

Partial function sensor diagnosis           - outputs: SD=sensor diagnosis

                                            - inputs: S/SD=block/sensor diagnosis
                                                      B/SD=condition/sensor diagnosis
                                                      F/SD=flip-flop/sensor diagnosis
```

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FB DLSH 29.10 Detailed description of function

Introduction:

The diagnostic function must detect all electrical connection faults of the lambda sensor. Output signals are the fault bit E_lsh, the cycle bit Z_lsh and the bit for sensor operation readiness B_sbbhk.

The fault types, B_maxflsh (KS_UBat), B_sigflsh (wiring interruption, sensor heating defective), B_nplflsh (wire-to-wire SC) and a signal for fault healing (B_nolsh) are passed to the fault management logic.
These fault types are stored in a flip-flop in the permanent RAM and they are transferred to the fault memory as B_mxlsh (SC-UBat), B_silsh (wiring interruption); B_nplsh (wire-to-wire SC).
Generally, a transfer to the fault management can only take place (B_dshen = 1) if the dew point end downstream catalyst B_atmtpk = 1 is exceeded and thus the sensor heating is switched on with B_hshe =1 and if a sensor-specific time TUSEINH has elapsed and hence was permanently switched on for at least the time TTBMH (that means especially not dutycycled). At the same time the battery voltage ub may not lie above the threshold UBDLS, lamsons_w must be equal to 1 and the exhaust gas temperature from the model must be less than the threshold TABGMCSD and B_nmot mußt be equal to 1 (nmot < NMIN).
With the bit B_cdlsh = 0 the entire diagnostic function %DLSH is switched off. With the bit SY_STERHK = 0 a switch-over from Stereo to Mono can be performed.

Preconditions for the diagnostic function

The diagnosis and the detection of sensor readiness for operation can only be carried out in this form, if a potential-free sensor and a sensor evaluation circuit with a reverse voltage source are used.
The function can only be used in conjunction with the function %HLS.

Operation readiness:

The internal resistance of the cold sensor is very high so that the voltage of the sensor evaluation circuit always remains within a given range (independent of the mixture), determined by the reverse-voltage source (USREMH < ushk < USREFH).
With increasing sensor temperature, the internal resistance decreases and the sensor voltage dominates the reverse voltage source. Due to the steep sensor characteristic, the sensor voltage is always different to the reverse voltage, so that the voltage of the evaluation circuit leaves the range USREMH < ushk < USREFH. The operating readiness of the sensor is not only, like so far, switched on via the sensor parameters. Only once the time TUSEINH has elapsed the operating readiness can be detected, if the following applies permanently for at least the time t = TRSE to the voltage ushk:
USREFH <= ushk <= USMAX or ushk <= USREMH. During the time TUSEINH all interferences which cause an early turn-on are suppressed. Furthermore, the fault 'wire-to-wire SC' (B_nplsh) may not exist in the lower turn-on range.
If the sensor heating has been turned on without any interruption for at least the time TTBMH (B_ueinh=1), then it can be assumed that, with properly working sensor heating, the sensor has a low impedance (high impedance shunt does not affect sensor signal) and, theoretically, the sensor should therefore be ready for operation. If the sensor voltage then is still within the voltage range USREMH < ushk < USREFH without interruption for longer than the time TRSAH, then a wiring interruption or a defective sensor heating is assumed (B_silsh).
The operation readiness B_sbbhk is reset for all detected faults of the sensor downstream catalyst. The operation readiness is generally reset for initialization (C_ini = 1).
As long as the sensor is cold, neither a fault is present nor is the sensor ready for operation.

Possible faults:

If the sensor voltage ushk remains within the voltage range USREMH < ushk < USREFH, the flip-flop B_uhsig is set. When leaving this voltage range this flip-flop B_uhsig is again reset. The reset is performed after a delay by the time TASIG.
If influence peaks (e.g. clocked heating), which lie outside the voltage range, take place on the sensor voltage in case of wiring interruption (sensor voltage within the range), then they are deactivated by the time TASIG and the flip-flop B_uhsig is not reset. If the flip-flop B_uhsig remains set for longer than the time TRSAH (sensor voltage within the range), then a wiring interruption or a defective sensor heating is assumed. The fault B_silsh is reported.

If the voltage of the evaluation circuit is permanently above the value USMAX for longer than the time TUSKS, then there is a SC of the sensor signal wire to UBatt. The fault B_mxlsh is reported.
The fault detection delayed by the time TUSKS serves as a safeguard against interferences.

There is a wire-to-wire SC between sensor signal and ground lead, if the following applies:
The evaluation voltage for B_acsdh = 1, i.e. for active Lambda control (B_lrhk = 1) and switched off secondary air (B_sls = 0) and secondary air diagnosis (B_dsls = 0 ; B_dtes = 0 and B_esls = 0), as well as the "not set" error flag of the secondary air pump (E_slpe = 0), and the "not set" error flags of the canister purge control (E_tes = 0; E_teve = 0), lies below the threshold USMIN without interruption for longer than the time TUSDUH.
The fault B_nplsh is set by the flip-flop B_adsh in the permanent RAM. If a wire-to-wire SC is still present at the following start, then the closed-loop Lambda control is prohibited in the lower lean turn-on range by the stored fault. The flip-flop is only reset once the sensor voltage ushk is above the threshold USMIN.
If a wire-to-wire SC is already present during a start, then the threshold USREMH is undershot and the operating readiness B_sbbhk is set, so that B_lrhk can become active. Thus it is ensured that a wire-to-wire SC can be detected during start.
A defective sensor with lowered sensor characteristic (CDS) is detected in %DLSAHK.
The fault B_mnflsh is set to 0.

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Short trip test (function is requested by a tester)

In case a tester is connected (B_fa = 1) the diagnostic function "DLSH" is blocked until the specific request (B_falsh = 1) is made. For this function request the large times TRSAH and TUSDUH are switched to markedly smaller times TRSAFA and TUSDUFA, so that a short trip test becomes possible. In order to detect a wire-to-wire SC the control readiness B_lrhk of the downstream controller is set to the value 1 by B_falsh = 1.
So that the sensor voltage ushk downstream catalyst lies outside the checked voltage bands (throughput of the catalyst is low due to low load) an enrichment by DLAMELSH is performed by B_falsh = 1 in %LAMKO.
The sensor voltage downstream catalyst ushk is then definitely above 500 mV, so that all possible faults (wiring interruption and wire-to-wire SC) can be checked.
If ushk lies above the threshold USFHK, then a wire-to-wire SC test is also possible upstream of catalyst in %DLSV.

No fault, fault healed:

If the sensor heating was permanently switched on for longer than the time TTBMH and if the operating readiness B_sbbhk is set and if the sensor voltage ushk lies above the control threshold usrhk (B_usrhk = 0), then it is very likely that there is no fault. A trigger B_nolsh is sent to the fault management.

Fault management:

From the three fault types the error flag and the cycle flag are created. The cycle flag, however, is also set after each no-fault resp. healing-trigger and it is reset after each ECU initialization C_ini. If an error is detected as having been healed (B_nolsh), then the error flag is reset. By the fault management logic the CARB lamp is only triggered if after 2 trips the cycle flag and the error flag are each set.

APP DLSH 29.10 Application hint

Useful application values:

```
TUSKS  : 100 ms
TRSE   : 200 ms
TRSAH  : 600 s
TUSDUH :  80 s (duration must be chosen a little shorter than the longest uninterrupted active control
                 readiness B_lrhk in the FTP75 test)
TUSDUFA:  50 s
TRSAFA :  50 s
TTBMH  :  90 s (time 10s longer than injection secondary air pump)
TUSEINH : 5 ..20 s dependent on sensor type (smaller than switch-on time in the HT test in the FTP75 by a fact. 0.7)
TASIG  :  60 ms
UBDLS  :  11 V
TABGMCSD: 700° C
DLAMELSH: 0.05 dependent on catalyst size
```

In the following diagram the voltage values, which are to be adjusted are entered.

```
                ^                                                  ^
     ushk       |                                                  |   U_ADC        U_Sonde
                |  SC to U_Bat
USMAX           |-------------------------------------------------|  = 1.50  V      1.50   V
                |  Release of operation readiness
                |  after t > TRSE (=200ms)                         |  = 0.600 V      0.600  V - Control thresh. KFUSRHK
USREFH          |-------------------------------------------------|  = 0.500 V      0.500  V
                |  Signal interruption  or sensor cold
                |  (sensor heating defective)  after t > TRSAH (=600s)
USREMH          |-------------------------------------------------|  = 0.400 V      0.400  V
                |  release of operation readiness after
                |  t > TRSE (=200ms)
USMIN           |-------------------------------------------------|  = 0.060 V      0.060  V
                |  wire-to-wire SC, if t > TUSDUH (=40 s)          |
```

DLSA 51.10 Lambda sensor aging monitoring

FDEF DLSA 51.10 Function definition

Function definition of the Lambda sensor aging monitoring

The diagnosis of Lambda sensor aging DLSA serves for detection of upstream lambda sensors, which inadmissibly exceed the emission limits because of aging effects.
For detection of a shifted upstream sensor characteristic the correction factor atv of the superimposed I-controller is used.
This I-controller ensures (for the two-sensor-control) that by means of the controller delay time TV a lawful emission behaviour is obtained, even in case of a sensor characteristic shift.
For detection of an upstream sensor, which is too slow, cycle duration monitoring of the sensor signal is applied.

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Overview: "Two Sensor Control and Lambda Sensor Aging Monitoring Upstream Catalyst"

Abbreviations in the block diagram, as far as they are not defined in %DLSA:

atv = regulated variable of the integrator for the reference controller; B_lr = condition flag for the lambda closed loop control
B_lrhk = condition flag for the downstream lambda control; F_sgnlr = flag, for usvk RICH or LEAN
fr = control factor; ushk = voltage of downstream sensor; usvk = voltage of upstream sensor; USR = control threshold

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these informations directly from the fault path status managed in the DFPM.

For each fault path "wxyz" of this diagnosis function the following values are defined:

```
        Status fault path wxyz:                sfpwxyz
              Error flag wxyz:                 E_wxyz
              Cycle flag wxyz:                 Z_wxyz
              Fault type  wxyz:                TYP_wxyz: (B_mxwxyz, B_mnwxyz)
              Clear fault path:                B_clwxyz
              Default value active:            B_bkwxyz  (optional)
          Fault path code wxyz:             CDTwxyz
          Fault class wxyz:                 CLAwxyz
          Fault intensity wxyz:             TSFwxyz
          CARB CODE wxyz:                   CDCwxyz
          Table of ambient cond. wxyz:      FFTwxyz
```

In this FDEF the following fault paths wxyz are treated:

```
        Fault path name                 used abbreviation (substitutes "wxyz")

        Lambda sensor upstream CAT cycle duration monitoring bank 1     latp
        Lambda sensor upstream CAT cycle duration monitoring bank 2     latp2

        Lambda sensor upstream CAT atv monitoring bank 1            latv
        Lambda sensor upstream CAT atv monitoring bank 2            latv2
```

DLSA-SVK atv monitoring (bank1)

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DLSA-SVK atv monitoring (bank2)

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(Bank2)

For B_cdlatv = 0 (switch-off) :

For Mono with bit switch-over SY_STERHK = 0:

DLSA-SVK monitoring of cycle duration
==========

Codewort CWDLSA:
Bit 2: 0 ——> cycle duration tplrvk_w with tv-value
1 ——> cycle duration tpotv_w without tv-value

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The filters tpsvkmf_w and tpsvkmf2_w are event-controlled.

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Release function for cycle duration monitoring with short trip

For B_cdlatp = 0 (switch-off):

For Mono with bit switch-over SY_STERVK = 0:

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switch off condition for DLSA

ABK DLSA 51.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZDPVK			FW	number of periodes for ready flag of Usvk period monitoring
ANZTP			FW	number of unconsidered cycles for cycle duration monitoring
CDCLATP	BLOKNR		KL	code word CARB: lambda sensor aging tp
CDCLATP2	BLOKNR		KL	code word lamp: lambda sensor aging tp, cyl.row 2
CDCLATV	BLOKNR		KL	code word CARB: lambda sensor aging tv
CDCLATV2	BLOKNR		KL	code word CARB: lambda sensor aging tv, cyl.row 2
CDLATP			FW	code word oxgen sensor aging diagnosis (TP) in OBDII mode (inv.: in Europe mode)
CDLATV			FW	code word lambda sensor monitoring (Tv) in OBDII mode (invers: Europe mode
CDTLATP			FW	code word tester: lambda sensor aging tp [015]
CDTLATP2			FW	code word tester: lambda sensor aging tp, cyl.row 2 [021]
CDTLATV			FW	code word tester: lambda sensor aging tv [016]
CDTLATV2			FW	code word tester: lambda sensor aging tv, cyl.row 2 [022]
CLALATP			FW	fault class: O2 sensor aging pre cat TP
CLALATP2			FW	fault class:
CLALATV			FW	fault class: O2 sensor aging pre cat Tv
CLALATV2			FW	fault class:
FFTLATP	BLOKNR		KL	Table ambient conditions Lambda sensor aging Tp upstream catalyst
FFTLATP2	BLOKNR		KL	Table ambient conditions Lambda sensor aging Tp upstream catalyst bank2
FFTLATV	BLOKNR		KL	Table ambient conditions Lambda sensor aging Tv upstream catalyst
FFTLATV2	BLOKNR		KL	Table ambient conditions Lambda sensor aging Tv upstream catalyst bank2
KFTPKOR	NMOT	RL	KF	correction map for the measured cycle duration TP (tpsvkof)
NTPKTO			FW	upper speed threshold for cycle duration monitoring, short test
NTPKTU			FW	lower speed threshold for cycle duration monitoring, short test
NTPVKO			FW	upper speed threshold for cycle duration monitoring upstream catalyst
NTPVKU			FW	lower speed threshold for cycle duration monitoring upstream catalyst
RLTPKTO			FW	upper load threshold for cycle duration monitoring, short test
RLTPKTU			FW	lower load threshold for cycle duration monitoring, short test
RLTPVKO			FW	upper load threshold for cycle duration monitoring upstream catalyst
RLTPVKU			FW	lower load threshold for cycle duration monitoring upstream catalyst
TKTPVK			FW	exhaust gas temperature (from ATM) for TP monitoring lambda sensor before KAT
TSFLATP			FW	fault active time: lamda sensor ageing time period
TSFLATP2			FW	fault active time: lambda sensor ageing time period, bank 2
TSFLATV			FW	fault active time: lambda sensor aging TV
TSFLATV2			FW	fault active time: lambda sensor ageing TV, bank 2
TSTEAA			FW	inhibit time after condition B_te (canister purge active)
TSVKKO			FW	upper limit of cycle duration of lambda sensor upstream cat at cat fault
TSVKKTO			FW	upper limit for cycle duration of oxygen sensor upstream, short test
TSVKKTU			FW	lower limit for cycle duration of oxygen sensor upstream, short test
TSVKKU			FW	lower limit of cycle duration of lambda sensor upstream cat at cat fault
TSVKO			FW	upper limit for cycle duration of lambda sensor upstream cat
TSVKU			FW	lower limit for cycle duration of lambda sensor upstream cat
TVLRHMN			FW	lower limit for tv-correction
TVLRHMN2			FW	lower limit for tv-correction unequal parameter bank2

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Parameter	Source-X	Source-Y	Type	Description
TVLRHMX			FW	upper limit for tv-correction
TVLRHMX2			FW	upper limit for tv-correction unequal parameter bank2
TWDDTV			FW	delay time for readyness flag delta-TV diagnosis
ZFTSVK			FW	time constant for filter cycle duration of sensor upstream catalyst

Variable	Source	Type	Description
ATV	LRHK	EIN	current integrator value of lambda control downstream cat
ATV2	LRHK	EIN	current integrator value of lambda control downstream cat 2
B_CDLATP	PROKON	EIN	function active per codeword CDLATP
B_CDLATV	PROKON	EIN	function active per codeword CDLATV
B_CLLATP		EIN	Clear fault path in DLSA.
B_CLLATP2		EIN	Clear fault path in DLSA. Bank2
B_CLLATV		EIN	Clear fault path in DLSA.
B_CLLATV2		EIN	Clear fault path in DLSA. Bank2
B_DLAFF	DLSA	LOK	Number of valid Tp measurements reached since B_dlatp=1
B_DLAFF2	DLSA	LOK	Number of valid Tp measurements reached since B_dlatp2=1 bank2
B_DLATP	DLSA	AUS	condition for active diagnosis: lambda sensor aging TP
B_DLATP2	DLSA	AUS	condition for active diagnosis: lambda sensor aging TP (cylinder row 2)
B_DLATV	DLSA	AUS	condition for active diagnosis of lambda sensor aging TV
B_DLATV2	DLSA	AUS	condition for active diagnosis of lambda sensor aging TV (cylinder row 2)
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_DTEST		EIN	condition for start of TEV opening
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_ENWS	DNWS	EIN	condition error camshaft control
B_FA		EIN	condition general function request
B_FATP		EIN	condition diagnosis oxygen sensor aging TP function request
B_FATP2		EIN	condition diagnosis oxygen sensor aging TP function request bank2
B_FATV		EIN	condition diagnosis oxygen sensor aging TV function request
B_FATV2		EIN	condition diagnosis oxygen sensor aging TV function request bank2
B_GASP	LRAEB	EIN	condition for basic mixture adaptation disabled
B_GASP2		EIN	condition for basic mixture adaptation disabled, bank2
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRHK	LRHK	EIN	condition for lambda closed loop control downstream cat
B_LRHK2	LRHK	EIN	condition for lambda closed loop control downstream cat (bank 2)
B_LRTPP	LR	EIN	Periodic time valid, static cond. for %LR (amplitude/periodic time) = TRUE
B_LRTPP2	LR	EIN	static condition for lambda controller (amplitude/periodic time) bank2
B_LSASTP	DLSA	LOK	flag for general disabling conditions for DLSA
B_LSASTP2	DLSA	LOK	flag for general disabling conditions for DLSA bank2
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_MNLATP	DLSA	AUS	Condition for fault type ”minimum value” of cycle duration upstream cat detected
B_MNLATP2	DLSA	AUS	Condition for fault type ”min. value” of cycle duration upstr. cat detec. bank2
B_MNLATV	DLSA	AUS	Condition for fault type ”minimum value” for ATV-test upstream cat detected
B_MNLATV2	DLSA	AUS	Condition for fault type ”minimum value” for ATV-test upstr. cat detected bank2
B_MXLATP	DLSA	AUS	Condition for fault type ”maximum value” for cycle duration upstr. cat detected
B_MXLATP2	DLSA	AUS	Condition for fault type ”max.value” for cycle duration upstr. cat detec. bank2
B_MXLATV	DLSA	AUS	Condition for fault type ”maximum value” for ATV-test upstream cat detected
B_MXLATV2	DLSA	AUS	Condition for fault type ”maximum value” for ATV-test upstr. cat detected bank2
B_NOLATP	DLSA	LOK	Condition diagnosis cycle duration finished with o.k. report
B_NOLATP2	DLSA	LOK	Condition diagnosis cycle duration finished with o.k. report bank2
B_NOLATV	DLSA	LOK	Condition diagnosis atv-test finished with o.k. report
B_NOLATV2	DLSA	LOK	Condition diagnosis atv-test finished with o.k. report bank2
B_TE	TEBEB	EIN	Condition canister purge active
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
E_AGRE		EIN	error flag: EGR power stage monitoring
E_AGRF		EIN	error flag: EGR flow monitoring
E_HSH	DHLS	EIN	error flag: lambda sensor heating downstream cat
E_HSH2	DHLS	EIN	error flag: lambda sensor heating downstream cat on the right
E_HSV	DHLS	EIN	error flag: lambda sensor heating upstream cat
E_HSV2	DHLS	EIN	error flag: lambda sensor heating upstream cat on the right
E_KAT	DKAT	EIN	error flag: catalyst conversion
E_KAT2	DKAT	EIN	error flag: catalyst conversion (cylinder row 2)
E_LATP	DLSA	AUS	error flag: lambda sensor aging tp
E_LATP2	DLSA	AUS	error flag: lambda sensor aging tp (cylinder row 2)
E_LATV	DLSA	AUS	error flag: lambda sensor aging tv
E_LATV2	DLSA	AUS	error flag: lambda sensor aging tv (cylinder row 2)
E_LM	DHFM	EIN	Error flag: main load sensor
E_PH	DPH	EIN	error flag: phase sensor
E_TA	GGTFA	EIN	error flag: TANS
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_UB	GGUB	EIN	error flag: power supply voltage UB
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
SFPLATP	DLSA	AUS	status fault path:
SFPLATP2	DLSA	AUS	status fault path:

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Variable	Source	Type	Description
SFPLATV	DLSA	AUS	status fault path:
SFPLATV2	DLSA	AUS	status fault path:
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERSY	PROKON	EIN	system constant condition stereo lambda control symmetrical
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TFRN2_W		EIN	time duration lambda controller negativ slope, bank 2
TFRN_W		EIN	time duration lambda controller negativ slope
TFRP2_W		EIN	time duration lambda controller positiv slope, bank 2
TFRP_W		EIN	time duration lambda controller positiv slope
TPLRVK2_W	LR	EIN	cycle duration of sensor upstream cat, calculated by %LR, bank 2
TPLRVK_W	LR	EIN	cycle duration of sensor upstream cat, calculated by %LR
TPOTV2_W	DLSA	LOK	cycle duration of sensor upstream cat, without tv-value bank2
TPOTV_W	DLSA	LOK	cycle duration of sensor upstream cat, without tv-value
TPSVKMF2_W	DLSA	AUS	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (word)
TPSVKMF_W	DLSA	AUS	filtered cycle duration of sensor signal upstream cat. (word)
TPSVKOF2_W	DLSA	LOK	measured cycle duration of sensor upstream cat, without filter, cylinder row 2
TPSVKOF_W	DLSA	LOK	measured cycle duration of sensor upstream cat, without filter
TYP_LATP	DLSA	LOK	Fault type: lambda sensor aging Tp upstream
TYP_LATP2	DLSA	LOK	Fault type: lambda sensor aging Tp upstream bank2
TYP_LATV	DLSA	LOK	Fault type: lambda sensor aging Tv upstream
TYP_LATV2	DLSA	LOK	Fault type: lambda sensor aging Tv upstream bank2
TZLSATV	DLSA	LOK	present time counter value for ready flag of atv-monitoring
TZLSATV2	DLSA	LOK	present time counter value for ready flag of atv-monitoring, cylinder row 2
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USRHK	LRHK	EIN	momentary control threshold for downstream lambda control
USRHK2	LRHK	EIN	momentary control threshold for downstream lambda control, bank2
ZLSATP	DLSA	LOK	present cycle counter for ready flag of cycle duration monitoring
ZLSATP2	DLSA	LOK	present cycle counter for ready flag of cycle duration monitoring, cylinder row2
ZWPVK	DLSA	LOK	waiting cycle counter for cycle duration monitoring
Z_HSV	DHLS	EIN	cycle flag of lambda sensor heating upstream cat
Z_HSV2	DHLS	EIN	cycle flag of lambda sensor heating upstream cat, cylinder row 2
Z_LATP	DLSA	AUS	cycle flag of lambda sensor aging tp
Z_LATP2	DLSA	AUS	cycle flag of lambda sensor aging tp (cylinder row 2)
Z_LATV	DLSA	AUS	cycle flag of lambda sensor aging tv
Z_LATV2	DLSA	AUS	cycle flag of lambda sensor aging tv (cylinder row 2)

FB DLSA 51.10 Detailed description of function

1. DLSA TV monitoring of the upstream Lambda sensor

The definition of the function "Monitoring of Lambda sensor aging" is based on a cascade control with a Lambda sensor installed upstream and downstream of the catalyst. In order to create a rich-shift of the mixture, the present Lambda controller is operating with a dp-portion. Now, a two-level controller with I-portion and "P"-portion has been introduced, where the rich shift is caused by the delay time tvlr. The delay time tvlr is constructed by the map KFRTV (constants) and the corrective value tvlrh. The tvlrh value may be positive or negative.

A two-level controller with the control difference from voltage of downstream sensor and a load point dependent voltage set point creates the corrective value tvlrh by means of an integrator (atv: adaptation TV) and the weighting map KFFTV. The corrective value tvlrh increases or decreases the corresponding TV map value, dependent on the changed sensor characteristics, which result in the course of the sensor life.

The atv-diagnosis is only activated, if the fault flag of DKAT (catalyst diagnosis) has not been set, i.e., the catalyst is working properly. This check is required due to the fact that an aged or defective catalyst can cause a TV-shift. A Lambda sensor which may only cause a marginal TV-shift, can therefore be detected as defective. However, a defective upstream lambda sensor blocks the DKAT, i.e., a defective catalyst could not be detected without this check. Therefore, in case a catalyst is detected as defective, only the dynamic properties of the upstream lambda sensor are monitored. Furthermore the general DLSA turn-on condition (F_lsastp) has to be fulfilled and the downstream lambda control (B_lrhk) must be active.

The evaluation routine includes the comparison of the atv value with the upper and lower threshold for the DLSA (TVLRHMX, TVLRHMN).
By B_stersy = 0 a switch-over is performed for bank2 to not equal parameter TVLRHMN2 and TVLRHMX2.
If the regulated variable atv is below TVLRHMN (falling short of the minimum) or above TVLRHMX (exceeding the maximum), then the sensor error flag E_latv is set, due to a poor upstream lambda sensor.
In case the atv-value is between TVLRHMN and TVLRHMX (no error), then the sensor error flag E_latv will not be set.

The ready-flag Z_latv for the atv-diagnosis of DLSA is only set, if the momentary time count (tzlsatv) is equal to or exceeds the reference time TWDDTV.

Quicktest:
If a scan tool is connected, (B_fa = 1), the atv monitoring of the DLSA is disabled until the command for the atv-quicktest (B_fatv = 1) is received. Since the LRHK control value is relatively slow, no real test for characteristically shifted front sensor is performed. During the atv quicktest the cycle flag Z_latv is set immediately, the actual atv value compared with the border thresholds (TVLRHMN, TVLRHMX) and the result transmitted via E_latv.

2. DLSA cycle duration monitoring of the upstream Lambda sensor

Cycle duration monitoring of the upstream sensor is required due to the fact that the dynamic properties may deteriorate, the mean sensor voltage, however, remains constant. This dynamic shift of the lambda sensor characteristic may result in exceeding the emission limits.

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The cycle duration is determined in the lambda control %LR. In the process the P-portion and the tv-time from the catalyst deoxidization are automatically excluded from the calculation.
An incorrectly measured cycle duration (B_lrtpp = FALSE) is not taken over into the filter for the formation of the TP-mean value. The measurement of the cycle duration only takes place in an adjustable engine speed, load range. If the engine speed, load window is entered for the monitoring of the cycle duration, also a definable number of valid measured cycles (ANZTP) can be disabled. Together with the steady-state condition of the %LR this possibility is necessary to make the DLSA cycle duration monitoring immune against interferences. In order to be able to increase the detection range and thus to increase the number of detected cycles, the cycle duration is weighted by the factor KFTPKOR. By this factor the operating point dependent influence of dead time and response time of the sensor on the cycle duration is described. The corrective map KFTPKOR is the same map as the weighting map KFFTV in %LRHK and it must therefore not be adjusted again.

In order to avoid excessively long cycle durations (caused by Lambda deviations) during the transient stage of mixture adaptation, and canister purge adaptation, the condition flag B_te is monitored. Disturbances which can be caused by canister purging at the beginning of a purge control phase are eliminated by means of the blocking time TSTEAA.

The delay counter zwpvk is only reset, when the condition flag B_dlatp releases the cycle duration monitoring.

Tpsvkmf is initialized with 0 in the event of powerfail or when clearing the fault memory. Thereafter tpsvkmf=tpsvkof is set at the first valid measurement of the cycle duration.
Otherwise tpsvkmf is initialized with the last value stored in the RAM.

The mean value of the cycle duration of upstream lambda sensor is compared with an upper and lower limit. It has been proven efficient to operate with two pairs of fault thresholds (TSVKO, TSVKU and TSVKKATO, TSVKKATU). If the catalyst monitoring has detected a fault, then the cycle duration of the upstream sensor signal is compared with more stringent fault thresholds. By evaluating the amplitude ratio (usvk/ushk), a slower upstream sensor may erroneously result in considering a properly working (border line) catalyst as insufficient (concerning emissions).
This comparison takes place in an operating point, where the differences in cycle durations between "good" and "slow" lambda sensors are at a maximum. Depending on the momentary cycle duration of the sensor signal, within the predetermined duration limits or outside, the MIL is/is not activated by the fault evaluation algorithm by means of the cycle duration monitoring of the upstream sensor.
If a defective lambda sensor has been detected, based on the above procedure, then "Fault dynamic sensor characteristic" (slow sensor) must be reported to the diagnosis routine via the flag E_latp.

The ready flag Z_latp for cycle duration monitoring is set after ANZDPVK measured cycles, which are valid. The cycle counter zlsatp is reset during cranking.

Quicktest:
If a scan tool is connected, (B_fa = 1), the cycle duration monitoring of the DLSA is disabled until the command for the quicktest of cycle duration (B_fatp = 1) is received. This quicktest is performed in its own engine operating area (zero load, increased RPM). The cycle duration in this area is compared with the quicktest specific thresholds (TSVKKTO, TSVKKTU).

4. General DLSA turn-on conditions

For the DLSA, the following cross-connections with other OBD II diagnosis functions are relevant:

Function:		Processed by means of:
DAGRE	Diagnosis EGR power stage	B_lsastp
DAGRF	Diagnosis EGR	B_lsastp
DASE	Diagnosis misfire detection (emission relevant)	B_lsastp
DEV	Diagnosis injectors	LRVK and LRHK
DHFM	Diagnosis load sensing	E_lm directly
DHLS	Diagnosis sensor heating	B_lsastp
DKAT	Diagnosis catalyst conversion	E_kat directly
DKVS	Diagnosis fuel supply system	B_lsastp
DLSH	Diagnosis downstream lambda sensor	LRHK
DLSV	Diagnosis upstream lambda sensor	LRVK and LRHK
DPH	Diagnosis phase sensor	B_lsastp
DSLS	Diagnosis secondary air system	B_dsls
DTEV/DTES	Diagnosis canister purge valve	B_lsastp
DTEVE	Diagnosis canister purge valve (driver stage)	B_lsastp
DUBAT	Diagnosis UBAT	B_lsastp

During active DLSA, the DSLS (diagnosis of secondary air system) must not be turned on. This is considered by the condition flag B_dsls. The Lambda closed-loop control is active, when the diagnosis of the secondary air system is performed. However, the cycle duration of the sensor signal and the correction factor of the downstream lambda control are inadmissibly influenced by the operation of the secondary air pump. Therefore, this interaction between DLSA and DSLS must be interrupted by means of the flag B_dsls.

If the DTEV (diagnosis of canister purge valve) is active, then the cycle duration monitoring shows a wrong result based on the air-fuel mixture from active carbon filter and canister purge valve. In order to prevent this effect, the flag B_dtest from the DTEV is checked in the release function for the DLSA.
If B_dtest is set, then the DLSA is blocked. This occurs, when the canister purge valve is opened for DTEV.

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5. Stereo version

For stereo exhaust system the three DLSA diagnosis functions must be performed twice, for each exhaust pipe the lambda sensor upstream and downstream catalyst is to be monitored. The general turn-on conditions SY_STERVK/SY_STERHK = 1 (stereo) are to be executed.
Scanned error flags of stereo-OBD II functions are to be scanned, combined by an OR function, by the DLSA turn-on conditions.

6. Measures to be taken in case of clearing of the fault memory or in the event of powerfail

If the fault memory is cleared or in the event of powerfail, the following conditions for the DLSA are given:

a.) The filter for the cycle duration monitoring is initialized, i.e. the starting value for tpsvkmf is again the first valid measurement of the cycle duration value.

b.) The cycle time counter tzlsatv is reset.

c.) The counter for delay cycles zwpvk is reset.

d.) The cycle counter zlsatp is reset.

APP DLSA 51.10 Application hint

Application hints

DLSA - European version (selected via EURO bits)

For the European version, the DLSA-atv-monitoring, the DLSA cycle duration monitoring, and the DLSA oscillation check can be turned off. The partial functions are then not longer processed.

atv-monitoring can be switched off via the bit B_cdlatv:
(B_cdlatv=0) --> atv-monitoring blocked, E_latv/2 = 0, Z_latv/2 = 1, B_dsvkd/2 = 0
(B_cdlatv=1) --> atv-monitoring active

Cycle duration monitoring can be switched off via the bit B_cdlatp:
(B_cdlatp=0) --> Cycle duration monitoring blocked, E_latp/2 = 0, Z_latp/2 = 1
(B_cdlatp=1) --> Cycle duration monitoring active

Function-orientated selection of the diagnosis labels in the VS100:

Fault memory relevant values of the diagnosis function xyz are assigned to the function DFPM_xyz in the function-orientated selection.

Requirements for DLSA calibration:

The two sensor Lambda control and the transient control must have been completely calibrated:

Parameters to be calibrated:
The classification between properly working and defective upstream lambda sensors is carried out by means of the DLSA fault limits TVLRHMX, TVLRHMN, TSVKO, TSVKU, TSVKKATO and TSVKKATU.
It is very unlikely that the lower fault limits for cycle duration monitoring (TSVKU, TSVKKATU) ever will be used for sensor evaluation, since upstream sensors with faster response time do not have a negative impact on emissions. However, the lower limits could be possibly used for detection of "chemical noise".

The constant ZFTSVK determines the filter time constant of the upstream sensor cycle duration monitoring. The lower ZFTSVK, the less the influence of the next input value on the filter output.

With ANZTP, the number of valid measured periods at entrance into the defined n-, tl-window can be calibrated, which are neglected. In order to carry over as many as possible valid periods into the filter, ANZTP should reflect a low value.

NTPVKU, NTPVKO, TLTPVKU and TLTPVKO determine the n-, tl-window, in which the cycle duration monitoring is performed.

TWDDTV is the time threshold, at which the ready flag for atv-monitoring is set.
ANZDPVK contains the minimum number of measured usvk-periods of the cycle duration monitoring, before the ready flag can be set for this diagnosis section.

Disturbances, which may occur during the transition stage between mixture adaptation and purge control adaptation, are suppressed by means of the blocking time TSTEAA. Cycle duration monitoring will be only released if the condition flag B_te is still set after the blocking time TSTEAA or the mixture adaptation is active. By this, excessively long cycle durations at the beginning of a canister purge phase can be suppressed.

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Calibration values:


ANZDPVK     20
ANZTP        1
NTPVKO      2400 rpm
NTPVKU      1800 rpm
NTPKTO      1800 rpm short trip
NTPKTU      1000 rpm short trip
RLTPVKO       70 %  upper load in the large hill in the FTP 75
RLTPVKU       40 % lower load in the large hill in the FTP 75
RLTPKTO       40 %  short trip
RLTPKTU       20 %  short trip
TSTEAA        10 s
TVLRHMX     + 800 ms
TVLRHMN     - 800 ms
ZFTSVK         0.1
TWDDTV        200 s
TSVKO          3 ... 5 s dependent on catalyst volume
TSVKU          0.2 s
TSVKKTO        3 ... 5 s dependent on catalyst volume
TSVKKTU        0.2 s
```

DLSAHK 8.10 Ageing monitoring for lambda sensor downstream of catalytic converter

FDEF DLSAHK 8.10 Function definition

Oscillation check for sensor downstream catalyst

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Test function for oscillation check with Lambda adjustment in %LAMKO

Checking of the sensor voltage downstream catalyst during fuel cut-off

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Checking of the sensor dynamics downstream catalyst during fuel cut-off

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Release function of the oscillation check downstream catalyst

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Fault management:

Bank1:

Bank2:

From Codeword CDLASH for B_cdlash = 0 (switch-off):

For Mono with bit switch-over SY_STERHK = 0:

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these informations directly from the fault path status managed in the DFPM.

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For each fault path "lash" of this diagnosis function the following values are defined:

	Bank 1	Bank 2
Status fault path lash	sfplash	sfplash2
Error flag lash	E_lash	E_lash2
Cycle flag lash	Z_lash	Z_lash2
Fault type lash	TYP_lash:(B_mxlash, B_mnlash, B_nplash)	TYP_lash2:(B_mxlash2, B_mnlash2, B_nplash2
Clear fault path:	B_cllash	B_cllash2
Default value active:	B_bklash (optional)	B_bklash2 (optional)
Fault path code lash:	CDTlash	CDTlash2
Fault class lash:	CLAlash	CLAlash2
Fault intensity lash:	TSFlash	TSFlash2
CARB CODE lash	CDClash	CDClash2
Table of ambient cond. lash:	FFTlash	FFTlash2

ABK DLSAHK 8.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZDYNSH			FW	Amount of dynamic measurement for swinging check of sensor post cat
CDCLASH	BLOKNR		KL	code word CARB: lambda sensor aging downstream cat
CDCLASH2	BLOKNR		KL	code word CARB: lambda sensor aging downstream cat, Cyl.row 2
CDLASH			FW	code word O2-sensor aging diagnosis (SHK) in OBDII mode (invers => Europe mode)
CDTLASH			FW	code word tester: lambda sensor aging downstream catalyst [017]
CDTLASH2			FW	code word tester: lambda sensor aging downstream catalyst, cyl.row 2 [023]
CLALASH			FW	fault class: O2 sensor aging post cat
CLALASH2			FW	Fault class: Lambda-sensor aging downstream of catalytic converter, bank 2
CWDLSAHK			FW	code word for test aging of O2-sensor post cat
DLAMLASHF			FW	Delta Lambda set point (rich) for the test oscillation check downstream
DLAMLASHM			FW	Delta Lambda set point (lean) for the test oscillation check downstream
DMRLASH			FW	torque reserve for diagnosis monitoring ageing lambdasensor downstream Kat
FFTLASH	BLOKNR		KL	Table ambient conditions for Lambda sensor downstream catalyst
FFTLASH2	BLOKNR		KL	Table ambient conditions Lambda sensor downstream catalyst bank2
FRMLASHO			FW	upper threshold for mean value of lamda control factor
FRMLASHU			FW	lower threshold for mean value of lamda control factor
KMXSTG			FW	Filter constant for filter max. gradient for sensor downstream catalyst
MLLASH			FW	Air mass threshold for oscillation check downstream catalyst
MLOSTEST			FW	upper air mass threshold for start of test oscillation check downstream catalyst
MLUSSTG			FW	Air mass threshold for dynamic check downstream catalyst
MLUSTEST			FW	lower air mass threshold for start of test oscillation check downstream catalyst
SMLDYN			FW	air mass threshold for sensor dynamic downstream KAT
TFRMB			FW	time delay for detect. the mean value of lamda control factor within thresholds
TLLASH			FW	time delay for reset lamlash_w if lamsons_w is not lamlash_w
TRIPFASH			FW	minimum time for active close loop reguation pre catalyst
TSALASH			FW	Time after fuel cut-off for the checking of the sensor downstream catalyst
TSFLASH			FW	fault active time: lambda sensor ageing catalyst downstream
TSFLASH2			FW	fault active time: lamda sesor ageing catalyst downstream, bank 2
TTLASH			FW	Time for voltage of O2 sensor post cat lower/higher than desired threshold
TUSCHUB			FW	Delay time for interference peaks at thrust detection of the rear oxygen sensor
TUSDYN			FW	Delay time for the detection of dynamic sensor faults downstream catalyst
TUSENLASH			FW	time for duration until lean/rich detection is allowed
TUSHSMIN			FW	Minimum time for measuring the gradient for enable filter
TUSLASH			FW	Test time for duration enrichment/enleanment downstream catalyst
TUSSA			FW	delay time after crossing the control threshold downstream cat
USHLEAN			FW	Threshold for lean volt. for reset dynamic measurement of sensor downstream cat.
USHRICH			FW	Threshold for rich volt. for valid dyn. measurement of sensor downstream cat.
USHSTGMX			FW	Value for maximum gradient for initial value of filter
USHSTSOLL			FW	Threshold for permitted gradient of the sensor voltage downstream catalyst
USSCHUB			FW	Threshold for sensor voltage downstream catalyst after fuel cut-off

Variable	Source	Type	Description
B_ABGSTG	DLSAHK	LOK	condition modeltemperature (tkatm od. tanhkm_w) is above threshold
B_ABGSTG2	DLSAHK	LOK	condition modeltemp. (tkatm od. tanhkm_w) is above threshold bank2
B_CDLASH	PROKON	EIN	function active per codeword CDLASH
B_CLLASH		EIN	Delete fault path in DLSA.
B_CLLASH2		EIN	Delete fault path in DLSA Bank2
B_DDYLASH	DLSAHK	LOK	Condition sensor downstream catalyst dynamically slow
B_DDYLASH2	DLSAHK	LOK	Condition sensor downstream catalyst dynamically slow ‘dynamical‘ bank2
B_DLASH	DLSAHK	LOK	active diagnosis:^oxygen sensor aging downstream catalyst function
B_DLASH2	DLSAHK	LOK	active diagnosis: oxygen sensor aging downstream catalyst (cylinder row 2)
B_DSHK	DLSAHK	LOK	Condition diagnosis in %DLSH and %DHLS finished with o.k. downstream cat report
B_DSHK2	DLSAHK	LOK	Cond. diagnosis in %DLSH and %DHLS finished with o.k. downstr. cat report bank2
B_DSLS	DSLSLR	EIN	condition for active diagnosis of secondary air system
B_DTEST		EIN	condition for start of TEV opening
B_DUSHSCH	DLSAHK	LOK	Cond. threshold sen. downst. cat. during fuel cut-off not undershot ‘dynamical‘
B_DUSHSCH2	DLSAHK	LOK	Cond. threshold sen. downst. cat. during fuel cut-off not undershot ‘dyn.‘ bank2
B_DYLASH	DLSAHK	LOK	Condition sensor downstream catalyst dynamically slow ‘static‘
B_DYLASH2	DLSAHK	LOK	Condition sensor downstream catalyst dynamically slow ‘static‘ bank2
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_ENFMST	DLSAHK	LOK	Condition enable for filter, take over maximum of the gradient
B_ENLASH	DLSAHK	LOK	Condition test for oscillation check terminated, release cycle bit

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Variable	Source	Type	Description
B_ENLASH2	DLSAHK	LOK	Condition test for oscillation check terminated, release cycle bit bank2
B_EVLOC	AEVAB	EIN	Status: all injection valves are activated
B_FASH		EIN	condition diagnosis oxygen sensor aging downstream catalyst function request
B_FASH2		EIN	condition diag. oxygen sensor aging downstream catalyst function request bank2
B_FRMLASH	DLSAHK	LOK	condition mean value of lambda control factor within threshold
B_FRMLASH2	DLSAHK	LOK	condition mean value of lambda control factor within threshold bank2
B_GAEING		EIN	condition basic adaption Bank 1 steady state
B_GAEING2		EIN	condition for adaptive lambda pilot control 2 successful
B_LAMEND	DLSAHK	LOK	Condition end of the Lambda adjustment in %LAMKO
B_LAMEND2	DLSAHK	LOK	Condition end of the Lambda adjustment in %LAMKO bank2
B_LAMLASH	DLSAHK	LOK	Condition for enleanment in %LAMKO
B_LAMLASH2	DLSAHK	LOK	Condition for enleanment in %LAMKO bank2
B_LAMVERG	DLSAHK	LOK	Condition comparison of desired Lambda in %DLSAHK with %LAMKO corresponding
B_LAMVERG2	DLSAHK	LOK	Cond. comparison of desired Lambda in %DLSAHK with %LAMKO corresponding bank2
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_LRHK	LRHK	EIN	condition for lambda closed loop control downstream cat
B_LRHK2	LRHK	EIN	condition for lambda closed loop control downstream cat (bank 2)
B_LSAHKSP	DLSAHK	LOK	flag for general disabling conditions for DLSAHK
B_LSAHKSP2	DLSAHK	LOK	flag for general disabling conditions for DLSAHK bank2
B_MAXLASH	DLSAHK	LOK	Condition for ”max.value” for oscillat. check downst.cat detec.
B_MAXLASH2	DLSAHK	LOK	Condition for ”max.value” for oscillat. check downst.cat detec. bank2
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_MINLASH	DLSAHK	LOK	Condition for ”min. value” of oscillation check downstr. cat detec.
B_MINLASH2	DLSAHK	LOK	Condition for ”min. value” of oscillation check downstr. cat detec. bank2
B_MLDYN	DLSAHK	LOK	Condition for minimal air mass in fuel cut off for dynamic measurement
B_MLUSTEST	DLSAHK	LOK	condition ml is within threshold
B_MNLASH	DLSAHK	AUS	Condition for fault type ”min. value” of oscillation check downstr. cat detec.
B_MNLASH2	DLSAHK	AUS	Condition for fault type ”min. value” of oscill. check downstr. cat detec. bank2
B_MXLASH	DLSAHK	AUS	Condition for fault type ”max.value” for oscillat. check downst.cat detec.
B_MXLASH2	DLSAHK	AUS	Condition for fault type ”max.value” for oscillat. check downst.cat detec. bank2
B_NOLASH	DLSAHK	LOK	Condition diagnosis oscillation check finished with o.k. report
B_NOLASH2	DLSAHK	LOK	Condition diagnosis oscillation check finished with o.k. report bank2
B_NPLASH	DLSAHK	AUS	Error typ ’value not plausible’ for swinging check post cat
B_NPLASH2	DLSAHK	AUS	Error typ ’value not plausible’ for swinging check post cat bank 2
B_SBBHK	DLSH	EIN	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	EIN	condition for lambda sensor downstream cat ready for operation bank2
B_STEIGM	DLSAHK	LOK	Condition measure gradient of the sensor signal
B_STEIGM2	DLSAHK	LOK	Condition measure gradient of the sensor signal bank2
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
B_TESLASH	DLSAHK	LOK	Condition perform test for check of the sensor downstream catalyst
B_TESLASH2	DLSAHK	LOK	Condition perform test for check of the sensor downstream catalyst bank2
B_TRFASH	DLSAHK	LOK	Condition Short trip started for oszilation check of O2-sensor post cat
B_TRFASH2	DLSAHK	LOK	Condition Short trip started for oszilation check of O2-sensor bank 2
B_USHKF	DLSAHK	LOK	Condition sensor voltage downstream cat. ”Rich” (set point exceeded)
B_USHKF2	DLSAHK	LOK	Condition sensor voltage downstream catalyst ”Rich” (set point exceeded) bank2
B_USHKM	DLSAHK	LOK	Condition sensor voltage downstream catalyst ”Lean” (set point undershot)
B_USHKM2	DLSAHK	LOK	Condition sensor voltage downstream catalyst ”LEAN” (set point undershot) bank2
B_USHSCH	DLSAHK	LOK	Cond. threshold sen. downst. cat. during fuel cut-off not undershot ‘dynamical‘
B_USHSCH2	DLSAHK	LOK	Cond. threshold sen. downst. cat. during fuel cut-off not undershot ‘dyn.‘ bank2
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DMRLASH_W	DLSAHK	AUS	torque reserve for lambda sensor ageing diagnosis downstream cat
E_AGRE		EIN	error flag: EGR power stage monitoring
E_AGRF		EIN	error flag: EGR flow monitoring
E_HSH	DHLS	EIN	error flag: lambda sensor heating downstream cat
E_HSH2	DHLS	EIN	error flag: lambda sensor heating downstream cat on the right
E_LASH	DLSAHK	AUS	error flag: lambda sensor aging downstream cat
E_LASH2	DLSAHK	AUS	error flag: lambda sensor aging downstream cat (cylinder row 2)
E_LSH	DLSH	EIN	error flag: lambda sensor downstream cat
E_LSH2	DLSH	EIN	Errorflag: Lambda-Sensor downstream bank2
E_PH	DPH	EIN	error flag: phase sensor
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_UB	GGUB	EIN	error flag: power supply voltage UB
FRM2_W	LR	EIN	fast mean value of lambda control factor bank 2(word)
FRMTRIP2_W	DLSAHK	LOK	Mean value of fr-factor for short trip of oszillation check
FRMTRIP_W	DLSAHK	LOK	Mean value of fr-factor for short trip of oszillation check
FRM_W	LR	EIN	fast mean value of lambda control factor (word)
LAMFRM2_W	DLSAHK	LOK	Lamdba offset from mean value lambda regulation factor bank 2
LAMFRM_W	DLSAHK	LOK	Lamdba offset from mean value lambda regulation factor
LAMLASH2_W	DLSAHK	AUS	Desired Lambda for test oscillation check downstream catalyst bank2
LAMLASH_W	DLSAHK	AUS	Desired Lambda for test oscillation check downstream catalyst
MLDYN_W	DLSAHK	LOK	integrated air mass at fuel cut off
ML_W	EGFE	EIN	air mass flow filtered (Word)
SFPLASH	DLSAHK	AUS	status fault path:
SFPLASH2	DLSAHK	AUS	status fault path:
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
TYP_LASH	DLSAHK	AUS	Fault type: lambda sensor aging downstream
TYP_LASH2	DLSAHK	AUS	Fault type: lambda sensor aging downstream bank2
USHFMXSTG	DLSAHK	LOK	Filtered maximum gradient of the sensor voltage downstream catalyst
USHFMXSTG2	DLSAHK	LOK	Filtered maximum gradient of the sensor voltage downstream catalyst bank2

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Variable	Source	Type	Description
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USHKMXSTG	DLSAHK	LOK	Maximum gradient of the sensor voltage downstream catalyst
USHKMXSTG2	DLSAHK	LOK	Maximum gradient of the sensor voltage downstream catalyst bank2
USHKSTEIG	DLSAHK	LOK	Gradient of the sensor voltage downstream catalyst
USHKSTEIG2	DLSAHK	LOK	Gradient of the sensor voltage downstream catalyst bank2
USRHK	LRHK	EIN	momentary control threshold for downstream lambda control
USRHK2	LRHK	EIN	momentary control threshold for downstream lambda control, bank2
ZLASH2_W	DLSAHK	LOK	Time counter for sensor voltage downstream cat. above/below the set point bank2
ZLASH_W	DLSAHK	LOK	Time counter for the sensor voltage downstream cat. above/below the set point
ZWDYNSH	DLSAHK	LOK	Counter for amount of dynamic measurement for O2 sensor post cat
ZWDYNSH2	DLSAHK	LOK	Counter for amount of dynamic measurement for O2 sensor post cat bank 2
Z_HSH	DHLS	EIN	cycle flag of lambda sensor heating downstream cat
Z_HSH2	DHLS	EIN	cycle flag of lambda sensor heating downstream cat, cylinder row 2
Z_LASH	DLSAHK	AUS	cycle flag of lambda sensor aging downstream cat
Z_LASH2	DLSAHK	AUS	cycle flag of lambda sensor aging downstream cat, cylinder row 2
Z_LSH	DLSH	EIN	cycle-flag: lambda sensor downstream cat
Z_LSH2	DLSH	EIN	cycle-Flag: Lambda-sensor downstream cat bank2

FB DLSAHK 8.10 Detailed description of function

Introduction:

The task of the diagnosis function is to check the voltage level of the sensor downstream catalyst.

1. Oscillation check: If the sensor signal constantly remains below or above the set point, then the pilot control (%LRHK, %LRSHK) will enrich or enlean the mixture until the limit stop is reached by means of the integral controller (limiting values of the integral component are exceeded). The sensor upstream catalyst, which is absolutely o.k., is in this case erroneously detected to be defective.

2. Checking during fuel cut-off: The sensor voltage must fall short of a defined voltage threshold.

3. Dynamics check during fuel cut-off: A dynamically slow sensor can be detected by measuring the ascending gradients.

Release function:

The release function of the oscillation check for the sensor downstream catalyst is only active B_dlash = 1, if the general release conditions B_lashksp = 0 are given and if the electrical and the heater diagnosis for the sensor downstream catalyst have successfully been terminated B_dshk = 1 and if the air mass ml has exceeded a certain threshold (MLLSAH) as well as the pilot control downstream catalyst B_lrhk = 1 being turned on.

Oscillation check downstream catalyst:

The two flip-flops B_ushkf and B_ushkm are reset by C_ini. They may be set again until the cycle bit Z_lash = 1 at operating readiness B_sbbhk = 1 and the delay time TUSENLASH are set, if ushk >= usrhk and ushk <= usrhk are each given for longer than the time TUSSA.
The sensor downstream catalyst is o.k., if the sensor voltage is greater than or equal to the set point usrhk of the pilot control and the controller moves into the direction "lean" (B_ushkf = 1) and if ushk is less than or equal to the set point usrhk and the controller moves into the direction "rich" (B_ushkm = 1).
If the sensor voltage ushk during control operation (B_lrhk = 1 and B_dlash =1) remains below or above the set point usrhk (one of the flip-flops B_ushkf or B_ushkm is not set) for longer than the time TTLASH, then by a controlled enrichment or enleanment by means of a test function it is checked, whether the sensor voltage can be moved above or below the set point usrhk.

If the counter zlash_w during control operation downstream catalyst has exceeded the time TTLSAH, then the flip-flop B_entest is set. Thereafter, with sufficient air mass flow MLUSTEST < ml < MLOSTEST, without catalyst "deoxidization" B_lrka = 0, no fault flags B_lsahksp = 0 as well as B_evloc = 1 (no fuel cut-off) and also the mean value frm_w of lambda control is inside the thresholds FRMLASHO and FRMLASHU for the time TFRMB the bit B_teslash is set.
With this bit a switch is closed, by which dependent on set rich/lean flip-flop (B_ushkf or B_ushkm), the delta Lambda value DLAMLASH which is added or subtracted from Lambda 1.0, is passed to the RAM lamlash_w. In addition the condition B_lamlash is set in case the Lambda is not equal to 1. For the Lambda coordination %LAMKO the Lamda value lamlash_w to be adjusted and the condition B_lamlash are given. Thereafter lamlash_w over lamsons_w (Lambda set point) is included in the calculation in the fuel path in %GR. The triggering to Lambda "rich" or "lean" is therefore only performed into one direction, dependent on which flip-flop B_ushkf or B_ushkm is set.
Simultaneously the bit B_lamvergl is set by the B_teslash delayed by one clock pulse and the performed comparison of lamlash_w with lamsons_w from %LAMKO and B_lamlash set from Lambda not equal to 1.
The controlled enrichment resp. enleanment and the test time TUSLASH are interrupted during a fuel cut-off phase or if ml < MLUSTEST.
If the sensor voltage ushk moves below or above the set point value usrhk (both flip-flops B_ushkf and B_ushkm are set) during the test time TUSLASH, then the test is aborted, by setting the Lambda equal to 1 by means of another switch. The condition B_nolash =1 (no fault) is set.
If one of the flip-flops B_ushkf or B_ushkm is not set once the test time TUSLASH has elapsed and the set trigger B_lamend, then the flip-flop B_enlash for the fault release is set by B_lamend = 1 and the dynamic fault trigger B_maxlash or B_minlash can be set.
The cycle flag Z-lash and the error flag E_lash are set set via B_maxlash or B_minlash.
Simultaneously the timer counter z_lash_w and the flip-flop B_entest are reset by means of B_lamend = 1, which is delayed by one clock pulse. With the reset of B_entest it is ensured, that the test procedure is switched off , if the sensor is defect.
Since B_enlash always remains set during a trip after the first test procedure for the fault release, a fault entry can only be performed with active Lambda control, i.e. B_dlash = 1. This means that when a fault occurs during the test procedure (e.g.

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heating E_hsh = 1) and thus one of the flip-flops B_ushkf or B_ushkm cannot be set, then this fault is not accepted, since B_dlash is not set after the test procedure.
Until to the next trip the counters are reset again by C_ini, so that the test procedure can start again.

Short trip for oscillation check:

With connected scan tool and B_fa =1 the oscillation check is blocked. The quick test is performed with B_fash =1, by switching through DLAMLASHF (enrichment) or DLAMLASHM (enleanment) via the switch and by setting B_lamlash = 1. If both flip-flops B_ushkf and B_ushkm have already been set prior to the quick test having been started, then DLAMLASHFor LAMLASHM is not switched through and lamlash_w remains set at 1.0. The sensor downstream catalyst is o.k. then. The short trip must be performed for longer than the time TUSLASH, so that in case a fault is possibly present (B_ushkf or B_ushkm not set) B_enlash can be set for the fault release.

Checking of the sensor voltage downstream catalyst during fuel cut-off

After a fuel cut-off duration TSALSAH has elapsed and no electrical sensor fault from %DLSH (Z_lsh = 1 and E_lsh = 0, the sensor is sufficiently hot) a check is performed during fuel cut-off, on whether the sensor voltage ushk falls short of a threshold USSCHUB. If the sensor voltage during fuel cut-off remains greater than the threshold USSCHUB, then the bit B_dushsch is set by the trigger and the flip-flop B_ushsch is set in the permanent RAM. The fault B_minlash is set by the bit B_dushsch = 1.
The delay time TUSCHUB is only for suppression of interference peakfrom the sensor voltage.

During normal operating a setting of the cycle bit Z_lash is independent of this check and therefore it must not be waited for the start of a fuel cut-off duration. This is important on vehicles with automatic transmission, on which a fuel cut-off rarely occurs.

By setting the flip-flop B_ushsch in the permanent RAM it is achieved that during the 2. trip the bit B_nolash cannot be set and thus also not the cycle bit Z_lash. The error flag E_lash remains set. The cycle bit can only be set during the next check in the fuel cut-off phase B_sa, by either this fault being confirmed again of by the flip-flop B_ushsch in the permanent RAM being reset in case of healing, if the sensor voltage ushk falls short of the threshold USSCHUB.
B_nolash = 1 results from the resetting of B_ushsch and thus also the error flag E_lash is reset.
By means of the trigger B_dushsch it is avoided that the MIL lamp is triggered prior to this fuel cut-off check during the 2. trip.

Checking of the sensor dynamics downstream catalyst during fuel cut-off

If the sensor downstream catalyst is dynamically slow, then a "bad" catalyst can be detected as being "good" (avkat small).

With a measurement of the sensor edge times it is not possible to differentiate, also during fuel cut-off, between a dynamically good and bad sensor, especially in case of a bad catalyst.
Dynamically good and bad sensors, however, can be detected more easily, if the maximum ascending gradient of the sensor voltage is determined during fuel cut-off.
The ascending gradient ushksteig (absolute value from new-old value of the sensor voltage ushk) is measured, if during fuel cut-off (B_sa = 1) the sensor downstream catalyst is o.k. with regard to heater diagnosis and electrical diagnosis and if the sensor voltage is greater USHRICH and greater USHLEAN. The measurement of the ascending gradient is aborted, if the sensor voltage ushk < USHLEAN or if B_sa = 0. With B_sa = 0 the flip-flop B_steigm is reset. For each measurement during fuel cut-off the maximum ascending gradient ushkmxstg is calculated again. This value is only passed (B_enfmst=1) on to an event filter ushfmxstg, if the fuel cut-off duration B_sa (B_steigm = 1) is present for a minimum duration TUSHSMIN and if the integrated air mass during fuel cut-off has exceeded a threshold value SMLDYN.
In the event of powerfail C_pwf or clear fault path B_cllash the initial value USHSTGMX is written into the event filter in the permanent RAM.
The filter constant amounts to KMXSTG. If with a dynamically slow sensor the filter value ushfmxstg is less than the limiting value USHSTSOLL, then the flip-flop B_dylash in the permanent RAM is set and about the trigger B_ddylash=1 fault B_nplsah in the permanent RAM and the error E_lsah in the permanent RAM are set. B_dylash and B_ddylash can only be set, if after start it takes place a certain number ANZDYNSH of dynamic measurements (transient effect from event filter ushfmxstg).
The fault B_nplash resp. E_lash has healed again, if after a sufficient fuel cut-off duration the maximum ascending gradient ushfmxstg is again greater than the threshold value USHSTSOLL.
During normal operating a setting of the cycle bit Z_lash is independent of this check and therefore it must not be waited for the start of a fuel cut-off duration. This is important on vehicles with automatic transmission, on which a fuel cut-off rarely occurs.

By setting the flip-flop B_dylash in the permanent RAM it is achieved that during the 2. trip the bit B_nolash cannot be set and thus also not the cycle bit Z_lash. The error flag E_lash remains set. The cycle bit can only be set during the next check in the fuel cut-off phase B_sa with sufficient fuel cut-off duration (B_enfmst = 1), by either this fault being confirmed again of by the flip-flop B_dylash in the permanent RAM being reset in case of healing.
B_nolash = 1 results from the resetting of B_dylash and thus also the error flag E_lash is reset.
By means of the trigger B_ddylash it is avoided that the MIL lamp is triggered prior to this fuel cut-off check during the 2. trip.

Fault management:

The error flag E_lash and the cycle flag Z_lash are set by means of the trigger from the 3 fault types B_maxlash, B_minlash and B_ddylash. The cycle flag Z_lash is also set by no-fault B_nolash and it is reset during each Electronic Control Unit initialization C_ini. The cycle flag and the error flag are also reset via the clear bit B_cllash.
With the code bit B_cdlash = 0 the entire function DLSAHK is switched off and the error flag E_lash is reset and the cycle flag Z_lash is set.
The fault triggers B_maxlash, B_minlash and B_ddylash also set the fault flip-flops B_mxlash, B_mnlash and B_nplash in the permanent RAM. These can only be reset again via no-fault B_nolash resp. E_lashres.

General DLSAHK turn-on conditions

For the DLSAHK the following cross-connections with other OBD II diagnosis functions are relevant:

Function: Processed by means of:

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DAGRE	Diagnosis EGR power stage	B_lsahksp
DAGRF	Diagnosis EGR	B_lsahksp
DASE	Diagnosis misfire detection (emission relevant)	B_lsahksp
DEV	Diagnosis injectors	LRVK and LRHK
DHFM	Diagnosis load sensing	E_lm directly
DHLS	Diagnosis sensor heating	B_lsahksp
DKVS	Diagnosis fuel supply system	B_lsahksp
DLSH	Diagnosis downstream lambda sensor	LRHK
DPH	Diagnosis phase sensor	B_lsastp
DSLS	Diagnosis secondary air system	B_dsls
DTEV/DTES	Diagnosis canister purge valve	B_lsahksp
DTEVE	Diagnosis canister purge valve - power stage	B_lsahksp
DUBAT	Diagnosis UBAT	B_lsahksp

APP DLSAHK 8.10 Application hint

Application hints

The oscillation check sensor downstream catalyst can be switched off by the bit B_cdlash:

(B_cdlash=0) --> oscillation check blocked, E_lash/2 = 0, Z_lash/2 = 1
(B_cdlash=1) --> oscillation check active

Preconditions for DLSAHK application:

The two sensor Lambda control (LC or LCS upstream catalyst and Nernst sensor downstream catalyst) and the transient control must have been completely adjusted.

Application values:

TUSSA	2 s	
TFRMB	3 s	
TUSENLASH	30 s	
TUSLASH	10 s	dependent on catalyst size
TSALASH	5 s	dependent on catalyst size
TTLSAH	100 s	dependent on catalyst size
DLAMLASF	0.10	dependent on catalyst size
DLAMLASM	0.07	dependent on catalyst size
FRMLASSHO	1.035	for contiuous lambda control 1.10
FRMLASHU	0.975	for continous lambda control 0.90
TUSHSMIN	3 s	dependent on catalyst size
TUSCHUB	200 ms	
USHRICH	550 mV	
USHLEAN	100 mV	
USHTEST	100 mV	
USSCHUB	100 mV	
USHSTSOLL	5 mV/ms	
USHSTGMX	70 mV/ms	
KMXSTG	0.5	
MLLASH	50 kg/h	choose such that the flow in the catalyst is as large as possible
MLUSTEST	20 kg/h	above mass flow during idling
MLOSTEST	120 kg/h	
SMLDYN	15 g	dependent on catalyst size
ANZDYNSH	4	number of dynamic tests dependent from vehicle (manual/automatic transmission)
DMRLASH	7%	for short-trip: choose such that the flow in the catalyst is as large as possible ml >= MLLASH

DLSSA 14.80 Signal output from lambda sensors

FDEF DLSSA 14.80 Function definition

Signal output for labda sensor upstream catalyst with conventional lambda control (SY_STETLR := FALSE)
==========

While the Lambda sensor aging diagnosis (%DLSA) is active, the Lambda sensor signal upstream catalyst can be considered as being characteristic for the quality of the mounted Lambda sensor upstream catalyst as far as shape and frequency are concerned. By the given Lambda sensor signal, output parameters are continuously calculated, like with the cycle duration monitoring for the up-stream Lambda sensor. These parameters describe the shape of the upstream Lambda sensor signal. The calculated parameters together with the integrator value atv of th downstream control and the cycle duration of the upstream Lambda sensor and various constants are then outputted via a tester interface. For the sensor voltage downstream catalyst the min. and max. values as well as the mean control threshold are sent to the tester if requested. The parameters to be calculated, their value range as well as the quantization which is to be used are described by the SAE standard J1979.

Function block diagram:

Is calculated for SY_STETLR :=FALSE

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```
tfrn_w/2                                                                  tuspnf/2
 ---------------------------------->---+-------------------------------+-->----------
B_dlatp/2                                | time of the usvkj from the    |
 ---------------------------------->---+ positive to the negative edge  |
(Enable  flag for the cycle duration     | - - - - - - - - - - - - - - - +-->usmxsan/2
 monitoring of the %DLSA, is also used   | Determination of the max. value |
 for enabling of the DLSSA)              | of the upstr. sensor voltage  |
                                         | - - - - - - - - - - - - - - - +-->usmnsan/2
                                         | Determination of the min. value |
                                         | of the upstr. sensor voltage  |
                                         | - - - - - - - - - - - - - - - +-->atvfett/2
atv/2     (manipulated variable of LRHK) |                               |
 ---------------------------------->---+ conversion to output format   +-->atvmager/2
tpsvkmf/2_w (cycle duration of the SVK)  |                               |
 ---------------------------------->---+ - - - - - - - - - - - - - - - +-->tpsvlssa/2
USR       (ZPR-control threshold, %LR)   | conversion to output format   |
 ---------------------------------->---+ - - - - - - - - - - - - - - - +-->USRJ
usvk/2    (upstream sensor voltage)      | conversion to output format   |
 ---------------------------------->---+ - - - - - - - - - - - - - - - +-->usvkj/2
                                         | Subtraction of the neg. offset |
USMNSAMN  (lower limiting value for minimum usvkj)                        USMNSAMN
 ---->-------------------------------------------------------------->---------
USMNSAMX  (upper limiting value for minimum usvkj)                        USMNSAMX
 ---->-------------------------------------------------------------->---------
USMXSAMN  (lower limiting value for maximum usvkj)                        USMXSAMN
 ---->-------------------------------------------------------------->---------
USMXSAMX  (upper limiting value for maximum usvkj)                        USMXSAMX
 ---->-------------------------------------------------------------->---------
TUSPNMN   (lower threshold value for the time betw. pos. and neg. edge)   TUSPNMN
 ---->-------------------------------------------------------------->---------
TUSPNMX   (upper threshold value for the time betw. pos. and neg. edge)   TUSPNMX
 ---->-------------------------------------------------------------->---------
ATVFETTO  (upper limiting value for atvfett)                              ATVFETTO
 ---->-------------------------------------------------------------->---------
ATVFETTU  (lower limiting value for atvfett)                              ATVFETTU
 ---->-------------------------------------------------------------->---------
ATVMAGO   (upper limiting value for the atvmager)                         ATVMAGO
 ---->-------------------------------------------------------------->---------
ATVMAGU   (lower limiting value for the atvmager)                         ATVMAGU
 ---->-------------------------------------------------------------->---------
TPSVKMN   (lower limiting value for the cycle duration)                   TPSVKMN
 ---->-------------------------------------------------------------->---------
TPSVKMX   (upper limiting value for the cycle duration)                   TPSVKMX
 ---->-------------------------------------------------------------->---------
```

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Determination of the minimum and maximum sensor voltage upstream catalyst:
==========

will be calculated for SY_STETLR := FALSE

Delete fault path DLSSA caused from different functions:

Signal output for labda sensor upstream catalyst with continous lambda control (SY_STETLR := TRUE)
==========

During active oxygen sensor aging diagnosis the sensor signal (shape and frequency) can be considered as characteristic for the quality of the installed upstream sensor. By means of the present section DLSSA, several parameters are calculated continuously (like cycle duration monitoring of the upstream sensor). These parameters describe the characteristic of the upstream Lambda sensor signal. The calculated values are provided via a tester interface, together with the correction value of the downstream controller, the dynamic property value of the upstream continuos sensor and different constants by a tester interface.

Block diagram of the function:

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Function block diagram : Sensor downstream catalyst

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Determination of the minimum and maximum sensor voltage downstream catalyst:
==========

will be calculated for SY_STETLR := TRUE / FALSE

Calculation of the time between crossing the threhold negative to positive and positive to negative upstream catalyst:

ABK DLSSA 14.80 Abbreviations

The input values for the convetional control are defined in %LR, %LRHK and %DLSA. The corresponding input values for the continuous control are defined in %LRS, %LRSHK, %GGLSU and %DLSU. The local values and the output values need to be defined anew for the Lambda sensor signal output.

Parameter	Source-X	Source-Y	Type	Description
ATVFETTO			FW	upper threshold for atvfett, CARB tester, DLSSA
ATVFETTU			FW	lower threshold for atvfett, CARB tester, DLSSA
ATVMAGO			FW	upper threshold for atvmager, CARB tester, DLSSA
ATVMAGU			FW	lower threshold for atvmager, CARB tester, DLSSA
DLAHISATO			FW	upper threshold for dlahisa, CARB tester, DLSSALRS
DLAHISATU			FW	lower threshold for dlahisa, CARB tester, DLSSALRS
DYNLSUTO			FW	upper threshold for dynlsusa, CARB tester, DLSSALRS
DYNLSUTU			FW	lower threshold for dynlsusa, CARB tester, DLSSALRS
LAMSSAMN			FW	lower threshold for lamsosa and lamsisa, CARB tester, DLSSALRS
LAMSSAMX			FW	upper threshold for lamsosa and lamsisa, CARB tester, DLSSALRS
SAFK1			FW	filter constant 1 for lambda sensor signal access
SAFK2			FW	filter constant 2 for lambda sensor signal access
TPSVKMN			FW	minimum cycle duration of upstream lambda sensor, DLSSA
TPSVKMX			FW	maximum cycle duration of upstream lambda sensor, DLSSA
TUSPNMN			FW	min. time of the sensor voltage between pos. and neg. slope
TUSPNMX			FW	max. time of the sensor voltage between pos. and neg. slope
TWDLSSA			FW	minium test duration for DLSSA extreme value evaluation
USIVMAXH			FW	Init value for max.sensor volt. downstr. cat. after powerfail/clear fault memory
USIVMAXV			FW	Init value for max. sensor volt. upstr. cat. after powerfail/clear fault memory
USIVMINH			FW	Init value for min.sensor volt. downstr. cat. after powerfail/clear fault memory

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Parameter	Source-X	Source-Y	Type	Description
USIVMINV			FW	Init value for min. sensor volt. upstr. cat. after powerfail/clear fault memory
USMNSAMN			FW	max. detected sensor voltage for signal output (min. plaus. value)
USMNSAMX			FW	min. detected sensor voltage for signal output (max. plaus. value)
USMNSHMN			FW	max. detected sensor voltage downstr. cat. for signal output (min. plaus. value)
USMNSHMX			FW	min. detected sensor voltage downstr. cat. for signal output (max. plaus. value)
USMXSAMN			FW	max. detected sensor voltage for signal output (min. plaus. value)
USMXSAMX			FW	max. detected sensor voltage for signal output (max. plaus. value)
USMXSHMN			FW	max. detected sensor voltage downstr. cat. for signal output (min. plaus. value)
USMXSHMX			FW	max. detected sensor voltage downstr. cat. for signal output (max. plaus. value)
USR			FW	controller theshold for lambda control upstream catalyst
USRHKSH			FW	controller theshold for lambda control downstream catalyst, DLSSA display
USRHKSHJ			FW	controller theshold for lambda control downstream catalyst, DLSSA display

Variable	Source	Type	Description
ATV	LRHK	EIN	current integrator value of lambda control downstream cat
ATV2	LRHK	EIN	current integrator value of lambda control downstream cat 2
ATVFETT	DLSSA	AUS	atv shifting to 'rich', DLSSA
ATVFETT2	DLSSA	AUS	atv shifting to 'rich', DLSSA (bank2)
ATVMAGER	DLSSA	AUS	atv shifting to 'lean', DLSSA
ATVMAGER2	DLSSA	AUS	atv shifting to 'lean', DLSSA (bank2)
B_DLATP	DLSA	EIN	condition for active diagnosis: lambda sensor aging TP
B_DLATP2	DLSA	EIN	condition for active diagnosis: lambda sensor aging TP (cylinder row 2)
B_LCLMOD5	DLSSA	LOK	Clear nonvalatile RAM of DLSSA
B_LCLMOD52	DLSSA	LOK	Clear nonvalatile RAM of DLSSA
B_LRHK	LRHK	EIN	condition for lambda closed loop control downstream cat
B_LRHK2	LRHK	EIN	condition for lambda closed loop control downstream cat (bank 2)
B_LRTPP	LR	EIN	Periodic time valid, static cond. for %LR (amplitude/periodic time) = TRUE
B_LRTPP2	LR	EIN	static condition for lambda controller (amplitude/periodic time) bank2
B_TUSPN	DLSSA	LOK	Condition time between sensor transitions tfrn_w (%LR) valid
B_TUSPN2	DLSSA	LOK	Condition time between sensor transitions tfrn2_w (%LR) valid
B_TUSRE	DLSSA	LOK	Condition result for filtred half period for sensor upstream cat
B_TUSRE2	DLSSA	LOK	Condition result for filtred half period for sensor upstream cat bank2
C_PWF		EIN	ECU-condition powerfail initialisation
DLAHI2_W		EIN	I-portion of the continuous LRHK2
DLAHISA	DLSSA	AUS	I part LRSHK, signal output DLSSA (SY_STETLR := TRUE), bank 1
DLAHISA2	DLSSA	AUS	I part LRSHK, signal output DLSSA (SY_STETLR := TRUE), bank 2
DLAHI_W		EIN	I-portion of the LRSHK
DYNLSU2_W		EIN	Dynamical value of the LSU, bank 2
DYNLSUSA	DLSSA	AUS	signal output DLSSA: dynamic value LSU, bank 1
DYNLSUSA2	DLSSA	AUS	signal output DLSSA: dynamic value LSU, bank 2
DYNLSU_W		EIN	Dynamical value of the LSU
LAMSISA	DLSSA	AUS	Signal output DLSSA: measured value lambda, bank 1
LAMSISA2	DLSSA	AUS	Signal output DLSSA: measured value lambda, bank 2
LAMSONI2_W		EIN	Lambda actual value
LAMSONI_W		EIN	Lambda actual value
LAMSONS2_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location
LAMSOSA	DLSSA	AUS	Signal output DLSSA: lambda set value %LRS, bank 1
LAMSOSA2	DLSSA	AUS	Signal output DLSSA: lambda set value %LRS, bank 2
SY_STETLR	PROKON	EIN	System constant condition continuous Lambda control present
TFRN2_W		EIN	time duration lambda controller negativ slope, bank 2
TFRN_W		EIN	time duration lambda controller negativ slope
TPSVKMF2_W	DLSA	EIN	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (word)
TPSVKMF_W	DLSA	EIN	filtered cycle duration of sensor signal upstream cat. (word)
TPSVLSA2	DLSSA	AUS	cycle duration (sensor signal upstream cat) for DLSSA (bank2)
TPSVLSSA	DLSSA	AUS	cycle duration (sensor signal upstream cat) for DLSSA
TPSVLSSA2	DLSSA	AUS	cycle duration (sensor signal upstream cat) for DLSSA (bank2)
TUSPNF	DLSSA	AUS	filtered time between positive and negative usvk slope, DLSSA
TUSPNF2	DLSSA	AUS	filtered time between positive and negative usvk slope, DLSSA (bank2)
TWDLSSA2_W	DLSSA	LOK	timer of minimum test duration for DLSSA-extreme evaluation bank2
TWDLSSA_W	DLSSA	LOK	timer of minimum test duration for DLSSA-extreme evaluation
TWDLSSH2_W	DLSSA	LOK	timer of minimum test duration for DLSSA-extreme evaluation downstream cat bank2
TWDLSSH_W	DLSSA	LOK	timer of minimum test duration for DLSSA-extreme evaluation downstream cat
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USHKJ	DLSSA	LOK	output voltage oxygen sensor downstream catalyst without offset, DLSSA, bank 1
USHKJ2	DLSSA	LOK	output voltage oxygen sensor downstream catalyst without offset, DLSSA, bank 2
USHKJF2_W	DLSSA	LOK	fiterd output voltage oxygen sensor downstream cat without offset, DLSSA (bank2)
USHKJF_W	DLSSA	LOK	fiterd output voltage oxygen sensor downstream catalyst without offset, DLSSA
USMNSAA	DLSSA	LOK	minimum established sensor voltage value upstream cat (old), DLSSA, bank 1
USMNSAA2	DLSSA	LOK	minimum established sensor voltage value upstream cat (old), DLSSA, bank 2
USMNSAN	DLSSA	AUS	minimum established sensor voltage value upstream cat (new), DLSSA
USMNSAN2	DLSSA	AUS	minimum established sensor voltage value upstream cat (new), DLSSA (bank2)
USMNSHA	DLSSA	LOK	minimum established sensor voltage value upstream cat (old), DLSSA, bank 1
USMNSHA2	DLSSA	LOK	minimum established sensor voltage value upstream cat (old), DLSSA, bank 2
USMNSHN	DLSSA	AUS	minimum established sensor voltage value downstream cat (new), DLSSA
USMNSHN2	DLSSA	AUS	minimum established sensor voltage value downstream cat (new), DLSSA
USMXSAA	DLSSA	LOK	maximum established sensor voltage value upstream cat (old), DLSSA, bank 1
USMXSAA2	DLSSA	LOK	maximum established sensor voltage value upstream cat (old), DLSSA, bank 2
USMXSAN	DLSSA	AUS	maximum established sensor voltage value upstream cat (new), DLSSA
USMXSAN2	DLSSA	AUS	maximum established sensor voltage value upstream cat (new), DLSSA (bank2)

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Variable	Source	Type	Description
USMXSHA	DLSSA	LOK	maximum established sensor voltage value upstream cat (old), DLSSA, bank 1
USMXSHA2	DLSSA	LOK	maximum established sensor voltage value upstream cat (old), DLSSA, bank 2
USMXSHN	DLSSA	AUS	maximum established sensor voltage value downstream cat (new), DLSSA
USMXSHN2	DLSSA	AUS	maximum established sensor voltage value downstream cat (new), DLSSA
USRJ	DLSSA	AUS	lambda control threshold without offset, DLSSA
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2
USVKJ	DLSSA	AUS	output voltage oxygen sensor upstream catalyst without offset, DLSSA
USVKJ2	DLSSA	AUS	output voltage oxygen sensor upstream catalyst without offset, DLSSA (Bank2)
USVKJF2_W	DLSSA	LOK	filterd output voltage oxygen sensor upstream cat. without offset, DLSSA (bank2)
USVKJF_W	DLSSA	LOK	filterd output voltage oxygen sensor upstream catalyst without offset, DLSSA

FB DLSSA 14.80 Detailed description of function

```
Data to be calculated for the Lambda sensor signal output for the conventional control:

tuspnf:   Time of the sensor voltage between positive and negative edge
usmxsan:  maximum detected sensor voltage value for signal output upstream catalyst
usmnsan:  minimum detected sensor voltage value for signal output upstream catalyst
usmxshn:  maximum detected sensor voltage value for signal output downstream catalyst
usmnshn:  minimum detected sensor voltage value for signal output downstream catalyst
atvfett:  Integrator manipulated variable for the pilot control towards RICH
atvmager: Integrator manipulated variable for the pilot control towards LEAN
tpsvlssa: Cycle duration of the sensor signal upstream catalyst for signal output
usrj:     Control threshold of the Lambda control (without offset)
usvkj:    Sensor voltage upstream catalyst without negative voltage offset


Data to be calculated for the Lambda sensor signal output for the continuous control:

dlahisa:  Integrator control variable of the downstream control

Data to be calculated for the Lambda sensor downstream catalyst:

usrhkshj: Control threshold of the pilot control downstream catalyst (without offset)
ushkj:    Sensor voltage downstream catalyst (without offset)


1. Determination of the minimum and maximum sensor voltage upstream (SY_STETLR := FALSE) /downstream catalyst

With initialization C_ini the RAM-cells for the old maximum (usmxsaa resp. usmxsha) and for the old minimum (usmnsaa resp. usmnsha)
are set to the starting value USRJ resp. USRHKSHJ.
The RAM-cells for the new maximum (usmxsan resp.usmxshn) and for the new minimum (usmnsan resp. usmnshn) are reset with
powerfail.
The new extremums (minimum resp. maximum of the Lambda sensor voltage upstream and downstream catalyst) are output via the
tester interface.

While driving the absolute minimum resp. maximum is formed within a n-,tl-range, which is preset by the %DLSA.
The current extremum is entered into the RAM-cell "old maximum" resp. "old minimum". The purpose of the filters is to smooth the
input signal usvkj and ushkj.

The extremums are formed according to the following principal:
If the sensor voltage usvkjf_w resp. ushkjf_w is greater than the presently stored positive peak value usmxsaa resp. usmxsha, then
it is overwritten by the currently filtered sensor voltage usvkj resp. ushkj.
If the sensor voltage usvkj resp.ushkj is less than the presently stored negative peak value usmnsaa resp. usmnsha, then it is
overwritten by the currently filtered sensor voltage usvkj resp. ushkj.

As long as the enable flag of the %DLSA cycle duration monitoring (B_dlatp) or of active closed loop B_lrhk remains set for
longer than the time TWDLSSA (engine is in a defined nmot-, rl-range), the new extremum is always overwritten by the current old
extremum and thus made available to the tester interface. The output signal (usmnsan resp. usmnshn as well as usmxsan resp.
usmxshn), however, remains active, i.e. it does not remain frozen for good at an extreme value.

2. Calculation of the time between positive and negative edge upstream catalyst (SY_STETLR := FALSE)

By the section %LR the total time of a controller cycle tpsvkmf_w is calculated summing the positive integrator time tfrp_w and
the negative integrator time tfrn_w. tfrn_w is the time for the positive half cycle of the lambda control and is exactly the time
requested by the SCAN-tool. For (B_dlatp AND B_lrtpp) = TRUE the most recent time tfrn_w will be taken as input to the recursive
filter. As B_lrtpp is calculated in the 10 ms time slot the Bit status is buffered by the  Flip Flop B_tuspn. This Flip Flop will
be reset at the end of the filter calculation using the Bit B_tusre. The RAM used with the recursive filter is located in a non
volatile RAM. The filter constant is SAFK2.


3. I-part of the downstream control   (SY_STETLR := FALSE)

The output value atv of the integrator is given in 40ms increments as absolute value in atvfett and atvmager. This conversion is
necessary since atv is a signed-byte value and can contain positive as well as negative values, however, the CARB tester interface
only allows positive values. For this reason this value is entered into atvfett, if atv contains a positive value and atvmager
is zero in this case. If the value of atv is negative this value is entered as absolute value into atvmager and atvfett is set
to zero.
The quantization between atv (see %LRHK) and atvfett resp. atvmager (40ms) differs! The limiting values for atvfett are ATVFETTO
and ATVFETTU, for atvmager the limiting values are ATVMAGO and ATVMAGU.

4. Cycle duration (SY_STETLR := FALSE)
```

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The cycle duration of the Lambda sensor signal upstream catalyst (tpsvkmf_w) is quantized with 10ms, for the DLSSA the cycle duration (tpsvlssa) needs to be quantized with 40ms. The value tpsvkmf determined in the %LR must therefore be converted accordingly for the DLSSA. The limiting values for tpsvkmf_w are TPSVKMN and TPSVKMX.

5. Control threshold, sensor voltage upstream catalyst (SY_STETLR := FALSE)

The control threshold USR and the sensor voltage upstream catalyst must be converted for the DLSSA output to the CARB tester, since a negative voltage offset is included in the calculation of the BOSCH conversion formula. However, this offset is not provided in the SAE1979. This means that this offset must be subtracted from the constant USR and from the variables usvk. The resulting values are USRJ and usvkj. The conversion formula is the same in both cases.

6. Integrator control variable of downstream control (%LRSHK) (SY_STETLR := TRUE)

The absolute value of the integrator output value dlahi_w is stored in dlahisa (0.0039/increment).
This conversion is required as dlahi_w is considered a two-byte value. Furthermore, dlahi_w may contain positive and negative values. The limits for dlahisa are DLAHISATO and DLAHISATU. However, according to CARB, only unsigned values are permitted. Therefore a offset of HEX 80 is added to dlahisa.

7. Dynamic value dynlsu for the LSU (SY_STETLR := TRUE)

The dynamic properties of the LSU a characterized by the value dynlus calculated by the section %DLSU. dynlsu_w is converted to the Byte-value dynlsusa. The limits for dynlsusa are DYNLSUTU and DYNLSUTO.

8. Threshold value for downstream sensor (SY_STETLR := TRUE/FALSE)

The threshold value USRHKSHJ and the downstream sensor signal voltage must be converted for the DLSSA output, before it is transferred to the CARB tester, since a negative voltage offset is considered in the BOSCH conversion formula (this offset is not considered in SAE 1979). That means that this offset must be subtracted from the variable ushk, which then results in the values ushkj. In either case the conversion formula is the same. The representative controller threshold USRHKSHJ is directly defined as fixed value and output to the tester.

9. DLSSA output routine:

The following values are outputted via the tester interface:

Sensor upstream catalyst (SY_STETLR := FALSE)

```
tuspnf:   filtered time of the sensor voltage between positive and negative edge
usmxsan:  maximum detected sensor voltage value for signal output
usmnsan:  minimum detected sensor voltage value for signal output
atvfett:  TV shift towards RICH
atvmager: TV shift towards LEAN
tpsvlssa: averaged cycle duration of the sensor signal upstream catalyst
usrj:     control threshold from %LR (without offset)
USMNSAMN: minimum detected sensor voltage value for signal output (min. plaus. value)
USMNSAMX: maximum detected sensor voltage value for signal output (max. plaus. value)
USMXSAMN: maximum detected sensor voltage value for signal output (min. plaus. value)
USMXSAMX: minimum detected sensor voltage value for signal output (max. plaus. value)
TUSPNMN:  minimum time of the sensor voltage between positive and negative edge
TUSPNMX:  maximum time of the sensor voltage between positive and negative edge
ATVFETTO: upper limiting value for atvfett
ATVFETTU: lower limiting value for atvfett
ATVMAGO:  upper limiting value for atvmager
ATVMAGU:  lower limiting value for atvmager
TPSVKMN:  lower limiting value for the cycle duration
TPSVKMX:  upper limiting value for the cycle duration
```

Sensor upstream catalyst (SY_STETLR := TRUE)

```
dlahisa:     Integral part calculated by LRSHK
dynlsusa:    Dynamic value calculated by section DLSU
lamsosa:     controller threshold used by %LRS
lamsisa:     actual lambda used by %LRS
LAMSSAMN:    minimum lambda for signal output (min. plausible value)
LAMSSAMX:    maximum lambda for signal output (max. plausible value)
DLAHISATO:   upper threshold for dlahisa
DLAHISATU:   lower threshold for dalhisa
DYNLSUSATO:  upper threshold for dynamic value LSU
DYNLSUSATU:  lower threshold for dynamic value LSU
```

Sensor downstream catalyst (SY_STETLR := TRUE/FALSE)

```
usmxshn:  maximum detected sensor voltage value downstream catalyst for signal output
usmnshn:  minimum detected sensor voltage value downstream catalyst for signal output
USMNSHMN: minimum detected sensor voltage value for signal output (min. plaus. value)
USMNSHMX: minimum detected sensor voltage value downstream catalyst for signal output (max. plaus. value)
USMXSHMN: maximum detected sensor voltage value downstream catalyst for signal output (min. plaus. value)
USMXSHMX: maximum detected sensor voltage value downstream catalyst for signal output (max. plaus. value)
USRHKSHJ: threshold control from %LRHK
```

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The CARB tester interface needs the information in which test IDs data are given, which are to be outputted. This information is given by the test IDs $00, $20, $40, $60, $80, $A0, $C0 and $E0, which are to be understood as bit strings.

The logic "1" in the bit string means that the corresponding value is outputted, the "0" signalizes that no value is outputted from this test ID.
Test ID $00: output upstream sensor , Nernst-Type, conventional control (SY_STETLR := FALSE)

selected by date3/bit 0 (bank 1 /sensor 1)
selected by date3/bit 4 (bank 2 /sensor 1)=====> stereo

	DATA-A								DATA-B								DATA-C								DATA-D							
TEST ID	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20
output yes/no	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	USRJ	USRJ					USMNSAN	USMXSAN	TUSPNF																							^

following ID's used

Test ID $20:

	DATA-A								DATA-B								DATA-C								DATA-D							
TEST-ID	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F	40
output yes/no	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
																ATVFETT	ATVMAGER	TPSVLSSA														

Test ID $40, test ID $60, test ID $80, test ID $A0, test ID $C0 and test ID $E0:

	DATA-A								DATA-B								DATA-C								DATA-D							
TEST ID	x1	x2	x3	x4	x5	x6	x7	x8	x9	xA	xB	xC	xD	xE	xF	x0	x1	x2	x3	x4	x5	x6	x7	x8	x9	xA	xB	xC	xD	xE	xF	x0
output yes/no	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Test ID $00: output upstream sensor , LSU-Type, conventional control (SY_STETLR := TRUE)

selected by date3/bit 0 (bank 1 /sensor 1)
selected by date3/bit 4 (bank 2 /sensor 1)=====> stereo

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DATA-A DATA-B DATA-C DATA-D

TEST-ID	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20
output yes/no	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

^

f o l l o w i n g I D’s u s e d

Test-ID $20:

DATA-A DATA-B DATA-C DATA-D

TEST-ID	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F	40
output yes/no	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

^

f o l l o w i n g I D’s u s e d

DATA-A DATA-B DATA-C DATA-D

TEST-ID	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	60
output yes/no	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

^

f o l l o w i n g I D’s u s e d

DATA-A DATA-B DATA-C DATA-D

TEST-ID	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F	80
output yes/no	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

^

f o l l o w i n g I D’s u s e d

By user definable test-id’s

DATA-A DATA-B DATA-C DATA-D

TEST-ID	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F	90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F	A0
output yes/no	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

^

L A M S I S A J
L A M S O S A J
D Y N L S U S A J
D L A H I S A J

n o f o l l o w i n g I D’s

Test-ID $A0, Test-ID $C0 und Test-ID $E0:

DATA-A DATA-B DATA-C DATA-D

TEST-ID	x1	x2	x3	x4	x5	x6	x7	x8	x9	xA	xB	xC	xD	xE	xF	x0	x1	x2	x3	x4	x5	x6	x7	x8	x9	xA	xB	xC	xD	xE	xF	x0
output yes/no	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Test ID $00: output downstream catalyst (SY_STETLR := TRUE/FALSE):
selected by date3/bit 1 (bank 1 /sensor 2)
selected by date3/bit 5 (bank 2 /sensor 2) =====> stereo

	DATA-A								DATA-B								DATA-C								DATA-D							
TEST ID	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20
output yes/no	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	U	U					U	U																								
	S	S					S	S																								
	R	R					M	M									n o	f o l l o w i n g							I D's							
	H	H					N	X																								
	K	K					S	S																								
	S	S					H	H																								
	H	H					N	N																								
	J	J																														

Test ID $20:

	DATA-A								DATA-B								DATA-C								DATA-D							
TEST-ID	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F	40
output yes/no	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Test ID $40, test ID $60, test ID $80, test ID $A0, test ID $C0 and test ID $E0:

	DATA-A								DATA-B								DATA-C								DATA-D							
TEST-ID	x1	x2	x3	x4	x5	x6	x7	x8	x9	xA	xB	xC	xD	xE	xF	x0	x1	x2	x3	x4	x5	x6	x7	x8	x9	xA	xB	xC	xD	xE	xF	x0
output yes/no	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APP DLSSA 14.80 Application hint

FW name	typical value
ATVFETTO	1.2 s
ATVFETTU	0 s
ATVMAGO	1.2 s
ATVMAGU	0 s
SAFK1	0.1
SAFK2	0.1
TPSVKMN	0.3 s
TPSVKMX	3 s
TUSPNMN	0.15 s
TUSPNMX	1.5 s
TWDLSSA	10 s
USMNSAMN	0.005 V
USMNSAMX	0.4 V
USMXSAMN	0.5 V
USMXSAMX	1.05V
USMNSHMN	0.005 V
USMNSHMX	0.4V
USMXSHMN	0.5 V
USMXSHMX	1.05 V

FW name	typical value
DLAHISATO	0.05
DLAHISATU	-0.05
DYNLSUTU	0.3
DDYNLSTO	4,0
SAFK2	0.1
TWDLSSA	10 s
LAMSSAMN	0.7
LAMSSAMX	2.0

Assignment DLSSA parameter - tester interface

Nernst- sensor upstream catalyst

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Test ID	test value	min. Limit	max. Limit
$01	usrj	-	-
$02	usrj	-	-
$07	usmnsan	USMNSAMN	USMNSAMX
	usmnshn	USMNSHMN	USMNSHMX
$08	usmxsan	USMXSAMN	USMXSAMX
	usmxshn	USMXSHMN	USMXSHMX
$09	tuspnf	TUSPNMN	TUSPNMX
$30	atvfett	ATVFETTU	ATVFETTO
$31	atvmager	ATVMAGU	ATVMAGO
$32	tpsvlssa	TPSVKMN	TPSVKMX

LSU- sensor upstream catalyst

$81	lamsisa	LAMSSAMN	LAMSSAMX
$82	lamsosa	LAMSSAMN	LAMSSAMX
$83	dynlsusa	DYNLSUSATU	DDYNLSUSATO
$84	dlahisa	DLAHISATU	DLAHISATO

Nernst- sensor downstream catalyst

Test ID	test value	min. Limit	max. Limit
$01	usrhkshj	-	-
$02	usrhkshj	-	-
$07	usmnshn	USMNSHMN	USMNSHMX
$08	usmxshn	USMXSHMN	USMXSHMX

The test IDs $00, $20, $40, $60, $80, $A0, $C0 and $E0 are used for the output management.

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DHLS 31.10 Diagnosis; Sensor heating

FDEF DHLS 31.10 Function definition

Overview heater diagnosis

dhls-dhls

Status fault path: sfphsh/v
Error flag: E_hsh/v
Cycle flag: Z_hsh/v
Fault type: TYP_hsh/v
(B_mxhsh/v, B_mnhsh/v, B_sihsh/v, B_nphsh/v)
Clear fault path: B_clhsh/v

Default value active: B_bkhsh/v (optional)
Fault path code: CDTHSH/V
Fault class: CLAHSH/V
Fault intensity: TSFHSH/V
CARB CODE: CDCHSH/V
Table of ambient cond.: FFTHSH/V

Heater diagnosis bank1 upstream catalyst

dhls-dhlsvk

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Heater diagnosis bank2 upstream catalyst

dhls-dhlsvk2

Heater diagnosis bank1 downstream catalyst

dhls-dhlshk

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Heater diagnosis bank2 downstream catalyst

dhls-dhlshk2

ABK DHLS 31.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCHSH	BLOKNR		KL	code word CARB: lambda sensor heating downstream cat
CDCHSH2	BLOKNR		KL	code word CARB: lambda sensor heating downstream cat
CDCHSV	BLOKNR		KL	code word CARB: lambda sensor heating upstream cat
CDCHSV2	BLOKNR		KL	code word CARB: lambda sensor heating upstream cat; (bank2)
CDTHSH			FW	code word tester: oxygen sensor heater downstream catalyst
CDTHSH2			FW	code word tester: oxygen sensor heater downstream catalyst, cyl. row 2
CDTHSV			FW	code word tester: oxygen sensor heater upstream catalyst
CDTHSV2			FW	code word tester: oxygen sensor heater upstream catalyst, cyl. row 2
CLAHSH			FW	Fault class: Heating, lambda sensor downstream of catalytic converter
CLAHSH2			FW	Fault class: Heating, lambda sensor 2 downstream of catalytic converter
CLAHSV			FW	fault class: Heating O2 sensor pre cat
CLAHSV2			FW	fault class:
FFTHSH	BLOKNR		KL	Table of ambient condition for heating O2-sensor post cat
FFTHSH2	BLOKNR		KL	Table ambient conditions heating lambda sensor downstream catalyst bank2
FFTHSV	BLOKNR		KL	Table of ambient condition for heating O2-sensor pre cat
FFTHSV2	BLOKNR		KL	Table of ambient condition for heating O2-sensor post cat bank 2
FRINH1	TKATMF		KL	Multiplication factor for RIN nominal value downstream of the catalyzer
FRINH2	TKATMF2		KL	Multiplication factor for RIN nominal value downstream of the catalyzer
FRINV1	TABGMF		KL	Multiplicativ factor for RIN desired value pre cat
FRINV2	TABGMF2		KL	Multiplicativ factor for RIN desired value pre cat
KFRINH	TKATMF	PHLSNHF	KF	MAP for Nernst resistor post cat
KFRINH2	TKATMF2	PHLSNHF2	KF	MAP for Nernst resistor post cat bank 2
KFRINV	TABGMF	PHLSNVF	KF	MAP for Nernst resistor pre cat
KFRINV2	TABGMF2	PHLSNVF2	KF	MAP for Nernst resistor post cat , bank 2
TADHMN			FW	lower Temperature threshold for die heater diagnostic routine
TADHMX			FW	upper Temperature threshold for die heater diagnostic routine
TSFHSH			FW	fault active time: lambda sensor heating catalyst downstream
TSFHSH2			FW	fault active time: lambda sensor heating catalyst downstream, bank2
TSFHSV			FW	fault active time: lambda sensor heating catalyst upstream
TSFHSV2			FW	fault active time: lambda sensor heating catalyst upstream, bank 2
TVFHS			FW	Dejettering time for heater power stage
TVHSEE			FW	Debounce time for heater output stage fault
TVRIF			FW	Delay time for Ri fault
UBDLS			FW	battery voltage threshold for release the sensor diagnosis
UBDLSMX			FW	upper battery voltage threshold for the sensor diagnosis
UHDMN			FW	Threshold for powered heater power stage
UHDMX			FW	Threshold for not powerded heater power stage
ZKARIH			FW	Filter time const. sim. dyn. ceramic temp. for exhaust emis. temp. downstr. cat.
ZKARIV			FW	Filter time constant for modeling of dynamic of ceramic temp. from ATM pre cat
ZKPRIH			FW	Filter for sim. of dynamics for ceramic temp. from elec. heat. downstr.of cat.
ZKPRIV			FW	Filter for modeling of dynamic of ceramic temp. from electric circuit pre cat

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_ATMTPA	ATM	EIN	condition temperature upstream catalyst exceeds dew-point
B_ATMTPA2	ATM	EIN	condition temperature upstream catalyst exceeds dew-point2

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Variable	Source	Type	Description
B_ATMTPK	ATM	EIN	condition temperature downstream catalyst exceeds dew-point
B_ATMTPK2	ATM	EIN	condition temperature downstream catalyst exceeds dew-point2
B_CDHSH	PROKON	EIN	function active per codeword CDHSH
B_CDHSV	PROKON	EIN	function active per codeword CDHSV
B_CLHSH		EIN	condition clear failure path DHLSHK
B_CLHSH2		EIN	condition clear failure path DHLSHK2
B_CLHSV		EIN	condition clear failure path DHLSVK
B_CLHSV2		EIN	condition clear failure path DHLSVK2
B_HSHE	HLS	EIN	condition for lambda sensor heating-switch downstream cat on
B_HSHE2	HLS	EIN	condition for lambda sensor2 heating-switch downstream cat on
B_HSVE	HLS	EIN	condition for lambda sensor heating-switch upstream cat on
B_HSVE2	HLS	EIN	condition for lambda sensor2 heating-switch upstream cat on
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_MNHSH	DHLS	AUS	Short circuit of heating O2 sensor post cat to ground
B_MNHSH2	DHLS	AUS	Short circuit of heating O2 sensor post cat to ground
B_MNHSV	DHLS	AUS	Short circuit heater Lambda sensor upstream of the catalyzer to ground
B_MNHSV2	DHLS	AUS	Short circuit heater Lambda sensor2 upstream of the catalyzer to ground
B_MXHSH	DHLS	AUS	Short circuit of heating O2 sensor post cat to Ubatt
B_MXHSH2	DHLS	AUS	Short circuit of heating O2 sensor 2 post cat to Ubatt
B_MXHSV	DHLS	AUS	Short circuit heater Lambda sensor upstream of the catalyzer to UB
B_MXHSV2	DHLS	AUS	Short circuit heater Lambda sensor2 upstream of the catalyzer to UB
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_NPFHSH	DHLS	LOK	Nernst resistance sensor downstream of the catalyzer too large
B_NPFHSH2	DHLS	LOK	Nernst resistance sensor 2 downstream of the catalyzer too large
B_NPFHSV	DHLS	LOK	Nernst resistance sensor upstream of the catalyzer too large
B_NPFHSV2	DHLS	LOK	Nernst resistance sensor 2 upstream of the catalyzer too large
B_NPHSH	DHLS	AUS	Nernst resistance sensor downstream of the catalyzer too large
B_NPHSH2	DHLS	AUS	Nernst resistance sensor 2 downstream of the catalyzer too large
B_NPHSV	DHLS	AUS	Nernst resistance sensor upstream of the catalyzer too large
B_NPHSV2	DHLS	AUS	Nernst resistance sensor 2 upstream of the catalyzer too large
B_RINH	GGLSH	EIN	Condition internal resistance of Ri-measur. of sensor active downstream cat.
B_RINH2	GGLSH	EIN	Condition internal resist. of Ri-meas. sensor active downstream cat. bank2
B_RINV	GGLSV	EIN	Condition: Internal resistance Ri of O2 sensor activ,pre cat
B_RINV2	GGLSV	EIN	Condition: Internal resistance Ri of O2 sensor activ,pre cat bank 2
B_SIHSH	DHLS	AUS	Load disconnection lambda sensor heating downstrean cat.
B_SIHSH2	DHLS	AUS	Load disconnection lambda sensor heating downstrean cat. bank 2
B_SIHSV	DHLS	AUS	Load drop sensor heating upstream of the catalyzer
B_SIHSV2	DHLS	AUS	Load drop sensor heating2 upstream of the catalyzer
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_HSH	DHLS	AUS	error flag: lambda sensor heating downstream cat
E_HSH2	DHLS	AUS	error flag: lambda sensor heating downstream cat on the right
E_HSV	DHLS	AUS	error flag: lambda sensor heating upstream cat
E_HSV2	DHLS	AUS	error flag: lambda sensor heating upstream cat on the right
PHLSNH	HLS	EIN	Standardized heating power of the Lambda sensor downstream of the catalyzer
PHLSNH2	HLS	EIN	Standardized heating power of the Lambda sensor 2 downstream of the catalyzer
PHLSNHF	DHLS	LOK	Standardized heating power of Lambda sensor downstream of catalyzer, filtered
PHLSNHF2	DHLS	LOK	Standardized heating power of Lambda sensor 2 downstream of catalyzer, filtered
PHLSNV	HLS	EIN	normalized heating power of lambda sensor upstream of catalyst
PHLSNV2	HLS	EIN	normalized heating power of lambda sensor 2 upstream of catalyst
PHLSNVF	DHLS	LOK	Norm heating power of lambda sensor,pre cat, filtered
PHLSNVF2	DHLS	LOK	Norm heating power of lambda sensor 2 pre cat, filtered
RINH2_W	GGLSH	EIN	Act. value (word) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH_W	GGLSH	EIN	Actual value (word) internal res. Ri-Nernst cell lambda sensor downstream cat
RINKFH	DHLS	LOK	Internal resistance Nernst cell of Lambda sensor from mapping upstream of cat.
RINKFH2	DHLS	LOK	Internal resistance Nernst cell of Lambda sensor 2 from mapping upstream of cat.
RINKFV	DHLS	LOK	Internal resistance of lambda sensor from map pre cat
RINKFV2	DHLS	LOK	Internal resistance of lambda sensor 2 from map pre cat
RINSH2_W	DHLS	LOK	Lim. value internal resistance Nernst cell of Lambda sensor 2 downstream of cat.
RINSH_W	DHLS	LOK	Lim. value internal resistance Nernst cell of Lambda sensor downstream of cat.
RINSV2_W	DHLS	LOK	Limit value of internal resistor of Nernst cell of lambda sen post cat bank 2
RINSV_W	DHLS	LOK	Limit value of internal resistor of Nernst cell of lambda sen. post cat
RINV2_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor 2, pre ca
RINV_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor,pre cat (word)
R_T100		EIN	Time schedule 100 ms
R_T50		EIN	Time schedule 50 ms
SFPHSH	DHLS	AUS	status fault path:
SFPHSH2	DHLS	AUS	status fault path:
SFPHSV	DHLS	AUS	Fault-path status: Lambda-sensor heating upstream of catalytic converter
SFPHSV2	DHLS	AUS	Fault-path status: Lambda-sensor 2 heating upstream of catalytic converter
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TABGMF	DHLS	LOK	Exhaust gas temperature upsteam cat from exhaust temperature -filtered-
TABGMF2	DHLS	LOK	exhaust gas temperature upsteam cat from exhaust temperature -filtered- Bank 2
TKATM	ATM	EIN	catalyst temperature (model)
TKATM2	ATM	EIN	catalyst temperature (model), bank2
TKATMF	DHLS	LOK	Filtered catalyzer temperature from model
TKATMF2	DHLS	LOK	Filtered catalyzer temperature from model, Bank2
UB	GGUB	EIN	battery voltage

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Variable	Source	Type	Description
UHSH		EIN	Voltage at ECU heating power stage, post cat
UHSH2		EIN	Voltage at ECU heating power stage 2, post cat
UHSV		EIN	Voltage at the heater output stage upstream of the catalyzer
UHSV2		EIN	Voltage at the heater output stage 2 upstream of the catalyzer
Z_HSH	DHLS	AUS	cycle flag of lambda sensor heating downstream cat
Z_HSH2	DHLS	AUS	cycle flag of lambda sensor heating downstream cat, cylinder row 2
Z_HSV	DHLS	AUS	cycle flag of lambda sensor heating upstream cat
Z_HSV2	DHLS	AUS	cycle flag of lambda sensor heating upstream cat, cylinder row 2

FB DHLS 31.10 Detailed description of function

With this DHLS an indirect check is performed on whether the heating of the Lambda sensor is operational, i.e. the measurement of the heater current by means of a shunt performed so far is abandoned.
As criterion for the diagnosis the internal resistance of the Nernst cell of the Lambda sensor is used. With defective sensor heating the internal resistance (rinv_w) is essentially larger. For the determination of rinv_w the sensor voltage must be periodically connected to load with 0,5mA for 10ms (%GGLSV/H).
In addition the switching behaviour of the heater power stage is monitored. For this an ADC-channel with a circuit per power stage is necessary, which is scanned in the 10ms grid. This circuit is necessary for the detection of "load drop".
Circuit: 10 kOhm to ground, 10 kOhm to 5 Volt and connection ADC to power stage output via 22 kOhm.

Diagnosis internal resistance of the Nernst cell

Since the internal resistance rinv_w is also dependent on the exhaust gas temperature and on the el. heating performance (phlsnv), the typical value of rinv_w is stored in a map from tabgm and phlsnv.
tabgm and phlsnv are filtered, since a change only affects rinv_w after a delay.

Preconditions:
1. rinv_w is updated (B_rinv = 1)
2. The exhaust gas temperature is greater than the threshold TADHMN and lower than TADHMX
3. UB is within the diagnosis range

Diagnosis:
If rinv_w is less than rinsv_w, then B_hsokv is set (Ri OK!) if additionally the switching behaviour of the power stage is OK.
If rinv_w is greater, then B_nphsv is set (Ri too large!).

Diagnosis switching behaviour of the heater power stage

For diagnosis purposes the power stage is switched off every 10s for 100ms (in %HLS). Then a check on whether the power stage is operational and whether the heater is connected to the battery voltage is performed.

Preconditions:
1. The power stage is switched on and off
2. UB must lie within the diagnosis range
3. The switch-off capability of the power stage (heater connected to UB) is stored

Diagnosis:
By a logic combination of the input and output of the power stage the power stage operation is checked.
The faults are delayed by the time TVFHS in order to take into consideration fault reports, which are caused by calculation execution times between B_hsve and uhsv.

Fault management

The debouncing of the heater faults is performed during two drives. If a heater fault is detected the fault lamp is only triggered if a fault is again detected during the second drive.

APP DHLS 31.10 Application hint

Fault memory relevant values of the %DHLSHK are assigned to the %DFPM_hsh in the function-orientated selection.

To be adjusted:					Sensor type:		
					LSH25P	LSH25PL	LSF4.7
TADHMN = 200°C	UBDLSMX = 15.5V	TVHSEE = 5s		ZKARIV, ZKARIH =	20s	46s	21s
TADHMX = 600 °C	UBDLS = 10.7V	UHDMN = 2.34V		ZKPRIV, ZKPRIH =	35s	35s	10s
TVFHS = 0.04s	UHSN = 13.0V (%HLS)	UHDMX = 3.6V					

TVRIF = 3s

KFRINV_W

The map values are determined by a measuring sensor with typical Nernst and heater internal resistance (from K3-LS/ESV).
The measuring sensor must be of the same type as the intended control sensor.
Adjust exhaust gas temperature to a base point value by an according selection of load and engine speed. It is possible to adjust phlsnv (performance) to a base point value by changing THSVKTA (in %HLS). Enter the value of rinv_w into the map after approx. 60s.

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phlsnv	LSH25P EX. GAS TEMPERATURE 200	300	400	500	600
PERFORM 1.0					
PERFORM 0.8					
PERFORM 0.7					

phlsnh	LSH25PL EX. GAS TEMPERATURE 200	300	400	500	600
PERFORM 1.0					
PERFORM 0.8					
PERFORM 0.7					

phlsnv	LSF4.7 EX. GAS TEMPERATURE 200	300	400	500	600
PERFORM 1.0	288	256	224	192	160
PERFORM 0.8	448	384	352	320	224
PERFORM 0.7	704	608	544	384	320

FRINV1/2 tkatmf/FRINH 200/63 300/63 400/30 500/10 600/5

The larger the factor FRINV/H is adjusted the more "inaccurate" the diagnosis of the internal resistance of the Nernst cell becomes. The map KFRINV/H , %ATM and the %HLS must already have been adjusted.
The faults E_hsv and B_nphsv should be entered, if the sensor heating operates with little heating performance only. This can be achieved by connecting a resistor in series to the heater and if FRINV/H is changed accordingly.
Necessary resistor: LSF4.7 ~ 20 Ohm, LSH25 ~ 5 Ohm.
Approach:
Connecting the resistor in series to the heater, then do the same as description for KFRINV/H (only for phlsnh = 1).
FRINH = rinv_w with series-resistor / rinv_w without series_resistor.

GGUB 11.10 Sensor variable for battery voltage incl. diagnosis

FDEF GGUB 11.10 Function definition

ggub-ggub

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Fault memory management:

```
Status fault path UB:   SFPUB
Error flag UB:          E_ub
Cycle flag UB:          Z_ub
Fault type UB:          B_mxub
                        B_mnub
                        B_npub
                       (B_siub)


Reset fault path:      C_fcmclr & B_club
Fault path UB:                     CDTUB
Fault class UB:                    CLAUB
Fault rate UB:                     TSFUB
Carb Code UB:                      CDCUB
Freeze frame table ub:             FFTUB
```

ABK GGUB 11.10 Abbreviations

ABK GGUB 11.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCUB	BLOKNR		KL	code word CARB: battery voltage UB (onboard)
CDTUB			FW	code word tester: power supply voltage UB
CLAUB			FW	error class: battery voltage UB (onboard)
FFTUB	BLOKNR		KL	freeze frame table: battery voltage UB (onboard)
TDNSUB			FW	time period for battery after start
TDUB			FW	delay time of voltage diagnosis
TSFUB			FW	fault active time: battery voltage UB (onboard)
UBDE			FW	replace value for UBATT at damaged AD-channel
UBDMN1			FW	min. battery voltage (power supply)
UBDMN2			FW	min. battery voltage (ADC)
UBDMX			FW	max. battery voltage
UBNACHL			FW	UB-replace value during ECU afterrun
VMDUB			FW	Lower threshold of vehicle speed for battery voltage diagnosis

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_BKUB	GGUB	AUS	condition backup value for battery voltage (onboard)
B_CLUB		EIN	condition clear fault path battery voltage (onboard)
B_MNUB	GGUB	AUS	fault type: minimum value of battery voltage (onboard)
B_MXUB	GGUB	AUS	fault type: maximum value battery voltage (onboard) exceeded
B_NPUB	GGUB	AUS	Error type: signal of battery voltage not plausible
B_STEND	BBSTT	EIN	condition end of start
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF		EIN	ECU-condition powerfail initialisation
E_UB	GGUB	AUS	error flag: power supply voltage UB
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SFPUB	GGUB	AUS	status fault path: battery voltage UB (onboard)
SY_UBKL15	PROKON	EIN	system constant onboard battery voltage scanned from ignition key on input
SY_UBSQ_W		EIN	System constant conversion factor UB resolution to standard quantization ubsq
UB	GGUB	AUS	battery voltage
UBSQ	GGUB	AUS	battery voltage (on board), conversed to standard quantization
UBSQF	GGUB	AUS	battery voltage (on board), conversed to standard quantization and low pass filt
UBSQF_W	GGUB	AUS	battery voltage (on board), conversed to standard quantization and low pass filt
UBSQ_W	GGUB	AUS	battery voltage (on board), conversed to standard quantization
VFZG	GGVFZG	EIN	vehicle speed (km/h)
WUB	GGUB	LOK	battery voltage; scanned value of ADC
WUB_W		EIN	battery voltage; scanned value of ADC (16Bit from 10Bit resolution)
Z_UB	GGUB	AUS	cycle flag: power supply voltage UB

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FB GGUB 11.10 Detailed description of function

If the signal is below the threshold UBDMN2, this points to a fault in the UB determination in the ECU (e.g. ADC), since, if U <= 2.5 V, the processor does not work. The use of a substitute value (UBDE) is only useful and intended of this type of fault.

On the other hand a max. value check is only effective after the delay TDNSUB and only with a rolling vehicle (and with faultless speed signal). This is intended to avoid a faulty diagnosis which could arise, for example in the case of start assistance with a 24 V battery. Conversely, if setting conditions for B_maxflr will disappear, a B_maxflr based error will be reset in case of falling below max. threshold only.

The check of the lower threshold UBDMN1 (fault in board voltage system) is also allowed only after the waiting period TDNSUB from the start end when the board voltage has recovered from the breakdown caused by the start procedure.

As soon as one of the threshold value scans (>UBDMX / <UBDMN1 / <UBDMN2) have been fulfilled, the respectiv bits (B_maxflr /B_minflr /B_plaus) and the error and cycle flags after expiry of the debouncing time TDUB will be set simultaneously. A common debouncing period is provided for the fault detection in order to limit the expenditure of ram cells for the time monitoring. Conversely in I.O. case (B_noflr) the debouncing period TDUB also has to expire before the fault flag is reset.

The cycle flag is either set parallel to the fault B_minflr / E_ub, as described above, or, in all other cases, especially when no fault is detected, at the latest when the recovery period TDNSUB expires after the start end.

APP GGUB 11.10 Application hint

Reference values: UBDMX 16 V; UBDMN1 10 V; UBDMN2 2,5 V; TDNSUB ca. 3 min
TDUB ca. 200ms

DU5REF 1.20 Diagnosis: 5 V internal power voltage

FDEF DU5REF 1.20 Function definition

du5ref-du5ref

ABK DU5REF 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCU5REF	BLOKNR		KL	code word CARB: APU voltage supply (5V)
CDTU5REF			FW	code word tester: voltage supply (5V)
CLAU5REF			FW	fault class: voltage supply (5V)
FFTU5REF	BLOKNR		KL	freeze frame: voltage supply (5V)
TDU5REF			FW	error detection 5 V reference / time for interrogation
TSFU5REF			FW	fault active time: voltage supply (5V)
U5REFMN			FW	min. threshold 5 Volt reference voltage diagnostic

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_CLU5REF		EIN	Condition error flag delete "5 V reference"
B_MNU5REF	DU5REF	AUS	fault type: too low 5 V reference voltage
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_U5REF	DU5REF	AUS	error flag: internal 5 V reference voltage
IUREFSP1_W		EIN	adc value incl. channel number, 5 V reference voltage
IUREFSP2_W		EIN	adc value incl. channel number, 5 V reference voltage
U5REF1	DU5REF	AUS	adc value 5 V reference voltage 1
U5REF1_W	DU5REF	LOK	adc value 5 V reference voltage 1
U5REF2	DU5REF	AUS	adc value 5 V reference voltage 2

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Variable	Source	Type	Description
U5REF2_W	DU5REF	LOK	adc value 5 V reference voltage 2
Z_U5REF	DU5REF	AUS	cycle-flag: internal 5V reference voltage

FB DU5REF 1.20 Detailed description of function

APP DU5REF 1.20 Application hint

GGTFM 36.40 Signal engine temperature sensor

FDEF GGTFM 36.40 Function definition

overview

ggtfm-ggtfm

detection of blockheater

ggtfm-blckheat

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ggtfm-err-detect

ggtfm-tmot-dekr

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model calculations for engine coolant temperature (overview)

ggtfm-model-calc

reference temperature:
initialization and control block

ggtfm-ref-mtemp

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substitute temperature:
initialization and control block

ggtfm-subst-mtemp

Fault memory management:

```
Status fault path TMOT: SFPTM
Error flag TMOT:        E_tm
Cycle flag TMOT:        Z_tm
Fault type TMOT:        B_mxtm
                        B_mntm
                        B_nptm
                        B_sitm


Reset fault path:      C_fcmclr & B_cltm
Fault path TMOT :                 CDTTM
Fault class TMOT:                 CLATM
Fault rate TMOT:                  TSFTM
Carb Code TMOT:                   CDCTM
Freeze frame table TMOT:          FFTTM
```

ABK GGTFM 36.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCTM	BLOKNR		KL	code word CARB: engine coolant temperature TMOT
CDTTM			FW	code word tester: engine temperature
CLATM			FW	error class: engine coolant temperature TMOT
DTLRTML	ML		KL	proportion factor to decrease waiting time up to tmot-threshold for closed loop
DTMDMA			FW	start offset for engine temperature model
DTMDNPO			FW	offset on engine temperature model to upper threshold for non-plausibility
DTMSRT			FW	difference of engine cool.temp.to starttemp.for retriggering models (blockheater
FABSTT	TABST_W		KL	Factor parking time for model temperature
FFTTM	BLOKNR		KL	freeze frame table: engine temperature TMOT
KFDTMTE	ML	TMEW	KF	char. map for gradient of engine coolant temperature in substitute temp. model
KFDTMTR	ML	TMRW	KF	char. map for gradient of engine coolant temperature in reference model
KFDTMTU	ML	TUMG	KF	char. map for correction gradient of engine coolant temp. at low warming up
KLDTMRS	TMRW		KL	char.line for gradient of engine coolant temp. during cutoff for reference model
TADMM			FW	1. step width (time) for engine temperature model
TDTM			FW	debouncing time, engine temperature sensor
TDTMMA			FW	delay time load value engine temperature model
TMDMMA			FW	begin temperature for engine temperature model
TMDMMAT	TABST_W		KL	Default temperature dependent on parking time during TDTMMA
TMDMMAU			FW	lower start temperature from tans for engine temperature model
TMDMMEE			FW	final temperature for substitute value of engine temperature
TMDMMER			FW	final temperature for reference value of engine temperature

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Parameter	Source-X	Source-Y	Type	Description
TMDMN			FW	minimum engine temperature
TMDMX			FW	maximum engine temperature
TMLRTMS	TMST		KL	engine temp. threshold for lambda control depending on cranking temp. tmst
TMMXRT			FW	max. engine cool.temp. for retriggering models (blockheater-detection)
TMOTELI	WTMOT		KL	engine temperature calculation, inverse function
TNSRT			FW	max. time after start to retrigger calculation of engine temperature model
TSFTM			FW	fault active time: engine coolant temperature sensor TMOT
TUMDETM			FW	substitute value of ambient (-air) temperature for engine coolant temp. model
TWLRTMS	TMST		KL	waiting time up to check engine temp. signal exceeding threshold for closed loop

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_ANFW	GGTFM	LOK	condition drive away support activated
B_BKTM	GGTFM	AUS	condition backup value for engine coolant temperature
B_CLTM		EIN	condition clear fault path engine coolant temperature TMOT
B_ETOL	PROKON	EIN	Condition fault in oil temperature
B_ETUM	GGTFUMG	EIN	Condition fault in ambient temperature
B_MNTM	GGTFM	AUS	fault type: minimum value of engine coolant temperature
B_MXMNTM	GGTFM	AUS	Condition min- or max fault of engine temperature sensor existing
B_MXTM	GGTFM	AUS	fault type: maximum value of engine coolant temperature exceeded
B_NMIN		EIN	condition lower speed: n $<$ NMIN
B_NMOT	BGNMOT	EIN	condition engine speed: n $>$ NMIN
B_NOKATFZ	KATV	EIN	condition: no cat vehicle
B_NPTM	GGTFM	AUS	Error type: engine coolant temperature signal not plausible to model
B_SA	MDRED	EIN	Condition fuel cut-off
B_SITM	GGTFM	AUS	Error type: coolant temperature below threshold to cut in lambda closed loop
B_ST	BBSTT	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_TMDMME	GGTFM	AUS	Condition final temperature of engine temperature model reached
B_TMMN	GGTFM	LOK	Condition: blockheater detected
B_TMSRT	GGTFM	AUS	condition: retriggering engine temperature model after start
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_CINS	DCINS	EIN	Error flag: CAN interface, timeout instrument
E_TA	GGTFA	EIN	error flag: TANS
E_TM	GGTFM	AUS	Error flag: engine temperature tmot
ML	BGSRM	EIN	air mass flow
R_T100		EIN	Time schedule 100 ms
R_T1S		EIN	Time schedule 1 s
SFPTM	GGTFM	AUS	status fault path: engine coolant temperature TMOT
SY_TABST		EIN	System constant: Off-time exists (initial. GGTFM default value)
SY_TFMA	PROKON	EIN	system constant: intake air temperature signal available (initial. GGTFM)
SY_TFMO	PROKON	EIN	system constant: engine oil temperature signal available (initial. GGTFM)
SY_TFUMG	PROKON	EIN	system constant: ambient temperature sensor present
TABST_W	BGTABST	EIN	soak time
TANS	GGTFA	EIN	Intake air temperature
TDLRTM	GGTFM	AUS	remaining time up to check of tmot-signal exceeding threshold for closed loop
TMEW	GGTFM	AUS	model-based substitute value for engine temperature signal in case of error
TMEWAB	GGTFM	AUS	Engine temperature default value from model when parking
TMOT	GGTFM	AUS	Engine temperature
TMOTAB	GGTFM	AUS	engine coolant temperature at engine stop or cut-off cranking
TMOTLIN	GGTFM	AUS	Engine coolant temperature, linearised and calculated
TMOTVT	GGTFM	LOK	engine coolant temperature at low-pass input
TMRW	GGTFM	AUS	model-based reference value for plausibility check of engine temperature signal
TMRWEND	GGTFM	LOK	final value for the reference value of the engine temperature model
TMST	GGTFM	AUS	engine temperature at start
TOL		EIN	Engine-oil-temperature
TUMG	GGTFUMG	EIN	Ambient air temperature
WTMOT		EIN	ADC result of engine temperature sensor
Z_TM	GGTFM	AUS	cycle flag:ˆengine temperature TMOT

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FB GGTFM 36.40 Detailed description of function

Description of the overview and detection of blockheating:

Under normal circumstances, the engine temperature tmot is established from the input signal utmot linearized via TMOTELI. In the event of an error, which is determined via the fault detection, there is an immediate switchover to a substitute temperature which is computed from a model.
The fault detection tests for plausibility of the temperature course as well as testing the minimum and maximum values.

That temperature initially sampled is stored as engine start temperature (under tmst), to be refreshed at the beginning of start.
A start with pre-heated block is supposed according to the measured temperature curve during a one-shot timeout after start (TNSRT). As long as the engine temperature is determined to be lower than the value intially measured (in this case B_tmsrt =true is valid), the value for engine start temperature is refreshed up to its minimum as preparation for retriggering models. As soon as these conditions disappear, the calculations of the minimum plausibility limit (reference temperature model) resp. the waiting time up to check exceeding cut-in temperature for lambda closed loop control will be released.

In order to receive a "turn-off ignition" temperature, the validated temperature value is stored cyclically in a permanent-RAM cell named tmotab under nomal operation conditions after end-of-start; restoring additionally during start up to any break.

Description of the fault detection:

If the linearized engine temperature tmotlin exceeds the maximum or minimum plausibility limits, B_maxflr and B_minflr are set respectively, as are the error and cycle flags after the debounce time TDTM has elapsed.

A plausibility check of the engine temperature is performed by a comparison of the measured engine temperature tmotlin with a reference temperature tmrw. The reference temperature tmrw which is continually updated is reduced by the safety margin DTMDMA and compared with the temperature determined. If this does not increase by the amount expected (e.g. parallel circuit or short circuit to a plausible potential),the error flag is set is set after the same debounce time TDTM as above. During the retrigger phase induced by blochheating, the plausibility check is precautionarily disabled.

Furthermore, it is checked whether the engine temperature exceeds the switch-on threshold for lambda closed loop control. The engine temperature must exceed this threshold after a given period of time which depends on the engine starting temperature. The processing of the waiting time tdlrtm is influenced depending on the air mass flow. Decreasing of the waiting time is stopped during fuel cutoff mode in particular. If the temperature threshold to cut in lambda control is not reached within the time this period has elapsed, the B_signal=1 is set and a fault entry is made by E_tm.
As the waiting time until attainment of the cut-in threshold is itself dependent on this temperature, the waiting time must be adjusted accordingly to a change in the temperature threshold.
The error path B_signal is suppressed after a start with the block heater as long as the conditions for this are present (B_tmsrt=1).

The cycle flag is set immediately upon occurrence of a fault E_tm. The cycle flag is set without a fault entry, not only after expiration of the waiting time tdlrtm but also when the reference temperature tmrw has reached the cut-in temperature for lambda closed loop control.

The error flag is reset by B_noflr, if there is no fault present for the debounce time TDTM. This debounce time is necessary in order that at scattered interferences on e.g. a broken line will not always be detected as being in order.

B_maxflr: - low input voltage by short circuit to ground
The picked up signal by the RB's standard NTC engine temperature sensor permit the direct information of an unplausible temperature range above TMDMX.

B_minflr: - high input voltage by cable drop or short circuit to supply voltage
For the circuitry variant without R_parallel, this threshold must be disabled, i.e. TMDMN=00h.

B_plaus: - increase in the engine temperature is not plausible

B_signal: - engine temperature threshold to enable lambda closed loop control not attained after the waiting period

Model temperatures:
By the creation of a model, a reference temperature for the diagnosis and a substitute temperature, which is employed, if a fault condition exists, are established. Both model temperatures' characteristic lines are independent of each other.

Description of the reference temperature:
Beginning with the measured starting temperature, the reference temperature is updated after a delay time TADMM with a (rising or falling) gradient map-dependent on the air mass flow and the temperature level currently computed. The increase of the model temperature is limited by an upper final value tmrwend. This final value is derived from the maximum of TMDMMER and the engine temperature threshold to cut in the lambda closed loop control.
Unlike the versions up to 25.xx, possible drops in the engine temperatures or very low rises, such as can occur for example for very low ambient temperatures and operations near to idling/fuel cutoff, are taken into account in the calculation of the reference temperature; i.e. temperature gradients (= gradient S) with a negative sign can be stored in the map KFDTMTR resp. in the characteristic line KLDTMRS, that is selected during fuel cutoff.

Description of the substitute temperature:
The substitute temperature is established similar to the reference temperature. They differ however in the following points: In order to prevent an incorrect selection in case of a later detected non-plausibility of tmotlin, initialization here is not done by starting temperature. Instead of this the initial value is taken from the engine oil temperature, if this signal is available and correct, otherwise from the intake air temperature tans. Finally a substitute value TMDMMA is taken in case of an error E_ta or if no TANS-sensor is present. The initial value taken from tans is also limited to TMDMMA as required.
The earliest possible detection of an unplausible Tmot value (following the first AD conversion or for the E_tm already set from the previous cycle) leads to the selection of a substitute value. Unlike the versions up to 25.xx, calculations are permitted to reduce the substitute temperature for operations near idling (negative temperature gradients are hence also possible in the map KFDTMTE).

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APP GGTFM 36.40 Application hint

Method of proceeding for applications:

IMPORTANT (OBDII recall may occur if not observed):
The passenger compartment heating(s) is to be operated at the highest power level for all measurements around the GGTFM applications, i.e. heater fan at the highest level as well, intaken air from the outside, windows open (so-called "coffee start" conditions).
As a minimum, both measurements designated with (***) shall be performed in the cold cell at -40 degC.
A blower shall be directed to the radiator grill for circulation in the engine compartment.

1. The following measurable signals shall be recorded: air mass flow, engine speed, engine temperature. A sampling rate of once per second would be sufficient.

2. 5 warm-up characteristics should be recorded for generation of the characteristic maps KFDTMTR,-E:
   - (***) Warming-up at nominal idling speed (minimum air mass flow)
   - Warming-up at full load and nominal speed (maximum air mass flow)
   - 3 additional warming-ups between these with the following levels of speed and air mass flow:
     - (***) double idling speed and triple idling air mass flow
     - half the nominal speed and 25 % of the maximum air mass flow
     - 75 % of the nominal speed and 60 % of the maximum air mass flow

3. The gradients of the temperature are to be transferred into the map points accordingly to their dependency on air mass flow and temperature. IMPORTANT: the gradient 0 is to be entered for the idling air mass flow and that minimal temperature, which adjusts itself under above mentionned worst-case conditions in the stationary idling operation mode. The gradients are negative signed above this temperature !

4. The dead time until inception of the temperature modelling (TADMM) is determined as follows:
   - the temperature curves recorded shall be approximated by compensating straight lines.
   - the intersection of these straight lines with the initial temperature gives the dead time.
   - The maximum value of the 5 temperature curves is to be chosen for the dead time.

5. DTMDMA shall be set such that the actual engine temperature cannot fall below (tmrw-DTMDMA) under any circumstances (recommended value 10 degC).

6. The starting temperature TMDMMA, which is assumed for as the starting temperature for the model, if not only the coolant temperature but also the (oil- and) intake air temperature have already been detected as being faulty, shall be set such that an engine start takes place under most of all conditions (especially for a turned-off engine which is still warm).

7. The final values for the temperature model shall be set as follows:
   - TMDMMEE = nominal opening temperature of the radiator thermostat valve (recommended value 90 degC).
   - TMDMMER = minimum possible temperature during normal operation under worst-case conditions (recommended value 60 degC).

8. The time for a possible retriggering of the model TNSRT takes a drop in the engine temperature after starting into account in case of engine pre-warming (block heater). TNSRT shall be set such that the output temperature will be reached within this time even if the engine has been warmed-up considerably (recommended value: 2 min).
   The fixed value DTMSRT means a hystersis threshold to reset the retrigger condition of blockheater (recommended value: 2 degC).

9. The characteristic line DTLRTML shall be filled by value 0 up to twice the idling air mass flow as a minimum. Above this, values can be set to 1.

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GGTFA 15.10 Diagnosis; intake air temperature sensor

FDEF GGTFA 15.10 Function definition

GGTFA acquisition and diagnostic checks of signal from intake air temperature input

ggtfa-ggtfa

```
Fault memory management:
_______________________

Status fault path TANS: SFPTA
Error flag TANS:        E_ta
Cycle flag TANS:        Z_ta
Fault type TANS:        B_mxta
                        B_mnta
                        B_npta
                        B_sita


Reset fault path:      C_fcmclr & B_clta
Fault path TANS :                 CDTTA
Fault class TANS:                 CLATA
Fault rate TANS:                  TSFTA
Carb Code TANS:                   CDCTA
Freeze frame table TANS:          FFTTA
```

ABK GGTFA 15.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCTA	BLOKNR		KL	code word CARB: intake air temperature
CDTTA			FW	code word tester: intake-air temperature
CLATA			FW	error class: intake air temperature TANS
FFTTA	BLOKNR		KL	freeze frame table: air intake temperature TANS
TADE			FW	substitute value air temperature in case of fault
TADMN			FW	intake-air temperature min.
TADMX			FW	intake-air temperature max.
TANSELI	WTANS		KL	intake air temperature calculation, inverse function
TDNSTA			FW	exhaust manifold warming time from start, for TANS - Diagnostic
TDTA			FW	time for diagnosis intake air temperature sensor
TDTAL			FW	intake-air temperature error detection/time-out from B_LL = 1
TSFTA			FW	fault active time: intake air temperature sensor TANS

Variable	Source	Type	Description
B_BKTA	GGTFA	AUS	condition backup value for intake air temperature
B_CLTA		EIN	condition clear fault path intake air temperature TANS
B_LL	MSF	EIN	Condition idle
B_MNTA	GGTFA	AUS	fault type: minimum value of intake air temperature TANS
B_MXTA	GGTFA	AUS	fault type: maximum value of intake air temperature TANS exceeded
B_SA	MDRED	EIN	Condition fuel cut-off

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Variable	Source	Type	Description
B_STEND	BBSTT	EIN	condition end of start
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_NORM		EIN	ECU-condition normal engine management operation
C_PWF		EIN	ECU-condition powerfail initialisation
E_TA	GGTFA	AUS	error flag: TANS
R_T1S		EIN	Time schedule 1 s
SFPTA	GGTFA	AUS	status fault path: air intake temperature TANS
SY_TFMAP	PROKON	EIN	system constant: intake air temp.sensor with shunt resistor in input circuitry
TANS	GGTFA	AUS	Intake air temperature
TANSAB	GGTFA	AUS	Intake air temperature when engine is shut-off
TANSLIN	GGTFA	AUS	intake air temperature, linearised and calculated
WTANS		EIN	ADC-value for intake air temperature
Z_TA	GGTFA	AUS	cycle flag: intake air temperature

FB GGTFA 15.10 Detailed description of function

Following function description for version TANS-NTC circuitry with pullup-R and with parallel resistor to TANS-sensor (e.g. 2,87 kOhms resp. 36,5 kOhms) --> SY_TFMAP=1 !

Fault detection (set Errorflag E_ta)
Directly scanning of exceeding the threshold values is practicable without any additional conditions.
Debouncing times overlap electric disturbance by coupling on the lines as well as line-conducted faults or short loose contacts.
In a tolerance calculation the following fault cases were observed:

- Short circuit at sensor input (E.A.TANS) to UBat/5V : Sampling maximum value of utans --> tanslin below TADMN.
  Generally sensor or/and printed circuit board parts melted in event of short-circuit to UB; damages in case of short circuits to 5V dependent on temperature resp. current on occurrence of fault!

- Short circuit at sensor input (E.A.TANS) to ground : Sampling minimum value of utans --> tanslin above TADMX.
  Taking into account voltage drops and other uncertainties, the threshold should be choosen corresponding to a value of a regular intake air temperature of more than approx. 125 deg.C (does not occur).

- Interruption of sensor lines : Sampling high value of utans --> tanslin exceeding TADMN
  Assuming a shunt at the sensor input (E.A.TANS) of RN = 500 kOhms, a fault under those conditions corresponds to a plausible intake air temperature of less than -35 deg.C.

Faults are only cleared after a debouncing time to prevent switchover to faulty plausible values, e.g. resulting from electrical interference coupled in the cable, when dropped off.

Cycle flag Z_ta is set either as soon as a fault is detected or, in case of no fault, after all branches of the test have been run through.

Following function description for version TANS-NTC circuitry with pullup-R only (e.g. 1kOhm), no parallel resistor to TANS-sensor --> SY_TFMAP=0 !

Fault detection (set Errorflag E_ta)
Directly scanning of exceeding of threshold values is only practicable for maximum limit without additional conditions.
Debouncing times overlap electric disturbance by coupling on the lines as well as line-conducted faults or short loose contacts.
In a tolerance calculation the following fault cases were observed:

- Short circuit at sensor input (E.A.TANS) to UBat/5V : Sampling maximum value of utans --> tanslin below TADMN.
  Generally sensor or/and printed circuit board parts melted in event of short-circuit to UB; damages in case of short circuits to 5V dependent on temperature resp. current on occurrence of fault!

- Short circuit at sensor input (E.A.TANS) to ground : Sampling minimum value of utans --> tanslin above TADMX.
  Taking into account voltage drops and other uncertainties, the threshold should be choosen corresponding to a value of a regular intake air temperature of more than approx. 140 deg.C (does not occur).

- Interruption of sensor lines : Sampling high value of utans --> tanslin exceeding TADMN (?)
  Assuming a shunt at the sensor input (E.A.TANS) of RN = 500 kOhm, a fault under those conditions corresponds to a plausible intake air temperature of (-30 ..-32) deg.C. That won't be low enough for cold-starts in many applications.
  In order to diagnose this fault, additional conditions (as waiting time TDNSTA after end-of-start elapsed, idling for time TDTAL at a minimum and no fuel cutoff) are scanned and, if matched, enable to assume safely, that the TANS sensor must output a higher value as a result of heat transmission from the engine. Otherwise --> below TADMN.

Faults are only cleared after a debouncing time to prevent switchover to faulty plausible values, e.g. resulting from electrical interference coupled in the cable, when dropped off.

Cycle flag Z_ta is set either as soon as a fault is detected or, in case of no fault, after all branches of the test have been run through.

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APP GGTFA 15.10 Application hint

Checking of the tanslin < TADMN fault detection, which can occur as a consequence of a short circuit to supply voltage or a break, may only be provoked by a break; applying battery voltage may cause the NTC sensor to be damaged !

Reference values for RB-TANS standard sensor circuitry with shunt resistor
(under above mentionned dimensioning R_vor = 2,87 kOhms , R_par = 36,5 kOhms):
TADMX approx. 125 deg.C ; TADMN approx. -35 deg.C (tolerance!) ; TADE 20 deg.C ; TDTA approx. 200 msec

Reference values for RB-TANS standard sensor circuitry without shunt resistor
(under above mentionned dimensioning R_vor = 1 kOhm , no R_par):
TADMX ca. 140 deg.C ; TADMN ca. -30 deg.C (Toleranz!) ; TADE 20 deg.C ; TDTA ca. 200 msec , TDNSTA ca. 4 min

GGTKA 1.10 Sensor variable for radiator-outlet temperature, TKA

FDEF GGTKA 1.10 Function definition

ggtka-ggtka

Fault Code Memory Management:
"_____"

Status fault path TKA	: sfptka	Clear fault path	: C_fcmclr & B_cltka
Error flag TKA	: E_tka	Fault path TKA	: CDTTKA
Cycle flag TKA	: Z_tka	Fault class TKA	: CLATKA
Fault type TKA	: B_mxtka	Fault severity TKA	: TSFTKA
	B_mntka	CARB Code TKA	: CDCTKA
		Ambient conditions TKA	: FFTTKA Ambient conditions see %DFFT

ABK GGTKA 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCTKA	BLOKNR		KL	Code word CARB: Engine temperature downstream cooler
CDTTKA			FW	Code word tester: Engine temperature downstream cooler
CLATKA			FW	error class: Engine temperature downstream cooler
FFTTKA	BLOKNR		KL	Freeze frame table: Engine temperature downstream cooler
TDTKAUS			FW	Debouncing time fault detection temperature radiator output
TKAELI	WTKA		KL	Temperature radiator output sensing and linearization
TKAUSDE			FW	Default value temperature radiator output in case of fault
TKAUSDMN			FW	Min. temperature radiator output
TKAUSDMX			FW	Max. temperature radiator output
TSFTKA			FW	Error active time: Engine temperature downstream cooler

Variable	Source	Type	Description
B_BKTKA	GGTKA	AUS	Condition default value for temperature radiator outlet
B_CLTKA		EIN	Condition clear fault path temperature radiator outlet TKA
B_MNTKA	GGTKA	AUS	Fault type: Minimum value of temperature radiator outlet is undershot
B_MXTKA	GGTKA	AUS	Fault type: Maximum value of temperature radiator outlet is exceeded
C_FCMCLR		EIN	system state: reset fault memory

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Variable	Source	Type	Description
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_TKA	GGTKA	AUS	Error flag: Temperature radiator outlet
SFPTKA	GGTKA	AUS	Status fault path: Temperature radiator outlet
TKA	GGTKA	AUS	Temperature engine radiator outlet (coolant)
TKALIN	GGTKA	AUS	Temperature radiator outlet linearized and converted
WTKA		EIN	A/D value for TKA (temperature radiator outlet)
Z_TKA	GGTKA	AUS	Cycle flag temperature radiator outlet

FB GGTKA 1.10 Detailed description of function

APP GGTKA 1.10 Application hint

GGTFUMG 4.40 Signal ambient temperature sensor

FDEF GGTFUMG 4.40 Function definition

ggtfumg-ggtfumg

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ggtfumg-fcmtumg

No text for FDEF available!

ABK GGTFUMG 4.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCTUM	BLOKNR		KL	code word CARB: ambient (-air) temperature TUM
CDKTUM			FW	code word customer: ambient (-air) temperature
CDTTUM			FW	code word tester: ambient (-air) temperature
CLATUM			FW	error class: ambient (-air) temperature TUM
DTUMTA			FW	offset intake-air temperature -> ambient temperature
FFTTUM	BLOKNR		KL	freeze frame table: ambient (-air) temperature TUM
IMTUMGTA			FW	threshold integrated air mass for determination ambient temperature
NTUMGTA			FW	threshold engine speed for determination ambient temperature (from TANS)
TDTUM			FW	debouncing time for diagnosis of ambient (-air) temperature TUM
TDTUMNF			FW	debouncing time for error healing of ambient (-air) temperature TUM
TSFTUM			FW	fault active time: ambient (-air) temperature sensor TUM
TUMGTAI			FW	initial value of ambient temperature
VTUMGTA			FW	threshold velocity for determination ambient temperature from TANS

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_BKTUM	GGTFUMG	AUS	condition backup value for ambient (air) temperature
B_CLTUM		EIN	condition clear fault path ambient (air) temperature TUM
B_CTUNP	GGTFUMG	LOK	Condition fault in ambient temperature CAN signal
B_ETUM	GGTFUMG	AUS	Condition fault in ambient temperature
B_INS3COK	CANINS	EIN	Condition CAN message INST3 present
B_KL15		EIN	condition ignition switch on
B_NPTUM	GGTFUMG	AUS	Error type: ambient (-air) temperature signal not plausible
B_TFU	PROKON	EIN	condition ambient temperature sensor exists
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_CINS	GGTFUMG	LOK	Error flag: CAN interface, timeout instrument
E_TA	GGTFA	EIN	error flag: TANS
E_TUM	GGTFUMG	AUS	Error Flag: ambient (air) temperature tumg
IMLATM	ATM	EIN	integrated air mass flow from engine start to maximum value
NMOT	BGNMOT	EIN	engine speed
R_T100		EIN	Time schedule 100 ms
TANS	GGTFA	EIN	Intake air temperature
TUMG	GGTFUMG	AUS	Ambient air temperature
TUMGCAN	GGTFUMG	LOK	Ambient air temperature recieved CAN message
TUMGTA	GGTFUMG	LOK	ambient temperature from intake-air temperature
VFZG	GGVFZG	EIN	vehicle speed (km/h)
Z_TUM	GGTFUMG	AUS	Cycle flag: ambient (air) temperature TUM

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FB GGTFUMG 4.40 Detailed description of function

APP GGTFUMG 4.40 Application hint

GGTSG 1.10 Sensor variable and documentation of temperature control unit

FDEF GGTSG 1.10 Function definition

ggtsg-ggtsg

Acquisition and statistics of the internal control unit temperature

The internal ECU temperature and the engine speed range is determined in a time cycle, which can be preset with TSTSG, and a counter histsg (I) assigned to the map and a total acquisition counter histsgg are incremented.
Once a counter histsg(i) reaches the value FFFFh the statistics has been acquired completely and is terminated.
The statistical map is stored in the EEROM.
The map areas are defined by the base point assignment STNSG1 ...5 (nmot) and STTSG1...5 (tsg).
The statistical map and the total acquisition counter can be initialized/reset again with the value 0000h in the EEPROM by means of a KWP write-command.

Structure of the statistical map:

For the indication of the histsg(i) - RAM-cells the following rule is used in the software:

i = sttsg + (6 * stnmot)

sttsg = 0...5 6 temperature ranges
stnmot = 0...5 6 engine speed ranges
histsg(i) = word-size

The starting address of the map should be known in the DAM file with histsg (i=0).

ABK GGTSG 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
STNSG1			FW	Base point distribution nmot-1 ECU temperature histogram
STNSG2			FW	Base point distribution nmot-2 ECU temperature histogram
STNSG3			FW	Base point distribution nmot-3 ECU temperature histogram
STNSG4			FW	Base point distribution nmot-4 ECU temperature histogram
STNSG5			FW	Base point distribution nmot-5 ECU temperature histogram
STTSG1			FW	Base point distribution 1 tsg ECU temperature histogram
STTSG2			FW	Base point distribution 2 tsg ECU temperature histogram
STTSG3			FW	Base point distribution 3 tsg ECU temperature histogram
STTSG4			FW	Base point distribution 4 tsg ECU temperature histogram
STTSG5			FW	Base point distribution 5 tsg ECU temperature histogram
TSGELI	WTSG		KL	ecu ambient temperature calculation
TSTSG			FW	Time interval for the acquisition of the ECU temperature histogram

Variable	Source	Type	Description
HISTSG	GGTSG	LOK	Counter of the sensed ECU temperature values for entry into statistics
HISTSGG	GGTSG	LOK	Counter of total sum of the sensed ECU temperature values for statistics
TSG	GGTSG	AUS	ECU temperature
WTSG		EIN	Value temperature ECU

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FB GGTSG 1.10 Detailed description of function

APP GGTSG 1.10 Application hint

UETM 2.10 Engine overtemperature display

FDEF UETM 2.10 Function definition

uetm-uetm

ABK UETM 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DUETMOT			FW	Delta engine-overtemperature threshold
TUETM			FW	Overtemperature time after start-up
UETMOT			FW	Engine-temperature threshold

Variable	Source	Type	Description
B_KL15		EIN	condition ignition switch on
B_NMIN		EIN	condition lower speed: n < NMIN
B_NOUETM	UETM	LOK	condition no overtemperature during afterrunning
B_STEND	BBSTT	EIN	condition end of start
B_UETM	UETM	AUS	Condition overtemperature
B_UETMC	UETM	AUS	condition excess temperature CAN message
C_INI		EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
TMOT	GGTFM	EIN	Engine temperature
TNST_W	BBSTT	EIN	time after end of start

FB UETM 2.10 Detailed description of function

The status "overtemperature" is transmitted by this signal to the combi-instrument for triggering a warning lamp.

The function is active with terminal Kl.15 ON.
B_nouetm has to be saved in the non-volatile RAM.

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APP UETM 2.10 Application hint

ETR 8.20 Electric thermostat control

FDEF ETR 8.20 Function definition

etr-etr

etr-umschaltbi

ABK ETR 8.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DTANSETR			FW	intake-air temperature hysteresis for thermostat control
DTMETR			FW	temperature hysteresis for electric thermostat control
DVFZETR			FW	vehicle speed hysteresis for electric thermostat control
KFETRD	VFZG	WDKBA	KF	Setpoint for electr. thermostat control from dk
KFETRT	VFZG	TANS	KF	Setpoint for electr. thermostat control from tans

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Parameter	Source-X	Source-Y	Type	Description
TAETRMN			FW	intake-air temperature for electric thermostat control
TVETRA			FW	Delay time to clear B_etr
TVETRE			FW	Delay time to set B_etr
TWETRS			FW	Desired temperature when requesting heat exchanger protection, substitutes FWETR
VFZETR			FW	threshold vehicle speed for electric thermostat control

Variable	Source	Type	Description
B_ETR	ETR	AUS	condition electrical thermostat control
B_ETRET		EIN	condition electrical thermostat control by tester
B_ETRTAM	ETR	LOK	Switch-over of electric thermostat control to fixed value at low tans
B_ETRVFZG	ETR	LOK	condition electrical thermostat control by VFZG
B_FAETR		EIN	condition function request elctrical thermostat control
B_GOT	CANEGS	EIN	condition excess temperature gear box
B_NTKW	CANINS	EIN	Condition request of low coolant temperature (heat-exchanger protection)
B_VL	MSF	EIN	Condition for wide open throttle
TANS	GGTFA	EIN	Intake air temperature
TMOT	GGTFM	EIN	Engine temperature
VFZG	GGVFZG	EIN	vehicle speed (km/h)
WDKBA	GGDVE	EIN	throttle angle

FB ETR 8.20 Detailed description of function

```
The function ETR describes a symmetric two-step controller with hysteresis.
During control operation of the thermostat (B_etr=1) a partial-flow of the coolant is led through the radiator and the water
temperature tmot cools down. Thereby it is possible to keep the engine at its optimum thermal operating point.

The current input is dependent on the maps KFETRD (throttle valve component) and KFETRT (tans component). The smaller map value
(minimum selection) always acts. Only KFETRD acts at full load (B_vl = 1), at high speed or low ambient temperatures only  KFETRT.
The temperature setpoint is subject to the hysteresis DTMETR as well as to the separate activation / deactivation delay  TVETRE
and TVETRA in order to avoid an incorrect current input.

When the protective heat exchanger function is requested (B_ntkw = 1) or when the transmission control is requested in case of
excessive temperature of the transmission oil (B_got = TRUE), TWETRS is generally switched over.
The current input can be controlled "from the outside" by means of a suitable tester for testing purposes.
```

APP ETR 8.20 Application hint

DTHM 4.70 diagnosis: thermostat monitoring

FDEF DTHM 4.70 Function definition

```
DTHM: overview
==============
```

dthm-main

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```
ETHM: error detection
=====================
```

fault detection

dthm-ethm

dthm-ethm

```
BBDTHM: operating range conditions
==================================
```

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dthm-bbdthm

dthm-bbdthm

```
FCMCLR: Clear Fault Code Memory
===============================
```

dthm-fcmclr

dthm-fcmclr

```
MODE6THM: Beschreiben des CARB Mode 6
=====================================
```

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dthm-mode6thm

dthm-mode6thm

```
CWDTHM: Initialisierung der Mode 6 Zellen
=========================================
```

dthm-cwdthm

dthm-cwdthm

```
THM_DFPM: Fault Code Memory Accesses
====================================
```

dthm-thm-dfpm

dthm-thm-dfpm

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Fault memory management:

```
Status fault path THM:  SFPTHM
Error flag THM :        E_thm
Cycle flag THM :        Z_thm
Fault type THM :       (B_mxthm)
                       (B_mnthm)
                        B_npthm
                       (B_sithm)


Reset fault path:      C_fcmclr & B_clthm
Fault path THM :                  CDTTHM
Fault class THM:                  CLATHM
Fault rate THM :                  TSFTHM
Carb Code THM  :                  CDCTHM
Freeze frame table THM :          FFTTHM
```

ABK DTHM 4.70 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDTHM			FW	code word for function DTHM
DTDTHM			FW	delta debouncing time for healing of an engine coolant thermostat error
DTHMDTKA			FW	safety offset of engine temperature to TKA for thermostat monitoring
IDTHMU			FW	lower threshold of integrated airmass for enabling thermostat diagnostics
KLIMTHMTM	TMST		KL	Threshold integrated air mass thermostat monitoring dependent on tmst
KLTATHMKA	TKA		KL	waiting time to enable thermostat monitoring dependent on tKA-temperature
KLTHMDTKA	TKA		KL	safety offset of engine temperature to TKA for thermostat monitoring
NDTHMO			FW	upper engine speed threshold to enable thermostat monitoring
NDTHMU			FW	lower engine speed threshold to enable thermostat monitoring
TC6CTHM			FW	mode 6: component ID for diagnosis coolant water thermostat
TDTHM			FW	debouncing time for engine coolant thermostat monitoring
TMSDTHMO			FW	upper threshold of engine coolant temp. for thermostat monitoring
TMSDTHMU			FW	lower threshold of engine coolant temp. for thermostat monitoring
TTHMDMX			FW	max. engine cool.temp. to enable thermostat monitoring
VDTHMU			FW	lower vehicle speed threshold to enable thermostat monitoring

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_BBDTHM	DTHM	LOK	condition operation mode for thermostat monitoring present
B_BETHM	DTHM	AUS	condition : function request for DTHM short test
B_BKTHM	DTHM	AUS	Condition Backup value for thermostat monitoring
B_CLTHM		EIN	condition clear fault path engine coolant thermostat
B_ETHMR	DTHM	LOK	condition thermostat failure stored to the RS_Flip-Flop
B_ETHMS	DTHM	LOK	condition thermostat failure monitored and to set cycle flag
B_FTTHM	DTHM	AUS	Condition fault entry by tester for thermostat monitoring
B_LL	MSF	EIN	Condition idle
B_LOWRA	BBLOR	EIN	condition gear box in low range
B_MNTHM	DTHM	AUS	fault type : minimum value for thermostat monitoring
B_MXMNTM	GGTFM	EIN	Condition min- or max fault of engine temperature sensor existing
B_MXTHM	DTHM	AUS	fault type: maximun value for thermostat monitoring
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_NPTHM	DTHM	AUS	fault type : condition not plausibel for thermostat monitoring
B_PWF		EIN	Condition for powerfail
B_SA	MDRED	EIN	Condition fuel cut-off
B_SITHM	DTHM	AUS	fault type: signal error for thermostat monitoring
B_STEND	BBSTT	EIN	condition end of start
B_TMDMME	GGTFM	EIN	Condition final temperature of engine temperature model reached
B_ZTHMS	DTHM	LOK	condition end value temp.model is reached and operating range was enabled
DFP_THM		EIN	Internal fault path number: water temperature monitoring
DFP_TKA		EIN	ECU internal fault path no: temperature radiator outlet
DFP_VFZ		EIN	ECU int. fault path no.: vehicle speed signal
DTHMTMKA	DTHM	LOK	delta between engine and radiator outlet water temp. in diagnosis thermostat
E_THM	DTHM	AUS	error flag: engine coolant thermostat
E_TKA	GGTKA	EIN	Error flag: Temperature radiator outlet
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
IMLATM	ATM	EIN	integrated air mass flow from engine start to maximum value
IMTHMU	DTHM	LOK	lower threshold for integrated air mass in thermostat diagnosis out of KLIMTHMTM
M6CTHM	DTHM	AUS	Mode 6-Memory: Component ID for thermostat monitoring
M6STHM	DTHM	AUS	Mode 6-Memory: Threshold value for thermostat monitoring
M6WTHM	DTHM	AUS	Mode 6-Memory: Measured value for thermostat monitoring
ML	BGSRM	EIN	air mass flow
NMOT	BGNMOT	EIN	engine speed
SFPTHM	DTHM	AUS	status fault path: engine thermostat THM
STHMDTKA	DTHM	LOK	Threshold temperture difference tmot to tka for detection of faulty thermostat
TANS	GGTFA	EIN	Intake air temperature
TKA	GGTKA	EIN	Temperature engine radiator outlet (coolant)
TMOTLIN	GGTFM	EIN	Engine coolant temperature, linearised and calculated
TMST	GGTFM	EIN	engine temperature at start

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Variable	Source	Type	Description
VFZG	GGVFZG	EIN	vehicle speed (km/h)
Z_THM	DTHM	AUS	cycle flag: engine coolant thermostat

FB DTHM 4.70 Detailed description of function

After a cold engine start a not proper working thermostat, e. g. the thermostat got stucked at an open position or is missing, leads to a delayed heating up of the coolant temperature under the circumstance of low ambient temperatures and vehicle drive. This may delay or even cancel engine temperature dependent functions or diagnostics. To detect this, the warming of the coolant temperature is observed by the diagnostic function %DTHM - thermostat monitoring.

The diagnostic function %DTHM - thermostat monitoring - consists of following parts :

* determination and enabling of the operating range of diagnostics
* detection of a thermostat failure based on a reference signal of the temperature sensor located at the outlet of the coolant radiator

The part determination and enabling of the operating range of diagnostics is watching the engine and vehicle driving conditions, where the diagnostics are probably useful.
At the function part "detection of a thermostat failure" the difference between the measured coolant temperature is performed, in case of a too small difference an error is stored. At the same time the cycle flag is set and the healing of the failure is surveilled.

BBDTHM: Determination and enabling of the operating range of diagnostics
==========

The operating condition of diagnostics is limited, because it is not useful and not safe enough to carry out a diagnostic at all engine operation and vehicle driving conditions.
The diagnosis is enabled only in the case that the following conditions are fulfilled at the same time :

* coolant temperature sensor without failure
* vehicle speed signal without failure
* no idling
* no fuel cut off
* engine speed larger than a threshold (--> engine coolant flow)
* vehicle speed larger than a threshold (--> cooling by the radiator)
* integrated air mass flow following engine exceeds a threshold
* engine coolant temperature at start below a upper threshold
* engine coolant temperature at start above a lower threshold
* delay time after engine start passed

Detection of a thermostat failure
==========

The block detection of a thermostat failure contains two pathes, one to set the error flag, the other to set the cycle flag. Last one also monitores the failure healing.
An error will be detected in case of
* the measured coolant temperature tmotlin is closer than the threshold DTHMDTKA to the reference of the radiator oulet temperature tka

  and at the same time

* the operating range condition B_bbdthm enables diagnostics
  and
* the upper coolant temperature limit TTHMDMX is not yet reached.

If this state is present longer than the debouncing time TDTHM, an estimated thermostat failure is stored and the cycle flag is set. The thermostat failure is only stored as an error in fault code memory, if the cycle flag of engine coolant temperature sensor diagnostics is set and no error E_tm occurred.
If the upper value of the engine coolant temperature TTHMDMX is reached without detecting a thermostat failure, no further storage of a thermostat failure is possible, that means, the diagnostics will be inactive furtheron in this trip.
A healing of the thermostat failure is possible, if - as long as the upper temperature limit is not exceeded - the operating criteria of the diagnostic are enabled for at least the time TDTHM, prolonged by DTDTHM and no thermostat failure has occurred. In this case a stored error is reset. Additionally a thermostat failure is reset (written over) by an error of the coolant temperature sensor.

