# MSS54
# module description
# EDK

| | Department | Date | name | Filename |
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| **editor** | EE-221 | December 4, 2003 | | 3.02 |

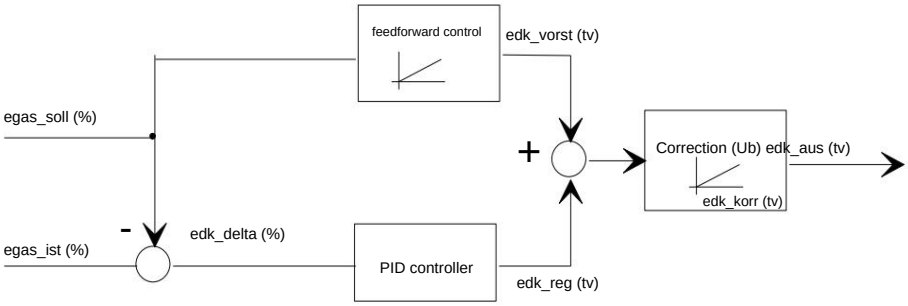
## Table of contents:

( automatically from chapter headings )

## 1st OVERVIEW

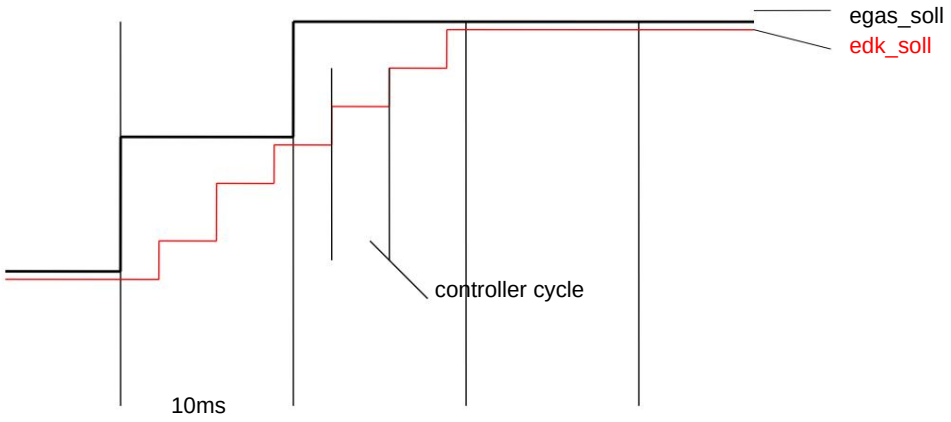
The throttle valve control consists of the following parts:

- Calculation of the input tax value
- Position controller
- Correction of the output value via Ubatt
- Diagnosis




## 2nd TARGET VALUE DETERMINATION

The setpoint **egas_soll** is determined in the EGAS module every 10ms.
Internally, another setpoint **(edk_soll)** is maintained, which, when **egas_soll** changes, is adjusted to the new setpoint in several steps depending on the controller cycle.




This internally managed setpoint avoids jumps in the control deviation **(edk_delta),** which would otherwise occur with each update of the setpoint.

# 3. ACTUATOR FEEDBACK RECORDING

The current DK potentiometer is used as the actual value **(egas_ist)** (see module WDK).

## **3.1.** ADAPTATION

### 3.1.1. ZERO POINT ADAPTION

The zero point adaptation of the throttle valve takes place during the PredriveCheck (see modules PDR and WDK).

### 3.1.2. FULL LOAD ADAPTATION

The full load adaptation of the DK system takes place in the follow-up if one of the following conditions is met:

- Virgin control unit
- Loss of adaptation data
- Call via DIS
- Error message about the security concept

Process:

After ignition off and n = 0, the following sequence is run through once:

- Approaching the setpoint on **K_EDK_A100_B1** (approx. 85%) via ramp **K_EDK_A100_INC**
- Waiting time **K_EDK_A100_WAIT1,** so that the setpoint can be safely adjusted.
- Further ramp-like increase of the setpoint by **K_EDK_A100_INC2** until the actual value can no longer follow ÿ permanent controller deviation **K_EDK_A100_DELTA**
- Waiting time K_EDK_A100_WAIT2 with check whether the stop value remains stable (at demand will continue to increase).
- Call the routine **wdk_a100_adapt()** to adapt the DK • Drive EDK to zero via ramp (setpoint with each cycle by **K_EDK_A100_DEC** reduce).
- End control

