PROJECT: MSS54

CHAPTER: 4.02

MODULE: INJECTION

FUNCTION: CALCULATION OF INJECTION TIME

PARTIAL FUNCTION: SEQUENTIAL INJECTION MASS AND INJECTION TIME

AUTHORIZATION

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CHANGE DOCUMENTATION FROM R360

version	Date	comment
r360	June 1, 2001	Specifics from FH Mayer and documentation from MSS54 project merged
R380	29.10.2001 rm	: Change of the nomenclature of the injection correction factors by FH Mayer
R380	13.11.2001 ke	: Display variable ti_eff_out

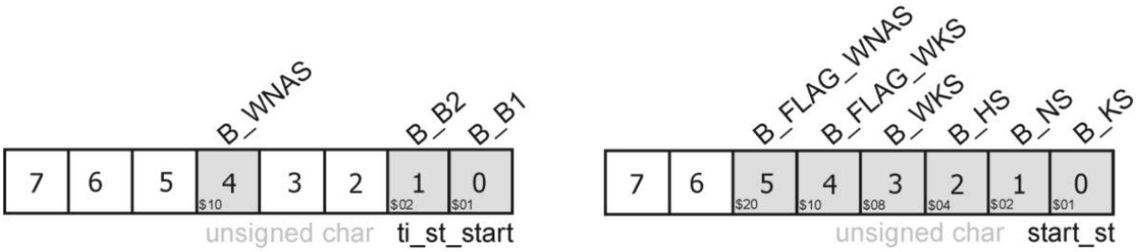
1 FUNCTIONAL DESCRIPTION

1.1 PHYSICAL BACKGROUND

In the injection module, the associated fuel mass is determined based on an air mass that is specified for the working cycle in a cycle-consistent manner. The basic injection mass is calculated to give a target total fuel mass, taking correction parameters into account. This value is then used for fuel balancing in the injection operating mode transition module. The injection time is then calculated after taking into account the adaptation values and component corrections.

1.2 CALCULATION OF CORRECTION FACTORS

The operating status is documented via status bytes:



[File : st_bytes.gif]

1.2.1 CALCULATION OF THE BASIC ADJUSTMENT FACTOR

The constant K_TI_MK_GA can be specified via the application system as a multiplicative intervention on the fuel mass. It should be noted that this constant must be given neutral data for normal operation.

(1) ti_mk_f_ga = K_TI_MK_GA

1.2.2 CALCULATION OF THE START FACTOR

The start factor is only required in the START operating mode. The calculation takes place when the engine is stopped (B_MS), so that a valid value is already available when the transition to start B_START occurs. This factor is determined as long as the system is in START mode.

• There are conditions that must be taken into account when calculating the factor ti_mk_f_start:

Hot start B_HS (tmot > K_TI_MK_TMOT_HS),
Normal start B_NS (K_TI_MK_TMOT_KS<=tmot<=K_TI_MK_TMOT_HS),
Cold start B_KS and
Repeat cold start B_WKS.

These conditions are checked and set in the function ti_set_startbereich().

• Determining the switching conditions for the start range of
Area1 to area2 in the start are defined as follows:

B_B1 to B_B2, IF

n > KL_TI_MK_TMOT_B2
OR
ti_anz_seg_zaehler > K_TI_MK_KW.

These conditions are checked and set in the TI module when entering Start.

• A repeat cold start is defined as follows:

B_WKS = 1 if tmot <
K_TI_MK_TMOT_KS AND
B_FLAG_WKS was set in the previous engine run
AND downtime t_motor_steht <
KL_TI_MK_WKS_MS_TMOT
OTHERWISE
B_WKS = 0
B_KS = 1.

The repeat cold start flag B_FLAG_WKS (BIT4 in start_st) is set if

the engine is switched off (B_KLA)
AND the engine was switched off in the starting area B_B2
OR the total engine running time was less than
KL_TI_MK_WKS_ML_TMOT, OTHERWISE

B_FLAG_WKS is deleted.

The data is then saved in the NVRAM.

