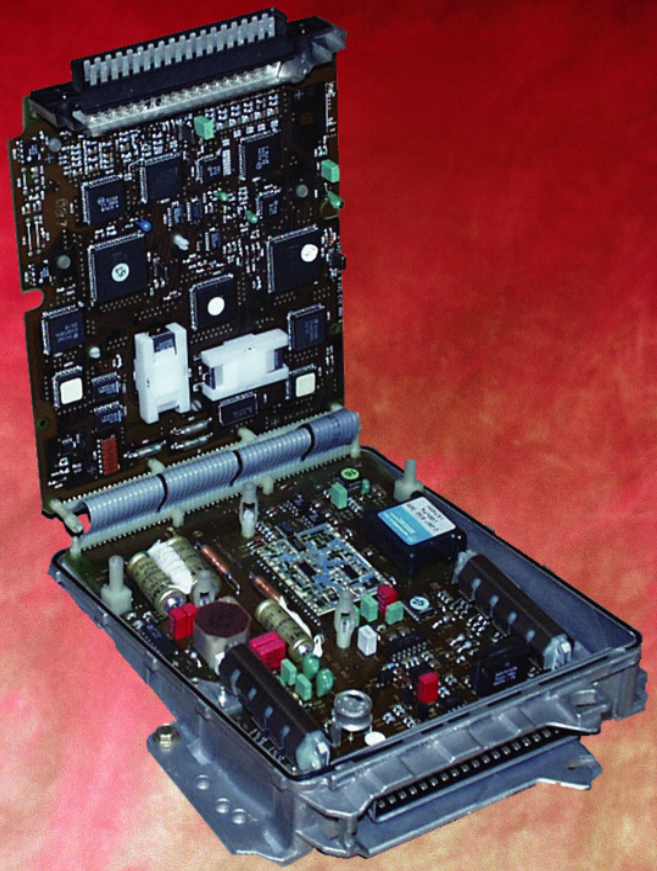
Technical Information

Electronic Diesel Control
Repair Manual

EDC MS 5 - D 2876 LUH ...



Dear Customer

These instructions are intended to help you to repair the electronic Diesel control system properly.

In writing these instructions, we have assumed that you have the necessary knowledge of control systems for working on and with the electronic diesel control.

Important instructions which concern technical safety and protection of persons are emphasised as shown below.

Caution:
This refers to working and operating procedures which must be complied with in order to prevent damage to or destruction of material.

Note:
Explanations useful for understanding the working or operating procedure to be performed.

Best regards
MAN Nutzfahrzeuge Aktiengesellschaft
Nuremberg Plant

Since our products are in continuous development, we reserve the right to make technical modifications.

Contents

General

Important safety regulations are summarized in this quick-reference overview and arranged by topic to effectively convey the knowledge necessary to avoid accidents causing injury, damage or environmental hazard.
The engine operating manual contains further information.

Important:
Should an accident occur despite all precautionary measures, particularly one involving contact with corrosive acid, penetration of fuel under the skin, scalding by hot oil, antifreeze splashing into the eyes etc. **you must seek medical assistance immediately.**

1. Instructions for avoiding accidents likely to cause injury

Only authorized and qualified personnel are permitted to carry out inspection, adjustment and repair work

- Secure and chock vehicles to prevent the vehicle rolling

- Firmly secure units and assemblies on disassembly
- Only authorized personnel are permitted to start and operate the engine
- Do not stand too close to rotating parts while the engine is running
  Wear close-fitting working clothes

- Do not touch a hot engine with bare hands:
  Risk of burns

- Keep area surrounding engine, ladders and stairways free of oil and grease.
  Accidents caused by slipping can have serious consequences
- Only work with tools which are in good condition. Damaged or worn spanners and wrenches can slip off: Risk of injury
- Persons must not stand under an engine suspended on a crane hook. Keep lifting gear in perfect condition

- Only open coolant circuit once the engine has cooled down. Follow the instructions given under “Care and Maintenance” in the Operating Manual exactly if it is not possible to avoid opening the coolant circuit with the engine at operating temperature

- Do not tighten or loosen pipes and hoses that are under pressure (lubricant circuit, coolant circuit and any downstream hydraulic oil circuits): Risk of injury caused by liquids escaping under pressure

- Do not place hands under the fuel jet when checking injection nozzles.
  Do not inhale fuel mist
- Always disconnect battery when working on the electrical system

- Do not use rapid charger to start the engine. Rapid charging of batteries is only permitted with the positive and negative leads disconnected!
- Disconnect batteries only with the ignition turned off
- Observe manufacturer's instructions for handling batteries.
  Caution:
  Battery acid is toxic and corrosive. Battery gasses are explosive

- Only use suitable measuring instruments to **measure voltages**! The minimum input resistance of a measuring instrument should be 10 MΩ
- Only disconnect or connect wiring harness connectors on electronic control units with the **ignition turned off!**

Disconnect batteries and connect the positive lead to the negative lead such that they are electrically conductive before carrying out any electric welding work. Earth the welding set as close to the weld as possible. Do not place cables of welding set parallel to electrical lines in the vehicle.

Refer to the "Welders Code of Practice" for further accident prevention measures.

- **When carrying out repaint jobs**, electronic components may be subject to high temperatures (max. 95°C) for only very short periods; a period of up to approx. 2 hours is permissible at a max. temperature of 85°C, disconnect batteries

Limitation of liability for parts and accessories

In your own interest, we strongly recommend you use only accessories and original MAN parts expressly approved by MAN for your MAN engine. The reliability, safety and suitability of these parts and accessories have been tested specially for MAN engines. Despite us keeping a constant eye on the market, we cannot assess and be held responsible for these properties in other products, even if they bear TÜV (German testing and inspection institute) approval or any other official approval in any particular case.

Laying up or storage

Special measures must be implemented in accordance with MAN Company Standard M 3069 Part 3 if engines are to be laid up or placed into storage for more than 3 months.

Electronic Diesel Control EDC

General

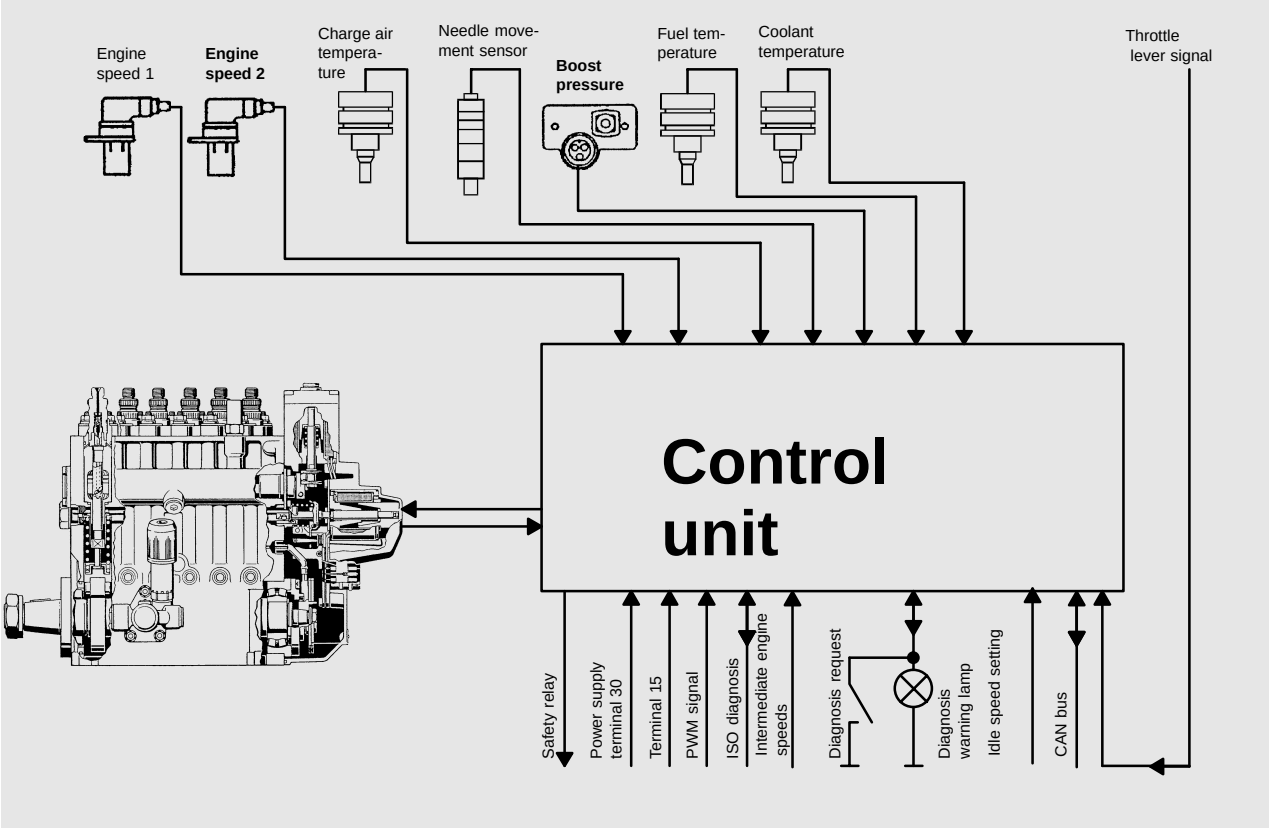
The requirements set by customers and legislation in respect of fuel consumption, exhaust emission and noise characteristics etc. on Diesel engines have grown over the years and will be even more stringent in the future.

The fact that conventional mechanical injection systems have reached their performance limits has made electronically controlled fuel injection systems necessary.

Such systems increase engine efficiency, improve driving comfort and lessen the burden on the environment.

EDC (**E**lectronic **D**iesel **C**ontrol) meets these requirements.

System description: EDC MS5



The engine can be triggered

– elektrically with the 2,9 – 4,5V signal or alternatively CAN bus

The controller contains

– the linear solenoid
– the control rod position transducer

The linear solenoid is actuated by the electronic control unit.
The control unit processes information which it receives via

– the control rod position transducer
– the drive position selection
– charge-air pressure sensor
– coolant temperature sensor
– charge-air temperature sensor
– the engine rpm sensors
– the needle movement sensor
– and the fuel temperature sensor (in the injection pump).

The diagnosis request pushbutton and the EDC indicator lamp are used in detecting faults and signalling them through a code.

An ISO interface provides a communication with the MAN-cats test and diagnostic computer.

The control unit, with its program adapted to the engine model concerned, determines the optimum setting of the control rod from all the measured values.

To ensure the vehicle can reach the nearest workshop in the event of one or several sensors failing, an emergency operation function is integrated in the control unit which, depending on the situation, enables the vessel to continue on its way, albeit with restricted functions.

When the brakes are applied, the system operates as an intermediate engine speed controller with a proportional degree of 0, i.e. a set intermediate engine speed is maintained exactly provided the engine develops sufficient power output for this purpose.

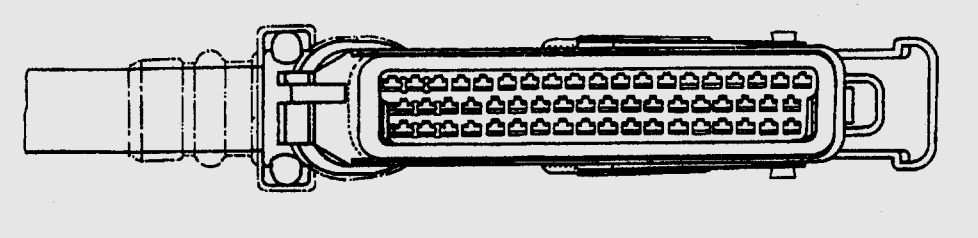
The idle speed control operates in the same way as the intermediate engine speed control. The idle speed is exactly maintained by means of the idle speed governor as long as the engine output is sufficient for this. The regulated idle speed can be varied within certain limits.

Starting-fuel delivery is output when either a lower start recognition speed is exceeded. The starting fuel volume and cold idle speed are limited as a function of the coolant temperature to avoid impermissible smoke emission and unnecessary revving of the engine after starting.

Control unit plug connector

Pinouts

19 1
37 20
55 38

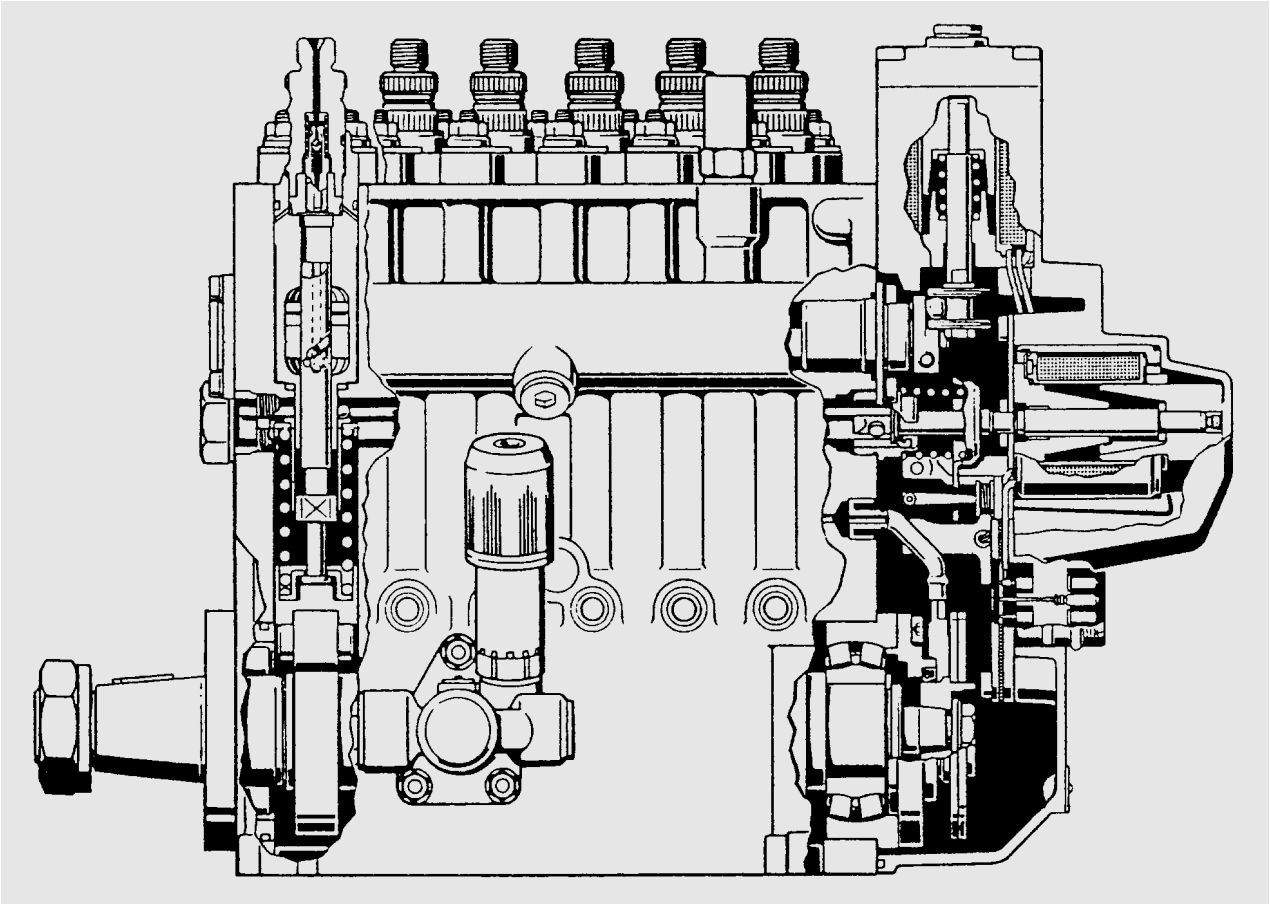


Pin assignments of control unit plug connector

EDC Pin	**Connection to component** (**O**=Output**, I**=Input)
1	Injection pump controller pin 8 **O** Jumper to pin 2 (activation of fuel volume regulator) **O**
2	Jumper to pin 1 (activation of fuel-delivery regulator) **O**
3	Control-slide mechanism
4	Control-slide mechanism
5	Not used
6	Not used
7	Not used
8	Not used
9	Injection pump controller pin 5 (control rod position sensor, instrument coil)
10	Injection pump controller pin 1 (control rod position sensor, reference coil)
11	Injection pump controller pin 6 (control rod position sensor, centre pick–off)
12	Not used
13	Negative from control unit for (Sensor ground) – rpm sensor – charge-air pressure sensor – drive stage selection – charge-air temperature sensor – coolant temperature sensor – resistor bank – fuel temperature sensor
14	Safety-relay **O**
15	Control unit power supply battery + (via main relay and fuse) **I**
16	Control unit power supply battery + (via main relay and fuse) **I**
17	Earth for auxiliary rpm sensor and needle movement sensor
18	Power supply battery –
19	Power supply battery –
20	EDC indicator lamp and diagnostic lamp **O**
21	RPM sensor (twisted with cable pin 13) **I**
22	Auxiliary rpm sensor (twisted with cable pin 17) **I**
23	Intermediate engine speed control ZDR 1 **I**
24	Not used

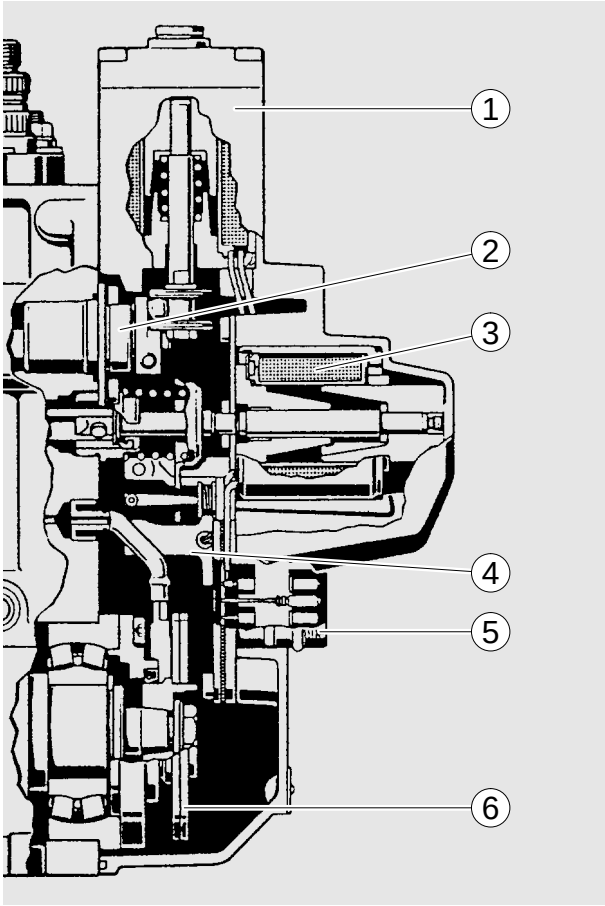
EDC Pin	**Connection to component** (**O**=Output**, I**=Input)
25	Not used
26	Not used
27	Drive stage selection (signal) **I**
28	Engine speed signal output from control unit (square–wave pulses) **O**
29	Multiplex signal **O**
30	CAN-L
31	CAN-H
32	Needle movement sensor (signal)
33	Turbo pressure sensor (supply) **O**
34	Fuel temperature sensor **I**
35	Resistor bank
36	Turbo pressure sensor (signal) **I**
37	Not used
38	Not used
39	Empty fuel switch signal
40	External engine cut-out
41	Intermediate engine speed control ZDR 2 **I**
42	Not used
43	Not used
44	Resistance group **I**
45	Drive stage selection (supply)
46	Relay power supply batt.+ (main relay) **O**
47	Relay power supply n/o contact **I**
48	Diagnostic connection (K-link)
49	Diagnostic connection (L-link)
50	Not used
51	Resistor bank 3 kΩ
52	Assigned to batt.+ (to enable multiplex signal) **I**
53	Coolant temperature sensor **I**
54	Resistance group
55	Turbo air temperature sensor **I**

MS 5 injection pump



The MS 5 injection pump, also known as a “control-slide pump” has a mechanism which regulates the start of injection by performing a “lifting / sliding” movement. The pump comprises a heavy-duty conventional injection module, as used on the familiar P-pumps, a flange-mounted electromagnetic fuel volume regulator, in place of the mechanical regulator, and an electromagnetic regulator for the start of injection (pilot stroke / start of delivery regulator).
The difference between this system and the familiar P-pump is primarily in the plunger.

MS 5 Electromagnetic fuel volume regulator

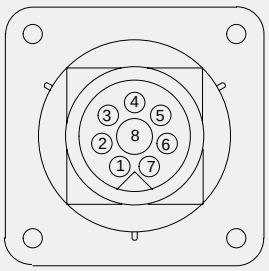


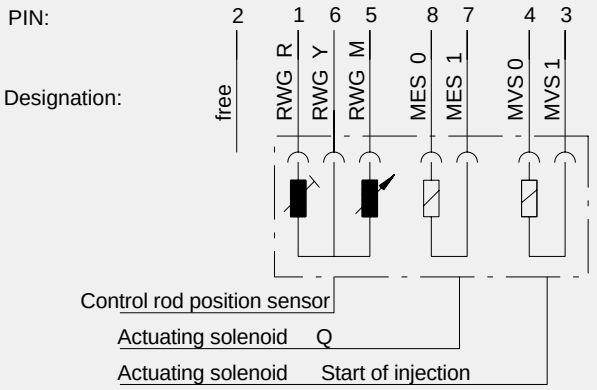
1 Actuating solenoid for start of delivery
2 Control-slider adjusting shaft
3 Control position actuating solenoid
4 Control rod position sensor
5 Electrical connection
6 Plate for blocking start of delivery and part of the oil pressure delivery pump

The fuel volume regulator works in the same way as the familiar EDC-RE regulators which use the P-pump (MS 5). The most important component of the fuel-delivery regulator is a linear solenoid whose armature acts directly on the control rod thus determining the injection volume by means of the control position. When no current is supplied, the control rod is held in the stop position by means of a spring.

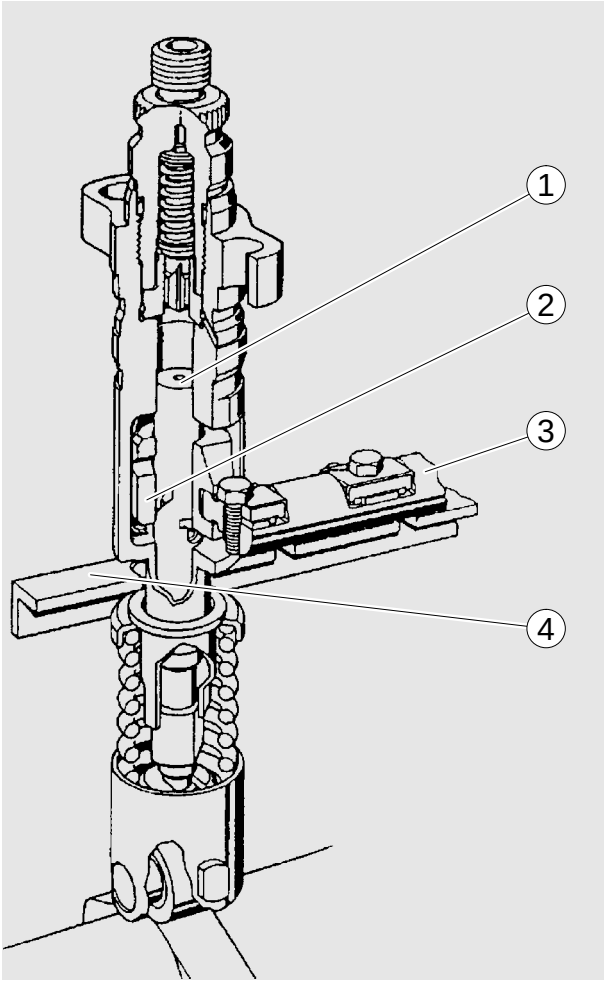
The pilot feed / start of delivery regulator also contains a linear solenoid, whose armature, by means of an adjusting lever, causes the control-slider adjusting shaft to rotate. When no current is supplied, the adjusting shaft is also held in position by a spring, so that the control-slider is in its uppermost position, in the “late” start of delivery position.

The regulator also has a control rod position sensor and an oil pump (viscous pump).





Control-slider adjusting mechanism



1 Pump plunger
2 Control-slider
3 Control-slider adjusting shaft
4 Control rod

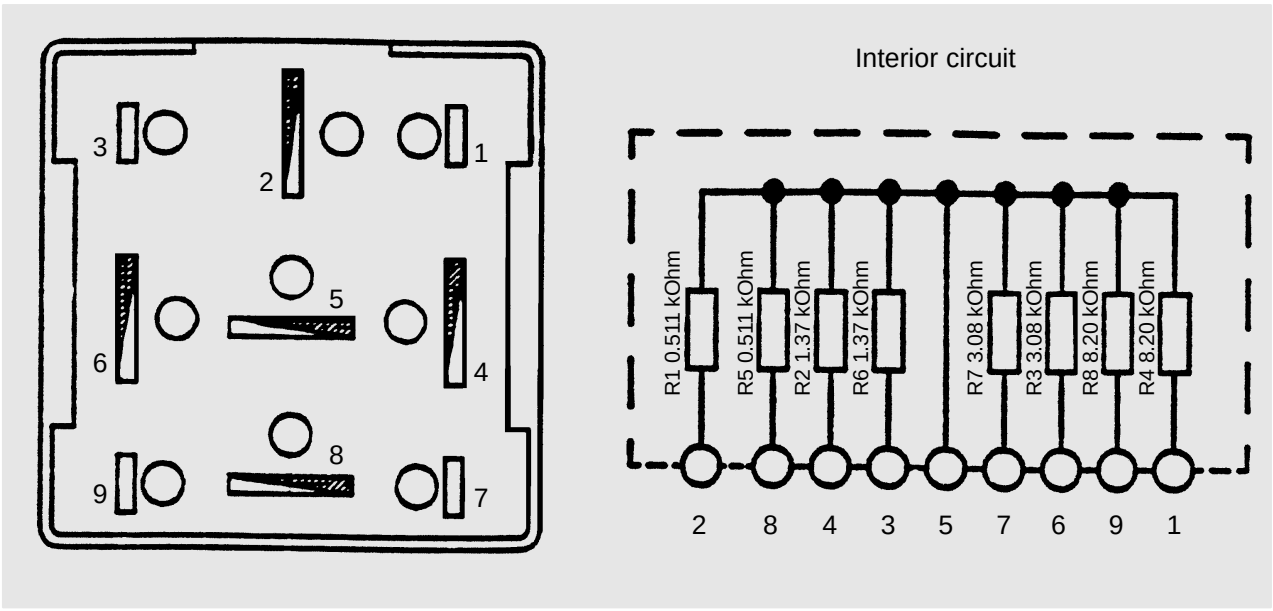
The difference between this system and the P-pump is primarily in the pumping element. The element cylinder contains a window and a control-slider which slides on the element plunger. The control-slider contains the control bore for the start and end of delivery. Because the control-slider can be height-adjusted, the start and end of delivery can be changed.
The pump housing contains a rotating adjusting shaft with drivers which engage in a groove on the control-slider. When the shaft is rotated, the height of all the control-sliders is adjusted evenly, thereby changing the pilot stroke and the start of delivery.

Resistor bank

On commercial vehicles, certain items of data are fed to the EDC which are not required for railway operation.

An example of such data is a signal from the tachograph (speedometer, tachograph) which is used for controlling or limiting the driving speed (see Page 36).

Some unused EDC connections must be closed by resistors since the EDC constantly conducts a signal-range check, as described on Page 20.



Redundant cut-out device Safety relay

The relay (redundant cut-out device) is a safety-critical component.

If certain faults occur in the EDC system the relay interrupts the voltage supply for the control-rod travel operating magnet.

The control rod is pulled back to the stop position by a return spring.

