Project: MSS54

Module: Fuel System Diagnosis

1. General

For OBDII, a fault in the fuel supply system must be detected so that a deviation in the mixture pre-control can be prevented and thus the mean value of the control factor deviates from ONE.

The mixture adaptation will first try to learn such an error in order to be able to correct the error in dynamic operation. However, these additive and multiplicative adaptations can only compensate for deviations within certain limits (approximately +/- 25%).

2. Monitoring for oil dilution

If fuel is emitting gases in the engine oil, a lambda deviation up to the lean limit can occur when the engine warms up after starting. To avoid a misdiagnosis, the KSD is blocked until the fuel content in the oil has fallen below the "critical" limit again.

2.1. Blocking the KSD

To lock the diagnosis, the counter **ksd_oel_sperr** is considered.

If this counter exceeds a threshold, oil dilution is detected:

ksd_oel_sperr > K_KSD_OEL_SPERR_MAX

ÿ BIT 7 in **ksd_st** is set

As long as this condition is set, the fuel system diagnosis is locked.

2.1.1. Incrementing ksd_oel_sperr

When entering the **START** operating state (to also take into account start aborts), the counter **ksd_oel_sperr,** which has been stored in **a non-volatile** memory, **is incremented** depending on the starting temperature of the engine and then compared to the **oil dilution threshold.**

ksd_oel_sperr(new) = ksd_oel_sperr(old) + KL_KSD_OEL_INC(tmot_start)

(limiting ksd_oel_sperr to 255)

2.1.2. Decrementing ksd_oel_sperr

The maximum value of the oil temperature **toel_max** is determined during each engine run .

Depending on the maximum oil temperature, the counter **ksd_oel_sperr is decremented during the transition to KL15_AUS** and then stored in a non-volatile memory.

ksd_oel_sperr(adapt) = ksd_oel_sperr(akt) - KL_KSD_OEL_DEC(toel_max)

3. Fuel system diagnosis

For this diagnosis, the **lambda controller** including the **lambda adaptations** is examined and checked for violations. The function runs in 100ms intervals.

3.1. Switch-off conditions

• the engine has not been running for a certain time **KL_KSD_T_MOT**

• a **diagnostic error** is present:

!B_WDK_FEHLERFREI_DPR
B_TPU_360MODE
B_HFM_ERROR
B_TEV_FEHLER
B_TEFC_FEHLER
B_SLS_KLEMM_FEHLER
B_SLV_SH_TO_GND
B_LA_VKAT1/2_HUB_FEHLER
B_LASV1/2_ERROR
B_LSHV1/2_ERROR

• Oil dilution was detected **(B_KSD_OEL_SPERR)**

• the engine temperature is still below the MIN threshold **K_KSD_TMOT_MIN** or already above the MAX threshold **K_KSD_TMOT_MAX**

• the intake air temperature is greater than a threshold **K_KSD_TAN**

• a waiting time was added due to the application of the brake **(B_S_BLS_TIME_LA)**

ÿ as soon as one of these switch-off conditions is met, BIT0 /**BIT1** is set in **ksd_st**

3.2. Entry requirements

To release the diagnosis, the following conditions must be met (bank-selective):

• the lambda controller must have been active for a certain time (number of P-steps)

B_LA1/2 & (la_p_spr_count1/2 > K_KSD_P_SPR)

• no tank ventilation adaptation takes place and the TE valve is too

B_TE_LERN & tetv <= 0

• no switch-off condition is present

BIT0 / BIT1 in ksd_st

3.3. Diagnostic procedure

This diagnosis runs continuously within the driving cycle, ie as soon as the diagnosis time **K_KSD_DIAG_T** has expired and the error handling has taken place, the **entire**
Drain reopened.

If the switch-on conditions are met, the entry adaptations (factor/offset) are recorded in order to obtain a defined deviation. However, no adaptations are stored if an error is detected in this diagnostic part or if one of the error counters has been counted. The reason for this is that the adaptation deviations should be related to the adaptations in which the error occurred (otherwise an error can be learned).

