Electronic Throttle Control EMLIIIS

Note

The vehicle is not ready for operation if basic adaptation of the pedal position sensor has not been carried out correctly. Although the engine can be started it does not respond to the throttle system.

Functions

The use of dynamic stability control (DSC) on the 12-cylinder engines M73B54 in the series E31 and E38 renders an electronic accelerator pedal necessary.

For this purpose, the principle of the electronic throttle control (EML M30 and EML M70) known from the 6-cylinder engines M30 and the 12-cylinder engines M70 was taken as a basis and further developed to a considerable extent.

As before, the electronic throttle control EMLIIIS enables any setting of the throttle position independent of driver requirements. In contrast to conventional throttle operating systems, there is no mechanical connection (linkage or operating cable) between the throttle valve and accelerator pedal. In this way it is possible by means of interventions in cylinder charging to prevent the drive wheels spinning or locking thus maintaining vehicle stability.

In addition to interventions in cylinder charging on the basis of the requirements of driving dynamics, other operating conditions are possible which make it necessary to influence the throttle angles; these requirements have been extended and adapted to the M73B54 engine:

- Position of throttle valves for optimum engine start
- Control of throttle angle for stabilisation of idler speed (cylinder synchronisation, ZSY)
- Adjustment of throttles while coasting to reduce high vacuum in the intake pipe
- Reduction of throttle angle to limit engine speed and limit driving speed
- Cruise control (FGR) by corresponding activation of throttle valves

Components

The EMLIIIS system consists of following components:

- EMLIIIS control unit
- Pedal position sensor including external safety path
- Kick-down switch
- Electronic brake switch
- 2 throttle valves for both rows of cylinders
- Steering column switch for operating cruise control on E31 vehicles
- Cruise control (FGR) main switch and operating unit in multifunction steering wheel for operating cruise control on E38 vehicles
- Connection via CAN-bus to the control units of digital motor electronics (DMER and DMEL), adaptive transmission control (AGS) and of dynamic stability control (DSC)
- Connection to EML warning lamp in instrument cluster on E31 vehicles
- Connection to check-control module of instrument cluster on E38 vehicles
- Connection to fault lamp (check-engine lamp) in instrument cluster on US vehicles

Safety Concept

Since the EMLIIIS system controls access to the engine output particular importance must be attached to ensuring a high degree of safety. Furthermore, facilities must be provided to ensure the vehicle remains operable in the event of a defect.

This is achieved by way of a redundancy concept for components critical to safety, i.e. these components are installed in duplicate or triplicate in order to prevent unwanted intervention in the engine output or to ensure safe emergency operation in the event of an individual fault occurring:

- Dual computer concept in the EMLIIIS control unit, i.e. 2 microprocessors (computer MC1 and computer MC2) carry out all working steps simultaneously and are controlled accordingly; in addition, each computer features its own memory module (EEPROM)
- The pedal position sensor (PWG) records the accelerator pedal angle simultaneously with 3 PWG

sensors (PWG1-SIG, PWG2-SIG, PWG3-SIG) and compares all 3 signals with respect to each other to ensure they are correct
- The 3 measured signals of the PWG sensors are routed via separate, shielded supply lines to the 3 angle pulse generator ICs in the EMLIIIS control unit where they are evaluated separately.
- Each throttle valve is controlled by 2 stepper motors with the one operated by computer MC1 and the other by computer MC2.
- The activation signals for the 4 stepper motors of the 2 throttle valves are sent from a total of 8 stepper motor ICs on separate supply lines.
- Each throttle valve features 2 potentiometers for correct feedback of the current throttle position.
- 2 supply voltages are provided for the 4 potentiometers so that in each throttle valve one potentiometer is supplied by the one voltage and the other by the other voltage.
- The electronic brake switch detects operation of the brake in a dual system and sends these signals on 2 separate supply lines to the EMLIIIS control unit.

In addition, all functions and components of the EMLIIIS are constantly tested and monitored by the EMLIIIS control unit and, depending on how serious the fault is, either a function or even a component (e.g. one of the 2 throttle valves) is deactivated. Added to this, the safety fuel cutout in the two DME control units can be activated via an external safety path independent of the EMLIIIS control unit.