# 4th THE CONTROL OF THE ACTUATOR

## 4.1. PRE-CONTROL

The servomotor must hold the desired throttle valve position against the throttle valve return springs. For this reason, a duty cycle is used as a pre-control for

Compensation of the spring force is output. This output value is calculated in the 10ms task from the characteristic curve **KL_EDK_VORST .**

edk_vorst = KL_EDK_VORST = f ( egas_soll )

#### 4.2. POSITION CONTROLLER

The position control runs as a PID controller according to the formula

**y = xp + xi + xd.**

where the P-part is the **xp = e*Kp** , xi = **e*Ki + xit-1** , xd = **(et - et-2) * Kd** is.

The control deviation **e** is calculated from the difference between the setpoint value **(egas_soll)** and the actual value of the actuator **egas_ist** (or **edk_soll** to **egas_ist) .**

The P-component is determined separately for positive and negative control deviations from the characteristic curves **KL_EDK_PPOS** and **KL_EDK_PNEG .**

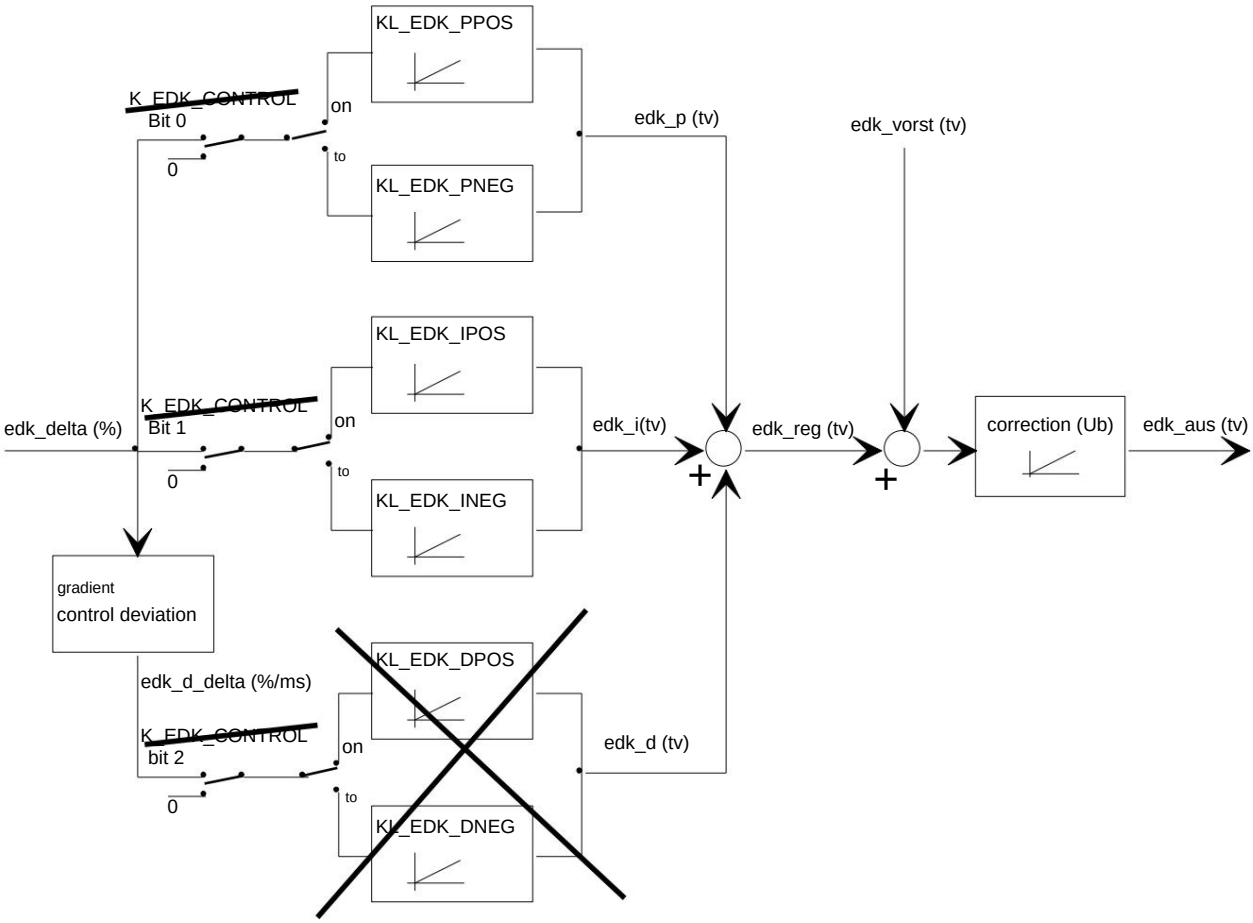
The I-component is determined separately for positive and negative control deviations from the characteristic curves **KL_EDK_IPOS** and **KL_EDK_INEG .**
The I component is limited by **K_EDK_IBEGR .**
If the control deviation is greater than **± K_EDK_IDELTA** (e.g. in the case of a jump), the I component is deleted.