1.2.2.1 Hot start and area 2 (B_HS and B_B2)

(2) ti_mk_f_start = ti_mk_f_n_ks(KL_TI_MK_N_KS) *
ti_mk_f_tan_hs(KL_TI_MK_TAN_HS)

1.2.2.2 Hot start and !Area2 (B_HS and !B_B2)

(3) ti_mk_f_start = ti_mk_f_tan_hs(KL_TI_MK_TAN_HS)

1.2.2.3 !Hot start and area 2 and !Repeat cold start (!B_HS and B_B2 and !B_WKS)

(4) ti_mk_f_start = ti_mk_f_n_ks(KL_TI_MK_N_KS)
*ti_mk_f_tmot_ks(KL_TI_MK_TMOT_KS)
*ti_mk_f_kw_zaehler(KL_TI_MK_KW)

1.2.2.4 !Hot start and area 2 and repeat cold start (!B_HS and B_B2 and B_WKS)

(5) ti_mk_f_start = ti_mk_f_n_ks(KL_TI_MK_N_KS)
* ti_mk_f_tmot_ks(KL_TI_MK_TMOT_KS)
* ti_mk_f_kw_zaehler(KL_TI_MK_KW)
* K_TI_MK_WKS_B2

1.2.2.5 !Hot start and !Range2 and !Repeat cold start (!B_HS and !B_B2 and !B_WKS)

(6) ti_mk_f_start = ti_mk_f_tmot_ks(KL_TI_MK_TMOT_KS)

1.2.2.6 !Hot start and !Range2 and repeat cold start (!B_HS and !B_B2 and B_WKS)

(7) ti_mk_f_start = ti_mk_f_tmot_ks(KL_TI_MK_TMOT_KS)
*K_TI_MK_WKS_B1

1.2.3 CALCULATION OF THE FACTOR IN STATIONARY OPERATION

The factor ti_mk_f_stat is multiplied by the fuel mass as a stationary lambda correction value.

1.2.3.1 Full load

(8) ti_mk_f_stat = KF_TI_MK_N_WI_VL

1.2.3.2 All other operating states

(9) ti_mk_f_stat = KF_TI_MK_N_WI

1.2.4 CALCULATION OF THE CAT PROTECTION FACTOR

When activated, the catalytic converter protection factor is always **>= 1.0** and depends on the ignition angle reduction.
The catalytic converter protection is implemented via a pre-control and an I-controller. As soon as the catalytic converter protection factor is > 1.0, ie the catalytic converter is cooled, the lambda control is deactivated.

1.2.4.1 Feedforward control

The entry condition for calculating a pre-control value not equal to one is met when the retraction ignition angles from the knock control and the knock path adaptation assume negative values. Only then is the pre-control determined bank-selectively:

(10) dtz_sum[j] = kr_dtz_sum[j] + ka_dtz_sum[j]

with j = 1, 2 (Bank-j)

Here, dtz_sum[j] is the sum of all retraction angles related to a bank and always has a numerical value less than zero.

The ignition angle offset ti_mk_tz_offset_kats is applied as a threshold value for the calculation of the pilot control value.

ti_mk_tz_offset_kats =
IF VL
KL_TI_MK_KATS_VL_N
OTHERWISE
KF_TI_MK_KATS_N_WI.

This results in:

(11) temp[j] = (-1) * (dtz_sum[j] + ti_tz_offset_kats)

(12) ti_mk_f_kats_steuer[j] = 1 + (temp[j] * K_TI_MK_KATS)

with j = 1, 2 (Bank-j)

If the difference between the sum of the retraction angles and the offset value is positive, Eq. (11), the pre-control factor ti_mk_f_kats_steuer[j] = 1.0 is set, otherwise it is multiplied by minus one and included in Eq. (12).

1.2.4.2 I-controller

In order to activate the I controller, a wi threshold must be exceeded. This is to avoid an unnecessarily long enrichment.

The release condition is met if:

wi > KL_TI_MK_KATS_WI_SCHW_N

If this release condition is not met, ti_mk_f_kats_regler = 0 is set.

The I-controller is implemented using a state machine whose state variable is the exhaust gas temperature TABG. The exhaust gas temperature must exceed a threshold for the controller to be activated:

TABG >= K_TI_MK_KATS_TABG_EIN

As a result, the state KATS_AKTIV is set.