3.3.1. Determination of entry adaptation

The following values are stored with each new KSD run:

ksd_laa_f1/2	=	laa_f1/2
ksd_laa_offset1/2	=	laa_offset1/2

These entry adaptations are stored in a non-volatile memory so that the correct adaptation value is assumed for the next driving cycle in the event of an error.

3.3.2. Determination of the lambda deviation

The total lambda deviation is the delta of the adaptation deviations, related on the inlet adaptations and the lambda controller (averaged):

ksd_lam1/2 = laa_regler1/2 + ksd_f1/2_delta + ksd_offset1/2_delta

= laa_Controller1/2 + (laa_f1/2 - ksd_laa_f1/2) + (operating point-independent deviation)
ksd_offset1/2_delta

ksd_offset1/2_delta = ((ksd_offset1/2_delta_ms * K_LAA_N_NORM) / n40) / ti_vorst

ksd_offset1/2_delta_ms = (laa_offset1/2 - ksd_laa_offset1/2)

3.3.3. Diagnostic process

When diagnosing, a general distinction is made between whether the vehicle is idling or operating at partial load:

Idle (adjusted - B_LFR_EINGEREGELT) &&

(v < K_KSD_V):

As soon as the lambda deviation **ksd_lam1/2** exceeds the MIN or MAX thresholds, the time counter ksd_ll_max_t1/2 or ksd_ll_min_t1/2 is incremented:

ksd_lam1/2 > K_KSD_LL_LAM_MAX => **ksd_ll_max_t1/2**

ksd_lam1/2 < K_KSD_LL_LAM_MIN => **ksd_ll_min_t1/2**

partial load:

The following boundary conditions apply:

ÿ Speed range: ÿ RF range:

K_KSD_N_MIN < n < K_KSD_N_MAX
K_KSD_RF_MIN < rf < K_KSD_RF_MAX

As soon as the lambda deviation **ksd_lam1/2** exceeds the MIN or MAX thresholds, the time counter ksd_tl_max_t1/2 or ksd_tl_min_t1/2 is incremented:

ksd_lam1/2 > K_KSD_TL_LAM_MAX	**=>**	**ksd_tl_max_t1/2**
ksd_lam1/2 < K_KSD_TL_LAM_MIN	**=>**	**ksd_tl_min_t1/2**

In general, the counters are stopped again as soon as the thresholds are exceeded or undercut again. This means that the times during which the diagnostic thresholds are exceeded are added up over the entire diagnostic period.

Error handling:

If the diagnostic time **K_KSD_DIAG_T** has expired, the time counters representing the limit value violations are checked for temporal diagnostic thresholds.
If one of these time counters exceeds a threshold, an error is entered:

If:

- **ksd_ll_max1/2 > K_KSD_LL_MAX_T**

ÿ ksd1/2_ed : KSD1/2_ERROR SH_TO_UB

- **ksd_ll_min1/2 > K_KSD_LL_MIN_T**

ÿ kds1/2_ed: KSD1/2_ERROR SH_TO_GND

- **ksd_tl_max1/2 > K_KSD_TL_MAX_T**

ÿ ksd1/2_ed: KSD1/2_FAILURE OPENLOAD

- **ksd_tl_min1/2 > K_KSD_TL_MIN_T**

ÿ ksd1/2_ed: KSD1/2_ERROR IMPLAUSIBLE

In order to detect short-term deviations that have not yet led to an error entry, info variables are set - ie these are counters (ksd_ll_max_trig1/2, ksd_ll_min_trig1/2, ksd_tl_min_trig1/2 and ksd_tl_max_trig1/2) that are incremented as soon as exceedances or undershoots are detected (ksd_ll/tl_min/max_t1/2 != 0). These info variables can also be found in the DS2 tool - no non-volatile storage, as the whole thing should always be related to one engine run - the significance is reduced if it were related to the entire engine life!!!.

If none of the thresholds is exceeded, a registered error is cured.