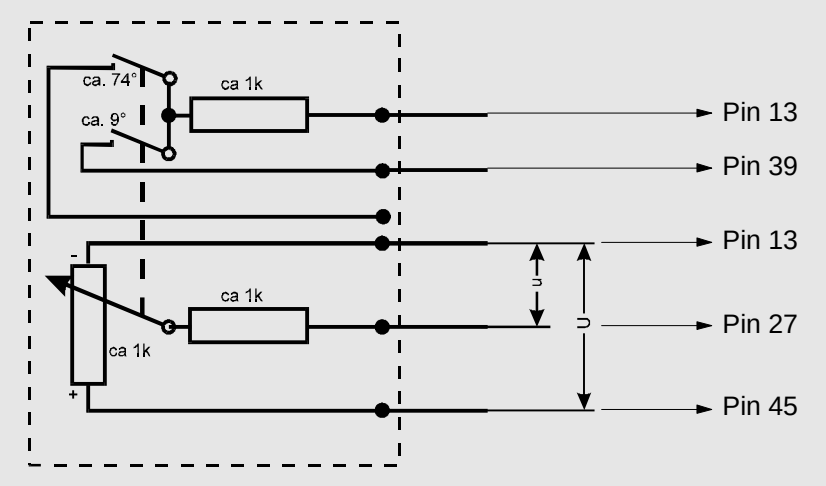
The safety relay is under current throughout operation. To activate it (e.g. emergency switch-off of the engine) the EDC control unit interrupts the current circuit.

Drive stage selection

Function

The drive stage selection device transfers driver's requests in the form of voltages to the control unit. The control unit then derives the corresponding engine speed or volumetric charge from these voltages.

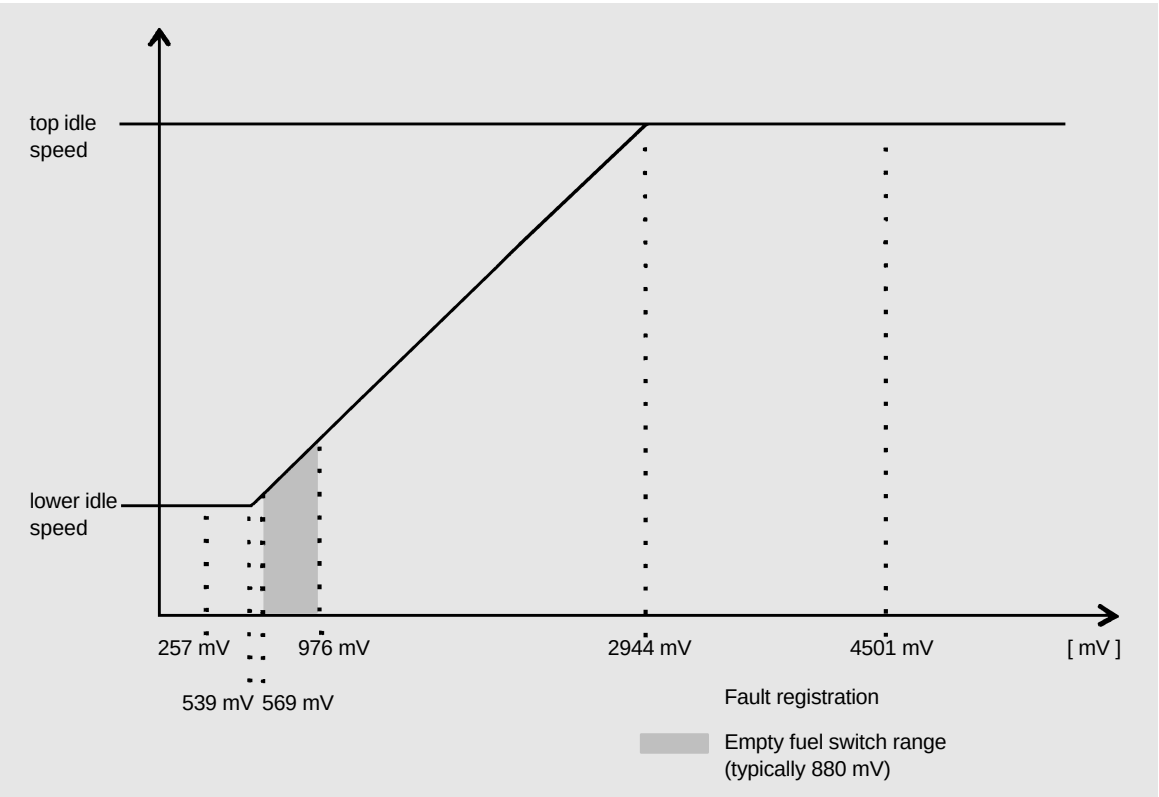
Block diagram



U = Reference voltage, approx. 5 V from the EDC control unit
u = Setpoint

Pedal travel sensor simulation values

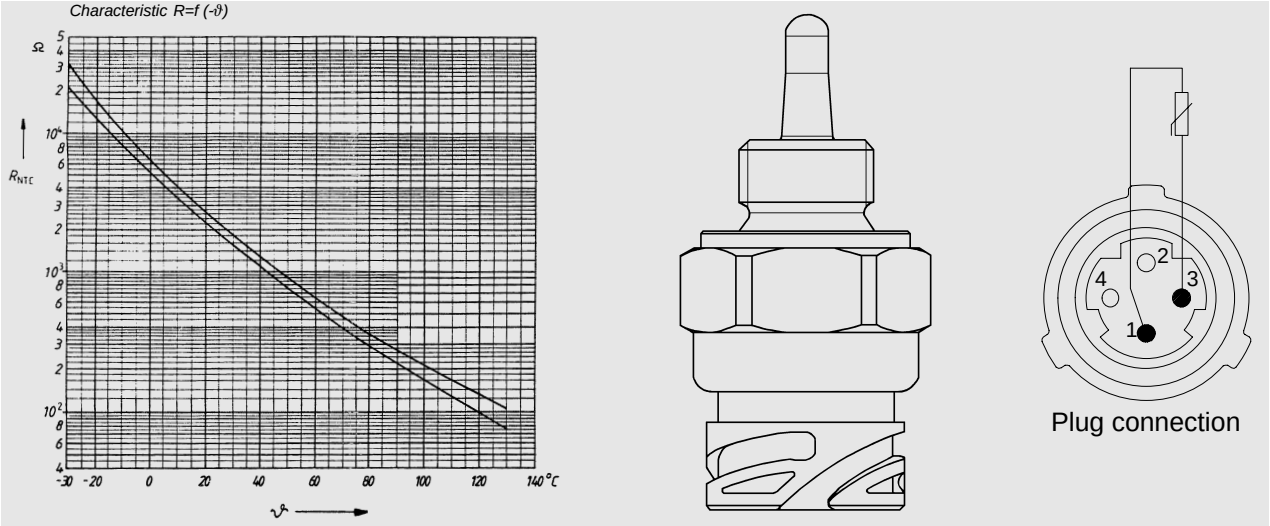
Upper idle speed: 257–539 V 2944–4501 mV
Empty fuel switch: switch-on point at 569–976 mV (typically 800 mV)



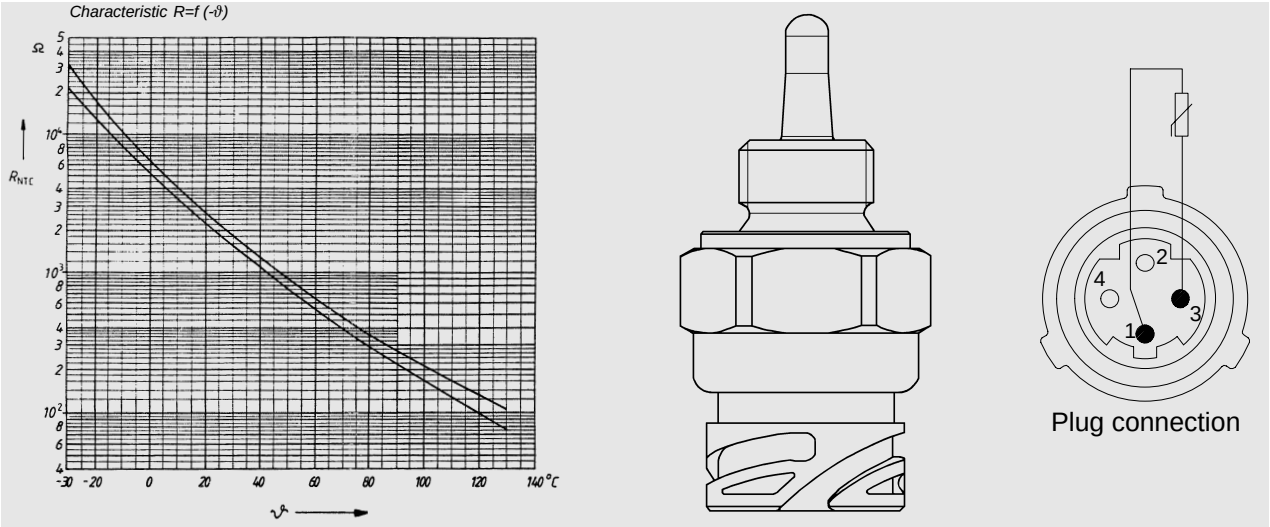
Exceptionally, the voltage "u" is produced electronically as drive position selection, or the setpoint selection (drive position selection) takes place via the CAN bus.

Charge-air, coolant and fuel temperature sensors

Charge-air B197 (51.27421–0165)



Coolant / Fuel B124 (51.27421–0172)

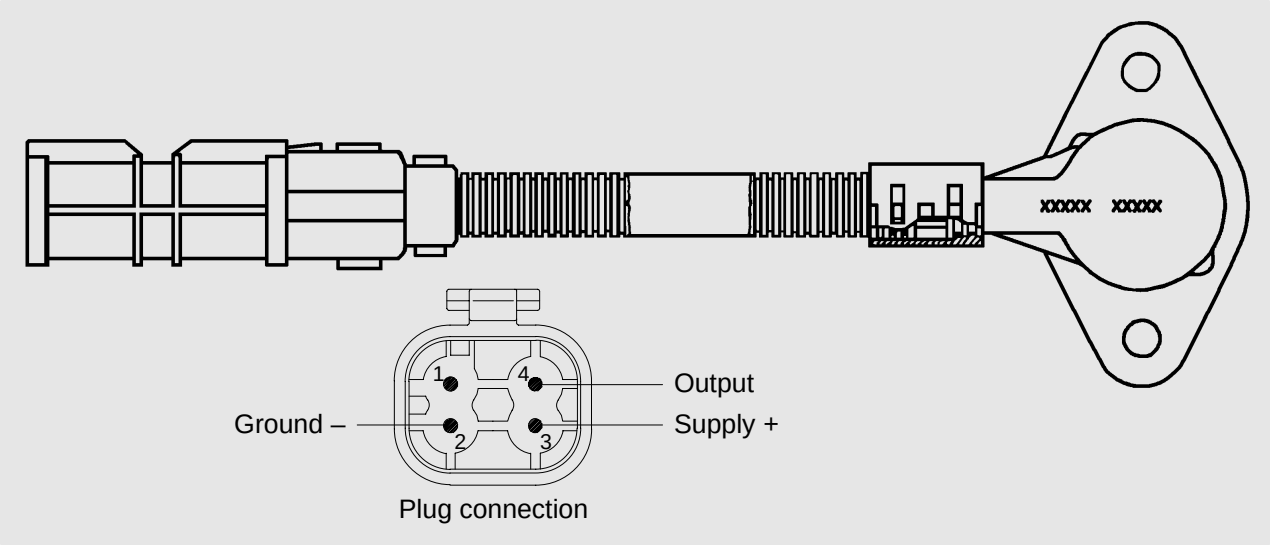


Function

The temperature sensors for charge air, coolant and fuel are NTC resistors.
The coolant temperature sensor is located in the coolant circuit and the turbo air temperature sensor in the turbo air circuit after the intercooler. They supply the control unit with information relating to the coolant and turbo air temperature.

The fuel temperature sensor is part of the injection pump and measures the fuel temperature for determination of the fuel density.
Depending on the fuel density the control unit determines the injection quantity and thus also the duration of injection.

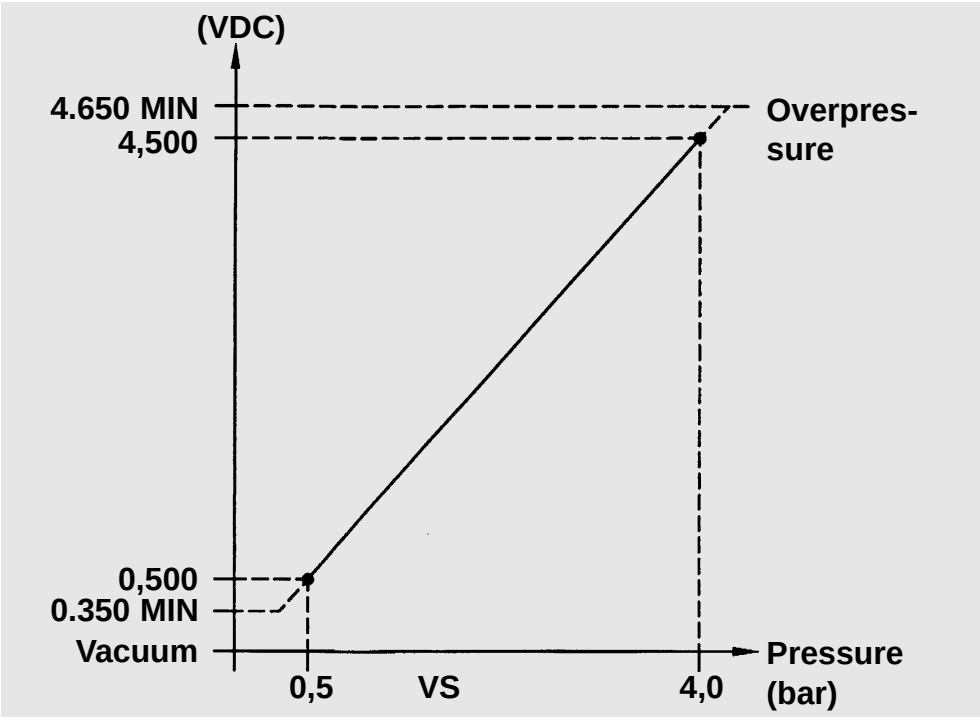
Charge-air pressure sensor (51.27421–0181)



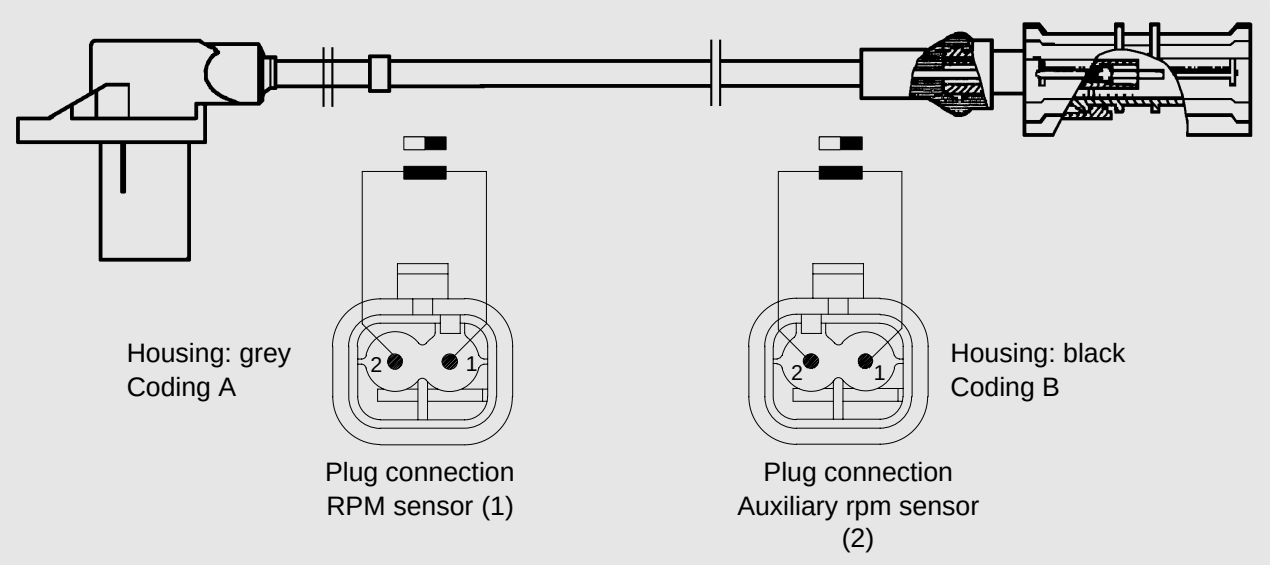
Function

The pressure sensor element consists of an Si-diaphragm which contains several piezo-resistive (pressure-sensitive) semiconductor resistors. The pressure to be measured “deflects” the sprung diaphragms. As a result, extended or compressed zones are created on the surface of the diaphragms. The action of these forces changes the electrical ratings of semiconductor resistor arrays arranged in these zones. These values are a measure for the pressure to be measured.

Curve



RPM sensor



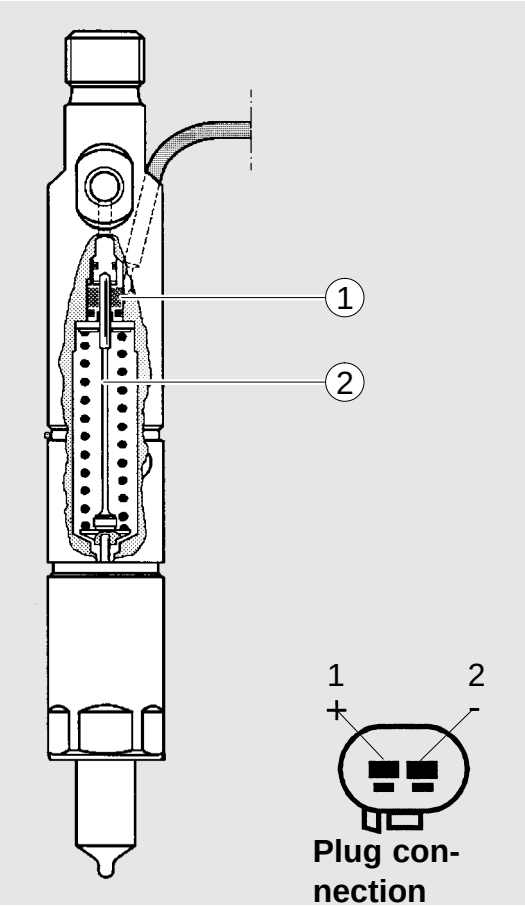
Function

The rpm sensor consists of a permanent magnet and a coil with a high number of windings. The magnet “touches” the rotaring component to be measured, normally a crown gear or grooved ring gear; with its magnetic field.
With the EDC MS5 system, there are 6 grooves on the flywheel.
When a groove passes the sensor, the magnetic current is reduced. This generates an induction voltage in the sensor coil which is measured by the electronic control. The distance between the sensor and the grooved ring gear is approx. 1 mm.

Two rpm sensors are required to ensure reliable operation of the EDC system.
Both rpm sensors are installed in the flywheel housing.
A distinction is made between the rpm sensor and the auxiliary rpm sensor.
The rpm sensor is installed in the flywheel housing such that an rpm pulse is triggered 105 after TDC.
The auxiliary rpm sensor is installed in the flywheel housing in such a way that an auxiliary speed pulse is triggered 185 after TDC. The signals of the auxiliary rpm sensor are used only for redundant engine speed sensing.

Caution:
Do not confuse installation locations of the rpm sensor (1) and the auxiliary rpm sensor (2), nor the “+” and “–” wires of the sensors.

Injector and needle movement sensor



1 Coil
2 Pressure pin

The needle movement sensor records the start of injection using a sensor which is incorporated directly into the injector holder. This sensor, through its detection of the needle movement, is used to calculate the fuel injection timing.

Start procedure

The gear stage must be selected (idle speed request setpoint specification) to start the engine.

Changing idle speed

Idle speed setting is possible using EOL programming (MAN Cats), but this should only be performed by MAN customer service personnel.

Intermediate engine speed control

Different intermediate engine speeds can be programmed by means of MAN-Cats:

- ZDR 1, ZDR 2 and ZDR 3
  These intermediate engine speeds are set by corresponding pin connection.

The intermediate engine speeds can be changed using EOL programming (MAN-Cats), but this should only be performed by MAN customer service personnel.

General

The EDC system continuously checks itself. It does this by running a signal-range check. During this check, all signals are scanned for presence and plausibility within a certain time frame (determined by the software).
The control unit itself is also constantly checked the whole time the program is running. The first check is always carried out when the ignition is turned on.
Any faults occurring during operation are stored for the purpose of subsequent diagnosis.
A maximum of 5 faults can be stored simultaneously in the fault memory. The faults are stored in the order in which they occurred. If more than 5 faults occur, the least significant fault is deleted.

Fault storage includes

- allocation of fault priority,
- identification of the type of fault,
- recording of fault frequency.

Sporadic faults are recorded by a frequency counter the first time they occur. This means that a certain frequency number is set which is decremented by one during every start procedure. If the fault no longer occurs, it is deleted when the counter reaches zero.

To report the fault, the diagnostic lamp either comes on permanently or remains off, depending on the significance of the fault. If several faults are stored, the **steady light** has priority over **OFF**.
Only faults currently present are indicated. Faults which are stored but which are not currently present are not indicated.

There are two fault memories:

- Fault memory for diagnosis via ISO interface. This memory can be read out and cleared with MAN-Cats
- Fault memory for diagnosis via flash code. The flash code memory can be read out and cleared with the aid of the diagnosis button.

Faults are always entered in both fault memories simultaneously and can be read out even after the ignition has been switched off and back on again.

Indicator lamp check:
The EDC indicator lamp lights as a lamp test for approximately 2 seconds after the ignition is switched on.

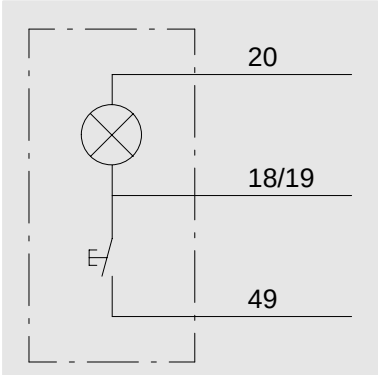
The following measures are implemented automatically depending on the significance of the fault:

- Changeover to suitable substitute function to enable continued yet restricted operation
- Reduction of engine speed to idle speed (drive stage 0)
- Immediate shut-down of the engine if required for safety reasons. Depending on the type of fault, engine shut-down is done by reducing the fuel delivery volume to zero or by way of an emergency shut-down with safety relay.

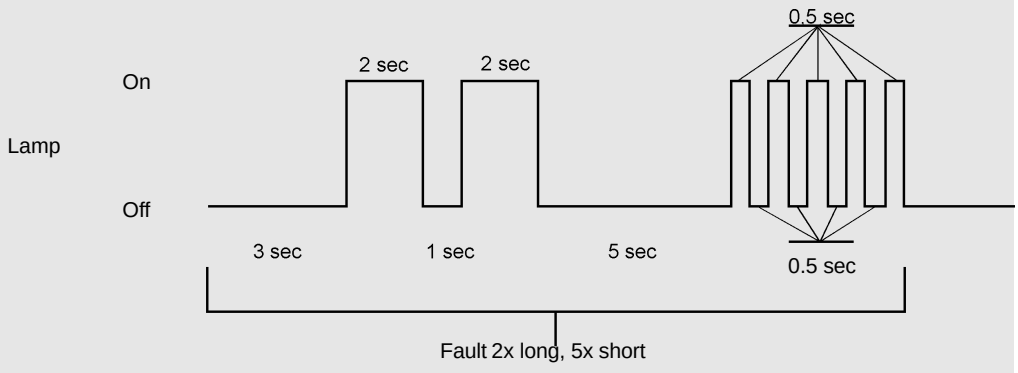
Flash code

To read out the fault memory

- With the engine stationary or running and the “ignition“ switched on, press and hold the diagnosis request button for at least 2 seconds. The diagnosis lamp will not come on
- The flash procedure starts after a pause of approximately 3 seconds. The flash code is divided into long and short pulses
- The diagnostic system always outputs only one fault at a time. In order to check whether several faults are stored, the fault scanning procedure must be repeated until the fault that was shown first reappears



Example of a flash code output



OFF phase before output:	3 seconds
ON duration of a long pulse:	2 seconds
OFF phase between two long pulses:	1 second
OFF phase between long and short pulses:	5 seconds
ON duration of a short pulse:	0,5 seconds
OFF phase between two short pulses:	0,5 seconds

To clear fault memory

1. Press request button
2. Switch on ignition
3. Press and hold request button for a further 3 seconds but not longer than 10 seconds

Fault code output MAN MS5 EDC

Overview of flash codes					
Number of flashes		Fault code	Fault path	Steady light fault	Maintai-ned light Reset a) / b)
Long	Short				
0	0		No fault stored		
	1	81h	Pedal value transmitter / Drive stage selection	Yes	b)
	3	83h	Boost air temperature sensing	Yes	b)
	4	84h	Engine speed sensing (primär)	Yes	b)
	5	85h	Boost pressure sensor	Yes	b)
	6	86h	Control rod position sensing	Yes	a)
	7	87h	Coolant temperature sensing	Yes	b)
	8	88h	Speed sensing / Resistor bank	Yes	b)
	10	8AH	Fuel volume regulator monitoring	Yes	a)
	14	8EH	Auxiliary rpm sensor	Yes	b)
1	1	11h	Fuel temperature sensing	No	–
1	3	13h	Undervoltage	No	–
1	6	96h	Control unit (computer coupling)	Yes	a)
1	7	17h	Overrevving	Yes	b)
1	8	18h	Start of injection control deviation	Yes	b)
1	10	1AH	Needle movement sensor	No	–
1	12	1CH	Resistor bank control unit pin 35	No	–
1	13	1DH	Control box	Yes	b)
1	15	1FH	Control unit (CAN-System)	No	–
2	5	25h	If only this fault code is stored in the memory, testing is not possible as the sensor is located in the control unit.	Yes	b)
2	7	A7H	Resistance bank, control unit pin 54	Yes	b)
2	8	A8H	Atmospheric pressure sensing	Yes	b)
2	13	2DH	FM message	Yes	b)
3	1	31h	Safety relay	No	–
3	2	32h	EEPROM processor 1 error	No	–
3	3	33h	EEPROM processor 2 error	No	–
3	4	34h	Stop-extern-input	No	–
3	6	36h	Intercooler	Yes	b)
3	7	37H *	Output stage error	No	–
3	8	38h	Afterrunning not completed	No	–
3	9	39H	Afterrunning watchdog error	No	–
3	10	3AH	Control rod position sensor – loose contact	No	–
3	11	3BH *	AGR-Fault (control deviation)	Yes	b)

* MS5 stage 5

a) Reset by “Ignition” Off / On (cold restart)

b) Reset takes place automatically once the fault is rectified

List of checking procedures EDC MS 5

1. Checks while engine is stationary (Ignition off, control unit not connected)

– Engine temperature ≈25°C
– Control unit **not (!!!)** connected, cable harness adapter connected
– Measure resistance between PIN+ and PIN– with multimeter

	PIN+	PIN–	Setpoint	Measured value
Control rod position sensor[1)]	11	9	18–25 Ohms	. . . . . Ohms
	11	10	18–25 Ohms	. . . . . Ohms
	18	9	>10 MOhms	. . . . . MOhms
	18	10	>10 MOhms	. . . . . MOhms
RPM sensor (DZG)	21	13	0.8–1.0 kOhm	. . . . . kOhms
Auxiliary rpm sensor (HZG)	22	17	0.8–1.0 kOhm	. . . . . kOhms
Fuel-delivery regulator	15	1	0.7–1.3 Ohms	. . . . . Ohms
	18	1	>10 MOhms	. . . . . MOhms
	16	2	0.7–1.3 Ohms	. . . . . Ohms
Control-slide mechanism [3)]	15	3	1.2–2.0 Ohms	. . . . . Ohms
	18	3	>10 MOhms	. . . . . MOhms
	16	4	1.2–2.0 Ohms	. . . . . Ohms
Ground	13	18	>10 MOhms	. . . . . MOhms
	17	19	>10 MOhms	. . . . . MOhms
Needle movement sensor [3)]	32	17	90–130 Ohms	. . . . . Ohms
Safety relay	14	19	240–300 Ohms	. . . . . Ohms
The following checks may be carried out in addition to the voltage measurements (see below).				
The following checks may be carried out in addition to the voltage measurements (see below).	53	13	1.3–3.6 kOhms [2)]	. . . . . kOhms
Fuel temperature sensor	34	13	1.3–3.6 kOhms	. . . . . kOhms
Charge-air temperature sensor	55	13	1.3–3.6 kOhms	. . . . . kOhms
Boost pressure sensor	33, 36	13	Resistance measurement not appropriate	
Multistage switch	35	13	500–520 Ohms	. . . . . Ohms
Reduction inaktiv	51	13	2.8–3.2 kOhms	. . . . . kOhms

1) Exact measurements are possible only at defined temperatures.
2) Resistance approximately 230–460 W with engine at operating temperature (approximately 80°C)
3) only D2866LUHxx and D2876

2. Test for engine when running and vehicle stationary (gearbox neutral)

– Engine temperature > 30°C
– EDC control unit connected
– Corrective measures

	Setpoint	Measured value	Remark	MAN-Cats
RPM sensor (DZG)	n=lower idle	n=.....rpm	Min (low. idle speed)	Engine speed
	n=upper idle	n=.....rpm	Max (top idle speed)	(Monitoring 2)
Auxiliary rpm sensor (HZG)	n=lower idle	n=.....rpm	Min (low. idle speed)	Engine speed
	n=upper idle	n=.....rpm	Max (top idle speed)	(Monitoring 2)

– Measure voltage between PIN+ and PIN– with multimeter

	PIN +	PIN –	Set-point value [V]	Measured value [V]	Remark	Engine speed	MAN-Cats (Monitoring)
Control unit supply (U–Batt)	15 47	18 19	U-Batt U-Batt	. . . .		Idle speed	
Reference voltage	45 33	13 13	4,75–5,25 4,75–5,25	. . . .		Idle speed	
Idle speed switch (LGS, NO contact) [4]	39	13	4,75–5,25 0–2,00	. . . .	Throttle lever min. Throttle lever max.	Idle speed upper idle	Open Closed
Charge-air temperature sensor (LTF)	55	13	4,17–2,62	. . . . . .	10–50°C	Idle speed	10–50°C
Water temperature sensor (WTF)	53	13	3,46–1,22	. . . . . .	30–90°C	Idle speed	30–90°C
Fuel temperature sensor (WTF)	34	13	4,17–2,62	. . . . . .	10–50°C	Idle speed	10–50°C
Boost pressure sensor (LDF)	36	13	0,94–1,20 1,10–1,70	. . . .	Throttle lever min. Throttle lever max.	Idle speed upper idle	0–100 mbar 300–600 mbar

– **Check main relay**

	PIN+	PIN–	Set-point value [V]	Measured value [V]	Remark
Main relay	47	18	U-Batt	. . . . .	Ignition on
			0 V	. . . . .	Ignition off
	46	18	0 V	. . . . .	Ignition on
			U-Batt	. . . . .	Ignition off

* Pin 46 must switch to U–Batt within 0.5 to 5 seconds after ignition has been switched off.