APP DTHM 4.70 Application hint

Values for first application (Suggestions from measurement/simulation):
==========

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parameter	Suggestion	Comment
DTHMDTKA	< 5°C (5K) ?	
DTDTHM	0.5 sec	
IDTHMU	3 kg	
KLTATHMKA	.. s	see ...
NDTHMU	960 / min	
TADTHM	2 sec	
TDTHM	1 sec	
TMSDTHMU	50 °C	estimated, awaited to be tuned down !
VDTHMU	15 km/h	
TTHMDMX	75 °C ??	lowest opening temperature of the thermostat (incl. tolerances) !

MLS 49.50 Electric cooling fan control

FDEF MLS 49.50 Function definition

mls-mls

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mls-mls-nachl

mls-mls-hys

ABK MLS 49.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FMLVFZG	VFZG		KL	Correction factor E-fan-pulse duty cycle from vfzg
TALUNL			FW	duty factor for EC-bloer afterrunning control at 10 Hz
TAMHYS			FW	Pulse duty cycle E-fan hysteresis
TAMLAC	STMLAC		KL	Request E-fan-pulse duty cycle of air conditioner
TAMLSMN			FW	minimum E-fan-pulse duty cyccle
TAMLSMX			FW	maximum E-fan-pulse duty cyccle
TAMLSNH	TAMLAUS		KL	Request E-fan-pulse duty cycle after hysteresis

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Parameter	Source-X	Source-Y	Type	Description
TAMLTKA	TKA		KL	Request E-fan-pulse duty cycle from radiator output temperature
TAMLU			FW	Insensitivity threshold E- fan-pulse duty cycle
TNLSGMN			FW	minimum time for ECM-switch-off delay

Variable	Source	Type	Description
B_FAMLS		EIN	Condition functional request engine fan
B_NACHL	MOTAUS	EIN	ECU control for ECU switch off delay
B_NACHLN	MLS	LOK	control of ECU afterrunning after n > NMIN
B_NL10	MLS	LOK	conditiom EC blower afterrun control at 10 Hz
B_NMIN		EIN	condition lower speed: n < NMIN
B_STEND	BBSTT	EIN	condition end of start
B_UETM	UETM	EIN	Condition overtemperature
C_INI		EIN	ECU-condition for intialisation
FQML	MLS	AUS	TA frequency E-fan
STMLAC	CANINS	EIN	Request stage E-fan of air conditioner
TAML	MLS	AUS	Duty cycle E-fan
TAMLAUS	MLS	LOK	Duty cycle engine fan after standardization
TAMLDIA		EIN	Duty cycle E-fan diagnostic intervention
TAMLNH	MLS	DOK	Duty factor for E-blower after hysteresis (percentile blower performance)
TAMLNL	MLS	LOK	Duty factor for E-blower during blower afterrunning
TAMLS	MLS	LOK	Duty cycle (percentage fan performance)
TKA	GGTKA	EIN	Temperature engine radiator outlet (coolant)
TNACHL_W	MOTAUS	EIN	time of ECU switch off delay
UB	GGUB	EIN	battery voltage
VFZG	GGVFZG	EIN	vehicle speed (km/h)

FB MLS 49.50 Detailed description of function

The function regulates the speed of the electric engine fan by the output of a duty ratio.

The radiator exiting temperature, TKA, and a demand level for the air-conditioning system (4-bit) made available from CAN are converted by characteristics into demands for duty ratios for the radiator. The maximum from both demands is selected and accordingly corrected depending on the vehicle speed and the battery voltage.
The calculated duty ratio can be limited to the minimum value TAMLSMN as well as to the maximum value TAMLSMX.

The function is only active when the engine is running and if the duty-ratio demand exceeds the threshold value TAMLU.

Objective of the block mls_hys is to limit the change in the speed of the fan when "passing through" the temperature at the radiator outlet (tka). To this end, the output (tamlnh) only follows the input variable (tamls) when the difference between the new setpoint value and the old setpoint value is greater than a programmed hysteresis (TAMHYS).
The hysteresis in added to the input in this case in order to prevent jumps in the output.
The outpt follows the input directly again as soon as the input is greater than the current input value.
If the input is 0, then the output is set to 0 as well. This is in order to prevent the output from remaining at the hysteresis value for a setpoint value of 0.

The duty ratio to be outputted, tamlaus, is determined using the formula
tamlaus = (13/ub*(0.8333*(tamlnh-10)+33.33)-33.33)*1.2+10 (depends on ub and tamlnh).
This done in order to limit the current flowing over the plug-in contacts.

A triggering duty ratio can be entered at the input tamldia for diagnosis of the actuator. The diagnostic function is independent of the engine running and takes precedence over other demands. Control of the initial start-up is also active during the diagnosis.

A triggering duty ratio, TALUNL, is outputted with a frequency of 10 Hz at the fan control during the ECU after-run and for a given overtemperature of B_uetm = TRUE.

APP MLS 49.50 Application hint

The characteristic curve TAMLSNH should be applied as follows (proposal)

tamlaus	33 % ..... 100 %
TAMLSNH	10 % ..... 90 %

1/3 of the ML engine-fan output at 10 % TAMLSNH
Full ML engine-fan output at 90 % TAMLSNH
Zero ML engine-fan output at TAMLSNH < 5%

Normal operation: TV-output engine-fan control frequency 100 Hz (immediate constant, cannot be applied)
Fan after-running: TV-output engine-fan control frequency 10 Hz (immediate constant, cannot be applied)

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KOS 107.10 Control of A/C compressor

FDEF KOS 107.10 Function definition

kos-kos

kos-kos

Overview of the air-conditioner compressor control:

The air-conditioner compressor control is subdivided into four partial functions, which are:
- KOS_AC_INTERF : Interface between the signals of the air-conditioner and of the motronic
- KOS_ON_OFF : Activation and deactivation conditions dependent on the engine operation conditions
- KOA_AUS : Hard deactivation conditions from the outside
- KOS_TIMER : Monitoring on whether the minimum and maximum activation and deactivation times are adhered to
- KOS_MANAGER : Triggers the air-conditioner compressor dependent on the informations from above-mentioned functions

kos-kos-ac-int

kos-kos-ac-int

Interface between the external signals of the air-conditioner and of the motronic:

(This partial function is project-specific)

The air-conditioner supplies two informations in form of a switch input:

Inputs of the air-conditioner:
- B_ac : Switch air-conditioner readiness, corresponds to the request for increased idle speed
- B_ko : Switch air-conditioner compressor, corresponds to the request for compressor operation

Outputs from the interface:
- B_nac : Condition increase idle speed, regarding this also refer to %LLRNS
- B_ko : Condition air-conditioner desires compressor operation

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kos-kos-on-off

Activation and deactivation conditions for the air-conditioner compressor:

Engine activation and deactivation conditions for the air-conditioner compressor:

The air-conditioner compressor remains blocked in any case for the time TNSTKO after end of start.
During vehicle operation the air-conditioner compressor is only blocked resp. deactivated if it is the cause for an insufficient torque at the clutch.
This is the case if the sum from driver's request mifal and compressor load torque mdko is greater than the maximum torque of the engine for the current engine speed. This is stored in the characteristic MDKOAN.
The compressor can be activated again if the torque demand (mifal + mdko) lies below a threshold MDKOEN.

The deactivation of the air-conditioner compressor can be limited to a speed range less than VKOAO. No torque-dependent deactivation of the air-conditioner compressor is performed if the vehicle speed lies above the threshold VKOAO.

If the engine temperature is greater than the threshold TMKOAO or lies below the threshold TMKOAU, the compressor is blocked.
The output B_kooff forces a permanent blocking of the compressor independent of a maximum deactivation time.
The same applies if the bit B_koa is set to 1.

For various diagnostic functions it is important that the compressor state remains unchanged, since they need the behavior of the torque controller and since thereby disturbing activation and deactivation of loads should be avoided.

kos-kos-aus

Hard deactivation conditions for the air-conditioner compressor

Hard deactivation conditions for the air-conditioner compressor exist in the functional part KOS_AUS.
These are project-specific and are summarized here, in order to make an adjustment of the function KOS easier.

If the condition B_koa = 1, the air-conditioner compressor is switched off permanently.
If the condition B_koa = 0, the KOS will be performed normal (the compressor is switched according to demand and KOS decision)

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kos-kos-timer

Monitoring of the minimum and maximum state times for the compressor:

Dependent on the engine speed the following state times can be defined for the compressor:

"- TKOAMNN : Minimum off-time; the compressor remains deactivated for at least this time before it" can be activated again.

"- TKOEMNN : Minimum on-time; the compressor remains active for at least this time before it" can be deactivated again.

"- TKOAMXN : Maximum off-time; the compressor is enabled again at the latest after this time."

The times TKOAMNN and TKOEMNN serve to protect the compressor clutch to prevent a temporal too frequent switching.
The time TKOAMXN prohibits a permanent deactivation of the compressor, if the driver constantly drives at an operating point, at which the compressor is blocked. Thus it is guaranteed that also the air-conditioner can still operate.
If the time TKOAMXN is set greater than the threshold LIMTKOA, the compressor can remain deactivated unlimited.

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kos-kos-manage

Compressor control manager of the various informations:

The manager decides dependent on the input signals whether the air-conditioner compressor is to be activated or deactivated.
In addition the manager controls the smooth activation procedure of the compressor.
The condition B_ko has in any case the highest priority. It represents the activation condition. The only purpose of the KOS here is that it supplies the enable condition for this.
The compressor is enabled if the operating point of the engine permits this (B_koena = 1) or if the compressor has already been inactive for a maximum time (B_komxoff = 1) and a minimum off-time has elapsed (B_komnoff = 1).
The compressor can be blocked, if the operating point of the engine demands this (B_koena = 0) and if the compressor has already been active for a minimum time (B_komnon = 1).

The compressor is in any case deactivated via the input B_kooff, without consideration of on- or off-times.

The current state of the compressor is frozen via the input B_kosta.

The activation procedure (triggering of output stage) takes place in two steps:

First step: B_acres = 1, B_koe = 0: The compressor still remains switched off, only the torque margin is increased.

After the time TVKOE:

Second step: B_acres = 0, B_koe = 1: The compressor is activated, the torque margin is decreased to the normal value again.

The deactivation procedure takes place in one step:

B_acres = 0 and B_koe = 0: The compressor is switched off

Parallel to the activation and deactivation of the compressor the consumer load torque is increased resp. decreased.

ABK KOS 107.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
LIMTKOA			FW	Time thresholöd to switch off the AC-compressor indefinitly
MDKOAN	NMOT		KL	Torque threshold to switch the AC-compressor off
MDKOEN	NMOT		KL	Torque threshold to switch the AC-compressor on
TKOAMNN	NMOT		KL	minimum shutdown time for air-conditioning compressor
TKOAMXN	NMOT		KL	maximum shutdown time for air-conditioning compressor
TKOEMNN	NMOT		KL	minimal time of air-condition compressor beeing swiched on
TMKOAO			FW	Upper coolant temperature for swichting off the AC-compressor
TMKOAU			FW	Lower coolant temperature for swichting off the AC-compressor
TNSTKO			FW	AC OFF time after engine start
TVKOE			FW	delay time for compressor ON
VKOAO			FW	Upper vehicle speed threshold to inhibit the AC-compressor

Variable	Source	Type	Description
B_ACRES	KOS	AUS	Condition for increasing the torque reserve by AC-stand-by
B_KO	KOS	LOK	condition AC compressor authorised
B_KOE	KOS	AUS	Condition for AC-compressor ON
B_KOENA	KOS	LOK	Condition AC-compressor is enabled
B_KOMNOFF	KOS	LOK	Condtion AC-compressor is swiched off for more mor than an minimal time
B_KOMNON	KOS	LOK	Condtion AC-compressor is swiched on for more mor than an minimal time
B_KOMXOFF	KOS	LOK	Condtion AC-compressor is swiched off for more than a maximal time
B_KOOFF	KOS	LOK	Condition for immediate swiching off the AC-compressor

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Variable	Source	Type	Description
B_KOSTA	KOS	LOK	Condition for freezing the actual compressor state
B_NAC	KOS	AUS	condition for increased idle-speed at AC
B_STEND	BBSTT	EIN	condition end of start
B_VL	MSF	EIN	Condition for wide open throttle
C_INI		EIN	ECU-condition for intialisation
MDKO	MDVERB	EIN	torque needed for air condition
MIFAL_W	MDFAW	EIN	Indicated driver's wish torque for torque coordination cylinder filling
NMOT	BGNMOT	EIN	engine speed
S_AC		EIN	A/C stand-by position
S_KO		EIN	A/C compressor active
TMOT	GGTFM	EIN	Engine temperature
VFZG	GGVFZG	EIN	vehicle speed (km/h)

FB KOS 107.10 Detailed description of function

APP KOS 107.10 Application hint

The following figure shows a graphic illustration of an example for the adjustment of the parameters of KOS.

Deactivation threshold MDKOAN : Distinctly below the idle speed the deactivation threshold lies at zero. Thereby it is made possible that the compressor is switched off as soon as the engine speed is too low.
The minimum on-time TKOEMNN is set to zero, which causes the compressor being switched off in this engine speed range independent of how long it has already been active .
The maximum deactivation threshold TKOAMXN is greater than LIMTKOA and thus never again leads to an activation of the compressor as long as this engine speed range is not exited.

With increasing engine speed MDKOAN approaches the curve of the maximum engine torque as fast as possible so that the availability of the compressor is as high as possible.
At high engine speeds it may be necessary to protect the compressor from overrevving. For this, the compressor is switched off again via MDKOAN=0 in this engine speed range. The same time conditions apply here as with underspeed.

Activation threshold MDKOEN : The activation threshold typically takes a course a little below the deactivation threshold in order to reach a hysteresis regarding the torque during activation and deactivation of the compressor at constant engine speed.

In the range of high engine speeds the two characteristics MDKOAN and MDKOEN take an engine speed offset course to each other. A strong engine speed hysteresis is thus achieved during the deactivation and the reactivation.

Minimum on-time TKOEMNN : At under and at overspeed the minimum on-time is set to zero so that the compressor is in any case immediately switched off when this engine speed range is entered.
In between TKOEMNN complies with the details of the vehicle manufacturer.

Minimum off-time TKOAMNN : The minimum off-time is not essential for the compressor control. It is only dictated by the requirements of the air-conditioner manufacturer, who thus has the possibility to protect the compressor clutch by avoiding too frequent switching.

Maximum off-time TKOAMXN : The maximum off-time of the compressor must lie above the threshold LIMTKOA at under- or overspeed so that the KOS cannot activate the compressor again in case of longer operation in these engine speed ranges.
Between these engine speed limits TKOAMXN is pre-defined by the desired availability of the air-conditioner and is therefore a detail of the vehicle manufacturer.

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kos-kos-app

BGRBS 2.30 Calculated wheel acceleration from wheel speed

FDEF BGRBS 2.30 Function definition

ABK BGRBS 2.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TMVDBS			FW	Debounce time, acceleration signal diagnosis
VASRM			FW	Vehicle speed threshold for rough road detection
VBSMX			FW	Upper plausibility threshold for wheel speed

Variable	Source	Type	Description
BSC	BGRBS	AUS	Wheel acceleration calculated from ABS sensor signal
B_ASC2COK	CANASR	EIN	Condition ASC installed and ASC2 message present
B_CLSWE		EIN	flag : clear fault path diagnosis acceleration sensor
B_MXSWE	BGRBS	LOK	acceleration signal exceeds threshold
B_SISWE	BGRBS	LOK	Fault type: No speed signal present
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
DV_LH	BGRBS	LOK	Wheel-speed difference, rear left
DV_LV	BGRBS	LOK	Wheel-speed difference, front left
DV_RH	BGRBS	LOK	Wheel-speed difference, rear right
DV_RV	BGRBS	LOK	Wheel-speed difference, front right
E_SWE	BGRBS	AUS	error flag: acceleration sensor for rough surface detection
VFZG	GGVFZG	EIN	vehicle speed (km/h)
VRAD_LH		EIN	Wheel speed, rear left
VRAD_LV		EIN	Wheel speed, front left

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Variable	Source	Type	Description
VRAD_RH		EIN	Wheel speed, rear right
VRAD_RV		EIN	Wheel speed, front right
Z_SWE	BGRBS	AUS	cycle flag:^acceleration sensor for rough surface detection

FB BGRBS 2.30 Detailed description of function

APP BGRBS 2.30 Application hint

DSWEC 5.10 Bumpy road detection from wheel acceleration, -> via CAN from ABS CU

FDEF DSWEC 5.10 Function definition

Rough road detection by means of the wheel acceleration derived from the ABS sensor signal.
Hint: The %DSWEC is given the input signal bsc(n) from the customer-specific function %BGRBS !

Hint : The rough road function %DSWEC can be deactivated by means of the Euro-switch (B_cdswe = 0).
In this case B_swe = 0 applies.

ABK DSWEC 5.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FABSALU			FW	decrease factor for acceleration signal at bad road conditions
FIBSALU			FW	filter factor acceleration signal at bad road conditions
FSWALUV	VFZG		KL	rough road detection threshold = f (vehicle speed)

Variable	Source	Type	Description
BSC	BGRBS	EIN	Wheel acceleration calculated from ABS sensor signal
BSSP	DSWEC	LOK	storage value signal acceleration sensor
B_CDSWE	PROKON	EIN	function active per codeword CDSWE
B_SWE	DSWEC	AUS	Condition rough road detected
B_SWEV	DSWEC	LOK	Condition rough road supposed
E_SWE	BGRBS	EIN	error flag: acceleration sensor for rough surface detection
VFZG	GGVFZG	EIN	vehicle speed (km/h)

FB DSWEC 5.10 Detailed description of function

1. General function description

1.1 Task of the function

The task of the %DSWEC is to detect that a rough road is being driven across by means of the transmitted wheel acceleration bsc. As soon as a rough road is detected the bit B_swe is set upon which, e.g. the rough road detection is temporarily deactivated (also see %DMDSTP). The deactivation is necessary since drive shaft vibrations due to a rough road can lead to a misdetection of misfire.

1.2 Reference source of the wheel acceleration signal bsc(n)

The wheel acceleration signal bsc(n) needed for the evaluation is made available by a customer-specific function %BGRBS.
In principle 3 different versions of the %BGRBS can be distinguished:

(a) In the standard version the %BGRBS receives that wheel acceleration (maximum selection), which is send by the ABS ECU via the CAN-bus.

(b) In case the ABS ECU transmits the no. of wheel rotations instead of the wheel acceleration via the CAN-bus, a conversion of the no. of wheel rotations into wheel acceleration is performed in the %BGRBS.

(c) Special solution for vehicles without CAN-bus on which, however, an ABS-sensor is mounted, but no segment times are formed in the motronic. In this case the %BGRBS calculates the wheel acceleration from the wheel speed.
Hint : On vehicles without CAN-bus (resp. also without ABS ECU) but with mounted ABS-sensor the segment times should preferably be formed from the ABS sensor signal and for the rough road detection the %DSWER should be used.

1.3 Signal requirement for bsc(n)

The wheel acceleration signal bsc(n) must have been derived from the ABS wheel sensor signal. The accuracy should be at least 1 [m/s^2] and it should preferably be present in the 10ms time grid.

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2. Concrete description of the signal path

2.1 Filtering of the the acceleration signal
From the acceleration signal bsc(n) the memory value bssp(n) is formed by non-linear filtering as follows:

bssp(n) = bssp(n-1) + FIBSALU * [bsc(n) - bssp(n-1)] for bsc(n) > bssp(n-1) (1)
bssp(n) = bssp(n-1) - FABSALU * (time interval) for bsc(n) < bssp(n-1) (2)

(time interval = 100 ms)

The filter calculation for the upward control (1) is performed in the same time grid in which the signal bsc(n) is available [usually in the 10ms or in the 20ms grid]. The filter calculation for the downward control (2) is on contrast performed only in the 100ms time grid.
[For the selection of the filter coefficients also see application hints.]

2.3 Rough road decision
The filter output value bssp(n) is compared to the threshold FSWALUV. FSWALUV is a speed-dependent characteristic line with 4 base points. An interpolation is not carried out.
As long as the value bssp(n) lies above FSWALUV the bit B_swev is set.

As long as no error is detected (E_swe = 0; is formed in %BGRBS), the output signal B_swe corresponds to the bit B_swev. However, as soon as the result of the rough road calculation is no longer meaningful, due to an error (E_swe = 1;e.g. defect ABS wheel sensor) the rough road bit B_swe is set to zero. Thus it is avoided that, e.g. in case of a sensor fault, the misfire detection is permanently deactivated via B_swe. [The decision on whether in this case the misfire detection should be deactivated or not must take place in the %DMDSTP].

2.4 Deactivation of the function via the Euro-switch B_cdswe
The function %DSWEC is deactivated if the Euro-switch has the value B_cdswe = 0. In this case always B_swe = 0.

APP DSWEC 5.10 Application hint

Reference source bsc(n)

For the use of the %DSWEC a customer-specific function %BGRBS is necessary, which supplies the necessary input signal bsc(n).
[For this also see point 1.2 of the function description !]

Selecting the filter coefficients

The filter coefficient FIBSALU for the upward control of the value bssp(t) must be chosen so great that a sufficiently quick rough road detection is possible. In case the acceleration signal is directly available from the ABS ECU via CAN-bus, a filtering may possibly not be necessary for upward control. In this case FIBSALU can be set to one.

Calculation of the acceleration

Measured values e.g. DIM:
Mode of acquisition: time-synchronous
ECU-grid: 10ms
Scanning time: 10ms

Analog window1 (length: 30sec or longer): bsc, bssp
Digital window (length: as analog window1): B_swe
Digits: vfzg

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STA 7.20 Automatic start control

FDEF STA 7.20 Function definition

sta-sta

Hints:
- New start only possible after terminal (Kl) 15 OFF ——> Kl.15 ON
- If the DME has no valid EGS CAN message, then B_pn = 0 (P/N) is assumed
- In case of an engine speed reset the starter function is continued.

ABK STA 7.20 Abbreviations

{NINI = 20 rpm } Immediate-constant

Parameter	Source-X	Source-Y	Type	Description
CWSTA			FW	code word for controlling start relay - automatic
NINI			FW	initialisation speed threshold
NSTMXM	TMOT		KL	speed limit for end of cranking starter activation
TANMX			FW	starter activation time limit
TPAST			FW	debounce time starter activation
TSTA			FW	delay time to detection blocking engine
TSTSV			FW	Pre-delay time after S_kl50 1->0 (starter disengaged)

Variable	Source	Type	Description
B_AUTGET	CANEGS	EIN	condition automatic gearbox
B_ESTART		EIN	Condition terminal (KL) 50 on
B_EZ	DSTA	EIN	prohibiting of engine running
B_KL15		EIN	condition ignition switch on
B_PN	CANEGS	EIN	condition: position P or N of automatic transmission selected
B_STA	STA	AUS	condition automatic start
B_STA0AG	STA	DOK	condition: start automatic AG vehicle
B_STA0HG	STA	DOK	condition: start automatic HG vehicle
C_INI		EIN	ECU-condition for intialisation
NMOT_W	BGNMOT	EIN	engine speed
TMOT	GGTFM	EIN	Engine temperature

FB STA 7.20 Detailed description of function

The automatic start shall rule out that the driver operates the starter for too long to thus achieve a temporal minimization of the noise generation. A comfort improvement for the start sequence shall furthermore be realized.

With automatic transmission:

The automatic start is intended for vehicles with automatic transmission. The starting procedure shall only be possible when the selector lever is in position "P" and "N"; sampling of the CAN message from the EGS and interlocking by hardware L2 switch (at the start relay, with the AT in a make contact version).
A short operating of the ignition key into position START activates the starter (tip function, B_estart (=> S_start (ECU-Pin 4-40), the starter is triggered if B_sta = TRUE).

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Principle:

Principle AT + automatic start

With manual transmission:

With the manual transmission the starter triggering is "only" looped through after the debouncing (TPAST).
The relay on the MT is a break contact. The starter is triggered by KL50 via the EWS ECU. If, e.g. nmot_w exceeds the threshold NSTMXM, the bit B_sta becomes equal to TRUE and thereby current is fed to the relay (relay opens, the starting procedure is interrupted). So that current is not constantly fed to the relay the relay triggering must be interrupted TSTSV seconds after B_estart 1->0 (B_sta=FALSE).

Principle:

Principle MT + automatic start

The starting procedure is terminated:

- if automatic run is detected n > NSTMXM (AT+MT)
- if the engine does not start after a pre-defined time TANMX (AT +MT)
- if the driving position is engaged (AT)
- if the engine does not rotate after the waiting time TSTA has elapsed (engine is mechanically locked) (AT + MT)
- if the ignition is turned off (AT + MT)
- if B_estart 1 -> 0 (after TSTSV) switch-off delay (MT)

On vehicles without mounted automatic start:

the starter is triggered via the EWS ECU (ignition lock KL50 -> EWS-ECU -> starter).

On US vehicles:

In addition to the "normal" clutch switch another one is mounted in US vehicles. It is connected to the EWS ECU and only releases the starting procedure once the clutch pedal was "COMPLETELY" floored.

Special features: New start only possible after ignition "OFF" ——> "ON"(Kl.15 0 ——> 1).
If the DME has no valid CAN message from the EGS when the selector lever is sampled, the selector lever position "P/N" is assumed.

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APP STA 7.20 Application hint

DSTS 1.20 Diagnosis; automatic start input signals

FDEF DSTS 1.20 Function definition

```
Fault memory management:

Fault path status STS      : sfpsts                 Fault path deletion      : C_fcmclr & B_clsts
Error flag STS          : E_sts                  Fault path STS          : CDTSTS
Cycle flag STS          : Z_sts                  Fault class  STS        : CLASTS
Fault type STS                  : B_sists                Fault severity SS       : TSFSTS
                                                 Carb-Code STS           : CDCSTS
                                                 Env. conditions STS   : FFTSTS     Environmental conditions see %DFFT
Done in module %DFPM!
```

ABK DSTS 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCSTS	BLOKNR		KL	code word CARB: starter control
CDKSTS			FW	code word customer: starter control
CDTSTS			FW	code word tester: starter control
CLASTS			FW	error class: starter control
CWSTA			FW	code word for controlling start relay - automatic
FFTSTA	BLOKNR		KL	Freeze frame table: automatic start
NDSTS			FW	engine-speed threshold for diagnosis starter control
TSFSTS			FW	fault active time: starter signal
TWDSTS			FW	delay time for diagnosis starter control

Variable	Source	Type	Description
B_KL15		EIN	condition ignition switch on
B_SISTS	DSTS	AUS	Fault type: Automatic starter signal fault (signal input)
C_INI		EIN	ECU-condition for intialisation
E_STS	DSTS	AUS	error flag: start signal
Z_STS	DSTS	AUS	cycle flag: start signal

FB DSTS 1.20 Detailed description of function

The function constantly checks (in the background raster) port 2.1 (S_estart) and sets a signal fault, if B_estart=TRUE is detected during the engine run.

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APP DSTS 1.20 Application hint

DSTA 3.10 Diagnosis; automatic start output signals

FDEF DSTA 3.10 Function definition

dsta-dsta

dsta-dstacontro

Fault Code Memory Management:

Status fault path STA	:	SFPSTA	Clear fault path	:	C_fcmclr & B_clsta
Error flag STA	:	E_sta	Fault path STA	:	CDTSTA
Cycle flag STA	:	Z_sta	Fault class STA	:	CLASTA
			Fault severity STA	:	TSFSTA
			Carb-Code STA	:	CDCSTA
			Ambient conditions STA	:	FFTSTA

Ambient conditions see %DFFT

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ABK DSTA 3.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCSTA	BLOKNR		KL	code word CARB: starter activation
CDTSTA			FW	code word tester: starter activation [237]
CLASTA			FW	error class: automatic start
FFTSTA	BLOKNR		KL	Freeze frame table: automatic start
NDSTA			FW	engine threshold for diagnosis starter activation
TPDSTA			FW	debounce time for diagnosis starter activation
TSFSTA			FW	fault active time: start automatic
TWDSTA			FW	delay time for active diagnosis starter activation

Variable	Source	Type	Description
B_ESTART		EIN	Condition terminal (KL) 50 on
B_EZ	DSTA	AUS	prohibiting of engine running
B_KL15		EIN	condition ignition switch on
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_STA	DSTA	AUS	error flag: automatic start
NMOT_W	BGNMOT	EIN	engine speed
SFPSTA	DSTA	AUS	Status fault path : Automatic start triggering
Z_STA	DSTA	AUS	cycle flag: automatic start

FB DSTA 3.10 Detailed description of function

The diagnosis automatic start diagnoses faults in the starter triggering (output stage destroyed, relay stuck, triggering line to ground, etc.)
After KL15 is switched on and after a waiting time TWDSTA has elapsed a check for tooth edges is performed in a 100ms measuring window. With faultless operation (no tooth edges within the window) the engine run is enabled (B_EZ=1).
If engine speed pulses are detected within the 100ms-measuring window then it is prolonged. If TPDSTA is reached during a measuring window a fault entry is performed.

The engine run at detected fault is only enabled if a start request is reliably detected.
(Transition B_estart OFF——>ON detected).
After the engine run was enabled B_EZ=1 is held also in case of a SW-reset (C_ini=1).

APP DSTA 3.10 Application hint

The waiting time TWDSTA corresponds to the time from when the solenoid switch is put under current until the 1st tooth signalis detected.

ALE 2.2 Detection of engine stop position

FDEF ALE 2.2 Function definition

The run-on detection supplies that stop position of the engine, at which it comes to a standstill. This stop position is used during the subsequent start for the injection timing.
The run-on detection is started when the engine is turned off via ignition lock B_kl15. The signals of the speed sensor are evaluated while the engine is running-on. In the end, the found stop position is stored in the permanent RAM.

Run-on detection with back-swing detection:

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```
B_kl15:
        0

B_ale:                                                                                                                  1
                                                                                                   .<-100 ms->.
Phase:                                                                                             .          .
                                                                                                   .          .
                                                                                                   .          .
                                                                                                   .          .
NBM with back-swing:                                                          |----> backwards    .          .
 BM       BM       BM       BM       BM       BM                                                    .          .
|--||...||--||...||--||...||--||...||--||...||--|| | | | | | | | | | | | | | | T0 |  T1  |T2 |  |  |  |     |          .
                                                                                                   .          .
Engine position:     60        0       60        0 1 2 3 4 5 6 7 8 9 0 1 2 13   14     14  13 12 11  10      9          .
Tooth counter:                                                                                                  ----> zzale
Cylinder counter:                                                             ^                                 ----> zylale
                                                                              |
                                                          back-swing position: 14  ------------------------------> zzrale
```

If a tooth period with a period time greater TRD occurs during the engine run-on, this tooth value is stored as back-swing position zzrale, provided the following conditions are fulfilled: The back-swing rotation point lies between two TDC points and the following TDC point.

```
        Back-swing detection, if
                         (n < 1000/TRD 1/min) i.e. when  (T1 > TRD [ms])
        4-cylinder:     & (90°KW before TDC < alpha (T1) < 0°KW before TDC)
        6-cylinder:     & (60°KW before TDC < alpha (T1) < 0°KW before TDC)
        V8-cylinder:    & (45°KW before TDC < alpha (T1) < 0°KW before TDC)
        V12-cylinder:   no back-swing correction
```

The tooth counter continues counting after the back-swing detection. The run-on detection is aborted 100 ms after the latest tooth interrupt and the counts are stored in zzale and in zylale.
The found stop position is determined from the variables zzale,zzrale and zylale and then it is stored as virtual starting position for the next start in zzstp and in zylstp. The condition run-on detection is set (B_ale=1) valid.

The run-on position is reset to not plausible values during the next start after the start detection.
The condition B_ale is reset (B_ale = 0) as soon as end of start (B_sten) is reached.
If the engine is stalled (B_kl15 = 1) or if no synchronization is given when the engine is turned off, then no run-on detection is performed and the run-on values contain not plausible values.

Special Features of the 12-Cylinder Engine:

The two banks are synchronizes via CAN - also in case of virtual tr's (as during 'normal start').
That means: Both banks need to have learned a valid run-on position and both need to permit a quick start (pay special attention to the engine-temperature threshold in %EASTT)

Special Features at Re-Synchronization:

If it is detected during the re-synchronization that the injection dependent on the virtual tr-mark has taken place for longer than end of intake (at incorrect run-on position; dependent on the data entered into the pre-injection angle and on the start ti's), then the injection is stopped for one camshaft revolution (also refer to EASTT).
Re-synchronization, otherwise, acts like a jump of the pre-injection angle.

Invalid Run-on Values:

If no end of start (B_sten) is reached during the "driving cycle" (B_kl15 0 -> 1 -> 0), then no run-on position is determined => The subsequent start takes place without quick start.

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Temporal Curve of the Available Variables:

```
                                                                  (B)
                *        *        *        *      |                    |          |                        *        *
                *  *     *  *     *  *     *  *   |                    |          |                        *  *     *  *
            *   *    *   *    *   *    *   *    * |                    |          |                        *    *   *
              *  *      * *      * *      * *     ***********************          *                        *      * *
zzmot           *        *        *        *      |                    *************** ***************************        *
                                                  |                    |  |<--->|<--->|  |                        |
                                                  |                    TPRELL ZZINI    |                        |
                                 oooooooooo       |                    |<-ZTPREL>|     |                        |
                         oooooooooo       o       |                    |              |                        ooooooo
                oooooooooo                o       |                    |              |                   ooooooooo
            oooooo                        o       |                    |              oooooooooooo            |
                                          o       |                    oooooooooo     |                        |
zylvek                                    oooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooo
                                                  |                    |  |  +      |  +      |  +      |
                                                  |                    |  |    +    |    +    |    +    |
                                                  |                    |  |      +  |      +  |      +  |
zzvirt                                            |                    |  |         |         |         |
                                                  |                    |  |         |         |         |
                                          (A)     |          (C)       |  (D)    |         |  (E)    |
                                                  |                    |         |         |         |
                 ---------------- Run-on ----------------------------->|---------------> restart
```

zzmot: Tooth counter engine
- counts "negative" tooth edges downwards
- counts from 120/ZYLANZ .... 1, i.e. for 6-/12-cyl. from 20 ...1 and for 8-cyl. 15 ... 1; in the process, position 20 resp. 15 represents the tr-mark.

zylvek: Cylinder vector
- counts the software cylinder from 0 .... ZYLANZ-1
- always points to the cylinder to be fired next (at not ignition-synchronous measurement)!!!

zzvirt: Virtual tooth counter
- is set to the run-on position in case of permitted quick start.
- counts just as zzmot
- stops when synchronization has been performed

Position A: The run-on position is stored in zzstp and zylstp at engine standstill.
A reversal point that has occurred is taken into consideration in the process (is not illustrated in above diagram for simplification reasons)
zzmot corrected ---> zzstp
zylvek corrected ---> zylstp

Position B: Only once the starter is turned does the debouncing time TPRELL start and thereafter ZZINI.
Hence 3 teeth are "collected", in order to be able to perform the gap test
=> ZTPREL must be at least ZZINI + 3 (max. 120/ZYLANZ)

Position C: During initialization, zzvirt and zylvek are set to the run-on position:
zzvirt = zzstp - ZTPREL (zylvek is not corrected in case of under-flow)
zylvek = zylstp

Position D: zzvirt counts once 3 teeth have been collected and generates virtual tr's (in which merely the ignition is blocked!).

Position E:
- Parallel to virtual tr's being generated, the synchronization is checked (gap search and inquiry of the status PG signal)
- When synchronization has taken place, the virtual tr's are suppressed; zzvirt is frozen and the virtual tooth position zylvirt is stored.
  zzvirt -> stop
  zylvek -> zylvirt (prior to synchronization)
- Simultaneously the synchronization point is stored in zzsync and in zylsync (attention: this happens during every synchronization !)

=> From the difference between zzsync/zylsync and zzvirt/zylvirt it is possible to determine, by how many teeth re-synchronization needed to be performed!

Examples for the 8-Cylinder Engine:

zzvirt	zylvirt	zzsync	zylsync	delta zz	del zyl	delta in deg. KW
15	0	15	0	0	0	0
14	0	15	0	+1	0	+6 deg.
1	7	15	0	-1	0	-6 deg.
1	6	15	0	-1	-1	-96 deg.
15	1	15	0	0	+1	90 deg.
1	0	15	0	+14	0	84 deg.

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ABK ALE 2.2 Abbreviations

```
alpha(T1)              -       Crankshaft angle, at which back-swinging is detected
OT      -              -       Top Dead Center (TDC)
T0,T1,T2-              -       Period of the speed signal
```

Parameter	Source-X	Source-Y	Type	Description
TMESP			FW	Engine temperature threshold quick start
TRD			FW	tooth period time for reverse rotation during stop
WESSTO			FW	Offset angle injection for quick start
ZTPREL			FW	number of teeth during start recognition

Variable	Source	Type	Description
B_ALE	ALE	AUS	condition engine stop position detected
B_KL15		EIN	condition ignition switch on
ZYLALE	ALE	AUS	cylinder number for engine stop position detection
ZYLSTP	ALE	AUS	cylinder number of current start position
ZZALE	ALE	AUS	tooth counter engine stop position detection
ZZRALE	ALE	AUS	tooth counter reverse rotation detection during stop
ZZSTP	ALE	AUS	tooth counter of current start position

FB ALE 2.2 Detailed description of function

```
The virtual engine position after the start detection results according to:
              Engine position after start detection = Start position - ZTPREL
ZTPREL represents those teeth that "arrive" during the start detection (tooth interrupt, debouncing time TPRELL,
debouncing teeth ZZINI, tooth period measurement). ZTPREL may amount to 1 segment at the maximum (in number of teeth).

The timing of the injection during start is based on this position, provided it is detected as being plausible (B_ale=1).
The run-on position is not plausible
        B_ale = 0       when  zzale = zzrale = zylale = AAh
After detected start, these storage cells are overwritten with not plausible values (AAh).

If the engine position is changed once the vehicle has been parked (e.g. pushing, while gear is engaged), then the actual
run-on position is changed. Since the starting position then does not agree with the run-on position, a timing fault of the
first injection pulses up until the new synchronization occurs. Thereby longer starting times may arise.
```

APP ALE 2.2 Application hint

```
TRD:    This value determines, at what tooth period back-swinging of the engine is detected. If the value is chosen to be too
        high, back-swinging is not always detected. If the value, however, is chosen to be too low, back-swinging is detected
        too early or even incorrectly. In order to choose the correct value, several run-on attempts are to be performed and in
        the process the digital tooth signals after the conditioning circuit (CJ53, CJ400) should be recorded. From this, the
        back-swing position can be detected and typical values for the tooth period during back-swinging can be measured
        (measuring device: e.g.: UV-recorder). The smallest tooth period, at which back-swinging occurs, is to be chosen as
        application value. Typical values for the tooth period during back-swinging are: 40 to 100 ms, i.e. lowest value: 30 ms.

TPKL15: The run-on time TPKL15 should be at least 3 seconds to ensure a secure run-on detection.

ZTPREL: The spare teeth ZTPREL for the debouncing phase during the next start are to be adjusted such that the deviation between
        the actual and the virtual engine position is minimized.
        Guidance values: ZTPREL = ZZINI + 3 + TPRELL [ms]/10 (ME 1.0)

Check of the virtual engine position: At start, virtual tr- or tn-marks are already set prior to the synchronization.
        During the transition into the synchronized range, it is possible to evaluate the deviation to the actual engine position
        by means of this signal.
```

KVA 42.20 Output signal: display of fuel consumption

FDEF KVA 42.20 Function definition

```
Sorry, no copy avaible ... sch...
No text for FDEF available!
```

ABK KVA 42.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FKVAUM			FW	calibration factor for injection time in fuel consumption
FRLFSDP	DPUS_W		KL	injection correction for RLFS
KRKTE			FW	conversion from relative fuel mass rk into effective injection time te

Variable	Source	Type	Description
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
C_INI		EIN	ECU-condition for intialisation
DPUS_W	AES	EIN	delta between ambient and intake manifold pressure
D_ANZTI		EIN	
FRKTE		EIN	factor: conversion rel. fuel mass rk into effect. injection time te
KVAREST	KVA	LOK	
KVAVERBR	KVA	AUS	Fuel-quantity consumption via CAN; normed in u-litre
RKTE_W	TEB	EIN	relative fuel part of the purge control
TE2_W		EIN	effective injection time bank 2 (word)

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Variable	Source	Type	Description
TETE_W	KVA	LOK	
TE_W		EIN	effective injection time (word)

FB KVA 42.20 Detailed description of function

APP KVA 42.20 Application hint

VS_VERST 2.40 Adjusting parameters for McMess

FDEF VS_VERST 2.40 Function definition

Position	Label	Adjusting variable	Initial.value	Variable	Limit	Quant/INC.	Frame	%Section
1	vszw	Ignition timing	0° KW	Byte	-96..95.25°KW	0.75 °KW		ZUE
2	vsfrk	Mixture factor	1,0	Byte	0.75..1.25	0.001953		ESGRU
3	vsvw	Advancement angle	0° KW	Byte	-768°...762°	6° KW		ESVW
4	vsns	Nominal speed	0 RPM	Byte	0..2550/min	10 RPM		LLRNS
5	vszwkr[0]	Ignition timing firing 1	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
6	vszwkr[1]	Ignition timing firing 2	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
7	vszwkr[2]	Ignition timing firing 3	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
8	vszwkr[3]	Ignition timing firing 4	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
9	vszwkr[4]	Ignition timing firing 5	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
10	vszwkr[5]	Ignition timing firing 6	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
11	vszwkr[6]	Ignition timing firing 7	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
12	vszwkr[7]	Ignition timing firing 8	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
13	vske	Knock detection threshold	0	Byte	-8..8	0,0627		KRKE
14	vsdmr	Torque reserve	0 %	Byte	0..99.6%	0.3906%		MDKOL
15	vsfpses	Manifold air pressure	1	Byte	0..2	0,0078		AES

In case turbo installed: SY_TURBO = true

16	vsrlmx	max.rl for LDR	0%	Byte	Conv.: rel_sb_q0p75			LDRLMX
17	vsldtv	TV LDR for appl. control	0%	Byte	Conv.:tv_ub_q0p64			LDTVMA

In case camshaft adjustment present: SY_NWS = 2

18	vswnws	Angle NW for VANOS	0°	Byte	wkw_ub_q0p25	0,25 °KW		WNWEIN

%VS_VERST describes the parameters to be adjusted by means of McMess. The effects of the adjustment are described in the pertinent sections on the individual functions (refer to above table in %Section).

The RAM cells are set once to the initialization values given above for the following conditions:

1. C_ini
2. For B_mcacti = 0 (McMESS is not active). B_mcacti is updated in the 1-sec time frame.
3. For entry and exit in McMESS communication (item 3 not applicable as required, corresponds to item 2).

If CWVSV = 0 VS_VERST isn't active. Only for CWVSV > 0 adjustment with McMess is possible.

ABK VS_VERST 2.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWVSV			FW	code word f. deactivation VS_VERST (CWVSV = 0: VS_VERST inactive)

Variable	Source	Type	Description
B_MCACTI	VS_VERST	LOK	Condition McMESS active
SY_NWS	PROKON	EIN	system constant camshaft control: none, 2 point or continuous
SY_TURBO	PROKON	EIN	system constant for turbocharged engine

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Variable	Source	Type	Description
VSDMR	VS_VERST	AUS	adjustable torque reserve via VSxy
VSFPSES	VS_VERST	AUS	factor for modifying intake manifold pressure during Application injection
VSFRK	VS_VERST	AUS	Correction of the relative fuel mass by adjusting systems
VSKE	VS_VERST	AUS	adjustable offset for knock detection threshold via VS20
VSLDTV	VS_VERST	AUS	Correction value boost control from VS-sysrem for application
VSNS	VS_VERST	AUS	Change of target engine speed with calibrationg tool VSxy
VSRLMX	VS_VERST	AUS	Additive load correction for rlmx from application system
VSVW	VS_VERST	AUS	change in the phase injection angle by the application system
VSWNWS	VS_VERST	AUS	Change of the variable camshaft angle by adjusting system VSxy
VSZW	VS_VERST	AUS	Ignition-timing correction by adjusting system
VSZWKR	VS_VERST	AUS	cylinder individual adjustment of ignition angle by VS2x

FB VS_VERST 2.40 Detailed description of function

APP VS_VERST 2.40 Application hint

STECK 394.30 Plug pin arrangement

FDEF STECK 394.30 Function definition

ME 7.2 M62LEV C-Model

Module 1

Pin no.		I/O	Cross sect.	Pin no.		I/O	Cross sect.	Pin no.		I/O	Cross sect.
1 o	S_KL15 circt. Kl.15 (426)	E	0.35	4 o	M_EL gnd. electronics	M	1.50	7 o	U_UBD perm. plus	E	0.75
2 o	U_PROG (428)	E	0.35	5 o	M_EV gnd. injection	M	2.50	8 o	U_UBR switched UB	E	0.75
3 o	D_DIAK K-lead (206/432)	I/O	0.35	6 o	M_ES gnd. end stages	M	1.50	9 o	——	-	——

Module 2

Pin no.		I/O	Cross sect.	Pin no.		I/O	Cross sect.
1 *	LSHHK2 probe heating h cat.	A	1.50	7 *	LSHHK1 probe heating after cat.	A	1.50
2 *	——	E	0.35	8 *	M-LSHK2 probe gnd. after cat.	M	0.35
3 *	CAN-L (437)	I/O	0.35	9 *	M-LSVK1 probe gnd. before cat.	M	0.35
4 *	CAN-H (436)	I/O	0.35	10 *	M-LSVK2 probe gnd. before cat.	M	0.35
5 *	M-CAN CAN shield (435)	M	0.35	11 *	M-LSHK1 probe gnd. after cat.	M	0.35
6 *	DIAGK K lead (103,432)	I/O	0.35	12 *	E_ZSR ign. current (ign.)	E	——
13 *	LSHVK2 probe heat. before cat.	A	1.50	19 *	LSHVK1 probe heating before cat.	A	1.50
14 *	LSHK2 signal LS after cat.	E	0.35	20 *	——	A	——
15 *	LSVK1 signal LS before cat.	E	0.35	21 *	——	-	——
16 *	LSVK2 signal LS before cat.	E	0.35	22 *	——	-	——
17 *	LSHK1 signal LS after cat.	E	0.35	23 *	HR Main relay	A	0.50
18 *	RL/KKU fuel circulation	A	0.50	24 *	——	-	——

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Module 3

Pin no.		I/O	Cross sect.	Pin no.		I/O	Cross sect.
1 *	EV8	A	0.50	14 *	EV7	A	0.50
2 *	EV6	A	0.50	15 *	EV5	A	0.50
3 *	TEV tank venting valve	A	0.50	16 *	T_NWE2 starter NW2	A	0.50
4 *	EGW control, thermal budget	A	0.50	17 *	M_EL gnd. electronics3	M	
5 *	——	-	—	18 *	——	-	—
6 *	M-EL gnd. electronics2	M		19 *	NWGE2 signal NW sensor	E	0.35
7 *	5VHFM 5V reference HFM5	A	0.50	20 *	NWGE1 signal NW sensor	E	0.35
8 *	DKG2 (IP2S)	E	0.35	21 *	M_TMOT gnd. engine temps.	M	0.35
9 *	M-HFM gnd. HFM signal	M	0.35	22 *	TMOT engine temp. sen.	E	0.35
10 *	5VDKG 5V supply DKG1,2	A	1.00	23 *	HFM signal HFM	E	0.35
11 *	SLV Sec. air vent. (403)	A	0.50	24 *	DKG1 (IP1S)	E	0.35
12 *	S_KL30H (402)	B		25 *	M_DKG gnd. DKG1,2	M	0.35
13 *	S_KL61 (401)	B		26 *	jumper to 411 oil press.	B	
27 *	EV4	A	0.50	40 *	EV3	A	0.50
28 *	EV2 cyl.3	A	0.50	41 *	EV1	A	0.50
29 *	T_NWE1 starter NW1	A	0.50	42 *	DCP DC-engine control unit (+)	A	1.00
30 *	SSP relay suction p.	A	0.50	43 *	DCM DC-engine control unit (-)	A	1.00
31 *	KFK el.thermostat control	A		44 *	——	-	—
32 *	KWDG-A speed transm.	E	0.35	45 *	M_KWDG shield KWDG	M	0.35
33 *	M_EL gnd. electronics4	M	0.50	46 *	KWDG-B speed transm.	E	0.35
34 *	TANS temperature sensor	E	0.35	47 *	M_TANS gnd. temp. sensor	M	0.35
35 *	M_KS2 gnd./shield KS2	M	0.35	48 *	M_KS1 gnd./shield KS1	M	0.35
36 *	KS2 knock sens. cyl.	E	0.35	49 *	KS1 knock s. cyl.	E	0.35
37 *	KS4 knock sens. cyl.	E	0.35	50 *	KS3 knock s. cyl.	E	0.35
38 *	M_KS4 gnd./shield	M	0.35	51 *	M_KS3 gnd./shield	M	0.35
39 *	jumper to 421 oil level	B		52 *	SLPV2 valve SLP (431)	A	0.50

Module 4

Pin no.		I/O	Cross sect.	Pin no.		I/O	Cross sect.
1 *	jumper to 313 KL61	B	—	11 *	jumper to 326 oil press.	B	
2 *	jumper to 312 KL30H	B	—	12 *	M_FW2 gnd. PWG2	M	—
3 *	SLPV1 sec. air pump(311)	A	0.50	13 *	E_FW2 Signal PWG2	E	—
4 *	ELUE relay el. fan	A	0.35	14 *	U_FW2 5V-Vers. PWG2	A	0.35
5 *	E.A.FST (Morgan only)	E	—	15 *	M_EL5 gnd. electronics	M	0.50
6 *	S_start ign. key circuit	E	0.35	16 *	——	E	—
7 *	M_FW1 gnd. PWG1	M	0.35	17 *	DMTD tN-signal	A	0.35
8 *	E_FW1 signal PWG1	E	0.35	18 *	A.S.DMTLH/Exhaust flap	A	0.50
9 *	U_FW1 5V supply PWG1	-	—	19 *	——	-	—
10 *	EKP EKP relay	A	0.50	20 *	A.S.DMTLP	A	0.50
21 *	jumper to 339 oil level	B		31 *	SLPV2 sec. air pump(352)	A	0.50
22 *	VFZ velocity signal	E	0.35	32 *	DIAGK	I/O	0.35
23 *	S_KUP clutch switch	E	0.35	33 *	EWS immobilizer	I/O	0.35
24 *	S_BLS braking light switch	E	0.35	34 *	LDPR feedback LDP	E	0.35
25 *	S_FGRMAIN main switch FGR	E	0.35	35 *	M_CAN gnd. CAN (205)	M	0.35
26 *	S_KL.15 - signal (101)	E	0.35	36 *	CAN-H (204)	I/O	0.35
27 *	D_MFL multi-funct. steer. wheel	E	0.35	37 *	CAN-L (203)	I/O	0.35
28 *	UPROG (102)	E	0.35	38 *	M_TKA gnd. TKA	M	0.35
29 *	KOREL compressor relay	A	0.50	39 *	TKA temp.cool. water outlet	E	0.35
30 *	LDP / A.S.DMTLV	A	0.50	40 *	START relay start release	A	1.00

Module 5

Pin no.		I/O	Cross sect.	Pin no.		I/O	Cross sect.	Pin no.		I/O	Cross sect.
1 o	ZUE7 ignition cylinder 7	A	1.00	4 o	ZUE6 ignition cylinder 3	A	1.00	7 o	ZUE3 ignition cylinder 4	A	1.00
2 o	ZUE4 ignition cylinder 8	A	1.00	5 o	M_ZUE gnd. ignition	M	2.50	8 o	ZUE2 ignition cylinder 5	A	1.00
3 o	ZUE8 ignition cylinder 2	A	1.00	6 o	ZUE1 ignition cylinder 1	A	1.00	9 o	ZUE5 ignition cylinder 6	A	1.00

Remark: o JPT contacts 2.8 x 0.8 Imax.= 8A (modules 1;5)
* MQS contacts 0.64 x 0.64 Imax.= 2.0 A (modules 2;3;4)

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ABK STECK 394.30 Abbreviations

FB STECK 394.30 Detailed description of function

APP STECK 394.30 Application hint

CANUE 1.40 CAN overview; messages and identifiers

FDEF CANUE 1.40 Function definition

CAN - messages: In accordance with customer specifications —— CAN- Status 11H / Rev ——
==========

Message	System	Identifier (Hex) (Dec)	Data-Length	Issue Period	Configuration System comb.	Configuration autom. Detection	Message and signal definition
ASC1	DSC3	0153H 339D	8H	10/20 ms		x	%CANASR
ASC2	DSC3	01F0H 496D	8H	20 ms			
ASC3	DSC3	01F3H 499D	8H	20 ms			
ASC4	ASC/DSC	01F8H 504D	8H	20 ms		x	
EGS1	EGS	043FH 1087D	5H	E/100 ms	KONFIG		%CANEGS
DME1	DME	0316H 790D	8H	10 ms	X		%CANDME
DME2	DME	0329H 809D	8H	10 ms	X		
DME4	DME	0545H 1349D	8H	10 ms	X		%CANINS
INSTR2	Estate	0613H 1555D	8H	200 ms	X		
INSTR3	Estate	0615H 1557D	8H	1000 ms	X		
ACC1	ACC	052CH 1324D	8H	20 ms		x	%CANACC
LWS1	LWS	01F5H 501D	5H	10 ms	X		%CANLWS
TCU1	TCU	0445H 1093D	8H	100 ms		x	%CANTCU

Transmission parameters / Initialization / System shut-down:

Parameter	min	type	max	Unit
Switch-on delay (Kl. 87 with time after Kl.15)	-	-	120	ms
Shut-down delay (Kl. 87 with time after Kl.15)	1	5	unlimited	sec

The CAN data bus is driven with a transmission rate of 500 kBit/sec.

Remark (1): Only those signal names in the ME system are issued in the initial realization.
Additional signals defined in the CAN specification will be updated with the initialization value.

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ABK CANUE 1.40 Abbreviations

FB CANUE 1.40 Detailed description of function

APP CANUE 1.40 Application hint

CANDME 1.180 DME CAN message and signal definitions

FDEF CANDME 1.180 Function definition

```
Übertragungsparamater - Bedingungen:    Botschaft DME1,  DME2

        Toleranz der Ausgabeperiode     + - 6 ms
        Latenzzeit                      max. 5 ms
        Sendebedingung                  Stromversorgung von DME-Hauptrelais;
                                        Kl.15 EIN und UBatt > 6V und in Selbsthaltephase
        Remote-Betrieb                  nein
        Empfangsbereit nach Power-Up    =< 50 ms
        Sendebereit nach Power-Up       120 ms =< t2 =< 140 ms

Anmerkung (1): In der Erstrealisierung werden nur die im ME-System vorhandenen Signalnamen ausgegeben.
               Weitere im CAN-Lastenheft definierte Signale werden mit dem Initialisierungswert aktualisiert.
```

```
  Botschaft                        : DME1     Sender: Motronic
  Identifier                       : 316 H    (011 0001 0110 B)
  Data Length Code                 : 8 H
  Übertragungsrate                 : 500 KB
  Quarzfrequenz                    : 20 MHz
```

Signal-bezeich.	Signalname in ME (1)	Byte-Nr.	Start-B im Byte	Bit-Anz.	Init.-Wert	Unplaus. Wert	Bereich (phys.)	Sonstige Bedingungen	Umrechnungsfaktor (HEX) ——> (PHYS)
S_KL15	B_KL15	1	0	1	01 H			0 = aus, Selbsthaltephase 1 = Kl.15 ein	
E_n (Fehler DRZ-Sign.)	E_n	1	1	1	00 H				
ASC-Quittung	B_ascdme	1	2	1	00 H			0 = Fehler in ASC-Botsch. 1 = ASC-Botschaft i.O.	
frei		1	3	1	00 H				
Status Md-Eingriff STAT_MD_E	siehe Beschreibung unten	1	4	2	00 H			siehe Signal-Beschreibung	
frei		1	6	1	00 H				

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Signal-bezeich.	Signalname in ME (1)	Byte-Nr.	Start-B im Byte	Bit-Anz.	Init.-Wert	Unplaus. Wert	Bereich (phys.)	Sonstige Bedingungen	Umrechnungsfaktor (HEX) ——> (PHYS)
Fehler Lastsignal F_TL_MES	E_lm	1	7	1	00 H				
Indiziertes Motor-Md nach Md-Eingriff	miistc	2	0	8	00 H		0 / 99.6 % MDNORM	Beschreibung siehe unten !	(PH) = 0.39 * (HEX)
N_MOT (low) N_MOT (high)	nmot_w	3 4	0 0	8 8	00 H 00 H		0 / 10240 1/min	LSB MSB	(PH)= 0.15625* (HEX)
MD_IND	B_sa=0: mivbeg_w B_sa=1: 0	5	0	8	00 H		0 / 99.6 % MDNORM	siehe unten	(PH) = 0.39 * (HEX)
MD_REIB	mdverl_w	6	0	8	00 H		0 / 99.6 % MDNORM	MDVERL_B = mdverl_w	(PH) = 0.39 * (HEX)
Schalter Katheizen B1		7	0	1	00 H			0 = KAT-Heiz. Bank 1 aus 1 = KAT-Heiz. Bank 1 ein	
Schalter Katheizen B2		7	1	1	00 H			0 = KAT-Heiz. Bank 2 aus 1 = KAT-Heiz. Bank 2 ein	
S_MDASC	B_mdasc	7	2	1	00 H		siehe unten	0 = ASC-Schnittstelle ohne ALIVE-Signal 1 = ASC-Schnittstelle mit ALIVE-Signal	
frei		7	3	5	00 H				
MD_IND_LM	mdindlm	8	0	8	00 H		0 / 99.6 %		(PH) = 0.39 * (HEX)

Speicherlayout Botschaft DME1 nach BMW-Lastenheft:

MD_IND_LM							56
frei				S_MDASC	S_KATH2	S_KATH1	48
MD_REIB							40
MD_IND							32
N_MOT (high)							24
N_MOT (low)							16
MD_IND_NE							8
F_TL_MES	00H	STAT_MD_E	00H	Q_ASC	F_N_MOT	S_KL15	0

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Botschaft	: DME2 Sender: Motronic
Identifier	: 329 H (011 0010 1001 B)
Data Length Code	: 8 H
Übertragungsrate	: 500 KB
Quarzfrequenz	: 20 MHz

Signal-bezeich.	Label in DME (1)	Byte-Nr.	Start-B im Byte	Bit-Anz.	Init.-Wert	Unplaus. Wert	range (phys.)	Sonstige Bedingungen	Umrechnungsfaktor (HEX) ——> (PHYS)
MUL_INFO	see follow note	1	0	6	CAN-Stand			Gemultiplexte Information	siehe Signaldefinition
MUL_COD	see follow note	1	6	2				Kennzeichnung der Information	siehe Signaldefinition
Motor-Temp. T_MOT	tmot	2	0	8	FF H		-48 / 142.5 grad C	FFH =Fehlerkennzeichnung bei (E_tm=1) T_MOT=FFH	(PH)=0.75 *(HEX) -48
P_LUFT	pu_w	3	0	8	00 H	FFH	600..1106hPa entspricht: 01H...FEH		(PH=2*(HEX)+598[hPa]
S_KUP	B_kuppl	4	0	1	00 H				
S_NIV_LL	B_nivns	4	1	1	00 H			0=LL-Drehzahl > Schwelle 1=LL-Drehzahl < Schwelle	
Q_ACC_DME	B_accdme	4	2	1	00 H			wird in der CANACC gebildet (Plauscheck ACC)	
frei		4	3	2	00 H				
BED_FGR	B_fgrxxx	4	5	3	00 H	07H		siehe Dekodiertabelle u.	
W_VP_FGR	wpfgr_w	5	0	8	00 H			wird auf FE begrenzt	(PH)=0.390625 * (HEX)
Winkel Fahrpedal/	wped	6	0	8	00 H		0 / 99.2 [0H / FEH]	00 = Leerlauf FE = Kickdowndruckpunkt	(PH)=0.390625 * (HEX)

Fortsetzung Botschaft DME2:

LABEL	Signalname in ME (1)	Byte-Nr.	Start-B im Byte	Bit-Anz.	Init.-Wert	Unplaus. Wert	Bereich (phys.)	Sonstige Bedingungen	Umrechnungsfaktor (HEX) ——> (PHYS)
Bremslicht-schalter	B_brems	7	0	1	00 H			0 = Bremse Ruhestellung 1 = Bremse betätigt	
Bremslicht-schalter Fehler	E_brems	7	1	1	00 H			Bremsschaltersystem 0 = fehlerfrei und i.O. 1 = Fehler erkannt	
S_KD	B_kd	7	2	1	00 H			0 = kein Kickdown oder FPP Fehler erkannt 1 = Kickdown erkannt	
B_FGR	fgr_stat	7	3	3	00 H			Bildung in %BBACC	
S_SHIFTLOCK	siehe rechts	7	6	2	00 H			wenn B_falls=1 dann S_SHIFTLOOK=$3 wenn B_falls=0 dann S_SHIFTLOOK=$0	
frei		8	0	8	00 H				

memory layout message DME2 nach BMW-Lastenheft:

frei					56
S_SHIFTLOCK	B_FGR	S_KD	F_BS	S_BS	48
W_FPDK					40
frei					32
BED_FGR	frei	Q_ACC_DME	S_NIV_LL	S_KUP	24
P_LUFT					16
T_MOT					8
MUL_COD	MUL_INFO				0

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MUL_COD und MUL_INFO: Signaldefinition und funktionale Anforderungen
Die Übertragung von MUL_INFO und MUL_COD beginnt generell mit dem CAN_STAND.
Die Umschaltung der Information erfolgt im zeitlichen Abstand bon 50...100ms. (Typ.Wert 65ms.)
Das zyklische Umschalten der Information erfogt nur während Kl.15 EIN ist.

Signaldefinition und Information	MUL_COD		MUL_INFO	Physikal. Bereich	Umrechnung
	Bit7	Bit6	Bit5 Bit0		
CAN_STAND	0	0	Init-Wert = 11 H		
frei	0	1	Init-Wert = 00 H		
OBD_STEUER	1	0	Init-Wert = 00 H		Übernahme Ramzelle obdsteuer
MD_NORM	1	1	MDNORM	0 / 1008 Nm 0 / 3F H	(PH)= 16 * (HEX)

Bildung von B_mdasc:

Wenn im CWDASC das Bit 0 nicht gesetzt wird, dann wird B_mdasc == TRUE (damit das ASC-SG den ALIVE-Zähler über CAN sendet (ÜE (I)I)
Wenn im CWDASC das Bit 0 gesetzt ist, dann wird B_mdasc == FALSE (simple Überwachung aktiv, DASC, UFMSRC ohne Alivezähler)

Decoder table BED_FGR :

Bit 31	Bit 30	Bit 29	Funktion
0	0	0	keine Bedienung (B_fgrhsa=1)
0	0	1	Setzen / Beschleunigen (B_fgrtbe=1)
0	1	0	Setzen / Verzögern (B_fgrtve=1)
0	1	1	Wiederaufnahme (B_fgrtwa=1)
1	0	0	Abschalten siehe rechts
1	0	1	nicht belegt
1	1	0	nicht belegt
1	1	1	Fehler liegt vor (B_fgrhe=1)

Ausschaltverzögerungen nach Betätigung !

candme-stat-dme

candme-stat-dme

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Status Momenteneingriff STAT_MD_E

STAT_MD_E	function
0	Eingriffswunsch wird ausgeführt Es erfolgt keine Aussage über die Stellgenauigkeit; die Abweichung zu MD_IND_NE zum extern angeforderten Sollmoment ermittelt der betroffene CAN-Teilnehmer selbst.
1	Eingriffswunsch über Zündung kann nicht vollständig ausgeführt werden. Die maximale Zündwinkelverstellung zwspae ist erreicht. Der Füllungseingriff kann vollständig ausgeführt werden. Das Gesamtsollmoment kann je nach Anforderung nicht vollständig eingestellt werden.
2	Eingriffswunsch über Füllung kann nicht vollständig ausgeführt werden. (Stellgliedanschlag oder Systemfehler liegt vor) Der Zündungseingriff kann vollständig ausgeführt werden. Das Gesamtsollmoment kann je nach Anforderung nicht vollständig eingestellt werden.
3	Eingriffswunsch über Zündung und Einspritzung / Füllung wird nicht vollständig ausgeführt. Ein interner Fehler liegt vor.

Signal MD_IND :
if condition B_sa = 0 : MD_IND = mivbeg_w
condition B_sa = 1 : MD_IND = 0

Bildung von miistc:

Bei Änderungen von redist (redist_neu < redist_alt) kann es geschehen, daß miist_w einen positiven Sprung aufweist. Um diesen rechnerischen Sprung nicht auf dem CAN-Bus auszugeben, wird das Signal miistc gebildet. miistc ist im Grunde miist_w, nur bei dem genannten Fall wird nicht miist_w auf miistc kopiert sondern es wird miist_w(t-1) auf miistc (Verzögerung) kopiert.

Ausgabe Fahrpedalwinkel:
Ist der Low-Byte-Inhalt der berechneten Fahrpedalwinkels wped_w ungleich 0 wird im CAN-Signal wped immer = 0,39 % ausgegeben.

Signal definition P_LUFT

Initialization value: 00H
Error marking: FFH, if E_dsu = TRUE
Physical range: 600..1106hPa entspricht: 01H...FEH
Conversion: (PH=2*(HEX)+598[hPa]

ABK CANDME 1.180 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDASC			FW	code for ASC monitoring switchover
MDNORM			FW	maximum limit indicate engine torque
TVFGRAT			FW	debounce time cruise control switch off
TVFGRSE			FW	debounce time cruise control switch on

Variable	Source	Type	Description
B_ACCDME	DACC	EIN	Condition acknowledgement of the ACC requirement
B_ASCDME	DASC	EIN	Condition : Acknowledgement of ASC message OK
B_BREMS	CANDME	AUS	condition: brake operated
B_FALLS		EIN	condition: requirement to change engine speed by tester
B_FGRAT	GGMFL	EIN	condition: tip-switch off CC lever control
B_FGRHE	GGMFL	EIN	condition: CC-lever fault
B_FGRTBE	GGMFL	EIN	condition: Cruise control button ACCELERATE
B_FGRTSE	GGMFL	EIN	condition: CC button (+ or -) set
B_FGRTVE	GGMFL	EIN	condition: Cruise control button DECELERATE
B_FGRTWA	GGMFL	EIN	condition: Cruise control button RESUME
B_I_SKA_FR	SREAKT	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_KD	GGPED	EIN	Condition: kick-down
B_KL15		EIN	condition ignition switch on
B_LL	MSF	EIN	Condition idle
B_MDASC	CANDME	AUS	Condition ASC interface with ASC ALIVE signal
B_PWGNOTFR	GGPED	EIN	FR error reaction pedal-travel sensor limphome
B_SA	MDRED	EIN	Condition fuel cut-off
E_BREMS	GGEGAS	EIN	error flag: brake pedal signal
E_DK	GGDVE	EIN	Error flag: throttle position sensor
E_DSU	GGDSAS	EIN	error flag: Pressure Sensor Ambient
E_LM	DHFM	EIN	Error flag: main load sensor
E_N	DDG	EIN	error flag: engine speed sensor
FGR_STAT	BBACC	EIN	Status driving speed controller
MDINDLM	BGMDLM	EIN	indicated real engine torque; egs interface
MDVERL_W	MDVER	EIN	Resistant torque of the engine
MIISTC		EIN	Indicated engine torque high-pressure phase actual value for output on CAN bus
MIVBEG_W		EIN	Indicated torque requested by driver before slope limitation
NMOT_W	BGNMOT	EIN	engine speed
OBDSTEUER		EIN	From CAN signal, OBD_STEUER conditioned parameter for ME

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Variable	Source	Type	Description
PU	GGDSAS	EIN	Ambient pressure
STAT_MD_E	CANDME	AUS	CAN signal: Status torque intervention
TMOT	GGTFM	EIN	Engine temperature
WPED	GGPED	EIN	Standardized accelerator pedal angle
WPFGR_W	MDFAW	EIN	Recalculated accelerator pedal position in cruise mode
ZWOUT	ZUE	EIN	Ignition angle output value
ZWSPAE	ZWMIN	EIN	retarded ignition angle

FB CANDME 1.180 Detailed description of function

APP CANDME 1.180 Application hint

CANEGS 1.90 CAN message and signal definition transmission control

FDEF CANEGS 1.90 Function definition

```
Message                      : EGS1     Sender: transmission control  EGS1
Identifier                   : 043F H    (100 0011 1111 B)
Data length code             : 8 H
Transmission rate            : 500 KB
Quartz frequency             : 20 Mhz
```

Signal-designation	Signal name in ME (1)	Byte-No.	Start-B in byte	Bit-No.	Init.-Value	not plaus Value	Range (phys.)	Misc. Conditions	Conversion factor (HEX) ——> (PHYS)
GANG_INF	gangauti B_pn, B_fs	1	0	3	00 H			target gear Receiver: ASC and DME	refer to signal definition below
S_SCHALT		1	3	1	00 H			Gear-changing active	0 = no gear changing 1 = gear changing running
OBD_F		1	4	1	00 H			OBD-relevant fault	0 = no fault 1 = fault present
S_GTS	B_gts	1	5	1	00 H				
S_WK	B_wk / B_wkr	1	6	2	03 H	03H			see following signal definition
GANG_WHL_ANZ		2	0	4	00 H				
OBD_STAT_GS	obdstegs	2	4	4	0F H				OBS_STAT_GS aligned right-hand side in obdstegs
spare		3	0	5	00 H				
PRG_INF_ANZ		3	5	3	05 H				currently not used
MD_IND_GS Torque inter-vention for EGS function	migsrc_w	4	0	8	FF H		0 / 99.6094 [00H / FF]	00 = max. reduction FF = no reduction	(PH) = 0.390625 * (HEX)

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Signal-designation	Signal name in ME (1)	Byte-No.	Start-B in the byte	Bit-	Init.-No.	not plaus Value	Range Value	Misc. (phys.) Conditions	Conversion factor (HEX) ——> (PHYS)
N_ABTR	see nabtrc_w	5	0	8	00 H	** H	see definition below		
L_GS		6	0	2	00 H				only for combi instrument
GS_TYP		6	2	1	00 H				currently not used
S_EGW		6	3	1	00 H				
S_GOT	B_got	6	4	1	00 H			Condition transm. oil overtemperature	0 = no requirement 1 = addit. cooling
NAB	see nabtrc_w	6	5	1	00 H		see definition below		
STR_VERST		6	6	10	00 H	3FF H			
MD_GETRIEBE	mdwancan	8	0	8	00 H		0 / 99.6094 %		(PH)=0.390625*(HEX)

Memory-layout message EGS1 according to BMW specification:

MD_GETRIEBE						56
STR_VERST (hi)						48
STR_VERST (lo)	frei	S_GOT	S_EGW	GS_TYP	L_GS	40
N_ABTR						32
MD_IND_GS						24
PRG_INF_ANZ		NAB				16
OBD_STAT_GS			GANG_WHL_ANZ			8
S_WK	S_GTS	OBD_F	S_SCHALT	GANG_INF		0

Transmission parameters - Conditions:	Message EGS1
Output period	Result-controlled output, otherwise every 100 ms
Latency time	max. 5 ms
Sending condition	Power supply from DME main relay; Kl.15 ON and UBatt > 6 V and in self-locking phase
Remote mode	no
Ready to receive after power-up	=< 100 ms
Ready to send after power-up	120 ms =< t2 =< 140 ms

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Evaluation of EGS message:
==========

a) Valid EGS CAN message present -> B_egscok = 1 :

b) Fault detection EGS CAN message:
-> time-out of 500 ms for EGS CAN message triggers fault: "CAN time-out transmission" off. ——> Refer to: %DCGE

-> The initialization values for other functions are made available for a detected fault.

c) Automatic EGS detection from CAN message after powerfail

B_autget must be saved in the non-volatile RAM.

Decoder table for CAN signal GANG_INF for B_pn, B_fs and gangauti:

GANG_INF	function	B_pn	gangauti	B_fs
000B	for detection of N or P (no power transmission)	FALSE	0	FALSE
001B	1st gear	TRUE	1	TRUE
010B	2nd gear	TRUE	2	TRUE
011B	3rd gear	TRUE	3	TRUE
100B	4th gear	TRUE	4	TRUE
101B	5th gear	TRUE	5	TRUE
110B	6th gear (if available)	TRUE	6	TRUE
111B	Reverse gear	TRUE	7	TRUE

S_WK		Converter lockup clutch	Set Condition B_wk	Set Condition B_wkr
Bit 7	Bit 6	function		
0	0	Converter lockup clutch disengaged	0	0
0	1	Converter lockup clutch regulated	0	1
1	0	Converter lockup clutch closed	1	0
1	1	Not defined; position not known	1	1

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conversion output shaft speed nabtrc_w of 13 Bit message:

Bit 15	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
nabtrc_w 0	0	0	0	0	N_ABTR								NAB				

```
Initialization value:  00H
Error marking:         1FFFH
Physical range:        00A0...1FFEH
Conversion:            (PH) = 1 upm * (Hex)
Note:                  If output shaft speed < 160 upm, each bit of N_ABTR and NAB
                       transmitted  by 0, sensor range unspecificated.
```

ABK CANEGS 1.90 Abbreviations

Variable	Source	Type	Description
B_AUTGET	CANEGS	AUS	condition automatic gearbox
B_CGENEW	CANEGS	AUS	condition CAN interface EGS message ready
B_EGSCOK	CANEGS	AUS	Condition: CAN message of the gearbox is received
B_EGSNEW	CANEGS	AUS	Condition that a new transmission message has been detected
B_FS	CANEGS	AUS	Condition driving state (automatic gear box)
B_GOT	CANEGS	AUS	condition excess temperature gear box
B_GTS	CANEGS	AUS	Condition: Transmission protection
B_PN	CANEGS	AUS	condition: position P or N of automatic transmission selected
B_WK	CANEGS	AUS	condition: converter lockup clutch closed
B_WKR	CANEGS	AUS	condition clutch controlled
C_INI	CANEGS	LOK	ECU-condition for intialisation
GANGAUTI	CANEGS	AUS	current gear of automatic gearbox received by CAN
MDWANCAN	CANEGS	AUS	Torque request for the converter via CAN
MIGSRC_W	CANEGS	AUS	Torque reduction request transmission control (CAN message)
NABTRC_W	CANEGS	AUS	Output shaft speed of gear box via CAN
OBDSTEGS	CANEGS	AUS	From CAN signal, OBD_STAT_GS Conditioned parameter for ME

FB CANEGS 1.90 Detailed description of function

APP CANEGS 1.90 Application hint

DCGE 13.20 Diagnosis; CAN timeout GE interface

FDEF DCGE 13.20 Function definition

dcge-dcge

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```
                 Test criteria:  No CAN message EGS1 for t > time-out (500 ms) and Ub > UBDCAN, and transmission control detected
                                 and B_kl15 = 1

   Fault rectification criteria:  Message received during last 10 ms, B_egsnew = 1

             Standby variables:

Effect on overall system: Transmission control in the emergency program


(*):   Unlike in the description, this path is served in the module %DFPM, or the flags are managed in %DFPM;


Standby measures:
Effects on the system: EGS in emergency program

Error memory management:
```

Status error path :	SFPCGE	Delete Error path:	C_fcmclr & B_clcge
Error flag :	E_cge	Error path :	CDTCGE
Cycle flag :	Z_cge	Error class :	CLACGE
Error type :	B_sicge	Error severity :	TSFCGE
		CARB code :	CDCCGE
		Environmental conditions :	FFTCGE

ABK DCGE 13.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCCGE	BLOKNR		KL	code word CARB: CAN interface, timeout transmission control system
CDTCGE			FW	code word tester: CAN interface, timeout EGS [236]
CLACGE			FW	fault class: CAN interface, timeout EGS
FFTCGE	BLOKNR		KL	Freeze Frame table: CAN interface, timeout EGS
TDCGE			FW	Time for timeout detection CAN interface EGS
TSFCGE			FW	fault active time: CAN interface, time-out EGS
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_AUTGET	CANEGS	EIN	condition automatic gearbox
B_CLCGE	DCGE	LOK	condition clear fault path CGE
B_EGSNEW	CANEGS	EIN	Condition that a new transmission message has been detected
B_KL15		EIN	condition ignition switch on
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_PWF		EIN	Condition for powerfail
B_SICGE	DCGE	AUS	signal error CAN interface EGS
C_FCMCLR	DCGE	LOK	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
E_CGE	DCGE	AUS	error flag: CAN-interface timeout EGS
SFPCGE	DCGE	AUS	status fault path: timeout CAN interface EGS
UB	GGUB	EIN	battery voltage
Z_CGE	DCGE	AUS	cycle flag: CAN interface, timeout transmission control unit

FB DCGE 13.20 Detailed description of function

```
The function monitors the CAN message EGS1 for time-out. Sender of the message is the transmission control.
The time-out monitoring is active when the battery voltage is greater than UBDCAN, B_kl15 = 1 and the automatic AGS detection
B_agpkw is set. The AGS detection B_agpkw and B_egsnew are provided from the section %CANEGS.
The sampling rate is 10 ms.
The error E_cge is detected if no further EGS1 message has been received for t > time-out = 500 ms. ( B_egsnew = 0 )
The internal monitoring-time counter is reset if another EGS1 message is received during the monitoring time ( B_egsnew = 1).
Fault rectification and reset of the error flags E_cge if B_egsnew = 1.
The cycle flag Z_cge is always set after t (time counter as of engine running) > 500 ms.
E_cge and Z_cge are reset by the command "Delete error memory".
```

APP DCGE 13.20 Application hint

CANINS 1.110 CAN message and signal definition, combined instrument

FDEF CANINS 1.110 Function definition

ABK CANINS 1.110 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TVMFLA			FW	debounce time cruise control lamp

Variable	Source	Type	Description
B_AC	CANINS	AUS	Condition for additional air by air condition on
B_EPCL	CANINS	AUS	Condition for activation of electronic powertrain control lamp
B_FGRHSA	GGMFL	EIN	condition: CC main switch off
B_FSTCANOK	CANINS	AUS	CAN: Condition fuel level message okay
B_INS2COK	CANINS	AUS	condition: CAN-message INSTR2 received

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Variable	Source	Type	Description
B_INS2NEW	CANINS	AUS	condition CAN interface instruments 2 o.k. status
B_INS3COK	CANINS	AUS	Condition CAN message INST3 present
B_INS3NEW	CANINS	AUS	condition CAN interface instruments 3 o.k. status
B_KO	CANINS	AUS	condition AC compressor authorised
B_KOGER	CANINS	AUS	Condition closed loop/open loop controlled A/C-compressor
B_MIL	DMIL	EIN	MIL turn-on
B_NTKW	CANINS	AUS	Condition request of low coolant temperature (heat-exchanger protection)
B_TALCAN	CANINS	AUS	condition: tank empty from CAN
B_TNS	CANINS	AUS	Condition from switch day/night illumination
B_UETM	UETM	EIN	Condition overtemperature
C_INI	CANINS	LOK	ECU-condition for intialisation
EKPAUSC	CANINS	AUS	CAN message EKP shutdown via Crash-Sensor Airbag control unit
KMSTAND	CANINS	AUS	Route of the vehicle as information via CAN
KVAVERBR	KVA	EIN	Fuel-quantity consumption via CAN; normed in u-litre
L_FGR	GGMFL	EIN	Status FGR readiness lamp
MDKOG	CANINS	AUS	torque needed for air condition
STMLAC	CANINS	AUS	Request stage E-fan of air conditioner
TFST	CANINS	AUS	Tank level
TRMIN_W	CANINS	AUS	relative time in minutes
TUMG	CANINS	AUS	Ambient air temperature

FB CANINS 1.110 Detailed description of function

APP CANINS 1.110 Application hint

DCINS 5.20 Diagnostics; CAN timeout instrument (Combi)

FDEF DCINS 5.20 Function definition

dcins-dcins

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(*) Unlike in the description, this path is served in the module %DFPM, or the flags are managed in %DFPM;

Test criteria: No CAN message Instr2, B_ins3new = 0 or Instr3, B_ins3new = 0
for t > TDCINS and Ub > UBDCAN and S_kl15 = ON

Fault rectification criteria: Conditions are not met

Standby variables: S_fst = 0 ; S_ac = 1 ; S_ko = 0 ; lmkk = 0 [Nm] ; S_NTKW = 1; tabstell = TABSTER
S_tns = 1 ; tumg = -30 [°C]

Error memory management:

Status error path :	SFPCINS	Delete Error path:	C_fcmclr & B_clcins
Error flag :	E_cins	Error path :	CDTCINS
Cycle flag :	Z_cins	Error class :	CLACINS
Error type :	B_sicins	Error severity :	TSFCINS
		CARB code :	CDCCINS
		Environmental conditions :	FFTCINS

ABK DCINS 5.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCCINS	BLOKNR		KL	code word CARB: CAN interface, timeout instrument
CDTCINS			FW	code word tester: CAN-Timeout, Instruments
CLACINS			FW	fault class: CAN interface, timeout instruments
FFTCINS	BLOKNR		KL	Freeze frame table: CAN-Timeout, instrument panel
TDCINS			FW	Time for timeout detection CAN interface combi-instrument
TDHCINS			FW	Time for fault rectification CAN timeout combined instrument
TSFCINS			FW	fault active time: CAN interface, time-out control panel
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_CLCINS	DCINS	LOK	condition clear fault path CINS
B_INS2NEW	CANINS	EIN	condition CAN interface instruments 2 o.k. status
B_INS3NEW	CANINS	EIN	condition CAN interface instruments 3 o.k. status
B_KL15		EIN	condition ignition switch on
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_PWF		EIN	Condition for powerfail
B_SICINS	DCINS	AUS	signal error CAN interface instruments
C_FCMCLR	DCINS	LOK	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
E_CINS	DCINS	AUS	Error flag: CAN interface, timeout instrument
SFPCINS	DCINS	AUS	status fault path: timeout CAN interface instruments
UB	GGUB	EIN	battery voltage
Z_CINS	DCINS	AUS	Cycle flag: CAN interface, timeout instrument

FB DCINS 5.20 Detailed description of function

The function monitors the CAN message Instr2, (B_ins2new) and Instr3 (B_ins3new) for time-out.
Sender of the message is the combi-instrument.
Time-out monitoring is active if the battery voltage is greater than UBDCAN and Kl.15 is on (no monitoring during the hold phase).
Die sampling rate is 10 ms. The error E_cins is detected if B_ins2new or B_ins3new = 0 for t > TDCINS.
The internal surveillance time counter is reset if another instrument message is received during the monitoring time.
Fault rectification and reset of the error flag E_cins if instrument messages have been received again for t > TDHCINS.
The cycle flag Z_cins is always set after time counter > TDCINS.
E_cins and Z_cins are reset by the command "Delete error memory".

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APP DCINS 5.20 Application hint

GGAIRB 1.20 Sensor variable: airbag

FDEF GGAIRB 1.20 Function definition

ggairb-ggairb

ABK GGAIRB 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TCEKP			FW	monitoring CAN timeout for EKP shutdown

Variable	Source	Type	Description
B_AIRBAG	GGAIRB	AUS	condition airbag activated
B_INS3COK	CANINS	EIN	Condition CAN message INST3 present
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
C_INI		EIN	ECU-condition for intialisation
EKPAUSC	CANINS	EIN	CAN message EKP shutdown via Crash-Sensor Airbag control unit

FB GGAIRB 1.20 Detailed description of function

The EKP fuel pump shall be shut down in an accident for safety reasons.
A crash signal (ekpausc) is received from the airbag ECU via CAN to do this.
A crash is present when ekpausc changes from 00 to 01 (arming) and then from 01 to 03 within a given period of time.
The function is reset again if 00 or 02 is received again during the arming state.
The function is also reset if 01 is transmitted from the airbag ECU for longer TCEKP seconds. A crash is only detected again in this case when the the airbag ECU has transmitted the normal value of 00 again.

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APP GGAIRB 1.20 Application hint

CANLWS 1.10 CAN message and signal definition steering-wheel angle sensor

FDEF CANLWS 1.10 Function definition

```
Message                          : LWS1     Sender: LWS
Identifier                       : 1F5H    (001 1111 0101 B)
Data Length Code                 : 8 H
Transmission rate                : 500 KB
Quartz frequency                 : 20 MHz
```

Signal-design.	Signal name in ME (1)	Byte-no.	Start-B in byte	Bit-No.	Init. Value	n.plaus. Value	Range (phys.)	Misc. Conditions	conversion factor (HEX) ——> (PHYS)
LWS_LRW	lws_w	1	0	16	8000H	8000H	+1433.6 °/ -1433.6 °	LWS-steering-wheel angle	LRW = 0.04375*(Hex) [degrees]
LWS_LRWPKT		3	0	16	8000H			LWS-steering-wheel angle speed	
LWS_ID		5	0	8	00H			ID for zero-setting of the steering-whee angle sensor	
LWS_STAT		6	0	4	——			Internal status	
LWS_CNT		6	4	4	00H			Telegram counter	
LWS_MPX		7	0	16	8000H			multiplexed LWS values	

Memory layout message LWS1 according to BMW specifications:

LWS_MPX (hi)		56
LWS_MPX (lo)		48
LWS_CNT	LWS_STAT	40
LWS_ID		32
LWS_LRWPKT (hi)		24
LWS_LRWPKT (lo)		16
LWS_LRW (hi)		8
LWS_LRW (lo)		0

```
Transmission parameters - conditions:    Message LWS1

        Output period                    10 ms (cyclic)
        Output tolerance                 -2.0 ms ... +4.0 ms
        Latency time                     < 0.7 ms
        Send condition                   Kl.87 ON and UBatt > 6V
        Remote operation                 no
        Ready to receive after power-up  t2 =< 250 ms
        Ready to send after power-up     120 ms =< t2 =< 500 ms
        Phase relation to a
        different message                yes, synchronized with the message ASC2


 Angular output (physical range):
 ====================================

 +1433.6 deg. = 7FFFH (left limit)
     0   deg. = 0000H (straight-ahead position)
 -1433.6 deg. = FFFFH (right limit)
```

ABK CANLWS 1.10 Abbreviations

Variable	Source	Type	Description
LWS_W	CANLWS	AUS	Steering angle

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FB CANLWS 1.10 Detailed description of function

APP CANLWS 1.10 Application hint

CANASR 1.80 CAN message and signal definition drive-slip regulation

FDEF CANASR 1.80 Function definition

```
Message                          : ASC1     Sender: ASC5 / DSC3
Identifier                       : 0153 H    (001 0101 0011 B)
Data Length Code                 : 8 H
Transmission rate                : 500 KB
Quartz frequency                 : 20 MHz
```

Signal designation	Signal name in ME (1)	Byte no.	Start-B in byte	No. bits	Init. value	Implaus. value	Range (phys.)	Other conditions	Conversion factor (HEX) ——> (PHYS)
Demand for ASC	B_asrext	1	0	1	00 H				0 = passive or MSR 1 = ASC regulated
Demand for MSR	B_msrext	1	1	1	00 H				0 = passive or ASC 1 = MSR regulated
Status ASC passive		1	2	1	00 H			evaluation in EGS	0 = ASC active 1 = ASC passive
ASC switching influence		1	3	1	00 H				
S_BLS		1	4	1	00 H				
L_BAS		1	5	1	00 H				
L_EBV		1	6	1	00 H				
ABS lamp		1	7	1	00 H				
ASC lamp		2	0	1	00 H				
ASC_REG	B_asc_reg	2	1	1	00 H				0 = no intervention 1 = interv. active
F_V1 Fault in V1 signal	B_evfzgv1	2	2	1	00 H				
V1 mean front-wheel speed	vfzgv1_w	2	3	13	1FFFH	F_V1	(0)2,75/512km/h 0/1FFFh		(PH)=0.0625*(HEX)

Message content ASC1 (continued):

Signal designation	Signal name in ME (1)	Byte no.	Start-B in byte	No. bits	Init.-value	Implaus. value	Range (phys.)	Other conditions	Conversion factor (HEX) ——> (PHYS)
MD_IND_ASC Torque inter-vention for ASC function	miasrs	4	0	8	FF H	0FF H	0 / 99.6094 [00H / FF]	00 = max. reduction FF = no reduction See description e) See description f)	(PH)=0.390625 * (HEX)
MD_IND_MSR Torque inter-vention for MSR function	mimsr	5	0	8	00 H	00 H	0 / 99.6094 [00H / FF]	00 = No Md increase FF = Max. Md increase See description f)	(PH)=0.390625 * (HEX)
W_VDK Pre-throttle valve angle		6	0	8	FE H	FF H			
MD_IND_ASC_LM Torque inter-vention for MSR function	miasrl	7	0	8	FF H	FF H	0 / 99.6094 [00H / FF]	00 = Max. reduction FF = No reduction See description e) See description f)	(PH)=0.390625 * (HEX)
ASC_ALIVE	asc_alive	8	0	4	00 H		0H..0FH		
Not used		8	4	4	00 H				

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Memory layout for message ASC1 according to BMW specification:

00H				ASC_ALIVE				56
MD_IND_ASC_LM / FFH								48
W_VDK (optional) / FFH								40
MD_IND_MSR								32
MD_IND_ASC								24
V1 (high)								16
V1 (low)					F_V1	ASC_REG	L_ASC	8
L_ABS	L_EBV	L_BAS	S_BLS	ASC_SBE	ASC_PAS	B_MSR	B_ASC	0

Transmission parameters - conditions: Message ASC1

Output period	10 ms, for DSC3: 20 ms: Tolerance + - 1 ms
Latency	max. 5 ms
Transmission condition	Power supply von DME main relay; Kl.15 ON and UBatt > 6 V, and in self-holding phase
Remote mode	no
Ready to receive after Power-up	120 ms =< t2 =< 500 ms
Ready to send after Power-up	120 ms =< t2 =< 500 ms

Evaluation of ASC message:
==========

a) Automatic ASC detectionh from CAN message after a Powerfail

B_ascpkw must be saved in the non-volatile RAM.

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b.1) Valid ASC1 CAN message present -> B_asc1cok = 1 :

b.2) Valid ASC2 CAN message present -> B_asc2cok = 1 :

b.3) Valid ASC3 CAN message present -> B_asc3cok = 1 :

c) Fault detection of ASC CAN message (via B_ascXnew):
-> Timeout of 500 ms for ASC1 CAN message triggers fault: "CAN timeout ASC" ——> Refer to: %DCAS
-> Timeout of 500 ms for ASC2 CAN message triggers fault: "CAN timeout ASC" ——> Refer to: %DCAS
-> No timeout fault triggered by ASC3 because there might be ECU's that do support ASC3 (tansmit)
-> For a detected fault, the initialization values for miasrl and miasrs are made available after a ramp control-up for other functions.

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d.1) Processing status bit for ASR regulating intervention: Set B_asc_reg

d.2) Processing status bit for DSC regulating intervention: Set B_dsc_reg

e) A cut-off of MD_IND_ASC_LM (i.e. MD_IND_ASC_LM=MD_IND_ASC) follows (see diagram given below) for the case that MD_IND_ASC > MD_IND_ASC_LM ! If E_as or (tdcas (timer) < as timeout time - 100 ms) is set during an ASC regulation routine, then the current ASC torque (miasrl, miasrs) must be set per ramp to the neutral value 0xFF. The 16-bit variables are described by the 8-bit value only in the case of ASR control.

canasr-canasr

canasr-canasr

f) mimsr, miasrs and miasrl are read out from CAN as 8-bit variables and used as the input in diagnostic functions. The associated 16-bit values miasrs_w and miasrl_w are also formed here (%CANASR) and enter the MD structure as input variables, unlike mimsr_w that is formed in the function %DASC only after the plausibility check !

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```
Message                          : ASC2     Transmitter: ASC5 / DSC3
Identifier                       : 01F0 H    (001 1111 0000 B)
Data Length Code                 : 8 H
Transmission rate                : 500 KB
Quartz frequency                 : 20 MHz
```

Signal designation	Signal name in ME (1)	Byte no.	Start-B in byte	No. bits	Init.-value	Implaus. value	Range (phys.)	Other conditions	Conversion factor (HEX) ——> (PHYS)
VRad l. front VRD_LV_ASC	vrad_lv	1	0	13	1FFFh	1FFFh	0.....512 km/h 0h..1FFEh		(PH)=0.0625*(HEX)
ASC_FREI1		2	5	3	00 H				
VRad r. front VRD_RV_ASC	vrad_rv	3	0	13	1FFFh	1FFFh	0.....512 km/h 0h..1FFEh		(PH)=0.0625*(HEX)
ASC_FREI2		4	5	3	00 H				
VRad l. rear VRD_LH_ASC	vrad_lh	5	0	13	1FFFh	1FFFh	0.....512 km/h 0h..1FFEh		(PH)=0.0625*(HEX)
ASC_FREI3		6	5	3	00 H				
VRad r. rear VRD_RH_ASC	vrad_rh	7	0	13	1FFFh	1FFFh	0.....512 km/h 0h..1FFEh		(PH)=0.0625*(HEX)
ASC_FREI4		8	5	3	00 H				

Memory layout message for ASC2 according to BMW specification:

00H	VRD_RH_ASC(hi)	56
VRD_RH_ASC(lo)		48
00H	VRD_LH_ASC(hi)	40
VRD_LH_ASC(lo)		32
00H	VRD_RV_ASC(hi)	24
VRD_RV_ASC(lo)		16
00H	VRD_LV_ASC(hi)	8
VRD_LV_ASC(lo)		0

```
Transmission parameters - conditions:   Message ASC2

        Output period                   10 ms, for DSC3: 20 ms: Tolerance + - 1 ms
        Latency                         max. 5 ms
        Transmission condition          Power supply from DME main relay;
                                        Kl.15 ON and UBatt > 6 V and in self-hold phase
        Remote mode                     no
        Ready to receive after Power-up 120 ms =< t2 =< 500 ms
        Ready to send after Power-up    120 ms =< t2 =< 500 ms
```

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```
Message                          : ASC3     Transmitter: ASC5 / DSC3
Identifier                       : 01F3 H    (001 1111 0011 B)
Data Length Code                 : 8 H
Transmission rate                : 500 KB
Quartz frequency                 : 20 MHz
```

Signal designation	Signal name in ME (1)	Byte no.	Start-B in byte	No. bits	Init. value	Implaus. value	Range (phys.)	Other conditions	Conversion factor (HEX) ——> (PHYS)
DSC_REG	B_dsc_reg	5	2	1	00 H	-		See description d.2)	

Memory layout for message ASC3 according to BMW specification:

00H					56
BAS_DATEN					48
AY_REF(hi)					40
AY_REF(lo)	BAS_CODE	S_HBA	DSC_REG	AX_REF(hi)	32
AX_REF(lo)					24
BAS_STAT		BAS_FBR	Q_ACC_BAS	BAS_DEF	16
FDR_MUL(hi)					8
FDR_MUL(lo)				FDR_COM	0

Transmission parameters - conditions: Message ASC3

```
        Output period                  for DSC3: 20 ms: Tolerance + - 1 ms
        Latency                        max. 5 ms
        Transmission condition         Power supply from DME main relay;
                                       Kl.15 ON and UBatt > 6 V and in self-hold phase
        Remote mode                    no
        Ready to receive afterPower-up 120 ms =< t2 =< 500 ms
        Ready to send after Power-up   120 ms =< t2 =< 500 ms
```

```
Botschaft                        : ASC4     transmitter: ASC / DSC-ECU
Identifier                       : 01F8 H    (001 1111 1000 B)
Data Length Code                 : 8 H
Transmission rate                : 500 KB
Quartz frequency                 : 20 MHz
```

Signal designation	Signal name in ME (1)	Byte no.	Start-B in byte	No. bits	Init. value	Implaus. value	Range (phys.)	Other conditions	Conversion factor (HEX) ——> (PHYS)
S_HDC	B_hdca	1	0	3	00 H	07H		see description	see below

memory layout CAN message ASC4 according to BMW specification:

TW_IND_MSR (high)						56
TW_IND_MSR (low)						48
TW_IND_ASC (high)						40
TW_IND_ASC (low)						32
RDR_HR	RDR_HL	RDR_VR	RDR_VL			24
P_BRAKE						16
B_OFFROAD	B_TW_ASC	B_TW_MSR	00H	L_HDC	S_HDC	8
S_WHEEL_ACC						0

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```
Transmission parameters - conditions:  Message ASC4

        Output period                   for DSC-ECU: 20 ms: Tolerance + - 5 ms
        Latency                         max. 5 ms
        Transmission condition          Power supply from DME main relay;
                                        Kl.15 ON and UBatt > 6 V and in self-hold phase
        Remote mode                     no
        Ready to receive afterPower-up  120 ms =< t2 =< 500 ms
        Ready to send after Power-up    120 ms =< t2 =< 500 ms
```

conversion S_HDC (Status Hill Descent Control) of B_hdca:

S_HDC	Function	B_hdca
00H	HDC off (Not selected)	FALSE
01H	HDC disabled, not in correct gear	TRUE
02H	HDC disabled, not in low range (if applicable)	TRUE
03H	HDC disabled due to excessive speed	TRUE
04H	HDC inaktiv, temporarily	TRUE
05H	HDC enabled, but not active	TRUE
06H	HDC active (i.e. enabled and going down hill)	TRUE
07H	HDC error	FALSE

ABK CANASR 1.80 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DMAUFASC			FW	Delta torque controlled increase after ASC fault
TDCAS			FW	Time for timeout detection CAN interface ASC

Variable	Source	Type	Description
ASC4COD	CANASR	LOK	Automatic TXU-ECU control unit detection
ASCCOD	CANASR	LOK	Automatic ASC control unit detection
ASC_ALIVE	CANASR	AUS	ASC alive counter
B_ASC1COK	CANASR	AUS	condition CAN-ASC1 message with o.k. status
B_ASC1NEW	CANASR	AUS	condition CAN-ASC1 message current receive
B_ASC2COK	CANASR	AUS	Condition ASC installed and ASC2 message present
B_ASC2NEW	CANASR	AUS	condition CAN-ASC2 interface with o.k. status
B_ASC3COK	CANASR	AUS	Condition: CAN-message ASC3 received
B_ASC3NEW	CANASR	AUS	condition CAN-ASC3 interface current receive
B_ASC4COK	CANASR	AUS	condition CAN-ASC4 interface with o.k. status
B_ASC4NEW	CANASR	AUS	condition CAN-ASC4 message current receive
B_ASCPKW	CANASR	AUS	condition vehicle with ASC detected and CAN message not interrupted
B_ASC_REG	CANASR	AUS	CAN-message: ASC in action (with break intervention)
B_ASREXT	CANASR	AUS	condition for externe ASR
B_DSC_REG	CANASR	AUS	CAN message: DSC controls (engine and braking interventions)
B_EVFZGV1	CANASR	AUS	Condition error in speed signal V1 (via CAN)
B_HDC	CANASR	AUS	Condition hill desent control active
B_HDCA	CANASR	LOK	Condition hill desent control request
B_MSREXT	CANASR	AUS	Condition external MSR demand
C_INI	CANASR	LOK	ECU-condition for intialisation
E_AS	DASC	EIN	errorflag: ASR-intervention
MIASRL		EIN	Ind. ASC torque for air path
MIASRL_W	CANASR	AUS	desired indicated torque from ASR for slow intervention
MIASRS		EIN	indicated nominal torque ASR for quick intervention
MIASRS_W	CANASR	AUS	desired indicated torque from ASR for quick intervention
MIMSR	CANASR	AUS	desired indicated torque from MSR
TDCAS_CTR1		EIN	Timer no new ASC1 message arrived
VFZGV1_W	CANASR	AUS	Vehicle speed, CAN signal

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FB CANASR 1.80 Detailed description of function

APP CANASR 1.80 Application hint

DCAS 8.30 Diagnosis CAN timeout ASC interface

FDEF DCAS 8.30 Function definition

dcas-dcas

```
(*)  Unlike in the description, this path is served in the module %DFPM, or the flags are managed in %DFPM;


                 Test criteria:  No CAN messages B_asc1new / B_asc2new = 0 for t > time-out (500 ms)
                                 and Ubatt > UBDCAN and ASC vehicle detected and B_kl15 = 1.

  Fault rectification criteria:  IF B_4x4pkw=FALSE THEN B_asc1new and B_asc2new = TRUE
                                 IF B_4x4pkw= TRUE THEN B_asc1new & B_asc2new &B_asc4new = TRUE

             Standby variables:  Initialization values valid

Error memory management:
```

Status error path :	SFPCAS	Delete Error path:	C_fcmclr & B_clcas
Error flag :	E_cas	Error path :	CDTCAS, CDKCAS
Cycle flag :	Z_cas	Error class :	CLACAS
Error type :	B_sicas	Error severity :	TSFCAS
		CARB code :	CDCCAS
		environmental conditions :	FFTCAS

ABK DCAS 8.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCCAS	BLOKNR		KL	code word CARB: CAN interface, timeout ASC
CDTCAS			FW	code word tester: CAN interface, time out ASC [216]
CLACAS			FW	fault class: timeout asc-message
FFTCAS	BLOKNR		KL	Freeze Frame table: CAN, timeout ASC
TDCAS			FW	Time for timeout detection CAN interface ASC
TSFCAS			FW	fault active time: CAN interface, time-out ASC
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_4X4PKW		EIN	condition vehicle with 4x4 detected and CAN message ASC4 not interrupted
B_ASC1NEW	CANASR	EIN	condition CAN-ASC1 message current receive
B_ASC2NEW	CANASR	EIN	condition CAN-ASC2 interface with o.k. status
B_ASC4NEW	CANASR	EIN	condition CAN-ASC4 message current receive

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Variable	Source	Type	Description
B_ASCPKW	CANASR	EIN	condition vehicle with ASC detected and CAN message not interrupted
B_CLCAS	DCAS	LOK	condition clear fault path CAS
B_KL15		EIN	condition ignition switch on
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_PWF		EIN	Condition for powerfail
B_SICAS	DCAS	AUS	signal error CAN interface ASC
C_FCMCLR	DCAS	LOK	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
E_CAS	DCAS	AUS	errorflag: CAN-interface, timeout ASC
SFPCAS	DCAS	AUS	status fault path: timeout CAN interface ASC
UB	GGUB	EIN	battery voltage
Z_CAS	DCAS	AUS	cyclus flag: CAN interface, timeout ASC

FB DCAS 8.30 Detailed description of function

The function monitors the CAN messages ASC1 and ASC2 for time-out. Sender of the message is the traction slip control.
Time-out monitoring is active when the battery voltage is greater than UBDCAN, S_kl15 = 1 and the automatic ASC detection B_ascpkw is set. The ASC detection B_ascpkw and the activity bits B_asc1new, B_asc2new are provided from the section %CANASR. The sampling rate is 10 ms.
The error E_cas is detected when B_asc1new or B_asc2new = 0 for t > TDCAS.
The internal monitoring-time counter is reset if another ASC message is received during the monitoring time. Fault rectification and reset of the error flag E_cas if ASC messages were received during the last 20 ms.
The cycle flag Z_cas is always set after timmot (time counter as of engine running) > TDCAS.
E_cas and Z_cas are reset by the command "Delete error memory".

APP DCAS 8.30 Application hint

DASC 1.40 Diagnostics for ASC signals

FDEF DASC 1.40 Function definition

dasc-dasc

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dasc-errordetec

dasc-errordetec

dasc-mask

dasc-mask

ABK DASC 1.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
BZ_MSR_M			FW	MSR message counter mask (0Fh for 4-bit message counter)
CWDASC			FW	code for ASC monitoring switchover
MIMSRMXN	NMOT_W		KL	Maximum permissible MSR torque
TASCNP			FW	Debounce time ASC signal not plausible
TASCNP2			FW	Debounce time ASC signal not plausible

Variable	Source	Type	Description
ASC_ALIVE	CANASR	EIN	ASC alive counter
BZASC_M	DASC	LOK	Message counter after masking
B_ASCDME	DASC	AUS	Condition : Acknowledgement of ASC message OK
B_ASCSIPL	DASC	AUS	Condition ASC signal plausible
B_ASREXT	CANASR	EIN	condition for externe ASR
B_CLAS		EIN	condition clear fault path ASR/TC interface

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Variable	Source	Type	Description
B_MSREXT	CANASR	EIN	Condition external MSR demand
B_NOMSR_UM	UFUE	EIN	MSR moment required not transferred to function monitoring
B_NPAS	DASC	AUS	signal not plausibel: ASR/TC interface
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_AS	DASC	AUS	errorflag: ASR-intervention
E_CAS	DCAS	EIN	errorflag: CAN-interface, timeout ASC
MIASRL		EIN	Ind. ASC torque for air path
MIASRS		EIN	indicated nominal torque ASR for quick intervention
MIMSR	CANASR	EIN	desired indicated torque from MSR
MIMSR_W	DASC	AUS	desired indicated torque from MSR
NMOT_W	BGNMOT	EIN	engine speed
R_T10		EIN	Time schedule 10 ms
Z_AS	DASC	AUS	cyclus flag: traction control intervention

FB DASC 1.40 Detailed description of function

The function checks the ASC CAN signals miasrl, miasrs, mimsr..., for plausibility and current applicability, and in the event of a fault, sets B_npas after a debounce. MSR intervention is prohibited by this. B_ascdme signals to the ASC control unit that the message from this has been correctly understood by the DME. B_ascsipl signals internally in DME that the ASC signals are OK.

mimsr is copied into the high-byte of mimsr_w provided there is no fault present.

Switchover (with and without Alive counter) in the surveillance mode is made using the code word CWDASC.

APP DASC 1.40 Application hint

TASCNP2 = 80 ms, TASCNP = 580 should be larger than the timer for ASC CAN time-out in order that E_as will not be entered by mistake.
In matching this the UE II % UFMSRC label, MSRC_T_UM = 600 ms.

CANTXU 1.10 CAN message and signal definition Transfer Box Control ECU (TXU)

FDEF CANTXU 1.10 Function definition

Message : EGS1 Sender: transfer control unit TXU1
Identifier : 0445 H (100 0100 0101 B)
Data length code : 8 H
Transmission rate : 500 KB
Quartz frequency : 20 Mhz

Signal designation	Signal name in ME (1)	Byte-no.	Start-B in byte	Bit no.	Init. Value	Implaus Value	Range (phys.)	Misc. Conditions	Conversion factor (HEX) ——> (PHYS)
TXU_CR		1	0	3	00 H				See signal definition below
TXU_TR		1	3	3	00 H				See signal definition below
Not used		1	6	2	00 H				
TXU_ERR	B_esttxu	2	0	4	00 H				See signal definition below
TXU_STAT		2	4	4	00 H				
MD_IND_TXU Torque inter-vention for TXU function	mitxu_w	3	0	8	FF H	0FF H	0 / 99.6094 [00H / FF]	00 = Max. reduction FF = No reduction See description	(PH)=0.390625 * (HEX)
OBD_STAT_TXU	obdsttxu	4	1	4	00 H			no user only reading in RAM	OBDSTAT_TXU rechts-bündig in obdsttxu
frei		4	5	2	00 H				
TXU_RCP	B_txurcip	4	7	1	00 H			0 = No range change in progess 1 = Range change in progress	
frei		4	8	1	00 H				
frei		5	1	40	00 H				
Not used		4	0	40	00 H				

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Memory-layout message TXU1 according to BMW specification:

00H							56
00H							48
00H							40
TXU_GANG_ANZ *				TXU_RANGE_ANZ *		TXU_COGS_ANZ *	32
L_TXU *	TXU_RCP	TXU_N_REQ *	TXU_SM *	OBD_STAT_TXU			24
MD_IND_TXU							16
TXU_STAT				TXU_ERR			8
TXU_SL_REQ *		TXU_TR			TXU_CR		0

remarks: * only documentation, no using

Transfer unit parameters - Conditions:	Message TXU1
Output period	every 100 ms +/- 10 ms
Latency time	max. 10 ms
Sending condition	Power supply from DME main relay; Kl.15 ON and UBatt > 6 V and in self-locking phase
Remote mode	no
Ready to receive after power-up	=< 100 ms
Ready to send after power-up	120 ms =< t2 =< 140 ms

Evaluation of TXU1 message:
==========

a) Valid TXU1 CAN message present -> B_txucok = 1 :

b) Fault detection TXU1 CAN message:
-> time-out of 2000 ms for TXU1 CAN message triggers fault: "CAN time-out transfer control unit" off. ——> Refer to: %DCTXU

-> The initialization values for other functions are made available for a detected fault.

c) Automatic TXU1 detection from CAN message after powerfail

B_txuget must be saved in the non-volatile RAM.

Decoder table for CAN signal TXU_CR (current range status) for B_lowr:

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TXU_CR	Funktion	B_lowr
000B	intermediate position	FALSE
001B	Transfer case in low range	TRUE
010B	Transfer case in neutral	FALSE
011B	Transfer case in high range	FALSE
...B	Not defined	FALSE
111B	no position available (error	FALSE

Decoder table for CAN signal TXU_TR (target range status) for B_tlowr:

TXU_TR	function	B_tlowr
000B	Not defined	FALSE
001B	Target low range	TRUE
010B	Target transfer box neutral	FALSE
011B	Target high range	FALSE
...B	Not defined	FALSE
111B	Not defined	FALSE

Decoder table for CAN-signal TXU_ERR for B_etxu (Error status transfer case)

TXU_ERR	function	B_esttxu
000B	no error	FALSE
001B	major transfer case problem	TRUE
...B	Not defined	FALSE
111B	Not defined	FALSE

ABK CANTXU 1.10 Abbreviations

Variable	Source	Type	Description
B_ESTTXU	CANTXU	AUS	condition error status transfer gearbox TXU
B_LOWR	CANTXU	AUS	Condition low range active
B_TLOWR	CANTXU	AUS	condition lever in low range
B_TXUCOK	CANTXU	AUS	condition: CAN-message TXU received
B_TXUGET	CANTXU	AUS	condition transfer gearbox TXU
B_TXUNEW	CANTXU	AUS	condition CAN interface TXU message ready
B_TXURCIP	CANTXU	AUS	condition gear change in progress transfer gearbox TXU
MITXU_W	CANTXU	AUS	Torque reduction request transmission control (CAN TXU message)
OBDSTTXU	CANTXU	AUS	From CAN signal, OBD_STAT_TXU Conditioned parameter for ME

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FB CANTXU 1.10 Detailed description of function

APP CANTXU 1.10 Application hint

DCTXU 1.10 Diagnosis; CAN timeout interface TXU

FDEF DCTXU 1.10 Function definition

dctxu-dctxu

```
(*):   Unlike in the description, this path is served in the module %DFPM, or the flags are managed in %DFPM;


                  Test criteria:  No CAN message TXU1 for t > time-out TDTXU and Ub > UBDCAN, and transmission control detected
                                  and B_kl15 = 1

   Fault rectification criteria:  Message received during last 300 ms, B_txunew = 1

             Standby variables:

Effect on overall system: Transmission control in the emergency program

Standby measures:
Effects on the system: unknow

Error memory management:
```

Status error path :	SFPCTXU	Delete Error path:	C_fcmclr & B_clctxu
Error flag :	E_ctxu	Error path :	CDTCTXU
Cycle flag :	Z_ctxu	Error class :	CLACTXU
Error type :	B_sictxu	Error severity :	TSFCTXU
		CARB code :	CDCCTXU
		Environmental conditions :	FFTCTXU

ABK DCTXU 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCCTXU	BLOKNR		KL	code word CARB: CAN interface, timeout transfer control unit TXU
CDTCTXU			FW	code word tester: CAN interface, timeout TXU
CLACTXU			FW	fault class: CAN interface, timeout TXU
FFTCTXU	BLOKNR		KL	Freeze Frame table: CAN interface, timeout TXU
TDTXU			FW	Time for timeout detection CAN interface TXU
TSFCTXU			FW	fault active time: CAN interface, time-out TXU
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_CLCTXU	DCTXU	LOK	condition clear fault path TXU
B_KL15		EIN	condition ignition switch on

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Variable	Source	Type	Description
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_PWF		EIN	Condition for powerfail
B_SICTXU	DCTXU	AUS	signal error CAN interface TXU
B_TXUGET	CANTXU	EIN	condition transfer gearbox TXU
B_TXUNEW	CANTXU	EIN	condition CAN interface TXU message ready
C_FCMCLR	DCTXU	LOK	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
E_CTXU	DCTXU	AUS	error flag: CAN-interface timeout TXU
SFPCTXU	DCTXU	AUS	status fault path: timeout CAN interface TXU
UB	GGUB	EIN	battery voltage
Z_CTXU	DCTXU	AUS	cycle flag: CAN interface, timeout transfer control unit TXU

FB DCTXU 1.10 Detailed description of function

```
The function monitors the CAN message TXU1 for time-out. Sender of the message is the transmission control.
The time-out monitoring is active when the battery voltage is greater than UBDCAN, B_kl15 = 1 and the automatic AGS detection
B_agpkw is set. The AGS detection B_agpkw and B_txunew are provided from the section %CANTXU.
The sampling rate is 10 ms.
The error E_ctxu is detected if no further TXU1 message has been received for t > time-out = 500 ms. ( B_txunew = 0 )
The internal monitoring-time counter is reset if another TXU1 message is received during the monitoring time ( B_txunew = 1).
Fault rectification and reset of the error flags E_ctxu if B_txunew = 1.
The cycle flag Z_ctxu is always set after t (time counter as of engine running) > 500 ms.
E_ctxu and Z_ctxu are reset by the command "Delete error memory".
```

APP DCTXU 1.10 Application hint

BBLOR 1.30 Operating gearbox low range

FDEF BBLOR 1.30 Function definition

bblor-bblor

bblor-bblor

```
Detection of car operating with switched on reduced gearbox.
B_lowr will be recieve by CAN message from the track control unit.
B_lowra for switch on the throttle map.
```

ABK BBLOR 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWLOWR			FW	
VMINLR			FW	vehicle speed threshold for low range active
VMINLRO			FW	vehicle speed threshold for low range switch off

Variable	Source	Type	Description
B_LL	MSF	EIN	Condition idle
B_LORCALC	DGLOR	EIN	Condition: tranfer box in low range as calculated by DME
B_LOWR	PROKON	EIN	Condition low range active
B_LOWRA	BBLOR	AUS	condition gear box in low range
B_LOWRAPP	BBLOR	AUS	condition gear box in low range in application
B_TXUCP	DGLOR	EIN	Condition: TXU vs. actual range data on CAN unplausible
E_CTXU	DCTXU	EIN	error flag: CAN-interface timeout TXU

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Variable	Source	Type	Description
E_GLOR	DGLOR	EIN	Errorflag: gear low range
VFZG_W	GGVFZG	EIN	Vehicle speed

FB BBLOR 1.30 Detailed description of function

The purpose of this function is to provide a controlled switching method to and from the internal DME "low range" operating mode (switching between pedal maps, de-activating some OBD functions, etc,).
Note that all other ME7.2 functions which use "low range" information must use the B_LOWRA information and not the B_LOWR information. The setting of the B_LOWRA information is only allowed under certain vehicle operating conditions (see TXU information in "Low Range Plausibility Test" description above). In particular, due to the switching of pedal maps between high and low range, ME7.2 will only allow its internal range information (B_LOWRA) to change under engine idle conditions. The default condition is B_LOWRA=0 (i.e. vehicle in high range) if these switching conditions are not met or there is a low range implausible error.

APP BBLOR 1.30 Application hint

DGLOR 2.30 Diagnosis; gear in low range

FDEF DGLOR 2.30 Function definition

DGLOR: Übersicht Diagnose Getriebe im Low Range
==========

dglor-main

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TXU_CAN_plaus: Plausibility test of TXU CAN data

dglor-txu-can-plaus

dglor-txu-can-plaus

Calc_range: This function calculates the transfer box range based on vehicle speed and automatic gearbox output shaft speed

dglor-calc-range

dglor-calc-range

Plaus_check: This function compares the CAN range data vs. the calculated range data for a plausibility test

dglor-plaus-check

dglor-plaus-check

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```
Fehlereintrag und Heilung:
==========================
```

Action Table for fault path GLOR in DFPM:

	E_glor	Z_glor	B_npglor
nplError:	S	S	S
Healing:	R	S	R

S: set R: reset

Attribute DFP_GLOR:
- **Unsigned Discrete**
- **Parameter**
- **Imported**
- **Non volatile**
- **Calibration: yes**

Attribute Klasse sfp_GLOR:
- **Instanz: sfp_GLOR**
- **local**

dglor-dfpm-glor

dglor-dfpm-glor

```
Fehlerspeicher löschen:
=======================
```

Reset of the Error- and Cyclebits in %DFPM

dglor-fcmclr

dglor-fcmclr

ABK DGLOR 2.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KTRANS			FW	Driveline gearing ratio constant
SNABEGS			FW	threshold for valid CAN EGS1 signal of nabtrc_w
TTXUPL			FW	Plausibility check error delay time
TXUHIRMN			FW	minimum calculated gear ratio in high range
TXUHIRMX			FW	maximum calculated gear ratio in high range
TXULORMN			FW	minimum calculated gear ratio in low range
TXULORMX			FW	maximum calculated gear ratio in low range
TXUSHMX			FW	maximum time for TXU to change range
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

Variable	Source	Type	Description
B_ACTRPL	DGLOR	AUS	Condition: low range status implausible
B_CLGLOR		EIN	Condition: clear fault path TXU in low Range
B_EGSNEW	CANEGS	EIN	Condition that a new transmission message has been detected
B_HIRCALC	DGLOR	AUS	Condition: tranfer box in high range as calculated by DME
B_KL15		EIN	condition ignition switch on
B_LORCALC	DGLOR	AUS	Condition: tranfer box in low range as calculated by DME
B_LORPLAUS	DGLOR	AUS	Condition: Low Range status unplausible (filtered)
B_LOWR	PROKON	EIN	Condition low range active

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Variable	Source	Type	Description
B_NOTXCALC	DGLOR	AUS	Condition: transfer box range caculation not possible
B_NPGLOR	DGLOR	AUS	Condition: Fault path low range calculation unplausible
B_PN	CANEGS	EIN	condition: position P or N of automatic transmission selected
B_PWF		EIN	Condition for powerfail
B_TLOWR	CANTXU	EIN	condition lever in low range
B_TXUCOK	CANTXU	EIN	condition: CAN-message TXU received
B_TXUCP	DGLOR	AUS	Condition: TXU vs. actual range data on CAN unplausible
B_TXUGET	CANTXU	EIN	condition transfer gearbox TXU
B_TXUNEW	CANTXU	EIN	condition CAN interface TXU message ready
B_TXURCIP	CANTXU	EIN	condition gear change in progress transfer gearbox TXU
C_INI		EIN	ECU-condition for intialisation
E_CGE	DCGE	EIN	error flag: CAN-interface timeout EGS
E_CTXU	DCTXU	EIN	error flag: CAN-interface timeout TXU
E_GLOR	DGLOR	AUS	Errorflag: gear low range
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
NABTRC_W	CANEGS	EIN	Output shaft speed of gear box via CAN
TXURATIO	DGLOR	AUS	calculated gear ration of tranfer box
UB	GGUB	EIN	battery voltage
VFZG_W	GGVFZG	EIN	Vehicle speed
Z_GLOR	DGLOR	AUS	Cycle flag: gear low range
Z_VFZ	DVFZ	EIN	cycle flag: vehicle speed signal

FB DGLOR 2.30 Detailed description of function

Low Range Plausibility Test

Purpose of this function is to validate the range information transmitted by the TXU, and in particular to validate the "low range" condition.

Function operates on 2 levels:
- Checking the plausibility of the actual TXU CAN data (actual range vs. target range)
- Checking the range information from CAN vs. calculated range

A plausibility error will result in DME assuming a default of B_lowra = 0, i.e. assume vehicle is in "high range".
This is handled by the function %BBLOR.

Notes about TXU functionality:
- The range change request to the TXU is via a momentary switch
- TXU "target range" data is the processed version of the drivers request, i.e. will indicate what the TXU is trying to achieve and not simply what the driver has requested (i.e. if range shift conditions are not met, target range will revert to current range after a short delay)
- It is possible for the target range and actual range to differ for a reasonable length of time during a range change. TXU error detection operates after approx. 30 seconds of trying to change range. Normal range changes are complete in approx. 1 second.
- Currently defined transfer box gear ratios are:

High range = 1:1
Low range = 2.7:1

TXU defined range change conditions:
- Automatic transmission must be in neutral (shift interlock in operation during change to prevent N -> D (or N -> R!) shift during range change).
- Note: for L30 Phase II,’ Shift on Move while in "D"’ is a requirement but this is not a requirement for ME7.2 as it will be replaced with ME9.2 and the NG V engine family at L30 Phase II.
- Shift interlock function will prevent N Ü D shifts at engine speeds > 3000 rpm
- Maximum vehicle speed for High Ü Low range change = 16 kph (10 mph)
-Maximum vehicle speed for Low Ü High range change = 48 kph (30 mph)

Note about EGS CAN information:
- Note that the automatic gearbox output shaft speed information N_ABTR contained in the EGS1 CAN message is only 8 bits with 32 rpm/bit resolution. It is proposed that bits 16 to 20 inclusive of EGS1 are used for increasing the resolution of N_ABTR to 1 rpm/bit. ME7.2 should therefore allow for this improved N_ABTR information in it’s handling of the EGS1 CAN message, although the least significant 5 bits N_ABTR should currently be masked out (=0) until this improved functionality is available.

Fault code management:
Fault path
Debouncing FSP-Storage
Debouncing healing
Fault light

Ambient condition 1:
Ambient condition 2:
Ambient condition 3:

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APP DGLOR 2.30 Application hint

KTRANS Calculation
==========

The KTRANS data is based on the following calculation, which assumes either high or low range is correctly engaged:

$$\text{Vehicle wheel speed (rpm)} = \frac{\text{Gearbox output shaft speed (rpm)}}{\text{Transfer Box Gear Ratio} * \text{Axle Differential Gear Ratio}}$$

and

$$\text{Vehicle wheel speed (rpm)} = \frac{\text{Vehicle Road Speed (kph)} * 1000}{\text{Wheel Rolling Distance (m)} * 60}$$

Hence,

$$\frac{\text{Vehicle Road Speed (kph)} * 1000}{\text{Wheel Rolling Distance (m)} * 60} = \frac{\text{Gearbox output shaft speed (rpm)}}{\text{Transfer Box Gear Ratio} * \text{Axle Differential Gear Ratio}}$$

which gives,

$$\text{Transfer Box Gear Ratio} = \frac{\text{Gearbox output shaft speed (rpm)} * \text{Wheel Rolling Distance (m)} * 60}{\text{Axle Differential Gear Ratio} * \text{Vehicle Road Speed (kph)} * 1000}$$

$$= \frac{\text{Gearbox output shaft speed (rpm)}}{\text{Vehicle Road Speed (kph)}} * \text{KTRANS}$$

$$= \frac{\text{N_abtr}}{\text{vfzg_w}} * \text{KTRANS}$$

where

$$\text{KTRANS} = \frac{\text{Wheel Rolling Distance (m)} * 60}{\text{Axle Differential Gear Ratio} * 1000}$$

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CANACC 1.100 CAN message and signal definition ACC

FDEF CANACC 1.100 Function definition

```
Message                          : ACC1     Transmitter: ACC ECU
Identifier                       : 52C H    (0101 0010 1100 B)
Data Length Code                 : 8 H
Tranmission rate                 : 500 KB
Quartz frequency                 : 20 MHz
```

Signal designation	Signal name in ME (1)	Byte no.	Start-B in byte	No. bits	Init. value	Implaus. value	Range (phys.)	Other conditions	Conversion factor (HEX) ——> (PHYS)
ACC_VSA	B_savacc	1	0	1	00H	-	00..01H		
ACC_DEF	B_accdef	1	1	1	00H	-	00..01H		
ACC_STAT	acc_stat	1	2	3	00H	-	00..07H	ACC_Status	See table below
frei		1	5	1	00H	-			
B_MD	B_mdacc	1	6	1	00H	siehe ->	00..01H	Fault identification: B_mdacc=1 and B_bremsacc=1	
B_BRE	B_bremsacc	1	7	1	00H	siehe ->	00..01H		
ACC_MUL_CODE		2	0	4	00H	-	00..0FH		
ACC_ALIVE	zaccalive	2	4	4	00H	-	00..0FH		
ACC_MUL_INFO		3	0	8	00H	FFH	00..FFH		
MD_IND_ACC	miacc	4	0	8	00H	siehe unten	00..FFH	Torque intervention for ACC factor based on MD_NORM	(PH)=0.390625*(HEX) See below
BRE_ACC	bremsacc	5	0	8	00H	siehe unten	00..FFH	Braking intervention for ACC factor based on BRE_NORM	(PH)=0.390625*(HEX)
VSET		6	0	6	00H	-	00..32H		
OBJVALID		6	6	1	00H	-			
TAKEOVER		6	7	1	00H	-			

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SEN_DTY		7	0	1	00H	-			
SHIFTREQ		7	1	1	00H	-			
DIST_ANZ		7	2	2	00H	-			
Not used		7	4	4	00H	-			
Not used		8	0	8	00H	-			

Memory layout for message ACC1 according to BMW specification:

00H						56
00H			00H	DIST_ANZ	SHIFTREQ	SEN_DTY	48
TAKEOVER	OBJVALID	VSET				40
BRE_ACC						32
MD_IND_ACC						24
ACC_MUL_INFO						16
ACC_ALIVE			ACC_MUL_CODE			8
B_BRE	B_MD	00H	ACC_STAT	ACC_DEF	ACC_VSA	0

Transmission parameters - conditions: Message ACC1

Output period	20 ms
Output period tolerance	+ - 5 ms
Latency	max. 5 ms
Transmission condition	Kl.15 ON and UBatt > 6V
Remote mode	no
Ready to receive after Power-up	=< 100 ms
Ready to send after Power-up	120 ms =< t2 =< 140 ms

Evaluation of ACC messages:
==========

a) Valid ACC CAN message present -> B_acccok = 1. Otherwise B_acccok = 0 after 500 ms and all values set to Init value.

b) Fault detection ACC CAN message:
-> The RAM cells are made available with the initialization values for other functions in the event that a fault is detected.

c) Automatic ACC detection from CAN message after a Powerfail
-> The RAM cells are filled with the initialization values if no ACC ECU detected !

B_acc must be saved in the non-volatile RAM or in the EEPROM.
B_acc is reset by the bit B_clbacc (KWP 2000*-Service "Selective deletion of adaptations").

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d) Conversion of acc_stat:

acc_stat	Meaning
00H	Passive
01H	Active 'standby mode'
02H	Regulation 'Standard'
03H	Regulation 'Increased dynamics'
04H	Currently not used
05H	Currently not used
06H	Currently not used
07H	Currently not used

f) Conversion of MD_IND_ACC:

MD_IND_ACC is a 1-byte variable with the quantization 0.390625/increment. A 2-byte variable is necessary for further processing in the ME. MD_IND_ACC is copied in miacc. miacc is copied into the high byte of miacc_w.

ABK CANACC 1.100 Abbreviations

Variable	Source	Type	Description
ACCCOD	CANACC	LOK	Automatic ACC control unit detection
ACC_STAT	CANACC	AUS	ACC status (CAN signal)
BREMSACC	CANACC	AUS	Brake intervention for ACC function with respect to BRE_NORM
B_ACC	CANACC	AUS	Condition: ACC-control unit exists
B_ACCCOK	CANACC	AUS	Condition CAN message ACC1 present
B_ACCDEF	CANACC	AUS	Condition defect in ACC relation
B_ACCDME	CANACC	AUS	Condition acknowledgement of the ACC requirement
B_ACCNEW	CANACC	AUS	condition CAN interface ACC message ready
B_BREMSACC	CANACC	AUS	Condition brake request ACC via CAN
B_CLBACC	CANACC	LOK	Condition delete the bit B_acc via KWP2000* Service
B_MDACC	CANACC	AUS	Condition torque request ACC via CAN
B_SAVACC	CANACC	AUS	Condition: overrun fuel cut-off forbidden by ACC
MIACC	CANACC	AUS	Torque demand from ACC (with respect to MD_NORM)
ZACCALIVE	CANACC	AUS	Message counter for ACC via CAN

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FB CANACC 1.100 Detailed description of function

APP CANACC 1.100 Application hint

DCACC 1.30 Diagnosis; CAN timeout ACC interface

FDEF DCACC 1.30 Function definition

dcacc-dcacc

```
(*)  Unlike in the description, this path is served in the module %DFPM, or the flags are managed in %DFPM;


            Test criteria:  No CAN message ACC1 for t > TDCACC and Ub > UBDCAN and ACC system detected
                             and B_kl15 = 1

        Fault rectification criteria:  Message received during last 10 ms, B_accnew = 1

            Standby variables:  Provide initialization values

Standby measures:  Reset ACC signal monitoring Q_ACC_DME = 0. (Message DME2). ACC system goes into irreversible fault status.

Error memory management:
------------------------

a) Time-out monitoring

Status error path :       SFPCACC              Delete Error path:              C_fcmclr & B_clcacc
Error flag :              E_cacc               Error path :                    CDTCACC
Cycle flag :              Z_cacc               Error class :                   CLACACC
Error type :              B_sicacc             Error severity :                TSFCACC
                                               CARB code :                     CDCCACC
                                               Environmental conditions :      FFTCACC

Additional error paths: - Activity monitoring ACC
                        (no change in ACC sender message ACC_ALIVE after elapse of monitoring time T_ALIVETEST_MS = 150 ms)

                      - ACC signal plausibility
                        (exclusion of torque and brake request after elapse of error tolerance time T_PLAUSERR_MS = 150 ms)
```

ABK DCACC 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCCGE	BLOKNR		KL	code word CARB: CAN interface, timeout transmission control system
CDTCGE			FW	code word tester: CAN interface, timeout EGS [236]
CLACGE			FW	fault class: CAN interface, timeout EGS
FFTCGE	BLOKNR		KL	Freeze Frame table: CAN interface, timeout EGS
TDCACC			FW	Time for timeout detection CAN interface ACC
TSFCGE			FW	fault active time: CAN interface, time-out EGS
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

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Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
B_ACC	CANACC	EIN	Condition: ACC-control unit exists
B_ACCNEW	CANACC	EIN	condition CAN interface ACC message ready
B_CLCACC	DCACC	LOK	condition clear fault path CACC
B_KL15		EIN	condition ignition switch on
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_PWF		EIN	Condition for powerfail
B_SICACC	DCACC	AUS	signal error CAN interface ACC
C_FCMCLR	DCACC	LOK	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
E_CACC	DCACC	AUS	errorflag: CAN-interface, timeout ACC
SFPCGE	DCACC	AUS	status fault path: timeout CAN interface EGS
TDCACC_CTR	DCACC	LOK	Timer no new ACC message arrived
UB	GGUB	EIN	battery voltage
Z_CACC	DCACC	AUS	cycleflag: CAN-interface, timeout ACC

FB DCACC 1.30 Detailed description of function

The function monitors the CAN message ACC1 for time-out. Sender of the message is the ACC/FDR control unit.
The time-out monitoring is active if the battery voltage is greater than UBDCAN, B_kl15 = 1 and the automatic ACC detection B_accvar has been set. The ACC detection B_accvar is provided from the section %CANACC. The sampling rate is 20 ms.
The fault E_cacc is detected when no further ACC1 message has been detected for t > TDCACC. The internal monitoring time counter is reset if another ACC1 message is received during the monitoring time.
Fault rectification and reset of the error flags E_cacc if another ACC1 message was received during the last 20 ms.
The cycle flag Z_cacc is always set after timmot_w (time counter as of engine running) > TDCACC.
E_cacc and Z_cacc are rest by the command "Delete error memory".

APP DCACC 1.30 Application hint

DACC 1.60 Plausibility check ACC signal diagnostics

FDEF DACC 1.60 Function definition

Plausibility check MD_IND_ACC, BRE_ACC and ACC_ALIVE, but only for an installed ACC CONTROL UNIT (B_acc = TRUE).

dacc-dacc

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dacc-errordetec

ABK DACC 1.60 Abbreviations

Caution: Overflows for computing operations (breamsacc-zaccalive) and (miacc+zaccalive) are permitted !!!!
If B_acc = FALSE, then B_accdme = FALSE, Z_acc = TRUE, E_acc = FALSE and miacc_w = 0 % set !

Parameter	Source-X	Source-Y	Type	Description
CDCACC	BLOKNR		KL	code word CARB: ACC
CDKACC			FW	Code word customer: ACC check
CDTACC			FW	code word tester: ACC
CLAACC			FW	Fault class: ACC
FFTACC	BLOKNR		KL	Freeze Frame table: ACC
FLCACC			FW	fault set debouncing: ACC plausibility
HLCACC			FW	fault reset debouncing: ACC plausibility
TACCNP			FW	Debounce time ACC fault not plausible
TACCSI			FW	Debounce time ACC signal fault

Variable	Source	Type	Description
ACC_STAT	CANACC	EIN	ACC status (CAN signal)
BLOKNR		EIN	DAMOS source for flashing-code block number during diagnosis
BREMSACC	CANACC	EIN	Brake intervention for ACC function with respect to BRE_NORM
B_ACC	CANACC	EIN	Condition: ACC-control unit exists
B_ACCDME	DACC	AUS	Condition acknowledgement of the ACC requirement
B_ACCNOR	BBACC	EIN	condition ACC shows no reaction to shutdown conditions
B_ACCSIPL	DACC	AUS	Condition ACC signal plausible
B_BREMSACC	CANACC	EIN	Condition brake request ACC via CAN
B_CLACC		EIN	Condition error flag delete "ACC error"
B_MDACC	CANACC	EIN	Condition torque request ACC via CAN
B_MFLEN	BBACC	EIN	Condition FGR ACC control active
B_MXACC	DACC	AUS	condition for fault type "maximum value" detected (no ACC reaction)
B_NOACC_UM	UFFGRC	EIN	Condition transfer of ACC torque
B_NPACC	DACC	AUS	Error type not plausible: ACC signal not plausible
B_SIACC	DACC	AUS	Signal fault ACC
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_ACC	DACC	AUS	Error flag: ACC
MIACC	CANACC	EIN	Torque demand from ACC (with respect to MD_NORM)
MIACC_W	DACC	AUS	Torque demand from ACC, indicated torque
R_T20		EIN	Time schedule 20 ms
TACCZAL	DACC	DOK	Timer: Zeit in der sich der Alivezähler nicht geändert hat
TDCACC_CTR		EIN	Timer no new ACC message arrived
ZACCALIVE	CANACC	EIN	Message counter for ACC via CAN
Z_ACC	DACC	AUS	Cycle flag: ACC

FB DACC 1.60 Detailed description of function

For an installed ACC CONTROL UNIT, the function continually checks the ACC messages miacc, brake acc, B_mdacc, B_brake acc and zaccalive for plausibility (B_npacc) and activity (B_siacc) and sets E_acc in the event of a fault. The individual error types are debounced over the timers TACCNP and TACCSI, the rectification takes places when B_siacc = FALSE and B_npacc = FALSE.

As long as there is no plausibility error (B_accsipl = TRUE), no ACC-brake intervention (B_brake acc = TRUE), no signal error (B_siacc = FALSE) and no CAN time-out present - this is assured by B_mflen as all ACC-abort and error conditions are reflected here - then miacc is copied into the high byte of miacc_w. Otherwise miacc_w will by overwritten with 0 !!

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Overview of ACC operation

dacc-uebers

dacc-uebers

APP DACC 1.60 Application hint

TACCNP = TACCSI = 120 ms, matching this UE II %UFFGRC ACCA_T_UM = 160 ms ACCC_T_UM = 580 (must be greater than the CAN time-out (500 ms)).

BGMRACC 1.10 Calculated variable relative ACC torque

FDEF BGMRACC 1.10 Function definition

bgmracc-bgmracc

bgmracc-bgmracc

ABK BGMRACC 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMRMI	NMOT_W	FMIACC_W	KF	Map for torque increase in pedal overtravel relative in ind torque

Variable	Source	Type	Description
B_ACC	CANACC	EIN	Condition: ACC-control unit exists
B_UPUEW	BGMRACC	DOK	condition for swtchover to pedal overtravel
FMIACC_W	BGMRACC	DOK	factor relative to indicated torque
MIACC_W	DACC	EIN	Torque demand from ACC, indicated torque
MIMAX_W	MDMAX	EIN	maximum attainable indicated torque
MIMIN_W	MDMIN	EIN	Minimal engine torque
MIMXL1_W	MDMAX	EIN	maximum optimal torque at lambda = 1
MRACC_W	BGMRACC	AUS	Relative torque request by ACC
NMOT_W	BGNMOT	EIN	engine speed

FB BGMRACC 1.10 Detailed description of function

The function calculates a relative ACC torque. from the induced ACC torque. This is then used in calculations in the MD structure. mracc_w is set to 0 if there is no ACC ECU installed !

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APP BGMRACC 1.10 Application hint

BBACC 1.30 Operating conditions of ACC (adaptiv cruise control)

FDEF BBACC 1.30 Function definition

No text for FDEF available!

ABK BBACC 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TACCMXRMP			FW (REF)	
TACCREAKX			FW	max. permissible for ACC shutdown reaction after MFL OFF
TACCSRG			FW (REF)	
TVFGRSTAT			FW	

Variable	Source	Type	Description
ACC_STAT	CANACC	EIN	ACC status (CAN signal)
B_ACC	CANACC	EIN	Condition: ACC-control unit exists
B_ACCARM	BBACC	AUS	condition rev. shutdown by DME
B_ACCDEF	CANACC	EIN	Condition defect in ACC relation
B_ACCDME	DACC	EIN	Condition acknowledgement of the ACC requirement
B_ACCNOR	BBACC	AUS	condition ACC shows no reaction to shutdown conditions
B_ACCTGO	BBACC	LOK	
B_BESCH		EIN	condition: cruise control in acceleration mode
B_BREMS	GGEGAS	EIN	condition: brake operated
B_DKPU	SREAKT	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_FGRAI	BBFGR	EIN	condition: cruise control deactivation is not reversible
B_FGRAL		EIN	condition: cruise control slow switch off
B_FGRAS	BBFGR	EIN	condition: cruise control fast switch off
B_FGRAT	GGMFL	EIN	condition: tip-switch off CC lever control
B_FGREN		EIN	condition: cruise control is active (enable)
B_FGRHSA	GGMFL	EIN	condition: CC main switch off
B_FGRKFM	FGRMD	EIN	condition: cruise control in cruising mode (ME)
B_FGRTSE	GGMFL	EIN	condition: CC button (+ or -) set
B_FGRTWA	GGMFL	EIN	condition: Cruise control button RESUME
B_FGRVEM	FGRMD	EIN	condition: cruise control in decelerating mode (ME)
B_FS	CANEGS	EIN	Condition driving state (automatic gear box)
B_MDACC	CANACC	EIN	Condition torque request ACC via CAN
B_MFLAI	BBACC	AUS	Condition FGR ACC shutdown irreversible
B_MFLAL	BBACC	AUS	Condition FGR ACC shutdown slow
B_MFLAR	BBACC	AUS	Condition FGR shutdown reversible
B_MFLAS	BBACC	AUS	Set condition fast FGR-ACC-deactivation
B_MFLEN	BBACC	AUS	Condition FGR ACC control active
B_NMAX	NMAXMD	EIN	1 = maximum engine speed exceeded
B_WIAUF	FGRMD	EIN	condition: cruise control in resuming mode
E_BREMS	GGEGAS	EIN	error flag: brake pedal signal
E_CACC	DCACC	EIN	errorflag: CAN-interface, timeout ACC
E_CAS	DCAS	EIN	errorflag: CAN-interface, timeout ASC
E_CGE	DCGE	EIN	error flag: CAN-interface timeout EGS
E_KUPPL	DKUPPL	EIN	error flag: clutch pedal signal
E_MFL	GGMFL	EIN	Error flag: multifunctional steering wheel (MFL)
E_N	DDG	EIN	error flag: engine speed sensor
FGRSTATU	BBACC	AUS	
FGR_STAT	BBACC	AUS	Status driving speed controller
GANGI	BBGANG	EIN	Engaged gear
L_FGR	GGMFL	EIN	Status FGR readiness lamp
MRACC		EIN	
STAT_MD_E	CANDME	EIN	CAN signal: Status torque intervention
ZAACCPOS	BBACC	LOK	

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FB BBACC 1.30 Detailed description of function

APP BBACC 1.30 Application hint

DMDUE 9.90 Diagnostic routine misfire detection Overview

FDEF DMDUE 9.90 Function definition

modular concept misfire detection

* function only for engines with even number of cylinders

With the Codeword CDMD the whole misfire detection can be stopped.
If B_cdmd=0, misfire detection is stopped and E_ase=0, E_ask=0, Z_ase=1, Z_ask=1, B_mderk=0.
For B_cdmd=1 misfire detection is active.

In case of 2 ecu's (SY_2SG = 1) all function except of %DMDSTP are deactivated in the Master-ECU (B_master = 1) and are calculated in the Slave-ECU (B_master = 0).
The Stop-Conditions have to be transmitted via CAN from the Master-ECU to the Slave-ECU. The Slave-ECU has to evaluate the stop-conditions from the Master-ECU.

To ensure correct function of the misfire-detection algorithms the system for measuring the segment durations (speed sensor, sensor wheel) has to met the following specifications:

1) Chapter: Komponenten Gruppe Sensoren
   Designation: KGS_DG
   Title: Eingeber-Inkrementsystem

2) Geberradspezifikation zur Aussetzererkennung über Drehzahlerfassung

ABK DMDUE 9.90 Abbreviations

Variable	Source	Type	Description
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_MASTER		EIN	Condition MASTER-ECU
B_MDSTIM_M	DMDUE	LOK	monitor, cond. for stimulated ignition misfiring, stimuli-signal from ZAG
B_MDZYL1_M	DMDUE	LOK	monitor, cylinder 1 identification
B_ZASA_M	DMDUE	LOK	monitor, ZAS load switchover is active
FDMD_M	DMDUE	LOK	status diagnosis misfire detection, drum, delayed output
FLG_M	DMDUE	LOK	monitor status calculation of the engine roughness
SY_2SG	PROKON	EIN	system constant 2 motronic systems

FB DMDUE 9.90 Detailed description of function

The description can be found in the single function-descriptions

This function only describes the interface between the different functions.

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APP DMDUE 9.90 Application hint

1) Monitor function

Because of the calculation in background the output-variables are not synchronized. For the application it is necessary to measure some values like segment time, engine roughness, etc. synchroneously.
This is ensured in the monitor-function, which provided these signals synchroneously but related up to 128 ignitions.
For the differentiation between the actual and the related values, the related byte- and word-values and bits will end with '_m'.

Following values are provided synchroneously but related:

ts_m	segment duration ts(n-1) (s. %DMDTSB) (from tr(n-1) bis tr(n)), crankshaft segment (n-1)	2 byte
tsk_m	segment duration tsk(n-1) (in case of B_for=1: corrected after completed adaptation), (s. %DMDFON) (from tr(n-1) to tr(n)), crankshaft segment (n-1)	2 byte
luts_m	engine roughness value, segment (n-1) (s. %DMDLU)	1 byte
lurs_m	engine roughness reference value (s. %DMDLU)	1 byte
lums_m	engine roughness mean value (s. %DMDLU)	1 byte
lurms_m	refernce value for engine roughness mean value (s. %DMDLU)	1 byte
dluts_m	differential engine roughness (s. %DMDDLU)	1 byte
dlurs_m	differential engine roughness reference value (s. %DMDDLU)	1 byte
fluts_m	filtered engine roughness (s. %DMDLUA)	1 byte
luar_m	filtered engine roughness reference value (s. %DMDLUA)	1 byte
fostat_m	status of adaptation (s. %DMDFON)	1 byte
rl_m	corresponding load signal	1 byte

flg_m ASEFLAG, status bits 1 byte
- bit 7: B_mdstop_m = 1 --> engine roughness calculation is locked for specific operating conditions (%DMDSTP)
- bit 6: B_fof_m = 1 --> conditions for fuel-off adaptation are fulfilled (see %DMDFON)
- bit 5: B_tsroov_m = 1 --> overflow in segment duration (see %DMDTSB)
- bit 4: B_mdzyl1_m = 1 --> cylinder detection, active at cyl. 1 and ignition 1
- bit 3: B_lustop_m = 1 --> engine roughness calculation is locked for specific operating conditions (%DMDSTP)
- bit 2: B_luerk_m = 1 --> misfire detected; luts > lurs
- bit 1: B_mdstim_m = 1 --> stimuli signal from misfire generator (ZAG), ignition misfiring enabled
- bit 0: B_fon_m = 1 --> conditions for fuel-on adaptation are fulfilled (see %DMDFON)

fdmd_m DMDFLAG, status bits 1 byte
- bit 7: B_plokn_m = 1 --> plausibility in actual speed range (see %DMDFON)
- bit 6: B_forn_m = 1 --> adaptation stabilized in current speed range (B_for=1) (see %DMDFON)
- bit 5: B_fordo_m = 1 --> at least 1 dominant range has stabilized (see %DMDFON)
- bit 4: B_for_m = 1 --> adaptation stabilized in current operating range (see %DMDFON)
- bit 3: B_tnalu_m = 1 --> test phase after detected misfire in DMDLU or DMDDLU (see %DMDLU)
- bit 2: B_analu_m = 1 --> deactivation after first detected misfire active (see DMDLU)
- bit 1: B_luaerk_m = 1 --> misfire detected in DMDLUA (see %DMDLUA)
- bit 0: B_dluerk_m = 1 --> misfire detected in DMDDLU (see %DMDDLU)

DMDLU 4.60 Diagnostic routine misfire detection: Irregular running

FDEF DMDLU 4.60 Function definition

Overview misfire detection: interface with other functions see %DMDUE

Overview %DMDLU:

The whole misfire detection can be locked with the Eurocodeword CDMD.
For B_cdmd = 0 the function DMDLU is locked, i. e. luts, luts1..SY_ZYLZA, B_analu, B_tnalu, B_luerk and lursktm are set to 0.
For B_cdmd = 1 the function DMDLU is active.

In case of 2 ecu's (SY_2SG = 1) the function %DMDLU is deactivated in the Master ecu (B_master = 1)

Overview calculation of reference value:

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ABK DMDLU 4.60 Abbreviations

Subscripts and reference points used:
(n) = Crankshaft segments
(i) = Camshaft revolutions; NW - Umdr.
(j) = Crankshaft revolutions; KW - Umdr.
(t) = Time

tsk(n) corrected segment duration at the time n
tsk(n+1) corrected segment duration at the time n+1
luts(n) engine roughness - test value
lurs(i) engine roughness reference
lums(n) engine roughness mean value
lurms(n) engine roughness mean value reference

DMDLAD logical and temporary combination of results from different functions for misfire detetion
DMDDLU differential imbalance
DMDSTP stopconditions for misfire detection
SY_FLUQ quantization factor engine roughness computation; system variable.
Variation only by means of a new DAMOS specification
U crankshaft revolution
d... difference
zzyl cylinder number
SY_ZYLZA number of cylinders

Parameter	Source-X	Source-Y	Type	Description
ANALUN	NMOT		KL	number of combustions for deactivation after detected misfire
DMXRLU			FW	variation limitation for max. reduction of the engine roughness reference values
FIAMALU			FW	increase factor for filter mutiple misfire detection
FIMALU			FW	filter factor multiple misfire detection
FLUV1			FW	switch for modification 1 - calculation of running irregularity
FLUV2			FW	switch for modification 2 - calculation of engine roughness
KFAMAL	NMOT	RL	KF	map reduction factor of the engine roughness reference value at multiple misfire

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Parameter	Source-X	Source-Y	Type	Description
KFAMAL1	NMOT	RL	KF	map reduction factor of the engine roughness reference value at multiple misfire
KFLURB	NMOT	RL	KF	map for engine roughness - reference base value
KFLURB1	NMOT	RL	KF	map for engine roughness - reference base value
KFLURB2	NMOT	RL	KF	map for engine roughness - reference base value
KFLURBZ	NMOT	RL	KF	map for engine roughness base value, in case of ZAS
KFLURM	NMOT	RL	KF	reference base value map for engine roughness for misfire detection
KFLURM1	NMOT	RL	KF	reference base value map for engine roughness for misfire detection
LURBRL	RL		KL	reference value for engine roughness, vehicle speed zero
LURKH	DMRKH		KL	dmrkh-depen. engine roughness reference correction value, during cat heating
LURKTM	TMOT		KL	Tmot-dependent engine roughness reference correcting value
LURMIN1	NMOT		KL	speed dependensy of engine roughness referenz minimum value 1
LURMIN2	NMOT		KL	speed dependensy of engine roughness referenz minimum value 2
LURMIN3	NMOT		KL	speed dependensy of engine roughness referenz minimum value 3
NFLUV			FW	rpm threshhold for midification - calculation of running irregularity
P_ZYL			FW	distance for calculation arithm. mean value - DMDLU
TNALU			FW	duration of test-phase after detected misfire

Variable	Source	Type	Description
B_ANALU	DMDLU	AUS	condition for deactivation after first detected misfiring
B_ANALU_M	DMDLU	LOK	monitor, cond. for deactivation after first detected misfire
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_LL	MSF	EIN	Condition idle
B_LUERK	DMDLU	AUS	condition for misfiring detected, from DMDLU
B_LUERK_M	DMDLU	LOK	monitor, condition for misfire detected in DMDLU
B_LUSTOP		EIN	misfire detection stop
B_MASTER		EIN	Condition MASTER-ECU
B_MDSTOP		EIN	misfire detection stop
B_TNALU	DMDLU	AUS	condition for active test phase after detected misfiring
B_TNALU_M	DMDLU	LOK	monitor, cond. for active test phase after detected misfire
B_WK	CANEGS	EIN	condition: converter lockup clutch closed
B_WKR	CANEGS	EIN	condition clutch controlled
B_ZASA		EIN	ZAS load switchover is active
E_VFZ	DVFZ	EIN	Error flag: vehicle speed signal
FAMAL	DMDLU	LOK	factor for reduction of LUR value at multiple misfire, from KFFAMALU
FLURKH	DMDLU	LOK	factor for reduction of LUR value at cat-heating, from KL LURKH
FOSTAT	DMDFON	EIN	state of fuel-on/-off adaptation in actual map range
LUMS	DMDLU	DOK	engine roughness mean value for multiple misfire detection
LUMS_M	DMDLU	LOK	monitor, engine roughness mean value for multiple misfire detection
LURMS	DMDLU	DOK	cranking instability reference for multiple misfire detection -> compar to lums
LURMS_M	DMDLU	LOK	monitor, cranking instability reference for multi misfire detection, signed
LURS	DMDLU	DOK	engine roughness reference value
LURSKTM	DMDLU	AUS	tmot-dependent offset for engine roughness value dlurs, signed
LURS_M	DMDLU	LOK	monitir engine roughness reference value
LURS_MIN	DMDLU	AUS	value of LUR in case of not finished sensor wheel adaptation, value from LURMIN*
LUTS	DMDLU	AUS	engine roughness test value
LUTS1	DMDLU	AUS	engine roughness test value, cylinder or ignition 1, signed
LUTS2	DMDLU	AUS	engine roughness test value, cylinder or ignition 2, signed
LUTS3	DMDLU	AUS	engine roughness test value, cylinder or ignition 3, signed
LUTS4	DMDLU	AUS	engine roughness test value, cylinder or ignition 4, signed
LUTS5	DMDLU	AUS	engine roughness test value, cylinder or ignition 5, signed
LUTS6	DMDLU	AUS	engine roughness test value, cylinder or ignition 6, signed
LUTS7	DMDLU	AUS	engine roughness test value, cylinder or ignition 7, signed
LUTS8	DMDLU	AUS	engine roughness test value, cylinder or ignition 8, signed
LUTS_M	DMDLU	LOK	monitor engine roughness test value
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
SY_2SG	PROKON	EIN	system constant 2 motronic systems
TMOT	GGTFM	EIN	Engine temperature
TSK	DMDFON	EIN	corrected segment duration
VFZG	GGVFZG	EIN	vehicle speed (km/h)
ZZYL		EIN	SW-cylinder counter

FB DMDLU 4.60 Detailed description of function

```
1.  Misfire detection
    The following operating steps are performed for each measured segment, corrected by the fuel-on adaptation
    The data are processed asynchroneously to the combustion cycle, after several segment data have been collected.
```

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1.1 Calculation of the engine roughness luts(n), Luts1(n), luts2(n), ... lutsSY_ZYLZA(n)
The engine roughness is calculated in general according to the following formula:
lut(n) is related to 1 crankshaft revolution (physical unit: (rev./s)^2). The segment duration (physical unit: us) is therefore to be multiplied by zylza/2 each.

$$luts(n) = \frac{[tsk(n+1) - tsk(n)] - \text{compensation time}}{tsk(n)^3}$$

The calculated engine roughness value is also stored cylinder specific.

During ZAS-mode (B_zasa=1) the engine roughness is calculated as follows:

$$luts(n) = \frac{[tsk(n+1) - tsk(n-1)] - (2 * \text{compensation time})}{tsk(n)^3}$$

The luts-values for the cylinders cut-off are set to 0.

1.1.1 Calculation of compensation time according to the median procedure
For FLUV=1 and nmot<NFLUV the dynamic compensation time is calculated according to the median procedure.
Median is defined as the mean value of a data sequence (based on the values).
Medians are used for statistical evaluations, in order to eliminate outliers.
The engine roughness must be calculated continuously for each segment. For processing, six measuring values are required.
At first, 5 differences Dts1 to Dts5 are constructed of 2 consecutive segments.
Calculated is the engine roughness value, which is related to the segment tsk(n).

Dts1 = [tsk(n-1) - tsk(n-3)] / 2
Dts2 = tsk(n) - tsk(n-1)
Dts3 = tsk(n-1) - tsk(n)
Dts4 = tsk(n-2) - tsk(n-1)
Dts5 = tsk(n-3) - tsk(n-2)

The first differential value Dts corresponds to the mean value of two consecutive differences. By applying this procedure, it is also possible to detect misfire rates > 50%.

The 5 differences Dts1 to Dts5 are sorted, based on their value and then converted into the values DGts1 to DGts5.
(DGts1 corresponds to the highest value).

DGts1 = highest value of Dts1 to Dts5
DGts2 = second highest value of Dts1 to Dts5
DGts3 = third highest value of Dts1 to Dts5
DGts4 = fourth highest value of Dts1 to Dts5
DGts5 = fifth highest value of Dts1 to Dts5

The engine roughness is calculated based on:

compensation time = DGts3 -> $luts(n) = \frac{Dts3 - DGts3}{tsk(n)^3}$

1.1.2 Calculation of compensation time according to the arithmetical meanvalue
For FLUV1=0 and FLUV2=1 or for FLUV1=1 and nmot>NFLUV the compensation time is calculated according to the arithmetical meanvalue.

Dts6 = [tsk(n-p_zyl+SY_ZYLZA) - tsk(n-p_zyl)] / SY_ZYLZA; p_zyl = ((SY_ZYLZA/2)-1)

The engine roughness is calculated based on:

compensation time = Dts6 -> $luts(n) = \frac{Dts3 - Dts6}{tsk(n)^3}$

1.1.3 Quantization parameter FLUQ
The parameter SY_FLUQ can be chosen, so that the optimum quantization of the engine roughness values are ensured.
The choice of SY_FLUQ = LUEXP (systemconstant variable)
results with tsquant = T1INCT (system constant variable)
in a quantisation of luquant = LUQUANT (system constant variable)

1.1.4 Overview of the calcualtions of the compensation time:

FLUV1	FLUV2	n	calculation of compensation time
1	x	n < NFLUV	median
1	x	n > NFLUV	arithmetical mean-value
0	1	x	arithmetical mean-value

x: means not relevant here.

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1.2 Detecting of multiple misfiring supplementary information lums(n)
If several cylinders are misfiring (e.g., also alternating one combustion/one misfire event), the calculated engine roughness values may be that low so that the reference value is not exceeded during misfiring and therefore, misfiring would not be detected. Based on this fact, the periodicity of the engine roughness value is used as additional information during multiple misfiring.

The engine roughness values are filtered based on the following equation:

lums(n) = (1 - FIMALU) * lums(n-1) + FIMALU * FIAMALU * (| luts(n-1) - 0.5*luts(n-2) - 0.5 * luts(n) |)

During deactivation at specific operating conditions (B_mdstop=1, B_lustop=1, see 1.5), the lums-calculation is going on, but starts after the deactivation with the value 0.
During deactivation after a detected misfire (see 1.6) the filtering resp. the lums-calculation is stopped.
If both deactivations are valid simultaneously, B_analu possesses the higher priority, e.g. lums is stopped and not set to 0.
In case of ZAS-mode (B_zasa=1) lums is set to 0.

1.3 Calculation of the engine roughness reference value:
The engine roughness value lurs consists of a base value (KFLURB) and a coolant-temperature-dependent correction value LURKTM.
The base value is determined by the map KFLURB for B_wk=0, by the map KFLURB1 for B_wk=1 and by the map KFLURB2 for B_wkr=1.
In case of ZAS-mode (B_zasa=1) the base value is determined by the map KFLURBZ independant of B_wk and B_wkr.
In case of idle an vehicle speed = 0 (and E_vfz=0) the base value is determined by the load dependant characteristic line LURBRL (independant of B_wk, B_wkr, B_zasa).

Furthermore, the correction value lursktm, determined by a characteristic line LURKTM, is added on the base value.
During cat-heating for better detection during the first 1000 crankshaft rev. the threshhold lurs can be decreased by the factor flurkh. flurkh is calculated from the characteristic line LURKH, dependant on the difference torque dmrkh used for cat-heating.

Offset to lurs of LURMIN* in case of not yet performed resp. not completed adaptation. LURMIN1..3 are characteristic lines over the speed.
If the adaptation is not yet completed to the reference value lurs is added the minimum value LURMIN3. LURMIN3 must hold out the inaccuracy of the segment duration. If the adaptation is completed in a dominant range the reference value is increased by the value LURMIN2. LURMIN2 must hold out the speed and load dependeces. If the adaptation is completed in a speed-dominant range of the actual speed the reference value lurs is increased by the minimum value LURMIN1. LURMIN1 must hold out the load-dependance of the actual speed-range. If the adaptation is completed in the actual range and all values of the actual speed-range are plausible there is no further offset to lurs.
The offset to lurs for the actual range depends on fostat (see %DMDFON):

fostat = 3: offset LURMIN3
fostat = 2: offset LURMIN2
fostat = 1: offset LURMIN1
fostat = 0: no further offset of lurs

different characteristic lines of LURMI*::

The new reference value lurs(i) is compared with the old reference value lurs(i-2). A change towards smaller reference values is limited by the variation constant DMXRLU. After 2 camshaft-rotations lurs can be decreased of DMXRLU.