A serious fault in a component detected by the self-diagnosis function of the EMLIIIS control unit is signalled to the driver by means of a warning lamp with the inscription "EML" (in E31 vehicles) or the message "engine emergency program" in the check-control module (in E38 vehicles).

Pedal position sensor (PWG)

The pedal position sensor in the EMLIIIS system is used to record the driver's requirements. For this purpose, a measured signal (signal name PWGx-SIG; x = 1, 2 or 3) proportional to the accelerator pedal angle is generated in a pair of coils in the pedal position sensor (PWG).

3 pedal position sensors are installed in order to ensure in the event of a sensor failing that the driver's requirements are recorded without losses in safety.

The 3 measured signals are transferred via 3 shielded supply lines to the EMLIIIS control unit where they are processed in 3 evaluation circuits (so-called angle pulse generator ICs, WIG-ICs).

The valid value range of the accelerator pedal angle is between 0 and 99.6 %.

The WIG-ICs also feature

- a calibration function to adjust tolerances
- and an oscillator to generate the input signal (signal name PWGx-OSZ, x = 1, 2 or 3) for the PWG sensor.

By way of the self-diagnosis function of the EMLIIIS control unit, every step from acquisition up to evaluation of the driver's requests, including the calibration function and PWG basic adaptation is monitored and in the event of a malfunction, the cause is indicated and described.

Basic adaptation of pedal position sensor

In order to compensate for production-related tolerances in the pedal position sensor (PWG) system, the PWG limit stop (idle point and kick-down limit stop) are determined in a basic adaptation-learn mode. For this reason, it is necessary when replacing the EMLIIIS control unit or the pedal position sensor to carry out PWG basic adaptation in order to adapt the new tolerances. To ensure this step is carried out, the engine will not accept the throttle system before PWG basic adaptation has been carried out.

The EMLIIIS control unit assumes the start status for learn mode when the PWG basic adaptation values are deleted by one of the following conditions:

- A new variant is coded in the EMLIIIS control unit; this is only possible with the encoding program "encoding ZCS" via the DIS or MoDiC testers.
- The pedal position sensor (PWG) is unplugged at ignition ON so that all 3 signals are detected as faulty
- The PWG adaptation values are reset by means of the corresponding instruction on the DIS or MoDiC testers

The PWG basic adaptation procedure is described both in the diagnosis program of the EMLIIIS system as well as in the encoding program "encoding ZCS".

Only after PWG basic adaptation has been carried out correctly are the learn words stored in 2 EEPROM's in

the EMLIIIS control unit and sensing of the driver's request is enabled.

Note

The defect code memory in the EMLIIIS control unit is cleared automatically after successful PWG basic adaptation when the variant was newly coded or the PWG unplugged beforehand. Therefore read out the defect code memory or print out the test code beforehand to ensure no defect information is lost.

Safety fuel cutout (SKA)

The safety fuel cutout signal for the two DME control units can come on the one hand from the EMLIIIS control unit and on the other hand from the external safety path specially used for this purpose.

The safety path consists of the brake light switch, a 4-degree switch in the pedal position sensor (PWG) and 2 diodes in the pedal position sensor (PWG). This path independent of the EMLIIIS control unit ensures that a defective EMLIIIS control unit cannot activate the accelerator system uncontrolled since, when the accelerator pedal is not depressed (4-degree switch closed) the signal of the operated brake is routed via this path to both DME control units thus activating the safety fuel cutout.

2 driving situations which result in activation of the safety fuel cutout function are described in the following:

- When idle is detected, the EMLIIIS control unit automatically outputs the signal for safety fuel cutout to both DME control units.
- If the brake is pressed and the accelerator pedal is not depressed, the two DME control units additionally receive via the external safety path the brake signal as a request to activate the safety fuel cutout.

The correct status of the safety fuel cutout is constantly checked by the self-diagnosis function in the EMLIIIS control unit.