3. ZDR-Intermediate engine speed control test

– Wiring harness adapter connected
– EDC control unit connected
– Short–circuit Pin 15 and Pin 23 / Pin 41

Pin 23 [V]	Pin 41 [V]	Speed	ZDR-Pos.	Measured value [1/min]
24	0	ZDR- 1	1	. . . . .
0	24	ZDR- 2	2	. . . . .
24	24	ZDR- 3	3	. . . . .

4. Flash code diagnosis check

EDC control unit connected
Corrective measures
Engine running:

Check procedure
– Short–circuit rpm sensor; connect pin 21 to pin 13 to do this
– Diagnosis lamp lights up
– Engine speed is measured by auxiliary rpm sensor
– Disconnect connection between pin 21 and pin 13
– Press diagnosis button for at least 3 seconds but no more than 10 seconds
– Check flash code (4x short = rpm sensor)
– Deleting the fault memory; do this by turning off ignition pressing diagnosis button, turning on ignition, pressing and holding button for at least 3 seconds but not longer than 10 seconds

5. Safety relay check

EDC control unit connected
Corrective measures
Engine running:

Check procedure
– Disconnect pin 14
– Engine should shut down after no more than 10 seconds

6. . Capacitance reserve check

The power capacitance of the line leading to the control rod position transducer must not exceed the specified maximum capacitance. The capacitance increases if the line is dirty or moist. This check is designed to establish how much capacitance reserve is still available.

EDC control unit connected
Corrective measures

Check procedure
– Connect capacitance decade between pin 11 and pin 13
– Connect additional capacitance until the engine no longer starts
– Record value

Setpoint:
>400 pF without wiring harness adapter
(capacitance of wiring harness adapter approx. 100 pF,
wiring harness dry at approx. 25°C)

– **Deleting the fault memory**
After the checks have been completed, the fault memory must be cleared with MAN-Cats.
No fault must be stored when the ignition” is turned on again. If this is not the case, the fault must be located and eliminated in accordance with the troubleshooting procedure.

1. EDC self-diagnosis or flash code output	2. Starter turns over engine only slowly or not at all	3. Starter turns, engine does not start, engine does not start / difficult to start when cold	4. Engine stalls (dies) during operation, no longer starts (starter turns), engine does not start / starts with difficulty when hot	5. . Sudden, temporary engine shut-down, engine does not reach full revs	6. Engine only runs at idle speed, no throttle response	7. Engine only runs at elevated idle speed, no throttle response	8. Rated engine speed distinctly reduced (even under no load)	9. Reduced output in all ranges	10. Irregular engine operation, traction loss	11. Unstable idle speed, engine hunting, misfiring, knocking in engine	12. Engine judder	13. Unusual combustion noise	14. Excessive smoke emission: White smoke / blue smoke	15. Excessive smoke emission: Black smoke	16. Engine temperature too high (coolant loss)	17. Intermediate engine speed control cannot be activated / does not switch off, engine revs too high	18. Fuel consumption too high	19. Lubricating oil pressure too low	20. Lubricating oil pressure too high	21. Lubricating oil consumption too high	22. Engine too loud / mechanical noise	**Possible causes**
x	x																				Batteries discharged, battery lead connections loose or corroded, break in power circuit
x																					Crank gear blocked
x	x																				Starter solenoid switch sticking (clicks) / defective, cable connection loose or damaged
x	x																				Starter / starter interlock relay defective (carbon brushes worked loose / worn, winding defective, short to ground)
x																	x	x	x		Engine oil viscosity unsuitable, not suitable for ambient temperature, lubricating oil quality does not correspond to specifications
						x													x		Oil level in sump too high
																	x				Oil level in sump too low, oil in sump too thin (mixed with condensate or fuel)
																	x				Engine temperature too high
																	x				Oil filter clogged
																	x	x			Oil pressure gauge faulty
																	x				Safety valve in oil circuit defective (does not close, spring fatigued or broken)
																	x			x	Bearing wear
																	x				Oil pump gears worn
																				x	Crankshaft timing gears worn, tooth flank backlash too great
								x		x								x			Engine cold
										x											Lubricating oil entering combustion chamber (piston rings worn, piston rings broken) – valve stem guide worn – overpressure in crankcase (crankcase vent clogged)
																		x			Relief valve in oil circuit faulty (does not open), oil lines / oil galleries clogged
																			x		Leaks in lubricating oil circuit, particularly at turbocharger and oil cooler
								x											x		Piston rings heavily worn, broken
								x												x	Piston pin or crankshaft bearing worn
																			x		Valve stems worn
	x							x												x	Valve clearance not correct
	x							x													Valves jam
	x	x				x		x													Compression deficient, or more than 3–4 bar pressure difference between individual cylinders
	x							x					x								Valve seats leaking
o			x										x								Increased power consumption due to faulty secondary consumers such as hydraulic pumps, fan, etc, power take-off engaged
			x			x				x			x							x	Air cleaner soiled or clogged, charge-air system leaking, air inlet / exhaust lines clogged / leaking
	x	x	x	x		x	x		x		x		x								Fuel low pressure system: Fuel tank, prefilter, water trap faulty / clogged / mould / fungal attack, fuel unsuitable / contaminated (paraffin added)
	x	x	x			x	x	x		x			x								Fuel low pressure system: Fuel lines leaking, broken, clogged

x = Probable
o = Possible

1. EDC self-diagnosis or flash code output	2. Starter turns over engine only slowly or not at all	3. Starter turns, engine does not start, engine does not start / difficult to start when cold	4. Engine stalls (dies) during operation, no longer starts (starter turns), engine does not start / starts with difficulty when hot	5. . Sudden, temporary engine shut-down, engine does not reach full revs	6. Engine only runs at idle speed, no throttle response	7. Engine only runs at elevated idle speed, no throttle response	8. Rated engine speed distinctly reduced (even under no load)	9. Reduced output in all ranges	10. Irregular engine operation, traction loss	11. Unstable idle speed, engine hunting, misfiring, knocking in engine	12. Engine judder	13. Unusual combustion noise	14. Excessive smoke emission: White smoke / blue smoke	15. Excessive smoke emission: Black smoke	16. Engine temperature too high (coolant loss)	17. Intermediate engine speed control cannot be activated / does not switch off, engine revs too high	18. Fuel consumption too high	19. Lubricating oil pressure too low	20. Lubricating oil pressure too high	21. Lubricating oil consumption too high	22. Engine too loud / mechanical noise	**Possible causes**
	x	x	x			x	x		x		x											Fuel low pressure system: Air in system (turn on ignition when bleeding system)
	x	x	x			x	x	x	x		x					x						Fuel low pressure system: Fuel pump, overflow valve, main filter
	x					x		x	x	x	o	x				x						Fuel high pressure system: Jets defective / clogged / leaking / coked
						x		x	x	x						o						Fuel high pressure system: Pressure lines – constriction, cavitation, leaking
		x				x		o	x	x	x	x				o						Fuel high pressure system: Injection pump worn/set incorrectly
						o			x	o						o						Fuel high pressure system: Injection pump constant-pressure control valve / return flow restrictor defective
	x	x	x			o	x															Safty relay defective, drive faulty
	o	o				o		x		o	x	x				x						Injection pump-engine allocation: Start of delivery incorrect (basic installation), start of delivery set incorrectly
x	x	x	x			o		x	o													Injection pump–controller: Stiff movement-fuel delivery controller (control deviation)
x	x	x	x				o															Control rod position transducer in controller: Connection lines, break, short-circuit
	o					o					o											Control rod position transducer in controller: Set incorrectly
x	x		o																			Control rod position transducer in controller: Capacitance reserve of wiring harness too low (e.g. water penetrated wiring harness)
						x		o	x	o		o										Injection pump: Delivery set incorrectly / uniform delivery, lower idle speed set too low
x	o	x	x	x									x									Delivery actuating solenoid in controller: Connection lines, break, short–circuit, or CAN–Bus
x				x		x	x	x	o													Drive stage selection defective: Connection lines, break, short-circuit
x																						EDC rpm sensor faulty, implausible with auxiliary rpm sensor, line fault
									x	o												EDC rpm sensor, polarity reversed
x																						EDC rpm sensor faulty, implausible with auxiliary rpm sensor, line fault
x	x	x	x	o			o	o					o									EDC detects incorrect engine speed (interference signal on rpm sensor line)
x	x	x	x						o													Both rpm sensors faulty, line fault
x						x						x										EDC boost pressure sensor: faulty, incorrect, implausible with atmospheric pressure sensor, line fault
						x		x			o	x										Exhaust turbocharger leaking or faulty
																					x	Turbine and compressor rotor in turbocharger dirty (out-of-balance, irregular running)
												x										Intercooler leaking, faulty
	x									x												Flame starting system defective
x	o					x	x			o		x										EDC coolant temperature sensor: faulty, line fault
x						x	x															EDC charge-air temperature sensor: faulty, line fault
o						x						x										Radiator dirty or cooling system failure (temperatures too high)
												x										Coolant level too low, air in coolant circuit
												x										V-belt for water pump drive not tensioned correctly
																					x	Incorrect V-belt tension

x = Probable
o = Possible

1. EDC self-diagnosis or flash code output																						
	2. Starter turns over engine only slowly or not at all																					
		3. Starter turns, engine does not start, engine does not start / difficult to start when cold																				
			4. Engine stalls (dies) during operation, no longer starts (starter turns), engine does not start / starts with difficulty when hot																			
				5. . Sudden, temporary engine shut-down, engine does not reach full revs																		
					6. Engine only runs at idle speed, no throttle response																	
						7. Engine only runs at elevated idle speed, no throttle response																
							8. Rated engine speed distinctly reduced (even under no load)															
								9. Reduced output in all ranges													
									10. Irregular engine operation, traction loss												
										11. Unstable idle speed, engine hunting, misfiring, knocking in engine											
											12. Engine judder										
												13. Unusual combustion noise									
													14. Excessive smoke emission: White smoke / blue smoke								
														15. Excessive smoke emission: Black smoke							
															16. Engine temperature too high (coolant loss)						
																17. Intermediate engine speed control cannot be activated / does not switch off, engine revs too high					
																	18. Fuel consumption too high				
																		19. Lubricating oil pressure too low			
																			20. Lubricating oil pressure too high		
																				21. Lubricating oil consumption too high	
																					22. Engine too loud / mechanical noise

																						Possible causes
														x								Water pump leaking, faulty / thermostat faulty, does not open
														x								Coolant lines leaking, clogged or twisted
												x										Coolant entering combustion chamber (cylinder head / gasket leaking)
								x														Resistor bank EDC control unit pin 51
x		x	x	o				o														Power supply to EDC control unit interrupted or battery voltage too low / Relay K1 faulty
		x	x	o				o														Line terminal 15 to EDC control unit (pin 47) interrupted/loose contact
														x								Line defective: Line defective: Pin 23 or 41
x		o	o	o																		EDC control unit faulty (internal fault)
		x				x	x	x		o	o		o	x								Incorrect EDC control unit (check MAN part number)
						x	x								o							Intermediate engine speed activated
		x																				EOL programming terminated / voltage interrupt
x																						Afterrunning not completed (e.g. shutdown via EMERGENCY STOP)
															x							EOL programming: Configuration incorrect
										x												Engine bearings worn
x		o				x																Injection pump pilot stroke / start of delivery regulator: stiff movement

x = Probable
o = Possible

The following troubleshooting program contains all faults which can be detected by the diagnostic system.

The order corresponds to the numerical sequence of the flash code, irrespective of the significance of the fault.
It is therefore not arranged on the basis of “fault is indicated by EDC indicator lamp” or “fault is not indicated by EDC indicator lamp”.

The entire fault code memory should always be read out and all stored fault codes noted down before starting the engine test.
This is important because lines or components need to be disconnected when troubleshooting the system and this can cause the corresponding fault codes to be set and stored.
For this reason, the fault memory should always be cleared after intermediate checks.

The “test lines” test stage must always be performed as follows:

– Break or contact resistance
  Set-point: approx. 0 Ω
– Short to negative
  Set-point value: ∞ Ω
– Short to positive
  Set-point value: ∞ Ω
– Short to adjacent lines
  Set-point value: ∞ Ω
– Loose contacts

After rectifying faults and checking, repeat test and delete fault code memory.

All checks which refer to the control unit plug connector are conducted with the aid of the socket box. The pin designations on the control unit plug connector are identical to those of the test sockets on the socket box.

Note:
The connection to the control unit must be disconnected at the socket box when resistance measurements are being carried out.

Drive stage selection

Flash code: 1x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Drive stage selection
– Signal too high
– Signal too low
– Signal implausible with idle speed switch

Effect of fault: Engine assumes lower idle speed

Possible cause: Line break, short-circuit, power supply interrupted, pedal travel sensor faulty, control unit faulty

Test precondition: Socket box connected
Ignition switched on

Test	Measurement	Corrective measures
Power supply	Measure voltage at the socket box across pin 45 (+) and pin 13 (–) **Set-point value:** 4,75–5,25 V	– Check lines – Check plug connections – If no fault found, replace control unit (disconnect the control unit only when the current is switched off)
Drive stage selection PWG Min. 0 % PWG Max. 100 %	Measure voltage at socket box across pin 27 (+) and pin 13 (–) **Set-point value:** Idle speed setting: 0,3–0,5 V Full load setting: 2,9–4,5 V	– Check lines – Check plug connections – Replace drive stage selection
Idle speed switch PWG Min. 0 % PWG Max. 100 %	Measure voltage at socket box across pin 39 (+) and pin 13 (–) **Set-point value:** Idle speed setting: 4,75–5,25 V Full load setting: 0,0–2,0 V	– Check lines – Check plug connections Switch open Switch closed

Charge-air temperature sensor

Flash code: 3x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Charge-air temperature sensor

Effect of fault: Reduced full load quantity*

Possible cause: Line break, short-circuit, charge-air temperatur sensor faulty, control 8nit faulty

Test precondition: EDC control unit connected
Socked box connected

Test	Measurement	Corrective measures
Sensor resistance	Measure resistance at the socket box across pin 55 and pin 13 **Set-point value:** 3.8–0.8 kΩ at 10–50°C	– Check lines – Check plug connections – Replace temperatur sensor – If no fault found, replace control unit
Sensor voltage	Measure voltage at socket box across pin 55 and pin 13 **Set-point value:** 4,17–2,62 V at 10–50°C	

* Function not envisaged in EDC control unit. Reduction must be carried out using the vehicle management system.

RPM sensor

Flash code: 4x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

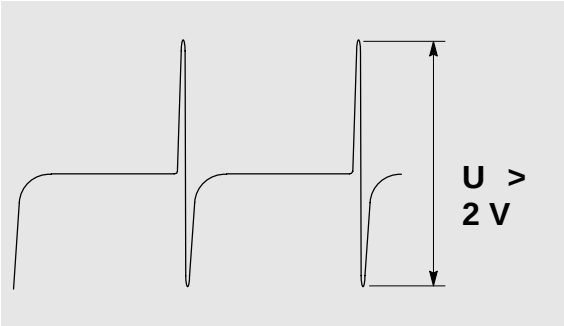
Fault path: rpm sensor
– Statically implausible
– Dynamically implausible
– Implausible with auxiliary rpm sensor

Effect of fault: If the auxiliary rpm sensor also fails, the engine will be shut down by safty relay

Possible cause: Line break, short to ground, rpm sensor faulty, control unitfaulty

Test precondition: Disconnect EDC control unit to ensure the engine can not start up
Socked box connected

Test	Measurement	Corrective measures
Resistance	Measure resistance at socket box across pin 21 and pin 13 **Set-point value:** 800–1000 Ω	– Check lines – Check plug connections – If no fault found, replace rpm sensor
Engine speed signal	Check signal at socket box at starting speed across pin 21 (+) and pin 13 (–) with oscilloscope **Set-point value:** see diagram	



Boost pressure sensor

Flash code: 5x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Boost pressure sensor
– Signal too high
– Signal too low
– Signal implausible with atmospheric pressure sensor (in control unit)

Effect of fault: 60 to 70 % reduction in power

Possible cause: Line braek, short-circuit to ground, boost pressure sensor faulty, control unit faulty

Test precondition: EDC control unit connected
Corrective measures
Ignition switched on

Test	Measurement	Corrective measures
Power supply	Measure voltage at socket box across pin 33 (+) and pin 13 (–) **Set-point value:** 4,75–5,25 V	– Check lines – Check plug connections – If no fault found, replace control unit (disconnect the control unit only when the current is switched off)
Signal voltage	Measure voltage at socket box across pin 36 (+) and pin 13 (–) **Set-point value:** Lower Idle speed: 0,94–1,20 V Upper Idle speed: 1,10–1,70 V	
	If all the values are OK, the atmospheric pressure sensor in the control unit may be faulty	– Replace control unit (only disconnect control unit once the current is switched off)

Control rod position sensor

Flash code: 6x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Control rod position sensor
– Signal too high
– Signal too low

Effect of fault: This fault results in the engine being shut down by setting the control rod travel to 0. The engine cannot be started if this fault is currently present (EDC indicator lamp permanently on).

Possible cause: Line break, short-circuit to ground, too little capacitance reserve, control rod position sensor set incorrectly, injection pump faulty

Test precondition: EDC control unit disconnected
Socked box connected

Test	Measurement	Corrective measures
Instrument coil	Measure resistance at socket box across pin 11 and pin 9 **Set-point value:** 18–25 Ω	– Check lines – Check plug connections – If no fault found, repair injection pump
Reference coil	Measure resistance at socket box across pin 11 and pin 10 **Set-point value:** 18–25 Ω	
	Measure resistance at socket box across pin 18 and pin 9 **Set-point value:** > 10 MΩ	
	Measure resistance at socket box between pin 18 and pin 10 **Set-point value:** > 10 MΩ	
	In addition to the possibility of an electrical fault, the fault described here may also be caused by incorrect setting of the control rod position sensor	– Remove injection pump – Adjust control rod position sensor

Coolant temperature sensor

Flash code: 7x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Coolant temperature sensor

Effect of fault: The substitute value provided in the control unit for such cases results in a reduction in power output (e.g. in the event of radiator contamination or failure of cooling system).

Possible cause: Line break, short-circuit, temperature sensor faulty, control unit faulty, failure or contamination of cooling system.

Test precondition: EDC control unit disconnected
Socked box connected

Test	Measurement	Corrective measures
Sensor resistance (control unit disconnected)	Measure resistance at the socket box across pin 53 and pin 13 **Set-point value:** 1.3–3.6 kΩ at 15–30°C 230–460 Ω at 75–80°C	– Check lines – Check plug connections – Replace temperatur sensor – If no fault found, replace control unit (disconnect the control unit only when the current is switched off)
Sensor voltage (control unit connected)	Measure voltage at socket box between pin 53 and pin 13 **Set-point value:** 3,46–1,22 V at 30–90°C	

Resistor bank

Driving speed

Flash code: 8x long

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Resistance for the sensors not present – speed of travel (pin 51) and torque limit (pin 35)
Resistor bank defective,
Resistance values incorrect

Effect of fault: Reduction in power output

Possible cause: Line break, short-circuit to ground, resistor bank

Test precondition: EDC control unit disconnected
Socked box connected

Test	Measurement	Corrective measures
Resistor bank	Measure resistance across **Set-point values:** Pin 13 and Pin 35 500–520 Ω Pin 13 and Pin 51 2.8–3.2 kΩ	– Check lines – Check plug connections – If no fault found, replace resistor bank

Fuel volume regulator

Flash code: 10x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Fuel volume regulator monitoring

Effect of fault: The setpoint – actual value comparison for activating the fuel volume regulator has resulted in a control deviation which has exceeded a specified time threshold. This fault results in the engine being shut down. The engine can only be restarted when the fault is no longer present and the ignition is switched off and on again once.

Possible cause: Line break, short-circuit, injection pump faulty (internal fault in regulator or stiff movement), capacitance reserve of line leading to control rod position sensor too low

Test precondition: EDC control unit disconnected
Socked box connected

Test	Measurement	Corrective measures
Actuating solenoid	Measure resistance at socket box across pin 15 and pin 1, pin 16 and pin 2 **Set-point value**: 0,7–1,3 Ω Measure resistance at the socket box across pin 18 and pin 1 **Set-point value:** > 10 MΩ	– Check lines – Check plug connections – If no fault found, replace injection pump

Auxiliary rpm sensor

Flash code: 14x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

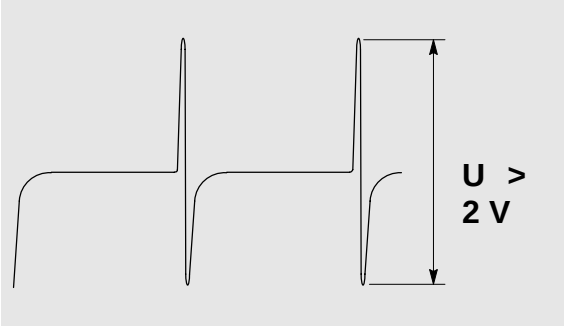
Fault path: Auxiliary rpm sensor
– Statically implausible
– Dynamically implausible
– Implausible with rpm sensor

Effect of fault: If the rpm sensor also fails, the engine will be shut down

Possible cause: Line break, short to ground, rpm sensor faulty, control unitfaulty

Test precondition: Disconnect EDC control unit to ensure the engine cannot start up
Socked box connected

Test	Measurement	Corrective measures
Resistance	Measure resistance at the socket box across pin 22 and pin 17 **Set-point value:** 800–1000 Ω	– Check lines – Check plug connections – If no fault found, replace auxiliary rpm sensor
Engine speed signal	Check signal at socked box at starting speed across pin 22 (+) and Pin 17 (–) with oscilloscope **Set-point value:** see diagram	



Fuel temperature sensor

Flash code: 1x long, 1x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Fuel temperature sensor

Effect of fault: This fault has no direct effect.
The substitute value provided in the control unit for such events may result in a slight reduction in power output.

Possible cause: Line break, short-circuit, fuel temperature sensor faulty, control unit faulty, failure or contamination of cooling system.

Test precondition: EDC control unit disconnected
Socked box connected

Test	Measurement	Corrective measures
Sensor resistance (control unit disconnected)	Measure resistance at the socket box across pin 34 and pin 13 **Set-point value:** 1.3–3.6 KΩ at 15–30°C	– Check lines – Check plug connections – Replace temperatur sensor – If no fault found, replace control unit
Sensor voltage (control unit connected)	Measure voltage at socket box between pin 34 and pin 13 **Set-point value:** 4,17–2,62 V at 10–50°C	

Undervoltage

Flash code: 1x long, 3x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Control unit power supply (battery voltage too low)

Effect of fault: The EDC system or the engine can behave in various ways depending on the magnitude of the voltage drop:
– No power
– Highly irregular engine operation
– No engine operation
– Excessive smoke emission
– Contradictory fault memory entries

Possible cause: Battery discharged or faulty, alternator faulty, line break, short-circuit, main relay faulty

Test precondition: EDC control unit disconnected
Socked box connected
Ignition switched on

Test	Measurement	Corrective measures
Power supply	To activate the main relay K1, connect jumper across pin 46 and pin 19 Measure voltage at socket box across pins 15/16 (+) and pins 18/19 (–) **Set-point value:** 24–28 V	– Check lines – Check plug connections – Replace main relay

Control unit

Flash code: 1x long, 6x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Control unit fault (processor coupling)

Effect of fault: Engine is shut down by “no power applied to fuel delivery output stage” and control position set to 0
If this fault occurs only temporarily, the engine can be restarted after switching the “ignition” off and on again

Possible cause: Injection pump defective, control unit defective, wiring harness defective

Test precondition: EDC control unit connected

Test	Measurement	Corrective measures
Control unit	This fault signal can also occur in the event of extremely low power supply (loose contacts or undervoltage) Internal fault in control unit	– Check lines – Check plug connections – Replace control unit (only disconnect control unit once the current is switched off)

Engine overspeed

Flash code: 1x long, 7x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Engine overspeed

Effect of fault: Fuel delivery is interrupted. Safty relay is deactivated.
If no other fault is present, fuel delivery will continue once the engine overspeed range has been left.

Possible cause: Stiff control rod. Injection pump defective, control unit defective, wiring harness defective, engine being towed

Test	Measurement	Corrective measures
	If no other faults are present, no further action is necessary	– Deleting the fault memory
Injection pump	If the fault occurs more frequently, check injection pump, control unit and lines.	– Replace lines – Replace control unit (only disconnect control unit once the current is switched off) – Replace injection pump

Start of injection control deviation / Pilot stroke regulator

Flash code: 1x long, 8x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Start of injection regulator control deviation

Effect of fault: Reduced full load quantity
Reduction in power output
Possible increased smoke emissions
The set-point actual value comparison of the pilot stroke regulator has resulted in a control deviation which has exceeded a specified time threshold.
The system switches from closed-loop control to open-loop control with a fixed pre-set start of injection map.

Possible cause: Line break, short-circuit, plug connections to injection pump / bulkhead / control unit: oxidised, expanded, pushed back, damagedneedle movement sensor faulty, rpm sensor faulty, fault in fuel system (leaking, clogged, air in system), air cleaner (clogged, faulty), injection pump faulty (internal fault in regulator or stiff movement)

Test precondition: Socked box connected

Note: When this fault occurs, always check the needle movement sensor and rpm sensor function paths, even if there is no corresponding fault in the fault memory.