State KATS_AKTIV:

As long as the exhaust gas temperature exceeds the switch-on threshold (K_TI_MK_KATS_TABG_EIN), the controller value is calculated as follows:

(13) ti_mk_f_kats_regulator(k) = ti_mk_f_kats_regulator(k-1)
+ KL_TI_MK_KATS_DELTA_ML

The next state is reached when the exhaust gas temperature exceeds a next higher threshold.

TABG >= K_TI_MK_KATS_TABG_SCHNELL

As a result, the state KATS_SCHNELL is set.

The reduction state is reached when the reduction threshold is exceeded.

TABG <= K_TI_MK_KATS_TABG_AUS

As a result, the state KATS_ABREGELN is set.

However, if the exhaust gas temperature is between the increase and decrease thresholds, the controller is stopped to prevent an overflow (integrator stop).

State KATS_SCHNELL:

In this state, an overdrive is generated using a factor.

(14) ti_mk_f_kats_regulator(k) = ti_mk_f_kats_regulator(k-1)

+ (KL_TI_MK_KATS_DELTA_ML
*K_TI_MK_KATS_FAK_SCHNELL)

The slow control range is reached again when the exhaust gas temperature threshold

TABG < K_TI_MK_KATS_TABG_SCHNELL

This again corresponds to the state KATS_AKTIV.

State KATS_ABREGELN:

In the following state, the controller is regulated back to zero because the exhaust gas temperature has fallen below the applicable switch-off threshold.

(15) ti_mk_f_kats_regulator(k) = ti_mk_f_kats_regulator(k-1)
- KL_TI_MK_KATS_DELTA_ML

However, if the exhaust gas temperature threshold rises above the control threshold during this process, the state changes back to KATS_AKTIV.

1.2.4.3 Total enrichment factor

The following factor is included in the injection mass equation (Chapter 4.2, Eq.(7)),

(16) ti_mk_f_kats[j] = ti_mk_f_kats_steuer[j] + ti_mk_f_kats_regler

and with j = 1, 2 the bank-selective influence is taken into account. A limitation of the total enrichment factor to K_TI_MK_F_KATS_MAX is carried out before the calculation.

1.2.5 CALCULATION OF THE AFTER-START FACTOR

The calculation is carried out in the 10 msec task. The post-start factor is regulated using an exponential function. The starting value for the exponential function is determined during the transition from the START operating state to MOTOR RUNNING.

If the post-start factor is smaller than the threshold K_TI_MK_SCH_NAS, the Time constant ti_mk_tau_nas calculated as follows:

(17) ti_mk_tau_nas = KF_TI_MK_TAN_TMOT_NAS
*K_TI_MK_TAU_NAS

If the post-start factor is greater than or equal to the threshold K_TI_MK_SCH_NAS, the time constant ti_mk_tau_nas is calculated as follows:

(18) ti_mk_tau_nas = KF_TI_MK_TAN_TMOT_NAS

The condition for a repeat restart is defined as follows:

B_WNAS = 1, IF

the last start was a cold start or a repeated cold start (tmot < K_TI_MK_TMOT_KS)
AND the downtime t_motor_steht < KL_TI_MK_WKS_MS_TMOT
AND B_FLAG_WNAS was set
OTHERWISE
B_WNAS = 0.

The repeat restart flag B_FLAG_WNAS (BIT5 in start_st) is set,

IF
the engine is switched off (B_KLA)
AND the engine running time is within the limits when switched off
K_TI_MK_TMIN_WNAS < t_ml < K_TI_MK_TMAX_WNAS moves,
OTHERWISE
B_FLAG_WNAS is deleted.

The data is then saved in the NVRAM.

The post-start factor ti_mk_f_nas is only used in the operating state MOTOR RUNNING calculated:

(19) ti_mk_f_nas_word(k) = ti_mk_f_nas_word(k-1)
- (ti_mk_f_nas_word(k-1)
*ti_mk_tau_nas(k))

(20) ti_mk_f_nas(k) = 1 + ti_mk_f_nas_word(k)

The factor ti_mk_f_nas_word is only calculated in the START operating state and then used as the starting value for the exponential function.

1.2.5.1 During hot start

(21) ti_mk_f_nas_word = KL_TI_MK_TAN_NAS

1.2.5.2 No hot start and no repeated cold start

(22) ti_mk_f_nas_word = KL_TI_MK_TMOT_NAS

1.2.5.3 No hot start and repeated cold start

(23) ti_mk_f_nas_word = KL_TI_MK_TMOT_NAS
* K_TI_MK_WNAS

1.2.6 CALCULATION OF THE WARM-UP FACTOR

The calculation of the warm-up factor ti_mk_f_wl is performed in the 10 msec task.