1.4 Determination if misfiring
Misfire detection is performed by comparing the engine roughness reference lurs(i) with the engine roughness value luts(n).
If luts > lurs, then a single misfire is detected. (exception during deactivation of B_analu=1 (see 1.6) and B_mdstop=1 and B_lustop = 1 (see %DMDSTP)).

In case lums(n) exceeds the value lurms(i), then lurs is reduced by a n-/tl-dependant factor famal in case of completed adaptation (fostat=0 or fostat = 1).
The factor famal is got of a map over nmot and rl (KFAMAL in case of B_wk=0 and KFAMAL1 in case of B_wk=1).
The threshhold lurms results of a base value KFLURM and a coolant-temperature dependant offset lursktm (LURKTM). Changes towards smaller reference values are limited by the variation constant DMXRLU, see lurs (over 2 camshaft rotations).

lum > lurms => lurs = lurs * famal[0..1] ; if fostat = 0 V fostat = 1

1.5 Deactivation in case of abnormal conditions
In case of rough road, high load- and speed-changes, engine-torque jumps, ... the misfire detection is deactivated to provide misdetections, B_mdstop=1 or B_lustop=1.
The calculation of luts and lums goes on, so that the rough-road-detection with satistical methods (%DSWES) is able to go on. After the deactivation the calculation of luts and lums starts at 0 so there will be no 'past time information' in the filters.

In case of B_mdstop=1 or B_lustop=1 the bit B_luerk is not set, independant from the comparsion of luts > lurs.

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1.6 Deactivation after detected misfiring:
If misfiring is detected within the previous segment, then misfire detection is deactivated during the next ANALUN segments and B_analu = 1. ANALUN is a characteristic line over speed. After this deactivation, a test phase with the duration of about > TNALU segments takes place and B_tnalu=1.
If an additional misfire is detected during this test phase, then no further deactivation via ANALUN is carried out and the test phase remains active (B_tnalu=1). The test phase is completed after TNALU segments after the last detected misfire.
If ANALUN = 0, then no deactivation after detected misfiring takes place.
By applying this measure, misdetection due to post-oscillation (which may be triggered by single misfiring) is suppressed.
Continuous misfiring, however, is detected reliably.
The calcualtion and monitoring of luts is going on. Only the detection of misfire is suppressed. (B_luerk=0 even if luts>lurs).
The lums-calculation is stopped during B_analu=1.
A deactivation also takes place if misfire is detected in %DMDDLU and B_analu = 1 is set.

APP DMDLU 4.60 Application hint

1) Monitor function
For the application of the misfire detection, it is necessary, to synchroneously monitor the segment time, the luts-value and several status bits. This is ensured with the monitor function.
For the description of the monitor-function and a list of related values see %DMDUE.

2) SY_FLUQ is a system variable, a variation is only possible by means of a new DAMOS specification.

3) Function deactivation:
For application purposes the misfire detection can be deactivated by setting NMXALU = 0 rpm in %DMDSTP.

4) Sensitivity of misfire detection:
LURMIN3: corresponds to the maximum possible faults (mechanical sensor wheel tolerances and torsional vibrations)
e.g. — 1,2°crankshaft
LURMIN2: corrensponds to the max. possible faults over the speed (speed dependance of adaptation values)
e.g. — 0,15°crankshaft
LURMIN1: corresponds to the max. possible fault over the load (load dependance of adaptation values in each speed range)
e.g. — 0,1°crankshaft

LURMIN*-expansion to neighbour ranges:

5) B_analu and B_tnalu:
B_analu and B_tnalu of %DMDLU and %DMDDLU are stored in one physical RAM-cell. So it is possible that both functions influence the other function and B_analu and B_tnalu are simultaneous in- and output.

6) short test of function DMDLU
For a short validation of the function the engine roughness values luts_ap can be compared in normal and in misfire mode (e. g. Mode 6 at ZAG).In areas of mean speed and load the luts_ap values in case of misfire must be visible higher than in case of normal combustions.

DMDDLU 7.40 Diagnostic routine Misfire Detection, forming the diff. for irregular running

FDEF DMDDLU 7.40 Function definition

Overview DMDDLU:

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B_analu, B_tnalu is triggered or retriggered by luts or by dluts.

The whole misfire detection can be locked with the Eurocodeword CDMD.
For B_cdmd=0 the function DMDDLU is locked, B_dluerk, B_analu and B_tnalu are set to 0.
For B_cdmd=1 the function DMDDLU is active.

This function is only active for engines with even cylinder numbers.
For SY_ZYLZA 0 odd B_dluerk is set to 0.

In case of 2 ecu's (SY_2SG = 1) the function %DMDDLU is deactivated in the Master-ecu (B_master = 1).

ABK DMDDLU 7.40 Abbreviations

Indices and reference points used:
(n) = Crankshaft segments

luts(n)	Imbalance test variable, updating in synchro
dluts(n)	Differential imbalance, updating in synchro
dlurs	Differential imbalance reference value
DMDLAD	logical and temporary combination of the results from different functions for misfire detection
DMDLU	misfire detection with engine roughness
DMDSTP	stop conditions for misfire detection
SY_FLUQ	Quantization factor for imbalance calculation; system variable, change only possible via new DAMOS specification.
U	Crankshaft revolution
d...	Differential
SY_ZYLZA	Number of cylinders

Parameter	Source-X	Source-Y	Type	Description
DLURMIN	NMOT		KL	speed dependensy of engine roughness referenz minimum value 1
DMXRDL			FW	variation limit for max. reduction of engine roughness reference value dlur
KFDLUR	NMOT	RL	KF	map engine roughness difference dluts referenz value
KFDLUR1	NMOT	RL	KF	map engine roughness difference dluts referenz value
KFDLUR2	NMOT	RL	KF	map engine roughness difference dluts referenz value
KFDLURZ	NMOT	RL	KF	map engine roughness difference dluts referenz value at ZAS (cylinder cut-off)
NMIDLU			FW	min. engine speed for deactivating misfire detection DMDDLU

Variable	Source	Type	Description
B_ANALU	DMDLU	EIN	condition for deactivation after first detected misfiring
B_ANALU_M	DMDDLU	LOK	monitor, cond. for deactivation after first detected misfire
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_DLUERK	DMDDLU	AUS	condition for misfiring detected, from DMDDLU
B_DLUERK_M	DMDDLU	LOK	monitor, misfire detected in DMDDLU
B_LUSTOP		EIN	misfire detection stop
B_MASTER		EIN	Condition MASTER-ECU
B_MDSTOP		EIN	misfire detection stop
B_WK	CANEGS	EIN	condition: converter lockup clutch closed
B_WKR	CANEGS	EIN	condition clutch controlled
B_ZASA		EIN	ZAS load switchover is active
DLURS	DMDDLU	DOK	engine roughness difference reference value
DLURS_M	DMDDLU	LOK	monitr, engine roughness difference reference value, signed, delayed output
DLUTS	DMDDLU	DOK	difference engine roughness test value
DLUTS_M	DMDDLU	LOK	monitor, difference engine roughness test value, signed, delayed output
FOSTAT	DMDFON	EIN	state of fuel-on/-off adaptation in actual map range
LURSKTM	DMDLU	EIN	tmot-dependent offset for engine roughness value dlurs, signed
LUTS	DMDLU	EIN	engine roughness test value
NMOT	BGNMOT	EIN	engine speed

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Variable	Source	Type	Description
RL	EGFE	EIN	relative air charge
SY_2SG	PROKON	EIN	system constant 2 motronic systems

FB DMDDLU 7.40 Detailed description of function

1. Introduction:
The function described below allows the recognition of single and permanent misfires, and of non-symmetrical multiple misfires.
The quality of detection is independent of sensor wheel accuracy (crankshaft-synchronous segment time fluctuations), so symmetrical multiple misfires (also generating crankshaft-synchronous segment time fluctuations) cannot be recognized.

2. Calculation of differential imbalance dluts(n):
The imbalance values luts(n) and luts(n+(zylza/2)) belonging to the same crankshaft segment are subtracted.

dluts(n) = luts(n) - luts(n+(zylza/2))

If one of the two cylinders misfires, the differential dluts increases.
dluts is compared with the threshold value dlurs. dlurs is calculated relative to load and engine speed (8x8) via the map.
If the differential dluts(n) exceeds the threshold valve dlurs, then combustion misfires occur.

If both cylinders 1 crankshaft revolution apart misfire, the differential dluts is approximated to 0 as in normal operation.

In case of ZAS-mode the engine roughness luts of the non-fired cylinders is equal to 0. So the dlut-calculation doesn’t differ.

3. Calculation of reference value dlurs:
A base value is calculated from the load- and rpm-dependent map KFDLUR for B_wk=0, KFDLUR1 for B_wk=1 and KFDLUR2 for B_wkr=1.
In case of ZAS-mode the map KFDLURZ is used independant of B_wk and B_wkr.
To this base value a tmot-dependent offset lursktm (from %DMDLU) is added.
Depending on the adaptation status (fostat >= 2) an offset will be added to the reference value.
Negative variations in the reference values are limited by the variation limiter DMXRDL (corresponds to DMXRLU, see %DMDLU),
i. e. dlurs(i-2) - dlurs(i) <= DMXRDL.

4. Masking:
As with the basic functions (see %DMDUE), %DMDDLU must also be masked under the same critical operating conditions:
Masking at B_mdstop, B_lustop
Masking at B_analu
B_analu can be triggered here either by dluts misfire detection or by luts misfire detection.
The ANALUN masking is deactivated with TNALU in the event of permanent misfires. (see %DMDLU)

Also the function DMDDLU is masked for speed below the speed-dependant threshhold NMIDLU.
In lower rpm-ranges instabil luts values can occur and will be probrably subtracted or added by the dlut calculation.

Während einer der o.g. Ausblendungen wird die Differenzlaufunruhe dluts weiter berechhcnet, bei dluts > dlurs wird jedoch nicht auf Aussetzer erkannt.

APP DMDDLU 7.40 Application hint

1. A PC simulation program (dmdsim.exe) is provided for the dluts calculation. (Off-line application)

2. For KFDLUR the values of KFLURB can be used in the 1st stage. Usually the values for the corresponding operating points should not overlap. However, the two maps can be used to adjust the sensitivity of the various methods to specific ranges.

3. To be noted in the application of KFDLUR:
Typical dluts curves:

e.g. 4-cylinder engine:

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```
            Single MF       Permanent MF                 Multiple MF         Multiple consecutive MF
        ^       *           *   *   *   *   *            symmetrical         **  **  **
        |                                                 * * * * *
 luts   |
        0 ******____*********_________________**********__________***********__________*****************_____>
                 ***          *** *** *** *** ***
                                                           * * * *
                                                                                  **  **

        ^
        |            ! !                                                        **  **
        |            |
        |        *   |        *   *   *   *   *                                      **
        |            |
dluts   |            |                                          *        *
        |        *  <|        *
        0 ****___*__*_******__*___*___*___*___*__********__*******__*********___________******************___>
                 **                                 **
                                                           *        *
                *           *                                           **
                                 **  **  **  **
```

In the application of dlurs it must be noted that prior to the actual misfire, a smaller positive dluts value may occur. Therefore, dlurs must not be set to too small a value.

4. Peculiarities in B_analu-masking due to the retroactive dluts calculation:

e.g. 4-cylinder engine: (prerequisite regarding luts: ZAD has stabilized)

```
            Single MF       Permanent MF
        ^       *           *   *   *   *   *
        |
 luts   |
        0 ******____*********_________________**********_____>
                 ***          *** *** *** *** ***
                                                           B_analu due to luts > lurs

                                                           B_tnalu

        ^       *           *   *   *   *   *
        |
dluts   |
        |       *           *
        0 ****___*__*_******__*___*___*___*___*__************___>
                 **                                 **
                *           *
                                 **  **  **  **
```

If luts<=lurs (luts has detected no misfire):

```
                                                           B_analu due to dluts > dlurs

                                                           B_tnalu
```

dluts(n) requires luts(n+2) for its calculation. (e.g. 4-cyl. engine). In the ECU, dluts(n) can thus only be calculated 2 ignitions later in retrospect. The correct arrangement (resetting by 2 ignitions) is produced via the monitor drum.

If B_analu due to luts>lurs is already set at the time of the dluts(n) calculation, then no B_analu is set with dluts.

Triggering of B_analu due to dluts>dlurs can only occur 2 ignitions later (4-cyl. engine) because of the delayed calculation. B_analu, B_tnalu are thus shifted by 2 ignitions.
Because of the typical luts curve (see above, negative dluts) after a misfire, this is not critical.

5. DMXRDL should cut in slower than DMXRLU, i.e. -> DMXRLU > DMXRDL. Under dynamics (negative load change) the interference of luts may accumulate due to summation, which is why "mis-detections" can occur if cut-in is too fast.
   (Remark: Genuine misfires frequently occur here, but these should not be detected!)

   DMXRDL should be applied especially slowly in vehicles with manual switch or turbocharged engines.

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6. Re. monitor function:
   For the application of msifire detection it is necessary that some values like dluts, dlurs, etc. are synchronized.
   This is ensured in the monitor-function.
   For the description of the monitor-function and a list of related values see %DMDUE.

7. short test of function DMDDLU
   For a short test of the function the difference-engine-roughness value dluts can be compared in normal combustion mode and in misfire mode (e. g. Mode 6 at ZAG). In areas of mean speed and load a clear difference of dluts between normal and misfire mode must be visible.

DMDLUA 4.10 Diagnostic routine Misfire Detection irregular running spacing

FDEF DMDLUA 4.10 Function definition

Overview DMDLUA:

The entire functions for misfire detection can be locked with the Eurocodeword CDMD.
For B_cdmd=0 the function DMDLUA is locked and B_luaerk is set to 0.
For B_cdmd=1 the function DMDLUA is active.

ABK DMDLUA 4.10 Abbreviations

(i) camshaft revolutions; NW-Umdr.
(n) crankshaft segments
zzyl cylinder number
SY_ZYLZA number of cylinders

Parameter	Source-X	Source-Y	Type	Description
DMXRFL			FW	limitation for max. reduction of the filter engine roughness reference values
FLUTN	NMOT		KL	filter factor running irregularity
KFLUAR	NMOT	RL	KF	map for engine roughness distance reference value
KFLUAR1	NMOT	RL	KF	map for engine roughness distance reference value
KFLUAR2	NMOT	RL	KF	map for engine roughness distance reference value
KFLUARZ	NMOT	RL	KF	map for engine roughness distance reference value at ZAS (cylinder cut-off)

Variable	Source	Type	Description
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_LUAERK	DMDLUA	AUS	condition for misfiring detected, with engine roughness distance, from DMDLUA
B_LUAERK_M	DMDLUA	LOK	monitor, misfire detected in DMDLUA
B_LUSTOP		EIN	misfire detection stop
B_MDSTOP		EIN	misfire detection stop

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Variable	Source	Type	Description
B_MDZYL1	DMDLUA	LOK	con. for cylinder ident. (f.t>TALUST),LU-calculation disabled (f.t<TALUST)
B_WK	CANEGS	EIN	condition: converter lockup clutch closed
B_WKR	CANEGS	EIN	condition clutch controlled
B_ZASA		EIN	ZAS load switchover is active
FFLUTN	DMDLUA	LOK	filter facot over speed for filtering the engine roughness
FLUTS1	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 1, signed
FLUTS2	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 2, signed
FLUTS3	DMDLUA	LOK	filter engine roughness test value, cylinder or inition 3, signed
FLUTS4	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 4, signed
FLUTS5	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 5, signed
FLUTS6	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 6, signed
FLUTS7	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 7, signed
FLUTS8	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 8, signed
LUAR	DMDLUA	DOK	engine roughness distance reference value
LUARMN	DMDLUA	LOK	engine roughness distance reference value minimum
LUAROFF	DMDLUA	LOK	engine roughness distance reference value offset
LUAR_M	DMDLUA	LOK	monitor, engine roughness distance reference value, delayed output
LURS_MIN	DMDLU	EIN	value of LUR in case of not finished sensor wheel adaptation, value from LURMIN*
LUTS1	DMDLU	EIN	engine roughness test value, cylinder or ignition 1, signed
LUTS2	DMDLU	EIN	engine roughness test value, cylinder or ignition 2, signed
LUTS3	DMDLU	EIN	engine roughness test value, cylinder or ignition 3, signed
LUTS4	DMDLU	EIN	engine roughness test value, cylinder or ignition 4, signed
LUTS5	DMDLU	EIN	engine roughness test value, cylinder or ignition 5, signed
LUTS6	DMDLU	EIN	engine roughness test value, cylinder or ignition 6, signed
LUTS7	DMDLU	EIN	engine roughness test value, cylinder or ignition 7, signed
LUTS8	DMDLU	EIN	engine roughness test value, cylinder or ignition 8, signed
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge

FB DMDLUA 4.10 Detailed description of function

```
1. Introduction
   The described function as follows permits the detection of continuous misfirng in one or more cylinders. For this the
   cylinder individuell engine roughenss luts(cyl) are filtered by a recursive low pass filter (fluts(cyl)) and are compared
   with an adapting threshhold luar.
   The detection ratio is nearly independant of the number of misfiring cylinders.
   The detection ratio is dependant of the adaptation status (e.g. of the fuel-on adaptation).

   Single misifre ( < 2 - 10 misifre per cylinder, according to fflutn) cannot be detected.

2. Calculation of fluts(cyl)
   The engine roughness luts(cyl)(i) are filtered cylinder individuell. The time constant ffluts is determined by a characteristic
   line FLUTN over speed.

   fluts(zyl)(i)  =  ( 1 - fflutn ) * fluts(zyl)(i-1)  +  fflutn * luts(zyl)(i)

   During masking of misfire detection (B_mdstop=1, B_lustop=1) the filtered values fluts(cyl) are set to 0. After the masking
   (B_md/lustop: 1 -> 0 ) the filtering begins at 0. Previous values are not considered.
   In case of ZAS-mode (B_zasa=1) the luts values of the cut-off cylinders are set to 0 so the corresponding fluts values are
   also 0 and the fluts calculation hasn't to be changed.

3. Calculation of reference value luar
   the reference value luar consists of a adapting minimum luarmn and an additive offset luaroff. The offset luaroff is
   calculated from the speed and load dependant map KFLUAR in case of B_wk=0, of KFLUAR1 for B_wk=1 and of KFLUAR2 for B_wkr=1.
   In case of ZAS-mode luaroff is calculated from the map KFLUARZ independant of B_wk and B_wkr.

   If the adaptation is not yet completed the offset value luaroff is increased by twice the value lurmin
   (from LURMIN*, see %DMDLU).
   Negative variations in the reference value are limited by the variation limiter DMXRFL (corresponding to DMXRLU in %DMDLU),
   i. e. luar(i-2) - luar(i) <= DMXRFL.

   The minimum value luarmn is the minimum of all filtered values fluts(cyl) during one camshaft revolution.

4. Determination if continuous misfire
   Continuous misfire is determined with a comparsion of the filtered fluts(cyl) and the referenc value luar. If fluts(cyl)
   exceeds the threshhold luar misfire is detected in the corresponding cylinder.
   The bit B_luaerk(n) is set at the corresponding ignition.
```

APP DMDLUA 4.10 Application hint

```
1. Monitor-function
   For application of misfire detection it is necessary to synchroneously monitor some variables and several status bits.
   This is ensured with the monitor function.
   For the description of the monitor-function and a list of the related values see %DMDUE.

2. physical background:
   During normal and misifre conditions the total amount of the luts values during one camshaft revolution is nearly equal to 0.
   During misfire in cylinder no. one e.g. the luts1 increases whereas the remaining luts2..lutsSY_ZYLZA desrease respectivley
   become negative. The total amount of all luts values over one camshaft revolution is 0. This is also valid for misfire
   in multiple cylinders.

   The distance between misfiring cylinder (positive luts) and firing cylinders (negative luts) is nearly the same and independant
   of the number of misfiring and firing cylinders.
```

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Example 4-cylinder-engine:

```
            single misfire  continuous misfire            multiple misfire    multiple misfire
                                                          symmetrical         consecutive


        ^ .......*............*.  *   *   *   *    .........            ........**  **  **   .............
        |                       ...................         * * * * *  .         .          .
*:luts  |                                                    ..      ..           .       ..
".:luar |                                                       ......             ....... "
       0——******————*********———————————————*********————————***********——————————*****************————>
                 ***          *** *** *** *** ***

                                                              * * * *
                                                                                  **  **
```

3. Standard application values:
   DMXRFL: 2 - 4 * DMXRLU, dependant on fflutn, luar must be slower than fluts(cyl) to avoid misdetection during dynamic conditions.

   FLUTN: 0.4 (lower rpm) ... 0.1 (higher rpm, > 4000/min)

   KFLUAR: the values of KFLURN can be used in the 1st stage (see %DMDLU)

4. Difference between DMDLUA and lums (see %DMDLU)
   lums serves espacilly for detection of symmetrical misfire. In this case lums shows advanteges at high cylinder engines. For 4-cyl.-engines DMDLUA ca be sufficient for detection of multiple misfire. So this function shall be applicated first and in case of non sufficient detection ratio lums shall be activated.

5. Improvement with DMDLUA:
   - in case of poor and rough idling detection of continuous misfire can be protected with the function DMDLUA
   - similar in case of unsystematical speed vcariations (unsymmetrical distributed over all cylinders) during cold starting the misfire detection for continuous misfire can be protected. For this lurktm (see %DMDLU) isn't considered.
   - DMDLUA is still now nonsensitive for post-oscillations. For that ANALU/TNALU aren't considered. Post-oscillations vary unsymmetrical over all cylinders (observe flutn, choose smaller -> 0,1)
     It must be tested if post-oscillations appear camshaft synchron. In this case the filters may run away. If the post-oscillations are not camshaft synchron they may disappear after filtering.

6. short test of function DMDLUA
   For a short validation of the function the filtered engineroughness values fluts1..SY_ZYLZA can be compared in normal and in misfire mode (e. g. Mode 6 at ZAG). In areas of mean speed and load a high increasing of the fluts values of the misfiring cylinder must be visible.

DMDFON 6.20 Diagnosis Misfire Detection fuel-on Adaptation

FDEF DMDFON 6.20 Function definition

1.0 Overview:

The combined acting of the function %DMDFON together with other functions of the misfire detection and the outwardly connections are shown in the overview %DMDUE.

The adaptation can be switched off by the code word CDFO. CDFO > 0: function active. By means of the code word CDFO the adaptation can also be reset (like after powerfail): CDFO = 0, thereafter again CDFO > 0 to reactivate the adaptation.

The complete misfire detection can be switched off by the code word CDMD. If bit B_cdmd = 0, then the function DMDFON is stopped, if B_cdmd = 1 the function is active.

The reset counters dfseresz, flmxresz are set to zero after powerfail or if CDFO is set to zero. If the reset is triggered by the function itself then the reset counters are not set to zero.

Distinction btween AT, MT cars:
not AT cars: KFCFO, SLFOON, DFSEFON is used if B_autget = 0
AT cars: KFCFO2, SLFOO2N, DFSEFO2N is used if B_autget = 1

ABK DMDFON 6.20 Abbreviations

Indices and reference points used:
(n) = Crankshaft segments
(i) = Camshaft revolutions; NW - rev.
(j) = Crankshaft revolutions; KW - rev.
(t) = Time

ts(n)	Segment duration of Crankshaft segment n
ts(n+1)	Segment duration of Crankshaft segment n+1
zylza	Number of cylinders
Zdg.	Ignition, is counted through in ignition order
xx	Operating ranges (speed, load)
nn	Engine speed range

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Parameter	Source-X	Source-Y	Type	Description
ALFO			FW	start value for learning filter at fuel-on/fuel-off adaptation
ANWFOHE			FW	number of camshaft rotations for healing
ANWFOST			FW	number of camshaft rotations for reactivation the adaptation after disabling
CDFO			FW	code to deactivate and reset the adaptation
DFSEFO2N	NMOT		KL	max. plausible speed-dependent variance of FSE values
DFSEFON	NMOT		KL	max. plausible speed-dependent variance of FSE values
DFSERES			FW	difference of adaptation values to reset fuel-on/-off adaptation
FLFO			FW	filter factor for learningfilter of fuel-on/-off adaptation
FS1FO			FW	filter factor segment duration filter 1 of fuel-on/-off adaptation
FS2FO			FW	filter factor segment duration filter 2 of fuel-on/-off adaptation
KFCFO	NMOT	RL	KF	map for definition of range characteristics (dominant..)
KFCFO2	NMOT	RL	KF	map for definition of range characteristics (dominant..)
LURFOST			FW	engine roughness referenz value for stop of the fuel-on/-off adaptation
MDERKFON			FW	number of misfires to stop adaptation (healing)
SLFOO2N	NMOT		KL	speed dep. upper threshold for learning filter value at fuel-on/-off adaptation
SLFOON	NMOT		KL	speed dep. upper threshold for learning filter value at fuel-on/-off adaptation
SLFOU			FW	lower threshold for learning filter value at fuel-on/-off adaptation

Variable	Source		Type	Description
ANWFOH	DMDFON		LOK	counts number of camshaft rotations for healing of fuel-on/-off adaptation
ANWFOS	DMDFON		LOK	counts number of camshaft rot.(conditions for adapt. OK to beginning of learing)
B_AUTGET	CANEGS		EIN	condition automatic gearbox
B_CDMD	PROKON		EIN	function active per codeword CDMD
B_FODO	DMDFON		LOK	condition fuel-on/-off adaptation in a dominant operating range active
B_FODON	DMDFON		LOK	condition fuel-on adaptation in a speed dominant operating range active
B_FOF	DMDFON		DOK	condition fuel-off adaptation active
B_FOFSTP			EIN	condition fuel-off adaptation stopped
B_FOF_M	DMDFON		LOK	monitor, condition fuel-off adapation active
B_FOHE	DMDFON		LOK	actual range is a healing range
B_FOHOLD	DMDFON		LOK	fuel-on adaptation deactivated
B_FOLUNW	DMDFON		LOK	condition to large for fuel-on/-off adaptation
B_FON	DMDFON		DOK	condition fuel-on adaptation active
B_FONSTP			EIN	condition fuel-on adaptation stopped
B_FONTM	DMDFON		LOK	engine temperature high enough for fuel-on-adaption
B_FON_M	DMDFON		LOK	monitor, condition fuel-on adaptation active
B_FOR	DMDFON		DOK	condition fuel-on/-off adaptation actual ready
B_FOR11	DMDFON		LOK	map range 11 ready
B_FOR12	DMDFON		LOK	map range 12 ready
B_FOR13	DMDFON		LOK	map range 13 ready
B_FOR21	DMDFON		LOK	map range 21 ready
B_FOR22	DMDFON		LOK	map range 22 ready
B_FOR23	DMDFON		LOK	map range 23 ready
B_FOR31	DMDFON		LOK	KF range 31 already learned
B_FOR32	DMDFON		LOK	KF range 32 already learned
B_FOR33	DMDFON		LOK	KF range 33 already learned
B_FOR41	DMDFON		LOK	KF range 41 already learned
B_FOR42	DMDFON		LOK	KF range 42 already learned
B_FOR43	DMDFON		LOK	KF range 43 already learned
B_FOR51	DMDFON		LOK	KF range 51 already learned
B_FOR52	DMDFON		LOK	KF range 52 already learned
B_FOR53	DMDFON		LOK	KF range 53 already learned
B_FOR61	DMDFON		LOK	KF range 61 already learned
B_FOR62	DMDFON		LOK	KF range 62 already learned
B_FOR63	DMDFON		LOK	KF range 63 already learned
B_FOR71	DMDFON		LOK	KF range 71 already learned
B_FOR72	DMDFON		LOK	KF range 72 already learned
B_FOR73	DMDFON		LOK	KF range 73 already learned
B_FOR81	DMDFON		LOK	KF range 81 already learned
B_FOR82	DMDFON		LOK	KF range 82 already learned
B_FOR83	DMDFON		LOK	KF range 83 already learned
B_FORDO	DMDFON		DOK	condition fuel-on/-off adaptation in at least one dominant range ready
B_FORDO_M	DMDFON		LOK	monitor, cond. adaptation in at least one dominant range ready
B_FORN	DMDFON		DOK	condition fuel-on/-off adaptation actual speed range ready
B_FORN01	DMDFON		LOK	at least one range in speed range 01 is ready
B_FORN02	DMDFON		LOK	at least one range in speed range 02 is ready
B_FORN03	DMDFON		LOK	at least one range in speed range 03 is ready
B_FORN04	DMDFON		LOK	at least one range in speed range 04 is ready
B_FORN05	DMDFON		LOK	at least one range in speed range 05 is ready
B_FORN06	DMDFON		LOK	at least one range in speed range 06 is ready
B_FORN07	DMDFON		LOK	at least one range in speed range 07 is ready
B_FORN08	DMDFON		LOK	at least one range in speed range 08 is ready
B_FORN_M	DMDFON		LOK	monitor, cond. adaptation in actual speed range ready
B_FORSET	DMDFON		LOK	reset of fuel-on/-off adaptation
B_FORUN	DMDFON		LOK	state fuel-on/-off adaptation active
B_FOR_M	DMDFON		LOK	monitor, cond. adaptation in actual range ready
B_FOS	DMDFON		LOK	condition fuel-on/-off actual range is a fuel cut-off range
B_FOXFG	DMDFON		LOK	condition fuel-on/-off allowed
B_MDERK	DMDLAD		EIN	misfiring detected from multpile functions
B_MDSTOP			EIN	misfire detection stop
B_MDSTOP_M			EIN	monitor, misfire detection stopped
B_MDZYL1	DMDFON		DOK	con. for cylinder ident. (f.t>TALUST),LU-calculation disabled (f.t<TALUST)

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Variable	Source	Type	Description
B_MDZYL1_M		EIN	monitor, cylinder 1 identification
B_PLOK	DMDFON	LOK	FSE values in all speed ranges plausible
B_PLOK01	DMDFON	LOK	FSE values in speed range 01 plausible
B_PLOK02	DMDFON	LOK	FSE values in speed range 02 plausible
B_PLOK03	DMDFON	LOK	FSE values in speed range 03 plausible
B_PLOK04	DMDFON	LOK	FSE values in speed range 04 plausible
B_PLOK05	DMDFON	LOK	FSE values in speed range 05 plausible
B_PLOK06	DMDFON	LOK	FSE values in speed range 06 plausible
B_PLOK07	DMDFON	LOK	FSE values in speed range 07 plausible
B_PLOK08	DMDFON	LOK	FSE values in speed range 08 plausible
B_PLOKN	DMDFON	DOK	FSE values in actual speed range plausible
B_PLOKN_M	DMDFON	LOK	monitor, FSE values in actual speed range plausible
B_TSROOV	DMDTSB	EIN	condition segment duration word overflow
B_TSROOV_M	DMDFON	LOK	monitor, condition segment duration word overflow
CFOXX	DMDFON	LOK	shows characteristics of actual map area (fuel-on/-off adaptation)
DFSE01	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 01 positiv
DFSE02	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 02 positiv
DFSE03	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 3 positiv
DFSE04	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 4 positiv
DFSE05	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 5 positiv
DFSE06	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 6 positiv
DFSE07	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 7 positiv
DFSE08	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 8 positiv
DFSEN	DMDFON	LOK	difference of FSE values in normal operation at actual speed range
DFSERESZ	DMDFON	LOK	reset counter plausibility check FSE
FDMD_M	DMDFON	LOK	status diagnosis misfire detection, drum, delayed output
FFONN1	DMDFON	LOK	status byte fuel-on/-off adaptation (map ranges ready)
FFONN2	DMDFON	LOK	status byte fuel-on/off adaptation (map ranges ready)
FFONN3	DMDFON	LOK	status byte fuel-on/-off adaptation (map ranges ready)
FFORN1	DMDFON	LOK	status byte fuel-on/-off adaptation (speed ranges ready)
FFPL1	DMDFON	LOK	status byte of fuel-on/-off adaption (FSE values in speed ranges plausible I)
FLG_M	DMDFON	LOK	monitor status calculation of the engine roughness
FLMX	DMDFON	LOK	actual maximum learning filter value
FLMXRESZ	DMDFON	LOK	reset counter learning filter not plausible
FLN11_02	DMDFON	LOK	learning filter value, negative, operating range 11, cylinder 2
FLN11_03	DMDFON	LOK	learning filter value, negative
FLN11_04	DMDFON	LOK	learning filter value, negative
FLN11_05	DMDFON	LOK	learning filter value, negative
FLN11_06	DMDFON	LOK	learning filter value, negative
FLN11_07	DMDFON	LOK	learning filter value, negative
FLN11_08	DMDFON	LOK	learning filter value, negative
FLN12_02	DMDFON	LOK	learning filter value, negative
FLN12_03	DMDFON	LOK	learning filter value, negative
FLN12_04	DMDFON	LOK	learning filter value, negative
FLN12_05	DMDFON	LOK	learning filter value, negative
FLN12_06	DMDFON	LOK	learning filter value, negative
FLN12_07	DMDFON	LOK	learning filter value, negative
FLN12_08	DMDFON	LOK	learning filter value, negative
FLN13_02	DMDFON	LOK	learning filter value, negative
FLN13_03	DMDFON	LOK	learning filter value, negative
FLN13_04	DMDFON	LOK	learning filter value, negative
FLN13_05	DMDFON	LOK	learning filter value, negative
FLN13_06	DMDFON	LOK	learning filter value, negative
FLN13_07	DMDFON	LOK	learning filter value, negative
FLN13_08	DMDFON	LOK	learning filter value, negative
FLN21_02	DMDFON	LOK	learning filter value, negative
FLN21_03	DMDFON	LOK	learning filter value, negative
FLN21_04	DMDFON	LOK	learning filter value, negative
FLN21_05	DMDFON	LOK	learning filter value, negative
FLN21_06	DMDFON	LOK	learning filter value, negative
FLN21_07	DMDFON	LOK	learning filter value, negative
FLN21_08	DMDFON	LOK	learning filter value, negative
FLN22_02	DMDFON	LOK	learning filter value, negative
FLN22_03	DMDFON	LOK	learning filter value, negative
FLN22_04	DMDFON	LOK	learning filter value, negative
FLN22_05	DMDFON	LOK	learning filter value, negative
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FLN23_04	DMDFON	LOK	learning filter value, negative
FLN23_05	DMDFON	LOK	learning filter value, negative
FLN23_06	DMDFON	LOK	learning filter value, negative
FLN23_07	DMDFON	LOK	learning filter value, negative
FLN23_08	DMDFON	LOK	learning filter value, negative
FLN31_02	DMDFON	LOK	learning filter value, negative
FLN31_03	DMDFON	LOK	learning filter value, negative
FLN31_04	DMDFON	LOK	learning filter value, negative
FLN31_05	DMDFON	LOK	learning filter value, negative
FLN31_06	DMDFON	LOK	learning filter value, negative
FLN31_07	DMDFON	LOK	learning filter value, negative

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Variable	Source	Type	Description
FLN31_08	DMDFON	LOK	learning filter value, negative
FLN32_02	DMDFON	LOK	learning filter value, negative
FLN32_03	DMDFON	LOK	learning filter value, negative
FLN32_04	DMDFON	LOK	learning filter value, negative
FLN32_05	DMDFON	LOK	learning filter value, negative
FLN32_06	DMDFON	LOK	learning filter value, negative
FLN32_07	DMDFON	LOK	learning filter value, negative
FLN32_08	DMDFON	LOK	learning filter value, negative
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FLN33_05	DMDFON	LOK	learning filter value, negative
FLN33_06	DMDFON	LOK	learning filter value, negative
FLN33_07	DMDFON	LOK	learning filter value, negative
FLN33_08	DMDFON	LOK	learning filter value, negative
FLN41_02	DMDFON	LOK	learning filter value, negative
FLN41_03	DMDFON	LOK	learning filter value, negative
FLN41_04	DMDFON	LOK	learning filter value, negative
FLN41_05	DMDFON	LOK	learning filter value, negative
FLN41_06	DMDFON	LOK	learning filter value, negative
FLN41_07	DMDFON	LOK	learning filter value, negative
FLN41_08	DMDFON	LOK	learning filter value, negative
FLN42_02	DMDFON	LOK	learning filter value, negative
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FLN42_06	DMDFON	LOK	learning filter value, negative
FLN42_07	DMDFON	LOK	learning filter value, negative
FLN42_08	DMDFON	LOK	learning filter value, negative
FLN43_02	DMDFON	LOK	learning filter value, negative
FLN43_03	DMDFON	LOK	learning filter value, negative
FLN43_04	DMDFON	LOK	learning filter value, negative
FLN43_05	DMDFON	LOK	learning filter value, negative
FLN43_06	DMDFON	LOK	learning filter value, negative
FLN43_07	DMDFON	LOK	learning filter value, negative
FLN43_08	DMDFON	LOK	learning filter value, negative
FLN51_02	DMDFON	LOK	learning filter value, negative
FLN51_03	DMDFON	LOK	learning filter value, negative
FLN51_04	DMDFON	LOK	learning filter value, negative
FLN51_05	DMDFON	LOK	learning filter value, negative
FLN51_06	DMDFON	LOK	learning filter value, negative
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FLN51_08	DMDFON	LOK	learning filter value, negative
FLN52_02	DMDFON	LOK	learning filter value, negative
FLN52_03	DMDFON	LOK	learning filter value, negative
FLN52_04	DMDFON	LOK	learning filter value, negative
FLN52_05	DMDFON	LOK	learning filter value, negative
FLN52_06	DMDFON	LOK	learning filter value, negative
FLN52_07	DMDFON	LOK	learning filter value, negative
FLN52_08	DMDFON	LOK	learning filter value, negative
FLN53_02	DMDFON	LOK	Learning filter value, negative
FLN53_03	DMDFON	LOK	learning filter value, negative
FLN53_04	DMDFON	LOK	learning filter value, negative
FLN53_05	DMDFON	LOK	learning filter value, negative
FLN53_06	DMDFON	LOK	learning filter value, negative
FLN53_07	DMDFON	LOK	learning filter value, negative
FLN53_08	DMDFON	LOK	learning filter value, negative
FLN61_02	DMDFON	LOK	learning filter value, negative
FLN61_03	DMDFON	LOK	learning filter value, negative
FLN61_04	DMDFON	LOK	learning filter value, negative
FLN61_05	DMDFON	LOK	learning filter value, negative
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FLN62_05	DMDFON	LOK	learning filter value, negative
FLN62_06	DMDFON	LOK	learning filter value, negative
FLN62_07	DMDFON	LOK	learning filter value, negative
FLN62_08	DMDFON	LOK	learning filter value, negative
FLN63_02	DMDFON	LOK	learning filter value, negative
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FLN63_05	DMDFON	LOK	learning filter value, negative
FLN63_06	DMDFON	LOK	learning filter value, negative
FLN63_07	DMDFON	LOK	learning filter value, negative
FLN63_08	DMDFON	LOK	learning filter value, negative
FLN71_02	DMDFON	LOK	learning filter value, negative
FLN71_03	DMDFON	LOK	learning filter value, negative
FLN71_04	DMDFON	LOK	learning filter value, negative
FLN71_05	DMDFON	LOK	learning filter value, negative

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Variable	Source	Type	Description
FLN71_06	DMDFON	LOK	learning filter value, negative
FLN71_07	DMDFON	LOK	learning filter value, negative
FLN71_08	DMDFON	LOK	learning filter value, negative
FLN72_02	DMDFON	LOK	learning filter value, negative
FLN72_03	DMDFON	LOK	learning filter value, negative
FLN72_04	DMDFON	LOK	learning filter value, negative
FLN72_05	DMDFON	LOK	learning filter value, negative
FLN72_06	DMDFON	LOK	learning filter value, negative
FLN72_07	DMDFON	LOK	learning filter value, negative
FLN72_08	DMDFON	LOK	learning filter value, negative
FLN73_02	DMDFON	LOK	learning filter value, negative
FLN73_03	DMDFON	LOK	learning filter value, negative
FLN73_04	DMDFON	LOK	learning filter value, negative
FLN73_05	DMDFON	LOK	learning filter value, negative
FLN73_06	DMDFON	LOK	learning filter value, negative
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FLN73_08	DMDFON	LOK	learning filter value, negative
FLN81_02	DMDFON	LOK	learning filter value, negative
FLN81_03	DMDFON	LOK	learning filter value, negative
FLN81_04	DMDFON	LOK	learning filter value, negative
FLN81_05	DMDFON	LOK	learning filter value, negative
FLN81_06	DMDFON	LOK	learning filter value, negative
FLN81_07	DMDFON	LOK	learning filter value, negative
FLN81_08	DMDFON	LOK	learning filter value, negative
FLN82_02	DMDFON	LOK	learning filter value, negative
FLN82_03	DMDFON	LOK	learning filter value, negative
FLN82_04	DMDFON	LOK	learning filter value, negative
FLN82_05	DMDFON	LOK	learning filter value, negative
FLN82_06	DMDFON	LOK	learning filter value, negative
FLN82_07	DMDFON	LOK	learning filter value, negative
FLN82_08	DMDFON	LOK	learning filter value, negative
FLN83_02	DMDFON	LOK	learning filter value, negative
FLN83_03	DMDFON	LOK	learning filter value, negative
FLN83_04	DMDFON	LOK	learning filter value, negative
FLN83_05	DMDFON	LOK	learning filter value, negative
FLN83_06	DMDFON	LOK	learning filter value, negative
FLN83_07	DMDFON	LOK	learning filter value, negative
FLN83_08	DMDFON	LOK	learning filter value, negative
FLP11_02	DMDFON	LOK	learning filter value, positive
FLP11_03	DMDFON	LOK	learning filter value, positiv
FLP11_04	DMDFON	LOK	learning filter value, positiv
FLP11_05	DMDFON	LOK	learning filter value, positiv
FLP11_06	DMDFON	LOK	learning filter value, positiv
FLP11_07	DMDFON	LOK	learning filter value, positiv
FLP11_08	DMDFON	LOK	learning filter value, positiv
FLP12_02	DMDFON	LOK	learning filter value, positiv
FLP12_03	DMDFON	LOK	learning filter value, positiv
FLP12_04	DMDFON	LOK	learning filter value, positiv
FLP12_05	DMDFON	LOK	learning filter value, positiv
FLP12_06	DMDFON	LOK	learning filter value, positiv
FLP12_07	DMDFON	LOK	learning filter value, positiv
FLP12_08	DMDFON	LOK	learning filter value, positiv
FLP13_02	DMDFON	LOK	learning filter value, positiv
FLP13_03	DMDFON	LOK	learning filter value, positiv
FLP13_04	DMDFON	LOK	learning filter value, positiv
FLP13_05	DMDFON	LOK	learning filter value, positiv
FLP13_06	DMDFON	LOK	learning filter value, positiv
FLP13_07	DMDFON	LOK	learning filter value, positiv
FLP13_08	DMDFON	LOK	learning filter value, positiv
FLP21_02	DMDFON	LOK	learning filter value, positiv
FLP21_03	DMDFON	LOK	learning filter value, positiv
FLP21_04	DMDFON	LOK	learning filter value, positiv
FLP21_05	DMDFON	LOK	learning filter value, positiv
FLP21_06	DMDFON	LOK	learning filter value, positiv
FLP21_07	DMDFON	LOK	learning filter value, positiv
FLP21_08	DMDFON	LOK	learning filter value, positiv
FLP22_02	DMDFON	LOK	learning filter value, positiv
FLP22_03	DMDFON	LOK	learning filter value, positiv
FLP22_04	DMDFON	LOK	learning filter value, positiv
FLP22_05	DMDFON	LOK	learning filter value, positiv
FLP22_06	DMDFON	LOK	learning filter value, positiv
FLP22_07	DMDFON	LOK	learning filter value, positiv
FLP22_08	DMDFON	LOK	learning filter value, positiv
FLP23_02	DMDFON	LOK	learning filter value, positiv
FLP23_03	DMDFON	LOK	learning filter value, positiv
FLP23_04	DMDFON	LOK	learning filter value, positiv
FLP23_05	DMDFON	LOK	learning filter value, positiv
FLP23_06	DMDFON	LOK	learning filter value, positiv
FLP23_07	DMDFON	LOK	learning filter value, positiv
FLP23_08	DMDFON	LOK	learning filter value, positiv
FLP31_02	DMDFON	LOK	learning filter value, positiv
FLP31_03	DMDFON	LOK	learning filter value, positiv

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Variable	Source	Type	Description
FLP31_04	DMDFON	LOK	learning filter value, positiv
FLP31_05	DMDFON	LOK	learning filter value, positiv
FLP31_06	DMDFON	LOK	learning filter value, positiv
FLP31_07	DMDFON	LOK	learning filter value, positiv
FLP31_08	DMDFON	LOK	learning filter value, positiv
FLP32_02	DMDFON	LOK	learning filter value, positiv
FLP32_03	DMDFON	LOK	learning filter value, positiv
FLP32_04	DMDFON	LOK	learning filter value, positiv
FLP32_05	DMDFON	LOK	learning filter value, positiv
FLP32_06	DMDFON	LOK	learning filter value, positiv
FLP32_07	DMDFON	LOK	learning filter value, positiv
FLP32_08	DMDFON	LOK	learning filter value, positiv
FLP33_02	DMDFON	LOK	learning filter value, positiv
FLP33_03	DMDFON	LOK	learning filter value, positiv
FLP33_04	DMDFON	LOK	learning filter value, positiv
FLP33_05	DMDFON	LOK	learning filter value, positiv
FLP33_06	DMDFON	LOK	learning filter value, positiv
FLP33_07	DMDFON	LOK	learning filter value, positiv
FLP33_08	DMDFON	LOK	learning filter value, positiv
FLP41_02	DMDFON	LOK	learning filter value, positiv
FLP41_03	DMDFON	LOK	learning filter value, positiv
FLP41_04	DMDFON	LOK	learning filter value, positiv
FLP41_05	DMDFON	LOK	learning filter value, positiv
FLP41_06	DMDFON	LOK	learning filter value, positiv
FLP41_07	DMDFON	LOK	learning filter value, positiv
FLP41_08	DMDFON	LOK	learning filter value, positiv
FLP42_02	DMDFON	LOK	learning filter value, positiv
FLP42_03	DMDFON	LOK	learning filter value, positiv
FLP42_04	DMDFON	LOK	learning filter value, positiv
FLP42_05	DMDFON	LOK	learning filter value, positiv
FLP42_06	DMDFON	LOK	learning filter value, positiv
FLP42_07	DMDFON	LOK	learning filter value, positiv
FLP42_08	DMDFON	LOK	learning filter value, positiv
FLP43_02	DMDFON	LOK	learning filter value, positiv
FLP43_03	DMDFON	LOK	learning filter value, positiv
FLP43_04	DMDFON	LOK	learning filter value, positiv
FLP43_05	DMDFON	LOK	learning filter value, positiv
FLP43_06	DMDFON	LOK	learning filter value, positiv
FLP43_07	DMDFON	LOK	learning filter value, positiv
FLP43_08	DMDFON	LOK	learning filter value, positiv
FLP51_02	DMDFON	LOK	learning filter value, positiv
FLP51_03	DMDFON	LOK	learning filter value, positiv
FLP51_04	DMDFON	LOK	learning filter value, positiv
FLP51_05	DMDFON	LOK	learning filter value, positiv
FLP51_06	DMDFON	LOK	learning filter value, positiv
FLP51_07	DMDFON	LOK	learning filter value, positiv
FLP51_08	DMDFON	LOK	learning filter value, positiv
FLP52_02	DMDFON	LOK	learning filter value, positiv
FLP52_03	DMDFON	LOK	learning filter value, positiv
FLP52_04	DMDFON	LOK	learning filter value, positiv
FLP52_05	DMDFON	LOK	learning filter value, positiv
FLP52_06	DMDFON	LOK	learning filter value, positiv
FLP52_07	DMDFON	LOK	learning filter value, positiv
FLP52_08	DMDFON	LOK	learning filter value, positiv
FLP53_02	DMDFON	LOK	learning filter value, positiv
FLP53_03	DMDFON	LOK	learning filter value, positiv
FLP53_04	DMDFON	LOK	learning filter value, positiv
FLP53_05	DMDFON	LOK	learning filter value, positiv
FLP53_06	DMDFON	LOK	learning filter value, positiv
FLP53_07	DMDFON	LOK	learning filter value, positiv
FLP53_08	DMDFON	LOK	learning filter value, positiv
FLP61_02	DMDFON	LOK	learning filter value, positiv
FLP61_03	DMDFON	LOK	learning filter value, positiv
FLP61_04	DMDFON	LOK	learning filter value, positiv
FLP61_05	DMDFON	LOK	learning filter value, positiv
FLP61_06	DMDFON	LOK	learning filter value, positiv
FLP61_07	DMDFON	LOK	learning filter value, positiv
FLP61_08	DMDFON	LOK	learning filter value, positiv
FLP62_02	DMDFON	LOK	learning filter value, positiv
FLP62_03	DMDFON	LOK	learning filter value, positiv
FLP62_04	DMDFON	LOK	learning filter value, positiv
FLP62_05	DMDFON	LOK	learning filter value, positiv
FLP62_06	DMDFON	LOK	learning filter value, positiv
FLP62_07	DMDFON	LOK	learning filter value, positiv
FLP62_08	DMDFON	LOK	learning filter value, positiv
FLP63_02	DMDFON	LOK	learning filter value, positiv
FLP63_03	DMDFON	LOK	learning filter value, positiv
FLP63_04	DMDFON	LOK	learning filter value, positiv
FLP63_05	DMDFON	LOK	learning filter value, positiv
FLP63_06	DMDFON	LOK	learning filter value, positiv
FLP63_07	DMDFON	LOK	learning filter value, positiv
FLP63_08	DMDFON	LOK	learning filter value, positiv

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Variable	Source	Type	Description
FLP71_02	DMDFON	LOK	learning filter value, positiv
FLP71_03	DMDFON	LOK	learning filter value, positiv
FLP71_04	DMDFON	LOK	learning filter value, positiv
FLP71_05	DMDFON	LOK	learning filter value, positiv
FLP71_06	DMDFON	LOK	learning filter value, positiv
FLP71_07	DMDFON	LOK	learning filter value, positiv
FLP71_08	DMDFON	LOK	learning filter value, positiv
FLP72_02	DMDFON	LOK	learning filter value, positiv
FLP72_03	DMDFON	LOK	learning filter value, positiv
FLP72_04	DMDFON	LOK	learning filter value, positiv
FLP72_05	DMDFON	LOK	learning filter value, positiv
FLP72_06	DMDFON	LOK	learning filter value, positiv
FLP72_07	DMDFON	LOK	learning filter value, positiv
FLP72_08	DMDFON	LOK	learning filter value, positiv
FLP73_02	DMDFON	LOK	learning filter value, positiv
FLP73_03	DMDFON	LOK	learning filter value, positiv
FLP73_04	DMDFON	LOK	learning filter value, positiv
FLP73_05	DMDFON	LOK	learning filter value, positiv
FLP73_06	DMDFON	LOK	learning filter value, positiv
FLP73_07	DMDFON	LOK	learning filter value, positiv
FLP73_08	DMDFON	LOK	learning filter value, positiv
FLP81_02	DMDFON	LOK	learning filter value, positiv
FLP81_03	DMDFON	LOK	learning filter value, positiv
FLP81_04	DMDFON	LOK	learning filter value, positiv
FLP81_05	DMDFON	LOK	learning filter value, positiv
FLP81_06	DMDFON	LOK	learning filter value, positiv
FLP81_07	DMDFON	LOK	learning filter value, positiv
FLP81_08	DMDFON	LOK	learning filter value, positiv
FLP82_02	DMDFON	LOK	learning filter value, positiv
FLP82_03	DMDFON	LOK	learning filter value, positiv
FLP82_04	DMDFON	LOK	learning filter value, positiv
FLP82_05	DMDFON	LOK	learning filter value, positiv
FLP82_06	DMDFON	LOK	learning filter value, positiv
FLP82_07	DMDFON	LOK	learning filter value, positiv
FLP82_08	DMDFON	LOK	learning filter value, positiv
FLP83_02	DMDFON	LOK	learning filter value, positiv
FLP83_03	DMDFON	LOK	learning filter value, positiv
FLP83_04	DMDFON	LOK	learning filter value, positiv
FLP83_05	DMDFON	LOK	learning filter value, positiv
FLP83_06	DMDFON	LOK	learning filter value, positiv
FLP83_07	DMDFON	LOK	learning filter value, positiv
FLP83_08	DMDFON	LOK	learning filter value, positiv
FOSTAT	DMDFON	AUS	state of fuel-on/-off adaptation in actual map range
FS11_02	DMDFON	LOK	filter value segment duration, operating range 11
FS11_03	DMDFON	LOK	filter value segment duration, operating range 11
FS11_04	DMDFON	LOK	filter value segment duration, operating range 11
FS11_05	DMDFON	LOK	filter value segment duration, operating range 11
FS11_06	DMDFON	LOK	filter value segment duration, operating range 11
FS11_07	DMDFON	LOK	filter value segment duration, operating range 11
FS11_08	DMDFON	LOK	filter value segment duration, operating range 11
FS12_02	DMDFON	LOK	filter value segment duration, operating range 12
FS12_03	DMDFON	LOK	filter value segment duration, operating range 12
FS12_04	DMDFON	LOK	filter value segment duration, operating range 12
FS12_05	DMDFON	LOK	filter value segment duration, operating range 12
FS12_06	DMDFON	LOK	filter value segment duration, operating range 12
FS12_07	DMDFON	LOK	filter value segment duration, operating range 12
FS12_08	DMDFON	LOK	filter value segment duration, operating range 12
FS13_02	DMDFON	LOK	filter value segment duration, operating range 13
FS13_03	DMDFON	LOK	filter value segment duration, operating range 13
FS13_04	DMDFON	LOK	filter value segment duration, operating range 13
FS13_05	DMDFON	LOK	filter value segment duration, operating range 13
FS13_06	DMDFON	LOK	filter value segment duration, operating range 13
FS13_07	DMDFON	LOK	filter value segment duration, operating range 13
FS13_08	DMDFON	LOK	filter value segment duration, operating range 13
FS21_02	DMDFON	LOK	filter value segment duration, operating range 21
FS21_03	DMDFON	LOK	filter value segment duration, operating range 21
FS21_04	DMDFON	LOK	filter value segment duration, operating range 21
FS21_05	DMDFON	LOK	filter value segment duration, operating range 21
FS21_06	DMDFON	LOK	filter value segment duration, operating range 21
FS21_07	DMDFON	LOK	filter value segment duration, operating range 21
FS21_08	DMDFON	LOK	filter value segment duration, operating range 21
FS22_02	DMDFON	LOK	filter value segment duration, operating range 22
FS22_03	DMDFON	LOK	filter value segment duration, operating range 22
FS22_04	DMDFON	LOK	filter value segment duration, operating range 22
FS22_05	DMDFON	LOK	filter value segment duration, operating range 22
FS22_06	DMDFON	LOK	filter value segment duration, operating range 22
FS22_07	DMDFON	LOK	filter value segment duration, operating range 22
FS22_08	DMDFON	LOK	filter value segment duration, operating range 22
FS23_02	DMDFON	LOK	filter value segment duration, operating range 23
FS23_03	DMDFON	LOK	filter value segment duration, operating range 23
FS23_04	DMDFON	LOK	filter value segment duration, operating range 23
FS23_05	DMDFON	LOK	filter value segment duration, operating range 23

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Variable	Source	Type	Description
FS23_06	DMDFON	LOK	filter value segment duration, operating range 23
FS23_07	DMDFON	LOK	filter value segment duration, operating range 23
FS23_08	DMDFON	LOK	filter value segment duration, operating range 23
FS31_02	DMDFON	LOK	filter value segment duration, operating range 31, cylinder 2
FS31_03	DMDFON	LOK	filter value segment duration, operating range 31
FS31_04	DMDFON	LOK	filter value segment duration, operating range 31
FS31_05	DMDFON	LOK	filter value segment duration, operating range 31
FS31_06	DMDFON	LOK	filter value segment duration, operating range 31
FS31_07	DMDFON	LOK	filter value segment duration, operating range 31
FS31_08	DMDFON	LOK	filter value segment duration, operating range 31
FS32_02	DMDFON	LOK	filter value segment duration, operating range 32, cylinder 2
FS32_03	DMDFON	LOK	filter value segment duration, operating range 32
FS32_04	DMDFON	LOK	filter value segment duration, operating range 32
FS32_05	DMDFON	LOK	filter value segment duration, operating range 32
FS32_06	DMDFON	LOK	filter value segment duration, operating range 32
FS32_07	DMDFON	LOK	filter value segment duration, operating range 32
FS32_08	DMDFON	LOK	filter value segment duration, operating range 32
FS33_02	DMDFON	LOK	filter value segment duration, operating range 33, cylinder 2
FS33_03	DMDFON	LOK	filter value segment duration, operating range 33
FS33_04	DMDFON	LOK	filter value segment duration, operating range 33
FS33_05	DMDFON	LOK	filter value segment duration, operating range 33
FS33_06	DMDFON	LOK	filter value segment duration, operating range 33
FS33_07	DMDFON	LOK	filter value segment duration, operating range 33
FS33_08	DMDFON	LOK	filter value segment duration, operating range 33
FS41_02	DMDFON	LOK	filter value segment duration, operating range 41, cylinder 2
FS41_03	DMDFON	LOK	filter value segment duration, operating range 41
FS41_04	DMDFON	LOK	filter value segment duration, operating range 41
FS41_05	DMDFON	LOK	filter value segment duration, operating range 41
FS41_06	DMDFON	LOK	filter value segment duration, operating range 41
FS41_07	DMDFON	LOK	filter value segment duration, operating range 41
FS41_08	DMDFON	LOK	filter value segment duration, operating range 41
FS42_02	DMDFON	LOK	filter value segment duration, operating range 42, cylinder 2
FS42_03	DMDFON	LOK	filter value segment duration, operating range 42
FS42_04	DMDFON	LOK	filter value segment duration, operating range 42
FS42_05	DMDFON	LOK	filter value segment duration, operating range 42
FS42_06	DMDFON	LOK	filter value segment duration, operating range 42
FS42_07	DMDFON	LOK	filter value segment duration, operating range 42
FS42_08	DMDFON	LOK	filter value segment duration, operating range 42
FS43_02	DMDFON	LOK	filter value segment duration, operating range 43, cylinder 2
FS43_03	DMDFON	LOK	filter value segment duration, operating range 43
FS43_04	DMDFON	LOK	filter value segment duration, operating range 43
FS43_05	DMDFON	LOK	filter value segment duration, operating range 43
FS43_06	DMDFON	LOK	filter value segment duration, operating range 43
FS43_07	DMDFON	LOK	filter value segment duration, operating range 43
FS43_08	DMDFON	LOK	filter value segment duration, operating range 43
FS51_02	DMDFON	LOK	filter value segment duration, operating range 51, cylinder 2
FS51_03	DMDFON	LOK	filter value segment duration, operating range 51
FS51_04	DMDFON	LOK	filter value segment duration, operating range 51
FS51_05	DMDFON	LOK	filter value segment duration, operating range 51
FS51_06	DMDFON	LOK	filter value segment duration, operating range 51
FS51_07	DMDFON	LOK	filter value segment duration, operating range 51
FS51_08	DMDFON	LOK	filter value segment duration, operating range 51
FS52_02	DMDFON	LOK	filter value segment duration, operating range 52, cylinder 2
FS52_03	DMDFON	LOK	filter value segment duration, operating range 52
FS52_04	DMDFON	LOK	filter value segment duration, operating range 52
FS52_05	DMDFON	LOK	filter value segment duration, operating range 52
FS52_06	DMDFON	LOK	filter value segment duration, operating range 52
FS52_07	DMDFON	LOK	filter value segment duration, operating range 52
FS52_08	DMDFON	LOK	filter value segment duration, operating range 52
FS53_02	DMDFON	LOK	filter value segment duration, operating range 53, cylinder 2
FS53_03	DMDFON	LOK	filter value segment duration, operating range 53
FS53_04	DMDFON	LOK	filter value segment duration, operating range 53
FS53_05	DMDFON	LOK	filter value segment duration, operating range 53
FS53_06	DMDFON	LOK	filter value segment duration, operating range 53
FS53_07	DMDFON	LOK	filter value segment duration, operating range 53
FS53_08	DMDFON	LOK	filter value segment duration, operating range 53
FS61_02	DMDFON	LOK	filter value segment duration, operating range 61, cylinder 2
FS61_03	DMDFON	LOK	filter value segment duration, operating range 61
FS61_04	DMDFON	LOK	filter value segment duration, operating range 61
FS61_05	DMDFON	LOK	filter value segment duration, operating range 61
FS61_06	DMDFON	LOK	filter value segment duration, operating range 61
FS61_07	DMDFON	LOK	filter value segment duration, operating range 61
FS61_08	DMDFON	LOK	filter value segment duration, operating range 61
FS62_02	DMDFON	LOK	filter value segment duration, operating range 62, cylinder 2
FS62_03	DMDFON	LOK	filter value segment duration, operating range 62
FS62_04	DMDFON	LOK	filter value segment duration, operating range 62
FS62_05	DMDFON	LOK	filter value segment duration, operating range 62
FS62_06	DMDFON	LOK	filter value segment duration, operating range 62
FS62_07	DMDFON	LOK	filter value segment duration, operating range 62
FS62_08	DMDFON	LOK	filter value segment duration, operating range 62
FS63_02	DMDFON	LOK	filter value segment duration, operating range 63, cylinder 2
FS63_03	DMDFON	LOK	filter value segment duration, operating range 63

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Variable	Source	Type	Description
FS63_04	DMDFON	LOK	filter value segment duration, operating range 63
FS63_05	DMDFON	LOK	filter value segment duration, operating range 63
FS63_06	DMDFON	LOK	filter value segment duration, operating range 63
FS63_07	DMDFON	LOK	filter value segment duration, operating range 63
FS63_08	DMDFON	LOK	filter value segment duration, operating range 63
FS71_02	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 2
FS71_03	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 3
FS71_04	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 4
FS71_05	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 5
FS71_06	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 6
FS71_07	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 7
FS71_08	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 8
FS72_02	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 2
FS72_03	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 3
FS72_04	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 4
FS72_05	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 5
FS72_06	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 6
FS72_07	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 7
FS72_08	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 8
FS73_02	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 2
FS73_03	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 3
FS73_04	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 4
FS73_05	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 5
FS73_06	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 6
FS73_07	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 7
FS73_08	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 8
FS81_02	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 2
FS81_03	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 3
FS81_04	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 4
FS81_05	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 5
FS81_06	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 6
FS81_07	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 7
FS81_08	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 8
FS82_02	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 2
FS82_03	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 3
FS82_04	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 4
FS82_05	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 5
FS82_06	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 6
FS82_07	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 7
FS82_08	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 8
FS83_02	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 2
FS83_03	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 3
FS83_04	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 4
FS83_05	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 5
FS83_06	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 6
FS83_07	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 7
FS83_08	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 8
FSE	DMDFON	LOK	actual filter value segment duration, for correction of segment duration
FSE11_02	DMDFON	LOK	filter value segment duration, for calculation, operating range 11, cylinder 2
FSE11_03	DMDFON	LOK	filter value segment duration, for calculation
FSE11_04	DMDFON	LOK	filter value segment duration, for calculation
FSE11_05	DMDFON	LOK	filter value segment duration, for calculation
FSE11_06	DMDFON	LOK	filter value segment duration, for calculation
FSE11_07	DMDFON	LOK	filter value segment duration, for calculation
FSE11_08	DMDFON	LOK	filter value segment duration, for calculation
FSE12_02	DMDFON	LOK	filter value segment duration, for calculation
FSE12_03	DMDFON	LOK	filter value segment duration, for calculation
FSE12_04	DMDFON	LOK	filter value segment duration, for calculation
FSE12_05	DMDFON	LOK	filter value segment duration, for calculation
FSE12_06	DMDFON	LOK	filter value segment duration, for calculation
FSE12_07	DMDFON	LOK	filter value segment duration, for calculation
FSE12_08	DMDFON	LOK	filter value segment duration, for calculation
FSE13_02	DMDFON	LOK	filter value segment duration, for calculation
FSE13_03	DMDFON	LOK	filter value segment duration, for calculation
FSE13_04	DMDFON	LOK	filter value segment duration, for calculation
FSE13_05	DMDFON	LOK	filter value segment duration, for calculation
FSE13_06	DMDFON	LOK	filter value segment duration, for calculation
FSE13_07	DMDFON	LOK	filter value segment duration, for calculation
FSE13_08	DMDFON	LOK	filter value segment duration, for calculation
FSE21_02	DMDFON	LOK	filter value segment duration, for calculation
FSE21_03	DMDFON	LOK	filter value segment duration, for calculation
FSE21_04	DMDFON	LOK	filter value segment duration, for calculation
FSE21_05	DMDFON	LOK	filter value segment duration, for calculation
FSE21_06	DMDFON	LOK	filter value segment duration, for calculation
FSE21_07	DMDFON	LOK	filter value segment duration, for calculation
FSE21_08	DMDFON	LOK	filter value segment duration, for calculation
FSE22_02	DMDFON	LOK	filter value segment duration, for calculation
FSE22_03	DMDFON	LOK	filter value segment duration, for calculation
FSE22_04	DMDFON	LOK	filter value segment duration, for calculation
FSE22_05	DMDFON	LOK	filter value segment duration, for calculation
FSE22_06	DMDFON	LOK	filter value segment duration, for calculation
FSE22_07	DMDFON	LOK	filter value segment duration, for calculation

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Variable	Source	Type	Description
FSE22_08	DMDFON	LOK	filter value segment duration, for calculation
FSE23_02	DMDFON	LOK	filter value segment duration, for calculation
FSE23_03	DMDFON	LOK	filter value segment duration, for calculation
FSE23_04	DMDFON	LOK	filter value segment duration, for calculation
FSE23_05	DMDFON	LOK	filter value segment duration, for calculation
FSE23_06	DMDFON	LOK	filter value segment duration, for calculation
FSE23_07	DMDFON	LOK	filter value segment duration, for calculation
FSE23_08	DMDFON	LOK	filter value segment duration, for calculation
FSE31_02	DMDFON	LOK	filter value segment duration, for calculation
FSE31_03	DMDFON	LOK	filter value segment duration, for calculation
FSE31_04	DMDFON	LOK	filter value segment duration, for calculation
FSE31_05	DMDFON	LOK	filter value segment duration, for calculation
FSE31_06	DMDFON	LOK	filter value segment duration, for calculation
FSE31_07	DMDFON	LOK	filter value segment duration, for calculation
FSE31_08	DMDFON	LOK	filter value segment duration, for calculation
FSE32_02	DMDFON	LOK	filter value segment duration, for calculation
FSE32_03	DMDFON	LOK	filter value segment duration, for calculation
FSE32_04	DMDFON	LOK	filter value segment duration, for calculation
FSE32_05	DMDFON	LOK	filter value segment duration, for calculation
FSE32_06	DMDFON	LOK	filter value segment duration, for calculation
FSE32_07	DMDFON	LOK	filter value segment duration, for calculation
FSE32_08	DMDFON	LOK	filter value segment duration, for calculation
FSE33_02	DMDFON	LOK	filter value segment duration, for calculation
FSE33_03	DMDFON	LOK	filter value segment duration, for calculation
FSE33_04	DMDFON	LOK	filter value segment duration, for calculation
FSE33_05	DMDFON	LOK	filter value segment duration, for calculation
FSE33_06	DMDFON	LOK	filter value segment duration, for calculation
FSE33_07	DMDFON	LOK	filter value segment duration, for calculation
FSE33_08	DMDFON	LOK	filter value segment duration, for calculation
FSE41_02	DMDFON	LOK	filter value segment duration, for calculation
FSE41_03	DMDFON	LOK	filter value segment duration, for calculation
FSE41_04	DMDFON	LOK	filter value segment duration, for calculation
FSE41_05	DMDFON	LOK	filter value segment duration, for calculation
FSE41_06	DMDFON	LOK	filter value segment duration, for calculation
FSE41_07	DMDFON	LOK	filter value segment duration, for calculation
FSE41_08	DMDFON	LOK	filter value segment duration, for calculation
FSE42_02	DMDFON	LOK	filter value segment duration, for calculation
FSE42_03	DMDFON	LOK	filter value segment duration, for calculation
FSE42_04	DMDFON	LOK	filter value segment duration, for calculation
FSE42_05	DMDFON	LOK	filter value segment duration, for calculation
FSE42_06	DMDFON	LOK	filter value segment duration, for calculation
FSE42_07	DMDFON	LOK	filter value segment duration, for calculation
FSE42_08	DMDFON	LOK	filter value segment duration, for calculation
FSE43_02	DMDFON	LOK	filter value segment duration, for calculation
FSE43_03	DMDFON	LOK	filter value segment duration, for calculation
FSE43_04	DMDFON	LOK	filter value segment duration, for calculation
FSE43_05	DMDFON	LOK	filter value segment duration, for calculation
FSE43_06	DMDFON	LOK	filter value segment duration, for calculation
FSE43_07	DMDFON	LOK	filter value segment duration, for calculation
FSE43_08	DMDFON	LOK	filter value segment duration, for calculation
FSE51_02	DMDFON	LOK	filter value segment duration, for calculation
FSE51_03	DMDFON	LOK	filter value segment duration, for calculation
FSE51_04	DMDFON	LOK	filter value segment duration, for calculation
FSE51_05	DMDFON	LOK	filter value segment duration, for calculation
FSE51_06	DMDFON	LOK	filter value segment duration, for calculation
FSE51_07	DMDFON	LOK	filter value segment duration, for calculation
FSE51_08	DMDFON	LOK	filter value segment duration, for calculation
FSE52_02	DMDFON	LOK	filter value segment duration, for calculation
FSE52_03	DMDFON	LOK	filter value segment duration, for calculation
FSE52_04	DMDFON	LOK	filter value segment duration, for calculation
FSE52_05	DMDFON	LOK	filter value segment duration, for calculation
FSE52_06	DMDFON	LOK	filter value segment duration, for calculation
FSE52_07	DMDFON	LOK	filter value segment duration, for calculation
FSE52_08	DMDFON	LOK	filter value segment duration, for calculation
FSE53_02	DMDFON	LOK	filter value segment duration, for calculation
FSE53_03	DMDFON	LOK	filter value segment duration, for calculation
FSE53_04	DMDFON	LOK	filter value segment duration, for calculation
FSE53_05	DMDFON	LOK	filter value segment duration, for calculation
FSE53_06	DMDFON	LOK	filter value segment duration, for calculation
FSE53_07	DMDFON	LOK	filter value segment duration, for calculation
FSE53_08	DMDFON	LOK	filter value segment duration, for calculation
FSE61_02	DMDFON	LOK	filter value segment duration, for calculation
FSE61_03	DMDFON	LOK	filter value segment duration, for calculation
FSE61_04	DMDFON	LOK	filter value segment duration, for calculation
FSE61_05	DMDFON	LOK	filter value segment duration, for calculation
FSE61_06	DMDFON	LOK	filter value segment duration, for calculation
FSE61_07	DMDFON	LOK	filter value segment duration, for calculation
FSE61_08	DMDFON	LOK	filter value segment duration, for calculation
FSE62_02	DMDFON	LOK	filter value segment duration, for calculation
FSE62_03	DMDFON	LOK	filter value segment duration, for calculation
FSE62_04	DMDFON	LOK	filter value segment duration, for calculation
FSE62_05	DMDFON	LOK	filter value segment duration, for calculation

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Variable	Source	Type	Description
FSE62_06	DMDFON	LOK	filter value segment duration, for calculation
FSE62_07	DMDFON	LOK	filter value segment duration, for calculation
FSE62_08	DMDFON	LOK	filter value segment duration, for calculation
FSE63_02	DMDFON	LOK	filter value segment duration, for calculation
FSE63_03	DMDFON	LOK	filter value segment duration, for calculation
FSE63_04	DMDFON	LOK	filter value segment duration, for calculation
FSE63_05	DMDFON	LOK	filter value segment duration, for calculation
FSE63_06	DMDFON	LOK	filter value segment duration, for calculation
FSE63_07	DMDFON	LOK	filter value segment duration, for calculation
FSE63_08	DMDFON	LOK	filter value segment duration, for calculation
FSE71_02	DMDFON	LOK	filter value segment duration, for calculation
FSE71_03	DMDFON	LOK	filter value segment duration, for calculation
FSE71_04	DMDFON	LOK	filter value segment duration, for calculation
FSE71_05	DMDFON	LOK	filter value segment duration, for calculation
FSE71_06	DMDFON	LOK	filter value segment duration, for calculation
FSE71_07	DMDFON	LOK	filter value segment duration, for calculation
FSE71_08	DMDFON	LOK	filter value segment duration, for calculation
FSE72_02	DMDFON	LOK	filter value segment duration, for calculation
FSE72_03	DMDFON	LOK	filter value segment duration, for calculation
FSE72_04	DMDFON	LOK	filter value segment duration, for calculation
FSE72_05	DMDFON	LOK	filter value segment duration, for calculation
FSE72_06	DMDFON	LOK	filter value segment duration, for calculation
FSE72_07	DMDFON	LOK	filter value segment duration, for calculation
FSE72_08	DMDFON	LOK	filter value segment duration, for calculation
FSE73_02	DMDFON	LOK	filter value segment duration, for calculation
FSE73_03	DMDFON	LOK	filter value segment duration, for calculation
FSE73_04	DMDFON	LOK	filter value segment duration, for calculation
FSE73_05	DMDFON	LOK	filter value segment duration, for calculation
FSE73_06	DMDFON	LOK	filter value segment duration, for calculation
FSE73_07	DMDFON	LOK	filter value segment duration, for calculation
FSE73_08	DMDFON	LOK	filter value segment duration, for calculation
FSE81_02	DMDFON	LOK	filter value segment duration, for calculation
FSE81_03	DMDFON	LOK	filter value segment duration, for calculation
FSE81_04	DMDFON	LOK	filter value segment duration, for calculation
FSE81_05	DMDFON	LOK	filter value segment duration, for calculation
FSE81_06	DMDFON	LOK	filter value segment duration, for calculation
FSE81_07	DMDFON	LOK	filter value segment duration, for calculation
FSE81_08	DMDFON	LOK	filter value segment duration, for calculation
FSE82_02	DMDFON	LOK	filter value segment duration, for calculation
FSE82_03	DMDFON	LOK	filter value segment duration, for calculation
FSE82_04	DMDFON	LOK	filter value segment duration, for calculation
FSE82_05	DMDFON	LOK	filter value segment duration, for calculation
FSE82_06	DMDFON	LOK	filter value segment duration, for calculation
FSE82_07	DMDFON	LOK	filter value segment duration, for calculation
FSE82_08	DMDFON	LOK	filter value segment duration, for calculation
FSE83_02	DMDFON	LOK	filter value segment duration, for calculation
FSE83_03	DMDFON	LOK	filter value segment duration, for calculation
FSE83_04	DMDFON	LOK	filter value segment duration, for calculation
FSE83_05	DMDFON	LOK	filter value segment duration, for calculation
FSE83_06	DMDFON	LOK	filter value segment duration, for calculation
FSE83_07	DMDFON	LOK	filter value segment duration, for calculation
FSE83_08	DMDFON	LOK	filter value segment duration, for calculation
FZABGS		EIN	fault counter, summary, counts emission relevant misfirings of all cylinders
IDXFOB	DMDFON	LOK	index: shows actual map range (speed, load)
IDXFON	DMDFON	LOK	speed index operating range fuel-on adaptation
IDXFORL	DMDFON	LOK	load index operating range fuel-on adaptation
LUNW	DMDFON	LOK	Engine roughness for 1 camshaft revolution
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
R_SYN		EIN	Synchro schedule
TS01	DMDFON	LOK	segment duration cylinder 1
TS02	DMDFON	LOK	segment duration cylinder 2
TS03	DMDFON	LOK	segment duration cylinder 3
TS04	DMDFON	LOK	segment duration cylinder 4
TS05	DMDFON	LOK	segment duration cylinder 5
TS06	DMDFON	LOK	segment duration cylinder 6
TS07	DMDFON	LOK	segment duration cylinder 7
TS08	DMDFON	LOK	segment duration cylinder 8
TSK	DMDFON	AUS	corrected segment duration
TSK01	DMDFON	LOK	corrected segment duration cylinder 1
TSK02	DMDFON	LOK	corrected segment duration cylinder 2
TSK03	DMDFON	LOK	corrected segment duration cylinder 3
TSK04	DMDFON	LOK	corrected segment duration cylinder 4
TSK05	DMDFON	LOK	corrected segment duration cylinder 5
TSK06	DMDFON	LOK	corrected segment duration cylinder 6
TSK07	DMDFON	LOK	corrected segment duration cylinder 7
TSK08	DMDFON	LOK	corrected segment duration cylinder 8
TSK_M	DMDFON	LOK	monitor corrected segment duration
TSROH_W	DMDTSB	EIN	segment duration uncorrected
TS_M	DMDFON	LOK	monitor segment duration
XS02	DMDFON	LOK	segment deviation, standardized
XS03	DMDFON	LOK	segment deviation, standardized

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Variable	Source	Type	Description
XS04	DMDFON	LOK	segment deviation, standardized
XS05	DMDFON	LOK	segment deviation, standardized
XS06	DMDFON	LOK	segment deviation, standardized
XS07	DMDFON	LOK	segment deviation, standardized
XS08	DMDFON	LOK	segment deviation, standardized
ZZYL		EIN	SW-cylinder counter

FB DMDFON 6.20 Detailed description of function

1.1. Introduction:

The adaptation learns systematic camshaft-synchronous and therewith cylinder-individual disturbances of the segment time tsroh_w. These disturbances include disturbances caused by mechanical inaccuracies of the sensor wheel (crankshaft-synchronous) as well as distrubances caused by torsional vibrations (camshaft-synchronous).

The adaptation can be performed during load operation (fuel-on adaptation -> "fon") and during fuel cut-off operation (fuel-off adaptation -> "fof").

The adaptation is stopped if misfire operation is detected and during non-steady-state operating conditions.

1.2. Data acquisition:

The duration of crankshaft segments is measured continuously and stored in a drum memory. The data are then processed asynchronously. (The values no longer needed are deleted so that updated measuring values may always be entered into the memory.) More details of the drum memory are described in %DMDUE. Measured values that come from the drum memory are marked by the extension _m.

The data stored in the memory comply with the segment duration of consecutive segments.

More details of data acquisition and application of the measurement window are shown in %DMDTSB.

1.3. Overview of operating ranges (load and engine speed ranges):

24 operating ranges are defined. Eight speed base points (x) and three load base points (y) are used to share out these ranges. The currently active range is identified by the index idxfob. If the current map range is out of a range that is used for adaptation then idxfob is set to 0.

The operating ranges are set by the nmot/rl base points of the characteristic map KFCFO:

rl									
y4 rl3	13	23	33	43	53	63	73	83*	
y3 rl2	12	22	32	42	52	62	72	83	
y2 rl1	11	21	31	41	51	61	71	81	
y1									
	x1	x2	x3	x4	x5	x6	x7	x8	x9
	n1	n2	n3	n4	n5	n6	n7	n8	

-------> nmot

n1, ...: engine speed base points of KFCFO for the interpolation of fse.. (shown by index: idxfon)
rl1,...: load base points of KFCFO for the interpolation of fse.. (shown by index: idxforl)
x1,....: engine speed range limits, are calculated from n*:
x1 = n1 - (n2-n1)/2, x2 = n2 - (n2-n1)/2, x3 = n3 - (n3-n2)/2 ..... x9 = n8 + (n8-n7)/2

y1,....: load range limits, are calculated from rl*:
y1 = rl1 - (rl2-rl1)/2, y2 = rl2 - (rl2-rl1)/2, y3 = rl3 - (rl3-rl2)/2 ..... y4 = rl3 + (rl3-rl2)/2

*: Index: idxfob (current characteristic map range)

1.4. Overview of RAM areas resp. of the adaptation values stored in the RAM:

In each of the 3x8 nmot/rl-ranges (zylza - 1) filter values fsxx_02, fsxx_03, ... , fsxx_(zylza) are formed.
The values are each time stored non-volatily in the cache of the RAM. The values indicate the current status of the adaptation in the individual operating ranges.

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There also exists a RAM characteristic map reflecting current filter values fsexx_(Zdg) (i) which are used for the calculation of the segment time correction.

Segment time correction:
By interpolation over load and engine speed the correcting value is formed from the range-specific filter values fsexx_(Zdg)(i). The raw segment time ts(n) is corrected synchronous to ignition by the interpolation result fse(n). The product is the corrected segment duration tsk(n) (e.g. tsk(n) = (1 + fse(n)) * ts(n)).

(Attention: ECU-internal calculation; in the VS100-system fse is given in degrees crankshaft).
The inclusion in the calculation depends on the progress of the adaptation.

In each of the 3x8 nmot/rl-ranges 2 * (zylza - 1) learning filter values are formed. The values are also stored non-volatily in the cache of the RAM.

Furthermore the adaptation status B_forxx is also stored range-specifically in the RAM:
B_forxx = 1: Adaptation stabilized resp. completed;
B_forxx = 0: Adaptation not yet stabilized

2. Calculation procedure:

The adaptation comprises the following points:
Calculation of cylinder assignment, segment deviation, dynamic correction, normalization and filtering.

2.1. Overview:

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ds02,...ds(zylza): segment deviation (see 2.4)
xs02,...xs(zylza): segment deviation standardized (see 2.4)

Values that are stored im the drum memory (see %DMDUE) cannot be measured directly. They can only be measured with a time delay. Corresponding values are marked with the extension _m.

2.2. Conditions for adaptation:

2.2.1. Conditions for fuel-on adaptation resp. setting of B_fon:

Overview:

Fuel-on adaptation is carried out (B_fon = 1) if
1. no strong segment time changes occur (lunw(n) <= LURFOST); B_folunw = 0.
   These segment time changes may be caused by misfire or by engine speed dynamics.

$$lunw(n) = \frac{abs\ [\ tsk(n) - tsk(n\text{-}zylza)\ ]}{tsk(n)\ \hat{}\ 3}$$

(The conversion is done in (U/s)^2 -> dimension engine roughness -> conversion by fluq -> see %DMDLU)

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2. no misfires are detected (in this case all detection methods are taken into consideration) and the learning filter flmx does not drift away (flmx <= SLFOON, B_fohold = 0). See chapter "healing"

3. no deactivation of misfire detection or fuel-on adaptation occurs (B_mdstop=0, B_fonstp=0).

4. no further conditions to deactivate fuel-on adaptation occur (see %DMDSTP).

5. The adaptation can be switched off by the code word CDFO. CDFO > 0: function active. By means of the code word CDFO the adaptation can also be reset (like after powerfail): CDFO -> 0, thereafter again CDFO > 0 to reactivate the adaptation.

6. the engine speed and the load lie within one of the operating ranges.

Since calculation is carried out asynchronously (virtually off-line) a retroactive masking is performed on the already stored values (for this look at "Course of the calculation": Favourable: retroactive masking for e.g. 2 camshaft revolutions)

2.2.2. Conditions for fuel-off adaptation resp. setting of B_fof:

Overview:

A fuel-off adaptation is carried out if
1. no strong segment time changes occur (lunw(n) <= LURFOST); B_folunw = 0. (see fuel-on adaptation)

2. no deactivation of fuel-off-Adaptation occurs (B_fofstp=0).

3. see above, as with B_fon

4. there exists a corresponding engine speed range (set by KFCFO; value 4 in lowest operation range of the speed range => fuel cut-off range)

Since calculation is carried out asynchronously (virtually off-line) a retroactive masking is performed on the already stored values (for this look at "Course of the calculation": Favourable: retroactive masking for e.g. 2 camshaft revolutions)

2.2.3. Further conditions for the learning start (learning strategy):

Once the condtions for fuel-on (B_fon) or fuel-off adaptation (B-fof) have been fulfilled, ANWFOST camshaft revolutions are still waited for, until the learning starts (-> camshaft counter anwfos).

Due to the learning strategy, the learning may be blocked in a map range at a certain moment. An engine speed dominant range, for example, cannot learn until a dominant range has stabilized. A normal range cannot learn until the engine speed dominant range of the engine speed range has stabilized.
(Description of the range characteristics see chapter 3.1)

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2.3. Cylinder assignment of individual segments:
During adaptation the segment of cylinder 1 (ts01, B_mdzyl1 = 1) is used as the reference (is not corrected).
The other segments (for 4 cyl.: ts02, ts03, ts04) are corrected during the segment time calculation by the learned filter value fsexx_(Zdg)(n).

The chronological sequence of crankshaft segments (period of individual ignition intervals) and their designations are illustrated in the following diagrams:

Example 4-cylinder engine:
The cylinders are listed in their firing order.

Example 6-cylinder engine:

2.4. Calculation of segment deviation and dynamic correction: The calculation described below occurs at every camshaft revolution.
The deviation between a computed value and a measured value (for 2 camshaft revolutions) is evaluated.
The computed value is composed of the reference segment and a dynamic correction.
(The dynamic correction is determined by linear interpolation and serves to compensate for an increase or reduction in engine speed.)

Segment deviation = Reference segment - Measured value + Dynamic correction

Example 4-cylinder engine:

$$ds02(i) = ts01(i) - ts02(i) + \frac{ts01(i+1) - ts01(i)}{zylza}$$

$$ds03(i) = ts01(i) - ts03(i) + \frac{2 * [\ ts01(i+1) - ts01(i)\ ]}{zylza}$$

$$ds04(i) = ts01(i) - ts04(i) + \frac{3 * [\ ts01(i+1) - ts01(i)\ ]}{zylza}$$

2.5. Normalization of segment deviations:
Subsequent division by the corresponding segment e.g. ts02(i) converts the deviation into an angle-proportional variable (independent of engine speed), which corresponds to the deviation of the segments.

$$xs02'(i) = \frac{ts02(i) + ds02(i)}{ts02(i)}$$

$$xs03'(i) = \frac{ts03(i) + ds03(i)}{ts03(i)}$$

$$xs04'(i) = \frac{ts04(i) + ds04(i)}{ts04(i)}$$

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The values xs02‘, xs03‘... are displayed in deg. crankshaft.

$$xs02(i) = \frac{ds02(i)}{ts02(i)}$$

xs02‘(i) = 1 + xs02(i)

2.6. Filtering of segment deviation resp. calculation of filter values fsxx_(Zdg)(i):
The normalized differential segment times xs*(i) are smoothed by a low-pass filter (filter factor FS1FO or FS2FO).
The result represents the range-specific filter value fsxx_(Zdg)(i):
[Zdg: from 2..zylza]

fsxx_(Zdg)(i) = (1 - FS1/2FO) * fsxx_(Zdg)(i-1) + (FS1/2FO) * xs(Zdg)(i)

fsxx_(Zdg)(i) is formed in each operating range from the current differential segment times.
The currently learning range is identified by the index idxfob.
The segment time filter values fsxx_(Zdg)(i) are stored non-volatily in the RAM for each operating range. (Output of the filter values fsxx_(Zdg)(i) in the unit deg. crankshaft.)

A restriction to plausible maximum values is performed:
- ALFO <= fsxx_(Zdg)(i) <= ALFO (Unit: in deg. crankshaft as deviation from reference segment)

ALFO corresponds to the greatest possible deviation (sensor wheel tolerances and torsional vibrations).

The filter factors FS1FO resp. FS2FO are dictated by adjustable fixed values, whereby FS1FO resp. FS2FO are selected dependent on the progress of the adaptation:
FS1FO, if B_forxx=0
FS2FO, if B_forxx=1

The correction of the segment times (with the filter values) takes into account the learning progress or adaptationstatus.
Dependent on the progress, either the current filter value fsxx_(Zdg)(i) or a filter value from the adjacent rangesis used.
(See "Learning strategy")
The filter value used for segment time correction is designated is formed by interplation between the individual operating range filter values fsexx_(Zdg)(i).

2.7.Calculation of learning progress resp. calculation of flpxx_(Zdg)(i)/flnxx_(Zdg)(i) and flmx(i):

Overview learning filter:

Calculation of flpxx_(Zdg)(i) and flnxx_(Zdg)(i):
To check whether adaptation is complete, 2 learning filter values exist for each filter value fsxx_(Zdgl)(i).
That means 2 filter values are formed for each operating range.
The measure used here is the difference between the normalized segment time deviations xs(Zdg)(i) (= the current measured value) and the filtered values fsxx_(Zdg)(i) (i.e. the values calculated so far).
The filter flpxx_(Zdg)(i) starts at the maximum possible deviation ALFO, flnxx_(Zdg)(i) starts at -ALFO.
The learning filters flpxx_(Zdg)(i), flnxx_(Zdg)(i) filter towards the diminishing deviation
xs(Zdg)(i) - fsxx_(Zdg)(i). [Zdg: from 2..zylza]

flpxx_(Zdg)(i) =
(1-FLFO) * flpxx_(Zdg)(i-1) + FLFO * [xs(Zdg)(i) - fsxx_(Zdg)(i)]

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flnxx_(Zdg)(i) =
(1-FLFO) * flnxx_(Zdg)(i-1) + FLFO * [xs(Zdg)(i) - fsxx_(Zdg)(i)]

start. value: flpxx_(Zdg)(i) = ALFO
flnxx_(Zdg)(i) = -ALFO

xs(Zdg)(i) - fsxx_(Zdg)(i) ——>

flpxx_(Zdg) and flnxx_(Zdg) tend towards 0 during the adaptation.

ALFO corresponds to the maximum possible deviation (sensor wheel tolerances and torsional vibrations).

Formation of flmx(i), Setting of B_forxx:
The absolute value is formed from the filter values flpxx_(Zdg)(i) and flnxx_(Zdg)(i) and then the greatest filter value flmx(i) (-> flmx = max (|flpxx_(Zdg)|, |flnxx_(Zdg)|; maximum across all cylinders) is compared to the threshold values SLFOU (FW) and SLFOON (KL). SLFOON uses the same speed base points as KFCFO.

If the value flmx(i) lies above the threshold SLFOON, then B_forxx = 0 (flmx > SLFOON).
(for: fuel-on/fuel-off adaptation ready; xx: operating range)

If the value lies below the threshold SLFOU, adaptation is regarded as stabilized (respectively ready; flmx < SLFOU -> B_forxx = 1). If flmx(i) then rises above the threshold SLFOON from below (flmx > SLFOON), the adaptation reacts as follows:
- if the actual range is a dominant range or a fuel cut-off range then the adaptation is restarted (reset), the reset counter flmxresz is incremented
- in other ranges B_forxx is set to zero (B_forxx = 0) and the adaptation is stopped (B_fohold -> 1)

In case of small changes in flmx(i) (< SLFOON) the adaptation is still regarded as stabilized (B_forxx = 1). There is thus a hysteresis range between SLFOU and SLFOON.

In addition to B_forxx, in which the adaptation status of the corresponding range xx is stored, the bit B_for is formed. B_for shows the adaptation status of the current operating range. (B_for is stored in the drum => measure B_for_m.)

The adaptation generates a status (fostat) by the status-bits (B_fordo, B_fornnn, B_forxx and B_ploknn). This status applies to the current operating range. The sensitivity of the misfire detection is adjusted dependent on the adaptation progress (fostat). Corresponding detection thresholds are assigned to each status (see %DMDLU).

If the conditions for the adaptation in the current operating range are fulfilled then B_fon=1 (fuel-on adaptation) resp. B_fof =1 (fuel-off adaptation) is set. Otherwise, if conditions are not fulfilled fuel-on/fuel-off adaptation: B_fon/B_fof=0 . The adaptation is active as soon as bit B_forun is set (B_fon resp. B_fof = 1 and ANWFOST completed and learning strategy allows learning / see 2.2.3). In addition the bit B_fodo is set, if the conditions for the adaptation in a dominant range (dominant fuel-on range or fuel cut-off range) are fulfilled. If a non-dominant range or no range is active B_fodo = 0 applies.

Overview of temporal course:

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```
                          idxfob not equal 0
                          ------------------->
                 ^
^        ALFO   - |******
|                |      *   flmx(i)
| ° KW           |     *
                 |      *                                                    ^
                 |       *                          **                       | B_forxx = 0
         SLFOON - |------------------*-------------------------***--********** Hysteresis-      -+-
         SLFOU  - |----------------------*-------------------**-------------- range             -+-
                 |                       *          *******                   | B_forxx = 1
             0 - |-------------------------***-------------------------------> t            v

                 ^
                 |                                  *       *  *
                 | e.g. fsxx_02           *                      * *
                 |                  *                                *****
                 |            *                                          ******
                 |          *
                 |        *
             0 - |******-------------------------------------------------------> t

              1
      B_forxx 0 ----------------------------------------------------------
              1
      B_fon   0 ----------------------------------------------------------
  resp. B_fof

              1
      B_fohold 0 ---------------------------------------------------------
```

Attention: In case the operating range is a dominant range or a fuel cut-off range, the entire adaptation is reset, if flmx > SLFOON (after stabilized adaptation), the reset counter flmxresz is incremented.

3. Learning resp. adaptation strategy:

3.1. Definition resp. setting of the operating range status:

A status can be assigned to each range. The setting of the status is performed via the characteristic map KFCFO.

Value bit

1 0 means normal operating range:
In this range adaptation is performed (B_fon = 1) and the learned value is used for segment time correction (dependent on the learning progress).

2 1 means dominant range:
Range which is frequently entered (B_fodo = 1) and in which misfire should also be detected without adaptation.
In the dominant range the first rough adaptation is performed which is spread to adjacent ranges (for B_fordo 0 ->1).

4 2 means fuel cut-off range (fuel-off-range): Each fuel-off-range is automatically dominant.
In a fuel cut-off range the load information is not relevant. Within the engine speed limits adjusted via KFCFO adaptation is only performed (B_fodo = 1)if the condition B_fof = 1 is set.
It is only possible to define the lowest line (low load) of KFCFO as fuel cut-off range.
The load base points of the lowest line are only of interest for the correction of the segment durations with the adaptation values. For the correction of segment durations the fuel cut-off ranges are treated like all other ranges.
That means that the values learned during fuel cut-off are used for the correction of segment durations.

8 3 means dominant range within an engine speed range ("dominant n-range"):
This range must be the first to be stabilized within an enginge speed range. The adaptation values are then spread to the entire engine speed range (if a rough adaptation has already taken place). This range should frequently be entered and misfires must here be detected as accurately as possible in comparison to the other ranges of the enginge speed range. (Favourable: high load. In each enginge speed range at least one range of the type *+2, *+4 or *+8 must be present. If the first learning phase has been terminated then the ranges of type *+2, *+4, *+8 within an engine speed range have equal rights.(*: can be 0 or 128)

16 4 means blocked range:
In this range an adaptation is performed (B_fon = 1), the filter values are calculated, however the bit B_for is not set in this range, that means the learned values are not used for the segment time correction.
The value of the 1. learned dominant range of which learning has been terminated (-> spreading of the dominant range, phase 1) or of the 1. learned engine speed range of which learning has been terminated (phase 2) is included in the calculation.

128 7 means healing range. If misfire has been detected at first a healing range must be entered (B_fohe = 1) before adaptation is continued. (Exception: in a fuel cut-off range it is also possible to learn if healing is active (B_fohold = 1). Within a healing range misfire should always definately be detected even without adaptation.
Only combinations 128+1, 128+2, 128+8 are possible or useful. That means a healing range can only be a normal range, a dominant range within an engine speed range or a dominant range (a fuel cut-off range can not be defined as a healing range).

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The label cfoxx indicates the characteristics of the range that is current for learning (e. g. cfoxx = 130, if the current range is a dominant healing range).

Example KFCFO

13 128+1	23 128+1	33 128+8	43 8	53 8	63 8	73 8	83* 8	rl
12 128+2	22 128+2	32 1	42 1	52 1	62 1	72 1	82 1	
11 4	21 1	31 1	41 1	51 1	61 1	71 1	81 16	
eng. speed range 1	eng. speed range 2	eng. speed range 3	eng. speed range 4	eng. speed range 5	eng. speed range 6	eng. speed range 7	eng. speed range 8	

B_fof

nmot

*: Index: idxfob

Status of operating range

3.2. Spreading of the first learned ranges to adjacent ranges (3-phase-adaptation):

The adaptation is subdivided into 3 phases:

Depending on the learning progress in these 3 phases the sensitivity of misfire detection is increased.

1. phase: adaptation in the dominant range resp. fuel cut-off: (-> B_fordo=1)

At first a rough adaptation is performed during which the rough mechanical inaccuracies of the sensor wheel are learned. This first rough adaptation is stabilized if >= 1 dominant fuel-on range or fuel cut-off range has finished learning.(B_fordo=1). (Remark: if a fuel cut-off range is set then it is automatically regarded as being dominant.)

Principal picture:

after powerfail:

rl

1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1

nmot

1: stands for factor = 1.0 in fs..fse.., i.e.. no ts-correction, state after powerfail

=====>

1 dominant range has finished learning:

D	D	D	D	D	D	D	D
D	D	D	D	D	D	D	D
D	D	D	D	D	D	D	D

D: complies to the filt. values of the 1. learned dominant range, which is used in the entire operating range for the segment time correction

Once the first dominant range has been learned (B_fordo=1) the values of this range are used for segment time correction in the entire operating range of the engine.These dominant values are spread to the entire engine operating range. This spreading resp. overwriting occurs only once as soon as flmx(i) is smaller than SLFOU (flmx(i) < SLFOU) in the dominant range. If the dominant range continues to adapt spreading to the adjacent ranges resp. overwriting of the adjacent ranges no longer occurs.

When other dominant ranges have finished learning, the adjacent ranges are no longer overwritten. In other words: Once the first dominant range has finished learning, the remaining ranges all adopt equal status regardless of whether they were previously dominant or non-dominant.

The dominant range of a speed range and a normal range con only learn if a dominant range is stabilized.

For the enginge speed range in which the dominant operating range lies the bit B_forn* = 1 is already set after the dominant range has stabilized. (see phase 2)(* e.g. 01...08)

2. phase: adaptation in an engine speed range: (-> B_forn01/02/03... = 1)

An engine speed range is considered to have stabilized if the dominant range of the engine speed range has stabilized.

The dominant range of a speed range can only learn if a dominant range is stabilized.

Example:
In the engine speed range 1 the range 12 is dominant.
Then the engine speed range has stabilized (B_forn1 = 1), if: B_for12 = 1 applies.

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Principal picture:

one dominant range has finished learning (phase 1 completed)

in each engine speed range at least 1 dominant range within the engine speed range has finished learning

N1: complies to the filter values which are used in engine speed range 1 for segment time correction.

As soon as a dominant range within the engine speed range has finished learning the learned filter values are used within this engine speed range for the segment time correction (spread to the various loads).
In other words: The values learned in the dominant range of the engine speed range are spread to the entire engine speed range.

This spreading resp. overwriting occurs only once as soon as flmx(i) < SLFOU is in the dominant range of the engine speed range. If the dominant range continues to adapt spreading to the adjacent ranges resp. overwriting of the adjacent ranges no longer occurs.

The termination of the learning of the other non-dominant ranges of the engine speed range does not lead to an overwritting of the adjacent ranges. With other words: After the dominant range of the engine speed range has finished learning all ranges of the engine speed range adopt an equal status.

3. phase: Fine adaptation resp. adaptation in the according load/engine speed range: (-> B_forxx = 1)

The fine adaptation has completely stabilized if in all load/engine speed ranges B_forxx is set.

A normal range con only learn if a dominant range and the dominant range of the speed range ist stabilized.

Principal picture:

one dominant range within each engine speed range has finished learning

all load/engine speed ranges have finished learning, fine adaptation is terminated

N1: complies to the filter values used in engine speed range 1- for segment time correction.

1..: complies to the filter values used in the according load/engine speed range for segment time correction.

As soon as an operating range has finished learning (flmx(i) < SLFOU, B_forxx = 1),the learned filter values are used within this operating range for the segment time correction.
If B_forxx = 1, the filter values fsexx are spread together with the filter values fsxx. That means both filter values are identical (except quantization).

3.3. Detailed example for the 3-phase-adaptation:

The following diagram illustrates the engine operating range with the filter values used, after only the dominant range 21 has stabilized (B_for21 = B_fodo = 1). [For the sake of simplicity the cyl. designations have been omitted and just 3x6 operation areas are shown.]

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rl						
	fse21 13 fs13; 0	fse21 23 fs23; 0	fse21 33 fs33; 0	fse21 43 fs43; 0	fse21 53 fs53; 0	fse21 63* fs63; 0
	fse21 12 fs12; 0	fse21 22 fs22; 0	fse21 32 fs32; 0	fse21 42 fs42; 0	fse21 52 fs52; 0	fse21 62 fs62; 0
	fse21 11 fs11; 0	fse21 21 =fs21; 1	fse21 31 fs31; 0	fse21 41 fs41; 0	fse21 51 fs51; 0	fse21 61 fs61; 0

B_forn01=0 B_forn02=1 B_forn03=0 B_forn04=0 B_forn05=0 B_forn06=0

> nmot

calculated filter value resp. filter value used for segment time correction
filter value learned in the range; adaptation status B_forxx

Now the dominant range 41 stabilizes within the engine speed range 4.
The value learned in range 41 is spread to the engine speed range 4 and is there used for the segment time correction.

rl						
	fse21 13 fs13; 0	fse21 23 fs23; 0	fse21 33 fs33; 0	fse41 43 fs43; 0	fse21 53 fs53; 0	fse21 63* fs63; 0
	fse21 12 fs12; 0	fse21 22 fs22; 0	fse21 32 fs32; 0	fse41 42 fs42; 0	fse21 52 fs52; 0	fse21 62 fs62; 0
	fse21 11 fs11; 0	fse21 21 =fs21; 1	fse21 31 fs31; 0	fse41 41 =fs41; 1	fse21 51 fs51; 0	fse21 61 fs61; 0

B_forn01=0 B_forn02=1 B_forn03=0 B_forn04=1 B_forn05=0 B_forn06=0

> nmot

calculated filter value resp. filter value used for segment time correction
filter value learned in the range; adaptation status B_forxx

When other ranges (including non-dominant ranges) have stabilized (B_forxx=1), the now-learned filter value fsxx_(Zdg)(i) is used for segment time correction in the stabilized range. _Hereafter: fsexx_(Zdg)(i) = fsxx_(Zdg)(i).

e.g.: ranges 11, 12, 21, 41 and 42 have stabilized (B_for11 = B_for12 = B_for21 = B_for41 = B_for42 = 1)
(Precondition: range 11 is the dominant range of engine speed range 1)

rl						
	fse11 13 fs13; 0	fse21 23 fs23; 0	fse21 33 fs33; 0	fse41 43 fs43; 0	fse21 53 fs53; 0	fse21 63* fs63; 0
	fse12 12 =fs12; 1	fse21 22 fs22; 0	fse21 32 fs32; 0	fse42 42 =fs42; 1	fse21 52 fs52; 0	fse21 62 fs62; 0
	fse11 11 =fs11; 1	fse21 21 =fs21; 1	fse21 31 fs31; 0	fse41 41 =fs41; 1	fse21 51 fs51; 0	fse21 61 fs61; 0

B_forn01=1 B_forn02=1 B_forn03=0 B_forn04=1 B_forn05=0 B_forn06=0

> nmot

calculated filter value resp. filter value used for segment time correction
filter value learned in the range; adaptation status B_forxx

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3.4. Consideration of the learning/adaptation progress for the sensitivity of misfire detection:

Corresponding to the adaptation progress in the 3 adaptation phases the sensitivity of the misfire detection is increased.
There are 4 sensitivity stages during misfire detection:

	status byte fostat:
- stage 3: after powerfail:	fostat = 3
- stage 2: after adaptation 1. phase:	fostat = 2
- stage 1: after adaptation 2. phase:	fostat = 1
- stage 0: after adaptation 3. phase and B_ploknn = 1: (see under plausiblity check)	fostat = 0

For the current operating range (+ subrange) the adaptation puts a status information (fostat) at the disposal of the misfire detection (%DMDLU). From the status information which indicates the learning progress the misfire detection fixes the according LURMIN* thresholds.

The bits B_fordo, B_fornnn, B_forxx and B_ploknn clearly indicate the adaptation status of the current operating range.

The table shows the definate assignment:

B_fordo	B_fornnn	B_forxx	B_ploknn	Status (fostat)
0	X	X	X	3
1	0	X	X	2
1	1	0	X	1
1	1	1	0	1
1	1	1	1	0

nn = current eng. speed range, xx = current operating range, X = not relevant

The assignment of the adaptation status (fostat) to the according LURMIN thresholds is described in %DMDLU.

fostat indicates the current adaptation status in the corresponding operating range.

Due to interpolation the adaptation state of the adjacent range has to be considered when fixing the status. (see example in app)
For this an operating range is again subdivided into 4 equal parts (subranges). The subranges numbered from 0 to 3. When driving in the corresponding subrange each time the adaptation state of the adjacent subranges which lie outside the main range is checked. The least advanced status is then used. That means status of the current range = worst status from: current range,3 adjoining ranges of the current range.

e.g.:
If driving in the main range 22, subrange 2, the main ranges 12, 11 and 21 are checked. If the learning progress of these adjacent main ranges 12, 11 and 21 is worse (no. of the status is larger) than in the main range 22 then the least advanced status is used.

*: position of the adaptation mean values, from here interpolation is performed.
'.....': range limit subrange
'———': " main range

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3.5. Healing:

The filtering of the adaptation filters fs* is stopped as soon as misfires are detected and the counter for misfires fzabgs (DMDMIL) is above the threshold MDERKFON or if the learning filter flmx drifts away (flmx > SLFOON). (If flmx rises above SLFOON (flmx > SLFOON) within a dominant range or a fuel cut-off range then the adaptation gets restarted (reset of all ready-bits).) MDERKFON indicates the number of misfires that can occure within a certain number of crankshaft rotations before the adaptation is stopped (see calculation of fzabgs in DMDMIL).
The learning filter recognizes the changes before the adaptation values drift away (-> important: FLFO = 4 * FS1FO).
The filtering is reactivated only if healing in a healing range is finished. The stop of the adaptation occurs in the entire operating range except in fuel cut-off range (-> B_fohold = 1).
Healing is performed if while driving in a coherent healing range (B_fohe = 1) no misfires were detected . For healing a coherent healing range must be entered constantly for ANWFOHE crankshaft revolutions (counter anwfoh).

After the engine was turned off the healing status must be stored until the next engine start procedure.

Just in exceptional cases the threshold MDERKFON should be unequal to zero (see applikation hints).
In case both inputs are "1" on the flip-flop then the reset has priority (e.g. flmx > SLFOON, B_forxx = 1, and ANWFOHE completed).

The evaluation of the expression [(flmx > SLFOON) & B_forxx] takes place befor B_forxx is reseted after having exceeded the threshold SLFOON.

The deactivation is carried out retroactive. That means that when misfire is detected the values dating back a few camshaft revolutions are not used for the adaptation.

3.6 Plausibility check of the adaptation values:

The plausibility check should prefent that the learned misfires are taken into account for the calculation. Furthermore it should be prevented that any RAM changes (for example due to EMI stabilization) lead to error detections.

Misfires lead to load-dependent adaptation values. That means if misfires are learned larger adaptation values are obtained with increasing load resp. the differences between the adaptation values of one engine speed range are larger than during normal operating. Torsional vibrations do not necessarily show this load dependance.

The typical deviations during normal operating between the adaptation values of one engine speed range are stored in the characteristic line DFSEFON in deg. crankshaft. The actual value of DFSEON that is used for the plausibility check is named dfsen.

The characteristic line has just as many n-base points as KFCFO.

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13 FSE13_(Zdg)	23 FSE23_(Zdg)	33 FSE33_(Zdg)	43 FSE43_(Zdg)	53 FSE53_(Zdg)	63 FSE63_(Zdg)	73 FSE73_(Zdg)	83 FSE83_(Zdg)	rl
12 FSE12_(Zdg)	22 FSE22_(Zdg)	32 FSE32_(Zdg)	42 FSE42_(Zdg)	52 FSE52_(Zdg)	62 FSE62_(Zdg)	72 FSE72_(Zdg)	82 FSE82_(Zdg)	
11 FSE11_(Zdg)	21 FSE21_(Zdg)	31 FSE31_(Zdg)	41 FSE41_(Zdg)	51 FSE51_(Zdg)	61 FSE61_(Zdg)	71 FSE71_(Zdg)	81 FSE81_(Zdg)	

-------> nmot

eng.speed range 1	eng.speed range 2	eng.speed range 3	eng.speed range 4	eng.speed range 5	eng.speed range 6	eng.speed range 7	eng.speed range 8

char. line DFSEFON:

V
dfsen

The check should if possible be performed at least once for each background program run and this should be done independent of the current adaptation status.

Each time the maximum deviation of the FSE values is calculated via load for each engine speed range.

```
engine speed range 8:
dfse08 = max[ max(fse81_02, fse82_02, fse83_02) - min(fse81_02, fse82_02, fse83_02),
              max(fse81_03, fse82_03, fse83_03) - min(fse81_03, fse82_03, fse83_03),
              max(fse81_04, fse82_04, fse83_04) - min(fse81_04, fse82_04, fse83_04),
                                .                               .
                                .                               .
              max(fse81_08, fse82_08, fse83_08) - min(fse81_08, fse82_08, fse83_08) ]

engine speed range 7:
dfse07 = max[ max(fse71_02, fse72_02, fse73_02) - min(fse71_02, fse72_02, fse73_02),
              max(fse71_03, fse72_03, fse73_03) - min(fse71_03, fse72_03, fse73_03),
              max(fse71_04, fse72_04, fse73_04) - min(fse71_04, fse72_04, fse73_04),
                                .                               .
                                .                               .
              max(fse71_08, fse72_08, fse73_08) - min(fse71_08, fse72_08, fse73_08) ]

correspondingly:
dfse06 = max[ ... ]
dfse05 = max[ ... ]
dfse04 = max[ ... ]
dfse03 = max[ ... ]
dfse02 = max[ ... ]
dfse01 = max[ ... ]
```

Checking of the plausibility:

```
                          B_plok08 = 1
        dfse08  < dfsen   ------------->
                          B_plok07 = 1
        dfse07  < dfsen   ------------->
                          B_plok06 = 1
        dfse06  < dfsen   -------------> & ------------------------> B_plok
                 .                 .
                 .                 .
                 .                 .
                          B_plok01 = 1
        dfse01  < dfsen   ------------->
```

If the plausibility condition in an engine speed range nn is not fulfilled (B_ploknn=0) then the adaptation status (fostat) is not switched to 0 resp. reswitched from 0 to 1 (see table in chapter 3.4). The detection threshold of the misfire detection is adjusted correspondingly by %DMDLU.

B_plokn shows if values in the actual speed range are plausible.

Should the deviations of the FSE values of an engine speed range differ largly, these may be caused by RAM overturns for example, then the adaptation is reseted (reset) and the reset counter dfseresz is incremented (complete reset of all values except reset counters, B_forset = 1, -> fostat = 3).

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```
dfse08 > DFSERES  ------------>
dfse07 > DFSERES  ------------>
dfse06 > DFSERES  ------------>
dfse05 > DFSERES  ------------>
                                 v ----------------------> B_forset (*)
dfse04 > DFSERES  ------------>
dfse03 > DFSERES  ------------>
dfse02 > DFSERES  ------------>
dfse01 > DFSERES  ------------>

                                   (*): it is not possible to messure B_forset because it is
                                        set and reset in-between two calculation cycles
```

4. Starting values and filter factors
After a "computer cold start", powerfail (B_pwf: 1 -> 0), CDFON -> 0 the following values are predefined:

ds(Zdg)(i) = 0 usec
xs(Zdg)(i) = 0 °deg. KW
fsxx_(Zdg)(i) = fsexx_(Zdg)(i) = 0 deg. KW (complies to factor = 1.0)

flpxx_(Zdg)(i) = flmx(i) = ALFO deg. KW
flnxx_(Zdg)(i) = - ALFO deg. KW

dfseresz = 0;
flmxresz = 0;

Attention: If the reset is triggered by the function itself then the reset counters dfseresz and flmxresz are not set to zero.

APP DMDFON 6.20 Application hint

App.-suggestion for a 4-cyl. engine:

```
FS1FO:          0.005...0.01
FS2FO:          0.002
FLFO:           0.02..0.04 = 4 * FS1FO ; the learning filter must always be faster than the adaptation filter so that changes are
                                         detected beforehand, before the adaptation values have drifted away.
                                         At flmx > SLFOON the filtering is then immediately stopped. (reset in dominant and
                                         fuel cut-off range)
                                         The sensitivity of the misfire detection is switched to stage 1 (-> LURMIN1)
                                         important: thus no more misfire detection is possible in this range,
                                                    result: misfires must always be detected before flmx > SLFOON

                 important: the filter factors of fluts should be faster (i.e. larger value) than FLFO so that the misfires are
                            detected via fluts and the adaptation is stopped in time.
                            lunw here serves as immediate stop trigger.


k = - (1/F) * ln (1-A);         A: 0..1, percentage of final value
                                k: number of filter steps
e.g.: F = 0.01, A = 0.99 (99 % of final value)

k = 460; (after 460 camshaft revolutions the adaptation has stabilized to 99 % of the final value, jump function presupposed as
         input)

ALFO:           1,2 deg. crankshaft
SLFOU:          0,03 deg. crankshaft
SLFOON:         0,09 deg. crankshaft  (at low speed higher, at high speed lower)
ANWFOST:        25
LURFOST:        15

DFSERES:        same as ALFO            (max. value, on which adaptation can be carried out)
MDERKFON:       0
```

Prior to the application of KFCFO the systematic engine speed fluctuations in the entire operating range of different vehicles of the according project should be looked at.
Here the engine speed dependance and load dependance of the adaptation values (fs* resp. fse) is important.
Depending on this KFCFO must be fixed with regard to the load and engine speed base points as well as the states of the individual ranges.

KFCFO:

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rl in%	2250	3150	4050	4750	5250	5600	5800	6000	6200	base points
80										
	13	23	33	43	53	63	73	83*		70 ->
60										
	12	22	32	42	52	62	72	82		50 ->
40										
	11	21	31	41	51	61	71	81		30 ->
20										
base points	2700	3600	4500	5000	5500	5700	5900	6100		

-> nmot

*: idxfob

The range limits always lie in the middle between the base points (not the other way round!).
On the edge of the characteristic map the range limits are spread outwards as described in 1.2.

App. of KFCFO:

Dominant ranges should be positioned such that a stabilization of the adaptation values in the FTP75 test is possible. However this is not layed down by the legislator (CARB). For the certification a vehicle on which adaptation has already been terminated may be provided.

Operation ranges in which the adaptation values are not savely stabilized should be inhibited. Attention, in blocked ranges and partially in their adjacent ranges fostat does not reach 0 (see 3.4)!

In each engine speed range there must be at least one range of the type (value) *+2, *+4 or *+8.
If the first learning phase is completed then the ranges of types *+2, *+4 or *+8 within a engine speed range adopt an equal status.
(*: can be 0 or 128)

Example-value characteristic line DFSEFON: (for vehicles with little torsional vibrations)

eng.speed range 1	eng.speed range 2	eng.speed range 3	eng.speed range 4	eng.speed range 5	eng.speed range 6	eng.speed range 7	eng.speed range 8
0,1	0,08	0,08	0,08	0,06	0,06	0,05	0,05

V
dfsen

During application of DFSEFON it must always be taken into account what happens when misfires are learned in the various different operating ranges. The interrelation between the currently active characteristic line LURMIN* is important.

If the plausibility condition in an engine speed range nn is not fulfilled (B_ploknn=0) the sensitivity of the misfire detection is worsened to stage 1 (LURMIN1).
The sensitivity is worsened no further since only misfires are not detected during small loads. Misfires during higher loads should be detected even though the sensitivity is poor.
Again during smaller load the deviation learned by a misfire is so small that by LURMIN1 no misdetection due to this error learning should be performed.

The sensitivity of the misfire detection is only set back to stage 1 if the plausibility check for all load ranges of an engine speed range has successfully been carried out (B_ploknn=1).

Usually higher load ranges at high engine speeds may be entered much more often than at lower load ranges.

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Example-Course of the adaptation values over the load during constant engine speed:

MDERKFON should be set to zero. If mis-detections occure at special conditions (engaging the clutch, changing gears) and if this mis-detections can not be prevented (conditions for adaptation) then MDERKFON is allowed to be > 0 (as small as possible). This method makes it possible not to stop the adaptation at this special conditions (engaging the clutch, changing gears).
(See calculation of fzabgs in DMDMIL.)

DMDSTP 4.60 Diagnostic of misfire detection : Stop conditions

DMDLAD 3.10 Logic and Delay; Logical operation,different blocks for misfire detection

FDEF DMDLAD 3.10 Function definition

Overview DMDLAD:

The entire functions for misfire detection can be locked with the Eurocodeword CDMD.
For B_cdmd=0 the function DMDLAD is locked and B_mderk and B_mderkf are set to 0.
For B_cdmd=1 the function DMDLAD is active.

ABK DMDLAD 3.10 Abbreviations

Subscripts and reference points used:
(n) = crankshaft segments

SY_ZYLZA = number of cylinders

Variable	Source	Type	Description
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_DLUERK	DMDDLU	EIN	condition for misfiring detected, from DMDDLU
B_LUAERK	DMDLUA	EIN	condition for misfiring detected, with engine roughness distance, from DMDLUA
B_LUERK	DMDLU	EIN	condition for misfiring detected, from DMDLU
B_MDERK	DMDLAD	AUS	misfiring detected from multpile functions

FB DMDLAD 3.10 Detailed description of function

1. Logical and temporal combination of the results different functions for misfire detection
   The detection results several functions for misfire detection are combined.
   It is the matter of the following functions and result signals:
   DMDLU -> B_luerk
   DMDDLU -> B_dluerk
   DMDLUA -> B_luaerk

   All signals are set at the time/ignition when misfire is detected. So a cylinder identification and temporal association is possible (see %DMDMIL).

   The result is a combined signal for detection and identification of misfire and for the stop of the adaptation (see %DMDFON).

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1.1 Temporal synchronisation
The problem of the temporal synchronization is solved in the different functions themselve.
e.g. at the calculation time n+(SY_ZYLZA/2) the result bit B_dluerk(n) is set retroactive.

1.2 Logical combination
All temporal synchronized result signals (B_luerk, B_dluerk, B_luaerk) are OR-combined. If at least one of these signals is set the output B_mderk is set to 1.

APP DMDLAD 3.10 Application hint

DMDMIL 3.30 Fault trestment of misfire detection, control on MIL and rectification

FDEF DMDMIL 3.30 Function definition

1. Fault counting algorithm

2.1. Fault detection

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During the after-run:

Ambient conditions: tfst (tank filling), rl (load), nmot (engine speed), tmot (engine temperature)

The function DMDMIL can be blocked via the code word CDMD.
If B_cdmd=0 the function is blocked, i.e. E_md=0, E_mdSY_ZYLZA=0, Z_md=1, Z_mdSY_ZYLZA=1.
If B_cdmd=1 the function is active.

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ABK DMDMIL 3.30 Abbreviations

zzyl	Cylinder number
SY_ZYLZA	No. of cylinders
BF	Operating window engine operation
AFT	Temporary operating window with misfires
AF	Final operating window with misfires
FSP	Fault memory
exh. fault	Exhaust gas relevant fault
cat. fault	catalyst damaging fault
Start fault	exhaust gas relevant fault during the first interval after start
MD	Misfire Detection (description for cross coupling matrix)
ID	Cylinder identification (description for cross coupling matrix)

Parameter	Source-X	Source-Y	Type	Description
AFNTOL			FW	tolerance for decreasing the misfire window in the speed range
AHEAGW			FW	misfire frequency at which emission limits occures
AHEAGWS			FW	misfire frequency at which emission limits occures
AHEARV			FW	misfire frequency at which other functions will be stopped
AHEKA			FW	misfire frequency at which fuel cutoff occures
AHEKS			FW	misfire frequency at which catalyst damage occures
AHEKS1			FW	misfire frequency at which catalyst damge occurs during first intervall
AINTKA			FW	number of interval misfire frequency at which ti- cutoff
AZYTIAB			FW	maximum number of cylinder with ti- cut off at which catalyst damage occures
CDCMD	BLOKNR		KL	Code word CARB: misfire, multiple
CDCMD01	BLOKNR		KL	Code word CARB: misfire cyl. 1
CDCMD02	BLOKNR		KL	Code word CARB: misfire cylinder 2
CDCMD03	BLOKNR		KL	Code word CARB: misfire cylinder 3
CDCMD04	BLOKNR		KL	Code word CARB: misfire cylinder 4
CDCMD05	BLOKNR		KL	Code word CARB: misfire cylinder 5
CDCMD06	BLOKNR		KL	Code word CARB: misfire cylinder 6
CDCMD07	BLOKNR		KL	Code word CARB: misfire cylinder 7
CDCMD08	BLOKNR		KL	Code word CARB: misfire cylinder 8
CDTMD			FW	Code word tester: misfire, multiple
CDTMD01			FW	Code word tester: misfire cyl. 1
CDTMD02			FW	Code word tester: misfire cylinder 2
CDTMD03			FW	Code word tester: misfire cylinder 3
CDTMD04			FW	Code word tester: misfire cylinder 4
CDTMD05			FW	Code word tester: misfire cylinder 5
CDTMD06			FW	Code word tester: misfire cylinder 6
CDTMD07			FW	Code word tester: misfire cylinder 7
CDTMD08			FW	Code word tester: misfire cylinder 8
FASKIV1			FW	factor for increasing the 1. cat-interval, misfire detection
KFKSWF	N	TL	KF	map for catalyst protection, weighting factors
MILANTI			FW	MIL is on during ti turn-off in 1. dcy
TMASKIV1			FW	temp. threshhold for increasing 1. cat-interval, misfire detection
TMWUC			FW	engine temperture threshold for fulfilment ”warm up cycle”

Variable	Source	Type	Description
AFNMN	DMDMIL	LOK	area of misfirings, minimum engine speed
AFNMX	DMDMIL	LOK	area of misfirings, maximum engine speed
AFRLMN	DMDMIL	LOK	area of misfirings, minimum load
AFRLMX	DMDMIL	LOK	area of misfirings, maximum load
AFTNMN	DMDMIL	LOK	area of misfirings, minimum engine speed, temporary
AFTNMX	DMDMIL	LOK	area of misfirings, maximum engine speed, temporary
AFTRLMN	DMDMIL	LOK	area of misfirings, minimum load, temporary
AFTRLMX	DMDMIL	LOK	area of misfirings, maximum load, temporary
AINT_0	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 1
AINT_1	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 2
AINT_2	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 3
AINT_3	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 4
AINT_4	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 5
AINT_5	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 6
AINT_6	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 7
AINT_7	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 8
AZYCNT	DMDMIL	LOK	amount of deactivateg cylinders because of cat. damaging misfire
BFNMN	DMDMIL	LOK	area of engine operation, minimum engine speed
BFNMX	DMDMIL	LOK	area of engine operation, maximum engine speed
BFRLMN	DMDMIL	LOK	area of engine operation, minimum load
BFRLMX	DMDMIL	LOK	area of engine operation, maximum load
B_AFKLT	DMDMIL	LOK	window for misfiring, condition cold, TMOT<TMWUC
B_AFTKLT	DMDMIL	LOK	window for misfiring, temporary, condition cold, TMOT<TMWUC
B_AFTWRM	DMDMIL	LOK	window for misfiring, temporary, condition warm, TMOT>TMWUC
B_AFWRM	DMDMIL	LOK	window for misfiring, condition warm, TMOT>TMWUC
B_BFKLT	DMDMIL	LOK	window engine operation, condition cold, TMOT<TMWUC
B_BFWRM	DMDMIL	LOK	window engine operation, condition warm, TMOT>TMWUC
B_BLKMD	DMDMIL	AUS	MIL-trigger blinking controlled by misfire detection
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_DCY	DDCY	EIN	condition for 'driving cycle' fulfilled
B_LUSTOP		EIN	misfire detection stop
B_MDARV	DMDMIL	AUS	critical misfire rate detected
B_MDKAT	DMDMIL	AUS	cat. damaging misfire rate exceeded (for deactivation of other functions)
B_MDSTOP		EIN	misfire detection stop

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Variable	Source	Type	Description
B_MILMD	DMDMIL	AUS	MIL-trigger on controlled by misfire detection, during ti turn-off
B_MNMD	DMDMIL	LOK	Fault type min.: misfire, multiple
B_MXMD	DMDMIL	LOK	Fault type max.: misfire, multiple
B_NPMD	DMDMIL	LOK	Fault type not plaus.: misfire, multiple
B_SP1	DMDMIL	AUS	FLC-trigger of misfire detection
B_SP2	DMDMIL	AUS	HLC-trigger of misfire detection
B_SYNPH		EIN	condition synchronization phase
B_TIAB1	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ignition 1
B_TIAB2	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 2
B_TIAB3	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 3
B_TIAB4	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 4
B_TIAB5	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 5
B_TIAB6	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 6
B_TIAB7	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 7
B_TIAB8	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 8
B_WUC	DWUC	EIN	condition for detected 'warm up cycle'
E_EV		EIN	error flag: general injector fault (power stage)
E_EV1	DEVE	EIN	error flag: injection valve of cyl. 1
E_EV2	DEVE	EIN	error flag: injection valve of cyl. 2
E_EV3	DEVE	EIN	error flag: injection valve of cyl. 3
E_EV4	DEVE	EIN	error flag: injection valve of cyl. 4
E_EV5	DEVE	EIN	error flag: injection valve of cyl. 5
E_EV6	DEVE	EIN	error flag: injection valve of cyl. 6
E_EV7	DEVE	EIN	error flag: injection valve of cyl. 7
E_EV8	DEVE	EIN	error flag: injection valve of cyl. 8
E_MD	DMDMIL	AUS	Error flag: misfire, multiple
E_MD01	DMDMIL	AUS	Error flag: misfire ignition 1
E_MD02	DMDMIL	AUS	Error flag: misfire ignition 2
E_MD03	DMDMIL	AUS	Error flag: misfire ignition 3
E_MD04	DMDMIL	AUS	Error flag: misfire ignition 4
E_MD05	DMDMIL	AUS	Error flag: misfire ignition 5
E_MD06	DMDMIL	AUS	Error flag: misfire ignition 6
E_MD07	DMDMIL	AUS	Error flag: misfire ignition 7
E_MD08	DMDMIL	AUS	Error flag: misfire ignition 8
FIVZABG	DMDMIL	LOK	intervall counter emission relevant misfiring
FLGKAT	DMDMIL	LOK	state flag cat. damaging misfire rates or ti turn-off
FLGTIAB	DMDMIL	AUS	state flag ti turn-of by catalyst damaging misfiring rates
FZABGS_W	DMDMIL	LOK	fault counter, summary, counts emission relevant misfirings of all cylinders
FZABG_W_0	DMDMIL	LOK	fault counter ign. 1, counts emission relevant misfirings of ignition 1
FZABG_W_1	DMDMIL	LOK	fault counter ign. 2, counts emission relevant misfirings of ignition 2
FZABG_W_2	DMDMIL	LOK	fault counter ign. 3, counts emission relevant misfirings of ignition 3
FZABG_W_3	DMDMIL	LOK	fault counter ign. 4, counts emission relevant misfirings of ignition 4
FZABG_W_4	DMDMIL	LOK	fault counter ign. 5, counts emission relevant misfirings of ignition 5
FZABG_W_5	DMDMIL	LOK	fault counter ign. 6, counts emission relevant misfirings of ignition 6
FZABG_W_6	DMDMIL	LOK	fault counter ign. 7, counts emission relevant misfirings of ignition 7
FZABG_W_7	DMDMIL	LOK	fault counter ign. 8, counts emission relevant misfirings of ignition 8
FZARV_W	DMDMIL	LOK	fault counter, counts misfirings of all cylinders
FZKATS1_W	DMDMIL	LOK	failure counter, summary, counts catalyst damaging misfiring of cylinder bank 1
FZKATS2_W	DMDMIL	LOK	failure counter, summary, counts catalyst damaging misfiring of cylinder bank 2
FZKATS_W	DMDMIL	LOK	fault counter, summary, counts catalyst damaging misfirings of all cylinders
FZKAT_W_0	DMDMIL	LOK	fault counter ign. 1, counts cat. damaging misfire of ignition 1
FZKAT_W_1	DMDMIL	LOK	fault counter ign. 2, counts cat. damaging misfire of ignition 2
FZKAT_W_2	DMDMIL	LOK	fault counter ign. 3, counts cat. damaging misfire of ignition 3
FZKAT_W_3	DMDMIL	LOK	fault counter ign. 4, counts cat. damaging misfire of ignition 4
FZKAT_W_4	DMDMIL	LOK	fault counter ign. 5, counts cat. damaging misfire of ignition 5
FZKAT_W_5	DMDMIL	LOK	fault counter ign. 6, counts cat. damaging misfire of ignition 6
FZKAT_W_6	DMDMIL	LOK	fault counter ign. 7, counts cat. damaging misfire of ignition 7
FZKAT_W_7	DMDMIL	LOK	fault counter ign. 8, counts cat. damaging misfire of ignition 8
IVZABG_W	DMDMIL	LOK	interval counter for emission relevant faults (0 - 1000 crankshaft revolutions)
IVZARV_W	DMDMIL	LOK	interval counter for misfires (0-60 crankshaft revolutions)
IVZKAT_W	DMDMIL	LOK	interval counter for catalyst damaging misfirings (0 - 200 crankshaft revs.)
KSWF	DMDMIL	LOK	catalyst protection weighting factors, from KFKSWF
NMOT	BGNMOT	EIN	engine speed
RL	EGFE	EIN	relative air charge
TFST	CANINS	EIN	Tank level
TMOT	GGTFM	EIN	Engine temperature
Z_MD	DMDMIL	AUS	Cycle flag: misfire, multiple
Z_MD01	DMDMIL	AUS	Cycle flag: misfire ignition 1
Z_MD02	DMDMIL	AUS	Cycle flag: misfire ignition 2
Z_MD03	DMDMIL	AUS	Cycle flag: misfire ignition 3
Z_MD04	DMDMIL	AUS	Cycle flag: misfire ignition 4
Z_MD05	DMDMIL	AUS	Cycle flag: misfire ignition 5
Z_MD06	DMDMIL	AUS	Cycle flag: misfire ignition 6
Z_MD07	DMDMIL	AUS	Cycle flag: misfire ignition 7
Z_MD08	DMDMIL	AUS	Cycle flag: misfire ignition 8

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FB DMDMIL 3.30 Detailed description of function

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by entering the entire status word of the fault path into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mxxyz etc. are contents of this status word. For error and cycle flags of external fault paths, which occur as inputs access methods, are available which read these informations directly from the fault path status managed in the DFPM.

For each fault path the following values are defined:

```
        Status fault path xyz:          sfpxyz
          Error flag xyz:               E_xyz (bit 0 in sfpxyz)
          Cycle flag xyz:               Z_xyz (bit 1 in sfpxyz)
          Fault type xyz:               TYP_xyz
                                          B_mxxyz
                                          B_mnxyz
                                          B_sixyz
                                          B_npxyz
          Clear fault path:             B_clxyz
          Default value active:         B_bkxyz
        Fault path code xyz:            CDTxyz
        Fault class xyz:                CLAxyz
        Fault intensity xyz:            TSFxyz
        CARB code xyz:                  CDCxyz
        Table of ambient cond. xyz:     FFTxyz
        Fault index xyz:                DFPxyz
```

The following fault paths are defined in this function definition:

```
        MD =   Misfires, total fault (multiple)
        MD01 = Misfires, ignition 1
        MD02 = Misfires, ignition 2
        MD03 = Misfires, ignition 3
        MD04 = Misfires, ignition 4
        MD05 = Misfires, ignition 5
        MD06 = Misfires, ignition 6
        MD07 = Misfires, ignition 7
        MD08 = Misfires, ignition 8
```

Fault memory relevant values of the function DMDMIL are assigned to the function-oriented selection of the function DFPM_DMDMIL.

Precondition for the understanding of the misfire fault treatment is the FDEF %DFPM for the general fault treatment.

1. Reaching of the misfire rate
Corresponding to the OBDII legislation of the CARB a distinction must be made between "exhaust gas relevant" misfires after start and while driving (misfires cause the exhaust emission standard to be exceeded by a factor of 1.5) and "cat. damaging" misfires (CAT is endangered).

1.1 Exhaust gas relevant misfires
For the detection of exhaust gas relevant misfires the number of misfires which have occurred within an interval of 1000 crankshaft revolutions (KWU) are relevant. If the number of occuring misfires during this interval is so high that the exhaust emission standard is exceeded by a factor of 1.5, then the exhaust gas relevant misfire rate has been reached resp. exceeded.

An interval counter ivzabg counts the combustions during which the misfire detection is active (so B_mdstop = B_lustop = 0). When reaching the maximum value of 1000 KWU (complies to 500 * SY_ZYLZA combustions) the interval counter ivzabg is reset.

If a misfire is detected during a combustion the total fault counter fzabgs and the fault counters of the misfiring cylinders fzabg_(zzyl-1) are increased by 1. The fault counters are reset at the end of the 1000 KWU interval.

Exhaust gas relevant misfires after start:
If the total fault counter fzabgs exceeds the threshold value AHEAGWS at the end of the first interval after start, then exhaust gas relevant misfires exist after start and a fault entry is performed.

Exhaust gas relevant misfires while driving:
If the threshold value AHEAGW is in total exceeded 4 times by the total fault counter fzabgs during the dcy (as from the 2. interval) then exhaust gas relevant misfires exist during the driving cycle and a fault entry is performed.

1.2 Catalyst damaging misfires
For the detection of catalyst damaging misfires the number of misfires which have occurred during an interval of 200 KWU are relevant. If the number of misfires occurring during this interval is so high that the catalyst is endangered, then the catalyst damaging misfire rate has been reached resp. exceeded.
The first interval after start can be increased up to 1000 KWU via the factor FASKIV1, if the engine temperature tmot after start does not lie above the threshold TMASKIV1 (tmot is measured at the first calcutaing step of DMD). Since the catalyst is not at operating temperature when the engine is cold, no catalyst damage due to misfires can occur during the first 1000 KWU after start.

An interval counter ivzkat counts the combustions during which the misfire detection is active (so B_mdstop = B_lustop = 0). When reaching the maximum value of 200 KWU (complies to 100 * SY_ZYLZA combustions) the interval counter ivzkat is reset.

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If a misfire is detected during a combustion the total fault counter fzkats, the total fault counters fzkats1 and fzkats2, which are each assigned to a bank on separate exhaust systems, and the fault counters of the misfiring cylinders fzkat_(zzyl-1) are increased by the value kswf. kswf is calculated from the map KFKSWF over load and engine speed and it contains values which are weighted according to catalyst damage (large value with high engine speed and high load).
The fault counters are reset at the end of the 200 KWU interval.
As soon as one of the total fault counters fzkats1 or fzkats2 exceeds the threshold value AHEKS (or AHEKS1 in the 1. prolonged interval), catalyst damaging misfires exist and a fault entry is made (not only at the end of the interval).
As long as catalyst damaging misfires exist, i.e. fzkats1 or fzkats2 > AHEKS, the bit B_blkmd is set and the MIL flashes.
Also the Bit B_mdkat is set. With this Bit other functions can be deactivated during cat. damaging misfiring.
If at the end of the interval fzkats1 and fzkats2 < AHEKS, the bit B_blkmd and B_mdkat is reset and the MIL no longer flashes.
In case of catalyst damage it is also indicated in the status byte flgkat as to which cylinder has catalyst damaging misfires.
flgkat resp. the respective bit is reset after an interval without threshold value exceeding, however, remains set in case of ti cut-off.

Ti cut-off:
After AINTKA intervals, during which fzkat_(zzyl-1) > AHEKA and fzkats1 or fzkats2 > AHEKS, the injection of the respective cylinder is switched off, if the max. no. of cutout cylinders is not already given and if there is no injector fault at open valve.
For this the cyl. fault counters fzkat_(zzyl-1) are compared with the threshold AHEKA in case of detected cat. misfires (fzkats1 or fzkats2 > AHEKS). If the threshold is exceeded the counter aint_(zzyl-1) is incremented, with fzkats1 < AHEKS and fzkats2 < AHEKS it is decremented.
If aint_(zzyl-1) is greater than AINTKA - as long as no AZYTIAB-cylinders have yet been switched off and also no injector fault with open valve yet exists at the misfiring cylinder (E_evxx, fault type B_mnevxx) - then the bit of the respective cylinder in flgtiab and the bit B_tiab_(zzyl) are set to 1, the injection is switched off and the counter of the cutout cylinder azycnt is increased by 1. For AZYTIAB = 0 no cut-off takes place. The cut-off remains active until a new engine start is performed.
During a deactivation the cylinder-individual fault counters of the cutout cylinders are no longer increased.
If all misfiring cylinders have been cutout, misfires are no longer counted, fzkats1 and fzkats2 < AHEKS, and dependent on the MILANTI the MIL will change from flashing to off (MILANTI=0) or from flashing to on (MILANTI=1) in the 1. dcy and in the 2. dcy it will change from flashing to on.
For the switch-off of the Lambda control see %LREB and for the switch-off of the full-load enrichment see %RLASE.

1.3 Occurence of misfire faults
If the misfire rate for a fault entry has been reached or exceeded, the bit E_md and the trigger B_sp1 are set.
If no misfire window yet exists, then the temporary misfire window is decreased by the permitted tolerance and stored as final misfire window (see 3.).
A cylinder identification is performed if B_synph=1. A cylinder is detected to be misfiring if the cylinder-individual fault counter fzabg_(zzyl-1) exceeds the mean value fzabgs/SY_ZYLZA or if the cylinder-individual fault counter fzkat_(zzyl-1) exceeds the mean value fzkats/SY_ZYLZA. The bit E_mdSY_ZYLZA is also set for the misfiring cylinders.
The bits E_md and E_mdzzyl remain set until the end of the first faultless dcy with window overlap.

Misfire faults are debounced via 2 driving cycles (dcy), that means if misfire faults occur for the first time a non-debounced fault entry is performed (pending fault memory entry).
- If misfire faults occur again during the next dcy, then the fault entry is debounced and the error lamp (MIL) comes on (resp. flashes in case of catalyst damaging misfires).
- If no misfire faults occur during a subsequent dcy and the dcy took place under similar conditions (regarding load, engine speed and engine temperature, window overlap s. 3.), then the pending fault memory entry is cleared (resp. remains visible to the customer service) and the misfire window is reset.
- If no window overlap is achieved during the subsequent dcy, then the pending fault memory entry is cleared after 80 dcy.

If a debounced fault entry exists and the MIL is on, then the MIL goes out after 3 faultless dcy with window overlap and the fault entry is cleared 40 warm-up cycles (wuc) later.

1.4 Misfire rate for the switch-off of other ECU functions (e. g. BBLDR)
With exh. misfires, e.g. at 1000 rpm, the bit E_md is only set after 4 min. (4 * 1000 KWU).
In order to enable a quicker reaction to misfires in other functions there is another counter, which counts the misfire rate in an interval of 60 KWU. If a certain misfire rate, e.g. 5% is exceeded within this interval, then the bit B_mdarv is set.

An interval counter ivzarv counts the combustions during which the misfire detection is active (i.e. B_mdstop = B_lustop = 0).
Once the maximum value of 60 KW revolutions has been reached (complies to 30 * SY_ZYLZA comubstions), the interval counter ivzarv is reset.

If misfiring is detected during a combustion, then the fault counter fzarv is increased by 1. At the end of the 60 KWU interval the fault counter is reset.

If the counter fzarv exceeds the threshold AHEARV at the end of the interval, then the bit B_mdarv is set. If the threshold is undershot at the end of the interval, then the bit B_mdarv is reset.

2. Setting and resetting of various state conditions

Faultless dcy:
B_dcy = 1 and
ivzabg at least once = 0 (>1000 KWU) and
B_sp1 = 0 (threshold value was not exceeded)

Fault trigger B_sp1:
If fzkats1 or fzkats2 > AHEKS or at the end of the 1000 KWU interval fzabgs > AHEAGW / AHEAGWS (during 1. interval), then the trigger B_sp1 is set. B_sp1 remains set until the after-run has ended.

Healing trigger B_sp2:
If the dcy was faultless and the window overlap was fulfilled, i.e. BF >= AF, the healing trigger B_sp2 is set in the after-run.
B_sp2 is set until the end of the after-run. Once B_sp2 was set 3 times the MIL will go out and the AF is reset.

Cycle bits Z_md, Z_mdSY_ZYLZA:
The cycle bits Z_md, Z_mdSY_ZYLZA are set after the first 1000 KWU interval has elapsed or in case a fault already occurs beforehand, that means fzkats1 or fzkats2 > AHEKS.
The cycle bits remain set until the after-run has ended.

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Error bits E_md, E_mdSY_ZYLZA:
The error bits E_md, E_mdSY_ZYLZA are set, if the no. of misfires for a fault entry has been reached (fzkats1 or fzkats2 > AHEKS; fzabgs > AHEAGW in the 1. interval; fzabgs > AHEAGW at least 4x during the dcy).
The error bits E_md, E_mdSY_ZYLZA are reset at the end of a faultless dcy with window overlap.

Clear bits B_clmd, B_clmdSY_ZYLZA:
By setting of the clear bits (call-up of the clearing process) all fault counters, interval counters, error and cycle bits, counters of the ti cut-off and the operating windows are reset.

Operating window BF:
The operating window BF is updated during the entire dcy if there is no cutout (s. %DMDSTP) and it begins with starting values.

Temporary misfire window AFT:
The temporary misfire window AFT is updated with each occurring misfire and it is reset at the end of the 1000 KWU intervals (reset to the starting values).

Misfire window AF:
After misfire faults have occurred for the first time the temporary misfire window is decreased by the permitted tolerance (20% load, 375 rpm) and stored in the final misfire window.
The misfire window is reset in the after-run after 3 faultless dcy with window overlap at debounced entry or after 1 faultless dcy with window overlap or after 80 dcy without window overlap at non-debounced fault entry.

Fault memory entry:
Non-debounced entry: when the first misfire faults occur
Debounced entry: when misfire faults occur during the 2. dcy or during a subsequent dcy, if a non-debounced misfire fault already exists.
Clearing of a non-debounced fault memory entry: after a faultless dcy with window overlap or after 80 dcy without window overlap (still remains visible to customer service)
Clearing of a debounced fault memory entry: 40 wuc after MIL turned off (still remains visible to customer service)
Fault type: with cat. faults: B_mxflr, with exh. faults while driving: B_mnflr, with exh. faults after start: B_npflr.
The fault type B_mxflr is not overwritten by any other fault type, the fault type B_mnflr is not overwritten by the fault type B_npflr.

Output scantool (s. %TCSORT):
- If only one cylinder is identified to be misfiring, then only the fault entry of the corresponding cylinder is output. The output of the total fault (E_md) is then suppressed.
- If several cylinders are identified to be misfiring, then in any case the total fault is output as ’multiple fault’. The additional output of the cylinder-individual faults can be suppressed dependent on the data entered in TCSORT.

B_blkmd:
The bit B_blkmd directly triggers the flashing of the MIL. It is set if fzkats1 > AHEKS or fzkats2 > AHEKS. If this condition is no longer given at the end of the interval, then the bit B_blkmd is reset.

B_mdkat:
The bit B_mdkat is set if fzkats1 > AHEKS or fzkats2 > AHEKS. If this condition is no longer given at the end of the interval then the Bit B_mdkat is reset. With the Bit B_mdkat other functions can be deactivated during cat. damaging misfiring.
B_milmd:
The bit B_milmd turns on the MIL directly, if ti cut-off exists and if MILANTI=1 (relevant only during 1.dcy, with pending fault memory entry)

MIL:
The MIL comes on during the 2. dcy with misfire faults and it goes out again after 3 faultless dcy with window overlap.
In addition the MIL flashes, if the threshold for cat. misfires AHEKS is exceeded by fzkats1 or fzkats2. During the first dcy with misfire faults the MIL flashes with cat. faults and it goes out again, if the cat. faults no longer exist.
In the 2. and in the subsequent dcy with misfire faults the MIL flashes if cat. faults exist and it stays on if cat. faults no longer exist.
With ti cut-off the MIL may also be on during the 1. dcy if MILANTI=1, although catalyst damage is no longer given.

DFPM:
DLC: is decremented if B_dcy=1
FLC: is decremented if B_sp1=1 & Z_md=1
HLC: is decremented if B_sp2=1 & Z_md=1

B_mdarv:
If a certain misfire rate is exceeded at the end of the 60 KWU interval, then B_mdarv is set. If the misfire rate is undershot again, then B_mdarv is reset again.

flgtiab, B_tiab01..08:
With ti cut-off the bit B_tiabzzyl and the corresponding bit in flgtiab is set.

flgkat:
With catalyst damage the corresponding bit of the misfiring cylinder in flgkat is set.

3. Definition of operating windows
In order to turn off the MIL it is necessary to store the operating ranges load, engine speed and engine temperature, in which faults have occurred resp. have been detected.

For this the following operating windows are needed:
BF - operating window, is updated constantly (every 200ms) during the entire driving cycle, if DMD is active
AFT - temporary misfire window, is updated with each misfire
AF - final misfire window, taken over during the fault memory entry from the AFT

A window is defined by 5 parameters:
nmn = lowest engine speed nmx = highest engine speed
rlmn = lowest load rlmx = highest load
and the warming up status (see B_wuc, tmot < or > TMWUC)

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3.1 Starting values for range windows BF, AFT and AF:

```
bfnmn  = FF (hex),      bfnmx  = 0
aftnmn = FF (hex),      aftnmx = 0
afnmn  = FF (hex),      afnmx  = 0

bfrlmn  = FF (hex),     bfrlmx  = 0
aftrlmn = FF (hex),     aftrlmx = 0
afrlmn  = FF (hex),     afrlmx  = 0

B_bfwrm  = 0,                   B_bfklt  = 0
B_aftwrm = 0,                   B_aftklt = 0
B_afwrm  = 0,                   B_afklt  = 0
```

3.2 Operating window BF

This window is set to starting values at engine start. The updating is performed at active misfire detection (B_mdstop = 0 and B_lustop = 0, see %DMDSTP) during the entire engine cycle (until ignition off), independent of whether faults are detected or not.

Correction of the operating window (in the 200ms grid):

```
If nmot  > bfnmx, then bfnmx  = nmot,
if nmot  < bfnmn, then bfnmn  = nmot,
if rl > bfrlmx, then bfrlmx = rl,
if rl < bfrlmn, then bfrlmn = rl,
if tmot > TMWUC, then B_bfwrm = 1,
if tmot < TMWUC, then B_bfklt = 1
```

3.3 Misfire windows AF and AFT

Generally speaking the misfire window shows that range, in which misfires have occurred. A distinction is made here between a temporary and a final misfire window.

Updating of the temporary misfire window AFT:

The temporary AFT is updated with each (individual) misfire that is detected:

```
If n  > aftnmx,  then aftnmx   = n,
if n  < aftnmn,  then aftnmn   = n,
if rl > aftrlmx, then aftrlmx  = rl,
if rl < aftrlmn, then aftrlmn  = rl,
if tmot > TMWUC, then B_aftwrm = 1,
if tmot < TMWUC, then B_aftklt = 1,
(with B_aftwrm = B_aftklt = 1, then misfires first with tmot < TMWUC and thereafter with tmot > TMWUC)
```

After every 1000 KWU the AFT is reset to the starting values.

Updating of the final misfire window AF:

The contents of the temporary misfire window is decreased by the legally permitted tolerance and stored in the final misfire window during the first fault memory entry (exhaust gas resp. catalyst damaging faults).

```
afnmx  = aftnmx  - 375/2 rpm (*)
afnmn  = aftnmn  + 375/2 rpm (*)
if afnmx < afnmn, then afnmx = afnmn = (afnmx+afnmn)/2
(*): by the quantization of nmot with 40 rpm here 320/2 = 160 rpm are realized
The speed tolerance is given in AFNTOL. In older VS100-Versions AFNTOL can be applicated.
CAUTION: AFNTOL must be 160 rpm !!!

afrlmx = 0.90 * aftrlmx
afrlmn = 1.10 * aftrlmn.
if afrlmx < afrlmn, then afrlmx = afrlmn = (afrlmx+afrlmn)/2

The temperature status is adopted without change
B_afklt = B_aftklt
B_afwrm = B_aftwrm
```

3.4 Checking of the window overlap

Similar operating conditions are given, if

```
        1. B_bfwrm = B_afwrm, if B_afwrm = 1
        2. B_bfklt = B_afklt, if B_afklt = 1
        3. bfrlmx >= afrlmx     and bfrlmn <= afrlmn
        4. bfnmx  >= afnmx      and bfnmn  <= afnmn
```

that means the window condition is fulfilled if the operating window overlaps the misfire window (AF is included in the BF).

Example for a fulfilled window condition resp. window overlap:

4. Flow charts

4.1 Misfire in only 1 dcy

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y: 1000 KWU interval
Nl.: after-run
ff mFa: faultless dcy with window overlap
ff oFa: faultless dcy without window overlap

4.2 Misfires in 2 dcy, exhaust gas relevant, during the dcy

y: 1000 KWU interval
Nl.: after-run
ff mFa: faultless dcy with window overlap
ff oFa: faultless dcy without window overlap
wuc: warm-up cycle

4.3 Misfires in 2 dcy, catalyst damaging

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x: 200 KWU interval
Nl.: after-run
ff mFa: faultless dcy with window overlap
ff oFa: faultless dcy without window overlap
wuc: warm-up-cycle

4.4 Misfires in 2 dcy, catalyst damaging, with ti cut-off

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```
x:      200 KWU interval
Nl.:    after-run
ff mFa: faultless dcy with window overlap
ff oFa: faultless dcy without window overlap
wuc:    warm-up cycle
```

APP DMDMIL 3.30 Application hint

```
1. Classes of the fault types:
   CLAMD = 2
   CLAMDSY_ZYLZA = 2
   ATTENTION: Since the flashing of the MIL is triggered directly, the class should not be changed.
              Otherwise the MIL will possibly flash without a fault entry having been made.

2. Quicktest of the function DMDMIL
   For a quick check of the function it is possible to measure the interval counters ivzabg and ivzkat as well as the fault
   counters fzkabgs and fzkats. The interval counters must count the combustions, during B_mdstop=0 and B_lustop=0. The fault
   counters must count each individual misfire that was detected (weighted in fzkats with kswf).

3. ATTENTION: In case of MILANTI=1 it is possible, that during a temp. error (during 1. dcy) the MIL is on but there is only
              in Mode 7 a fault code entry visible !!!
              To agree with the legislation MILANTI should be 0.
```

DMDTSB 1.20 Diagnosis misfire detection by segment time formation

FDEF DMDTSB 1.20 Function definition

The duration of crankshaft segments is continuously measured. The data stored in the memory correspond to the segment duration of consecutive segments: segment times. For each ignition a segment time (tsroh_w) is determined. Segment start resp. segment end lie between 2 consecutive DTCs.

ABK DMDTSB 1.20 Abbreviations

Conversion formula:

tsquant Quantization segment time

Parameter	Source-X	Source-Y	Type	Description
KAMFZ			FW	start of sampling segment time monitoring misfire detection

Variable	Source	Type	Description
B_TSROOV	DMDTSB	AUS	condition segment duration word overflow
R_SYN		EIN	Synchro schedule
SY_FREQCPU	PROKON	EIN	System constant CPU frequency
SY_GRDWRT	PROKON	EIN	System constant basic value, space between SW reference mark to OT in teeth
TSROH_W	DMDTSB	AUS	segment duration uncorrected

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FB DMDTSB 1.20 Detailed description of function

The beginning of the measuring window (= segment start) can be shifted via KAMFZ in 6 deg. crankshaft angle (CA) steps (corresponds to one tooth).
KAMFZ gives the beginning of the measuring window in deg. CA before DTC. KAMFZ is limited by the software to the following values:

KAMFZ,max = SY_GRDWRT + (segment length in no. of teeth - 1) * 6 deg. CA
KAMFZ,min = SY_GRDWRT - (segment length in no. of teeth - 1) * 6 deg. CA

(KAMFZ is a signed value!; SY_GRDWRT is the distance R_syn (tr-mark) to DTC)

The lenght of the measuring window in deg. CA is dependent on the amount of cylinders. It corresponds to the distance between two DTCs:
Length of measuring window = 360 /(SY_ZYLZA/2) deg. CA.

For the quantization of tsroh_w two system frequencies are distinguished (20 MHz, 24 MHz, see table).

Quantization for tsroh_w:

	system frequency	
cylinder number	20 MHz (SY_FREQCPU = 20 000) tsquant = 0,8 us	24 MHz (SY_FREQCPU = 24 000) tsquant = 0,666 us
3	3/2 * tsquant	3/2 * tsquant
4	3/2 * tsquant	4/3 * tsquant
5	1 * tsquant	4/3 * tsquant
6	1 * tsquant	1 * tsquant
8	1 * tsquant	1 * tsquant

In case of segment time overflow, i.e. tsroh_w can no longer be represented as 16 bit value, the condition B_tsroov (ts-overflow) is set and tsroh_w is limited to maximum value.

CA signal (ex. 6-cyl.):

```
              R_syn         DTC (cyl. 1)              R_syn         DTC (cyl. 2)            R_syn
                |               |                       |               |                     |
                v               v                       v               v                     v

 ...  | |     | | |
```

APP DMDTSB 1.20 Application hint

KAMFZ may not be adjusted such that a segment start or a segment end is in the gap (attention with 3- and 5-cylinder projects). If possible the segment borders should have a mimimum clearance of 3 teeth to the gap. Reason: The gap distorts the magnetic flow in front of and behind the gap, i.e. the measurements of the tooth edges taken in the area around the gap are applied to with a greater error.

By an optimization of the measuring window position the noise ratio of the misfire detection can be improved. The measuring window must be positioned such that an optimal detection of the segment time increase, occuring due to a misfire is ensured. During the ignition beforehand resp. afterwards no segment time increase may be detectable. As far as the engine roughness lut is concerned there should be a clear-cut lut value in case of a misfire. If the segment position is not optimal this one clear-cut lut value distributes itself to 2 lut increases.
Possibly the wrong cylinder is then identified.

Typical values for KAMFZ, which can vary vehicle-specifically:

Engine:	KAMFZ (deg. CA before DTC)
4-cyl.	108
6-cyl.	60
8-cyl.	42

The measuring window position should be determined on the roller dynamometer during steady-state at high engine speeds and low loads (e.g. 5000 rpm, zero load resp. low load). Generally it applies: optimize the measuring window position at an operating point at which an improvement of the noise ratio is especially necessary!

DMDFLU 2.10 Diagnostic misfire detection filtering irregular running

FDEF DMDFLU 2.10 Function definition

No text for FDEF available!

ABK DMDFLU 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ZLUTSFI			FW	

Variable	Source	Type	Description
B_LL	MSF	EIN	Condition idle
B_MDZYL1_M		EIN	monitor, cylinder 1 identification
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
LUTSFI1	DMDFLU	AUS	filtering engine roughness test value of cylinder 1
LUTSFI2	DMDFLU	AUS	filtering engine roughness test value of cylinder 2
LUTSFI3	DMDFLU	AUS	filtering engine roughness test value of cylinder 3
LUTSFI4	DMDFLU	AUS	filtering engine roughness test value of cylinder 4
LUTSFI5	DMDFLU	AUS	filtering engine roughness test value of cylinder 5
LUTSFI6	DMDFLU	AUS	filtering engine roughness test value of cylinder 6
LUTSFI7	DMDFLU	AUS	filtering engine roughness test value of cylinder 7
LUTSFI8	DMDFLU	AUS	filtering engine roughness test value of cylinder 8
LUTS_M		EIN	monitor engine roughness test value
MDZZYL	DMDFLU	LOK	cylinder counter filtering irregular running
R_SYN		EIN	Synchro schedule

FB DMDFLU 2.10 Detailed description of function

APP DMDFLU 2.10 Application hint

DEKON 3.40 Configuration of power stage diagnosis

FDEF DEKON 3.40 Function definition

arrange of power stage - components

1. configuration power stage
   ==========

In dem Steuergerät ME7 werden folgende Endstufenbausteine eingesetzt:
  2 * CJ920 , beinhaltet 14 Low Side-Endstufen für Nennströme von 0.6A , 2.2A , 2.7A
  1 * CJ420 , beinhaltet 4 gleiche Low Side-Endstufen für Nennstrom von jeweils 2,2 A.

Die Beschreibung erfolgt hier mit 8-Bit langen Konfigurationsbytes einheitlich für alle IC-Typen.
Mit jedem dieser Bytes werden 4 ES erfaßt. Mit je 2 aufeinanderfolgenden Bits wird 1 ES konfiguriert;
das bedeutet für CJ920:
  Zur vollständigen Beschreibung gehören 4 Konfigurationsbytes je IC; das 4.Byte enthält demnach 2*2 Füll-Bits.
  Entspricht einer virtuellen Aufteilung in 4 Gruppen zu je 4 ES.

remark nc ——> power stage not exist or not connected

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Bitposition in ESKONF[i]	7 6	5 4	3 2	1 0	76 54 32 10
0 / ..920/1	TEV	EV6	EV3	EV1	ESKONF[0] ——> 00 00 00 00
1 / ..920/1	-/DMTLH(*)	KFK	EV8	?	ESKONF[1] ——> 11 00 00 11
2 / ..920/1	LUE(A)	EKP	NWSE1	KKU	ESKONF[2] ——> 00 10 00 11 (Sonderbehandlg.EKP-Rel)
3 / ..920/1	NC	NC	*** SLP ***	?	ESKONF[3] ——> 11 11 00 11
4 / ..920/2	EV7	DMTLH/MIL(*)	EV2	EV4	ESKONF[4] ——> 00 00 00 00
5 / ..920/2	LDP / TDMV	LDR	EV5	*** SLV ***	ESKONF[5] ——> 00 11 00 00
6 / ..920/2	KOS	START	NWSE2	?	ESKONF[6] ——> 00 00 00 11
7 / ..920/2	NC	NC	?	TDMP	ESKONF[7] ——> 11 11 11 11
8 / ..420	?	?	?	?	ESKONF[8] ——> 00 00 00 00

Die Eintragungen beginnen mit dem Index 0 bei dem CJxxx-Baustein, dessen DA-Ausgang mit der CPU verbunden ist.
(*)Only at vehicles with B_nocins = TRUE (-> Morgan)

enable power stage diagnostics

Über die Konfigurations-Bytes ESKONF müssen, abhängig vom Ausrüstungsgrad des Fahrzeuges, Funktionen und Endstufen aktiv/inaktiv gesetzt werden. Gleichzeitig kann in der Belegung von 2 Bits für jede Endstufe der Ablauf der Diagnose festgelegt werden. Zuordnung Bitmuster:

bit 1	bit 0	
0	0	Diagnose aktiv mit OBDII-Fehlerspeicherung mit Heilungsprüfung
0	1	Diagnose aktiv ohne OBDII-Fehlerspeicherung mit Heilungsprüfung
1	0	Diagnose aktiv ohne OBDII-Fehlerspeicherung ohne Heilungsprüfung
1	1	Diagnose inaktiv

Die ES-Diagnose wird auf "inaktiv" gesetzt,wenn das Aggregat nicht verbaut ist , oder wenn für das verbaute Aggregat keine ES-Diagnose realisiert ist.