Test	Measurement	Corrective measures
Actuating solenoid	Measure resistance at the socket box across pin 15 and pin 3 and pin 16 and pin 4 **Set-point value:** 1,2–2,0 Ω Measure resistance at the socket box across pin 18 and pin 3 **Set-point value:** > 10MΩ	– Check lines – Check plug connections – If no fault found, replace injection pump
Needle movement sensor	see needle movement sensor test	see needle movement sensor test
rpm sensor	see rpm sensor test	see rpm sensor test

Needle movement sensor (NBF)

Flash code: 1x long, 10x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Needle movement sensor
– not enough pulses
– too many pulses
– internal resistance incorrect

Effect of fault: Reduced full load quantity
Reduction in power output
The system switches from closed-loop mode to open-loop mode with a fixed, pre-set start of injection map.
If the fault is no longer present, the system will switch back to normal closed-loop control.

Possible cause: Line break, short-circuit to ground, Needle movement sensor faulty

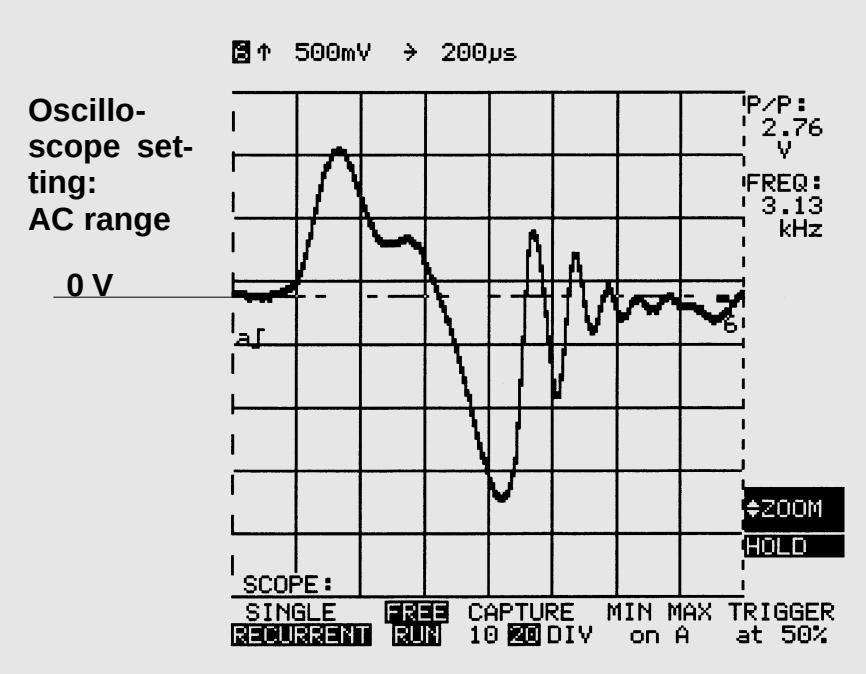
Test precondition: Socked box connected

Test	Measurement	Corrective measures
Internal resistance	Measure the resistance at the socket box across pin 32 and pin 17 **Set-point value:** 90–130 Ω	– Check lines – Check plug connections – Replace needle movement sensor

Other possible causes:

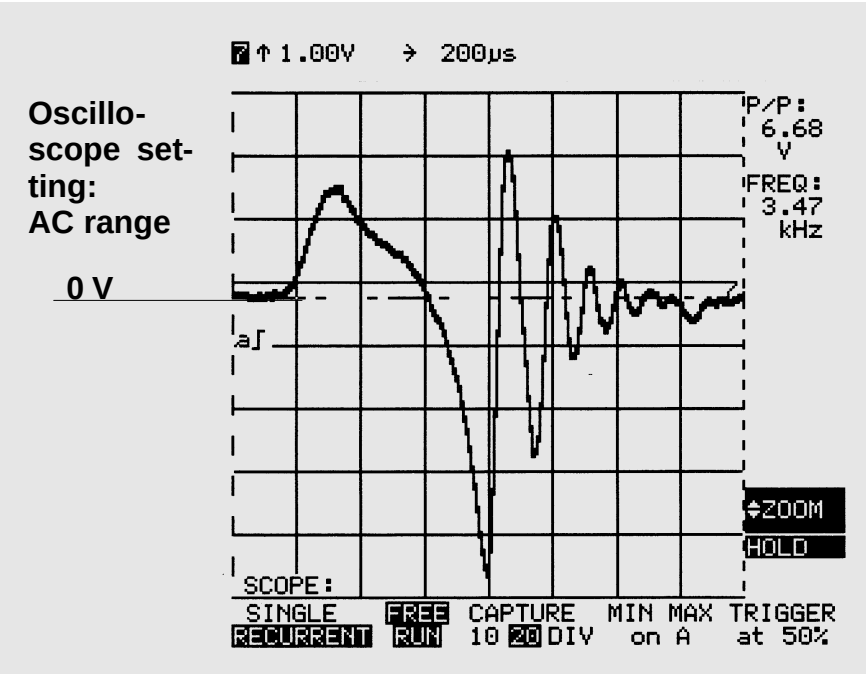
– Faulty pulses from the rpm sensor (including without fault message)
– Interference pulses between control unit and needle movement sensor (e.g. from switching relays)
– Needle movement sensor affected by structure-borne noise resulting from mechanical damage (e.g. valve gear, pistons)
– Jamming nozzle needle
– Fault in the fuel low pressure system caused by faulty or incorrect overflow valve, air or leaks in the system, faulty safty relay, faulty fuel pump, clogged filters or faulty injection pump

Voltage signal of the needle movement sensor at 600 rpm



The diagram above shows the qualitative curve of the NBF signal at an engine speed of 600 rpm.

Voltage signal of the needle movement sensor at 1200 rpm



Resistance bank (control unit Pin 35)

Flash code: 1x long, 12x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Multistage switch for engine speed reduction
– Voltage to high
– Voltage to low
– Wrong voltage

Effect of fault: None with standard circuit

Function: Voltage signals are ascertained via the multistage input (control unit pin 35), their values are determined by external resistor interrupters in the EDC control box.

Possible cause: Line break, short-circuit, resistor bank defective, control unit defective

Test precondition: EDC control unit disconnected
Socked box connected

Test	Measurement	Corrective measures
Resistor bank	Measure resistance at the socket box across pin 35 and pin 13 **Set-point value:** Torque limit inaktiv: 0,4–0,7 kΩ Torque limit aktiv: 6,2–11,6 kΩ The fault also occurs when the resistance is 0 Ω or ∞ Ω	Check lines – Check plug connections – Replace EDC control box

Resistor bank

Flash code: 1x long, 13x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Control box faulty
– Voltage values incorrect or implausible

Effect of fault: The idle position can no longer be activated.
If the fault was only temporary (e.g. operating unit activated several times) the system will be ready for operation after switching the ignition” off an on again.

Function: The operating unit is resistor-coded, i.e. the control unit recognizes each switching state according to the voltage level supplied. Faults are detected when incorrect values are output over a certain period of time; Under certain conditions this fault may not be detected.

Possible cause: Line break, short-circuit, EDC control box faulty, incorrect operation

Test precondition: EDC control unit connected
socket box connected
ignition switched on

Test	Measurement	Corrective measures
Control box	Measure voltage at socket box between pin 44 and pin 13 Switch through all settings of the operating unit and determine relevant voltage value **Set-point value:** Not actuated 3,15 – 3,55 V	– Check lines – Check plug connections – Replace the control box – If no fault found, replace control unit as a check (disconnect the control unit only when the current is switched off)

CAN system (control unit)

Flash code: 1x long, 15x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Control unit faulty

Effect of fault: The data exchange has been interrupted. Some engine data (speed, temperature of water and charge air, boost pressure and fuel consumption) no longer displayed.

Possible cause: Line break, short-circuit

Test	Measurement	Corrective measures
Control unit	No further testing necessary	– Replace control unit (only disconnect control unit once the current is switched off)

Main relay

Flash code: 2x long, 5x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Main relay
Contact sticks or jams (does not open)

Effect of fault: Under certain conditions, this fault may not be detected

Function: The negative side of the relay coil is triggered by the EDC control unit via the control unit output pin 46. The main relay switch-off is delayed after the ignition is switched off (run-on).
During the run-on phase, various processor functions are checked and any faults stored in the fault memory.

Possible cause: Short to ground, main relay faulty

Test precondition: EDC control unit connected
Socked box connected

Test	Measurement	Corrective measures
Main relay	Measure voltage at socket box between pin 47 and pin 18 **Set-point values:** 0 V at “ignition” off U-Batt at “ignition” on Measure voltage at socket box between pin 46 and pin 18 **Set-point values:** U-Batt at “ignition” off 0 V at “ignition” on	– Check lines – Check plug connections – If line OK, replace main relay

Note:
Pin 46 must switch to U-Batt within 5 seconds of the ignition being switched off (processor run-on).

Atmospheric pressure sensor (in control unit)

Flash code: 2x long, 8x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Atmospheric pressure sensor in control unit faulty

Effect of fault: The power reduction at high altitudes for the protection of the exhaust turbocharger is not activated

Possible cause: Control unit faulty

Test	Measurement	Corrective measures
Control unit	If only this fault code is stored in the memory, testing is not possible, as the sensor is located in the control unit. If, however, a faulty boost pressure sensor is also detected, this should be chekked first in accordance with the boost pressure sensor test (page 33).	– Replace control unit (only disconnect control unit once the current is switched off)

CAN system (TSC1-FM message)

Flash code: 2x long, 13x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: EDC – CAN communication is faulty

Effect of fault: Idle speed

Possible cause: Line break

Test precondition: EDC control unit and CAN computer disconnected
Socket box connected to EDC plug

Test	Measurement	Corrective measures
Resistance	Resistance measurement between pin 30 (CAN-L) on the socket box and a downstream computer **Set-point value:** 0 Ω	– Check line – Check plug connection
	Resistance measurement between pin 31 (CAN-H) on the socket box and a downstream computer **Set-point value:** 0 Ω	

Safety relay

Flash code: 3x long, 1x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Safety relay

Effect of fault: Engine is shut down
Engine will not start

Function: The safety relay performs an important safety function in its capacity as an independent, higher-ranking (redundant) engine shut-off device
The safety relay is activated in certain emergency situations when the engine can no longer be shut off by controlling fuel delivery to zero – e.g. when the control rod has jammed.
The safety relay interrupts the positive power supply (pins 15 and 16) to the quantity magnet.

Possible cause: Possible cause: Line break, short-circuit, safety relay defective, faulty activation from control unit (control unit defective)

Test precondition: Socked box connected

Test	Measurement	Corrective measures
Check Safety relay	Start engine and let it idle Pull off bridge at pin 14 on test box Engine must stop within approx. 3 seconds a) EDC pin 14 and pin 24 (relay K2) **Set-point value:** 30–70 Ω b) EDC pin 19 and pin 21 (relay K2) **Set-point value:** ≈0 Ω	– Check line – Check plug connection – Replace safety relay
Power supply	Switch on “ignition” Measure voltage at socket box across pin 14 (+) and pin 19 (–) **Set-point value:** U-Batt	– Check line – Check plug connection – Replace safety relay If no fault found: – Replace control unit
Coil resistance Safety relay	Switch off ”ignition” Disconnect control unit Measure resistance at socket box across Pin 14 and Pin 19 **Set-point value:** 240–300 Ω	– Check line – Check plug connection – Replace safety relay

Note:
When bleeding the fuel system using the presupply pump, power must be supplied to the safety relay, i.e. **the fuel system cannot be bled without the ”ignition” being switched on!**
See page 25 for function test.

Note:
When bleeding the fuel system using the presupply pump, power must be supplied to the safety relay, i.e. **the fuel system cannot be bled without the ”ignition” being switched on!**
See page 25 for function test.

Control unit, EEPROM processor 1 fault

Flash code: 3x long, 2x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Processor 1 in control unit faulty (EEPROM 1)

Possible cause: Control unit faulty, EOL programming not completed (voltage supply interrupted)

Effect of fault: Engine is shut off
Engine will not start

Test	Measurement	Corrective measures
Power supply	No further testing necessary	– Complete EOL programming, clear fault codes – Replace control unit (only disconnect control unit once the current is switched off)
Control unit		

Control unit, EEPROM processor 2 fault

Flash code: 3x long, 3x short

Fault indication: Fault is indicated by the EDC indicator lamp coming on continuously

Fault path: Processor 2 in control unit faulty (EEPROM 2)

Possible cause: Control unit faulty, EOL programming not completed (voltage supply interrupted)

Effect of fault: Engine is shut off
Engine will not start

Test	Measurement	Corrective measures
Power supply	No further testing necessary	– Complete EOL programming, clear fault codes – Replace control unit (only disconnect control unit once the current is switched off)
Control unit		

Intercooler bypass

Flash code:	3x long, 6x short
Fault indication:	Indicator lamp coming on continuously
Fault path:	Boost temperature to high (over 90° C)
Effect of fault:	None
Possible cause:	Intercooler dirty Intercooler fan faulty Charge-air temperature sensor fault(0x long, 3x short)

Output stage error

Flash code: 3x long, 7x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Cables / actuators for the relevant function

Effect of fault: The relevant output stage in the control unit is not triggered. Function not available

Possible cause: Control unit faulty (Hardware-error)

Note vehicle–specific circuit diagrams

Test	Measurement	Corrective measures
Output stage component	Depends on the component	– Check lines – Check plug connections – Check the component – Replace control unit (only disconnect control unit once the current is switched off)

Control unit (processor run–on)

Flash code: 3x long, 8x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Control unit
– Processor run-on did not take place

Effect of fault: No direct effect

Function: Every time the engine is turned off, run-on takes place automatically for the purpose of checking the various processor functions

Possible cause: Control unit faulty, main relay faulty, battery voltage switched off before “ignition” of

Test precondition: EDC control unit disconnected
Socked box connected

Test	Measurement	Corrective measures
Control unit	Test same as for undervoltage (page 40) and main relay (page 49)	– Switch ignition on and off again, clear fault code – Same as pages 40 and 49 – Replace control unit (only disconnect control unit once the current is switched off)

Other possible causes:

– Engine was shut down via battery + (e.g. by disconnecting the battery or actuating the main fuse switch)
– Power supply fault (e.g. undervoltage, main relay faulty, loose contact)

Control unit watchdog run-on fault

Flash code: 3x long, 9x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Control unit faulty (watchdog test)

Effect of fault: None

Test	Measurement	Corrective measures
Control unit	No further testing necessary	– Replace control unit (only disconnect control unit once the current is switched off)

Other possible causes:

– Engine was shut down via battery + (e.g. by disconnecting the battery or actuating the main fuse switch)
– Power supply fault (e.g. undervoltage, main relay K1 faulty, loose contact)

Control rod position sensor – loose contact

Flash code: 3x long, 10x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Control rod position sensor
– Signal too high
– Signal too low

Effect of fault: None

Possible cause: Line break, short-circuit, too little capacitance reserve (see page 25), control rod position sensor set incorrectly, injection pump faulty

Test precondition: EDC control unit disconnected
Socked box connected

Test	Measurement	Corrective measures
Instrument coil	Measure resistance at socket box across pin 11 and pin 9 **Set-point value:** 18–25 Ω	– Check lines – Check plug connections – If no fault found, repair injection pump
Reference coil	Measure resistance at socket box across pin 11 and pin 10 **Set-point value:** 18–25 Ω	
	Measure resistance at socket box across pin 18 and pin 9 **Set-point value:** > 10 MΩ	
	Measure resistance at socket box between pin 18 and pin 10 **Set-point value:** > 10 MΩ	
	In addition to the possibility of an electrical fault, the fault described here may also be caused by incorrect setting of the control rod position sensor	– Remove injection pump – Adjust control rod position sensor

EGR actuator (permanent deviation)

Flash code: 3x long, 11x short

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: EGR actuator

Effect of fault: EGR function not available

Possible cause: Cable interrupted, short–circuit, check–back switch defective, mechanical defect on actuator

Test precondition: Socket box connected

Note: In diagnosis mode the EGR actuator test can be activated via MAN-Cats. If the fault memory is read out after the actuator test it always contains the fault 3B Hex. ”EGR actuator, permanent deviation” (3x long, 11x short), even if the fault was deleted before the actuator test.
Although it is unsatisfactory for service, this behaviour is unfortunately unavoidable and is correct for the coded software.
The fault memory must therefore be deleted without fail after the EGR actuator test.

Note vehicle–specific circuit diagrams

Test	Measurement	Corrective measures
Check-back switch (reed contact)	Measure resistance at the socket box across pin 15 and pin 24 **Set-point value:** >1 Ω	– Check lines – Check plug connections – If no fault found, replace control unit
Solenoid valve triggering	Measure resistance at the socket box across pin 39 and pin 18 **Set-point value:** 39–47 Ω	– Check lines – Check plug connections – If no fault found, replace control unit

PBM interface

Flash code: None

Fault indication: Fault is not indicated by the EDC indicator lamp

Fault path: Control unit input pin 52
– Faulty
– Interrupted

Effect of fault: No PBM signal at pin 29 (steady voltage U-Batt)

Possible cause: Short to negative Line break:

Test precondition: EDC control unit connected
Socked box connected
“Ignition” switched off

Test	Measurement	Corrective measures
Lines	Measure resistance at socket box across pin 52 and pin 19 **Setpoint:** ∞ Ω	– Check line – Check plug connection
	Measure resistance at socket box across pin 29 and pin 19 **Setpoint:** ∞ Ω	

Note:
Battery voltage must be applied at pin 52 against pin 18/19 with the “ignition” switched on.

Pin No.	Abbreviation	Description
1	MES O	Activation for fuel–delivery actuator – Output, fuel-delivery control circuit – I_{max} 11 A temporarily, on average 4.5 A, against batt., pulsed f=variable, pulse-width modulated
2	MES O	Activation for fuel–delivery actuator – Output, fuel-delivery control circuit
3	VHS O	Control-slide mechanism
4	VHS O	Control-slide mechanism
5	MBR 1	Not used
6	LEB 1	Not used
7	WGS 1	Not used
8	LKS 1	Not used
9	RWG M	Control rod position transducer measuring coil (RWG 2) – Control rod position evaluator circuit
10	RWG R	Control rod position transducer reference coil (RWG O) – Control rod position evaluator circuit
11	RWG Y	Control rod position transducer centre pick–off (RWG 1) – Control rod position evaluator circuit
12	CAN O	Not used
13	GND A	Sensor ground
14	EAB 1	Electrical shut–down – Output (switch) – I_{max} 1 A, $U_{batt.}$ against batt. –,
15	Bat +	Batt.+ via main relay – Input battery + – I with engine stationary 0.9 A, idle speed 1.5 A, operation 4.5 A, temporarily 16 A
16	Bat +	Batt.+ via main relay – Input battery +
17	NBF 0, HZGO	Needle movement sensor and auxiliary rpm sensor – Reference ground
18	Bat –	Battery negative – Input battery – – I same as batt.+ (terminals 15 and 16)
19	Bat –	Battery negative – Input battery –
20	DIA-B	Diagnosis lamp – Output (switch) – I_{max} 1 A, $U_{batt.}$ against batt. –,
21	DZG 1	RPM sensor signal – Input, dynamic – Alternating voltage U_{PP} idle speed approx. 2 V, max. 80 V, f=number of cyl. XN $sec.^{-1}$
22	HZG 1	Auxiliary rpm sensor signal – Input, dynamic – Alternating voltage U_{PP} idle speed approx. 2 V, max. 80 V, f=number of cyl. XN $sec.^{-1}$
23	ZDR-E1	Intermediate engine speed control 1 – Input, static Batt.+
24	BRK-E	Not used
25	FMS-E	Not used
26	KUP-E	Not used
27	PWG 1	Pedal travel sensor signal – Input, analog – Direct voltage, U approx. 0.4 to 4 V
28	TDS-A	Engine speed signal – Output – $U_{batt.}$ against batt. –, square-wave signal, f=number of cyl. X N $sec.^{-1}$
29	MPS-A	Multiplex signal – Interfaces

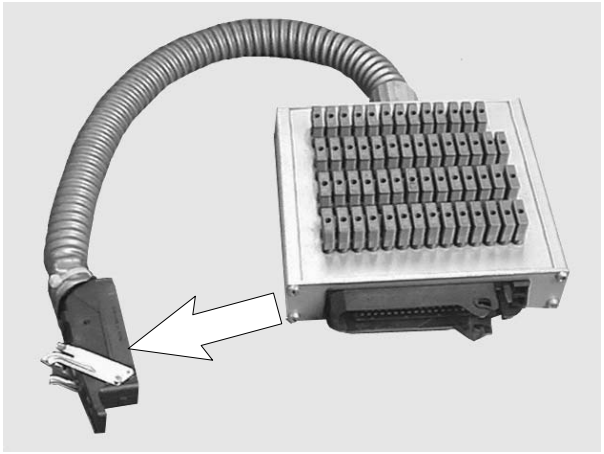
Pin No.	Abbreviation	Description
30	CAN-L	Controller Area Network – Interfaces
31	CAN–H	Controller Area Network – Interfaces
32	NBF 1	Needle movement sensor – Input, dynamic – U_{PP} approx. 2 V
33	LDF 2	– boost pressure sensor – Output, supply – Controlled direct voltage, U approx. 5 V
34	KTF 1	Fuel temperature sensor – Input, analog
35	MDB 1	Multi-stage input (torque limitation) – Input, analog – Input by change in resistance
36	LDF 1	Boost pressure sensor signal – Input, analog
37	FGB 1	Not used
38	EOL E	Not used
39	LGS-E	Idle speed switch signal – Input, static – against GND-O (terminal 13)
40	MST-E	External engine cut–out
41	ZDR-E2	Intermediate engine speed control 2 – Input, static Batt.+
42	MBR-E	Not used
43	BRE-E	Not used
44	FGR 1	Speed control device
45	PWG 2	Pedal travel sensor – Output, supply – Controlled direct voltage, U approx. 5 V
46	HRL O	Main relay – Output (switch) – I_{max} 0.3 A, batt. – against batt.+
47	K15-E	Terminal 15, digit. Data for control unit – Input, static Batt.+
48	ISO-K	ISO-K link to ISO protocol – Interfaces
49	ISO-L	ISO-L link to ISO protocol – Interfaces
50	TKS-E	Door contact switch – Input, static Batt.+
51	FGG 1	Driving speed sensor signal – Input, dynamic – Square-wave voltage U_{PP} 8.5 V, f. variable
52	PB1-E	Pulse-width modulated input signal 1 – Interface
53	WTF 1	Coolant temperature sensor – Input, analog
54	HGB 1	Multi-stage input, maximum speed limitation – Input, analog – Input by change in resistance
55	LTF 1	Charge-air temperature sensor

Bosch socket box Y261 A30 186

Fig. 1

Connection between control unit and EDC cable harness in terminal box for testing EDC

Arrow: Control unit plug



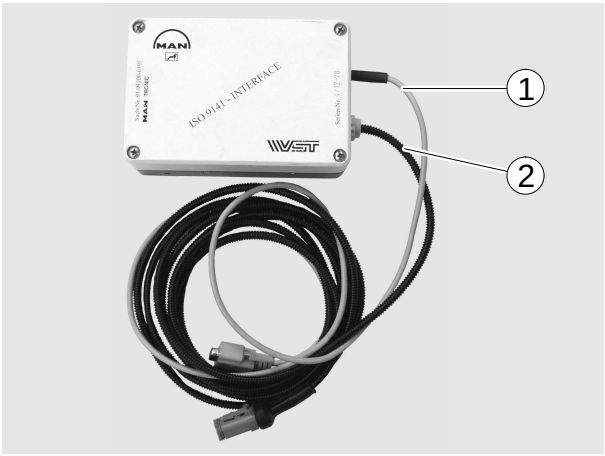
1

MAN-Cats interface 93.09000–6015
(Connection between adapter cable and note book)

Fig. 2

① Connector for note book

② Connector for MAN-Cats interface in terminal box

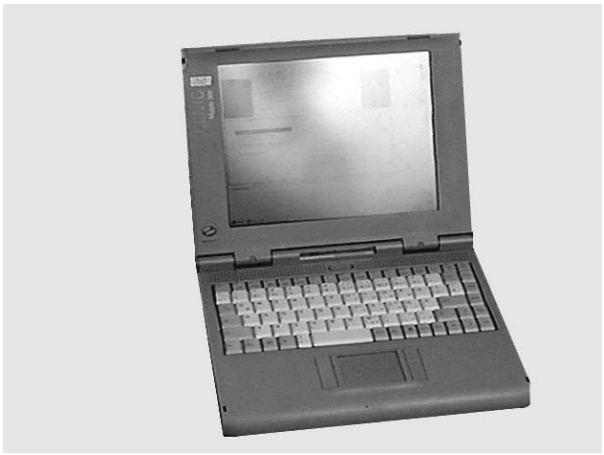


2

Notebook computer
minimum equipment:

Fig. 3

- 386 processor
- 4 MB RAM
- RS 232 Com 1 interface
- MS-DOS 5.0 or higher



3

MAN CATS is a diagnostics system for the engine electronics which operates with the aid of a laptop computer.

The features the following functions:

1. Reading EDC errors in text format
2 Clearing the fault memory
3. Monitoring the following operational parameters:
   - Boost pressure
   - Control rod position
   - Engine speed
   - Coolant temperature
   - Charge air temperature
   - Fuel temperature
   - Pedal travel sensor position, i.e. throttle lever position
   - Battery voltage
   - Additional EDC parameters
   - Needle movement sensor

However, the monitoring data **cannot be stored or printed**.

The following equipment is necessary to work with the laptop:

- **Interface, white**
  MAN Item no. 93.09000–6015
- **MAN-Cats software**
  Operating system disk D1
  MAN Item no. 81.99298–8130 German
  81.99298–8071 French
  81.99298–8082 English
  81.99298–8033 Spanish
  81.99298–8014 Italian
- **Diagnostic software**
  EDC Bosch MS 5, Disk D 12
  MAN Item no. 81.99298–8300 German
  81.99298–8231 French
  81.99298–8222 English
  81.99298–8193 Spanish
  81.99298–8134 Italian

Caution:
An existing laptop should meet the following minimum criteria for EDC:

- 386 processor
- 4 MB RAM
- 9-pin serial port

The MAN Cats software may only be run on MS DOS 5.0 or higher.

The following PC is required for the MMDS diagnostics system

Laptop with the following specification

Suitable for the MMDS diagnostics system for MAN marine engines:

- 266 MHz processor
- 32 MB RAM
- Min. 1,0 GByte hard drive
- CD-ROM drive
- Floppy disk drive
- Lithium battery charger (without memory effect)
- Trackball
- Serial interface, cable-based
- TFT display, 800 x 600 resolution (pixels width x height), min. 256 colours

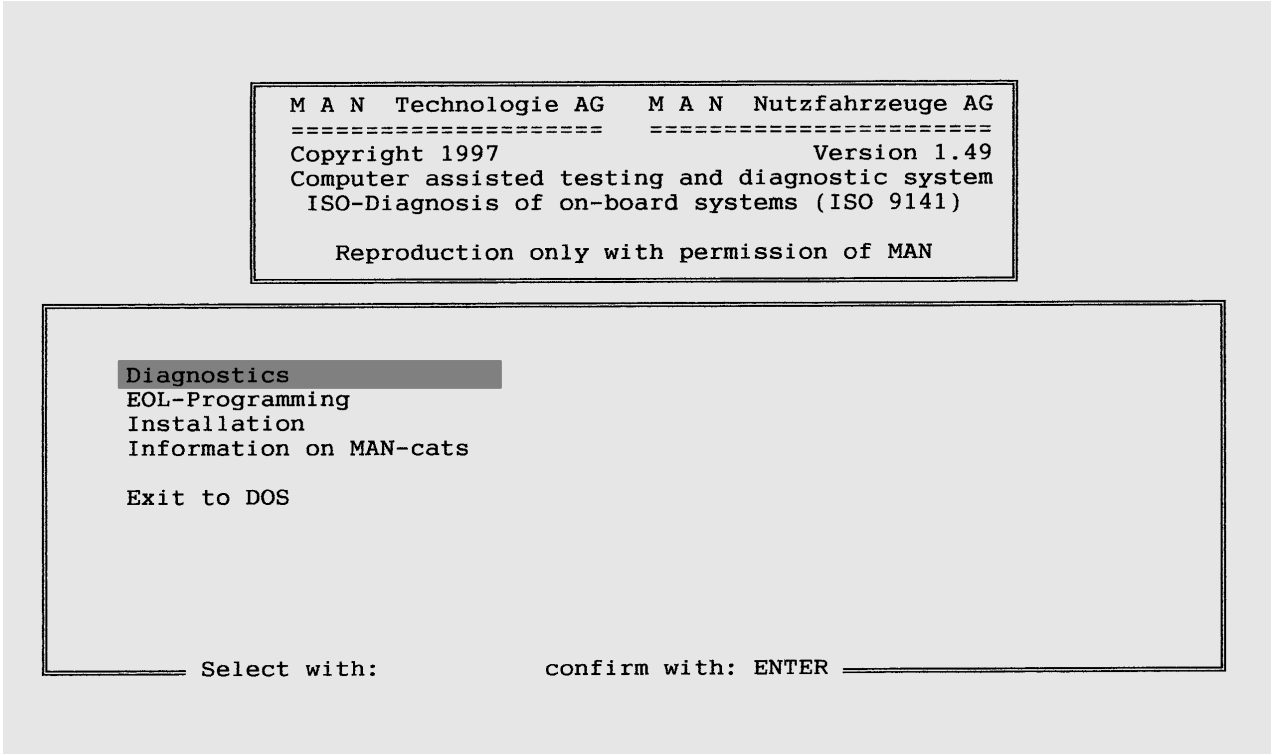
The software can be installed under DOS (version 5) or Windows.