4. Constants, characteristics, maps, variables

4.1. Constants

K_KSD_N_MAX	Max. speed threshold for TL diagnosis
K_KSD_N_MIN	Min. speed threshold for TL diagnosis
K_KSD_RF_MAX	Max. RF threshold for TL diagnosis
K_KSD_RF_MIN	Min. RF threshold for TL diagnosis
K_KSD_TMOT_MIN/MAX	On/off condition: TMOT thresholds
K_KSD_TAN	Switch-on condition: TAN threshold
K_KSD_P_SPR	Switch-on condition: Number of P-steps of the lambda controller
K_KSD_V	Speed threshold for LL diagnosis, otherwise false detections possible
K_KSD_LL_LAM_MAX	upper threshold in LL for lambda deviation -> from here the time counter for the exceedance is increased
K_KSD_LL_LAM_MIN	lower threshold in the LL for lambda deviation -> from here the time counter for the undershoot is increased
K_KSD_TL_LAM_MAX	upper threshold in TL for lambda deviation -> from here the time counter for the exceedance is increased
K_KSD_TL_LAM_MIN	lower threshold in the LL for lambda deviation -> from here the time counter for the undershoot is increased
K_KSD_LL_MAX_T	Diag.Threshold/LL for the time counter of exceedances
K_KSD_LL_MIN_T	Diag.Threshold/LL for the time counter of undershoots
K_KSD_TL_MAX_T	Diag.Threshold/TL for the time counter of exceedances
K_KSD_TL_MIN_T	Diag.Threshold/TL for the time counter of undershoots
K_KSD_DIAG_T	diagnostic time for KSD
K_KSD_OEL_SPERR_MAX	Threshold for detecting fuel in oil
KL_KSD_T_MOT	Time the engine must have been running before the diagnosis can begin
KL_KSD_OEL_INC	Detection of oil dilution - increment, depending on tmot_start at START
KL_KSD_OEL_DEC	Detection of oil dilution - decrement, depending on toel_max at KL15_AUS

4.2. Variables

laa_schw_st1/2	status byte of the adaptation error thresholds Bit 0: upper adaptation offset threshold exceeded Bit 1: lower adaptation offset threshold exceeded Bit 2: upper adaptation factor threshold exceeded Bit 3: lower adaptation factor threshold exceeded Bit 4: Limitation of the adaptation offset is active Bit 5: Limitation of the adaptation factor is active

Bit 6:
Bit 7:

laa_f1/2	adaptation factor 1 or 2
laa_offset1/2	Adaptation offset 1 or 2 without speed weighting with 32 bit resolution
ksd1/2_ed	error variable for KSD
ksd_st	status byte for KSD diagnosis Bit 0: Abort condition Bank1 is present Bit 1: Abort condition Bank2 is present Bit 2: Start adaptations Bank1 were stored away Bit 3: Diagnostic time Bank1 has expired Bit 4: Start adaptations Bank2 were stored away Bit 5: Diagnostic time Bank2 has expired Bit 6: ---------- Bit 7: Oil dilution was detected
ksd_laa_f1/2	Adaptation factor 1/2 at the start of the KSD
ksd_laa_offset1/2	Adaptation offset1/2 when starting the KSD (laa_offset1/2)
ksd_f1/2_delta	Delta between adaptation factor at start of KSD and current adaptation factor
ksd_offset1/2_delta_ms	Delta between adaptation offset at start d. KSD and current adaptation offset in ms
ksd_offset1/2_delta	Operating point-independent adaptation offset in %
ksd_lam1/2	total lambda deviation (average lambda value + Delta factor[%] + Delta offset[%]
ksd_ll_max_t1/2	Time in which the total lambda deviation exceeds the max. threshold exceeded in the LL
ksd_tl_max_t1/2	Time in which the total lambda deviation exceeds the max. threshold in the TL exceeded
ksd_ll_min_t1/2	Time in which the total lambda deviation fell below the min. threshold in the LL
ksd_tl_min_t1/2	Time in which the total lambda deviation fell below the min. threshold in the TL
ksd_diag_time1/2	diagnosis time of the KSD
ksd_oel_sperr	counter for detecting oil dilution
ksd_tl/ll_min/max_t1/2	Info variables to detect over-/undershoots, even without to detect error entries