Sonderbehandlung Endstufen-Diagnose: - Sekundärluftpumpe und Sekundärluftventil mit KAT-V Erkennung:
- externe Fehlerlampe mit B_nocins

wenn B_nokatfz = TRUE -> ist ES-Diagnose für SLP und SLV inaktiv.
wenn B_nocins = FALSE -> ist ES-Diagnose für MIL inaktiv

ABK DEKON 3.40 Abbreviations

list of abbreviations:

EV*	Einspritzventil
EKP	Kraftstoffpumpe
TEV	Tankentlüftungsventil
LUE	Elektrischer Motorlüfter
NWSE*	Endstufe Nockenwellensteuerung
KKU	Umschaltventil Kraftstoffkreislauf
MIL	externe Fehlerlampe
LDR	Umschaltventil Ladedruck
KOS	Endstufe Klimakompressor
KFK	Kennfeldkühlung/elektr. Thermostat
SLV	Sekundärluftventil
SLP	Sekundärluftpumpe
START	Endstufe Startrelais
LDP	Leckdiagnosepumpe
TDMV	DM-TL Modul Umschaltventil
TDMP	DM-TL Modul Pumpe

ABK DEKON 3.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ESKONF			FW	configuration of power stage (actuators)
Variable	**Source**		**Type**	**Description**
B_NOKATFZ	KATV		EIN	condition: no cat vehicle

FB DEKON 3.40 Detailed description of function

APP DEKON 3.40 Application hint

DECJ 16.11 Diagnosis; Power stage CJ9x

FDEF DECJ 16.11 Function definition

The following presentation of the output stage diagnostics applies in its entirety for the types CJ450 (with excess temperature shut-off): Restrictions for the other versions: effects (*) and "Special 450-supplement" block not applicable

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Bit1(j), bit2(j) in CJxxx fault shift register SR is set for an unplausible comparison of e(j) with a(j)
Assignment : i = variable for output stage IC ; j = varialble for output stage / IC (see %DEKON for ES assignment)

For the case of output stages of the type CJ405, CJ420, CJ920 (with display for excess temperature):
The same bit pattern is used to detect excess temperature as for detection of a line drop. Differentiation for diagnostics and verification by means of control : ES off --> line drop , ES on --> display of excess temperature (not implemented in ME7)

Scan CJxxx fault shift register SR with control SY and clock pulse
Initiate fault healing check according to THP - run through of 100 ms time base

For output stages of the type CJ450 (with shut-off for excess temperature):
Call the CJxxx fault healing check for B_mxxyz according to THP * THPL-run through of 100 ms time base.

The output stage faults stored in the CJxxx fault memory as verified fault types (i,j) are transferred into the OBDII fault memory, except for output stages of the types CJ405, CJ420, CJ920 (with display of excess temperature).
Organization of the fault memory in accordance with the functional description %DFPM.

ABK DECJ 16.11 Abbreviations

ES	Output stage	
SR	CJxxx fault shift register	
DE	Data input (serial) in CJxxx fault shift register	
DA	Data output (serial) from CJxxx fault shift register	
B_mnxyz	Fault type: less than minimum value fault path "xyz" (wildcard)	
B_mxxyz	Fault type: greater than maximum value fault path "xyz" (wildcard)	
B_sixyz	Fault type: signal inactive fault path "xyz" (wildcard)	
UBCJMN	Immediate constant	Minimum battery voltage for enabling CJxxx output stage diagnostics
UBCJMX	Immediate constant	Maximum battery voltage for enabling CJxxx output stage diagnostics
UBCJTJ	Immediate constant	Battery voltage threshold for CJ450 KS_UBat healing check
NDECJ	Immediate constant	Engine speed threshold for CJxxx output stage diagnostics
THP	Immediate constant	Number of time base run through for fault healing check
THPL	Immediate constant	CJ450 KS_UBat healing check after THP * THPL runs

For output stages of the type CJ450 (with shut-off for excess temperature):

CJ450_TJ_ZEIT	Immediate constant	Turn-on time of the CJ450 ES for KS_UBat healing check

Parameter	Source-X	Source-Y	Type	Description
NDECJ			FW	Engine speed threshold f. CJ400-power stage diagnosis
UBCJMN			FW	Min. Ubat-threshold f. release of the CJ400-power stage diagnosis
UBCJMX			FW	Max. Ubat-threshold f. release of the CJ400-power stage diagnosis

Variable	Source	Type	Description
B_DESEE	DECJ	AUS	Diagnosis power stage: entry conditions fulfilled
B_ESDIA	DECJ	AUS	Power stage diagnosis active

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Variable	Source	Type	Description
NMOT	BGNMOT	EIN	engine speed
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
UB	GGUB	EIN	battery voltage

FB DECJ 16.11 Detailed description of function

Output stage diagnostics in IC hardware:

The output stage component includes 4 output stages (ES) resp. 14 ES (on CJ920). The input level and the output level are checked in each ES for plausibility by monitoring the hardware. Any detected fault is stored in a shift register (SR) as 2-bit information for each ES (see Table FDEF for coding) and can be read out from here via a serial interface.

Short-circuit to ground and (KS_Masse) and line drop (Ltg.abfall) are detected when the ES are in the disabled state; whereas a short circuit to UBat (KS_Bat) is detected for a conducting ES. The defective ES is switched off to protect the ES IC in the case of KS_UBat. Reactivation is possible following a change in the flank from high --> low at the input or by reset.

Special feature of the CJ450:
The output stages have a limiting maximum current. KS_UBat can only be detected by a shut-off for excess temperature.

The serial transfer shift register -> CPU is controlled by 3 CPU ports (SY = low : changeover of fault set parallelly to shift serially, SY: low -> high : shift register deleted upon completion of the transfer; clock pulse: the information is shifted by a positive clock pulse flank, DA: serial data output shift register). The interface is extended without additional CPU ports by cascading the shift register (connection of DA to DE of the next IC). The level of the DA line is set to low for an entry of a fault in the shift register.

Realization of the software interface for ES diagnostics:

The assignment of the output stage IC’s is described in terms of configuration bytes in %DEKON. At the same time, the diagnostic routine can be determined by assigning 2 bits to each output stage.

bit 1	bit 0	
0	0	Diagnostics active with OBDII fault storage and with healing check
0	1	Diagnostics active without OBDII fault storage, with healing check
1	0	Diagnostics active without OBDII fault storage and without healing check
1	1	Diagnostics inactive

Read-out of the IC shift register is only permissible in a programmable UBat and speed range.
The UBat thresholds UBCJMN and UBCJMX are determined by the functional limit of the IC. The computation base must already be started in the system in which operation of the CJxxx diagnostics is performed. The diagnostics routine is disabled until the programmable speed threshold NDECJ is exceeded. It is possible to suppress the start range by means of the speed threshold NDECJ.
The index >i< is assigned to the power stage IC’s and the index >j< to the individual output stages.

The level of the DA line is sampled in each 100 ms time base run through for the condition B_desee = true. For a low level of the DA line, there is an ES fault present as detected by the hardware which must now be selected according to output stage and fault type by reading out the interface. The level of the line SY is pulled down to low in order to start the read-out process and one bit of information is subsequently shifted on the DA line out of the shift register and stored in a buffer memory in the CPU as a "fault to be verified" with each positive flank on the clock pulse line. Allocation of the fault type and the corresponding output stage is now possible from the position of the set bit information.

The diagnostics software takes over control of an output stage with a detected fault for verification of the fault (B_esdia = true). The output stage detected as being out of order is disabled. The shift register is deleted by setting and resetting the SY line in the ES IC. The output stage is controlled in the 10 ms time base such that the fault types KS_Masse, line drop and KS_UBat can be generated. The fault status in the shift register is "frozen" by setting the SY line to low. The ES control is returned to the pertinent ES driver software (B_esdia = false).
The CJxxx shift register cascade is read out during the subsequent run through the 100 ms time base. If fault type and output stage can now be verified, there then follows a transfer into a fault memory for verified output stage faults and the transfer into the OBDII fault memory. Following readout, the shift register in the CJxxx is enabled again by setting the SY level to high.

A time counter is started at the same time as fault verification. A check for healing of those output stages detected as being defective is performed after elapse of this counter. The time THP is set by a defined number of program runs.
The healing check of the output stages is carried out in the same manner as described for fault verification. During the healing check, those output stages are controlled which are stored with a verified fault type.

For output stages of the type CJ450 (with shut-off for excess temperature):
Fault verification and healing check for KS_UBat:
A short circuit to UBat cannot be detected with certainty by the standard control procedure for KS_UBat during the check for verification and healing because of the thermal time constant. The fault KS_UBat is therefore considered as being verified when it has occurred twice.

The fault healing check switches over to its own time control. The healing check is performed following a time period is formed as the product of the run times THP * THPL. Control of the defective ES is then for longer than 1 sec (specified in CJ450_TJ_ZEIT), if the UBat threshold (UBCJTJ) is exceeded. The possibility of transferring the fault from the ES IC is disabled throughout the control time CJ450_TJ_ZEIT.

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APP DECJ 16.11 Application hint

DKOSE 6.20 Diagnosis of power stage for AC compressor

FDEF DKOSE 6.20 Function definition

Diagnosis CJ400, resp. CJ 920 see %DECJ

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Substitution measures: non

Error memory management:

Status error path kose:	SFPKOS
Error flag :	E_kos
Cycle flag :	Z_kos
Error type :	B_mnkos B_mxkos B_sikos
Delete error path:	C_fcmclr & B_clkos
Error path :	CDTKOS
Error class :	CLAKOS
Error intensity :	TSFKOS
Carb code :	CDCKOS
Environmental conditions :	FFTKOS

ABK DKOSE 6.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCKOS	BLOKNR		KL	code word CARB: power stage for air condition compressor
CDTKOS			FW	code word tester: power stage for air condition compressor
CLAKOS			FW	fault class: air condition power stage
FFTKOS	BLOKNR		KL	freeze frame table: power stage of air condition
FLCKOS			FW	fault set debouncing: power stage for air condition compressor
HLCKOS			FW	fault reset debouncing: power stage for air condition compressor

Variable	Source	Type	Description
B_CLKOS		EIN	condition: clear fault path A/C power stage
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_KOE	KOS	EIN	Condition for AC-compressor ON

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Variable	Source	Type	Description
B_MNKOS	DKOSE	AUS	Error type: short circuit to ground air cond. power stage
B_MXKOS	DKOSE	AUS	error type: short circuit to Ubat A/C power stage
B_SIKOS	DKOSE	AUS	error type: cable disconnection of A/C power stage
C_FCMCLR		EIN	system state: reset fault memory
C_INI	DKOSE	LOK	ECU-condition for intialisation
E_KOS	DKOSE	AUS	error flag: AC-compressor control
Z_KOS	DKOSE	AUS	cycle flag: AC-compressor control

FB DKOSE 6.20 Detailed description of function

Together with the CJ400/CJ920 diagnosis %DECJ the air condition power stage diagnosis forms a function unit.
The diagnosis describes the forming of the error bit E_kos and of the cycle bit Z_kos.

The setting of the cycle flag is performed for one via an error entry and for the other via a definitely checked not to be due error. This definitate check is given if both switch states of the power stage, i.e. an on-state and an off-state were reached once. If an error is detected an error verification is activated in %DECJ which is performed independent of the external power stage request and which is definitely terminated after approx. 500 ms. Thereafter the the cycle flag is set in case no error occured.

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APP DKOSE 6.20 Application hint

DMLSE 7.20 Diagnosis; power stage check of electric cooling fan

FDEF DMLSE 7.20 Function definition

Diagnosis CJ400, resp. CJ 920 see %DECJ

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Substitution measures: non

Error memory management:

Status error path mle:	SFPMLE
Error flag :	E_mle
Cycle flag :	Z_mle
Error type :	B_mnmle B_mxmle B_simle
Delete error path:	C_fcmclr & B_clmle
Error path :	CDTMLE
Error class :	CLAMLE
Error intensity :	TSFMLE
Carb code :	CDCMLE
Environmental conditions :	FFTMLE

ABK DMLSE 7.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCMLE	BLOKNR		KL	code word CARB: Power stage engine fan
CDTMLE			FW	code word tester: Power stage engine fan
CLAMLE			FW	fault class: cooling fan power stage
FFTMLE	BLOKNR		KL	freeze frame table: power stage engine fan
FLCMLE			FW	fault set debouncing: power stage engine fan
HLCMLE			FW	fault reset debouncing: Power stage engine fan

Variable	Source	Type	Description
B_CLMLE		EIN	condition: clear fault path cooling fan power stage
B_DESEE	DMLSE	LOK	Diagnosis power stage: entry conditions fulfilled
B_KOE	KOS	EIN	Condition for AC-compressor ON

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Variable	Source	Type	Description
B_MNMLE	DMLSE	AUS	Error type: short circuit to ground cooling fan power stage
B_MXMLE	DMLSE	AUS	error type: short circuit to Ubat cooling fan power stage
B_SIMLE	DMLSE	AUS	error type: cable disconnection of cooling fan power stage
C_INI		EIN	ECU-condition for intialisation
E_MLE	DMLSE	AUS	error flag: engine fan power stage
Z_MLE	DMLSE	AUS	cycle flag: engine fan power stage

FB DMLSE 7.20 Detailed description of function

Together with the CJ400/CJ920 diagnosis %DECJ the secondary air valve power stage diagnosis forms a function unit.
The diagnosis describes the forming of the error bit E_mle and of the cycle bit Z_mle.

The setting of the cycle flag is performed for one via an error entry and for the other via a definitely checked not to be due error. This definitate check is given if both switch states of the power stage, i.e. an on-state and an off-state were reached once. If an error is detected an error verification is activated in %DECJ which is performed independent of the external power stage request and which is definitely terminated after approx. 500 ms. Thereafter the the cycle flag is set in case no error occured.

APP DMLSE 7.20 Application hint

DNWSE 6.20 Diagnosis; camshaft control power stage

FDEF DNWSE 6.20 Function definition

Diagnosis CJ 400, or. CJ 920 see %DECJ

(*) Contrary to the description, this path is served by the module %DFPM and the flags are handled in %DFPM;
(#) Contrary to the description, this path is served by the module %DECJ;

Fault memory management:

```
Status fault path NWSE: SFPNWSE
Error flag NWSE:        E_nwse
Cycle flag NWSE:        Z_nwse
Fault type NWSE:        B_mxnwse
                        B_mnnwse
                        B_sinwse


Reset fault path:      C_fcmclr & B_clnwse
Fault path NWSE  :                CDTNWSE
Fault class NWSE:                 CLANWSE
Fault rate NWSE:                  TSFNWSE
Carb Code NWSE:                   CDCNWSE
Freeze frame table NWSE:          FFTNWSE
```

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ABK DNWSE 6.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCNWSE	BLOKNR		KL	code word CARB: power stage of camshaft control valve
CDTNWSE			FW	code word tester: power stage of camshaft control valve
CLANWSE			FW	fault class: power stage of camshaft control valve
FFTNWSE	BLOKNR		KL	freeze frame table: power stage of camshaft control valve
TSFNWSE			FW	fault active time: power stage of camshaft control valve

Variable	Source	Type	Description
B_CLNWSE		EIN	condition clear fault path camshaft control power stage
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_MNNWSE		EIN	error type: short circuit ground of power stage of camshaft control valve
B_MXNWSE		EIN	error type: short circuit Ubat of power stage of camshaft control valve
B_NWS	MSF	EIN	Condition camshaft control
B_SINWSE		EIN	error type: cable disconnection of power stage of camshaft control valve
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_NWSE	DNWSE	AUS	error flag: power stage of camshaft control valve
SFPNWSE	DNWSE	AUS	status fault path: power stage of camshaft control
Z_NWSE	DNWSE	AUS	cycle flag: power stage of camshaft control valve

FB DNWSE 6.20 Detailed description of function

The requirement for diagnosis of the camshaft control (NWS) power stage is the use of a CJ400 or CJ920 type power stage. Recognition of an implausible state at the power stage and retrieval of the fault type from the IC is described in the section %DECJ.

The fault types from the CJ400 diagnosis are compiled for further processing in other ECU functions according to their effects on the camshaft control. Short circuit to UBat or cable failure result in the camshaft control moving to the retarded end position. In contrast, a short circuit to ground (B_mnnwse) results in the NWS being constantly at the advanced end position.

The cycle flag Z_nwse is set in the event of a power stage fault in the CJ400 diagnosis. The cycle flag is set by this function if the condition B_desee indicates that a CJ400 diagnosis can be performed and if the NWS power stage has been actuated to both states via the condition B_nws.

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APP DNWSE 6.20 Application hint

DSLVE 13.20 Diagnosis; plausibility check power stage of secondary air valve

FDEF DSLVE 13.20 Function definition

Diagnosis CJ400, resp. CJ 920 see %DECJ

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Substitution measures: non

Error memory management:

Status error path SLVE:	SFPSLVE
Error flag SLVE:	E_slve
Cycle flag SLVE:	Z_slve
Error type SLVE:	B_mnslve B_mxslve B_sislve
Delete error path:	C_fcmclr & B_clslve
Error path SLVE:	CDTSLVE
Error class SLVE:	CLASLVE
Error intensity SLVE:	TSFSLVE
Carb code SLVE:	CDCSLVE
Environmental conditions SLVE:	FFTSLVE

ABK DSLVE 13.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCSLVE	BLOKNR		KL	code word CARB: secondary air valve (power stage)
CDTSLVE			FW	code word tester: secondary air valve (power stage)
CLASLVE			FW	fault class: secondary air valve power stage
FFTSLVE	BLOKNR		KL	freeze frame table: secondary air valve power stage
TSFSLVE			FW	fault active time: secondary air valve driver stage

Variable	Source	Type	Description
B_CLSLVE		EIN	condition: clear fault path secondary air valve power stage
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_MNSLVE	DSLVE	AUS	error type: short circuit to ground secondary air valve power stage
B_MXSLVE	DSLVE	AUS	error type: short circuit to Ubat secondary air valve power stage

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Variable	Source	Type	Description
B_SISLVE	DSLVE	AUS	error type: cable disconnection of secondary air valve power stage
B_SLV	SLS	EIN	condition for secondary air valve
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_SLVE	DSLVE	AUS	error flag: secondary air valve (power stage)
Z_SLVE	DSLVE	AUS	cycle flag: secondary air valve (power stage)

FB DSLVE 13.20 Detailed description of function

Together with the CJ400/CJ920 diagnosis %DECJ the secondary air valve power stage diagnosis forms a function unit.
The diagnosis describes the forming of the error bit E_slve and of the cycle bit Z_slve.

The setting of the cycle flag is performed for one via an error entry and for the other via a definitely checked not to be due error. This definitate check is given if both switch states of the power stage, i.e. an on-state and an off-state were reached once. If an error is detected an error verification is activated in %DECJ which is performed independent of the external power stage request and which is definitely terminated after approx. 500 ms. Thereafter the the cycle flag is set in case no error occured.

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APP DSLVE 13.20 Application hint

DSLPE 9.20 Diagnosis; plausibility check power stage of secondary air pump

FDEF DSLPE 9.20 Function definition

Diagnosis CJ400, resp. CJ 920 see %DECJ

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Substitution measures: non

Error memory management:

Status error path:	sfpslpe
Error flag:	E_slpe
Cycle flag:	Z_slpe
Error type:	B_mnslpe B_mxslpe B_sislpe
Delete error path:	C_fcmclr & B_clslpe
Error path:	CDTSLPE
Error class:	CLASLPE
Error intensity:	TSFSLPE
Carb code:	CDCSLPE
Environmental conditions:	FFTSLPE

ABK DSLPE 9.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCSLPE	BLOKNR		KL	code word CARB: secondary air pump (power stage)
CDTSLPE			FW	code word tester: secondary air pump (power stage)
CLASLPE			FW	fault class: secondary air pump power stage
FFTSLPE	BLOKNR		KL	freeze frame table: secondary air pump power stage
TSFSLPE			FW	fault active time: secondary air pump driver stage

Variable	Source	Type	Description
B_CLSLPE		EIN	condition: clear fault path secondary air pump power stage
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_MNSLPE	DSLPE	AUS	error type: short circuit to ground secondary air pump power stage
B_MXSLPE	DSLPE	AUS	error type: short circuit to Ubat secondary air pump power stage
B_SISLPE	DSLPE	AUS	error type: cable disconnection of secondary air pump power stage
B_SLP	SLS	EIN	condition for secondary air pump

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Variable	Source	Type	Description
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_SLPE	DSLPE	AUS	error flag: secondary air pump (power stage)
Z_SLPE	DSLPE	AUS	cycle flag: secondary air pump (power stage)

FB DSLPE 9.20 Detailed description of function

Together with the CJ400/CJ920 diagnosis %DECJ the secondary air valve power stage diagnosis forms a function unit.
The diagnosis describes the forming of the error bit E_slpe and of the cycle bit Z_slpe.

The setting of the cycle flag is performed for one via an error entry and for the other via a definitely checked not to be due error. This definitate check is given if both switch states of the power stage, i.e. an on-state and an off-state were reached once. If an error is detected an error verification is activated in %DECJ which is performed independent of the external power stage request and which is definitely terminated after approx. 500 ms. Thereafter the the cycle flag is set in case no error occured.

No power stage diagnosis at ECU- afterrun.

APP DSLPE 9.20 Application hint

DEKPE 11.11 Diagnosis; power stage of fuel pump relay

FDEF DEKPE 11.11 Function definition

Diagnosis-CJ400 : see %DECJ

(*) deviant from the description this path is served in the module %DFPM, resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Error memory management:

Status error path KPE:		SFPKPE
Error flag KPE	:	E_KPE
Cycle flag KPE	:	Z_KPE
Error type KPE	:	Typ_kpe
Kind of error KPE	:	B_mxkpe
		B_mnkpe
		B_sikpe

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```
Clear error path:          C_fcmclr & B_clkpe
Error path KPE:            CDTKPE
Error class:               CLAKPE
Error intensity KPE:       TSFKPE
Carb code KPE:             CDCKPE
Ambient conditions KPE:    FFTKPE
```

ABK DEKPE 11.11 Abbreviations

```
CJ400                                       fourfold power stage of the type CJ400
ES                                          power stage
EKP                                         electric fuel pump
KPE                                         power stage fuel pump relay
EKPFZ                                       counter for error debouncing of the EKP relay power stage
EKPPZ                                       counter of the test pulse output

EKPFA  = 3              Immediate constant  counter starting value of the error debouncing EKP relay power stage
EKPPA  =10              Immediate constant  counter starting value of the test pulse output
```

Parameter	Source-X	Source-Y	Type	Description
CDCKPE	BLOKNR		KL	Code word CARB: fuel pump relay power stage
CDTKPE			FW	Code word tester: fuel pump relay power stage
CLAKPE			FW	Error class: fuel pump relay power stage
FFTKPE	BLOKNR		KL	Freeze frame table: fuel pump relay power stage
TSFKPE			FW	Fault active time: fuel pump relay power stage

Variable	Source	Type	Description
B_CLKPE		EIN	Condition clear fault path fuel pump relay power stage
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_MNKPE		EIN	Condition fault type short circuit to ground of fuel pump power stage detected
B_MXKPE		EIN	fault type short circuit to Ubat of fuel pump power stage detected
B_SIKPE		EIN	Condition for fault type open circuit of fuel pump power stage detected
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
EKPFZ	DEKPE	LOK	Power stage diagnostic EKP relais: counter for dejettering of error
EKPPZ	DEKPE	LOK	Power stage diagnostic EKP relais: counter test puls trigger
E_KPE	DEKPE	AUS	Error flag: fuel pump relay power stage
Z_KPE	DEKPE	AUS	Cycle flag: fuel pump relay power stage

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FB DEKPE 11.11 Detailed description of function

The EKP power stage is switched on as soon as the engine speed impulses are detected. When switching the ignition off via terminal 15 or in case of engine stop the relay power stage is switched off (see description operating modes EKP: AEKP). With this kind of triggering it is not possible to detect a short circuit to ground or a wire disconnection during normal operating, since the ES is not operated in a control state which allows this error detection.

So that the power stage diagnosis can be performed the power stage is switched off by means of a test pulse of max. 250 microsec. duration (this switching time does not yet lead to an opening of the relay contacts). It must be ensured that the 250 microsec. duration is not prolonged unpermissibly by interrupts thus leading to the EKP relay being switched off. The generation of test pulse and the triggering of the EKP-relay power stage is performed in the 100 ms grid; thereafter the EKP-relay triggering follows as is defined in the section %AEKP.

After an engine start (C_ini =1: engine speed pulses are detected, program changes to normal operting) the counter (EKPPZ) is preset with the starting value EKPPA. The counter is decremented in the 100 ms grid (R_100), if the condition B_desee indicates that an error detection is possible from the ES-IC.
Until the counter reaches the value 0 the EKP-relay power stage is triggered via a 250 microsec. pulse. The output of the impulse is always performed once the CJ400-diagnosis module is in the state OK so that a detected error can be read immediately in the ES-IC.

Setting of the cycle bit Z_kpe:

The cycle bit can be set as soon as test pulses were transmitted to the power stage and if it was indicated by the condition B_desee that an error diagnosis was possible on the power stage IC. After the output of the test pulse the switching possiblities of the power stage have been checked. Once the debouncing counter EKPPZ reaches the value 0 the cycle bit is set. With the setting of the error bit also the cycle bit is set, if a power stage error is detected with the output sequence of the test pulses.

Setting of the error bit E_kpe in case of wire disconnection or short circuit to ground:

If these errors are given at the power stage, it can be detected during the output sequence of the test pulses. For the error debouncing the error bit is not set until the counter EKPFZ was decremented to the value 0. The error type detected last is then entered into the error memory.

Setting of the error bit E_kpe in case of short circuit to UBat:

A short circuit to Ubat can be detected during normal operating. The special error treatment (verification, check of healing) of the EKP-relay power stage takes place in the CJ400-diagnosis module. For the protection of the power stage there is a switch-off of the switching transistor on the IC. This switch-off becomes active if the error type short circuit to Ubat is entered into the CJ400-shift register. The interlock is released by means of an edge change at the power stage input for a another triggering. For error verification and for check of healing this HW-interlock is removed with a pulse lasting for 10 microsec. The ECU software then immediately enables the power stage again.

Error verification, error healing check wire disconnection and short circuit to ground:

It must be ensured that the relay contacts do not open during an error verification or a healing check. For this reason it is not possible to use the standard CJ400-verification or -healing check.

For the error verification of the power stage error short circuit to ground the power stage is triggered by the test pulse. If following this an error can be read via the CJ400-diagnosis, this error detection is debounced by means of the counter EKPFZ. Once the counter reaches the count 0 the error bit is set and the detected error type is entered into the error memory.

A healing check can then no longer be performed during the following engine operation. If the power stage is triggered again by the output of the test pulse sequence after a new start and no power stage is detected, then this is considered as a criterion for an error healing. The error bit E_kpe is reset.

Setting of the error bit E_kpe in case of short circuit to UBat:

A short circuit to Ubat can be detected during normal operating. The special error treatment (verification, check of healing) of the EKP-relay power stage takes place in the CJ400-diagnosis module. For the protection of the power stage there is a switch-off of the switching transistor on the IC. This switch-off becomes active if the error type short circuit to Ubat is entered into the CJ400-shift register. The interlock is released by means of an edge change at the power stage input for a another triggering. For error verification and for check of healing this HW-interlock is removed with a pulse lasting for 10 microsec. The ECU software then immediately enables the power stage again.

APP DEKPE 11.11 Application hint

Filter time in the CJ400 for the setting of the flip-flop in the shift register: 60 to 200 µsec

Estimation of the max. capacitance at the power stage output: < 1nF --> then with LA the max. voltage threshold 12 V is reached in 120 usec.

DTEVE 9.30 Diagnosis; power stage of canister purge valve

FDEF DTEVE 9.30 Function definition

Diagnostic function for CJ 400 , CJ 920 see %DECJ

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(*) this path is calculated in %DFPM and the flags are flags of the status register
(#) this path is calculated in % DECJ

In case of fault:
- B_atev: B_gasp = TRUE (see %LRA)

Fault code management:

status fault-path TEVE: SFPTEVE
Errorflag TEVE: E_teve
Cycleflag TEVE: Z_teve
possible kinds of fault TEVE: B_mxteve
B_mnteve
B_siteve

Reset fault path C_fcmclr & B_clteve
Fault path TEVE : CDTTEVE
Fault class TEVE: CLATEVE
Fault rate TEVE: TSFTEVE
CARB Code TEVE: CDCTEVE
Freeze frame Table TEVE: FFTTEVE

ABK DTEVE 9.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCTEVE	BLOKNR		KL	code word CARB: canister purge valve power stage
CDTTEVE			FW	code word tester: canister purge valve (power stage)
CLATEVE			FW	fault class: canister purge valve power stage
FFTTEVE	BLOKNR		KL	freeze frame table: canister purge valve (power stage)
TSFTEVE			FW	fault active time: canister purge valve driver stage

Variable	Source	Type	Description
B_ATEV	DTEVE	AUS	condition power stage diagnostic TEV on
B_CLTEVE		EIN	condition clear fault path TEVE
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_MNTEVE	DTEVE	AUS	fault type: short circuit ground canister purge valve power stage
B_MXTEVE	DTEVE	AUS	fault type: short circuit Ubat canister purge valve power stage
B_SITEVE	DTEVE	AUS	fault type: cable disconnection of canister purge valve power stage
B_ZTEV	DTEVE	AUS	condition power stage diagnostic TEV closed
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_TEVE	DTEVE	AUS	error flag: canister purge valve power stage
TATEOUT	ATEV	EIN	output duty cycle for canister purge valve
Z_TEVE	DTEVE	AUS	cycle flag: canister purge valve power stage

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FB DTEVE 9.30 Detailed description of function

APP DTEVE 9.30 Application hint

See general application of diagnostic parameters of power stages

DDMPME 1.30 Diagnosis of Power Stage of DM-TL Pump Motor

FDEF DDMPME 1.30 Function definition

ddmpme-ddmpme

BBDMTLPM: Short Circuit to ub

ddmpme-bbdmtlpm

Fault memory management:

```
Status fault path PME: SFPDMPME
Error flag DMPME:      E_dmpme
Cycle flag DMPME:      Z_dmpme
Fault type DMPME:      B_mxdmpme
                       B_mndmpme
                       B_sidmpme

Reset fault path:      C_fcmclr & B_cldmpme
Fault path         DMPME:   CDTDMPME
Fault class        DMPME:   CLADMPME
Fault rate         DMPME:   TSFDMPME
Carb Code          DMPME:   CDCDMPME
Freeze frame table DMPME:   FFTDMPME
```

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ABK DDMPME 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TWUPKSO			FW	waiting time for short circuit detection
TWUPKSWE			FW	waiting time for power stage restart with short circuit
UBPMEO			FW	maximum battery voltage for DM-TL pump motor control
UPTESO			FW	upper threshold pump voltage for short circuit detection

Variable	Source	Type	Description
B_ADMTPM	DDMTL	EIN	condition DMTL-pump-motor turned on
B_CDDMTL	PROKON	EIN	function enabled per codeword
B_CLDMPME		EIN	condition clear fault path DMPME
B_CLDPMEE		EIN	condition clear fault path DPMEE
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_DMTLPM	DDMPME	AUS	condition DMTL-pump-motor turned on
B_KL15		EIN	condition ignition switch on
B_MNDMPME	DDMPME	LOK	error type: short circuit ground DM-TL pump motor (power stage)
B_MNDPMEE		EIN	error type: short circuit ground DM-TL pump motor (power stage)
B_MXDMPME	DDMPME	LOK	error type: short circuit Ubat DM-TL pump motor (power stage)
B_PMEKSO	DDMPME	LOK	short circuit Ubat DM-TL pump motor (power stage)
B_SIDMPME	DDMPME	LOK	error type: cable disconnection DM-TL pump motor (power stage)
B_SIDPMEE		EIN	error type: cable disconnection DM-TL pump motor (power stage)
B_ZDMPME	DDMPME	LOK	cycle flag: fault of power stage DM-TL pump motor
B_ZDPMEE	DDMPME	LOK	cycle flag: short circuit to ground DM-TL pump motor
B_ZMEKSO	DDMPME	LOK	cycle flag: short circuit to ub DM-TL pump motor
B_ZMEKSOZ	DDMPME	LOK	cycle flag: short circuit to ub DM-TL pump motor
B_ZXDMPME	DDMPME	LOK	cycle flag: short circuit to ub DM-TL pump motor
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_DMPME	DDMPME	AUS	error flag: DM-TL pump motor (power stage)
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
UBSQ	GGUB	EIN	battery voltage (on board), conversed to standard quantization
UPTES_W	GGDMTL	EIN	voltage of pump motor current of leakage detection
Z_DMPME	DDMPME	AUS	cycle flag: DM-TL pump motor valve (power stage)

FB DDMPME 1.30 Detailed description of function

Aufgabe:
Erkennung Endstufenfehler der DM-TL-Pumpenmotorendstufe und Schutz des Pumpenstrommesswiderstands im Kurzschlussfall.

Loesung:
Voraussetzung für die Diagnose der DM-TL Pumpenendstufe ist die Verwendung einer Endstufe vom Typ CJ400/CJ920. Die Erkennung von Lastabfall und Kurzschluss nach Masse geschieht in der CJxx-Diagnose ueber den Feherpfad E_dpmee und die Fehlerarten B_sidpmee und B_mndpmee.
Die Erkennung der Fehlerart Kurzschluss nach ub ist nicht direkt in der Endstufenhardware moeglich, da der Strommesswiderstand in der Kollektorleitung der Endstufe verhindert, dass das Kollektorpotential im Kurzschlussfall nach ub geht.

Deshalb wird der Spannungsabfall am Strommesswiderstand per A/D-Kanal eingelesen (Spannung ubtes_w) und ueberwacht, ob diese Spannung bei eingeschalteter Pumpe (B_admtpm) kleiner als die Schwelle UBTESO ist. Da der Anlaufstrom der Pumpe zusammnen mit der A/D-Eingangsfilterung fuer eine gewisse Zeit zu einem hohen Spannungsabfall am Strommesswiderstand fuehrt, muss bis zur Kurzzschlussentscheidung die Zeit TWUPKSO gewartet werden; allerdings darf diese Zeit nicht zu gross gewaehlt werden, da ansonsten der Strommesswiderstand im SG ueberlastet wird.
Ist ein Kurzschluss nach ub erkannt (B_pmekso = true) wird die Pumpenmotorendstufe abgeschaltet (B_dmtlpm = false) und nach einer Wartezeit von TWUPKSWE immer wieder ein Wiedereinschaltversuch durchgefuehrt, bis der Kurzschlussfehler geheilt ist.
TWUPKSO darf nicht zu klein gewaehlt werden, da ansonsten der Strommesswiderstand ueberlastet wird.

Dieser Kurzschluss nach ub wird als Fehler E_dmpme als Fehlerart B_mxdmpme angezeigt. Die Fehlerarten B_mndpmee bzw. B_npdpmee werden auf denselben Fehler E_dmpme als Fehlerart B_mndmpme bzw. B_npdmpme kopiert.

Das Zyklusflag Z_dmpme wird jedem erkannten Endstufenfehler gesetzt.
Bei ausgeschalteter Pumpe (B_admtpm = false) wird bis zum Setzen des Zyklusflags (Z_dmpme) 0.5 s gewartet, um trotz Entprellzeit in der CJ-Diagnose sicherzustellen, dass dort kein Fehler erkannt wurde. Zusaetzlich muss bei eingeschalteter Pumpe die Kurzschluss-erkennung nach ub abgeschlossen sein (B_zxdmpme = true).

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APP DDMPME 1.30 Application hint

```
Preconditions:
 - DMTL module connected to ACF, electrical connections checked
 - Setting of  B_cddmtl in %PROKON = true, to activate %DDMTL (normally bay means of code word CDDMTL)

Default selection of the parameters:
 - Pump voltage threshold short-circuit deactivation pump power stage UPTESO = 4 V (Attention: Do not change, danger of ECU damage!)
 - Waiting time pump power stage short-circuit deactivation TWUPKSO = 0.05 s       (Attention: Do not change, danger of ECU damage!)
 - Wartezeit Wiedereinschaltversuch Pumpenendstufe TWUPKSWE =  70 s                (Attention: Do not change, danger of ECU damage!)
 - obere Batteriespannungsschwelle UBPMEO = 15.5 V  ( > UBTEDO in %DDMTL)          (Attention: Do not change, danger of ECU damage!)
 - Setting of configuration of pump motor power stage with faul E_dpmee ESKONF (no MIL !)

Ausschalten der Funktion:
 - Bit B_cddmtl = false durch Setzen Codewort in Funktion %PROKON

Beeinflußte Funktionen:
 - Funktion %DDMTL, da DM-TL Pumpenmotor evtl nicht eingeschaltet wird.

Vorgehensweise:
 - Pruefung, ob Vorschlagswerte eingetragen wurden
```

DDMMVE 4.20 Diagnosis of Power Stage of DM-TL Solenoid

FDEF DDMMVE 4.20 Function definition

Diagnosis CJ 400, or. CJ 920 see %DECJ

(*) Contrary to the description, this path is served by the module %DFPM and the flags are handled in %DFPM;
(#) Contrary to the description, this path is served by the module %DECJ;

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ddmmve-ddmmve

Fault memory management:

```
Status fault path MVE: SFPMVE
Error flag MVE:        E_mve
Cycle flag MVE:        Z_mve
Fault type MVE:        B_mxmve
                        B_mnmve
                        B_simve


Reset fault path:      C_fcmclr & B_clmve
Fault path MVE  :                 CDTMVE
Fault class MVE:                  CLAMVE
Fault rate MVE:                   TSFMVE
Carb Code MVE:                    CDCMVE
Freeze frame table MVE:           FFTMVE
```

ABK DDMMVE 4.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TABTESMN			FW	minimum key off time for evap leakage diagnosis
TEFABE			FW	Duration diagnosis-systemtest at end of line
TNSTESMN			FW	minimum post cranking time for evap leakage diagnosis

Variable	Source	Type	Description
B_CLDMMVE		EIN	condition clear fault path DMMVE
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_DMKTKE		EIN	condition smallest leak detection enabled after refueling
B_DMMTEV	DDMMVE	AUS	close canister purge valve for power stage test DMTL-solenoid
B_DMMVTP	DDMMVE	AUS	condition power stage test DMTL-solenoid turned on
B_FCMCLR		EIN	condition fault memory clear
B_KL15		EIN	condition ignition switch on
B_STEND	BBSTT	EIN	condition end of start
R_T100		EIN	Time schedule 100 ms
TABST_W	BGTABST	EIN	soak time
TATEIST		EIN	actual duty-cycle of the PCV
TNSE_W	BBSTT	EIN	time counter at end of start (16 bit)
TOP_W	DTOP	EIN	operating time since powerfail
Z_DMMVE		EIN	cycle flag: DM-TL change-over valve (power stage)

FB DDMMVE 4.20 Detailed description of function

The requirement for diagnosis of the change-over valve power stage is the use of a CJ400 or CJ920 type power stage. Recognition of an implausible state at the power stage and retrieval of the fault type from the IC is described in the section %DECJ.

The fault types from the CJ400 diagnosis are compiled for further processing in other ECU functions according to their effects on the change-over valve position. A short circuit to ground (B_mnmve) results in the valve being constantly powered.

The cycle flag Z_mve is set in the event of a power stage fault in the CJ400 diagnosis. The cycle flag is set by this function if the condition B_desee indicates that a CJ400 diagnosis can be performed and if the change-over valve power stage has been actuated to both states via the condition B_dmtlmv.

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APP DDMMVE 4.20 Application hint

DSTAE 2.20 Diagnosis; powerstage automatic start control

FDEF DSTAE 2.20 Function definition

Diagnosis CJ400, resp. CJ 920 see %DECJ

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Substitution measures: non

Error memory management:

Status error path STAE:	SFPSTAE
Error flag STAE:	E_stae
Cycle flag STAE:	Z_stae
Error type STAE:	B_mnstae B_mxstae B_sistae
Delete error path:	C_fcmclr & B_clstae
Error path STAE:	CDTSTAE
Error class STAE:	CLASTAE
Error intensity STAE:	TSFSTAE
Carb code STAE:	CDCSTAE
Environmental conditions STAE:	FFTSTAE

ABK DSTAE 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCSTAE	BLOKNR		KL	code word CARB: automatic start power stage
CDTSTAE			FW	code word tester: automatic start power stage [233]
CLASTAE			FW	fault class: start relais power stage
FFTSTAE	BLOKNR		KL	freeze frame table: power stage of start relais
FLCSTAE			FW	fault set debouncing: automatic start power stage
HLCSTAE			FW	fault reset debouncing: automatic start power stage

Variable	Source	Type	Description
B_CLSTAE		EIN	condition: clear fault path start relais power stage
B_DESEE	DSTAE	LOK	Diagnosis power stage: entry conditions fulfilled
B_MNSTAE	DSTAE	AUS	Error type: short circuit to ground start realis power stage

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Variable	Source	Type	Description
B_MXSTAE	DSTAE	AUS	error type: short circuit to Ubat start relais power stage
B_SISTAE	DSTAE	AUS	error type: cable disconnection of start relais power stage
B_STA	STA	EIN	condition automatic start
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_STAE	DSTAE	AUS	error flag: automatic start
Z_STAE	DSTAE	AUS	cycle flag: automatic start

FB DSTAE 2.20 Detailed description of function

Together with the CJ400/CJ920 diagnosis %DECJ the secondary air valve power stage diagnosis forms a function unit.
The diagnosis describes the forming of the error bit E_stae and of the cycle bit Z_stae.

The setting of the cycle flag is performed for one via an error entry and for the other via a definitely checked not to be due error. This definitate check is given if both switch states of the power stage, i.e. an on-state and an off-state were reached once. If an error is detected an error verification is activated in %DECJ which is performed independent of the external power stage request and which is definitely terminated after approx. 500 ms. Thereafter the the cycle flag is set in case no error occured.

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APP DSTAE 2.20 Application hint

DETS 2.20 Power stage diagnosis; electric thermostat control (OL)

FDEF DETS 2.20 Function definition

Diagnosis CJ400, resp. CJ 920 see %DECJ

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Substitution measures: non

Error memory management:

Status error path :	SFPETS
Error flag :	E_ets
Cycle flag :	Z_ets
Error type :	B_mnets B_mxets B_siets
Delete error path:	C_fcmclr & B_clets
Error path :	CDTETS
Error class :	CLAETS
Error intensity :	TSFETS
Carb code :	CDCETS
Environmental conditions :	FFTETS

ABK DETS 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCETS	BLOKNR		KL	code word CARB: thermostat electric
CDTETS			FW	code word tester: thremostat electric [139]
CLAETS			FW	error class: ETS power stage
FFTETS	BLOKNR		KL	freeze frame table: ETS power-stage
FLCETS			FW	fault set debouncing: thermostat electric
HLCETS			FW	fault reset debouncing: powerstage fan control ecu box
LDETS			FW	error -> lamp: thermostat electric

Variable	Source	Type	Description
B_CLETS		EIN	condition clear fault path electrical thermostat
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled

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Variable	Source	Type	Description
B_ETR	DETS	LOK	condition electrical thermostat control
B_MNETS	DETS	AUS	fault type min: shortcut of electrical thermostat output stage to ground
B_MXETS	DETS	AUS	error type: short circuit to Ubat ETS power stage
B_SIETS	DETS	AUS	error type: cable disconnection of ETS power stage
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_ETS	DETS	AUS	error flag: electronic thermostat
Z_ETS	DETS	AUS	cycle flag: electronic thermostat

FB DETS 2.20 Detailed description of function

Together with the CJ400/CJ920 diagnosis %DECJ the electrical thermostat power stage diagnosis forms a function unit. The diagnosis describes the forming of the error bit E_ets and of the cycle bit Z_ets.

The setting of the cycle flag is performed for one via an error entry and for the other via a definitely checked not to be due error. This definitate check is given if both switch states of the power stage, i.e. an on-state and an off-state were reached once. If an error is detected an error verification is activated in %DECJ which is performed independent of the external power stage request and which is definitely terminated after approx. 500 ms. Thereafter the the cycle flag is set in case no error occured.

APP DETS 2.20 Application hint

DEVE 6.30 Diagnosis; power stage of injector valve

FDEF DEVE 6.30 Function definition

Diagnosis CJ 400, resp. CJ 920 refer to %DECJ

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Paths that do not exist due to a cylinder number less than 8 (E_evi and Z_evi), are set by definition as follows:

```
        E_evi (i>ZYLZA) = false
        Z_evi (i>ZYLZA) = true
```

Example: On a 6-cylinder engine E_ev7 = E_ev8 = false and Z_ev7 = Z_ev8 = true.

```
E_ev (i=n) ------>
   ...              +---+
E_ev (i=1) ------>  | V |----------> B_eev
                    +---+
```

(*) deviant to the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant to the description this path is served in the module %DECJ;

Fault Code Memory Management:

```
Status fault path EV:   sfpev
Error flag  EV:         E_ev
Cycle flag EV:          Z_ev
Fault type EV:          Typ_ev
Kind of fault EV:       B_mxev
                        B_mnev
                        B_siev


Clear fault path:       C_fcmclr & B_clev
Fault path EV:                     CDTEV
Fault class EV:                    CLAEV
Fault severity EV:                 TSFEV
CARB Code EV:                      CDCEV
Ambient conditions EV:             FFTEV
```

ABK DEVE 6.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCEV1	BLOKNR		KL	code word CARB: injector 1
CDCEV2	BLOKNR		KL	code word CARB: injector 2
CDCEV3	BLOKNR		KL	code word CARB: injector 3
CDCEV4	BLOKNR		KL	code word CARB: injector 4
CDCEV5	BLOKNR		KL	code word CARB: injector 5
CDCEV6	BLOKNR		KL	code word CARB: injector 6
CDCEV7	BLOKNR		KL	code word CARB: injector 7
CDCEV8	BLOKNR		KL	code word CARB: injector 8
CDTEV1			FW	code word tester: injection valve of cyl. 1
CDTEV2			FW	code word tester: injection valve of cyl. 2
CDTEV3			FW	code word tester: injection valve of cyl. 3
CDTEV4			FW	code word tester: injection valve of cyl. 4
CDTEV5			FW	code word tester: injection valve of cyl. 5
CDTEV6			FW	code word tester: injection valve of cyl. 6
CDTEV7			FW	code word tester: injection valve of cyl. 7
CDTEV8			FW	code word tester: injection valve of cyl. 8
CLAEV1			FW	error class: injector power stage 1
CLAEV2			FW	error class: injector power stage 2
CLAEV3			FW	error class: injector power stage 3
CLAEV4			FW	error class: injector power stage 4
CLAEV5			FW	error class: injector power stage 5
CLAEV6			FW	error class: injector power stage 6
CLAEV7			FW	error class: injector power stage 7
CLAEV8			FW	error class: injector power stage 8
FFTEV1	BLOKNR		KL	freeze frame table: injector power stage 1
FFTEV2	BLOKNR		KL	freeze frame table: injector power stage 2
FFTEV3	BLOKNR		KL	freeze frame table: injector power stage 3
FFTEV4	BLOKNR		KL	freeze frame table: injector power stage 4
FFTEV5	BLOKNR		KL	freeze frame table: injector power stage 5
FFTEV6	BLOKNR		KL	freeze frame table: injector power stage 6
FFTEV7	BLOKNR		KL	freeze frame table: injector power stage 7
FFTEV8	BLOKNR		KL	freeze frame table: injector power stage 8
TSFEV1			FW	fault active time: injector of cyl 1
TSFEV2			FW	fault active time: injector of cyl 2
TSFEV3			FW	fault active time: injector of cyl 3
TSFEV4			FW	fault active time: injector of cyl 4
TSFEV5			FW	fault active time: injector of cyl 5
TSFEV6			FW	fault active time: injector of cyl 6
TSFEV7			FW	fault active time: injector of cyl 7
TSFEV8			FW	fault active time: injector of cyl 8
ZYLZA			FW	number of cylinders

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Variable	Source	Type	Description
B_CLEV		EIN	condition clear fault path injector power stage
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_EEV	DEVE	AUS	condition injector fault (power stage)
B_MNEV1		EIN	Error type: short circuit to ground at power stage injector 1
B_MNEV2		EIN	Error type: short circuit to ground at power stage injector 2
B_MNEV3		EIN	Error type: short circuit to ground at power stage injector 3
B_MNEV4		EIN	Error type: short circuit to ground at power stage injector 4
B_MNEV5		EIN	Error type: short circuit to ground at power stage injector 5
B_MNEV6		EIN	Error type: short circuit to ground at power stage injector 6
B_MNEV7		EIN	Error type: short circuit to ground at power stage injector 7
B_MNEV8		EIN	Error type: short circuit to ground at power stage injector 8
B_MXEV1		EIN	Error type: short circuit to B+ at power stage injector 1
B_MXEV2		EIN	Error type: short circuit to B+ at power stage injector 2
B_MXEV3		EIN	Error type: short circuit to B+ at power stage injector 3
B_MXEV4		EIN	Error type: short circuit to B+ at power stage injector 4
B_MXEV5		EIN	Error type: short circuit to B+ at power stage injector 5
B_MXEV6		EIN	Error type: short circuit to B+ at power stage injector 6
B_MXEV7		EIN	Error type: short circuit to B+ at power stage injector 7
B_MXEV8		EIN	Error type: short circuit to B+ at power stage injector 8
B_SA	MDRED	EIN	Condition fuel cut-off
B_SIEV1		EIN	Error type: interruption at power stage injector 1
B_SIEV2		EIN	Error type: interruption at power stage injector 2
B_SIEV3		EIN	Error type: interruption at power stage injector 3
B_SIEV4		EIN	Error type: interruption at power stage injector 4
B_SIEV5		EIN	Error type: interruption at power stage injector 5
B_SIEV6		EIN	Error type: interruption at power stage injector 6
B_SIEV7		EIN	Error type: interruption at power stage injector 7
B_SIEV8		EIN	Error type: interruption at power stage injector 8
B_STEND	BBSTT	EIN	condition end of start
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
EVZ_AUSTOT	AEVAB	EIN	injection cut off pattern total
E_EV1	DEVE	AUS	error flag: injection valve of cyl. 1
E_EV2	DEVE	AUS	error flag: injection valve of cyl. 2
E_EV3	DEVE	AUS	error flag: injection valve of cyl. 3
E_EV4	DEVE	AUS	error flag: injection valve of cyl. 4
E_EV5	DEVE	AUS	error flag: injection valve of cyl. 5
E_EV6	DEVE	AUS	error flag: injection valve of cyl. 6
E_EV7	DEVE	AUS	error flag: injection valve of cyl. 7
E_EV8	DEVE	AUS	error flag: injection valve of cyl. 8
Z_EV1	DEVE	AUS	cycle flag: injection valve of cyl. 1
Z_EV2	DEVE	AUS	cycle flag: injection valve of cyl. 2
Z_EV3	DEVE	AUS	cycle flag: injection valve of cyl. 3
Z_EV4	DEVE	AUS	cycle flag: injection valve of cyl. 4
Z_EV5	DEVE	AUS	cycle flag: injection valve of cyl. 5
Z_EV6	DEVE	AUS	cycle flag: injection valve of cyl. 6
Z_EV7	DEVE	AUS	cycle flag: injection valve of cyl. 7
Z_EV8	DEVE	AUS	cycle flag: injection valve of cyl. 8

FB DEVE 6.30 Detailed description of function

Precondition for the diagnosis of the injector (EV) output stage is the use of an output stage of the type CJ400/CJ920. Detection of a not plausible state at the output stage and reading of the fault type from the IC is described in the section %DECJ.

The fault types from the CJ400 diagnosis are summarized for further processing in other ECU functions according to the effect on the injector. Short-circuit to UBat (B_mxev) or wire interruption (B_siev) lead to the injector permanently being closed. In case of a short-circuit to ground (B_mnev) in contrast, the injector is permanently open.

The individual cycle flags Z_ev(i) are also set by the CJ400 diagnosis when an output stage fault has been detected. The cycle flags are set by this function, if the condition B_desee indicates that a CJ400 diagnosis can be performed and if the injector output stages were active for a certain time. This is ensured by means of the conditions B_stend and B_sa.
Additionally it is ensured via the byte evz_austot that no injector output stage was deactivated due to the cylinder cutout.

-> No output stage diagnosis during the ECU after-run

APP DEVE 6.30 Application hint

DMILE 8.20 OBDII; MIL-power stage

FDEF DMILE 8.20 Function definition

Diagnose CJ 400, or CJ 920 see %DECJ

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(*) in difference to this description this part is handled within module %DFPM.
(#) in difference to this description this part is handled within module %DECJ.

Fault path managment:

Status of fault path mile: sfpmile
Errorflag MILE: E_mile
Cycleflag MILE: Z_mile
Fault types MILE: B_mxmile; B_mnmile; B_simile

Delete fault path: C_fcmclr & B_clmile
Tester code fault path MILE: CDTMILE
Class of fault path MILE: CLAMILE
Fault active time MILE: TSFMILE
CARB-code MILE: CDCMILE
Ambient conditions MILE: FFTMILE

ABK DMILE 8.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCMILE	BLOKNR		KL	Code word CARB: MIL power stage
CDTMILE			FW	code word tester: MIL power stage
CLAMILE			FW	error class: MIL power stage
FFTMILE	BLOKNR		KL	freeze frame table: MIL power stage
TSFMILE			FW	fault active time: MIL power stage

Variable	Source	Type	Description
B_CLMILE	DMILE	LOK	condition clear fault path MIL power stage
B_DESEE	DECJ	EIN	Diagnosis power stage: entry conditions fulfilled
B_MIL	DMIL	EIN	MIL turn-on
B_MNMILE	DMILE	AUS	Error type: short circuit to ground at MIL power stage
B_MXMILE	DMILE	AUS	Error type: short circuit to B+ at MIL power stage
B_SIMILE	DMILE	AUS	Error type: interruption at MIL power stage
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
C_PWF		EIN	ECU-condition powerfail initialisation
E_MILE	DMILE	AUS	Error flag: MIL power stage
SFPMILE	DMILE	AUS	status fault path: MIL power stage
Z_MILE	DMILE	AUS	Cycle flag: MIL power stage

FB DMILE 8.20 Detailed description of function

Precondition for this diagnostic of the MIL powerstage is the use of powerstage type CJ401.
Recognition of non plausible function of the powerstage and its fault type is descriped in %DECJ.

Activation of the cycle flag:
Whenever both states on/off of the powerstage are reached without fault, the cycle flag is set.
If with one of the states on/off a fault occurs, %DECJ starts a verification in addition to the regular use of the powerstage.
Duration of this verification is less than 500ms. If the fault is detected with this verification, the cycle flag is set.

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APP DMILE 8.20 Application hint

Default value for CDTMILE = 165 dez.

ELS 1.10 Fan control ecu box

FDEF ELS 1.10 Function definition

els-els

Note: Calculations are performed in the 100-ms time frame

ABK ELS 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DTEBLEIN			FW	hysteresis temperature threshold for control units box fan control
TEBLEIN			FW	
TTEBL			FW	duration of control units box fan control after start

Variable	Source	Type	Description
B_EBL	ELS	AUS	condition control units box cooling fan
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
C_INI		EIN	ECU-condition for intialisation
TSG	GGTSG	EIN	ECU temperature

FB ELS 1.10 Detailed description of function

The function switches the E-box blower by means of a relay.
The E-box blower is triggered on reaching a certain speed (B_nmot = 1) or when a certain ECU temperature is exceeded. For activation after start-up, operation is terminated again after elapse of the time TTEBL.

APP ELS 1.10 Application hint

DEPCL 1.20 Diagnosis; electronic powertrain control lamp

FDEF DEPCL 1.20 Function definition

Whithin the class table there is data CLAdfp defining which faults activate the EPCL. (——> see class table %DCLA)

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ABK DEPCL 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TEPCL			FW	Time after engine start for end of EPCL test
TEPCLI			FW	Time after INI for end of EPCL test

Variable	Source	Type	Description
B_EPCL	DEPCL	AUS	Condition for activation of electronic powertrain control lamp
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization

FB DEPCL 1.20 Detailed description of function

The EPCL has to be activated for min. a view seconds for visual control with ignition on and engine not running.

After the detection of a fault which has a strong impact to the driveability, the EPCL has to be activated immediately.

After healing of all relevant faults the EPCL may be switched off immediately.

To ensure the selftest of the power stage the EPCL has to be activated by only ECU.
Other ECU's have to send a request to activate and deactivate the EPCL (e.g. via CAN).

APP DEPCL 1.20 Application hint

For deactivation of EPCL with delaytime TEPCL after engine is running:
TEPCLI set to max. value; Default data for TEPCL is 3 sec.
For deactivation of EPCL with delaytime TEPCLI after INI:
TEPCLI auf z.B. 3 sec setzen; TEPCL >= TEPCLI setzen, sonst überwiegt TEPCL bei Schnellstart.

DTOP 3.10 Diagnosis; operating time

FDEF DTOP 3.10 Function definition

dtop-dtop

ABK DTOP 3.10 Abbreviations

Variable	Source	Type	Description
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF		EIN	ECU-condition powerfail initialisation
TOP_W	DTOP	AUS	operating time since powerfail

FB DTOP 3.10 Detailed description of function

The counter is incremented by 1 every 360 seconds and multuplied by 6 so that top_w is given the unit min (quantization: 6 min/inc).
The running-hours counter is counting as soon as the engine starts to turn (i.e. B_nmot = 1).
The variable top_w is initialized with the EEPROM contents after a powerfail; top_w is written into the EEPROM during every after-run !

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APP DTOP 3.10 Application hint

DFPM 3.20 OBDII; Fault path manager

FDEF DFPM 3.20 Function definition

overview: Diagnostic fault path manager whithin the system.

```
                                                  ┌──fcmTrig()   Methode für Ereignistriggerung
                                                  │              aus z.B. %DDCY, %DWUC, etc.
                                                  v
 ┌──────────────────────────────────────────────────────────────────────────────────────────────┐
 │ status                                                                                       │
 │ array (sfp)          fault code Memory FCM                                                   │
 │                                                                                              │
 │ ┌──────┐  ┌──fcmErr()──>┌──────────────────────────┐   <──────     methods for              │
 │ │      │  ├──fcmZyf()──>│                          │               testerinterface            │
 │ │      │  ├──fcmOk()───>│                          │               e.g. %SCATT, KWP2000 etc.  │
 │ │      │  ├──fcmTyp()──>│                          │                          see ->%DTIPx.y  │
 │ │      │  │              │                          │                                          │
 │ │      │  │              │                          │                                          │
 │ │      │  │              │                          │                                          
```

FB DFPM 3.20 Detailed description of function

overview:

1. memory areas of the DFPM
1.1 status array (sfp)
1.2 fault code memory (fcm)

2. methods
2.1 methods for actions of the diagnostic functions
2.2 methods for actions internal DFPM
2.3 methods for event trigger
2.4 methods for MIL activation
2.5 methods for tester interface

3. DFPM processes

4. used data

5. description of function
5.1 fault recognition; change of error flag E_abc 0->1; call method fcmErr()
5.2 fault recognition; change of fault type; call method fcmTyp()
5.3 o.k. recognition; change of error flag E_abc 1->0; call method fcmOk()
5.4 test recognition; change of cycle flag Z_abc 0->1; call method fcmZyf()
5.5 trigger recogn.; e.g. change of B_dcy 0->1; call method fcmTrig()
5.6 time trigger for fault active time internal process dfpm_time
5.7 afterrun internal process dfpm_nl see -->%DFPMNLx.y ##
5.8 short overview of the strategie for MIL activation

6. references

description:

1. memory areas of the DFPM
The both memory areas status array (sfp) and fault code memory (fcm) are located within the buffered RAM.
data loss with power fail is possible.

1.1 status array (sfpdfp); each fault path dfp has ecaxtly one status word sfpdfp (16bit) with the following content:

1.1.0	bit0	E_dfp	fault flag; testresult of the latest test
1.1.1	bit1	Z_dfp	cycle flag; confirmation for min. one successfull test during this driving cycle.
1.1.2	bit2		reserved
1.1.3	bit3		reserved
1.1.4	bit4		reserved
1.1.5	bit5		reserved
1.1.6	bit6	B_bkdfp	flag for backup value; active whenever dfp uses backup values.
1.1.7	bit7	B_cldfp	clear flag; interface for fault path specific actions during erasure of the fault code memory
1.1.8	bit8	B_mxdfp	fault type flag; ’value higher than high limit’ with latest test
1.1.9	bit9	B_mndfp	fault type flag; ’value lower than low limit’ with latest test
1.1.10	bit10	B_sidfp	fault type flag; ’no signal’ with latest test
1.1.11	bit11	B_npdfp	fault type flag; ’result not plausible’ with latest test
1.1.12	bit12	sfpdfp.12	fault exists and is stored within FCM
1.1.13	bit13	sfpdfp.13	fault path minimum once tested since powerfail / FCM clear (dfp-ready)
1.1.14	bit14		reserved
1.1.15	bit15		reserved

1.2 fault code memory (fcm); only info after test with fault result is stored with the following content (bytes):

Maximum SY_fcmsize fault path entries are possible.

1.2.1 byte0 dfp fault path identifier; each program release has a own table of dfp no. from 0 to n.

1.2.2 byte1 tsf counter for fault active time; each stored fault has a value with the measured time during the fault was active (E-dfp = 1). During afterrun each fault path with tsf > TSFdfp and E_dfp=0 is set to emission related (like E_dfp=1). With first storage of the fault the tsf is set to 0. With engine start and n > nmin tsf is set to 0, this is to allow measuring of tsf from last driving cycle during ign. on and engine not running. With tsf = FFh the counter is stopped without overflow.

1.2.3 byte2 fps status of fault path with latest entry (E_dfp etc.)

bit2.0	fps.erfact	copy of the latest E_dfp out of status array sfpdfp
bit2.1	fps.zyf	copy of the latest Z_dfp out of status array sfpdfp
bit2.2	fps.ekd	reserved, not yet used
bit2.3	fps.zkd	reserved, not yet used
bit2.4	fps.fa	entry of fault code during activity of service testequipment
bit2.5	fps.be	entry of fault code during activity of end of line testequipment
bit2.6	fps.nn1	reserved, not yet used
bit2.7	fps.nn2	reserved, not yet used

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```
1.2.4   byte3   typ     type of fault at first and latest entry.
         bit3.0 typ.actmax      'value was higher than high limit' with latest entry
         bit3.1 typ.actmin      'value was lower than low limit' with latest entry
         bit3.2 typ.actsig      'no signal' with latest entry
         bit3.3 typ.actnpl      'result not plausible' with latest entry
         bit3.4 typ.inimax      'value was higher than high limit' with first entry
         bit3.5 typ.inimin      'value was lower than low limit' with first entry
         bit3.6 typ.inisig      'no signal' with first entry
         bit3.7 typ.ininpl      'result not plausible' with first entry

1.2.5   byte4   fes     status of fault entry; dynamicaly evaluation of CARB relation
         bit4.0 fes.erfprl      errorflag debounced
         bit4.1 fes.dauer       FLC was min. onetimes at zero, FCM deletion due to CARB
         bit4.2 fes.scatt       fault entry is visible for scan tool   (dynamic)  see ->%TCSORT
         bit4.3 fes.mil         fault entry is relevant for MIL
         bit4.4 fes.blink       fault entry with MIL blinking
         bit4.5 fes.multi       sporadic fault
         bit4.6 fes.epcl        fault entry is relevant for EPCL                        (see ->%DEPCLx.y)
         bit4.7 fes.nn2         reserved

1.2.6   byte5   cla     class of fault path; entry from class table                     (see ->%DCLAx.y)

1.2.7   byte6   flc     MIL-on - counter; trigger due to class table

1.2.8   byte7   hlc     MIL-off - counter; trigger due to class table

1.2.9   byte8   dlc     delete counter; For each detected fault an individual fault delete counter (DLCabc) is used.
                        It determines the duration of storage of the corresponding fault. At each first detection (not yet
                        debounced, 'probable fault') dlcdfp is set due to class table CLAdfp to DLCPRL (e.g. 80 dec).
                        If this fault is neither confirmed nor detected as healed within these DLCPRL dcy/wuc, it will be deleted.
                        As soon as a 'probable' fault is detected as healed, the dlcdfp is set to the value ADSTKD acc. CLAdfp.
                        As soon as a 'probable' fault is confirmed, the dlcdfp is set to the value ADSTFD (40dez) acc. CARB.
                        This value is fixed up to recognized healing (MIL off acc. this fault).
                        As long as a 'probable fault' is not yet 'confirmed', or as soon as a fault is detected as healed, the
                        corresponding dlcdfp is decremented by 1 in the stop phase of each cycle where 'warm-up cycle' was
                        detected (B_wuc=1 ). --> %DWUC.
                        If dlcdfp reaches here the value 0, the fault (and if necessary its corresponding freeze frame) will be
                        erased completely out of the memory.

1.2.10  byte9           First freeze frame value  according to  -->%DFRZx.y

According to the configuration by systemconstants the following ambient conditions can be stored:   see-->%DFCMx.y

1.2.11  Extended freeze frame with length SY_ffesize

1.2.12  Entry of  SY_envblok  blocks of ambient conditions out of FFTdfp with length SY_dfpmenv
        & SY_dfptim ext. ambient conditions                                                    -->%DUMWEXx.y
        Structure of the block of ambient conditions see -->%DFCMx.y

1.2.13  hz  frequency counter
        with each new detection after healing (intermittend fault) the hz is incremented by 1. Max. is 255 without overflow

1.2.14  cks     checksum for this fault path entry

1.2.15  Depending on overall length of the entry one add. byte with value 00 is used to keep the entry within word-structure.

2.  methods
____________

2.1    methods for actions of the diagnostic functions
2.1.1   getSfp()        read out of the status word sfpdfp of a fault path dfp out of the status array
2.1.2   repSfp()        write the statusword sfpdfp of a fault path dfp into the status array
2.1.3   getErf()        read out of the error flag E_dfp of a fault path dfp out of the status array
2.1.4   getZyf()        read out of the cycle flag Z_dfp of a fault path dfp out of the status array
2.1.5   getClf()        read out of the clear flag B_cldfp of a fault path dfp out of the status array

2.2    methods for actions internal DFPM
2.2.1   fcmErr()        fault path sends message: fault detected
2.2.2   fcmZyf()        fault path sends message: cycle flag is set, test fullfilled
2.2.3   fcmOk()         fault path sends message: fault healing or o.k. detected
2.2.4   fcmTyp()        fault path sends message: change of fault type

2.3    methods for trigger events
2.3.1   fcmTrig()       call of a specific trigger event (B_dcy, B_wuc etc.)

2.4    methods for activation of MIL or EPCL
2.4.1   getDfpmMil()    search for MIL related state within the fault code memory
2.4.2   getDfpmEpcl()   search for EPCL related state within the fault code memory

2.5    methods for tester interface     see-->%DTIPx.y

3.  processes inside DFPM
3.1     dfpm_nl         generates the DFPM specific actions within afterrun    see -->%DFPMNLx.y                    ##
3.2     dfpm_clr        generates the DFPM specific actions within FCM deletion
3.3     dfpm_ini        generates the DFPM specific actions within initialisation task
3.4     dfpm_time       generates the DFPM specific actions within the time task (e.g. every 200 ms)
3.5     dfpm_check      verification of the FCM for plausible entries.
```

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4. used data

4.1 overall data

4.1.1 CLA table with different data as described in ->%DCLAx.y

4.1.2 FFT table with the selectable ambient conditions; described in ->%DFFTx.y

4.2 fault path specific data

4.2.1 CLAdfp fixed value; classification like class table ->%DCLAx.y

4.2.2 TSFdfp fixed value; max. value for tsf for decission if sporadic fault is emmission related.

4.2.3 FFTdfp block of fixed values with length SY_dfpmenv; selection of the value out of FFT-table. ->%DFFTx.y

4.2.4 CDTdfp fixed value(16bit); fault path specific number for responce to the service tester with RB-K3 standard.
The CDTdfp numbers are RB-K3 standardized by K3/EKS3-My, -Fk in chronological order.
attention: no. 00 is not allowed, sign for empty memory
no. >=65280 dez (FF00h) are stop criteria for fault memorisation.

4.2.5 CDCdfp block of fixed values (4*16bit); SAE-fault codes for output to the OBD scan tool. -->%DCDCx.y
The fault path identifier dfp has to be converted to the format of the SAE standard J2012.
For each of the four possible fault types there is a specific code.
Data application due to customer requirements.

5. descriptions of functional details
Entry, update and verification of the entries in the fault code memory are carried out only by one of the following trigger:

5.1 fault detection; change in errorflag E_dfp 0->1; call of method fcmErr()

Whenever a errorflag E_dfp inside status word sfpdfp is set by a diagnostic function, the method fcmErr() is active.

First inside the fault code memory is searched for an existing entry of the faultpath dfp,

- if dfp is not yet stored a new entry is generated ——> 5.1.1
- if dfp is stored a update is generated ——> 5.1.2

5.1.1 new entry: the following values are stored at the end of the fault code memory

dfp	fault path identifier
fps	fault path status
typ.ini	fault path type at first entry (B_mxdfp etc.)
fes	fault path status of entry; dynamical evaluation of the CARB related status
cla	class of the fault path; CLAdfp
flc	MIL on - counter; is set to initial value due to classtable and the decremented by 1 only if the trigger event and the cycle flag Z_dfp are true.
tsf	fault active time; set to 0
hlc	MIL off - counter; is set to initial value due to CLAdfp
dlc	delete counter; is set to initial value due to fault path status fes.
hz	frequency counter; set to 1
frz0....	freeze frame; stored due to FFT, see -->%DFRZx.y
ini_env...	ambient conditions due to FFTdfp and -->%DUMWEXx.y at initial detection
cks	write checksum

5.1.2 Update: the following values are updated:

fps	fault path status; new value
typ.act	fault path type at this entry (B_mxdfp etc.)
fes	fault path status of entry; dynamical evaluation of the CARB related status
flc	MIL on - counter; decremented by 1 only if the trigger event and the cycle flag Z_dfp are true.
hlc	MIL off - counter; is set to initial value due to CLAdfp
dlc	delete counter; is set to initial value due to fault path status fes.
hz	frequency counter; increment by 1
act_env(x)	ambient conditions due to FFTdfp stored to place X at this detection (->%DUMWEXx.y) X = minimum out of frequency counter HZ and SY_envblok Not yet used blocks of ambient conditions are set to FFhex
cks	write new checksum

5.2 fault detection; change of fault type, call method fcmTyp()

Whenever a fault type flag B_xxdfp inside status word sfpdfp is changed by a diagnostic function, method fcmTyp() is active.
The following values are updated inside the FCM:

typ.act	fault path type at this entry (B_mxdfp etc.)
cks	write new checksum

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5.3 detection of healing; change of errorflag E_dfp 1->0; call method fcmOk()

Whenever the error flag E_dfp inside status word sfpdfp is reset by a diagnostic function, method fcmOk() is active.
The following values are updated inside the FCM:

With pending, not yet CARB debounced fault path status:

fps	fault path status; new value
fes	fault path status of entry; dynamical evaluation of the CARB related status
dlc	delete counter; is set to ADSTKD
cks	write new checksum

With CARB debounced fault path status:

fps	fault path status; new value
fes	fault path status of entry; dynamical evaluation of the CARB related status
flc	MIL on - counter; incremented by 1 only if the trigger event and the cycle flag Z_dfp are true.
hlc	MIL off - counter; decrement by 1 only if the trigger event and the cycle flag Z_dfp are true.
cks	write new checksum

5.4 test recognition; change of cycle flag Z_abc 0->1; call method fcmZyf()

Whenever the cycle flag Z_dfp inside status word sfpdfp is set by a diagnostic function, method fcmZyf() is active.
The following values are updated inside the FCM (only if fault code entry is existing):

fps	fault path status; new value
fes	fault path status of entry; dynamical evaluation of the CARB related status
cks	write new checksum

Whenever this E_dfp = 1 the following values are updated additionally:

flc	MIL on - counter; decremented by 1 only if the trigger event (e.g. B_dcy) is true.
hlc	MIL off - counter; set to initial value due to CLAdfp

or, if this E_dfp = 0, the following values are updated aditionally:

hlc	MIL off - counter; decrement by 1 only if the trigger event is true.

5.5 trigger recogn.; e.g. change of B_dcy 0->1; call method fcmTrig()
Whenever one of the trigger functions is fullfilled, method fcmTrig() is active.
The following values are updated inside the FCM:

fes	fault path status of entry; dynamical evaluation of the CARB related status
flc	MIL on - counter; decremented by 1 only if the selected trigger event (due to classtable CLAdfp) and the cycle flag Z_dfp and the errorflag E_dfp are true.
hlc	MIL off - counter; decremented by 1 only if the selected trigger event (due to classtable CLAdfp) and the cycle flag Z_dfp are true and errorflag E_dfp = 0.
cks	write new checksum

5.6 time trigger for fault active time internal process dfpm_time
The following values are updated inside the FCM (only if fault code entry is existing):

tsf	fault active time; increment by 1 if Z_dfp = 1 and E_dfp = 1
cks	write new checksum

5.7 afterrun internal process dfpm_nl see -->%DFPMNLx.y ##

flc	MIL on - counter; decremented by 1 only if Z_dfp=1, E_dfp=0 and tsf > TSPdfp. Set to initial value due to CLAdfp only if Z_dfp=1, E_dfp=0 und tsf <= TSPdfp.
dlc	delete counter; only if B_wuc = 1 each dlc of the stored and healed entries is decremented by 1.
cks	write new checksum

5.8 short overview of the strategie for MIL activation
Description is based on change of states, only in the following 5 cases the fault code manager gets activ:

case 1: Change within the cycle status (e.g. B_dcy 0 -> 1)

Cycle status (e.g. B_dcy)	cycle flag Z_xyz	error flag E_xyz	MIL on counter FLC	MIL off counter HLC	comment
0 -> 1	0	0/1	FLC = FLC	HLC = HLC	waiting for cycle flag
0 -> 1	1	0	FLC = FLC	HLC = HLC-1	o.k.- recognition
0 -> 1	1	1	FLC = FLC-1	HLC = HLC	fault recognition

case 2: fault path test is fullfilled (Z_xyz 0 -> 1)

Cycle status (e.g. B_dcy)	cycle flag Z_xyz	error flag E_xyz	MIL on counter FLC	MIL off counter HLC	comment
0	0 -> 1	0/1	FLC = FLC	HLC = HLC	waiting for cycle status
1	0 -> 1	0	FLC = FLC	HLC = HLC-1	o.k.- recognition
1	0 -> 1	1	FLC = FLC-1	HLC = HLC	fault recognition

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case 3: fault is detected (E_xyz 0 -> 1)

Cycle status (e.g. B_dcy)	cycle flag Z_xyz	error flag E_xyz	MIL on counter FLC	MIL off counter HLC	comment
0	0/1	0 -> 1	FLC = FLC	HLC = HLC	waiting for cycle status
1	0	0 -> 1	FLC = FLC	HLC = max.	stopped healing
1	1	0 -> 1	FLC = FLC-1	HLC = max.	fault recognition

case 4: healing is detected (E_xyz 1 -> 0)

Cycle status (e.g. B_dcy)	cycle flag Z_xyz	error flag E_xyz	MIL on counter FLC	MIL off counter HLC	comment
0	0/1	1 -> 0	FLC = FLC	HLC = HLC	waiting for cycle status
1	0	1 -> 0	FLC = FLC	HLC = HLC	waiting for cycle flag
1	1	1 -> 0	FLC = FLC+1	HLC = HLC-1	active debouncing for healing

case 5: actions in afterrun

Cycle status (e.g. B_dcy)	cycle flag Z_xyz	error flag E_xyz	MIL on counter FLC	MIL off counter HLC	comment
0	0/1	0/1	FLC = FLC	HLC = HLC	driving cycle too short
1	0	0/1	FLC = FLC	HLC = HLC	cycle flag missing
1	1	0 & TSF<limit	FLC = max.	HLC = HLC	driving cycle not MIL rel.
1	1	0 & TSF>limit	FLC = FLC-1	HLC = HLC	driving cycle with sporadic fault
1	1	1	FLC = FLC	HLC = HLC	actions during driving cycle fullfilled

6. References

To complete the description of the whole fault code manager the following sections have to be included:

description of projectspecific content of FCM	-->%DFCMx.y
description of classtable CLA	-->%DCLAx.y
description of selectable trigger events	-->%DTRIGx.y
Beschreibung der Aktivitäten im Nachlauf	-->%DFPMNLx.y ##
description of the add. 8 bit ambient conditions / freeze frame values (plattform)	-->%DFFTCNVx.y
description of the selectable ambient conditions / freeze frame values (plattform)	-->%DFFTx.y
description of the selectable ambient conditions / freeze frame values (customer)	-->%DFFTKx.y
description of the used freeze frame values	-->%DFRZx.y
description of the used extendet ambient condition values /-strategy	-->%DUMWEXx.y, -->%DTOPx.y
description of SAE fault codes	-->%DCDCx.y
description of the available methodes for testerkommunication	-->%DTIPx.y
description of the evaluation 'driving cycle'	-->%DDCYx.y
description of the evaluation 'warm up cycle'	-->%DWUCx.y
activation of the MIL	-->%DMILx.y
activation of the EPCL	-->%DEPCLx.y
Inspection/Maintenance-readinesscode	-->%DIMCx.y
readout of the fault code memory by OBDII scan tool	-->%SCATTx.y
or servive tester e.g. KTS500	-->%T2...x.y or %TK...x.y

APP DFPM 3.20 Application hint

For functionsspecific labelselection within VS100 etc. the DFPM-related fault path data are available with DFPM_<function>.

Classtable CLA::
Default table is prepared by K3/EKS3-Mayer, -Frank.
One class (CLAdfp = 0) is reserved for deactivation of fault code storage for this fault.
Fault recognition within status array and e.g.limp home modes/values are still active in this case.

Fault active time TSFdfp:
Attention ! With low TSFdfp, decrementation of FLC is going faster -> MIL activation very soon!
With TSFdfp = 127,5 sec (255dez) the evaluation is switched off.

Fault codes CDTdfp:
The fault specific codes CDTdfp must be standardized RB K3-specifically due to the introduction of OBDII fault processing so that the greatest reliability is guaranteed in fault memory entries and conversion into CARB-specific tester codes.
The conversion into CARB codes is described at %SCATT and %DCDC.

For measurement and application purposes the RAM cell dfp_ap is established. At each fault detection the identifier dfp of the triggering fault is stored in this cell so that the information of the last detected fault is always available.
If the topical stored fault is detected as "healed" or deleted the dfp_ap will be set to 00h.

delete counter dlc (initial value is due to CLAdfp)
CARB-debounced = 40 dez; CARB-pending (only special faults) = 80 dez.; only service related faults = approx. 10 dez.

SAE fault codes CDCdfp: see -->%DCDCx.y

Quality:
To assure the correct function of the DFPM due to the CARB regulations, it is very important to have correct function of the diagnostic functions with the fault recognation and the info-excange with the DFPM via status array.
CARB related diagnostic evaluations have to be fullfilled within a FTP72 cycle.

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DFRZ 20.20 OBDII; description ’freeze frame’

FDEF DFRZ 20.20 Function definition

```
With new fault entry the following freeze frame values are stored within the fault code memory:

CARB-freeze frame according to the values 1 to 11 out of the basic freeze frame table                  see -->%DFFTx.y      ##
Extended freeze frame values according data EFFDFPM with length SY_ffesize out of the basic freeze frame table              ##
```

ABK DFRZ 20.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
EFFDFPM	BLOKNR		KL	Declaration of freeze frame extension out of table DFFT
SY_FFESIZE			SYS	system constant: Size of Freeze Frame-extension

FB DFRZ 20.20 Detailed description of function

APP DFRZ 20.20 Application hint

```
Selection of the extended freeze frame values is possible by data EFFDFPM out of data FFT                 -->%DFFTx.y
```

DFCM 1.10 OBDII; description fault code memory

FDEF DFCM 1.10 Function definition

```
fault code memory (fcm); only info after test with fault result is stored with the following content (bytes):
For maximum number of fault path entries see SY_fcmsize
*____________________________________________________________________________________________________________

byte0   dfp     fault path identifier; each program release has a own table of dfp no. from 0 to n.

byte1   tsf     counter for fault active time; each stored fault has a value with the measured time during the fault was
                active (E-dfp = 1). During afterrun each fault path with tsf > TSFdfp and E_dfp=0 is set to emission
                related (like E_dfp=1).  With first storage of the fault the tsf is set to 0. With engine start and
                n > nmin tsf is set to 0, this is to allow measuring of tsf from last driving cycle during ign. on
                and engine not running. With tsf = FFh the counter is stopped without overflow.

byte2   fps     status of fault path with latest entry (E_dfp etc.)
bit2.0  fps.erfact      copy of the latest E_dfp out of status array sfpdfp
bit2.1  fps.zyf         copy of the latest Z_dfp out of status array sfpdfp
bit2.2  fps.ekd         reserved, not yet used
bit2.3  fps.zkd         reserved, not yet used
bit2.4  fps.fa          entry of fault code during activity of service testequipment
bit2.5  fps.be          entry of fault code during activity of end of line testequipment
bit2.6  fps.nn1         reserved, not yet used
bit2.7  fps.nn2         reserved, not yet used

byte3   typ     type of fault at first and latest entry.
bit3.0  typ.actmax      ’value was higher than high limit’ with latest entry
bit3.1  typ.actmin      ’value was lower than low limit’ with latest entry
bit3.2  typ.actsig      ’no signal’ with latest entry
bit3.3  typ.actnpl      ’result not plausible’ with latest entry
bit3.4  typ.inimax      ’value was higher than high limit’ with first entry
bit3.5  typ.inimin      ’value was lower than low limit’ with first entry
bit3.6  typ.inisig      ’no signal’ with first entry
bit3.7  typ.ininpl      ’result not plausible’ with first entry

byte4   fes     status of fault entry; dynamicaly evaluation of CARB relation
bit4.0  fes.erfprl      errorflag debounced
bit4.1  fes.dauer       FLC was min. onetimes at zero, FCM deletion due to CARB
bit4.2  fes.scatt       fault entry is visible for scan tool   (dynamic)                        -->%TCSORT
bit4.3  fes.mil         fault entry is relevant for MIL
bit4.4  fes.blink       fault entry with MIL blinking
bit4.5  fes.multi       sporadic fault
bit4.6  fes.epcl        fault entry is relevant for EPCL                                        -->%DEPCL
bit4.7  fes.nn2         reserved

byte5   cla     class of fault path; entry from class table                                     -->%DCLA

byte6   flc     MIL-on - counter; trigger due to class table

byte7   hlc     MIL-off - counter; trigger due to class table

byte8   dlc     delete counter; For each detected fault an individual fault delete counter (DLCabc) is used.
                It determines the duration of storage of the corresponding fault. At each first detection (not yet
                debounced, ’probable fault’) dlcdfp is set due to class table CLAdfp to DLCPRL (e.g. 80 dec).
                If this fault is neither confirmed nor detected as healed within these DLCPRL dcy/wuc, it will be deleted.
                As soon as a ’probable’ fault is detected as healed, the dlcdfp is set to the value ADSTKD acc. CLAdfp.
                As soon as a ’probable’ fault is confirmed, the dlcdfp is set to the value ADSTFD (40dez) acc. CARB.
                This value is fixed up to recognized healing (MIL off acc. this fault).
                As long as a ’probable fault’ is not yet ’confirmed’, or as soon as a fault is detected as healed, the
                corresponding dlcdfp is decremented by 1 in the stop phase of each cycle where ’warm-up cycle’ was
                detected (B_wuc=1 ). --> %DWUC.
                If dlcdfp reaches here the value 0, the fault (and if necessary its corresponding freeze frame) will be
                erased completely out of the memory.
```

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```
byte9           First freeze frame value      (SY_ffcsize = 11)                                -->%DFRZ  -->%DFFT
byte19          Last freeze frame value                                                        -->%DFRZ  -->%DFFT
                Freeze Frame Extension by EFFDFPM is not used (SY_ffesize = 0)

Two blocks of service environmental conditions are activated (SY_envblok = 2)

byte20-23       Initial entry of service environmental conditions
byte20          Operating Time  top_w (high-Byte) at initial fault entry                      -->%DUMWEX  -->%DTOP
byte21          Operating Time  top_w (low -Byte) at initial fault entry                       -->%DUMWEX  -->%DTOP
byte22          Ambient condition according FFTdfp-blocknumber 0 at initial fault entry        -->%DFFT
byte23          Ambient condition according FFTdfp-blocknumber 1 at initial fault entry        -->%DFFT
                The number of values within the FFTdfp-block ist fixed by SY_DFPMENV (in this case = 2)

byte24-27       Latest entry of service environmental conditions
byte24          Operating Time  top_w (high-Byte) at latest fault entry                        -->%DUMWEX  -->%DTOP
byte25          Operating Time  top_w (low -Byte) at latest fault entry                        -->%DUMWEX  -->%DTOP
byte26          Ambient condition according FFTdfp-blocknumber 0 at latest fault entry         -->%DFFT
byte27          Ambient condition according FFTdfp-blocknumber 1 at latest fault entry         -->%DFFT
                The number of values within the FFTdfp-block ist fixed by SY_DFPMENV (in this case = 2)

byte28          frequency counter hz
                At the first detection of a fault the frequency counter is set to the initial value 01.
                At each 'new detection' after detected healing, (e.g. at loose contacts) the frequency counter is
                increased by 1. Max. value 255 limits the frequency counter to the top; no overflow active.

byte29          checksum cks for this fault path entry
```

ABK DFCM 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
EFFDFPM	BLOKNR		KL	Declaration of freeze frame extension out of table DFFT

Variable	Source	Type	Description
SY_DFPMENV		EIN	system constant: environmental conditions in fault code memory
SY_ENVBLOK		EIN	system constant; no. of blocks ambient conditions in fault code memory
SY_FCMSIZE		EIN	system constant: Maximum number of fault entries
SY_FFCSIZE		EIN	system constant: Size of CARB-Freeze Frame
SY_FFESIZE		EIN	system constant: Size of Freeze Frame-extension

FB DFCM 1.10 Detailed description of function

The fault code memory (fcm) is located within the buffered RAM. Loss of data with power fail is possible.

APP DFCM 1.10 Application hint

For byte 0 (dfp) the programm specific correllation of the stored number is to be selected out of the alphbetic list of the fault path stati sfpaaa to sfpzzz. sfpaaa starts with nr 0.

DFPMNL 1.20 Diagnosis; OBDII fault path managment afterrunning condition

FDEF DFPMNL 1.20 Function definition

Funktion läuft, wenn nicht anders angegeben (z.B. C_ini), im Hintergrund.

##

ABK DFPMNL 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SY_DFPNL			SYS	

Variable	Source	Type	Description
B_NLDTE	DDMTL	EIN	request for ECM afterrun from leak detection
B_NLOBD	DFPMNL	AUS	request for ECM afterrun from OBD
E_DMTK	DDMTL	EIN	error flag: evap system monitoring - smallest leak
E_DMTKNM	DDMTL	EIN	error flag: evap system monitoring - smallest leak (not MIL on)
E_DMTL	DDMTL	EIN	error flag: DMTL-module

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FB DFPMNL 1.20 Detailed description of function

In dieser Funktion werden die Fahrtende-Bewertungen der Fehlereinträge im Fehlerspeicher durchgeführt.

Zur Anforderung der Nachlauffunktion wird B_nlobd an %MOTAUS übergeben bis alle Fehlerspeichereinträge bearbeitet sind.

Zur Kennzeichnung von Diagnosefunktionen mit Prüfung im Nachlauf wird in dieser Funktion das Array 'dfpnlarray' angelegt
und mit folgenden Funktionen (vorerst) hart, also nicht applizierbar, bestückt: DFP_DMTL, DFP_DMTK und DFP_DMTKNM. ##

Diese evtl. im Fehlerspeicher gespeicherten Fehler DFP_DMTL, DFP_DMTK und DFP_DMTKNM werden im Nachlauf ##
somit erst bewertet, wenn ihre zugehörige Nachlauf-Anforderung B_nldte abgeschlossen ist,
also ein aktuelles Prüfergebnis vorliegt.

Alle weiteren Fehlerspeichereinträge werden unmittelbar zu Beginn des Nachlaufs bewertet.

APP DFPMNL 1.20 Application hint

Aufbau des Steuerarrays dfpnlarray mit SY_DFPNL = 3 ——> 3 Words !!: ##

Word-Nr.	Funktion	High-Byte	Low-Byte_bit1	Low-Byte_bit0	
1	DFP_dmtl	dfp-Nr.	1 = Fkt. noch aktiv	1 = Fkt. bearbeitet	
2	DFP_dmtk	dfp-Nr.	1 = Fkt. noch aktiv	1 = Fkt. bearbeitet	
3	DFP_dmtknm	dfp-Nr.	1 = Fkt. noch aktiv	1 = Fkt. bearbeitet	##

DFFT 1.40 Diagnostics; Freeze frame selection table

FDEF DFFT 1.40 Function definition

Reference table of the measurement values in FFTdfp available for selection: (max. 99 !)
Quantisation of the fault code memory entry is due to the according label or the additionally described calculation
For 'not supported' values (FF) is used (eg. values for bank #2 within single bank-system) ##
Values with xxx_u are not shure existing as byte. Maybe they are created within %DFFTCNVx.y as xxx_u ! ##

Structure:
- No. 0 — Substitute for 'not_used'
- No. 1 to 15 — Reserved for CARB-Freeze Frame (lt. SAE J1979)
- No. 16 to 99 — Reserved for common values out of platform
- No. 100 to 255 — Reserved for project- / customerspecific add-ons; see ——>%DFFTKx.y

No.	Value	Description	
0		not_used	
1	flglrs	Control status Bank 1	
2	flglrs2	Control status Bank 2	
3	rml	relative air mass	##
4	tmot_u	Engine temperature acc. SAE J1979	##
5	fr_u	Control factor bank1 (byte)	##
6	fra_u	Adaptation factor bank1 (byte)	##
7	fr2_u	Control factor bank2 (byte); if single bank system (SY_stervk=0) 'not supported' is used	##
8	fra2_u	Adaptation factor bank2 (byte); if single bank system (SY_stervk=0) 'not supported' is used	##
9	not supported	reserved for Intake-manifold pressure Q: 1kPA SAE J1979 Mode2,PID$0B	##
10	nmot	Engine speed; Quantization is recalculated with output. ->%TC2MOD	##
11	vfzg_u	Vehicle speed acc. SAE J1979	##
12-16	not used	Reserved for extension SAE	
17	ml	Mass air flow	
18	tmot	Engine coolant temperature quantification systemspecific	##
19	tans	Intake-air temperature	
20	ub	Battery voltage	
21	wdkba	throttle angle	
22	usvk	Sensor voltage upstream catalyst bank 1	
23	ushk	Sensor voltage downstream catalyst bank 1	
24	usvk2	Sensor voltage upstream catalyst bank 2 if single bank system (SY_stervk = 0) 'not supported' is used	##
25	ushk2	Sensor voltage downstream catalyst bank 2 if single bank system (SY_stervk = 0) 'not supported' is used	##
26	rl	relative air charge	##
27	upwg1_u	voltage of pedal sensor poti 1 (byte)	
28	upwg2_u	voltage of pedal sensor poti 2 (byte)	
29	upwg2d_u	double voltage of pedal sensor poti 2 (byte)	
30	skapfad	Pathidentifier out of SKA	
31	egaspfad	Pathidentifier out of EGAS	
32	mpfad	Pathidentifier out of torque calculation	
33	mi_duf	Pathidentifier out of torque comparison	
34	rstpfad	Pathidentifier out of reset	
35	wped	standardized angle of accellerator pedal	

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No.	Value	Description
36	tumg	Ambient temperature
37	tmew	engine temperature, backup value out of model
38	udkp1_u	Voltage throttle poti 1 (byte)
39	udkp2_u	Voltage throttle poti 2 (byte)
40	wdks	desired throttle angle, refering to lower mechanical stop
41	tabgm	Exhaust temperature upstream catalyst, out of model
42	tabgm2	Exhaust temperature upstream catalyst bank 2, out of model if single bank system (SY_stervk = 0) 'not supported' is used ##
43	tkatm	Catalyst temperature, out of model
44	tkatm2	Catalyst temperature, bank 2, out of model if single bank system (SY_stervk = 0) 'not supported' is used ##
45	uhsv	Voltage at the heater output stage upstream of the catalyst
46	uhsv2	Voltage at the heater output stage upstream of the catalyst bank 2 if single bank system (SY_stervk = 0) 'not supported' is used ##
47	uhsh	Voltage at the heater output stage downstream of the catalyst
48	uhsh2	Voltage at the heater output stage downstream of the catalyst bank 2 if single bank system (SY_stervk = 0) 'not supported' is used ##
49	rinv_u	Internal resistance oxygen sensor upstream catalyst (byte)
50	rinv2_u	Internal resistance oxygen sensor upstream catalyst bank 2 (byte) if single bank system (SY_stervk = 0) 'not supported' is used ##
51	rinh_u	Internal resistance oxygen sensor downstream catalyst (byte)
52	rinh2_u	Internal resistance oxygen sensor downstream catalyst bank 2 (byte) if single bank system (SY_stervk = 0) 'not supported' is used ##
53	pu	Ambient pressure
54	tpsvkmf_u	filtered cycle duration of sensor signal upstream cat. (byte)
55	tpsvkmf2_u	filtered cycle duration of sensor signal upstream cat. bank 2 (byte) if single bank system (SY_stervk = 0) 'not supported' is used ##
56	(fr_u)	replaced by no. 5 ##
57	(fra_u)	replaced by no. 6 ##
58	(fr2_u)	replaced by no. 7 ##
59	(fra2_u)	replaced by no. 8 ##
60	tfst	fuel level 1l/inc
61	(rl)	replaced by no. 26 ##
62-99	not used	add-ons up to max. #99 tbd only by the responsable for %DFPM !!
100-255	not used	Reserved for project- / customerspecific add-ons

ABK DFFT 1.40 Abbreviations

Variable	Source	Type	Description
EGASPFAD	DUF	EIN	ETS-path as environmental condition for diagnosis of function monitoring
FLGLRS	LREB	EIN	CARB FREEZE FRAME byte, bank 1, for lambda control
FLGLRS2	LREB	EIN	CARB FREEZE FRAME byte, bank 2, for lambda control
FR2_U	DFFTCNV	EIN	Lambda controller output (byte)
FRA2_U	DFFTCNV	EIN	multiplicative correction of the mixture adaptation (byte)
FRA_U	DFFTCNV	EIN	multiplicative correction of the mixture adaptation (byte)
FR_U	DFFTCNV	EIN	Lambda controller output (byte)
MI_DUF	DUF	EIN	actual torque at response of torque comparison in the function monitoring
ML	BGSRM	EIN	air mass flow
MPFAD	DUF	EIN	Torque path in function and function monitoring as environmental cond. of diag.
NMOT	BGNMOT	EIN	engine speed
PU	GGDSAS	EIN	Ambient pressure
RINH2_U	DFFTCNV	EIN	Act. value (byte) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH_U	DFFTCNV	EIN	Actual value (byte) internal res. Ri-Nernst cell lambda sensor downstream cat
RINV2_U	DFFTCNV	EIN	Actuel value of internal resistance of lambda sensor 2, pre cat (byte)
RINV_U	DFFTCNV	EIN	Actuel value of internal resistance of lambda sensor,pre cat (byte)
RL	EGFE	EIN	relative air charge
RML	BGRML	EIN	relative air mass (calc. load value) acc. to SAE J1979
RSTPFAD	DUR	EIN	Reset-path as environment condition for the diagnosis of processor monitoring
SKAPFAD	DUF	EIN	freeze frame information for SKA
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TANS	GGTFA	EIN	Intake air temperature
TFST	CANINS	EIN	Tank level
TKATM	ATM	EIN	catalyst temperature (model)
TKATM2	ATM	EIN	catalyst temperature (model), bank2
TMEW	GGTFM	EIN	model-based substitute value for engine temperature signal in case of error
TMOT	GGTFM	EIN	Engine temperature
TMOT_U	DFFTCNV	EIN	Engine temperature with defined quantisation for FSP-freese frame
TPSVKMF2_U	DFFTCNV	EIN	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (byte)
TPSVKMF_U	DFFTCNV	EIN	filtered cycle duration of sensor signal upstream cat. (byte)
TUMG	GGTFUMG	EIN	Ambient air temperature
UB	GGUB	EIN	battery voltage
UDKP1_U	DFFTCNV	EIN	sensor voltage from throttle-valve potentiometer 1 (byte)
UDKP2_U	DFFTCNV	EIN	sensor voltage from throttle-valve potentiometer 2 (byte)
UHSH		EIN	Voltage at ECU heating power stage, post cat
UHSH2		EIN	Voltage at ECU heating power stage 2, post cat
UHSV		EIN	Voltage at the heater output stage upstream of the catalyzer
UHSV2		EIN	Voltage at the heater output stage 2 upstream of the catalyzer
UPWG1_U	DFFTCNV	EIN	Voltage PWG potentiometer 1 (byte)
UPWG2D_U	DFFTCNV	EIN	Doubled PWG potentiometer-2 voltage (byte)
UPWG2_U	DFFTCNV	EIN	Voltage PWG potentiometer 2 (byte)
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst

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Variable	Source	Type	Description
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2
VFZG_U	DFFTCNV	EIN	Vehicle speed
WDKBA	GGDVE	EIN	throttle angle
WDKS	FUEDK	EIN	desired throttle angle w.r.t. to lower mechanical stop
WPED	GGPED	EIN	Standardized accelerator pedal angle

FB DFFT 1.40 Detailed description of function

APP DFFT 1.40 Application hint

Achtung, bei Änderung, Applikation von FFTdfp müssen zwingend auch die Testerservices entsprechend angepasst werden.
Z.B. muß bei Anwendung von DIAS auf das neue .hex-File referenziert werden.

DFFTK 2.70 Diagnosis; customer-specific list for selection of freeze-frame values

FDEF DFFTK 2.70 Function definition

Referenztabelle der in FFTdfp anwählbaren kundenspezifischen Messwerte: (max. 155 von Nr. 100 bis 255)
Quantisierung im Fehlerspeichereintrag entsprechend Label oder zusätzlich angegebener Umrechnung
Falls der Wert im System nicht vorhanden ist, wird 00 eingetragen (z.B. Bank 2 - Werte bei 1-Bank - Systemen)

Struktur: Nr. 100 - 255 Reserviert für projekt- / kundenspezifische Ergänzung, noch ohne Struktur

Nr.	Wert	Beschreibung	Nr.	Wert	Beschreibung
100	wdknlp_u		130	lamsons_u	
101	udkp1a_u		131	lamsons2_u	
102	igokr_u		132	tmst	
103	uusvk_u		133	frm_u	
104	uusvk2_u		134	frm2_u	
105	uushk_u		135	ahkat	
106	uushk2_u		136	ahkat2	
107	taml		137	tvlrhi	
108	wnwi1_u		138	tvlrhi2	
109	wnwi2_u		139	frhol_u	
110	tanwrhf_0_A		140	tnse_u	
111	tanwrhf_1_A		141	rkrn_u_0	
112	vfzg2		142	rkrn_u_1	
113	adhfm_u	adc_hfm	143	rkrn_u_2	
114	adtm_u	adc_tm	144	rkrn_u_3	
115	adta_u	adc_ta	145	rkrn_u_4	
116	adtka_u	adc_tka	146	rkrn_u_5	
117	addsu_u	adc_dsu	147	rkrn_u_6	
118	wdknlpr_u		148	rkrn_u_7	
119	ikrmet		149	flgtiab	
120	tkatmf		150	fstt	
121	tkatmf2		151	iptref	
122	tabgmf		152	tdmlka	
123	tabgmf2		153	iptumv	
124	phlsnv		154	iptgh	
125	phlsnv2		155	u5ref1	
126	phlsnh		156	u5ref2	
126	phlsnh		156	u5ref2	
127	phlsnh2				
128	igod_u				
129	ikrma				
157-255	not used	Ergänzung bis max. Nr.255 ausschließlich durch den Projektverantwortlichen			

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ABK DFFTK 2.70 Abbreviations

FB DFFTK 2.70 Detailed description of function

APP DFFTK 2.70 Application hint

DFFTCNV 1.51 Diagnosis; freeze frame table, conversion to bytes

FDEF DFFTCNV 1.51 Function definition

Alle für die Fehlerspeicherung benötigten Umweltwerte, die nicht als Byte-Wert vorliegen, werden in dieser Funktion z.B. aus Word-Größe xxx_w auf Byte-Größe xxx_u umgerechnet und für %DFFTx.y und %DFFTKx.y bereitgestellt.

Im vorliegenden Fall sind dies folgende Umrechnungen:

Basiswert mit Umr.	Byte-Wert	Quantisierung	Datentyp
rl_w *1)	rl_u		unsigned byte
upwg1_w / 4	upwg1_u	spg_ub_b5	unsigned byte
upwg2_w / 4	upwg2_u	spg_ub_b5	unsigned byte
upwg2d_w / 4	upwg2d_u	spg_ub_b5	unsigned byte
udkp1_w / 16	udkp1_u	spg_ub_b5	unsigned byte
udkp2_w / 16	udkp2_u	spg_ub_b5	unsigned byte
rinv_w / 32	rinv_u	r_ub_q64	unsigned byte
rinv2_w / 32	rinv2_u	r_ub_q64	unsigned byte
rinh_w / 32	rinh_u	r_ub_q64	unsigned byte
rinh2_w / 32	rinh2_u	r_ub_q64	unsigned byte
tpsvkmf_w / 4	tpsvkmf_u	t10msxs_ub_b10p2	unsigned byte
tpsvkmf2_w / 4	tpsvkmf2_u	t10msxs_ub_b10p2	unsigned byte
fr_w / 256	fr_u	fak_ub_b2	unsigned byte
fra_w / 256	fra_u	fak_ub_b2	unsigned byte
fr2_w / 256	fr2_u	fak_ub_b2	unsigned byte
fra2_w / 256	fra2_u	fak_ub_b2	unsigned byte
udkp1a_w / 16	udkp1a_u	spg_ub_q0p019	unsigned byte
igokr_w / 256	igokr_u	spgg_sb_b3052	signed byte
uusvk_w / 4	uusvk_u	spg_ub_b5	unsigned byte
uusvk2_w / 4	uusvk2_u	spg_ub_b5	unsigned byte
uushk_w / 4	uushk_u	spg_ub_b5	unsigned byte
uushk2_w / 4	uushk2_u	spg_ub_b5	unsigned byte
wnwi1_w / 256	wnwi1_u	wkw_sb_b128	signed byte
wnwi2_w / 256	wnwi2_u	wkw_sb_b128	signed byte
	adhfm_u		unsigned byte (0..255, 0..5V, kommt direkt aus der A/D-Trommel)
wtmot	adtm_u		signed byte
wtans	adta_u		signed byte
wtka	adtka_u		signed byte

"*1) (255 * rl_w / rlugd_w) * (nmot_w / NMAX)

Basiswert mit Umr.	Byte-Wert	Quantisierung	Datentyp	
	addsu_u		unsigned byte (0..255, 0..5V, kommt direkt aus der A/D-Trommel)	
igod_w / 256	igod_u			##
lamsons_w / 256	lamsons_u			##
lamsons2_w / 256	lamsons2_u			##
frm_w / 256	frm_u			##
frm2_w / 256	frm2_u			##
tmotlin	tmot_u	temp_ub_q1_040	entspr. SAE-Quantisierung	##
vfzg	vfzg_u	vfzg_q1p0	entspr. SAE-Quantisierung	##
frhol_w / 256	frhol_u	fak_ub_b2	unsigned byte	
tnse_w / 256	tnse_u	t2p56sxs_ub_b6528	unsigned byte	
wdknlp_w / 256	wdknlp_u		unsigned byte	
wdknlpr_w / 256	wdknlpr_u		unsigned byte	
rkrn_w_(i)	rkrn_u_(i)	spg_q0p625	unsigned byte	

ABK DFFTCNV 1.51 Abbreviations

Variable	Source	Type	Description
ADDSU_U	DFFTCNV	AUS	ADC measured value ambient pressure sensor
ADHFM_U	DFFTCNV	AUS	AD value of mass airflow meter
ADTA_U	DFFTCNV	AUS	measured ADC value of intake air temperature
ADTKA_U	DFFTCNV	AUS	measured ADC value for coolant outlet temperature; DFPM env. conds.
ADTM_U	DFFTCNV	AUS	ADC measured value of cooling water temperature: DTPM env. cond.
FR2_U	DFFTCNV	AUS	Lambda controller output (byte)
FR2_W	LR	EIN	Lambda controller output (word)
FRA2_U	DFFTCNV	AUS	multiplicative correction of the mixture adaptation (byte)
FRA2_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FRA_U	DFFTCNV	AUS	multiplicative correction of the mixture adaptation (byte)
FRA_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FRM2_U	DFFTCNV	AUS	fast mean value of lambda control factor bank 2
FRM2_W	LR	EIN	fast mean value of lambda control factor bank 2(word)
FRM_U	DFFTCNV	AUS	fast mean value of lambda control factor
FRM_W	LR	EIN	fast mean value of lambda control factor (word)
FR_U	DFFTCNV	AUS	Lambda controller output (byte)
FR_W	LR	EIN	Lambda controller output (word)
IGOD_U	DFFTCNV	AUS	integrator gradient for zero test diagnosis knock control

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Variable	Source	Type	Description
IGOD_W	GGKS	EIN	integrator gradient for zero test diagnosis knock control
IGOKR_U	DFFTCNV	AUS	integrator gradient for offset correction knock control (byte)
IGOKR_W		EIN	integrator gradient for offset correction knock control (word)
LAMSONS2_U	DFFTCNV	AUS	required lambda referred to lambda sensor fitting location bank2
LAMSONS2_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_U	DFFTCNV	AUS	required lambda referred to lambda sensor fitting location
LAMSONS_W	LAMKO	EIN	required lambda referred to lambda sensor fitting location
RINH2_U	DFFTCNV	AUS	Act. value (byte) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH2_W	GGLSH	EIN	Act. value (word) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH_U	DFFTCNV	AUS	Actual value (byte) internal res. Ri-Nernst cell lambda sensor downstream cat
RINH_W	GGLSH	EIN	Actual value (word) internal res. Ri-Nernst cell lambda sensor downstream cat
RINV2_U	DFFTCNV	AUS	Actuel value of internal resistance of lambda sensor 2, pre cat (byte)
RINV2_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor 2, pre ca
RINV_U	DFFTCNV	AUS	Actuel value of internal resistance of lambda sensor,pre cat (byte)
RINV_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor,pre cat (word)
RKRN_U_0	DFFTCNV	AUS	normalized knock-control reference level (byte), SW cylinder 0
RKRN_U_1	DFFTCNV	AUS	normalized knock-control reference level (byte), SW cylinder 1
RKRN_U_2	DFFTCNV	AUS	normalized knock-control reference level (byte), SW cylinder 2
RKRN_U_3	DFFTCNV	AUS	normalized knock-control reference level (byte), SW cylinder 3
RKRN_U_4	DFFTCNV	AUS	normalized knock-control reference level (byte), SW cylinder 4
RKRN_U_5	DFFTCNV	AUS	normalized knock-control reference level (byte), SW cylinder 5
RKRN_U_6	DFFTCNV	AUS	normalized knock-control reference level (byte), SW cylinder 6
RKRN_U_7	DFFTCNV	AUS	normalized knock-control reference level (byte), SW cylinder 7
RKRN_W_0		EIN	reference pegel nominaized for knock regulation
RKRN_W_1		EIN	reference pegel nominaized for knock regulation
RKRN_W_2		EIN	reference pegel nominaized for knock regulation
RKRN_W_3		EIN	reference pegel nominaized for knock regulation
RKRN_W_4		EIN	reference pegel nominaized for knock regulation
RKRN_W_5		EIN	reference pegel nominaized for knock regulation
RKRN_W_6		EIN	reference pegel nominaized for knock regulation
RKRN_W_7		EIN	reference pegel nominaized for knock regulation
RL_U	DFFTCNV	AUS	relative air charge (byte) for ambient cond. of fault code memory
RL_W	EGFE	EIN	relative air charge (Word)
TMOTLIN	GGTFM	EIN	Engine coolant temperature, linearised and calculated
TMOT_U	DFFTCNV	AUS	Engine temperature with defined quantisation for FSP-freese frame
TPSVKMF2_U	DFFTCNV	AUS	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (byte)
TPSVKMF2_W	DLSA	EIN	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (word)
TPSVKMF_U	DFFTCNV	AUS	filtered cycle duration of sensor signal upstream cat. (byte)
TPSVKMF_W	DLSA	EIN	filtered cycle duration of sensor signal upstream cat. (word)
UDKP1A_U	DFFTCNV	AUS	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop (byte)
UDKP1A_W	BGDVE	EIN	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop (word)
UDKP1_U	DFFTCNV	AUS	sensor voltage from throttle-valve potentiometer 1 (byte)
UDKP1_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UDKP2_U	DFFTCNV	AUS	sensor voltage from throttle-valve potentiometer 2 (byte)
UDKP2_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UPWG1_U	DFFTCNV	AUS	Voltage PWG potentiometer 1 (byte)
UPWG1_W	GGPEDV	EIN	Voltage PWG potentiometer 1 (word)
UPWG2D_U	DFFTCNV	AUS	Doubled PWG potentiometer-2 voltage (byte)
UPWG2D_W		EIN	Doubled PWG potentiometer-2 voltage (word)
UPWG2_U	DFFTCNV	AUS	Voltage PWG potentiometer 2 (byte)
UPWG2_W	GGPEDV	EIN	Voltage PWG potentiometer 2 (word)
UUSHK2_U	DFFTCNV	AUS	ADC-voltage lambda sensor downstream catalyst bank2 (byte)
UUSHK2_W		EIN	ADC-voltage lambda sensor downstream catalyst bank2 (word)
UUSHK_U	DFFTCNV	AUS	ADC-voltage lambda sensor downstream catalyst (byte)
UUSHK_W		EIN	ADC-voltage lambda sensor downstream catalyst (word)
UUSVK2_U	DFFTCNV	AUS	ADC voltage for lambda sensor upstream of catalyzer 2 (byte)
UUSVK2_W		EIN	ADC voltage for lambda sensor upstream of catalyzer 2 (Word)
UUSVK_U	DFFTCNV	AUS	ADC voltage for lambda sensor upstream of catalyzer (byte)
UUSVK_W		EIN	ADC voltage for lambda sensor upstream of catalyzer (Word)
VFZG	GGVFZG	EIN	vehicle speed (km/h)
VFZG_U	DFFTCNV	AUS	Vehicle speed
WNWI2_U	DFFTCNV	AUS	actual shifting angle of the camshaft 2 (byte)
WNWI2_W		EIN	actual shifting angle of the camshaft 2 (word)
WNWI_U	DFFTCNV	AUS	actual shifting angle of the camshaft (byte)
WNWI_W	WANWKW	EIN	actual shifting angle of the camshaft (word)

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FB DFFTCNV 1.51 Detailed description of function

APP DFFTCNV 1.51 Application hint

DTRIG 1.10 OBDII; Selectable trigger for fault path management

FDEF DTRIG 1.10 Function definition

The following trigger events are selectable by the shown number: for more info see ——>%DCLA

number	trigger	comment
0	B_no	no trigger selected
1	B_tim	timetrigger, Quantification according ——>%DFPMx.y
2	B_dcy	Driving Cycle, see ——>%DDCYx.y
3	B_wuc	Warm Up Cycle, see ——>%DWUCx.y
4	B_sp1	special trigger 1 see ——>%DMDMILx.y
5	B_sp2	special trigger 2 see ——>%DMDMILx.y
6	B_sp3	special trigger 3 see ——>%DKVSx.y

ABK DTRIG 1.10 Abbreviations

Variable	Source	Type	Description
B_DCY	DDCY	EIN	condition for 'driving cycle' fulfilled
B_NO	DTRIG	LOK	Infinite-trigger of the fault path manager
B_SP1	DMDMIL	EIN	FLC-trigger of misfire detection
B_SP2	DMDMIL	EIN	HLC-trigger of misfire detection
B_SP3		EIN	special cycle trigger diagnosis fuel supply system
B_TIM	DTRIG	LOK	time trigger for fault path management
B_WUC	DWUC	EIN	condition for detected 'warm up cycle'

FB DTRIG 1.10 Detailed description of function

APP DTRIG 1.10 Application hint

BGRML 1.20 Calculation Value of Relative Air Mass according to SAE J1979 Mode $01 + $02 PID

FDEF BGRML 1.20 Function definition

SY_TURBO = 0:

SY_TURBO = 1:

ABK BGRML 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
MLMAX			FW	maximum air-quantity for load calculation SAE J1979

Variable	Source	Type	Description
FPVDK_W	EGFE	EIN	correction factor for pressure upstream of throttle valve, 16-bit
ML_W	EGFE	EIN	air mass flow filtered (Word)
RML	BGRML	AUS	relative air mass (calc. load value) acc. to SAE J1979

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FB BGRML 1.20 Detailed description of function

Areas of utilization such as e.g. the SCAN TOOL transfer according to SAE J1979 necessitate the variable "relative air mass" (rml), also referred to as "Calculated Load Value" (CLV) in the SAE J1979. In accordance to SAE J1979 the formula is:

$$CLV = \frac{\text{Current airflow}}{\text{Peak airflow (@sea level)}} * \frac{\text{Atmospheric pressure (@sea level)}}{\text{Barometric pressure}} * 100\ \%$$

Derived from this the following results

a) for an aspirating engine (SY_TURBO = 0):

$$rml = \frac{ml_w}{MLMAX * fpvdk_w} * 100\%$$

b) for a turbo engine (SY_TURBO = 1):

$$rml = \frac{ml_w}{MLMAX} * 100\%$$

On systems with turbo charger the inclusion of altitude correction factors is dropped!

The calculation of rml is performed for a) + b) with the quantization 0 ... 255 dec corresponds to 0 ... 100 % .
The calculation is to be performed every 100 ms.

APP BGRML 1.20 Application hint

Determination of MLMAX:
MLMAX corresponds to the peak airflow of the engine at fully open throttle valve and high engine speed.
The value MLMAX is usually known to engine manufacturers and is to be adjusted in agreement with the customer.

Example (with open throttle valve):

DUMWEX 3.10 Extended ambient conditions

FDEF DUMWEX 3.10 Function definition

With new fault path entry or -update the following ambient conditions are stored additionally to FFTdfp in the FCM:

Mileage : kmstand Quantification see -->%CANINS
SY_dfpmtim = 2

ABK DUMWEX 3.10 Abbreviations

Variable	Source	Type	Description
KMSTAND	CANINS	EIN	Route of the vehicle as information via CAN
SY_DFPMTIM		EIN	system constant: Time info in fault code memory

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FB DUMWEX 3.10 Detailed description of function

APP DUMWEX 3.10 Application hint

DDCY 14.0 OBDII; fulfillment condition 'driving cycle'

FDEF DDCY 14.0 Function definition

ABK DDCY 14.0 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TWBDCY			FW	waiting time for condition 'driving cycle'

Variable	Source	Type	Description
BBDCY	DDCY	AUS	Byte for condition B_dcy as trigger relevant in DCLA
B_DCY	DDCY	AUS	condition for 'driving cycle' fulfilled
B_STEND	BBSTT	EIN	condition end of start
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation

FB DDCY 14.0 Detailed description of function

TWBDCY seconds after engine start the 'driving cycle' condition B_dcy is set and stored untill end of cycle.
With change of B_dcy 0 -> 1 inside the fault path manager all dcy-actions are run by method 'fcmTrig(B_dcy) once per cycle.

With deletion of the fault code memory via C_fcmclr (even with running engine) B_dcy is reset and TWBDCY is started again.

APP DDCY 14.0 Application hint

Default value for TWBDCY: 5 sec; this for sure running of the engine in advance of 'sharpness' of the system.
TWBDCY >> 5 sec gives more security, has to be CARB declared case by case.

DWUC 13.0 OBDII; fulfillment condition 'warm up cycle'

FDEF DWUC 13.0 Function definition

ABK DWUC 13.0 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DTMWUC			FW	delta engine temperture threshold for fulfilment "warm up cycle"
TMWUC			FW	engine temperture threshold for fulfilment "warm up cycle"
TMWUCST			FW	engine temperture threshold during cranking for fulfilment "warm up cycle"

Variable	Source	Type	Description
BBWUC	DWUC	AUS	Byte for condition B_wuc as trigger relevant in DCLA
B_STEND	BBSTT	EIN	condition end of start
B_WUC	DWUC	AUS	condition for detected 'warm up cycle'
C_FCMCLR		EIN	system state: reset fault memory

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Variable	Source	Type	Description
C_INI		EIN	ECU-condition for intialisation
TMOT	GGTFM	EIN	Engine temperature
TMSTEM	DWUC	LOK	engine temperature at end of start memorized

FB DWUC 13.0 Detailed description of function

Following an engine start below the start temperature TMWUCST with subsequent heating by min. DTMWUC and attainment of the upper temperature threshold TMWUC, the running cycle is assigned the status ’warm-up cycle’ with B_wuc = 1.

During the start (B_st = 1), tmstem is continuously updated and remains stored at the start end (B_st 1->0) for the engine run.
An update for tmstem is performed once for deletion of the fault memory (e.g. for a running engine as well).
Amongst others, B_wuc is also reset by the command ’Delete fault memory’ in C_fcmclr.

The corresponding debounce measures are executed by initiating with fcmTrig(B_wuc) when the ’warm up cycle’ is fulfilled. -> %DFPM

APP DWUC 13.0 Application hint

```
Recommended values:   DTMWUC  =   21.00 deg. C
                      TMWUC   =   71.25 deg. C
                      TMWUCST = < 69.75 deg. C
```

DIMC 28.30 OBDII; inspection/maintenance-ready

FDEF DIMC 28.30 Function definition

If the fault memory has been deleted (by a possible tester command or a power failure), it may be necessary to first output a code ’ready’ to the tester upon request which indicates that not all of the required tests for faults from the OBD system have been performed.

This means that each fault test for faults relevant to the exhaust emission given in ’evsup1’ must reset a permanently stored preset bit as soon as the test has been completed in accordance with procedures (regardless of whether the result is ’acceptable’ or ’discrepant’).

As CARB couples the number of tests for reaching readiness with the MIL on - debounce (e.g. 2 driving cycles), the number of the previous driving cycles since a power failure or a deletion of the memory must be included in the assessment, at least in for the first suspected fault. To do this, a corresponding counter is cry... is run with each ’ready’ function.

Structure of the path identifier ’evsup1’ and the readiness byte ’ready’ due to SAE J1979 (Mode 1 PID 1 Data C + D):

B_cdagr	B_cdhsv	B_cdlsv	0	B_cdsls	B_cdtes or B_cddmtl or B_cdldp	B_kath	B_cdkat & B_katfz
7	6	5	4	3	2	1	0
v	v	v	v	v	v	v	v
B_agrrdy	B_hsrdy	B_lsrdy	0	B_slsrdy	B_tesrdy	B_kathrdy	B_katrdy
7	6	5	4	3	2	1	0

Byte ’evsup1’ includes the designation of the currently installed test paths as required in SAE J1979 Mode 1 PID 1 Data C.

Following fault memory deletion or power fail, ’ready’ is described with ’evsup1’.

Byte ’ready’ includes the momentary test status of the installed test paths as required in SAE J1979 Mode 1 PID 1 Data C.

The bits for faults not present in the respective system are left as ’0’ during initialization.
(e.g. Bit 1: catalyzer heating system; Bit 4: air-conditioner coolant)

Each fully completed fault check of a path, irrespective of whether ’fault’ or ’no fault’ has been detected, increments the ready counter cry... until the maximum value of each is reached (255) and are maintained there without overflow.

The ’ready’ condition is fulfilled when all B_...rdy - flags in the flag byte ’ready’ = 0.

Formation of the ’evsup’ byte:

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Formation of the 'ready' byte:

ABK DIMC 28.30 Abbreviations

Variable	Source	Type	Description
B_CDHSV	PROKON	EIN	function active per codeword CDHSV
B_CDLDP	PROKON	EIN	function active per codeword CDLDP
B_CDLSV	PROKON	EIN	function active per codeword CDLSV
B_CDSLS	PROKON	EIN	function active per codeword CDSLS

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Variable	Source	Type	Description
B_CDTES	PROKON	EIN	function active per codeword CDTES
B_HSRDY	DIMC	AUS	status O2 sensor heater tested for ”ready byte”
B_KATFZ	PROKON	EIN	condition: cat fitted in vehicle
B_KATH	PROKON	EIN	Condition cat-heater installed in vehicle
B_KATRDY	DIMC	AUS	status catalyst tested for ”ready byte”
B_LSRDY	DIMC	AUS	status O2 sensors tested for ”ready byte”
B_PWF		EIN	Condition for powerfail
B_SLSRDY	DIMC	AUS	status SAI system tested for ”ready byte”
B_TESRDY	DIMC	AUS	status purge system tested for ”ready byte”
C_FCMCLR		EIN	system state: reset fault memory
C_INI		EIN	ECU-condition for intialisation
EVSUP1	DIMC	AUS	function identifier for support SAE J1979 mode 2
E_HSH	DHLS	EIN	error flag: lambda sensor heating downstream cat
E_HSH2	DHLS	EIN	error flag: lambda sensor heating downstream cat on the right
E_HSV	DHLS	EIN	error flag: lambda sensor heating upstream cat
E_HSV2	DHLS	EIN	error flag: lambda sensor heating upstream cat on the right
E_KAT	DKAT	EIN	error flag: catalyst conversion
E_KAT2	DKAT	EIN	error flag: catalyst conversion (cylinder row 2)
E_LASH	DLSAHK	EIN	error flag: lambda sensor aging downstream cat
E_LASH2	DLSAHK	EIN	error flag: lambda sensor aging downstream cat (cylinder row 2)
E_LATP	DLSA	EIN	error flag: lambda sensor aging tp
E_LATP2	DLSA	EIN	error flag: lambda sensor aging tp (cylinder row 2)
E_LATV	DLSA	EIN	error flag: lambda sensor aging tv
E_LATV2	DLSA	EIN	error flag: lambda sensor aging tv (cylinder row 2)
E_LSH	DLSH	EIN	error flag: lambda sensor downstream cat
E_LSH2	DLSH	EIN	Errorflag: Lambda-Sensor downstream bank2
E_LSV	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_LSV2	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_SLS	DSLSLR	EIN	error flag: secondary air system
E_SLS2	DSLSLR	EIN	error flag: secondary air system, cylinder row 2
E_TES	DTEVN	EIN	error flag: canister purge system diagnosis
E_TESK	DLDP	EIN	error flag: evap system monitoring - smallest leak
READY	DIMC	AUS	readiness byte for support SAE J1979 mode 2
Z_HSH	DHLS	EIN	cycle flag of lambda sensor heating downstream cat
Z_HSH2	DHLS	EIN	cycle flag of lambda sensor heating downstream cat, cylinder row 2
Z_HSV	DHLS	EIN	cycle flag of lambda sensor heating upstream cat
Z_HSV2	DHLS	EIN	cycle flag of lambda sensor heating upstream cat, cylinder row 2
Z_KAT	DKAT	EIN	cycle flag of catalyst conversion
Z_KAT2	DKAT	EIN	cycle flag: catalyst conversion (2nd bank)
Z_LASH	DLSAHK	EIN	cycle flag of lambda sensor aging downstream cat
Z_LASH2	DLSAHK	EIN	cycle flag of lambda sensor aging downstream cat, cylinder row 2
Z_LATP	DLSA	EIN	cycle flag of lambda sensor aging tp
Z_LATP2	DLSA	EIN	cycle flag of lambda sensor aging tp (cylinder row 2)
Z_LATV	DLSA	EIN	cycle flag of lambda sensor aging tv
Z_LATV2	DLSA	EIN	cycle flag of lambda sensor aging tv (cylinder row 2)
Z_LSH	DLSH	EIN	cycle-flag: lambda sensor downstream cat
Z_LSH2	DLSH	EIN	cycle-Flag: Lambda-sensor downstream cat bank2
Z_LSV	DLSV	EIN	cycle flag: lambda sensor upstream of catalyst
Z_LSV2	DLSV	EIN	cycle flag: 2nd lambda sensor upstream of catalyst
Z_SLS	DSLSLR	EIN	cycle flag: secondary air system
Z_SLS2	DSLSLR	EIN	cycle flag: secondary air system bank 2
Z_TES	DTEVN	EIN	cycle flag of canister purge system
Z_TESK	DLDP	EIN	cycle flag of evap system monitoring - smallest leak

FB DIMC 28.30 Detailed description of function

```
Readiness Flag for Evap. System Leak Check:
Readiness code for evap could be set to complete based on the 0.040" diagnostic
and not wait for the 0.020".
```

APP DIMC 28.30 Application hint

```
The values of for the counter SRY.. are derived from the dating of the corr. FLC.., refer to Classtab (Standard MY97 is 2)
```

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DMIL 28.30 OBDII; MIL control

FDEF DMIL 28.30 Function definition

dmil-dmil

Faults which the MIL shall not control, can be dated accordingly (--> Classification table %DFPM)

ABK DMIL 28.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWNOMIL			FW	code word MIL-control not active
TLAED			FW	waiting time until fault lamp off after start

Variable	Source	Type	Description
B_BLKEB	DMIL	LOK	MIL activation blinking by own module
B_BLKFB		EIN	MIL-trigger blinking controlled by external ECU
B_BLKMD	DMDMIL	EIN	MIL-trigger blinking controlled by misfire detection
B_KMMIL	DMIL	AUS	MIL turn-on related to mileage
B_MIL	DMIL	AUS	MIL turn-on
B_MILBLK	DMIL	LOK	MIL turn-on blinking
B_MILFB		EIN	MIL controlled by external ECU
B_MILMD	DMDMIL	EIN	MIL-trigger on controlled by misfire detection, during ti turn-off
B_MILST	DMIL	LOK	MIL turn-on, test function during start
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_NOKATFZ	KATV	EIN	condition: no cat vehicle
C_FCMCLR		EIN	system state: reset fault memory
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_NACHL		EIN	ECU condition for ECU switch off delay

FB DMIL 28.30 Detailed description of function

Legislation requires the display of faults relevant to exhaust emission by a fault lamp (MIL) in the instrumentation board.
The fault lamp may not be used for other purposes.
It shall display one of the following signs when triggered:
-Check Engine-; -Service Engine Soon-; -Check Powertrain- or -Service Powertrain Soon-

The MIL must illuminate for Ignition ON and standing engine for functional control.

For detected faults which are relevant to exhaust emission, the MIL must illuminate at latest following debounce of the legally permissible fault detection.

For special faults (e.g. detection of misfire rates damaging to the catalyzer), the MIL must blink immediately with 1 Hz.

The MIL may extinguish at the earliest after the legally permissible rectification debounce following detected rectification of all faults.

The MIL may only be controlled by one master SG on account of the checking function for ignition ON and the output stage diagnostics. Other SG's send requests for lamp control to this master SG, e.g. via CAN.

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APP DMIL 28.30 Application hint

Set TLAED to 3 seconds.

BGKMST 5.10 Calculation of odometer value (Km)

FDEF BGKMST 5.10 Function definition

bgkmst-bgkmst

bgkmst-kmst-fz

ABK BGKMST 5.10 Abbreviations

Variable	Source	Type	Description
B_INS2COK	CANINS	EIN	condition: CAN-message INSTR2 received
B_KMMIL	DMIL	EIN	MIL turn-on related to mileage
B_NMOT	BGNMOT	EIN	condition engine speed: n > NMIN
B_PWF		EIN	Condition for powerfail
C_FCMCLR	BGKMST	LOK	system state: reset fault memory
KMSTAND	CANINS	EIN	Route of the vehicle as information via CAN
KMSTMIL_W	BGKMST	AUS	Drive distance with MIL on

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Variable	Source	Type	Description
KMST_W	BGKMST	AUS	Drive distance since last power fail
R_T1000		EIN	Time schedule 1000 ms
VFZG_U	DFFTCNV	EIN	Vehicle speed

FB BGKMST 5.10 Detailed description of function

```
EOBD fordert die Erfassung der mit aktivierter MIL zurückgelegten Fahrstrecke.
Diese wird in kmstmil_w aus der Fahrgeschwindigkeit vfzg_u aufintegriert.
Die Quantisierung und Ausgabe von kmstmil_w erfolgt gemäß SAE J1979, Mode 1, PID$21.  ->%TC1MODx.y

Für Kundendiensttester wird zusätzlich die Fahrstrecke kmst_w seit powerfail ermittelt.
```

APP BGKMST 5.10 Application hint

```
Zur Steuerung der Funktion über B_kmmil wird eine entsprechend angepasste DMIL benötigt.  ->%DMIL
Achtung: B_kmmil ermittelt nur den MIL-Status der Motorsteuerung, andere Systeme müssen eine entsprechende
Funktion aufweisen.
Zur Werteausgabe ist eine entsprechend angepasste SCAN-TOOL-Kommunikation nötig:    ->%TC1MOD
```

DTIP 1.20 OBDII; tester interface package

FDEF DTIP 1.20 Function definition

```
The following methods to get interaction with an external scan tool via according interface are supported:

getErrCnt       readout of the number of emission related fault entries

getErrLine()    readout of the specific line of the fault code memory
                content of the line see -->%DFCMx.y

getErrDfp()     readout of the specific fault path of the fault code memory
                content of the line see -->%DFCMx.y

delFCM          deletion of the complete fault code memory FCM with status array sfpdfp and possibly parts of diagnostic functions

delErrDfp()     deletion of this specific fault path entry with status array sfpdfp and possibly parts of the diagnostic function.

getInfoLine()   readout of short info out of selected FCM line (Byte 0  to  Byte 5); see -->%DFCMx.y

getInfoDfp()    readout of short info out of this specific fault path entry (Byte 0  to  Byte 5); see -->%DFCMx.y

    readout of the fault code memory by OBDII scan tool                                -->%SCATTx.y
                                  or servive tester e.g. KTS500                        -->%T2...x.v; %TK...x.y

Additionally the CARB freeze frame no.0 is selected for output to scan tool according SAE J1972 mode 2.
```

ABK DTIP 1.20 Abbreviations

FB DTIP 1.20 Detailed description of function

APP DTIP 1.20 Application hint

OBDSV 1.20 OBD status management

FDEF OBDSV 1.20 Function definition

obdsv-ffext

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obdsv-dmfb

Decoding obdsteuer:

Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Funktion
x	x	x	x	x	1	condition warm-up cycle (B_wuc=1)
x	x	x	x	1	x	condition trip (B_trip=1)
x	x	x	1	x	x	condition driving cycle (B_dcy=1)
0	0	0	x	x	x	no request FF
0	0	1	x	x	x	request FF by DME
0	1	0	x	x	x	request FF by EGS

ABK OBDSV 1.20 Abbreviations

Variable	Source	Type	Description
A	OBDSV	LOK	vector ECU-states
B_BLKFB	OBDSV	LOK	MIL-trigger blinking controlled by external ECU
B_EGSCOK	CANEGS	EIN	Condition: CAN message of the gearbox is received
B_FCMCLR		EIN	condition fault memory clear
B_MILFB	OBDSV	LOK	MIL controlled by external ECU
B_PWF		EIN	Condition for powerfail
B_XFF	OBDSV	LOK	condition external freeze frame
C_PWF		EIN	ECU-condition powerfail initialisation
E_CGE	DCGE	EIN	error flag: CAN-interface timeout EGS
FFZDFP		EIN	fault path identification number (dfp) of freeze frame zero
OBDSTEGS	CANEGS	EIN	From CAN signal, OBD_STAT_GS Conditioned parameter for ME

FB OBDSV 1.20 Detailed description of function

APP OBDSV 1.20 Application hint

SCATT 20.30 SCAN TOOL-tester interface

FDEF SCATT 20.30 Function definition

```
I n t e r f a c e  and  d a t a  t r a n s f e r
Interface and data transfer are defined in ISO 9141-2.
Telegram format, mode 1 - 8 as well as the PIDs are defined in SAE J1979.

Mode 1: transfer of the measured values of all ECUs                                  ——> %TC1MOD
Mode 2: transfer of the ambient conditions of all ECUs (freeze frame) at fault detection  ——> %TC2MOD
Mode 3: transfer of the fault codes from stored emmission related faults
Mode 4: deletion of fault code memory with reset of association stored data (freeze frame etc.)
Mode 5: transfer of the oxygen sensor values                                         ——> %TC5MOD
Mode 6: transfer of test values and test limits from none continuous tested functions  ——> %TC6MOD
        (misfire detection, fuel system, comprehensive components)
Mode 7: transfer of the fault codes from stored pending fault codes
Mode 8: request control of on-board system, test or component                        ——> %TC8MOD
```

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C o m m u n i c a t i o n a c t i v a t i o n
The Communication activation is corresponding with ISO 9141-2 and the specification from the German Car Manufacturer working group.
Caution! For some PID's / TID's that are not supportet, an empty message may be returned.
Maximum support is mode 1 to 8!

SAE J1979 modes 3, 4 and 7 are included in this desciption.
The modes 1, 2, 5, 6 and 8 are describted in %TC*MOD x.y (* = 1, 2, 5, 6 and 8).

M o d e 3

The basis of this section is SAE J1979 mode 3:
The mode 3 is designed to give an access on the confirmed fault codes, that are CARB relevant.
Only the fault codes with (fes.scatt = 1) & (fes.dauer = 1) in the fault path statusbyte will be indicated.
The storage and output are chronological.
The function TCSORT is able to separate the fault codes output.
With empty fault code memory the response 00.
Fault code structure see --> %DFPM.

M o d e 4
The basis of this section is SAE J1979 mode 4:
The mode 4 is designed to erase the CARB relevant debounced fault codes from the fault memory.
After GST request the following steps will happen:
- fault memory including fault counter and freeze frame data will be erased
- measured oxygen sensor values refering mode 5 will be erased
- basis data refering mode 1 PID $01 (readiness) will be reset
- monitoring test results refering mode 6 and 7 will be erased

M o d e 7
The basis of this section is SAE J1979 mode 7:
Mode 7 shall permit access to stored but not yet confirmed fault, relevant to CARB for fault detection
((fes scatt = 1) & (fes.dauer = 0) & (dfp not in Mode 6)).
The storage and output are chronological.
The function TCSORT is able to separate the fault codes output.
With empty fault code memory the response is 00.
Fault code structure see --> %DFPM.

ABK SCATT 20.30 Abbreviations

ISO: International Organisation for Standardization
SAE: Society of Automotive Engineers, Inc.

Variable	Source	Type	Description
SY_DELFCMS		EIN	system constant: selection of the reset routine for scan tool mode $04
SY_ISOPROT		EIN	System constant: tester protocol selection of the ISO-standards for scan tool

FB SCATT 20.30 Detailed description of function

The function of the interface is described by the above mentioned standards:
ISO9141-2: description of the hardware requests, the initialization of the diagnosis and the timing
SAE J1979: description of the protocol and the contents SAE J1979 refers to some other SAE standards,
in which further information is written

APP SCATT 20.30 Application hint

TC1MOD 20.80 Tester communication CARB; Mode 1

FDEF TC1MOD 20.80 Function definition

General:
Basis of this description is SAE J1979 Mode $01:
Mode $01 shall enable access to the momentary resp. most current exhaust gas relevant data.
In the process only the o r i g i n a l m e a s u r e d v a l u e s (so e.g. no default values) are permitted.

The selection of the transfer protocol is performed prior to the compiler run via the system constant SY_ISOPROT.
SY_ISOPROT = 0 (=Default): communication according to ISO 9141-2
SY_ISOPROT = 1 : communication according to ISO 14230-4
For each ECU only one transfer protocol is realized.

SY_ISOPROT = 0 (communication according to ISO 9141-2):
Only those PID's are responded to, which are reported as being supported by PID $00.

SY_ISOPROT = 1 (communication according to ISO 14230-4):
When a not supported PID is requested the following message (negative response) is created:

No.	Mnemonic	Description
12h	SFNS-IF	subFunctionNotSupported-invalidFormat

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PID $00: Bit-coded transfer of the PID's supported by the ECU (PID $00 must by all means be contained in Mode 1).

Distribution of the system constants SY_M1I00A, SY_M1I00B, SY_M1I00C a. SY_M1I00D:

Configuration:	SY_M1I00A	SY_M1I00B	SY_M1I00C	SY_M1I00D
DATA:	A	B	C	D
DATA Byte #:	3	4	5	6
Bit:	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
PID in hex:	01 02 03 04 05 06 07 08	09 0A 0B 0C 0D 0E 0F 10	11 12 13 14 15 16 17 18	19 1A 1B 1C 1D 1E 1F 20

The PID's $20; $40; $60; $80; $A0; $C0 and $E0 are dealt with analogous.
DATA A - D (SY_M1I00A - SY_M1I00D): Is entered by the SW developer.
The structure of PID $20 is similar to PID $00, however, for the PID's $21 - $40 and so on.

0 = PID n is not supported in Mode 1 (not supported)
1 = PID n is supported in Mode 1 (supported)

PID $01: Number of emission-related powertrain Trouble codes and MIL status
DATA A:
Bit 0 to 6: Number of codes stored in this module
The fault code memory is searched for entered, debounced and CARB-relevant faults.
Stored misfire faults are filtered via the function %TCSORTx.y, thereafter the amount of faults is adjusted.
This amount is entered into DATA A bit 0 to 6 (this corresponds to 0 ... 127 dec).

Bit 7: MIL status with 1 = MIL on, 0 = MIL off):
The fault memory is searched for at least one entry with the status "MIL on".

DATA B: Bit-coded identification of the supported continuously active diagnostic routines and of their state:
(0 = not supported, 1 = supported)
Bit 0 = Misfire detection (comes from B_cdmd %PROKONx.y, B_cdmd = 1 corresponds to evsup0_Bit 0 = 1)
Bit 1 = Fuel system (comes from B_cdkvs from %PROKONx.y, B_cdkvs = 1 corresponds to evsup0_Bit 1 = 1)
Bit 2 = Comprehensive Component (set sharp to 1 , since always present)
Bit 3 to 7 set to sharp 0, since not used resp. not necessary in this constellation.
--> Output AKKU - contents in case of request
(AKKU-contents is only given in the request buffer and therefore not readable by VS100)

DATA C: Bit-coded identification of the supported sporadically active diagnostic routines:
(0 = not supported, 1 = supported)
Bit 0 = Catalyst
Bit 1 = Heated catalyst
Bit 2 = Purge control
Bit 3 = Secondary air
Bit 4 = Climatic coolant
Bit 5 = Lambda sensor
Bit 6 = Lambda sensor heater
Bit 7 = Exhaust gas recirculation
--> output evsup1 (comes from DIMC)

DATA D: Bit-coded identification of the test status of the respective function.
(0 = not supported or test is performed, 1 = test not yet performed). Assignment just as with DATA C.
--> Output of the RAM-cell ready from --> %DIMCx.y

PID $02: Is not supported in Mode 1.

PID $03: Output Status Fuel Supply System Bank 1 + 2
DATA A: Bit-coded output of status of fuel-supply system bank 1
Only one of the following bits each may be set to 1:
Bit 0 = Controller readiness not yet reached
Bit 1 = Control active without limitation
Bit 2 = Open loop due to driving condition (fuel cut-off etc.)
Bit 3 = Open loop due to fault
Bit 4 = Control active with limitations
Bit 5 to 7 = not used (are set to 0)
——> Output flglrs, corresponds to the SAE-quantization

DATA B: Bit-coded output of status of fuel-supply system bank 2
Coding like on the 1-bank system (DATA A)
On a 1-bank system (SY_STERVK = false) is set to $00.

```
SY_STERVK ————————┐
                  v
00 hex ————————o ——— o————————————————————————————> output
flglrs2 ———————o
```

(flglrs2 corresponds to the SAE-quantization)

PID $04 DATA A: Calculated load value in percent of the max. load.
SAE-quantization: (Quant = 100%/256)
--> Output rml, corresponds to the SAE-quantization

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```
PID $05 DATA A: Engine coolant temperature
        SAE-quantization: ( $00 = -40 deg. C,  $FF = 215 deg. C, quant = 1 deg. C)
        --> convert tmotlin to the SAE-quantization and output


PID $06 DATA A: Short term fuel trim - Bank 1
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128, 0% at 128)
        ---> output high-byte of fr_w, corresponds to the SAE-quantization


PID $07 DATA A: Long term fuel trim - Bank 1
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128 )
        ---> output high-byte of fra_w, corresponds to the SAE-quantization


PID $08 DATA A: Short term fuel trim - Bank 2
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128 )
        ---> output high-byte of fr2_w, corresponds to the SAE-quantization


PID $09 DATA A: Long term fuel trim - Bank 2
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128 )
        ---> output high-byte of fra2_w, corresponds to the SAE-quantization

PID $0A is not supported.

PID $0B DATA A: Manifold pressure (absolute)
        SAE-quantization: ( $00 = 0 kPa, $FF = 255 kPa, quant = 1 kPa)
        --> output psdss_u  corresponds to the SAE-quantization

PID $0C DATA A: Engine speed high-Byte
        DATA B: Engine speed low-Byte
        SAE-quantization: ($0000 ... $FFFF = 0 ... 16383,75 rpm; 1 incr = 0,25 rpm)
        --> output nmot_w, corresponds to the SAE-quantization

PID $0D DATA A: Vehicle speed
        SAE-quantization: ( $00 = 0 km/h, $FF = 255 km/h, quant = 1 km/h)
        --> vfzg (comes from %GGVFZGx.y with the quantization: 0 ... 318,75 km/h, 1 incr. = 1,25 km/h),
        output after conversion to SAE-quantization.


PID $0E DATA A: Ignition timing advance for #1 cylinder
        SAE-quantization: ($00 = -64,0 deg., $80 = 0 deg., $FF = +63,5 deg., quant = 0,5 deg.)
        ---> zwzyl1 (comes from %ZUE with the quantization: 0,75 deg. KW/incr, -96 - +95,25 deg. KW),
        output after conversion to SAE-quantization.

PID $0F DATA A: Intake air temperature
        SAE-quantization: ( $00 = -40 deg. C, $FF = 215 deg. C, quant = 1 deg. C )
        --> convert tanslin to SAE-quantization and output

PID $10 DATA A: Air mass high-Byte
        DATA B: Air mass low-Byte
        SAE-quantization: ( $0000 = 0 g/sec,  $FFFF = 655.35 g/sec, quant = 0,01 g/sec )
        --> mshfm_w (comes from BGSRMx.y with the quantization: 0 ... 6553,5 kg/h, 0,1 kg/h per incr.)
        output after conversion to SAE-quantization.

PID $11 DATA A: Absolute throttle position sensor
        SAE-quantization: ( $00 = 0 %, $FF = 100 %, quant = 100%/255 )
        --> output wdkba, corresponds to the SAE-quantization

PID $12 DATA A: Commanded secondary air status
        Presently only this constellation is known. If secondary air system is given then injection of air upstream 1st catalyst
        of each bank.
        B_slsfz = 0 in the AKKU corresponds to bit 0 - 7 = 0
        (B_slsfz = 1) & (B_sls = 1) in the AKKU corresponds to bit 0 = 1,
        (B_slsfz = 1) & (B_sls = 0) in the AKKU corresponds to bit 2 = 1, remaining bits are to be set to 0.
        --> output AKKU - contents in case of request
        (AKKU-contents is only given in the request buffer and therefore not readable by VS100)

PID $13 DATA A: Location of oxygen sensors installed in the vehicle, where sensor 1 is closest to the engine ( 1 = sensor mounted )
        (alternative to PID $1D)
        Bit 0: Bank 1, sensor 1 (RB = upstream catalyst bank 1) mounted
        Bit 1: Bank 1, sensor 2 (RB = downstream catalyst bank 1) mounted
        Bit 2: Bank 1, sensor 3 mounted (not RB-typical)
        Bit 3: Bank 1, sensor 4 mounted (not RB-typical)
        Bit 4: Bank 2, sensor 1 (RB = upstream catalyst bank 2) mounted
        Bit 5: Bank 2, sensor 2 (RB = downstream catalyst bank 2) mounted
        Bit 6: Bank 2, sensor 3 mounted (not RB-typical)
        Bit 7: Bank 2, sensor 4 mounted (not RB-typical)
        --> output AKKU, bit composition corresponds to the SAE-requirement.

        The bits 2, 3, 6 a. 7 are set sharp to "0" during the output, since this constellation is not RB-typical.
```

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PID $14 DATA A: Oxygen sensor output voltage of sensor upstream catalyst, bank 1 ($00 = 0 V, $FF = 1,275 V, quant = 0,005 V)
Is only supported on systems with 2-step Lambda control!
——> usvkj (comes from DLSSAx.y and corresponds to the SAE-quantization)

DATA B: short term fuel trim of sensor upstr. cat, bank 1 ($00 = -100%, $80 = 0%, %FF = +99,22%, quant = 100%/128, 0% at 128)
Is only supported on systems with 2-step Lambda control!
——> output high-byte of fr_w (comes from %Lrx.y), it corresponds to the SAE-quantization

PID $15 DATA A: Oxygen sensor output voltage of sensor downstream catalyst, bank 1 ($00 = 0 V, $FF = 1,275 V, quant = 0,005 V)
——> output ushkj (comes from DLSSAx.y), conversion corresponds to the SAE-quantization

DATA B: short term fuel trim of sensor downstr. cat, bank 1
($00 = -100%, $80 = 0%, %FF = +99,22%, quant = 100%/128, 0% at 128)
——> output $FF, since sensor is not used for the control.

PID $16 + $17: Sensor 3 + 4 of bank 1; not used here.

PID $18 DATA A: Oxygen sensor output voltage of sensor upstream catalyst, bank 2 ($00 = 0 V, $FF = 1,275 V, quant = 0,005 V)
Is only supported on systems with 2-step Lambda control!
——> usvkj2 (comes from DLSSAx.y and corresponds to the SAE-quantization)

DATA B: short term fuel trim of sensor upstr. cat, bank 2 ($00 = -100%, $80 = 0%, %FF = +99,22%, quant = 100%/128, 0% at 128)
Is only supported on systems with 2-step Lambda control!
——> output high-byte of fr2_w (comes from %Lrx.y)

PID $19 DATA A: Oxygen sensor output voltage of sensor downstream catalyst, bank 2 ($00 = 0 V, $FF = 1,275 V, quant = 0,005 V)
——> output ushkj2 (comes from DLSSAx.y), conversion corresponds to the SAE-quantization

DATA B: short term fuel trim of sensor downstr. cat, bank 2
($00 = -100%, $80 = 0%, %FF = +99,22%, quant = 100%/128, 0% at 128)
——> output $FF, since sensor is not used for the control.

PID $1A + $1B: Sensor 3 + 4 of bank 2; not used here.

PID $1C DATA A: OBD requirements
——> output CWOBD

CWOBD in dec:	Certification according to:
01	OBDII-CARB
02	OBD-EPA
03	OBDII-CARB + OBD-EPA
04	OBDI
05	no OBD-requirements
06	EOBD

Data are entered into CWOBD after an investigation of the project-specifically-used certification.

PID $1D DATA A: Location of oxygen sensors (1 = Sensor mounted)
(PID $1D is only enabled if PID $13 is not activated.)
Bit 0: Bank 1, sensor 1
Bit 1: Bank 1, sensor 2
Bit 2: Bank 2, sensor 1
Bit 3: Bank 2, sensor 2
Bit 4: Bank 3, sensor 1
Bit 5: Bank 3, sensor 2
Bit 6: Bank 4, sensor 1
Bit 7: Bank 4, sensor 2
--> output AKKU - contents in case of request
(AKKU-contents is only given in the request buffer and therefore not readable by VS100)

PID $20 Bit-coded transfer of the PID's >$20 supported by the ECU
PID $20 must always be included in case of an activation of PID's >$20.

Configuration:	SY_M1I20A	SY_M1I20B	SY_M1I20C	SY_M1I20D
DATA:	A	B	C	D
DATA Byte #:	3	4	5	6
Bit:	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
PID in hex:	21 22 23 24 25 26 27 28	29 2A 2B 2C 2D 2E 2F 30	31 32 33 34 35 36 37 38	39 3A 3B 3C 3D 3E 3F 40

For further details refer to PID $00.

PID $21 Trip with "MIL on"
SAE-quantization: (Quant = 1km / incr, 0 ... 65535)
--> output kmstmil_w, corresponds to the SAE-quantization

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ABK TC1MOD 20.80 Abbreviations

```
ISO:  International Organization for Standardization
SAE:  Society of Automotive Engineers, Inc.
```

Parameter	Source-X	Source-Y	Type	Description
CWKONLS			FW	code word for configuration lambda sensor
CWOBD			FW	code word for configuration OBD certifikation
MLMAX			FW	maximum air-quantity for load calculation SAE J1979
NMAX			FW	engine-speed limitation, transient limit

Variable	Source	Type	Description
B_SLS	SLS	EIN	Condition for active secondary air
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
FLGLRS	LREB	EIN	CARB FREEZE FRAME byte, bank 1, for lambda control
FLGLRS2	LREB	EIN	CARB FREEZE FRAME byte, bank 2, for lambda control
FPVDK_W	EGFE	EIN	correction factor for pressure upstream of throttle valve, 16-bit
FR2_W	LR	EIN	Lambda controller output (word)
FRA2_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FRA_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FR_W	LR	EIN	Lambda controller output (word)
KMSTMIL_W	BGKMST	EIN	Drive distance with MIL on
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSHFM_W	GGHFM	EIN	air-mass flow HFM
NMOT_W	BGNMOT	EIN	engine speed
PSDSS_U		EIN	Intake manifold pressure from pressure sensor (DS-S) with SAE quantisation
SY_ISOPROT		EIN	System constant: tester protocol selection of the ISO-standards for scan tool
SY_M1I00A	PROKON	EIN	System constant coding from DATA A in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00B	PROKON	EIN	System constant coding from DATA B in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00C	PROKON	EIN	System constant coding from DATA C in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00D	PROKON	EIN	System constant coding from DATA D in Mode 1 PID $00 acc. to SAE J1979
SY_M1I20A		EIN	System constant coding from DATA A in Mode 1 PID $20 acc. to SAE J1979
SY_M1I20B		EIN	System constant coding from DATA B in Mode 1 PID $20 acc. to SAE J1979
SY_M1I20C		EIN	System constant coding from DATA C in Mode 1 PID $20 acc. to SAE J1979
SY_M1I20D		EIN	System constant coding from DATA D in Mode 1 PID $20 acc. to SAE J1979
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
TANSLIN	GGTFA	EIN	intake air temperature, linearised and calculated
TMOTLIN	GGTFM	EIN	Engine coolant temperature, linearised and calculated
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2
VFZG	GGVFZG	EIN	vehicle speed (km/h)
WDKBA	GGDVE	EIN	throttle angle
ZWZYL1	ZUE	EIN	ignition angle cylinder 1

FB TC1MOD 20.80 Detailed description of function

APP TC1MOD 20.80 Application hint

The variable CWOBD must by all means be adjusted according to below-mentioned table in correspondence to the certification degree:

Certification according to	CWOBD in dec:
OBDII-CARB	01
OBD-EPA	02
OBDII-CARB + OBD-EPA	03
OBDI	04
no OBD-requirements	05
EOBD	06

TC2MOD 21.20 Tester communication CARB; Mode 2

FDEF TC2MOD 21.20 Function definition

```
Basis of this description is SAE J1979 Mode 2:
Mode 2 shall enable access to freeze-frame data stored in case of fault detection.
In the process only original measured values (so e.g. no default values) are permitted.

Communication

The selection of the transfer protocol is performed prior to the compiler run via the system constant SY_ISOPROT.
SY_ISOPROT = 0 (=Default): communication according to ISO 9141-2
SY_ISOPROT = 1           : communication according to ISO 14230-4
```

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SY_ISOPROT = 0 (communication according to ISO 9141-2):
Only those PID's are responded to, which are reported as being supported by PID $00.
If no Freeze Frame is enabled (ffzdfp = 00), the inquiry for Mode $02 is answered by those PID's, which are marked as being supported in the PID $00. The response is made with the stipulated message length, however, instead of the freeze frame only zeros are sent.

SY_ISOPROT = 1 (communication according to ISO 14230-4):
Dependent on the requirement one of the following messages (negative response) is created:

No.	Mnemonic	Description
12h	SFNS-IF	requested PID/TID is not supported (subFunctionNotSupported-invalidFormat)
22h	CNCORSE	no Freeze Frame #00 stored for Mode $02 (conditionsNotCorrect or requestSequenceError)

Freeze Frame:
Description of freeze frame see ——>%DFFT, %DTIP and %DFPM x.y.

Only once the fault was confirmed is the freeze frame with the number 00 stipulated by CARB formed and released for the output.
The content of the RAM-cell ffzdfp points to the dfp with the Freeze Frame 00.
This can either be a so-called "external freeze frame" of the EGS ECU or a normal DME freeze frame. An "external freeze frame" of the EGS has priority when selecting the data to be shifted, since it is ensured by the function %OBDSV that an external freeze frame can only exist if no DME freeze frame is entered.
The memory cell from the Freeze Frame table in the FCM for the Freeze Frame 00 is marked by the contraction frzx_ffzdfp (x stands for 0 to n; n is an internal FCM no.) in this description.

PID $00: Bit-coded transfer of the PID's supported by the ECU (PID $00 must by all means be contained in Mode 2).

Meaning of the system constants SY_M2I00A, SY_M2I00B, SY_M2I00C a. SY_M2I00D.
DATA A - D (SY_M2I00A - SY_M2I00D):

	SY_M2I00A	SY_M2I00B	SY_M2I00C	SY_M2I00D
DATA:	A	B	C	D
DATA Byte #:	4	5	6	7
Bit:	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
PID in hex:	01 02 03 04 05 06 07 08	09 0A 0B 0C 0D 0E 0F 10	11 12 13 14 15 16 17 18	19 1A 1B 1C 1D 1E 1F 20

0 = PID n is not supported in Mode 2
1 = PID n is supported in Mode 2
In case an external freeze frame exists, $PID02 is not supported (see %OBDSV).

PID $01: not used in Mode 2

PID $02 Output of the fault code, which belongs to the freeze frame 00
With fault detection via the combustion miss detection the outputted fault paths are filtered with the function TCSORT x.y for the output to the tester.
In case an external freeze frame exists, $PID02 is not supported (see %OBDSV).

A fault code consists of 2 bytes, which are transferred to Data A and Data B.
Data A is composed of the BCD-coded high-byte of the SAE-code incl. the letter P, e.g. P01xx.
Data B is composed of the BCD-coded low-byte of the SAE-code incl. the letter P, e.g. Pxx37.
In case no freeze frame is stored, DATA A = 00 and DATA B = 00 is outputted.

PID $03:Output Status Fuel Supply System Bank 1 + 2
DATA A: Bit-coded output of status of fuel-supply system bank 1
Only one of the following bits each may be set to 1:
Bit 0 = Controller readiness not yet reached
Bit 1 = Control active without limitation
Bit 2 = Open loop due to driving condition (fuel cut-off etc.)
Bit 3 = Open loop due to fault
Bit 4 = Control active with limitations
Bit 5 to 7 = not used (must be set to 0)
——> Output frz0_ffzdfp

DATA B: Bit-coded output of status of fuel-supply system bank 2
--> Output frz1_ffzdfp
On 1-bank-systems the value 00 hex is given in frz1_ffzdfp.

PID $04 DATA A: Calculated load in percent of the max. load.
--> Output frz2_ffzdfp
The content of frz2_ffzdfp corresponds to the SAE-quantization.

PID $05 DATA A: Engine temperature
The content of frz3_ffzdfp corresponds to the SAE-quantization.

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```
PID $06 DATA A: Controller value of the Lambda control bank 1
        ——> Output frz4_ffzdfp
        In frz4_ffzdfp the value of the high-byte of fra_w is given. The content corresponds to the SAE-quantization
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128, 0% at 128)


PID $07 DATA A: Adaptation value of the Lambda control bank 1
        ——> Output frz5_ffzdfp
        In frz5_ffzdfp the value of the high-byte of fr2_w is given. The content corresponds to the SAE-quantization
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128, 0% at 128)


PID $08 DATA A: Controller value of the Lambda control bank 2
        ——> Output frz6_ffzdfp
        In frz6_ffzdfp the value of the high-byte of fr2_w is given. The content corresponds to the SAE-quantization
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128, 0% at 128)


PID $09 DATA A: Adaptation value of the Lambda control bank 2
        ——> Output frz7_ffzdfp
        In frz7_ffzdfp the value of the high-byte of fra2_w is given. The content corresponds to the SAE-quantization
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128, 0% at 128)

PID $0B DATA A: Manifold pressure (absolute)
        --> Output frz8_ffzdfp

PID $0C DATA A: Engine speed high-Byte
        DATA B: Engine speed low-Byte
        convert frz9_ffzdfp to SAE-quantization.
        The RAM-cell frz9_ffzdfp contains the engine speed as 8-bit value with the quantization of 40 rpm per increment.
        For the output this variable is to be converted to a 2-byte value with the SAE-quantization.
        SAE-quantization: ($0000 ... $FFFF = 0 ... 16383,75 rpm; 1 incr = 0,25 rpm)
        Conversion: frz9_ffzdfp * 160
        --> output result.

PID $0D DATA A: Vehicle speed
        The content of frz10_ffzdfp corresponds to the SAE-quantization.
```

ABK TC2MOD 21.20 Abbreviations

```
        frz0_ffzdfp ... frz10_ffzdfp: Name of the cells, in which the freeze frame data for the freeze frame 00 are given
        ISO:  International Organization for Standardization
        SAE:  Society of Automotive Engineers, Inc.
```

Variable	Source	Type	Description
FFZDFP		EIN	fault path identification number (dfp) of freeze frame zero
FR2_W	LR	EIN	Lambda controller output (word)
FRA2_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FRA_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FR_W	LR	EIN	Lambda controller output (word)
SY_ISOPROT		EIN	System constant: tester protocol selection of the ISO-standards for scan tool
SY_M2I00A	PROKON	EIN	System constant coding from DATA A in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00B	PROKON	EIN	System constant coding from DATA B in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00C	PROKON	EIN	System constant coding from DATA C in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00D	PROKON	EIN	System constant coding from DATA D in Mode 2 PID $00 acc. to SAE J1979

FB TC2MOD 21.20 Detailed description of function

APP TC2MOD 21.20 Application hint

```
Attention: frz0_ffzdfp ... frz10_ffzdfp cannot be assigned a fixed address, since all faults are entered chronologically and since
           the assignment to the freeze frame 00 to any arbitrary fault memory line is performed dependent on the priority control.
```

TC5MOD 20.10 Tester communikation CARB; Mode 5

FDEF TC5MOD 20.10 Function definition

```
M o d e  5
        Basis is the SAE J1979 Mode 5:
        Mode 5 shall enable lambda sensor values to be read out.
        Only the values from those lambda sensors are supported which have been identified for PID $13 or PID $1D in mode 1.
        Mode 5 is not supported if neither PID $13 nor PID $1D is active in mode 1.