Installation under Windows 95, 98, NT:

Copy the contents of the floppy disk labelled “D1” from the floppy disk drive to a new folder on the hard disk.
Run “Install.exe” from the hard disk.
When requested, select installation of the D12 diagnostics software and at the same time deselect D43.
When requested to do so, insert the next D12 disk and continue.

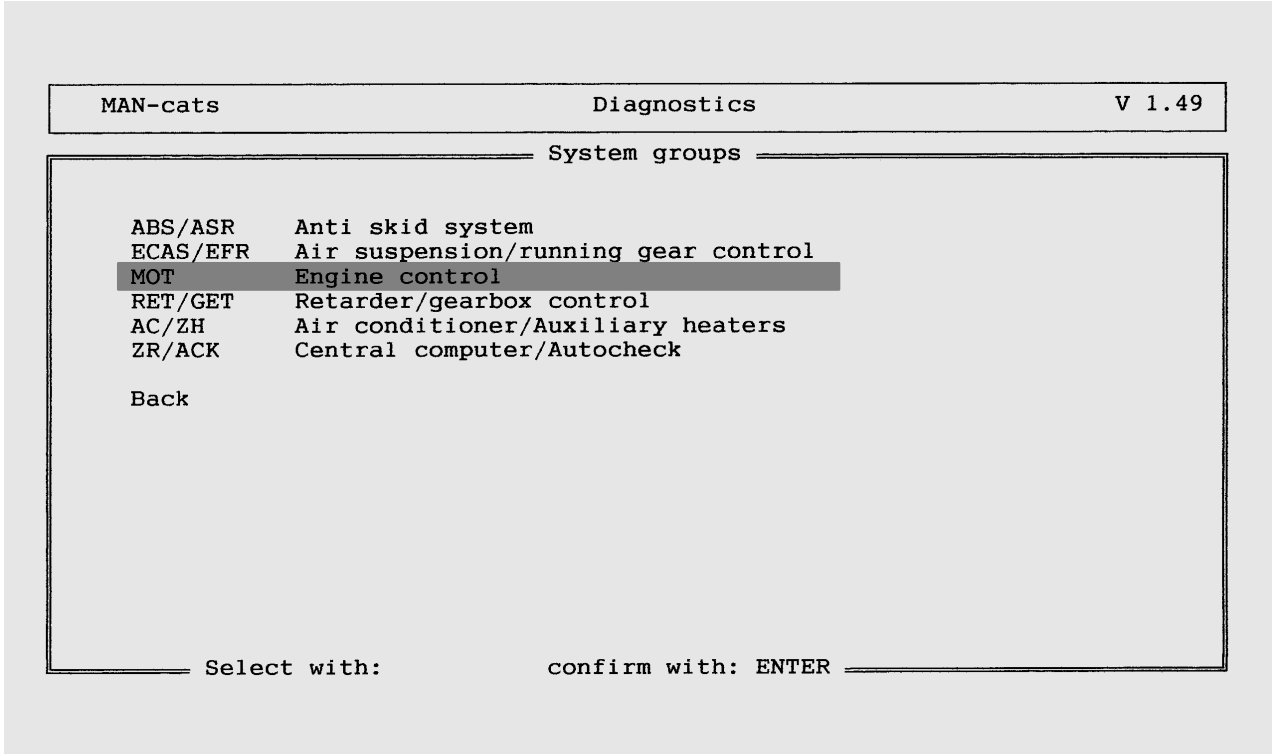
In DOS, the software is run by entering “C:man_cats diagnose”.

The following will appear on the screen:



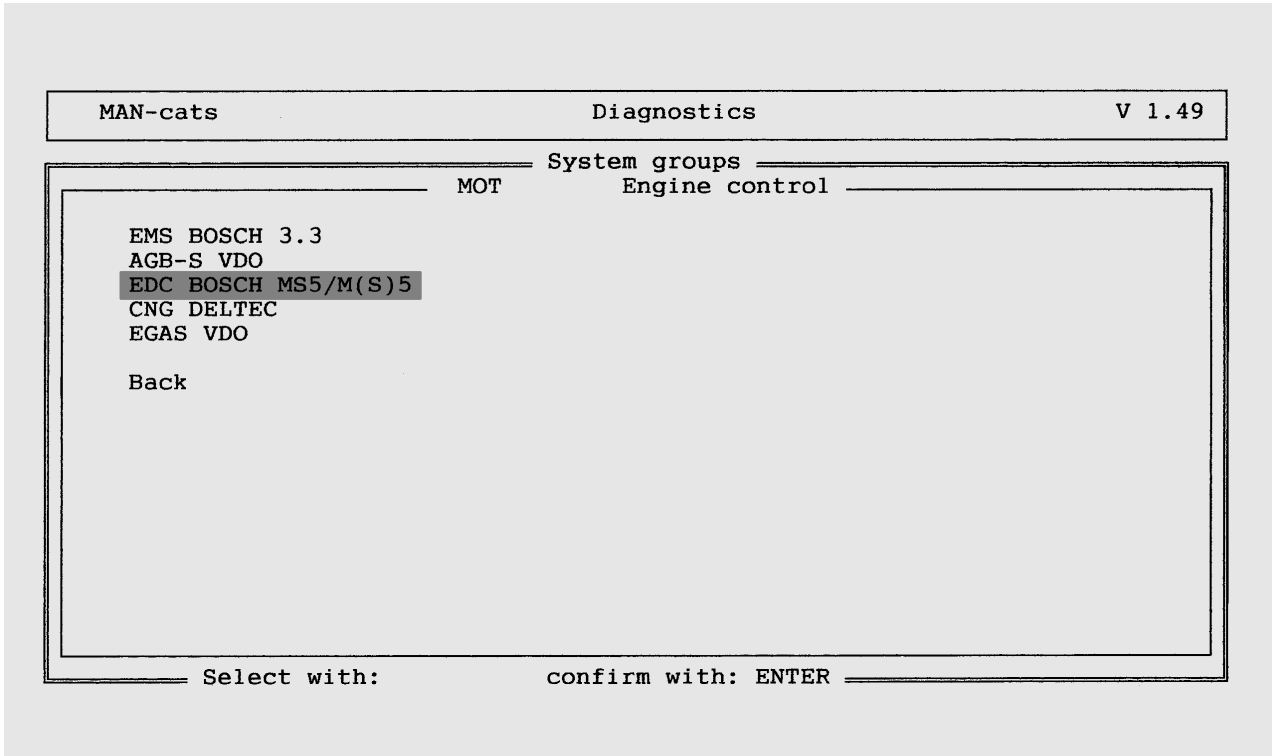
Use the arrow keys to highlight “Diagnostics”, then press “Enter”.

The following will appear on the screen:



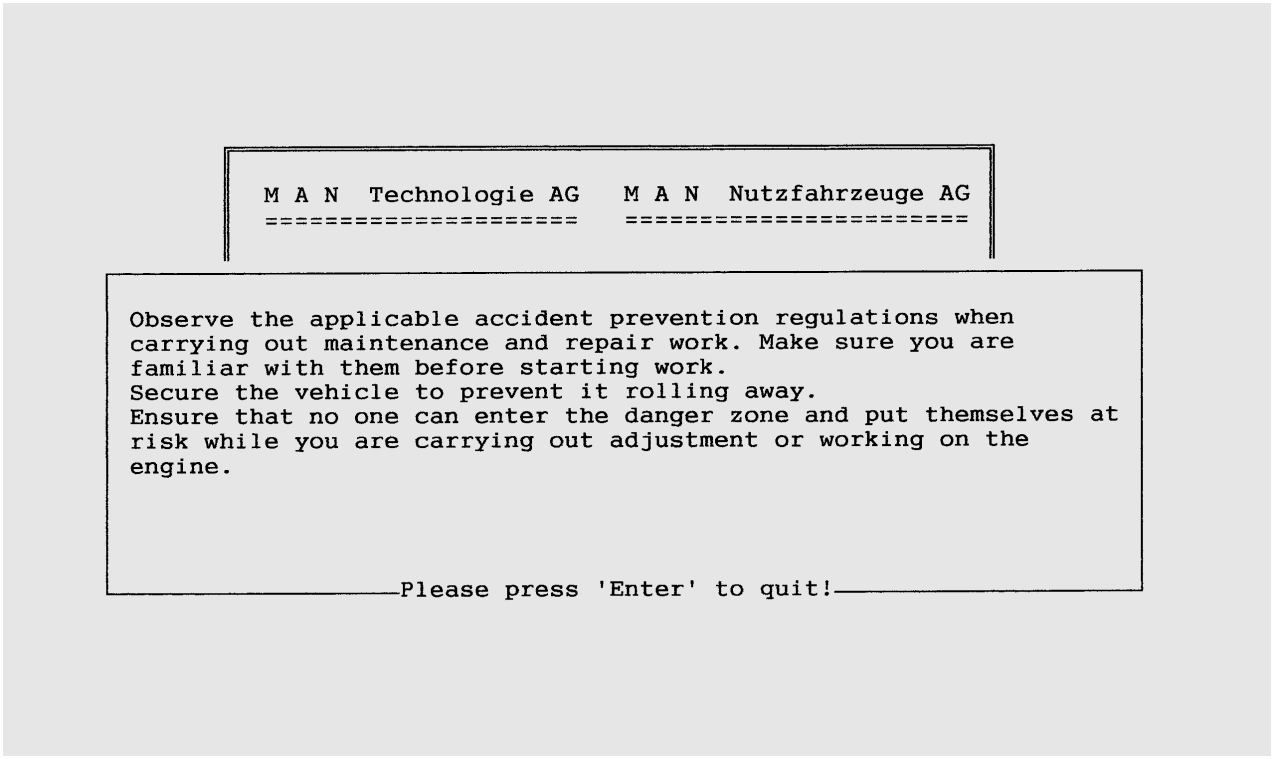
Using the arrow keys, select “Mot” engine control.

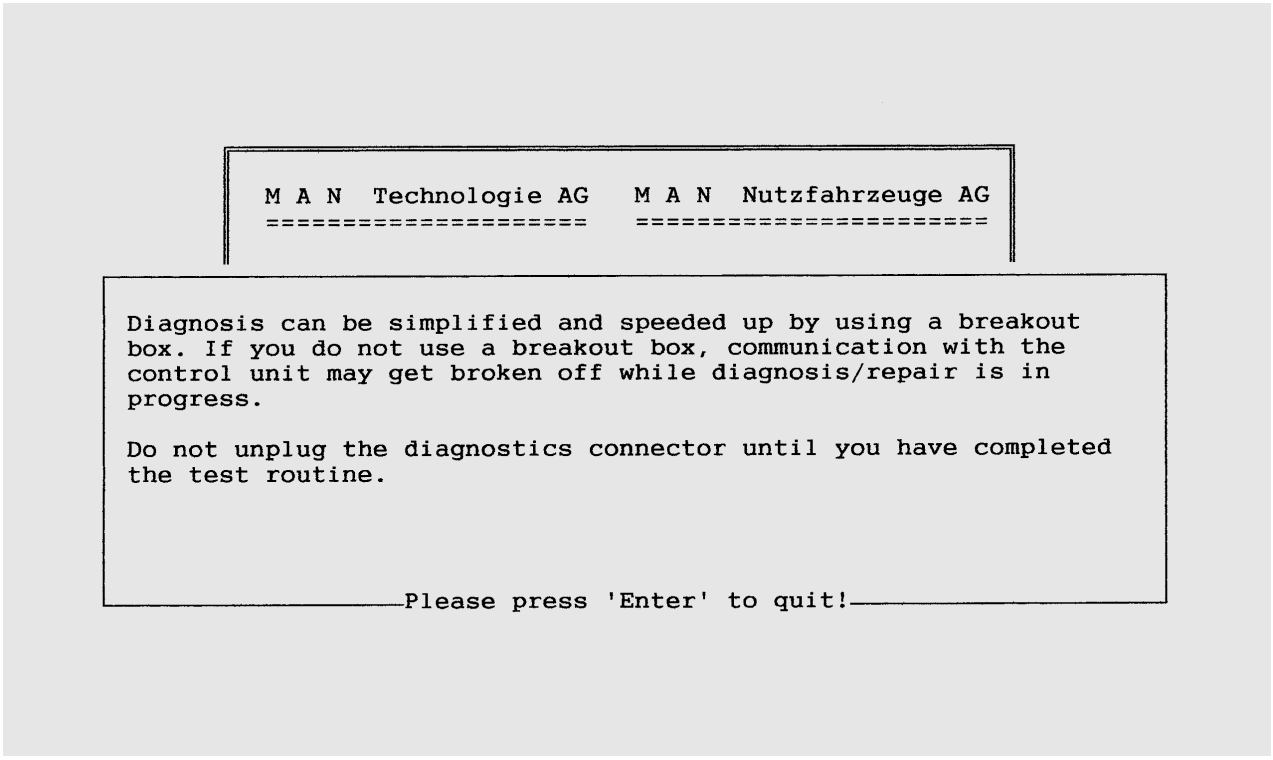
The following will appear on the screen:

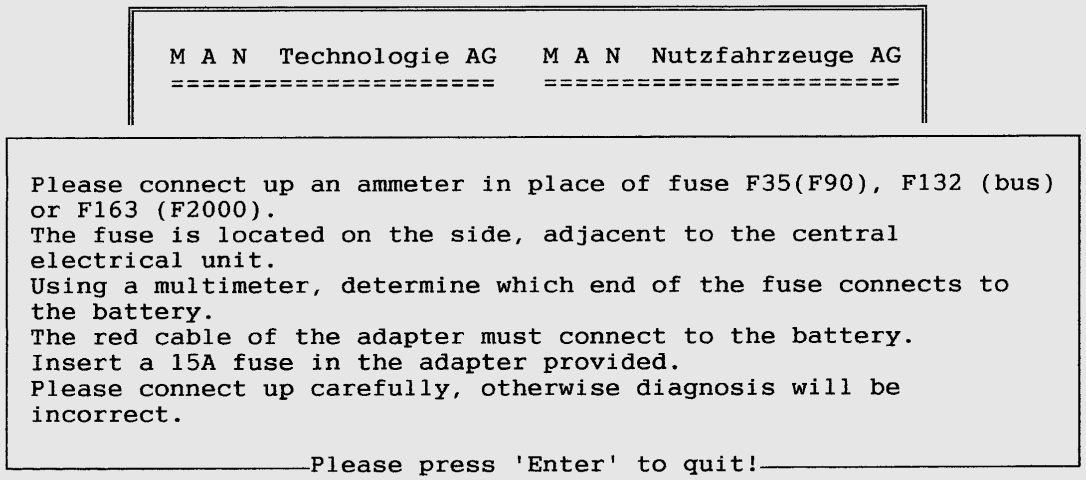


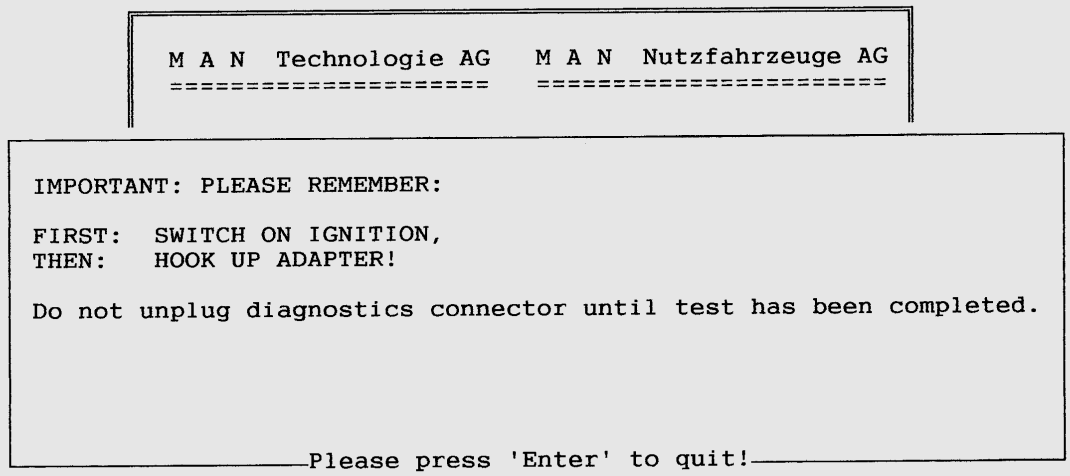
Using the arrow keys, select “EDC Bosch MS5/M(S)5”.

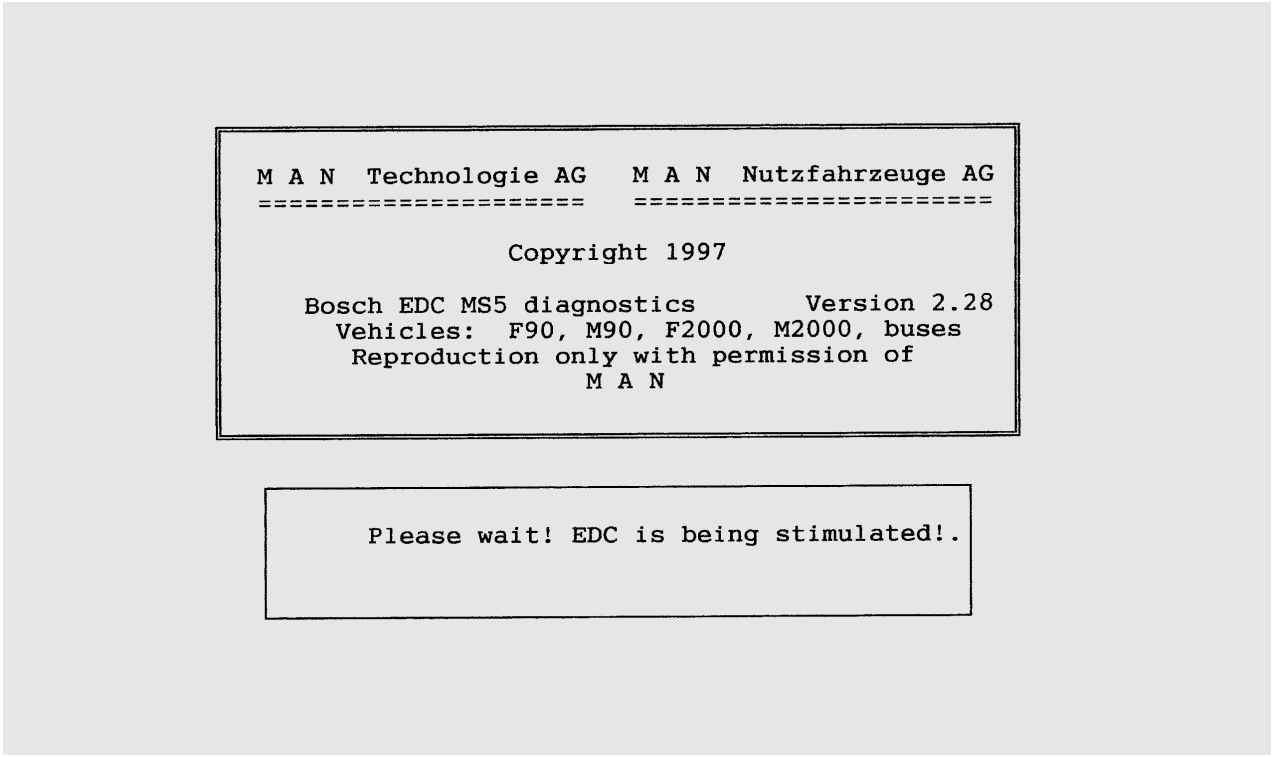
The following screens will appear:





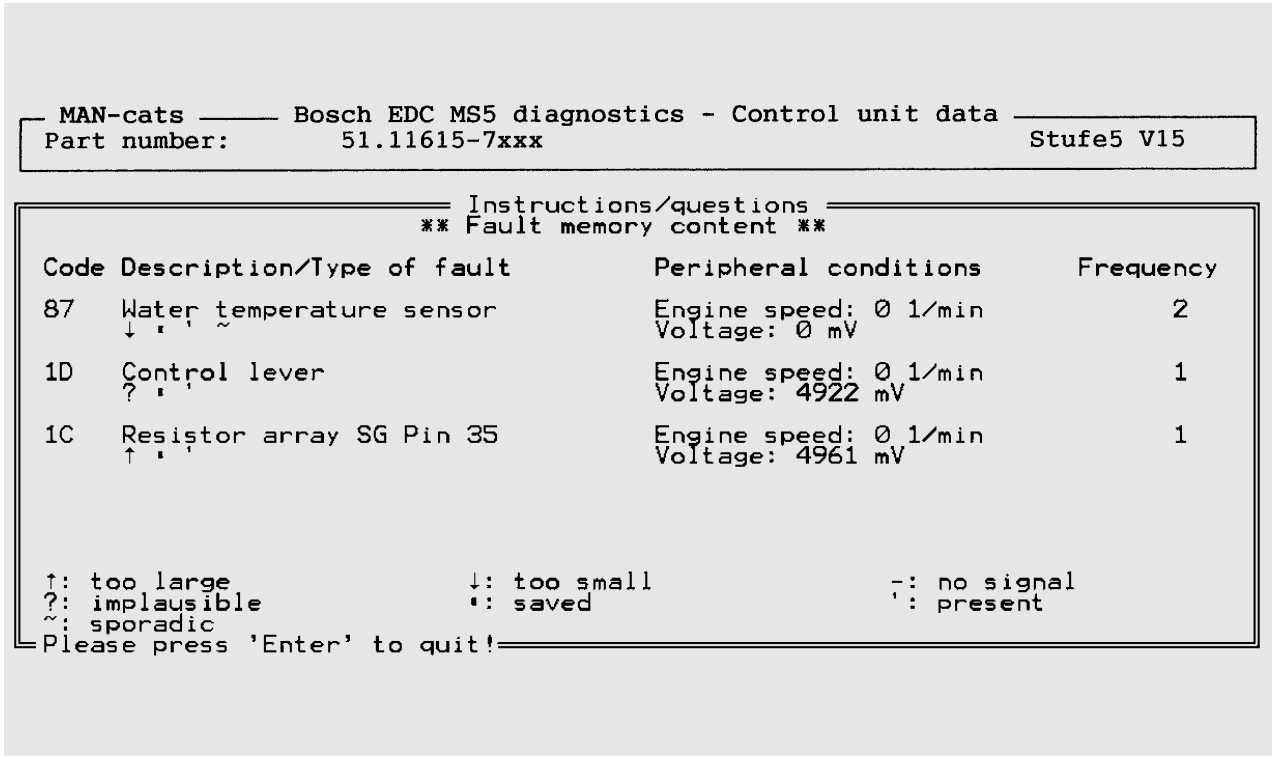

M A N Technologie AG
M A N Nutzfahrzeuge AG
Please connect up an ammeter in place of fuse F35(F90), F132 (bus) or F163 (F2000).
The fuse is located on the side, adjacent to the central electrical unit.
Using a multimeter, determine which end of the fuse connects to the battery.
The red cable of the adapter must connect to the battery.
Insert a 15A fuse in the adapter provided.
Please connect up carefully, otherwise diagnosis will be incorrect.
Please press 'Enter' to quit!


M A N Technologie AG
M A N Nutzfahrzeuge AG
IMPORTANT: PLEASE REMEMBER:
FIRST: SWITCH ON IGNITION,
THEN: HOOK UP ADAPTER!
Do not unplug diagnostics connector until test has been completed.
Please press 'Enter' to quit!



EDC is being scanned

After this stage, the contents of the fault memory are shown first (see screenshot below).