The warm-up factor is calculated from B_START and at B_ML and when no partially fired operation is active (!B_SKS_TIEINGRIFF; to protect the catalyst).

As soon as the lambda control is active, this factor is increased or decreased to 1.0 via a ramp with the gradient K_TI_D_WL (for MSN64: K_TI_MK_D_WL).
Retriggering is only possible via the B_START state.

Operating status KATHEIZEN:

1.2.6.1 Secondary air pump on

(24) ti_mk_f_wl = KF_TI_MK_TMOT_TML_SLP_F
* KF_TI_MK_N_WI_SLP_F
+(KF_TI_MK_TMOT_TML_SLP_M
* KF_TI_MK_N_WI_SLP_M)

1.2.6.2 Secondary air pump off

(25) ti_mk_f_wl = KF_TI_MK_TMOT_TML_KAT_F
* KF_TI_MK_N_WI_KAT_F
+(KF_TI_MK_TMOT_TML_KAT_M
* KF_TI_MK_N_WI_KAT_M)

Operating state NO CATHEIZING:

1.2.6.3 Secondary air pump off and no catalyst heating

(26) ti_mk_f_wl_long = KF_TI_MK_TMOT_TML_WL
* KF_TI_MK_N_WI_WL

During KATHEIZEN, a correction factor from the characteristic curve KL_TI_MK_TMOT_TAN_DIF, which depends on the temperature difference TMOT-TAN, is added to the calculated factor ti_mk_f_wl.

(27) ti_mk_f_wl =1+(ti_mk_f_wl_long+KL_TI_MK_TMOT_TAN_DIF)

1.2.7 CALCULATION OF CYLINDER-INDIVIDUAL CORRECTION FACTORS

The correction factor affects the injection time and is determined from an individual characteristic curve over speed.

(28) ti_f_zyl[i] = KL_TI_N_ZYL[i]

with i = 1, 2, …, n; n = number of cylinders

1.2.8 CALCULATION OF IDLE SYNCHRONIZATION OFFSET

There is an individual offset for each cylinder, which compensates for the different filling of the individual cylinders with the throttle valve closed at low engine speeds via the injection time.

(29) ti_sync[i] = (K_N_LL_SYNC / n40) * ti_ll_z[i]

with i = 1, 2, …, n; n = number of cylinders

The variables ti_ll_z[i] can be changed via the application system as well as via the diagnostic interface and can be stored in the NVRAM.

1.2.9 CALCULATION OF THE MOMENT FACTOR

Injection mass factors that influence the engine torque are summarized in one factor and passed on to the torque manager, chapter “Calculating lambda efficiencies”. Only mixture leaning during the warm-up phase is taken into account, factors for mixture enrichment (ti_mk_f_md > 1) are not included.

(30) ti_mk_f_md = ti_mk_f_wl * ti_mk_f_nas
* ((ti_mk_f_kats1 + ti_mk_f_kats2) / 2)

1.3 SEQUENTIAL INJECTION TIME

1.3.1 CALCULATION OF FUEL MASS AND INJECTION TIME

The air mass per cylinder and working cycle ml_zyl is calculated from the product of ml_soll_korr_eff[i] and the cylinder displacement. ml_soll_korr_eff[i] is the corrected air mass per working cycle and cylinder in relation to the cylinder displacement. ml_soll_korr_eff[i] is given in [mg/l*ASP]. Since ml_zyl only serves as an intermediate value and is directly proportional to ml_soll_korr_eff[i] via the cylinder displacement, the value is calculated segment-synchronously.

net and can also be viewed via an application system, but is not stored individually for each cylinder.

The cylinder-selective injection mass is formed from the quotient of the air mass and the stoichiometric air-fuel ratio.