        See %DLSSAx.y for values.
```

ABK TC5MOD 20.10 Abbreviations

```
        ISO:  International Organisation for Standardization
        SAE:  Society of Automotive Engineers, Inc.
```

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Variable	Source	Type	Description
SY_M5IH00A	PROKON	EIN	Sys. const. cod. DATA A Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00B	PROKON	EIN	Sys. const. cod. DATA B Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00C	PROKON	EIN	Sys. const. cod. DATA C Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00D	PROKON	EIN	Sys. const. cod. DATA D Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH20A		EIN	Sys. con. cod. DATA A in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IH20B		EIN	Sys. con. cod. DATA B in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IH20C		EIN	Sys. con. cod. DATA C in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IH20D		EIN	Sys. con. cod. DATA D in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IV00A	PROKON	EIN	Sys. const. cod. DATA A Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00B	PROKON	EIN	Sys. const. cod. DATA B Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00C	PROKON	EIN	Sys. const. cod. DATA C Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00D	PROKON	EIN	Sys. const. cod. DATA D Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20A	PROKON	EIN	Sys. const. cod. DATA A Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20B	PROKON	EIN	Sys. const. cod. DATA B Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20C	PROKON	EIN	Sys. const. cod. DATA C Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20D	PROKON	EIN	Sys. const. cod. DATA D Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40A		EIN	Sys. const. cod. DATA A Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40B		EIN	Sys. const. cod. DATA B Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40C		EIN	Sys. const. cod. DATA C Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40D		EIN	Sys. const. cod. DATA D Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60A		EIN	Sys. const. cod. DATA A Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60B		EIN	Sys. const. cod. DATA B Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60C		EIN	Sys. const. cod. DATA C Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60D		EIN	Sys. const. cod. DATA D Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80A		EIN	Sys. const. cod. DATA A Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80B		EIN	Sys. const. cod. DATA B Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80C		EIN	Sys. const. cod. DATA C Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80D		EIN	Sys. const. cod. DATA D Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.

FB TC5MOD 20.10 Detailed description of function

APP TC5MOD 20.10 Application hint

TC6MOD 21.50 Tester communikation CARB; Mode 6

FDEF TC6MOD 21.50 Function definition

No text for FDEF available!

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ABK TC6MOD 21.50 Abbreviations

FB TC6MOD 21.50 Detailed description of function

APP TC6MOD 21.50 Application hint

TC8MOD 20.0 Tester communikation CARB; Mode 8

FDEF TC8MOD 20.0 Function definition

```
        The structure of the communications protocol is described in %TCCOM

        Basis for this section is the SAE J1979 Mode 8 (status June 95):
        The purpose of this mode is to enable the off-board test device to control the operation of an on-board system, test,
        or component.
        The request for the differing activities (e.g. open valve or close valve, test duration etc.) is performed by means of the
        basic and diagnostics functions.

        As in the other modes, the 7 DATA bytes also come in useful here.
        In the DATA - Byte #1, the mode (here $08 hex from the tester to the ECU or $48 hex from the ECU to the tester) and in
        the DATA - Byte #2 is transferred to the respective TID number.


TID $00: Bit-coded transfer of the TID's supported by the SG.
        It is imperative that these are included in mode 8.

        The DATA - Bytes #3 - #7 are also referred to as DATA A - E.
   DATA A must be dated to $00 hex.
        Significance of the system constants SY_M8I00B, SY_M8I00C, SY_M8I00D and SY_M8I00E.
   DATA B - E (SY_M8I00B - SY_M1I00E):
                        |      SY_M8I00B           |      SY_M8I00C           |      SY_M8I00D           |       SY_M8I00E
        DATA:           |            B             |            C             |            D             |            E
        Bit:            |  7  6  5  4  3  2  1  0  |  7  6  5  4  3  2  1  0  |  7  6  5  4  3  2  1  0  |  7  6  5  4  3  2  1  0
        supported:      |  1  0  0  0  0  0  0  0  |  0  0  0  0  0  0  0  0  |  0  0  0  0  0  0  0  0  |  0  0  0  0  0  0  0  0
        TID in hex:     | 01 02 03 04 05 06 07 08  | 09 0A 0B 0C 0D 0E 0F 10  | 11 12 13 14 15 16 17 18  | 19 1A 1B 1C 1D 1E 1F 20
        Analogous procedure for the TID's  $20;  $40;  $60;  $80;  $A0;  $C0  and $E0.
        Response for requests up to >=$E0 is given even if the affected TID's are not supported.
        0 = TID n is not supported in mode 8
        1 = TID n is supported in mode 8



TID $01: EVAP system; Tightness testing
        The bit B_m8te is set by the request from Mode 8 and TID $01.
        B_m8te must reset the triggered test function.
```

ABK TC8MOD 20.0 Abbreviations

```
        ISO:  International Organisation for Standardization
        SAE:  Society of Automotive Engineers, Inc.
```

Variable	Source	Type	Description
B_M8TE	TC8MOD	AUS	condition to enable function evap system by SAE J1879 Mode 8 TID $01
SY_M8I00B	PROKON	EIN	System constant coding from DATA B in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00C	PROKON	EIN	System constant coding from DATA C in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00D	PROKON	EIN	System constant coding from DATA D in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00E		EIN	System constant coding from DATA E in mode 8 PID $00 according to SAE J1979

FB TC8MOD 20.0 Detailed description of function

APP TC8MOD 20.0 Application hint

TC9MOD 7.10 Tester communication CARB; Mode 9, Request vehicle information

FDEF TC9MOD 7.10 Function definition

```
        The basis of this description is SAE J1979 Mode 9:
        Mode 9 should make the access to vehicle-specific information such as "Calibration ID" and "Calibration
       Verification Number" (CVN) possible.


Communication protocol:

        The protocol driver recognizes the type of the transmission protocol and describes bit B_isoprot:
        B_isoprot = 0   communication according to ISO 9141-2
        B_isoprot = 1   communication according to ISO 14230-4

   B_isoprot = 0 (communication according to ISO 9141-2):
        Only the VITs which have been indicated as supported by the VIT $00 are responded.
```

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B_isoprot = 1 (communication according to ISO 14230-4):
If an immediate response is impossible, one of the following messages is generated (negative response):

No.	Mnemonic	Description
12h	SFNS-IF	Requested VIT is not supported (subFunctionNotSupported-invalidFormat)
78h	RCR-RP	Tester request correctly received, response not available yet (requestCorrectlyReceived-ResponsePending)

VIT $00: Bit-coded transmission of the VITs supported by the ECU (must absolutely be contained in Mode 9).
By means of the system constants SY_M9I00A, SY_M9I00B, SY_M9I00C and SY_M9I00D, the supported VITs are released.

DATA Byte # 3 contains the "Message Count" ($01)

DATA Bytes A - D (SY_M9I00A - SY_M9I00D):

	SY_M9I00A	SY_M9I00B	SY_M9I00C	SY_M9I00D
DATA:	A	B	C	D
DATA Byte #:	4	5	6	7
Bit:	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
VIT in hex:	01 02 03 04 05 06 07 08	09 0A 0B 0C 0D 0E 0F 10	11 12 13 14 15 16 17 18	19 1A 1B 1C 1D 1E 1F 20

The system constants SY_M9I00A - SY_M9I00D for data A - D are assigned by the SW-engineer.
Every bit in the system constants SY_M9I00A - SY_M9I00D is assigned to a particular VIT.
If the bit-value is 0, the related VIT is not supported.
If the bit-value is 1, the related VIT is supported.

Output: $01, SY_M9I00A, SY_M9I00B, SY_M9I00C and SY_M9I00D

Output / Example:

DATA Bytes						
#1	#2	#3	#4	#5	#6	#7
$49	$00	$01	SY_M9I00A - SY_M9I00D			

VIT $03: Number of response blocks for the transmission of the program state identification (Calibration ID)
By means of DATA Byte #3 the number of response blocks is transmitted.
DATA Byte #4 up to DATA Byte #7 are not used.

Output: 04 hex

Output / Example:

DATA Bytes		
#1	#2	#3
$49	$03	$08

VIT $04: Transmission of the program state identification (Calibration ID)
The Calibration ID consists of 16 ASCII - characters, i.e. 16 bytes. It is transmitted with 4 response blocks.
The number of response blocks is indicated via VIT $03.

A response block is composed of the header and 7 DATA Bytes.
In DATA Byte #1 and 2 the requested mode and VIT is transmitted.
In DATAByte #3 the number of the response block is indicated. The respective number must be determined prior to the transmission. The remaining DATA Bytes #4 to #7 of a response block are needed for the transmission of the Calibration ID.

Output: 1. Response block: CALIBID (characteristic value block with 4 characteristic values (bytes); DATA-bytes #4 to #7)
2. Response block: 4 bytes with $00 (DATA Bytes #4 to #7)
3. Response block: 4 bytes with $00 (DATA Bytes #4 to #7)
4. Response block: 4 bytes with $00 (DATA Bytes #4 to #7)

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Output :

DATA Bytes #1	#2	#3	#4	#5	#6	#7
$49	$04	$01	CALIBID 1			
$49	$04	$02				$00
$49	$04	$03	$00	$00	$00	$00
$49	$04	$04	$00	$00	$00	$00
$49	$04	$05	CALIBID 2			
$49	$04	$06				$00
$49	$04	$07	$00	$00	$00	$00
$49	$04	$08	$00	$00	$00	$00

Characteristic values 0 - 3 of CALIBID in DATA Byte #4 - #7

VIT $05: Number of response blocks for the transmission of the ECU-check sum (Calibration Verification Number (CVN))

Output: 01 hex

Output / Example:

DATA Bytes #1	#2	#3
$49	$05	$01

VIT $06: Transmission of the ECU-check sum (Calibration Verification Number (CVN))
Due to program run time reasons, the check sum calculation by the tester request "Mode $09 VIT $06" is only allowed to be released for an engine at rest (nmot_w = 0 rpm) and "terminal 15 ON".

if SY_CSBVAR = 0 (z.B. ME7):

Release of the check sum calculation:
When Mode $09 VIT $06 is requested, bit B_m9cvn is set to "1" at nmot_w = 0 and to "0" at C_ini.
The ckeck sum is calculated in function ROM_Test in module %URROM.

Invalid check sum
If the monitoring function detects an invalid check sum, a limited number of new check sum calculations is realized in the following initialization phase after "terminal 15 ON" (see %URROM and %URMEM).
With an invalid checks sum, the engine does not start anymore and a communication with the Scan Tool is no longer enabled. A new programming must be done!
As soon as a correct check sum has been detected, engine operation and Scan Tool communication are again permitted.

If the check sum has been calculated correctly, the value of cvn occurs as an output.

Output of the result of the check sum calculation:
The output depends on the communication protocol (B_isoprot):

Communication according to ISO 9141-2 (B_isoprot = 0):

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Communication according to ISO 14230-4 (B_isoprot = 1):

endif

if SY_CSBVAR = 1 (e.g. M7):

The check sum is only calculated by the funciton %DSGROM, if the engine is at rest (n = 0 rpm).
The number of response blocks is transmitted with VIT $05.

Release of the check sum calculation:
When Mode $09 VIT $06 is requested, bit B_m9cvn is set to "1" and to "0" at C_ini.

Output of the calculated check sum:
The output depends on the communication protocol (B_isoprot):

Communication according to ISO 9141-2 (B_isoprot = 0):

Communication according to ISO 14230-4 (B_isoprot = 1):

endif

Output: DATA Bytes #4, #5 and #6 with $00 and DATA Byte #7 with cvn

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Output / Example (pos. response):

DATA Bytes						
#1	#2	#3	#4	#5	#6	#7
$49	$06	$01	$00	$00	$00	cvn

ABK TC9MOD 7.10 Abbreviations

```
ISO:    International Organisation for Standardization
SAE:    Society of Automotive Engineers, Inc.
VIT:    Vehicle Identification Type
Cal-ID:Calibration ID (Software Identification)
```

Parameter	Source-X	Source-Y	Type	Description
SY_CSBVAR			SYS	System-constant: Variant of Checksumcalculation

Variable	Source	Type	Description
B_CKSBRDY	BGCVN	EIN	Check sum calculation ready
B_CKSNIO		EIN	Check sum result not o.k.
B_CKSVAL		EIN	Check sum validated and o.k.
B_ISOPROT		EIN	tester protocol by ISO-standards ISO 14230-4
B_M9CVN	TC9MOD	AUS	Condition for calculation of CVN according to SAE J1979 Mode $09
CVN	BGCVN	EIN	output checksum (CVN) corresponding SAE J1979 Mode $09
SY_M9I00A		EIN	System constant coding from DATA A in Mode $09 VIT $00 acc. to SAE J1979
SY_M9I00B		EIN	System constant coding from DATA B in Mode $09 VIT $00 acc. to SAE J1979
SY_M9I00C		EIN	System constant coding from DATA C in Mode $09 VIT $00 acc. to SAE J1979
SY_M9I00D		EIN	System constant coding from DATA D in Mode $09 VIT $00 acc. to SAE J1979

FB TC9MOD 7.10 Detailed description of function

APP TC9MOD 7.10 Application hint

The data assignment is done in the related %BGCVN.

BGCVN 3.10 Calculation value calibration verification Number CVN

FDEF BGCVN 3.10 Function definition

No text for FDEF available!

ABK BGCVN 3.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CALIBID			KWB	Calibration ID (Programmstep making) according to SAE J1979 for Mode $09
CVNIO			FW	calibr. verific. numb. for tester at proper detected check sum
SY_CSBVAR			SYS	System-constant: Variant of Checksumcalculation

Variable	Source	Type	Description
B_CKSBEOK	BGCVN	LOK	calculation check sum ready
B_CKSBRDY	BGCVN	AUS	Check sum calculation ready
B_CKSNIO		EIN	Check sum result not o.k.
B_CKSVAL		EIN	Check sum validated and o.k.
CVN	BGCVN	AUS	output checksum (CVN) corresponding SAE J1979 Mode $09

FB BGCVN 3.10 Detailed description of function

APP BGCVN 3.10 Application hint

TCSORT 3.10 Tester communicstion CARB; sort function

FDEF TCSORT 3.10 Function definition

Due to function-specific features the fault code memory (FCM) contains too much information for the user of a SCAN TOOL.

The method of combustion miss detection can be taken as example here:
Due to the detection strategy as a rule total faults (dfpmd) and single faults (dfpmd0x, x = cylinder number) are stored.
The CARB, however, explicitly prohibits the output of ’multiple misfire’ to the SCAN-TOOL for combustion misses on only one cylinder.
The output of fault codes to the SCAN-TOOL can therefore not take place 1:1 from the fault memory in case of misfire detection.

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Via the code word CWERFIL it is possible to chose 1 of 2 sorting versions. The result of the sorting can be seen in the following table (example for 3 cylinders).
CWERFIL = 0 dec; version A: Indicates only the multiple code for misfire on several cylinders and for 1 cylinder with misfire it indicates the code for this cylinder.
CWERFIL = 1 dec; version B: Indicates the multiple code for misfire on several cylinders and the code for the individual cylinders.

Generally the following applies to both versions for the fault output:
If only a single cylinder has misfire then only the code for this cylinder may be outputted to the SCAN TOOL with regard to misfire fault code.

Below a distinction between version A and B is made.

Version A (CWERFIL = 0):
As soon as misfires were detected on more than 1 cylinder and these were stored as fault paths in the FCM, a distinction must be made according to Mode 3 and Mode 7 dependent on the fault entry status fes.dauer.
Example: (dfpmd: (fes.dauer = 1)) & (dfpmd01-n: (fes.dauer = 0))
That corresponds to case 3 in the table below: During the 1st drive cylinder a has misfires and during the 2nd drive cylinder b, without a fault healing detection being performed in the meantime.
==> Mode 3 and Mode 1 PID $01 point to dfpmd. In Mode 7 no indication takes place.

Otherwise the following applies to version A:
If more than 1 misfire fault is given for the individual modes then only the SAE-code (CDCMD) for the total fault is to be outputted in the respective mode instead of the SAE-code (CDCMD01-n) for the single cylinders.

Version B (CWERFIL = 1):
In contrast to version A, version B outputs the multiple (CDCMD) code for misfires on several cylinders and the codes of the misfiring single cylinders (CDCMD01-n).

Table: Example for 3 cylinders (cyl. a, cyl. b + cyl. c)

	Misfire fault stored in the FCM				Version A CWERFIL = 0		Version B CWERFIL = 1	
case	mult.	cyl. a	cyl. b	cyl. c	GST_M7	GST_M3	GST_M7	GST_M3
1	dfpmd_u	dfpmd0a_u	——	——	30a	——	30a	——
2	dfpmd_u	dfpmd0a_u	dfpmd0b_u	——	300	——	300, 30a, 30b	——
3	dfpmd_e	dfpmd0a_u	dfpmd0b_u	——	——	300_f	30a, 30b	300_f
4	dfpmd_e	dfpmd0a_e	dfpmd0b_u	——	30b	30a_f	30b	300_f, 30a
5	dfpmd_e	dfpmd0a_e	——	——	——	30a_f	——	30a_f
6	dfpmd_e	dfpmd0a_e	dfpmd0b_e	——	——	300_f	——	300_f, 30a, 30b
7	dfpmd_u	——	——	——	——	300	——	300
8	dfpmd_e	——	——	——	——	300_f	——	300_f
9	dfpmd_e	dfpmd0a_u	dfpmd0b_u	dfpmd0c_e	——	300_f	30a, 30b	300_f, 30c

Explanations:
GST_M7 = Display Generic Scan Tool Mode 7
GST_M3 = Display Generic Scan Tool Mode 3
dfpmd_u = Misfire not debounced detected (pending)
dfpmd_e = Misfire debounced detected (MIL on)
dfpmda/b/c = Misfire on cyl. a, b or c detected
300 = Multiple code
30a = Code for cylinder a
30b = Code for cylinder b
***_f = code to the freeze frame 00 (e.g. 30b_f)

Effects on other functions

The result of this sorting function affects the following modes when outputted to the SCAN TOOL:

Mode 1 PID $01 DATA A: Output of the number of faults -->%TC1MODx.y
Mode 2 Output 'Freeze frame' -->%TC2MODx.y
Mode 3 Output of the debounced faults -->%SCATTx.y
Mode 7 Output of the not debounced faults -->%SCATTx.y

ABK TCSORT 3.10 Abbreviations

fes.dauer = 1: Fault has resp. had switched on the MIL
fes.scatt = 1: Fault entry is visible for SCAN TOOL only
fes.dauer and fes.scatt are described in more detail in the DFPM x.y.

Parameter	Source-X	Source-Y	Type	Description
CWERFIL			FW	Codeword for selection of misfire fault codes for output to scan tool

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Variable	Source	Type	Description
CW_ERFIL		EIN	Status codeword for selection of misfire fault codes for output to scan tool

FB TCSORT 3.10 Detailed description of function

APP TCSORT 3.10 Application hint

```
Version selection
Via the code word CWERFIL (see %PROKONx.y) it is possible to select a sorting version.
CWERFIL = 0 dec: Version A
CWERFIL = 1 dec: Version B
Which version is active can be seen by means of the RAM-cell cw_erfil.
When data of CWERFIL are changed they are only accepted if B_ini = 1, that means a change of version is only possible if terminal
15 on/off (INI).

Attention!
After a change from version A to B and vice versa, the fault code memory needs to be cleared and the misfire/s must be generated
again.
```

PROKON 8.110 Project configurations

FDEF PROKON 8.110 Function definition

```
    ! Beginn einer Strichlesgrafik

8.0      ---> SY_ZYLZA      false    ---> SY_TFA        9.0      ---> SY_EGFE
false    ---> SY_TURBO      false    ---> SY_TFMO       true     ---> SY_EGAS
90.0     ---> SY_ZZBANK      1.0     ---> SY_TFMA       0.0      ---> SY_DVEADA
true     ---> SY_STERVK     false    ---> SY_TFMAP      false    ---> SY_LLR
true     ---> SY_STERHK     true     ---> SY_TFUMG      false    ---> SY_AGR
false    ---> SY_STERSY     false    ---> SY_2SG        false    ---> SY_ATR
false    ---> SY_STETLR     false    ---> SY_ZAS        false    ---> SY_KWP71
1.0      ---> SY_NWS        20000.0  ---> SY_FREQCPU    37.0     ---> SY_FLUQ
1.0      ---> SY_STEREO     true     ---> SY_AIRBAG     true     ---> SY_TABST

    ! Ende einer Strichlesgrafik
```

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! Beginn einer Strichlesgrafik

0.0	SY_DNWSE		8.0	SY_REDMX		0.0	SY_WFS	
false	SY_PHTWIN		72.0	SY_WMAX		false	SY_F1GETR	
true	SY_CAN		-24.0	SY_WMIN		6.0	SY_UBDEDIS	
1.0	SY_ZNDAUS		0.0	SY_UMALS		7.0	SY_UBDEEN	
0.0	SY_KS1		205.0	SY_USOFF		6.0	SY_UBOKDIS	
1.0	SY_KS2		0.0	SY_UB13V		7.0	SY_UBOKDIS	
2.0	SY_KS3		6.0	SY_WNBM		0.0	SY_UBFQ	
3.0	SY_KS4	siehe %GGKS	2.0	SY_GAP	siehe %ESWL	false	SY_TFWL	
1.0	SY_TN		1.0	SY_CONFSL		0.0	SY_TLR	
0.0	SY_TFNS		0.0	SY_TEBF		0.0	SY_TVVR	
						54.0	SY_GRUNDWERT	

SY_WMAX = 72.0 entspricht 54 Grad KW
SY_WMIN = -32.0 entspricht -24 Grad KW

! Ende einer Strichlesgrafik

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191.0	SY_M1I00A	195.0	SY_M5IH00A
159.0	SY_M1I00B	0.0	SY_M5IH00B
249.0	SY_M1I00C	0.0	SY_M5IH00C
145.0	SY_M1I00D	0.0	SY_M5IH00D
127.0	SY_M2I00A	168.0	SY_M6I00A
152.0	SY_M2I00B	0.0	SY_M6I00B
0.0	SY_M2I00C	0.0	SY_M6I00C
0.0	SY_M2I00D	0.0	SY_M5I00D
195.0	SY_M5IV00A	128.0	SY_M8I00A
128.0	SY_M5IV00B	0.0	SY_M8I00B
0.0	SY_M5IV00C	0.0	SY_M8I00C
1.0	SY_M5IV00D	0.0	SY_M8I00D

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0.0 → SY_M5IV20A		
1.0 → SY_M5IV20B		
192.0 → SY_M5IV20C		
0.0 → SY_M5IV20D		
0.0 → SY_DVEADA	4.0 → SY_DFPMENV	2.0 → SY_DFPMTIM
0.0 → SY_FFESIZE	11.0 → SY_FFXSIZE	20.0 → SY_FCMSIZE
3.0 → SY_DFPMVAR	3.0 → SY_ENVBLOK	4.0 → SY_FFTSIZE
128.0 → SY_M1I20A	1.0 → SY_CDTSIZE	1.0 → SY_CLASIZE
0.0 → SY_M1I20B	1.0 → SY_TSFSIZE	4.0 → SY_CDCSIZE
0.0 → SY_M1I20C	1.0 → SY_CDKSIZE	0.0 → SY_CS32FM
0.0 → SY_M1I20D		0.0 → SYDSL10MS
0.0 → SY_UBKL15	0.0 → SY_AGR_DSS	0.0 → SY_DSL2MS

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Alle RAM-Zellen werden einmalig bei C_ini gesetzt und dann alle 100ms refresht.

Diagnosefunktion Nockenwellensteuerung Zyl.Bank 1

Diagnosefunktion Nockenwellensteuerung Zyl. Bank 2

Freigabe Diagnosefunktion Tankleckerkennung mit DM-TL Modul

Freigabe Diagnosefunktion Tankfüllstandsgeber

Konfiguration für Fahrzeugvariante mit/ohne CAN-Kombiinstrument

ABK PROKON 8.110 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDAGR			FW	code word DAGR inactiv (EURO-coding)
CDATR			FW	configuration byte diagnosis exhaust temperature control
CDATS			FW	configuration byte diagnosis exhaust temperature sensor
CDDMTL			FW	codeword to enable DMTL-diagnosis (Euro coding)
CDDST			FW	code word CARB: EURO byte for deactivation of tank press. sensor diagn.
CDEFST			FW	code word DFSTT inactiv (EURO-coding), CD..=0 -> no diagnosis
CDHSH			FW	code word heating diagnose after Kat (CDHSH = 0 => no diagnosis)
CDHSV			FW	code word heating diagnose upstr. Kat (CDHSV = 0 => no diagnosis)
CDKAT			FW	code word: catalyst diagnosis in OBDII-mode (invers: European mode)

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Parameter	Source-X	Source-Y	Type	Description
CDKVS			FW	code word: DKVS active/inactive, CD..=0 -> no diagnosis
CDLLR			FW	code word DLLR inactiv (EURO-coding), CD..=0 -> no diagnosis
CDLSA			FW	code word oxgen sensor aging diagnosis, configuration byte, for application
CDLSH			FW	code word lambda sensor diagnosis behind KAT in OBDII-Mode (invers: Europe mode)
CDLSV			FW	code word oxygen sensor diagnosis upstr. KAT in OBDII mode
CDMD			FW	code word DMD inactive(EURO-coding), CD..=0 -> no diagnosis
CDNWS			FW	code word DNWS inactiv (EURO-coding), CD..=0 -> no diagnosis
CDSLS			FW	code word secondary air system in OBDII mode (inv: Europe mode)
CDSLSE			FW	eurobyte for output stage diagnosis of secondary-valve/pump
CDSWE			FW	code word DSWE inactive (EURO-Coding), CD..=0 -> no diagnosis
CDTANKL			FW	code word DTANKL inactiv (EURO-coding), CD..=0 -> no diagnosis
CDTES			FW	code word disable canister-purge monotoring (Euro coding), CD..=0 -> no dia.
CWDTLECK			FW	
CWKLIMA			FW	code word air condition
CWKONABG			FW	code word for configuration exhaust emission treatment
CWKONFZ1			FW	code word for configuration vehicle
CWKONLS			FW	code word for configuration lambda sensor
CWLOWR			FW	
CWMDAPP			FW	code word for calibration without torque structure
CWNOCINS			FW	
CWOBD			FW	code word for configuration OBD certifikation
CWTF			FW	code word for configuration temperature sensors
CWUHR			FW	code word for the clock
NSWO1			FW	engine-speed threshold 1 for switching calculation
NSWO2			FW	engine-speed threshold 2 for switching calculation
SY_AGR_DSS			SYS	system constant
SY_DSL10MS			SYS	
SY_DSL2MS			SYS	

Variable	Source	Type	Description
B_ABSTNL	PROKON	AUS	condition soak time calculation via ECM-afterrun
B_AUAKT	PROKON	AUS	condition emission check active
B_CDAGR	PROKON	AUS	function active per codeword CDAGR
B_CDATR	PROKON	AUS	condition: diagnose exhaust temperature control enabled
B_CDATS	PROKON	AUS	condition diagnosis exhaust temperature sensor enabled
B_CDDMTL	PROKON	AUS	function enabled per codeword
B_CDDST	PROKON	AUS	function active per codeword CDDST
B_CDFST	PROKON	AUS	fuel level sensor diagnostic enable
B_CDHSH	PROKON	AUS	function active per codeword CDHSH
B_CDHSV	PROKON	AUS	function active per codeword CDHSV
B_CDKAT	PROKON	AUS	function active per codeword CDKAT
B_CDKVS	PROKON	AUS	function active per codeword CDKVS
B_CDLASH	PROKON	AUS	function active per codeword CDLASH
B_CDLATP	PROKON	AUS	function active per codeword CDLATP
B_CDLATV	PROKON	AUS	function active per codeword CDLATV
B_CDLDP	PROKON	AUS	function active per codeword CDLDP
B_CDLLR	PROKON	AUS	function active per codeword CDLLR
B_CDLSA	PROKON	AUS	function active per codeword CDLSA
B_CDLSH	PROKON	AUS	function active per codeword CDLSH
B_CDLSV	PROKON	AUS	function active per codeword CDLSV
B_CDMD	PROKON	AUS	function active per codeword CDMD
B_CDNWS	PROKON	AUS	function active per codeword CDNWS
B_CDNWS2	PROKON	AUS	function active per codeword CDNWS
B_CDSLS	PROKON	AUS	function active per codeword CDSLS
B_CDSLSE	PROKON	AUS	function active per codeword CDSLSE
B_CDSWE	PROKON	AUS	function active per codeword CDSWE
B_CDTANKL	PROKON	AUS	function active per codeword CDTANKL
B_CDTES	PROKON	AUS	function active per codeword CDTES
B_ETOL	PROKON	AUS	Condition fault in oil temperature
B_FPWDKAP	PROKON	AUS	throttle-valve control by accelerator pedal
B_KATFZ	PROKON	AUS	condition: cat fitted in vehicle
B_KATH	PROKON	AUS	Condition cat-heater installed in vehicle
B_LOWR	PROKON	AUS	Condition low range active
B_LSH	PROKON	AUS	Cond. lambda sensor inst. downstr. of cat., 2. sensor downst. of outlet (Bank1)
B_LSH2	PROKON	AUS	Cond. lambda sensor inst. downstr. of cat., 2. sensor downst. of outlet (Bank2)
B_LSV	PROKON	AUS	Cond. lambda sensor inst. upstr. of the cat., 1. sensor downst. of outlet(Bank1)
B_LSV2	PROKON	AUS	Cond. lambda sensor inst. upstr. of the cat., 1. sensor downst. of outlet(Bank2)
B_NDSAV	PROKON	AUS	Condition EEPROM emulation active
B_NOCINS	PROKON	AUS	condition: no CAN instrument panel
B_NOKATFZ	KATV	EIN	condition: no cat vehicle
B_NSWO1	PROKON	AUS	condition engine speed > NSWO1
B_NSWO2	PROKON	AUS	condition engine speed > NSWO2
B_SLSFZ	PROKON	AUS	condition: SLS fitted in vehicle
B_TFU	PROKON	AUS	condition ambient temperature sensor exists
B_UHRRMIN	PROKON	AUS	Condition clock with a relative counter of minutes
B_UHRRSEC	PROKON	AUS	Condition clock with a relative counter of seconds
B_WDKSAP	PROKON	AUS	throttle-blade contol by fixed value, bit 1 has priority
B_ZWAPPL	PROKON	AUS	Condition ignition-timing applications without torque intervention
CW_OBD	PROKON	AUS	Status Code word CWOBD
NMOT	BGNMOT	EIN	engine speed
SY_2SG	PROKON	AUS	system constant 2 motronic systems

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Variable	Source	Type	Description
SY_AGR	PROKON	AUS	system constant EGR present
SY_ATR	PROKON	AUS	system constant exhaust-gas temperatur controller built in
SY_CAN	PROKON	AUS	system constant CAN configuration
SY_CDCSIZE	PROKON	AUS	system constant: freeze frame count
SY_CDKSIZE	PROKON	AUS	system constant CDK-size
SY_CDTSIZE	PROKON	AUS	system constant: freeze frame count
SY_CLASIZE	PROKON	AUS	system constant: freeze frame count
SY_CS32FM	PROKON	AUS	system constant CPU type
SY_DNWSE	PROKON	AUS	Sys. const. diag. routine output stage camshaft control: none, capable of diag.
SY_DVEADA	PROKON	AUS	system constant BGVE: disabling injection and ignition during DV-E-adaptation
SY_EGAS	PROKON	AUS	system constant E-GAS present
SY_EGFE	PROKON	AUS	system characteristic input-value
SY_F1GETR	PROKON	AUS	System constant F1 transmission present
SY_FFTSIZE	PROKON	AUS	System constant: freeze frame count/field
SY_FLUQ	PROKON	AUS	System constant misfire detection quantization irregular running
SY_FREQCPU	PROKON	AUS	System constant CPU frequency
SY_GAP	PROKON	AUS	system constant: number of missing teeth in the gap
SY_GRDWRT	PROKON	AUS	System constant basic value, space between SW reference mark to OT in teeth
SY_KS1	PROKON	AUS	system constant: input of the CC195 onto which knock sensor 1 is connected
SY_KS2	PROKON	AUS	system constant: input of the CC195 onto which knock sensor 2 is connected
SY_KS3	PROKON	AUS	system constant: input of the CC195 onto which knock sensor 3 is connected
SY_KS4	PROKON	AUS	system constant: input of the CC195 onto which knock sensor 4 is connected
SY_KWP71	PROKON	AUS	System constant key-word protocol KWP71 present
SY_LLR	PROKON	AUS	System constant LLR configuration
SY_M1I00A	PROKON	AUS	System constant coding from DATA A in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00B	PROKON	AUS	System constant coding from DATA B in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00C	PROKON	AUS	System constant coding from DATA C in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00D	PROKON	AUS	System constant coding from DATA D in Mode 1 PID $00 acc. to SAE J1979
SY_M2I00A	PROKON	AUS	System constant coding from DATA A in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00B	PROKON	AUS	System constant coding from DATA B in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00C	PROKON	AUS	System constant coding from DATA C in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00D	PROKON	AUS	System constant coding from DATA D in Mode 2 PID $00 acc. to SAE J1979
SY_M5IH00A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IV00A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M6I00A	PROKON	AUS	System constant coding from DATA A in Mode $06 PID $00 acc. to SAE J1979
SY_M6I00B	PROKON	AUS	System constant coding from DATA B in Mode $06 PID $00 acc. to SAE J1979
SY_M6I00C	PROKON	AUS	System constant coding from DATA C in Mode $06 PID $00 acc. to SAE J1979
SY_M6I00D	PROKON	AUS	System constant coding from DATA D in Mode $06 PID $00 acc. to SAE J1979
SY_M8I00A	PROKON	AUS	System constant coding from DATA A in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00B	PROKON	AUS	System constant coding from DATA B in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00C	PROKON	AUS	System constant coding from DATA C in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00D	PROKON	AUS	System constant coding from DATA D in Mode 8 PID $00 acc. to SAE J1979
SY_NWS	PROKON	AUS	system constant camshaft control: none, 2 point or continuous
SY_PHTWIN	PROKON	AUS	system constant 1/2 phase sensing system (sensor, wheel)
SY_REDMX	PROKON	AUS	system constant: max. cylinder cutoff step
SY_STEREO	PROKON	AUS	system constant condition: stereo lambda control
SY_STERHK	PROKON	AUS	system parameter condition stereo downstream catalyst
SY_STERSY	PROKON	AUS	system constant condition stereo lambda control symmetrical
SY_STERVK	PROKON	AUS	system constant condition: stereo exhaust system upstream of cat
SY_STETLR	PROKON	AUS	System constant condition continuous Lambda control present
SY_TFA	PROKON	AUS	configuration of the fitting position of air temperature sensor
SY_TFMA	PROKON	AUS	system constant: intake air temperature signal available (initial. GGTFM)
SY_TFMAP	PROKON	AUS	system constant: intake air temp.sensor with shunt resistor in input circuitry
SY_TFMO	PROKON	AUS	system constant: engine oil temperature signal available (initial. GGTFM)
SY_TFUMG	PROKON	AUS	system constant: ambient temperature sensor present
SY_TFWL	PROKON	AUS	system constant service device intervention warm-up factor
SY_TSFSIZE	PROKON	AUS	System constant: freeze frame count
SY_TURBO	PROKON	AUS	system constant for turbocharged engine
SY_UB13V	PROKON	AUS	System constant UB value for 13 Volt
SY_UBDEDIS	PROKON	AUS	Ubatt threshold for disabling the DV-E output stage
SY_UBDEEN	PROKON	AUS	Ubatt threshold for enabling the DV-E output stage
SY_UBFQ	PROKON	AUS	System constant conversion factor for adaptation UB quantizations
SY_UBKL15	PROKON	AUS	system constant onboard battery voltage scanned from ignition key on input
SY_UBOKDIS	PROKON	AUS	System constant UB value for ES shutoff of DC motor
SY_UBOKEN	PROKON	AUS	System constant UB value for ES enabling of DC motor
SY_UMALS	PROKON	AUS	System constant voltage difference between sensor ground and electronic ground
SY_USOFF	PROKON	AUS	System constant voltage difference between sensor ground and electronic ground
SY_WFS	PROKON	AUS	system const. immobilizer (0:none, 1:via CAN, 2:via K-line)
SY_WMAX	PROKON	AUS	System constant earliest ignition timing that can be outputed
SY_WMIN	PROKON	AUS	System constant latest ignition timing that can be outputed
SY_ZAS	PROKON	AUS	system constant cylinder deactivation ZAS included

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Variable	Source	Type	Description
SY_ZNDAUS	PROKON	AUS	System constant ignition timing output (single or double fir.)
SY_ZYLZA	PROKON	AUS	system constant number of cylinders
SY_ZZBANK	PROKON	AUS	system constant cylinder assignment bank1/bank2, 0 bank1, 1 b.2, binary value

FB PROKON 8.110 Detailed description of function

```
1. Einleitung:

Die Funktion beschreibt die Projektkonfiguration. D. h. daß alle Systemkonstanten, alle globalen (mehrere
Funktionen betreffende) Codewörter und alle Euroschalter sind hier aufgeführt werden.


2.1. Softwarekonfiguration mittels Systemkonstanten SY_...:
Systemkonstanten bewirken eine unterschiedliche (bedingte) Compilierung und führen dadurch zu unterschiedlichen Hex-Files.
Systemkonstanten sind nicht applizierbar und mittels VS100 nicht lesbar.

In %PROKON sind Systemkonstanten Send-Connectoren in den Funktions-FDEFs als Receive-Connector definiert.
Man unterscheidet:
"- Systemrechenkonstanten:  "
  reine Rechengröße, Bsp.: SY_REDMX
"- Systembeschreibungskonstanten:  "
  können Funktionsteile/Kenngrößen umschalten, Bsp.: SY_ZYLZA,

2.2. Projektkonfiguration mittels Codewörter CW..:
Codewörter sind als Festwerte applizierbar. Es wird bei Änderung der Codewörtern immer das gleiche Programm verwendet.
Bsp.: CWKONFZ1
Die Schnittstelle zwischen %PROKON und den Funktionen, die die globalen Codewörter benutzen, erfolgt über Status-Bits bzw.
Bytes. Diese Bits werden in %PROKON aus den Codewörtern ausgewertet (Send-Connector) und in den entsprechenden
Funktionen eingelesen (Receive-Connector).
Damit wird eine spätere Projektkonfiguration am Bandende mittels Tester möglich.

2.2.1. Deaktivierung von Diagnosefunktionen mittels Euroschalter CD..:
Codewörter, die ein Abschalten von Diagnosefunktionen bewirken (Euroschalter), werden mit CD... bezeichnet.
Bsp.: CDSLS
```

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APP PROKON 8.110 Application hint

UFUE 4.10 ETS monitoring concept: function monitoring overview

FDEF UFUE 4.10 Function definition

ABK UFUE 4.10 Abbreviations

Variable	Source	Type	Description
B_DCDIS_UM	UFUE	LOK	Fault reaction information of the function monitoring
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_FGR_UM	UFUE	AUS	CC/ACC torque intervention in function monitoring permitted
B_I_SKA	UFUE	LOK	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_FR	SREAKT	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFUE	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_MZNS_UM	UFUE	LOK	afterstart torque increase of ETC-monitoring is active
B_NOMSR_UM	UFUE	AUS	MSR moment required not transferred to function monitoring
B_NOTLU	UFUE	LOK	Request standby air driving from the function
B_NOTLU_FR	SREAKT	EIN	Request for NFB from Function controller
B_UB_OK	ADVE	EIN	Battery voltage o.k.
B_UB_SKA	UFUE	LOK	Battery voltage not OK, undervoltage shut-off active
C_INI		EIN	ECU-condition for intialisation
EVZ_AUS	AEVAB	EIN	injection cut off pattern
EVZ_AUS_UM	UFUE	LOK	Injection cut off pattern in function monitoring
IUIPOTI1		EIN	ADC value incl. channel number throttle valve actual value potentiometer 1 loop
IUIPOTI2		EIN	ADC value incl. channel number throttle valve actual value potentiometer 2 loop
IUSPOTI1		EIN	ADC value incl. channel number nominal value potentiometer 1 loop (PWG)
IUSPOTI2		EIN	ADC value incl. channel number nominal value potentiometer 2 loop (PWG)
MFGR_UM	UFUE	LOK	Torque request from cruise control for function monitoring
MIFA_UM	UFUE	LOK	FGR-/ACC- or driver requested torque of function for function monitoring
MILSOL_UM	UFUE	LOK	driver torque request for charge used in function monitoring
MILSOL_W	MDKOL	EIN	driver torque request for charge
MI_UM	UFUE	LOK	Calculated actual torque in function monitoring
MMSR_UM	UFUE	LOK	Permissible MSR moment request for function monitoring

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Variable	Source	Type	Description
MZF_UM	UFUE	LOK	Filtered permissible torque of function monitoring
MZO_UM	UFUE	LOK	Tolerance offset for permissible torque in function monitoring
MZ_UM	UFUE	LOK	Permissible torque resulting from the coordination of function monitoring
NMOT	BGNMOT	EIN	engine speed
NMOT_UM	UFUE	LOK	engine speed in function monitoring
RL	EGFE	EIN	relative air charge
RL_UM	UFUE	LOK	Relative air charge in function monitoring
RL_W	EGFE	EIN	relative air charge (Word)
SPSN_UM	UFUE	LOK	Pedal value (8-bit) with lower limit to idling in function monitoring
TANS	GGTFA	EIN	Intake air temperature
TANS_UM	UFUE	LOK	Intake air temperature of the watchdog function
TMOT	GGTFM	EIN	Engine temperature
TMOT_UM	UFUE	LOK	Engine temperature in the watchdog function
UDKP1A	BGDVE	EIN	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop
UDKP2A	BGDVE	EIN	sensor voltage poti 2 of throttle actuator at (lower) mechanical stop
VFZG_UM	UFUE	LOK	engine speed in function monitoring
VFZG_W	GGVFZG	EIN	Vehicle speed
ZWOUT	ZUE	EIN	Ignition angle output value
ZWOUTCPL	ZUE	EIN	Single complement of the ignition angle for function monitoring
ZWOUT_UM	UFUE	LOK	Ignition angle in function monitoring

FB UFUE 4.10 Detailed description of function

This section is an overview of the watchdog function on torque level.

The sections are active in the 10ms-, 20ms- or 40ms-cycle. The assignment to the valid cycle is performed module-specifically.

In the process, they are called up in the following order in the 10ms-cycle:

%UFEING	Input signal transfer for watchdog function
%UFFGRE	FGR input information for the watchdog function
%UFNC	Speed monitoring for watchdog function
%UFZWC	Ignition angle monitoring for watchdog function
%UFRLC	Load-signal monitoring for watchdog function
%UFSPSC	Pedal-setpoint monitoring for watchdog function
%UFFGRC	FGR monitoring for watchdog function
%UFMSRC	Monitoring of the MSR torque intervention for the watchdog function
%UFMIST	Actual torque of the watchdog function
%UFMZUL	Permissible torque of the watchdog function
%UFMZF	Torque filter for the watchdog function
%UFMVER	Torque comparison of the watchdog function
%UFNSC	Post-start monitoring for the watchdog function
%UFREAC	Fault-reaction monitoring of the watchdog function

APP UFUE 4.10 Application hint

UFEING 10.10 ETS monitoring concept: Input signal transfer used in function monitoring

FDEF UFEING 10.10 Function definition

Transfer of the Input Signals for the Watchdog function

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ABK UFEING 10.10 Abbreviations

Variable	Source	Type	Description
B_I_SKA	UFEING	AUS	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_FR	SREAKT	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_NOTLU	UFEING	AUS	Request standby air driving from the function
B_NOTLU_FR	SREAKT	EIN	Request for NFB from Function controller
B_UB_OK	ADVE	EIN	Battery voltage o.k.
B_UB_SKA	UFEING	AUS	Battery voltage not OK, undervoltage shut-off active
EVZ_AUSTOT	AEVAB	EIN	injection cut off pattern total
EVZ_AUS_UM	UFEING	AUS	Injection cut off pattern in function monitoring
MIFA	MDFAW	EIN	desired indicated engine torque
MIFA_UM	UFEING	AUS	FGR-/ACC- or driver requested torque of function for function monitoring
MILSOL_UM	UFEING	AUS	driver torque request for charge used in function monitoring
MILSOL_W	MDKOL	EIN	driver torque request for charge
TANS	GGTFA	EIN	Intake air temperature
TANS_UM	UFEING	AUS	Intake air temperature of the watchdog function
TMOT	GGTFM	EIN	Engine temperature
TMOT_UM	UFEING	AUS	Engine temperature in the watchdog function
VFGR_UM	UFEING	AUS	engine speed in function monitoring
VFGR_W	BGVFGR	EIN	cruise control vehicle speed

FB UFEING 10.10 Detailed description of function

Input signal transfer for watchdog function

The module must be of assistance in the check of the program execution (see %URPAK).

The RAM and ROM areas affected by the function must be stored cyclically (see %URMEM).

The input signals needed for the watchdog function must be transferred cyclically to the watchdog function.

Instead of the air desired torque from the function the 'inactive value' MDIMX_UM is transferred to milsol_um, since the determination of milsol_w is physically not correct in the ME7 function %MDKOL. During fuel cut-off milsol_w has the value 0, although an actual torque mi_um is calculated (also see %UFMIST), which is distinctly higher.

```
The following informations are input signals for %URADCC:
iuspoti1        ADC-value incl. channel number setpoint poti 1
iasp1plaus      ADC-value incl. channel number setpoint poti 1 from the supervisor module


The following informations are input signals for %UFRLC:
b_wdk2sel       Fault at throttle valve (DK) poti 1, throttle sensor default function with DK poti 2
b_hfm           Condition HFM ready for measurement, i.e. load signal from HFM and not from DK info
rl              Relative air charge, i.e. load information rl from the function
rl_w            Relative air charge, i.e. load information rl_w from the function
iuipoti1        ADC-value incl. channel number for throttle valve poti 1
iuipoti2        ADC-value incl. channel number for throttle valve poti 2
udkp1a          Voltage throttle valve poti 1 at the (lower) limit stop
udkp2a          Voltage throttle valve poti 2 at the (lower) limit stop


The following informations are input signals for %UFZWC:
zwout           Ignition angle for the function
zwoutcpl        Complement of the ignition angle to make the ignition angle plausible in the watchdog function


The following informations are input signals for %UFSPSC:
iuspoti1        ADC-value incl. channel number setpoint poti 1
iuspoti2        ADC value incl. channel number setpoint poti 2
b_sp1s          SP1S is reference variable in the pedal sensor default function
b_sp2s          SP2S is reference variable in the pedal sensor default function
b_spsmin        In the pedal sensor default function the idle input applies
b_pwgnotfr      Pedal sensor default function from the function is active


The following informations are input signals for %UFFGRE:
S_bls           Stop-light switch information: Brake is applied
S_brs           Stop-light switch information: Brake is not applied
b_fgrab         FGR/ACC deactivation conditions active in the function
S_fgrwb         Switch resume/accelerate on the FGR stalk
S_fgrsv         Switch set/decelerate on the FGR stalk
S_fgrat         Switch OFF-TIP on the FGR stalk
S_fgrhs         Main switch on the FGR stalk


The following information is input signals for %UFNC:
nmot            Engine speed


The ASR/MSR data arrive in the function processor via CAN and are made available unprocessed to the watchdog function for the
evaluation in %UFMSRC.
```

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APP UFEING 10.10 Application hint

The data of the watchdog function are part of the monitoring concept and they may therefore not be changed arbitrarily.

Label	Source	Type	Description
b_i_ska_fr		VAR/EIN	functional fault reaction irrev. SKA (safety fuel deactivation)
b_i_ska		VAR/AUS	functional fault reaction irrev. SKA (safety fuel deactivation)
b_notlu_fr		VAR/EIN	functional fault reaction throttle actuator power stage at zero current
b_notlu		VAR/AUS	functional fault reaction throttle actuator power stage at zero current
b_ub_ok		VAR/EIN	battery voltage O.K., no undervoltage deactiv. of DK actuator power stage active
b_ub_ska		VAR/AUS	undervoltage deactivation of DK actuator power stage active
evz_austot		VAR/EIN	cylinder cutout mask for injection cutout as input info for the CIFI
evz_aus_um		VAR/AUS	cylinder cutout mask for injection cutout for the watchdog function
(milsol_w		VAR/EIN	current maximum, since slow desired torque)
milsol_um		VAR/AUS	current maximum, since slow desired torque for the watchdog function
(mifa		VAR/EIN	FGR/ACC or driver’s desired torque from function)
mifa_um		VAR/AUS	FGR/ACC or driver’s desired torque from function in the watchdog function
tans		VAR/EIN	intake air temperature
tans_um		VAR/AUS	intake air temperature in the watchdog function
tmot		VAR/EIN	engine temperature
tmot_um		VAR/AUS	engine temperature in the watchdog function
vfgr_w		VAR/EIN	vehicle speed in the function
vfgr_um		VAR/AUS	vehicle speed in the watchdog function

Label	Dependency	Type	Description
MDIMX_UM		FW	maximum reachable indicated engine torque for the watchdog function

UFMZF 1.10 ETS monitoring concept: Torque filter for function monitoring

FDEF UFMZF 1.10 Function definition

ABK UFMZF 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
MZFFIL_UM			FW	Filter time constant for delayed moment in function monitoring
MZFTV_UM			FW	Delay time for permissible moment mz_um in function monitoring

Variable	Source	Type	Description
MZF_LOW_UM	UFMZF	LOK	Fine adjustment for filtered permissible moment from function monitoring
MZF_UM	UFMZF	AUS	Filtered permissible torque of function monitoring
MZ_UM	UFMZUL	EIN	Permissible torque resulting from the coordination of function monitoring

FB UFMZF 1.10 Detailed description of function

Torque filter for the function surveillance

The module must contribute to control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40-ms time frame.

Delays occur for jumps from full load to idle-speed for the air mass measured in the manifold and are converted into a load signal. This means a lower value for the permissible torque. The actual torque that essentially depends on the load signal and the engine speed supplies higher values however during this delay.

In order that the function surveillance does not respond on account of an actual-torque value that is too high compared with the permissible torque, the permissible torque is delayed over a dead time and filtered by a low-pass filter of the first order, i.e. clearing the manifold pipe for a falling driver-requested torque is simulated by this.

The dead time and the low-pass filter do not act for jumps in the torque from idle-speed to full load because functional monitoring allows an actual torque that is too low compared with the permissible torque.

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APP UFMZF 1.10 Application hint

The data of function surveillance are part of the monitoring concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
mz_um		VAR/EIN	Permissible torque from the driver request
mzf_um		VAR/AUS	Filtered permissible torque
mzf_low_um		VAR/LOK	Filtered permissible torque carried to after the decimal point

Label	Dependency	Type	Designation
MZFTV_UM		FW	Delay time for permissible torque MZ_UM
MZFFIL_UM		FW	Filter time constant for delayed torque

UFMZUL 5.10 ETS monitoring concept: Calculation of permissible torque in UF

FDEF UFMZUL 5.10 Function definition

ABK UFMZUL 5.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMDZOF_UM	MZ_UM	NMOT_UM	KF	map for offset tolerance depending on permissible torque
KFMPED_UM	SPSN_UM	NMOT_UM	KF	map for permissible torque from the pedal position in function monitoring
KFMPNS_UM	SPSN_UM	NMOT_UM	KF	map for permissible torque from pedal position for a cold engine

Variable	Source	Type	Description
B_MZNS_UM	UFNSC	EIN	afterstart torque increase of ETC-monitoring is active
MFGR_UM	UFFGRC	EIN	Torque request from cruise control for function monitoring
MMSR_UM	UFMSRC	EIN	Permissible MSR moment request for function monitoring
MPED_UM	UFMZUL	LOK	Permissible indicated torque from accelerator pedal in function monitoring
MZMAX_UM	UFMZUL	LOK	Permissible torque from the maximum selection in function monitoring
MZO_UM	UFMZUL	AUS	Tolerance offset for permissible torque in function monitoring
MZ_UM	UFMZUL	AUS	Permissible torque resulting from the coordination of function monitoring

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FB UFMZUL 5.10 Detailed description of function

Permissible Torque of the Watchdog Function

The module must be of assistance in the check of the program execution (see %URPAK).

The RAM and ROM areas affected by the function must be stored cyclically (see %URMEM).

The function shall be processed in the 40ms cycle.

The torque KFMPED_UM permissible due to the accelerator position is calculated (and filtered, cf. %UFMZF) via a map interpolation dependent on the pedal set point and the engine speed. The offset is stored in the map KFMDZOF in dependency on the permissible torque mz_um and on the engine speed. The offset torque mzo_um is not filtered. Due to the addressing of the offset over engine speed and permissible desired torque a high offset can be used for high permissible torque.

As long as the bit B_mzns_um is active during post-start (cf. %UFNSC), the map KFMPNS_UM (instead of KFPED_UM) is used with cold engine. This map is also filtered and the same offset is taken into account.
Thereby the increased drag torque at cold engine can on one hand be taken into consideration, on the other hand it is possible to reduce the permissible torque at warm engine so as to achieve a controllable reaction in case of a fault.

With permitted increasing torque intervention by the road speed controller mfgr_um from %UFFGRC or with permitted increasing torque intervention of the MSR mmsr_um from %UFMSRC the permissible torque becomes valid by the maximum selection between mped_um, mfgr_um and mmsr_um. Future external interventions, which must additionally be secured, are taken into account in the maximum selection between mfgr_um and mmsr_um. This is expressed in the function definition by the points and the input with 0.

Thereafter the minimum selection between the mzmax_um determined by the coordination of the permissible torque and the currently valid desired torque for the air path milsol_um is formed.
The resulting permissible torque can thereby pass through the subsequent torque filter for the elimination of the manifold time constant.
In addition the watchdog function is thus - with correct milsol - used for the fact that no higher torque than desired is allowed for.

Cross reference: This function of the watchdog function corresponds to the function %MDZUL in the functional plane.

APP UFMZUL 5.10 Application hint

The data of the watchdog function are part of the monitoring concept and they may therefore not be changed arbitrarily.

Label	Source	Type	Description
b_mzns_um		VAR/EIN	Condition for permissible torque during post-start
mped_um		VAR/LOK	permissible torque from the pedal position
mfgr_um		VAR/EIN	permissible torque from the road speed control
mmsr_um		VAR/EIN	permissible torque from the MSR setting
mzo_um		VAR/AUS	tolerance offset for the permissible torque
mz_um		VAR/AUS	resulting permissible torque
mzmax_um		VAR/LOK	permissible torque from the maximum selection in the coordination

Label	Dependency	Type	Description
SPSNV08_UM	spsn_um	KL	pedal set point base points
NMV08_UM	nmot_um	KL	engine speed base points for torque
MDST 08_UM	mz_um	KL	torque base points
KFMPED_UM	spsnst08_um, nmst08_um	KF	map for permissible torque from the pedal position
KFMPNS_UM	spsnst08_um, nmst08_um	KF	map for permissible torque from the pedal position during post-start
KFMDZOF_UM	mdst08_um, nmst08_um	KF	map for offset tolerance in dependency on the permissible torque

While the offset so far was stored dependent on engine speed and pedal set point (KFMZOF_UM) it is now stored dependent on permissible torque and engine speed (KFMDZOF). Changing the data is possible as follows:
For a fixed engine speed and a fixed pedal set point an offset torque is obtained from the map KFMZOF. This offset is now entered into the map KFMDZOF for the respective engine speed base points and the torque base point, which results from the map KFMPED_UM (at same engine speed and same pedal angle).

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UFNSC 2.10 ETS monitoring concept: Afterstart monitoring for function monitoring

FDEF UFNSC 2.10 Function definition

ABK UFNSC 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NSC_T_UM			FW	After-start monitoring time for the watchdog function
NSOF_T_UM			FW	Debouncing time for the switch-off of the after-start expansion
N_START_UM			FW	Engine speed threshold for underspeed exit for the watchdog function
N_STEND_UM			FW	Engine speed threshold for end of start in the watchdog function
TANSMN_UM			FW	Intake air temp. threshold for after-start expansion in the watchdog function
TMNSMN_UM			FW	Engine temp. threshold for the after-start expansion in the watchdog function

Variable	Source	Type	Description
B_MZNS_UM	UFNSC	AUS	afterstart torque increase of ETC-monitoring is active
B_NSAKT_UM	UFNSC	LOK	After-start active for the watchdog function
B_NSEND_UM	UFNSC	LOK	After-time monitoring time elapsed for the watchdog function
C_INI		EIN	ECU-condition for intialisation
NMOT_UM	UFNC	EIN	engine speed in function monitoring
TANS_UM	UFEING	EIN	Intake air temperature of the watchdog function
TMOT_UM	UFEING	EIN	Engine temperature in the watchdog function

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FB UFNSC 2.10 Detailed description of function

After-start monitoring for the watchdog function

The module must be of assistance in the check of the program run (see %URPAK).

The RAM and ROM areas affected by the function must be stored cyclically (see %URMEM).

The function is to be processed in the 40ms grid.

In order to improve the monitoring quality it is possible to switch to an increased permissible torque (see %UFMZUL) during the after-start dependent on the engine and intake air temperature.

The after-start expansion becomes active, as soon as the conditions for B_mzns_um are fulfilled, that means as soon as
* the identifier after-start monitoring times elapsed B_nsend_um is not set (B_nsakt_um is set) and
* the engine temperature is less than the threshold TMNSMN_UM and
* the air temperature is less than the threshold TANSMN_UM.
The after-start monitoring time (NSC_T_UM) is started, if the identifier after-start active (b_nsakt_um) is being set.

The irreversible switchover from after-start to normal operation is performed with the resetting of the condition B_mzns_um after a debouncing time NSOF_T_UM, if
* the engine temperature is greater than the threshold TMNSMN_UM or
* the air temperature is greater than the threshold TANSMN_UM.
Furthermore the switchover is performed compulsorily after the setting of the identifier after-start monitoring time elapsed (b_nsend_um).
The transition at the end of the after-start is filtered (see %UFMZF).

In case of an underspeed exit, i.e. engine speed < threshold for start N_START_UM, the following actions are performed:
- Clearing of the debouncing time
- Clearing of the after-start monitoring time
- Clearing of the identifier after-start monitoring time elapsed
- Clearing of the identifier after-start active

Cross-reference: This function of the watchdog function corresponds to the after-start detection on the functional level in %MDZUL.

APP UFNSC 2.10 Application hint

The data of the watchdog function are part of the monitoring concept and they may therefore not be changed arbitrarily.

Label	Source	Type	Description
b_mzns_um		VAR/AUS	After-start expansion of the perm. torque active for watchdog function
b_nsakt_um		VAR/LOK	After-start active for the watchdog function
b_nsend_um		VAR/LOK	After-start monitoring time elapsed for the watchdog function
tans_um		VAR/EIN	Intake air temperature in the watchdog function
tmot_um		VAR/EIN	Engine temperature in the watchdog function
nmot_um		VAR/EIN	Engine speed for the watchdog function

Label	Dependency	Type	Description
NSOF_T_UM		FW	Debouncing time for switch-off of after-start expansion in the watchdog function
NSC_T_UM		FW	After-start monitoring time for the watchdog function
N_START_UM		FW	Engine speed threshold for underspeed exit for the watchdog function
N_STEND_UM		FW	Engine speed threshold for end of start for the watchdog function

UFMIST 2.10 ETS monitoring concept: Calculation of the actual torque in UF

FDEF UFMIST 2.10 Function definition

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ABK UFMIST 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMI_UM	RL_UM	NMOT_UM	KF	map of optimum engine torque
KFZW_UM	RL_UM	NMOT_UM	KF	map of optimum ignition angle
KLETAZW_UM	DZW_UM		KL	ignition efficiency depending on delta ignition angle

Variable	Source	Type	Description
DZW_UM	UFMIST	LOK	Delta ignition angle between zwopt and zwout in function monitoring
ETAZW_UM	UFMIST	LOK	Efficiency of actual ignition angle in function monitoring
MIOPT_UM	UFMIST	LOK	Optimum indicated torque in function monitoring
MI_UM	UFMIST	AUS	Calculated actual torque in function monitoring
NMOT_UM	UFNC	EIN	engine speed in function monitoring
RL_UM		EIN	Relative air charge in function monitoring
ZWOPT_UM	UFMIST	LOK	Optimum ignition angle in function monitoring
ZWOUT_UM	UFZWC	EIN	Ignition angle in function monitoring

FB UFMIST 2.10 Detailed description of function

Actual moment of function monitoring

The module must contribute to the control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40 ms time frame.

The actual moment is calculated as a function of the speed, load and ignition timing.
The ignition timing is thereby defined as positive in front of OT and negative after OT.

APP UFMIST 2.10 Application hint

The data from function monitoring are part of the surveillance concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
rl_um		VAR/EIN	Relative air charge in function monitoring
zwout_um		VAR/EIN	Actual ignition timing in function monitoring
nmot_um		VAR/EIN	Engine speed in function monitoring
miopt_um		VAR/LOK	Optimum induced moment in function monitoring
zwopt_um		VAR/LOK	Optimum ignition timing in function monitoring
dzw_um		VAR/LOK	Difference in ignition timing in function monitoring
etazw_um		VAR/LOK	Ignition timing in function monitoring
mi_um		VAR/AUS	Actual moment in function monitoring

Label	Dependency	Load	Designation
RLV08_UM	rl_um	KL	Load signal setpoints in function monitoring
NZWV08_UM	nmot_um	KL	Speed setpoints for determining the actual moment in function monitoring
DZWV08_UM	dzw_um	KL	Speed setpoints for difference in ignition timing
KFMI_UM	rlst08_um, nzwst08_um	KF	Performance characteristics for optimum induced moment in function monitoring
KFZW_UM	rlst08_um, nzwst08_um	KF	Performance characteristics for optimum ignition timing in function monitoring
KLETAZW_UM	dzwst08_um	KL	Characteristic for ignition timing efficiency in function monitoring

UFREAC 2.20 ETS monitoring concept: Monitoring of fault reaction of function monitoring

FDEF UFREAC 2.20 Function definition

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ABK UFREAC 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KLNPED_UM	SPSN_UM		KL	Speed lim. as func. of nominal pedal value, in DK drive standby func.,func.mon.
REAC_T1_UM			FW	Fault time for functional-fault reaction monitoring in UF
REAC_T2_UM			FW	Fault time for function monitoring - fault reaction monitoring in UF
RST_TV_UM			FW	Identifier for requesting a reset pulse control factor from function monitoring
SKADRHZ_UM			FW	Engine limiting speed for entire fuel cut-off SKA

Variable	Source	Type	Description
B_DCDIS_UM	UFREAC	AUS	Fault reaction information of the function monitoring
B_I_SKA	UFEING	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFREAC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_NOTLU	UFEING	EIN	Request standby air driving from the function
B_UB_SKA	UFEING	EIN	Battery voltage not OK, undervoltage shut-off active
EI_REAC_UM	UFREAC	AUS	irreversible error bit of fault reaction monitoring from function monitoring
EVZ_AUS_UM	UFEING	EIN	Injection cut off pattern in function monitoring
NMOT_UM	UFNC	EIN	engine speed in function monitoring
NSKA_UM	UFREAC	LOK	Limiting speed for active fault response in function monitoring
REAC_C1_UM	UFREAC	LOK	error counter 1 for fault reaction monitoring in function monitoring response
REAC_C2_UM	UFREAC	LOK	error counter 2 for fault reaction monitoring in function monitoring
RST_TV	UFREAC	AUS	Variable in the permanent RAM for reset pulse control factor from funct. monito.
SPSN_UM	UFSPSC	EIN	Pedal value (8-bit) with lower limit to idling in function monitoring

FB UFREAC 2.20 Detailed description of function

Fault-reaction monitoring of the watchdog function

The module must be of assistance in the program execution check (see %URPAK).

The RAM and ROM areas affected by the function must be stored cyclically (see %URMEM).

The function shall be processed in the 40ms cycle.

The functionality of the fault reactions must be monitored.
This is important, since the fault reactions must definitely be executed for the watchdog function.
This applies to fault reactions from the function, on the basis of which the watchdog function is completely or partially deactivated and also to the fault reactions from the watchdog function, without which they will not reach their performance reduction target in case of a fault.

If a desired deactivation of the throttle actuator power stage with the accompanying engine speed limitation via injection cutout does not occur, an attempt is made after a defined fault tolerance time in case of deactivation requests from the function to activate the fault reaction on an additional path by means of the fault-reaction request and information of the watchdog function.

If the deactivation of the throttle actuator power stage was triggered by the watchdog function, then in the case of a fault, i.e. if the engine speed limitation via injection cutout does not become active, a software reset is triggered after a defined fault tolerance time. In this case the identifier is loaded into the permanent RAM for "reset pulse duty cycle" prior to the software reset being triggered.
During the following initialization the ROM and RAM check, which is usually performed during the after-run as well as a defined waiting time is activated by this identifier prior to power stage release resp. to the end of the initialization.

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APP UFREAC 2.20 Application hint

The data of the watchdog function are part of the monitoring concept and they may therefore not be changed arbitrarily.

Label	Source	Type	Description
b_i_ska		VAR/EIN	functional fault reaction irrev. SKA (safety fuel deactivation)
b_notlu		VAR/EIN	functional fault reaction throttle actuator power stage at zero current
b_ub_ska		VAR/EIN	undervoltage deactivation of the throttle actuator power stage active
b_dcdis_um		VAR/LOK	fault reaction info (deactivation of the throttle actuator power stage) of watchdog funct.
b_i_ska_um		VAR/AUS	watchdog function fault reaction irrev. SKA (safety fuel deactivation)
ei_reac_um		VAR/AUS	irreversible fault bit during the fault reaction monitoring of the watchdog function
evz_aus_um		VAR/EIN	cylinder cutout mask for injection cutout in the watchdog function
nmot_um		VAR/EIN	engine speed for the watchdog function
nska_um		VAR/LOK	limit engine speed for complete injection cutout in the fault reaction
reac_c1_um		VAR/LOK	fault counter 1 for fault reaction monitoring in the watchdog function
reac_c2_um		VAR/LOK	fault counter 2 for fault reaction monitoring in the watchdog function
rst_tv		VAR/AUS	identifier in the permanent RAM for "reset pulse duty cycle" from the watchdog function

Label	Dependency	Type	Description
NPEDV08_UM	spsn_um	KL	pedal setpoint base points for engine speed threshold
KLNPED_UM	npedst08_r	KL	pedal setpoint dependent maximum engine speed in the DK drive default function
M_allEVaus_um		FW	deactivation mask for complete injection cutout
REAC_T1_UM		FW	fault tolerance time 1 for fault reaction monitoring in the watchdog function
REAC_T2_UM		FW	fault tolerance time 2 for fault reaction monitoring in the watchdog function
SKA_DRHZ_UM		FW	limit engine speed for complete injection cutout at SKA
RST_TV_UM		FW	identifier for the request of a "reset pulse duty cycle" from the watchdog function

UFFGRC 2.50 ETS monitoring concept: Monitoring of Cruise Control of function monitoring

FDEF UFFGRC 2.50 Function definition

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uffgrc-uffgrc

If there is no ACC ECu (ACC = automatic cruise control) installed (B_acc == FALSE), then B_noacc_um = FALSE
ei_accc_um = FALSE shall be set!
The input variables for ACC monitoring are taken directly from the CAN buffer!
B_noacc_um is used in %DUF > 1.10 and describes the RAM cell path mpfad in the event of a fault!

ABK UFFGRC 2.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ACCA_T_UM			FW	
ACCC_T_UM			FW	
VMIN_UM			FW	Minimum speed for FGR operation in function monitoring

Variable	Source	Type	Description
ACC_STAT	CANACC	EIN	ACC status (CAN signal)
BREMSACC	CANACC	EIN	Brake intervention for ACC function with respect to BRE_NORM
B_BREMSACC	CANACC	EIN	Condition brake request ACC via CAN
B_BREMS_UM	UFFGRE	EIN	condition of function monitoring: brake pedal pressed
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_FGREN_UM	UFFGRE	EIN	CC/ACC turn-on from control lever valid in function monitoring
B_FGR_UM	UFFGRC	AUS	CC/ACC torque intervention in function monitoring permitted
B_MDACC	CANACC	EIN	Condition torque request ACC via CAN
B_NOACC_UM	UFFGRC	AUS	Condition transfer of ACC torque
C_INI		EIN	ECU-condition for intialisation
EI_ACCC_UM	UFFGRC	AUS	irreversible error bit for the ACC monitoring
MFGR_UM	UFFGRC	AUS	Torque request from cruise control for function monitoring
MIACC	CANACC	EIN	Torque demand from ACC (with respect to MD_NORM)
MIFA_UM	UFEING	EIN	FGR-/ACC- or driver requested torque of function for function monitoring
VFGR_UM	UFEING	EIN	engine speed in function monitoring
ZACCALIVE	CANACC	EIN	Message counter for ACC via CAN

FB UFFGRC 2.50 Detailed description of function

Monitoring greater intervention in functioning monitoring
*

The module shall provide a contribution to the program flow control (see %URPAK).

Cyclic safeguarding by the function is required for the RAM and ROM areas affected (see %URMEM).

The function shall be executed in the 40-ms time frame.

The increase torque intervention is only then transferred from the function when the validity of this is recognized by its own evaluation of this as being permissible.
A check is made in order to enable FGR/ACC intervention (FGR = vehicle speed control) of whether there a valid switch-on condition and that there is no pending shutdown. Additionally, a check is made whether the brake information is inactive and whether the minimum speed has been exceeded. Furthermore, the FGR/ACC torque demand is only then transferred into function monitoring torque coordination if the FGR/ACC torque intervention is active in the function.

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APP UFFGRC 2.50 Application hint

```
The function monitoring data constitute part of the monitoring concept and may not be arbitrarily amended for this reason.
ACCC_T_UM       580 ms
ACCA_T_UM       160 ms
The times must agree with the ÜE I %DACC data TACCNP = 120 ms and TACCSI = 120 ms
```

UFFGRE 2.30 ETS monitoring concept: CC input information used in function monitoring

FDEF UFFGRE 2.30 Function definition

FGR vehicle-speed controller input informationen for function monitoring

ABK UFFGRE 2.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
BREMS_T_UM			FW	Debounce time for operated brake in function monitoring
TFGRENUM			FW	tolerance time for FGR switch-on after detecting FGR in function monitoring

Variable	Source	Type	Description
B_BREMS_UM	UFFGRE	AUS	condition of function monitoring: brake pedal pressed
B_FGRAB	BBFGR	EIN	CC/ACC shut-off from the function
B_FGRAT	GGMFL	EIN	condition: tip-switch off CC lever control
B_FGREN		EIN	condition: cruise control is active (enable)
B_FGREN_UM	UFFGRE	AUS	CC/ACC turn-on from control lever valid in function monitoring
B_FGRHSA	GGMFL	EIN	condition: CC main switch off
B_FGRTBE	GGMFL	EIN	condition: Cruise control button ACCELERATE
B_FGRTVE	GGMFL	EIN	condition: Cruise control button DECELERATE
B_FGRTWA	GGMFL	EIN	condition: Cruise control button RESUME
S_BLS		EIN	brake light switch (true=activated pedal)
S_BRS		EIN	Switch for brake

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FB UFFGRE 2.30 Detailed description of function

FGR vehicle-speed controller information for function monitoring

The module must contribute to program flow control (see %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (see %URMEM).

The function shall be worked through in the 40-ms time frame.

Permission for an increasing torque intervention is granted if there is no shutdown condition from the function present and a valid switch-on signal has been detected.
A valid switch-on signal is defined by a valid combination of keys. This leads to the vehicle-speed controller being set. If B_fgren_um has been unjustifiably set, then the bit B_fgren_um is set to false again by using the UE I bit B_fgren (if B_fgren = false) after the debounce time TFGRENUM has expired !

Permission for an increasing torque intervention is canceled again when a FGR / ACC shutdown condition from the function is present, or if the brake is operated for longer than a certain length of time

In addition to this, braking information is generated resulting from the brake-signal ports (S_brs, S_bls) that prevents the FGR / ACC torque value from being transferred in FGR / ACC intervention monitoring.

APP UFFGRE 2.30 Application hint

Die Daten der Funktionsüberwachung sind Bestandteil des Überwachungskonzepts und dürfen deshalb nicht beliebig verändert werden.

UFMSRC 6.30 ETS monitoring concept: MSR intervention surveillance for function monitoring

FDEF UFMSRC 6.30 Function definition

ufmsrc-ufmsrc

Mask (Operation Bit by Bit And)

ABK UFMSRC 6.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
BZ_MSR_M			FW	MSR message counter mask (0Fh for 4-bit message counter)
CWNOMSRU			FW	code word for MSR monitoring not active
MSRC_T_UM			FW	Fault time for MSR intervention surveillance in function monitoring

Variable	Source	Type	Description
ASC_ALIVE	CANASR	EIN	ASC alive counter
BZ_M	UFMSRC	LOK	CAN message counter after masking
B_ASREXT	CANASR	EIN	condition for externe ASR
B_MSREXT	CANASR	EIN	Condition external MSR demand
B_NOMSR_UM	UFMSRC	AUS	MSR moment required not transferred to function monitoring
C_INI		EIN	ECU-condition for intialisation
EI_MSRC_UM	UFMSRC	AUS	Irreversible error bit for MSR surveillance function monitoring
MDIND_ASRL		EIN	ASR moment requirement for intervention over air path
MDIND_ASRS		EIN	ASR moment requirement for rapid intervention

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Variable	Source	Type	Description
MDIND_MSR		EIN	MSR moment requirement
MMSR_UM	UFMSRC	AUS	Permissible MSR moment request for function monitoring

FB UFMSRC 6.30 Detailed description of function

MSR-intervention surveillance of function monitoring

The module must contribute to the program flow control (see %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (see %URMEM).

The function shall be worked through in the 40-ms time frame-Raster.

The ASR/MSR data arrive in the function computer via CAN and are made available for function monitoring without any further processing. The data are read out directly from the CAN buffer.

The code ei_msrc_um is set after elapse of the fault-tolerance time.

If the ASR/MSR data are in order, then the bit b_nomsr_um is canceled, and for "MSR intervention plausible" for the target value for the MSR torque md_ind_msr, are transferred into the boosting value mmsr_um. The desired boost in the MSR torque, mmsr_um, is otherwise set to 0.

The codeword switches over the MSR monitoring (with and without alive counter).

Monitoring for current status for a given message counter

- The 4-bit message counter asc_alive is incremented by the sending ECU. If the message counter is incremented by the sending ECU every 10 ms, then a differentiation is made in each 40-ms test cycle between the old and the new message counter.

In the event of discrepancies in the current status, i.e. in case there is no differentiation made between the old message and the new message counter, then a reversible fault reaction becomes active because an interruption in CAN messages shall not lead to function "Ignition off" being disabled.

Monitoring for plausibility and message consistency

1) ASR active message (b_asrext = 1)
   - MSR inactive (b_msrext = 0, mdind_msr = 0)
   - mdind_asrl <> 255
   - mdind_asrs <> 255

2) MSR active message (b_msrext = 1)
   - ASR inactive (b_asrext = 0)
   - ASR torque input for rapid intervention to save the MSR value mdind_asrs = CPL (mdind_msr - asc_alive)
   - or mdind_asrs= CPL(mdind_msr)
   - mdind_msr <> 0

3) Inactive message (b_asrext = 0 and b_msrext = 0)
   - ASR torque input for rapid intervention is inactive, i.e. mdind_asrs = FFH
   - ASR torque input for rapid intervention over air path is inactive, i.e. mdind_asrl = FFH

APP UFMSRC 6.30 Application hint

The data for function monitoring constitute part of the monitoring concept and may therefore not be changed arbitrarily.
MSRC_T_UM = 600 ms, matching UE I-data %DASC TASCNP = 580 ms, TASCNP2 = 80 ms.

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UFMVER 2.10 ETS monitoring concept: Torque comparison of function monitoring

FDEF UFMVER 2.10 Function definition

ABK UFMVER 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
MVER_T_UM			FW	Fault time for moment comparison in function monitoring

Variable	Source	Type	Description
B_DCDIS_UM	UFMVER	AUS	Fault reaction information of the function monitoring
B_I_SKA	UFEING	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFMVER	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_NOTLU	UFEING	EIN	Request standby air driving from the function
B_UB_SKA	UFEING	EIN	Battery voltage not OK, undervoltage shut-off active
EI_MVER_UM	UFMVER	AUS	Irreversible error bit for torque comparison from function monitoring
MDIF_W_UM	UFMVER	AUS	Difference between permissible and actual torque in function monitoring
MI_UM	UFMIST	EIN	Calculated actual torque in function monitoring
MVER_C_UM	UFMVER	LOK	Error counter for torque comparison of function monitoring
MZFO_UM	UFMVER	LOK	Filtered permissible moment including offset in function monitoring
MZF_UM	UFMZF	EIN	Filtered permissible torque of function monitoring
MZO_UM	UFMZUL	EIN	Tolerance offset for permissible torque in function monitoring

FB UFMVER 2.10 Detailed description of function

Moment comparison in function monitoring

The module must contribute to the control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processing in the 40 ms time frame.

During moment comparison, the actual moment (refer to %UFMIST) is checked if this has exceeded the permissible moment (refer to %UFMZUL).
A comparison of the moment cannot be performed if the nominal pedal value has not been updated because the supply to the pickup is no longer assured.
Thus the moment comparison is not executed for an undervoltage shut-off of the DK actuator output stage.
If the fault response "DK actuator output stage currentless" is effective because of other faults, there shall be no detection of faults in the moment comparison in addition to these.
It is for this reason that the moment comparison is no longer executed in this case either.
In this case a check is then made in the fault response surveillance of function monitoring (%UFREAC) as to whether the undervoltage shut-off or the fault response "DK actuator output stage currentless" is in fact executed and not just indicated.

If the actual moment exceeds the permissible moment for longer than an applicable fault time MVER_T_UM, then the fault bit ei_mver_um, the fault response information b_dcdis_um (shut-down of the DK actuator output stage) and the function monitoring fault response b_i_ska_um (irreversible SKA) are set.
If the actual moment mi_um is not greater than the permissible moment mzfo_um which is given by adding the filtered permissible moment mzf_um to the tolerance offset mzo_um, then the fault counter mver_c_um is deleted.

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APP UFMVER 2.10 Application hint

The data in function monitoring are part of the surveillance concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
mzf_um		VAR/EIN	Filtered permissible moment
mzfo_um		VAR/EIN	Filtered permissible moment with offset
mzo_um		VAR/EIN	Offset for permissible moment
mi_um		VAR/EIN	Actual moment
mdif_w_um		VAR/AUS	Difference between permissible and actual moment
mver_c_um		VAR/LOK	Fault counter for moment comparison in function monitoring
ei_mver_um		VAR/AUS	Irreversible fault bit for moment comparison in function monitoring
b_dcdis_um		VAR/AUS	Fault response information (shut-down of the DK actuator output stage) in function monitoring
b_i_ska_um		VAR/AUS	Function surveillance fault response irrev. SKA (safety fuel shut-off)
b_i_ska		VAR/EIN	Function fault response irreversible SKA (safety fuel shut-off)
b_notlu		VAR/EIN	Function fault response DK actuator ES currentless
b_ub_ska		VAR/EIN	Undervoltage shut-off of the DK actuator output stage active

Label	Dependency	Type	Designation
MVER_T_UM		FW	Fault time for moment comparison in function monitoring

UFNC 2.20 ETS monitoring concept: Monitoring of engine speed for function monitoring

FDEF UFNC 2.20 Function definition

Engine speed surveillance for function monitoring

ABK UFNC 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NC_T_UM			FW	Fault tolerance time for engine speed monitoring in function monitoring
NDIF_UM			FW	Permissible difference between nmot and nz_um in function monitoring
NMIN_UM			FW	Minimum speed for engine speed surveillance in function monitoring
NZMUL_UM			FW	Multiplier for conv. of the number of teeth in engine speed for func. monitor.
TZTOL_UM			FW	Tolerance between time and tooth counter detection in timer increments

Variable	Source	Type	Description
B_DCDIS_UM	UFNC	AUS	Fault reaction information of the function monitoring
B_I_SKA_UM	UFNC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
EI_NC_UM	UFNC	AUS	irreversible error bit for engine speed comparison from function monitoring
NC_C_UM	UFNC	LOK	Error counter for engine speed for function monitoring
NMOT	BGNMOT	EIN	engine speed

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Variable	Source	Type	Description
NMOT_UM	UFNC	AUS	engine speed in function monitoring
NZ_UM	UFNC	LOK	engine speed resulting from tooth-counter difference per time in function mon.
TALT_UM	UFNC	LOK	Timer value of previous point for computation in 40 ms time slot
TCAP_UM	UFNC	LOK	Timer value of current point for computation in 40 ms time slot
TDIF_UM	UFNC	LOK	Difference between current and previous computation point in time
ZALT_UM	UFNC	LOK	Tooth counter value from previous point for computation in 40 ms time slot
ZCAP_UM	UFNC	LOK	Tooth counter value of current point for computation in 40 ms time slot
ZDIF_UM	UFNC	LOK	Difference between current and previous tooth counter value

FB UFNC 2.20 Detailed description of function

Engine speed surveillance for function monitoring

The module must contribute to the control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40 ms time frame.

The engine speed must be monitored on the basis of redundant information.
To this end, the engine speed is safeguarded by a variable to record the speed for function monitoring, which is also of relevance for the ignition output.
It is meaningful to use the tooth counter for this.
The counter for the tooth flanks serves as a requirement to compare the ignition and is evaluated in the 40 ms time as the number of increments per measuring frame, i.e. as the number of teeth during a period of measurement.
A time which matches the current tooth counter value is thereby transferred as well, so as to be able to include any deviations from the standard frame time by floating processing in the 10 ms time frame.

The following sequence is executed in the 40 ms time frame which is generated from the 10 ms time frame:

1) Reading of the timer status from the running operating system timer with fixed quantization (SYSTEM_TIME_LOW)
2) Reading the tooth counter status from the running event counter
3) Consistency check:
   Reading the timer status again and in case the difference in time is too large (> TZTOL_UM) from the first timer status,
   Reading the tooth counter status again in order than any synchronization triggered between reading the timer and the tooth counter does not prevent these from matching
4) Transferring the timer status in tcap_um and event counter in zcap_um
5) Forming a difference from the current and the preceding timer status: tdif_um = tcap_um - talt_um
6) Forming a difference from the current and the preceding tooth counter status: zdif_um = zcap_um - zalt_um
7) Converting the number of teeth zdif_um to the corresponding engine speed nz_um:

   The conversion from the number of teeth to the engine speed is made using the following equation, as used in function monitoring:

$$nz_um = NZMUL_UM * \frac{zdif_um}{tdif_um}$$

8) Checking the computed and the functional engine speed for the maximum permissible offset:
   $|nz_um - nmot| > NDIF_UM$ denotes a deviation which is too large

   In the event that engine speed values match each other, then the fault counter is deleted and nmot is transferred into nmot_um for further use.
   In the case of fault, it is first inquired whether the minimum speed for function monitoring NMIN_UM has been exceeded by the computed speed nz_um.
   If this is the case, the fault nc_c_um is incremented to its final status of NC_T_UM, otherwise the fault counter nc_c_um is deleted. In both cases, the maximum value from nmot and nz_um is taken as the valid speed value in nmot_um.
   In case the final status is reached, a fault information ei_nc_um is set and the fault response irreversibly SKA triggered (b_i_ska_um=1, b_dcdis_um=1).

9) Storing the current timer and tooth counter status as the preceding values:
   talt_um = tcap_um
   zalt_um = zcap_um

The missing valid values in talt_um and zalt_um for the first initiation of the program can lead to the fault counter nc_c_um counting to 1.
Dynamic processes for high speeds, which can lead to different speed information in nmot and zdif_um, are taken into account in the permissible tolerance NDIF_UM for the comparison.
In certain circumstances, low speeds are updated less frequently in nmot than in zdif_um.
This must be permitted by the fault tolerance time NC_T_UM and the tolerance NDIF_UM for a comparison.

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APP UFNC 2.20 Application hint

The data in function monitoring are part of the surveillance concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
tcap_um		VAR/LOK	Timer value of the current computing point in the 40 ms time frame
talt_um		VAR/LOK	Timer value of the preceding computing point in the 40 ms time frame
zcap_um		VAR/LOK	Tooth counter value of the current computing point in the 40 ms time frame
zalt_um		VAR/LOK	Tooth counter value of the preceding computing point in the 40 ms time frame
tdif_um		VAR/LOK	Difference between the current and preceding computing points in timer steps
zdif_um		VAR/LOK	Difference between the current and the preceding tooth counter value
nz_um		VAR/LOK	Engine speed from the frame-time-corrected number of teeth
nc_c_um		VAR/LOK	Fault counter for speed comparison in function monitoring
nmot		VAR/EIN	Engine speed for the function
nmot_um		VAR/AUS	Engine speed for function monitoring
ei_nc_um		VAR/AUS	Irreversible fault bit for speed plausibility of function monitoring
b_dcdis_um		VAR/AUS	Fault response information (shut-off of the DK actuation output stage) of function monitoring
b_i_ska_um		VAR/AUS	Function surveillance fault response irrev. SKA (safety fuel shut-off)

Label	Dependency	Type	Designation
NDIF_UM		FW	Permitted difference between nmot and speed nz_um computed from number of teeth
NC_T_UM		FW	Fault tolerance time for speed comparison of function monitoring
NMIN_UM		FW	Minimum speed for function monitoring
TZTOL_UM	Esystim	FW	Tolerance between time and tooth counter recording in timer increments
NZMUL_UM	En, Esystim	FW	Multiplier for conversion of the number of teeth into speed

The engine speed is determined with the help of the following conversion from the number of teeth measured zdif_um in the measuring period tdif_um:

$$nz_um\ [En/min] = \frac{n\ [RPM]}{En\ [RPM]} = \frac{f58z\ [teeth/s]\ \ teeth/s * 60\ s/min}{En\ [RPM]\ RPM * \ z\ \ teeth/rev} = \frac{f58z\ [teeth/s]}{En\ [RPM]} * \frac{60}{z}$$

$$= \frac{zdif_um\ [teeth]}{tdif_um\ [steps] * Esystim\ [s/step]} * \frac{1}{En\ [RPM]} * \frac{60}{z} = \frac{zdif_um}{tdif_um} * NZMUL_UM$$

$$\text{where} \quad NZMUL_UM = \frac{60}{z} * \frac{1}{Esystim\ [s/step]} * \frac{1}{En\ [RPM]}$$

n = Engine speed
En = Resolution of the speed nz_um in RPM
z = 58 = Number of teeth per revolution
f58z = Mean tooth frequency
Esystim = Resolution of the system timer used for measuring the time for calculation of tdif_um in s/timer-step

The low byte of the ERCOS system time SYSTEM_TIME_LOW with 12.8 us/step is used as the time information.

It applies for a resolution En [RPM] = 40 for NMOT or NZ_UM and Esystim [s/Timerstep] = 12,8 / 1000 000 that:

$$NZMUL_UM = \frac{60}{z} * \frac{1}{Esystim\ [s/step]} * \frac{1}{En\ [RPM]} = \frac{60}{58} * \frac{1}{12.8\ /\ 1000\ 000} * \frac{1}{40} = \frac{60 * 1000\ 000}{58 * 12,8 * 40} = 2021$$

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UFOBP 1.10 ETS monitoring concept: OBP operation of function monitoring

FDEF UFOBP 1.10 Function definition

ABK UFOBP 1.10 Abbreviations

FB UFOBP 1.10 Detailed description of function

OBP operation of the function surveillance

The module must contribute to control of the program sequence (refer to %URPAK).

Requirement:
The surveillance module (UM) may not be shut down during the on-board check (OBP), such that its monitoring function is continuously active in normal operation as well, and cannot be shut down either.
It is for this reason that the function computer (FR) in the OBP has to serve the surveillance module (UM) as in normal operation.
In normal operation, the query initiated by the surveillance module (UM) is iterated through the function surveillance modules with the help of the process sequencing control, and valid response is formed from this for the surveillance module (UM).

A special program section that iterates through a special OBP module of the program sequencing control and forms a valid response for the surveillance module (UM) is used in OBP operation so that order effects on the OBP are excluded for changes in function surveillance.

Definition:
This special OBP module of function surveillance monitors the ignition and injection outputs in the Capture Compare Unit for a shutdown capture-compare mode.
A software reset is triggered in the case of a fault.

APP UFOBP 1.10 Application hint

UFRLC 4.10 ETS monitoring concept: Monitoring of load signal for function monitoring

FDEF UFRLC 4.10 Function definition

Monitoring of the load signal by a plausibility check with the load information from the function

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Monitoring of the load signal by a plausibility check with the throttle valve information

ABK UFRLC 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
IP1A_MX_UM			FW	Max. voltage for DK actual value pot. 1 at lower limit for function monitoring
IP2A_MN_UM			FW	Min. voltage for DK actual value pot. 2 at lower limit for function monitoring
IPA_T_UM			FW	Fault tolerance time for lower DK limit in invalid range for func. monitoring
KFRLIP_UM	IPSN_UM	NMOT_UM	KF	characteristic map for load signal calculation on throttle angle
NRLIP_UM			FW	Engine speed threshold for the rl/rlip comparison in function monitoring
RLC_T_UM			FW	Fault tolerance time for rl comparison with the function in function monitoring
RLIPFIL_UM			FW	Filter time constant for delayed load information rlipt_um in function monitor.
RLIPTV_UM			FW	Delay time for load information rlip_um in functioning monitoring
RLIP_T_UM			FW	Fault tolerance time for the rl/rlip comparison in function monitoring
RL_BO_UM			FW	Offset for tolerance straight line f(rl_um) for rlipf_um in function monitoring
RL_MO_UM			FW	Increase for tolerance straight line f(rl_um) for rlipf_um in function monitor.

Variable	Source	Type	Description
B_DCDIS_UM	UFRLC	AUS	Fault reaction information of the function monitoring
B_HFM	DHFM	EIN	Condition: HFM ready to measure
B_I_SKA	UFEING	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFRLC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_NOTLU	UFEING	EIN	Request standby air driving from the function
B_UB_SKA	UFEING	EIN	Battery voltage not OK, undervoltage shut-off active
B_WDK2SEL	GGDVE	EIN	Condition: DV-E position control is performed with actual-value-poti 2
EI_IPA_UM	UFRLC	AUS	Irrevers. error bit for lower DK limit in invalid range of function monitoring
EI_RLC_UM	UFRLC	AUS	Irrevers. error bit for comparison of rl with the function in function monitor.
EI_RLIP_UM	UFRLC	AUS	Irreversible error bit for rl/rlip comparison in function monitoring
IPA_C_UM	UFRLC	LOK	Fault counter for lower DK limit in invalid range for function monitoring
IPSN_UM	UFRLC	LOK	Active DK actual-value potenti. info. without lower limit for function monitor.
IUIPOTI1		EIN	ADC value incl. channel number throttle valve actual value potentiometer 1 loop
IUIPOTI2		EIN	ADC value incl. channel number throttle valve actual value potentiometer 2 loop
NMOT_UM	UFNC	EIN	engine speed in function monitoring

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Variable	Source	Type	Description
RL	EGFE	EIN	relative air charge
RLC_C_UM	UFRLC	LOK	Error counter for rl comparison with the function in function monitoring
RLIPF_L_UM	UFRLC	LOK	= rlipf_low_um fine adjustment of rlipf_um in function monitoring
RLIPF_UM	UFRLC	LOK	Relative air charge from secondary load signal after low pass in funct. monito.
RLIP_C_UM	UFRLC	LOK	Error counter for rl/rlip comparison in function monitoring
RLIP_UM	UFRLC	LOK	relative air charge from auxiliary load signal
RLZO_UM	UFRLC	LOK	Upper tolerance limit for rl from secondary load signal in function monitoring
RL_UM	UFRLC	LOK	Relative air charge in function monitoring
RL_W	EGFE	EIN	relative air charge (Word)
RL_W_UM	UFRLC	LOK	relative air charge (Word)
UDKP1A	BGDVE	EIN	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop
UDKP2A	BGDVE	EIN	sensor voltage poti 2 of throttle actuator at (lower) mechanical stop

FB UFRLC 4.10 Detailed description of function

Monitoring of the load signal for the watchdog function

The module must be of assistance in the check of the program execution (see %URPAK).

The RAM and ROM areas affected by the function must be stored cyclically (see %URMEM).

The function shall be processed in the 40ms cycle.

The load signal must be checked on the basis of redundant information.

Monitoring of the load signal by a plausibility check with the load information from the function

The consistency of the variables rl and rl_w generated in the SYNC cycle is guaranteed by the two variables being read twice in succession.
In case rl_w from the 1st reading is identical to rl_w from the 2nd reading then rl and rl_w from the 1st reading are taken over as current variables, otherwise rl and rl_w from the 2nd reading are taken over as current variables.

By means of the RL comparison between the word variable rl_w used in the function and the 8-bit variable rl it is detected whether the transfer of the load information was performed such that the same load information is used in the function and in the watchdog function.
In the process the load information in the function serves as basis for the injection time calculation and the load information in the watchdog function for the calculation of the actual torque.
If the signal rl_w converted to rl and rl are not identical then a fault tolerance time starts. Once it has reached its final count the fault information, the fault reaction and also the fault reaction information are set.

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Monitoring of the load signal by a plausibility check with the throttle valve information

For the transfer of the input signals for the determination of the load information from the throttle valve the valid voltage range at the lower limit stop of the chosen throttle-position sensor is checked.
If the threshold for the lower limit stop of TP sensor 1 at not selected TP sensor 2 is exceeded or if the threshold for the lower limit stop of TP sensor 2 at selected TP sensor 2 is undershot then this leads to a fault tolerance time being started. The fault tolerance time is cleared if no threshold violation is given.
Once the fault tolerance time has reached its final count the fault information, the fault reaction and also the fault reaction information are set.

The throttle valve position can be converted to a rl information by means of the engine speed.
Since the throttle valve information is faster than the load information from the HFM, the load information determined from the throttle valve position, which is used for the check on an upper tolerance limit at increasing load information from the throttle valve is delayed via a lag element and a low pass.
The comparison of the two load information takes place by means of an upper limiting straight line for the load information from throttle valve, which is calculated dependent on the currently effective load information.
The currently effective load information rl_um is in the process determined from the HFM resp. if it was detected as being defective from the first TP sensor. With detected defective load sensor or with TP sensor default function the comparative variable rlipf_um from ipsn_um is therefore switched to the second TP sensor by means of the second TP sensor.
If the load information is generated from the secondary load signal TP sensor 1 then the lag element and the low pass are switched off since the two throttle information, the load information of which are then compared exist simultaneously.
If the deviation is greater than the permissible tolerance, which is determined by possible not to be eliminated influences, then a fault tolerance time starts.
If the load information from the throttle valve is within the permissible tolerance then the fault tolerance time is cleared.
A limitation to the upper limiting straight line rlzo_um = f(rl_um) for rlipf_um, i.e. the rl from the throttle actual-value information is permissible, since an incorrect high load signal will lead to the torque comparison being triggered, which must therefor not be taken into consideration here.
In addition the filter settings would be critical regarding a downward comparison.

When a fixed defined threshold for the engine speed is undershot the fault counter is stopped until the threshold is exceeded again. Below this engine speed threshold the load information is of no significance for safety reasons and the calculation from the throttle information may exhibit extreme faults.
The fault counter is furthermore stopped at active undervoltage deactivation since the throttle information can then no longer be evaluated reliably. The fault counter is also stopped in case of the fault reactions ’limp-home air driving’ or ’irrev. safety fuel deactivation’ from the function or ’throttle output stage currentless’ from the watchdog function, in order to ensure a sequential error interlocking.

Once the fault tolerance time has reached its final count the fault information, fault reaction and also the fault reaction information are set.

When the filter becomes active the drum memory for the dead time as well as the initial value for the low-pass filter must have been preset with the currently determined load value from the map.

APP UFRLC 4.10 Application hint

The data of the watchdog function are part of the monitoring concept and may not be changed arbitrarily.

Label	Source	Type	Description
b_dcdis_um		VAR/AUS	Fault-reaction info (deactivation of throttle actuator output stage) of watchdog function
b_hfm		VAR/EIN	Condition HFM ready for measurement, i.e. load signal from HFM and not from throttle info
b_i_ska		VAR/EIN	Functional fault reaction irrev. SKA (safety fuel deactivation)
b_i_ska_um		VAR/AUS	Watchdog function fault reaction irrev. SKA (safety fuel deactivation)
b_notlu		VAR/EIN	Functional fault reaction throttle-actuator output stage currentless
b_ub_ska		VAR/EIN	Battery voltage not o.k., undervoltage deactivation of throttle-actuator output stage active
b_wdk2sel		VAR/EIN	Fault at throttle poti 1, TP sensor default function with throttle poti 2
ei_ipa_um		VAR/AUS	irrev. fault bit for lower throttle limit stop in invalid range in the watchdog function
ei_rlc_um		VAR/AUS	irreversible fault bit during rl-comparison with the function
ei_rlip_um		VAR/AUS	irreversible fault bit during rl/rlip-comparison
ipa_c_um		VAR/LOK	Fault counter for lower throttle limit stop in invalid range for the watchdog function
ipsn_um		VAR/LOK	active throttle actual-value poti-info converted to rising straight line without lower limit stop
iuipoti1		VAR/EIN	ADC-value incl. channel number for throttle poti 1
iuipoti2		VAR/EIN	ADC-value incl. channel number for throttle poti 2
nmot_um		VAR/EIN	Engine speed for the watchdog function
rlc_c_um		VAR/LOK	Fault counter for rl-comparison with the function
rlip_um		VAR/LOK	rl-information from the throttle actual-value poti-information for the watchdog function
rlip_c_um		VAR/LOK	Fault counter for plausibility check between rl_um and rlipf_um
rlipf_um		VAR/LOK	rl from throttle actual-value poti downstream low-pass filter for the watchdog function
rlipf_low_um		VAR/LOK	Low byte of rl from throttle actual-value poti downstream LP for the watchdog function
rlzo_um		VAR/LOK	Tolerance limit for rl from throttle actual-value poti dependent on valid rl_um
rl		VAR/EIN	relative air charge, i.e. load information rl from the function
rl_w		VAR/EIN	relative air charge, i.e. load information rl_w from the function
rl_um		VAR/LOK	Load information rl from the function for the watchdog function
rl_w_um		VAR/LOK	Load information rl_w from the function for the watchdog function
udkp1a		VAR/EIN	Voltage throttle poti 1 at the (lower) limit stop
udkp2a		VAR/EIN	Voltage throttle poti 2 at the (lower) limit stop

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Label	Dependency	Type	Description
IPA_T_UM		FW	Fault tolerance time for lower TP limit stop in the invalid range for the watchdog function
IP1A_MX_UM		FW	max. voltage for throttle actual-value poti 1 at the lower limit stop for the watchdog function
IP2A_MN_UM		FW	min. voltage for throttle actual-value poti 2 at the lower limit stop for the watchdog function
KFRLIP_UM	ipsn_um, nmot_um	KF	Map for rl-information
NRLIP_UM		FW	Engine speed threshold for the rl-comparison
RLC_T_UM		FW	Fault tolerance time for rl-comparison with the function
RLIP_T_UM		FW	Fault tolerance time for plausibility check between rl_um and rlipf_um
RLIPTV_UM		FW	Delay time for load information rlip_um
RLIPFIL_UM		FW	Filter-time constant for delayed load information rlipt_um
RL_MO_UM		FW	Gradient for tolerance straight line for rlipf_um in dependency on rl_um
RL_BO_UM		FW	Offset for tolerance straight line for rlipf_um in dependency on rl_um

UFSPSC 3.11 ETS monitoring concept: Monitoring of accelerator pedal value for function m.

FDEF UFSPSC 3.11 Function definition

No text for FDEF available!

ABK UFSPSC 3.11 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SP12LL_UM			FW	maximum difference between SP1S and SP2S below full load
SP12VG_UM			FW	maximum difference between SP1S and SP2S above full load range
SPSC_MINUM			FW	= SPSC_MIN_UM Pedal idling gas limit for function monitoring
SPSC_T_UM			FW	Fault time for nominal values in func. monitor. which are mutually not plaus.
SPSVG_UM			FW	Threshold full load for switch over of max. tolerance

Variable	Source	Type	Description
B_BREMS_UM	UFFGRE	EIN	condition of function monitoring: brake pedal pressed
B_DCDIS_UM	UFSPSC	AUS	Fault reaction information of the function monitoring
B_I_SKA_UM	UFSPSC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_PWGNOTFR	GGPED	EIN	FR error reaction pedal-travel sensor limphome
B_PWGNOTUM	UFSPSC	AUS	= b_pwgnot_um function monitoring fault response PWG idling (= b_pwgnot_sr)
B_SP1S	GGPED	EIN	message to SR: SP1S is command variable
B_SP2S	GGPED	EIN	SP2S is valid set value for PWG failure driving
B_SPSMIN	GGPED	EIN	message to SR: '1' = pedal-travel sensor limphome with SPSMIN
B_UB_SKA	UFEING	EIN	Battery voltage not OK, undervoltage shut-off active
EI_SPSC_UM	UFSPSC	AUS	irrevers. error bit for pedal value plausibility check in function monitoring
IUSPOTI1		EIN	ADC value incl. channel number nominal value potentiometer 1 loop (PWG)
IUSPOTI2		EIN	ADC value incl. channel number nominal value potentiometer 2 loop (PWG)
SP1SN_UM	UFSPSC	LOK	Value from SP1S with lower limit to idling for function monitoring
SP1S_UM	UFSPSC	LOK	Current value for nominal value potentiometer 1 (PWG) for function monitoring
SP2SN_UM	UFSPSC	LOK	Value from SP2S with lower limit to idling for function monitoring
SP2S_UM	UFSPSC	LOK	Current value for nominal value potentiometer 2 (PWG) for function monitoring
SPSC_C_UM	UFSPSC	LOK	Error counter for mutually non-plausible values in function monitoring
SPSN_UM	UFSPSC	AUS	Pedal value (8-bit) with lower limit to idling in function monitoring

FB UFSPSC 3.11 Detailed description of function

APP UFSPSC 3.11 Application hint

UFZWC 2.20 ETS monitoring concept: Monitoring of ignition angle for function monitoring

FDEF UFZWC 2.20 Function definition

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ABK UFZWC 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ZWC_T_UM			FW	Fault tolerance time for ignition angle monitoring in function monitoring.
ZYLANZ_UM			FW	Cylinder number for ignition angle monitoring in function monitoring

Variable	Source	Type	Description
B_DCDIS_UM	UFZWC	AUS	Fault reaction information of the function monitoring
B_I_SKA_UM	UFZWC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
EI_ZWC_UM	UFZWC	AUS	irrevers. error bit for ignition angle monitoring from function monitoring
ZWC_C_UM	UFZWC	LOK	Error counter for ignition angle monitoring in function monitoring
ZWOUT	ZUE	EIN	Ignition angle output value
ZWOUTCPL	ZUE	EIN	Single complement of the ignition angle for function monitoring
ZWOUT_UM	UFZWC	AUS	Ignition angle in function monitoring

FB UFZWC 2.20 Detailed description of function

Ignition-timing monitoring for function surveillance

The module must contribute to control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40-ms time frame.

Statistically, there is an adjustment of the ignition timing to retardation in certain operating states. Such ignition-timing adjustments reduce the engine torque given as an efficiency of 100 %, to e.g. 70 %.

The efficiency or ignition timing must also be taken into account as an input variable of function surveillance because function surveillance executes a torque comparison.

In the event that the ignition timing is acting in function surveillance with an efficiency of e.g. 70 %, and in function surveillance a discrepant ignition timing is taken for an efficiency of e.g. 50 % (value is incorrect from overwriting from another position), then there is a dormant error present. For function surveillance, this means a detected actual torque that is too low for the torque comparison.
If an additional error then occurs in the function that leads to an increase in performance, then function surveillance would not detect this error.
Monitoring the ignition timing is necessary for this reason.
This cannot be interpreted as a double error because without being able to detect the dormant error that can exist over many driving cycles, the performance-increasing error applies in the function as the prime error.

Requirement

Double storage of the ignition timing is implemented in the SYNC matrix, in that the complement of the current ignition timing zwout (refer to %ZUE) is saved as well after zwoutcpl. A writability check (according to %URMEM) is not necessary because the ignition timing is acting directly as an output variable and the absence of writability does not cause an update of the ignition timing.

Ignition-timing monitoring by plausibility of the double storage

Consistency check:

Consistency is assured for the variables zwout and zwoutcpl generated in the SYNC matrix in that both variables are read out twice in succession.
In case zwout from the 1st reading is identical with zwout from the 2nd reading, then zwout, zwoutcpl from the first reading are transferred as the currently applicable variables; otherwise zwout and zwoutcpl from the 2nd reading are taken as the current variables.

Double-storage check:

Both of the current variables are compared with one another, whereby the one variable must be the complement of the other variable.
In the event of an error, the ignition timing zwout_um is not updated for function surveillance and the error counter is incremented by ZYLANZ_UM (number of cylinders). An incrementation by ZYLANZ_UM is necessary in order that a cylinder-specific error will lead to a detection of the error.
The ignition timing zwout_um is otherwise transferred from the current Variable zwout for function surveillance and the error counter is decremented by 1 to the error-counter status of 0.

APP UFZWC 2.20 Application hint

The data of function surveillance are part of the monitoring concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
b_dcdis_um		VAR/AUS	Error-reaction information (shutdown of the throttle-valve actuator output stage) of function surveillance
b_i_ska_um		VAR/AUS	Function surveillance error reaction irrev. SKA (safety fuel shutdown)
ei_zwc_um		VAR/AUS	Irreversible error bit by ignition-timing plausibility of function surveillance
zwout		VAR/EIN	Ignition timing for the function
zwoutcpl		VAR/EIN	Ignition-timimg complement for plausibility of the ignition timing in functional surveillance
zwout_um		VAR/AUS	Ignition timing for function surveillance
zwc_c_um		VAR/LOK	Error counter in ignition-timing monitoring

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Label	Dependency	Type	Designation
ZYLANZ_UM		FW	Number of cylinders for monitoring the ignition timing in function surveillance
ZWC_T_UM		FW	Error tolerance time in ignition-timing monitoring

UMAUSC 1.11 ETS monitoring concept: test of the shut-down path of the monitoring module

FDEF UMAUSC 1.11 Function definition

ABK UMAUSC 1.11 Abbreviations

FB UMAUSC 1.11 Detailed description of function

Testing of the shut-down path from the supervising module

The shut-down path by means of the supervising module (UM) is tested by the function controller (FR) within its supervising function of the supervising module (UM).

Following completion of its initialization, the UM switches the output stages on for a short time and then off again in order that the FR is able to test the shut-down functions of the output stages. This occurs during a defined time window following release of the UM reset.

The status message from an output stage module is checked after the FR has switched on the output stages. The output stage shut-down is thereby evaluated before the FR sends the first information to the UM and the UM enables the output stages.

Following the reset, the communications is established between the function controller and the supervising module as follows:

- the FR terminates it initialization and releases the RSTOUT
- the UM runs through its initialization
- the UM switches the output stages on and off again
- the FR checks the shut-down of the output stages by the UM
- the inquiry/response communication begins (see %UMTOUT)

t1: time for UM initialization
t2: time for enable of the output stages
t4: minimum time for requesting the shut-down status message

POR = Power on reset

RSTOUT = Reset output from the function controller, reset input at the monitoring module

ESENUM = Output stage enable of the monitoring module

SPI = Synchronous serial interface between function controller and monitoring module

It is thereby of importance that the initialization sequences are kept short in order to maintain a short period of time prior to enable of the output stages.

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APP UMAUSC 1.11 Application hint

UMFPW 2.10 ETS monitoring concept: flash programming request in the monitoring module (UM)

FDEF UMFPW 2.10 Function definition

ABK UMFPW 2.10 Abbreviations

FB UMFPW 2.10 Detailed description of function

Transition of the monitoring module (UM) into flash programming mode

The output stages may be shut down during flash programming. This state is not critical from the technical safety viewpoint. Consequently it is permissible that the interface between the function controller (FR) and the monitoring module is not served for an active flash programming.

The following occurs via the evaluation of a defined incorrect response operating as flash programming request information: In this case the inquiry/response communication is interrupted following this defined response for flash programming request. The UM finds itself in an eternal loop in which it disables the output stages.
If the flash programming process is completed, a software reset is triggered by the function controller.

Reaction to valid response for normal operation:
UM in normal operation, enable output stages, error counter - 1

Reaction to another defined response for flash programming:
UM in flash programming mode, eternal loop until reset with disabled output stages

Reaction to invalid response:
error counter + 1, at final status reset with disabled output stages

Due to the communication between function controller and monitoring module via a synchronous serial interface which the functions computer controls as master, the switchover to flash programming mode in the monitoring module cannot be detected by the missing operation of the interface in the function controller. A defined flash programming request acknowledgement QFPW having the value 0FFh is transmitted for this.

For a correct selection in normal operation, the possibility of a flash programming request AFPW from the function controller is not given. Neither shall the monitoring module erroneously detect a flash programming request AFPW as response from the function controller via the serial interface. It is for this reason that safeguarding the response by additional information at a defined position in the data block as complement of the flash programming request is meaningful.

If the monitoring module is found to be erroneously in the flash programming mode, the function controller triggers a reset after having detected a flash programming request acknowledgement instead of a valid inquiry.
If a transmission error leads to the monitoring module not accepting the flash programming request, then there is a normal inquiry in place of the flash programming request acknowledgement. The function controller can, on the basis of this, re-generate the request to go over onto flash programming mode. This delay must be accepted from a possible external flash programming device.

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POR = Power on reset

RSTOUT = Reset output from the function controller, reset input at the monitoring module

ESENUM = Output stage enable of the monitoring module

SPI = Synchronous serial interface between function controller and monitoring module

ASync1 = First synchronization response from the function controller
ASync2 = Second synchronization response from the function controller

AFPW = Flash programming request from the function controller
QFPW = Flash programming acknowledgement from the monitoring module
F1 = first inquiry from the monitoring module
F2 = second inquiry from the monitoring module
Fn = nth inquiry from the monitoring module

APP UMFPW 2.10 Application hint

UMFSEL 1.10 ETS monitoring concept: inquiry selection in the monitoring module(UM)

FDEF UMFSEL 1.10 Function definition

FrReg = MAX(1,FrReg) * 2 + ((b7 EOR b6) EOR (b4 EOR b2))

Inquiry = LowNibble (FrReg)

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ABK UMFSEL 1.10 Abbreviations

FB UMFSEL 1.10 Detailed description of function

Random Inquiry Selection in the Supervisor Module for the Inquiry/Response Communication in the Functional Processor

The supervisor module (UM) poses 16 different inquiries via a random generator and expects an unambiguous response to each inquiry from the functional processor (FR). If the FR does not find a correct response, it sends a defined 17th response, which is in any case detected as being incorrect by the UM, since it is incorrect for each possibly posed inquiry.

The inquiries posed to the FR are determined by means of a pseudo-random generator.
The random generator is based on an 8-bit shift register with 4 feedback connections, which are connected by an exclusive OR operation. The pseudo-random sequence repeats itself after 255 shift operations. The content of the shift register provides the new inquiry selection in the low-nibble.

If an inquiry is incorrectly responded to, then this inquiry is repeated and the content of the shift register is maintained.

APP UMFSEL 1.10 Application hint

UMKOM 2.10 ETS monitoring concept: Inquiry/response communication between UM/FR

FDEF UMKOM 2.10 Function definition

ABK UMKOM 2.10 Abbreviations

FB UMKOM 2.10 Detailed description of function

Inquiry/response communication between the monitoring module and the function controller

The main flow of information for the monitoring function comprises
a1) Forwarding the inquiries from the monitoring module (UM) to the function controller (FR)
a2) The feedback of the fault counter status from the monitoring module to the function controller
b) The response from the function controller to the monitoring module

It is meaningful that 16 valid inquiry/response pairs are established for response by the fault reaction in the monitoring module following 5 incorrect responses in succession.
It is hereby important that the 16 valid inquiries from the monitoring module can be detected exactly by the function controller.

Furthermore, it is meaningful that the response is formed at the 16-bit level at least, in order to obtain a minimum of 65520 impossible responses, i.e. irrespective of the inquiry, as well as the 16 possible responses.
The responses expected from the inquiries raised shall be defined, i.e. shall not depend on the number of the modules interfacing with the program process control in the FR.
This means that a conversion of the program process control contents is performed in a meaningful way in the FR.
In order to do this, a 17th invalid response must be specified at the interface to the monitoring module in addition to the 16 valid responses.

The expectation of a correct response assigned to the inquiry thereby set does not allow an uncontrolled behaviour that performs a cyclic operation of the monitoring module without any appropriate processing in the function controller.

It is meaningful for an optimum utilization of the interface to interleave the inquiries set and the responses outputted, i.e. to obtain the response to the preceding inquiry following the setting of an inquiry and to output the current response in the function controller after setting the subsequent inquiry.
The provision of an inquiry just received is not possible without a time delay
as the monitoring software in the FR is included in evaluation the response.

The FR outputs the response to the preceding inquiry during the processing of the last inquiry. Hence there is regular data transmission and synchronization taking place between the FR and the UM (refer also to %UMTOUT).

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The inquiries shall not correspond to the expected responses, i.e. if the UM sets the 00, then the response to this should not be 00. The following assignment shall be complied with:

Inquiry	Response
00	12
01	03
02	08
03	04
04	14
05	13
06	15
07	09
08	02
09	00
10	07
11	10
12	05
13	11
14	06
15	01

An internal counter is increased by 3 if the monitoring module receives an incorrect response and which, for a final status of >= 13, triggers a defined fault reaction. This fault reaction definitely shuts all output stages down under all circumstances and leads to a transfer to the safe state by this. In addition to this, the monitoring module triggers a software reset at the function controller in parallel to shutting down the output stages, in order to permit a correct restart for limited incorrect response with respect to time.

For errors in the content of the responses, the fault counter in the monitoring module is raised in increments of 3 up to a final status of >= 13, or is decremented to 0 for responses which are correct.

In order to keep the time for enabled output stages as short as possible (long off, short on) for permanently present faults and the fault reaction defined by software reset, the fault counters in the function controller and monitoring module are pre-assigned with the status 11 (11 = final status -3 +1, i.e. -3 for increase at fault and +1 for lowering at OK).

An output stage is only then enabled if the communication starts up correctly and the fault counter in the monitoring module is decremented to 10.
In addition to this, the FR must correctly supply the first permanently defined synchronization response in order that the UM gives the output stage release.
If the second permanently defined synchronization response is incorrect, the monitoring module runs immediately from 10 back to its final status of 13 and thereby into the fault reaction.
The first fault counter values transmitted by UM must be correct as well in order that the FR does not run into a fault reaction but rather to decrementing its fault counter.

If the monitoring module receives an incorrect response then it repeats the incorrectly responded inquiry such that inquiry-specific faults lead to a fault reaction.

The inquiry which the monitoring module sends to the function controller is expected again within the defined time slot.
For a detection of the correct value for the fault counter transmitted by the UM, it is permissible to conclude that the UM is working correctly.

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The targeted put in of the 17th response which is intentionally and definitely incorrect, the function controller tests the monitoring module by comparing the fault counter of the monitoring module with its own expected value for the fault counter.
The function controller thereby then gives a incorrect response in normal operation if the fault counter transmitted by UM of the UM is exactly 0.
If the fault counter of the monitoring module deviates from the expected value from the function controller, then the last response form (correct or incorrect) is repeated. This occurs automatically by inclusion of an incorrect response at a fault counter value of 0 transmitted by the UM. In addition to this, the value expected for the fault counter on the basis of the fault counter transmitted by UM and the expected treatment (+3 for an incorrect or -1 for a correct response) is defined again.

If the fault counter of the monitoring module deviates from the value expected from the function controller, then the FR increases a fault counter by 3, for a final status of 13 of which will also trigger a software reset.
If the expected fault counter status arrives at the function controller then the fault counter is decremented to 0.

The monitoring module information is thereby transferred in one byte:
High-nibble = fault counter status (range of values 0 to 12=0Dh, for flash program acknowledgement 15=0Fh)
Low-nibble = inquiry (range of values 0 to 0Fh)

The RAM cell for the inquiry setting is thereby also assured by the transfer in a common byte with the evaluation of the fault counter information.

Sequence at the beginning with transition to the normal operation state:

A10 is then the first incorrect response which the function controller introduces. From this point onwards, every fourth response introduced is incorrect, provided there is no fault otherwise present. The inquiries F10 and F12 as well as F16 and F14 are identical by doing this as those inquiries with incorrect responses are repeated.

Sequence for faults independent of the inquiry:

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```
10 ms time slot for
the data transfer       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

40 ms time slot for
the inquiry sequence                |                   |                   |                   |

40 ms time slot for
response sequence       |                   |                   |                   |                   |

Data transfer via
the interface:
                        A1        F3        A2        F4        A3        F5        A4        F6        A5
                        correct             incorrect           incorrect           incorrect           incorr.
fault counter                     0                   3                   6                   9
transmitted by UM

Data transfer via
the interface:
                        A5        F7        A6
                        incorrect           incorrect
fault counter                     12             15 >= 13 ——> fault reaction
transmitted by UM
```

The fault is thus active following five incorrect responses.
The fault reaction time is thus for faults which are independent of the inquiries 5*40 ms = 200 ms.

Sequence for inquiry-specific faults:

```
10 ms time slot for
data transfer           |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

40 ms time slot for
the inquiry sequence                |                   |                   |                   |

40 ms time slot for
response sequence       |                   |                   |                   |                   |

Data transfer via
the interface:
                        A1        F3=x      A2        F4        A3        F5=x      A4        F6        A5
                        correct             correct             incorrect           correct             incorr.
fault counter                     1                   0                   3                   2
transmitted by UM

Data transfer via
the interface:
                        A5        F7=x      A6        F8        A7        F9=x      A8        F10       A9
                        incorrect           correct             incorrect           correct             incorr.
fault counter                     5                   4                   7                   6
transmitted by UM

Data transfer via
the interface:
                        A9        F11=x     A10       F12       A11       F13=x     A12       F14       A13
                        incorrect           correct             incorrect           correct             incorr.
fault counter                     9                   8                   11                   10
transmitted by UM

Data transfer via
the interface:
                        A13
                        incorrect
fault counter              13 >= 13 ——> fault reaction
transmitted by UM
```

The fault reaction is active by this for inquiry-specific fault reactions after six incorrect responses at the latest (with correct responses between).
The fault reaction time is thus for inquiry-specific faults 11*40 ms = 440 ms.

APP UMKOM 2.10 Application hint

UMTOUT 2.10 ETS monitoring concept: time-out for UM/FR-communication

FDEF UMTOUT 2.10 Function definition

ABK UMTOUT 2.10 Abbreviations

FB UMTOUT 2.10 Detailed description of function

Testing of the timing between monitoring module and function controller

The monitoring module (UM) is hardware which is independent of the function controller (FR) and has its own clock.

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The UM makes different inquiries to the FR in an arbitrary sequence which require a correct response within a defined time period. The window watchdog function of the monitoring module is to wait for the response at the right point in time.

Operation is no longer permissible in the event of defective communication between the function controller and monitoring module. This is assured by cyclic triggering of error reactions by the monitoring module as reaction to timing errors.

The error reaction is defined as disabled output stages and software reset, thereby enabling the system to be restarted. This reaction is active immediately for time-out errors.

The time monitoring is to be executed as follows:
- The monitoring module checks the timing of synchronization by means of the interface operating controlled from the function controller. To do this, time information from the operating system of the monitoring module shall be made available which check for limiting values. This can take place in 10ms, 20ms or 40ms time slot.
- The function controller cannot directly watch the timing via the coupling because of its master function at the interface. The function controller thus tests the contents of the monitoring module inquiry and error counter for plausibility (see %UMKOM)

The communication is established between the function controller and the monitoring module after the reset as follows:

- the FR terminates its initialization and releases the RSTOUT
- the UM runs through its initialization
- the UM switches the output stages on and off again (see %UMAUSC)
- the FR checks the shut-down of the output stages by the UM (see %UMAUSC)
- the FR sends an initial defined response ASync1
- the UM synchronizes automatically to the first response from the FR
- the UM sends its first inquiry following a defined period of time after the response
- the FR sends its second defined response ASync2
- the UM sends its second inquiry
- the FR sends its response to the first inquiry from UM

- The cyclic interlock sequence of inquiry/response is continued

t1: time used to initialize the UM
t2: time for release of the output stages
t4: max. time for requesting the shut-down status message
TOSynch: Synchronization time-out

POR = Power on reset

RSTOUT = Reset output from the function controller, reset input at the monitoring module

ESENUM = Output stage enable of the monitoring module

SPI = Synchronous serial interface between function controller and monitoring module

ASync1 = First synchronization response from the function controller
ASync2 = Second synchronization response from the function controller
A1 = Response from the function controller to the first inquiry from the monitoring module
F1 = First inquiry from the monitoring module
F2 = Second inquiry from the monitoring module

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APP UMTOUT 2.10 Application hint

URADCC 2.20 ETS monitoring concept: test of the AD-converter

FDEF URADCC 2.20 Function definition

ABK URADCC 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ADCC_T_UM			FW	Error time for ADC values for sp1s that become increasingly less mutually plaus.
SP1ADC_DIF			FW	Max. Diff. bet. setp.-val.poti1 & setp.-val.poti1 from surv. module in sta. case
SP1_STAT			FW	Bandwidth for detection of sp1s stationary
SP1_STAT_T			FW	Time for detection of sp1s stationary

Variable	Source	Type	Description
ADCC_C_UM	URADCC	LOK	Error counter ADC values for sp1s that become increasingly less mutually plaus.
B_DCDIS_UM	URADCC	AUS	Fault reaction information of the function monitoring
B_I_SKA_UM	URADCC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_PWGNOTUM	URADCC	AUS	= b_pwgnot_um function monitoring fault response PWG idling (= b_pwgnot_sr)
EI_ADCC_UM	URADCC	AUS	Irreversible error bit for the AD converter surveillance
IASP1PLAUS		EIN	ADC value incl. channel no. setpoint value for poti 1 loop (PWG) from second ADC
IUSPOTI1		EIN	ADC value incl. channel number nominal value potentiometer 1 loop (PWG)
SP1P_A_UM	URADCC	LOK	Old 10-ms value for setpoint value poti 1 (PWG) from surveillance module for ADC
SP1P_ST_UM	URADCC	LOK	Stationary counter for setpoint value potentiometer 1 from surveillance module
SP1S_A_UM	URADCC	LOK	Old 10-ms value for setpoint value poti 1 (PWG) for the function surveillance
SP1S_ST_UM	URADCC	LOK	Stationary counter for setpoint value potentiometer 1

FB URADCC 2.20 Detailed description of function

AD-converter test

The module must contribute to control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40-ms time frame.

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The ADC value for the reference variable from the pedal value sensor is read in on the function computer by means of the on-chip ADC and a second AD converter that is on a second and different component in the surveillance modulator.
In the case of large pedal dynamics, these values cannot be compared for a bandwidth that is meaningful and it is for this reason, or the difference in threshold is exceeded, that a check is made whether at least one of the two comparison values lies in a defined stationary bandwidth. An error counter only runs when at least one of the two AD values is stationary, the final status of which sets the error information, the error-reaction information as well as the error-reaction idle-speed requirement and the SKA safety fuel shutdown.

The current pedal value is saved at exactly that time as the age for the subsequent processing cycle if a stationary consideration must follow because of the deviation in both AD conversion results.
If both AD-conversion results lie in the permissible bandwidth, then the counter for the stationary consideration and the error-tolerance counter as well, are deleted for the AD-converter error.
The detection for a stationary value is only meaningful and possible when scanning is in the 10-ms time frame.

APP URADCC 2.20 Application hint

The data of function surveillance are part of the monitoring concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
b_dcdis_um		VAR/AUS	Error-reaction info from func. surveillance (shutdown of throttle-valve actuator output stage)
b_i_ska_um		VAR/AUS	Function surveillance error-reaction irreversible SKA (safety fuel shutdown)
b_pwgnot_um		VAR/AUS	Function surveillance error-reaction: PWG idle-speed requirement active
ei_adcc_um		VAR/AUS	Irreversible error bit for monitoring AD converter
iuspoti1		VAR/EIN	ADC value incl. channel number setpoint-value potentiometer 1
iasp1plaus		VAR/EIN	ADC value incl. channel number setpoint-value potentiometer 1 from surveillance module
sp1s_r		VAR/TMP	Temporary current setpoint-value potentiometer 1-value for the function surveillance
sp1p_r		VAR/TMP	Temporary current setpoint-value potentiometer 1-value from surveillance module for the ADC test
sp1s_a_um		VAR/LOK	Old value for setpoint-value potentiometer 1 for function surveillance
sp1p_a_um		VAR/LOK	Old Value for setpoint-value potentiometer 1 from the surveillance module for the ADC test
adcc_c_um		VAR/LOK	Error counter ADC values that are not mutually plausible for sp1s
sp1s_st_um		VAR/LOK	Stationary counter for sp1s_r
sp1p_st_um		VAR/LOK	Stationary counter for sp1p_r

Label	Dependency	Type	Designation
ADCC_T_UM		FW	Error time for ADC values for sp1s that are not mutually plausible
SP1_STAT		FW	Bandwidth for detection of sp1s stationary
SP1_STAT_T		FW	Time for detection of sp1s stationary
SP1ADC_DIF		FW	Maximum difference between sp1s_r and sp1p_r in the stationary case

URCPU 2.10 ETS monitoring concept: Instruction test by means of level 2’

FDEF URCPU 2.10 Function definition

Level 2’

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ABK URCPU 2.10 Abbreviations

FB URCPU 2.10 Detailed description of function

Instruction test with Level 2'

This section describes the instruction test with the help of Level 2'. Level 2' is a image of Level 2, which is formed from the following components:

%UFFGRC	Cruise control monitoring for function monitoring
%UFMSRC	MSR monitoring for function monitoring
%UFMZUL	Permissible torque for function monitoring
%UFMZF	Torque filter for function monitoring
%UFMIST	Actual torque for function monitoring
%UFMVER	Torque comparison for function monitoring
%UFREAC	Fault reaction monitoring for function monitoring

The reason for introducing this transparent instruction test by means of the safety-relevant torque comparison in Level 2 is, to detect an incorrect processing at Level 2. Without the instruction test in Level 2', a incorrect processing of the monitoring function, as executed in Level 2, cannot be detected with certainty. It would thereby be problematical if the function monitoring is active without being detected as such. An active function monitoring which is incorrect becomes apparent in the fault reaction and is thereby detected.

It is assured by the instruction test over the monitoring function that the instructions used here are processed correctly in the test case. Through the inclusion of the performed test results in forming the response for the monitoring module, i.e. in the monitoring module, the test is performed for the instruction test running correctly in a separate intelligent component. Inquiry-specific test data are thereby selected (refer also to %UMKOM, %UMFSEL), which act as input signals for the Level 2'. The execution of the instruction test in its own RAM and ROM areas thereby lead to the function monitoring running without being influenced by the instruction test itself. A utilization of the sub-programs from Level 2 (setpoint search, interpolation) is thereby meaningful.

Dependent on the inquiry set from the monitoring module, a permanently defined set of test data is specified for the Level 2'.

All variables used in the instruction test, i.e. those local variables are superimposed with test data as well, in order to reach a defined result.
The test data are chosen such that the differing torque interventions will be effective as a function of the inquiries set. Taking the nominal torque into account in the response contribution thereby leads to each nominal torque formation path being included in the response regardless of the inquiry set, and hence to a fault detection in the event of a fault which is independent of the inquiry.

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The 16-bit response contribution uma2_res is determined as follows:

uma2_res = word (mped_uc) + word (mmsr_uc) + word (mfgr_uc) + word (mzfo_uc) - word (mi_uc) + word (mver_c_uc)
+ 256* reac_c1_uc + 2048* reac_c2_uc + 16384 (in case b_i_ska_uc=1)
and
uma2_res = word (mped_uc) + word (mmsr_uc) + word (mfgr_uc) + word (mzfo_uc) - word (mi_uc) + word (mver_c_uc)
+ 256* reac_c1_uc + 2048* reac_c2_uc + 0 (in case b_i_ska_uc=0)

This response contribution must vary according to the specific inquiry. It is requested in addition for the conversion into a valid response.
By this, the 16-bit contribution of the program flow check uma_res and the 16-bit contribution of the instruction test uma2_res are required with exact bit correctness as 32-bit information for decoding into a correct response.

APP URCPU 2.10 Application hint

The selection of the test data is made such that fault states are set.

Each monitoring path must be operated as often as possible at intervals which are as short as possible and the result must flow into the formation of the response.

After freezing the data in Level 2, the data from Level 2’ shall follow as required.

URMEM 1.11 ETS monitoring concept: cyclic memory test

FDEF URMEM 1.11 Function definition

ABK URMEM 1.11 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
RST_TV_UM			FW	Identifier for requesting a reset pulse control factor from function monitoring

Variable	Source	Type	Description
RST_TV	URMEM	AUS	Variable in the permanent RAM for reset pulse control factor from funct. monito.

FB URMEM 1.11 Detailed description of function

Cyclic Memory Test

Cyclic RAM Securing

To ensure the monitoring functionality a cyclic securing must take place in the RAM.

A cyclic partial RAM test must therefore take place in the function processor and in the watchdog module on UM functionality, i.e. for the RAM-cells, which are used outside of their generating during the monitoring.
RAM-cells, which in the case of a fault are detected as being defective without self-diagnosis due to their evaluation in the other processor or which are secured by other own testing mechanisms may be exempted.
An example for this is the response of the function processor to the watchdog module. The response test in the watchdog module will detect the fault independent of whether the content of the RAM-cell is incorrect for the response in the function processor or in the watchdog module.

When they are generated the RAM contents are stored as value and complement for the cyclic RAM securing and one of the two values is checked for writability. There are two alternatives for this:
a) Writability test directly after writing when processing in registers:
   One of the two values is read back after writing and compared to its desired value. If the values do not correspond to each other then a system reset is triggered.
b) Writability test by a cyclic RAM test with chessboard pattern when processing in variables:
   One of the two values is checked cyclically with the following sequence: Safe content, write 55H, check for 55H, write AAH, check for AAH, restore content.
   If the test values do not correspond then a system reset is triggered.

The double storage in value and complement is checked for consistency prior to further use. The affected RAM-cells must therefore also be initialized as value and complement provided they are already used during the first run and thus checked beforehand.
Bit information is in the process secured by means of a byte variable, where the bit information 0 and 1 correspond to defined constants, the values of which are inquired upon for consistency to the bit prior to the bit being used.

The fault reaction is defined as system reset in all paths of the RAM securing, i.e. output stage currentless and software reset (function processor) resp. output stage currentless and software reset triggered at the function processor (watchdog module).
It enables a restart of the system in case of malfunctions.
Triggering of a software reset in the function processor takes place in the module URAUSG by means of a software-reset request from the cyclic RAM securing, which was secured via the double storage. This software-reset request enables the adjustment of a debouncing and a healing, which is timewise matched to the fault detection.
Prior to the debounced triggering of a software reset the identifier is loaded into the permanent RAM for reset duty cycle. The RAM and ROM check (usually performed during the after-run) as well as a defined waiting time prior to the release of the output stage resp. end of the initialization is activated via this identifier in the subsequent initialization.
With permanent defects in the RAM, which no longer allow for writing or which prevent a consistency of the affected data a system reset is triggered over and over again and thereby the fault reaction is never left.

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Cyclic ROM Securing

The module must be of assistance in the check of the program execution (cf. %URPAK).

To ensure the monitoring functionality a cyclic securing must take place in the ROM.

A cyclic partial ROM test must therefore take place in the function processor via monitoring functions, i.e. of that ROM area, which is used by the monitoring and which is not secured otherwise.
So the serving of the interface as well as the compiling of information for the other processor can be exempted, since a fault within it is anyhow found in the other processor.
Furthermore ROM areas can be exempted, which are exclusively used for the monitoring of the second processor.
Testing of these ROM contents to avoid sleeping faults in the monitoring is sufficient once during the driving cycle. The watchdog processor can thereby be designed without cyclic ROM securing.
A cyclic ROM securing in the watchdog module would only be of assistance in case of double faults, i.e. if in addition to the fault in the watchdog module a fault in the function processor, which is detectable by the watchdog module occurs during the same driving cycle.

For the cyclic partial ROM test the affected ROM area (code and data) is stored either completely or in parts with a check sum each. The ROM area is added cyclically word by word and compared to the accompanying check sum in the ROM.
In the process the affected ROM area is subdivided so that in the cycle of the monitoring software (40ms) always one part is processed. Falsifications of the used RAM contents (especially of the ROM pointer) lead to a fault not reliably being detected and they must therefore be separately secured in the RAM (cf. cyclic RAM securing).

The fault reaction is - unlike with the entire ROM test in the after-run - defined as output stages currentless and software reset. It enables a restart of the system in case of possible malfunctions.
Triggering of a software reset in the function processor takes place in the module URAUSG by means of a software-reset request from the cyclic ROM securing, which was secured via the double storage. This software-reset request enables the adjustment of a debouncing and a healing, which is timewise matched to the fault detection.
Prior to the debounced triggering of a software reset the identifier is loaded into the permanent RAM for reset duty cycle. The RAM and ROM check (usually performed during the after-run) as well as a defined waiting time prior to the release of the output stage resp. end of the initialization is activated via this identifier in the subsequent initialization.
With a permanent defect in the ROM of the watchdog function a software reset is repeatedly triggered and the attempt is made to terminate the ROM test successfully in order to be able to resume normal driving operation.

APP URMEM 1.11 Application hint

The data of this watchdog function are part of the monitoring concept and may not be changed arbitrarily.

Label	Source	Type	Description
rst_tv		VAR/AUS	Identifier in the permanent RAM for reset-duty-cycle from the watchdog function

Label	Dependency	Type	Description
RST_TV_UM		FW	Identifier to request a reset-duty-cycle from the watchdog function

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URPAK 1.10 ETS monitoring concept: program flow check

FDEF URPAK 1.10 Function definition K3/EAM

EGAS Überwachungskonzept Programmablaufkontrolle

urpak-fo2098

urpak-fo2098

ABK URPAK 1.10 Abbreviations

FB URPAK 1.10 Detailed description of function

Program execution check

Function

The execution check ensures that important program parts are executed cyclically in a defined time cycle.

The use of important CPU instructions for the processing of the execution check, which are used on the functional level as well as in the watchdog function shall in addition enable the detection of faults, which were possibly made during the execution of instructions. For this the following processing is performed:
a) defined inquiry detection from a given input information complex.
b) defined arithmetic operations at the beginning after the inquiry was received, in the important program parts and at the end prior to the allocation of the response
c) Allocation of the results from the program execution check regarding a defined correct or incorrect response to the supervisor module

Boundary conditions

A program module is detected as having been executed if it is correctly started and terminated.
This modular framework in form of a start and end processing must meet the following conditions:
a) Each concerned module must be processed in the given time cycle. The processing of the program execution check must always be active, so as not to allow for faults in the processing cycle.
b) The not performed execution of a module may not be allowed to be substituted by a single or multiple execution of another module.
c) Faults in the program execution of these important program parts must lead to a defined fault reaction.
d) The program execution check must lead to variable responses for variable inquiries to avoid that a once correctly processed execution check will always lead to the correct response.
e) The back-up of the ROM in the defined area must be performed separately, so as to ensure that the program code between start and end processing of program modules is correct (see %URMEM).

By the module-specific definition of individual prime numbers as module identifiers and their constant cyclic processing to create a response to an inquiry of the separate HW supervisor module it is possible to fulfill the requirements a), b). and c).
Including the posed inquiry into the program execution check to form the response fulfills requirement d).

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Realization example

The conditioning of inquiry, response and the program execution check are active during the after-run and during normal operation since the supervisor module (UM) cannot distinguish the after-run from the normal operation. This applies in the same way to the modules, which make a cyclic contribution to the program execution check.

The inquiry UMFRG made by the supervisor module is checked for the permissible value range and re-standardized to a value range (UMF_PTR) which can be processed by the program execution check. If the value range is violated the incorrectly posed inquiry leads to an incorrect response.
The current inquiry UMF_PTR is looped through all modules, which are part of the safety-relevant program and it, is included in the program execution check.

The module-start-counter (MBEG_C) is initialized with the current inquiry (UMF_PTR) for this and it is incremented in each module of the watchdog function. The module-end-counter (MEND_C) is initialized with the result from a multiplication and division by the current inquiry (UMF_PTR) as well as with constant contributions to the execution check and it is increased by a module-individual value in each module of the watchdog function.

At the end of the program execution check the result UMA_RES is determined from these two counters
(UMA_RES = 1024 * MBEG_C + MEND_C). This result is compared with 16 valid results prior to a new inquiry being taken on.
For this, two constants exist for each module from the watchdog function:
1. Number of call-ups in the 40ms cycle
2. Module-individual identifier
With a valid result the correct response, otherwise the response defined as incorrect is made available in UMANT.

During operation the determined response is transferred and the posed inquiry is taken over every 40 ms.
Thus the program execution check is usefully always active. When a new inquiry arrives a processing cycle is started which is terminated - when the next inquiry arrives - after 40ms.

APP URPAK 1.10 Application hint

URRAM 2.10 ETS monitoring concept: RAM-test

FDEF URRAM 2.10 Function definition

ABK URRAM 2.10 Abbreviations

Variable	Source	Type	Description
RST_TV	URMEM	EIN	Variable in the permanent RAM for reset pulse control factor from funct. monito.

FB URRAM 2.10 Detailed description of function

RAM test

Procedure:
* Write the complement of the addresses in the RAM cells to be tested, subsequently test the contents and write the value of the addresses in the RAM cells to be tested, read out, check and clear as the check result is OK.

Frequency:
* in each driving cycle

Detectable errors:
* setability/clearability of all bits
* writability/readability of the memory cells
* errors on address/data lines
* address decoder errors

RAM test in the function controller

Marginal conditions:
* permanent RAM present
* controller afterrun defined
* time required for RAM test in the initialization is not acceptable (external RAM e.g. larger than 8 Kbyte)

RAM cells to be tested:
* CPU RAM (internal RAM and onchip XRAM)
* external RAM

Point in time:
* in the standard initialization prior to release of the monitoring module
    * external RAM only permanent RAM (without OBP RAM) in the initial initialization, i.e. prior to first use
    * repeated test for external RAM without permanent RAM in case the information in the permanent RAM does not contain the identifier "RAM test error-free".
    * Writability test of the permanent RAM cell for the information "RAM test error-free" by the chess board pattern with the following sequence: save contents, write 55H, test for 55H, write AAH, test for AAH, save back contents.
* in the standard initialization following release of the monitoring module and prior to enable of the interrupts
    * CPU RAM (internal RAM and onchip XRAM)
* in the afterrun following run-down of the operating system and disabling of the interrupts
    * external RAM without permanent RAM

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Error reaction from initial or standard initialization or repeated testing or writability test:
* output stages will be or remain shut down,
* software reset,
* repetition of the RAM test,
* engine start possible if RAM is detected as being error-free,
* no serving of the data transfer to the monitoring module

Error reaction from computer afterrun:
* repeat test in the next standard initialization
* destruction of the identifier "RAM test error-free" at the following drive cycle as information in the permanent RAM

RAM test in the monitoring module

Marginal condition:
* time required for RAM test in the initialization acceptable (only internal RAM)

RAM cells to be tested:
* CPU RAM (internal RAM and onchip XRAM)

Point in time:
* in the standard initialization
    * CPU RAM (internal RAM and onchip XRAM)

Error reaction:
* output stages will be or remain shut down,
* software reset at the function controller (i.e. system reset),
* repetition of the RAM test,
* engine start possible if RAM is detected as being error-free,
* no serving of the data transfer to the function controller

APP URRAM 2.10 Application hint

URROM 2.20 ETS monitoring concept: ROM-test

FDEF URROM 2.20 Function definition

ABK URROM 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ROMRSTA_UM			FW	Max. number of resets for error detection in the ROM check during initialization

Variable	Source	Type	Description
ROMRSTC_UM	URROM	LOK	Counter for resets for error detection in the ROM check during initialization

FB URROM 2.20 Detailed description of function

ROM test

Procedure:
* Wordwise checksum over the entire ROM range in blocks with assigned check word.

Frequency:
* In each driving cycle

Errors that can be detected:
* Losses / falsifications of data in memory cells
* Readability of memory cells
* Faults on address / data lines
* Bus faults

ROM test in the function computer

Secondary condition:
* Permanent RAM available
* Computer afterrunning defined
* Time required for ROM test during initialization not acceptable (ROM code e.g. larger than 64 Kbyte)

Point in time:
* During a standard initialization prior to enabling the surveillance module
    * Repeat check of the discrepant block or all the blocks in the event of several discrepant blocks in case the corresponding information in the permanent RAM contains the identifier "Discrepant ROM test".
* During computer afterrunning
    * All blocks of the entire ROM range

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Error reaction from possible repeated checks:
* Output stages become or remain suppressed,
* Software reset by transfer of the reset path "SUPERVISOR_RESET_ROM",
* Repeat of the ROM test,
* Engine start-up possible if the ROM has been detected as being error-free

In the event that a checksum error is detected in the ROM test during initialization, then an error counter in the permanent RAM is incremented before a software reset is triggered.
This error counter is deleted again when an error-free condition is detected during the ROM test, or the final status has been reached for the error counter.
Deleting the error counter when the final status has been reached shall also ensure that the foreseen number of ROM tests is carried out again for "Ignition off/on".
This is meaningful in order to make a transition possible into the normal operating mode in case the error is no longer present the next time the ignition is switched on.
A return to the boot block or into the internal ROM when the final status of the error counter is reached enables the Flash content to be programmed again.
This is above all then important if a status that has been programmed by mistake remains in the reset ROM-test loop because of an error in the checksum.
If it is only that a checksum has been incorrectly entered, then although typical by triggering a powerfail, the transition into the normal operating mode is possible by programming the Flash. This does not apply for checksum errors in the range to be cyclically checked (refer to %URMEM).

Error reaction from computer afterrunning:
* Repeat of the check during the next standard initialization
* Transfer of the identifier "Discrepant ROM test" to the subsequent driving cycle as information in the permanent RAM
  With the allocation of the block detected as being discrepant, or the information "Several ROM blocks discrepant"

ROM test in the surveillance module

Secondary condition:
* Time required for the ROM test during initialization is acceptable (ROM code e.g., not larger than 64 Kbyte)

Point in time:
* During standard initialization
    * All blocks of the entire ROM range

Error reaction:
* Output stages become or remain shutdown,
* Output of software reset to the function computer (i.e. system reset),
* Repeat of the ROM test,
* Engine start-up possible if the ROM is detected as being error-free,
* No operation of data transfer to the function computer

APP URROM 2.20 Application hint

SREAKT 5.10 EGAS: safety concept, failure reactions

FDEF SREAKT 5.10 Function definition

sreakt-sreakt

ABK SREAKT 5.10 Abbreviations

Variable	Source	Type	Description
B_DKNOLU	SREAKT	AUS	condition: power supply of throttle actuator cut off
B_DKPIU	SREAKT	AUS	Condition: irreversible SKA
B_DKPRU	SREAKT	AUS	Condition: reversible SKA
B_DKPU	SREAKT	AUS	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DKUNB	GGDVE	EIN	condition: unknown throttle blade position
B_DLRBE		EIN	Condition: DLR correction range exceeded
B_DLRPIDE		EIN	Condition: Fault, DLR correction range at limit
B_FPRZAB	BGDVE	EIN	Condition: Abort of DV-E return spring check, spring does not close

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Variable	Source	Type	Description
B_I_SKA_FR	SREAKT	AUS	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_NLPNE		EIN	Condition: NLP not reached for DK standby trip
B_NOTLU_FR	SREAKT	AUS	Request for NFB from Function controller
B_UBDVE	ADVE	EIN	Condition: Battery voltage for DV-E control OK
B_UMAUAB	BGDVE	EIN	Condition: UMA learning stopped during first initialization (SKA)
B_WDKSIVE		EIN	Condition: Fault in comparing DK angle nominal value/actual value

FB SREAKT 5.10 Detailed description of function

The task of this function is the evaluation of fault bits which are generated by differing functions within the scope of the EGAS surveillance. Appropriate standby functions (DK actuator standby functions or safety fuel shutoff) are introduced as required and depending on the faults which are detected.

APP SREAKT 5.10 Application hint

DUF 4.10 Diagnostic interface of the function monitoring

FDEF DUF 4.10 Function definition

No text for FDEF available!

ABK DUF 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCUFMV	BLOKNR		KL	Code word CARB: monitoring of the function: torque comparison
CDCUFSKA	BLOKNR		KL	Code word CARB: monitoring of the function: safety fuel cut-off
CDKUFMV			FW	Code word customer: monitoring of the function: torque comparison
CDKUFSKA			FW	Code word customer: monitoring of the function: safety fuel cut-off
CDTUFMV			FW	Code word tester: monitoring of the function: torque comparison
CDTUFSKA			FW	Code word tester: monitoring of the function: safety fuel cut-off
CLAUFMV			FW	Fault class: monitoring of the function: torque comparison
CLAUFSKA			FW	Fault class: monitoring of the function: safety fuel cut-off
DUF_T			FW	time for setting the cycle flags of function monitoring diagnosis
FFTUFMV	BLOKNR		KL	Freeze frame table: monitoring of the function: torque comparison
FFTUFSKA	BLOKNR		KL	Freeze frame table: monitoring of the function: safety fuel cut-off
NMN_DUF			FW	engine speed threshold for setting the cycle flag of the function monitoring dia
TSFUFMV			FW	Fault active time: monitoring of the function: torque comparison
TSFUFSKA			FW	Fault active time: monitoring of the function: safety fuel cut-off

Variable	Source	Type	Description
B_CLUFMV		EIN	Flag for clearance: monitoring of the function: torque comparison
B_CLUFSKA		EIN	Flag for clearance: monitoring of the function: safety fuel cut-off
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_FGR_UM	UFUE	EIN	CC/ACC torque intervention in function monitoring permitted
B_HFM	DHFM	EIN	Condition: HFM ready to measure
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_MIBEG	MDKOG	EIN	condition torque limit active
B_MSR	MDKOG	EIN	Condition MSR
B_NOACC_UM	UFFGRC	EIN	Condition transfer of ACC torque
B_NOMSR_UM	UFUE	EIN	MSR moment required not transferred to function monitoring
B_NOTLU_FR	SREAKT	EIN	Request for NFB from Function controller
B_NPUFMV	DUF	AUS	fault type not plaus.: monitoring of the function: torque comparison
B_NPUFSKA	DUF	AUS	fault type not plaus.: monitoring of the function: safety fuel cut-off
B_PWGNOTFR	GGPED	EIN	FR error reaction pedal-travel sensor limphome
B_SP1S	GGPED	EIN	message to SR: SP1S is command variable
B_SP2S	GGPED	EIN	SP2S is valid set value for PWG failure driving
B_SPSMIN	GGPED	EIN	message to SR: '1' = pedal-travel sensor limphome with SPSMIN
B_UB_OK	ADVE	EIN	Battery voltage o.k.
B_WDK2SEL	GGDVE	EIN	Condition: DV-E position control is performed with actual-value-poti 2
DUF_C	DUF	LOK	Time counter for setting cycle flags of the function surveillance diag. routine
EGASPFAD	DUF	AUS	ETS-path as environmental condition for diagnosis of function monitoring
EI_ADCC_UM	URADCC	EIN	Irreversible error bit for the AD converter surveillance
EI_IPA_UM	UFRLC	EIN	Irrevers. error bit for lower DK limit in invalid range of function monitoring
EI_MVER_UM	UFMVER	EIN	Irreversible error bit for torque comparison from function monitoring
EI_NC_UM	UFNC	EIN	irreversible error bit for engine speed comparison from function monitoring
EI_REAC_UM	UFREAC	EIN	irreversible error bit of fault reaction monitoring from function monitoring
EI_RLC_UM	UFRLC	EIN	Irrevers. error bit for comparison of rl with the function in function monitor.
EI_RLIP_UM	UFRLC	EIN	Irreversible error bit for rl/rlip comparison in function monitoring
EI_SPSC_UM	UFSPSC	EIN	irrevers. error bit for pedal value plausibility check in function monitoring
EI_ZWC_UM	UFZWC	EIN	irrevers. error bit for ignition angle monitoring from function monitoring
E_UFMV	DUF	AUS	Error flag: monitoring of the function: torque comparison
E_UFSKA	DUF	AUS	Error flag: monitoring of the function: safety fuel cut-off
MI_DUF	DUF	AUS	actual torque at response of torque comparison in the function monitoring
MI_UM	UFMIST	EIN	Calculated actual torque in function monitoring
MPFAD	DUF	AUS	Torque path in function and function monitoring as environmental cond. of diag.
NMOT_UM	UFNC	EIN	engine speed in function monitoring
SFPUFMV	DUF	AUS	status word: monitoring of the function: torque comparison
SFPUFSKA	DUF	AUS	status word: monitoring of the function: safety fuel cut-off

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Variable	Source	Type	Description
SKAPFAD	DUF	AUS	freeze frame information for SKA
Z_UFMV	DUF	AUS	cycle flag: monitoring of the function: torque comparison
Z_UFSKA	DUF	AUS	cycle flag: monitoring of the function: safety fuel cut-off

FB DUF 4.10 Detailed description of function

APP DUF 4.10 Application hint

DUR 1.20 Diagnosis from computer monitoring

FDEF DUR 1.20 Function definition

(*1): Unlike in the description, this part is realized in the module %DFPM
(*2): The activities triggered by C_(*) are implemented in the SW in separate processes

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E_urrom:

Environmental condition 1 : rstpfad Environmental condition 2 : -

E_urram:

Environmental condition 1 : rstpfad Environmental condition 2 : -

E_urrst:

Environmental condition 1 : rstpfad Environmental condition 2 : -

ABK DUR 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCURRAM	BLOKNR		KL	Code word CARB: monitoring of the controller: RAM
CDCURROM	BLOKNR		KL	Code word CARB: monitoring of the controller: ROM
CDCURRST	BLOKNR		KL	Code word CARB: monitoring of the controller: Reset
CDKURRAM			FW	Code word customer: monitoring of the controller: RAM
CDKURROM			FW	Code word customer: monitoring of the controller: ROM
CDKURRST			FW	Code word customer: monitoring of the controller: Reset
CDTURRAM			FW	Code word tester: monitoring of the controller: RAM
CDTURROM			FW	Code word tester: monitoring of the controller: ROM
CDTURRST			FW	Code word tester: monitoring of the controller: Reset
CLAURRAM			FW	Fault class: monitoring of the controller: RAM
CLAURROM			FW	Fault class: monitoring of the controller: ROM
CLAURRST			FW	Fault class: monitoring of the controller: Reset
FFTURRAM	BLOKNR		KL	Freeze frame tabele: monitoring of the controller: RAM
FFTURROM	BLOKNR		KL	Freeze frame tabele: monitoring of the controller: ROM
FFTURRST	BLOKNR		KL	Freeze frame tabele: monitoring of the controller: Reset
TSFURRAM			FW	Fault active time: monitoring of the controller: RAM
TSFURROM			FW	Fault active time: monitoring of the controller: ROM
TSFURRST			FW	Fault active time: monitoring of the controller: Reset

Variable	Source	Type	Description
B_CLURRAM		EIN	Flag for clearance: monitoring of the controller: RAM
B_CLURROM		EIN	Flag for clearance: monitoring of the controller: ROM
B_CLURRST		EIN	Flag for clearance: monitoring of the controller: Reset
B_NPURRAM	DUR	AUS	fault type not plaus.: monitoring of the controller: RAM
B_NPURROM	DUR	AUS	fault type not plaus.: monitoring of the controller: ROM
B_NPURRST	DUR	AUS	fault type not plaus.: monitoring of the controller: Reset
E_URRAM	DUR	AUS	error flag: monitoring of the controller: RAM
E_URROM	DUR	AUS	error flag: monitoring of the controller: ROM
E_URRST	DUR	AUS	Error flag: monitoring of the controller: Reset
RSTPFAD	DUR	AUS	Reset-path as environment condition for the diagnosis of processor monitoring
SFPURRAM	DUR	AUS	status word: monitoring of the controller: RAM
SFPURROM	DUR	AUS	status word: monitoring of the controller: ROM
SFPURRST	DUR	AUS	status word: monitoring of the controller: Reset
Z_URRAM	DUR	AUS	cycle flag: monitoring of the controller: RAM
Z_URROM	DUR	AUS	cycle flag: monitoring of the controller: ROM
Z_URRST	DUR	AUS	cycle flag: monitoring of the controller: Reset

FB DUR 1.20 Detailed description of function

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Diagnosis from database monitoring

The diagnostics function must run during initialization following the initialization section for the reset pulse duty factor and after the DFPM initialization, because all cycle bits are deleted during DFPM initialization.

Cyclic processing is also possible during operation, e.g. in the 100-ms time frame, in case difficulties in integration are encountered in initialization.

The separation is made into errors from the RAM tests, the ROM tests and in other errors with the defined error reaction Reset.

The following assignment thereby applies:

```
SUPERVISOR_RESET_TV     = Reset to create a pulse duty factor between Reset and Operation (refer to %URMEM, %UFREAC)

SUPERVISOR_RESET_ROM    = Reset from the ROM test during initialization (refer to %URROM)
=> rstpfad = 01
SUPERVISOR_RESET_ROMZ   = Reset from the cyclic, partial ROM test via the monitoring components (refer to %URMEM)
=> rstpfad = 02

SUPERVISOR_RESET_RAM    = Reset from the RAM test during initialization via an external RAM (refer to %URRAM)
=> rstpfad = 03
SUPERVISOR_RESET_RAMI   = Reset from the RAM test during initialization via an internal RAM (refer to %URRAM)
=> rstpfad = 04
SUPERVISOR_RESET_RAMZ   = Reset from the cyclic, partial RAM backup of surveillance variables (refer to %URMEM)
=> rstpfad = 05

SUPERVISOR_RESET_FU     = Reset from the error-reaction monitoring of function surveillance (refer to %UFREAC)
=> rstpfad = 06
SUPERVISOR_RESET_UM     = Reset from the discrepant error-counter check-back signal from the surveillance module (refer to %UMKOM)
=> rstpfad = 07
SUPERVISOR_DISPS_RESET  = Reset from the shutdown-path test (refer to %UMAUSC)
=> rstpfad = 08
SUPERVISOR_NOQUEST_RESET= Reset from a missing inquiry from the surveillance module (refer to %UMTOUT/ %UMKOM),
                          for communication via SPI with function computer as the master not possible
=> rstpfad = 09
```

The assignment of the chracteristic rstpfad is fixed for analysis in the diagnostic routine. For a symbolic inquiry as to the reason for a reset to be entered, this assignment must then be corrected in the above list.

The entry in the error memory can however only take place when there is no statistical error that would prevent a reset by its error reaction since the entry can be executed or be read out.
The entries defined above are thus possible in the error memory for errors that are no longer present at the point in time of the entry.
There is thus a sequence conceivable in which a memory error is detected during initialization for instance, that leads to a reset. If this memory error is no longer present in one of the subsequent test sequences within initialization, then the transition is made into normal operation without any impairment of the function, and the error no longer present is entered into the error memory.

Error-type information as well as cycle and error flags are displayed as outputs in block diagrams. The output is not however by the transfer of individual bits, but rather by writing back the entire status word sfpxyz of the error path XYZ into central diagnostics management, DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contained in this status word. Access methods are available for those error and cycle flags that occur as inputs from other error paths, that directly read in this information from the error-path status managed by the DFPM.

The following variables have been defined for each error path XYZ of this diagnostic function:

```
Status error path XYZ:                        sfpxyz
   Error flag xyz:                            E_xyz
   Cycle flag xyz:                            Z_xyz
   Error type xyz:                            TYP_xyz: (B_mxxyz, B_mnxyz, B_sixyz, B_npxyz)
   Delete error path:                         B_clxyz
   Standby value active:                      B_bkxyz (optional)
Error path code xyz:                          CDTXYZ
Error class xyz:                              CLAXYZ
Error severity xyz:                           TSFXYZ
CARB code xyz:                                CDCXYZ
Table of environmental conditions xyz:        FFTXYZ
```

The following error paths xyz are covered in this FDEF:

Error path name	Abbreviation used (replaces "xyz")
Computer monitoring: ROM	URROM
Computer monitoring: RAM	URRAM
Computer monitoring: Reset	URRST

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APP DUR 1.20 Application hint

MOTOR 245.10 Engine data

FDEF MOTOR 245.10 Function definition

No text for FDEF available!

T2DFA 1.40 KWP2000; activation of diagnostic function

FDEF T2DFA 1.40 Function definition

Es werden zwei Fälle unterschieden:

1) Funktionsansteuerung:
Über das Diagnoseprotokoll wird von einem Tester per Telegramm ein Systemcheck angefordert. Die ggf. mit dem Telegramm übertragenen Schnittstellenparameter greifen in die entsprechende Motorfunktion ein, so daß bestimmte Abläufe unter einfacheren Randbedingungen bzw. unter Umgehung längerer Zeitzähler schneller ablaufen.
Bei zyklischer Abfrage der entsprechenden Zyklusbits bzw. der maßgebenden RAM-Zellen erhält man am Bandende Kenntnis über die Funktion/Nichtfunktion der getesteten Baugruppe/SW-Funktion.

2) Bauteileansteuerung:
Über das Diagnoseprotokoll wird von einem Tester per Telegramm die Ansteuerung einer Endstufe angefordert. Die ggf. mit dem Telegramm übertragenen Schnittstellenparameter (Einschalten, Ausschalten, Tastverhältnis) wirken direkt auf die entsprechende Endstufe. (vgl. alte VS23-Stellglieddiagnose). Die normale Motorfunktion läuft im Hintergrund weiter.
Die Trennung findet auf HW-Schalen-Ebene durch einfache Umschaltung statt. Auf diese Weise erhält man keinerlei qualitative Aussage über die Güte einer Funktion sondern nur durch optische, bzw. akustische Kontrolle eine Aussage über angeschlossene Endstufenaggregate.