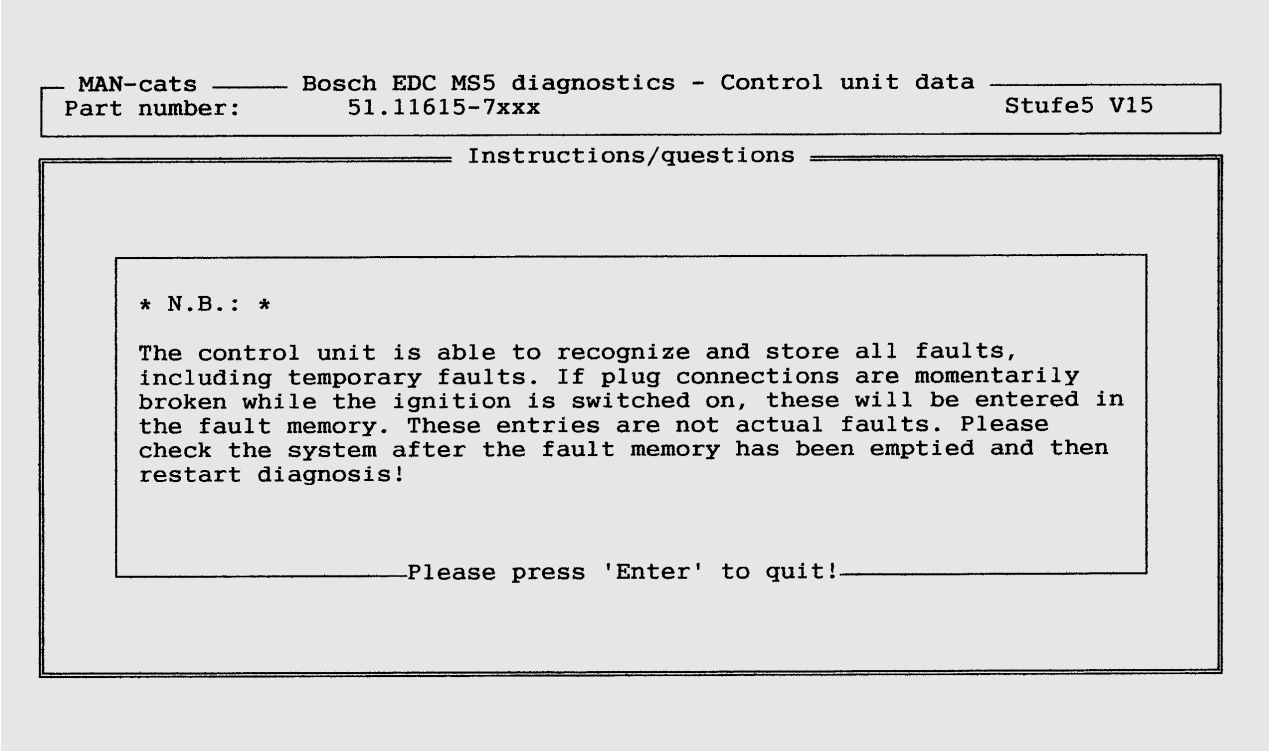
Fault description:

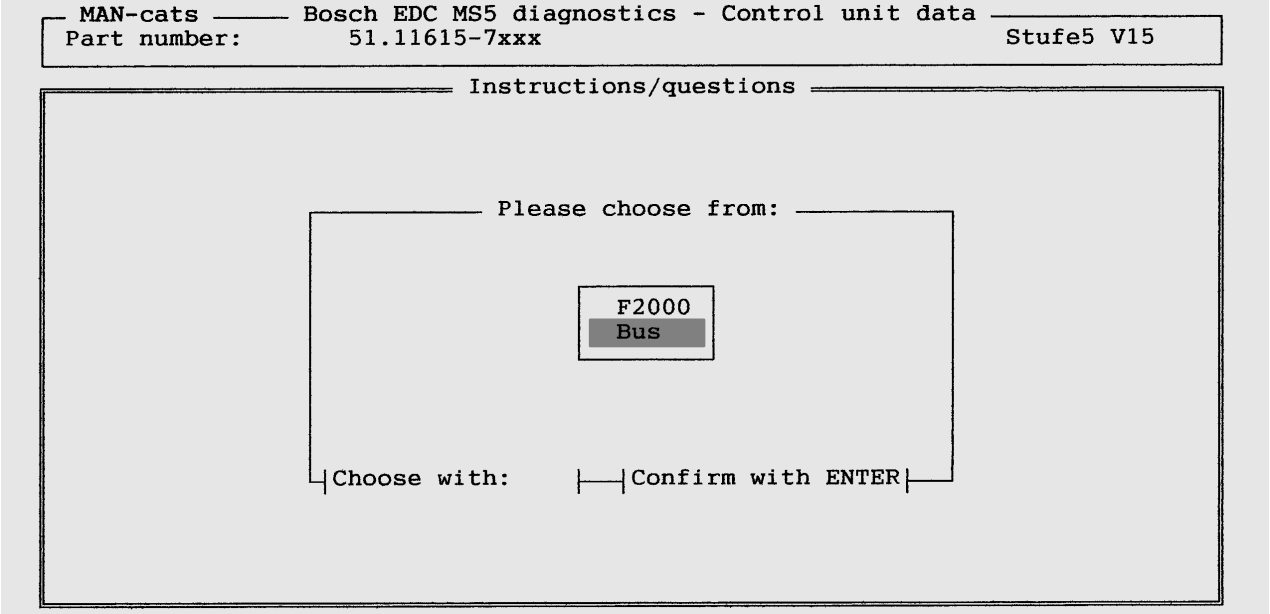
↑	: too great	≙	measured value too high
↓	: too small	≙	measured value too low
–	: no signal	≙	possible line break, sensor faulty
?	: implausible	≙	unknown fault
■	: saved	≙	fault has been stored
◤	: present	≙	fault exists at present
~	: sporadic	≙	momentary fault

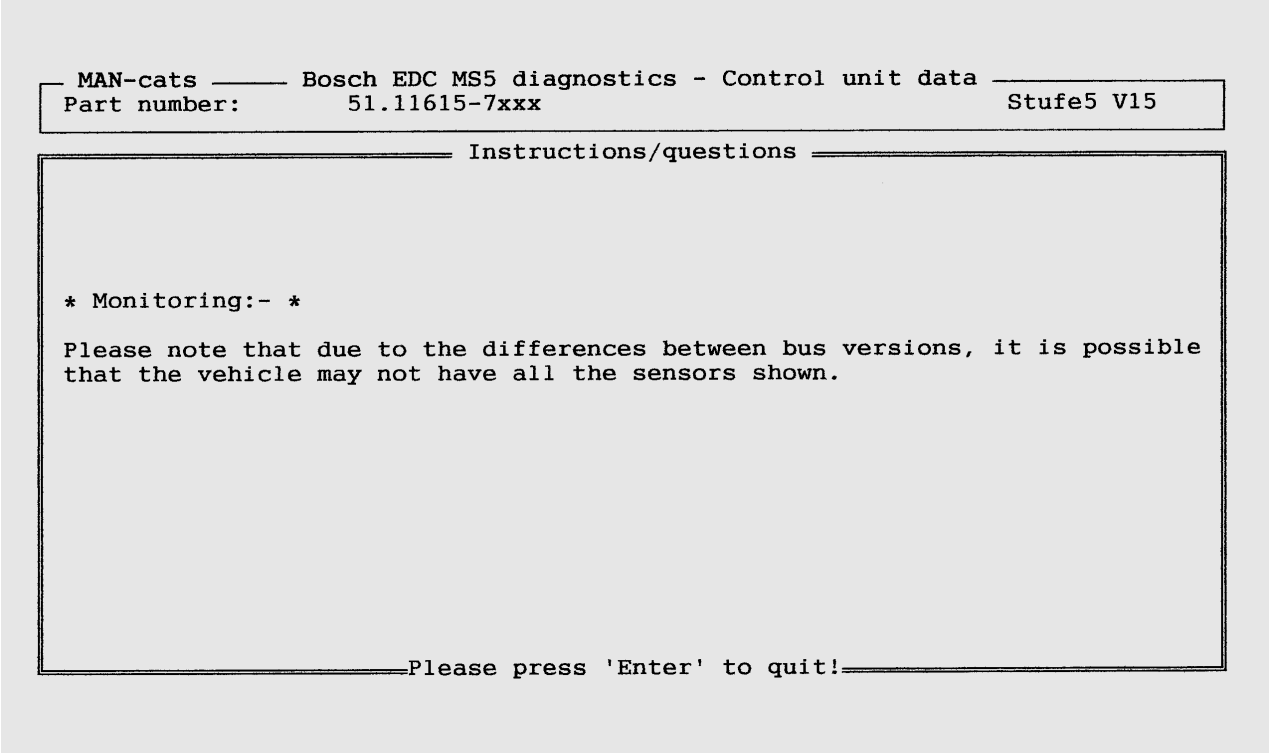
Frequency: Depending on the channel, the EDC counts the faults from 1 to 40 or 1 to 210. If the fault is no longer present when ignition is switched back on again, the frequency of the fault is reduced by 1. (Our example therefore shows 3 faults which were present at least once).

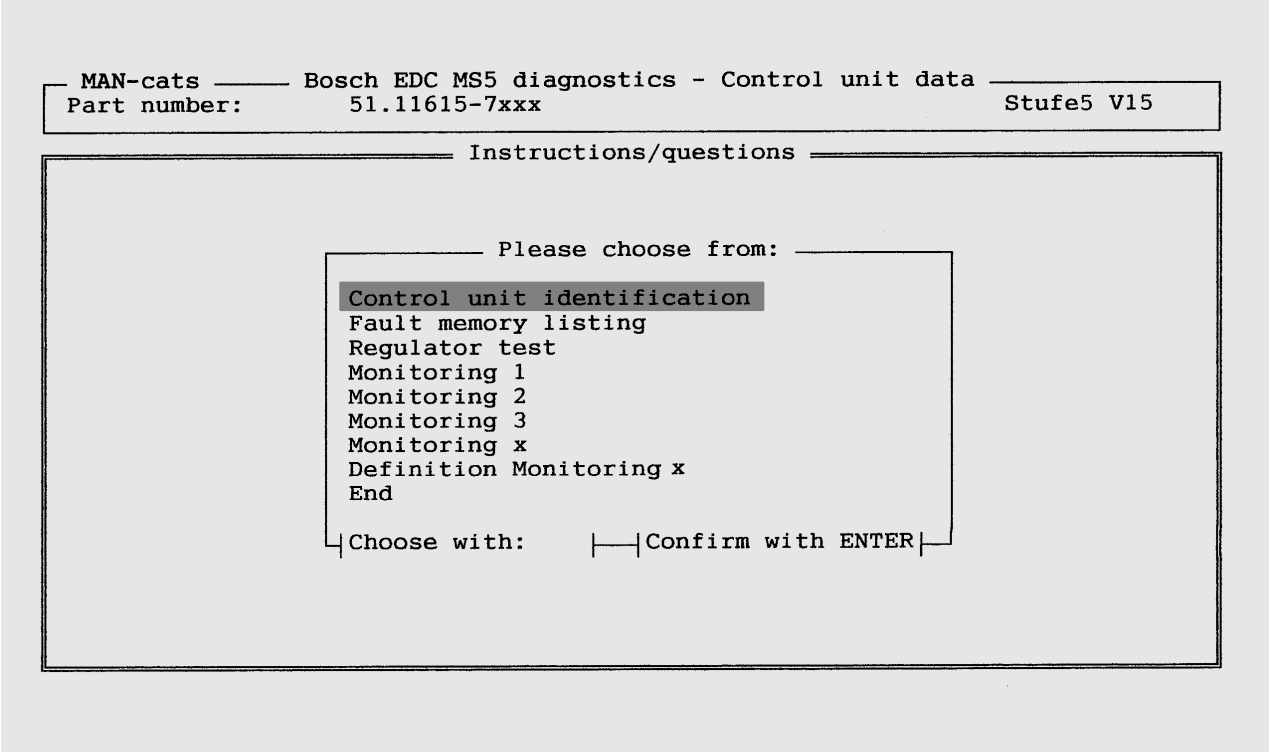
Peripheral conditions: shows other important channels as additional information, e.g. the engine speed at which the fault occurred and the magnitude of the fault.

Once the fault memory has been examined and noted, press “Enter” to go the submenu where you select the “Bus” function.


MAN-cats
Bosch EDC MS5 diagnostics - Control unit data
Part number: 51.11615-7xxx
Stufe5 V15
Instructions/questions
* N.B.: *
The control unit is able to recognize and store all faults, including temporary faults. If plug connections are momentarily broken while the ignition is switched on, these will be entered in the fault memory. These entries are not actual faults. Please check the system after the fault memory has been emptied and then restart diagnosis!
Please press 'Enter' to quit!


MAN-cats
Bosch EDC MS5 diagnostics - Control unit data
Part number: 51.11615-7xxx
Stufe5 V15
Instructions/questions
Please choose from:
F2000
Bus
Choose with:
Confirm with ENTER

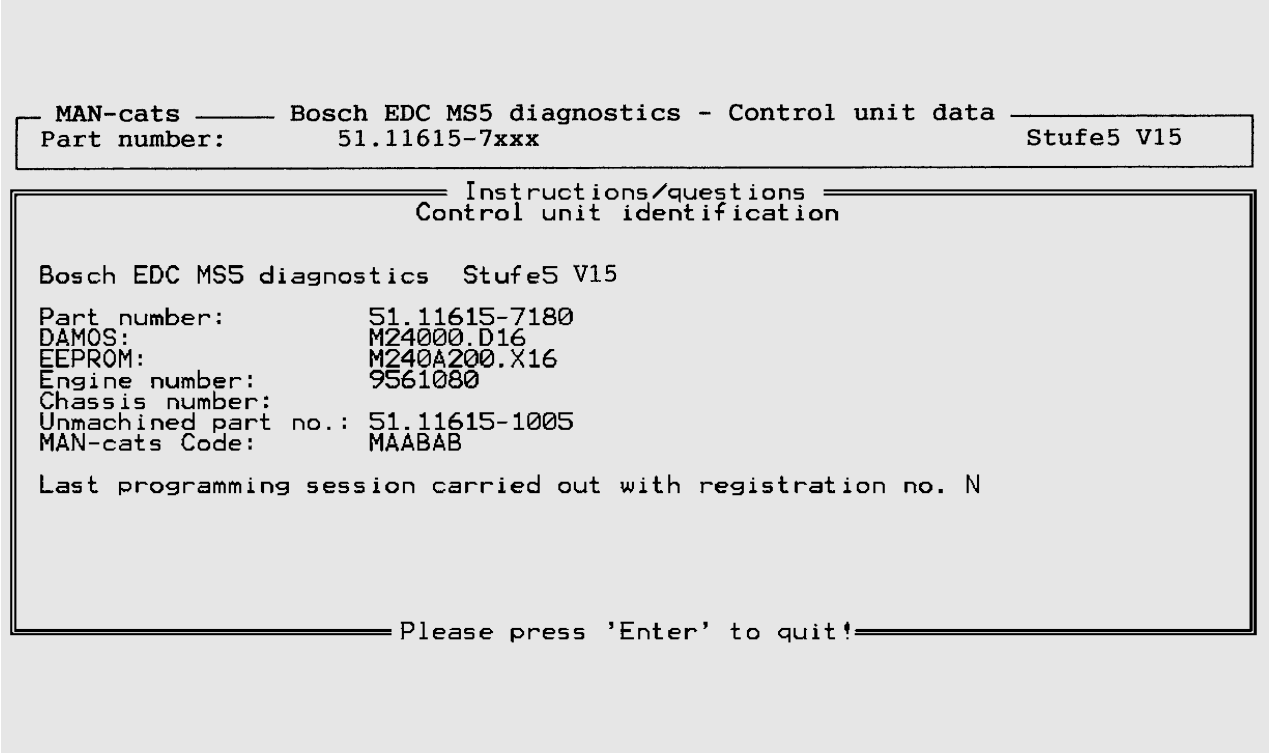




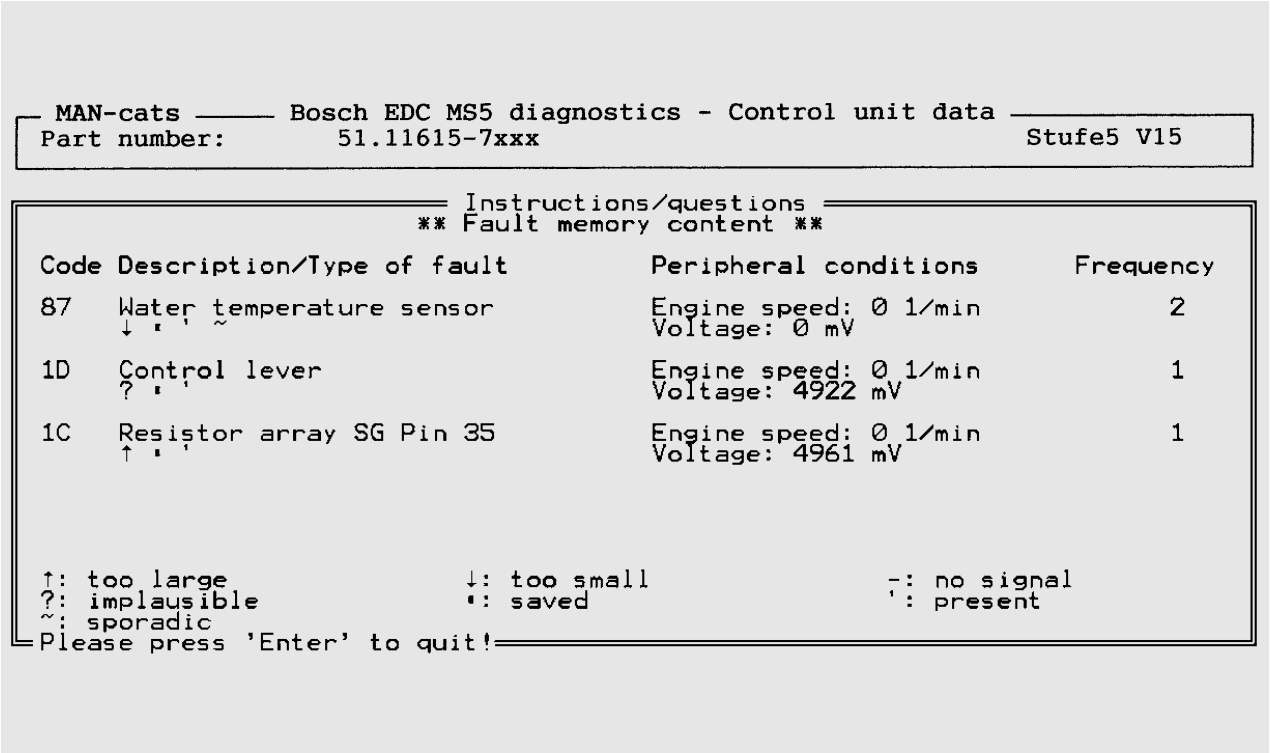
Guided by the menu, you now come to the “Instructions / Questions” dialogue box.

Depending on the version of the software, here you will find various submenus which are explained in detail on the following pages.

In the “Control unit identification” submenu, you will find, for example, the engine number, which must be checked. If the wrong control unit has been assigned to the wrong engine, it is essential that you inform MAN. For further details, see the screenshot below.

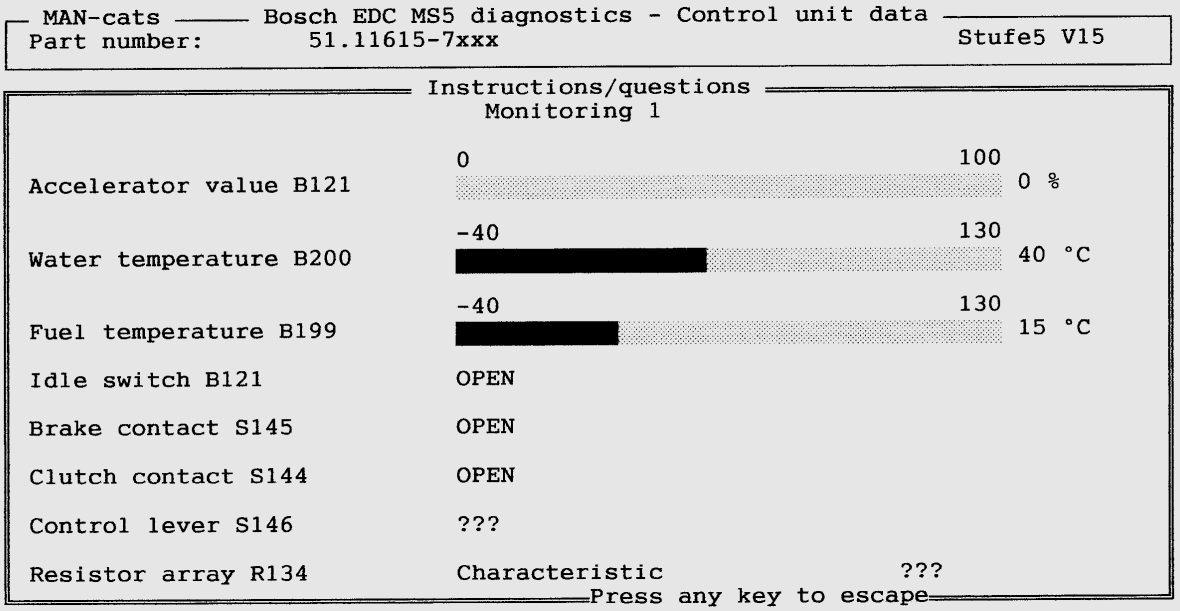


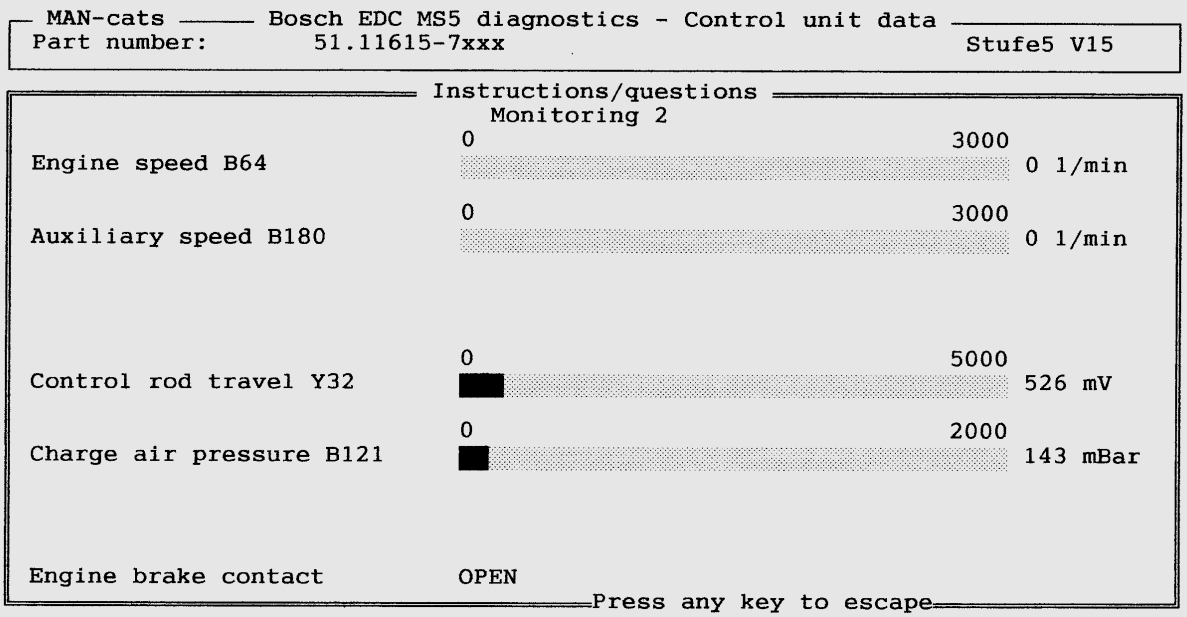
The next submenu, “Fault memory contents” once again shows the current fault memory of the EDC (see screenshot below as an example).

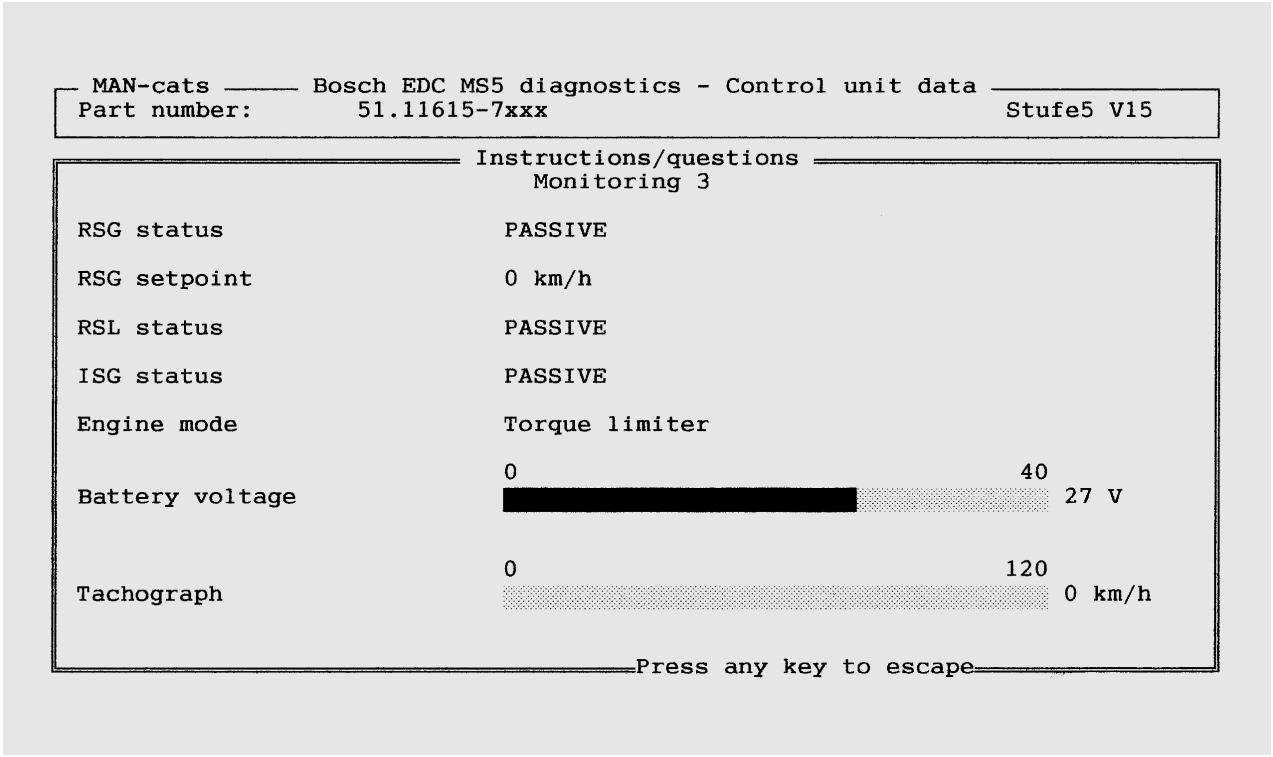


The “Actuator test” submenu item contains an “EHAB” test and will not be dealt with in greater detail here.

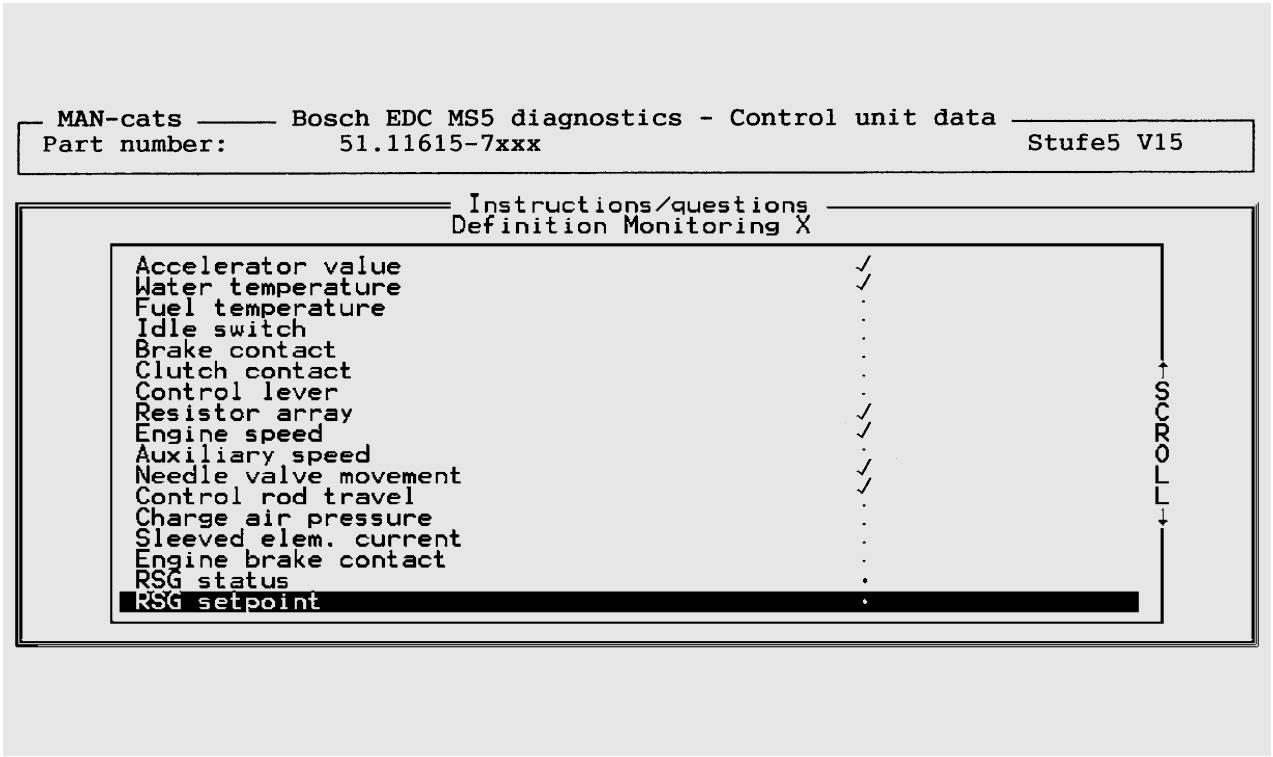
“Monitoring 1–3” shows various engine parameters, see the following screenshots. The measured data cannot be stored.