The relationship between injected fuel mass and injection time is as follows:

(1) mk_zyl[i] = K_TI_EV_QSTAT * ti[i]

with:
mk_zyl[i]: cylinder-selective fuel mass [mg]
ti[i]: effective, cylinder-selective injection time [ms]
K_TI_EV_QSTAT: Factor from injection valve characteristic curve [mg/ms] (pressure dependent)

From equation (1) follows:

(2) ti[i] = mk_zyl[i] / K_TI_EV_QSTAT

1.3.2 OPERATING STATE START

1.3.2.1 Fuel mass in START

If the START condition is met, the cylinder-selective injection mass is:

(3) ml_zyl = ml_soll_korr_eff[i] * K_RF_HUBVOLUMEN / cfg_zylinderanzahl

(4) mk_zyl[i] = (ml_zyl/K_TI_L_STOECH) starting injection mass (cyl.selective)
* ti_mk_f_ga Basic adjustment factor
* ti_mk_f_start start injection factor
* ti_mk_start_f_p_umg ambient pressure dependent factor

Fuel balancing in the injection mode transition module does not take place in START operating mode.

1.3.2.2 Injection time in START

In principle, after the calculation of mk_zyl, the module tiueb is called to balance the fuel masses, but this does not make any contribution in the start operating state, so that using equation (2) the corrected, cylinder-selective injection time at start is:

(5) ti_[i] = ((mk_zyl[i] / K_TI_EV_QSTAT
* ti_f_adapt[j]) + Adaptation factor (bank-selective)
ti_offset_adapt[j]) + Adaptation offset (bank-selective)
ti_sync[i] idle synchronization offsets (cylinder-specific)

Note for software developers: The software uses the following operating modes:

The same formula is used for starting and engine running. However, the factor ti_f_zyl is at start always 1.0, because it is only interpolated from characteristics in the full load operating state, which cannot occur simultaneously with the start operating state.

1.3.3 OPERATING STATE MOTOR RUNNING

1.3.3.1 Fuel mass when ENGINE IS RUNNING

When the ENGINE RUNNING operating mode is active, the cylinder-selective injection mass is calculated as follows:

(6) ml_zyl = ml_soll_korr_eff[i] * K_RF_HUBVOLUMEN / cfg_zylinderanzahl

(7) mk_zyl[i] = (ml_zyl/K_TI_L_STOECH) basic injection mass (cyl.selective)
* ti_mk_f_ga Basic adjustment factor
* ti_mk_f_stat stationary factor
* ti_mk_f_nas post-start factor
* ti_f_mk_wl warm-up factor
* ba_f_ti acceleration enrichment
* ti_mk_f_we reinstatement factor
* ti_mk_f_sks Factor regarding safety concept (K_TI_MK_SKS)
* ti_mk_f_kats[j] KAT protection factor (bank-selective)

The fuel mass calculated here is now used for fuel balancing in the injection operating mode transition module. In SES operation, in addition to the currently required fuel mass, the flow fuel mass is also required for balancing. The flow fuel mass is determined as follows:

If an operating mode change from FES to SES is detected, the VL target air mass at the current engine speed follows with the corrected, maximum indicated work wi_max (torque manager module) from the map KF_ML_SOLL_BAS_5 (target air mass SES+4V). The resulting VL target air mass must still be related to the current ambient conditions.

The flow-fuel mass is then calculated analogously to equations (6) and (7):

(8) ml_vl_zyl = ml_soll_vl_korr_eff[i] * K_RF_HUBVOLUMEN/cfg_zylinderanzahl
(9) mk_vl_zyl[i]= (ml_vl_zyl/K_TI_L_STOECH) VL injection mass (cyl.selective)
* ti_mk_f_ga Basic adjustment factor
* ti_mk_f_stat stationary factor
* ti_mk_f_nas post-start factor
* ti_mk_f_wl warm-up factor
* ba_f_ti acceleration enrichment
* ti_mk_f_we reinstatement factor
* ti_mk_f_sks Factor regarding safety concept (K_TI_MK_SKS)
* ti_mk_f_kats[j] KAT protection factor (bank-selective)

Note: The flow fuel mass can only be calculated in SES operating mode.

Ml_vl_zyl is only an auxiliary variable that is not visible in the application system.

1.3.3.2 Injection time when ENGINE RUNNING

After calculating mk_zyl[i], the tiueb module is called for fuel balancing. The parameters passed are mk_zyl[i] and mk_vl_zyl[i]. The tiueb module supplies a corrected fuel mass mk_korr, which in turn is the input value for the injection time calculation.