Über diese Funktion werden die Ansteuerbits, optionale Schnittstellenparameter und alle nicht der eigentlichen Motorfunktion bzw. dem entsprechenden KWP2000-Telegramm zuzuordnenden Teilfunktionen (z.B. Tastverhältnis-Erzeugung bei Bauteilansteuerung Lambdasondenheizung) festgelegt.

Merkmale Funktionsansteuerung:
Alle Funktionsansteuerungen dürfen parallel laufen, der Tester stellt deren Verträglichkeit sicher.
Keine Timeout-Überwachung. Einmal per Telegramm (Diagnosefunktion Start) angeworfen, läuft die Funktion bis zum Empfang des entsprechenden Telegramms (Diagnosefunktion Stop), einem generellen (Stop Communication) oder einem Reset durch KL15 weiter.

Der Tester kann bei laufender Funktion über entsprechende Telegramme für die Funktion relevante RAM-Zellen abfragen und die Funktionsgüte bzw. deren Fortschritt anhand der zurückgemeldeten Stati beurteilen.

Die Diagnosestati (Funktion läuft), (Funktion nicht angestoßen), (Funktion beendet) müssen vom Tester selbst verwaltet werden.

- Steuerung des Funktionseingriffs über die Bits mit den Namen B_fa und B_fadfp (dfp = Funktionskürzel).
- Start/Stop der Funktionen über die Telegramme StartRoutinByLocalIdentifier, Diagnosefunktion Start bzw. StopRoutineByLocalIdentifier, Diagnosefunktion Stop mit den Funktionsnummern RELI_ und den Schnittstellenparametern REYO_ bzw. REYS_.

Merkmale Bauteileansteuerung:
- Bis auf gekennzeichnete Ausnahmen dürfen alle Bauteilansteuerungen parallel laufen.
- Ansteuerung unter Kontrolle des Testers auch bei laufendem Motor erlaubt.
- Gemeinsamer Timeout von 20sec, retriggerbar durch eine weitere oder dieselbe Ansteuerung.
- Beenden der Ansteuerung über ablaufenden Timeout, Reset oder die Telegramme (Freigabe an Motorfunktion) oder (Stop Communication).
- Normale Motorfunktion läuft im Hintergrund weiter. Umschaltung durch Bits mit den Namen B_bt und B_btdfp.
- Start/Stop der Ansteuerung über das Telegramm InputOutputControlByLocalIdentifier, I/O-Status vorgeben mit den Bauteilnummern IOLI_ und den Schnittstellenparametern IOCP_.

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Realisierte Eingriffe auf Funktionen:

Funktions-ansteuerung	Fkt-Nr RELI_	FDEF	Parameter REYO_	Eingriff über	Funktionsstatus REYS_
Sekundärluft	20	%SLS83.60 %DSLSLR2.20	0	B_fa, B_fasls	slsstat
Tankdiagnose	21	%DLDP16.20	0	B_fa, B_fadldp	stptrw
TEV-Check	22	%DTEVN22.60	0	B_fa, B_fates	tesstat
VANOS-Test1 Verstellzeit	23	%WNWEIN5.10 %WNWTST1.10	Verstellwinkel wnwstst	B_fa, B_fanws	nwsstat, -2; tnwsfi, -2; tnwssi, -2
VANOS-Test2 Dichtheit	24	%WNWEIN5.10 %WNWR4.10	Verstellwinkel wnwstst	B_fa, B_fanwsd	nwsdstat, -2; wnwi_w[0], wnwi_w[1]
EV-Ausblenden	25	%AEVAB2.10	Bit-Ausblend-muster devoff	B_fa, B_faevz	
Leerlaufsteller	26	%LLRNS %BBSAWE	Solldrehzahl	B_fa, B_falls	llsstat
Adaptionen sperren	D8	%LRAEB	0	B_fa, B_falra	
Lambdaregelung aus	D9	%LREB	0	B_fa, B_falr, -2	
Tankdiagnose DM-TL	DA	%DDMTL	0	B_fa, B_fadmtl, B_fadmet	stpdmtl, statdmtl, Bit0 = B_admtll, Bit1 = E_dmtk Bit2 = E_dmtl Hi-, Low-Byte IPTESKF_W Hi-, Low-Byte IPTGLMN_W Hi-, Low-Byte IPTREF_W

Realisierte Eingriffe auf Bauteile:

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Bauteil-ansteuerung	Nr. IOLI_	FDEF	Parameter IOCP_	HW-Schale Funktion	Eingriff über
E-Lüfter	C1	%MLS49.20	Tastverhältnis variabel tamldia	Funktion	B_fa, B_famls
SLPV1 Sekundärluftpumpe	C2	%SLS83.60	ein/aus (ggf. Tastv.) B_slpet	HW	B_bt, B_btslp
KFK-Thermostat	C3	%ETR8.10	ein/aus B_etret	Funktion	B_fa, B_faetr
SLPV2 Sekundärluftventil	C4	%SLS83.60	ein/aus B_slvet	HW	B_bt, B_btslv
TEV	C5	%ATEV2.0	Tastverhältnis variabel t_bttev LOW-Zeit	HW	B_bt,B_bttev
EKP-Relais	C6	%AEKP2.30	ein/aus B_ekpet	HW	B_bt, B_btekp
LS-Heizung1 v. Kat	C7	%HLS16.20	Tastverh. variabel t_bthsv	HW	B_bt, B_bthsv
LS-Heizung1 h. Kat	C8	- , -	dto. t_bthsh	HW	B_bt, B_bthsh
LS-Heizung2 v. Kat	C9	- , -	dto. t_bthsv2	HW	B_bt, B_bthsv2
LS-Heizung2 h. Kat	CA	- , -	dto. t_bthsh2	HW	B_bt, B_bthsh2
Einspritzventil 1,..,5 Einspritzventil 6,..,8	CB,..CF D1,..D3	%T2DFA	200 usec Massetastung pro 100 ms	Funktion ti_evx	B_bt, B_btev1,...,8
Leck-Diagnose-Pumpe	D5	%DLDP16.20	nur Einschaltfunktion über B_ldpein	Funktion	B_bt, B_btldp
Startrelais	D6	%STA7.10	ein/aus B_staet	HW	B_bt, B_btsta
Klimakompressor	D7	%KOS107.0	ein/aus B_koset	HW	B_bt, B_btkos
E-Box Lüfter	D8		ein/aus B_eblet	HW	B_bt, B_btebl

Bauteil-ansteuerung	Nr. IOLI_	FDEF	Parameter IOCP_	HW-Schale Funktion	Eingriff über
DM-TL Pumpenmotor	DA	%DDMTL	ein/aus B_dmpmet	Funktion	B_bt, B_dmpmet
DM-TL Magnetventil	DB	%DDMTL	ein/aus B_dmmvet	Funktion	B_bt, B_dmmvet

speziell für Lambdasondenheizung gilt zusätzlich:
- Prinzipiell 100ms Einschaltzeit.
  Übergabeparameter IOCP_ ist in diesem Fall variable Ausschaltzeit in Vielfachen der Einschaltzeit.
  Minimale Ausschaltzeit: 100ms (0 bzw. 1), maximale Ausschaltzeit: 25,5sec (255). Umrechnung: dez.
- EXRAM-Zeitzähler für Ausschaltzeit hsvtim, hshtim, hsv2tim, hsh2tim; Umrechnung dez 1Inc = 100ms.
- EXRAM-Reloadwert für Zeitzähler t_bthsv, t_bthsh, t_bthsv2, t_bthsh2; Umrechnung dez 1Inc = 100ms.
- Überwachung im 100ms-Raster

speziell für Startrelais gilt zusätzlich:
- Automat: Ansteuerung nur bei bei Stellung P oder N und Drehzahl Null. Bei Handschalter keine Bedingung.

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ABK T2DFA 1.40 Abbreviations

FB T2DFA 1.40 Detailed description of function

APP T2DFA 1.40 Application hint

T2DCLA 1.10 KWP2000; reset adaptive value

FDEF T2DCLA 1.10 Function definition

sorry, no FDEF

ABK T2DCLA 1.10 Abbreviations

FB T2DCLA 1.10 Detailed description of function

APP T2DCLA 1.10 Application hint

EEPROM 11.10 EEPROM treatment

FDEF EEPROM 11.10 Function definition

ABK EEPROM 11.10 Abbreviations

FB EEPROM 11.10 Detailed description of function

EEPROM treatment

Data which are to be maintained also in the event of powerfail are stored in the EEPROM.

Partitioning of the EEPROM

The project-specific structure and partition as well as the contents of the EEPROM are determined in a header file.
The area of the EEPROM is divided into blocks and pages. A block may consist of one or several pages.
Blocks have version numbers in order to be able to detect a changed EEPROM assignment and the consistency of EEPROM and program version. These blocks are used for the logical structuring and it is possible to to initialize them individually.
The version number and the length of the block are stored in the first two bytes of the first page of a block.

Structure of a page

The typical length of a page is 16 bytes (for presently used EEPROMs). For the configuration of the page a page descriptor exist in the flash-EPROM.

The following is specified in the page descriptor:
- Is the check sum stored in the last two bytes of the page ?
- Is the page mirror-imaged in the RAM ?
- Is the page the first page in the block or the double storage of the first page ?
- Is external writing into the page allowed ?
- Is external reading of the page allowed ?
- Is the initialization of the data on detection of non-correctable errors (check sum test) allowed ?
- Is the page the first or the second page of a double storage ?

In the individual pages and blocks the data are to be divided such that the chosen integrity strategy, described below, is sufficient for all data and that the configuration of the page and of the block suits all data of the page.
It is useful to store the first page of a block twice, so that in case of incorrect data in this page not the entire block is going to be initialized.

Access mode

In the permanent RAM a mirror-image of the EEPROM pages can be stored. This is configurated in the page descriptor for each page.

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During the initialization of the ECU program the EEPROM pages (as far as they are configurated as page with mirror-image in the permanent RAM and as far as it was determined by means of check sum test that the contents is correct) are copied into the corresponding mirror-image pages in the the permanent RAM. In case of changed data the contents of the mirror-imaged pages is written into the the corresponding pages in the EEPROM during the ECU after-run. Furthermore, it is possible to write event-triggered data into an EEPROM page and, as far as configurated, into the corresponding mirror-image page.

The functions only have access to the data of the mirror and not to the EEPROM directly. An exception here, is the reading via external services (e.g. tester). Since the data in the mirror cannot be entered into the DAMOS (they are addressed by a structure) and since they are thus not available to application tools, it is necessary to use an additional RAM-cell for application relevant values, and to copy their contents cyclic or during the ECU

after-run into the mirror. During the copying procedure the check sum is updated via a routine (subtraction of the value to be overwritten and summing of the value to be written).

In the process the following must be paid attention to:

- When only copying during the ECU after-run there is a risk that the RAM-cell was corrupted since the latest writing procedure (program error or inverted bit).
  Data which were changed in such a way are then interpreted as correct data and they may possibly be stored in the EEPROM for a long time.
- Since the above-mentioned routine must be used for the copying into the mirror, it is run-time relevant in case of cyclic call-up in small time cycles.
- It is recommendable to perform a plausibilty check on the value to be written, just prior to the writing procedure !

The EEPROM can be cleared completely (in future) and it can then be initialized again.

Data integrity

After each writing procedure into the EEPROM the correctness is checked by another reading and by comparing the transmitted data.
Incorrect writing procedures are repeated up to two times..
The external reading and writing access (e.g. tester) can, as already mentioned above, be configurated via the page descriptor.
Dependent on the demand made on the data integrity of a page it is possible to choose between different storage modes and combinations of them.

- Single storage
- Multiple storage (presently only double storage is realized)
- Check sum in the page in the EEPROM and in the mirror.

With multiple storage, however, only one mirror-image of the page is stored in the permament RAM.
During the reading of a page the data contents is checked for correctness by means of the check sum.
If a loss of data is detected during the reading of the EEPROM pages in the ECU program initialization, then the redundant storage modes are used in the following order so as to determine the correct data:

1. Multiple storage (s) in the EEPROM
2. Mirror page in the permanent RAM
3. Default values from the flash EPROM

The correction for the mirror is performed immediately, i.e. during the reading in the ECU program initialization. For the EEPROM pages it is performed only during the after-run by overwriting them with the corrected mirror pages.

The contents of the EEPROM is project-specific and it is defined in the section EEDAT.

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APP EEPROM 11.10 Application hint

T2DMTL 1.40 KWP2000: Request service DMTL system test

FDEF T2DMTL 1.40 Function definition

t2dmtl-fadmtlbe

condition DM-TL- system test by car manufacturing

remark: B_fadmtls is generated from the tester message with !B_fadmtle (=function stop)

t2dmtl-t2dmtl-sy

generation of function status by tank leakage diagnosis

stpdmtl = function status tank leakage diagnosis

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stpdmtl	state of condition	condition variable in %DDMTL
5	function not active	isadmtl = 0
6	function finished	Z_dmtk \ Z_dmtl
0	function running	isadmtl 4 \ 7...10
1	- reference measurement	isadmtl = 1
2	- rough leak test\extra rough leck test	isadmtl = 2 \ 3
3	- smallest leak test	isadmtl = 5
4	- reference measurement 2	isadmtl = 6
10	function can not be started	B_dmtlfe = False
11	- Ubatt beyond thresholds	B_ubdmte = False
12	- deviation of ref. current too big	B_diprfo = TRUE
13	- electrical fault (E_tes,..)	B_esdmte = False
14	- max. time of diagnosis succeeded	B_txdmts = TRUE
15	- no rough leak test enabled	B_dmtge = False
20	function aborted	B_admtls = True
21	- refueling detected	B_dtetk = True
22	- filler cap opened	B_dtetd = True
23	- Ubatt-deviation too big	B_dubtes = True
24	- condition Kl. 15 OFF/ON recognized	B_dmkl15 = True

stpdmtla = freeze functionsstate tank leak diagnosis

stpdmtla	state of condition	condition variable in %DDMTL
0	function running	isadmtl 4 \ 7...10
1	- reference measurement	isadmtl = 1
2	- rough leak test \ extra rough leck test	isadmtl = 2 \ 3
3	- smallest leak test	isadmtl = 5
4	- reference measurement 2	isadmtl = 6
10	function can not be started	B_dmtlfe = False
11	- Ubatt beyond thresholds	B_ubdmte = False
12	- deviation of ref. current too big	B_diprfo = TRUE
13	- electrical fault (E_tes,..)	B_esdmte = False
14	- max. time of diagnosis succeeded	B_txdmts = TRUE
15	- no rough leak test enabled	B_dmtge = False
20	function aborted	B_admtls = True
21	- refueling detected	B_dtetk = True
22	- filler cap opened	B_dtetd = True
23	- Ubatt-deviation too big	B_dubtes = True
24	- condition Kl. 15 OFF/ON recognized	B_dmkl15 = True
30	function finished, tight system	isadmtl 7 -> 11
31	function finished, smallest leak	isadmtl 8 -> 11
32	function finished, rough leak	isadmtl 9 -> 11
33	function finished, module error	isadmtl 10 -> 11
34	function finished, no rough leak	isadmtl 4 -> 11

ABK T2DMTL 1.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TEFABE			FW	Duration diagnosis-systemtest at end of line
TFADTLMX			FW	max. duration for DM-TL systemtest at end of line

Variable	Source	Type	Description
B_ADMTLL		EIN	Condition DDMTL-state machine running
B_ADMTLS		EIN	Condition DDMTL-state machine should stop
B_DIPRFO		EIN	Condition delta reference current exceeded
B_DMKL15	DDMTL	EIN	Condition power on during smallest leak check
B_DMTLFE		EIN	condition enable function request rough and smallest leak detection
B_DTETD		EIN	Condition refueling recognized
B_DTETK		EIN	Condition refueling recognized
B_DUBTES		EIN	condition big battery voltage fluctuations during tank leakage diagnosis
B_ESDMTE	DDMTL	EIN	Condition DDMTL enabled due to power stage faults
B_FADMTL	T2DMTL	AUS	condition leak detection request
B_FADMTLE		EIN	condition leak detection request, enable condition
B_FADMTLS	T2DMTL	LOK	condition leak detection request, stopped
B_FADTLBE	T2DMTL	LOK	condition leak detection request during vehicle production
B_STEND	BBSTT	EIN	condition end of start
B_TXDMTS		EIN	Condition DDMTL stopped due to max time
B_UBDMTE		EIN	Condition DDMTL enabled due to ub
C_PWF		EIN	ECU-condition powerfail initialisation
ISADMTL		EIN	state number of DMTL-state machine
R_T100		EIN	Time schedule 100 ms
STPDMTL	T2DMTL	AUS	function state counter DM-TL short test
STPDMTLA	T2DMTL	AUS	function state counter DM-TL for tester output from last driving cycle

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Variable	Source	Type	Description
TFADTLBE	T2DMTL	LOK	time counter leak detection request stop
TOP_W	DTOP	EIN	operating time since powerfail
Z_DMTK	DDMTL	EIN	cycle flag of evap system monitoring - smallest leak

FB T2DMTL 1.40 Detailed description of function

APP T2DMTL 1.40 Application hint

EEDAT 2.20 Data in EEPROM

FDEF EEDAT 2.20 Function definition

```
 Funktion Nutzdaten sichern im Flash ("EEPROM-Emulation")

 Arbeitsweise der Funktion "Nutzdaten sichern":

 Nach dem Ausschalten des Motors wird in der Haltephase unter bestimmten Bedingungen ein Teil der
 Daten aus dem RAM des Steuergerätes in den EEPROM-Baustein kopiert. Erkennt das System bei einem
 Start ein Powerfail, werden die geretteten Daten in das RAM zurückkopiert. Diese Daten
 gehen also auch beim Abklemmen der Batterie nicht verloren.

Folgende Daten werden im EEPROM gespeichert:
_____________________________________________


   DIF (Werte aus dem Label DIF_DAT)
   KD-Prüfstempel
   km-Stand beim letzten Löschen des Fehlerspeichers
   Werte aus EWS
   aus Funktion %CANACC:  Bedingung ACC-SG verbaut B_acc
   aus Funktion %DTOP:    Betriebsstundenzähler top_w (6 min / Quant)
   aus Funktion %BGDVE:   udknlp1, udknlp2, udkp1as_w, udkp1vo_w, udkp1vv_w, udkp2as_w, wdknlp_w
                          B_lrnws, B_nlperf
   aus Funktion %AMUENE:  Überdrehzahlereignis nmax_w, kmstnmax, anznmax
   aus Funktion %BBPEDBR:  anzpbr_w, kmstpbr_w
   aus Funktion %MDVERAD: dmvadll_w, dmvadko_w, dmvadfs_w, dmvadfk_w
   aus Funktion %LRA:     frau_w,  frao_w,  rkat_w,  rkaz_w
                          frau2_w, frao2_w, rkat2_w, rkaz2_w
   aus Funktion %LLRABG:  dnllmv, dnsacmv, dnslbv, dnfsacmv, dnfsmv
   aus Funktion %COSA:    co_pot

In der Ini-Phase wird der EEPROM-Inhalt (vgl. %EEPROM) in seinen RAM-Spiegel kopiert.
Unter bestimmten Voraussetzungen werden die Werte aus dem RAM-Spiegel in die zugehörigen RAM-Zellen
der einzelnen Funktionen kopiert:

a) Bei erkanntem Powerfail B_pwf = TRUE:

    %DTOP:     top_w
    %AMUENE:   nmax_w, kmstnmax, anznmax
    %BBPEDBR:  anzpbr_w, kmstpbr_w
    %BGDVE:    udknlp1, udknlp2, udkp1as_w, udkp1vo_w, udkp1vv_w, udkp2as_w, wdknlp_w, B_lrnws, B_nlperf
    EWS-Werte


   Stimmt die DIF-Nummer im EEPROM nicht mit dem Eintrag im FLASH überein, so wird angenommen, dass inzwischen
   ein neuer Datensatz programmiert wurde und nur die unter a) genanten Werte werden übernommen.
   Es wird zusätzlich das Flag B_eepdif (Differenz zwischen EEPROM-DIF und FLASH-DIF) auf TRUE gesetzt.

b)   Stimmt die DIF-Nummer überein (B_eepdif=0) werden zusätzlich folgende Werte übernommen:
       B_acc

c) Zusätzlich kann das Lesen/Speichern einiger Werte mit dem Bit B_ndsav aus CWNSABG Bit 0 unterbunden werden.

   Bei Powerfail und DIF-Konsistenz und B_ndsav = TRUE werden zusätzlich folgende Werte übernommen:

    %MDVERAD:  dmvadll_w, dmvadko_w, dmvadfs_w, dmvadfk_w
    %LRA:      frau_w,  frao_w,  rkat_w,  rkaz_w
               frau2_w, frao2_w, rkat2_w, rkaz2_w
    %LLRABG:   dnllmv, dnsacmv, dnslbv, dnfsacmv, dnfsmv
    %COSA:     co_pot

d)  Folgende Werte werden nur im RAM-Spiegel gehalten, ein Zugriff erfolgt direkt auf den Spiegel.

      DIF
      KD-Prüfstempel
      km-Stand beim letzen Löschen des Fehlerspeichers
```

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ABK EEDAT 2.20 Abbreviations

Variable	Source	Type	Description
ANZNMAX	AMUENE	EIN	Number of times NMAX exceeded
ANZPBR_W	BBPEDBR	EIN	number of PWG-pedal plausibility checks
B_ACC	CANACC	EIN	Condition: ACC-control unit exists
B_LRNWS		EIN	learned value save bit
B_NLPERF		EIN	Permanent RAM, condition: NLP acquisition successful
CO_POT		EIN	idle CO adjusting potmeter
DMVADFK_W		EIN	Delta resistant torque from resistant torque adaptation(B_fs=1 & B_ko=1)
DMVADFS_W		EIN	Delta resistant torque from resistant torque adaptation(B_fs=1)
DMVADKO_W		EIN	Delta resistant torque from resistant torque adaptation(B_ko=1)
DMVADLL_W		EIN	Delta resistant torque from resistant torque adaptation(B_ll=1)
DNFSACMV		EIN	LLRNS: Delta desired speed of DS2 communicator, AC with FS
DNFSMV		EIN	LLRNS: Delta desired speed of DS2 communicator, with FS
DNLLMV		EIN	LLRNS: Delta desired speed of DS2 communicator
DNSACMV		EIN	LLRNS: Delta desired speed of DS2 communicator, AC without FS
DNSLBV		EIN	LLRNS: Delta desired speed of DS2 communicator, from LLRUB
FRAO2_W	LRA	EIN	multipl. mixture adaptation factor higher load bank 2 (Word)
FRAO_W	LRA	EIN	multipl. mixture adaptation factor higher load (word)
FRAU2_W	LRA	EIN	multipl. mixture adaptation factor of the lower mult. section of bank 2 (Word)
FRAU_W	LRA	EIN	multipl. mixture adaptation factor of the lower mult. section (Word)
KMSTNMAX	AMUENE	EIN	mileage counter reference mark
KMSTPBR		EIN	mileage counter reference mark
NMAX_W	AMUENE	EIN	Actual maxi engine speed
RKAT2_W	LRA	EIN	additive correction (per time) of the mixture adaptation bank 2 (Word)
RKAT_W	LRA	EIN	additive correction (per time) of the mixture adaptation (Word)
RKAZ2_W	LRA	EIN	additive corretion (per ignition) of the mixture adaptatition Bank 2 (Word)
RKAZ_W	LRA	EIN	additive correction (per ignition) of the mixture adaptation
TOP_W	DTOP	EIN	operating time since powerfail
UDKNLP1		EIN	Voltage DK-Poti 1 at the NLP
UDKNLP2		EIN	Voltage DK-Poti 2 at the NLP
UDKP1AS_W		EIN	Voltage DK-poti 1 at the lower limit stop, steady-state part
UDKP1VO_W	BGDVE	EIN	voltage offset of DK potentiometer 1 amplification charcteristic
UDKP1VV_W	BGDVE	EIN	amplification of throttle potentiometer 1
UDKP2AS_W		EIN	voltage DK-poti 2 at the lower limit stop, steady-state part
WDKNLP_W	BGDVE	EIN	throttle angle in the limphome air position

FB EEDAT 2.20 Detailed description of function

APP EEDAT 2.20 Application hint

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Cross reference list

Symbol	Type	Created within	Used within
ABGMSIGH	FW	DLSH (627)	
ABGMSIGV	FW	DLSV (609)	
ABOLRAR	FW	BBBO (475)	
ABOMX	FW	BBBO (475)	
ACCA_T_UM	FW	UFFGRC (900)	
ACCC_T_UM	FW	UFFGRC (900)	
ADCC_T_UM	FW	URADCC (923)	
ADKATNF	FW	DKAT (310)	
AFNTOL	FW	DMDMIL (800)	
AFSTB	FW	GGFSTT (443)	
AGANGW	FW	DKUPPL (561)	
AHEAGW	FW	DMDMIL (800)	
AHEAGWS	FW	DMDMIL (800)	
AHEARV	FW	DMDMIL (800)	
AHEKA	FW	DMDMIL (800)	
AHEKS	FW	DMDMIL (800)	
AHEKS1	FW	DMDMIL (800)	
AHKATKM	KL	DKAT (310)	
AHKATMN	FW	DKAT (310)	
AHKATMX	FW	DKAT (310)	
AHKATS	FW	DKAT (310)	
AHKATSB	FW	DKAT (310)	
AHKTTSW	FW	DKAT (310)	
AIMV	FW	GGVFZG (580)	
AINTKA	FW	DMDMIL (800)	
AIODTEX	FW	DTEVN (403)	
AKUPPLB	FW	DKUPPL (561)	
ALFO	FW	DMDFON (772)	
ANALUN	KL	DMDLU (761)	
ANSWPUK	FW	DLDP (404)	
ANWFLMX	FW	DNWS (267), WANWKW (257)	
ANWFOHE	FW	DMDFON (772)	
ANWFOST	FW	DMDFON (772)	
ANWFOZA	FW	ZNDAUS (215)	
ANZDPVK	FW	DLSA (634)	
ANZDYNSH	FW	DLSAHK (645)	
ANZGEM	FW	DLSV (609)	
ANZRIBEH	FW	GGLSH (599)	
ANZRIBEV	FW	GGLSV (588)	
ANZTIBMX	FW	ESNST (166)	
ANZTIWS	FW	ESSTT (162)	
ANZTP	FW	DLSA (634)	
ANZTPMX	FW	FGRMD (499)	
APDTEX	FW	DTEVN (403)	
APEKTDX	FW	DKAT (310)	
ASIDNWS	FW	DNWS (267)	
ASIDNWSMX	FW	DNWS (267)	
ATISLATM	KL	ESWL (171)	
ATMABKA	KL	ATM (302)	
ATMABKK	KL	ATM (302)	
ATMTANS	KL	ATM (302)	
ATVFETTO	FW	DLSSA (654)	
ATVFETTU	FW	DLSSA (654)	
ATVINI	FW	LRHK (365)	
ATVINI2	FW	LRHK (365)	
ATVMAGO	FW	DLSSA (654)	
ATVMAGU	FW	DLSSA (654)	
ATVMN	FW	LRHK (365)	
ATVMX	FW	LRHK (365)	
AVKATFS	FW	DKAT (310)	
AVRALU	FW	DMDSTP (799)	
AZKRLDYN	KL	KRDY (237)	
AZKRNDYN	KL	KRDY (237)	
AZYTIAB	FW	DMDMIL (800)	
BFGRO	FW	BBFGR (492)	
BFGRU	FW	BBFGR (492)	
BMFA	FW	DDG (568)	
BMFMX	FW	DDG (568)	
BNWPOL	FW	WANWKW (257)	
BRABEVI	KL	FGRMD (499)	
BRATD	FW	FGRMD (499)	
BRATU	FW	FGRMD (499)	
BRAWA1GA	KL	FGRMD (499)	
BRAWA2GA	KL	FGRMD (499)	
BRAWA3GA	KL	FGRMD (499)	
BRAWAVI	KL	FGRMD (499)	
BREMS_T_UM	FW	UFFGRE (902)	
BTRKHTMS	KL	BBKHZ (282)	
BZ_MSR_M	FW	DASC (740), UFMSRC (903)	
CALIBID	KWB	BGCVN (876)	
CBGRLP	FW	BGRLP (125)	

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Symbol	Type	Created within	Used within
CDAGR	FW	PROKON (878)	
CDATR	FW	PROKON (878)	
CDATS	FW	PROKON (878)	
CDCACC	KL	DACC (756)	
CDCCAS	KL	DCAS (739)	
CDCCGE	KL	DCACC (755), DCGE (726)	
CDCCINS	KL	DCINS (728)	
CDCCTXU	KL	DCTXU (745)	
CDCDVEE	KL	ADVE (548)	
CDCDVEF	KL	BGDVE (534)	
CDCDVEL	KL	ADVE (548)	
CDCDVEN	KL	BGDVE (534)	
CDCDVER	KL	ADVE (548)	
CDCDVEU	KL	BGDVE (534)	
CDCDVEV	KL	BGDVE (534)	
CDCETS	KL	DETS (834)	
CDCEV1	KL	DEVE (835)	
CDCEV2	KL	DEVE (835)	
CDCEV3	KL	DEVE (835)	
CDCEV4	KL	DEVE (835)	
CDCEV5	KL	DEVE (835)	
CDCEV6	KL	DEVE (835)	
CDCEV7	KL	DEVE (835)	
CDCEV8	KL	DEVE (835)	
CDCFRAO	KL	DKVS (476)	
CDCFRAO2	KL	DKVS (476)	
CDCFRAU	KL	DKVS (476)	
CDCFRAU2	KL	DKVS (476)	
CDCFRST	KL	DKVS (476)	
CDCFRST2	KL	DKVS (476)	
CDCHSH	KL	DHLS (666)	
CDCHSH2	KL	DHLS (666)	
CDCHSV	KL	DHLS (666)	
CDCHSV2	KL	DHLS (666)	
CDCKOS	KL	DKOSE (816)	
CDCKPE	KL	DEKPE (824)	
CDCKRNT	KL	DKRNT (247)	
CDCKROF	KL	DKRNT (247)	
CDCKRTP	KL	DKRTP (252)	
CDCLASH	KL	DLSAHK (645)	
CDCLASH2	KL	DLSAHK (645)	
CDCLATP	KL	DLSA (634)	
CDCLATP2	KL	DLSA (634)	
CDCLATV	KL	DLSA (634)	
CDCLATV2	KL	DLSA (634)	
CDCLDPE	KL	DLDPE (409)	
CDCLSH	KL	DLSH (627)	
CDCLSH2	KL	DLSH (627)	
CDCMD	KL	DMDMIL (800)	
CDCMD01	KL	DMDMIL (800)	
CDCMD02	KL	DMDMIL (800)	
CDCMD03	KL	DMDMIL (800)	
CDCMD04	KL	DMDMIL (800)	
CDCMD05	KL	DMDMIL (800)	
CDCMD06	KL	DMDMIL (800)	
CDCMD07	KL	DMDMIL (800)	
CDCMD08	KL	DMDMIL (800)	
CDCMILE	KL	DMILE (837)	
CDCMLE	KL	DMLSE (818)	
CDCNWSE	KL	DNWSE (819)	
CDCPH	KL	DPH (571)	
CDCPH2	KL	DPH (571)	
CDCRKAT	KL	DKVS (476)	
CDCRKAT2	KL	DKVS (476)	
CDCRKAZ	KL	DKVS (476)	
CDCRKAZ2	KL	DKVS (476)	
CDCSLPE	KL	DSLPE (823)	
CDCSLS	KL	DSLSLR (289)	
CDCSLS2	KL	DSLSLR (289)	
CDCSLV	KL	DSLSLR (289)	
CDCSLV2	KL	DSLSLR (289)	
CDCSLVE	KL	DSLVE (821)	
CDCSTA	KL	DSTA (709)	
CDCSTAE	KL	DSTAE (832)	
CDCSTS	KL	DSTS (708)	
CDCTA	KL	GGTFA (681)	
CDCTEVE	KL	DTEVE (826)	
CDCTKA	KL	GGTKA (683)	
CDCTM	KL	GGTFM (674)	
CDCTUM	KL	GGTFUMG (684)	
CDCU5REF	KL	DU5REF (673)	
CDCUB	KL	GGUB (671)	

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Symbol	Type	Created within	Used within
CDCUFMV	KL	DUF (932)	
CDCUFSKA	KL	DUF (932)	
CDCURRAM	KL	DUR (933)	
CDCURROM	KL	DUR (933)	
CDCURRST	KL	DUR (933)	
CDDMTL	FW	PROKON (878)	
CDDST	FW	PROKON (878)	
CDEFST	FW	PROKON (878)	
CDFO	FW	DMDFON (772)	
CDHSH	FW	PROKON (878)	
CDHSV	FW	KATV (324), PROKON (878)	
CDKACC	FW	DACC (756)	
CDKAT	FW	PROKON (878)	
CDKATLK	FW	DKAT (310)	
CDKDVEE	FW	ADVE (548)	
CDKDVEF	FW	BGDVE (534)	
CDKDVEL	FW	ADVE (548)	
CDKDVEN	FW	BGDVE (534)	
CDKDVER	FW	ADVE (548)	
CDKDVEU	FW	BGDVE (534)	
CDKDVEV	FW	BGDVE (534)	
CDKLSV2	FW	DLSV (609)	
CDKRTP	FW	GGKS (218)	
CDKS1	FW	DKRS (242)	
CDKS2	FW	DKRS (242)	
CDKS3	FW	DKRS (242)	
CDKS4	FW	DKRS (242)	
CDKSTS	FW	DSTS (708)	
CDKTUM	FW	GGTFUMG (684)	
CDKUFMV	FW	DUF (932)	
CDKUFSKA	FW	DUF (932)	
CDKURRAM	FW	DUR (933)	
CDKURROM	FW	DUR (933)	
CDKURRST	FW	DUR (933)	
CDKVS	FW	PROKON (878)	
CDLASH	FW	DLSAHK (645)	
CDLATP	FW	DLSA (634)	
CDLATV	FW	DLSA (634)	
CDLFRAO	KL	DKVS (476)	
CDLFRAO2	KL	DKVS (476)	
CDLFRAU	KL	DKVS (476)	
CDLFRAU2	KL	DKVS (476)	
CDLFRST	KL	DKVS (476)	
CDLFRST2	KL	DKVS (476)	
CDLLR	FW	PROKON (878)	
CDLRKAT	KL	DKVS (476)	
CDLRKAT2	KL	DKVS (476)	
CDLRKAZ	KL	DKVS (476)	
CDLRKAZ2	KL	DKVS (476)	
CDLSA	FW	PROKON (878)	
CDLSH	FW	PROKON (878)	
CDLSV	FW	PROKON (878)	
CDMD	FW	PROKON (878)	
CDNWS	FW	PROKON (878)	
CDSLS	FW	PROKON (878)	
CDSLSE	FW	PROKON (878)	
CDSWE	FW	PROKON (878)	
CDTACC	FW	DACC (756)	
CDTANKL	FW	PROKON (878)	
CDTCAS	FW	DCAS (739)	
CDTCGE	FW	DCACC (755), DCGE (726)	
CDTCINS	FW	DCINS (728)	
CDTCTXU	FW	DCTXU (745)	
CDTDVEE	FW	ADVE (548)	
CDTDVEF	FW	BGDVE (534)	
CDTDVEL	FW	ADVE (548)	
CDTDVEN	FW	BGDVE (534)	
CDTDVER	FW	ADVE (548)	
CDTDVEU	FW	BGDVE (534)	
CDTDVEV	FW	BGDVE (534)	
CDTES	FW	PROKON (878)	
CDTETS	FW	DETS (834)	
CDTEV1	FW	DEVE (835)	
CDTEV2	FW	DEVE (835)	
CDTEV3	FW	DEVE (835)	
CDTEV4	FW	DEVE (835)	
CDTEV5	FW	DEVE (835)	
CDTEV6	FW	DEVE (835)	
CDTEV7	FW	DEVE (835)	
CDTEV8	FW	DEVE (835)	
CDTHSH	FW	DHLS (666)	
CDTHSH2	FW	DHLS (666)	

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Symbol	Type	Created within	Used within
CDTHSV	FW	DHLS (666)	
CDTHSV2	FW	DHLS (666)	
CDTKOS	FW	DKOSE (816)	
CDTKPE	FW	DEKPE (824)	
CDTKRNT	FW	DKRNT (247)	
CDTKROF	FW	DKRNT (247)	
CDTKRTP	FW	DKRTP (252)	
CDTLASH	FW	DLSAHK (645)	
CDTLASH2	FW	DLSAHK (645)	
CDTLATP	FW	DLSA (634)	
CDTLATP2	FW	DLSA (634)	
CDTLATV	FW	DLSA (634)	
CDTLATV2	FW	DLSA (634)	
CDTLDPE	FW	DLDPE (409)	
CDTLSH	FW	DLSH (627)	
CDTLSH2	FW	DLSH (627)	
CDTLSV2	FW	DLSV (609)	
CDTMD	FW	DMDMIL (800)	
CDTMD01	FW	DMDMIL (800)	
CDTMD02	FW	DMDMIL (800)	
CDTMD03	FW	DMDMIL (800)	
CDTMD04	FW	DMDMIL (800)	
CDTMD05	FW	DMDMIL (800)	
CDTMD06	FW	DMDMIL (800)	
CDTMD07	FW	DMDMIL (800)	
CDTMD08	FW	DMDMIL (800)	
CDTMILE	FW	DMILE (837)	
CDTMLE	FW	DMLSE (818)	
CDTNWSE	FW	DNWSE (819)	
CDTPH	FW	DPH (571)	
CDTPH2	FW	DPH (571)	
CDTSLPE	FW	DSLPE (823)	
CDTSLS	FW	DSLSLR (289)	
CDTSLS2	FW	DSLSLR (289)	
CDTSLV	FW	DSLSLR (289)	
CDTSLV2	FW	DSLSLR (289)	
CDTSLVE	FW	DSLVE (821)	
CDTSTA	FW	DSTA (709)	
CDTSTAE	FW	DSTAE (832)	
CDTSTS	FW	DSTS (708)	
CDTTA	FW	GGTFA (681)	
CDTTEVE	FW	DTEVE (826)	
CDTTKA	FW	GGTKA (683)	
CDTTM	FW	GGTFM (674)	
CDTTUM	FW	GGTFUMG (684)	
CDTU5REF	FW	DU5REF (673)	
CDTUB	FW	GGUB (671)	
CDTUFMV	FW	DUF (932)	
CDTUFSKA	FW	DUF (932)	
CDTURRAM	FW	DUR (933)	
CDTURROM	FW	DUR (933)	
CDTURRST	FW	DUR (933)	
CFRA	FW	LR (338)	
CLAACC	FW	DACC (756)	
CLACAS	FW	DCAS (739)	
CLACGE	FW	DCACC (755), DCGE (726)	
CLACINS	FW	DCINS (728)	
CLACTXU	FW	DCTXU (745)	
CLADVEE	FW	ADVE (548)	
CLADVEF	FW	BGDVE (534)	
CLADVEL	FW	ADVE (548)	
CLADVEN	FW	BGDVE (534)	
CLADVER	FW	ADVE (548)	
CLADVEU	FW	BGDVE (534)	
CLADVEV	FW	BGDVE (534)	
CLAETS	FW	DETS (834)	
CLAEV1	FW	DEVE (835)	
CLAEV2	FW	DEVE (835)	
CLAEV3	FW	DEVE (835)	
CLAEV4	FW	DEVE (835)	
CLAEV5	FW	DEVE (835)	
CLAEV6	FW	DEVE (835)	
CLAEV7	FW	DEVE (835)	
CLAEV8	FW	DEVE (835)	
CLAHSH	FW	DHLS (666)	
CLAHSH2	FW	DHLS (666)	
CLAHSV	FW	DHLS (666)	
CLAHSV2	FW	DHLS (666)	
CLAKOS	FW	DKOSE (816)	
CLAKPE	FW	DEKPE (824)	
CLAKRNT	FW	DKRNT (247)	
CLAKROF	FW	DKRNT (247)	

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Symbol	Type	Created within	Used within
CLAKRTP	FW	DKRTP (252)	
CLALASH	FW	DLSAHK (645)	
CLALASH2	FW	DLSAHK (645)	
CLALATP	FW	DLSA (634)	
CLALATP2	FW	DLSA (634)	
CLALATV	FW	DLSA (634)	
CLALATV2	FW	DLSA (634)	
CLALDPE	FW	DLDPE (409)	
CLALSH	FW	DLSH (627)	
CLALSH2	FW	DLSH (627)	
CLALSV2	FW	DLSV (609)	
CLAMILE	FW	DMILE (837)	
CLAMLE	FW	DMLSE (818)	
CLANWSE	FW	DNWSE (819)	
CLAPH	FW	DPH (571)	
CLAPH2	FW	DPH (571)	
CLASLPE	FW	DSLPE (823)	
CLASLS	FW	DSLSLR (289)	
CLASLS2	FW	DSLSLR (289)	
CLASLV	FW	DSLSLR (289)	
CLASLV2	FW	DSLSLR (289)	
CLASLVE	FW	DSLVE (821)	
CLASTA	FW	DSTA (709)	
CLASTAE	FW	DSTAE (832)	
CLASTS	FW	DSTS (708)	
CLATA	FW	GGTFA (681)	
CLATEVE	FW	DTEVE (826)	
CLATKA	FW	GGTKA (683)	
CLATM	FW	GGTFM (674)	
CLATUM	FW	GGTFUMG (684)	
CLAU5REF	FW	DU5REF (673)	
CLAUB	FW	GGUB (671)	
CLAUFMV	FW	DUF (932)	
CLAUFSKA	FW	DUF (932)	
CLAURRAM	FW	DUR (933)	
CLAURROM	FW	DUR (933)	
CLAURRST	FW	DUR (933)	
CLRHK	FW	LRHK (365)	
CLRKA	FW	LRKA (353)	
CLRZWTMS	FW	LREB (328)	
CNFKUPPL	FW	LLRBB (81)	
CNFMDVER	FW	MDVER (53)	
CPLRA	FW	DKVS (476)	
CREDSTU	FW	MDRED (73)	
CVNIO	FW	BGCVN (876)	
CWBBFGR	FW	BBFGR (492)	
CWBFGROF	FW	BBFGR (492)	
CWBWEEN	FW	GGPED (513)	
CWDASC	FW	CANDME (718), DASC (740)	
CWDDMTL	FW	DDMTL (411)	
CWDDMTL2	FW	DDMTL (411)	
CWDEGFE	FW	DEGFE (116)	
CWDKRNT	FW	DKRNT (247), GGKS (218)	
CWDKROF	FW	DKRNT (247), GGKS (218)	
CWDKRTP	FW	DKRTP (252), GGKS (218)	
CWDLSAHK	FW	DLSAHK (645)	
CWDMFAB	FW	MDFAW (31)	
CWDSLSY	FW	DSLSLR (289)	
CWDTHM	FW	DTHM (689)	
CWDTLECK	FW	DLDP (404), PROKON (878)	
CWDVMX	FW	VMAXMD (78)	
CWERFIL	FW	TCSORT (876)	
CWESSTT	FW	ESSTT (162)	
CWFASL	FW	SLS (275)	
CWFGRMD	FW	FGRMD (499)	
CWFSTD	FW	DFSTT (449)	
CWGGEGAS	FW	GGEGAS (560)	
CWGGFST	FW	GGFSTT (443)	
CWGGLSH	FW	GGLSH (599)	
CWGGLSV	FW	GGLSV (588)	
CWGGMFL	FW	GGMFL (490)	
CWHDMTL	FW	HDMTL (442)	
CWKHMD	FW	KHMD (287)	
CWKHZ	FW	BBKHZ (282)	
CWKLIMA	FW	PROKON (878)	
CWKONABG	FW	PROKON (878)	
CWKONFZ1	FW	PROKON (878)	
CWKONLS	FW	PROKON (878), TC1MOD (864)	
CWKR	FW	KRDY (237)	
CWLLRMR	FW	LLRMR (92)	
CWLOWR	FW	BBLOR (746), PROKON (878)	
CWMDAPP	FW	PROKON (878)	

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Symbol	Type	Created within	Used within
CWMDKOG	FW	MDKOG (40)	
CWNOCINS	FW	PROKON (878)	
CWNOMIL	FW	DMIL (860)	
CWNOMSRU	FW	UFMSRC (903)	
CWOBD	FW	PROKON (878), TC1MOD (864)	
CWPKAPP	FW	AES (189)	
CWSLS	FW	SLS (275)	
CWSLSOF	FW	SLS (275)	
CWSTA	FW	DSTS (708), STA (706)	
CWTEZW	FW	MDKOG (40)	
CWTF	FW	PROKON (878)	
CWUHR	FW	PROKON (878)	
CWVSV	FW	VS_VERST (714)	
CWZWE	FW	MDKOG (40)	
CWZWVMX	FW	BGMDLM (44), MDKOG (40)	
DANTGESWNV	FW	ADVE (548)	
DANTGESWV	FW	ADVE (548)	
DANTSCHWNV	FW	ADVE (548)	
DANTSCHWV	FW	ADVE (548)	
DASA	FW	DLLR (94)	
DFKMSMN	FW	BGMSZS (111)	
DFKMSMX	FW	BGMSZS (111)	
DFKPVMN	FW	BGMSZS (111)	
DFKPVMX	FW	BGMSZS (111)	
DFRMN	FW	LR (338)	
DFRMST	FW	DKVS (476)	
DFRSPS	FW	LR (338)	
DFSEFO2N	KL	DMDFON (772)	
DFSEFON	KL	DMDFON (772)	
DFSERES	FW	DMDFON (772)	
DFSKVO	FW	DFSTT (449)	
DFSKVU	FW	DFSTT (449)	
DFTEAHB	FW	TEB (380)	
DFTEDS	FW	BBTEGA (371)	
DHAKTIV	FW	DLDP (404)	
DIFFMAX	FW	BGPUK (407)	
DILBN	KL	BGLBZ (99)	
DILBST	FW	BGLBZ (99)	
DIPRFO	FW	DDMTL (411)	
DIPTREF	FW	DDMTL (411)	
DIPTSTAB	FW	DDMTL (411)	
DIPTUMVU	FW	DDMTL (411)	
DITEDTD	FW	DDMTL (411)	
DITEDTK	FW	DDMTL (411)	
DITNS	FW	BGLBZ (99)	
DKATCW	FW	DKAT (310)	
DKLAGERT	FW	ADVE (548)	
DKPSTGMIN	FW	BGDVE (534)	
DKROFN	KL	DKRNT (247)	
DKROKD	FW	DKRNT (247)	
DKROKMX	FW	GGKS (218)	
DKROKO	FW	GGKS (218)	
DKROKU	FW	DKRNT (247)	
DKVBD	FW	DFSTT (449)	
DLAHISATO	FW	DLSSA (654)	
DLAHISATU	FW	DLSSA (654)	
DLAMELSH	FW	DLSH (627)	
DLAMLASHF	FW	DLSAHK (645)	
DLAMLASHM	FW	DLSAHK (645)	
DLRDWDKSS1	FW	ADVE (548)	
DLRDWDKSS2	FW	ADVE (548)	
DLRIAMAXA	FW	ADVE (548)	
DLRIKLPAR	FW	ADVE (548)	
DLRININI	FW	ADVE (548)	
DLRKDONLP0	FW	ADVE (548)	
DLRKDUNLP0	FW	ADVE (548)	
DLRKDUNLP1	FW	ADVE (548)	
DLRKDUNLP2	FW	ADVE (548)	
DLRKIONLP0	KL	ADVE (548)	
DLRKIUNLP0	KL	ADVE (548)	
DLRKIUNLP1	KL	ADVE (548)	
DLRKIUNLP2	KL	ADVE (548)	
DLRKPONLP0	FW	ADVE (548)	
DLRKPUNLP0	FW	ADVE (548)	
DLRKPUNLP1	FW	ADVE (548)	
DLRKPUNLP2	FW	ADVE (548)	
DLRKREIS	FW	ADVE (548)	
DLRKREISST	FW	ADVE (548)	
DLRNLPD	FW	ADVE (548)	
DLRPID1T	FW	ADVE (548)	
DLRPID2T	FW	ADVE (548)	
DLRPIDMAX	FW	ADVE (548)	

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Symbol	Type	Created within	Used within
DLRPIDMIN	FW	ADVE (548)	
DLRPIDSTMN	FW	BGDVE (534)	
DLRUBSOLL	FW	ADVE (548)	
DLRUMABAND	FW	ADVE (548)	
DLRUMAIINI	FW	ADVE (548)	
DLSDHK	FW	MDFAW (31)	
DLSDHKLR	FW	MDFAW (31)	
DLURMIN	KL	DMDDLU (766)	
DMADFK	FW	MDVERAD (55)	
DMADFS	FW	MDVERAD (55)	
DMADKO	FW	MDVERAD (55)	
DMADLL	FW	MDVERAD (55)	
DMADMNFK	FW	MDVERAD (55)	
DMADMNFS	FW	MDVERAD (55)	
DMADMNKO	FW	MDVERAD (55)	
DMADMNLL	FW	MDVERAD (55)	
DMADMXFK	FW	MDVERAD (55)	
DMADMXFS	FW	MDVERAD (55)	
DMADMXKO	FW	MDVERAD (55)	
DMADMXLL	FW	MDVERAD (55)	
DMAUFASC	FW	CANASR (732)	
DMAUFN	KL	MDZW (211)	
DMDAROG	KL	ARMD (63)	
DMDARUG	KL	ARMD (63)	
DMDKOE	KL	MDVERB (52)	
DMDNSM	KL	MDVER (53)	
DMDPUG	KL	MDFAW (31)	
DMDPULRG	KL	MDFAW (31)	
DMIFSAWE	FW	MDFAW (31)	
DMLLRIDO	FW	DLLR (94)	
DMLLRIDU	FW	DLLR (94)	
DMLLRIDU2	FW	DLLR (94)	
DMLLRIMXN	KL	LLRRM (88)	
DMLLRMN	FW	LLRRM (88)	
DMLLRMXN	KL	LLRRM (88)	
DMLLRZMN	FW	LLRRM (88)	
DMLLRZMXN	KL	LLRRM (88)	
DMLSDUG	KL	MDFAW (31)	
DMLSDULR	KL	MDFAW (31)	
DMOFK	FW	MDVERAD (55)	
DMOFS	FW	MDVERAD (55)	
DMOKO	FW	MDVERAD (55)	
DMOLL	FW	MDVERAD (55)	
DMRESFS	FW	LLRMR (92)	
DMRESLL	FW	LLRMR (92)	
DMRESLW	KL	LLRMR (92)	
DMRFGRAL	FW	FGRAUS (511)	
DMRKHO	FW	MDKOG (40)	
DMRKHU	FW	MDKOG (40)	
DMRKTD	FW	DKAT (310)	
DMRLASH	FW	DLSAHK (645)	
DMRLSH	FW	DLSH (627)	
DMSTES	KL	TEB (380)	
DMXRDL	FW	DMDDLU (766)	
DMXRFL	FW	DMDLUA (770)	
DMXRLU	FW	DMDLU (761)	
DNARAO	FW	ARMD (63)	
DNDLLRO	FW	DLLR (94)	
DNDLLRU	FW	DLLR (94)	
DNFILO	FW	ARMD (63)	
DNIARNG	KL	ARMD (63)	
DNLLR	FW	LLRBB (81)	
DNLLRES	FW	LLRMR (92)	
DNMAXHG	KL	NMAXMD (76)	
DNMAXLR	FW	NMAXMD (76)	
DNMNI	FW	LLRRM (88)	
DNSAH	FW	BBSAWE (71)	
DNSAL	FW	BBSAWE (71)	
DNSLL	FW	BBSAWE (71)	
DNSNFX	FW	LLRNS (84)	
DNVSA	FW	BBSAWE (71)	
DNWEK	FW	BBSAWE (71)	
DPDSVLU	FW	GGDSAS (131)	
DPSF	FW	DDMTL (411)	
DPSLV	FW	SLS (275)	
DPUBABMX	FW	DLDP (404)	
DPUKORDH	FW	DLDP (404)	
DPUPS	FW	FUEDK (149)	
DPUPVDK	KL	GGDSAS (131)	
DRISIGH	FW	DLSH (627)	
DRISIGV	FW	DLSV (609)	
DRLDYNU	FW	BGRLP (125)	

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Symbol	Type	Created within	Used within
DRLKTDP	FW	DKAT (310)	
DRLSOLA	KL	DMDSTP (799)	
DSLGRAD	FW	GGDSAS (131)	
DSLOFS	FW	GGDSAS (131)	
DSTEMIN	FW	TEB (380)	
DSUGRAD	FW	GGDSAS (131)	
DSUOFS	FW	GGDSAS (131)	
DTABUNPL	FW	BGTABST (154)	
DTANSETR	FW	ETR (688)	
DTDTHM	FW	DTHM (689)	
DTEBLEIN	FW	ELS (839)	
DTEPRU	FW	BGRLP (125)	
DTHMDTKA	FW	DTHM (689)	
DTIABS	FW	EA (184)	
DTIREL	FW	EA (184)	
DTKATMN	FW	BBKHZ (282)	
DTKH	FW	BBKHZ (282)	
DTLRTML	KL	GGTFM (674)	
DTMABKH	FW	BBKHZ (282)	
DTMABMS	FW	MSMD (80)	
DTMDMA	FW	GGTFM (674)	
DTMDNPO	FW	GGTFM (674)	
DTMETR	FW	ETR (688)	
DTMLDP	FW	DLDP (404)	
DTMR	FW	LREB (328)	
DTMSRT	FW	GGTFM (674)	
DTMTMRW	FW	LREB (328)	
DTMWUC	FW	DWUC (856)	
DTUMTA	FW	BGTABST (154), GGTFUMG (684)	
DTUMTAT	FW	ATM (302)	
DTVKAML	KL	LRKA (353)	
DTVKAML2	KL	LRKA (353)	
DTWNWS	FW	ESNWS (174)	
DUBTES	FW	DDMTL (411)	
DUDKNLPO	FW	BGDVE (534)	
DUDKNLPU	FW	BGDVE (534)	
DUDKP1HY	FW	BGDVE (534), GGDVE (525)	
DUDKPTMP	FW	BGDVE (534)	
DUETMOT	FW	UETM (687)	
DUF_T	FW	DUF (932)	
DUKK	FW	ESUK (175)	
DUPW12	FW	GGPED (513)	
DUPW12BE	FW	GGPED (513)	
DUPW12TG	FW	GGPED (513)	
DUPW12VG	FW	GGPED (513)	
DUPWGHY	FW	GGPED (513)	
DUSRIH	FW	GGLSH (599)	
DUSRIV	FW	GGLSV (588)	
DUSSPH	FW	GGLSH (599)	
DUSSPV	FW	GGLSV (588)	
DVAQUGMX	FW	BBFGR (492)	
DVAQUKMX	FW	BBFGR (492)	
DVEEST	FW	ADVE (548)	
DVFGREO	FW	BBFGR (492)	
DVFGREU	FW	BBFGR (492)	
DVFZAR	FW	ARMD (63)	
DVFZBEG	FW	GGVFZG (580)	
DVFZETR	FW	ETR (688)	
DVIVZMX	FW	BBFGR (492)	
DVIVZTMX	FW	FGRMD (499)	
DVNG	KL	LLRRM (88)	
DVNGV	KL	LLRRM (88)	
DVSA	FW	BBSAWE (71)	
DVSAVO	FW	FGRMD (499)	
DVSAVU	FW	FGRMD (499)	
DVSKNBGA	KL	FGRMD (499)	
DVSKNVGA	KL	FGRMD (499)	
DVTIPUD	FW	FGRMD (499)	
DVZNG	KL	LLRRM (88)	
DVZNGV	KL	LLRRM (88)	
DVZVIMX	FW	BBFGR (492)	
DVZVITMX	FW	FGRMD (499)	
DVZVIWA	FW	FGRMD (499)	
DVZVRWA1	FW	FGRMD (499)	
DVZVRWA2	FW	FGRMD (499)	
DVZVRWA3	FW	FGRMD (499)	
DWDK12O	FW	GGDVE (525)	
DWDK13O	FW	GGDVE (525)	
DWDK23O	FW	GGDVE (525)	
DWDKSBAMX	KL	ADVE (548)	
DWDKSIKLS	FW	ADVE (548)	
DWKRMSN	KL	KRRA (227)	

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Symbol	Type	Created within	Used within
DWNWEB	FW	WNWEIN (254)	
DWPMXNOT	FW	GGPED (513)	
DYADMX	FW	KRDY (237)	
DYAMNV	FW	KRDY (237)	
DYAVF	FW	KRDY (237)	
DYESN	KL	KRDY (237)	
DYESOFN	KL	KRDY (237)	
DYNLSUTO	FW	DLSSA (654)	
DYNLSUTU	FW	DLSSA (654)	
DZWETA	KL	MDZW (211)	
DZWNWSUE	KL	MDBAS (50)	
DZWOAGR	KL	MDBAS (50)	
DZWOLA	KL	MDBAS (50)	
DZWOM	KL	MDBAS (50)	
DZWSPM	KL	ZWMIN (213)	
DZWSTTA	KL	ZWSTT (210)	
EFFDFPM	KL	DFCM (847), DFRZ (847)	
ENASAG	FW	BBSAWE (71)	
ESKONF	FW	DEKON (812)	
ETADZW	KL	MDBAS (50), ZWMIN (213), MDIST (49)	
ETALAM	KL	MDBAS (50)	
FABMDWA	KL	MDWAN (61)	
FABSALU	FW	DSWEC (704)	
FABSTT	KL	GGTFM (674)	
FALRKTD	FW	DKAT (310)	
FALRKTT	FW	DKAT (310)	
FASKIV1	FW	DMDMIL (800)	
FATMRML	KL	ATM (302)	
FATMRML2	KL	ATM (302)	
FATMVM	KL	ATM (302)	
FBTEB	KL	TEB (380)	
FBTEVA	KL	TEB (380)	
FDDN	KL	LLRRM (88)	
FDDZN	KL	LLRRM (88)	
FDKHLDP	FW	DLDP (404)	
FDVANS	KL	BGTEMPK (123)	
FETATEBN	KL	TEB (380)	
FFRITMS	KL	LR (338)	
FFTACC	KL	DACC (756)	
FFTCAS	KL	DCAS (739)	
FFTCGE	KL	DCACC (755), DCGE (726)	
FFTCINS	KL	DCINS (728)	
FFTCTXU	KL	DCTXU (745)	
FFTDVEE	KL	ADVE (548)	
FFTDVEF	KL	BGDVE (534)	
FFTDVEL	KL	ADVE (548)	
FFTDVEN	KL	BGDVE (534)	
FFTDVER	KL	ADVE (548)	
FFTDVEU	KL	BGDVE (534)	
FFTDVEV	KL	BGDVE (534)	
FFTETS	KL	DETS (834)	
FFTEV1	KL	DEVE (835)	
FFTEV2	KL	DEVE (835)	
FFTEV3	KL	DEVE (835)	
FFTEV4	KL	DEVE (835)	
FFTEV5	KL	DEVE (835)	
FFTEV6	KL	DEVE (835)	
FFTEV7	KL	DEVE (835)	
FFTEV8	KL	DEVE (835)	
FFTHSH	KL	DHLS (666)	
FFTHSH2	KL	DHLS (666)	
FFTHSV	KL	DHLS (666)	
FFTHSV2	KL	DHLS (666)	
FFTKOS	KL	DKOSE (816)	
FFTKPE	KL	DEKPE (824)	
FFTKRNT	KL	DKRNT (247)	
FFTKROF	KL	DKRNT (247)	
FFTKRTP	KL	DKRTP (252)	
FFTLASH	KL	DLSAHK (645)	
FFTLASH2	KL	DLSAHK (645)	
FFTLATP	KL	DLSA (634)	
FFTLATP2	KL	DLSA (634)	
FFTLATV	KL	DLSA (634)	
FFTLATV2	KL	DLSA (634)	
FFTLDPE	KL	DLDPE (409)	
FFTLSH	KL	DLSH (627)	
FFTLSH2	KL	DLSH (627)	
FFTMILE	KL	DMILE (837)	
FFTMLE	KL	DMLSE (818)	
FFTNWSE	KL	DNWSE (819)	
FFTPH	KL	DPH (571)	
FFTPH2	KL	DPH (571)	

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Symbol	Type	Created within	Used within
FFTSLPE	KL	DSLPE (823)	
FFTSLS	KL	DSLSLR (289)	
FFTSLS2	KL	DSLSLR (289)	
FFTSLV	KL	DSLSLR (289)	
FFTSLV2	KL	DSLSLR (289)	
FFTSLVE	KL	DSLVE (821)	
FFTSTA	KL	DSTA (709), DSTS (708)	
FFTSTAE	KL	DSTAE (832)	
FFTTA	KL	GGTFA (681)	
FFTTEVE	KL	DTEVE (826)	
FFTTKA	KL	GGTKA (683)	
FFTTM	KL	GGTFM (674)	
FFTTUM	KL	GGTFUMG (684)	
FFTU5REF	KL	DU5REF (673)	
FFTUB	KL	GGUB (671)	
FFTUFMV	KL	DUF (932)	
FFTUFSKA	KL	DUF (932)	
FFTURRAM	KL	DUR (933)	
FFTURROM	KL	DUR (933)	
FFTURRST	KL	DUR (933)	
FFWEKA	FW	LRKA (353)	
FHDLLR	FW	DLLR (94)	
FHODSL	FW	DSLSLR (289)	
FHOE	FW	GGDSAS (131)	
FHOKH	FW	BBKHZ (282)	
FHSTT	KL	ESSTT (162)	
FIAMALU	FW	DMDLU (761)	
FIBSALU	FW	DSWEC (704)	
FIMALU	FW	DMDLU (761)	
FIMHU	KL	ESWE (174)	
FIMWU	KL	ESWE (174)	
FIP2STAB	FW	DDMTL (411)	
FIPTGL	KL	DDMTL (411)	
FIPTGLR	KL	DDMTL (411)	
FIPTUBF	KL	DDMTL (411)	
FKATEB	KL	TEB (380)	
FKAXAVKAT	KL	LRKA (353)	
FKELDY	FW	KRKE (219)	
FKELDYA	FW	KRDY (237)	
FKENDY	FW	KRKE (219)	
FKHABMN	FW	BBKHZ (282)	
FKHLA	KL	BBKHZ (282)	
FKHLA2	KL	BBKHZ (282)	
FKHMD	KL	BBKHZ (282)	
FKKSN	KL	ESKS (172)	
FKKVS	KF	RKTI (192)	
FKMSDKMN	FW	BGMSZS (111)	
FKMSDKMX	FW	BGMSZS (111)	
FKPVDKE	FW	BGMSZS (111)	
FKPVDKMN	FW	BGMSZS (111)	
FKPVDKMX	FW	BGMSZS (111)	
FKSTT	KL	ESSTT (162)	
FKVAUM	FW	KVA (713)	
FLCACC	FW	DACC (756)	
FLCETS	FW	DETS (834)	
FLCKOS	FW	DKOSE (816)	
FLCLDPE	FW	DLDPE (409)	
FLCMLE	FW	DMLSE (818)	
FLCSTAE	FW	DSTAE (832)	
FLFO	FW	DMDFON (772)	
FLMLKAMA	FW	LRKA (353)	
FLMLKAPR	FW	LRKA (353)	
FLRAG	KL	ARMD (63)	
FLRAWG	KL	ARMD (63)	
FLRFKATE	KL	LR (338)	
FLRHG	KL	ARMD (63)	
FLRM	KL	LR (338)	
FLUTN	KL	DMDLUA (770)	
FLUV1	FW	DMDLU (761)	
FLUV2	FW	DMDLU (761)	
FMDKHFH	KL	KHMD (287)	
FMDKHFH2	KL	KHMD (287)	
FMDKHTM	KL	KHMD (287)	
FMDKHTM2	KL	KHMD (287)	
FMDWAT	KL	MDWAN (61)	
FMFKR	FW	GGKS (218)	
FMIHGN	KL	MDIHGS (68)	
FMIVL	FW	MDMAX (39)	
FMLKAMA	FW	LRKA (353)	
FMLVFZG	KL	MLS (695)	
FMSL	FW	SLS (275)	
FMSL2	FW	SLS (275)	

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Symbol	Type	Created within	Used within
FMSLAMN	FW	DSLSLR (289)	
FMSLAMX	FW	DSLSLR (289)	
FMSLOFF	FW	SLS (275)	
FMSRHOL	KL	SLS (275)	
FMSTMOT	KL	SLS (275)	
FNRAD	FW	MDWAN (61)	
FNSA	KL	ESNST (166)	
FNSNF	FW	LLRNS (84)	
FNSSM	KL	ESNST (166)	
FNSSTM	KL	LLRNS (84)	
FNSTABNV	KL	MDNSTAB (59)	
FNWADS	FW	WANWKW (257)	
FPMSTM	KL	MSMD (80)	
FPMSTME	KL	MSMD (80)	
FPRAT	FW	BGDVE (534)	
FPRMT	FW	BGDVE (534)	
FPRNMAX	FW	BGDVE (534)	
FPRTIM1_T	FW	BGDVE (534)	
FPRTIM2_T	FW	BGDVE (534)	
FPVMXN	KL	BGSRM (118)	
FPVMXN2	KL	BGSRM (118)	
FPWDKAPP	KL	FUEDK (149)	
FQFSTT	FW	GGFSTT (443)	
FQTEFR	KL	TEB (380)	
FQTEPT	KL	TEB (380)	
FQTEVA	KL	TEB (380)	
FRAE	FW	DKVS (476)	
FRAODN	FW	DKVS (476)	
FRAODX	FW	DKVS (476)	
FRAOMN	FW	LRA (463)	
FRAOMX	FW	LRA (463)	
FRAORN	FW	LRA (463)	
FRAORX	FW	LRA (463)	
FRARAG	KL	ARMD (63)	
FRARAWG	KL	ARMD (63)	
FRARHG	KL	ARMD (63)	
FRAUDN	FW	DKVS (476)	
FRAUDX	FW	DKVS (476)	
FRAUMN	FW	LRA (463)	
FRAUMX	FW	LRA (463)	
FRAURN	FW	LRA (463)	
FRAURX	FW	LRA (463)	
FRDO	FW	DLSVV (625)	
FRDU	FW	DLSVV (625)	
FRHB	FW	TEB (380)	
FRINH1	KL	DHLS (666)	
FRINH2	KL	DHLS (666)	
FRINOF	FW	GGLSH (599), GGLSV (588)	
FRINV1	KL	DHLS (666)	
FRINV2	KL	DHLS (666)	
FRIPTES	FW	LR (338)	
FRKAP	FW	ESGRU (161)	
FRLFSDP	KL	AES (189), KVA (713)	
FRLVTM	KL	MDMAX (39)	
FRMAX	FW	LR (338)	
FRMIN	FW	LR (338)	
FRMLASHO	FW	DLSAHK (645)	
FRMLASHU	FW	DLSAHK (645)	
FRMSTDN	FW	DKVS (476)	
FRMSTDX	FW	DKVS (476)	
FRTEMX	FW	LR (338)	
FS1FO	FW	DMDFON (772)	
FS2FO	FW	DMDFON (772)	
FSALULDP	FW	DLDP (404)	
FSRFTEF	FW	TEB (380)	
FSTDMN	FW	GGFSTT (443)	
FSTDMX	FW	GGFSTT (443)	
FSTDTOL	FW	GGFSTT (443)	
FSTHYS	FW	GGFSTT (443)	
FSTTAL	FW	GGFSTT (443)	
FSTTAL1	FW	GGFSTT (443)	
FSTTAV	FW	GGFSTT (443)	
FSTTEW	FW	GGFSTT (443)	
FSTTMX	FW	BGKV (459), GGFSTT (443)	
FSWALUV	KL	DSWEC (704)	
FTEADAB	FW	TEB (380)	
FTEADLDP	FW	DLDP (404)	
FTEADMX	FW	TEB (380)	
FTEADZU	FW	BBTEGA (371)	
FTEDS	FW	BBTEGA (371), LLRNS (84)	
FTEFHB	FW	TEB (380)	
FTEHB	FW	TEB (380)	

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Symbol	Type	Created within	Used within
FTEINIX	KL	TEB (380)	
FTETEDF	FW	DTEVN (403)	
FTETEDM	FW	DTEVN (403)	
FTMLAKH	KL	BBKHZ (282)	
FUEPMLD	KL	FUEDK (149)	
FUKNSTM	KL	ESUK (175)	
FUMRBRK	FW	TEB (380)	
FUMRMV	FW	BGTEV (143)	
FUMSTEK	FW	BGTEV (143)	
FVANST	FW	ESUK (175)	
FVERMN	KL	TEB (380)	
FVERZTE	FW	TEB (380)	
FVKKSN	KL	ESKS (172)	
FWFN	FW	ESUK (175)	
FWMABGW	FW	ATM (302)	
FWMABGW2	FW	ATM (302)	
FWMKATW	FW	ATM (302)	
FWMKATW2	FW	ATM (302)	
FWSTAA1	KL	ESNST (166)	
FWSTAA2	KL	ESNST (166)	
FWSTAA3	KL	ESNST (166)	
FWSTAA4	KL	ESNST (166)	
FZANSSA1	KL	ESNST (166)	
FZANSSA2	KL	ESNST (166)	
FZANSSM1	KL	ESNST (166)	
FZANSSM2	KL	ESNST (166)	
FZWSTNM	KL	ZWSTT (210)	
FZWSTTM	KL	ZWSTT (210)	
GAFGRO	FW	BBFGR (492)	
GAFGRU	FW	BBFGR (492)	
GDWRT	FW	GGKS (218), RUV (214)	
GRDWRT	FW	BGRLP (125)	
GVTMX	FW	GGFSTT (443)	
HLCACC	FW	DACC (756)	
HLCETS	FW	DETS (834)	
HLCKOS	FW	DKOSE (816)	
HLCLDPE	FW	DLDPE (409)	
HLCMLE	FW	DMLSE (818)	
HLCSTAE	FW	DSTAE (832)	
HOTEDU	FW	DDMTL (411)	
HTEDU	FW	DTEVN (403)	
IDTHMU	FW	DTHM (689)	
IGESGA	KL	BBGANG (70)	
IKURUN	KL	BBKURU (67)	
IKURUP	KL	BBKURU (67)	
ILBHYSO	FW	BGLBZ (99)	
ILBHYSU	FW	BGLBZ (99)	
ILBINI	FW	BGLBZ (99)	
ILBMN	FW	BGLBZ (99)	
ILBMX	FW	BGLBZ (99)	
ILMLKAXTK	KL	LRKA (353)	
ILMLKAXTK2	KL	LRKA (353)	
IMLATDSL	FW	DSLSLR (289)	
IMLATDSLK	FW	DSLSLR (289)	
IMLDSL	FW	DSLSLR (289)	
IMLHS	FW	ESSTT (162)	
IMLKAXTK	KL	LRKA (353)	
IMLKAXTK2	KL	LRKA (353)	
IMLKHMX	FW	BBKHZ (282)	
IMLKHTMS	KL	BBKHZ (282)	
IMLKS	FW	BBBO (475)	
IMLKVSMX	FW	DKVS (476)	
IMLSALR	FW	LREB (328)	
IMLSLMN	FW	SLS (275)	
IMLSLMX	FW	SLS (275)	
IMLSLSA	FW	SLS (275)	
IMLSLSE	FW	SLS (275)	
IMSLADAP	FW	DSLSLR (289)	
IMTUMGTA	FW	GGTFUMG (684)	
IMTUMTA	FW	BGTABST (154)	
IMTUMTAT	FW	ATM (302)	
IP1A_MX_UM	FW	UFRLC (909)	
IP2A_MN_UM	FW	UFRLC (909)	
IPA_T_UM	FW	UFRLC (909)	
IPTREFO	FW	DDMTL (411)	
IPTREFU	FW	DDMTL (411)	
IVDN	KL	LLRRM (88)	
IVDNV	KL	LLRRM (88)	
KAMFZ	FW	DMDTSB (810)	
KATBFML	KL	DKAT (310)	
KATBFMN	FW	DKAT (310)	
KATBFN	FW	DKAT (310)	

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Symbol	Type	Created within	Used within
KATBFNM	FW	DKAT (310)	
KATBFNP	FW	DKAT (310)	
KATBFSX	FW	DKAT (310)	
KATBFXM	KL	DKAT (310)	
KATBSG	FW	DKAT (310)	
KATBSH	FW	DKAT (310)	
KATBSHF	FW	DKAT (310)	
KATBSHG	FW	DKAT (310)	
KDLASHKI	KL	LRHK (365)	
KDLASHKI2	KL	LRHK (365)	
KDLASHKP	KL	LRHK (365)	
KDLASHKP2	KL	LRHK (365)	
KDLRIDDVE	FW	ADVE (548)	
KDMLDOLR	KF	MDFAW (31)	
KE1N	KL	KRKE (219)	
KE2N	KL	KRKE (219)	
KE3N	KL	KRKE (219)	
KE4N	KL	KRKE (219)	
KEMLN	KL	GGKS (218)	
KFABAK	KF	ESUK (175)	
KFAFTE	KF	BGTEV (143)	
KFAMAL	KF	DMDLU (761)	
KFAMAL1	KF	DMDLU (761)	
KFANS	KF	ESGRU (161)	
KFATMLA	KF	ATM (302)	
KFATMLA2	KF	ATM (302)	
KFATMLAE	KF	ATM (302)	
KFATMLAE2	KF	ATM (302)	
KFATMZW	KF	ATM (302)	
KFATMZW2	KF	ATM (302)	
KFATMZWE	KF	ATM (302)	
KFAVAK	KF	ESUK (175)	
KFBAKL	KF	ESUK (175)	
KFBS	KF	GK (158)	
KFCFO	KF	DMDFON (772)	
KFCFO2	KF	DMDFON (772)	
KFDILU	KF	BGLBZ (99)	
KFDLSD	KF	MDFAW (31)	
KFDLSDLR	KF	MDFAW (31)	
KFDLUR	KF	DMDDLU (766)	
KFDLUR1	KF	DMDDLU (766)	
KFDLUR2	KF	DMDDLU (766)	
KFDLURZ	KF	DMDDLU (766)	
KFDMDPLR	KF	MDFAW (31)	
KFDMDPO	KF	MDFAW (31)	
KFDMLSDO	KF	MDFAW (31)	
KFDTMTE	KF	GGTFM (674)	
KFDTMTR	KF	GGTFM (674)	
KFDTMTU	KF	GGTFM (674)	
KFDYES	KF	KRDY (237)	
KFDYESOF	KF	KRDY (237)	
KFETATE	KF	TEB (380)	
KFETRD	KF	ETR (688)	
KFETRT	KF	ETR (688)	
KFFMSML	KF	SLS (275)	
KFFTEAN	KF	TEB (380)	
KFFTEAX	KF	TEB (380)	
KFFTV	KF	LRHK (365)	
KFFTV2	KF	LRHK (365)	
KFFWK	KF	ZWKS (212)	
KFFWL	KF	ESWL (171)	
KFFWLW	KF	ESWL (171)	
KFFWNW	KF	ESNWS (174)	
KFFWST	KF	ESSTT (162)	
KFFWTBR	KF	BGTEMPK (123)	
KFKHFM	KF	GGHFM (105)	
KFKRMX	KF	KRRA (227)	
KFKSWF	KF	DMDMIL (800)	
KFKSZW	KF	ZWKS (212)	
KFKWTMP	KF	KHMD (287)	
KFLAMFA	KF	LAMFAW (271)	
KFLANS	KF	ESNST (166)	
KFLASWLR	KF	ESWL (171)	
KFLDFK	KF	GGDSAS (131)	
KFLF	KF	ESGRU (161)	
KFLUAR	KF	DMDLUA (770)	
KFLUAR1	KF	DMDLUA (770)	
KFLUAR2	KF	DMDLUA (770)	
KFLUARZ	KF	DMDLUA (770)	
KFLURB	KF	DMDLU (761)	
KFLURB1	KF	DMDLU (761)	
KFLURB2	KF	DMDLU (761)	

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Symbol	Type	Created within	Used within
KFLURBZ	KF	DMDLU (761)	
KFLURM	KF	DMDLU (761)	
KFLURM1	KF	DMDLU (761)	
KFMAKR	KF	GGKS (218)	
KFMDDSLA	KF	KHMD (287)	
KFMDKH	KF	KHMD (287)	
KFMDKH2	KF	KHMD (287)	
KFMDKO	KF	MDVERB (52)	
KFMDKOG	KF	MDVERB (52)	
KFMDS	KF	MDVER (53)	
KFMDST	KF	STMD (60)	
KFMDZOF_UM	KF	UFMZUL (894)	
KFMILSD	KF	MDFAW (31)	
KFMIMR	KF	MDFAW (31)	
KFMIOP	KF	MDBAS (50), MDMAX (39)	
KFMIRED	KF	VMAXMD (78)	
KFMIRED1	KF	NMAXMD (76)	
KFMIRL	KF	MDFUE (148)	
KFMIRLR	KF	VMAXMD (78)	
KFMIZUFIL	KF	MDZUL (45)	
KFMIZUNS	KF	MDZUL (45)	
KFMIZUOF	KF	MDZUL (45)	
KFMI_UM	KF	UFMIST (897)	
KFMLDMN	KF	DHFM (108)	
KFMLDMX	KF	DHFM (108)	
KFMPED_UM	KF	UFMZUL (894)	
KFMPNS_UM	KF	UFMZUL (894)	
KFMRES	KF	LLRMR (92)	
KFMRESFS	KF	LLRMR (92)	
KFMRMI	KF	BGMRACC (758), MDFAW (31)	
KFMSNWDK	KF	BGMSZS (111), BGRLP (125)	
KFNSWRL	KF	ESNST (166)	
KFPED	KF	MDFAW (31)	
KFPEDU	KF	MDFAW (31)	
KFPRG	KF	BGSRM (118)	
KFPRG2SU	KF	BGSRM (118)	
KFPRG3SU	KF	BGSRM (118)	
KFPRGSU	KF	BGSRM (118)	
KFPU	KF	GGHFM (105)	
KFPU2SU	KF	GGHFM (105)	
KFPU3SU	KF	GGHFM (105)	
KFPUSU	KF	GGHFM (105)	
KFQTE	KF	TEB (380)	
KFRI	KF	LR (338)	
KFRI2	KF	LR (338)	
KFRINH	KF	DHLS (666)	
KFRINH2	KF	DHLS (666)	
KFRINV	KF	DHLS (666)	
KFRINV2	KF	DHLS (666)	
KFRLIP_UM	KF	UFRLC (909)	
KFRP	KF	LR (338)	
KFRP2	KF	LR (338)	
KFRTV	KF	LR (338)	
KFRTV2	KF	LR (338)	
KFTATM	KF	ATM (302)	
KFTATM2	KF	ATM (302)	
KFTATX	KF	TEB (380)	
KFTDSTAB	KF	DDMTL (411)	
KFTEKA	KF	TEB (380)	
KFTEVP	KF	ATEV (402)	
KFTPKOR	KF	DLSA (634)	
KFTVSA	KF	BBSAWE (71)	
KFTVSALR	KF	BBSAWE (71)	
KFTVSAM	KF	BBSAWE (71)	
KFTVSAMLR	KF	BBSAWE (71)	
KFURL	KF	BGSRM (118)	
KFURL2SU	KF	BGSRM (118)	
KFURL3SU	KF	BGSRM (118)	
KFURLSU	KF	BGSRM (118)	
KFUSHK	KF	LRHK (365)	
KFUSHK2	KF	LRHK (365)	
KFVAKL	KF	ESUK (175)	
KFVOFFS	KF	FGRMD (499)	
KFWDKMSN	KF	FUEDK (149)	
KFWDKPP	KF	GGDVE (525)	
KFWEE	KF	EA (184)	
KFWEEK	KF	EA (184)	
KFWHSTT	KF	ESSTT (162)	
KFWK	KF	ZWKS (212)	
KFWKSTN	KF	ESSTT (162)	
KFWKSTT	KF	ESSTT (162)	
KFWMABG	KF	ATM (302)	

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Symbol	Type	Created within	Used within
KFWMABG2	KF	ATM (302)	
KFWMKAT	KF	ATM (302)	
KFWMKAT2	KF	ATM (302)	
KFWNLLK	KF	WNWEIN (254)	
KFWNLLW	KF	WNWEIN (254)	
KFWNSL	KF	WNWEIN (254)	
KFWNWK	KF	WNWEIN (254)	
KFWNWW	KF	WNWEIN (254)	
KFWNWWK	KF	WNWEIN (254)	
KFWPFGR	KF	MDFAW (31)	
KFWWNS	KF	ESNST (166)	
KFZDASH	KF	MDFAW (31)	
KFZDSHLR	KF	MDFAW (31)	
KFZLSD	KF	MDFAW (31)	
KFZLSDLR	KF	MDFAW (31)	
KFZW1	KF	ZWGRU (208)	
KFZW2	KF	ZWGRU (208)	
KFZWKS	KF	ESKS (172)	
KFZWMN	KF	ZWMIN (213)	
KFZWMNST	KF	ZWMIN (213)	
KFZWOP	KF	MDBAS (50)	
KFZWOP2	KF	MDBAS (50)	
KFZWVL	KF	ZWGRU (208)	
KFZWWLNM	KF	ZWWL (210)	
KFZWWLTM	KF	ZWWL (210)	
KFZW_UM	KF	UFMIST (897)	
KHCTEMN	FW	TEB (380)	
KHCTEMX	FW	TEB (380)	
KIFZGAG	KL	ARMD (63)	
KIFZGAWG	KL	ARMD (63)	
KIFZGHG	KL	ARMD (63)	
KIMSA	FW	BGMSZS (111)	
KIMSALL	FW	BGMSZS (111)	
KISRM	FW	BGSRM (118)	
KISRM2SU	FW	BGSRM (118)	
KISRM3SU	FW	BGSRM (118)	
KISRMSU	FW	BGSRM (118)	
KKFFGRGA	KL	FGRMD (499)	
KLAF	KL	BGMSZS (111), BGRLP (125), FUEDK (149)	
KLAFTE	KL	BGTEV (143)	
KLDTMRS	KL	GGTFM (674)	
KLDTPLDP	KL	DLDP (404)	
KLETAZW_UM	KL	UFMIST (897)	
KLFWST	KL	ESSTT (162)	
KLIMTHMTM	KL	DTHM (689)	
KLNPED_UM	KL	UFREAC (898)	
KLTATHMKA	KL	DTHM (689)	
KLTHMDTKA	KL	DTHM (689)	
KLWZTLDP	KL	DLDP (404)	
KMILSDLR	KF	MDFAW (31)	
KMXSTG	FW	DLSAHK (645)	
KNSNF	FW	LLRNS (84)	
KRAFGRGA	KL	FGRMD (499)	
KRAL1N	KL	KRRA (227)	
KRAL2N	KL	KRRA (227)	
KRALH	FW	KRRA (227)	
KRAN1	FW	KRRA (227)	
KRAN2	FW	KRRA (227)	
KRAN3	FW	KRRA (227)	
KRAN4	FW	KRRA (227)	
KRANH	FW	KRRA (227)	
KRDWA	FW	KRRA (227)	
KRDWSN	KL	KRRA (227)	
KRFHKS	FW	DKRS (242)	
KRFHT	FW	DKRNT (247), GGKS (218), DKRTP (252)	
KRFKN	KL	KRRA (227)	
KRFTP1	FW	KRKE (219)	
KRFTP2	FW	KRKE (219)	
KRFTP3	FW	KRKE (219)	
KRKFKS	FW	KRKE (219)	
KRKTE	FW	AES (189), KVA (713)	
KRLMDY	FW	KRRA (227)	
KRNMDY	FW	KRRA (227)	
KRVFN	KL	KRRA (227)	
KRVFSN	KL	KRRA (227)	
KRVST	FW	KRKE (219)	
KRWKRUM	FW	KRRA (227)	
KSZA	FW	DKRS (242), KRKE (219)	
KSZWE	FW	ZWKS (212)	
KTDWNWS	KF	DNWS (267)	
KTNDMRKH	FW	BBKHZ (282)	
KTRANS	FW	DGLOR (747)	

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Symbol	Type	Created within	Used within
KUMSRL	FW	BGKV (459), TEB (380), BGMSZS (111), FUEDK (149)	
KVLAD	FW	BGMSZS (111)	
LADFIL	FW	BGMSZS (111)	
LALIUSH	KL	LRHK (365)	
LALIUSH2	KL	LRHK (365)	
LALIUSRH	KL	LRHK (365)	
LALIUSRH2	KL	LRHK (365)	
LAMFAVL	KL	LAMFAW (271)	
LAMKAML	KL	LRKA (353)	
LAMKAML2	KL	LRKA (353)	
LAMLGF	FW	LAMKO (268)	
LAMLGMTM	KL	LAMKO (268)	
LAMSOSOF	FW	LAMKO (268)	
LAMSOSUF	FW	LAMKO (268)	
LAMSSAMN	FW	DLSSA (654)	
LAMSSAMX	FW	DLSSA (654)	
LASHKAB	FW	LRHK (365)	
LASOAB	FW	LAMKO (268)	
LASWLTM	KL	ESWL (171)	
LDETS	FW	DETS (834)	
LIMN	FW	LLRRM (88)	
LIMNDLLR	FW	LLRRM (88)	
LIMNDTES	FW	LLRRM (88)	
LIMNV	FW	LLRRM (88)	
LIMTKOA	FW	KOS (698)	
LIMX	FW	LLRRM (88)	
LIMXV	FW	LLRRM (88)	
LISTM	KL	LLRRM (88)	
LKRN	KL	KRRA (227)	
LLRICNF	FW	LLRRM (88)	
LNXQTM	KL	BGTABST (154)	
LRNST1_T	FW	BGDVE (534)	
LRNST3_T	FW	BGDVE (534)	
LRNST7_T	FW	BGDVE (534)	
LRNST9_T	FW	BGDVE (534)	
LRNVB_T	FW	BGDVE (534)	
LRNVB_TDI	FW	BGDVE (534)	
LURBRL	KL	DMDLU (761)	
LURFOST	FW	DMDFON (772)	
LURKH	KL	DMDLU (761)	
LURKTM	KL	DMDLU (761)	
LURMIN1	KL	DMDLU (761)	
LURMIN2	KL	DMDLU (761)	
LURMIN3	KL	DMDLU (761)	
MDERKFON	FW	DMDFON (772)	
MDHYEZ	FW	MDRED (73)	
MDHYST	FW	MDKOG (40)	
MDIAGMX	FW	BGMIGS (69)	
MDIMX	FW	BGMIGS (69), MDFAW (31), MDZUL (45), NMAXMD (76), VMAXMD (78), MSMD (80), MDKOL (48), MDKOG (40), MDIHGS (68)	
MDITXUMX	FW	BGMIGS (69)	
MDKOAN	KL	KOS (698)	
MDKOEN	KL	KOS (698)	
MDMSMIN	KL	MSMD (80)	
MDNORM	FW	CANDME (718)	
MDSL	FW	MDVERB (52)	
MDSM	KL	MDVER (53)	
MIHGSLG	KL	MDIHGS (68)	
MILANTI	FW	DMDMIL (800)	
MIMSRMXN	KL	DASC (740)	
MKLSDO	FW	MDFAW (31)	
MLDKVSF	FW	DKVS (476)	
MLDKVSG	FW	DKVS (476)	
MLDPKD	FW	DLDP (404)	
MLDSLAMN	FW	DSLSLR (289)	
MLDSLAMX	FW	DSLSLR (289)	
MLDSLKMN	FW	DSLSLR (289)	
MLDSLKMX	FW	DSLSLR (289)	
MLDSLMN	FW	DSLSLR (289)	
MLDSLMX	FW	DSLSLR (289)	
MLFKMSDK	FW	BGMSZS (111)	
MLHFM	KL	GGHFM (105)	
MLKHMX	FW	BBKHZ (282)	
MLLASH	FW	DLSAHK (645)	
MLMAX	FW	BGRML (854), TC1MOD (864)	
MLNKAX	FW	LRHK (365)	
MLO1	FW	LRA (463)	
MLO2	FW	LRA (463)	
MLO3	FW	LRA (463)	
MLOFS	FW	DHFM (108), GGHFM (105)	

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Symbol	Type	Created within	Used within
MLOSTEST	FW	DLSAHK (645)	
MLSLMX	FW	SLS (275)	
MLSUS	KL	BBKHZ (282)	
MLSUS2	KL	BBKHZ (282)	
MLU2	FW	LRA (463)	
MLU4	FW	LRA (463)	
MLUSSTG	FW	DLSAHK (645)	
MLUSTEST	FW	DLSAHK (645)	
MRESFSM	KL	LLRMR (92)	
MRESLLM	KL	LLRMR (92)	
MRESTEV	FW	LLRMR (92)	
MRFALLO	FW	MDFAW (31)	
MRFALLU	FW	MDFAW (31)	
MRFGRMAX	FW	FGRAUS (511), FGRMD (499)	
MRFGRMR	KL	FGRMD (499)	
MRFGRSTA	FW	FGRMD (499)	
MRFUEMXN	KL	MDFAW (31)	
MRMRFGR	KL	FGRMD (499)	
MSALLMN	FW	BGMSZS (111)	
MSALLMX	FW	BGMSZS (111)	
MSLBAS	FW	DSLSLR (289)	
MSLG	FW	BGMSZS (111)	
MSLOFMX	FW	DSLSLR (289)	
MSLUB	KL	SLS (275)	
MSLVMX	FW	DSLSLR (289)	
MSLVMX2	FW	DSLSLR (289)	
MSNTATE	KL	BGTEV (143)	
MSRC_T_UM	FW	UFMSRC (903)	
MVER_T_UM	FW	UFMVER (905)	
MZFFIL_UM	FW	UFMZF (893)	
MZFTV_UM	FW	UFMZF (893)	
N0	FW	COSA (193), LRA (463)	
NARA	FW	ARMD (63)	
NARASTG	FW	ARMD (63)	
NARLL	FW	ARMD (63)	
NASNOT	FW	MDKOG (40), MDKOL (48)	
NC_T_UM	FW	UFNC (906)	
NDECJ	FW	DECJ (813)	
NDIF_UM	FW	UFNC (906)	
NDKPPU	FW	GGDVE (525)	
NDKS	FW	DKRS (242)	
NDKTSO	FW	DKAT (310)	
NDKTSOT	FW	DKAT (310)	
NDKTSU	FW	DKAT (310)	
NDKTSUT	FW	DKAT (310)	
NDSTA	FW	DSTA (709)	
NDSTS	FW	DSTS (708)	
NDSU	FW	LLRRM (88)	
NDSVLO	FW	GGDSAS (131)	
NDSVLU	FW	GGDSAS (131)	
NDTHMO	FW	DTHM (689)	
NDTHMU	FW	DTHM (689)	
NDV	FW	DVFZ (581)	
NDVO	FW	DVFZ (581)	
NEVFZG	FW	WNWEIN (254)	
NFGRMAX	FW	BBFGR (492)	
NFHZ	FW	LLRNS (84)	
NFHZFS	FW	LLRNS (84)	
NFLUV	FW	DMDLU (761)	
NFSACVMN	FW	LLRABG (100)	
NFSACVMX	FW	LLRABG (100)	
NFSKHM	KL	BBKHZ (282)	
NFSKHM2	KL	BBKHZ (282)	
NFSLRM	KL	LLRNS (84)	
NFSM	KL	LLRNS (84)	
NFSMVMN	FW	LLRABG (100)	
NFSMVMX	FW	LLRABG (100)	
NGALU	KL	DMDSTP (799)	
NGANGMIN	FW	BBGANG (70)	
NGDNSA	FW	BBSAWE (71)	
NGFSAWE	FW	MDFAW (31)	
NGHGS	FW	MDIHGS (68)	
NGLMHEMX	FW	DDMTL (411), HDMTL (442)	
NGLMTKMX	FW	DDMTL (411)	
NGLTDA	FW	DDMTL (411)	
NGLTDW	FW	DDMTL (411)	
NGNSNF	FW	LLRNS (84)	
NINI	FW	STA (706)	
NKLDIPFMX	FW	DDMTL (411)	
NKLMTKMX	FW	DDMTL (411)	
NKLO	FW	ZWGRU (208)	
NKRF	FW	KRRA (227)	

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Symbol	Type	Created within	Used within
NKRFA	FW	KRRA (227)	
NKRUM	FW	KRDY (237)	
NKTDX	FW	DKAT (310)	
NKUPZWEO	FW	MDKOG (40)	
NKUPZWEU	FW	MDKOG (40)	
NLLKHM	KL	BBKHZ (282)	
NLLKHM2	KL	BBKHZ (282)	
NLLKT	FW	BBKHZ (282)	
NLLM	KL	LLRNS (84)	
NLLMVMN	FW	LLRABG (100)	
NLLMVMX	FW	LLRABG (100)	
NLLZWEO	FW	MDKOG (40)	
NLLZWEU	FW	MDKOG (40)	
NLPST1T	FW	BGDVE (534)	
NLPST2T	FW	BGDVE (534)	
NLRHO	FW	LRHK (365)	
NLRHU	FW	LRHK (365)	
NLRKA	FW	LRKA (353)	
NLRSHB	FW	LREB (328)	
NLSDZWEO	FW	MDKOG (40)	
NLSDZWEU	FW	MDKOG (40)	
NMAX	FW	NMAXMD (76), TC1MOD (864)	
NMAXLR	FW	NMAXMD (76)	
NMAXPG	KL	NMAXMD (76)	
NMAXPLR	FW	NMAXMD (76)	
NMIALU	FW	DMDSTP (799)	
NMIDLU	FW	DMDDLU (766)	
NMIN	FW	BBNMIN (574), LLRBB (81)	
NMINVMX	FW	VMAXMD (78)	
NMIN_UM	FW	UFNC (906)	
NMN_DUF	FW	DUF (932)	
NMSNDKO	FW	BGMSZS (111)	
NMXALU	FW	DMDSTP (799)	
NMXDAEF	KL	NMAXMD (76)	
NMXDKPU	FW	NMAXMD (76)	
NMXSKA	FW	AEVAB (196)	
NNSTA	KL	BBSTT (575)	
NNWAFMX	FW	WANWKW (257)	
NNWHYS	FW	WANWKW (257)	
NNWMAX	FW	WNWEIN (254)	
NO1	FW	LRA (463)	
NOBELSTP	FW	TEB (380)	
NOLRA	FW	LRA (463)	
NOVZTE	FW	BGTEV (143)	
NRKAB	FW	COSA (193), LRA (463)	
NRLIP_UM	FW	UFRLC (909)	
NRLMN	FW	FUEDK (149)	
NSAC	FW	LLRNS (84)	
NSACFS	FW	LLRNS (84)	
NSACMVMN	FW	LLRABG (100)	
NSACMVMX	FW	LLRABG (100)	
NSAUE1	FW	MDRED (73)	
NSC_T_UM	FW	UFNSC (896)	
NSLBVMN	FW	LLRABG (100)	
NSLBVMX	FW	LLRABG (100)	
NSLPP	KL	LLRNS (84)	
NSLPPFS	KL	LLRNS (84)	
NSLRM	KL	LLRNS (84)	
NSMNEGS	FW	LLRNS (84)	
NSNOT	FW	LLRNS (84)	
NSNOT1	FW	LLRNS (84)	
NSNOT1FS	FW	LLRNS (84)	
NSNOTFS	FW	LLRNS (84)	
NSOF_T_UM	FW	UFNSC (896)	
NSTART	FW	MDZUL (45)	
NSTEND	FW	MDZUL (45)	
NSTMXM	KL	STA (706)	
NSTNM	KL	BBSTT (575)	
NSUBO	FW	BGLBZ (99)	
NSUBU	FW	BGLBZ (99)	
NSWO1	FW	PROKON (878)	
NSWO2	FW	PROKON (878)	
NTAREIN	KL	ARMD (63)	
NTEB	FW	LLRNS (84)	
NTEBFS	FW	LLRNS (84)	
NTPKTO	FW	DLSA (634)	
NTPKTU	FW	DLSA (634)	
NTPVKO	FW	DLSA (634)	
NTPVKU	FW	DLSA (634)	
NTUMGTA	FW	GGTFUMG (684)	
NTUMTA	FW	BGTABST (154)	
NTUMTAT	FW	ATM (302)	

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Symbol	Type	Created within	Used within
NU3	FW	LRA (463)	
NUEMAX	FW	AMUENE (578)	
NVQUOT1O	FW	BBGANG (70)	
NVQUOT1U	FW	BBGANG (70)	
NVQUOT2O	FW	BBGANG (70)	
NVQUOT2U	FW	BBGANG (70)	
NVQUOT3O	FW	BBGANG (70)	
NVQUOT3U	FW	BBGANG (70)	
NVQUOT4O	FW	BBGANG (70)	
NVQUOT4U	FW	BBGANG (70)	
NVQUOT5O	FW	BBGANG (70)	
NVQUOT5U	FW	BBGANG (70)	
NVQUOT6O	FW	BBGANG (70)	
NVQUOT6U	FW	BBGANG (70)	
NWEM	KL	BBSAWE (71)	
NWENG	KL	BBSAWE (71)	
NWEUE1	FW	MDRED (73)	
NWNWS	FW	WNWEIN (254)	
NZMUL_UM	FW	UFNC (906)	
N_START_UM	FW	UFNSC (896)	
N_STEND_UM	FW	UFNSC (896)	
PGFLWA	FW	DDG (568)	
PHLSNHMN	FW	DLSH (627)	
PHNOKA	FW	DPH (571)	
PLRHAV	KL	LRHK (365)	
PLRHAV2	KL	LRHK (365)	
PLRHML	KL	LRHK (365)	
PLRHML2	KL	LRHK (365)	
PSAPES	FW	AES (189)	
PSLDPMX	FW	DLDP (404)	
PSPVDKUGN	KL	BGMSZS (111), BGRLP (125)	
PUE	FW	GGDSAS (131)	
PUKANS	KL	GGHFM (105)	
PUKORRV	KL	BGPUK (407)	
PUMN	FW	GGDSAS (131)	
PUMX	FW	GGDSAS (131)	
PUSMAX	FW	BGPUK (407)	
PUSMIN	FW	BGPUK (407)	
PUSPSMX	FW	GGDSAS (131)	
PVDKMN	FW	GGDSAS (131)	
PVDKMX	KL	GGDSAS (131)	
PVDKPSMX	FW	GGDSAS (131)	
PVDN	KL	LLRRM (88)	
PVDNV	KL	LLRRM (88)	
PVDNVZ	KL	LLRRM (88)	
PVDNZ	KL	LLRRM (88)	
PZWKRA	FW	KRDY (237)	
P_ZYL	FW	DMDLU (761)	
QUFRMN	FW	LR (338)	
QUFRMX	FW	LR (338)	
RBEL	FW	GGLSH (599)	
REAC_T1_UM	FW	UFREAC (898)	
REAC_T2_UM	FW	UFREAC (898)	
REDABM	KF	AEVAB (196)	
REDHYOC	FW	MDRED (73)	
REDHYUC	FW	MDRED (73)	
REDMX	FW	BGMDLM (44), MDIST (49), MDRED (73)	
REDZEM	KL	MDRED (73)	
REFINI	FW	KRKE (219)	
RINHMX	FW	GGLSH (599)	
RINVMX	FW	GGLSV (588)	
RISIGRESH	FW	DLSH (627)	
RISIGRESV	FW	DLSV (609)	
RKACOMN	FW	COSA (193)	
RKACOMX	FW	COSA (193)	
RKAE	FW	DKVS (476)	
RKATDN	FW	DKVS (476)	
RKATDX	FW	DKVS (476)	
RKATMN	FW	LRA (463)	
RKATMX	FW	LRA (463)	
RKATRN	FW	LRA (463)	
RKATRX	FW	LRA (463)	
RKAZDN	FW	DKVS (476)	
RKAZDX	FW	DKVS (476)	
RKAZMN	FW	LRA (463)	
RKAZMX	FW	LRA (463)	
RKAZRN	FW	LRA (463)	
RKAZRX	FW	LRA (463)	
RKBAU	FW	ESUK (175)	
RKRMX1N	KL	KRKE (219)	
RKRMX2N	KL	KRKE (219)	
RKSP	FW	GGLSH (599)	

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Symbol	Type	Created within	Used within
RKUKKLU	FW	ESUK (175)	
RKVAU	FW	ESUK (175)	
RLC_T_UM	FW	UFRLC (909)	
RLDKTOT	FW	DKAT (310)	
RLDKTSO	KL	DKAT (310)	
RLDKTSU	KL	DKAT (310)	
RLDKTUT	FW	DKAT (310)	
RLDLLR	FW	DLLR (94)	
RLIPFIL_UM	FW	UFRLC (909)	
RLIPTV_UM	FW	UFRLC (909)	
RLIP_T_UM	FW	UFRLC (909)	
RLKL	FW	ZWGRU (208)	
RLLDPRU	FW	DLDP (404)	
RLLRHON	KL	LRHK (365)	
RLLRHUN	KL	LRHK (365)	
RLLRSHB	FW	LREB (328)	
RLLRUN	KL	LREB (328)	
RLMNN	KL	MDFUE (148)	
RLMNSAN	KL	MDFUE (148)	
RLNOT	KL	BGMSZS (111)	
RLO2	FW	LRA (463)	
RLO3	FW	LRA (463)	
RLRAN	KL	LREB (328)	
RLRVAO	FW	LREB (328)	
RLSALUN	KL	DMDSTP (799)	
RLTPKTO	FW	DLSA (634)	
RLTPKTU	FW	DLSA (634)	
RLTPVKO	FW	DLSA (634)	
RLTPVKU	FW	DLSA (634)	
RLU2	FW	LRA (463)	
RLU3	FW	LRA (463)	
RLU4	FW	LRA (463)	
RLVMXN	KL	MDMAX (39)	
RLVPPMXN	KL	GGDVE (525)	
RL_BO_UM	FW	UFRLC (909)	
RL_MO_UM	FW	UFRLC (909)	
RMSLADA	FW	DSLSLR (289)	
RMSLMN	FW	DSLSLR (289)	
RMSLMN2	FW	DSLSLR (289)	
RMSLPMN	FW	DSLSLR (289)	
RMSLSUMN	FW	DSLSLR (289)	
RMSLTMN	FW	DSLSLR (289)	
ROMRSTA_UM	FW	URROM (930)	
RPTES	FW	GGDMTL (410)	
RST_TV_UM	FW	UFREAC (898), URMEM (926)	
SAFK1	FW	DLSSA (654)	
SAFK2	FW	DLSSA (654)	
SDMGLVU	FW	DDMTL (411)	
SENZZYL0	FW	DKRS (242), GGKS (218)	
SENZZYL1	FW	DKRS (242), GGKS (218)	
SENZZYL2	FW	DKRS (242), GGKS (218)	
SENZZYL3	FW	DKRS (242), GGKS (218)	
SENZZYL4	FW	DKRS (242)	
SENZZYL5	FW	DKRS (242)	
SFONTM	FW	DMDSTP (799)	
SFTEDA	FW	DDMTL (411)	
SKADRHZ_UM	FW	UFREAC (898)	
SLFOO2N	KL	DMDFON (772)	
SLFOON	KL	DMDFON (772)	
SLFOU	FW	DMDFON (772)	
SLOWRMX	FW	DFSTT (449)	
SMLDYN	FW	DLSAHK (645)	
SNABEGS	FW	DGLOR (747)	
SNM16ZUUB	SV	ZWGRU (208)	
SP12LL_UM	FW	UFSPSC (913)	
SP12VG_UM	FW	UFSPSC (913)	
SP1ADC_DIF	FW	URADCC (923)	
SP1_STAT	FW	URADCC (923)	
SP1_STAT_T	FW	URADCC (923)	
SPSC_MINUM	FW	UFSPSC (913)	
SPSC_T_UM	FW	UFSPSC (913)	
SPSVG_UM	FW	UFSPSC (913)	
SRL10ZUUB	SV	ZWGRU (208)	
STKRLDY	FW	KRRA (227)	
STKRNDY	FW	KRRA (227)	
STNSG1	FW	GGTSG (686)	
STNSG2	FW	GGTSG (686)	
STNSG3	FW	GGTSG (686)	
STNSG4	FW	GGTSG (686)	
STNSG5	FW	GGTSG (686)	
STTSG1	FW	GGTSG (686)	
STTSG2	FW	GGTSG (686)	

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Symbol	Type	Created within	Used within
STTSG3	FW	GGTSG (686)	
STTSG4	FW	GGTSG (686)	
STTSG5	FW	GGTSG (686)	
SY_AGR_DSS	SYS	PROKON (878)	GGDSAS (131)
SY_CSBVAR	SYS	BGCVN (876), TC9MOD (872)	
SY_DFPNL	SYS	DFPMNL (848)	
SY_DSL10MS	SYS	PROKON (878)	
SY_DSL2MS	SYS	PROKON (878)	
SY_EGFE	SYS		GGDSAS (131)
SY_FFESIZE	SYS	DFRZ (847)	
SY_STERVK	SYS		BBTEGA (371), BGKV (459), DLSV (609)
SY_TURBO	SYS		GGDSAS (131)
SY_ZYLZA	SYS		BGKV (459)
SZANSSM	KL	ESNST (166)	
TABGMCSD	FW	DLSH (627)	DLSV (609)
TABGMEX	FW	ATM (302)	
TABGMSLAD	FW	DSLSLR (289)	
TABSTKH	FW	BBKHZ (282)	
TABTESMN	FW	DDMMVE (830), DDMTL (411), HDMTL (442)	
TACCMXRMP	FW		BBACC (759)
TACCNP	FW	DACC (756)	
TACCREAKX	FW	BBACC (759)	
TACCSI	FW	DACC (756)	
TACCSRG	FW		BBACC (759)
TADE	FW	GGTFA (681)	
TADHMN	FW	DHLS (666)	
TADHMX	FW	DHLS (666)	
TADLLR	FW	DLLR (94)	
TADMM	FW	GGTFM (674)	
TADMN	FW	GGTFA (681)	
TADMX	FW	GGTFA (681)	
TAETRMN	FW	ETR (688)	
TALDPMX	FW	DLDP (404)	
TALDPO	FW	DLDP (404)	
TALDPRO	FW	DLDP (404)	
TALDPRU	FW	DLDP (404)	
TALDPU	FW	DLDP (404)	
TALUNL	FW	MLS (695)	
TALUST	FW	DMDSTP (799)	
TAMHYS	FW	MLS (695)	
TAMIALU	FW	DMDSTP (799)	
TAMLAC	KL	MLS (695)	
TAMLSMN	FW	MLS (695)	
TAMLSMX	FW	MLS (695)	
TAMLSNH	KL	MLS (695)	
TAMLTKA	KL	MLS (695)	
TAMLU	FW	MLS (695)	
TANDSLMN	FW	DSLSLR (289)	
TANDSLMX	FW	DSLSLR (289)	
TANDT	KL	ESSTT (162)	
TANKABN	FW	DFSTT (449)	
TANKDBE	FW	DDMTL (411)	
TANKDD	FW	DDMTL (411)	
TANKMN	FW	DFSTT (449)	
TANMX	FW	STA (706)	
TANSELI	KL	GGTFA (681)	
TANSMN	FW	MDZUL (45)	
TANSMN_UM	FW	UFNSC (896)	
TANW	FW	WNWEIN (254)	
TAPVLTM	KL	AEKP (204)	
TARA	FW	LRAEB (461)	
TARAU	FW	LREB (328)	
TASCNP	FW	DASC (740)	
TASCNP2	FW	DASC (740)	
TASHS	FW	LREB (328)	
TASIG	FW	DLSH (627)	DLSV (609)
TASLSO	FW	SLS (275)	
TASLSU	FW	SLS (275)	
TASTBFA	FW	ATM (302)	
TATEGMX	FW	ATEV (402)	
TATELL	FW	BBTEGA (371)	
TATEMSN	KL	ATEV (402)	
TATMKH	FW	ATM (302)	
TATMKH2	FW	ATM (302)	
TATMKW	FW	ATM (302)	
TATMSA	FW	ATM (302)	
TATMSTI	FW	ATM (302)	
TATMTMOT	FW	ATM (302)	
TATMTP	FW	ATM (302)	
TATMWMK	FW	ATM (302)	
TAWSP	FW	WANWKW (257)	
TAWSPE	FW	WANWKW (257)	

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Symbol	Type	Created within	Used within
TBLRH	FW	LRHK (365)	
TBLRH2	FW	LRHK (365)	
TBTEVIO	FW	DTEVN (403)	
TC6CSL	FW	DSLSLR (289)	
TC6CSL2	FW	DSLSLR (289)	
TC6CSLN	FW	DSLSLR (289)	
TC6CSLN2	FW	DSLSLR (289)	
TC6CSLV	FW	DSLSLR (289)	
TC6CSLV2	FW	DSLSLR (289)	
TC6CTHM	FW	DTHM (689)	
TCEKP	FW	GGAIRB (730)	
TDCACC	FW	DCACC (755)	
TDCAS	FW	CANASR (732), DCAS (739)	
TDCGE	FW	DCGE (726)	
TDCINS	FW	DCINS (728)	
TDDFL	FW	GGDSAS (131)	
TDDFLUGD	FW	GGDSAS (131)	
TDDFU	FW	GGDSAS (131)	
TDDFUUGD	FW	GGDSAS (131)	
TDDPSF	FW	DDMTL (411)	
TDDSLA	FW	SLS (275)	
TDEGFEMN	FW	DEGFE (116)	
TDEGFEMX	FW	DEGFE (116)	
TDEGFENO	FW	DEGFE (116)	
TDEGFEST	FW	DEGFE (116)	
TDFRKAD	FW	LRKA (353)	
TDFRKAU	FW	LRKA (353)	
TDHAKT	FW	DLDP (404)	
TDHCINS	FW	DCINS (728)	
TDKATAKT	FW	DKAT (310)	
TDKATATT	FW	DKAT (310)	
TDKLAGDE	FW	ADVE (548)	
TDKNLPE	FW	BGDVE (534)	
TDKUPNOG	FW	DKUPPL (561)	
TDLLR	FW	DLLR (94)	
TDLLRMN	FW	DLLR (94)	
TDLLRMX	FW	DLLR (94)	
TDLLRNF	FW	DLLR (94)	
TDLRPIDMX	FW	BGDVE (534)	
TDLSVV	FW	DLSVV (625)	
TDMFBSA	FW	MDFAW (31)	
TDMFBWE	FW	MDFAW (31)	
TDMFL	FW	GGMFL (490)	
TDMFLH	FW	GGMFL (490)	
TDMGLGTF	KL	DDMTL (411)	
TDMKLGTF	KL	DDMTL (411)	
TDMLMN	FW	DHFM (108)	
TDMLMX	FW	DHFM (108)	
TDMLNF	FW	DHFM (108)	
TDMLST	FW	DHFM (108)	
TDMRESLL	FW	LLRMR (92)	
TDMSLMN1	FW	DSLSLR (289)	
TDMSLMN4	FW	DSLSLR (289)	
TDMSLMNK	FW	DSLSLR (289)	
TDMSLO	FW	DSLSLR (289)	
TDMSLOF3	FW	DSLSLR (289)	
TDMSLOF5	FW	DSLSLR (289)	
TDMSLOFK	FW	DSLSLR (289)	
TDMSLOK	FW	DSLSLR (289)	
TDMSLV	FW	DSLSLR (289)	
TDMSLVK	FW	DSLSLR (289)	
TDMTGL	FW	DDMTL (411)	
TDMTGLR	FW	DDMTL (411)	
TDMTKL	FW	DDMTL (411)	
TDMTLMX	FW	DDMTL (411)	
TDMTREF	FW	DDMTL (411)	
TDMTREFW	FW	DDMTL (411)	
TDMTSTAB	FW	DDMTL (411)	
TDNSTA	FW	GGTFA (681)	
TDNSUB	FW	GGUB (671)	
TDNWS	FW	DNWS (267)	
TDNWSNOSI	FW	DNWS (267)	
TDSLKT	FW	SLS (275)	
TDSLMVBA	FW	DSLSLR (289)	
TDTA	FW	GGTFA (681)	
TDTAL	FW	GGTFA (681)	
TDTHM	FW	DTHM (689)	
TDTKAUS	FW	GGTKA (683)	
TDTM	FW	GGTFM (674)	
TDTMMA	FW	GGTFM (674)	
TDTUM	FW	GGTFUMG (684)	
TDTUMNF	FW	GGTFUMG (684)	

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Symbol	Type	Created within	Used within
TDTXU	FW	DCTXU (745)	
TDU5REF	FW	DU5REF (673)	
TDUB	FW	GGUB (671)	
TDUBHFM	FW	DHFM (108)	
TDV	FW	DVFZ (581)	
TDVIVZ	FW	BBFGR (492)	
TDVZVI	FW	BBFGR (492)	
TDWLSVV	FW	DLSVV (625)	
TDWNW	FW	DNWS (267)	
TEBF	FW	AEKP (204)	
TEBLEIN	FW	ELS (839)	
TEFABE	FW	DDMMVE (830), T2DMTL (941)	
TEMIN	FW	RKTI (192), TEB (380)	
TEPCL	FW	DEPCL (839)	
TEPCLI	FW	DEPCL (839)	
TFADTLMX	FW	T2DMTL (941)	
TFDLLRO	FW	DLLR (94)	
TFDLLRU	FW	DLLR (94)	
TFEDMMX	FW	DDMTL (411)	
TFGRAQU	FW	BBFGR (492)	
TFGRARLG	KL	BBFGR (492), FGRAUS (511)	
TFGRASCOF	FW	BBFGR (492)	
TFGRBREOF	FW	BBFGR (492)	
TFGRBTOFF	FW	GGMFL (490)	
TFGRBTON	FW	GGMFL (490)	
TFGRBTUBT	FW	GGMFL (490)	
TFGRDSCOF	FW	BBFGR (492)	
TFGRENUM	FW	UFFGRE (902)	
TFGRMNLE	FW	GGMFL (490)	
TFGRTP	FW	FGRMD (499)	
TFGRUEOB	FW	BBFGR (492)	
TFGRUM	FW	BBFGR (492)	
TFGRUNUB	FW	BBFGR (492)	
TFGRVRAB	FW	GGVFZG (580)	
TFIMSLI	FW	DSLSLR (289)	
TFIMSLIK	FW	DSLSLR (289)	
TFIMSLO	FW	DSLSLR (289)	
TFIMSLOK	FW	DSLSLR (289)	
TFIMSLV	FW	DSLSLR (289)	
TFIMSLVK	FW	DSLSLR (289)	
TFMIZU	FW	MDZUL (45)	
TFPWG2	FW	GGPED (513)	
TFRA	FW	DKVS (476)	
TFRAOZ	FW	DKVS (476)	
TFRAUZ	FW	DKVS (476)	
TFRMB	FW	DLSAHK (645)	
TFRMST	FW	DKVS (476)	
TFRMZST	FW	DKVS (476)	
TFSTNP	FW	DFSTT (449)	
TFTEINI	FW	TEB (380)	
TFUPI	FW	FUEDK (149)	
TFUPS	FW	FUEDK (149)	
TGGLS	FW	GGLSH (599), GGLSV (588)	
THEH	FW	HLS (582)	
THEV	FW	HLS (582)	
THHA	FW	HLS (582)	
THHA2	FW	HLS (582)	
THHAWU	FW	HLS (582)	
THOPP1	FW	GGPED (513)	
THOPP2	FW	GGPED (513)	
THSHKTK	KL	HLS (582)	
THSHKTK2	KL	HLS (582)	
THSRIH	FW	GGLSH (599)	
THSRIV	FW	GGLSV (588)	
THSVKTA	KL	HLS (582)	
THSVKTA2	KL	HLS (582)	
THVA	FW	HLS (582)	
THVA2	FW	HLS (582)	
THVAWU	FW	HLS (582)	
TIMSA	FW	BGMSZS (111)	
TIMSALL	FW	BGMSZS (111)	
TIPTPAMN	FW	DDMTL (411)	
TIPTPAMX	FW	DDMTL (411)	
TKAELI	KL	GGTKA (683)	
TKATDSL	FW	DSLSLR (289)	
TKATMLRH	FW	LRHK (365)	
TKATMLRH2	FW	LRHK (365)	
TKATMN	FW	BBKHZ (282)	
TKATMSHU	FW	DLSH (627)	
TKATSAN	KL	BBSAWE (71)	
TKATW	FW	BBKHZ (282)	
TKAUSDE	FW	GGTKA (683)	

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Symbol	Type	Created within	Used within
TKAUSDMN	FW	GGTKA (683)	
TKAUSDMX	FW	GGTKA (683)	
TKHABB	FW	BBKHZ (282)	
TKHFSAB	FW	BBKHZ (282)	
TKHLL	FW	BBKHZ (282)	
TKHLLAB	FW	BBKHZ (282)	
TKHLLMX	FW	BBKHZ (282)	
TKHLLMX2	FW	BBKHZ (282)	
TKHMX	FW	BBKHZ (282)	
TKOAMNN	KL	KOS (698)	
TKOAMXN	KL	KOS (698)	
TKOEMNN	KL	KOS (698)	
TKSTBFA	FW	ATM (302)	
TKTPVK	FW	DLSA (634)	
TLAED	FW	DMIL (860)	
TLAFA	FW	LAMFAW (271)	
TLDPEIN	FW	DLDP (404)	
TLDPFL	FW	DLDP (404)	
TLDPFP	FW	DLDP (404)	
TLDPFTE	FW	DLDP (404)	
TLDPLRMX	FW	DLDP (404)	
TLDPMN	FW	DLDP (404)	
TLDPNF	FW	DLDP (404)	
TLDPONMX	FW	DLDP (404)	
TLDPREF	FW	DLDP (404)	
TLDPRKL	FW	DLDP (404)	
TLDPRKO	FW	DLDP (404)	
TLDPRKZ	FW	DLDP (404)	
TLDPSD	FW	DLDP (404)	
TLDPST1	FW	DLDP (404)	
TLDPTD	FW	DLDP (404)	
TLDPVL	FW	DLDP (404)	
TLDPWAB	FW	DLDP (404)	
TLLASH	FW	DLSAHK (645)	
TLLCO	FW	COSA (193)	
TLMSSLAB	FW	SLS (275)	
TLMSSLMX	FW	SLS (275)	
TLRBAM	KL	LREB (328)	
TLRHS	FW	LREB (328)	
TLRTMS	KL	LREB (328)	
TLRVAM	KL	LREB (328)	
TLRZWTMS	KL	LREB (328)	
TMARSTM	KL	ARMD (63)	
TMASKIV1	FW	DMDMIL (800)	
TMASO	FW	DLSV (609)	
TMDLLR	FW	DLLR (94)	
TMDMAD	FW	MDVERAD (55)	
TMDMMA	FW	GGTFM (674)	
TMDMMAT	KL	GGTFM (674)	
TMDMMAU	FW	GGTFM (674)	
TMDMMEE	FW	GGTFM (674)	
TMDMMER	FW	GGTFM (674)	
TMDMN	FW	GGTFM (674)	
TMDMX	FW	GGTFM (674)	
TMDSLAMN	FW	DSLSLR (289)	
TMDSLMN	FW	DSLSLR (289)	
TMDSLMX	FW	DSLSLR (289)	
TMDV	FW	DVFZ (581)	
TMDYNA	FW	KRDY (237)	
TMESP	FW	ALE (710)	
TMFASLMN	FW	SLS (275)	
TMFKMSDKA	FW	BGMSZS (111)	
TMFLBE	FW	GGMFL (490)	
TMFLFQE	FW	GGMFL (490)	
TMFLTC	FW	GGMFL (490)	
TMH	FW	ESSTT (162)	
TMHSG	FW	ESSTT (162)	
TMINKAT	FW	DKAT (310)	
TMKOAO	FW	KOS (698)	
TMKOAU	FW	KOS (698)	
TMKR	FW	GGKS (218), KRDY (237), KRRA (227)	
TMKRAN	KL	KRRA (227)	
TMKS	FW	ESKS (172)	
TMLDPO	FW	DLDP (404)	
TMLDPU	FW	DLDP (404)	
TMLLRNS	FW	LLRABG (100)	
TMLRTMS	KL	GGTFM (674)	
TMMSX	FW	MSMD (80)	
TMMXRT	FW	GGTFM (674)	
TMNEB	FW	DLSV (609)	
TMNKATT	FW	DKAT (310)	
TMNSMN	FW	MDZUL (45)	

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Symbol	Type	Created within	Used within
TMNSMN_UM	FW	UFNSC (896)	
TMNV	FW	LLRABG (100)	
TMNVFS	FW	LLRABG (100)	
TMNW	FW	WNWEIN (254)	
TMOHSMN	FW	HLS (582)	
TMOTELI	KL	GGTFM (674)	
TMRA1	FW	LREB (328)	
TMRA2	FW	LREB (328)	
TMRAA	FW	LRAEB (461)	
TMRAK	FW	LREB (328)	
TMSDMTLU	FW	DDMTL (411), HDMTL (442)	
TMSDTHMO	FW	DTHM (689)	
TMSDTHMU	FW	DTHM (689)	
TMSHS	FW	LREB (328)	
TMSKS	FW	BBBO (475)	
TMSLOF	FW	BBKHZ (282)	
TMSNOGA	FW	BBTEGA (371)	
TMSSLO	FW	SLS (275)	
TMSSLSTO	FW	SLS (275)	
TMSSLSTU	FW	SLS (275)	
TMSSLU	FW	SLS (275)	
TMSTKA	KL	MSMD (80)	
TMSUTMUMA	FW	BGDVE (534)	
TMSV	FW	DLSV (609)	
TMSVA	FW	DLSV (609)	
TMTE	FW	TEBEB (378)	
TMTED	FW	DTEVN (403)	
TMVDBS	FW	BGRBS (703)	
TMVER	FW	MDKOG (40)	
TMVL	FW	LAMFAW (271)	
TMWUC	FW	DMDMIL (800), DWUC (856)	
TMWUCST	FW	DWUC (856)	
TN2FGRGA	KL	FGRMD (499)	
TNALU	FW	DMDLU (761)	
TNLDSCMX	FW	BGNLDSC (578)	
TNLEKPVL	FW	AEKP (204)	
TNLSGM	KL	BGTABST (154)	
TNLSGMN	FW	MLS (695), MOTAUS (576)	
TNLSGMX	FW	MOTAUS (576)	
TNMXPRG	KL	NMAXMD (76)	
TNMXPRLR	FW	NMAXMD (76)	
TNODTEV	FW	DTEVN (403)	
TNODTEVT	FW	DTEVN (403)	
TNOMF2	FW	DSLSLR (289)	
TNOMF3	FW	DSLSLR (289)	
TNOMF5	FW	DSLSLR (289)	
TNSC	FW	MDZUL (45)	
TNSDMRKH	FW	BBKHZ (282)	
TNSOF	FW	MDZUL (45)	
TNSRT	FW	GGTFM (674)	
TNSTDN	FW	DLSV (609)	
TNSTESMN	FW	DDMMVE (830), DDMTL (411)	
TNSTKO	FW	KOS (698)	
TNSURLP	FW	BGRLP (125)	
TNSUUK	FW	ESUK (175)	
TPAST	FW	STA (706)	
TPDSTA	FW	DSTA (709)	
TPLUHRR	FW	BGTABST (154)	
TPNSE	FW	GGDVE (525), GGPED (513)	
TPNSMD	FW	MDKOG (40)	
TPSVKMN	FW	DLSSA (654)	
TPSVKMX	FW	DLSSA (654)	
TPUKOR	FW	BGPUK (407)	
TPVL	FW	AEKP (204)	
TQTEAB	FW	TEB (380)	
TQTEDAB	FW	TEB (380)	
TRAB	FW	LREB (328)	
TRAU	FW	LREB (328)	
TRD	FW	ALE (710)	
TRIAKTH	FW	GGLSH (599)	
TRIAKTV	FW	GGLSV (588)	
TRIIMPH	FW	GGLSH (599)	
TRIIMPV	FW	GGLSV (588)	
TRIPFASH	FW	DLSAHK (645)	
TRKA	FW	DKVS (476)	
TRKATZ	FW	DKVS (476)	
TRKAZZ	FW	DKVS (476)	
TRSA	FW	DLSV (609)	
TRSAFA	FW	DLSH (627)	
TRSAH	FW	DLSH (627)	
TRSE	FW	DLSH (627)	DLSV (609)
TSAKAMN	FW	LRKA (353)	

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Symbol	Type	Created within	Used within
TSALASH	FW	DLSAHK (645)	
TSBBVTMS	KL	LREB (328)	
TSFCAS	FW	DCAS (739)	
TSFCGE	FW	DCACC (755), DCGE (726)	
TSFCINS	FW	DCINS (728)	
TSFCTXU	FW	DCTXU (745)	
TSFDVEE	FW	ADVE (548)	
TSFDVEF	FW	BGDVE (534)	
TSFDVEL	FW	ADVE (548)	
TSFDVEN	FW	BGDVE (534)	
TSFDVER	FW	ADVE (548)	
TSFDVEU	FW	BGDVE (534)	
TSFDVEV	FW	BGDVE (534)	
TSFEV1	FW	DEVE (835)	
TSFEV2	FW	DEVE (835)	
TSFEV3	FW	DEVE (835)	
TSFEV4	FW	DEVE (835)	
TSFEV5	FW	DEVE (835)	
TSFEV6	FW	DEVE (835)	
TSFEV7	FW	DEVE (835)	
TSFEV8	FW	DEVE (835)	
TSFHSH	FW	DHLS (666)	
TSFHSH2	FW	DHLS (666)	
TSFHSV	FW	DHLS (666)	
TSFHSV2	FW	DHLS (666)	
TSFKPE	FW	DEKPE (824)	
TSFKRNT	FW	DKRNT (247)	
TSFKROF	FW	DKRNT (247)	
TSFKRTP	FW	DKRTP (252)	
TSFLASH	FW	DLSAHK (645)	
TSFLASH2	FW	DLSAHK (645)	
TSFLATP	FW	DLSA (634)	
TSFLATP2	FW	DLSA (634)	
TSFLATV	FW	DLSA (634)	
TSFLATV2	FW	DLSA (634)	
TSFLSH	FW	DLSH (627)	
TSFLSH2	FW	DLSH (627)	
TSFLSV2	FW	DLSV (609)	
TSFMILE	FW	DMILE (837)	
TSFNWSE	FW	DNWSE (819)	
TSFPH	FW	DPH (571)	
TSFPH2	FW	DPH (571)	
TSFSLPE	FW	DSLPE (823)	
TSFSLS	FW	DSLSLR (289)	
TSFSLS2	FW	DSLSLR (289)	
TSFSLV	FW	DSLSLR (289)	
TSFSLV2	FW	DSLSLR (289)	
TSFSLVE	FW	DSLVE (821)	
TSFSTA	FW	DSTA (709)	
TSFSTS	FW	DSTS (708)	
TSFTA	FW	GGTFA (681)	
TSFTEVE	FW	DTEVE (826)	
TSFTKA	FW	GGTKA (683)	
TSFTM	FW	GGTFM (674)	
TSFTUM	FW	GGTFUMG (684)	
TSFU5REF	FW	DU5REF (673)	
TSFUB	FW	GGUB (671)	
TSFUFMV	FW	DUF (932)	
TSFUFSKA	FW	DUF (932)	
TSFURRAM	FW	DUR (933)	
TSFURROM	FW	DUR (933)	
TSFURRST	FW	DUR (933)	
TSGELI	KL	GGTSG (686)	
TSLABB	FW	SLS (275)	
TSLPMN	FW	SLS (275)	
TSLUBST	FW	SLS (275)	
TSPERN	KL	LR (338)	
TSPERN2	KL	LR (338)	
TSTA	FW	STA (706)	
TSTAEBR	FW	GGEGAS (560)	
TSTEAA	FW	DLSA (634)	
TSTSG	FW	GGTSG (686)	
TSTSV	FW	STA (706)	
TSUB	KL	ZUESZ (207)	
TSVKKO	FW	DLSA (634)	
TSVKKTO	FW	DLSA (634)	
TSVKKTU	FW	DLSA (634)	
TSVKKU	FW	DLSA (634)	
TSVKO	FW	DLSA (634)	
TSVKU	FW	DLSA (634)	
TSWKNBGA	KL	FGRMD (499)	
TSWKNVGA	KL	FGRMD (499)	

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Symbol	Type	Created within	Used within
TTBMH	FW	DLSH (627)	DLSV (609)
TTE	FW	BBTEGA (371)	
TTEAE	FW	BBTEGA (371)	
TTEAUS	FW	TEBEB (378)	
TTEBL	FW	ELS (839)	
TTEBSTP	FW	BBTEGA (371)	
TTEDUBV	FW	DDMTL (411)	
TTEGA	FW	BBTEGA (371)	
TTEGAI	FW	BBTEGA (371), DTEVN (403)	
TTEGAZO	FW	BBTEGA (371)	
TTEGAZU	FW	BBTEGA (371)	
TTEINI	FW	BBTEGA (371), DTEVN (403)	
TTEMN	FW	BBTEGA (371)	
TTEPRIO	FW	BBTEGA (371)	
TTEVUB	KL	ATEV (402)	
TTEZAO	FW	BBTEGA (371)	
TTEZAU	FW	BBTEGA (371)	
TTHMDMX	FW	DTHM (689)	
TTLASH	FW	DLSAHK (645)	
TTMUMASTA	FW	BGDVE (534)	
TTXUPL	FW	DGLOR (747)	
TUETM	FW	UETM (687)	
TULDPRO	FW	DLDP (404)	
TULDPRU	FW	DLDP (404)	
TUMDETM	FW	GGTFM (674)	
TUMGTAI	FW	GGTFUMG (684)	
TUMTAI	FW	BGTABST (154)	
TUMTAIT	FW	ATM (302)	
TUMTESO	FW	DDMTL (411)	
TUMTESU	FW	DDMTL (411)	
TUPWBWV	FW	GGPED (513)	
TUPWG12	FW	GGPED (513)	
TUPWG1O	FW	GGPED (513)	
TUPWG1U	FW	GGPED (513)	
TUPWG2O	FW	GGPED (513)	
TUPWG2U	FW	GGPED (513)	
TUSBELH	FW	GGLSH (599)	
TUSBELV	FW	GGLSV (588)	
TUSCHUB	FW	DLSAHK (645)	
TUSDU	FW	DLSV (609)	
TUSDUC	FW	DLSV (609)	
TUSDUFA	FW	DLSH (627)	
TUSDUH	FW	DLSH (627)	
TUSDYN	FW	DLSAHK (645)	
TUSEINH	FW	DLSH (627)	
TUSEINV	FW	DLSV (609)	
TUSENLASH	FW	DLSAHK (645)	
TUSFETT	FW	DLSV (609)	
TUSHSMIN	FW	DLSAHK (645)	
TUSKS	FW	DLSH (627)	DLSV (609)
TUSLASH	FW	DLSAHK (645)	
TUSMAX	FW	DLSH (627)	DLSV (609)
TUSPNMN	FW	DLSSA (654)	
TUSPNMX	FW	DLSSA (654)	
TUSSA	FW	DLSAHK (645)	
TUSTAL	FW	DLSH (627)	
TVAWDKP1	FW	GGDVE (525)	
TVAWDKP2	FW	GGDVE (525)	
TVAWF12	FW	GGDVE (525)	
TVCO	KL	COSA (193)	
TVDK	FW	LLRBB (81)	
TVDKAT	FW	DKAT (310)	
TVDSLOFF	FW	SLS (275)	
TVERBR	FW	GGEGAS (560)	
TVETRA	FW	ETR (688)	
TVETRE	FW	ETR (688)	
TVFGRAT	FW	CANDME (718)	
TVFGRSE	FW	CANDME (718)	
TVFGRSTAT	FW	BBACC (759)	
TVFHS	FW	DHLS (666)	
TVFSAM	KL	MDWAN (61)	
TVFSAWE	FW	MDFAW (31)	
TVFSEM	KL	MDWAN (61)	
TVFSTD	FW	DFSTT (449)	
TVFUE	FW	MDWAN (61)	
TVHALT	FW	GGFSTT (443)	
TVHATA	FW	DFSTT (449)	
TVHSEE	FW	DHLS (666)	
TVHSH	FW	HLS (582)	
TVHSV	FW	HLS (582)	
TVKL15	FW	GGFSTT (443)	
TVKOE	FW	KOS (698)	

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Symbol	Type	Created within	Used within
TVKS	FW	ESKS (172)	
TVKUP	FW	GGEGAS (560)	
TVKUPPL	FW	LLRBB (81)	
TVKURU	FW	BBKURU (67)	
TVLADV	KL	FGRMD (499)	
TVLISTUM	KL	LLRRM (88)	
TVLLRMRTEV	FW	LLRMR (92)	
TVLRA	FW	LRAEB (461)	
TVLRHMN	FW	DLSA (634)	
TVLRHMN2	FW	DLSA (634)	
TVLRHMX	FW	DLSA (634)	
TVLRHMX2	FW	DLSA (634)	
TVMFLA	FW	CANINS (727)	
TVMXPR	FW	VMAXMD (78)	
TVPDKP1	FW	GGDVE (525)	
TVPDKP2	FW	GGDVE (525)	
TVPWDK12	FW	GGDVE (525)	
TVPWDK13	FW	GGDVE (525)	
TVPWDK23	FW	GGDVE (525)	
TVRESFS	FW	LLRMR (92)	
TVRESLL	FW	LLRMR (92)	
TVRIF	FW	DHLS (666)	
TVSATEM	KL	TEB (380)	
TVSATM	KL	BBSAWE (71)	
TVSLVOFF	FW	SLS (275)	
TVSLVON	FW	SLS (275)	
TVUB	KL	AES (189)	
TVWDKS	FW	FUEDK (149)	
TWBDCY	FW	DDCY (856)	
TWDDTV	FW	DLSA (634)	
TWDKATST	FW	DKAT (310)	
TWDKSV	KL	FUEDK (149)	
TWDLSSA	FW	DLSSA (654)	
TWDMAD	FW	MDVERAD (55)	
TWDSTA	FW	DSTA (709)	
TWDSTS	FW	DSTS (708)	
TWETRS	FW	ETR (688)	
TWHLSLP	FW	DSLSLR (289)	
TWKL15IP	FW	DDMTL (411)	
TWKODTE	FW	DTEVN (403)	
TWKTDLP	FW	DKAT (310)	
TWLRTMS	KL	GGTFM (674)	
TWMLFE	FW	DSLSLR (289)	
TWMSLMIN	FW	DSLSLR (289)	
TWNWS	FW	ESNWS (174), WNWEIN (254)	
TWPEDBR	FW	BBPEDBR (579)	
TWTEDTA	FW	DDMTL (411)	
TWTEMV	FW	DDMTL (411)	
TWTESNL	FW	DDMTL (411)	
TWUPKSO	FW	DDMPME (828)	
TWUPKSWE	FW	DDMPME (828)	
TXUHIRMN	FW	DGLOR (747)	
TXUHIRMX	FW	DGLOR (747)	
TXULORMN	FW	DGLOR (747)	
TXULORMX	FW	DGLOR (747)	
TXUSHMX	FW	DGLOR (747)	
TZ2FGRGA	KL	FGRMD (499)	
TZMIN	FW	AEKP (204)	
TZSPINI	FW	ARMD (63)	
TZTOL_UM	FW	UFNC (906)	
U5REFMN	FW	DU5REF (673)	
UADPLMN	FW	GGDSAS (131)	
UADPLMX	FW	GGDSAS (131)	
UADPUMN	FW	GGDSAS (131)	
UADPUMX	FW	GGDSAS (131)	
UANAUFRP	FW	BGDVE (534)	
UANNMAX	FW	BGDVE (534)	
UANPEDMAX	FW	BGDVE (534)	
UANPIDMIN	FW	BGDVE (534)	
UANPIDMINA	FW	BGDVE (534)	
UANUATS	FW	BGDVE (534)	
UANZURP	FW	BGDVE (534)	
UAN_O_MT	FW	BGDVE (534)	
UAN_STORE	FW	BGDVE (534)	
UAN_U_MT	FW	BGDVE (534)	
UBCJMN	FW	DECJ (813)	
UBCJMX	FW	DECJ (813)	
UBDCAN	FW	DCACC (755), DCINS (728), DGLOR (747), DCTXU (745), DCAS (739), DCGE (726)	
UBDE	FW	GGUB (671)	
UBDLS	FW	DHLS (666), DLSH (627)	DLSV (609)
UBDLSMX	FW	DHLS (666)	

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Symbol	Type	Created within	Used within
UBDMN1	FW	GGUB (671)	
UBDMN2	FW	GGUB (671)	
UBDMX	FW	GGUB (671)	
UBHFM	FW	DHFM (108)	
UBHS	FW	HLS (582)	
UBLDPMX	FW	DLDP (404)	
UBMFLMN	FW	GGMFL (490)	
UBNACHL	FW	GGUB (671)	
UBNLMN	FW	MOTAUS (576)	
UBPMEO	FW	DDMPME (828)	
UBSLMN	FW	SLS (275)	
UBSLMX	FW	SLS (275)	
UBSLSTMN	FW	SLS (275)	
UBSTS	FW	AEKP (204)	
UBTEDFAO	FW	DDMTL (411)	
UBTEDFAU	FW	DDMTL (411)	
UBTEDO	FW	DDMTL (411)	
UBTEDU	FW	DDMTL (411)	
UBVDKPO	FW	GGDVE (525)	
UBVDKPU	FW	GGDVE (525)	
UB_UANL	FW	BGDVE (534)	
UDKNLP1N	FW	BGDVE (534)	
UDKNLP2N	FW	BGDVE (534)	
UDKP1AMAX	FW	BGDVE (534)	
UDKP1AMIN	FW	BGDVE (534)	
UDKP1AURI	FW	BGDVE (534)	
UDKP1DUS	FW	BGDVE (534)	
UDKP1NHUB	FW	BGDVE (534)	
UDKP1O	FW	GGDVE (525)	
UDKP1U	FW	GGDVE (525)	
UDKP1VID	FW	BGDVE (534)	
UDKP1VOMA	FW	BGDVE (534)	
UDKP1VOMI	FW	BGDVE (534)	
UDKP1VOSC	FW	BGDVE (534)	
UDKP1VUSC	FW	BGDVE (534)	
UDKP1VVMA	FW	BGDVE (534)	
UDKP1VVMI	FW	BGDVE (534)	
UDKP2AMAX	FW	BGDVE (534)	
UDKP2AMIN	FW	BGDVE (534)	
UDKP2AURI	FW	BGDVE (534)	
UDKP2O	FW	GGDVE (525)	
UDKP2U	FW	GGDVE (525)	
UDKPALOS	FW	BGDVE (534)	
UDKPAOFF	FW	BGDVE (534)	
UDKPATMX	FW	BGDVE (534)	
UDKRGOFS	FW	DKRNT (247)	
UDKRTP	FW	DKRTP (252)	
UDKSNO	KL	DKRS (242)	
UDKSNU	KL	DKRS (242)	
UETMOT	FW	UETM (687)	
UEVERG	KL	MDWAN (61)	
UHDMN	FW	DHLS (666)	
UHDMX	FW	DHLS (666), KATV (324)	
UHSN	FW	HLS (582)	
UKWNMAXG	KL	NMAXMD (76)	
UPTESO	FW	DDMPME (828)	
UPVGNENN	FW	BGDVE (534)	
UPW1LLMX	FW	GGPED (513)	
UPWG12U	FW	GGPED (513)	
UPWG1O	FW	GGPED (513)	
UPWG1U	FW	GGPED (513)	
UPWG2O	FW	GGPED (513)	
UPWG2U	FW	GGPED (513)	
UPWGKDO	FW	GGPED (513)	
UPWGKDU	FW	GGPED (513)	
UPWGO	FW	GGPED (513)	
UPWGTG	FW	GGPED (513)	
UPWGTL	FW	GGPED (513)	
UPWGU	FW	GGPED (513)	
UPWGUBF	FW	GGPED (513)	
UPWGVG	FW	GGPED (513)	
USDBO	FW	DLSV (609)	
USDBU	FW	DLSV (609)	
USFHK	FW	DLSV (609)	
USHKAMN	FW	LRKA (353)	
USHKAMX	FW	LRKA (353)	
USHLEAN	FW	DLSAHK (645)	
USHRICH	FW	DLSAHK (645)	
USHSTGMX	FW	DLSAHK (645)	
USHSTSOLL	FW	DLSAHK (645)	
USIVMAXH	FW	DLSSA (654)	
USIVMAXV	FW	DLSSA (654)	

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Symbol	Type	Created within	Used within
USIVMINH	FW	DLSSA (654)	
USIVMINV	FW	DLSSA (654)	
USMASO	FW	DLSV (609)	
USMAX	FW	DLSH (627)	DLSV (609)
USMHK	FW	DLSV (609)	
USMIN	FW	DLSH (627)	DLSV (609)
USMNSAMN	FW	DLSSA (654)	
USMNSAMX	FW	DLSSA (654)	
USMNSHMN	FW	DLSSA (654)	
USMNSHMX	FW	DLSSA (654)	
USMXSAMN	FW	DLSSA (654)	
USMXSAMX	FW	DLSSA (654)	
USMXSHMN	FW	DLSSA (654)	
USMXSHMX	FW	DLSSA (654)	
USR	FW	DLSSA (654), LREB (328), LR (338)	
USREF	FW	DLSV (609)	
USREFH	FW	DLSH (627)	
USREM	FW	DLSV (609)	
USREMH	FW	DLSH (627)	
USRHKSH	FW	DLSSA (654)	
USRHKSHJ	FW	DLSSA (654)	
USRIMINH	FW	GGLSH (599)	
USRIMINV	FW	GGLSV (588)	
USRIOH	FW	GGLSH (599)	
USRIOV	FW	GGLSV (588)	
USRIUH	FW	GGLSH (599)	
USRIUV	FW	GGLSV (588)	
USSCHUB	FW	DLSAHK (645)	
USVKAMX	FW	LRKA (353)	
UWNMAXLR	FW	NMAXMD (76)	
VABSCH	FW	VMAXMD (78)	
VABSCHLR	FW	VMAXMD (78)	
VARAU	FW	ARMD (63)	
VASRM	FW	BGRBS (703)	
VBGFGRAQ	FW	BBFGR (492)	
VBSMX	FW	BGRBS (703)	
VDKUPPLMN	FW	DKUPPL (561)	
VDMN	FW	DVFZ (581)	
VDMTLO	FW	DDMTL (411)	
VDSCMN	FW	BGNLDSC (578)	
VDTHMU	FW	DTHM (689)	
VFGRMAX	FW	BBFGR (492), FGRMD (499)	
VFGRMIN	FW	BBFGR (492), FGRMD (499)	
VFZETR	FW	ETR (688)	
VFZMN	FW	GGVFZG (580)	
VFZTANKD	FW	DDMTL (411)	
VHYST	FW	VMAXMD (78)	
VHYSTLR	FW	VMAXMD (78)	
VKOAO	FW	KOS (698)	
VKUPZWEO	FW	MDKOG (40)	
VKUPZWEU	FW	MDKOG (40)	
VLDPMX	FW	DLDP (404)	
VLDPRU	FW	DLDP (404)	
VLLR	FW	LLRBB (81)	
VLLZWEO	FW	MDKOG (40)	
VLLZWEU	FW	MDKOG (40)	
VLMXVZ	KL	FGRMD (499)	
VLSDZWEO	FW	MDKOG (40)	
VLSDZWEU	FW	MDKOG (40)	
VMAXLDP	FW	DLDP (404)	
VMAXO	FW	VMAXMD (78)	
VMAXOLR	FW	VMAXMD (78)	
VMAXP	FW	VMAXMD (78)	
VMAXPLR	FW	VMAXMD (78)	
VMDUB	FW	GGUB (671)	
VMINLR	FW	BBLOR (746)	
VMINLRO	FW	BBLOR (746)	
VMIN_UM	FW	UFFGRC (900)	
VREGLMAX	FW	BBFGR (492), FGRMD (499)	
VREGLMIN	FW	BBFGR (492), FGRMD (499)	
VRFGRMN	FW	GGVFZG (580)	
VSAA	FW	BBSAWE (71)	
VSLS	FW	SLS (275)	
VTUMGTA	FW	GGTFUMG (684)	
VTUMTA	FW	BGTABST (154)	
VTUMTAT	FW	ATM (302)	
VVORH	FW	VMAXMD (78)	
VVORHLR	FW	VMAXMD (78)	
WDKARN	KL	LRAEB (461)	
WDKBEWS	FW	ADVE (548)	
WDKDSVLU	KL	GGDSAS (131)	
WDKFMAON	KL	BGMSZS (111)	

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Symbol	Type	Created within	Used within
WDKFMAUN	KL	BGMSZS (111)	
WDKFPRZ1	FW	BGDVE (534)	
WDKFPRZ2	FW	BGDVE (534)	
WDKMSON	KL	BGMSZS (111)	
WDKNLPMA	FW	BGDVE (534)	
WDKNLPMI	FW	BGDVE (534)	
WDKNLPTOL	FW	ADVE (548)	
WDKREIB	FW	ADVE (548)	
WDKSAPP	FW	FUEDK (149)	
WDKSFPR	FW	BGDVE (534)	
WDKSTFEIN	FW	ADVE (548)	
WDKSTGROB	FW	ADVE (548)	
WDKSTMUMA	FW	BGDVE (534)	
WDKUGDN	KL	FUEDK (149)	
WDKVLN	KL	BBVL (38)	
WEAN	KL	EA (184)	
WEEM	KL	EA (184)	
WEESTM	KL	EA (184), EASTT (184)	
WEESTN	KL	EA (184), EASTT (184)	
WEESTS	FW	EA (184), EASTT (184)	
WEEVLN	KL	EA (184)	
WESBM	FW	BGRLP (125), EA (184), EASTT (184)	
WESSTO	FW	ALE (710)	
WFRL	KL	ESUK (175)	
WKORA	KL	ZWGRU (208)	
WKSVN	KL	ESKS (172)	
WLDPAB	FW	DLDP (404)	
WMABGKH	FW	ATM (302)	
WMABGKH2	FW	ATM (302)	
WNWAIMN	FW	DNWS (267)	
WNWAIMN2	FW	WNWEIN (254)	
WNWAIMX	FW	DNWS (267)	
WNWASMN	FW	WANWKW (257)	
WNWASMX	FW	WANWKW (257)	
WNWFVMN	FW	WNWEIN (254)	
WNWIMN	FW	WANWKW (257)	
WNWIMX	FW	WANWKW (257)	
WNWKM	KL	WANWKW (257)	
WNWKN	KL	WANWKW (257)	
WNWMN	FW	WNWEIN (254)	
WNWMX	FW	WNWEIN (254)	
WNWSPS	FW	WANWKW (257)	
WNWV	KL	WNWEIN (254)	
WNWVLN	KL	WNWEIN (254)	
WPEDFMX	FW	BBPEDBR (579)	
WPHN	KL	ZUE (206)	
WPMXNOT	FW	GGPED (513)	
WPUE1MX	FW	MDRED (73)	
WSNW	FW	WNWTST (267)	
WZCTCMX	FW	DLDP (404)	
WZLDPRO	FW	DLDP (404)	
WZSTLMX	FW	DLDP (404)	
ZATMAML	KL	ATM (302)	
ZATMAML2	KL	ATM (302)	
ZATMKML	KL	ATM (302)	
ZATMKML2	KL	ATM (302)	
ZATMRML	KL	ATM (302)	
ZATMRML2	KL	ATM (302)	
ZBALM	KL	ESUK (175)	
ZBFIL	FW	VMAXMD (78)	
ZBRT	FW	BGTEMPK (123)	
ZBTEML	KL	TEB (380)	
ZBWF	FW	GGPED (513)	
ZDFR	FW	LR (338)	
ZDGZA1	FW	ESNST (166)	
ZDGZA2	FW	ESNST (166)	
ZDKATAD	FW	DKAT (310)	
ZDKATAF	FW	DKAT (310)	
ZDKATSH	FW	DKAT (310)	
ZDKTBD	FW	DKAT (310)	
ZDKTBF	FW	DKAT (310)	
ZDSU	FW	GGDSAS (131)	
ZERBR	FW	GGEGAS (560)	
ZETABASN	KL	MDFUE (148)	
ZETATE	FW	TEB (380)	
ZFLMSSL	FW	SLS (275)	
ZFMDVERL	FW	MDVER (53)	
ZFMVRV	FW	BGVFGR (498)	
ZFRIH	FW	GGLSH (599)	
ZFRIV	FW	GGLSV (588)	
ZFRMST	FW	DKVS (476)	
ZFTSVK	FW	DLSA (634)	

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Symbol	Type	Created within	Used within
ZFV	FW	GGVFZG (580)	
ZIDFBM	FW	DDG (568)	
ZIDNOBM	FW	DDG (568)	
ZINMAXG	KL	NMAXMD (76)	
ZINMAXLR	FW	NMAXMD (76)	
ZIPTESB	FW	DDMTL (411)	
ZIPTESN	FW	DDMTL (411)	
ZIPTKTKN	FW	DDMTL (411)	
ZIVMAX	FW	VMAXMD (78)	
ZIVMAXLR	FW	VMAXMD (78)	
ZKARIH	FW	DHLS (666)	
ZKARIV	FW	DHLS (666)	
ZKDFST	FW	GGFSTT (443)	
ZKDMADFK	FW	MDVERAD (55)	
ZKDMADFS	FW	MDVERAD (55)	
ZKDMADKO	FW	MDVERAD (55)	
ZKDMADLL	FW	MDVERAD (55)	
ZKFRAOA	KL	LRA (463)	
ZKFRAUA	KL	LRA (463)	
ZKFSTV	KL	GGFSTT (443)	
ZKFTEAD	FW	TEB (380)	
ZKFUB	FW	BGUBF (282)	
ZKHABB	FW	BBKHZ (282)	
ZKLAMKH	FW	BBKHZ (282)	
ZKLAMKH2	FW	BBKHZ (282)	
ZKLANSWL	FW	ESWL (171)	
ZKLLRD	FW	LLRRM (88)	
ZKLLRDZ	FW	LLRRM (88)	
ZKMDKO	FW	MDVERB (52)	
ZKMDWA	FW	MDWAN (61)	
ZKMSDK	KL	BGMSZS (111)	
ZKNS	FW	LLRNS (84)	
ZKPRIH	FW	DHLS (666)	
ZKPRIV	FW	DHLS (666)	
ZKRKATA	KL	LRA (463)	
ZKRKAZ	FW	LRA (463)	
ZKSLPOFF	FW	SLS (275)	
ZKSLPON	FW	SLS (275)	
ZKSLSOFF	FW	SLS (275)	
ZKSLSON	FW	SLS (275)	
ZKTABTU	KL	BGTABST (154)	
ZKTDRL	FW	DKAT (310)	
ZKUBDLR	FW	ADVE (548)	
ZKURU	FW	BBKURU (67)	
ZKWDKSPT1	FW	ADVE (548)	
ZKWNW	FW	ESNWS (174)	
ZLASHKAB	FW	LRHK (365)	
ZLASOHML	KL	LRHK (365)	
ZLASOHML2	KL	LRHK (365)	
ZLIBG	FW	LLRRM (88)	
ZLRFRI	FW	LR (338)	
ZLRHML	KL	LRHK (365)	
ZLRHML2	KL	LRHK (365)	
ZLSDHK	FW	MDFAW (31)	
ZLSDHKLR	FW	MDFAW (31)	
ZLUTSFI	FW	DMDFLU (812)	
ZMDNS	FW	MDVER (53)	
ZMIBGR	FW	MDIHGS (68)	
ZMLRO	FW	DHFM (108)	
ZNGAR	FW	ARMD (63)	
ZNGFIL	FW	BGNG (565)	
ZNGHGS	FW	MDIHGS (68)	
ZNOSTMX	FW	AEKP (204)	
ZNSM	KL	LLRNS (84)	
ZNSUB	FW	LLRNS (84)	
ZTDAGR	FW	BGTEMPK (123)	
ZTMMBR	FW	BGTEMPK (123)	
ZTPREL	FW	ALE (710), EA (184), EASTT (184)	
ZUBTESB	FW	DDMTL (411)	
ZUBTESN	FW	DDMTL (411)	
ZUKK	FW	ESUK (175)	
ZUKNST	FW	ESUK (175)	
ZVALM	KL	ESUK (175)	
ZVTPRGSU	FW	BGSRM (118)	
ZWAPPL	FW	ZUE (206)	
ZWC_T_UM	FW	UFZWC (913)	
ZWDKM1	FW	BGWDKM (153)	
ZWDKM2	FW	BGWDKM (153)	
ZYLANZ_UM	FW	UFZWC (913)	
ZYLZA	FW	BGNMOT (564), DEVE (835), ESKS (172)	
ZYRKR	FW	KRKE (219)	
ZZWEETM	KL	EA (184)	

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Symbol	Type	Created within	Used within
ZZWMNST	FW	ZWMIN (213)	
A	LOK	OBDSV (862)	
ABAK	LOK	ESUK (175)	
ABMF	LOK	AEVAB (196)	
ABO	AUS	BBBO (475)	LRA (463)
ACCCOD	LOK	CANACC (752)	
ACC_STAT	AUS	CANACC (752)	BBACC (759), DACC (756), UFFGRC (900)
ADCC_C_UM	LOK	URADCC (923)	
ADDSU_U	AUS	DFFTCNV (852)	
ADHFM_U	AUS	DFFTCNV (852)	
ADTA_U	AUS	DFFTCNV (852)	
ADTKA_U	AUS	DFFTCNV (852)	
ADTM_U	AUS	DFFTCNV (852)	
AFNMN	LOK	DMDMIL (800)	
AFNMX	LOK	DMDMIL (800)	
AFRLMN	LOK	DMDMIL (800)	
AFRLMX	LOK	DMDMIL (800)	
AFTNMN	LOK	DMDMIL (800)	
AFTNMX	LOK	DMDMIL (800)	
AFTRLMN	LOK	DMDMIL (800)	
AFTRLMX	LOK	DMDMIL (800)	
AGRP	LOK	EGFE (104)	
AGRP_W	LOK	EGFE (104)	
AGRR	AUS	BGSRM (118)	MDBAS (50)
AGRRAT	LOK	EGFE (104)	
AGRR_W	AUS	BGSRM (118)	BGTEMPK (123), EGFE (104)
AHKAT	LOK	DKAT (310)	
AHKAT2	LOK	DKAT (310)	
AHKATN	LOK	DKAT (310)	
AHKATN2	LOK	DKAT (310)	
AHKTKI2_W	DOK	DKAT (310)	
AHKTKI_W	DOK	DKAT (310)	
AHKTNK	DOK	DKAT (310)	
AHKTNK2	DOK	DKAT (310)	
AINT_0	LOK	DMDMIL (800)	
AINT_1	LOK	DMDMIL (800)	
AINT_2	LOK	DMDMIL (800)	
AINT_3	LOK	DMDMIL (800)	
AINT_4	LOK	DMDMIL (800)	
AINT_5	LOK	DMDMIL (800)	
AINT_6	LOK	DMDMIL (800)	
AINT_7	LOK	DMDMIL (800)	
AKATBN	LOK	DKAT (310)	
AKATBN2	LOK	DKAT (310)	
ANWFOH	LOK	DMDFON (772)	
ANWFOS	LOK	DMDFON (772)	
ANZGANGW	AUS	DKUPPL (561)	
ANZKUPPLB	AUS	DKUPPL (561)	
ANZKWU_W	DOK	NMAXMD (76)	
ANZNMAX	AUS	AMUENE (578)	EEDAT (943)
ANZPBR_W	AUS	BBPEDBR (579)	EEDAT (943)
ANZTI	AUS	CIFINA (203)	BGKV (459), ESUK (175)
ANZTIB_W	AUS	ESNST (166)	ESWL (171)
ANZTID	LOK	BGKV (459)	
ANZTIST	DOK	ESSTT (162)	
ANZTI_W	AUS	CIFINA (203)	ESNST (166), ESSTT (162)
ANZTPDN	LOK	FGRMD (499)	
ANZTPUP	LOK	FGRMD (499)	
ANZUDSL_W	LOK	GGDSAS (131)	
APEDKT	LOK	DKAT (310)	
APEDKT2	LOK	DKAT (310)	
ASC4COD	LOK	CANASR (732)	
ASCCOD	LOK	CANASR (732)	
ASC_ALIVE	AUS	CANASR (732)	DASC (740), UFMSRC (903)
ATV	AUS	LRHK (365)	DLSA (634), DLSSA (654)
ATV2	AUS	LRHK (365)	DLSA (634), DLSSA (654)
ATVFETT	AUS	DLSSA (654)	
ATVFETT2	AUS	DLSSA (654)	
ATVINII	LOK	LRHK (365)	
ATVINII2	LOK	LRHK (365)	
ATVMAGER	AUS	DLSSA (654)	
ATVMAGER2	AUS	DLSSA (654)	
AUKK	DOK	ESUK (175)	
AVAK	LOK	ESUK (175)	
AVKATF	AUS	DKAT (310)	LRHK (365), LRKA (353)
AVKATF2	AUS	DKAT (310)	LRHK (365)
AZYCNT	LOK	DMDMIL (800)	
B	LOK	MS (6)	
BBDCY	AUS	DDCY (856)	
BBWUC	AUS	DWUC (856)	
BFNMN	LOK	DMDMIL (800)	
BFNMX	LOK	DMDMIL (800)	