Note

The EML test adapter used in the previous EML to test the external safety path is no longer required in the EMLIIIS (EML test adapter 12 7 010/011 with adapter lead 12 7 012/013)

Throttle valves (DK)

The throttle valve is a component part of the air intake system of the engine and controls the quantity of air required to combust the fuel.

In the EMLIIIS system, the 2 throttle valves for the 2 rows of cylinders are not opened and closed as in conventional systems by means of an operating cable but rather by actuator motors.

Stepper motors are used to drive the throttle valves which, in contrast to the DC motors used in the previous EML system, require no gear mechanism and therefore feature better dynamics.

Potentiometers which constantly signal the current position of the throttle valves to the EMLIIIS control unit are connected directly to the throttle valves.

In view of the fact that the throttle position has a direct influence on the engine output, for safety reasons, 2 stepper motors are installed per throttle valve and 2 potentiometers to signal their position.

Each throttle valve is driven simultaneously by 2 stepper motors mounted on the same drive shaft with one controlled by the computer MC1 and the other by computer MC2 so that the function of both throttle valves can be maintained by the other computer in the event of a computer failing.

Each stepper motor consists of a sine winding and a cosine winding, each of which are controlled via shielded, separate supply lines by its own stepper IC. If one stepper IC fails the function is adopted by the other stepper IC.

If, despite the integrated redundancy, perfect operation of the throttle valve can no longer be ensured due to a fault in a throttle valve, this throttle valve and thus the relevant row of cylinders is shut down. Restricted operation with the remaining row of cylinders is possible.

Each throttle valve features 2 independent potentiometers to signal the current position of the valve to the EMLIIIS control unit. The 2 potentiometers are operated with 2 voltage supplies which are decoupled from each other so that in the event of one voltage supply or one potentiometer failing the other potentiometer can still ensure correct position feedback.

As part of the self-diagnosis function, the throttle valves are checked exactly in a large number of tests:

- Checking the validity of the position feedback of 2 throttle valves
- Checking 2 supply voltages of 4 potentiometers
- Checking the difference of 2 potentiometer voltages of one throttle valve

- Comparing the setpoints (activation of stepper motor) with actual values (feedback of potentiometer) of each of the 2 throttle valves
- Comparing the setpoints calculated separately by each computer for one throttle valve
- Monitoring the 2 throttle valves before the engine start-phase (predrive check during initialisation phase); for this purpose, the EML warning lamp in the E31 is activated for the first 2 seconds and switched off again on completion of the predrive-check
- Testing the 8 stepper motor ICs before the engine start phase

Cruise control (FGR)

The cruise control uses the speed signal V1 of the CAN message from the DSC control unit as the control variable and calculates the required cylinder charging. The cruise control (FGR) is activated in different ways in the E31 and E38 (provided there are no switch-off conditions or switch-on inhibits):

- On E31 vehicles via operating lever (steering column switch LSS)
- On E38 vehicles via a main switch on the instrument panel and via the right-hand button pad in the multifunction steering wheel (MFL)

Data Transfer and FGR Operation in E31 Vehicles

In E31 vehicles data is transferred from the operating lever to the EMLIIIS control unit as in the previous EML system by means of resistor coding and the resulting analog voltage.

The following functions are possible, however, the steering column switch (LSS) is designed in such a way that several functions cannot be active simultaneously:

- Lever in rest position: Rest (voltage value 3.33 to 3.55 V)
- Lever forward: Set/accelerate (voltage value 0.76 to 0.91 V)
- Lever back: Decelerate (voltage value 2.49 to 2.75 V)
- Lever up: OFF (voltage value 4.13 to 4.27 V)
- Lever down: OFF (voltage value 4.13 to 4.27 V)
- Press lever: Resume (voltage value 1.57 to 1.80 V)

Data Transfer and FGR Operation in E38 Vehicles

In E38 vehicles, data is transferred from the multifunction steering wheel (MFL) to the EMLIIIS control unit via digital signals. There is no mechanical interlock between the buttons on the multifunction steering wheel (MFL) to prevent simultaneous operation of several functions so that the functions are recognized in accordance with a priority table with "OFF" having the highest priority.