Using equation (2) and after fuel mass balancing, the corrected cylinder-selective injection time in the ENGINE RUNNING operating mode is:

(10) ti[i] = (((mk_korr / K_TI_EV_QSTAT	
* ti_f_adapt[j])	Adaptation factor (bank-selective)
+ ti_offset_adapt[j]) *	Adaptation offset (bank-selective)
ti_f_zyl[i]) +	cylinder-specific factor
ti_sync[i]	idle synchronization offsets (cylinder-specific)

mk_korr refers to the fuel mass resulting from the balance calculation in the current segment.

1.3.4 LIMITATION AND UBATT CORRECTION OF THE INJECTION TIME

In general:
The injection time is limited to K_TI_MIN at the bottom and to K_TI_MAX at the top.

The on-board voltage correction offset ti_ub is then calculated from the characteristic curve KL_TI_UB and the TPU values for total injection time are determined:

(11) ti_eff[i] = ti[i] + ti_ub

As an aid to the application, the variables ti_eff_out[i] are calculated in 10ms intervals, which are set to zero when injection is suppressed, otherwise but agree with ti_eff[I].

1.4 FUNCTIONAL DIAGRAM

(to be defined !)

1.5 APPLICATION INSTRUCTIONS

(to be defined !)

1.6 CYLINDER DISABLING AND CYLINDER DISABLING

1.6.1 suppression during overrun cut-off

If the overrun cut-off condition B_SA is fulfilled, all cylinders are blocked. To do this, the injection pulses that have already started are fully injected and also ignited; only then are all further injection pulses suppressed, ie this cylinder is blocked every 90 °CA or 120 °CA (at the end of injection).

1.6.2. fade in after overrun cut-off

After all cylinders have been blocked, the intake manifold dries out. In order to rebuild the evaporated intake manifold wall film when reinstalling it, more fuel must be added than normal.

The reinstatement factor ti_mk_f_we compensates for this additional fuel requirement.

It is calculated as follows:

ti_mk_f_we = 1 + (ti_f_we_off * ti_f_we_ign)

The factor ti_f_we_off depends on the time for which the overrun fuel cut-off was active. It is calculated from two characteristic curves over time in SA, with one characteristic curve applying to hard and one to soft restart (KL_TI_WE_OFF_S or KL_TI_WE_OFF_H).

The factor ti_f_we_ign depends on the number of ignitions since re-start. This factor is regulated to 1.0 based on the number of ignitions. It is calculated from two characteristics based on the number of ignitions, with one characteristic for hard and one for soft re-start (KL_TI_WE_IGN_S or KL_TI_WE_IGN_H).

The ignition counter ti_we_ign counts the number of ignitions since re-insertion, regardless of whether it is a hard or soft re-insertion.

Every 90 °CA or 120 °CA (at fictitious end of injection) a cylinder is released again.

1.7 LOADING THE INJECTION TIME INTO THE TIME PROCESSOR UNIT

If the condition for a pre-spray B_VSP is met, it is output.

If the condition for sequential injection B_SSP is met, the TPU parameters for the injection times are updated in the 90 or 120°CA task and the TPU parameters for the injection ends are updated every 720 °CA.

1.8 INJECTION

The end of injection is calculated relative to the intake valve closing, ie 200 °CA means the end of injection is 200 °CA before the intake valve closes.

For the injection end value there are different operating conditions one constant each. Currently there are:

K_TI_ENDE_MAN, K_TI_ENDE_START, K_TI_ENDE_VL,
KL_TI_ENDE_0(to 5), K_TI_ENDE_11.
The filtering mechanism implemented in MSSxx has been removed.

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2 MODULE DATA

The function is calculated **segment-synchronously** in the master.