The D component is determined separately for positive and negative gradients of the control deviation **(edk_d_grad)** from the constants **K_EDK_DPOS** and **K_EDK_DNEG .**

If the amount of control deviation is greater than **± K_EDK_D_EIN_POS ,** the D component is switched off.

In the area around the zero point of the control deviation between **± K_EDK_D_NULL ,** the D component is switched off. If the setpoint **egas_soll** is greater than **K_EDK_D_ANSCHL,** the switch-off around the zero point of the control deviation is canceled in order to prevent the DK from being overdriven into the mechanical stop.

The contribution of the D controller is limited to **± K_EDK_D_MAX .**




The output value determined from **edk_reg** and **edk_vorst** is corrected using the characteristic curve **KL_EDK_KORR_U** via **Ub (edk_korr).**

The resulting control duty cycle is as follows.

| | | | |
|---|---|---|---|
| Edk_aus | = | ( edk_vorst | pre-tax value |
| | | ‡ edk_reg | controller value |
| | | ) edk_korr | voltage correction |

#### 4.2.1. CONTROLLER SHUTDOWN

When the motor is stopped, the setpoint is 0 and the WDK position is <= **K_EDK_CLOSED,** the servo motor is switched off. When the motor is running, the pilot control value is output to slightly preload the kinematics in the pulling direction and thus reduce the play at the zero point.

### 4.3. LIMITATION OF THE DUTY RATIO

The high time of the duty cycle edk_auss to be output is set via the variable **edk_ht_max** capped at the top.
The maximum achievable value is set via **K_EDK_MAX .**

In the background task, **edk_ht_max** is calculated:
• In case of an error in the EGAS system, it is limited to **K_EDK_SK_HT_MAX .**
• During 100% adaptation limited to **K_EDK_A100_HT_MAX**

## 5th SELF-DIAGNOSIS

### 5.1. DRIVER DIAGNOSIS MC33186

Via port E bit 4, the diagnostic output of the H-bridge can be used to determine whether the bridge has switched off due to overload. This happens at the beginning of each controller cycle. At the end of the controller cycle, an attempt is made to switch the bridge back on if necessary. The variable **edk_tr_diag_stat** informs the HW diagnostic routine **(edk_tr_diag())** that the bridge's protective circuit has been activated.

When the bridge is switched off, bit 0 is set in **ed_edk_tr_stat .**
When the bridge is disabled, bit 1 in **ed_edk_tr_stat** is set.

If the bridge switches itself off an error is stored in **edk_hw_ed** (Overtemp) bit 3.

| Mistake | impact | measure |
|---|---|---|
| overload of the Bridge | No control of the actuator | - File mistakes<br>- Switch the bridge back on |

### 5.2. SECURITY CONCEPT

See module description EGAS safety concept.

## 6th DIAGNOSIS VIA DS2

### 6.1. CONTROLLING THE DK VIA DS2

By calling **edk_write(edk_switch,edk_vorgabe)** the DK can be controlled via DS2.