In order to avoid malfunctions on the multifunction steering wheel, the driver must first switch on the cruise control (FGR) via the FGR main switch on the instrument panel (FGR ready indicator in instrument cluster lights up). The following functions are then possible:

- Buttons not operated: Rest
- Button "+" pressed: Set/accelerate
- Button "-" pressed: Decelerate
- Button "0" pressed: OFF
- Button "pointer" pressed: Resume

Switch-On Inhibits and Switch-Off Conditions

There are various switch-on inhibits and switch-off conditions in both vehicles.

Switch-on inhibits include CAN-bus faults in the DSC message or faults in the brake switch.

Cruise control (FGR) operation can be switched off soft or hard by the EMLIIIS control unit:

- Soft shut-down takes place when the "OFF" function is operated or when the travelling speed is too low
- Hard shut-down takes place when the brake is operated, at excessively high acceleration or excessively high travelling speed, if a gear is no longer engaged in the automatic transmission or in the case of certain defects detected by the self-diagnosis function in the EMLIIIS system.

Interfaces

The EMLIIIS control unit transmits and receives signals from other control units or components both in digital as well as in analog form.

Digital data transfer takes place via the CAN-bus between the control units, analog data transfer takes place to the brake switch, kick-down switch and fault indication in the instrument cluster.

CAN-bus

Communication between the EMLIIIS control unit and the control units AGS, both DMEs and DSC takes place via the CAN-bus, facilitating extensive data exchange on digital level. The only exception to this is the safety fuel cutout signal from the EMLIIIS control unit to both DME control units which is transferred via the external safety path.

For this purpose, a CAN-module is installed in the EMLIIIS control unit and in the other control units which are interconnected via a star coupler, to which shielded supply lines lead from each control unit with a total line resistance of 60 Ohm. This is achieved in that the terminal resistor in the DSC control unit (fixed to 120 Ohm) and in the AGS control unit (120 Ohm, activated by a jumper) are connected in parallel.

By way of self-diagnosis, the EMLIIIS control unit constantly checks both for correct transmission and reception of messages on the CAN-bus as well as identical CAN status of all control units.

Note

Particular care must be taken when replacing one of the CAN-bus control units to ensure the identical CAN status otherwise communication via the CAN-bus will not be possible. Check by means of diagnosis program on identification page under "Bus index".

Electronic brake switch

An electronic brake switch is installed in both series E31 and E38, in that 2 brake switches are accommodated in one housing. The function of the electronic brake switch is checked by the self-diagnosis function every time the brake is operated.

In E31 vehicles the electronics simulates the switching characteristics of the 2 mechanical brake switches of the previous EML system, which switch slightly offset. The first switch (BLS signal) is a make contact, i.e. during operation it closes to U-batt and transfers this signal to the external safety path. The slightly delayed second switch (BTS signal) is also a make contact which, however, when operated closes to ground and transfers this signal to the EMLIIIS control unit.

In E38 vehicles, the two brake switches switch at the same time exactly. The one switch (B-EML signal) is a make contact, i.e. when operated it closes to U-batt and transfers this signal to the external safety path. The second switch (BL-ON signal) is a break contact, i.e. when operated it opens from ground and transfers this signal to the EMLIIIS control unit.

Kick-down Switch (KDS)

The kick-down switch is used to activate the downshift procedure in automatic transmissions. This switch is used in all series E31 and E38 vehicles with 12-cylinder engine M73B54 since these vehicles are equipped solely with automatic transmission.

The kick-down switch in both series E31 and E38 is a make contact, i.e. when operated it closes to ground.

Fault Indication

The task of fault indication is to inform the driver of a fault in the EMLIIIS system which can lead to limitations in output or to deactivation of various functions, and is intended to draw the driver's attention to a necessary workshop visit.

In E31 vehicles, a fault is indicated in the form of a warning lamp with the inscription "EML" in the instrument cluster.

In E38 vehicles, a fault is indicated by way of a "engine emergency program" message in the check-control module of the instrument cluster.

Note

The ignition must be switched off for approx. 10 seconds after clearing the defect code memory of the EMLIIIS control unit. The fault indication is then deactivated when the ignition is switched on again.