	angle	background	1ms	10ms	20ms	100ms	1s
task	x						

variables

variable	Initialization Unit 0p mg/Asp Air mass		Range Quant. Impl. 0p-1638p			Page
ml_zyl	per cylinder and working cycle		1/40p		uw	
mk_zyl[i]	0p mg/Asp Cylinder-selective fuel mass		0p-131p	0.002p uw		
	for balancing					
mk_vl_zyl[i]	0p mg/Asp 0p-131p Cylinder-selective VL fuel mass for balancing			0.002	uw	
ti_ub	0p 0p-65.53p 0.001p uw	ms				
	On-board network voltage correction offset for the injection time					
ti[i]	0p 0p-65.53p 0.001p uw	ms				
	cylinder-selective injection time, without battery voltage correction					
ti_eff[i]	0p	ms	0p-65.53p 0.001p uw			
	Effective, cylinder-selective total injection time					
ti_mk_f_ga			0p-2p	1/128	ub	
	basic adjustment factor					
ti_mk_start_f_p_umg	0p	-	0p-2p	1/128p uw		
	Ambient pressure dependent correction factor for operating mode start					
ti_mk_f_start						
	starting injection factor					
ti_mk_f_stat			0p-2p	1/128p	ub	
	stationary factor					
ti_mk_f_nas			0p-4p	1/1024p uw		
	post-start factor					
ti_mk_f_wl			0p-4p	1/1024p uw		
	warm-up factor					
ba_f_ti			0p-2p	1/1024p uw		
ti_mk_f_we	reinstatement factor		0p-2p	1/128p	ub	
ti_mk_f_sks			0p-2p	1/128p	ub	
	factor regarding security concept					
ti_mk_f_kats1,2			0p-4p	1/1024p uw		
	cat protection factor Bank1/2					
ti_ausblend_soll						
	Number of cylinders to be hidden					
ti_ausblend_ist						
	Number of cylinders actually hidden					
ti_st_soll						
	Status of the target state of the injection (1 = channel active)					
ti_st_psp						
	Status of the actual state of the injection (! = channel active)					
ti_dkba1			0p-65.53p 1/1000 uw			
	after-spray					

ti_isr_count						
	interrupt counter of the PSP interrupts					
ti_st_start						
	Status word of the injection in the START operating state					
ti_off_time			0p- 268 million	1/16	ul	
	duration of the fade-out					
ti_zyl_off						
start_st						
	Status word of the START operating state					
ti_f_n_ks			0p-2p	1/128	ub	
	Cold start factor over speed					
ti_f_tan_hs			0p-64p	1/1024 uw		
	hot start factor via intake air temperature					
ti_f_tmot_ks			0p-64p	1/1024 uw		
	cold start factor above the engine temperature					
ti_f_no_zaehler						
	Limiting factor on the number of camshaft revolutions at start					
ti_tz_offset_kats		°KW			ub	
	Ignition angle offset for sum of retraction angles for injection correction factor for catalytic converter protection					
ti_kats_st						
	status for cat protection					
ti_f_kats_steuer1/2			0p-64p	1/1024 uw		
	Pre-tax value of the cat protection bank1/2					
ti_f_kats_regler				1/8192 uw		
	Controller value of the cat protection for Bank1/2					
ti_mk_f_f_nas_word				1/32768 uw		
	Start value and internal, more precise calculation value for the post-start factor					
ti_mk_nas				1/1024 uw		
	post-start factor					
ti_tau_nas				655/(x+1)	uw	
	curtailment time constant for the post-start					

parameter

app size	support points	Unit	Range	Quant.	Impl. 0p-10p 0.01p	Page
K_TI_EV_QSTAT		mg/ms			uw	
	slope factor from the injection valve characteristic curve					
K_TI_MIN		ms	0p-4p	0.001p uw		
	Minimum injection time					
K_TI_MAX		ms	0p-65.53p	0.001	uw	
	Maximum injection time					
K_TI_L_STOECH		-	0p-25p	0.1	ub	
	Stoichiometric air-fuel ratio					
K_TI_MK_SKS		-	0p-2p	0.01	ub	
	leaning factor for partially fired operation					
K_TI_START		ms	0p-65.35p	0.001	uw	
	starting base set					
K_TI_MK_NAS		-	0p-2p	0.01	ub	