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Symbol	Type	Created within	Used within
BFRLMN	LOK	DMDMIL (800)	
BFRLMX	LOK	DMDMIL (800)	
BFZGLF	LOK	VMAXMD (78)	
BFZGLFGR	AUS	BGVFGR (498)	BBFGR (492)
BFZGL_B	AUS	GGVFZG (580)	VMAXMD (78)
BITERR_CTR	EIN		GGMFL (490)
BLOKNR	EIN		DACC (756), DCACC (755), DCGE (726), DHLS (666), DCTXU (745), GGUB (671), GGTFUMG (684), GGTFM (674), GGDSAS (131), DU5REF (673), DTHM (689), DSLSLR (289), DPH (571), DLSV (609), DCINS (728), DCAS (739)
BREMSACC	AUS	CANACC (752)	DACC (756), UFFGRC (900)
BSC	AUS	BGRBS (703)	DSWEC (704)
BSSP	LOK	DLDP (404)	DSWEC (704)
BZASC_M	LOK	DASC (740)	
BZ_M	LOK	UFMSRC (903)	
B_2SG	EIN		AEVAB (196)
B_4X4PKW	EIN		DCAS (739)
B_ABGLE	LOK	BGDVE (534)	
B_ABGSTG	LOK	DLSAHK (645)	
B_ABGSTG2	LOK	DLSAHK (645)	
B_ABOR	AUS	BBBO (475)	LRA (463)
B_ABSTNL	AUS	PROKON (878)	BGTABST (154)
B_AC	AUS	CANINS (727)	
B_ACC	AUS	CANACC (752)	BBACC (759), BGMRACC (758), DACC (756), EEDAT (943), DCACC (755), BBFGR (492)
B_ACCARM	AUS	BBACC (759)	
B_ACCCOK	AUS	CANACC (752)	
B_ACCDEF	AUS	CANACC (752)	BBACC (759)
B_ACCDME	AUS	CANACC (752)	DACC (756), BBACC (759), CANDME (718)
B_ACCNEW	AUS	CANACC (752)	DCACC (755)
B_ACCNOR	AUS	BBACC (759)	DACC (756)
B_ACCSIPL	AUS	DACC (756)	
B_ACCTGO	LOK	BBACC (759)	
B_ACRES	AUS	KOS (698)	MDVERB (52)
B_ACSDH	LOK	DLSH (627)	
B_ACSDH2	LOK	DLSH (627)	
B_ACTRPL	AUS	DGLOR (747)	
B_ADCSD	LOK	DLSV (609)	
B_ADCSD2	LOK	DLSV (609)	
B_ADD	LOK	BGPUK (407)	
B_ADDE	LOK	DLSV (609)	
B_ADDE2	LOK	DLSV (609)	
B_ADMTLL	EIN		T2DMTL (941), DDMTL (411)
B_ADMTLS	EIN		T2DMTL (941), DDMTL (411)
B_ADMTPM	AUS	DDMTL (411)	DDMPME (828)
B_ADSH	LOK	DLSH (627)	
B_ADSH2	LOK	DLSH (627)	
B_ADSHS	LOK	DLSH (627)	
B_ADSHS2	LOK	DLSH (627)	
B_ADSVB	LOK	DLSV (609)	
B_ADSVB2	LOK	DLSV (609)	
B_ADWFK	LOK	MDVERAD (55)	
B_ADWFS	LOK	MDVERAD (55)	
B_ADWKO	LOK	MDVERAD (55)	
B_AFKLT	LOK	DMDMIL (800)	
B_AFTKLT	LOK	DMDMIL (800)	
B_AFTWRM	LOK	DMDMIL (800)	
B_AFWRM	LOK	DMDMIL (800)	
B_AIRBAG	AUS	GGAIRB (730)	AEKP (204), MOTAUS (576), DDMTL (411)
B_ALE	AUS	ALE (710)	
B_ALLZWE	EIN		BGMDLM (44), MDKOG (40)
B_ANALU	AUS	DMDLU (761)	DMDDLU (766)
B_ANALU_M	LOK	DMDDLU (766)	DMDLU (761)
B_ANFW	LOK	GGTFM (674)	
B_AR	LOK	ARMD (63)	
B_ASC1COK	AUS	CANASR (732)	BGVFGR (498)
B_ASC1NEW	AUS	CANASR (732)	DCAS (739)
B_ASC2COK	AUS	CANASR (732)	BGRBS (703)
B_ASC2NEW	AUS	CANASR (732)	DCAS (739)
B_ASC3COK	AUS	CANASR (732)	
B_ASC3NEW	AUS	CANASR (732)	
B_ASC4COK	AUS	CANASR (732)	
B_ASC4NEW	AUS	CANASR (732)	DCAS (739)
B_ASCDME	AUS	DASC (740)	CANDME (718)
B_ASCPKW	AUS	CANASR (732)	DCAS (739)
B_ASCSIPL	AUS	DASC (740)	
B_ASC_REG	AUS	CANASR (732)	BBFGR (492), DMDSTP (799)
B_ASLA	LOK	DSLSLR (289)	
B_ASLA2	LOK	DSLSLR (289)	
B_ASR	AUS	MDKOG (40)	BBFGR (492), MDRED (73)
B_ASREXT	AUS	CANASR (732)	ARMD (63), DASC (740), BBFGR (492), UFMSRC (903)
B_ATEV	AUS	DTEVE (826)	

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Symbol	Type	Created within	Used within
B_ATMST	LOK	ATM (302)	
B_ATMST2	LOK	ATM (302)	
B_ATMTPA	AUS	ATM (302)	DHLS (666), LR (338), TEBEB (378), HLS (582), DLSV (609)
B_ATMTPA2	AUS	ATM (302)	DHLS (666), DLSV (609), LR (338), HLS (582)
B_ATMTPF	AUS	ATM (302)	
B_ATMTPF2	AUS	ATM (302)	
B_ATMTPK	AUS	ATM (302)	DHLS (666), HLS (582), DLSH (627)
B_ATMTPK2	AUS	ATM (302)	DHLS (666), HLS (582), DLSH (627)
B_ATMTPL	AUS	ATM (302)	SLS (275)
B_ATMTPL2	AUS	ATM (302)	
B_ATVINI	LOK	LRHK (365)	
B_ATVINI2	LOK	LRHK (365)	
B_AUAKT	AUS	PROKON (878)	LRAEB (461)
B_AUTGET	AUS	CANEGS (723)	ARMD (63), BBGANG (70), MDFAW (31), STA (706), MDIHGS (68), DKUPPL (561), LLRNS (84), GGEGAS (560), DCGE (726), DMD-FON (772), BGMIGS (69)
B_BA	AUS	ESUK (175)	
B_BAG	AUS	ESUK (175)	DSLSLR (289), LREB (328)
B_BBDTHM	LOK	DTHM (689)	
B_BEDSL	AUS	GGDSAS (131)	
B_BEDSU	AUS	GGDSAS (131)	
B_BEDSVLU	AUS	GGDSAS (131)	
B_BELSV	AUS	DLSV (609)	
B_BELSV2	AUS	DLSV (609)	
B_BERGAB	LOK	DLDP (404)	
B_BESCH	EIN		BBACC (759), FGRMD (499)
B_BETHM	AUS	DTHM (689)	
B_BEVAB	AUS	AES (189)	AEVAB (196), LAMKO (268), LRKA (353)
B_BEVAB2	AUS	AES (189)	AEVAB (196), LAMKO (268), LRKA (353)
B_BFKLT	LOK	DMDMIL (800)	
B_BFWRM	LOK	DMDMIL (800)	
B_BKDSL	AUS	GGDSAS (131)	
B_BKDSU	AUS	GGDSAS (131)	
B_BKDSVLU	AUS	GGDSAS (131)	
B_BKDVEN	LOK	BGDVE (534)	
B_BKDVEU	LOK	BGDVE (534)	
B_BKDVEV	LOK	BGDVE (534)	
B_BKLSV	AUS	DLSV (609)	
B_BKLSV2	AUS	DLSV (609)	
B_BKTA	AUS	GGTFA (681)	
B_BKTHM	AUS	DTHM (689)	
B_BKTKA	AUS	GGTKA (683)	
B_BKTM	AUS	GGTFM (674)	
B_BKTUM	AUS	GGTFUMG (684)	
B_BKUB	AUS	GGUB (671)	
B_BL	EIN		BBPEDBR (579), GGEGAS (560)
B_BLKEB	LOK	DMIL (860)	
B_BLKFB	EIN		DMIL (860), OBDSV (862)
B_BLKMD	AUS	DMDMIL (800)	DMIL (860), LREB (328)
B_BLRKA	LOK	LRKA (353)	
B_BLRKA2	LOK	LRKA (353)	
B_BR	EIN		BBPEDBR (579), GGEGAS (560)
B_BR2K	AUS	GGEGAS (560)	
B_BREMS	AUS	CANDME (718)	GGEGAS (560), BBACC (759), BBFGR (492), SLS (275), GGPED (513), DKUPPL (561)
B_BREMSACC	AUS	CANACC (752)	DACC (756), UFFGRC (900)
B_BREMS_UM	AUS	UFFGRE (902)	UFFGRC (900), UFSPSC (913)
B_BT	EIN		DLDP (404)
B_BTLDP	EIN		DLDP (404)
B_BVDEL	LOK	LREB (328)	
B_BWF	LOK	GGPED (513)	
B_BWUNPL	LOK	GGPED (513)	
B_C95BF0	LOK	GGKS (218)	
B_C95BF1	LOK	GGKS (218)	
B_C95BF2	LOK	GGKS (218)	
B_C95BF3	LOK	GGKS (218)	
B_C95KS1	LOK	GGKS (218)	
B_C95KS2	LOK	GGKS (218)	
B_C95KS3	LOK	GGKS (218)	
B_C95KTI	LOK	GGKS (218)	
B_C95_G0	AUS	KRKE (219)	EGKE (216), GGKS (218)
B_C95_G1	AUS	KRKE (219)	EGKE (216), GGKS (218)
B_C95_G2	AUS	KRKE (219)	EGKE (216), GGKS (218)
B_CDAGR	AUS	PROKON (878)	
B_CDATR	AUS	PROKON (878)	
B_CDATS	AUS	PROKON (878)	
B_CDDMTL	AUS	PROKON (878)	DDMPME (828), DDMTL (411), HDMTL (442), GGDMTL (410)
B_CDDST	AUS	PROKON (878)	
B_CDFST	AUS	PROKON (878)	DFSTT (449)
B_CDHSH	AUS	PROKON (878)	DHLS (666)
B_CDHSV	AUS	PROKON (878)	DHLS (666), DIMC (857)
B_CDKAT	AUS	PROKON (878)	DKAT (310)

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Symbol	Type	Created within	Used within
B_CDKVS	AUS	PROKON (878)	DKVS (476)
B_CDLASH	AUS	PROKON (878)	DLSAHK (645)
B_CDLATP	AUS	PROKON (878)	DLSA (634)
B_CDLATV	AUS	PROKON (878)	DLSA (634)
B_CDLDP	AUS	PROKON (878)	DIMC (857)
B_CDLLR	AUS	PROKON (878)	DLLR (94)
B_CDLSA	AUS	PROKON (878)	
B_CDLSH	AUS	PROKON (878)	DLSH (627), DLSV (609)
B_CDLSV	AUS	PROKON (878)	DIMC (857), DLSV (609)
B_CDMD	AUS	PROKON (878)	DMDDLU (766), DMDUE (760), DMDSTP (799), DMDMIL (800), DMD-LAD (799), DMDLU (761), DMDFON (772), DMDLUA (770)
B_CDNWS	AUS	PROKON (878)	DNWS (267)
B_CDNWS2	AUS	PROKON (878)	DNWS (267)
B_CDSLS	AUS	PROKON (878)	DIMC (857), DSLSLR (289)
B_CDSLSE	AUS	PROKON (878)	
B_CDSWE	AUS	PROKON (878)	DSWEC (704)
B_CDTANKL	AUS	PROKON (878)	
B_CDTES	AUS	PROKON (878)	DIMC (857), DTEVN (403)
B_CGENEW	AUS	CANEGS (723)	
B_CKSBEOK	LOK	BGCVN (876)	
B_CKSBRDY	AUS	BGCVN (876)	TC9MOD (872)
B_CKSNIO	EIN		BGCVN (876), TC9MOD (872)
B_CKSVAL	EIN		BGCVN (876), TC9MOD (872)
B_CLACC	EIN		DACC (756)
B_CLAS	EIN		DASC (740)
B_CLBACC	LOK	CANACC (752)	
B_CLBM	EIN		DDG (568)
B_CLBREMS	EIN		GGEGAS (560)
B_CLBWF	EIN		GGPED (513)
B_CLCACC	LOK	DCACC (755)	
B_CLCAS	LOK	DCAS (739)	
B_CLCGE	LOK	DCGE (726)	
B_CLCINS	LOK	DCINS (728)	
B_CLCTXU	LOK	DCTXU (745)	
B_CLDHDMTE	EIN		DHDMTE (440)
B_CLDK	EIN		GGDVE (525)
B_CLDK1P	EIN		GGDVE (525)
B_CLDK2P	EIN		GGDVE (525)
B_CLDMMVE	EIN		DDMMVE (830)
B_CLDMPME	EIN		DDMPME (828)
B_CLDMTK	EIN		DDMTL (411)
B_CLDMTL	EIN		DDMTL (411)
B_CLDPMEE	EIN		DDMPME (828)
B_CLDSL	EIN		GGDSAS (131)
B_CLDSU	EIN		GGDSAS (131)
B_CLDSVLU	EIN		GGDSAS (131)
B_CLDVEE	EIN		ADVE (548)
B_CLDVEF	EIN		BGDVE (534)
B_CLDVEL	EIN		ADVE (548)
B_CLDVEN	EIN		BGDVE (534)
B_CLDVER	EIN		ADVE (548)
B_CLDVEU	EIN		BGDVE (534)
B_CLDVEV	EIN		BGDVE (534)
B_CLEGFE	EIN		DEGFE (116)
B_CLETS	EIN		DETS (834)
B_CLEV	EIN		DEVE (835)
B_CLFP1P	EIN		GGPED (513)
B_CLFP2P	EIN		GGPED (513)
B_CLFPP	EIN		GGPED (513)
B_CLFRAO	EIN		DKVS (476), LRA (463)
B_CLFRAO2	EIN		DKVS (476), LRA (463)
B_CLFRAU	EIN		DKVS (476), LRA (463)
B_CLFRAU2	EIN		DKVS (476), LRA (463)
B_CLFRST	EIN		DKVS (476)
B_CLFRST2	EIN		DKVS (476)
B_CLGLOR	EIN		DGLOR (747)
B_CLHSH	EIN		DHLS (666)
B_CLHSH2	EIN		DHLS (666)
B_CLHSV	EIN		DHLS (666)
B_CLHSV2	EIN		DHLS (666)
B_CLKAT	LOK	DKAT (310)	
B_CLKAT2	LOK	DKAT (310)	
B_CLKATFZ	EIN		KATV (324)
B_CLKOS	EIN		DKOSE (816)
B_CLKPE	EIN		DEKPE (824)
B_CLKRNT	EIN		DKRNT (247)
B_CLKROF	EIN		DKRNT (247)
B_CLKRTP	EIN		DKRTP (252)
B_CLKS1	EIN		DKRS (242)
B_CLKS2	EIN		DKRS (242)
B_CLKS3	EIN		DKRS (242)
B_CLKS4	EIN		DKRS (242)

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Symbol	Type	Created within	Used within
B_CLKUPPL	EIN		DKUPPL (561)
B_CLLASH	EIN		DLSAHK (645)
B_CLLASH2	EIN		DLSAHK (645)
B_CLLATP	EIN		DLSA (634)
B_CLLATP2	EIN		DLSA (634)
B_CLLATV	EIN		DLSA (634)
B_CLLATV2	EIN		DLSA (634)
B_CLLDP	LOK	DLDP (404)	
B_CLLDPE	EIN		DLDPE (409)
B_CLLLR	EIN		DLLR (94)
B_CLLM	EIN		DHFM (108)
B_CLLSH	EIN		DLSH (627)
B_CLLSH2	EIN		DLSH (627)
B_CLLSV	EIN		DLSV (609)
B_CLLSV2	EIN		DLSV (609)
B_CLLSVV	EIN		DLSVV (625)
B_CLMDB	EIN		MDKOG (40)
B_CLMFL	EIN		GGMFL (490)
B_CLMILE	LOK	DMILE (837)	
B_CLMLE	EIN		DMLSE (818)
B_CLN	EIN		DDG (568)
B_CLNWS	EIN		DNWS (267)
B_CLNWSE	EIN		DNWSE (819)
B_CLPH	EIN		DPH (571)
B_CLPH2	EIN		DPH (571)
B_CLRKAT	EIN		DKVS (476), LRA (463)
B_CLRKAT2	EIN		DKVS (476), LRA (463)
B_CLRKAZ	EIN		DKVS (476), LRA (463)
B_CLRKAZ2	EIN		DKVS (476), LRA (463)
B_CLSLPE	EIN		DSLPE (823)
B_CLSLS	EIN		DSLSLR (289)
B_CLSLS2	EIN		DSLSLR (289)
B_CLSLV	EIN		DSLSLR (289)
B_CLSLV2	EIN		DSLSLR (289)
B_CLSLVE	EIN		DSLVE (821)
B_CLSTAE	EIN		DSTAE (832)
B_CLSWE	EIN		BGRBS (703)
B_CLTA	EIN		GGTFA (681)
B_CLTESB	LOK	DLDP (404)	
B_CLTESK	LOK	DLDP (404)	
B_CLTEVE	EIN		DTEVE (826)
B_CLTHM	EIN		DTHM (689)
B_CLTKA	EIN		GGTKA (683)
B_CLTM	EIN		GGTFM (674)
B_CLTUM	EIN		GGTFUMG (684)
B_CLU5REF	EIN		DU5REF (673)
B_CLUB	EIN		GGUB (671)
B_CLUFMV	EIN		DUF (932)
B_CLUFSKA	EIN		DUF (932)
B_CLURRAM	EIN		DUR (933)
B_CLURROM	EIN		DUR (933)
B_CLURRST	EIN		DUR (933)
B_CLVFZ	EIN		DVFZ (581)
B_COTRIM	LOK	COSA (193)	
B_CRAUS	EIN		LREB (328)
B_CRDMTL	EIN		DDMTL (411)
B_CTCCKA	LOK	DLDP (404)	
B_CTCCKE	LOK	DLDP (404)	
B_CTOCKA	LOK	DLDP (404)	
B_CTOCKE	LOK	DLDP (404)	
B_CTUNP	LOK	GGTFUMG (684)	
B_CVT	EIN		BBSAWE (71)
B_CWDSLT	LOK	DSLSLR (289)	
B_CWSLA	EIN		DSLSLR (289)
B_DASH	AUS	MDFAW (31)	BBSAWE (71), MDKOG (40), LLRBB (81), BGMDLM (44)
B_DCDISFR	AUS	ADVE (548)	BGDVE (534)
B_DCDISR	AUS	BGDVE (534)	ADVE (548)
B_DCDIS_UM	AUS	UFMVER (905)	URADCC (923), UFZWC (913), UFSPSC (913), UFRLC (909), UF-REAC (898), UFNC (906), UFUE (890)
B_DCY	AUS	DDCY (856)	DFPM (841), DMDMIL (800), DTRIG (854)
B_DDYLASH	LOK	DLSAHK (645)	
B_DDYLASH2	LOK	DLSAHK (645)	
B_DESEE	AUS	DECJ (813)	DDMMVE (830), DEKPE (824), DETS (834), DEVE (835), DHDMTE (440), DKOSE (816), DMILE (837), DSLPE (823), DNWSE (819), HDMTL (442), DTEVE (826), DSLVE (821), DDMPME (828), DLDPE (409), DMLSE (818), DSTAE (832)
B_DFRF	AUS	LR (338)	
B_DFRF2	AUS	LR (338)	
B_DFRM	AUS	LR (338)	
B_DFRM2	AUS	LR (338)	
B_DFSKVO	LOK	DFSTT (449)	
B_DFSKVU	LOK	DFSTT (449)	

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Symbol	Type	Created within	Used within
B_DIPRFO	EIN		T2DMTL (941), DDMTL (411)
B_DKADEN	AUS	BGDVE (534)	ADVE (548)
B_DKINI	LOK	DKAT (310)	
B_DKINI2	LOK	DKAT (310)	
B_DKLPI	LOK	DKAT (310)	
B_DKLPI2	LOK	DKAT (310)	
B_DKNOLU	AUS	SREAKT (931)	ADVE (548), BBFGR (492), BGDVE (534), NMAXMD (76), MDVERAD (55), MDRED (73), LLRNS (84), DLLR (94), AEVAB (196)
B_DKNOT	AUS	GGDVE (525)	BGDVE (534)
B_DKP1E	LOK	GGDVE (525)	
B_DKP1MN	LOK	GGDVE (525)	
B_DKP1MX	LOK	GGDVE (525)	
B_DKP1NP	LOK	GGDVE (525)	
B_DKP2E	LOK	GGDVE (525)	
B_DKP2MN	LOK	GGDVE (525)	
B_DKP2MX	LOK	GGDVE (525)	
B_DKP2NP	LOK	GGDVE (525)	
B_DKPAW	LOK	GGDVE (525)	
B_DKPIU	AUS	SREAKT (931)	ADVE (548), BGDVE (534), BBFGR (492)
B_DKPRU	AUS	SREAKT (931)	
B_DKPU	AUS	SREAKT (931)	AEVAB (196), BBACC (759), DLLR (94), LLRNS (84), MDRED (73), NMAXMD (76), MDVERAD (55), GGDVE (525), DMDSTP (799)
B_DKTEN	DOK	DKAT (310)	
B_DKTEN2	DOK	DKAT (310)	
B_DKTLP	AUS	DKAT (310)	LR (338)
B_DKTNR	LOK	DKAT (310)	
B_DKTNR2	LOK	DKAT (310)	
B_DKTSB	LOK	DKAT (310)	
B_DKTSB2	LOK	DKAT (310)	
B_DKTSP	LOK	DKAT (310)	
B_DKTSP2	LOK	DKAT (310)	
B_DKTST	LOK	DKAT (310)	
B_DKTST2	LOK	DKAT (310)	
B_DKTT	LOK	DKAT (310)	
B_DKTT2	LOK	DKAT (310)	
B_DKUEVAB	DOK	AEVAB (196)	
B_DKUNB	AUS	GGDVE (525)	BBVL (38), SREAKT (931)
B_DKVSF	AUS	DKVS (476)	
B_DKVSFM	LOK	DKVS (476)	
B_DKVSTR	AUS	DKVS (476)	
B_DLAFF	LOK	DLSA (634)	
B_DLAFF2	LOK	DLSA (634)	
B_DLASH	LOK	DLSAHK (645)	
B_DLASH2	LOK	DLSAHK (645)	
B_DLATP	AUS	DLSA (634)	DLSSA (654)
B_DLATP2	AUS	DLSA (634)	DLSSA (654)
B_DLATV	AUS	DLSA (634)	
B_DLATV2	AUS	DLSA (634)	
B_DLDP	EIN		DLDPE (409), DLDP (404)
B_DLDPTE	AUS	GKRA (327)	BBTEGA (371), TEBEB (378), DLDP (404)
B_DLLR	AUS	DLLR (94)	LLRRM (88)
B_DLLRA	AUS	DLLR (94)	TEBEB (378)
B_DLRBE	EIN		SREAKT (931), ADVE (548)
B_DLRBEW	DOK	ADVE (548)	
B_DLRIKLA	DOK	ADVE (548)	
B_DLRIKLST	DOK	ADVE (548)	
B_DLRPARC	LOK	ADVE (548)	
B_DLRPIDE	EIN		SREAKT (931), ADVE (548)
B_DLRSPID	AUS	ADVE (548)	BGDVE (534)
B_DLRUMZU	LOK	ADVE (548)	
B_DLUERK	AUS	DMDDLU (766)	DMDLAD (799)
B_DLUERK_M	LOK	DMDDLU (766)	
B_DMASO	LOK	DLSV (609)	
B_DMASO2	LOK	DLSV (609)	
B_DMDIPTGE	EIN		HDMTL (442), DDMTL (411)
B_DMDIPTKE	EIN		HDMTL (442), DDMTL (411)
B_DMGLTD	LOK	DDMTL (411)	
B_DMKL15	AUS	DDMTL (411)	T2DMTL (941)
B_DMKTKE	EIN		DDMMVE (830), HDMTL (442), DDMTL (411)
B_DMKTKR	LOK	DDMTL (411)	
B_DMKTKS	LOK	DDMTL (411)	
B_DMMTEV	AUS	DDMMVE (830)	TEBEB (378)
B_DMMVET	EIN		DDMTL (411)
B_DMMVTP	AUS	DDMMVE (830)	
B_DMPMET	EIN		DDMTL (411)
B_DMTDC	LOK	DDMTL (411)	
B_DMTETE	LOK	DDMTL (411)	
B_DMTGE	LOK	DDMTL (411)	
B_DMTGLM	LOK	DDMTL (411)	
B_DMTGLMV	LOK	DDMTL (411)	
B_DMTGTZ	LOK	DDMTL (411)	
B_DMTGV	EIN		DDMTL (411)

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Symbol	Type	Created within	Used within
B_DMTGVS	LOK	DDMTL (411)	
B_DMTKE	LOK	DDMTL (411)	
B_DMTKEE	LOK	DDMTL (411)	
B_DMTKLM	LOK	DDMTL (411)	
B_DMTKLMV	LOK	DDMTL (411)	
B_DMTKTZ	LOK	DDMTL (411)	
B_DMTLFE	EIN		T2DMTL (941), DDMTL (411)
B_DMTLHE	LOK	DDMTL (411)	
B_DMTLMV	AUS	DDMTL (411)	
B_DMTLPE	LOK	DDMTL (411)	
B_DMTLPM	AUS	DDMPME (828)	
B_DMTLTDE	LOK	DDMTL (411)	
B_DMTLTZ	AUS	DDMTL (411)	BBTEGA (371), DTEVN (403)
B_DMTMV	LOK	DDMTL (411)	
B_DMTNGE	EIN		DDMTL (411)
B_DMTPM	LOK	DDMTL (411)	
B_DMTRFM	LOK	DDMTL (411)	
B_DNSLL	LOK	BBSAWE (71)	
B_DNT	LOK	GGKS (218)	
B_DNTB	LOK	GGKS (218)	
B_DP	LOK	MDFAW (31)	
B_DPSF	LOK	DDMTL (411)	
B_DPUABB	LOK	DLDP (404)	
B_DRUCK	EIN		DTEVN (403), DLDP (404)
B_DSC_REG	AUS	CANASR (732)	BBFGR (492)
B_DSHEN	LOK	DLSH (627)	
B_DSHEN2	LOK	DLSH (627)	
B_DSHK	LOK	DLSAHK (645)	
B_DSHK2	LOK	DLSAHK (645)	
B_DSI	LOK	DKRS (242)	
B_DSL	AUS	DSLSLR (289)	LREB (328)
B_DSL1	LOK	DSLSLR (289)	
B_DSL1AB	LOK	DSLSLR (289)	
B_DSL1E	LOK	DSLSLR (289)	
B_DSL2	LOK	DSLSLR (289)	
B_DSL2AB	LOK	DSLSLR (289)	
B_DSL2E	LOK	DSLSLR (289)	
B_DSL3	LOK	DSLSLR (289)	
B_DSL3AB	LOK	DSLSLR (289)	
B_DSL3E	LOK	DSLSLR (289)	
B_DSL4	LOK	DSLSLR (289)	
B_DSL4AB	LOK	DSLSLR (289)	
B_DSL4E	LOK	DSLSLR (289)	
B_DSL5	LOK	DSLSLR (289)	
B_DSL5AB	LOK	DSLSLR (289)	
B_DSL5E	LOK	DSLSLR (289)	
B_DSLA	AUS	DSLSLR (289)	BBKHZ (282), LAMKO (268)
B_DSLERR	LOK	DSLSLR (289)	
B_DSLFA	AUS	DSLSLR (289)	SLS (275)
B_DSLM	LOK	DSLSLR (289)	
B_DSLMAB	LOK	DSLSLR (289)	
B_DSLME	LOK	DSLSLR (289)	
B_DSLMES	LOK	DSLSLR (289)	
B_DSLO	LOK	DSLSLR (289)	
B_DSLOAB	LOK	DSLSLR (289)	
B_DSLOE	LOK	DSLSLR (289)	
B_DSLRESET	LOK	SLS (275)	
B_DSLS	AUS	DSLSLR (289)	BBSAWE (71), DLSV (609), DLSH (627), DLSAHK (645), DTEVN (403), LREB (328), LRAEB (461), TEBEB (378), LRHK (365), DLSA (634), DLLR (94)
B_DSLSET	LOK	SLS (275)	
B_DSLSK	EIN		LREB (328)
B_DSLSP4	AUS	DSLSLR (289)	SLS (275)
B_DSLT	LOK	DSLSLR (289)	
B_DSLTAB	LOK	DSLSLR (289)	
B_DSLTE	LOK	DSLSLR (289)	
B_DSLVH	LOK	BGMSZS (111)	
B_DSPE	AUS	DSLSLR (289)	SLS (275)
B_DSPER	LOK	DSLSLR (289)	
B_DSPES	LOK	DSLSLR (289)	
B_DSSV	LOK	BGMSZS (111)	
B_DSVEN	AUS	DLSV (609)	
B_DSVEN2	AUS	DLSV (609)	
B_DTANKM	LOK	DFSTT (449)	
B_DTEAA	EIN		BGTEV (143), TEBEB (378), DTEVN (403)
B_DTEAAV	AUS	GKRA (327)	
B_DTEABR	LOK	DTEVN (403)	
B_DTEBEL	LOK	DLDP (404)	DTEVN (403)
B_DTEBN	EIN		LLRMR (92), DLDP (404), DTEVN (403)
B_DTEFRR	AUS	GKRA (327)	LRINI (352)
B_DTEG	LOK	DDMTL (411)	
B_DTEGEN	LOK	DDMTL (411)	

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Symbol	Type	Created within	Used within
B_DTEGFA	LOK	DDMTL (411)	
B_DTEGTR	LOK	DDMTL (411)	
B_DTEKEN	DOK	DDMTL (411)	
B_DTEKFA	DOK	DDMTL (411)	
B_DTEKTR	LOK	DDMTL (411)	
B_DTES	AUS	GKRA (327)	ATEV (402), DLLR (94), BBTEGA (371), DLSV (609), DLSH (627), LLRRM (88), MDVERAD (55), DMDSTP (799), DTEVN (403)
B_DTEST	EIN		DLSA (634), LRAEB (461), GKEB (325), DLSAHK (645)
B_DTETD	EIN		T2DMTL (941), DDMTL (411)
B_DTETK	EIN		T2DMTL (941), DDMTL (411)
B_DTEVIO	EIN		DLDP (404), DTEVN (403)
B_DTP	LOK	GGKS (218)	
B_DTPB	LOK	GGKS (218)	
B_DUBTES	EIN		T2DMTL (941), DDMTL (411)
B_DUPW	LOK	GGPED (513)	
B_DUPW12	LOK	GGPED (513)	
B_DUSHSCH	LOK	DLSAHK (645)	
B_DUSHSCH2	LOK	DLSAHK (645)	
B_DVEADA	AUS	BGDVE (534)	AEVAB (196)
B_DVEESE	LOK	ADVE (548)	
B_DVEESH	LOK	ADVE (548)	
B_DYLASH	LOK	DLSAHK (645)	
B_DYLASH2	LOK	DLSAHK (645)	
B_E	LOK	MS (6)	
B_EBL	AUS	ELS (839)	
B_ECULOCK	EIN		AEVAB (196)
B_EDKVS	AUS	DKVS (476)	BBTEGA (371), LRHK (365), MDVERAD (55), LRA (463), DTEVN (403), DLSAHK (645), DLSA (634), DSLSLR (289), DMDSTP (799)
B_EDKVS2	AUS	DKVS (476)	BBTEGA (371), DLSAHK (645), DSLSLR (289), MDVERAD (55), LRHK (365), LRA (463), DLSA (634), DMDSTP (799)
B_EDMTG	LOK	DDMTL (411)	
B_EDMTK	LOK	DDMTL (411)	
B_EDMTKS	LOK	DDMTL (411)	
B_EDMTKSNM	AUS	DDMTL (411)	
B_EDP	LOK	MDFAW (31)	
B_EDSL	AUS	GGDSAS (131)	
B_EDSUU	LOK	GGDSAS (131)	
B_EEV	AUS	DEVE (835)	LREB (328), MDVERAD (55), DMDSTP (799)
B_EFRAO	LOK	DKVS (476)	
B_EFRAO2	LOK	DKVS (476)	
B_EFRAU	LOK	DKVS (476)	
B_EFRAU2	LOK	DKVS (476)	
B_EGGLDP	LOK	DLDP (404)	
B_EGSCOK	AUS	CANEGS (723)	LLRNS (84), OBDSV (862)
B_EGSNEW	AUS	CANEGS (723)	DCGE (726), DGLOR (747)
B_EHFM	AUS	DHFM (108)	EGFE (104)
B_EINLDP	LOK	DLDP (404)	
B_EKATS	DOK	DKAT (310)	
B_EKATS2	DOK	DKAT (310)	
B_EKP	AUS	AEKP (204)	
B_EKPD	LOK	AEKP (204)	
B_EKPN	LOK	AEKP (204)	
B_EKPUBN	LOK	AEKP (204)	
B_EKPVL	LOK	AEKP (204)	
B_ELSD	LOK	MDFAW (31)	
B_ENFMST	LOK	DLSAHK (645)	
B_ENLASH	LOK	DLSAHK (645)	
B_ENLASH2	LOK	DLSAHK (645)	
B_ENRINH	LOK	GGLSH (599)	
B_ENRINH2	LOK	GGLSH (599)	
B_ENRINV	LOK	GGLSV (588)	
B_ENRINV2	LOK	GGLSV (588)	
B_ENWS	AUS	DNWS (267)	DKAT (310), DTEVN (403), DLSA (634), DSLSLR (289), DLSVV (625)
B_EOBDLR	EIN		TEBEB (378), DLDP (404), LREB (328)
B_EOBDLR2	LOK	LREB (328)	
B_EPCL	AUS	CANINS (727)	DEPCL (839)
B_ERBR	LOK	GGEGAS (560)	
B_ERDKT	LOK	DKAT (310)	
B_ERDKT2	LOK	DKAT (310)	
B_ERINOFH	LOK	GGLSH (599)	
B_ERINOFH2	LOK	GGLSH (599)	
B_ERINOFV	LOK	GGLSV (588)	
B_ERINOFV2	LOK	GGLSV (588)	
B_ERKAT	LOK	DKVS (476)	
B_ERKAT2	LOK	DKVS (476)	
B_ERKAZ	LOK	DKVS (476)	
B_ERKAZ2	LOK	DKVS (476)	
B_ERROFS	LOK	DSLSLR (289)	
B_ERROFS2	LOK	DSLSLR (289)	
B_ESDIA	AUS	DECJ (813)	
B_ESDMTE	AUS	DDMTL (411)	T2DMTL (941)
B_ESLS	AUS	DSLSLR (289)	DLSH (627), LREB (328), DLSV (609)

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Symbol	Type	Created within	Used within
B_ESNWS	AUS	ESNWS (174)	LRAEB (461)
B_ESTART	EIN		DSTA (709), STA (706)
B_ESTLDP	LOK	DLDP (404)	
B_ESTTXU	AUS	CANTXU (742)	
B_ETHMR	LOK	DTHM (689)	
B_ETHMS	LOK	DTHM (689)	
B_ETOL	AUS	PROKON (878)	GGTFM (674)
B_ETR	AUS	ETR (688)	DETS (834)
B_ETRET	EIN		ETR (688)
B_ETRTAM	LOK	ETR (688)	
B_ETRVFZG	LOK	ETR (688)	
B_ETUM	AUS	GGTFUMG (684)	ATM (302), GGTFM (674), BGTABST (154)
B_EVASEL	AUS	AES (189)	AEVAB (196), DMDSTP (799)
B_EVFZGV1	AUS	CANASR (732)	BBFGR (492), BGVFGR (498)
B_EVLOC	AUS	AES (189)	AEVAB (196), ATEV (402), TEB (380), DSLSLR (289), DLSAHK (645), LREB (328), MDVERAD (55), DMDSTP (799)
B_EZ	AUS	DSTA (709)	STA (706)
B_FA	EIN		BBKHZ (282), SLS (275), LRAEB (461), LRA (463), DTEVN (403), DLSH (627), DLSA (634), DKVS (476), DDMTL (411), DKAT (310), DLDP (404)
B_FAATM	EIN		ATM (302)
B_FADLDP	EIN		DLDP (404)
B_FADMET	EIN		DDMTL (411)
B_FADMTL	AUS	T2DMTL (941)	DDMTL (411), DHDMTE (440)
B_FADMTLE	EIN		T2DMTL (941)
B_FADMTLP	LOK	DHDMTE (440)	
B_FADMTLS	LOK	T2DMTL (941)	
B_FADTLBE	LOK	T2DMTL (941)	
B_FAETR	EIN		ETR (688)
B_FAEVZ	EIN		AES (189), AEVAB (196)
B_FAKAT	LOK	DKAT (310)	
B_FAKAT2	LOK	DKAT (310)	
B_FAKVS	EIN		DKVS (476), LRA (463), LRAEB (461)
B_FALLS	EIN		BBSAWE (71), CANDME (718), LLRNS (84)
B_FALLSA	AUS	LLRNS (84)	
B_FALR	EIN		LREB (328)
B_FALRA	EIN		LRAEB (461)
B_FALSH	EIN		LAMKO (268), LRHK (365), DLSH (627)
B_FALSH2	EIN		DLSH (627), LAMKO (268), LRHK (365)
B_FAMLS	EIN		MLS (695)
B_FANWH	AUS	WNWTST (267)	
B_FANWHST	EIN		WNWTST (267)
B_FANWHST2	EIN		WNWTST (267)
B_FANWS	EIN		WNWTST (267)
B_FANWSD	EIN		WNWTST (267)
B_FANWTST	AUS	WNWTST (267)	WNWEIN (254)
B_FASH	EIN		DLSAHK (645)
B_FASH2	EIN		DLSAHK (645)
B_FASLA	AUS	SLS (275)	BBKHZ (282), KHMD (287), DSLSLR (289), LAMKO (268)
B_FASLARQ	AUS	SLS (275)	DSLSLR (289)
B_FASLS	EIN		DSLSLR (289), SLS (275)
B_FATES	EIN		DTEVN (403)
B_FATP	EIN		DLSA (634)
B_FATP2	EIN		DLSA (634)
B_FATV	EIN		DLSA (634)
B_FATV2	EIN		DLSA (634)
B_FBLDP	EIN		DLDP (404)
B_FBLDPW	EIN		DLDP (404)
B_FBM	EIN		DDG (568)
B_FCMCLR	EIN		DDMMVE (830), OBDSV (862)
B_FEDMMV	LOK	DDMTL (411)	
B_FEDMPM	LOK	DDMTL (411)	
B_FEDMTL	LOK	DDMTL (411)	
B_FEDMTZ	LOK	DDMTL (411)	
B_FGR	AUS	MDFAW (31)	BBACC (759), UFUE (890), UFFGRC (900), MDZUL (45), FGRMD (499), FGRAUS (511), DUF (932), BBFGR (492)
B_FGRAB	AUS	BBFGR (492)	UFFGRE (902)
B_FGRABZ	AUS	BGVFGR (498)	BBFGR (492)
B_FGRAEXT	LOK	BBFGR (492)	
B_FGRAI	AUS	BBFGR (492)	BBACC (759)
B_FGRAKT	LOK	FGRMD (499)	
B_FGRAL	EIN		BBACC (759), BBFGR (492)
B_FGRARI	LOK	FGRAUS (511)	
B_FGRARS	LOK	BBFGR (492)	
B_FGRAS	AUS	BBFGR (492)	BBACC (759), FGRAUS (511)
B_FGRAT	AUS	GGMFL (490)	BBACC (759), BBFGR (492), CANDME (718), UFFGRE (902)
B_FGRDVI	LOK	FGRMD (499)	
B_FGREN	EIN		BBACC (759), BBFGR (492), UFFGRE (902), MDFAW (31), FGRAUS (511)
B_FGRENE	AUS	FGRMD (499)	
B_FGRENV	AUS	BBFGR (492)	FGRMD (499)
B_FGREN_UM	AUS	UFFGRE (902)	UFFGRC (900)

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Symbol	Type	Created within	Used within
B_FGRES	LOK	BBFGR (492)	
B_FGRESV	AUS	BBFGR (492)	FGRMD (499)
B_FGRHE	AUS	GGMFL (490)	BBFGR (492), CANDME (718)
B_FGRHSA	AUS	GGMFL (490)	BBACC (759), UFFGRE (902), FGRMD (499), CANINS (727), BBFGR (492)
B_FGRKF	EIN		BBFGR (492)
B_FGRKFM	AUS	FGRMD (499)	BBACC (759)
B_FGRRA	LOK	FGRMD (499)	
B_FGRTBE	AUS	GGMFL (490)	BBFGR (492), UFFGRE (902), CANDME (718), FGRMD (499)
B_FGRTSE	AUS	GGMFL (490)	BBACC (759), BBFGR (492), FGRMD (499), CANDME (718)
B_FGRTVE	AUS	GGMFL (490)	BBFGR (492), FGRMD (499), UFFGRE (902), CANDME (718)
B_FGRTWA	AUS	GGMFL (490)	BBACC (759), UFFGRE (902), FGRMD (499), CANDME (718), BBFGR (492)
B_FGRVEM	AUS	FGRMD (499)	BBACC (759)
B_FGRVER	EIN		FGRAUS (511)
B_FGR_UM	AUS	UFFGRC (900)	UFUE (890), BBFGR (492), DUF (932)
B_FHZ	EIN		LLRNS (84)
B_FIL	EIN		BGMDLM (44), LLRBB (81), MDKOG (40), MDFAW (31)
B_FKMSMN	AUS	BGMSZS (111)	DEGFE (116)
B_FKMSMX	AUS	BGMSZS (111)	DEGFE (116)
B_FKPVMN	AUS	BGMSZS (111)	DEGFE (116)
B_FKPVMX	AUS	BGMSZS (111)	DEGFE (116)
B_FODO	LOK	DMDFON (772)	
B_FODON	LOK	DMDFON (772)	
B_FOF	DOK	DMDFON (772)	
B_FOFSTP	EIN		DMDFON (772), DMDSTP (799)
B_FOF_M	EIN		ZNDAUS (215), DMDFON (772)
B_FOHE	LOK	DMDFON (772)	
B_FOHOLD	LOK	DMDFON (772)	
B_FOLUNW	LOK	DMDFON (772)	
B_FON	DOK	DMDFON (772)	
B_FONSTP	EIN		DMDFON (772), DMDSTP (799)
B_FONTM	LOK	DMDFON (772)	DMDSTP (799)
B_FON_M	LOK	DMDFON (772)	
B_FOR	DOK	DMDFON (772)	
B_FOR11	LOK	DMDFON (772)	
B_FOR12	LOK	DMDFON (772)	
B_FOR13	LOK	DMDFON (772)	
B_FOR21	LOK	DMDFON (772)	
B_FOR22	LOK	DMDFON (772)	
B_FOR23	LOK	DMDFON (772)	
B_FOR31	LOK	DMDFON (772)	
B_FOR32	LOK	DMDFON (772)	
B_FOR33	LOK	DMDFON (772)	
B_FOR41	LOK	DMDFON (772)	
B_FOR42	LOK	DMDFON (772)	
B_FOR43	LOK	DMDFON (772)	
B_FOR51	LOK	DMDFON (772)	
B_FOR52	LOK	DMDFON (772)	
B_FOR53	LOK	DMDFON (772)	
B_FOR61	LOK	DMDFON (772)	
B_FOR62	LOK	DMDFON (772)	
B_FOR63	LOK	DMDFON (772)	
B_FOR71	LOK	DMDFON (772)	
B_FOR72	LOK	DMDFON (772)	
B_FOR73	LOK	DMDFON (772)	
B_FOR81	LOK	DMDFON (772)	
B_FOR82	LOK	DMDFON (772)	
B_FOR83	LOK	DMDFON (772)	
B_FORDO	DOK	DMDFON (772)	
B_FORDO_M	LOK	DMDFON (772)	
B_FORN	DOK	DMDFON (772)	
B_FORN01	LOK	DMDFON (772)	
B_FORN02	LOK	DMDFON (772)	
B_FORN03	LOK	DMDFON (772)	
B_FORN04	LOK	DMDFON (772)	
B_FORN05	LOK	DMDFON (772)	
B_FORN06	LOK	DMDFON (772)	
B_FORN07	LOK	DMDFON (772)	
B_FORN08	LOK	DMDFON (772)	
B_FORN_M	LOK	DMDFON (772)	
B_FORSET	LOK	DMDFON (772)	
B_FORUN	LOK	DMDFON (772)	
B_FOR_M	LOK	DMDFON (772)	
B_FOS	LOK	DMDFON (772)	
B_FOXFG	LOK	DMDFON (772)	
B_FPRAKT	LOK	BGDVE (534)	
B_FPRRDY	LOK	BGDVE (534)	
B_FPRZAB	AUS	BGDVE (534)	SREAKT (931)
B_FPRZE	LOK	BGDVE (534)	
B_FPRZOK	LOK	BGDVE (534)	
B_FPRZVB	LOK	BGDVE (534)	

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Symbol	Type	Created within	Used within
B_FPULS	LOK	DLDP (404)	
B_FPWDKAP	AUS	PROKON (878)	FUEDK (149)
B_FRAB	AUS	LR (338)	
B_FRAB2	AUS	LR (338)	
B_FRAO	AUS	LRA (463)	BBTEGA (371), DKVS (476), DTEVN (403)
B_FRAOAN	AUS	BBTEGA (371)	TEBEB (378)
B_FRAOR	AUS	LRA (463)	
B_FRAOR2	AUS	LRA (463)	
B_FRAU	AUS	LRA (463)	DKVS (476), DTEVN (403)
B_FRAUR	AUS	LRA (463)	DKVS (476)
B_FRAUR2	AUS	LRA (463)	DKVS (476)
B_FRINI	AUS	LRINI (352)	LR (338), GKRA (327)
B_FRINI2	AUS	LRINI (352)	LR (338)
B_FRMAX	AUS	LR (338)	TEB (380)
B_FRMAX2	AUS	LR (338)	TEB (380)
B_FRMIN	AUS	LR (338)	TEB (380)
B_FRMIN2	AUS	LR (338)	TEB (380)
B_FRMINI	LOK	LR (338)	
B_FRMINI2	LOK	LR (338)	
B_FRMLASH	LOK	DLSAHK (645)	
B_FRMLASH2	LOK	DLSAHK (645)	
B_FRSP	LOK	LR (338)	
B_FRSP2	LOK	LR (338)	
B_FRSTE	LOK	DKVS (476)	
B_FRSTE2	LOK	DKVS (476)	
B_FRZDH	EIN		DLDP (404)
B_FS	AUS	CANEGS (723)	BBACC (759), SLS (275), MDWAN (61), MDVERAD (55), LLRNS (84), LLRMR (92), LLRBB (81), BGLBZ (99), BBKHZ (282)
B_FSLR	LOK	LREB (328)	
B_FSLR2	LOK	LREB (328)	
B_FSTCANOK	AUS	CANINS (727)	DFSTT (449)
B_FSTCLR	LOK	DFSTT (449)	
B_FSTDAKT	LOK	DFSTT (449)	
B_FSTDMN	AUS	GGFSTT (443)	DDMTL (411), HDMTL (442)
B_FSTDMX	AUS	GGFSTT (443)	DDMTL (411)
B_FSTDY	LOK	GGFSTT (443)	
B_FSTINI	LOK	DFSTT (449)	
B_FSTLOWR	LOK	DFSTT (449)	
B_FSTSIGF	LOK	DFSTT (449)	
B_FSTSTA	LOK	GGFSTT (443)	
B_FSTTAB	LOK	DFSTT (449)	
B_FSTTD	AUS	DFSTT (449)	
B_FSTTDEN	LOK	DFSTT (449)	
B_FSTTEW	LOK	GGFSTT (443)	
B_FSTTG	AUS	GGFSTT (443)	DDMTL (411), HDMTL (442)
B_FSTTIN	AUS	DFSTT (449)	
B_FSTTSH	AUS	GGFSTT (443)	DFSTT (449)
B_FSTTVAL	AUS	GGFSTT (443)	DFSTT (449)
B_FSTTZU	LOK	DFSTT (449)	
B_FSU	DOK	MDWAN (61)	
B_FTDSL	AUS	GGDSAS (131)	
B_FTDSU	AUS	GGDSAS (131)	
B_FTDSVLU	AUS	GGDSAS (131)	
B_FTEDAB	EIN		TEBEB (378)
B_FTLSV	AUS	DLSV (609)	
B_FTLSV2	AUS	DLSV (609)	
B_FTTHM	AUS	DTHM (689)	
B_FTV	EIN		DNWS (267), WNWTST (267)
B_FTV2	EIN		DNWS (267), WNWTST (267)
B_GA	LOK	DLDP (404)	
B_GAE	AUS	DKVS (476)	BBTEGA (371), GKEB (325), DLDP (404)
B_GAE2	EIN		GKEB (325)
B_GAEFRA	AUS	DKVS (476)	BBTEGA (371)
B_GAEFRA2	AUS	DKVS (476)	BBTEGA (371)
B_GAEING	EIN		DLSAHK (645), DKVS (476)
B_GAEING2	EIN		DLSAHK (645), DKVS (476)
B_GANGOK	LOK	DKUPPL (561)	
B_GAP	AUS	BBTEGA (371)	GKEB (325), LRAEB (461), DLDP (404)
B_GASP	AUS	LRAEB (461)	BBTEGA (371), DLSA (634), GKEB (325)
B_GASP2	EIN		DLSA (634)
B_GLF	LOK	GGPED (513)	
B_GLVNM	LOK	DDMTL (411)	
B_GOT	AUS	CANEGS (723)	ETR (688), MSMD (80)
B_GRDST	EIN		BBTEGA (371)
B_GTS	AUS	CANEGS (723)	BGMIGS (69)
B_GWHS	AUS	BBGANG (70)	BBFGR (492)
B_GWRTE	LOK	TEB (380)	
B_HAG	AUS	GGDSAS (131)	BBKHZ (282), DSLSLR (289), DDMTL (411)
B_HDC	AUS	CANASR (732)	BBFGR (492)
B_HDCA	LOK	CANASR (732)	
B_HDMTL	AUS	HDMTL (442)	DHDMTE (440)
B_HDMTTP	LOK	DHDMTE (440)	

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Symbol	Type	Created within	Used within
B_HFM	AUS	DHFM (108)	BGMSZS (111), UFRLC (909), DUF (932), BGSRM (118), EGFE (104)
B_HFMI	LOK	BGMSZS (111)	
B_HFMV	LOK	BGMSZS (111)	
B_HGSNDY	AUS	MDIHGS (68)	
B_HIRCALC	AUS	DGLOR (747)	
B_HOLP1	LOK	GGPED (513)	
B_HOLP1A	LOK	GGPED (513)	
B_HOLP1L	LOK	GGPED (513)	
B_HOLP2	LOK	GGPED (513)	
B_HOLP2A	LOK	GGPED (513)	
B_HOLP2L	LOK	GGPED (513)	
B_HOP1MN	LOK	GGPED (513)	
B_HOP2MN	LOK	GGPED (513)	
B_HOPAKT	LOK	GGPED (513)	
B_HSHE	AUS	HLS (582)	DHLS (666), DLSH (627)
B_HSHE2	AUS	HLS (582)	DHLS (666), DLSH (627)
B_HSHMX	LOK	HLS (582)	
B_HSHMX2	LOK	HLS (582)	
B_HSRDY	AUS	DIMC (857)	
B_HST	AUS	ESSTT (162)	ESNST (166), ESVST (160)
B_HSVE	AUS	HLS (582)	DHLS (666), DLSV (609)
B_HSVE2	AUS	HLS (582)	DHLS (666), DLSV (609)
B_HSVMX	LOK	HLS (582)	
B_HSVMX2	LOK	HLS (582)	
B_IFLSD	LOK	MDFAW (31)	
B_IKLREST	DOK	ADVE (548)	
B_IKLSTAR	DOK	ADVE (548)	
B_ILMLKAT	AUS	LRKA (353)	
B_ILMLKAT2	AUS	LRKA (353)	
B_IMLKVSE	LOK	DKVS (476)	
B_IMLPRINI	LOK	BBKHZ (282)	
B_INI	EIN		MDWAN (61)
B_INIAR	LOK	ARMD (63)	
B_INIFRM	LOK	LR (338)	
B_INIFRM2	LOK	LR (338)	
B_INS2COK	AUS	CANINS (727)	BGKMST (861), BGTABST (154)
B_INS2NEW	AUS	CANINS (727)	DCINS (728)
B_INS3COK	AUS	CANINS (727)	BGTABST (154), GGTFUMG (684), GGAIRB (730)
B_INS3NEW	AUS	CANINS (727)	DCINS (728)
B_INT	LOK	LR (338)	
B_INT2	LOK	LR (338)	
B_INTZWV	DOK	BGMDLM (44)	
B_ISOPROT	EIN		TC9MOD (872)
B_J_SKA	AUS	UFEING (891)	UFMVER (905), UFRLC (909), UFREAC (898), UFUE (890)
B_J_SKA_FR	AUS	SREAKT (931)	CANDME (718), UFEING (891), UFUE (890)
B_J_SKA_UM	AUS	UFMVER (905)	UFNC (906), UFRLC (909), UFZWC (913), URADCC (923), UFUE (890), UFSPSC (913), UFREAC (898), ADVE (548), AEVAB (196), CANDME (718), BGDVE (534), SREAKT (931), DUF (932)
B_KATFZ	AUS	PROKON (878)	BBKHZ (282), DIMC (857)
B_KATH	AUS	PROKON (878)	DIMC (857)
B_KATRDY	AUS	DIMC (857)	
B_KAWE	LOK	LRKA (353)	
B_KAWE2	LOK	LRKA (353)	
B_KD	AUS	GGPED (513)	CANDME (718)
B_KFNB	LOK	FGRMD (499)	
B_KFNV	LOK	FGRMD (499)	
B_KH	AUS	BBKHZ (282)	ATM (302), BBSAWE (71), DTEVN (403), DMDLU (761), LAMKO (268), SLS (275), MDKOG (40), KHMD (287)
B_KHA	AUS	BBKHZ (282)	DSLSLR (289), SLS (275)
B_KHAB	AUS	BBKHZ (282)	SLS (275)
B_KHARES	LOK	BBKHZ (282)	
B_KHASET	LOK	BBKHZ (282)	
B_KHERR	LOK	BBKHZ (282)	
B_KHLL	LOK	BBKHZ (282)	
B_KHLLE	LOK	BBKHZ (282)	
B_KHLLMX	LOK	BBKHZ (282)	
B_KHN	LOK	BBKHZ (282)	
B_KHRES	LOK	BBKHZ (282)	
B_KHSET	LOK	BBKHZ (282)	
B_KHSTC	LOK	BBKHZ (282)	
B_KHZWE	LOK	MDKOG (40)	
B_KL	AUS	EGKE (216)	KRKE (219), KRDY (237), KRRA (227)
B_KL15	EIN		ADVE (548), ALE (710), BGNLDSC (578), CANDME (718), DCACC (755), DCGE (726), DCTXU (745), DCINS (728), WNWEIN (254), UETM (687), STA (706), MOTAUS (576), GGTFUMG (684), GGFSTT (443), DSTS (708), DSTA (709), DGLOR (747), DDMTL (411), DDMPME (828), DDMMVE (830), DCAS (739), BGLBZ (99)
B_KLDYNRM	DOK	KRDY (237)	
B_KLDYSTK	DOK	KRDY (237)	
B_KMMIL	AUS	DMIL (860)	BGKMST (861)
B_KO	AUS	CANINS (727)	DTEVN (403), KOS (698)

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Symbol	Type	Created within	Used within
B_KOE	AUS	KOS (698)	BBSAWE (71), MDVERB (52), MDVERAD (55), DKOSE (816), DMLSE (818), DMDSTP (799)
B_KOENA	LOK	KOS (698)	
B_KOGER	AUS	CANINS (727)	MDVERB (52)
B_KOMNOFF	LOK	KOS (698)	
B_KOMNON	LOK	KOS (698)	
B_KOMXOFF	LOK	KOS (698)	
B_KOOFF	LOK	KOS (698)	
B_KOSTA	LOK	KOS (698)	
B_KR	AUS	KRRA (227)	EGKE (216), KRKE (219), ZWGRU (208), GGKS (218)
B_KRA	LOK	KRRA (227)	
B_KRDWS	AUS	DKRS (242)	EGKE (216), KRRA (227), ZWGRU (208)
B_KRFV	LOK	KRRA (227)	
B_KRLDY	AUS	KRDY (237)	DKRS (242), KRKE (219), EGKE (216), KRRA (227), GGKS (218)
B_KRLDYA	AUS	KRDY (237)	KRRA (227)
B_KRLDYF	LOK	KRDY (237)	
B_KRNDY	AUS	KRDY (237)	DKRS (242), KRRA (227), EGKE (216), KRKE (219), GGKS (218)
B_KRVF	LOK	KRRA (227)	
B_KSE	AUS	ESKS (172)	LREB (328)
B_KSTEBF	EIN		AEKP (204)
B_KUPPL	AUS	GGEGAS (560)	ARMD (63), BBFGR (492), BBSAWE (71), LLRNS (84), MDKOG (40), SLS (275), MDFAW (31), LLRBB (81), BBKURU (67), DMDSTP (799)
B_KUPPLV	AUS	GGEGAS (560)	
B_KURN	AUS	BBKURU (67)	ARMD (63)
B_KURP	AUS	BBKURU (67)	ARMD (63)
B_KVBD	LOK	DFSTT (449)	
B_KVSFFL	LOK	DKVS (476)	
B_KVTA	AUS	BGKV (459)	DFSTT (449)
B_KW	AUS	BBKHZ (282)	ATM (302), DTEVN (403), MDKOG (40), KHMD (287)
B_LALGF	AUS	LAMKO (268)	
B_LALGF2	AUS	LAMKO (268)	
B_LAMBTS	LOK	LAMKO (268)	
B_LAMBTS2	LOK	LAMKO (268)	
B_LAMEND	LOK	DLSAHK (645)	
B_LAMEND2	LOK	DLSAHK (645)	
B_LAMKA	EIN		TEBEB (378), LAMKO (268)
B_LAMKA2	EIN		TEBEB (378), LAMKO (268)
B_LAMLASH	EIN		LAMKO (268), DLSAHK (645)
B_LAMLASH2	EIN		LAMKO (268), DLSAHK (645)
B_LAMNSE	AUS	ESNST (166)	LAMKO (268)
B_LAMNSWL	LOK	LAMKO (268)	
B_LAMSDEF	AUS	LAMKO (268)	TEBEB (378)
B_LAMVERG	LOK	DLSAHK (645)	
B_LAMVERG2	LOK	DLSAHK (645)	
B_LCLMOD5	LOK	DLSSA (654)	
B_LCLMOD52	LOK	DLSSA (654)	
B_LDEF	LOK	LAMKO (268)	
B_LDEF2	LOK	LAMKO (268)	
B_LDPABB	LOK	DLDP (404)	
B_LDPEIN	LOK	DLDP (404)	
B_LDPENA	LOK	DLDP (404)	
B_LDPF1	LOK	DLDP (404)	
B_LDPF2	LOK	DLDP (404)	
B_LDPF3	LOK	DLDP (404)	
B_LDPF4	LOK	DLDP (404)	
B_LDPF5	LOK	DLDP (404)	
B_LDPF6	LOK	DLDP (404)	
B_LDPP	EIN		DLDP (404)
B_LDPSTP	LOK	DLDP (404)	
B_LDRUGD	AUS	FUEDK (149)	
B_LL	AUS	MDFAW (31)	MSF (30), ARMD (63), BBSAWE (71), BBTEGA (371), BGRLP (125), EGFE (104), DTHM (689), DTEVN (403), DMDLU (761), DMDFLU (812), DLLR (94), COSA (193), CANDME (718), WNWEIN (254), SLS (275), LLRBB (81), LLRABG (100), KRDY (237), GKRA (327), GGTFA (681), ESWE (174), ESUK (175), ESNWS (174), MDMIN (51), MDKOG (40), LREB (328), LLRNS (84), LLRMR (92), BGLBZ (99), BBKHZ (282), BBLOR (746)
B_LLDIA	LOK	DLLR (94)	
B_LLR	AUS	LLRBB (81)	DLLR (94), MDVERAD (55), LLRRM (88), LLRMD (83)
B_LLREIN	AUS	LLRBB (81)	LLRMD (83), LLRNS (84), LLRRM (88), MDKOL (48), MDVERAD (55), ZUE (206), STMD (60), MDVER (53), MDKOG (40), MDMIN (51)
B_LLRI	AUS	LLRBB (81)	LLRRM (88), LLRMD (83)
B_LLRIMX	LOK	LLRRM (88)	
B_LLRPD	AUS	LLRBB (81)	LLRRM (88), LLRMD (83)
B_LMSSLOF	AUS	SLS (275)	BBKHZ (282)
B_LORCALC	AUS	DGLOR (747)	BBLOR (746)
B_LORPLAUS	AUS	DGLOR (747)	
B_LOWR	AUS	CANTXU (742)	PROKON (878), BBLOR (746), DGLOR (747)

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Symbol	Type	Created within	Used within
B_LOWRA	AUS	BBLOR (746)	BBFGR (492), DLSA (634), DLSAHK (645), LRAEB (461), LLRNS (84), GGMFL (490), DVFZ (581), DTHM (689), DTEVN (403), DSLSLR (289), DLSV (609), DLLR (94), VMAXMD (78), NMAXMD (76), MDFAW (31), BBSAWE (71), DFSTT (449), DKAT (310), DHLS (666), DDMTL (411), DLSH (627), DMDSTP (799)
B_LOWRAPP	AUS	BBLOR (746)	
B_LR	AUS	GKEB (325)	LREB (328), BBTEGA (371), DLSA (634), DLSVV (625), LR (338), TEB (380), TEBEB (378), LRHK (365), LRAEB (461), DTEVN (403), DLSV (609), DKVS (476), GKRA (327)
B_LR2	AUS	GKEB (325)	LREB (328), BBTEGA (371), DKVS (476), DLSA (634), LRHK (365), TEBEB (378), TEB (380), DLSVV (625), DLSV (609), LR (338), LRAEB (461), GKRA (327)
B_LR2S	LOK	LREB (328)	
B_LR2S2	LOK	LREB (328)	
B_LRA	AUS	GKEB (325)	LRAEB (461), DKVS (476), LRA (463), GKRA (327)
B_LRA2	AUS	GKEB (325)	LRAEB (461), DKVS (476), LRA (463), GKRA (327)
B_LRAR	AUS	TEB (380)	LRA (463)
B_LRARE	AUS	LRA (463)	DKVS (476)
B_LRARE2	AUS	LRA (463)	DKVS (476)
B_LRAREB	LOK	LRA (463)	
B_LREB100	LOK	LREB (328)	
B_LREBLE	LOK	LREB (328)	
B_LREBLE2	LOK	LREB (328)	
B_LREBPR	EIN		LREB (328)
B_LREBPR2	EIN		LREB (328)
B_LREBRI	LOK	LREB (328)	
B_LREBRI2	LOK	LREB (328)	
B_LRHK	AUS	LRHK (365)	DLSA (634), DLSSA (654), DLSH (627), DLSAHK (645)
B_LRHK2	AUS	LRHK (365)	DLSA (634), DLSSA (654), DLSH (627), DLSAHK (645)
B_LRHKB	LOK	LRHK (365)	
B_LRHKB2	LOK	LRHK (365)	
B_LRHKG	LOK	LRHK (365)	
B_LRHKGI	LOK	LRHK (365)	
B_LRHKP	LOK	LRHK (365)	
B_LRHKP2	LOK	LRHK (365)	
B_LRKA	AUS	LRKA (353)	LRHK (365), GKRA (327)
B_LRKA2	AUS	LRKA (353)	LRHK (365), GKRA (327)
B_LRKAA	LOK	LRKA (353)	
B_LRKAA2	LOK	LRKA (353)	
B_LRKAE	LOK	LRKA (353)	
B_LRKAE2	LOK	LRKA (353)	
B_LRKAEI	LOK	LRKA (353)	
B_LRKAEI2	LOK	LRKA (353)	
B_LRKAON	LOK	LRKA (353)	
B_LRKARG	LOK	LRKA (353)	
B_LRKARG2	LOK	LRKA (353)	
B_LRKAST	EIN		LREB (328), LRKA (353)
B_LRKAST2	EIN		LREB (328), LRKA (353)
B_LRNAKT	LOK	BGDVE (534)	
B_LRND	AUS	GKEB (325)	LREB (328), LR (338), LRINI (352), GKRA (327)
B_LRND2	AUS	GKEB (325)	LREB (328), LR (338), LRINI (352), GKRA (327)
B_LRNDA	AUS	LREB (328)	DSLSLR (289), ESWL (171)
B_LRNDA2	AUS	LREB (328)	DSLSLR (289), ESWL (171)
B_LRNDIA	EIN		BGDVE (534)
B_LRNERF	LOK	BGDVE (534)	
B_LRNFG	LOK	BGDVE (534)	
B_LRNRDY	AUS	BGDVE (534)	ADVE (548)
B_LRNTESA	LOK	BGDVE (534)	
B_LRNVB	LOK	BGDVE (534)	
B_LRNWS	EIN		EEDAT (943), BGDVE (534)
B_LRPSPA	LOK	LREB (328)	
B_LRRL	LOK	LREB (328)	
B_LRSP	AUS	LR (338)	LRHK (365)
B_LRSP2	AUS	LR (338)	LRHK (365)
B_LRSSA	EIN		TEBEB (378)
B_LRSSA2	EIN		TEBEB (378)
B_LRSTAT	AUS	LR (338)	
B_LRSTAT2	AUS	LR (338)	
B_LRSTTA	AUS	LR (338)	
B_LRSTTA2	AUS	LR (338)	
B_LRTPP	AUS	LR (338)	DLSA (634), DLSSA (654)
B_LRTPP2	AUS	LR (338)	DLSA (634), DLSSA (654)
B_LRVK	LOK	LREB (328)	
B_LRVK2	LOK	LREB (328)	
B_LRWLA	LOK	LREB (328)	
B_LS	LOK	MDFAW (31)	
B_LSADS	LOK	DLSV (609)	
B_LSADS2	LOK	DLSV (609)	
B_LSAHKSP	LOK	DLSAHK (645)	
B_LSAHKSP2	LOK	DLSAHK (645)	
B_LSASTP	LOK	DLSA (634)	
B_LSASTP2	LOK	DLSA (634)	

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Symbol	Type	Created within	Used within
B_LSD	EIN		MDKOG (40), MDFAW (31)
B_LSFET	LOK	DLSV (609)	
B_LSFET2	LOK	DLSV (609)	
B_LSH	AUS	PROKON (878)	GGLSH (599)
B_LSH2	AUS	PROKON (878)	GGLSH (599)
B_LSHUB	LOK	DLSV (609)	
B_LSHUB2	LOK	DLSV (609)	
B_LSRDY	AUS	DIMC (857)	
B_LSV	AUS	PROKON (878)	GGLSV (588)
B_LSV2	AUS	PROKON (878)	GGLSV (588)
B_LSVKLT	LOK	DLSV (609)	
B_LSVKLT2	LOK	DLSV (609)	
B_LSVN	LOK	DLSV (609)	
B_LSVN2	LOK	DLSV (609)	
B_LSVVSP	AUS	DLSVV (625)	LRA (463), LREB (328)
B_LUAERK	AUS	DMDLUA (770)	DMDLAD (799)
B_LUAERK_M	LOK	DMDLUA (770)	
B_LUENA	LOK	DMDSTP (799)	
B_LUERK	AUS	DMDLU (761)	DMDLAD (799)
B_LUERK_M	LOK	DMDLU (761)	
B_LUSTOP	EIN		DMDDLU (766), DMDLUA (770), DMDLU (761), DMDMIL (800), DMD-STP (799)
B_LUSTOPU	LOK	DMDSTP (799)	
B_M8TE	AUS	TC8MOD (872)	
B_M9CVN	AUS	TC9MOD (872)	
B_MADFK	LOK	MDVERAD (55)	
B_MADFS	LOK	MDVERAD (55)	
B_MADKO	LOK	MDVERAD (55)	
B_MADLL	LOK	MDVERAD (55)	
B_MADSTP	LOK	MDVERAD (55)	
B_MASO	LOK	DLSV (609)	
B_MASO2	LOK	DLSV (609)	
B_MASTER	EIN		DMDDLU (766), DMDLU (761), DMDUE (760)
B_MAXFLR	LOK	DLDP (404)	
B_MAXFLSH	LOK	DLSH (627)	
B_MAXFLSH2	LOK	DLSH (627)	
B_MAXFLSV	LOK	DLSV (609)	
B_MAXFLSV2	LOK	DLSV (609)	
B_MAXLASH	LOK	DLSAHK (645)	
B_MAXLASH2	LOK	DLSAHK (645)	
B_MCACTI	LOK	VS_VERST (714)	
B_MDACC	AUS	CANACC (752)	BBACC (759), DACC (756), UFFGRC (900)
B_MDARV	AUS	DMDMIL (800)	DKAT (310), DLSA (634), DLSAHK (645), DTEVN (403), LRAEB (461), LRHK (365), MDVERAD (55), DSLSLR (289), DMDSTP (799)
B_MDASC	AUS	CANDME (718)	
B_MDDRLA	LOK	DMDSTP (799)	
B_MDEE	LOK	MDRED (73)	
B_MDEIN	AUS	MDKOG (40)	LLRBB (81), DMDSTP (799)
B_MDERK	AUS	DMDLAD (799)	DMDFON (772), DMDSTP (799)
B_MDKAT	AUS	DMDMIL (800)	DKAT (310)
B_MDMIN	EIN		LLRRM (88)
B_MDNG	LOK	DMDSTP (799)	
B_MDNMOT	LOK	DMDSTP (799)	
B_MDRL	LOK	DMDSTP (799)	
B_MDSTIM_M	LOK	DMDUE (760)	
B_MDSTOP	EIN		DMDDLU (766), DMDFON (772), DMDMIL (800), DMDLUA (770), DMD-LU (761)
B_MDSTOP_M	EIN		DMDFON (772)
B_MDTNST	LOK	DMDSTP (799)	
B_MDZYL1	DOK	DMDFON (772)	DMDLUA (770)
B_MDZYL1_M	EIN		DMDFLU (812), DMDFON (772), DMDUE (760)
B_MESSE	LOK	DLDP (404)	
B_MF	AUS	EGKE (216)	GGKS (218), KRDY (237), KRKE (219), KRRA (227)
B_MFLAI	AUS	BBACC (759)	GGMFL (490)
B_MFLAL	AUS	BBACC (759)	GGMFL (490)
B_MFLAR	AUS	BBACC (759)	GGMFL (490)
B_MFLAS	AUS	BBACC (759)	GGMFL (490)
B_MFLEN	AUS	BBACC (759)	DACC (756), GGMFL (490)
B_MFLFRQE	EIN		GGMFL (490)
B_MFLNEW	EIN		GGMFL (490)
B_MFL_AUS	EIN		GGMFL (490)
B_MFL_SB	EIN		GGMFL (490)
B_MFL_VER	EIN		GGMFL (490)
B_MFL_WA	EIN		GGMFL (490)
B_MIBEG	AUS	MDKOG (40)	DUF (932), MDKOL (48), MDRED (73)
B_MIBEGDAU	DOK	MDKOG (40)	
B_MIBGR	AUS	MDIHGS (68)	
B_MIEXT	AUS	BGMDLM (44)	ARMD (63)
B_MIL	AUS	DMIL (860)	CANINS (727), DMILE (837)
B_MILBLK	LOK	DMIL (860)	
B_MILFB	EIN		DMIL (860), OBDSV (862)
B_MILMD	AUS	DMDMIL (800)	DMIL (860)

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Symbol	Type	Created within	Used within
B_MILST	LOK	DMIL (860)	
B_MINFLR	LOK	DLDP (404)	
B_MINLASH	LOK	DLSAHK (645)	
B_MINLASH2	LOK	DLSAHK (645)	
B_MIRDMTK	EIN		DDMTL (411)
B_MIZWE	LOK	MDKOG (40)	
B_MLDYN	LOK	DLSAHK (645)	
B_MLRSA	AUS	GKEB (325)	LREB (328), TEBEB (378)
B_MLSU	LOK	BBKHZ (282)	
B_MLUSTEST	LOK	DLSAHK (645)	
B_MNDHDMTE	EIN		DHDMTE (440)
B_MNDK1P	LOK	GGDVE (525)	
B_MNDK2P	LOK	GGDVE (525)	
B_MNDMPME	LOK	DDMPME (828)	
B_MNDMTK	LOK	DDMTL (411)	
B_MNDMTKNM	LOK	DDMTL (411)	
B_MNDMTL	EIN		DDMTL (411)
B_MNDPMEE	EIN		DDMPME (828)
B_MNDSL	AUS	GGDSAS (131)	
B_MNDSU	AUS	GGDSAS (131)	
B_MNDSVLU	AUS	GGDSAS (131)	
B_MNDVER	LOK	ADVE (548)	
B_MNEGFE	AUS	DEGFE (116)	
B_MNETS	AUS	DETS (834)	
B_MNEV1	EIN		DEVE (835)
B_MNEV2	EIN		DEVE (835)
B_MNEV3	EIN		DEVE (835)
B_MNEV4	EIN		DEVE (835)
B_MNEV5	EIN		DEVE (835)
B_MNEV6	EIN		DEVE (835)
B_MNEV7	EIN		DEVE (835)
B_MNEV8	EIN		DEVE (835)
B_MNFP1P	LOK	GGPED (513)	
B_MNFP2P	LOK	GGPED (513)	
B_MNFRAO	LOK	DKVS (476)	
B_MNFRAO2	LOK	DKVS (476)	
B_MNFRAU	LOK	DKVS (476)	
B_MNFRAU2	LOK	DKVS (476)	
B_MNFRST	LOK	DKVS (476)	
B_MNFRST2	LOK	DKVS (476)	
B_MNFST	AUS	DFSTT (449)	GGFSTT (443)
B_MNHSH	AUS	DHLS (666)	
B_MNHSH2	AUS	DHLS (666)	
B_MNHSV	AUS	DHLS (666)	
B_MNHSV2	AUS	DHLS (666)	
B_MNKOS	AUS	DKOSE (816)	
B_MNKPE	EIN		DEKPE (824)
B_MNKS1	AUS	DKRS (242)	
B_MNKS2	AUS	DKRS (242)	
B_MNKS3	AUS	DKRS (242)	
B_MNKS4	AUS	DKRS (242)	
B_MNLASH	AUS	DLSAHK (645)	
B_MNLASH2	AUS	DLSAHK (645)	
B_MNLATP	AUS	DLSA (634)	
B_MNLATP2	AUS	DLSA (634)	
B_MNLATV	AUS	DLSA (634)	
B_MNLATV2	AUS	DLSA (634)	
B_MNLDP	LOK	DLDP (404)	
B_MNLDPE	AUS	DLDPE (409)	
B_MNLLR	AUS	DLLR (94)	
B_MNLM	AUS	DHFM (108)	
B_MNLSV	AUS	DLSV (609)	
B_MNLSV2	AUS	DLSV (609)	
B_MNMD	LOK	DMDMIL (800)	
B_MNMFL	AUS	GGMFL (490)	
B_MNMFLV	DOK	GGMFL (490)	
B_MNMILE	AUS	DMILE (837)	
B_MNMLE	AUS	DMLSE (818)	
B_MNNWS	AUS	DNWS (267)	
B_MNNWS2	AUS	DNWS (267)	
B_MNNWSE	EIN		DNWSE (819)
B_MNPH	AUS	DPH (571)	
B_MNPH2	AUS	DPH (571)	
B_MNRKAT	LOK	DKVS (476)	
B_MNRKAT2	LOK	DKVS (476)	
B_MNRKAZ	LOK	DKVS (476)	
B_MNRKAZ2	LOK	DKVS (476)	
B_MNSLPE	AUS	DSLPE (823)	
B_MNSLS	AUS	DSLSLR (289)	
B_MNSLS2	AUS	DSLSLR (289)	
B_MNSLVE	AUS	DSLVE (821)	
B_MNSTAE	AUS	DSTAE (832)	

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Symbol	Type	Created within	Used within
B_MNTA	AUS	GGTFA (681)	
B_MNTESB	LOK	DLDP (404)	
B_MNTESK	LOK	DLDP (404)	
B_MNTEVE	AUS	DTEVE (826)	
B_MNTHM	AUS	DTHM (689)	
B_MNTKA	AUS	GGTKA (683)	
B_MNTM	AUS	GGTFM (674)	
B_MNU5REF	AUS	DU5REF (673)	
B_MNUB	AUS	GGUB (671)	
B_MSFSLR	LOK	LREB (328)	
B_MSFSLR2	LOK	LREB (328)	
B_MSLMIN	LOK	DSLSLR (289)	
B_MSLMIN2	LOK	DSLSLR (289)	
B_MSLMN	AUS	DSLSLR (289)	SLS (275)
B_MSLOFF	AUS	SLS (275)	BBKHZ (282)
B_MSLOFS	LOK	DSLSLR (289)	
B_MSLOFS2	LOK	DSLSLR (289)	
B_MSLON	LOK	SLS (275)	
B_MSLPMN	AUS	DSLSLR (289)	
B_MSLPMN2	AUS	DSLSLR (289)	
B_MSLR	LOK	LREB (328)	
B_MSLR2	LOK	LREB (328)	
B_MSMD	AUS	MSMD (80)	
B_MSR	AUS	MDKOG (40)	BGMDLM (44), DUF (932), MDRED (73), MDZUL (45)
B_MSREXT	AUS	CANASR (732)	ARMD (63), DASC (740), UFMSRC (903), BBFGR (492)
B_MXACC	AUS	DACC (756)	
B_MXDHDMTE	EIN		DHDMTE (440)
B_MXDK1P	LOK	GGDVE (525)	
B_MXDK2P	LOK	GGDVE (525)	
B_MXDMPME	LOK	DDMPME (828)	
B_MXDMTK	LOK	DDMTL (411)	
B_MXDMTL	AUS	DDMTL (411)	
B_MXDSL	AUS	GGDSAS (131)	
B_MXDSU	AUS	GGDSAS (131)	
B_MXDSVLU	AUS	GGDSAS (131)	
B_MXDVEF	LOK	BGDVE (534)	
B_MXDVER	LOK	ADVE (548)	
B_MXEGFE	AUS	DEGFE (116)	
B_MXETS	AUS	DETS (834)	
B_MXEV1	EIN		DEVE (835)
B_MXEV2	EIN		DEVE (835)
B_MXEV3	EIN		DEVE (835)
B_MXEV4	EIN		DEVE (835)
B_MXEV5	EIN		DEVE (835)
B_MXEV6	EIN		DEVE (835)
B_MXEV7	EIN		DEVE (835)
B_MXEV8	EIN		DEVE (835)
B_MXFP1P	LOK	GGPED (513)	
B_MXFP2P	LOK	GGPED (513)	
B_MXFRAO	LOK	DKVS (476)	
B_MXFRAO2	LOK	DKVS (476)	
B_MXFRAU	LOK	DKVS (476)	
B_MXFRAU2	LOK	DKVS (476)	
B_MXFRST	LOK	DKVS (476)	
B_MXFRST2	LOK	DKVS (476)	
B_MXFST	AUS	DFSTT (449)	GGFSTT (443)
B_MXHSH	AUS	DHLS (666)	
B_MXHSH2	AUS	DHLS (666)	
B_MXHSV	AUS	DHLS (666)	
B_MXHSV2	AUS	DHLS (666)	
B_MXKAT	AUS	DKAT (310)	
B_MXKAT2	AUS	DKAT (310)	
B_MXKOS	AUS	DKOSE (816)	
B_MXKPE	EIN		DEKPE (824)
B_MXKS1	AUS	DKRS (242)	
B_MXKS2	AUS	DKRS (242)	
B_MXKS3	AUS	DKRS (242)	
B_MXKS4	AUS	DKRS (242)	
B_MXLASH	AUS	DLSAHK (645)	
B_MXLASH2	AUS	DLSAHK (645)	
B_MXLATP	AUS	DLSA (634)	
B_MXLATP2	AUS	DLSA (634)	
B_MXLATV	AUS	DLSA (634)	
B_MXLATV2	AUS	DLSA (634)	
B_MXLDP	LOK	DLDP (404)	
B_MXLDPE	AUS	DLDPE (409)	
B_MXLLR	AUS	DLLR (94)	
B_MXLM	AUS	DHFM (108)	
B_MXLSH	AUS	DLSH (627)	
B_MXLSH2	AUS	DLSH (627)	
B_MXLSV	AUS	DLSV (609)	
B_MXLSV2	AUS	DLSV (609)	

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Symbol	Type	Created within	Used within
B_MXMD	LOK	DMDMIL (800)	
B_MXMDB	AUS	MDKOG (40)	
B_MXMFL	AUS	GGMFL (490)	
B_MXMFLV	DOK	GGMFL (490)	
B_MXMILE	AUS	DMILE (837)	
B_MXMLE	AUS	DMLSE (818)	
B_MXMNTM	AUS	GGTFM (674)	DTHM (689)
B_MXNWSE	EIN		DNWSE (819)
B_MXPH	AUS	DPH (571)	
B_MXPH2	AUS	DPH (571)	
B_MXRKAT	LOK	DKVS (476)	
B_MXRKAT2	LOK	DKVS (476)	
B_MXRKAZ	LOK	DKVS (476)	
B_MXRKAZ2	LOK	DKVS (476)	
B_MXSLPE	AUS	DSLPE (823)	
B_MXSLV	AUS	DSLSLR (289)	
B_MXSLV2	AUS	DSLSLR (289)	
B_MXSLVE	AUS	DSLVE (821)	
B_MXSTAE	AUS	DSTAE (832)	
B_MXSWE	LOK	BGRBS (703)	
B_MXTA	AUS	GGTFA (681)	
B_MXTESB	LOK	DLDP (404)	
B_MXTESK	LOK	DLDP (404)	
B_MXTEVE	AUS	DTEVE (826)	
B_MXTHM	AUS	DTHM (689)	
B_MXTKA	AUS	GGTKA (683)	
B_MXTM	AUS	GGTFM (674)	
B_MXUB	AUS	GGUB (671)	
B_MZNS	LOK	MDZUL (45)	
B_MZNS_UM	AUS	UFNSC (896)	MDZUL (45), UFMZUL (894), UFUE (890)
B_NAC	AUS	KOS (698)	LLRNS (84)
B_NACHL	AUS	MOTAUS (576)	DDMTL (411), MLS (695)
B_NACHLEND	AUS	MOTAUS (576)	AEKP (204)
B_NACHLN	LOK	MLS (695)	
B_NACHLRAM	AUS	MOTAUS (576)	
B_NDSAV	AUS	PROKON (878)	COSA (193), LLRABG (100)
B_NFTEV	EIN		LLRNS (84)
B_NGASOK	AUS	BGNG (565)	
B_NGLMTR	LOK	DDMTL (411)	
B_NIVNS	AUS	LLRNS (84)	
B_NKFL	AUS	DDMTL (411)	
B_NKFLG	AUS	DDMTL (411)	
B_NL10	LOK	MLS (695)	
B_NLACLS	EIN		MOTAUS (576)
B_NLALE	EIN		MOTAUS (576)
B_NLDSC	AUS	BGNLDSC (578)	MOTAUS (576)
B_NLDTE	AUS	DDMTL (411)	DFPMNL (848), MOTAUS (576)
B_NLDTEG	LOK	DDMTL (411)	
B_NLDTEK	LOK	DDMTL (411)	
B_NLEEPR	EIN		MOTAUS (576)
B_NLMLS	EIN		MOTAUS (576)
B_NLOBD	AUS	DFPMNL (848)	MOTAUS (576)
B_NLPE	AUS	ADVE (548)	BGDVE (534)
B_NLPERF	EIN		EEDAT (943), BGDVE (534)
B_NLPERFT	LOK	BGDVE (534)	
B_NLPNE	EIN		SREAKT (931)
B_NLPNEW	LOK	BGDVE (534)	
B_NLPREQ	LOK	BGDVE (534)	
B_NLSGLS	EIN		MOTAUS (576)
B_NLSIKO	EIN		MOTAUS (576)
B_NLWST	EIN		MOTAUS (576), BGTABST (154)
B_NMAX	AUS	NMAXMD (76)	BBACC (759), MDRED (73)
B_NMAXD	EIN		AEVAB (196), NMAXMD (76)
B_NMIN	EIN		AEKP (204), BGNMOT (564), BGTABST (154), GGTFM (674), UETM (687), MOTAUS (576), MLS (695), DDG (568)
B_NMOT	AUS	BGNMOT (564)	ATM (302), GGDSAS (131), GGAIRB (730), ELS (839), DTOP (840), DTHM (689), DSLSLR (289), DCINS (728), DCGE (726), DCAS (739), DCACC (755), BGMSZS (111), BGKMST (861), BBTEGA (371), BBSTT (575), BBKHZ (282), MDFAW (31), KVA (713), HDMTL (442), GGTFM (674), DMIL (860), DLSV (609), DHLS (666), DEPCL (839), DDMTL (411), DCTXU (745), TEB (380), SLS (275), BBPEDBR (579), DLSH (627)
B_NNOT	EIN		LLRNS (84)
B_NNWMX	AUS	WNWEIN (254)	
B_NO	LOK	DTRIG (854)	
B_NOACC_UM	AUS	UFFGRC (900)	DACC (756), DUF (932)
B_NOADV	AUS	WANWKW (257)	
B_NOCINS	AUS	PROKON (878)	
B_NOFRA	AUS	LRA (463)	DKVS (476)
B_NOKATFZ	AUS	KATV (324)	BBKHZ (282), COSA (193), PROKON (878), KHMD (287), GGTFM (674), DMIL (860), DEKON (812)
B_NOLASH	LOK	DLSAHK (645)	

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Symbol	Type	Created within	Used within
B_NOLASH2	LOK	DLSAHK (645)	
B_NOLATP	LOK	DLSA (634)	
B_NOLATP2	LOK	DLSA (634)	
B_NOLATV	LOK	DLSA (634)	
B_NOLATV2	LOK	DLSA (634)	
B_NOLDP	EIN		DLDP (404)
B_NOLLRFLR	LOK	DLLR (94)	
B_NOLRB	LOK	LREB (328)	
B_NOLRB2	LOK	LREB (328)	
B_NOLRE	LOK	LREB (328)	
B_NOLRE2	LOK	LREB (328)	
B_NOLRW	LOK	LREB (328)	
B_NOLRW2	LOK	LREB (328)	
B_NOLSH	AUS	DLSH (627)	
B_NOLSH2	AUS	DLSH (627)	
B_NOLSV	LOK	DLSV (609)	
B_NOLSV2	LOK	DLSV (609)	
B_NOMILKL	LOK	DDMTL (411)	
B_NOMSR_UM	AUS	UFMSRC (903)	UFUE (890), DASC (740), DUF (932)
B_NORKAM	LOK	DKVS (476)	
B_NORKAT	AUS	LRA (463)	DKVS (476)
B_NORKAZ	AUS	LRA (463)	DKVS (476)
B_NOTLU	AUS	UFEING (891)	UFMVER (905), UFRLC (909), UFREAC (898), UFUE (890)
B_NOTLU_FR	AUS	SREAKT (931)	DUF (932), UFUE (890), UFEING (891)
B_NOTXCALC	AUS	DGLOR (747)	
B_NOUETM	LOK	UETM (687)	
B_NOZWE	AUS	MDZW (211)	ZUE (206)
B_NPACC	AUS	DACC (756)	
B_NPAS	AUS	DASC (740)	
B_NPBREMS	AUS	GGEGAS (560)	
B_NPBWF	LOK	GGPED (513)	
B_NPDK	LOK	GGDVE (525)	
B_NPDK1P	LOK	GGDVE (525)	
B_NPDK2P	LOK	GGDVE (525)	
B_NPDMTL	EIN		DDMTL (411)
B_NPDSL	AUS	GGDSAS (131)	
B_NPDSU	AUS	GGDSAS (131)	
B_NPDSVLU	AUS	GGDSAS (131)	
B_NPDVEE	LOK	ADVE (548)	
B_NPDVEL	LOK	ADVE (548)	
B_NPDVEN	LOK	BGDVE (534)	
B_NPDVEU	LOK	BGDVE (534)	
B_NPDVEV	LOK	BGDVE (534)	
B_NPFHSH	LOK	DHLS (666)	
B_NPFHSH2	LOK	DHLS (666)	
B_NPFHSV	LOK	DHLS (666)	
B_NPFHSV2	LOK	DHLS (666)	
B_NPFP1P	LOK	GGPED (513)	
B_NPFP2P	LOK	GGPED (513)	
B_NPFPP	LOK	GGPED (513)	
B_NPFRST	LOK	DKVS (476)	
B_NPFRST2	LOK	DKVS (476)	
B_NPFST	AUS	DFSTT (449)	GGFSTT (443)
B_NPGLOR	AUS	DGLOR (747)	
B_NPHSH	AUS	DHLS (666)	
B_NPHSH2	AUS	DHLS (666)	
B_NPHSV	AUS	DHLS (666)	
B_NPHSV2	AUS	DHLS (666)	
B_NPKRNT	AUS	DKRNT (247)	
B_NPKROF	AUS	DKRNT (247)	
B_NPKRTP	AUS	DKRTP (252)	
B_NPLASH	AUS	DLSAHK (645)	
B_NPLASH2	AUS	DLSAHK (645)	
B_NPLDP	LOK	DLDP (404)	
B_NPLFLSH	LOK	DLSH (627)	
B_NPLFLSH2	AUS	DLSH (627)	
B_NPLFLSV	LOK	DLSV (609)	
B_NPLFLSV2	LOK	DLSV (609)	
B_NPLSV	AUS	DLSV (609)	
B_NPLSV2	AUS	DLSV (609)	
B_NPLSVV	AUS	DLSVV (625)	
B_NPMD	LOK	DMDMIL (800)	
B_NPMFL	AUS	GGMFL (490)	
B_NPNWS	AUS	DNWS (267)	
B_NPNWS2	AUS	DNWS (267)	
B_NPPH	AUS	DPH (571)	
B_NPPH2	AUS	DPH (571)	
B_NPTESB	LOK	DLDP (404)	
B_NPTESK	LOK	DLDP (404)	
B_NPTHM	AUS	DTHM (689)	
B_NPTM	AUS	GGTFM (674)	
B_NPTUM	AUS	GGTFUMG (684)	

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Symbol	Type	Created within	Used within
B_NPUB	AUS	GGUB (671)	
B_NPUFMV	AUS	DUF (932)	
B_NPUFSKA	AUS	DUF (932)	
B_NPURRAM	AUS	DUR (933)	
B_NPURROM	AUS	DUR (933)	
B_NPURRST	AUS	DUR (933)	
B_NSABG	LOK	LLRABG (100)	
B_NSAKT	LOK	MDZUL (45)	
B_NSAKT_UM	LOK	UFNSC (896)	
B_NSEND	LOK	MDZUL (45)	
B_NSEND_UM	LOK	UFNSC (896)	
B_NSP	AUS	BGRLP (125)	EA (184), ESVST (160)
B_NSUB	AUS	BGLBZ (99)	LLRNS (84)
B_NSWO1	AUS	PROKON (878)	DLLR (94), LLRRM (88), TEB (380), MDVERAD (55), LLRMR (92), LLRNS (84)
B_NSWO2	AUS	PROKON (878)	BGRLP (125), ESUK (175)
B_NTINI	LOK	GGKS (218)	
B_NTKW	AUS	CANINS (727)	ETR (688), MSMD (80)
B_NWADS	LOK	WANWKW (257)	
B_NWAF	AUS	WANWKW (257)	
B_NWI	AUS	WANWKW (257)	
B_NWOFF	EIN		WANWKW (257)
B_NWS	AUS	MSF (30)	DNWSE (819)
B_PHAD	EIN		DNWS (267), WNWTST (267)
B_PHAS2	EIN		DPH (571)
B_PHASE	EIN		DPH (571)
B_PHSOK	AUS	DPH (571)	
B_PHSOK2	AUS	DPH (571)	
B_PLAUS	AUS	DDG (568)	DLDP (404)
B_PLOK	LOK	DMDFON (772)	
B_PLOK01	LOK	DMDFON (772)	
B_PLOK02	LOK	DMDFON (772)	
B_PLOK03	LOK	DMDFON (772)	
B_PLOK04	LOK	DMDFON (772)	
B_PLOK05	LOK	DMDFON (772)	
B_PLOK06	LOK	DMDFON (772)	
B_PLOK07	LOK	DMDFON (772)	
B_PLOK08	LOK	DMDFON (772)	
B_PLOKN	DOK	DMDFON (772)	
B_PLOKN_M	LOK	DMDFON (772)	
B_PLRA	LOK	DKVS (476)	
B_PLTAB	LOK	BGTABST (154)	
B_PMEKSO	LOK	DDMPME (828)	
B_PN	AUS	CANEGS (723)	BGNLDSC (578), DGLOR (747), STA (706), LLRNS (84)
B_PRIPH	AUS	GGLSH (599)	
B_PRIPH2	AUS	GGLSH (599)	
B_PRIPV	AUS	GGLSV (588)	
B_PRIPV2	AUS	GGLSV (588)	
B_PSPAUS	LOK	LREB (328)	
B_PSPWL	LOK	LREB (328)	
B_PUERR	AUS	BGPUK (407)	DLDP (404)
B_PVL1	LOK	AEKP (204)	
B_PVL2	LOK	AEKP (204)	
B_PVLNL	LOK	AEKP (204)	
B_PWF	EIN		ADVE (548), BGLBZ (99), BGKMST (861), BGTABST (154), DCAS (739), DCINS (728), DCGE (726), GGFSTT (443), GGDSAS (131), DTHM (689), DLSV (609), DIMC (857), DGLOR (747), DFSTT (449), DEGFE (116), OBDSV (862), LR (338), LLRABG (100), DCTXU (745), DCACC (755), BGDVE (534), DKAT (310)
B_PWGBWF	LOK	GGPED (513)	
B_PWGNOTFR	AUS	GGPED (513)	BBFGR (492), CANDME (718), UFSPSC (913), DUF (932)
B_PWGNOTUM	AUS	UFSPSC (913)	URADCC (923), GGPED (513)
B_QTEDAB	AUS	TEBEB (378)	TEB (380)
B_READS	EIN		DLDP (404)
B_REDKL	LOK	ESUK (175)	
B_REFMAX	LOK	DLSV (609)	
B_REFMAX2	LOK	DLSV (609)	
B_REFO	LOK	DDMTL (411)	
B_REFU	LOK	DDMTL (411)	
B_REHS	LOK	HLS (582)	
B_RFMGV	LOK	DDMTL (411)	
B_RIAKV	LOK	GGLSV (588)	
B_RIAKV2	LOK	GGLSV (588)	
B_RIBEH	LOK	GGLSH (599)	
B_RIBEH2	LOK	GGLSH (599)	
B_RIBEV	LOK	GGLSV (588)	
B_RIBEV2	LOK	GGLSV (588)	
B_RIIBV	LOK	GGLSV (588)	
B_RIIBV2	LOK	GGLSV (588)	
B_RIIMPH	LOK	GGLSH (599)	
B_RIIMPV	LOK	GGLSV (588)	
B_RIMH	LOK	GGLSH (599)	

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Symbol	Type	Created within	Used within
B_RIMH2	LOK	GGLSH (599)	
B_RIMV	LOK	GGLSV (588)	
B_RIMV2	LOK	GGLSV (588)	
B_RINH	AUS	GGLSH (599)	DHLS (666)
B_RINH2	AUS	GGLSH (599)	DHLS (666)
B_RINV	AUS	GGLSV (588)	DHLS (666)
B_RINV2	AUS	GGLSV (588)	DHLS (666)
B_RIPUH	LOK	GGLSH (599)	
B_RIPUH2	LOK	GGLSH (599)	
B_RIPUV	LOK	GGLSV (588)	
B_RIPUV2	LOK	GGLSV (588)	
B_RIREH	LOK	GGLSH (599)	
B_RIREH2	LOK	GGLSH (599)	
B_RIREV	LOK	GGLSV (588)	
B_RIREV2	LOK	GGLSV (588)	
B_RISIGH	LOK	DLSH (627)	
B_RISIGH2	LOK	DLSH (627)	
B_RISIGV	LOK	DLSV (609)	
B_RISIGV2	LOK	DLSV (609)	
B_RKAM	LOK	DKVS (476)	
B_RKAMR	LOK	DKVS (476)	
B_RKAMR2	LOK	DKVS (476)	
B_RKAT	AUS	LRA (463)	DKVS (476), DTEVN (403)
B_RKATR	AUS	LRA (463)	DKVS (476)
B_RKATR2	AUS	LRA (463)	DKVS (476)
B_RKAZ	AUS	LRA (463)	DKVS (476), DTEVN (403)
B_RKAZR	AUS	LRA (463)	DKVS (476)
B_RKAZR2	AUS	LRA (463)	DKVS (476)
B_RLP	LOK	BGRLP (125)	
B_RLPNS	LOK	BGRLP (125)	
B_RLRAB	AUS	GKEB (325)	
B_RLVUGD	LOK	GGDVE (525)	
B_RLZWE	LOK	MDKOG (40)	
B_RSDMTG	DOK	DDMTL (411)	
B_RSNGL	LOK	DDMTL (411)	
B_SA	AUS	AES (189)	MDRED (73), ARMD (63), ATM (302), DEVE (835), CANDME (718), DKVS (476), DLSV (609), DTHM (689), ESUK (175), DVFZ (581), ZUE (206), ZNDAUS (215), MDVER (53), MDFUE (148), MDFAW (31), LRKA (353), LREB (328), LLRBB (81), GGTFM (674), GGTFA (681), GGLSV (588), GGLSH (599), ESWE (174), DLLR (94), DMDSTP (799)
B_SAB	AUS	BBSAWE (71)	MSF (30), LLRBB (81), MDFAW (31), TEB (380), MDRED (73), MD-MIN (51)
B_SABT	LOK	BBSAWE (71)	
B_SACVT	EIN		BBSAWE (71)
B_SAUE1	AUS	MDRED (73)	
B_SAVACC	AUS	CANACC (752)	
B_SAVFGR	EIN		BBSAWE (71), MDFAW (31)
B_SAVM	AUS	FGRMD (499)	
B_SBBHK	AUS	DLSH (627)	DLSAHK (645), LRHK (365), LRKA (353), HLS (582)
B_SBBHK2	AUS	DLSH (627)	DLSAHK (645), LRHK (365), HLS (582), LRKA (353)
B_SBBVK	AUS	DLSV (609)	HLS (582), LREB (328), TEBEB (378)
B_SBBVK2	AUS	DLSV (609)	HLS (582), TEBEB (378), LREB (328)
B_SDMGLV	LOK	DDMTL (411)	
B_SGA	EIN		AEVAB (196)
B_SGNALT	LOK	LR (338)	
B_SGNALT2	LOK	LR (338)	
B_SGNLR	AUS	LR (338)	
B_SGNLR2	AUS	LR (338)	
B_SGNRA	LOK	LR (338)	
B_SGNRA2	LOK	LR (338)	
B_SHUERF	EIN		GGLSV (588), GGLSH (599)
B_SHUERF2	EIN		GGLSV (588), GGLSH (599)
B_SIACC	AUS	DACC (756)	
B_SICACC	AUS	DCACC (755)	
B_SICAS	AUS	DCAS (739)	
B_SICGE	AUS	DCGE (726)	
B_SICINS	AUS	DCINS (728)	
B_SICTXU	AUS	DCTXU (745)	
B_SIDHDMTE	EIN		DHDMTE (440)
B_SIDMPME	LOK	DDMPME (828)	
B_SIDMTL	EIN		DDMTL (411)
B_SIDPMEE	EIN		DDMPME (828)
B_SIDSL	AUS	GGDSAS (131)	
B_SIDSU	AUS	GGDSAS (131)	
B_SIDSVLU	AUS	GGDSAS (131)	
B_SIETS	AUS	DETS (834)	
B_SIEV1	EIN		DEVE (835)
B_SIEV2	EIN		DEVE (835)
B_SIEV3	EIN		DEVE (835)
B_SIEV4	EIN		DEVE (835)
B_SIEV5	EIN		DEVE (835)
B_SIEV6	EIN		DEVE (835)

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Symbol	Type	Created within	Used within
B_SIEV7	EIN		DEVE (835)
B_SIEV8	EIN		DEVE (835)
B_SIFST	AUS	DFSTT (449)	GGFSTT (443)
B_SIGFLSH	LOK	DLSH (627)	
B_SIGFLSH2	LOK	DLSH (627)	
B_SIGFLSV	LOK	DLSV (609)	
B_SIGFLSV2	LOK	DLSV (609)	
B_SIHSH	AUS	DHLS (666)	
B_SIHSH2	AUS	DHLS (666)	
B_SIHSV	AUS	DHLS (666)	
B_SIHSV2	AUS	DHLS (666)	
B_SIKOS	AUS	DKOSE (816)	
B_SIKPE	EIN		DEKPE (824)
B_SIKUPPL	AUS	DKUPPL (561)	
B_SILDP	LOK	DLDP (404)	
B_SILDPE	AUS	DLDPE (409)	
B_SILSH	AUS	DLSH (627)	
B_SILSH2	AUS	DLSH (627)	
B_SILSV	AUS	DLSV (609)	
B_SILSV2	AUS	DLSV (609)	
B_SIMFL	AUS	GGMFL (490)	
B_SIMFLV	DOK	GGMFL (490)	
B_SIMILE	AUS	DMILE (837)	
B_SIMLE	AUS	DMLSE (818)	
B_SIN	AUS	DDG (568)	
B_SINWS	AUS	DNWS (267)	
B_SINWS2	AUS	DNWS (267)	
B_SINWSE	EIN		DNWSE (819)
B_SISLPE	AUS	DSLPE (823)	
B_SISLVE	AUS	DSLVE (821)	
B_SISTAE	AUS	DSTAE (832)	
B_SISTS	AUS	DSTS (708)	
B_SISWE	LOK	BGRBS (703)	
B_SITESK	LOK	DLDP (404)	
B_SITEVE	AUS	DTEVE (826)	
B_SITHM	AUS	DTHM (689)	
B_SITM	AUS	GGTFM (674)	
B_SIVFZ	AUS	DVFZ (581)	
B_SKAEVAB	DOK	AEVAB (196)	
B_SL	EIN		MDVERB (52)
B_SLA	LOK	DSLSLR (289)	
B_SLAR	LOK	DSLSLR (289)	
B_SLAS	LOK	DSLSLR (289)	
B_SLDSL4	LOK	SLS (275)	
B_SLKHOF	AUS	SLS (275)	BBKHZ (282)
B_SLKT	LOK	SLS (275)	
B_SLP	AUS	SLS (275)	DSLPE (823), WNWEIN (254), DSLSLR (289)
B_SLPENA	LOK	SLS (275)	
B_SLPOFF	AUS	SLS (275)	BBKHZ (282)
B_SLPOFST	LOK	SLS (275)	
B_SLS	AUS	SLS (275)	DLSH (627), DLSV (609), TEBEB (378), TC1MOD (864), LRKA (353), LREB (328), LRAEB (461), DSLSLR (289)
B_SLSADAP	AUS	SLS (275)	DSLSLR (289)
B_SLSDIS	LOK	SLS (275)	
B_SLSERR	LOK	SLS (275)	
B_SLSFZ	AUS	PROKON (878)	BBKHZ (282), DSLSLR (289), TC1MOD (864), SLS (275), LREB (328), LAMKO (268), LAKH (272)
B_SLSINHI	LOK	SLS (275)	
B_SLSOFF	AUS	SLS (275)	DSLSLR (289), LREB (328)
B_SLSRDY	AUS	DIMC (857)	
B_SLV	AUS	SLS (275)	DSLVE (821)
B_SP1	AUS	DMDMIL (800)	DTRIG (854)
B_SP1S	AUS	GGPED (513)	DUF (932), UFSPSC (913)
B_SP2	AUS	DMDMIL (800)	DTRIG (854)
B_SP2S	AUS	GGPED (513)	DUF (932), UFSPSC (913)
B_SP3	EIN		DTRIG (854)
B_SPSMIN	AUS	GGPED (513)	DUF (932), UFSPSC (913)
B_ST	AUS	BBSTT (575)	ADVE (548), DLLR (94), BGRLP (125), ZWMIN (213), SLS (275), LRHK (365), LREB (328), LLRRM (88), GGTFM (674), GGDVE (525), ESUK (175), ESSTT (162), ESNST (166), DPH (571), DLSV (609), BBKHZ (282), ATM (302), AEKP (204), DMDSTP (799)
B_STA	AUS	STA (706)	DSTAE (832)
B_STA0AG	DOK	STA (706)	
B_STA0HG	DOK	STA (706)	
B_STAA	EIN		ESNST (166), ESVST (160)
B_STAEBR	DOK	GGEGAS (560)	
B_START	EIN		EASTT (184)
B_STEIGM	LOK	DLSAHK (645)	
B_STEIGM2	LOK	DLSAHK (645)	

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Symbol	Type	Created within	Used within
B_STEND	AUS	BBSTT (575)	AEKP (204), ATM (302), ZWSTT (210), ZWGRU (208), WANWKW (257), UETM (687), T2DMTL (941), SLS (275), RKTI (192), MSMD (80), MLS (695), MDKOG (40), MDFAW (31), LREB (328), LLRRM (88), LLRNS (84), LLRMR (92), LLRBB (81), KRRA (227), KRKE (219), KOS (698), HLS (582), HDMTL (442), GGUB (671), GGTFM (674), GGTFA (681), GGPED (513), GGKS (218), GGDVE (525), ESWL (171), ESUK (175), ESSTT (162), ESNWS (174), ESNST (166), EA (184), DWUC (856), DTHM (689), DTEVN (403), DNWS (267), DLDP (404), DHFM (108), DEVE (835), DEGFE (116), DDMTL (411), DDMMVE (830), DDCY (856), BGTABST (154), BGRLP (125), BGLBZ (99), BBSAWE (71), BBKHZ (282), ARMD (63), BBBO (475)
B_STERHK	EIN		DLSH (627)
B_STERVK	EIN		LRINI (352)
B_STLDP	LOK	DLDP (404)	
B_STLDPV	LOK	DLDP (404)	
B_STNDNL	AUS	ATM (302)	
B_STV	EIN		DNWS (267)
B_STV2	EIN		DNWS (267)
B_SUMOD1	LOK	BGSRM (118)	
B_SUMOD2	LOK	BGSRM (118)	
B_SUMOD3	LOK	BGSRM (118)	
B_SUMV	LOK	DDMTL (411)	
B_SVUERF	EIN		GGLSH (599), GGLSV (588)
B_SVUERF2	EIN		GGLSH (599), GGLSV (588)
B_SWE	AUS	DSWEC (704)	DMDSTP (799)
B_SWEV	LOK	DSWEC (704)	
B_SWKNB	LOK	FGRMD (499)	
B_SWKNV	LOK	FGRMD (499)	
B_SYNPH	EIN		DKRS (242), DMDMIL (800), KRKE (219), DMDSTP (799)
B_SZKAT	LOK	DKAT (310)	
B_SZKAT2	LOK	DKAT (310)	
B_SZSLS	EIN		DSLSLR (289)
B_TAAKT	LOK	DLDP (404)	
B_TABUNPL	LOK	BGTABST (154)	
B_TAL	AUS	GGFSTT (443)	DKVS (476), DLSH (627)
B_TALCAN	AUS	CANINS (727)	GGFSTT (443)
B_TALVAL	AUS	GGFSTT (443)	DKVS (476), DLSH (627)
B_TANK	AUS	DFSTT (449)	DDMTL (411)
B_TANKAB	LOK	DFSTT (449)	
B_TANKD	AUS	DDMTL (411)	
B_TANKDO	LOK	DDMTL (411)	
B_TANKDY	LOK	DFSTT (449)	
B_TANKEND	LOK	DFSTT (449)	
B_TANKG	AUS	DFSTT (449)	DDMTL (411)
B_TANKS	LOK	DDMTL (411)	
B_TANKZU	LOK	DFSTT (449)	
B_TARAU	LOK	LREB (328)	
B_TAREF	LOK	DLDP (404)	
B_TAV	AUS	GGFSTT (443)	
B_TBENH	LOK	FGRMD (499)	
B_TBENT	LOK	FGRMD (499)	
B_TBEP	LOK	FGRMD (499)	
B_TBEPH	LOK	FGRMD (499)	
B_TE	AUS	GKEB (325)	TEBEB (378), BBTEGA (371), DLDP (404), DLSA (634), DKVS (476), TEB (380), LRAEB (461), LR (338), DSLSLR (289), GKRA (327)
B_TEABB	AUS	TEB (380)	BBTEGA (371), GKEB (325), DLDP (404)
B_TEAKT	LOK	TEB (380)	
B_TEF	AUS	GKEB (325)	TEBEB (378), TEB (380)
B_TEHB	AUS	TEB (380)	DLLR (94), DLSA (634), LRHK (365), DLSAHK (645), DMDSTP (799)
B_TEHBX	AUS	TEB (380)	BBTEGA (371), LR (338)
B_TEHBXF	LOK	BBTEGA (371)	
B_TEI	AUS	GKEB (325)	TEBEB (378), TEB (380), DTEVN (403)
B_TEMIN	AUS	RKTI (192)	LREB (328)
B_TEMIN2	AUS	RKTI (192)	LREB (328)
B_TEN	AUS	TEBEB (378)	TEB (380)
B_TEP	AUS	BBTEGA (371)	GKEB (325), TEB (380), TEBEB (378)
B_TEPI	LOK	BBTEGA (371)	
B_TEPZUS	LOK	BBTEGA (371)	
B_TESLASH	LOK	DLSAHK (645)	
B_TESLASH2	LOK	DLSAHK (645)	
B_TESRDY	AUS	DIMC (857)	
B_TEVZU	LOK	DDMTL (411)	
B_TEZA	EIN		BBTEGA (371)
B_TEZSTP	LOK	BBTEGA (371)	
B_TFST2OK	EIN		DFSTT (449)
B_TFSTOK	EIN		DFSTT (449)
B_TFU	AUS	PROKON (878)	ATM (302), GGTFUMG (684), BGTABST (154)
B_TIAB1	AUS	DMDMIL (800)	
B_TIAB2	AUS	DMDMIL (800)	
B_TIAB3	AUS	DMDMIL (800)	
B_TIAB4	AUS	DMDMIL (800)	
B_TIAB5	AUS	DMDMIL (800)	

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Symbol	Type	Created within	Used within
B_TIAB6	AUS	DMDMIL (800)	
B_TIAB7	AUS	DMDMIL (800)	
B_TIAB8	AUS	DMDMIL (800)	
B_TIM	LOK	DTRIG (854)	
B_TIMRS	LOK	DLDP (404)	
B_TIMSA	DOK	BGMSZS (111)	
B_TIMSALL	DOK	BGMSZS (111)	
B_TIRED	AUS	BGRLP (125)	ESVST (160)
B_TLABLP	LOK	DLDP (404)	
B_TLOWR	AUS	CANTXU (742)	DGLOR (747)
B_TLXLDP	LOK	DLDP (404)	
B_TMABS	DOK	DLDP (404)	
B_TMDMME	AUS	GGTFM (674)	DTHM (689)
B_TMKR	AUS	KRRA (227)	DKRS (242), GGKS (218), KRDY (237), EGKE (216)
B_TMLR	AUS	LREB (328)	
B_TMMN	LOK	GGTFM (674)	
B_TMSRT	AUS	GGTFM (674)	
B_TNALU	AUS	DMDLU (761)	
B_TNALU_M	LOK	DMDLU (761)	
B_TNS	AUS	CANINS (727)	BGLBZ (99)
B_TPDERL	LOK	FGRMD (499)	
B_TPDN	AUS	FGRMD (499)	
B_TPNT_AW	LOK	GGKS (218)	
B_TPNT_E	LOK	GGKS (218)	
B_TPUERL	LOK	FGRMD (499)	
B_TPUP	AUS	FGRMD (499)	
B_TPVL	LOK	AEKP (204)	
B_TRFASH	LOK	DLSAHK (645)	
B_TRFASH2	LOK	DLSAHK (645)	
B_TRKH	AUS	BBKHZ (282)	ATM (302)
B_TRSA	LOK	DLSV (609)	
B_TRSA2	LOK	DLSV (609)	
B_TRSAH	LOK	DLSH (627)	
B_TRSAH2	LOK	DLSH (627)	
B_TSENH	LOK	FGRMD (499)	
B_TSENT	LOK	FGRMD (499)	
B_TSPER	LOK	LR (338)	
B_TSPER2	LOK	LR (338)	
B_TSPON	LOK	LR (338)	
B_TSPON2	LOK	LR (338)	
B_TSROOV	AUS	DMDTSB (810)	DMDFON (772), DMDSTP (799)
B_TSROOV_M	LOK	DMDFON (772)	
B_TTBMH	EIN		GGLSV (588), DLSV (609)
B_TTBMH2	EIN		GGLSV (588), DLSV (609)
B_TTBMHH	EIN		GGLSH (599), DLSH (627)
B_TTBMHH2	EIN		GGLSH (599), DLSH (627)
B_TTEAE	LOK	BBTEGA (371)	
B_TUSPN	LOK	DLSSA (654)	
B_TUSPN2	LOK	DLSSA (654)	
B_TUSRE	LOK	DLSSA (654)	
B_TUSRE2	LOK	DLSSA (654)	
B_TVDKAT	LOK	DKAT (310)	
B_TVENH	LOK	FGRMD (499)	
B_TVENT	LOK	FGRMD (499)	
B_TVEP	LOK	FGRMD (499)	
B_TVEPH	LOK	FGRMD (499)	
B_TWAP	LOK	FGRMD (499)	
B_TWDMNL	LOK	DDMTL (411)	
B_TXDMTS	EIN		T2DMTL (941), DDMTL (411)
B_TXUCOK	AUS	CANTXU (742)	DGLOR (747)
B_TXUCP	AUS	DGLOR (747)	BBLOR (746)
B_TXUGET	AUS	CANTXU (742)	BGMIGS (69), DGLOR (747), DCTXU (745)
B_TXUNEW	AUS	CANTXU (742)	DCTXU (745), DGLOR (747)
B_TXURCIP	AUS	CANTXU (742)	DGLOR (747)
B_TZARNI	LOK	ARMD (63)	
B_U	LOK	MS (6)	
B_UBDMTE	EIN		T2DMTL (941)
B_UBDVE	AUS	ADVE (548)	SREAKT (931)
B_UBPVG	AUS	ADVE (548)	GGDVE (525), GGPED (513)
B_UB_OK	AUS	ADVE (548)	DUF (932), UFUE (890), UFEING (891)
B_UB_SKA	AUS	UFEING (891)	UFMVER (905), UFSPSC (913), UFREAC (898), UFRLC (909), UFUE (890)
B_UEBETU	LOK	FGRMD (499)	
B_UEBRKF	LOK	FGRMD (499)	
B_UEBVAU	LOK	FGRMD (499)	
B_UEINH	AUS	DLSH (627)	
B_UEINH2	AUS	DLSH (627)	
B_UEINV	LOK	DLSV (609)	
B_UEINV2	LOK	DLSV (609)	
B_UETM	AUS	UETM (687)	CANINS (727), MLS (695)
B_UETMC	AUS	UETM (687)	
B_UEVZTD	LOK	FGRMD (499)	

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Symbol	Type	Created within	Used within
B_UGD	AUS	FUEDK (149)	
B_UGDB	LOK	FUEDK (149)	
B_UGDS	AUS	FUEDK (149)	
B_UGDSET	LOK	FUEDK (149)	
B_UHRRMIN	AUS	PROKON (878)	BGTABST (154)
B_UHRRNPL	EIN		BGTABST (154)
B_UHRRSEC	AUS	PROKON (878)	AEKP (204), BGTABST (154)
B_UHSIG	LOK	DLSH (627)	
B_UHSIG2	LOK	DLSH (627)	
B_UK1	LOK	ESUK (175)	
B_UKG	AUS	ESUK (175)	LRAEB (461), ESVST (160)
B_UKNS	LOK	ESUK (175)	
B_UMAE	LOK	BGDVE (534)	
B_UMAERF	LOK	BGDVE (534)	
B_UMARDR	LOK	BGDVE (534)	
B_UMAUAB	AUS	BGDVE (534)	SREAKT (931)
B_UPUEW	DOK	BGMRACC (758)	
B_UPW12E	LOK	GGPED (513)	
B_UPW1MN	LOK	GGPED (513)	
B_UPW1MX	LOK	GGPED (513)	
B_UPW2MN	LOK	GGPED (513)	
B_UPW2MX	LOK	GGPED (513)	
B_UPWG1O	LOK	GGPED (513)	
B_UPWG1U	LOK	GGPED (513)	
B_UPWG2O	LOK	GGPED (513)	
B_UPWG2U	LOK	GGPED (513)	
B_USBEV	LOK	GGLSV (588)	
B_USBEV2	LOK	GGLSV (588)	
B_USHKF	LOK	DLSAHK (645)	
B_USHKF2	LOK	DLSAHK (645)	
B_USHKM	LOK	DLSAHK (645)	
B_USHKM2	LOK	DLSAHK (645)	
B_USHSCH	LOK	DLSAHK (645)	
B_USHSCH2	LOK	DLSAHK (645)	
B_UVSIG	LOK	DLSV (609)	
B_UVSIG2	LOK	DLSV (609)	
B_VA	AUS	ESUK (175)	
B_VAAU	LOK	ESUK (175)	
B_VADGE	LOK	DLSV (609)	
B_VADGE2	LOK	DLSV (609)	
B_VAG	AUS	ESUK (175)	DSLSLR (289), LREB (328)
B_VAKL	LOK	ESUK (175)	
B_VBEMG	AUS	ESSTT (162)	BGTABST (154)
B_VBMG	DOK	ESSTT (162)	
B_VGEFLR	LOK	DLSV (609)	
B_VGEFLR2	LOK	DLSV (609)	
B_VL	AUS	BBVL (38)	MSF (30), EA (184), KOS (698), LAMFAW (271), KRRA (227), LREAB (461), ZWGRU (208), WNWEIN (254), ESKS (172), ETR (688)
B_VLLR	AUS	LLRBB (81)	LLRRM (88), MDVERAD (55), LLRMD (83)
B_VMAX	AUS	VMAXMD (78)	
B_VNULL	AUS	GGVFZG (580)	BBGANG (70), MDFAW (31)
B_WAVO	LOK	FGRMD (499)	
B_WDK1V	AUS	GGDVE (525)	ADVE (548)
B_WDK2SEL	AUS	GGDVE (525)	BGDVE (534), DUF (932), UFRLC (909)
B_WDKSAP	AUS	PROKON (878)	FUEDK (149)
B_WDKSAUF	DOK	ADVE (548)	
B_WDKSIVE	EIN		SREAKT (931), ADVE (548)
B_WF	LOK	ESUK (175)	
B_WIAUF	AUS	FGRMD (499)	BBACC (759)
B_WK	AUS	CANEGS (723)	ARMD (63), DMDDLU (766), DMDLUA (770), MDFAW (31), DMDLU (761)
B_WKORA	LOK	ZWGRU (208)	
B_WKR	AUS	CANEGS (723)	ARMD (63), DMDLU (761), DMDLUA (770), DMDDLU (766)
B_WKRAL	LOK	KRRA (227)	
B_WKS	AUS	ESSTT (162)	ESNST (166), ESVST (160)
B_WNWMXBE	AUS	WNWEIN (254)	
B_WNWS	EIN		ESNWS (174), WNWEIN (254)
B_WST	AUS	ESSTT (162)	BBKHZ (282)
B_WUC	AUS	DWUC (856)	DFPM (841), DTRIG (854), DMDMIL (800)
B_XFF	LOK	OBDSV (862)	
B_Y	AUS	MS (6)	
B_ZASA	EIN		DMDDLU (766), DMDLUA (770), DMDLU (761)
B_ZASA_M	LOK	DMDUE (760)	
B_ZDMPME	LOK	DDMPME (828)	
B_ZDMTG	LOK	DDMTL (411)	
B_ZDMTGV	EIN		DDMTL (411)
B_ZDMTK	LOK	DDMTL (411)	
B_ZDPMEE	LOK	DDMPME (828)	
B_ZKATB	DOK	DKAT (310)	
B_ZKATB2	DOK	DKAT (310)	
B_ZKATS	LOK	DKAT (310)	
B_ZKATS2	LOK	DKAT (310)	

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Symbol	Type	Created within	Used within
B_ZKATZ	DOK	DKAT (310)	
B_ZKATZ2	DOK	DKAT (310)	
B_ZMEKSO	LOK	DDMPME (828)	
B_ZMEKSOZ	LOK	DDMPME (828)	
B_ZNDAUS	AUS	ZNDAUS (215)	
B_ZSLS	LOK	DSLSLR (289)	
B_ZTEV	AUS	DTEVE (826)	
B_ZTHMS	LOK	DTHM (689)	
B_ZWAPPL	AUS	PROKON (878)	ZUE (206)
B_ZWKRA	LOK	ZUE (206)	
B_ZWKRAA	AUS	KRRA (227)	KRDY (237)
B_ZWKRUM	LOK	KRRA (227)	
B_ZWMNSTE	LOK	ZWMIN (213)	
B_ZWVS	AUS	MDKOG (40)	MDZW (211)
B_ZWVZ	AUS	MDKOG (40)	MDZW (211)
B_ZXDMPME	LOK	DDMPME (828)	
C	LOK	MS (6)	
CFOXX	LOK	DMDFON (772)	
CO_POT	EIN		EEDAT (943), COSA (193)
CTRBWF	AUS	GGPED (513)	
CTRERBR	AUS	GGEGAS (560)	
CVN	AUS	BGCVN (876)	TC9MOD (872)
CW_ERFIL	EIN		TCSORT (876)
CW_OBD	AUS	PROKON (878)	
C_BMSUCH	EIN		BGNMOT (564)
C_FCMCLR	EIN		ADVE (548), DACC (756), DASC (740), BGRBS (703), BGDVE (534), DDG (568), DDCY (856), DWUC (856), DVFZ (581), DU5REF (673), DTEVE (826), DSTAE (832), DSLVE (821), DSLSLR (289), DSLPE (823), DPH (571), DNWSE (819), DNWS (267), DMILE (837), DMIL (860), DIMC (857), DHLS (666), DHFM (108), DHDMTE (440), DEVE (835), DETS (834), DEKPE (824), DDMTL (411), DLSVV (625), DLSH (627), DLSAHK (645), DLSA (634), DLLR (94), DKVS (476), DKUPPL (561), DKRTP (252), DKRS (242), DKRNT (247), DKOSE (816), DKAT (310), DDMPME (828), GGTKA (683), GGTFUMG (684), GGTFM (674), GGTFA (681), GGPED (513), GGMFL (490), GGEGAS (560), GGDVE (525), MDKOG (40), LRHK (365), LRA (463), GGUB (671), BGKMST (861), DCGE (726), DCINS (728), DLDP (404), DCTXU (745), DCAS (739), DCACC (755)
C_INI	EIN		ADVE (548), COSA (193), BGWDKM (153), BGVFGR (498), BGUBF (282), BGTEV (143), BGTEMPK (123), BBSAWE (71), BBKURU (67), BBKHZ (282), BBFGR (492), BBBO (475), ATM (302), ARMD (63), AEVAB (196), AES (189), AEKP (204), DHDMTE (440), DGLOR (747), DEVE (835), DETS (834), DEKPE (824), DDMTL (411), DDMPME (828), DDG (568), ZWSTT (210), UFUE (890), UFNSC (896), UFMSRC (903), UFFGRC (900), UETM (687), TEB (380), STA (706), SLS (275), RKTI (192), MSMD (80), MOTAUS (576), MLS (695), MDZUL (45), MDWAN (61), MDVERAD (55), MDVER (53), MDNSTAB (59), MDKOG (40), MDFUE (148), MDFAW (31), LRKA (353), LRHK (365), LREB (328), LRA (463), LR (338), LLRBB (81), LLRABG (100), LAMKO (268), LAMFAW (271), LAKH (272), KVA (713), KOS (698), HLS (582), GGUB (671), GGTKA (683), GGTFUMG (684), GGTFM (674), GGTFA (681), GGPED (513), GGMFL (490), GGLSV (588), GGLSH (599), GGKS (218), GGEGAS (560), GGDVE (525), GGAIRB (730), FUEDK (149), ESUK (175), ESSTT (162), ESNWS (174), ESNST (166), ELS (839), EGKE (216), DWUC (856), DVFZ (581), DU5REF (673), DTEVE (826), DSTS (708), DSTAE (832), DSTA (709), DSLVE (821), DSLSLR (289), DSLPE (823), DPH (571), DNWSE (819), DNWS (267), DMLSE (818), DMILE (837), DMDFLU (812), DLSVV (625), DLSAHK (645), DLSA (634), DLLR (94), DLDPE (409), DLDP (404), DKVS (476), DKUPPL (561), DKRTP (252), DKRS (242), DKRNT (247), DKAT (310), DIMC (857), DHLS (666), DHFM (108), DCGE (726), DCAS (739), DCACC (755), DASC (740), DACC (756), BGTABST (154), BGSRM (118), BGRLP (125), DDCY (856), DCTXU (745), DCINS (728), BGRBS (703), BGPUK (407), BGMSZS (111), BGDVE (534), CANASR (732), DKOSE (816), DLSH (627), DMDSTP (799), CANINS (727), CANEGS (723)
C_INISYN	EIN		BBSTT (575), DPH (571), DMIL (860), DEPCL (839), DDG (568), BGSRM (118), BGNG (565), BGNMOT (564)
C_NACHL	EIN		ADVE (548), AEKP (204), BBKHZ (282), ATM (302), BGDVE (534), UETM (687), SLS (275), MOTAUS (576), GGUB (671), GGPED (513), DTOP (840), DMIL (860), DHFM (108), BGTABST (154)
C_NORM	EIN		GGTFA (681), MOTAUS (576)
C_NSUCH	EIN		BGNMOT (564)

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Symbol	Type	Created within	Used within
C_PWF	EIN		ADVE (548), BBBO (475), AMUENE (578), BGMSZS (111), BGRBS (703), DACC (756), BGTABST (154), T2DMTL (941), OBDSV (862), MOTAUS (576), MDVERAD (55), MDKOG (40), LRHK (365), LRA (463), KRRA (227), KRDY (237), KATV (324), GGUB (671), GGTKA (683), GGTFUMG (684), GGTFM (674), GGTFA (681), GGPED (513), GGMFL (490), GGEGAS (560), GGDVE (525), FUEDK (149), ESSTT (162), EGKE (216), DVFZ (581), DU5REF (673), DTOP (840), DTEVE (826), DSTAE (832), DSTA (709), DSLVE (821), DPH (571), DNWSE (819), DNWS (267), DMILE (837), DMDFLU (812), DLSVV (625), DLSSA (654), DLSAHK (645), DSLSLR (289), DSLPE (823), DLLR (94), DLDP (404), DKVS (476), DKUPPL (561), DKRTP (252), DKRS (242), DKRNT (247), DHLS (666), DHFM (108), DHDMTE (440), DEVE (835), DETS (834), DEKPE (824), DDMTL (411), DDMPME (828), DDG (568), DASC (740), BGSRM (118), BGDVE (534), BBPEDBR (579), ATM (302)
C_SYN	EIN		BGNG (565), BGNMOT (564)
DEKPUB	LOK	AEKP (204)	
DEVOFF	EIN		AES (189), AEVAB (196)
DFP_DK	DOK	GGDSAS (131)	TEBEB (378)
DFP_DSL	DOK	GGDSAS (131)	
DFP_DSU	DOK	GGDSAS (131)	
DFP_DSVLU	DOK	GGDSAS (131)	
DFP_LDPE	DOK	TEBEB (378)	
DFP_LM	DOK	GGDSAS (131)	
DFP_LSV	DOK	DLSV (609)	
DFP_LSV2	DOK	DLSV (609)	
DFP_TES	DOK	DLSV (609)	
DFP_TEVE	DOK	DLSV (609)	TEBEB (378)
DFP_THM	EIN		DTHM (689)
DFP_TKA	EIN		DTHM (689)
DFP_TM	DOK	DLSV (609)	
DFP_VFZ	EIN		DTHM (689)
DFRKA2_W	LOK	GKRA (327)	
DFRKA_W	LOK	GKRA (327)	
DFRM2_W	LOK	LRA (463)	
DFRM_W	LOK	LRA (463)	
DFRSP2_W	AUS	LR (338)	
DFRSP_W	AUS	LR (338)	
DFRST2_W	AUS	LR (338)	
DFRSTGA2_W	LOK	LR (338)	
DFRSTGA_W	LOK	LR (338)	
DFRSTTE2_W	LOK	LR (338)	
DFRSTTE_W	LOK	LR (338)	
DFRST_W	AUS	LR (338)	
DFSE01	LOK	DMDFON (772)	
DFSE02	LOK	DMDFON (772)	
DFSE03	LOK	DMDFON (772)	
DFSE04	LOK	DMDFON (772)	
DFSE05	LOK	DMDFON (772)	
DFSE06	LOK	DMDFON (772)	
DFSE07	LOK	DMDFON (772)	
DFSE08	LOK	DMDFON (772)	
DFSEN	LOK	DMDFON (772)	
DFSERESZ	LOK	DMDFON (772)	
DFSKV_W	LOK	DFSTT (449)	
DFSTIGOF_W	LOK	DFSTT (449)	
DFSTIGO_W	LOK	DFSTT (449)	
DFSTT_W	LOK	DFSTT (449)	
DFTEF_W	LOK	TEB (380)	
DILB	AUS	BGLBZ (99)	
DIPTGL_W	LOK	DDMTL (411)	
DKATAKT2_W	LOK	DKAT (310)	
DKATAKT_W	LOK	DKAT (310)	
DKATEFRG	LOK	TEB (380)	
DKHC_W	LOK	TEB (380)	
DKLAGERC	LOK	ADVE (548)	
DKPSTG_W	AUS	BGDVE (534)	GGDVE (525)
DKVBIGO_W	LOK	DFSTT (449)	
DKVB_W	LOK	DFSTT (449)	
DLAHI2_W	EIN		DLSSA (654)
DLAHISA	AUS	DLSSA (654)	
DLAHISA2	AUS	DLSSA (654)	
DLAHI_W	EIN		DLSSA (654)
DLAHKAB2_W	LOK	LRHK (365)	
DLAHKAB_W	LOK	LRHK (365)	
DLAMATR2_W	EIN		LAMKO (268)
DLAMATR_W	EIN		LAMKO (268)
DLASHKI2_W	LOK	LRHK (365)	
DLASHKI_W	LOK	LRHK (365)	
DLASHKM2_W	LOK	LRHK (365)	
DLASHKM_W	LOK	LRHK (365)	
DLASHKP2_W	LOK	LRHK (365)	
DLASHKP_W	LOK	LRHK (365)	

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Symbol	Type	Created within	Used within
DLRBATKP_W	DOK	ADVE (548)	
DLRD	DOK	ADVE (548)	
DLRDANT_W	DOK	ADVE (548)	
DLRDSV_W	DOK	ADVE (548)	
DLRDSW_W	DOK	ADVE (548)	
DLRI	DOK	ADVE (548)	
DLRIAMAX	LOK	ADVE (548)	
DLRIANT_⊥	LOK	ADVE (548)	
DLRIANT_W	LOK	ADVE (548)	
DLRIKLST_W	LOK	ADVE (548)	
DLRIKL_W	LOK	ADVE (548)	
DLRKOMP	LOK	ADVE (548)	
DLRMXT	LOK	BGDVE (534)	
DLRNDIF_W	DOK	ADVE (548)	
DLRP	DOK	ADVE (548)	
DLRPANT_⊥	DOK	ADVE (548)	
DLRPIDC	LOK	ADVE (548)	
DLRRAST	DOK	ADVE (548)	
DLRSPID_W	AUS	ADVE (548)	BGDVE (534)
DLSD_W	LOK	MDFAW (31)	
DLURS	DOK	DMDDLU (766)	
DLURS_M	LOK	DMDDLU (766)	
DLUTS	DOK	DMDDLU (766)	
DLUTS_M	LOK	DMDDLU (766)	
DMAR_W	AUS	ARMD (63)	BGMDLM (44), MDKOG (40), MSF (30)
DMAUFR_W	LOK	MDZW (211)	
DMDPO_W	LOK	MDFAW (31)	
DMDPU_W	LOK	MDFAW (31)	
DMDRESDTEV	LOK	LLRMR (92)	
DMDRESFS	LOK	LLRMR (92)	
DMLLLMN_W	AUS	LLRMR (92)	MDKOL (48)
DMLLRDZ_W	LOK	LLRRM (88)	
DMLLRD_W	LOK	LLRRM (88)	
DMLLRI_W	AUS	LLRMD (83)	LLRRM (88), DLLR (94), MDVERAD (55), MDFAW (31), LLRBB (81), KHMD (287), MDMIN (51)
DMLLRPZ_W	DOK	LLRRM (88)	
DMLLRP_W	DOK	LLRRM (88)	
DMLLRZ_W	AUS	LLRRM (88)	MDKOG (40)
DMLLR_W	AUS	LLRMD (83)	MDMIN (51), LLRRM (88), BGMDLM (44), MDKOL (48), MSF (30)
DMLSDO_W	LOK	MDFAW (31)	
DMLSDU_W	LOK	MDFAW (31)	
DMNMXI_W	DOK	NMAXMD (76)	
DMNMXP_W	DOK	NMAXMD (76)	
DMRAC	AUS	MDVERB (52)	LLRMR (92)
DMRAR_W	LOK	FGRAUS (511)	
DMRDKT_W	AUS	DKAT (310)	
DMRDSLS_W	AUS	KHMD (287)	MDTRIP (301)
DMRKH	AUS	KHMD (287)	MDKOG (40), MDKOL (48), MSF (30)
DMRKHZ_W	LOK	KHMD (287)	
DMRKH_W	AUS	KHMD (287)	
DMRKT_W	AUS	MDTRIP (301)	BGMDLM (44), MDKOL (48), MDKOG (40)
DMRLASH_W	AUS	DLSAHK (645)	MDTRIP (301)
DMRLLR	AUS	LLRMD (83)	MDKOL (48), MSF (30)
DMRLLR_W	AUS	LLRMR (92)	MDMIN (51)
DMRLSH_W	AUS	DLSH (627)	MDTRIP (301)
DMVADFK_W	EIN		EEDAT (943), MDVERAD (55)
DMVADFS_W	EIN		EEDAT (943), MDVERAD (55)
DMVADKO_W	EIN		EEDAT (943), MDVERAD (55)
DMVADLL_W	EIN		EEDAT (943), MDVERAD (55)
DMVAD_W	AUS	MDVERAD (55)	MDVER (53), MDMIN (51)
DMVAMNFK_W	DOK	MDVERAD (55)	
DMVAMNFS_W	DOK	MDVERAD (55)	
DMVAMNKO_W	DOK	MDVERAD (55)	
DMVAMNLL_W	DOK	MDVERAD (55)	
DMVAMXFK_W	DOK	MDVERAD (55)	
DMVAMXFS_W	DOK	MDVERAD (55)	
DMVAMXKO_W	DOK	MDVERAD (55)	
DMVAMXLL_W	DOK	MDVERAD (55)	
DMVERL_W	AUS	MDMIN (51)	MDVER (53), MDFAW (31)
DMVMXI_W	DOK	VMAXMD (78)	
DMVMXP_W	DOK	VMAXMD (78)	
DMZMS_W	AUS	MDKOG (40)	
DN	EIN		LLRBB (81), LLRMD (83), LLRRM (88)
DNFSACMV	EIN		EEDAT (943), LLRNS (84), LLRABG (100)
DNFSMV	EIN		EEDAT (943), LLRABG (100), LLRNS (84)
DNIAR_W	LOK	ARMD (63)	
DNKRDYV	DOK	KRDY (237)	
DNLLMV	EIN		EEDAT (943), LLRNS (84), LLRABG (100)
DNMOTAS_W	AUS	BGNG (565)	
DNMOT_W	AUS	BGNG (565)	
DNS	AUS	LLRNS (84)	DLLR (94), LLRRM (88), LLRMR (92), LLRMD (83)
DNSA	LOK	BBSAWE (71)	

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Symbol	Type	Created within	Used within
DNSACMV	EIN		EEDAT (943), LLRABG (100), LLRNS (84)
DNSI_W	LOK	NMAXMD (76)	
DNSLBV	EIN		EEDAT (943), LLRABG (100), LLRNS (84)
DNTURB	LOK	MDWAN (61)	
DNVQUOTF_W	AUS	BBKURU (67)	
DNVQUOT_W	AUS	BBKURU (67)	
DN_W	EIN		LLRRM (88), LLRMD (83)
DPDK	EIN		FUEDK (149)
DPSDVS_W	LOK	BGRLP (125)	
DPSFG_W	AUS	BGSRM (118)	BGRLP (125)
DPSMP_W	LOK	BGRLP (125)	
DPUBAB_W	AUS	DLDP (404)	
DPUS_W	AUS	AES (189)	KVA (713)
DPVDKSPU_W	AUS	GGDSAS (131)	
DRKWTMP_W	LOK	KHMD (287)	
DRLFUE_W	EIN		FUEDK (149)
DRLKRDY	LOK	DMDSTP (799)	KRDY (237)
DRLLAD_W	LOK	BGMSZS (111)	
DRLP_W	AUS	BGRLP (125)	ESUK (175), KRDY (237)
DRLROH_W	AUS	EGFE (104)	
DRLSOL_W	AUS	MDFUE (148)	
DRL_W	AUS	BGSRM (118)	BGRLP (125), KRDY (237)
DTEVPHC	LOK	DTEVN (403)	
DTHMTMKA	LOK	DTHM (689)	
DTMUEMS	LOK	MSMD (80)	
DTVKA	AUS	LRKA (353)	LR (338), GKRA (327)
DTVKA2	AUS	LRKA (353)	LR (338), GKRA (327)
DTVKAI	LOK	LRKA (353)	
DTVKAI2	LOK	LRKA (353)	
DUF_C	LOK	DUF (932)	
DVEESC	LOK	ADVE (548)	
DVPRAE_W	LOK	VMAXMD (78)	
DVRABE_W	LOK	FGRMD (499)	
DVRAVE_W	LOK	FGRMD (499)	
DVSI_W	DOK	VMAXMD (78)	
DVZVI_W	LOK	FGRMD (499)	
DV_LH	LOK	BGRBS (703)	
DV_LV	LOK	BGRBS (703)	
DV_RH	LOK	BGRBS (703)	
DV_RV	LOK	BGRBS (703)	
DWDKBA_W	AUS	GGDVE (525)	
DWDKDLRA_W	DOK	ADVE (548)	
DWDKDLR_W	LOK	ADVE (548)	
DWDKSIMX	DOK	ADVE (548)	
DWDKS_KGE	LOK	ADVE (548)	
DWDKS_W	AUS	FUEDK (149)	ADVE (548)
DWFK_W	LOK	ESUK (175)	
DWFL_W	LOK	ESUK (175)	
DWF_W	LOK	ESUK (175)	
DWKR	AUS	KRRA (227)	
DWKRMSW	DOK	KRRA (227)	
DWKRZ	LOK	ZUE (206)	
DWPED	AUS	GGPED (513)	
DWPED_W	AUS	GGPED (513)	
DYESOFV	DOK	KRDY (237)	
DYESV	DOK	KRDY (237)	
DYNLSU2_W	EIN		DLSSA (654)
DYNLSUSA	AUS	DLSSA (654)	
DYNLSUSA2	AUS	DLSSA (654)	
DYNLSU_W	EIN		DLSSA (654)
DZWI	LOK	MDIST (49)	
DZWKS	AUS	ZWKS (212)	
DZWOAG	AUS	MDBAS (50)	ZWGRU (208)
DZWOL	AUS	MDBAS (50)	ZWGRU (208)
DZWOTM	LOK	MDBAS (50)	
DZWS	LOK	MDZW (211)	
DZWSPAE	LOK	ZWMIN (213)	
DZWWL	AUS	ZWWL (210)	ZUE (206)
DZW_UM	LOK	UFMIST (897)	
D_ANZTI	EIN		KVA (713)
E	LOK	MS (6)	
EEVX	LOK	AEVAB (196)	
EGASPFAD	AUS	DUF (932)	DFFT (849)
EI_ACCC_UM	AUS	UFFGRC (900)	
EI_ADCC_UM	AUS	URADCC (923)	DUF (932)
EI_IPA_UM	AUS	UFRLC (909)	DUF (932)
EI_MSRC_UM	AUS	UFMSRC (903)	
EI_MVER_UM	AUS	UFMVER (905)	DUF (932)
EI_NC_UM	AUS	UFNC (906)	DUF (932)
EI_REAC_UM	AUS	UFREAC (898)	DUF (932)
EI_RLC_UM	AUS	UFRLC (909)	DUF (932)
EI_RLIP_UM	AUS	UFRLC (909)	DUF (932)

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Symbol	Type	Created within	Used within
EI_SPSC_UM	AUS	UFSPSC (913)	DUF (932)
EI_ZWC_UM	AUS	UFZWC (913)	DUF (932)
EKPAUSC	AUS	CANINS (727)	GGAIRB (730)
EKPFZ	LOK	DEKPE (824)	
EKPPZ	LOK	DEKPE (824)	
ETABASF_W	DOK	MDFUE (148)	
ETABAS_W	DOK	MDFUE (148)	
ETALAB	AUS	MDBAS (50)	MDFUE (148)
ETATE	AUS	TEB (380)	
ETATEINT	LOK	TEB (380)	
ETATESOL	LOK	TEB (380)	
ETATRMN	AUS	MDBAS (50)	
ETAZABAS	DOK	BGMDLM (44)	
ETAZAIST	AUS	MDIST (49)	MDZW (211), MSF (30)
ETAZWB	AUS	MDBAS (50)	
ETAZWBM	AUS	MDBAS (50)	MDFUE (148), MDKOL (48), MSF (30)
ETAZWIMT	LOK	ATM (302)	
ETAZWIST	AUS	MDIST (49)	ATM (302)
ETAZWMN	AUS	ZWMIN (213)	AES (189), MDKOL (48), MDRED (73)
ETAZWMN_W	LOK	AES (189)	
ETAZWS	LOK	MDZW (211)	
ETAZW_UM	LOK	UFMIST (897)	
EVRBGN	LOK	AEVAB (196)	
EVRBGN_ONE	LOK	AEVAB (196)	
EVSUP1	AUS	DIMC (857)	
EVTMOD	AUS	BGTEMPK (123)	
EVZ_AGS	AUS	AEVAB (196)	AES (189)
EVZ_AUS	AUS	AEVAB (196)	UFUE (890), AES (189)
EVZ_AUSTOT	AUS	AEVAB (196)	DEVE (835), UFEING (891), AES (189)
EVZ_AUS_UM	AUS	UFEING (891)	UFREAC (898), UFUE (890)
E_ACC	AUS	DACC (756)	
E_AGRE	EIN		DLSA (634), DLSAHK (645)
E_AGRF	EIN		DLSA (634), DLSAHK (645)
E_AS	AUS	DASC (740)	BGNLDSC (578), CANASR (732)
E_BM	AUS	DDG (568)	LRAEB (461), DMDSTP (799)
E_BREMS	AUS	GGEGAS (560)	BBACC (759), CANDME (718), BBPEDBR (579), BBFGR (492)
E_BWF	AUS	GGPED (513)	
E_CACC	AUS	DCACC (755)	BBACC (759)
E_CAS	AUS	DCAS (739)	BBACC (759), BBFGR (492), DASC (740), BGNLDSC (578)
E_CGE	AUS	DCGE (726)	BBACC (759), OBDSV (862), BGNLDSC (578), BGMIGS (69), DGLOR (747), DLDP (404)
E_CINS	AUS	DCINS (728)	BGTABST (154), GGTFM (674), GGTFUMG (684)
E_CTXU	AUS	DCTXU (745)	BBLOR (746), BGMIGS (69), DGLOR (747)
E_DHDMTE	AUS	DHDMTE (440)	
E_DK	AUS	GGDVE (525)	BGMSZS (111), LRAEB (461), GGDSAS (131), EGFE (104), DTEVN (403), DLDP (404), DHFM (108), BGRLP (125), CANDME (718), TEBEB (378), MDVERAD (55)
E_DK1P	AUS	GGDVE (525)	
E_DK2P	AUS	GGDVE (525)	
E_DMMVE	EIN		DDMTL (411)
E_DMPME	AUS	DDMPME (828)	DDMTL (411)
E_DMTK	AUS	DDMTL (411)	DFPMNL (848)
E_DMTKNM	AUS	DDMTL (411)	DFPMNL (848)
E_DMTL	AUS	DDMTL (411)	DFPMNL (848)
E_DSL	AUS	GGDSAS (131)	BGMSZS (111)
E_DSS	EIN		BGMSZS (111)
E_DSSI	LOK	BGMSZS (111)	
E_DSU	AUS	GGDSAS (131)	BGPUK (407), CANDME (718)
E_DSVLU	AUS	GGDSAS (131)	
E_DVEE	LOK	ADVE (548)	
E_DVEF	AUS	BGDVE (534)	
E_DVEL	LOK	ADVE (548)	
E_DVEN	AUS	BGDVE (534)	
E_DVER	LOK	ADVE (548)	
E_DVEU	AUS	BGDVE (534)	LRAEB (461)
E_DVEV	AUS	BGDVE (534)	
E_EGFE	AUS	DEGFE (116)	
E_ETS	AUS	DETS (834)	
E_EV	EIN		DMDMIL (800)
E_EV1	AUS	DEVE (835)	AEVAB (196), DMDMIL (800)
E_EV2	AUS	DEVE (835)	AEVAB (196), DMDMIL (800)
E_EV3	AUS	DEVE (835)	AEVAB (196), DMDMIL (800)
E_EV4	AUS	DEVE (835)	AEVAB (196), DMDMIL (800)
E_EV5	AUS	DEVE (835)	AEVAB (196), DMDMIL (800)
E_EV6	AUS	DEVE (835)	AEVAB (196), DMDMIL (800)
E_EV7	AUS	DEVE (835)	AEVAB (196), DMDMIL (800)
E_EV8	AUS	DEVE (835)	AEVAB (196), DMDMIL (800)
E_FP1P	AUS	GGPED (513)	
E_FP2P	AUS	GGPED (513)	
E_FPP	AUS	GGPED (513)	DTEVN (403)
E_FRA	AUS	GKRA (327)	
E_FRA2	AUS	GKRA (327)	

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Symbol	Type	Created within	Used within
E_FRAO	AUS	DKVS (476)	DLDP (404)
E_FRAO2	AUS	DKVS (476)	DLDP (404)
E_FRAU	AUS	DKVS (476)	DLDP (404)
E_FRAU2	AUS	DKVS (476)	DLDP (404)
E_FRST	AUS	DKVS (476)	
E_FRST2	AUS	DKVS (476)	
E_FST	AUS	DFSTT (449)	DDMTL (411), GGFSTT (443)
E_GLOR	AUS	DGLOR (747)	BBLOR (746)
E_HFM	LOK	EGFE (104)	
E_HSH	AUS	DHLS (666)	DIMC (857), LRHK (365), DLSAHK (645), DLSA (634)
E_HSH2	AUS	DHLS (666)	DIMC (857), DLSA (634), DLSAHK (645), LRHK (365)
E_HSV	AUS	DHLS (666)	DIMC (857), LRHK (365), DLSA (634)
E_HSV2	AUS	DHLS (666)	DIMC (857), DLSA (634), LRHK (365)
E_KAT	AUS	DKAT (310)	DIMC (857), LRHK (365), DLSA (634)
E_KAT2	AUS	DKAT (310)	DIMC (857), DLSA (634), LRHK (365)
E_KOS	AUS	DKOSE (816)	
E_KPE	AUS	DEKPE (824)	
E_KRNT	AUS	DKRNT (247)	DKRS (242), EGKE (216)
E_KROF	AUS	DKRNT (247)	DKRS (242), EGKE (216)
E_KRTP	AUS	DKRTP (252)	DKRS (242), EGKE (216)
E_KS1	AUS	DKRS (242)	EGKE (216)
E_KS2	AUS	DKRS (242)	EGKE (216)
E_KS3	AUS	DKRS (242)	EGKE (216)
E_KS4	AUS	DKRS (242)	EGKE (216)
E_KUPPL	AUS	DKUPPL (561)	BBACC (759), GGEGAS (560), BGVFGR (498)
E_LASH	AUS	DLSAHK (645)	DIMC (857), LRHK (365)
E_LASH2	AUS	DLSAHK (645)	DIMC (857), LRHK (365)
E_LATP	AUS	DLSA (634)	DIMC (857), DKAT (310), DSLSLR (289)
E_LATP2	AUS	DLSA (634)	DIMC (857), DKAT (310), DSLSLR (289)
E_LATV	AUS	DLSA (634)	DIMC (857), LRHK (365), DSLSLR (289)
E_LATV2	AUS	DLSA (634)	DIMC (857), LRHK (365), DSLSLR (289)
E_LDP	AUS	DLDP (404)	DTEVN (403)
E_LDPE	AUS	DLDPE (409)	DLDP (404), TEBEB (378)
E_LLR	AUS	DLLR (94)	MDVERAD (55), DLDP (404)
E_LM	AUS	DHFM (108)	BBKHZ (282), BGTEV (143), CANDME (718), DLDP (404), DSLSLR (289), DTEVN (403), GGDVE (525), LRHK (365), LRAEB (461), MDVERAD (55), GGDSAS (131), DLSA (634), DLLR (94), BGMSZS (111), DMDSTP (799), EGFE (104)
E_LSH	AUS	DLSH (627)	DIMC (857), DLSAHK (645)
E_LSH2	AUS	DLSH (627)	DIMC (857), DLSAHK (645)
E_LSV	AUS	DLSV (609)	DIMC (857), TEB (380), LREB (328), DLDP (404)
E_LSV2	AUS	DLSV (609)	DIMC (857), TEB (380), LREB (328), DLDP (404)
E_LSVV	AUS	DLSVV (625)	DLDP (404)
E_MD	AUS	DMDMIL (800)	DKAT (310), DMDSTP (799)
E_MD01	AUS	DMDMIL (800)	
E_MD02	AUS	DMDMIL (800)	
E_MD03	AUS	DMDMIL (800)	
E_MD04	AUS	DMDMIL (800)	
E_MD05	AUS	DMDMIL (800)	
E_MD06	AUS	DMDMIL (800)	
E_MD07	AUS	DMDMIL (800)	
E_MD08	AUS	DMDMIL (800)	
E_MDB	AUS	MDKOG (40)	
E_MFL	AUS	GGMFL (490)	BBACC (759)
E_MILE	AUS	DMILE (837)	
E_MLE	AUS	DMLSE (818)	
E_N	AUS	DDG (568)	BBACC (759), CANDME (718), DMDSTP (799)
E_NWS	AUS	DNWS (267)	WNWEIN (254), DMDSTP (799)
E_NWS2	AUS	DNWS (267)	WNWEIN (254), DMDSTP (799)
E_NWSE	AUS	DNWSE (819)	DNWS (267), DMDSTP (799)
E_NWSE2	EIN		DNWS (267), DMDSTP (799)
E_PH	AUS	DPH (571)	DLSA (634), WNWEIN (254), DNWS (267), DLSAHK (645)
E_PH2	AUS	DPH (571)	DNWS (267), WNWEIN (254)
E_RKAT	AUS	DKVS (476)	DLDP (404)
E_RKAT2	AUS	DKVS (476)	DLDP (404)
E_RKAZ	AUS	DKVS (476)	DLDP (404)
E_RKAZ2	AUS	DKVS (476)	DLDP (404)
E_SLPE	AUS	DSLPE (823)	DSLSLR (289), LREB (328), SLS (275)
E_SLS	AUS	DSLSLR (289)	DIMC (857), LRHK (365)
E_SLS2	AUS	DSLSLR (289)	DIMC (857), LRHK (365)
E_SLV	AUS	DSLSLR (289)	
E_SLV2	AUS	DSLSLR (289)	
E_SLVE	AUS	DSLVE (821)	DSLSLR (289), SLS (275), LREB (328)
E_STA	AUS	DSTA (709)	
E_STAE	AUS	DSTAE (832)	
E_STS	AUS	DSTS (708)	
E_SWE	AUS	BGRBS (703)	DSWEC (704)
E_TA	AUS	GGTFA (681)	ATM (302), DLSA (634), BGTABST (154), DTEVN (403), GGTFUMG (684), ZWKS (212), LRAEB (461), GGTFM (674), DSLSLR (289), DLDP (404), DLLR (94), BBKHZ (282)

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Symbol	Type	Created within	Used within
E_TES	AUS	DTEVN (403)	DDMTL (411), LRAEB (461), LR (338), LLRMR (92), DSLSLR (289), DLSV (609), DLSH (627), DLSAHK (645), DLSA (634), DLLR (94), DLDP (404), DIMC (857), LRHK (365), DMDSTP (799)
E_TESB	AUS	DLDP (404)	
E_TESK	AUS	DLDP (404)	DIMC (857)
E_TEVE	AUS	DTEVE (826)	DDMTL (411), DLLR (94), DLDP (404), TEBEB (378), LRHK (365), LRAEB (461), DTEVN (403), DSLSLR (289), DLSV (609), DLSH (627), DLSAHK (645), DLSA (634), DMDSTP (799)
E_TEVE2	EIN		LRHK (365)
E_THM	AUS	DTHM (689)	
E_TKA	AUS	GGTKA (683)	DTHM (689)
E_TM	AUS	GGTFM (674)	BBKHZ (282), BGTABST (154), ZWKS (212), UETM (687), MDVERAD (55), LRAEB (461), LLRABG (100), DTHM (689), DTEVN (403), DSLSLR (289), DLSV (609), DDMTL (411), DLSA (634), DLLR (94), DLDP (404), COSA (193)
E_TUM	AUS	GGTFUMG (684)	ATM (302)
E_U5REF	AUS	DU5REF (673)	
E_UB	AUS	GGUB (671)	BGLBZ (99), MDVERAD (55), LRAEB (461), DTEVN (403), DSLSLR (289), DLSAHK (645), DLSA (634)
E_UFMV	AUS	DUF (932)	
E_UFSKA	AUS	DUF (932)	
E_URRAM	AUS	DUR (933)	
E_URROM	AUS	DUR (933)	
E_URRST	AUS	DUR (933)	
E_VFZ	AUS	DVFZ (581)	BBFGR (492), BGNLDSC (578), BBGANG (70), BGVFGR (498), DGLOR (747), DDMTL (411), WNWEIN (254), MDVERAD (55), GGVFZG (580), GGUB (671), DTHM (689), DTEVN (403), DMDLU (761), DLLR (94), DLDP (404)
E_VFZG	EIN		BGPUK (407)
FAFTEKF	LOK	BGTEV (143)	
FAFTE_W	LOK	BGTEV (143)	
FAHKATKM_W	AUS	DKAT (310)	
FALRDKT	AUS	DKAT (310)	LR (338)
FAMAL	LOK	DMDLU (761)	
FAVKATMX	LOK	LRKA (353)	
FBAKL_W	LOK	ESUK (175)	
FBANS	LOK	ESUK (175)	
FBANS_W	LOK	ESUK (175)	
FBETATE	LOK	TEB (380)	
FBKATE	LOK	TEB (380)	
FDAR	LOK	ARMD (63)	
FDMD_M	LOK	DMDFON (772)	DMDUE (760)
FFLUTN	LOK	DMDLUA (770)	
FFONN1	LOK	DMDFON (772)	
FFONN2	LOK	DMDFON (772)	
FFONN3	LOK	DMDFON (772)	
FFORN1	LOK	DMDFON (772)	
FFPL1	LOK	DMDFON (772)	
FFRI	LOK	LR (338)	
FFRI2	LOK	LR (338)	
FFZDFP	EIN		OBDSV (862), TC2MOD (868)
FGRSTATU	AUS	BBACC (759)	
FGRU	AUS	ESGRU (161)	ESVST (160), GK (158)
FGR_STAT	AUS	BBACC (759)	CANDME (718)
FGWRTE	LOK	TEB (380)	
FHO	AUS	GGDSAS (131)	DLLR (94), DTEVN (403)
FHO_W	AUS	GGDSAS (131)	BBKHZ (282), KHMD (287), MDMAX (39), DLDP (404), DSLSLR (289), BGSRM (118), BGTEV (143), DDMTL (411), EGFE (104)
FIPTES_W	LOK	DDMTL (411)	
FIVZABG	LOK	DMDMIL (800)	
FKATEAPP	LOK	TEB (380)	
FKATEFRG	LOK	TEB (380)	
FKATEI	AUS	TEB (380)	LR (338)
FKATES	LOK	TEB (380)	
FKHAB	AUS	BBKHZ (282)	
FKMSDKA_W	LOK	BGMSZS (111)	
FKMSDKS_W	LOK	BGMSZS (111)	
FKMSDK_W	EIN		FUEDK (149), BGMSZS (111)
FKS	AUS	ESKS (172)	ESVST (160), GK (158)
FKTNS	LOK	ESNST (166)	
FLAKH	AUS	BBKHZ (282)	LAKH (272)
FLAMKH	AUS	BBKHZ (282)	LAMKO (268)
FLAMSL2_W	AUS	SLS (275)	LAKH (272), LAMKO (268)
FLAMSL_W	AUS	SLS (275)	LAKH (272), LAMKO (268)
FLASKH	LOK	LAKH (272)	
FLGKAT	LOK	DMDMIL (800)	
FLGLRS	AUS	LREB (328)	DFFT (849), TC1MOD (864)
FLGLRS2	AUS	LREB (328)	DFFT (849), TC1MOD (864)
FLGTIAB	AUS	DMDMIL (800)	AES (189), AEVAB (196)
FLG_M	LOK	DMDFON (772)	DMDUE (760)
FLMSSL	AUS	SLS (275)	LAKH (272)
FLMSSLKH	LOK	LAKH (272)	