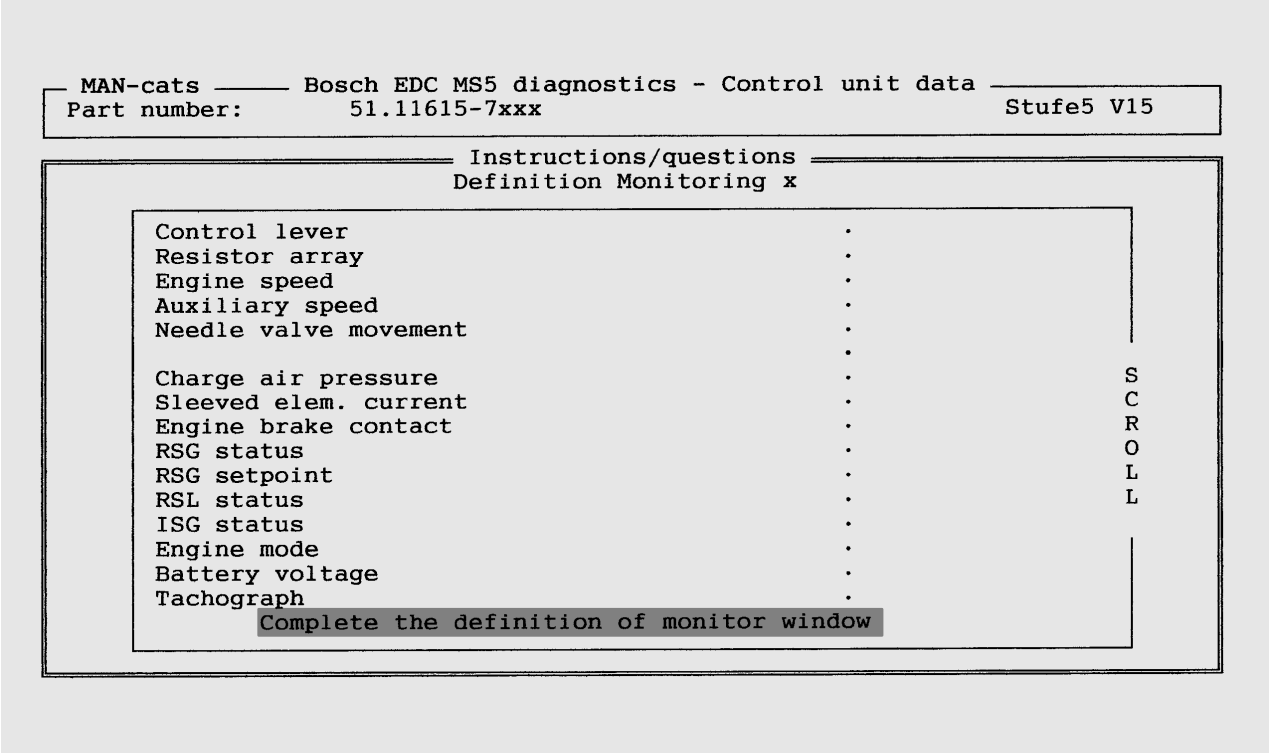




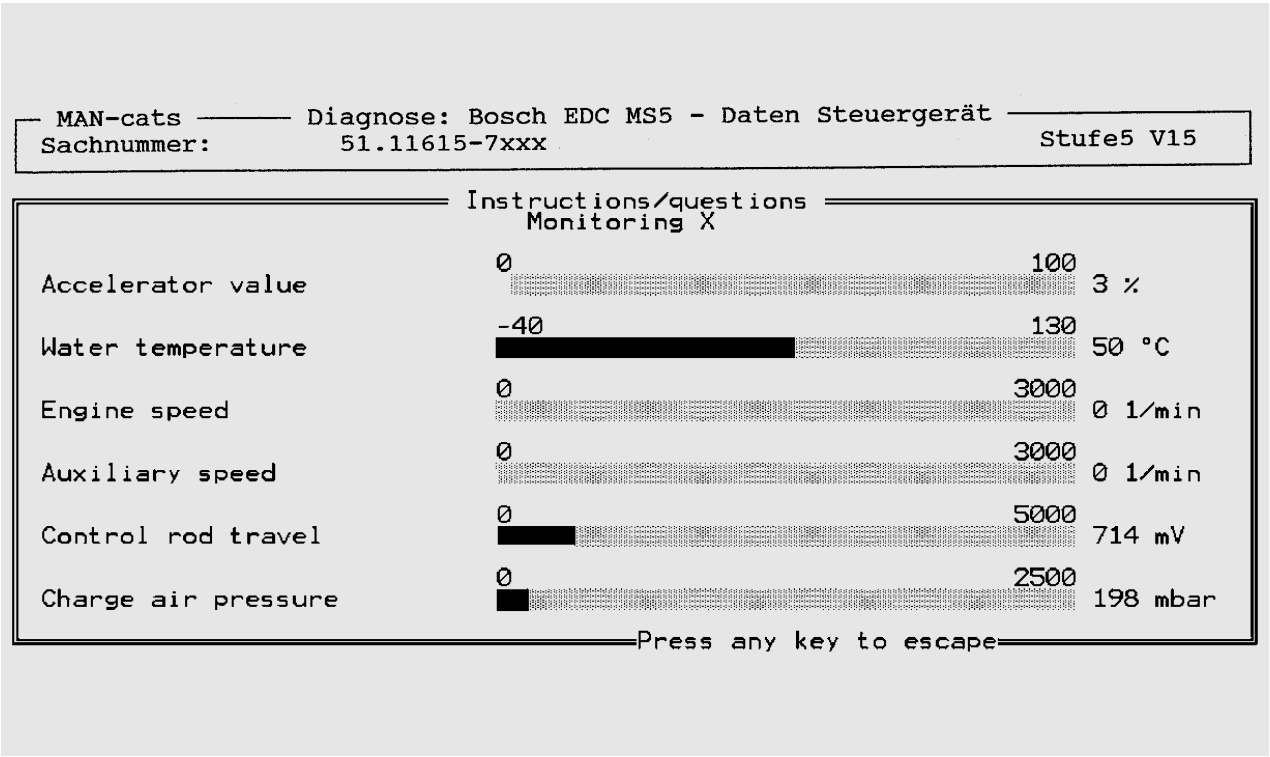


Depending on the software version, there is also a “Monitoring X” or “Definition monitoring X” submenu. In Definition Monitoring X, up to 6 freely selectable measuring channels can be selected by pressing “Enter” (see screenshot below).

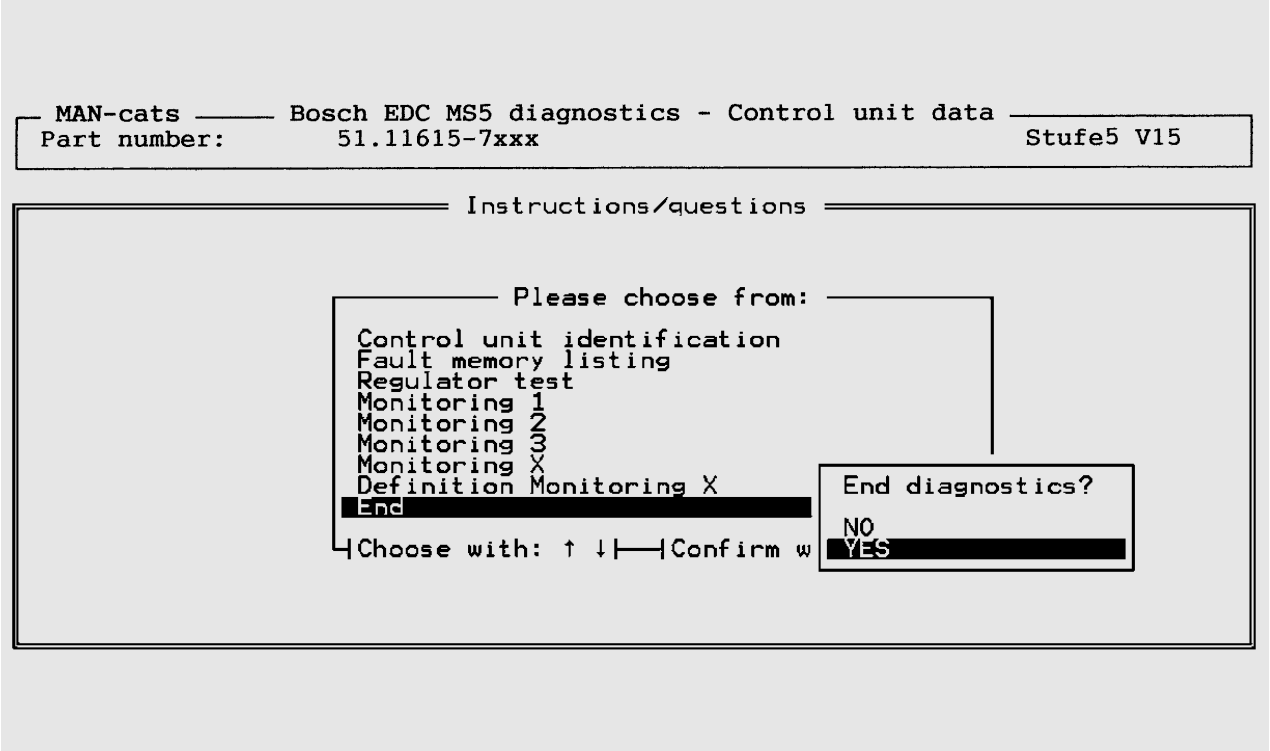




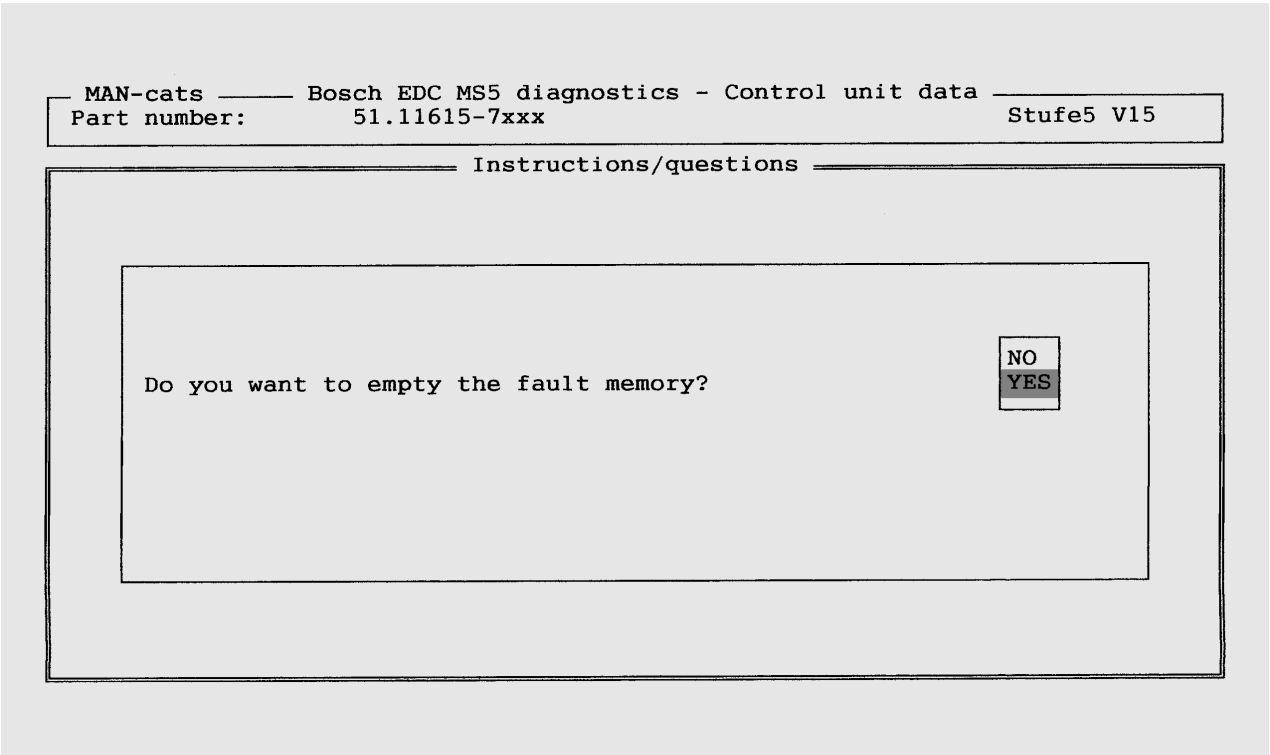
When you have finished selecting the measuring channels, select “Complete definition of monitor window”. After this, you can view the selected measuring channels in “Monitoring X” (see screenshot below).



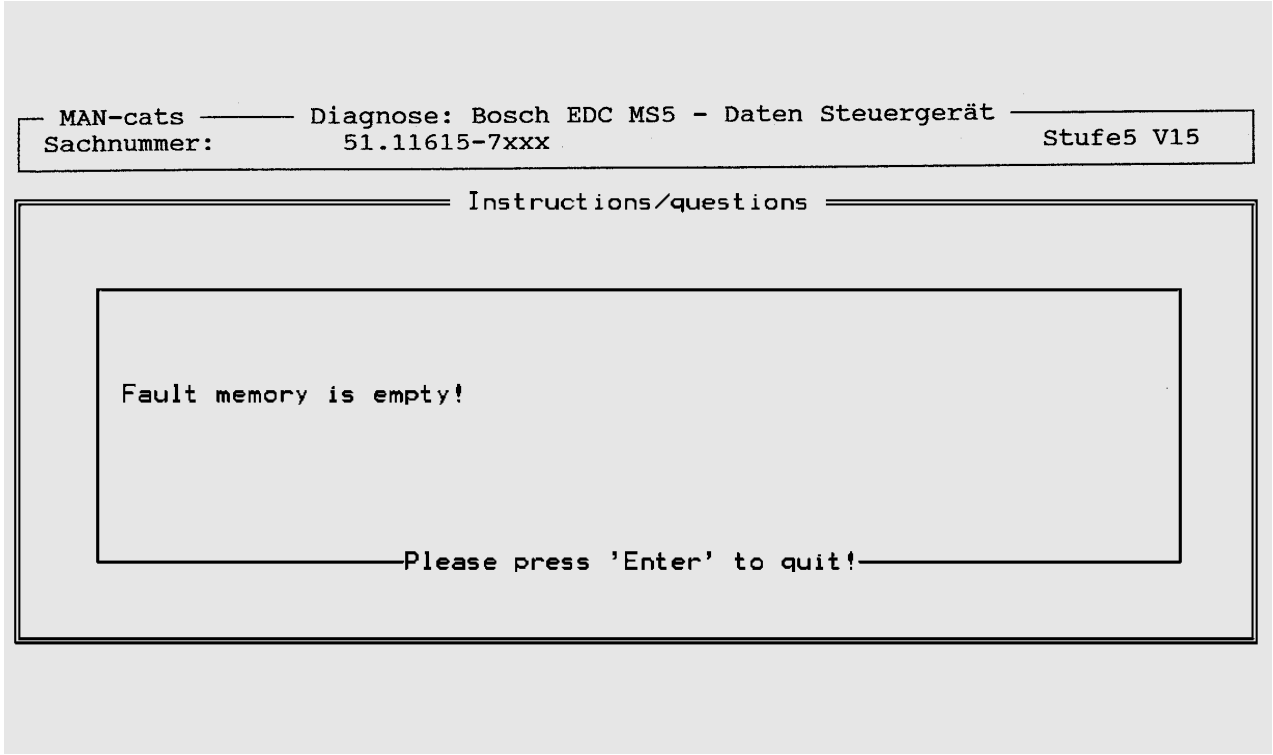
After diagnosing or measuring the engine parameters, select “End”. The following window will appear.

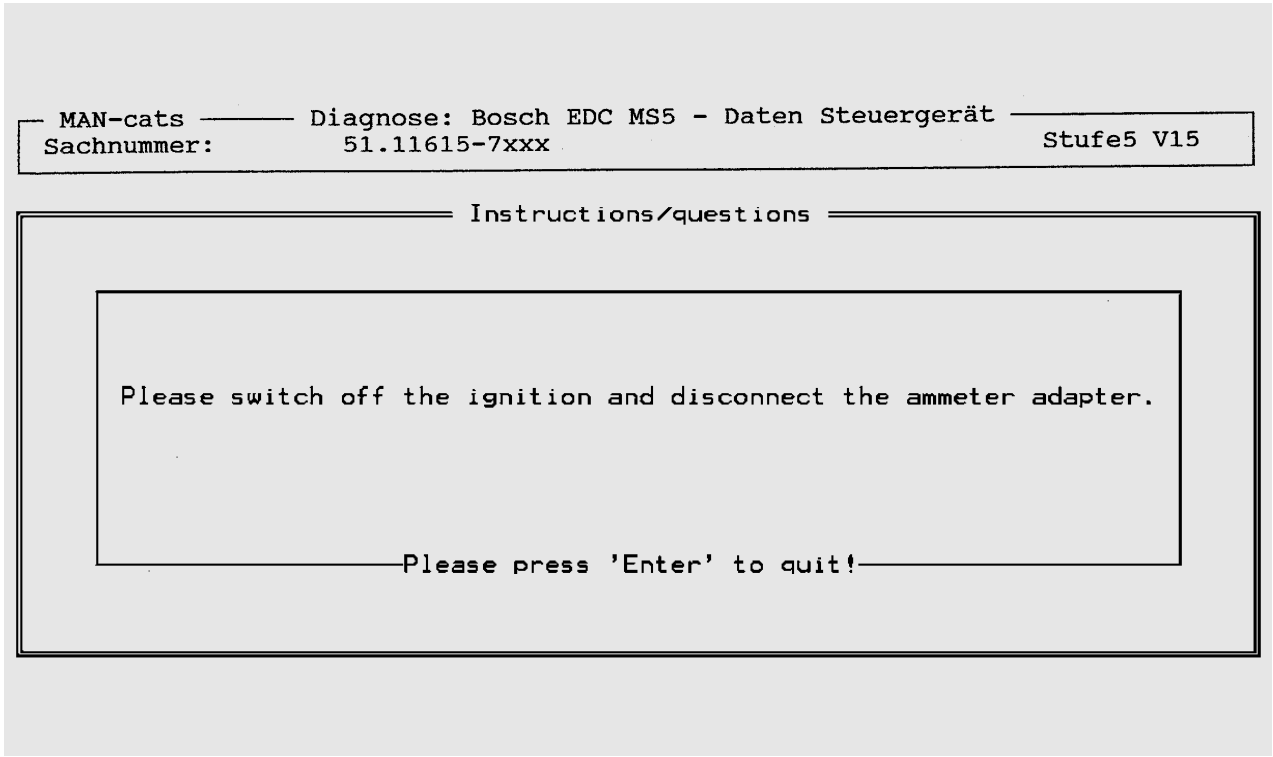


Once you have left the “Instructions / Questions” main menu by pressing “Enter”, the following will appear on the screen (see screenshot below).



Confirm with “Yes”. You will then be guided through the menu, using “Enter” to confirm (see ...)





Following the instructions above will return you to the beginning of the program.

You can now quit the “MAN_CATS” software by selecting “Exit”.

Rating data sheet

1. Revision list

Date	Revisions
30.05.1994	First issue
26.04.1999	New edition

2. Scope

This data sheet comprises the specifications and tests for the electronic control unit EDC-MS5 required to guarantee the functions listed in the following under the specified ambient conditions.

3. General features

3.1	Place of installation	Frame (chassis)
3.2	Electrical connection	55-pin plug connection
3.3	Weight	approx. 1.4 kg
3.4	Degree of protection	
	Protection against shock-hazard and foreign bodies	in accordance with DIN 40 050, Part 9; IP 54 A
	Protection against water ingress with connector plugged in	in accordance with DIN 40 050, Part 9; IP 54 A
	without protecting sleeve	in accordance with DIN 40 050, Part 9; IP 30

4. Temperature range

Ta: Temperature of mounting surface
Tu: Temperature of ambient air

4.1 Storage temperature

Permanent, not installed	–40°C ... +85°C
Temporary, max. 1h in installed position	–40°C ... +100°C

4.2 Operating temperature

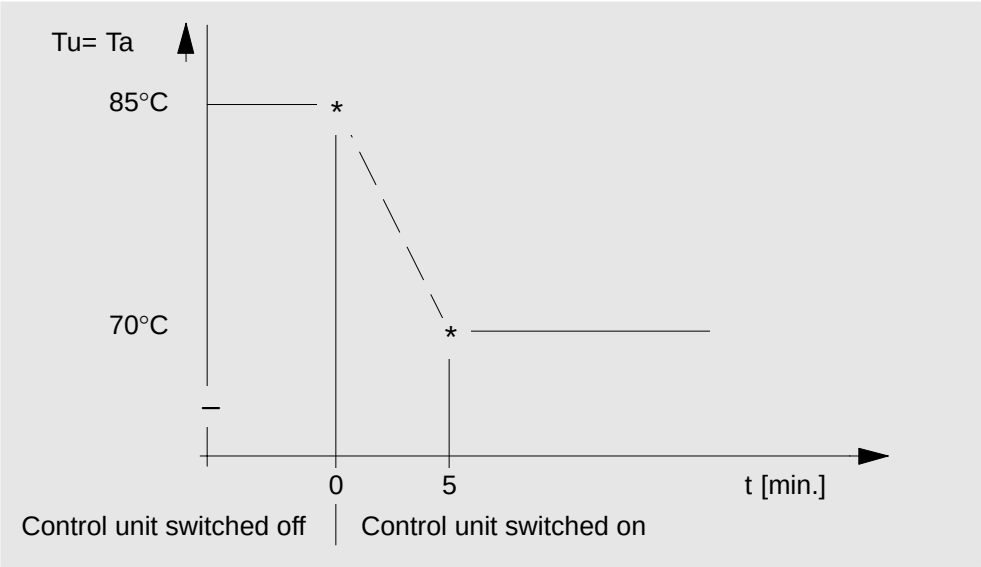
Still air

Ambient temperature Tu, permanent	–40°C ... +65°C
Mounting surface Ta, permanent	–40°C ... +65°C

Moving air

Ambient temperature Tu, permanent	–40°C ... +70°C
Mounting surface Ta, permanent	–40°C ... +70°C

Tu =Ta, temporary –40°C ... –85°C
See diagram:



5. Mechanical characteristics

5.1 Vibration stress

5.1.1	Sinusoidal vibration test in accordance with	DIN 40046 Part 8 ,Fc (IEC 68-2-6)
	Max. acceleration amplitude	50 m/s^2
	Frequency range	10 Hz ... 200 Hz
	Frequency change rate	1 okt./min.
	Test duration	24 h per main coordinate
5.1.2	Broadband noise test in accordance with	DIN 40046 Part 22, Fd (IEC 68-2-34)
	Total acceleration (effective value)	45 m/s^2
	Frequency range:	10 Hz ... 1000 Hz
	Test duration	24 h per main coordinate
5.2	Shock stress, test in accordance with	DIN 40046 Part 7, (IEC 68-2-27)
	Max. acceleration amplitude	1000 m/s^2
	Shock form	Semi-sinusoidal
	Duration of nominal shock	6 ms
	Test duration	3 shocks per main coordinate in both directions (18 shocks)

The frequency and acceleration value specified in 5.1 and 5.2 apply to the vibration testing table.

6. Electrical ratings

6.1 Supply voltage range

6.1.1 Rated voltage	24 V
6.1.2 Permissible supply voltage (measured at the batt.+, batt.– of the control unit)	7.0 ... 32 V normal operation min. 16 V for 50 ms after switching on terminals the control unit

The definition provided in Section 7 applies to the voltages U-batt+ ≤ 7 V or U-bat– ≥ 32 V.

6.1.3 Residual ripple of supply voltage (Operation without battery not permitted)

Effective value of supply voltage: U-batt eff = 500 mV max.

(Measured at the batt+, batt– terminals of the control unit with the control unit switched on and the engine running. The value need not be maintained during the start procedure)

6.2 Power loss, control unit

(idle speed, engine at operating temperature)	approx. 18 W
6.3 Polarity reversal protection	By coded control unit connector, polarity reversal of battery does not result in destruction of control unit when the main relay is activated by the control unit.

6.4 Short–circuit strength

– Conditions: Max. 1 short–circuit simultaneously – Ta and Tu≤ 65°C, – U-Batt ≤ 28V – control unit is powered with U–batt	For all plug connections against batt+, batt– and against one another except for BAT+, BAT–, GND 0. NBF 0. CAN H and L Restricted: RWGR. RWGM. RWGY short–circuit at max. 26 V permissible for max. duration of 1 min.
6.5 Heat radiation	max. 20 W

7. Immunity to interference

Pulses in accordance with ISO 7637–2 are permitted on the batt+/batt– line if they are within the following rated values.
The control unit can switch off as a precautionary measure in the case of supply voltages outside the range 7V ≤ U-Bat+ ≤ 32V.
The function is resumed on returning to the permissible voltage range.

7.1 ISO pulses 1 to 4

Test pulse	Vs [Volt]	Ri [Ohm]	tl [s]	Number of pulses	Test duration [h]
1a	–200	10	5	5 000	–
2	+100	10	0,5	5 000	–
3a	–200	50	100µ	–	1
3b	+200	50	100µ	–	1

7.2 ISO pulse 5 (load dump)

Vs = 57 V Ri = 2 Ω td = 200ms (at +U-Batt = 28V)

Set–up temperature	Ta ≤ 65°C
Ambient air	Tu ≤ 65°C
Minimum wait time between subsequent pulses	1 min
Number of pulses	10

Voltage limitation by the internal load dump feature cuts in at min. 34 V.

7.3 EMV

7.3.1 Irradiation immunity

Frequency range	1 MHz ... 1000 MHz (measure up to 400 MHz)
Field strength	100 V/m sinusoidal, non-modulated (stripline measurement)
Criterion	Engine overrevving or shutting down not permitted. Accuracy deviation permissible.

7.4 Interference suppression — In accordance with VDE 0879 Part 3, interference suppression level 2.

8. Resistance to motor vehicle-specific liquids / fluids

The control unit is resistant to diesel fuel, petrol, engine oil, engine cleaner, brake fluid, battery acid, windscreen washer fluid, isooctane / toluene

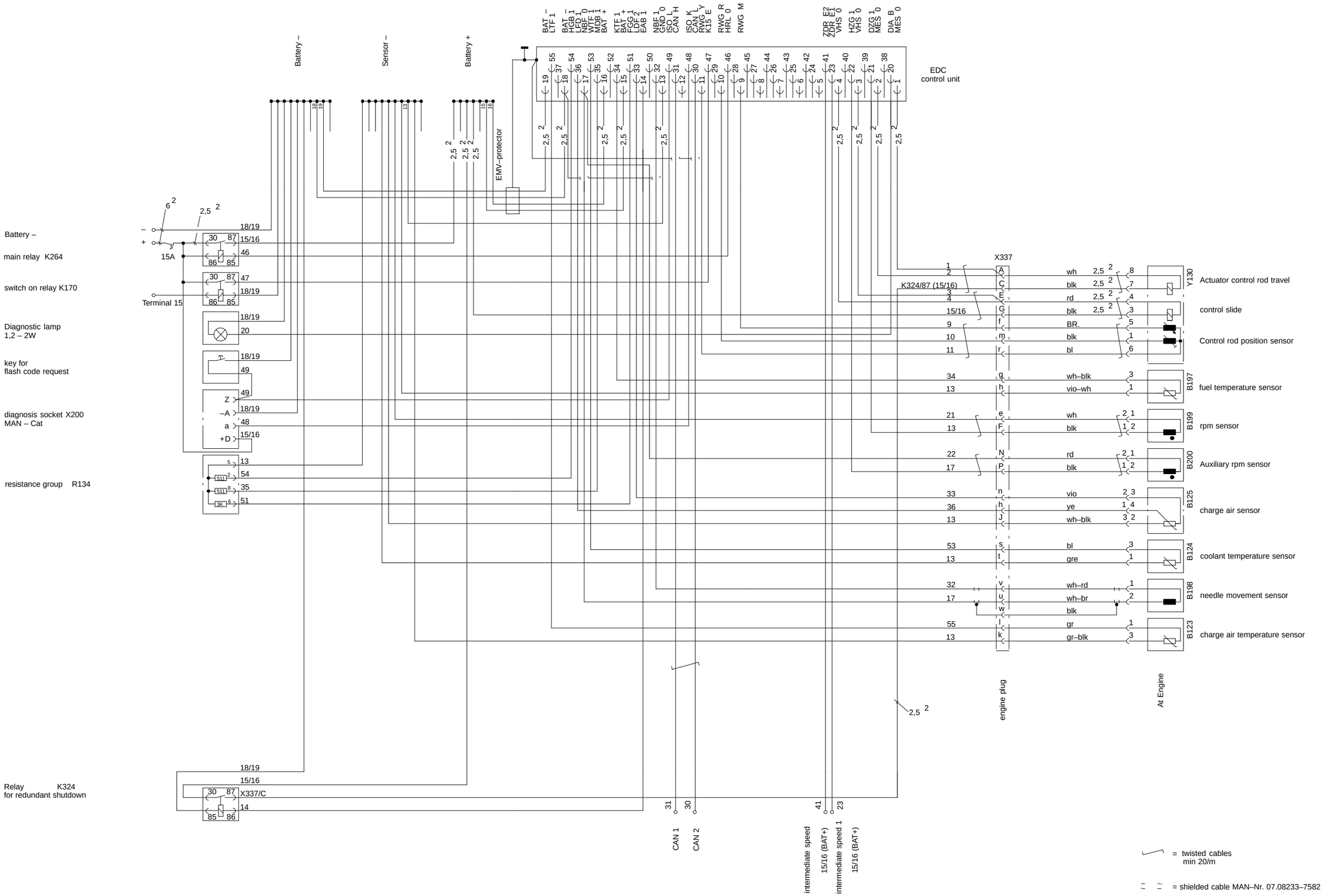
9. Mechanical test data

9.1	Vibration stress	As Point 5.1
9.2	Shock stress	As Point 5.2
9.3	Alternating temperature 3 (IEC 68–2–14 Nb)	Test Nb in accordance with DIN 2 Part 14 Clause
	Lower test temperature	–40°C
	Upper test temperature	+85°C
	Number of cycles	100
	Temperature change rate	< 10K/min
	Holding time at upper stress temperature	15 minutes each
9.4	Moisture resistance	
9.4.1	Test in accordance with DIN standard 68–2–30)	Test Db in accordance with FW 2 DIN 30 (IEC
	Number of cycles	28
	Function test after	7 cycles
9.4.2	Active moisture-alternating temperature test	
	Rel. humidity	95%
	Normal temperature phase at	40°C
	Duration	240 h
	Low temperature phase at	–10°C
	Duration	2 h
	Changeover time	< 3 min

10. Service life test

The service life test comprises a mechanical test in accordance with Points 5.1 and 5.2 as well as a climatic test in accordance with Points 9.3 and 9.4. Function measurements in accordance with the test and adjustment specifications are conducted after the individual tests.