	Switching threshold for the time constant at NAS					
K_TI_D_WL		%/s	0p-0.63p	10/6553 6	uw	
	Warm-up cut-off gradient with active lambda control					
K_TI_MK_GA		-	0p-2p	1/128	ub	
	basic adjustment factor					
K_TI_KATS		1/°KW	0p-0.01p	10/2621 4	ub	
	KAT protection factor					
K_TI_KATS_TABG_EIN		-	0p-2p	0.01	ub	
	Switch-on threshold TABG for controller KAT protection					
K_TI_KATS_TABG_SCHN ELL		-	0p-2p	1/16	ub	
	Threshold TABG for regulator KAT protection reinforced					
K_TI_KATS_TABG_AUS		-	0p-2p	0.01	ub	
	Switch-off threshold TABG for controller KAT protection					
K_TI_KATS_FAK_SCHNEL L		-	0p-16p	1/16	ub	
	Factor for Override Controller KAT Protection					
K_TI_MK_F_KATS_MAX		-	0p-4p	1/1024 uw		
	Max. Cat. Protection Factor					
K_TI_TAU_NAS		-	0p-4p	1/64	ub	
	weighting factor for tau at NAS					
K_TI_TMIN_WNAS		s	0p-255p	1	ub	
	Minimum time for WNAS					
K_TI_TMAX_WNAS		s	0p-255p	1	ub	
	Maximum time for WNAS					
K_TI_TMOT_HS		°C	-48p-207p 1		ub	
	Tmot threshold for hot start					
K_TI_TMOT_KS		°C	-48p-207p 1		ub	
	Tmot threshold for cold start					
K_TI_WKS_B1		-	0p-2p	1/128	ub	
	Repeat cold start factor in operating range B1					
K_TI_WKS_B2		-	0p-2p	1/128	ub	
	Repeat cold start factor in operating range B2					
K_TI_WNAS		-	0p-1p	1/256	ub	
	repeat cold start factor					
K_TIENDE_START		°KW	0p-6553p 0.1		ub	
	end of injection at start					
K_TIENDE_TMOT		°C	-48p-207p 1		ub	
	Tmot threshold for Tiende					
K_TIENDE_TMOT_HYS		°C	-48p-207p 1		ub	
	Tmot hysteresis for Tiende					
K_TIENDE_TAU		ms	0p-5100p 20		ub	
	Time constant Tau for Tiende					
K_TIENDE_TAU1		ms	0p-5100p 20		ub	
	Time constant Tau1 for Tiende					
K_TIENDE_N_TAU		1/min	0p-10200p 40		ub	
	n-threshold for Tiende Tau					
K_TIENDE_TAU2		s	0p-25p	0.1	ub	
	Tau for Tiende					
K_T_EKP_ON		ms	0p-65535p 1		uw	
	Minimum time of EKP					
K_TI_MIN		ms	0p-4p	0.0001 uw		
	Minimum injection time					
K_TI_MAX		ms	0p-65p	0.0001 uw		
	Maximum injection time					
K_TI_NO		1/NW-rev lean	0p-65535p 1		uw	
	factor for partially fired operation					
K_TI_PT_KORR_MAX		1/min	0p-10000p 1		uw	
	Max. N-threshold for PT_KORR factor					

K_TI_AUSS_COUNT		2U	0p-255p	1	ub	
	Number of blanks within K_TI_AUSS_BEREICH					
K_TI_AUSS_ZYL		-	0p-255p	1	ub	
	Mask for cylinders to be hidden					
K_N_MAX_VFEHLER		1/min	0p-10200p 1		uw	
	Nmax value at V-error					
K_N_LL_SYNC		1/min	0p-10200p 40		ub	
	n-threshold for LL-synchro					

characteristics

app size	support points	Unit	Range Quant. Impl. 0p-20p			Page
KL_TI_UB	In: 6xub Out: 6xti_ub	V ms	0p-65.53p	0.1p 0.001p	uw uw	
	Injection time correction via UB					
KL_TI_MK_START_F_P_UMG	In: 4xp_umg Out: 4xti_mk_start_f_p_umg	mbar -	500p-1150p 0p-2p	3p 0.01p	ub ub	
	KL for the ambient pressure-dependent correction factor					

3 INITIAL DATA OF THE FUNCTION

Parameter:

K_TI_EV_QSTAT 2.50

K_TI_MIN 0.90

K_TI_MAX 64.00

K_TI_L_STOECH 14.7

K_TI_MK_SKS 0.90

characteristics:

KL_TI_UB

UB [V]			10	12	14	16
TI_UB [ms]	6 3.88	8 2.06	1.38	1.00	0.76	0.60

KL_TI_MK_START_F_P_UMG

P_UMG [mbar]	701	800	974	1013
TI_MK_START_F_P_UMG [-]	1.00	1.00	1.00	1.00