The DK is only activated when the engine is stopped **(B_MS)** and in diagnostic mode **(B_DIAG).** If one of the two conditions is not met, no activation takes place and response 4 (condition not met) is returned.
The parameter **edk_switch** is used to distinguish whether the controller is given a setpoint (0) or whether the actuator is controlled with a duty cycle (1). If a different value is passed, no control takes place and the routine returns the result 2 (wrong parameter).

A value from 0 to 200 is passed via the parameter **edk_vorgabe .** The setpoint of the position controller (0 to 100%) is determined from this value, resulting in a resolution of ½%.
Here too, if a different value is passed, no control takes place and the feedback is 2 (wrong parameter).

If all parameters are correct and all conditions are met, the response is 0 (ok) and the DK is activated.

If the amount of control deviation is less than **± K_EDK_DS2_DMAX ,** the specified setpoint is considered to be regulated.

### **6.2.** OUTPUT **OF SYSTEM SIZES VIA DS2**

The following system parameters can be output via DS2:

| | | |
|---|---|---|
| adjustment time | **edk_ds2_t_stell** | Measures the time until the setpoint specified via DS2 is reached. |
| closing time | **edk_ds2_tschliess** | Time from switching off the controller until DK closed at the PDR. |
| maximum control deviation | **edk_ds2_abw_umax**<br>**edk_ds2_abw_omax** | Maximum control deviation that occurred after reaching the setpoint value set via DS2. |
| middle control deviation | **edk_ds2_abw_mw** | Mean value of the amount of control deviation after reaching the setpoint value set via DS2. |

## 7th CONSTANTS, CHARACTERISTIC CURVES AND VARIABLES

### 7.1. CONSTANTS

| | |
|---|---|
| **K_EDK_CONTROL** | former connection of the individual controller components |
| bit 5 | Output of pre-control value when controller is switched off in LL (only S54) |
| **K_EDK_UBMIN** | UB threshold for adaptation |
| **K_EDK_CYCL** | controller cycle in ms |
| **K_EDK_D_NULL** | switch-on limit D-controller |
| **K_EDK_D_MAX** | maximum allowed D-value |
| **K_EDK_DPOS** | K-factor D-controller positive |
| **K_EDK_DNEG** | K-factor D-controller negative |
| **K_EDK_D_EIN_POS** | Upper switch-on limit D-controller positive |
| **K_EDK_D_EIN_NEG** | Upper switch-on limit D-controller negative |
| **K_EDK_D_ANSCHL** | Deactivation of the zero limitation of the D controller |
| **K_EDK_I_NULL** | freezing limit of the I-controller |
| **K_EDK_IBEGR** | limitation of the I share |
| **K_EDK_IDELTA** | control deviation above which the I component is deleted |
| **K_EDK_A100_DELTA** | Control deviation from which the 100% adaptation of the specified target value is considered to have been reached |
| **K_EDK_A100_WAIT1** | Waiting time for 100% adaptation to area 1 |
| **K_EDK_A100_WAIT2** | Waiting time for 100% adaptation to area 2 |
| **K_EDK_A100_INC1** | step size for upward adaptation (0 to B1) |
| **K_EDK_A100_INC2** | step size for upward adaptation (from B1) |
| **K_EDK_A100_DEC3** | Step width when closing the flap after upward adaptation |
| **K_EDK_A100_B1** | Setpoint specification for first adaptation step upper stop |
| **K_EDK_A100_VL_ANSCHL** | Difference from the mechanical upper stop to 100% EDK position |
| **K_EDK_T_SPERR** | Minimum time without change after which the controller in LL turns off |
| **K_EDK_CLOSED** | threshold below which the controller is switched off |
| **K_EDK_ HT_MAX** | Maximum allowed TV |
| **K_EDK_A100_HT_MAX** | Maximum TV during adaptation |
| **K_EDK_SK_HT_MAX** | Maximum TV during emergency program |
| **K_EDK_AUS_HT_MAX** | Maximum TV after switching the bridge back on |
| **K_EDK_HT_MIN** | Smallest possible TV value |
| **K_EDK_HT_INC** | Step size for increasing the TV in case of error |
| **K_EDK_HT_TMOT** | limit temperature below which TV is limited |

| | |
|---|---|
| **K_EDK_ HT_AUSZEIT** | Time for limiting the TV after error |
| **K_EDK_ DS2_DMAX** | Threshold, target value of DS2 reached |
| **K_EDK_ DS2_TSPERR** | Waiting time, measure after adjustment time |
| **K_EDK_ DS2_TAU** | filter constant for mean control deviation |