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Symbol	Type	Created within	Used within
FLMX	LOK	DMDFON (772)	
FLMXRESZ	LOK	DMDFON (772)	
FLN11_02	LOK	DMDFON (772)	
FLN11_03	LOK	DMDFON (772)	
FLN11_04	LOK	DMDFON (772)	
FLN11_05	LOK	DMDFON (772)	
FLN11_06	LOK	DMDFON (772)	
FLN11_07	LOK	DMDFON (772)	
FLN11_08	LOK	DMDFON (772)	
FLN12_02	LOK	DMDFON (772)	
FLN12_03	LOK	DMDFON (772)	
FLN12_04	LOK	DMDFON (772)	
FLN12_05	LOK	DMDFON (772)	
FLN12_06	LOK	DMDFON (772)	
FLN12_07	LOK	DMDFON (772)	
FLN12_08	LOK	DMDFON (772)	
FLN13_02	LOK	DMDFON (772)	
FLN13_03	LOK	DMDFON (772)	
FLN13_04	LOK	DMDFON (772)	
FLN13_05	LOK	DMDFON (772)	
FLN13_06	LOK	DMDFON (772)	
FLN13_07	LOK	DMDFON (772)	
FLN13_08	LOK	DMDFON (772)	
FLN21_02	LOK	DMDFON (772)	
FLN21_03	LOK	DMDFON (772)	
FLN21_04	LOK	DMDFON (772)	
FLN21_05	LOK	DMDFON (772)	
FLN21_06	LOK	DMDFON (772)	
FLN21_07	LOK	DMDFON (772)	
FLN21_08	LOK	DMDFON (772)	
FLN22_02	LOK	DMDFON (772)	
FLN22_03	LOK	DMDFON (772)	
FLN22_04	LOK	DMDFON (772)	
FLN22_05	LOK	DMDFON (772)	
FLN22_06	LOK	DMDFON (772)	
FLN22_07	LOK	DMDFON (772)	
FLN22_08	LOK	DMDFON (772)	
FLN23_02	LOK	DMDFON (772)	
FLN23_03	LOK	DMDFON (772)	
FLN23_04	LOK	DMDFON (772)	
FLN23_05	LOK	DMDFON (772)	
FLN23_06	LOK	DMDFON (772)	
FLN23_07	LOK	DMDFON (772)	
FLN23_08	LOK	DMDFON (772)	
FLN31_02	LOK	DMDFON (772)	
FLN31_03	LOK	DMDFON (772)	
FLN31_04	LOK	DMDFON (772)	
FLN31_05	LOK	DMDFON (772)	
FLN31_06	LOK	DMDFON (772)	
FLN31_07	LOK	DMDFON (772)	
FLN31_08	LOK	DMDFON (772)	
FLN32_02	LOK	DMDFON (772)	
FLN32_03	LOK	DMDFON (772)	
FLN32_04	LOK	DMDFON (772)	
FLN32_05	LOK	DMDFON (772)	
FLN32_06	LOK	DMDFON (772)	
FLN32_07	LOK	DMDFON (772)	
FLN32_08	LOK	DMDFON (772)	
FLN33_02	LOK	DMDFON (772)	
FLN33_03	LOK	DMDFON (772)	
FLN33_04	LOK	DMDFON (772)	
FLN33_05	LOK	DMDFON (772)	
FLN33_06	LOK	DMDFON (772)	
FLN33_07	LOK	DMDFON (772)	
FLN33_08	LOK	DMDFON (772)	
FLN41_02	LOK	DMDFON (772)	
FLN41_03	LOK	DMDFON (772)	
FLN41_04	LOK	DMDFON (772)	
FLN41_05	LOK	DMDFON (772)	
FLN41_06	LOK	DMDFON (772)	
FLN41_07	LOK	DMDFON (772)	
FLN41_08	LOK	DMDFON (772)	
FLN42_02	LOK	DMDFON (772)	
FLN42_03	LOK	DMDFON (772)	
FLN42_04	LOK	DMDFON (772)	
FLN42_05	LOK	DMDFON (772)	
FLN42_06	LOK	DMDFON (772)	
FLN42_07	LOK	DMDFON (772)	
FLN42_08	LOK	DMDFON (772)	
FLN43_02	LOK	DMDFON (772)	
FLN43_03	LOK	DMDFON (772)	

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Symbol	Type	Created within	Used within
FLN43_04	LOK	DMDFON (772)	
FLN43_05	LOK	DMDFON (772)	
FLN43_06	LOK	DMDFON (772)	
FLN43_07	LOK	DMDFON (772)	
FLN43_08	LOK	DMDFON (772)	
FLN51_02	LOK	DMDFON (772)	
FLN51_03	LOK	DMDFON (772)	
FLN51_04	LOK	DMDFON (772)	
FLN51_05	LOK	DMDFON (772)	
FLN51_06	LOK	DMDFON (772)	
FLN51_07	LOK	DMDFON (772)	
FLN51_08	LOK	DMDFON (772)	
FLN52_02	LOK	DMDFON (772)	
FLN52_03	LOK	DMDFON (772)	
FLN52_04	LOK	DMDFON (772)	
FLN52_05	LOK	DMDFON (772)	
FLN52_06	LOK	DMDFON (772)	
FLN52_07	LOK	DMDFON (772)	
FLN52_08	LOK	DMDFON (772)	
FLN53_02	LOK	DMDFON (772)	
FLN53_03	LOK	DMDFON (772)	
FLN53_04	LOK	DMDFON (772)	
FLN53_05	LOK	DMDFON (772)	
FLN53_06	LOK	DMDFON (772)	
FLN53_07	LOK	DMDFON (772)	
FLN53_08	LOK	DMDFON (772)	
FLN61_02	LOK	DMDFON (772)	
FLN61_03	LOK	DMDFON (772)	
FLN61_04	LOK	DMDFON (772)	
FLN61_05	LOK	DMDFON (772)	
FLN61_06	LOK	DMDFON (772)	
FLN61_07	LOK	DMDFON (772)	
FLN61_08	LOK	DMDFON (772)	
FLN62_02	LOK	DMDFON (772)	
FLN62_03	LOK	DMDFON (772)	
FLN62_04	LOK	DMDFON (772)	
FLN62_05	LOK	DMDFON (772)	
FLN62_06	LOK	DMDFON (772)	
FLN62_07	LOK	DMDFON (772)	
FLN62_08	LOK	DMDFON (772)	
FLN63_02	LOK	DMDFON (772)	
FLN63_03	LOK	DMDFON (772)	
FLN63_04	LOK	DMDFON (772)	
FLN63_05	LOK	DMDFON (772)	
FLN63_06	LOK	DMDFON (772)	
FLN63_07	LOK	DMDFON (772)	
FLN63_08	LOK	DMDFON (772)	
FLN71_02	LOK	DMDFON (772)	
FLN71_03	LOK	DMDFON (772)	
FLN71_04	LOK	DMDFON (772)	
FLN71_05	LOK	DMDFON (772)	
FLN71_06	LOK	DMDFON (772)	
FLN71_07	LOK	DMDFON (772)	
FLN71_08	LOK	DMDFON (772)	
FLN72_02	LOK	DMDFON (772)	
FLN72_03	LOK	DMDFON (772)	
FLN72_04	LOK	DMDFON (772)	
FLN72_05	LOK	DMDFON (772)	
FLN72_06	LOK	DMDFON (772)	
FLN72_07	LOK	DMDFON (772)	
FLN72_08	LOK	DMDFON (772)	
FLN73_02	LOK	DMDFON (772)	
FLN73_03	LOK	DMDFON (772)	
FLN73_04	LOK	DMDFON (772)	
FLN73_05	LOK	DMDFON (772)	
FLN73_06	LOK	DMDFON (772)	
FLN73_07	LOK	DMDFON (772)	
FLN73_08	LOK	DMDFON (772)	
FLN81_02	LOK	DMDFON (772)	
FLN81_03	LOK	DMDFON (772)	
FLN81_04	LOK	DMDFON (772)	
FLN81_05	LOK	DMDFON (772)	
FLN81_06	LOK	DMDFON (772)	
FLN81_07	LOK	DMDFON (772)	
FLN81_08	LOK	DMDFON (772)	
FLN82_02	LOK	DMDFON (772)	
FLN82_03	LOK	DMDFON (772)	
FLN82_04	LOK	DMDFON (772)	
FLN82_05	LOK	DMDFON (772)	
FLN82_06	LOK	DMDFON (772)	
FLN82_07	LOK	DMDFON (772)	

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Symbol	Type	Created within	Used within
FLN82_08	LOK	DMDFON (772)	
FLN83_02	LOK	DMDFON (772)	
FLN83_03	LOK	DMDFON (772)	
FLN83_04	LOK	DMDFON (772)	
FLN83_05	LOK	DMDFON (772)	
FLN83_06	LOK	DMDFON (772)	
FLN83_07	LOK	DMDFON (772)	
FLN83_08	LOK	DMDFON (772)	
FLP11_02	LOK	DMDFON (772)	
FLP11_03	LOK	DMDFON (772)	
FLP11_04	LOK	DMDFON (772)	
FLP11_05	LOK	DMDFON (772)	
FLP11_06	LOK	DMDFON (772)	
FLP11_07	LOK	DMDFON (772)	
FLP11_08	LOK	DMDFON (772)	
FLP12_02	LOK	DMDFON (772)	
FLP12_03	LOK	DMDFON (772)	
FLP12_04	LOK	DMDFON (772)	
FLP12_05	LOK	DMDFON (772)	
FLP12_06	LOK	DMDFON (772)	
FLP12_07	LOK	DMDFON (772)	
FLP12_08	LOK	DMDFON (772)	
FLP13_02	LOK	DMDFON (772)	
FLP13_03	LOK	DMDFON (772)	
FLP13_04	LOK	DMDFON (772)	
FLP13_05	LOK	DMDFON (772)	
FLP13_06	LOK	DMDFON (772)	
FLP13_07	LOK	DMDFON (772)	
FLP13_08	LOK	DMDFON (772)	
FLP21_02	LOK	DMDFON (772)	
FLP21_03	LOK	DMDFON (772)	
FLP21_04	LOK	DMDFON (772)	
FLP21_05	LOK	DMDFON (772)	
FLP21_06	LOK	DMDFON (772)	
FLP21_07	LOK	DMDFON (772)	
FLP21_08	LOK	DMDFON (772)	
FLP22_02	LOK	DMDFON (772)	
FLP22_03	LOK	DMDFON (772)	
FLP22_04	LOK	DMDFON (772)	
FLP22_05	LOK	DMDFON (772)	
FLP22_06	LOK	DMDFON (772)	
FLP22_07	LOK	DMDFON (772)	
FLP22_08	LOK	DMDFON (772)	
FLP23_02	LOK	DMDFON (772)	
FLP23_03	LOK	DMDFON (772)	
FLP23_04	LOK	DMDFON (772)	
FLP23_05	LOK	DMDFON (772)	
FLP23_06	LOK	DMDFON (772)	
FLP23_07	LOK	DMDFON (772)	
FLP23_08	LOK	DMDFON (772)	
FLP31_02	LOK	DMDFON (772)	
FLP31_03	LOK	DMDFON (772)	
FLP31_04	LOK	DMDFON (772)	
FLP31_05	LOK	DMDFON (772)	
FLP31_06	LOK	DMDFON (772)	
FLP31_07	LOK	DMDFON (772)	
FLP31_08	LOK	DMDFON (772)	
FLP32_02	LOK	DMDFON (772)	
FLP32_03	LOK	DMDFON (772)	
FLP32_04	LOK	DMDFON (772)	
FLP32_05	LOK	DMDFON (772)	
FLP32_06	LOK	DMDFON (772)	
FLP32_07	LOK	DMDFON (772)	
FLP32_08	LOK	DMDFON (772)	
FLP33_02	LOK	DMDFON (772)	
FLP33_03	LOK	DMDFON (772)	
FLP33_04	LOK	DMDFON (772)	
FLP33_05	LOK	DMDFON (772)	
FLP33_06	LOK	DMDFON (772)	
FLP33_07	LOK	DMDFON (772)	
FLP33_08	LOK	DMDFON (772)	
FLP41_02	LOK	DMDFON (772)	
FLP41_03	LOK	DMDFON (772)	
FLP41_04	LOK	DMDFON (772)	
FLP41_05	LOK	DMDFON (772)	
FLP41_06	LOK	DMDFON (772)	
FLP41_07	LOK	DMDFON (772)	
FLP41_08	LOK	DMDFON (772)	
FLP42_02	LOK	DMDFON (772)	
FLP42_03	LOK	DMDFON (772)	
FLP42_04	LOK	DMDFON (772)	

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Symbol	Type	Created within	Used within
FLP42_05	LOK	DMDFON (772)	
FLP42_06	LOK	DMDFON (772)	
FLP42_07	LOK	DMDFON (772)	
FLP42_08	LOK	DMDFON (772)	
FLP43_02	LOK	DMDFON (772)	
FLP43_03	LOK	DMDFON (772)	
FLP43_04	LOK	DMDFON (772)	
FLP43_05	LOK	DMDFON (772)	
FLP43_06	LOK	DMDFON (772)	
FLP43_07	LOK	DMDFON (772)	
FLP43_08	LOK	DMDFON (772)	
FLP51_02	LOK	DMDFON (772)	
FLP51_03	LOK	DMDFON (772)	
FLP51_04	LOK	DMDFON (772)	
FLP51_05	LOK	DMDFON (772)	
FLP51_06	LOK	DMDFON (772)	
FLP51_07	LOK	DMDFON (772)	
FLP51_08	LOK	DMDFON (772)	
FLP52_02	LOK	DMDFON (772)	
FLP52_03	LOK	DMDFON (772)	
FLP52_04	LOK	DMDFON (772)	
FLP52_05	LOK	DMDFON (772)	
FLP52_06	LOK	DMDFON (772)	
FLP52_07	LOK	DMDFON (772)	
FLP52_08	LOK	DMDFON (772)	
FLP53_02	LOK	DMDFON (772)	
FLP53_03	LOK	DMDFON (772)	
FLP53_04	LOK	DMDFON (772)	
FLP53_05	LOK	DMDFON (772)	
FLP53_06	LOK	DMDFON (772)	
FLP53_07	LOK	DMDFON (772)	
FLP53_08	LOK	DMDFON (772)	
FLP61_02	LOK	DMDFON (772)	
FLP61_03	LOK	DMDFON (772)	
FLP61_04	LOK	DMDFON (772)	
FLP61_05	LOK	DMDFON (772)	
FLP61_06	LOK	DMDFON (772)	
FLP61_07	LOK	DMDFON (772)	
FLP61_08	LOK	DMDFON (772)	
FLP62_02	LOK	DMDFON (772)	
FLP62_03	LOK	DMDFON (772)	
FLP62_04	LOK	DMDFON (772)	
FLP62_05	LOK	DMDFON (772)	
FLP62_06	LOK	DMDFON (772)	
FLP62_07	LOK	DMDFON (772)	
FLP62_08	LOK	DMDFON (772)	
FLP63_02	LOK	DMDFON (772)	
FLP63_03	LOK	DMDFON (772)	
FLP63_04	LOK	DMDFON (772)	
FLP63_05	LOK	DMDFON (772)	
FLP63_06	LOK	DMDFON (772)	
FLP63_07	LOK	DMDFON (772)	
FLP63_08	LOK	DMDFON (772)	
FLP71_02	LOK	DMDFON (772)	
FLP71_03	LOK	DMDFON (772)	
FLP71_04	LOK	DMDFON (772)	
FLP71_05	LOK	DMDFON (772)	
FLP71_06	LOK	DMDFON (772)	
FLP71_07	LOK	DMDFON (772)	
FLP71_08	LOK	DMDFON (772)	
FLP72_02	LOK	DMDFON (772)	
FLP72_03	LOK	DMDFON (772)	
FLP72_04	LOK	DMDFON (772)	
FLP72_05	LOK	DMDFON (772)	
FLP72_06	LOK	DMDFON (772)	
FLP72_07	LOK	DMDFON (772)	
FLP72_08	LOK	DMDFON (772)	
FLP73_02	LOK	DMDFON (772)	
FLP73_03	LOK	DMDFON (772)	
FLP73_04	LOK	DMDFON (772)	
FLP73_05	LOK	DMDFON (772)	
FLP73_06	LOK	DMDFON (772)	
FLP73_07	LOK	DMDFON (772)	
FLP73_08	LOK	DMDFON (772)	
FLP81_02	LOK	DMDFON (772)	
FLP81_03	LOK	DMDFON (772)	
FLP81_04	LOK	DMDFON (772)	
FLP81_05	LOK	DMDFON (772)	
FLP81_06	LOK	DMDFON (772)	
FLP81_07	LOK	DMDFON (772)	
FLP81_08	LOK	DMDFON (772)	

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Symbol	Type	Created within	Used within
FLP82_02	LOK	DMDFON (772)	
FLP82_03	LOK	DMDFON (772)	
FLP82_04	LOK	DMDFON (772)	
FLP82_05	LOK	DMDFON (772)	
FLP82_06	LOK	DMDFON (772)	
FLP82_07	LOK	DMDFON (772)	
FLP82_08	LOK	DMDFON (772)	
FLP83_02	LOK	DMDFON (772)	
FLP83_03	LOK	DMDFON (772)	
FLP83_04	LOK	DMDFON (772)	
FLP83_05	LOK	DMDFON (772)	
FLP83_06	LOK	DMDFON (772)	
FLP83_07	LOK	DMDFON (772)	
FLP83_08	LOK	DMDFON (772)	
FLRAR	LOK	ARMD (63)	
FLR_AP	EIN		LR (338)
FLURKH	LOK	DMDLU (761)	
FLUTS1	LOK	DMDLUA (770)	
FLUTS2	LOK	DMDLUA (770)	
FLUTS3	LOK	DMDLUA (770)	
FLUTS4	LOK	DMDLUA (770)	
FLUTS5	LOK	DMDLUA (770)	
FLUTS6	LOK	DMDLUA (770)	
FLUTS7	LOK	DMDLUA (770)	
FLUTS8	LOK	DMDLUA (770)	
FMDKH	AUS	BBKHZ (282)	KHMD (287)
FMDKHTNS	DOK	BBKHZ (282)	
FMIACC_W	DOK	BGMRACC (758)	
FMIBGRV_W	AUS	MDIHGS (68)	
FMIBGR_W	AUS	MDIHGS (68)	
FMIL_W	DOK	MDFAW (31)	
FMKHFHO_W	LOK	KHMD (287)	
FMKHTM	LOK	KHMD (287)	
FMSAGD	LOK	SLS (275)	
FMSLA	AUS	DSLSLR (289)	SLS (275)
FMSLA2	AUS	DSLSLR (289)	SLS (275)
FMSLAV	LOK	DSLSLR (289)	
FMSLAV2	LOK	DSLSLR (289)	
FMSLDYN	EIN		LAKH (272), SLS (275)
FMSLRHO	LOK	SLS (275)	
FMSLTM	LOK	SLS (275)	
FNGWRTE	LOK	TEB (380)	
FNS	AUS	ESNST (166)	ESVST (160), GK (158)
FNSTAB_W	AUS	MDNSTAB (59)	MDMIN (51)
FNWUE	AUS	WNWEIN (254)	MDBAS (50), ZWGRU (208)
FOSTAT	AUS	DMDFON (772)	DMDDLU (766), DMDLU (761)
FPRSTEP_C	LOK	BGDVE (534)	
FPRTIM_C	LOK	BGDVE (534)	
FPUK	LOK	GGHFM (105)	
FPVDK	AUS	BGMSZS (111)	
FPVDKDS	AUS	GGDSAS (131)	GGDVE (525)
FPVDKDSL_W	AUS	GGDSAS (131)	
FPVDKDSU_W	AUS	GGDSAS (131)	
FPVDKDS_W	AUS	GGDSAS (131)	BGMSZS (111)
FPVDK_W	AUS	BGMSZS (111)	EGFE (104), BGRML (854), TC1MOD (864)
FQML	AUS	MLS (695)	
FR	LOK	GKRA (327)	
FR2_U	AUS	DFFTCNV (852)	DFFT (849)
FR2_W	AUS	GKRA (327)	LR (338), DFFTCNV (852), DLSVV (625), DKAT (310), TC1MOD (864), TC2MOD (868), LREB (328), GK (158)
FRA	LOK	GKRA (327)	
FRA2_U	AUS	DFFTCNV (852)	DFFT (849)
FRA2_W	AUS	GKRA (327)	LRA (463), DFFTCNV (852), TC2MOD (868), TC1MOD (864), GK (158)
FRAO2_W	AUS	LRA (463)	DKVS (476), EEDAT (943), GKRA (327)
FRAO_W	AUS	LRA (463)	DKVS (476), EEDAT (943), GKRA (327)
FRAU2_W	AUS	LRA (463)	DKVS (476), EEDAT (943), GKRA (327)
FRAUZS2_W	LOK	DKVS (476)	
FRAUZS_W	LOK	DKVS (476)	
FRAU_W	AUS	LRA (463)	DKVS (476), EEDAT (943), GKRA (327)
FRA_U	AUS	DFFTCNV (852)	DFFT (849)
FRA_W	AUS	GKRA (327)	LRA (463), DFFTCNV (852), TC2MOD (868), TC1MOD (864), GK (158)
FRBAND2_W	LOK	LR (338)	
FRBAND_W	LOK	LR (338)	
FRDTER_W	EIN		LRINI (352), GKRA (327)
FREGFTE	LOK	TEB (380)	
FRHODKR_W	LOK	FUEDK (149)	
FRHODK_W	AUS	BGMSZS (111)	BGRLP (125), FUEDK (149)
FRHOLK_W	LOK	BGRLP (125)	
FRHOL_W	AUS	EGFE (104)	GGDSAS (131), SLS (275)
FRI	LOK	LR (338)	
FRI2	LOK	LR (338)	
FRIBAND2_W	LOK	LR (338)	

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Symbol	Type	Created within	Used within
FRIBAND_W	LOK	LR (338)	
FRIINT	LOK	LR (338)	
FRIINT2	LOK	LR (338)	
FRINI2_W	AUS	LRINI (352)	LR (338)
FRINI_W	AUS	LRINI (352)	LR (338), GKRA (327)
FRINT2_W	LOK	LR (338)	
FRINT_W	LOK	LR (338)	
FRKTE	EIN		KVA (713), RKTI (192), AES (189)
FRM2_U	AUS	DFFTCNV (852)	
FRM2_W	AUS	LR (338)	DFFTCNV (852), DKVS (476), TEB (380), LRA (463), DSLSLR (289), DLSAHK (645), GKRA (327)
FRMIT	LOK	TEB (380)	
FRMIT_W	AUS	TEB (380)	
FRMN2_W	AUS	LR (338)	
FRMN_W	AUS	LR (338)	
FRMTRIP2_W	LOK	DLSAHK (645)	
FRMTRIP_W	LOK	DLSAHK (645)	
FRMX2_W	AUS	LR (338)	
FRMXA	LOK	TEB (380)	
FRMXAOLD_W	LOK	TEB (380)	
FRMXA_W	AUS	TEB (380)	
FRMX_W	AUS	LR (338)	
FRM_U	AUS	DFFTCNV (852)	
FRM_W	AUS	LR (338)	DFFTCNV (852), DSLSLR (289), DLSAHK (645), TEB (380), LRA (463), DKVS (476), GKRA (327)
FRP	LOK	LR (338)	
FRP2	LOK	LR (338)	
FRPINT	LOK	LR (338)	
FRPINT2	LOK	LR (338)	
FRSP2_W	LOK	LR (338)	
FRSP_W	LOK	LR (338)	
FRTV	LOK	LR (338)	
FRTV2	LOK	LR (338)	
FR_U	AUS	DFFTCNV (852)	DFFT (849)
FR_W	AUS	GKRA (327)	LR (338), DFFTCNV (852), DKAT (310), DLSVV (625), LREB (328), TC2MOD (868), TC1MOD (864), GK (158)
FS11_02	LOK	DMDFON (772)	
FS11_03	LOK	DMDFON (772)	
FS11_04	LOK	DMDFON (772)	
FS11_05	LOK	DMDFON (772)	
FS11_06	LOK	DMDFON (772)	
FS11_07	LOK	DMDFON (772)	
FS11_08	LOK	DMDFON (772)	
FS12_02	LOK	DMDFON (772)	
FS12_03	LOK	DMDFON (772)	
FS12_04	LOK	DMDFON (772)	
FS12_05	LOK	DMDFON (772)	
FS12_06	LOK	DMDFON (772)	
FS12_07	LOK	DMDFON (772)	
FS12_08	LOK	DMDFON (772)	
FS13_02	LOK	DMDFON (772)	
FS13_03	LOK	DMDFON (772)	
FS13_04	LOK	DMDFON (772)	
FS13_05	LOK	DMDFON (772)	
FS13_06	LOK	DMDFON (772)	
FS13_07	LOK	DMDFON (772)	
FS13_08	LOK	DMDFON (772)	
FS21_02	LOK	DMDFON (772)	
FS21_03	LOK	DMDFON (772)	
FS21_04	LOK	DMDFON (772)	
FS21_05	LOK	DMDFON (772)	
FS21_06	LOK	DMDFON (772)	
FS21_07	LOK	DMDFON (772)	
FS21_08	LOK	DMDFON (772)	
FS22_02	LOK	DMDFON (772)	
FS22_03	LOK	DMDFON (772)	
FS22_04	LOK	DMDFON (772)	
FS22_05	LOK	DMDFON (772)	
FS22_06	LOK	DMDFON (772)	
FS22_07	LOK	DMDFON (772)	
FS22_08	LOK	DMDFON (772)	
FS23_02	LOK	DMDFON (772)	
FS23_03	LOK	DMDFON (772)	
FS23_04	LOK	DMDFON (772)	
FS23_05	LOK	DMDFON (772)	
FS23_06	LOK	DMDFON (772)	
FS23_07	LOK	DMDFON (772)	
FS23_08	LOK	DMDFON (772)	
FS31_02	LOK	DMDFON (772)	
FS31_03	LOK	DMDFON (772)	
FS31_04	LOK	DMDFON (772)	
FS31_05	LOK	DMDFON (772)	

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Symbol	Type	Created within	Used within
FS31_06	LOK	DMDFON (772)	
FS31_07	LOK	DMDFON (772)	
FS31_08	LOK	DMDFON (772)	
FS32_02	LOK	DMDFON (772)	
FS32_03	LOK	DMDFON (772)	
FS32_04	LOK	DMDFON (772)	
FS32_05	LOK	DMDFON (772)	
FS32_06	LOK	DMDFON (772)	
FS32_07	LOK	DMDFON (772)	
FS32_08	LOK	DMDFON (772)	
FS33_02	LOK	DMDFON (772)	
FS33_03	LOK	DMDFON (772)	
FS33_04	LOK	DMDFON (772)	
FS33_05	LOK	DMDFON (772)	
FS33_06	LOK	DMDFON (772)	
FS33_07	LOK	DMDFON (772)	
FS33_08	LOK	DMDFON (772)	
FS41_02	LOK	DMDFON (772)	
FS41_03	LOK	DMDFON (772)	
FS41_04	LOK	DMDFON (772)	
FS41_05	LOK	DMDFON (772)	
FS41_06	LOK	DMDFON (772)	
FS41_07	LOK	DMDFON (772)	
FS41_08	LOK	DMDFON (772)	
FS42_02	LOK	DMDFON (772)	
FS42_03	LOK	DMDFON (772)	
FS42_04	LOK	DMDFON (772)	
FS42_05	LOK	DMDFON (772)	
FS42_06	LOK	DMDFON (772)	
FS42_07	LOK	DMDFON (772)	
FS42_08	LOK	DMDFON (772)	
FS43_02	LOK	DMDFON (772)	
FS43_03	LOK	DMDFON (772)	
FS43_04	LOK	DMDFON (772)	
FS43_05	LOK	DMDFON (772)	
FS43_06	LOK	DMDFON (772)	
FS43_07	LOK	DMDFON (772)	
FS43_08	LOK	DMDFON (772)	
FS51_02	LOK	DMDFON (772)	
FS51_03	LOK	DMDFON (772)	
FS51_04	LOK	DMDFON (772)	
FS51_05	LOK	DMDFON (772)	
FS51_06	LOK	DMDFON (772)	
FS51_07	LOK	DMDFON (772)	
FS51_08	LOK	DMDFON (772)	
FS52_02	LOK	DMDFON (772)	
FS52_03	LOK	DMDFON (772)	
FS52_04	LOK	DMDFON (772)	
FS52_05	LOK	DMDFON (772)	
FS52_06	LOK	DMDFON (772)	
FS52_07	LOK	DMDFON (772)	
FS52_08	LOK	DMDFON (772)	
FS53_02	LOK	DMDFON (772)	
FS53_03	LOK	DMDFON (772)	
FS53_04	LOK	DMDFON (772)	
FS53_05	LOK	DMDFON (772)	
FS53_06	LOK	DMDFON (772)	
FS53_07	LOK	DMDFON (772)	
FS53_08	LOK	DMDFON (772)	
FS61_02	LOK	DMDFON (772)	
FS61_03	LOK	DMDFON (772)	
FS61_04	LOK	DMDFON (772)	
FS61_05	LOK	DMDFON (772)	
FS61_06	LOK	DMDFON (772)	
FS61_07	LOK	DMDFON (772)	
FS61_08	LOK	DMDFON (772)	
FS62_02	LOK	DMDFON (772)	
FS62_03	LOK	DMDFON (772)	
FS62_04	LOK	DMDFON (772)	
FS62_05	LOK	DMDFON (772)	
FS62_06	LOK	DMDFON (772)	
FS62_07	LOK	DMDFON (772)	
FS62_08	LOK	DMDFON (772)	
FS63_02	LOK	DMDFON (772)	
FS63_03	LOK	DMDFON (772)	
FS63_04	LOK	DMDFON (772)	
FS63_05	LOK	DMDFON (772)	
FS63_06	LOK	DMDFON (772)	
FS63_07	LOK	DMDFON (772)	
FS63_08	LOK	DMDFON (772)	
FS71_02	LOK	DMDFON (772)	

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Symbol	Type	Created within	Used within
FS71_03	LOK	DMDFON (772)	
FS71_04	LOK	DMDFON (772)	
FS71_05	LOK	DMDFON (772)	
FS71_06	LOK	DMDFON (772)	
FS71_07	LOK	DMDFON (772)	
FS71_08	LOK	DMDFON (772)	
FS72_02	LOK	DMDFON (772)	
FS72_03	LOK	DMDFON (772)	
FS72_04	LOK	DMDFON (772)	
FS72_05	LOK	DMDFON (772)	
FS72_06	LOK	DMDFON (772)	
FS72_07	LOK	DMDFON (772)	
FS72_08	LOK	DMDFON (772)	
FS73_02	LOK	DMDFON (772)	
FS73_03	LOK	DMDFON (772)	
FS73_04	LOK	DMDFON (772)	
FS73_05	LOK	DMDFON (772)	
FS73_06	LOK	DMDFON (772)	
FS73_07	LOK	DMDFON (772)	
FS73_08	LOK	DMDFON (772)	
FS81_02	LOK	DMDFON (772)	
FS81_03	LOK	DMDFON (772)	
FS81_04	LOK	DMDFON (772)	
FS81_05	LOK	DMDFON (772)	
FS81_06	LOK	DMDFON (772)	
FS81_07	LOK	DMDFON (772)	
FS81_08	LOK	DMDFON (772)	
FS82_02	LOK	DMDFON (772)	
FS82_03	LOK	DMDFON (772)	
FS82_04	LOK	DMDFON (772)	
FS82_05	LOK	DMDFON (772)	
FS82_06	LOK	DMDFON (772)	
FS82_07	LOK	DMDFON (772)	
FS82_08	LOK	DMDFON (772)	
FS83_02	LOK	DMDFON (772)	
FS83_03	LOK	DMDFON (772)	
FS83_04	LOK	DMDFON (772)	
FS83_05	LOK	DMDFON (772)	
FS83_06	LOK	DMDFON (772)	
FS83_07	LOK	DMDFON (772)	
FS83_08	LOK	DMDFON (772)	
FSE	LOK	DMDFON (772)	
FSE11_02	LOK	DMDFON (772)	
FSE11_03	LOK	DMDFON (772)	
FSE11_04	LOK	DMDFON (772)	
FSE11_05	LOK	DMDFON (772)	
FSE11_06	LOK	DMDFON (772)	
FSE11_07	LOK	DMDFON (772)	
FSE11_08	LOK	DMDFON (772)	
FSE12_02	LOK	DMDFON (772)	
FSE12_03	LOK	DMDFON (772)	
FSE12_04	LOK	DMDFON (772)	
FSE12_05	LOK	DMDFON (772)	
FSE12_06	LOK	DMDFON (772)	
FSE12_07	LOK	DMDFON (772)	
FSE12_08	LOK	DMDFON (772)	
FSE13_02	LOK	DMDFON (772)	
FSE13_03	LOK	DMDFON (772)	
FSE13_04	LOK	DMDFON (772)	
FSE13_05	LOK	DMDFON (772)	
FSE13_06	LOK	DMDFON (772)	
FSE13_07	LOK	DMDFON (772)	
FSE13_08	LOK	DMDFON (772)	
FSE21_02	LOK	DMDFON (772)	
FSE21_03	LOK	DMDFON (772)	
FSE21_04	LOK	DMDFON (772)	
FSE21_05	LOK	DMDFON (772)	
FSE21_06	LOK	DMDFON (772)	
FSE21_07	LOK	DMDFON (772)	
FSE21_08	LOK	DMDFON (772)	
FSE22_02	LOK	DMDFON (772)	
FSE22_03	LOK	DMDFON (772)	
FSE22_04	LOK	DMDFON (772)	
FSE22_05	LOK	DMDFON (772)	
FSE22_06	LOK	DMDFON (772)	
FSE22_07	LOK	DMDFON (772)	
FSE22_08	LOK	DMDFON (772)	
FSE23_02	LOK	DMDFON (772)	
FSE23_03	LOK	DMDFON (772)	
FSE23_04	LOK	DMDFON (772)	
FSE23_05	LOK	DMDFON (772)	

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Symbol	Type	Created within	Used within
FSE23_06	LOK	DMDFON (772)	
FSE23_07	LOK	DMDFON (772)	
FSE23_08	LOK	DMDFON (772)	
FSE31_02	LOK	DMDFON (772)	
FSE31_03	LOK	DMDFON (772)	
FSE31_04	LOK	DMDFON (772)	
FSE31_05	LOK	DMDFON (772)	
FSE31_06	LOK	DMDFON (772)	
FSE31_07	LOK	DMDFON (772)	
FSE31_08	LOK	DMDFON (772)	
FSE32_02	LOK	DMDFON (772)	
FSE32_03	LOK	DMDFON (772)	
FSE32_04	LOK	DMDFON (772)	
FSE32_05	LOK	DMDFON (772)	
FSE32_06	LOK	DMDFON (772)	
FSE32_07	LOK	DMDFON (772)	
FSE32_08	LOK	DMDFON (772)	
FSE33_02	LOK	DMDFON (772)	
FSE33_03	LOK	DMDFON (772)	
FSE33_04	LOK	DMDFON (772)	
FSE33_05	LOK	DMDFON (772)	
FSE33_06	LOK	DMDFON (772)	
FSE33_07	LOK	DMDFON (772)	
FSE33_08	LOK	DMDFON (772)	
FSE41_02	LOK	DMDFON (772)	
FSE41_03	LOK	DMDFON (772)	
FSE41_04	LOK	DMDFON (772)	
FSE41_05	LOK	DMDFON (772)	
FSE41_06	LOK	DMDFON (772)	
FSE41_07	LOK	DMDFON (772)	
FSE41_08	LOK	DMDFON (772)	
FSE42_02	LOK	DMDFON (772)	
FSE42_03	LOK	DMDFON (772)	
FSE42_04	LOK	DMDFON (772)	
FSE42_05	LOK	DMDFON (772)	
FSE42_06	LOK	DMDFON (772)	
FSE42_07	LOK	DMDFON (772)	
FSE42_08	LOK	DMDFON (772)	
FSE43_02	LOK	DMDFON (772)	
FSE43_03	LOK	DMDFON (772)	
FSE43_04	LOK	DMDFON (772)	
FSE43_05	LOK	DMDFON (772)	
FSE43_06	LOK	DMDFON (772)	
FSE43_07	LOK	DMDFON (772)	
FSE43_08	LOK	DMDFON (772)	
FSE51_02	LOK	DMDFON (772)	
FSE51_03	LOK	DMDFON (772)	
FSE51_04	LOK	DMDFON (772)	
FSE51_05	LOK	DMDFON (772)	
FSE51_06	LOK	DMDFON (772)	
FSE51_07	LOK	DMDFON (772)	
FSE51_08	LOK	DMDFON (772)	
FSE52_02	LOK	DMDFON (772)	
FSE52_03	LOK	DMDFON (772)	
FSE52_04	LOK	DMDFON (772)	
FSE52_05	LOK	DMDFON (772)	
FSE52_06	LOK	DMDFON (772)	
FSE52_07	LOK	DMDFON (772)	
FSE52_08	LOK	DMDFON (772)	
FSE53_02	LOK	DMDFON (772)	
FSE53_03	LOK	DMDFON (772)	
FSE53_04	LOK	DMDFON (772)	
FSE53_05	LOK	DMDFON (772)	
FSE53_06	LOK	DMDFON (772)	
FSE53_07	LOK	DMDFON (772)	
FSE53_08	LOK	DMDFON (772)	
FSE61_02	LOK	DMDFON (772)	
FSE61_03	LOK	DMDFON (772)	
FSE61_04	LOK	DMDFON (772)	
FSE61_05	LOK	DMDFON (772)	
FSE61_06	LOK	DMDFON (772)	
FSE61_07	LOK	DMDFON (772)	
FSE61_08	LOK	DMDFON (772)	
FSE62_02	LOK	DMDFON (772)	
FSE62_03	LOK	DMDFON (772)	
FSE62_04	LOK	DMDFON (772)	
FSE62_05	LOK	DMDFON (772)	
FSE62_06	LOK	DMDFON (772)	
FSE62_07	LOK	DMDFON (772)	
FSE62_08	LOK	DMDFON (772)	
FSE63_02	LOK	DMDFON (772)	

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Symbol	Type	Created within	Used within
FSE63_03	LOK	DMDFON (772)	
FSE63_04	LOK	DMDFON (772)	
FSE63_05	LOK	DMDFON (772)	
FSE63_06	LOK	DMDFON (772)	
FSE63_07	LOK	DMDFON (772)	
FSE63_08	LOK	DMDFON (772)	
FSE71_02	LOK	DMDFON (772)	
FSE71_03	LOK	DMDFON (772)	
FSE71_04	LOK	DMDFON (772)	
FSE71_05	LOK	DMDFON (772)	
FSE71_06	LOK	DMDFON (772)	
FSE71_07	LOK	DMDFON (772)	
FSE71_08	LOK	DMDFON (772)	
FSE72_02	LOK	DMDFON (772)	
FSE72_03	LOK	DMDFON (772)	
FSE72_04	LOK	DMDFON (772)	
FSE72_05	LOK	DMDFON (772)	
FSE72_06	LOK	DMDFON (772)	
FSE72_07	LOK	DMDFON (772)	
FSE72_08	LOK	DMDFON (772)	
FSE73_02	LOK	DMDFON (772)	
FSE73_03	LOK	DMDFON (772)	
FSE73_04	LOK	DMDFON (772)	
FSE73_05	LOK	DMDFON (772)	
FSE73_06	LOK	DMDFON (772)	
FSE73_07	LOK	DMDFON (772)	
FSE73_08	LOK	DMDFON (772)	
FSE81_02	LOK	DMDFON (772)	
FSE81_03	LOK	DMDFON (772)	
FSE81_04	LOK	DMDFON (772)	
FSE81_05	LOK	DMDFON (772)	
FSE81_06	LOK	DMDFON (772)	
FSE81_07	LOK	DMDFON (772)	
FSE81_08	LOK	DMDFON (772)	
FSE82_02	LOK	DMDFON (772)	
FSE82_03	LOK	DMDFON (772)	
FSE82_04	LOK	DMDFON (772)	
FSE82_05	LOK	DMDFON (772)	
FSE82_06	LOK	DMDFON (772)	
FSE82_07	LOK	DMDFON (772)	
FSE82_08	LOK	DMDFON (772)	
FSE83_02	LOK	DMDFON (772)	
FSE83_03	LOK	DMDFON (772)	
FSE83_04	LOK	DMDFON (772)	
FSE83_05	LOK	DMDFON (772)	
FSE83_06	LOK	DMDFON (772)	
FSE83_07	LOK	DMDFON (772)	
FSE83_08	LOK	DMDFON (772)	
FSLPDYN	AUS	SLS (275)	LAKH (272)
FSLSDYN	LOK	LAKH (272)	
FSP_CL	EIN		DDMTL (411), DLDP (404)
FSP_CLP	LOK	DHDMTE (440)	
FST0_W	DOK	ESSTT (162)	
FSTADF_W	LOK	GGFSTT (443)	
FSTAKT_W	LOK	DFSTT (449)	
FSTALT_W	LOK	DFSTT (449)	
FSTHIN_W	LOK	DFSTT (449)	
FSTNEU_W	LOK	DFSTT (449)	
FSTT	AUS	GGFSTT (443)	
FSTTAF_W	LOK	GGFSTT (443)	
FSTTIN_W	LOK	DFSTT (449)	
FSTTVAL_W	LOK	GGFSTT (443)	
FSTT_W	AUS	GGFSTT (443)	DFSTT (449)
FST_W	AUS	ESSTT (162)	ESVST (160), GK (158)
FTBR	AUS	BGTEMPK (123)	EGFE (104)
FTBR_W	AUS	BGTEMPK (123)	BGSRM (118)
FTEAD	LOK	DLDP (404)	
FTEADF	AUS	TEB (380)	DDMTL (411)
FTEADF_W	LOK	TEB (380)	
FTEAD_W	AUS	TEB (380)	BBTEGA (371), LLRNS (84), DTEVN (403)
FTEFSOLD_W	LOK	TEB (380)	
FTEFSOLL_W	LOK	TEB (380)	
FTEFVA	LOK	TEB (380)	
FTEFVAB	LOK	TEB (380)	
FTEFVAMX_W	LOK	TEB (380)	
FTEFVA_W	AUS	TEB (380)	DLDP (404)
FTEML	LOK	TEB (380)	
FTHO_W	LOK	BGTEV (143)	
FTR_NW	LOK	EGFE (104)	
FTSR	AUS	BGTEMPK (123)	BGSRM (118), EGFE (104)
FTU	AUS	BGTEMPK (123)	GGDSAS (131), EGFE (104)
FTV	LOK	LRHK (365)	

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Symbol	Type	Created within	Used within
FTV2	LOK	LRHK (365)	
FTVDK	AUS	BGTEMPK (123)	BGMSZS (111), GGDVE (525), FUEDK (149), MDMAX (39), BGTEV (143), EGFE (104)
FTW	DOK	BGTEMPK (123)	
FUKA	EIN		ESUK (175)
FUKKL_W	DOK	ESUK (175)	
FUPSRL_W	AUS	BGSRM (118)	EGFE (104), BGRLP (125), FUEDK (149)
FVAKL_W	LOK	ESUK (175)	
FVANS	LOK	ESUK (175)	
FVERMTE_W	LOK	TEB (380)	
FVISRM_W	AUS	BGSRM (118)	BGRLP (125)
FVST_W	DOK	GK (158)	
FWE	AUS	ESVST (160)	ESWE (174), LRKA (353), GK (158)
FWL	AUS	ESVST (160)	ESWL (171), GK (158)
FWNW	AUS	ESNWS (174)	ESVST (160), GK (158)
FWPRS_W	LOK	BGRLP (125)	
FZABGS	EIN		DMDFON (772)
FZABGS_W	LOK	DMDMIL (800)	
FZABG_W_0	LOK	DMDMIL (800)	
FZABG_W_1	LOK	DMDMIL (800)	
FZABG_W_2	LOK	DMDMIL (800)	
FZABG_W_3	LOK	DMDMIL (800)	
FZABG_W_4	LOK	DMDMIL (800)	
FZABG_W_5	LOK	DMDMIL (800)	
FZABG_W_6	LOK	DMDMIL (800)	
FZABG_W_7	LOK	DMDMIL (800)	
FZANS1	LOK	ESNST (166)	
FZANS2	LOK	ESNST (166)	
FZARV_W	LOK	DMDMIL (800)	
FZKATS1_W	LOK	DMDMIL (800)	
FZKATS2_W	LOK	DMDMIL (800)	
FZKATS_W	LOK	DMDMIL (800)	
FZKAT_W_0	LOK	DMDMIL (800)	
FZKAT_W_1	LOK	DMDMIL (800)	
FZKAT_W_2	LOK	DMDMIL (800)	
FZKAT_W_3	LOK	DMDMIL (800)	
FZKAT_W_4	LOK	DMDMIL (800)	
FZKAT_W_5	LOK	DMDMIL (800)	
FZKAT_W_6	LOK	DMDMIL (800)	
FZKAT_W_7	LOK	DMDMIL (800)	
GANGAUTI	AUS	CANEGS (723)	BBGANG (70)
GANGI	AUS	BBGANG (70)	ARMD (63), NMAXMD (76), MSF (30), MDWAN (61), MDIHGS (68), MDFAW (31), LLRBB (81), FGRMD (499), FGRAUS (511), DKUP-PL (561), BBSAWE (71), BBKURU (67), BBACC (759), BBFGR (492)
GVTAF_W	AUS	GGFSTT (443)	DDMTL (411)
HISTSG	LOK	GGTSG (686)	
HISTSGG	LOK	GGTSG (686)	
IASP1PLAUS	EIN		URADCC (923)
IAVKATF	DOK	LRHK (365)	
IDLASHKM_W	DOK	LRHK (365)	
IDXFOB	LOK	DMDFON (772)	
IDXFON	LOK	DMDFON (772)	
IDXFORL	LOK	DMDFON (772)	
IGOD_U	AUS	DFFTCNV (852)	
IGOD_W	AUS	GGKS (218)	DFFTCNV (852), DKRNT (247)
IGOKR_U	AUS	DFFTCNV (852)	
IGOKR_W	EIN		DFFTCNV (852), EGKE (216), GGKS (218)
IKR	AUS	GGKS (218)	KRKE (219), EGKE (216)
IKRMA	AUS	GGKS (218)	DKRNT (247), DKRTP (252), KRKE (219), EGKE (216)
IKRME	AUS	GGKS (218)	KRKE (219), EGKE (216)
IKRMEN	AUS	GGKS (218)	
IKRMET	AUS	GGKS (218)	DKRTP (252), EGKE (216)
IKR_TST	LOK	GGKS (218)	
ILB	AUS	BGLBZ (99)	
ILMLKA2_W	LOK	LRKA (353)	
ILMLKAH2_W	LOK	LRKA (353)	
ILMLKAH_W	LOK	LRKA (353)	
ILMLKAM_W	LOK	LRKA (353)	
ILMLKAT2_W	AUS	LRKA (353)	
ILMLKAT_W	AUS	LRKA (353)	
ILMLKAV2_W	LOK	LRKA (353)	
ILMLKAV_W	LOK	LRKA (353)	
ILMLKAX2_W	LOK	LRKA (353)	
ILMLKAX_W	LOK	LRKA (353)	
ILMLKA_W	LOK	LRKA (353)	
IMLATM	AUS	ATM (302)	BGTABST (154), DTHM (689), GGTFUMG (684), ESSTT (162)
IMLATM_W	AUS	ATM (302)	BBKHZ (282), DSLSLR (289)
IMLBBO	AUS	BBBO (475)	
IMLKA2_W	LOK	LRKA (353)	
IMLKAV2_W	LOK	LRKA (353)	
IMLKAV_W	LOK	LRKA (353)	
IMLKAX2_W	LOK	LRKA (353)	

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Symbol	Type	Created within	Used within
IMLKAX_W	LOK	LRKA (353)	
IMLKA_W	LOK	LRKA (353)	
IMLKVSZS_W	LOK	DKVS (476)	
IMLKVS_W	LOK	DKVS (476)	
IMLPR	AUS	BBKHZ (282)	DSLSLR (289), LAKH (272), SLS (275)
IMLPR_W	AUS	BBKHZ (282)	
IMLRSA_W	DOK	LREB (328)	
IMLSLA_W	LOK	SLS (275)	
IMLSLE_W	LOK	SLS (275)	
IMSTEINI	LOK	TEB (380)	
IMTHMU	LOK	DTHM (689)	
INGAS	LOK	BGNG (565)	
INMAX	LOK	NMAXMD (76)	
IOKKR	AUS	GGKS (218)	
IPA_C_UM	LOK	UFRLC (909)	
IPRFMN_W	LOK	DDMTL (411)	
IPRFMX_W	LOK	DDMTL (411)	
IPSN_UM	LOK	UFRLC (909)	
IPTESKFH_W	LOK	DDMTL (411)	
IPTESKFM_W	LOK	DDMTL (411)	
IPTESKF_⊥	DOK	DDMTL (411)	
IPTESKF_W	LOK	DDMTL (411)	
IPTESK_W	LOK	DDMTL (411)	
IPTES_W	AUS	GGDMTL (410)	DDMTL (411)
IPTGH	LOK	DDMTL (411)	
IPTGH_W	LOK	DDMTL (411)	
IPTGL	LOK	DDMTL (411)	
IPTGLMN_W	LOK	DDMTL (411)	
IPTGLV_W	LOK	DDMTL (411)	
IPTGL_W	LOK	DDMTL (411)	
IPTKF_⊥	DOK	DDMTL (411)	
IPTKF_W	LOK	DDMTL (411)	
IPTKL	LOK	DDMTL (411)	
IPTKL_W	LOK	DDMTL (411)	
IPTKTKF_⊥	DOK	DDMTL (411)	
IPTKTKF_W	LOK	DDMTL (411)	
IPTREF	LOK	DDMTL (411)	
IPTREFR_W	LOK	DDMTL (411)	
IPTREF_W	LOK	DDMTL (411)	
IPTSGLV_W	LOK	DDMTL (411)	
IPTSGL_W	LOK	DDMTL (411)	
IPTSUMV_W	LOK	DDMTL (411)	
IPTUMV	LOK	DDMTL (411)	
IPTUMV_W	LOK	DDMTL (411)	
IPTVGLV_W	LOK	DDMTL (411)	
IPTVGL_W	LOK	DDMTL (411)	
IRSPSYN	AUS	BGNG (565)	
ISADMTL	EIN		T2DMTL (941), DDMTL (411)
IUIPOTI1	EIN		UFRLC (909), UFUE (890)
IUIPOTI2	EIN		UFRLC (909), UFUE (890)
IUREFSP1_W	EIN		DU5REF (673), GGPEDV (523)
IUREFSP2_W	EIN		DU5REF (673), GGPEDV (523)
IUSPOTI1	EIN		UFSPSC (913), UFUE (890), URADCC (923)
IUSPOTI1_W	EIN		GGPEDV (523)
IUSPOTI2	EIN		UFSPSC (913), UFUE (890)
IUSPOTI2_W	EIN		GGPEDV (523)
IVMAX	LOK	VMAXMD (78)	
IVZABG_W	LOK	DMDMIL (800)	
IVZARV_W	LOK	DMDMIL (800)	
IVZKAT_W	LOK	DMDMIL (800)	
IWFLSD_W	LOK	MDFAW (31)	
IWMATM2_W	AUS	ATM (302)	
IWMATM_W	AUS	ATM (302)	
JNWFL	EIN		WANWKW (257)
JNWFL_0	EIN		DNWS (267)
JNWFL_1	EIN		DNWS (267)
KATBF	LOK	DKAT (310)	
KATBF2	LOK	DKAT (310)	
KATBFI2_W	LOK	DKAT (310)	
KATBFI_W	LOK	DKAT (310)	
KATBFS	LOK	DKAT (310)	
KATBFS2	LOK	DKAT (310)	
KATBFTP	LOK	DKAT (310)	
KATBFTP2	LOK	DKAT (310)	
KATBSHD2_W	LOK	DKAT (310)	
KATBSHD_W	LOK	DKAT (310)	
KBDKT2_W	LOK	DKAT (310)	
KBDKT_W	LOK	DKAT (310)	
KE1W	LOK	KRKE (219)	
KE2W	LOK	KRKE (219)	
KE3W	LOK	KRKE (219)	
KE4W	LOK	KRKE (219)	

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Symbol	Type	Created within	Used within
KEK	AUS	EGKE (216)	KRKE (219), KRDY (237)
KEK_1	LOK	KRKE (219)	
KEK_2	LOK	KRKE (219)	
KEK_3	LOK	KRKE (219)	
KEK_4	LOK	KRKE (219)	
KEK_TST	LOK	KRKE (219)	
KFGR_W	LOK	FGRMD (499)	
KHC_W	LOK	TEB (380)	
KIFZ_W	LOK	ARMD (63)	
KMSTAND	AUS	CANINS (727)	AMUENE (578), BBPEDBR (579), BGKMST (861), DUMWEX (855), DKAT (310)
KMSTMIL_W	AUS	BGKMST (861)	TC1MOD (864)
KMSTNMAX	AUS	AMUENE (578)	EEDAT (943)
KMSTPBR	EIN		EEDAT (943)
KMSTPBR_W	AUS	BBPEDBR (579)	
KMST_W	AUS	BGKMST (861)	
KOPWM	EIN		MDVERB (52)
KRAL1W	DOK	KRRA (227)	
KRAL2W	DOK	KRRA (227)	
KRDWSW	DOK	KRRA (227)	
KRFKW	AUS	KRRA (227)	KRDY (237)
KRMXW	DOK	KRRA (227)	
KRVFSW	DOK	KRRA (227)	
KRVFW	DOK	KRRA (227)	
KSTAA	EIN		ESNST (166), ESSTT (162), ESVST (160)
KSWF	LOK	DMDMIL (800)	
KTEEV_W	LOK	TEB (380)	
KTETEV_W	LOK	TEB (380)	
KVAREST	LOK	KVA (713)	
KVAVERBR	AUS	KVA (713)	CANINS (727)
KVBADD_W	LOK	DFSTT (449)	
KVBAKT_W	LOK	DFSTT (449)	
KVBRES_W	LOK	DFSTT (449)	
KVB_W	AUS	BGKV (459)	DFSTT (449)
LAHKMZ	LOK	LRHK (365)	
LAHKMZ2	LOK	LRHK (365)	
LALGF	AUS	ESVST (160)	GK (158)
LALGM	AUS	ESVST (160)	GK (158)
LAMBAS	AUS	LAMKO (268)	MDBAS (50)
LAMBAS_W	LOK	MSF (30)	
LAMBTS_W	EIN		LAMKO (268)
LAMELSH2_W	AUS	DLSH (627)	LAMKO (268)
LAMELSH_W	AUS	DLSH (627)	LAMKO (268)
LAMFA_W	AUS	LAMFAW (271)	LAMKO (268)
LAMFRM2_W	LOK	DLSAHK (645)	
LAMFRM_W	LOK	DLSAHK (645)	
LAMHF2_W	LOK	LRHK (365)	
LAMHF_W	LOK	LRHK (365)	
LAMHM2_W	LOK	LRHK (365)	
LAMHM_W	LOK	LRHK (365)	
LAMKA2_W	AUS	LRKA (353)	LAMKO (268)
LAMKAI2_W	LOK	LRKA (353)	
LAMKAII2_W	LOK	LRKA (353)	
LAMKAII_W	LOK	LRKA (353)	
LAMKAI_W	LOK	LRKA (353)	
LAMKA_W	AUS	LRKA (353)	LAMKO (268)
LAMKH2_W	AUS	LAKH (272)	LAMKO (268)
LAMKHE2_W	LOK	LAMKO (268)	
LAMKHE_W	LOK	LAMKO (268)	
LAMKHR2_W	LOK	LAKH (272)	
LAMKHR_W	LOK	LAKH (272)	
LAMKH_W	AUS	LAKH (272)	LAMKO (268), MSF (30)
LAMLASH2_W	AUS	DLSAHK (645)	LAMKO (268)
LAMLASH_W	AUS	DLSAHK (645)	LAMKO (268)
LAMLGM	LOK	LAMKO (268)	
LAMNSWL_W	AUS	ESWL (171)	LAMKO (268), GK (158)
LAMNS_W	AUS	ESNST (166)	ESWL (171)
LAMS2_W	LOK	LAMKO (268)	
LAMSBG2_W	AUS	LAMKO (268)	GK (158)
LAMSBG_W	AUS	LAMKO (268)	GK (158)
LAMSISA	AUS	DLSSA (654)	
LAMSISA2	AUS	DLSSA (654)	
LAMSNKA2_W	LOK	LRKA (353)	
LAMSNKA_W	LOK	LRKA (353)	
LAMSOLH2_W	AUS	LRHK (365)	
LAMSOLH_W	AUS	LRHK (365)	
LAMSONH2_W	AUS	LRHK (365)	
LAMSONH_W	AUS	LRHK (365)	
LAMSONI2_W	EIN		DLSSA (654)
LAMSONI_W	EIN		DLSSA (654)
LAMSONS2_U	AUS	DFFTCNV (852)	

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Symbol	Type	Created within	Used within
LAMSONS2_W	AUS	LAMKO (268)	ATM (302), DFFTCNV (852), DLSSA (654), DSLSLR (289), GKEB (325), LREB (328), LRKA (353), GKRA (327), DLSV (609), DLSH (627), GK (158)
LAMSONS_U	AUS	DFFTCNV (852)	
LAMSONS_W	AUS	LAMKO (268)	ATM (302), TEBEB (378), LRKA (353), LREB (328), GKRA (327), GKEB (325), DSLSLR (289), DLSV (609), DFFTCNV (852), DLSSA (654), DLSH (627), GK (158)
LAMSOS2_W	LOK	LAMKO (268)	
LAMSOSA	AUS	DLSSA (654)	
LAMSOSA2	AUS	DLSSA (654)	
LAMSOS_W	LOK	LAMKO (268)	
LAMSUBG2_W	LOK	LAMKO (268)	
LAMSUBG_W	LOK	LAMKO (268)	
LAMS_W	LOK	LAMKO (268)	
LAMVOA2_W	AUS	LAMKO (268)	
LAMVOA_W	AUS	LAMKO (268)	
LAMWL_W	LOK	ESWL (171)	
LANSKH_W	LOK	LAKH (272)	
LASDSL_W	LOK	LAKH (272)	
LASKH_W	LOK	LAKH (272)	
LDFKI_W	AUS	GGDSAS (131)	
LDITV_W	EIN		FUEDK (149)
LIMAX_W	LOK	LLRRM (88)	
LIMIN_W	LOK	LLRRM (88)	
LIMNST	LOK	LLRRM (88)	
LKRNEW	LOK	KRDY (237)	
LKROLD	LOK	KRDY (237)	
LKRW	DOK	KRRA (227)	
LLSSTAT	AUS	LLRNS (84)	
LMSKH_W	LOK	LAKH (272)	
LMSSL2_W	LOK	LAKH (272)	
LMSSL_W	LOK	LAKH (272)	
LRFRMZ	LOK	LR (338)	
LRFRMZ2	LOK	LR (338)	
LRFRZ	LOK	LR (338)	
LRFRZ2	LOK	LR (338)	
LRKAZ	LOK	LRKA (353)	
LRKAZ2	LOK	LRKA (353)	
LRNSTEP_C	LOK	BGDVE (534)	
LRNTIM_C	LOK	BGDVE (534)	
LRNVB_C	LOK	BGDVE (534)	
LRNVB_ZT	LOK	BGDVE (534)	
LUAR	DOK	DMDLUA (770)	
LUARMN	LOK	DMDLUA (770)	
LUAROFF	LOK	DMDLUA (770)	
LUAR_M	LOK	DMDLUA (770)	
LUMS	DOK	DMDLU (761)	
LUMS_M	LOK	DMDLU (761)	
LUNW	LOK	DMDFON (772)	
LURMS	DOK	DMDLU (761)	
LURMS_M	LOK	DMDLU (761)	
LURS	DOK	DMDLU (761)	
LURSKTM	AUS	DMDLU (761)	DMDDLU (766)
LURS_M	LOK	DMDLU (761)	
LURS_MIN	AUS	DMDLU (761)	DMDLUA (770)
LUTS	AUS	DMDLU (761)	DMDDLU (766)
LUTS1	AUS	DMDLU (761)	DMDLUA (770)
LUTS2	AUS	DMDLU (761)	DMDLUA (770)
LUTS3	AUS	DMDLU (761)	DMDLUA (770)
LUTS4	AUS	DMDLU (761)	DMDLUA (770)
LUTS5	AUS	DMDLU (761)	DMDLUA (770)
LUTS6	AUS	DMDLU (761)	DMDLUA (770)
LUTS7	AUS	DMDLU (761)	DMDLUA (770)
LUTS8	AUS	DMDLU (761)	DMDLUA (770)
LUTSFI1	AUS	DMDFLU (812)	
LUTSFI2	AUS	DMDFLU (812)	
LUTSFI3	AUS	DMDFLU (812)	
LUTSFI4	AUS	DMDFLU (812)	
LUTSFI5	AUS	DMDFLU (812)	
LUTSFI6	AUS	DMDFLU (812)	
LUTSFI7	AUS	DMDFLU (812)	
LUTSFI8	AUS	DMDFLU (812)	
LUTS_M	EIN		DMDFLU (812), DMDLU (761)
LWS_W	AUS	CANLWS (731)	LLRMR (92)
L_FGR	AUS	GGMFL (490)	BBACC (759), CANINS (727)
M	LOK	MS (6)	
M6AMSL	AUS	DSLSLR (289)	
M6CDDMTL	AUS	DDMTL (411)	
M6CMSL	AUS	DSLSLR (289)	
M6CMSL2	AUS	DSLSLR (289)	
M6CMSLV	AUS	DSLSLR (289)	
M6CMSLV2	AUS	DSLSLR (289)	

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Symbol	Type	Created within	Used within
M6CTHM	AUS	DTHM (689)	
M6SDDMTL_W	AUS	DDMTL (411)	
M6SMSL2_W	AUS	DSLSLR (289)	
M6SMSLV2_W	AUS	DSLSLR (289)	
M6SMSLV_W	AUS	DSLSLR (289)	
M6SMSL_W	AUS	DSLSLR (289)	
M6STHM	AUS	DTHM (689)	
M6WDDMTL_W	AUS	DDMTL (411)	
M6WMSL2_W	AUS	DSLSLR (289)	
M6WMSLV2_W	AUS	DSLSLR (289)	
M6WMSLV_W	AUS	DSLSLR (289)	
M6WMSL_W	AUS	DSLSLR (289)	
M6WTHM	AUS	DTHM (689)	
MDBES_W	DOK	ARMD (63)	
MDIF_W_UM	AUS	UFMVER (905)	
MDINDG_W	LOK	MDIST (49)	
MDINDLM	AUS	BGMDLM (44)	CANDME (718)
MDIND_ASRL	EIN		UFMSRC (903)
MDIND_ASRS	EIN		UFMSRC (903)
MDIND_MSR	EIN		UFMSRC (903)
MDKO	AUS	MDVERB (52)	KOS (698)
MDKOG	AUS	CANINS (727)	MDVERB (52)
MDS_W	DOK	MDVER (53)	
MDVERB	AUS	MDVERB (52)	MDVER (53), MDMIN (51)
MDVERF_W	AUS	MDVER (53)	MDMIN (51)
MDVERL_W	AUS	MDMIN (51)	MDVER (53), ARMD (63), MDFAW (31), CANDME (718)
MDWANCAN	AUS	CANEGS (723)	
MDWAN_W	AUS	MDWAN (61)	MDVER (53), MDMIN (51)
MDZZYL	LOK	DMDFLU (812)	
MFGR_UM	AUS	UFFGRC (900)	UFMZUL (894), UFUE (890)
MFLROH	EIN		GGMFL (490)
MIACC	AUS	CANACC (752)	DACC (756), UFFGRC (900)
MIACC_W	AUS	DACC (756)	BGMRACC (758)
MIASRL	EIN		CANASR (732), DASC (740)
MIASRL_W	AUS	CANASR (732)	MDFAW (31), MDKOL (48), MDKOG (40), MSF (30)
MIASRS	EIN		CANASR (732), DASC (740)
MIASRS_W	AUS	CANASR (732)	MDKOG (40), MSF (30)
MIBAS_W	AUS	MDBAS (50)	AES (189), BGMDLM (44), MDZW (211), MDRED (73), MDKOG (40), MSF (30)
MIBDP_W	LOK	MDFAW (31)	
MIBEG_W	LOK	MDKOG (40)	
MIBGRV_W	AUS	MDIHGS (68)	
MIBGR_W	AUS	MDIHGS (68)	BGMDLM (44), MDKOG (40), MDKOL (48), MDFAW (31), MSF (30)
MIBLSD_W	LOK	MDFAW (31)	
MIEXTV_W	LOK	MDKOG (40)	
MIEXT_W	EIN		BGMDLM (44), MDKOG (40)
MIFA	AUS	MDFAW (31)	TEB (380), UFEING (891)
MIFAB_W	AUS	MDKOG (40)	NMAXMD (76), VMAXMD (78)
MIFAFU_W	DOK	MDKOL (48)	MDIHGS (68)
MIFAKH_W	LOK	KHMD (287)	
MIFAL_W	AUS	MDFAW (31)	KOS (698), MDKOL (48), MSF (30)
MIFA_UM	AUS	UFEING (891)	UFFGRC (900), UFUE (890)
MIFA_W	AUS	MDFAW (31)	ARMD (63), TEB (380), MDKOL (48), MDKOG (40), BGMDLM (44), KHMD (287), GKRA (327), MSF (30)
MIGEF_W	LOK	MDFAW (31)	
MIGES_W	AUS	BGMIGS (69)	MDFAW (31), MDKOL (48), MSF (30)
MIGSRC_W	AUS	CANEGS (723)	BGMIGS (69), MSF (30)
MIGS_W	AUS	BGMIGS (69)	MDKOG (40), MSF (30)
MIINT1_W	AUS	BGMDLM (44)	
MIINT2_W	AUS	BGMDLM (44)	
MIINT3_W	AUS	BGMDLM (44)	
MIINTV_W	AUS	BGMDLM (44)	
MIINT_W	AUS	BGMDLM (44)	MDIHGS (68)
MIISTC	EIN		CANDME (718)
MIIST_W	AUS	MDIST (49)	MSF (30), BGMDLM (44), VMAXMD (78), NMAXMD (76), MDFAW (31)
MIL1_W	DOK	MDFAW (31)	
MIL2_W	DOK	MDFAW (31)	
MILL_W	EIN		LLRBB (81), LLRMD (83), MDMIN (51)
MILRES_W	DOK	MDKOL (48)	MDKOG (40)
MILSOL_UM	AUS	UFEING (891)	UFUE (890)
MILSOL_W	AUS	MDKOL (48)	MDFUE (148), UFUE (890), UFEING (891), MDIHGS (68), MSF (30)
MIMAX_W	AUS	MDMAX (39)	BGMRACC (758), MDKOG (40), MDFAW (31), MSF (30)
MIMIN_W	AUS	MDMIN (51)	BGMRACC (758), MDFAW (31), STMD (60), MSF (30)
MIMSR	AUS	CANASR (732)	DASC (740)
MIMSR_W	AUS	DASC (740)	MDKOG (40), MSF (30), MDKOL (48)
MIMS_W	AUS	MSMD (80)	BGMDLM (44), MDFAW (31), MDKOL (48)
MIMXL1_W	AUS	MDMAX (39)	BGMRACC (758), MSMD (80), STMD (60), MDFAW (31)
MINBEG_W	LOK	MDFAW (31)	
MINMXS	DOK	NMAXMD (76)	
MINMX_W	AUS	NMAXMD (76)	BGMDLM (44), MDKOL (48), MDKOG (40), MDFAW (31), MSF (30)
MIOPTL1_W	LOK	MDBAS (50)	

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Symbol	Type	Created within	Used within
MIOPT_UM	LOK	UFMIST (897)	
MIOPT_W	AUS	MDBAS (50)	AES (189), TEB (380), MDZW (211), MDRED (73), MDIST (49), MSF (30)
MIRED	DOK	VMAXMD (78)	
MIRED1	DOK	NMAXMD (76)	
MISOLV_W	EIN		ARMD (63), MDKOG (40)
MISOLZ_W	LOK	ZUE (206)	
MISOL_W	EIN		AES (189), MDKOG (40), MDRED (73), MDZW (211), MSF (30)
MISOPL1_W	DOK	MDFUE (148)	
MISTT	AUS	STMD (60)	LLRBB (81), LLRMD (83), MDMIN (51)
MISZUL_W	AUS	MDZUL (45)	BGMDLM (44), MDFAW (31), MDKOG (40), MDKOL (48), MSF (30)
MITEBG_W	AUS	GKRA (327)	TEB (380), MDKOG (40), MDKOL (48)
MITXU_W	AUS	CANTXU (742)	BGMIGS (69), MSF (30)
MIVBEB_W	LOK	MDFAW (31)	
MIVBEG_W	EIN		CANDME (718), MDFAW (31)
MIVMXS	DOK	VMAXMD (78)	
MIVMX_W	AUS	VMAXMD (78)	BGMDLM (44), MDFAW (31), MDKOL (48), MDKOG (40), MSF (30)
MIZSOLV_W	LOK	MDKOG (40)	
MIZSOL_W	AUS	MDKOG (40)	BGMDLM (44), ZUE (206), MDZW (211), MSF (30)
MIZUFIL_W	LOK	MDZUL (45)	
MIZUOFIL	LOK	MDZUL (45)	
MIZUVFIL	LOK	MDZUL (45)	
MIZWMN_W	DOK	MDRED (73)	BGMDLM (44), MDZW (211)
MI_DUF	AUS	DUF (932)	DFFT (849)
MI_MR_W	DOK	MDFAW (31)	
MI_UM	AUS	UFMIST (897)	DUF (932), UFMVER (905), UFUE (890)
MKAR_W	DOK	ARMD (63)	
MKFANB_W	LOK	MDFAW (31)	
ML	AUS	BGSRM (118)	ATM (302), BBKHZ (282), DKVS (476), DTHM (689), GGTFM (674), LRHK (365), TEB (380), SLS (275), LRKA (353), LAKH (272), ESGRU (161), BGMSABG (286), DFFT (849), DKAT (310), EGFE (104)
MLBB	AUS	BGMSABG (286)	
MLBB2	AUS	BGMSABG (286)	
MLBB2_W	AUS	BGMSABG (286)	DSLSLR (289), SLS (275)
MLBB_W	AUS	BGMSABG (286)	DSLSLR (289), SLS (275)
MLDKNS_W	AUS	FUEDK (149)	
MLDKS_W	DOK	FUEDK (149)	
MLDYN_W	LOK	DLSAHK (645)	
MLHFMA_W	LOK	GGHFM (105)	
MLHFMM_W	AUS	GGHFM (105)	DHFM (108)
MLNKA2_W	DOK	LRHK (365)	
MLNKA_W	DOK	LRHK (365)	
MLSOL_W	AUS	FUEDK (149)	TEB (380)
MLSU	LOK	BBKHZ (282)	
MLWDKNS_W	LOK	FUEDK (149)	
ML_W	AUS	BGSRM (118)	EGFE (104), ATM (302), BBBO (475), BGMSABG (286), BGMSZS (111), BGRML (854), DLSAHK (645), DSLSLR (289), TEB (380), TC1MOD (864), SLS (275), LRKA (353), LRHK (365), LREB (328), LRA (463), GGDSAS (131), DLDP (404), DKAT (310)
MMSR_UM	AUS	UFMSRC (903)	UFMZUL (894), UFUE (890)
MPED_UM	LOK	UFMZUL (894)	
MPFAD	AUS	DUF (932)	DFFT (849)
MRACC	EIN		BBACC (759)
MRACC_W	AUS	BGMRACC (758)	
MRFAMX_W	AUS	MDFAW (31)	MDMAX (39), STMD (60)
MRFAV_W	AUS	MDFAW (31)	
MRFA_W	LOK	MDFAW (31)	
MRFGRI_W	LOK	FGRMD (499)	
MRFGRM_W	AUS	FGRMD (499)	
MRFGRU_W	LOK	FGRAUS (511)	
MRFGRV_W	EIN		FGRAUS (511)
MRFGR_W	AUS	FGRAUS (511)	FGRMD (499), MDFAW (31), MSF (30)
MRFUEMX_W	AUS	MDFAW (31)	FUEDK (149)
MRFUE_W	AUS	MDFAW (31)	FUEDK (149)
MRPED_W	EIN		FGRMD (499)
MRREGL_W	DOK	FGRMD (499)	
MRRGLI_W	LOK	FGRMD (499)	
MRSTT_W	AUS	STMD (60)	MDFAW (31)
MSABG	AUS	BGMSABG (286)	
MSABG2	AUS	BGMSABG (286)	
MSABG2_W	AUS	BGMSABG (286)	DSLSLR (289)
MSABG_W	AUS	BGMSABG (286)	DSLSLR (289)
MSAGR	LOK	EGFE (104)	
MSDIF_W	AUS	BGMSZS (111)	
MSDKALM_W	AUS	BGMSZS (111)	TEB (380)
MSDK_W	AUS	BGMSZS (111)	
MSHFM_W	AUS	GGHFM (105)	BGMSZS (111), TC1MOD (864), EGFE (104)
MSL	AUS	SLS (275)	BGMSABG (286), DSLSLR (289)
MSL2	AUS	SLS (275)	BGMSABG (286), DSLSLR (289)
MSLIF	LOK	DSLSLR (289)	
MSLIFT	LOK	DSLSLR (289)	
MSLIFT2	LOK	DSLSLR (289)	

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Symbol	Type	Created within	Used within
MSLIFT2_⊥	DOK	DSLSLR (289)	
MSLIFT_⊥	DOK	DSLSLR (289)	
MSLNENN	LOK	DSLSLR (289)	
MSLNENN2	LOK	DSLSLR (289)	
MSLNF	LOK	DSLSLR (289)	
MSLNF2	LOK	DSLSLR (289)	
MSLNF2_W	DOK	DSLSLR (289)	
MSLNF_W	DOK	DSLSLR (289)	
MSLNT	LOK	DSLSLR (289)	
MSLNT2	LOK	DSLSLR (289)	
MSLOFS	LOK	DSLSLR (289)	
MSLOFS2	LOK	DSLSLR (289)	
MSLOFS2_⊥	DOK	DSLSLR (289)	
MSLOFS_⊥	DOK	DSLSLR (289)	
MSLPUB	LOK	SLS (275)	
MSLSTAT	AUS	SLS (275)	
MSLT2_W	LOK	DSLSLR (289)	
MSLT_W	LOK	DSLSLR (289)	
MSLV	LOK	DSLSLR (289)	
MSLV2	LOK	DSLSLR (289)	
MSLVF	LOK	DSLSLR (289)	
MSLVF2	LOK	DSLSLR (289)	
MSLVFT	LOK	DSLSLR (289)	
MSLVFT2	LOK	DSLSLR (289)	
MSLVFT2_⊥	DOK	DSLSLR (289)	
MSLVFT_⊥	DOK	DSLSLR (289)	
MSLVT2_W	LOK	DSLSLR (289)	
MSLVT_W	LOK	DSLSLR (289)	
MSNDKO_W	AUS	BGMSZS (111)	BGRLP (125), FUEDK (149)
MSNDKPK_W	LOK	BGRLP (125)	
MSNDK_W	AUS	BGMSZS (111)	
MSNTETEV_W	LOK	BGTEV (143)	
MSNTEVO_W	AUS	BGTEV (143)	ATEV (402)
MSSGIN_W	LOK	TEB (380)	
MSS_W	LOK	BGMSZS (111)	
MSTE	AUS	BGTEV (143)	BGMSZS (111), BGRLP (125), TEB (380), EGFE (104)
MSTEDTE	AUS	BGTEV (143)	DDMTL (411)
MSTEEV_W	LOK	TEB (380)	
MSTEO	LOK	EGFE (104)	
MSTEO_W	AUS	BGTEV (143)	ATEV (402), TEB (380), EGFE (104)
MSTESMX_W	LOK	TEB (380)	
MSTESOLL_W	AUS	MSF (30)	TEB (380), ATEV (402), DTEVN (403)
MSTETEV_W	LOK	BGTEV (143)	
MSTE_W	AUS	BGTEV (143)	FUEDK (149), GKRA (327), TEB (380), EGFE (104)
MVER_C_UM	LOK	UFMVER (905)	
MZFO_UM	LOK	UFMVER (905)	
MZF_LOW_UM	LOK	UFMZF (893)	
MZF_UM	AUS	UFMZF (893)	UFMVER (905), UFUE (890)
MZMAX_UM	LOK	UFMZUL (894)	
MZO_UM	AUS	UFMZUL (894)	UFMVER (905), UFUE (890)
MZ_UM	AUS	UFMZUL (894)	UFMZF (893), UFUE (890)
N	EIN		ASCETBLK (7)
NABTRC_W	AUS	CANEGS (723)	DGLOR (747)
NADMTLL_W	AUS	DDMTL (411)	
NC_C_UM	LOK	UFNC (906)	
NDAR_W	DOK	ARMD (63)	
NDFDIF_W	LOK	ARMD (63)	
NDFIL_W	LOK	ARMD (63)	
NDIFF_W	DOK	ARMD (63)	
NDIPRFO_W	AUS	DDMTL (411)	
NFSKH	AUS	BBKHZ (282)	LLRNS (84)
NGAS_W	AUS	BGNG (565)	MDIHGS (68), ARMD (63)
NGFAR_W	AUS	ARMD (63)	
NGFIL	AUS	BGNG (565)	BBSAWE (71), KRDY (237), LLRNS (84), LLRRM (88)
NGFIL_W	AUS	BGNG (565)	MDFAW (31), NMAXMD (76), DMDSTP (799)
NGHGS_W	LOK	MDIHGS (68)	
NGLMHE	EIN		HDMTL (442), DDMTL (411)
NGLMTK	LOK	DDMTL (411)	
NGLTDCA	DOK	DDMTL (411)	
NGLTDCW	DOK	DDMTL (411)	
NIST	AUS	GGDG (562)	
NKFL	AUS	DDMTL (411)	
NKLMTK	LOK	DDMTL (411)	
NLLKH	AUS	BBKHZ (282)	LLRNS (84)
NLP1TIM	LOK	BGDVE (534)	
NLP2TIM	LOK	BGDVE (534)	
NMAX_W	AUS	AMUENE (578)	EEDAT (943)
NMOD_W	DOK	ARMD (63)	

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Symbol	Type	Created within	Used within
NMOT	AUS	BGNMOT (564)	AEVAB (196), ARMD (63), ATEV (402), BBFGR (492), ATM (302), DMDLU (761), DMDFON (772), DMDDLU (766), DLSA (634), DLDP (404), DKRS (242), DKRNT (247), DKAT (310), LRHK (365), LREB (328), LRAEB (461), LRA (463), LR (338), LLRRM (88), LLRBB (81), LAMFAW (271), UFUE (890), UFNC (906), TEB (380), SLS (275), RKTI (192), PROKON (878), MDZUL (45), MDVERB (52), ZWWL (210), ZWSTT (210), ZWMIN (213), ZWKS (212), ZWGRU (208), ZUE (206), WNWEIN (254), VMAXMD (78), MDRED (73), MDMIN (51), MDMAX (39), MDKOL (48), MDKOG (40), MDIHGS (68), MDFUE (148), LRKA (353), GGHFM (105), GGDVE (525), GGDSAS (131), FUEDK (149), ESWL (171), ESUK (175), ESSTT (162), ESKS (172), GK (158), GGTFUMG (684), GGKS (218), ESGRU (161), EGFE (104), EA (184), DVFZ (581), DTHM (689), DMDSTP (799), DMDMIL (800), DMDLUA (770), DECJ (813), COSA (193), BGTEV (143), BGTEMPK (123), BGTABST (154), BGMSZS (111), BBVL (38), BBSTT (575), LAKH (272), KRRA (227), KRKE (219), KRDY (237), KOS (698), DFFT (849), BBSAWE (71)
NMOTKOR	LOK	GGHFM (105)	
NMOTLL	EIN		BGDVE (534), BGLBZ (99), STMD (60), LLRNS (84), LLRMD (83)
NMOTPR_W	DOK	NMAXMD (76)	
NMOTRSP_W	AUS	BGNG (565)	
NMOT_UM	AUS	UFNC (906)	DUF (932), UFNSC (896), UFMIST (897), UFREAC (898), UFRLC (909), UFUE (890)
NMOT_W	AUS	BGNMOT (564)	AMUENE (578), BBGANG (70), ARMD (63), LLRRM (88), LLRMD (83), KHMD (287), GGDSAS (131), FUEDK (149), ESUK (175), DSTA (709), DHFM (108), MDZW (211), MDVER (53), MDNSTAB (59), MDMIN (51), MDMAX (39), MDFUE (148), MDFAW (31), MDBAS (50), TEB (380), TC1MOD (864), STA (706), NMAXMD (76), MSMD (80), MSF (30), DASC (740), CANDME (718), BGSRM (118), BGRLP (125), BGNG (565), BGMSZS (111), BGMRACC (758)
NSA	LOK	BBSAWE (71)	
NSACTR	LOK	ESNST (166)	ESVST (160)
NSACTR1	LOK	ESNST (166)	
NSACTR2	LOK	ESNST (166)	
NSACTR_W	LOK	ESVST (160)	
NSFSM	LOK	LLRNS (84)	
NSFSMN	LOK	LLRNS (84)	
NSKA_UM	LOK	UFREAC (898)	
NSLB	AUS	BGLBZ (99)	LLRNS (84)
NSLBZ	LOK	LLRNS (84)	
NSLLM	EIN		BGLBZ (99), LLRNS (84)
NSLLMN	LOK	LLRNS (84)	
NSNF	DOK	LLRNS (84)	
NSOL	AUS	LLRMD (83)	LLRNS (84), LLRRM (88), MDWAN (61), MDMIN (51)
NSOLFA	EIN		LLRNS (84)
NSST	AUS	LLRNS (84)	STMD (60)
NSTAT	EIN		LLRBB (81), LLRNS (84), MDNSTAB (59), MDMIN (51)
NSYN_CTR	EIN		DDG (568)
NTGLM_W	LOK	DDMTL (411)	
NTKLM_W	LOK	DDMTL (411)	
NTURB	LOK	MDWAN (61)	
NTURBV	LOK	MDWAN (61)	
NVQUOT_W	AUS	BBGANG (70)	BBKURU (67)
NWE	LOK	BBSAWE (71)	
NWSDSTAT	AUS	WNWTST (267)	
NWSDSTAT2	AUS	WNWTST (267)	
NWSSTAT	AUS	WNWTST (267)	
NWSSTAT2	AUS	WNWTST (267)	
NZ_UM	LOK	UFNC (906)	
OBDSTEGS	AUS	CANEGS (723)	OBDSV (862)
OBDSTEUER	EIN		CANDME (718)
OBDSTTXU	AUS	CANTXU (742)	
PDPLD	EIN		FUEDK (149)
PERCNT2_W	LOK	LRHK (365)	
PERCNT_W	LOK	LRHK (365)	
PHLSNH	AUS	HLS (582)	DHLS (666), DLSH (627)
PHLSNH2	AUS	HLS (582)	DHLS (666), DLSH (627)
PHLSNHF	LOK	DHLS (666)	
PHLSNHF2	LOK	DHLS (666)	
PHLSNV	AUS	HLS (582)	DHLS (666)
PHLSNV2	AUS	HLS (582)	DHLS (666)
PHLSNVF	LOK	DHLS (666)	
PHLSNVF2	LOK	DHLS (666)	
PHPW	LOK	DPH (571)	
PHPW2	LOK	DPH (571)	
PIRGRO_W	LOK	BGSRM (118)	
PIRG_W	AUS	BGSRM (118)	EGFE (104), BGRLP (125), FUEDK (149)
PLSOL	AUS	FUEDK (149)	
PLSOL_W	AUS	FUEDK (149)	GGDSAS (131)
PSAGR_W	EIN		BGSRM (118)
PSDSS_U	EIN		TC1MOD (864)
PSDSS_W	EIN		GGDSAS (131)

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Symbol	Type	Created within	Used within
PSES_W	LOK	AES (189)	
PSFG	LOK	EGFE (104)	
PSFG_W	AUS	BGSRM (118)	EGFE (104)
PSL	EIN		LLRNS (84)
PSMP_W	LOK	BGRLP (125)	
PSMX_W	AUS	BGSRM (118)	BGRLP (125)
PSPVDB_W	AUS	BGMSZS (111)	
PSPVDK_W	AUS	BGMSZS (111)	BGTEV (143), DLDP (404), FUEDK (149)
PSPVMIN_W	LOK	FUEDK (149)	
PSP_W	LOK	BGRLP (125)	
PSRLRO_W	LOK	BGSRM (118)	
PSSOL_W	AUS	FUEDK (149)	GGDSAS (131)
PSSPVDKD_W	LOK	GGDSAS (131)	
PS_W	AUS	BGSRM (118)	EGFE (104), AES (189), TEB (380), SLS (275), GGDSAS (131), BGRLP (125), BGMSZS (111)
PTE	EIN		GKRA (327), TEB (380)
PTV	LOK	LRHK (365)	
PTV2	LOK	LRHK (365)	
PU	AUS	GGDSAS (131)	AES (189), CANDME (718), TEB (380), SLS (275), DFFT (849)
PUKORFRZ	LOK	DLDP (404)	
PUKORF_W	AUS	BGPUK (407)	DLDP (404)
PUKOR_W	AUS	BGPUK (407)	DLDP (404)
PUMEAN_W	LOK	BGPUK (407)	
PUS_W	AUS	GGDSAS (131)	BGPUK (407)
PU_W	AUS	GGDSAS (131)	BGMSZS (111), BGSRM (118), FUEDK (149), EGFE (104)
PVDK	AUS	BGMSZS (111)	
PVDKDS	AUS	GGDSAS (131)	
PVDKDSL_W	AUS	GGDSAS (131)	
PVDKDSU_W	AUS	GGDSAS (131)	
PVDKDS_W	AUS	GGDSAS (131)	BGMSZS (111), BGSRM (118)
PVDKMX_W	LOK	GGDSAS (131)	
PVDKR_W	LOK	FUEDK (149)	
PVDKSPUD	AUS	GGDSAS (131)	
PVDKS_W	AUS	GGDSAS (131)	
PVDK_W	AUS	BGMSZS (111)	EGFE (104), BGRLP (125), FUEDK (149)
P_DVEESON	LOK	ADVE (548)	
QNST_W	DOK	STMD (60)	
QNTNS	LOK	MDWAN (61)	
QTETEMIN	LOK	TEB (380)	
R	LOK	DPH (571)	MS (6)
REAC_C1_UM	LOK	UFREAC (898)	
REAC_C2_UM	LOK	UFREAC (898)	
READY	AUS	DIMC (857)	
REDBAS	AUS	AES (189)	AEVAB (196), BGMDLM (44)
REDHYST	LOK	MDRED (73)	
REDIST	AUS	AES (189)	AEVAB (196), MDIST (49), ZUE (206), MSF (30)
REDNEU	LOK	MDRED (73)	
REDSOL	AUS	MDRED (73)	AEVAB (196), AES (189)
REDSOLR	LOK	AEVAB (196)	
REDSOL_ONE	LOK	AEVAB (196)	
REDZE	DOK	MDRED (73)	
REDZST_W	LOK	MDRED (73)	
RFAGR	LOK	EGFE (104)	
RFAGR_W	AUS	BGSRM (118)	EGFE (104), BGRLP (125), FUEDK (149)
RFGES_W	LOK	BGSRM (118)	EGFE (104)
RFSTT	AUS	GGFSTT (443)	
RGVTAF	AUS	GGFSTT (443)	
RINH2_U	AUS	DFFTCNV (852)	DFFT (849)
RINH2_W	AUS	GGLSH (599)	DFFTCNV (852), DHLS (666), DLSH (627)
RINH_U	AUS	DFFTCNV (852)	DFFT (849)
RINH_W	AUS	GGLSH (599)	DFFTCNV (852), DHLS (666), DLSH (627)
RINKFH	LOK	DHLS (666)	
RINKFH2	LOK	DHLS (666)	
RINKFV	LOK	DHLS (666)	
RINKFV2	LOK	DHLS (666)	
RINOFH2_W	LOK	GGLSH (599)	
RINOFH_W	LOK	GGLSH (599)	
RINOFV2_W	AUS	GGLSV (588)	
RINOFVA2_W	LOK	GGLSV (588)	
RINOFVA_W	LOK	GGLSV (588)	
RINOFV_W	AUS	GGLSV (588)	
RINSH2_W	LOK	DHLS (666)	
RINSH_W	LOK	DHLS (666)	
RINSV2_W	LOK	DHLS (666)	
RINSV_W	LOK	DHLS (666)	
RINV2_U	AUS	DFFTCNV (852)	DFFT (849)
RINV2_W	AUS	GGLSV (588)	DFFTCNV (852), DLSV (609), DHLS (666)
RINV_U	AUS	DFFTCNV (852)	DFFT (849)
RINV_W	AUS	GGLSV (588)	DFFTCNV (852), DHLS (666), DLSV (609)
RK2_W	AUS	GK (158)	MSF (30), AES (189), BGKV (459), RKTI (192)
RKA2_W	AUS	GKRA (327)	LRA (463), GK (158)
RKACO_W	AUS	COSA (193)	GK (158)

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Symbol	Type	Created within	Used within
RKAM2_W	LOK	DKVS (476)	
RKAMZS2_W	LOK	DKVS (476)	
RKAMZS_W	LOK	DKVS (476)	
RKAM_W	LOK	DKVS (476)	
RKAT2_W	AUS	LRA (463)	DKVS (476), EEDAT (943), GKRA (327)
RKAT_W	AUS	LRA (463)	DKVS (476), EEDAT (943), GKRA (327)
RKAZ2_W	AUS	LRA (463)	DKVS (476), EEDAT (943), GKRA (327)
RKAZ_W	AUS	LRA (463)	DKVS (476), EEDAT (943), GKRA (327)
RKA_W	AUS	GKRA (327)	LRA (463), GK (158)
RKKVA2_W	AUS	GK (158)	
RKKVA_W	AUS	GK (158)	
RKR	AUS	KRKE (219)	DKRS (242), EGKE (216)
RKRMX	LOK	KRKE (219)	
RKRMX1W	LOK	KRKE (219)	
RKRMX2W	LOK	KRKE (219)	
RKRN_U_0	AUS	DFFTCNV (852)	
RKRN_U_1	AUS	DFFTCNV (852)	
RKRN_U_2	AUS	DFFTCNV (852)	
RKRN_U_3	AUS	DFFTCNV (852)	
RKRN_U_4	AUS	DFFTCNV (852)	
RKRN_U_5	AUS	DFFTCNV (852)	
RKRN_U_6	AUS	DFFTCNV (852)	
RKRN_U_7	AUS	DFFTCNV (852)	
RKRN_W_0	EIN		DFFTCNV (852)
RKRN_W_1	EIN		DFFTCNV (852)
RKRN_W_2	EIN		DFFTCNV (852)
RKRN_W_3	EIN		DFFTCNV (852)
RKRN_W_4	EIN		DFFTCNV (852)
RKRN_W_5	EIN		DFFTCNV (852)
RKRN_W_6	EIN		DFFTCNV (852)
RKRN_W_7	EIN		DFFTCNV (852)
RKRTP	LOK	KRKE (219)	
RKR_TST	LOK	KRKE (219)	
RKTE_W	AUS	GKRA (327)	TEB (380), BGKV (459), KVA (713), GK (158)
RKUKG_W	AUS	ESUK (175)	ESVST (160), GK (158)
RKUKKL_W	LOK	ESUK (175)	
RKUKK_W	AUS	ESUK (175)	
RKUKL_W	LOK	ESUK (175)	
RKWE(Z)_W	AUS	ESVST (160)	
RK_W	AUS	GK (158)	MSF (30), AES (189), BGKV (459), RKTI (192)
RL	AUS	BGSRM (118)	EGFE (104), ATM (302), DFFT (849), DLLR (94), DMDDLU (766), DMDLU (761), DMDFON (772), LRA (463), LR (338), LAMFAW (271), LAKH (272), KRRA (227), GK (158), GGKS (218), GGHFM (105), ZWMIN (213), ZWKS (212), ZWGRU (208), WNWEIN (254), UFUE (890), UFRLC (909), TEB (380), SLS (275), LRHK (365), LREB (328), GGDVE (525), ESWL (171), ESNST (166), ESKS (172), ESGRU (161), DMDSTP (799), DMDMIL (800), DMDLUA (770), DLSA (634), DLDP (404), DKAT (310), BGTEMPK (123)
RLC_C_UM	LOK	UFRLC (909)	
RLDKTHP	DOK	DKAT (310)	
RLDKTHP2	DOK	DKAT (310)	
RLDVS	LOK	EGFE (104)	
RLDVS_W	AUS	BGMSZS (111)	BGRLP (125), EGFE (104)
RLIPF_L_UM	LOK	UFRLC (909)	
RLIPF_UM	LOK	UFRLC (909)	
RLIP_C_UM	LOK	UFRLC (909)	
RLIP_UM	LOK	UFRLC (909)	
RLMAX_W	EIN		MDFUE (148)
RLMIN_W	DOK	MDFUE (148)	MDKOG (40)
RLMP_W	LOK	BGRLP (125)	
RLP	AUS	BGRLP (125)	
RLP_W	AUS	BGRLP (125)	ESUK (175), GK (158), KRDY (237)
RLROH	LOK	EGFE (104)	
RLROHMP_W	LOK	BGRLP (125)	
RLROH_W	AUS	BGMSZS (111)	BGSRM (118), EGFE (104)
RLSOLK_W	LOK	FUEDK (149)	
RLSOL_W	AUS	MDFUE (148)	FUEDK (149), MDKOG (40)
RLTEEV_W	LOK	TEB (380)	
RLUGD_W	DOK	MDMAX (39)	
RLVPPL	LOK	GGDVE (525)	
RLVPPMX	LOK	GGDVE (525)	
RLZO_UM	LOK	UFRLC (909)	
RL_U	AUS	DFFTCNV (852)	
RL_UM	EIN		UFMIST (897), UFRLC (909), UFUE (890)
RL_W	AUS	BGSRM (118)	EGFE (104), BGRLP (125), VMAXMD (78), UFUE (890), UFRLC (909), MSF (30), MDVER (53), MDBAS (50), KRDY (237), DFFTCNV (852)
RL_W_UM	LOK	UFRLC (909)	
RML	AUS	BGRML (854)	DFFT (849)
RMSL	LOK	DSLSLR (289)	
RMSL2	LOK	DSLSLR (289)	
RMSLT	LOK	DSLSLR (289)	
RMSLT2	LOK	DSLSLR (289)	

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Symbol	Type	Created within	Used within
ROMRSTC_UM	LOK	URROM (930)	
RSTPFAD	AUS	DUR (933)	DFFT (849)
RST_TV	AUS	UFREAC (898)	URMEM (926), URRAM (929)
R_NBM	EIN		AEKP (204), BGNMOT (564)
R_SYN	EIN		BGMSZS (111), DMDTSB (810), DMDFON (772), RKTI (192), MDZW (211), MDBAS (50), GGKS (218), GGHFM (105), ESUK (175), ESSTT (162), ESNST (166), ESKS (172), BGSRM (118), BGRLP (125), BGNG (565), DMDFLU (812), BGNMOT (564)
R_SYN1	EIN		DPH (571)
R_SYNPH	EIN		DDG (568), DPH (571)
R_SYNPH2	EIN		DPH (571)
R_T1	EIN		GGHFM (105), GGLSV (588), GGLSH (599)
R_T10	EIN		AEKP (204), ESWL (171), DECJ (813), DDMPME (828), BGWDKM (153), BGRLP (125), BGNMOT (564), BGNG (565), BGMSZS (111), BBSTT (575), ATM (302), BBKHZ (282), LAMKO (268), KRRA (227), KRDY (237), HLS (582), GGUB (671), GGLSV (588), GGLSH (599), FUEDK (149), ZWSTT (210), NMAXMD (76), MOTAUS (576), MDIHGS (68), MDFUE (148), LRHK (365), LREB (328), DASC (740)
R_T100	EIN		ADVE (548), BBKHZ (282), BGPUK (407), DDG (568), DDMPME (828), DHLS (666), DKRS (242), GGLSV (588), GGLSH (599), GGKS (218), GGEGAS (560), ESUK (175), DSLSLR (289), DPH (571), DECJ (813), TEB (380), T2DMTL (941), SLS (275), RKTI (192), MOTAUS (576), LRHK (365), LR (338), LAMKO (268), LAKH (272), KRRA (227), KRKE (219), KRDY (237), HLS (582), GGUB (671), GGTFUMG (684), GGTFM (674), DDMMVE (830), BBSTT (575), BGTEMPK (123)
R_T1000	EIN		BGKMST (861), DKUPPL (561), DLDP (404), BGPUK (407)
R_T1S	EIN		AEKP (204), GGTFM (674), GGTFA (681), BGTABST (154)
R_T20	EIN		BGSRM (118), BGTEV (143), TEB (380), DACC (756), GGKS (218), BGVFGR (498)
R_T200	EIN		ADVE (548), BGDVE (534), BGMSZS (111), MSMD (80), LRA (463), ESGRU (161), ATM (302)
R_T50	EIN		BGTABST (154), DHLS (666), MDIHGS (68)
S	EIN		MS (6)
SDMGLVA_W	LOK	DDMTL (411)	
SDWFK_W	LOK	ESUK (175)	
SDWFL_W	LOK	ESUK (175)	
SFPCAS	AUS	DCAS (739)	
SFPCGE	AUS	DCACC (755)	DCGE (726)
SFPCINS	AUS	DCINS (728)	
SFPCTXU	AUS	DCTXU (745)	
SFPDSL	AUS	GGDSAS (131)	
SFPDSU	AUS	GGDSAS (131)	
SFPDSVLU	AUS	GGDSAS (131)	
SFPDVEE	LOK	ADVE (548)	
SFPDVEF	LOK	BGDVE (534)	
SFPDVEL	LOK	ADVE (548)	
SFPDVEN	LOK	BGDVE (534)	
SFPDVER	LOK	ADVE (548)	
SFPDVEU	LOK	BGDVE (534)	
SFPDVEV	LOK	BGDVE (534)	
SFPHSH	AUS	DHLS (666)	
SFPHSH2	AUS	DHLS (666)	
SFPHSV	AUS	DHLS (666)	
SFPHSV2	AUS	DHLS (666)	
SFPKRNT	AUS	DKRNT (247)	
SFPKROF	AUS	DKRNT (247)	
SFPKRTP	AUS	DKRTP (252)	
SFPLASH	AUS	DLSAHK (645)	
SFPLASH2	AUS	DLSAHK (645)	
SFPLATP	AUS	DLSA (634)	
SFPLATP2	AUS	DLSA (634)	
SFPLATV	AUS	DLSA (634)	
SFPLATV2	AUS	DLSA (634)	
SFPLSH	AUS	DLSH (627)	
SFPLSH2	AUS	DLSH (627)	
SFPLSV	AUS	DLSV (609)	
SFPLSV2	AUS	DLSV (609)	
SFPMILE	AUS	DMILE (837)	
SFPNWSE	AUS	DNWSE (819)	
SFPPH	AUS	DPH (571)	
SFPPH2	AUS	DPH (571)	
SFPSLS	AUS	DSLSLR (289)	
SFPSLS2	AUS	DSLSLR (289)	
SFPSLV	AUS	DSLSLR (289)	
SFPSLV2	AUS	DSLSLR (289)	
SFPSTA	AUS	DSTA (709)	
SFPTA	AUS	GGTFA (681)	
SFPTHM	AUS	DTHM (689)	
SFPTKA	AUS	GGTKA (683)	
SFPTM	AUS	GGTFM (674)	
SFPUB	AUS	GGUB (671)	
SFPUFMV	AUS	DUF (932)	

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Symbol	Type	Created within	Used within
SFPUFSKA	AUS	DUF (932)	
SFPURRAM	AUS	DUR (933)	
SFPURROM	AUS	DUR (933)	
SFPURRST	AUS	DUR (933)	
SKAPFAD	AUS	DUF (932)	DFFT (849)
SLOWR_W	LOK	DFSTT (449)	
SLSSTAT	AUS	DSLSLR (289)	
SP1P_A_UM	LOK	URADCC (923)	
SP1P_ST_UM	LOK	URADCC (923)	
SP1SN_UM	LOK	UFSPSC (913)	
SP1S_A_UM	LOK	URADCC (923)	
SP1S_ST_UM	LOK	URADCC (923)	
SP1S_UM	LOK	UFSPSC (913)	
SP2SN_UM	LOK	UFSPSC (913)	
SP2S_UM	LOK	UFSPSC (913)	
SPSC_C_UM	LOK	UFSPSC (913)	
SPSN_UM	AUS	UFSPSC (913)	UFREAC (898), UFUE (890)
STAT_MD_E	AUS	CANDME (718)	BBACC (759)
STHMDTKA	LOK	DTHM (689)	
STKRLX	LOK	KRRA (227)	
STKRNX	AUS	KRRA (227)	KRDY (237)
STMLAC	AUS	CANINS (727)	MLS (695)
STPDMTL	AUS	T2DMTL (941)	
STPDMTLA	AUS	T2DMTL (941)	
STPTR	EIN		DLDP (404)
STPTRW	LOK	DLDP (404)	
SUMODE	EIN		BGSRM (118), GGHFM (105)
SY_2SG	AUS	PROKON (878)	AEVAB (196), DMDDLU (766), DMDLU (761), DMDUE (760)
SY_AGR	AUS	PROKON (878)	
SY_AIRBAG	EIN		AEKP (204)
SY_ATR	AUS	PROKON (878)	LAMKO (268)
SY_CAN	AUS	PROKON (878)	
SY_CDCSIZE	AUS	PROKON (878)	
SY_CDKSIZE	AUS	PROKON (878)	
SY_CDTSIZE	AUS	PROKON (878)	
SY_CLASIZE	AUS	PROKON (878)	
SY_CS32FM	AUS	PROKON (878)	
SY_DELFCMS	EIN		SCATT (863)
SY_DFPMENV	EIN		DFCM (847), DFPM (841)
SY_DFPMTIM	EIN		DFPM (841), DUMWEX (855)
SY_DFPMVAR	EIN		DFPM (841)
SY_DNWSE	AUS	PROKON (878)	
SY_DVEADA	AUS	PROKON (878)	AEVAB (196)
SY_EGAS	AUS	PROKON (878)	TEB (380)
SY_EGFE	AUS	PROKON (878)	BGMSZS (111)
SY_ENVBLOK	EIN		DFCM (847), DFPM (841)
SY_F1GETR	AUS	PROKON (878)	
SY_FCMSIZE	EIN		DFCM (847), DFPM (841)
SY_FFCSIZE	EIN		DFCM (847)
SY_FFESIZE	EIN		DFCM (847), DFPM (841)
SY_FFTSIZE	AUS	PROKON (878)	
SY_FLUQ	AUS	PROKON (878)	
SY_FREQCPU	AUS	PROKON (878)	DMDTSB (810)
SY_GAP	AUS	PROKON (878)	
SY_GRDWRT	AUS	PROKON (878)	DMDTSB (810), GGKS (218)
SY_INGASOS	LOK	BGNG (565)	
SY_ISOPROT	EIN		SCATT (863), TC1MOD (864), TC2MOD (868)
SY_KS1	AUS	PROKON (878)	GGKS (218)
SY_KS2	AUS	PROKON (878)	GGKS (218)
SY_KS3	AUS	PROKON (878)	GGKS (218)
SY_KS4	AUS	PROKON (878)	GGKS (218)
SY_KWP71	AUS	PROKON (878)	
SY_LLR	AUS	PROKON (878)	
SY_M1I00A	AUS	PROKON (878)	TC1MOD (864)
SY_M1I00B	AUS	PROKON (878)	TC1MOD (864)
SY_M1I00C	AUS	PROKON (878)	TC1MOD (864)
SY_M1I00D	AUS	PROKON (878)	TC1MOD (864)
SY_M1I20A	EIN		TC1MOD (864)
SY_M1I20B	EIN		TC1MOD (864)
SY_M1I20C	EIN		TC1MOD (864)
SY_M1I20D	EIN		TC1MOD (864)
SY_M2I00A	AUS	PROKON (878)	TC2MOD (868)
SY_M2I00B	AUS	PROKON (878)	TC2MOD (868)
SY_M2I00C	AUS	PROKON (878)	TC2MOD (868)
SY_M2I00D	AUS	PROKON (878)	TC2MOD (868)
SY_M5IH00A	AUS	PROKON (878)	TC5MOD (870)
SY_M5IH00B	AUS	PROKON (878)	TC5MOD (870)
SY_M5IH00C	AUS	PROKON (878)	TC5MOD (870)
SY_M5IH00D	AUS	PROKON (878)	TC5MOD (870)
SY_M5IH20A	EIN		TC5MOD (870)
SY_M5IH20B	EIN		TC5MOD (870)
SY_M5IH20C	EIN		TC5MOD (870)

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Symbol	Type	Created within	Used within
SY_M5IH20D	EIN		TC5MOD (870)
SY_M5IV00A	AUS	PROKON (878)	TC5MOD (870)
SY_M5IV00B	AUS	PROKON (878)	TC5MOD (870)
SY_M5IV00C	AUS	PROKON (878)	TC5MOD (870)
SY_M5IV00D	AUS	PROKON (878)	TC5MOD (870)
SY_M5IV20A	AUS	PROKON (878)	TC5MOD (870)
SY_M5IV20B	AUS	PROKON (878)	TC5MOD (870)
SY_M5IV20C	AUS	PROKON (878)	TC5MOD (870)
SY_M5IV20D	AUS	PROKON (878)	TC5MOD (870)
SY_M5IV40A	EIN		TC5MOD (870)
SY_M5IV40B	EIN		TC5MOD (870)
SY_M5IV40C	EIN		TC5MOD (870)
SY_M5IV40D	EIN		TC5MOD (870)
SY_M5IV60A	EIN		TC5MOD (870)
SY_M5IV60B	EIN		TC5MOD (870)
SY_M5IV60C	EIN		TC5MOD (870)
SY_M5IV60D	EIN		TC5MOD (870)
SY_M5IV80A	EIN		TC5MOD (870)
SY_M5IV80B	EIN		TC5MOD (870)
SY_M5IV80C	EIN		TC5MOD (870)
SY_M5IV80D	EIN		TC5MOD (870)
SY_M6I00A	AUS	PROKON (878)	
SY_M6I00B	AUS	PROKON (878)	
SY_M6I00C	AUS	PROKON (878)	
SY_M6I00D	AUS	PROKON (878)	
SY_M8I00A	AUS	PROKON (878)	
SY_M8I00B	AUS	PROKON (878)	TC8MOD (872)
SY_M8I00C	AUS	PROKON (878)	TC8MOD (872)
SY_M8I00D	AUS	PROKON (878)	TC8MOD (872)
SY_M8I00E	EIN		TC8MOD (872)
SY_M9I00A	EIN		TC9MOD (872)
SY_M9I00B	EIN		TC9MOD (872)
SY_M9I00C	EIN		TC9MOD (872)
SY_M9I00D	EIN		TC9MOD (872)
SY_NWS	AUS	PROKON (878)	MDBAS (50), VS_VERST (714)
SY_PHTWIN	AUS	PROKON (878)	DDG (568), DPH (571)
SY_REDMX	AUS	PROKON (878)	AEVAB (196), ZUE (206)
SY_STEREO	AUS	PROKON (878)	
SY_STERHK	AUS	PROKON (878)	DHLS (666), TC1MOD (864), LRKA (353), LRHK (365), DLSAHK (645), DKAT (310), GGLSH (599), HLS (582), DLSA (634)
SY_STERSY	AUS	PROKON (878)	DLSA (634), LRKA (353), LRHK (365), LR (338)
SY_STERVK	AUS	PROKON (878)	DHLS (666), TEB (380), LRKA (353), LRHK (365), LREB (328), LRAEB (461), LRA (463), LR (338), LAMKO (268), LAKH (272), HLS (582), GGLSV (588), ESWL (171), DSLSLR (289), DKVS (476), TC1MOD (864), SLS (275), RKTI (192), DLSA (634)
SY_STETLR	AUS	PROKON (878)	DLSSA (654), LAKH (272), GGLSV (588)
SY_TABST	EIN		GGTFM (674)
SY_TEBF	EIN		AEKP (204)
SY_TFA	AUS	PROKON (878)	BGTEMPK (123)
SY_TFBA	EIN		ESUK (175)
SY_TFMA	AUS	PROKON (878)	GGTFM (674)
SY_TFMAP	AUS	PROKON (878)	GGTFA (681)
SY_TFMO	AUS	PROKON (878)	GGTFM (674)
SY_TFNS	EIN		ESNST (166)
SY_TFUMG	AUS	PROKON (878)	GGTFM (674)
SY_TFVA	EIN		ESUK (175)
SY_TFWL	AUS	PROKON (878)	ESWL (171)
SY_TLR	EIN		LR (338)
SY_TSFSIZE	AUS	PROKON (878)	
SY_TURBO	AUS	PROKON (878)	BGMSZS (111), VS_VERST (714), FUEDK (149), GGHFM (105)
SY_TVVR	EIN		VMAXMD (78)
SY_UB13V	AUS	PROKON (878)	
SY_UBDEDIS	AUS	PROKON (878)	ADVE (548)
SY_UBDEEN	AUS	PROKON (878)	ADVE (548)
SY_UBFQ	AUS	PROKON (878)	
SY_UBKL15	AUS	PROKON (878)	GGUB (671)
SY_UBOKDIS	AUS	PROKON (878)	
SY_UBOKEN	AUS	PROKON (878)	
SY_UBSQ_W	EIN		GGUB (671)
SY_UMALS	AUS	PROKON (878)	
SY_USOFF	AUS	PROKON (878)	
SY_WFS	AUS	PROKON (878)	
SY_WMAX	AUS	PROKON (878)	ZUE (206)
SY_WMIN	AUS	PROKON (878)	ZUE (206)
SY_ZAS	AUS	PROKON (878)	
SY_ZNDAUS	AUS	PROKON (878)	
SY_ZYLZA	AUS	PROKON (878)	AEVAB (196), TC1MOD (864), BGNG (565), KRRA (227), BGRLP (125), GGKS (218)
SY_ZZBANK	AUS	PROKON (878)	AEVAB (196)
SZOUT	AUS	MSF (30)	
SZOUT_W	AUS	ZUE (206)	ZUESZ (207)
S_AC	EIN		KOS (698)

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Symbol	Type	Created within	Used within
S_BLS	EIN		GGEGAS (560), UFFGRE (902)
S_BRS	EIN		GGEGAS (560), UFFGRE (902)
S_DP	LOK	MDFAW (31)	
S_FS	EIN		MDWAN (61)
S_KO	EIN		KOS (698)
S_KUPP	EIN		DKUPPL (561), GGEGAS (560)
S_LS	LOK	MDFAW (31)	
T	EIN		BGNMOT (564)
T1NWI_W	EIN		WANWKW (257)
TAAGR	EIN		EGFE (104)
TABGM	AUS	ATM (302)	DFFT (849), DHLS (666), HLS (582), DSLSLR (289), DLSV (609), DL-SA (634)
TABGM2	AUS	ATM (302)	DFFT (849), DHLS (666), HLS (582), DLSA (634), DLSV (609)
TABGM2_W	AUS	ATM (302)	
TABGMAB	LOK	ATM (302)	
TABGMAB2	LOK	ATM (302)	
TABGMF	LOK	DHLS (666)	
TABGMF2	LOK	DHLS (666)	
TABGMST	LOK	ATM (302)	
TABGMST2	LOK	ATM (302)	
TABGM_W	AUS	ATM (302)	
TABSMN_W	LOK	BGTABST (154)	
TABSNL_W	LOK	BGTABST (154)	
TABSSC_W	LOK	BGTABST (154)	
TABSTM_W	LOK	BGTABST (154)	
TABST_W	AUS	BGTABST (154)	AEKP (204), BBKHZ (282), HDMTL (442), GGTFM (674), ESSTT (162), ESNST (166), DDMTL (411), DDMMVE (830), ATM (302)
TACCZAL	DOK	DACC (756)	
TADTEA	EIN		ATEV (402), GKRA (327)
TAGS	LOK	EGFE (104)	
TAGS_W	EIN		BGTEMPK (123), EGFE (104)
TALDPREF	LOK	DLDP (404)	
TALT_UM	LOK	UFNC (906)	
TAML	AUS	MLS (695)	
TAMLAUS	LOK	MLS (695)	
TAMLDIA	EIN		MLS (695)
TAMLNH	DOK	MLS (695)	
TAMLNL	LOK	MLS (695)	
TAMLS	LOK	MLS (695)	
TANS	AUS	GGTFA (681)	ATM (302), BBSTT (575), GGTFUMG (684), GGTFM (674), EGFE (104), DTHM (689), DSLSLR (289), DLLR (94), DLDP (404), DFFT (849), BGTEMPK (123), BGTABST (154), ZWWL (210), ZWSTT (210), ZWKS (212), ZWGRU (208), WNWEIN (254), UFUE (890), UFEING (891), TEB (380), SLS (275), MDZUL (45), LREB (328), LRAEB (461), GGHFM (105), ETR (688), ESSTT (162), ESNST (166), ESGRU (161), BGDVE (534), BBTEGA (371), BBKHZ (282), DMDSTP (799)
TANSAB	AUS	GGTFA (681)	ESSTT (162)
TANSLIN	AUS	GGTFA (681)	TC1MOD (864)
TANSST	DOK	LREB (328)	
TANS_UM	AUS	UFEING (891)	UFNSC (896), UFUE (890)
TATEIST	EIN		DDMMVE (830), EGFE (104), BGTEV (143)
TATEOUT	AUS	ATEV (402)	DTEVE (826)
TATESLO1	LOK	BGTEV (143)	
TATESLO2	LOK	BGTEV (143)	
TATESLO3	LOK	BGTEV (143)	
TATESOLL	AUS	ATEV (402)	GKRA (327), BGTEV (143), GKEB (325), TEBEB (378)
TATMKF	DOK	ATM (302)	
TATMKF2	DOK	ATM (302)	
TATMSTA	LOK	ATM (302)	
TATMSTA2	LOK	ATM (302)	
TATU	LOK	ATM (302)	
TC6LDPC	AUS	DLDP (404)	
TC6LDPS	AUS	DLDP (404)	
TC6LDPW	AUS	DLDP (404)	
TCAP_UM	LOK	UFNC (906)	
TDCACC_CTR	EIN		DACC (756), DCACC (755)
TDCAS_CTR1	EIN		CANASR (732)
TDIF_UM	LOK	UFNC (906)	
TDLRTM	AUS	GGTFM (674)	
TDMGL_W	LOK	DDMTL (411)	
TDMKL_W	LOK	DDMTL (411)	
TDMLKA	LOK	DDMTL (411)	
TDMLKA_W	LOK	DDMTL (411)	
TDMRFA_W	LOK	DDMTL (411)	
TDMSTBA_W	LOK	DDMTL (411)	
TDMSTTH_W	LOK	DDMTL (411)	
TE2_W	EIN		KVA (713), TEB (380)
TEPHC	LOK	BBTEGA (371)	
TESSTAT	AUS	DTEVN (403)	
TETE_W	LOK	KVA (713)	
TEVPER	AUS	ATEV (402)	BGTEV (143)
TEVPERO1	LOK	BGTEV (143)	

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Symbol	Type	Created within	Used within
TEVPERO2	LOK	BGTEV (143)	
TEVPERO3	LOK	BGTEV (143)	
TEVPERVZ	LOK	BGTEV (143)	
TE_W	EIN		BGRLP (125), KVA (713), TEB (380)
TFADTLBE	LOK	T2DMTL (941)	
TFRN2_W	EIN		DLSA (634), DLSSA (654), LR (338)
TFRNINT2_W	LOK	LR (338)	
TFRNINT_W	LOK	LR (338)	
TFRN_W	EIN		DLSA (634), DLSSA (654), LR (338)
TFRP2_W	EIN		DLSA (634), LR (338)
TFRPINT2_W	LOK	LR (338)	
TFRPINT_W	LOK	LR (338)	
TFRP_W	EIN		DLSA (634), LR (338)
TFST	AUS	CANINS (727)	DFFT (849), DFSTT (449), GGFSTT (443), DMDMIL (800)
TFST2	EIN		GGFSTT (443)
TFST2NQ_W	LOK	GGFSTT (443)	
TFST2_DEZ	LOK	GGFSTT (443)	
TFSTNF_W	LOK	GGFSTT (443)	
TFSTNQ_DEZ	LOK	GGFSTT (443)	
TFSTNQ_W	LOK	GGFSTT (443)	
TFST_DEZ	LOK	GGFSTT (443)	
TFST_W	LOK	GGFSTT (443)	
TFWDKS_W	LOK	FUEDK (149)	
THHAIST	LOK	HLS (582)	
THHAIST2	LOK	HLS (582)	
THHAT	LOK	HLS (582)	
THHAT2	LOK	HLS (582)	
THVAIST	LOK	HLS (582)	
THVAIST2	LOK	HLS (582)	
THVAT	LOK	HLS (582)	
THVAT2	LOK	HLS (582)	
TI2_W	AUS	RKTI (192)	
TIMFP	LOK	DLDP (404)	
TIMRS	LOK	DLDP (404)	
TIMTP	LOK	DLDP (404)	
TIMVLDP	LOK	DLDP (404)	
TISTZYL	AUS	CIFINA (203)	ESSTT (162)
TI_B1	AUS	RKTI (192)	AES (189)
TI_B2	AUS	RKTI (192)	AES (189)
TI_EV0	AUS	AES (189)	
TI_EV1	LOK	AES (189)	
TI_EV7	AUS	AES (189)	
TI_EV8	LOK	AES (189)	
TI_TVU_W	AUS	RKTI (192)	AES (189)
TI_W	AUS	RKTI (192)	
TKA	AUS	GGTKA (683)	DTHM (689), MSMD (80), MLS (695)
TKALIN	AUS	GGTKA (683)	
TKATM	AUS	ATM (302)	BBKHZ (282), DHLS (666), DFFT (849), BBSAWE (71), LRHK (365), HLS (582), DSLSLR (289), DKAT (310), DLSH (627)
TKATM2	AUS	ATM (302)	DFFT (849), DHLS (666), LRHK (365), HLS (582), DKAT (310), DLSH (627)
TKATM2_W	AUS	ATM (302)	LRKA (353)
TKATMAB	LOK	ATM (302)	
TKATMAB2	LOK	ATM (302)	
TKATMF	LOK	DHLS (666)	
TKATMF2	LOK	DHLS (666)	
TKATMST	LOK	ATM (302)	
TKATMST2	LOK	ATM (302)	
TKATM_W	AUS	ATM (302)	LRKA (353)
TLOOP	LOK	BGDVE (534)	
TMABSLDP	EIN		DLDP (404)
TMEW	AUS	GGTFM (674)	DFFT (849)
TMEWAB	AUS	GGTFM (674)	
TMFA_W	LOK	GGKS (218)	
TMFLB	LOK	GGMFL (490)	
TMFLBE_CTR	EIN		GGMFL (490)
TMFLN_W	AUS	GGKS (218)	DKRNT (247)
TMFLTC_CTR	EIN		GGMFL (490)
TMFL_W	LOK	GGKS (218)	
TMLAUF_W	EIN		ESSTT (162)

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Symbol	Type	Created within	Used within
TMOT	AUS	GGTFM (674)	ARMD (63), DTEVN (403), DSLSLR (289), DNWS (267), DMDMIL (800), DMDLU (761), DLSV (609), DLLR (94), DLDP (404), DFFT (849), COSA (193), CANDME (718), ESWL (171), ESUK (175), ESNWS (174), ESKS (172), EGFE (104), DWUC (856), DVFZ (581), BBKHZ (282), KRRA (227), KRDY (237), KOS (698), KHMD (287), HLS (582), GGKS (218), ETR (688), BBSTT (575), ZWWL (210), ZWMIN (213), ZWKS (212), WNWEIN (254), UFUE (890), UFEING (891), UETM (687), TEBEB (378), TEB (380), STMD (60), STA (706), SLS (275), MSMD (80), MDZUL (45), MDVERAD (55), MDVER (53), MDRED (73), MDMAX (39), MDBAS (50), LREB (328), LRAEB (461), LR (338), LLRRM (88), LLRNS (84), LLRMR (92), LLRABG (100), LAMKO (268), LAMFAW (271), LAKH (272), BGDVE (534), BGTEMPK (123), BGMSZS (111), BBSAWE (71), ATM (302), DMDSTP (799)
TMOTAB	AUS	GGTFM (674)	AEKP (204), ESSTT (162), DLSV (609), BGTABST (154), BBKHZ (282)
TMOTLIN	AUS	GGTFM (674)	DFFTCNV (852), DTHM (689), LREB (328), TC1MOD (864)
TMOTVT	LOK	GGTFM (674)	
TMOT_U	AUS	DFFTCNV (852)	DFFT (849)
TMOT_UM	AUS	UFEING (891)	UFNSC (896), UFUE (890)
TMPUMAST	LOK	BGDVE (534)	
TMRW	AUS	GGTFM (674)	LREB (328)
TMRWEND	LOK	GGTFM (674)	
TMST	AUS	GGTFM (674)	ARMD (63), BBKHZ (282), BBSAWE (71), BBTEGA (371), BGTABST (154), ATM (302), ZWWL (210), ZWSTT (210), SLS (275), LAKH (272), HDMTL (442), ESWL (171), ESUK (175), ESSTT (162), ESNST (166), DTHM (689), DNWS (267), LREB (328), LR (338), DDMTL (411), BBBO (475)
TMSTEM	LOK	DWUC (856)	
TN	AUS	GGDG (562)	GGKS (218)
TN2FGR_W	LOK	FGRMD (499)	
TNACHL_W	AUS	MOTAUS (576)	AEKP (204), BGDVE (534), MLS (695)
TNBM_W	EIN		BGNMOT (564)
TNSE_W	AUS	BBSTT (575)	BBTEGA (371), DDMTL (411), ESSTT (162), DLLR (94), DKAT (310), DDMMVE (830)
TNST	EIN		BBKHZ (282), WNWEIN (254)
TNST_W	AUS	BBSTT (575)	BBKHZ (282), DLDP (404), WNWEIN (254), UETM (687), SLS (275), BGTABST (154), DMDSTP (799)
TNWSFI	AUS	WNWTST (267)	
TNWSFI2	AUS	WNWTST (267)	
TNWSSI	AUS	WNWTST (267)	
TNWSSI2	AUS	WNWTST (267)	
TOL	EIN		GGTFM (674)
TOP_W	AUS	DTOP (840)	DDMMVE (830), T2DMTL (941), EEDAT (943)
TPLDP	LOK	DLDP (404)	
TPLDPE	LOK	DLDP (404)	
TPLRVK2_W	AUS	LR (338)	DLSA (634)
TPLRVK_W	AUS	LR (338)	DLSA (634)
TPNT_AKTIV	AUS	EGKE (216)	GGKS (218), DKRNT (247), DKRTP (252)
TPOTV2_W	LOK	DLSA (634)	
TPOTV_W	LOK	DLSA (634)	
TPSVKMF2_U	AUS	DFFTCNV (852)	DFFT (849)
TPSVKMF2_W	AUS	DLSA (634)	DFFTCNV (852), DLSSA (654)
TPSVKMF_U	AUS	DFFTCNV (852)	DFFT (849)
TPSVKMF_W	AUS	DLSA (634)	DFFTCNV (852), DLSSA (654)
TPSVKOF2_W	LOK	DLSA (634)	
TPSVKOF_W	LOK	DLSA (634)	
TPSVLSA2	AUS	DLSSA (654)	
TPSVLSSA	AUS	DLSSA (654)	
TPSVLSSA2	AUS	DLSSA (654)	
TRMINAUS_W	LOK	BGTABST (154)	
TRMINEIN_W	LOK	BGTABST (154)	
TRMIN_W	AUS	CANINS (727)	BGTABST (154)
TS01	LOK	DMDFON (772)	
TS02	LOK	DMDFON (772)	
TS03	LOK	DMDFON (772)	
TS04	LOK	DMDFON (772)	
TS05	LOK	DMDFON (772)	
TS06	LOK	DMDFON (772)	
TS07	LOK	DMDFON (772)	
TS08	LOK	DMDFON (772)	
TSAKA	LOK	LRKA (353)	
TSAKA2	LOK	LRKA (353)	
TSEGRSP_W	AUS	BGNG (565)	
TSEG_W	AUS	BGNMOT (564)	BGNG (565)
TSG	AUS	GGTSG (686)	ELS (839)
TSGES_W	DOK	BGTEMPK (123)	
TSK	AUS	DMDFON (772)	DMDLU (761)
TSK01	LOK	DMDFON (772)	
TSK02	LOK	DMDFON (772)	
TSK03	LOK	DMDFON (772)	
TSK04	LOK	DMDFON (772)	
TSK05	LOK	DMDFON (772)	

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Symbol	Type	Created within	Used within
TSK06	LOK	DMDFON (772)	
TSK07	LOK	DMDFON (772)	
TSK08	LOK	DMDFON (772)	
TSK_M	LOK	DMDFON (772)	
TSPERR	LOK	LR (338)	
TSPERR2	LOK	LR (338)	
TSROH_W	AUS	DMDTSB (810)	DMDFON (772)
TSTLAUF_W	DOK	ESSTT (162)	
TS_M	LOK	DMDFON (772)	
TTMUMAD	LOK	BGDVE (534)	
TUMG	AUS	CANINS (727)	GGTFUMG (684), ATM (302), DFFT (849), DLDP (404), GGTFM (674), DDMTL (411), BGLBZ (99), BGTABST (154)
TUMGCAN	LOK	GGTFUMG (684)	
TUMGTA	LOK	GGTFUMG (684)	
TUMTA	LOK	BGTABST (154)	
TUM_EIN	LOK	BGTABST (154)	
TUSPNF	AUS	DLSSA (654)	
TUSPNF2	AUS	DLSSA (654)	
TV	LOK	LR (338)	
TV2	LOK	LR (338)	
TVLR	LOK	LR (338)	
TVLR2	LOK	LR (338)	
TVLRH	AUS	LRHK (365)	LR (338), GKRA (327)
TVLRH2	AUS	LRHK (365)	LR (338), GKRA (327)
TVLRHI	AUS	LRHK (365)	LR (338)
TVLRHI2	AUS	LRHK (365)	LR (338)
TVLRHP	LOK	LRHK (365)	
TVLRHP2	LOK	LRHK (365)	
TVRNR	LOK	AEVAB (196)	
TVU_W	EIN		BGRLP (125), RKTI (192), AES (189)
TWAN	EIN		MDWAN (61)
TWDLSSA2_W	LOK	DLSSA (654)	
TWDLSSA_W	LOK	DLSSA (654)	
TWDLSSH2_W	LOK	DLSSA (654)	
TWDLSSH_W	LOK	DLSSA (654)	
TXURATIO	AUS	DGLOR (747)	
TYP_DVEF	LOK	BGDVE (534)	
TYP_DVEN	LOK	BGDVE (534)	
TYP_DVEU	LOK	BGDVE (534)	
TYP_DVEV	LOK	BGDVE (534)	
TYP_LASH	AUS	DLSAHK (645)	
TYP_LASH2	AUS	DLSAHK (645)	
TYP_LATP	LOK	DLSA (634)	
TYP_LATP2	LOK	DLSA (634)	
TYP_LATV	LOK	DLSA (634)	
TYP_LATV2	LOK	DLSA (634)	
TYP_LSH	AUS	DLSH (627)	
TYP_LSH2	AUS	DLSH (627)	
TZ2FGR_W	LOK	FGRMD (499)	
TZLSATV	LOK	DLSA (634)	
TZLSATV2	LOK	DLSA (634)	
U	LOK	MS (6)	
U5REF1	AUS	DU5REF (673)	
U5REF1_W	LOK	DU5REF (673)	
U5REF2	AUS	DU5REF (673)	
U5REF2_W	LOK	DU5REF (673)	
UADKI	EIN		GGKS (218), EGKE (216)
UB	AUS	GGUB (671)	ADVE (548), AEKP (204), AES (189), ZUESZ (207), MOTAUS (576), MLS (695), DLDP (404), DHLS (666), DHFM (108), DCTXU (745), DCINS (728), DCGE (726), DCAS (739), DCACC (755), BGUBF (282), BGLBZ (99), BGDVE (534), HLS (582), GGMFL (490), GGDVE (525), DLSV (609), DGLOR (747), DFFT (849), DECJ (813), ATEV (402), DLSH (627)
UBF	AUS	BGUBF (282)	SLS (275)
UBSQ	AUS	GGUB (671)	DDMPME (828)
UBSQF	AUS	GGUB (671)	
UBSQF_W	AUS	GGUB (671)	
UBSQ_W	AUS	GGUB (671)	DDMTL (411)
UBTESF_L	DOK	DDMTL (411)	
UBTESF_W	LOK	DDMTL (411)	
UBTREF_W	LOK	DDMTL (411)	
UDKNLP1	EIN		EEDAT (943), BGDVE (534)
UDKNLP1R	LOK	BGDVE (534)	
UDKNLP2	EIN		EEDAT (943), BGDVE (534)
UDKNLP2R	LOK	BGDVE (534)	
UDKP1A	AUS	BGDVE (534)	UFRLC (909), UFUE (890)
UDKP1AALT	LOK	BGDVE (534)	
UDKP1ASR_W	LOK	BGDVE (534)	
UDKP1AS_W	EIN		EEDAT (943), BGDVE (534)
UDKP1A_U	AUS	DFFTCNV (852)	
UDKP1A_W	AUS	BGDVE (534)	DFFTCNV (852), GGDVE (525)
UDKP1ROB	LOK	BGDVE (534)	

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Symbol	Type	Created within	Used within
UDKP1RUN	LOK	BGDVE (534)	
UDKP1SV	AUS	BGDVE (534)	GGDVE (525)
UDKP1VOR	LOK	BGDVE (534)	
UDKP1VOU	AUS	BGDVE (534)	
UDKP1VO_W	AUS	BGDVE (534)	EEDAT (943), GGDVE (525)
UDKP1VROB	LOK	BGDVE (534)	
UDKP1VRUN	LOK	BGDVE (534)	
UDKP1VV	AUS	BGDVE (534)	
UDKP1VVR	LOK	BGDVE (534)	
UDKP1VV_W	AUS	BGDVE (534)	EEDAT (943), GGDVE (525)
UDKP1V_W	EIN		BGDVE (534), GGDVE (525)
UDKP1_U	AUS	DFFTCNV (852)	DFFT (849)
UDKP1_W	EIN		BGDVE (534), GGDVE (525), DFFTCNV (852)
UDKP2A	AUS	BGDVE (534)	UFRLC (909), UFUE (890)
UDKP2AALT	LOK	BGDVE (534)	
UDKP2ASR_W	LOK	BGDVE (534)	
UDKP2AS_W	EIN		EEDAT (943), BGDVE (534)
UDKP2A_W	AUS	BGDVE (534)	GGDVE (525)
UDKP2_U	AUS	DFFTCNV (852)	DFFT (849)
UDKP2_W	EIN		BGDVE (534), GGDVE (525), DFFTCNV (852)
UDKPAT_W	LOK	BGDVE (534)	
UDSLSUM_L	LOK	GGDSAS (131)	
UDSL_W	EIN		GGDSAS (131)
UDSU_W	EIN		GGDSAS (131)
UEVGES	AUS	BBGANG (70)	
UHFM	EIN		EGFE (104)
UHFM_W	EIN		GGHFM (105)
UHSH	EIN		DFFT (849), DHLS (666)
UHSH2	EIN		DFFT (849), DHLS (666)
UHSV	EIN		DFFT (849), DHLS (666), KATV (324)
UHSV2	EIN		DFFT (849), KATV (324), DHLS (666)
UMSRLN_W	AUS	BGMSZS (111)	BGRLP (125), BGSRM (118), FUEDK (149)
UPTES_W	AUS	GGDMTL (410)	DDMPME (828)
UPW2LL_W	LOK	GGPED (513)	
UPWG1_U	AUS	DFFTCNV (852)	DFFT (849)
UPWG1_W	AUS	GGPEDV (523)	DFFTCNV (852), GGPED (513)
UPWG2D_U	AUS	DFFTCNV (852)	DFFT (849)
UPWG2D_W	EIN		DFFTCNV (852), GGPED (513)
UPWG2FIL_W	LOK	GGPED (513)	
UPWG2_U	AUS	DFFTCNV (852)	DFFT (849)
UPWG2_W	AUS	GGPEDV (523)	DFFTCNV (852), GGPED (513)
UPWGEJ_W	LOK	GGPED (513)	
UPWG_W	LOK	GGPED (513)	
URDDKTP	LOK	DKAT (310)	
URDDKTP2	LOK	DKAT (310)	
USBEH2_W	LOK	GGLSH (599)	
USBEH_W	LOK	GGLSH (599)	
USBEV2_W	LOK	GGLSV (588)	
USBEV_W	LOK	GGLSV (588)	
USHDKTP	DOK	DKAT (310)	
USHDKTP2	DOK	DKAT (310)	
USHFMXSTG	LOK	DLSAHK (645)	
USHFMXSTG2	LOK	DLSAHK (645)	
USHK	AUS	GGLSH (599)	DFFT (849), TC1MOD (864), LRKA (353), GKRA (327), DLSSA (654), DLSH (627), DLSAHK (645), DLSA (634), DKAT (310)
USHK2	AUS	GGLSH (599)	DFFT (849), DLSA (634), DLSSA (654), DLSH (627), TC1MOD (864), LRKA (353), GKRA (327), DLSAHK (645), DKAT (310)
USHK2_W	AUS	GGLSH (599)	DLSV (609), LRHK (365)
USHKJ	LOK	DLSSA (654)	
USHKJ2	LOK	DLSSA (654)	
USHKJF2_W	LOK	DLSSA (654)	
USHKJF_W	LOK	DLSSA (654)	
USHKMXSTG	LOK	DLSAHK (645)	
USHKMXSTG2	LOK	DLSAHK (645)	
USHKR2_W	LOK	GGLSH (599)	
USHKR_W	LOK	GGLSH (599)	
USHKSTEIG	LOK	DLSAHK (645)	
USHKSTEIG2	LOK	DLSAHK (645)	
USHK_W	AUS	GGLSH (599)	DLSV (609), LRHK (365)
USMNSAA	LOK	DLSSA (654)	
USMNSAA2	LOK	DLSSA (654)	
USMNSAN	AUS	DLSSA (654)	
USMNSAN2	AUS	DLSSA (654)	
USMNSHA	LOK	DLSSA (654)	
USMNSHA2	LOK	DLSSA (654)	
USMNSHN	AUS	DLSSA (654)	
USMNSHN2	AUS	DLSSA (654)	
USMXSAA	LOK	DLSSA (654)	
USMXSAA2	LOK	DLSSA (654)	
USMXSAN	AUS	DLSSA (654)	
USMXSAN2	AUS	DLSSA (654)	
USMXSHA	LOK	DLSSA (654)	

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Symbol	Type	Created within	Used within
USMXSHA2	LOK	DLSSA (654)	
USMXSHN	AUS	DLSSA (654)	
USMXSHN2	AUS	DLSSA (654)	
USOBH2_W	LOK	GGLSH (599)	
USOBH_W	LOK	GGLSH (599)	
USOBV2_W	LOK	GGLSV (588)	
USOBV_W	LOK	GGLSV (588)	
USRHK	AUS	LRHK (365)	DLSA (634), DLSAHK (645)
USRHK2	AUS	LRHK (365)	DLSA (634), DLSAHK (645)
USRJ	AUS	DLSSA (654)	
USVK	AUS	GGLSV (588)	DFFT (849), TC1MOD (864), DLSSA (654), LR (338), LREB (328), LRKA (353)
USVK2	AUS	GGLSV (588)	DFFT (849), DLSSA (654), TC1MOD (864), LRKA (353), LREB (328), LR (338)
USVK2_W	AUS	GGLSV (588)	DLSV (609), GKRA (327)
USVKJ	AUS	DLSSA (654)	
USVKJ2	AUS	DLSSA (654)	
USVKJF2_W	LOK	DLSSA (654)	
USVKJF_W	LOK	DLSSA (654)	
USVKR2_W	LOK	GGLSV (588)	
USVKR_W	LOK	GGLSV (588)	
USVK_W	AUS	GGLSV (588)	DLSV (609), GKRA (327)
USVMB2_W	LOK	GGLSV (588)	
USVMB_W	LOK	GGLSV (588)	
USVOB2_W	LOK	GGLSV (588)	
USVOB_W	LOK	GGLSV (588)	
UUPTES_W_0	EIN		GGDMTL (410)
UUPTES_W_1	EIN		GGDMTL (410)
UUPTES_W_2	EIN		GGDMTL (410)
UUPTES_W_3	EIN		GGDMTL (410)
UUPTES_W_4	EIN		GGDMTL (410)
UUSHK2_U	AUS	DFFTCNV (852)	
UUSHK2_W	EIN		DFFTCNV (852), GGLSH (599)
UUSHK_U	AUS	DFFTCNV (852)	
UUSHK_W	EIN		DFFTCNV (852), GGLSH (599)
UUSHMB2_W	LOK	GGLSH (599)	
UUSHMB_W	LOK	GGLSH (599)	
UUSHOB2_W	LOK	GGLSH (599)	
UUSHOB_W	LOK	GGLSH (599)	
UUSVK2_U	AUS	DFFTCNV (852)	
UUSVK2_W	EIN		DFFTCNV (852), GGLSV (588)
UUSVK_U	AUS	DFFTCNV (852)	
UUSVK_W	EIN		DFFTCNV (852), GGLSV (588)
UUSVMB2_W	LOK	GGLSV (588)	
UUSVMB_W	LOK	GGLSV (588)	
UUSVOB2_W	LOK	GGLSV (588)	
UUSVOB_W	LOK	GGLSV (588)	
UZKW_W	EIN		NMAXMD (76)
VFGRRF_W	AUS	BGVFGR (498)	BBFGR (492)
VFGR_UM	AUS	UFEING (891)	UFFGRC (900)
VFGR_W	AUS	BGVFGR (498)	BBFGR (492), FGRMD (499), MSF (30), UFEING (891), VMAXMD (78)
VFIL_W	LOK	GGVFZG (580)	
VFZG	AUS	GGVFZG (580)	ARMD (63), DLLR (94), DLDP (404), DKUPPL (561), DFSTT (449), DFFTCNV (852), BGTABST (154), BGDVE (534), BGRBS (703), BGLBZ (99), GGUB (671), GGTFUMG (684), GGFSTT (443), ETR (688), DTHM (689), DTEVN (403), DSWEC (704), DMDLU (761), WNWEIN (254), TC1MOD (864), SLS (275), MLS (695), MDWAN (61), MDKOG (40), LLRBB (81), KOS (698), BBSAWE (71), ATM (302)
VFZGPR_W	DOK	VMAXMD (78)	
VFZGV1_W	AUS	CANASR (732)	BGVFGR (498)
VFZG_U	AUS	DFFTCNV (852)	BGKMST (861), DFFT (849)
VFZG_UM	LOK	UFUE (890)	
VFZG_W	AUS	GGVFZG (580)	BBGANG (70), VMAXMD (78), UFUE (890), DGLOR (747), DDMTL (411), BGVFGR (498), BGPUK (407), BGNLDSC (578), BBLOR (746)
VFZROH_W	AUS	GGVFZG (580)	DVFZ (581)
VFZV1F_W	LOK	BGVFGR (498)	
VIRKR	AUS	EGKE (216)	KRKE (219), KRDY (237)
VKR	AUS	KRKE (219)	DKRS (242), EGKE (216)
VKRC95	LOK	KRKE (219)	
VKR_TST	LOK	KRKE (219)	
VLAST_W	LOK	FGRMD (499)	
VOFFS_W	LOK	FGRMD (499)	
VRAD_LH	EIN		BGRBS (703)
VRAD_LV	EIN		BGRBS (703)
VRAD_RH	EIN		BGRBS (703)
VRAD_RV	EIN		BGRBS (703)
VRBEMX_W	LOK	FGRMD (499)	
VREGDIA_W	AUS	BGTEV (143)	
VREGL_W	LOK	FGRMD (499)	
VROH_W	EIN		GGVFZG (580)
VRVEMN_W	LOK	FGRMD (499)	

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Symbol	Type	Created within	Used within
VSDMR	AUS	VS_VERST (714)	MDKOL (48)
VSFPSES	AUS	VS_VERST (714)	AES (189)
VSFRK	AUS	VS_VERST (714)	ESGRU (161)
VSKE	AUS	VS_VERST (714)	KRKE (219)
VSKS_W	AUS	BGKV (459)	
VSLDTV	AUS	VS_VERST (714)	
VSNS	AUS	VS_VERST (714)	LLRNS (84)
VSRLMX	AUS	VS_VERST (714)	
VSTFBA	EIN		ESUK (175)
VSTFNS	EIN		ESNST (166)
VSTFVA	EIN		ESUK (175)
VSTFWL	EIN		ESWL (171)
VSTLR	EIN		LR (338)
VSTVVR	EIN		VMAXMD (78)
VSVW	AUS	VS_VERST (714)	
VSWNWS	AUS	VS_VERST (714)	WNWEIN (254)
VSZW	AUS	VS_VERST (714)	ZUE (206)
VSZWKR	AUS	VS_VERST (714)	KRRA (227)
VSZWM	LOK	KRRA (227)	
VWKW	DOK	BGRLP (125)	
VZIEL_W	AUS	FGRMD (499)	BBFGR (492)
W	EIN		MS (6), DLDP (404)
WDK1_W	LOK	GGDVE (525)	
WDK2_W	LOK	GGDVE (525)	
WDK3	LOK	GGDVE (525)	
WDKADA_W	AUS	BGDVE (534)	ADVE (548)
WDKBA	AUS	GGDVE (525)	BBVL (38), BGMSZS (111), BGTEV (143), ETR (688), LRAEB (461), TEB (380), TC1MOD (864), GGHFM (105), GGDSAS (131), EGFE (104), DFFT (849)
WDKBAALT_W	DOK	ADVE (548)	
WDKBAP_L	LOK	BGWDKM (153)	
WDKBAP_W	AUS	BGWDKM (153)	BGRLP (125)
WDKBAS_W	DOK	ADVE (548)	
WDKBA_W	AUS	GGDVE (525)	ADVE (548), DHFM (108), BGDVE (534), BGMSZS (111)
WDKDLR_W	LOK	ADVE (548)	
WDKNLP	AUS	BGDVE (534)	
WDKNLPR	AUS	BGDVE (534)	
WDKNLPR_W	LOK	BGDVE (534)	
WDKNLP_W	AUS	BGDVE (534)	ADVE (548), EEDAT (943)
WDKS	AUS	FUEDK (149)	DFFT (849)
WDKSFI_W	LOK	ADVE (548)	
WDKSGV_W	LOK	FUEDK (149)	
WDKSP_W	AUS	FUEDK (149)	BGWDKM (153)
WDKSSTSW_W	DOK	ADVE (548)	
WDKSV_W	LOK	FUEDK (149)	
WDKS_W	AUS	FUEDK (149)	MSF (30), ADVE (548), BGDVE (534)
WDKUGD_W	AUS	FUEDK (149)	BGMSZS (111), BGRLP (125)
WDKVABOB	LOK	BGDVE (534)	
WDKVABUB	LOK	BGDVE (534)	
WEA	AUS	AES (189)	EA (184), BGRLP (125)
WEE	AUS	AES (189)	EA (184), BGRLP (125)
WEENWCNT	LOK	EA (184)	
WEER	LOK	AES (189)	
WEEST	LOK	EASTT (184)	
WEESTZ	LOK	AES (189)	
WF_W	LOK	ESUK (175)	
WKR	LOK	KRRA (227)	
WKRA	LOK	KRRA (227)	
WKRATST	DOK	KRRA (227)	
WKRDY	AUS	KRDY (237)	KRRA (227)
WKRDYA	LOK	KRDY (237)	
WKRM	LOK	KRRA (227)	
WKRMA	AUS	KRRA (227)	
WKR_TST	DOK	KRRA (227)	
WMFA	LOK	GGKS (218)	
WMFL	LOK	GGKS (218)	
WNW	EIN		WNWEIN (254)
WNWAM	AUS	WNWEIN (254)	
WNWEM	EIN		EA (184)
WNWI2_U	AUS	DFFTCNV (852)	
WNWI2_W	EIN		DFFTCNV (852), WNWTST (267)
WNWI_U	AUS	DFFTCNV (852)	
WNWI_W	AUS	WANWKW (257)	DFFTCNV (852), WNWTST (267)
WNWKOR_W	EIN		WNWEIN (254), WANWKW (257)
WNWKW_W	EIN		WANWKW (257)
WNWS	AUS	WNWEIN (254)	DNWS (267), WANWKW (257)
WNWSMX	LOK	WNWEIN (254)	
WNWSP_W	LOK	WANWKW (257)	
WNWSP_W_0	EIN		DNWS (267), WNWEIN (254)
WNWSP_W_1	EIN		DNWS (267), WNWEIN (254)
WNWSP_W_2	EIN		DNWS (267), WNWEIN (254)
WNWSP_W_3	EIN		DNWS (267), WNWEIN (254)

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Symbol	Type	Created within	Used within
WNWSP_W_4	EIN		DNWS (267), WNWEIN (254)
WNWSP_W_5	EIN		DNWS (267), WNWEIN (254)
WNWSP_W_6	EIN		DNWS (267), WNWEIN (254)
WNWSP_W_7	EIN		DNWS (267), WNWEIN (254)
WNWSTST	EIN		WNWEIN (254), WNWTST (267)
WNWUE	EIN		EGFE (104), ESNWS (174), MDBAS (50)
WNWUE_W	EIN		BGSRM (118)
WPED	AUS	GGPED (513)	BGDVE (534), CANDME (718), MDRED (73), NMAXMD (76), MDZUL (45), DFFT (849)
WPEDV_W	AUS	GGPED (513)	
WPED_W	AUS	GGPED (513)	BBPEDBR (579), MSF (30), MDFAW (31), FUEDK (149)
WPFGR_W	AUS	MDFAW (31)	CANDME (718)
WPHG	DOK	ZUE (206)	
WPR	LOK	BGRLP (125)	
WPRNSP	LOK	BGRLP (125)	
WTANS	EIN		GGTFA (681)
WTKA	EIN		GGTKA (683)
WTMOT	EIN		GGTFM (674)
WTSG	EIN		GGTSG (686)
WUB	LOK	GGUB (671)	
WUB_W	EIN		GGUB (671)
WZCTC	LOK	DLDP (404)	
WZCTO	LOK	DLDP (404)	
XQTM_W	LOK	BGTABST (154)	
XS02	LOK	DMDFON (772)	
XS03	LOK	DMDFON (772)	
XS04	LOK	DMDFON (772)	
XS05	LOK	DMDFON (772)	
XS06	LOK	DMDFON (772)	
XS07	LOK	DMDFON (772)	
XS08	LOK	DMDFON (772)	
XZKRZNT	LOK	DKRNT (247)	
XZKRZOF	LOK	DKRNT (247)	
XZKRZS1	DOK	DKRS (242)	
XZKRZS2	DOK	DKRS (242)	
XZKRZS3	DOK	DKRS (242)	
XZKRZTP	LOK	DKRTP (252)	
XZSEN1	DOK	DKRS (242)	
XZSEN2	DOK	DKRS (242)	
XZSEN3	DOK	DKRS (242)	
XZSKRNT	AUS	DKRNT (247)	GGKS (218), EGKE (216)
XZSKROF	AUS	DKRNT (247)	GGKS (218), EGKE (216)
XZSKRTP	AUS	DKRTP (252)	GGKS (218), EGKE (216)
Y	AUS	MS (6)	
ZAACCPOS	LOK	BBACC (759)	
ZACCALIVE	AUS	CANACC (752)	DACC (756), UFFGRC (900)
ZALDY	LOK	KRDY (237)	
ZALT_UM	LOK	UFNC (906)	
ZATV	LOK	LRHK (365)	
ZATV2	LOK	LRHK (365)	
ZBALE	LOK	ESUK (175)	
ZCAP_UM	LOK	UFNC (906)	
ZDASH_W	LOK	MDFAW (31)	
ZDIF_UM	LOK	UFNC (906)	
ZDTEIO	LOK	DTEVN (403)	
ZDTEV	LOK	DTEVN (403)	
ZFLZ	EIN		GGKS (218)
ZKFSTF	LOK	GGFSTT (443)	
ZLASH2_W	LOK	DLSAHK (645)	
ZLASH_W	LOK	DLSAHK (645)	
ZLDY	LOK	KRDY (237)	
ZLSATP	LOK	DLSA (634)	
ZLSATP2	LOK	DLSA (634)	
ZLSD_W	LOK	MDFAW (31)	
ZNDY	LOK	KRDY (237)	
ZNOSTEND	LOK	AEKP (204)	
ZPHNOK	LOK	DPH (571)	
ZPHNOK2	LOK	DPH (571)	
ZRIBERV	LOK	GGLSV (588)	
ZRIBERV2	LOK	GGLSV (588)	
ZRINV2_W	LOK	GGLSV (588)	
ZRINV_W	LOK	GGLSV (588)	
ZRPH	EIN		DDG (568)
ZRPH2	EIN		DDG (568)
ZTPTN_A	LOK	GGKS (218)	
ZVALE	LOK	ESUK (175)	
ZWBAS	AUS	ZUE (206)	MDBAS (50), MSF (30)
ZWC_C_UM	LOK	UFZWC (913)	
ZWDYNSH	LOK	DLSAHK (645)	
ZWDYNSH2	LOK	DLSAHK (645)	
ZWGEFLR	AUS	DLSV (609)	
ZWGEFLR2	AUS	DLSV (609)	

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Symbol	Type	Created within	Used within
ZWGRU	AUS	ZWGRU (208)	ZUE (206)
ZWIST	AUS	ZUE (206)	MDIST (49), MSF (30)
ZWKRAFLD	EIN		KRRA (227)
ZWKS	AUS	ZWKS (212)	ZWGRU (208)
ZWMATM	AUS	ATM (302)	
ZWMATM2	AUS	ATM (302)	
ZWMATMF	AUS	ATM (302)	
ZWMATMF2	AUS	ATM (302)	
ZWOPT	AUS	MDBAS (50)	MDIST (49), MDZW (211), ZWMIN (213), MSF (30)
ZWOPTL1	LOK	MDBAS (50)	
ZWOPT_UM	LOK	UFMIST (897)	
ZWOUT	AUS	MSF (30)	ZUE (206), CANDME (718), UFZWC (913), UFUE (890), ESKS (172)
ZWOUTCPL	AUS	ZUE (206)	UFUE (890), UFZWC (913)
ZWOUTM	LOK	ESKS (172)	
ZWOUT_UM	AUS	UFZWC (913)	UFMIST (897), UFUE (890)
ZWPVK	LOK	DLSA (634)	
ZWSOL	AUS	MDZW (211)	ZUE (206)
ZWSPAE	AUS	ZWMIN (213)	CANDME (718), ZUE (206)
ZWSTT	AUS	ZWSTT (210)	ZUE (206)
ZWZYL1	AUS	ZUE (206)	TC1MOD (864)
ZYLALE	AUS	ALE (710)	
ZYLSTP	AUS	ALE (710)	
ZZALE	AUS	ALE (710)	
ZZBANK	LOK	AEVAB (196)	
ZZRALE	AUS	ALE (710)	
ZZSTP	AUS	ALE (710)	
ZZWDYKR	LOK	KRDY (237)	
ZZWDYMD	LOK	KRDY (237)	
ZZYL	EIN		AEVAB (196), DMDLU (761), DNWS (267), ESSTT (162), GGKS (218), DMDFON (772)
ZZYLKR	AUS	EGKE (216)	GGKS (218), KRDY (237), KRKE (219), KRRA (227)
ZZYLKRAL	LOK	KRRA (227)	
Z_ACC	AUS	DACC (756)	
Z_AS	AUS	DASC (740)	
Z_BM	AUS	DDG (568)	
Z_BREMS	AUS	GGEGAS (560)	
Z_BWF	LOK	GGPED (513)	
Z_CACC	AUS	DCACC (755)	
Z_CAS	AUS	DCAS (739)	
Z_CGE	AUS	DCGE (726)	
Z_CINS	AUS	DCINS (728)	
Z_CTXU	AUS	DCTXU (745)	
Z_DHDMTE	AUS	DHDMTE (440)	
Z_DK	LOK	GGDVE (525)	
Z_DK1P	LOK	GGDVE (525)	
Z_DK2P	LOK	GGDVE (525)	
Z_DMMVE	EIN		DDMMVE (830)
Z_DMPME	AUS	DDMPME (828)	
Z_DMTK	AUS	DDMTL (411)	T2DMTL (941)
Z_DMTKNM	AUS	DDMTL (411)	
Z_DMTL	AUS	DDMTL (411)	
Z_DSL	AUS	GGDSAS (131)	
Z_DSU	AUS	GGDSAS (131)	
Z_DSVLU	AUS	GGDSAS (131)	
Z_DVEE	LOK	ADVE (548)	
Z_DVEF	AUS	BGDVE (534)	
Z_DVEL	LOK	ADVE (548)	
Z_DVEN	AUS	BGDVE (534)	
Z_DVER	LOK	ADVE (548)	
Z_DVEU	AUS	BGDVE (534)	
Z_DVEV	AUS	BGDVE (534)	
Z_EGFE	AUS	DEGFE (116)	
Z_ETS	AUS	DETS (834)	
Z_EV1	AUS	DEVE (835)	
Z_EV2	AUS	DEVE (835)	
Z_EV3	AUS	DEVE (835)	
Z_EV4	AUS	DEVE (835)	
Z_EV5	AUS	DEVE (835)	
Z_EV6	AUS	DEVE (835)	
Z_EV7	AUS	DEVE (835)	
Z_EV8	AUS	DEVE (835)	
Z_FP1P	LOK	GGPED (513)	
Z_FP2P	LOK	GGPED (513)	
Z_FPP	LOK	GGPED (513)	
Z_FRA	AUS	GKRA (327)	
Z_FRA2	AUS	GKRA (327)	
Z_FRAO	AUS	DKVS (476)	BBTEGA (371)
Z_FRAO2	AUS	DKVS (476)	BBTEGA (371)
Z_FRAU	AUS	DKVS (476)	
Z_FRAU2	AUS	DKVS (476)	
Z_FRST	AUS	DKVS (476)	
Z_FRST2	AUS	DKVS (476)	

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Symbol	Type	Created within	Used within
Z_FST	AUS	DFSTT (449)	
Z_GLOR	AUS	DGLOR (747)	
Z_HFM	LOK	EGFE (104)	
Z_HSH	AUS	DHLS (666)	DIMC (857), DLSAHK (645)
Z_HSH2	AUS	DHLS (666)	DIMC (857), DLSAHK (645)
Z_HSV	AUS	DHLS (666)	DIMC (857), DLSA (634)
Z_HSV2	AUS	DHLS (666)	DIMC (857), DLSA (634)
Z_KAT	AUS	DKAT (310)	DIMC (857)
Z_KAT2	AUS	DKAT (310)	DIMC (857)
Z_KOS	AUS	DKOSE (816)	
Z_KPE	AUS	DEKPE (824)	
Z_KRNT	AUS	DKRNT (247)	EGKE (216)
Z_KROF	AUS	DKRNT (247)	EGKE (216)
Z_KRTP	AUS	DKRTP (252)	EGKE (216)
Z_KS1	AUS	DKRS (242)	EGKE (216)
Z_KS2	AUS	DKRS (242)	EGKE (216)
Z_KS3	AUS	DKRS (242)	EGKE (216)
Z_KS4	AUS	DKRS (242)	EGKE (216)
Z_KUPPL	AUS	DKUPPL (561)	
Z_LASH	AUS	DLSAHK (645)	DIMC (857), LRHK (365)
Z_LASH2	AUS	DLSAHK (645)	DIMC (857), LRHK (365)
Z_LATP	AUS	DLSA (634)	DIMC (857), DKAT (310)
Z_LATP2	AUS	DLSA (634)	DIMC (857), DKAT (310)
Z_LATV	AUS	DLSA (634)	DIMC (857)
Z_LATV2	AUS	DLSA (634)	DIMC (857)
Z_LDP	AUS	DLDP (404)	
Z_LDPE	AUS	DLDPE (409)	
Z_LLR	AUS	DLLR (94)	
Z_LM	AUS	DHFM (108)	EGFE (104)
Z_LSH	AUS	DLSH (627)	DIMC (857), DLSAHK (645)
Z_LSH2	AUS	DLSH (627)	DIMC (857), DLSAHK (645)
Z_LSV	AUS	DLSV (609)	DIMC (857)
Z_LSV2	AUS	DLSV (609)	DIMC (857)
Z_LSVV	AUS	DLSVV (625)	
Z_MD	AUS	DMDMIL (800)	
Z_MD01	AUS	DMDMIL (800)	
Z_MD02	AUS	DMDMIL (800)	
Z_MD03	AUS	DMDMIL (800)	
Z_MD04	AUS	DMDMIL (800)	
Z_MD05	AUS	DMDMIL (800)	
Z_MD06	AUS	DMDMIL (800)	
Z_MD07	AUS	DMDMIL (800)	
Z_MD08	AUS	DMDMIL (800)	
Z_MDB	AUS	MDKOG (40)	
Z_MFL	AUS	GGMFL (490)	
Z_MILE	AUS	DMILE (837)	
Z_MLE	AUS	DMLSE (818)	
Z_N	AUS	DDG (568)	
Z_NWS	AUS	DNWS (267)	WNWEIN (254)
Z_NWS2	AUS	DNWS (267)	WNWEIN (254)
Z_NWSE	AUS	DNWSE (819)	
Z_PH	AUS	DPH (571)	
Z_PH2	AUS	DPH (571)	
Z_RKAT	AUS	DKVS (476)	
Z_RKAT2	AUS	DKVS (476)	
Z_RKAZ	AUS	DKVS (476)	
Z_RKAZ2	AUS	DKVS (476)	
Z_SLPE	AUS	DSLPE (823)	
Z_SLS	AUS	DSLSLR (289)	DIMC (857), SLS (275)
Z_SLS2	AUS	DSLSLR (289)	DIMC (857)
Z_SLV	AUS	DSLSLR (289)	
Z_SLV2	AUS	DSLSLR (289)	
Z_SLVE	AUS	DSLVE (821)	
Z_STA	AUS	DSTA (709)	
Z_STAE	AUS	DSTAE (832)	
Z_STS	AUS	DSTS (708)	
Z_SWE	AUS	BGRBS (703)	
Z_TA	AUS	GGTFA (681)	
Z_TES	AUS	DTEVN (403)	DIMC (857), DLLR (94)
Z_TESB	AUS	DLDP (404)	
Z_TESK	AUS	DLDP (404)	DIMC (857)
Z_TEVE	AUS	DTEVE (826)	
Z_THM	AUS	DTHM (689)	
Z_TKA	AUS	GGTKA (683)	
Z_TM	AUS	GGTFM (674)	
Z_TUM	AUS	GGTFUMG (684)	
Z_U5REF	AUS	DU5REF (673)	
Z_UB	AUS	GGUB (671)	
Z_UFMV	AUS	DUF (932)	
Z_UFSKA	AUS	DUF (932)	
Z_URRAM	AUS	DUR (933)	
Z_URROM	AUS	DUR (933)	

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Symbol	Type	Created within	Used within
Z_URRST	AUS	DUR (933)	
Z_VFZ	AUS	DVFZ (581)	DGLOR (747)

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Chosen (resp. default) options

Option	Value
colophon	yes
damosfile	I:\PROGRA~1\MM3\..\mmapps\fdr3\lib\damos_dummy.sgm
efatable	yes
efatree	no
graphicborder	no
graphicinfo	no
inputfile	ME72C62GB.sgm
lineart	nice
minlines	2
newpage	owners
pavastfile	I:\PROGRA~1\MM3\..\mmapps\fdr3\lib\pavast_dummy.sgm
pavastnew	yes
pavastorig	retain

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