## 7.2. CHARACTERISTIC CURVES

| | |
|---|---|
| **KL_EDK_VORST** | pre-control value from DK setpoint |
| **KL_EDK_PPOS** | P-factor of the position controller control deviation greater than 0 |
| **KL_EDK_PNEG** | P-factor of the position controller control deviation less than 0 |
| **KL_EDK_IPOS** | I-factor of the position controller control deviation greater than 0 |
| **KL_EDK_INEG** | I-factor of the position controller control deviation less than 0 |
| **KL_EDK_KORR_U** | Correction of the duty cycle via Ubatt |

## 7.3. VARIABLES

| | |
|---|---|
| **edk_soll** | Setpoint specification from torque manager or PWG |
| **edk_soll_adapt** | setpoint specification adaptation routine |
| **edk_delta** | Control deviation in % 16 bit value |
| **edk_hw_ed** | status byte hardware H-bridge |
| Bit 0: | Error Maximum value exceeded |
| Bit 1: | Error Minimum value exceeded |
| Bit 2...7: | free |
| **edk_status** | status byte EDK |
| Bit 0: | 1: Rules according to PWG 0: Rules according to MM |
| Bit 1: | 1: Controller shutdown requested |
| Bit 2: | 1: Controller shutdown is active |
| Bit 3: | free |
| *Bit 4:* | *Adaptation value a0 lost from EEPROM* |
| *Bit 5:* | *Adaptation value a100 lost from EEPROM* |
| Bit 6: | 1: Adaptation active |
| Bit 7: | 1: EDK adaptation has taken place |
| **edk_tr_diag_stat** | Status byte driver diagnostics H-bridge |
| Bit 0: | 1: SF error detected by position controller, bridge disabled |
| Bit 1: | 1: Bridge must not be enabled |
| Bit 2...7: | free |
| **edk_lr_i** | Step size of the I-controller from characteristic curve over control deviation |
| **edk_p** | P-component of the output value |
| **edk_i** | I-part of the output value |

| | |
|---|---|
| **edk_d** | D-part of the output value |
| **edk_reg** | controller value of the PWM high time |
| **edk_vorst** | pre-control value of the PWM high time |
| **edk_aus** | output value of the PWM high time |
| **edk_korr_fak** | Correction factor from characteristic curve over Ub |
| **edk_korr** | Input tax value corrected via Ubatt |
| **edk_master_reset** | Triggering a reset on the master by writing to this variables |
| **edk_d_grad** | gradient of the control deviation |
| **edk_soll _diag** | target value specification via diagnosis |
| **edk_soll_inc** | Increase from edk_soll to egas_soll (setpoint adjustment to cycle time) |
| **edk_delta2** | Control deviation edk_soll - edk_ist (setpoint adjustment to cycle time) |
| **edk_d_grad2** | Gradient of the control deviation (setpoint adjustment to cycle time) |
| **edk_ht_max** | limitation of the duty cycle |
| **edk_ds2_tstell** | Adjustment time according to setpoint via DS2 |
| **edk_ds2_tschliess** | Closing time via spring after actuator switch off |
| **edk_ds2_abw_umax** | Maximum control deviation below when controlling DS2 |
| **edk_ds2_abw_omax** | Maximum control deviation above when controlling DS2 |
| **edk_ds2_abw_mw** | Mean control deviation below when controlling DS2 |
| **edk_ds2_sollw_alt** | last setpoint via DS2 |
| **edk_ds2_status** | Status byte control via DS2 |
| **edk_ds2_adapt_stat** | Status byte control adaptation via DS2 |