Connection diagram



8063

Electronic Diesel Control
Description of inputs and outputs

1. Key to definitions

C_{EMC}:	EMC capacitor
f:	Frequency
F_{abs}:	Absolute error
I_o:	Output current
KS:	Short-circuit
LL:	Idle speed
R_{pu}:	Pull-up resistor
R_q:	Shunt
R_{pd}:	Pull-down resistor
R_{in}:	Input resistance
R_{Gen}:	Internal alternator resistance
S_n:	Threshold correction
t_r:	Rise time
t_f:	Fall time
t_0:	Dead time for detecting signal 0 passage from high to low between connector pin and processor
τ:	Time constant
τ_{AL}:	Charge time constant
τ_{EL}:	Discharge time constant
U_o:	Output voltage
U_L:	Switching threshold for logical LOW
U_H:	Switching threshold for logical HIGH
U_{Hys}:	Hysteresis
U_{Gr}:	Basic threshold
U_{LL}:	Idle speed voltage
U_R:	Reference voltage of ADC, U_R=5V $\pm$ 4%
U_{in}:	Input voltage
U_{inz}:	Minimum or maximum permissible input voltage
U_{off}:	Cutout threshold
U_{oLK}:	Short-circuit at output set to logical LOW
U_{oHK}:	Short-circuit at output set to logical HIGH

2. General information

The control unit must be connected in accordance with circuit diagram 51.17099-8087 together with the assemblies belonging to the system.

If not otherwise specified, all inputs and outputs are short-circuit-proof to ground and $+U_{batt} \leq 28$ V, $T_U \leq 65°C$.

Operation without the battery is not permitted.

The control unit may be damaged as the result of the increased power loss in the event of a short-circuit in more than two plug connections against on another or against the supply voltage.

Supply voltages and ground connections are not short-circuit-proof and are not protected against polarity reversal.

If not otherwise specified, all values apply in the temperature and voltage range as specified by TKU.

Control unit supply:
BATT+ across pin 15, 16 (connected internally, must be connected externally)
BATT– across pin 18, 19 (connected internally, must be connected externally)

The time constant values τ apply at an internal alternator resistance of 0Ω.

The current directions are defined in accordance with the load count system:
Positive currents flow into the control unit.
Negative currents flow out of the control unit.

If not otherwise specified, the working range for analog inputs is from 0 .. U_R.

Data acquisition accuracy is always referred to $U_{Rnominal}$ =5.000V

3. Description of inputs and outputs

3.1Analog inputs

Plug connection: 27 Function group: Analog input

Connector designation: PWG 1 Reference ground: GND 0 (13)

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Input resistance	R_{in}	U_{in}	kΩ	97	100	103
Idle speed voltage	U_{LL}		V		GND 0	
Input filter	τ	R_{Gen}=0Ω	m_s	0.9	1.5	2.1
Input voltage						
Evaluation range	U_{inz}		V	0.1		U_R–0.1
Data acquisition accuracy ΔU_{in} from input pin up to number of processors	F_{abs}	U_{in} is in range of U_{inz}	%			±2

Remarks:
- The data acquisition accuracy is based on radiometric signal processing with sensor supply PEG 2.

Plug connection: 45 Function group: Sensor supply, short-circuit-proof

Connector designation: PWG 2

Description of output

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Output voltage	U_o	$I_{o\leq}$–10 mA	V	U_R–0.01	U_R=5V	U_R+0.01
Output short-circuit current	[I_k]	U_o=0V	mA	10		25

Remarks:

Plug connection:	44	Function group:	Analog input
Connector designation:	FGR 1	Reference ground:	GND 0 (13)

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Input resistance	R_{in}	U_{in}	kΩ	0.301	0.307	0.313
Idle speed voltage	U_{LL}		V		U_R	
Input filter	τ	R_{Gen}=0Ω	m_s	0.9	1.5	2.1
Input voltage						
Evaluation range	U_{inz}		V	0.1		U_R–0.1
Data acquisition accuracy ΔU_{in} from input pin up to number of processors	F_{abs}	U_{in} is in range of U_{inz}	%			±3.5

Remarks:

Plug connection:	35	Function group:	Analog input
Connector designation:	MDB 1		
Reference ground:	GND 0 (13)		

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Input resistance	R_{in}	U_{in}	kΩ	2.0	2.05	2.1
Idle speed voltage	U_{LL}		V		U_R	
Input filter	τ	R_{Gen}=0Ω	m_s	0.3	0.5	0.7
Input voltage						
Evaluation range	U_{inz}		V	0.3		U_R
Data acquisition accuracy ΔU_{in} from input pin up to number of processors	F_{abs}	U_{in} is in range of U_{inz}	%			±2.0

Remarks:

Plug connection: 54
Function group: Analog input

Connector designation: HGB 1
Reference ground: GND 0 (13)

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Input resistance	R_{in}	U_{in}	kΩ	2.0	2.05	2.1
Idle speed voltage	U_{LL}		V		U_R	
Input filter	τ	R_{Gen}=0Ω	m_s	0.9	1.5	2.1
Input voltage						
Evaluation range	U_{inz}		V	0.1		U_R–0.1
Data acquisition accuracy ΔU_{in} from input pin up to number of processors	F_{abs}	U_{in} is in range of U_{inz}	%			±2.5

Remarks:

Plug connection: 36 Function group: Analog input

Connector designation: LDF 1 Reference ground: GND 0 (13)

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Input resistance	R_{in}	Range U_{in}	kΩ	96	100	104
Idle speed voltage	U_{LL}		V		GND 0	
Input filter	τ	R_{Gen}=0Ω	m_s	43	73	100
Input voltage						
Evaluation range	U_{inz}		V	0.1		U_R–0.1
Data acquisition accuracy ΔU_{in} from input pin up to number of processors	F_{abs}	U_{in} is in range of U_{inz}	%			+1.3 –2.0

Remarks:
- The data acquisition accuracy is based on radiometric signal processing with sensor supply LDF2 (at LDF 2= U_R)
- The data acquisition accuracy was determined by quadratic addition of individual faults

Plug connection:	33	Function group:	Sensor supply, short-circuit-proof
Connector designation:	LDP 2		

Description of output

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Output voltage	U_o	$I_o \leq -30$ mA	V	U_R–0.02	U_R	U_R+0.02
Output short-circuit current	$[I_k]$	U_o=0V	mA	30		78

Remarks:

Plug connection:	53	Function group:	Analog input
Connector designation:	WTF 1	Reference ground:	GND 0 (13)

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Input resistance	R_{in}	U_{in}	kΩ	0.735	0.752	0.765
Idle speed voltage	U_{LL}		V		U_R	
Input filter	τ	R_{Gen}=0Ω	m_s	0.3	0.5	0.7
Input voltage						
Evaluation range	U_{inz}		V	0.3		U_R
Data acquisition accuracy ΔU_{in} from input pin up to number of processors	F_{abs}	U_{in} is in range of U_{inz}	%			±0.9

Remarks:

- The data acquisition accuracy is based on radiometric signal processing with sensor applied to GND 0.
- The data acquisition accuracy was determined by quadratic addition of individual faults

Plug connection:	34	Function group:	Analog input
Connector designation:	KTF 1	Reference ground:	GND 0 (13)

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Input resistance	R_{in}	U_{in}	kΩ	0.735	0.75	0.765
Idle speed voltage	U_{LL}		V		U_R	
Input filter	τ	R_{Gen}=0Ω	m_s	0.3	0.5	0.7
Input voltage						
Evaluation range	U_{inz}		V	0.3		U_R
Data acquisition accuracy ΔU_{in} from input pin up to number of processors	F_{abs}	U_{in} is in range of U_{inz}	%			±2

Remarks:

– The data acquisition accuracy is based on radiometric signal processing with sensor applied to GND 0.

3.2Digital inputs, static

Plug connection: 39 Function group: Digital input

Connector designation: LGS-E Reference ground: BATT– (18, 19)

Description of input

Characteristic parameter			Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor		C_{EMC}		nF	1.2	1.5	2.2
Input resistance		R_{in}		kΩ	46	50	54
Idle speed voltage		U_{LL}		V		U_R	
Input filter		τ	R_{Gen}=0Ω	m_s		0.8	
Input voltage							
Permissible range		U_{in}		V	0		BATT+
Switching thresholds	Low	U_L			1.85		
	High	U_H					3.15
Switching hysteresis		U_{HYS}				0	

Remarks:

Plug connection: 23 Function group: Digital input

Connector designation: ZDR-E1 Reference ground: BATT– (18, 19)

Description of input

Characteristic parameter			Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor		C_{EMC}		nF	1.2	1.5	2.2
Input resistance		R_{in}		kΩ	2.4	2.5	2.6
Idle speed voltage		U_{LL}		V		BATT–	
Input filter		τ	R_{Gen}=0Ω	m_s		0.93	
Pull-down against BATT–		R_{pd}		kΩ		2.7	
Input voltage							
Permissible range		U_{in}		V	0		BATT+
Switching thresholds	Low	U_L	R_{Gen}=0Ω	V	4.5		
	High	U_H		V			7.0
Switching hysteresis		U_{HYS}	R_{Gen}=0Ω	V		0	

Plug connection: 41 Function group: Digital input

Connector designation: ZDR-E2 Reference ground: BATT– (18, 19)

Description of input

Characteristic parameter			Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor		C_{EMC}		nF	1.2	1.5	2.2
Input resistance		R_{in}		kΩ	2.4	2.5	2.6
Idle speed voltage		U_{LL}		V		BATT–	
Input filter		τ	R_{Gen}=0Ω	m_s		0.93	
Pull-down against BATT–		R_{pd}		kΩ		2.7	
Input voltage							
Permissible range		U_{in}		V	0		BATT+
Switching thresholds	Low	U_L	R_{Gen}=0Ω	V	4.5		
	High	U_H		V			7.0
Switching hysteresis		U_{HYS}	R_{Gen}=0Ω	V		0	

Plug connection:	43	Function group:	Digital input
Connector designation:	BRE-E	Reference ground:	BATT– (18, 19)

Description of input

Characteristic parameter			Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor		C_{EMC}		nF	1.2	1.5	2.2
Input resistance		R_{in}		kΩ	2.4	2.5	2.6
Idle speed voltage		U_{LL}		V		BATT–	
Input filter		τ	R_{Gen}=0Ω	m_s		0.70	
Pull-down against BATT–		R_{pd}		kΩ		2.7	
Input voltage							
Permissible range		U_{in}		V	0		BATT+
Switching thresholds	Low	U_L	R_{Gen}=0Ω	V	3.5		
	High	U_H		V			5.5
Switching hysteresis		U_{HYS}	R_{Gen}=0Ω	V		0	

Remarks:

3.3Digital inputs, dynamic

Plug connection: 21 Function group: Inductive sensor input

Connector designation: DZG 1 Reference ground: GND 0 (13)

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Input resistance	R_{in}		kΩ	4.55	4.65	4.75
Idle speed voltage	U_{LL}		V		GND 0	
Input filter	τ	R_{Gen}=0Ω	m_s		1.5	
Input voltage range	U_{in}	Amplitude at t_p/T=0.1	V_s	0.5		100
Basic threshold	U_{Gr}		V		0.225	
Threshold correction in % of U_{in}	S_n		%		40	
Discharge constant	τ_{EL}		ms		250	
Dead time for detecting 0 passage (H->L) of input signal up to processor	t_o		µs			5

Remarks:

Plug connection:	22	Function group:	Inductive sensor input
Connector designation:	HZG 1	Reference ground:	GND 0 (13)

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Input resistance	R_{in}		kΩ	4.55	4.65	4.7
Idle speed voltage	U_{LL}		V		GND 0	
Input filter	τ	R_{Gen}=0Ω	m_s		1.5	
Input voltage range	U_{in}	Amplitude at t_p/T=0.1	V_s	0.5		100
Basic threshold	U_{Gr}		V		0.4	
Threshold correction in % of U_{in}	S_n		%		40	
Discharge constant	τ_{EL}		ms		250	
Dead time for detecting 0 passage (H->L) of input signal up to processor	t_o		μs			5

Remarks:

Plug connection:	51	Function group:	Digital input
Connector designation:	FGG 1	Reference ground:	GND 0 (13)

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Input resistance	R_{in}		kΩ	4.6	4.85	5.1
Idle speed voltage	U_{LL}	$[I_{in}]$=0 mA	V		4.8	
Input filter	τ	R_{Gen}=0Ω	m_s		2	
Pull-up against 8.5 V	R_{pu}		kΩ		5.11	
Input voltage						
Permissible range	U_{in}		V	0		BATT+
Minimum input signal	U_{Emin}	$t_r=t_f$<10 ms	V_{pp}	2		
R_i acquisition						
Short-circuit detection $+U_{Batt}$	U_{in}	R_{Gen}=0Ω	V	8.5	28	
Short-circuit detection $-U_{Batt}$	U_{in}	R_{Gen}=0Ω	V		0	0.5

Remarks:

3.4Switch outputs

Plug connection: 14 Function group: Output stage switching to BATT+

Connector designation: EAB 1

Description of output

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Output voltage	U_o	at 2A	V	BATT+		BATT+
Output current	I_o	Output stage enabled	A			2
		Output stage disabled	mA			5
Current limitation	I_{oK}		A			12
Switching edges		I_L=2A				
Rise time	t_r		µs	3		150
Fall time	t_f		µs	3		150

Remarks:

3.5Interfaces

Plug connection: 29 Function group: Interface
Connector designation: MPS-A
Reference ground: GND 0 (13)

Description of output

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Output voltage						
HIGH status	U_0	at R_L=200 ϰΩ		BATT+ –0.5 V		BATT+
LOW status		I_0=20 mA	V			1.3
Pull-up against BATT+	R_{PU}		kΩ	2.4	2.55	2.7
Short-circuit current	I_{oLK}	Short to BATT+	mA	65		150
Switching edges		R_L=10 kΩ C_L=10 nF				
Rise time	t_r		µs		10	70
Fall time	t_f		µs		1	

Remarks:

Plug connection:	20	Function group:	Interface
Connector designation:	DIA-B	Reference ground:	BATT– (18, 19)

Characteristic parameter			Conditions	Dim.	Min.	Typ.	Max.
Input							
EMC capacitor		C_{EMC}		nF	1.2	1.5	2.2
Input resistance		R_{in}		kΩ	45		125
Idle speed voltage		U_{LL}		V		0.2	0.5
Input filter		τ	R_{Gen}=0Ω	µs		28	
Permissible range		U_{in}		V	0		BATT+
Switching thresholds	Low	U_L	R_{Gen}=0Ω	V	4		
	High	U_H		V			8
Switching hysteresis		U_{Hys}	R_{Gen}=0Ω	V		1.5	
Output							
Output voltage (Low)		U_o	at 1 A	V	BATT+ –1.5 V		BATT+
Output current		I_o	Output stage enabled	A			1
			Output stage disabled	mA			5
Current limitation		I_{oK}		A			12
Switching edges							
Rise time		t_r	I_L=1A	µs	3		150
Fall time		t_f		µs	3		150

Plug connection:	48, 49	Function group:	Interface
Connector designation:	ISO-K/ISO-L 1	Reference ground:	BATT– (18, 19)

Description ISO K (48)

Input (when Tx=High, i.e. output stage disabled)

Characteristic parameter			Conditions	Dim.	Min.	Typ.	Max.
Input							
EMC capacitor		C_{EMC}		nF	1.2	1.5	2.0
Input resistance		R_{in}		kΩ	20		22
Idle speed voltage		U_{LL}		V		BATT+	
Input filter		τ	R_{Gen}=0Ω	µs		0.08	
Battery voltage range		BATT+		V	8.5		32
Permissible range		U_{in}		V	0		BATT+
Switching thresholds	Low	U_L	R_{Gen}=0Ω	%BATT+	40		
	High	U_H		%BATT+			60
Output							
Output voltage		U_o	at 33 mA	V			0.6
Output current		I_o	Output stage enabled	mA			35
			Output stage disabled	mA			0.1
Short-circuit current shut-down		I_{oK}		mA	63		

Description ISO L (49)

Characteristic parameter			Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor		C_{EMC}		nF	1.2	1.5	2.0
Input resistance		R_{in}		kΩ	20		22
Idle speed voltage		U_{LL}		V		BATT+	
Input filter		τ	R_{Gen}=0Ω	µs		0.08	
Battery voltage range		BATT+		V	8.5		32
Permissible range		U_{in}		V	0		BATT+
Switching thresholds	Low	U_L	R_{Gen}=0Ω	%BATT+	40		
	High	U_H		%BATT+			60

Plug connection:	52	Function group:	Interface
Connector designation:	PB1-E	Reference ground:	GND 0 (13)

Description of output

Characteristic parameter			Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor		C_{EMC}		nF	1.2	1.5	2.2
Input resistance		R_{in}		kΩ	31.0	31.5	32.0
Idle speed voltage		U_{LL}	BATT+= 28 V	V		0	
Input filter		τ	R_{Gen}=0Ω	µs		7	
Pull-down against BATT–		R_{pd}		kΩ		39.7	
Input voltage							
Permissible range		U_{in}		V	0		BATT+
Switching thresholds	Low	U_L	R_{Gen}=0Ω	V	3.0		
	High	U_H		V			6.0
Switching hysteresis		U_{Hys}	R_{Gen}=0Ω	V		1.2	
Function range		BATT+		V	10		32

Remarks:

Plug connection: 28 Function group: Interface

Connector designation: TDS-A Reference ground: GND 0 (13)

Description of output

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Output voltage						
HIGH status	U_o	R_L=200 ϰΩ		BATT+ –0.5 V		BATT+
LOW status		I_o=12 mA	V			1.2
Pull-up against BATT+	R_{PU}		kΩ	2.4	2.55	2.7
Short-circuit current	I_{oLK}	Short to BATT+	mA	65		150
Switching edges		R_L=10 kΩ C_L=10 nF				
Rise time	t_r		µs		10	70
Fall time	t_f		µs		1	

Remarks:

3.6Fuel-delivery control circuit

Plug connection:	1, 2	Function group:	Switching output to BATT–
Connector designation:	MES 0		
Reference pin:	BATT– (18, 19)		

Description of output

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	2.4	3.0	4.4
Output voltage	U_{oL}	ON, at 11 A	V		1.2	1.8 V
	U_{oH}	OFF			BATT+	BATT+
LOW status		I_o=20 mA	V			1.5 V
Output current	I_o	Output stage disabled	mA			5
Current limitation	I_{oK}	Peak value	A			18
Switching edges		R_L=10 kΩ C_L=10 nF				
Rise time	t_r		µs		10	70
Fall time	t_f		µs		1	

Remarks:

This output stage is designed for operation together with the fuel delivery regulator of the injection system. The effective current value is determined by the duty factor of the output stage transistor, the battery voltage and the fuel delivery regulator
(R, L).
This signal controls the position of the control rod (see RWG M, Y, R).

Plug connection: 9 Function group: Control rod position evaluator circuit

Connector designation: RWG-M

Description of output

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Output voltage		With sensor				
Alternating voltage component	U_{AC}	at 6 mm control rod travel	V_{pp}		2.6	
Direct voltage component	U_{DC}		V		3.0	
Output frequency	f	With sensor	kHz		10	
Short-circuit protection	U_{KS}	max. 1 min.	V	–1		26

Remarks:

- Control rod position transducer with pick-off instrument coil
- A sinusoidal alternating voltage (to RWG-R in phase opposition) with superimposed direct voltage can be measured with the sensor connected.
- The inductive position sensor for the control rod in the injection system is evaluated via the 3 plug connections RWG-M, R and Y. A voltage proportional to the control position is made available in the control unit.
- Regulations concerning the installation of cables – particularly with regard to the capacitance per unit length – must be complied with.

Plug connection: 10 Function group: Control rod position evaluator circuit

Connector designation: RWG-R

Description of output

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Output voltage		With sensor				
Alternating voltage component	U_{AC}		V_{pp}		2.5	
Direct voltage component	U_{DC}		V		3.0	
Output frequency	f	With sensor	kHz		10	
Short-circuit protection	U_{KS}	max. 1 min.	V	–1		26

Remarks:

- Control rod position transducer with pick-off reference coil
- A sinusoidal alternating voltage with superimposed direct voltage can be measured with the sensor connected.
- The inductive position sensor for the control rod in the injection system is evaluated via the 3 plug connections RWG-M, R and Y. A voltage proportional to the control position is made available in the control unit.
- Regulations concerning the installation of cables – particularly with regard to the capacitance per unit length – must be complied with.

Plug connection: 11 Function group: Control rod position evaluator circuit

Connector designation: RWG-Y

Description of input

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}	Not applicable				
Input filter	τ	R_{Gen}=0Ω	µm		5.5	
Input voltage	U_E	With sensor	V		3	
Input resistance	R_E	U_E=3 V	kΩ	85		95
Short-circuit protection	U_{KS}	max. 1 min.	V	–1		26

Remarks:

– Control rod position transducer centre pick-off

– A direct voltage with a low alternating voltage component can be measured with the sensor connected.

– The inductive position sensor for the control rod in the injection system is evaluated via the 3 plug connections RWG-M, R and Y. A voltage proportional to the control position is made available in the control unit.

– Regulations concerning the installation of cables – particularly with regard to the capacitance per unit length – must be complied with.

3.7Main relay control

Plug connection:	47	Function group:	Digital input
Connector designation:	K15-E	Reference ground:	BATT– (18, 19)

Description of input

Characteristic parameter			Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor		C_{EMC}		nF	1.2	1.5	2.2
Input resistance		R_{in}		kΩ	2.5		
Idle speed voltage		U_{LL}		V			
Input filter		τ	R_{Gen}=0Ω	µs		250	
Input voltage							
Permissible range		U_{in}		V	–26		BATT+
Switching thresholds	Low	U_L	R_{Gen}=0Ω		2.5		
	High	U_H					16
Switching hysteresis		U_{Hys}	R_{Gen}=0Ω	V		5	

Remarks:

The main relay is activated (HRL 0) by the terminal 15 voltage (ignition lock) being applied at K15-E. If necessary, the control unit can deactivate the main relay with a delay when shutting down the vehicle.

This function can be programmed by way of software.

Plug connection: 46 Function group: Output stage switching to BATT–

Connector designation: HRL 0

Description of output

Characteristic parameter		Conditions	Dim.	Min.	Typ.	Max.
EMC capacitor	C_{EMC}		nF	1.2	1.5	2.2
Output voltage	U_o	at 0.3 A	V			1.2
Output current	I_o	Output stage disabled	mA			5.0
		Output stage enabled	A			0.3
Short-circuit current shutdown	I_{oK}		A	0.4		0.7
Switching edges						
Rise time	t_r		µs			
Fall time	t_f		µs			
Main relay resistance	R_{HRL}	T_{HRL}=20°C	Ω	160		

Remarks:

Electronic Diesel Control Guidelines for Preparing Wiring Harnesses

1. Introduction

In the EDC systems, it is very important to ensure correct connection between the sensors and actuators on the one hand and the control unit on the other.
This is achieved by means of a wiring harness. The system may fail and functions can be impaired if the plug connections and electrical lines are not selected and connected correctly in accordance with specifications.
Malfunctions with their cause in the wiring harness are very difficult to locate, making subsequent inspection and rectification intricate and expensive. Wiring harness and plug connection failures which remain undetected are often mistakenly attributed to unit/component failures.

2. General

The EDC wiring harness is subject to particular requirements with regard to design and environmental influences to ensure it does not interfere with the EDC functions.
Individual customer standards are not restricted by this guideline, but rather they are used as the basis for general wiring harness manufacture.
Information is only provided on lines which belong to the EDC system.

The relevant system connector drawings and terminal connection diagrams serve as the basis for wiring harness manufacture. They are compiled specifically for every new EDC system.
The connector drawing with parts list (Annex 1) represents the scope of delivery of the plug connectors used, indicates what wire cross sections are used and where individual connection points are to be planned. The terminal connection drawing with control unit connector assignments (Annex 2) shows in schematic form the connection between control units and actuators as well as sensors. It also indicates what wires are to be shielded or twisted. When assessing a system, the vehicle must be examined for possible irradiation and emission in an electromagnetic compatibility (EMC) test bay with a standard wiring harness.

Measures for the purpose of galvanic, capacitive and inductive decoupling must be implemented to ensure high EMC-specific interference immunity is achieved.
Some of these measures are:

– Isolation of power circuits from sensor lines by separate cable routing

– Avoiding routing wires subject to pulses and sensor wires in parallel

– Shielding of cables and wires

– Twisting wires in pairs

– If possible, maintaining distance between wires and cables of different systems

3. Plug connectors and sockets

Blade and pin terminal plugs are used as the connection elements in EDC systems. Refer to the wiring harness drawing (Annex 1) for the plug connectors used in the relevant project. Any customer-specific plug connectors to be used should be checked in accordance with Bosch connector specifications.
Zinc, silver and gold are used as contact materials. The same materials should always be used for the PIN and socket.

- Mounting contacts in connector housings:

  – The notes on design and assembly (Annex 3) should be used as the basis for producing connectors and wiring harnesses.

– The contact handling procedure is described in Point A 1.

4. Cable/wires, general

Heat and diesel resistant PVC or PUR insulated copper stranded wires complying with DIN 72551 should be used. For strength reasons, the minimum permissible wire cross section is 0.5 $mm^{2.}$ Specified cross sections:

– 0.5 – 1.0 mm^2 for all instrumentation and control lines

– 1.0 – 2.5 mm^2 for all 12 V or 24 V supply lines

– 4.0 – 6.0 mm^2 for supply leads from the battery to the connection points

Observe Points 5.1 and 6. when selecting the cross section.

Cables not subjected to mechanical load can also be designed as leads with reduced insulation thickness.
A low-capacitance special cable (e.g. 3x1.0 mm^2 Radox 125) may be necessary for the control rod position transducer line if this involves a longer wiring harness.

For protection purposes, the lines should be routed in a non-woven PVC tube complying with DIN 40621 which must be diesel and oil-proof in the engine compartment.

4.1Wiring harnesses

The wires of the EDC system are combined in a wiring harness and must not be routed together with other systems. Malfunctions attributable to the wiring harness are not expected, if the specified limits are complied with. The specified limits should be considered as extreme values, i.e. lower values are to be aimed for. In addition to the physical limits for wiring harnesses and the corresponding measuring procedure, concrete proposals with regard to the design of the wiring harness are also provided.

- Wiring harnesses which, based on experience, fulfil the physical limits.

  – Length up to 6.0 m, wiring harnesses made up of individual conductors, with loose to close bundling of conductors. The cables leading to the control rod position transducer should be made up of either twisted conductors or a 3-core cable.

  – Length up to 8.0 m, wiring harnesses made up of individual conductors, loosely arranged in a plastic tube, while closely routed wires (bundled every 50 cm, twin wires, twisted wires) are used for supply and return lines to pulsed actuators (inductive coupling) and a 3-core low-capacitance cable is used for the supply leads to the control rod position transducer.

  – Length over 8.0 m, wiring harnesses in which the conductors considered as sources of interference (e.g. pulsed actuator lines) and interference-sensitive lines (sensors) are bundled separately, and a 3-core low-capacitance special cable is used for the supply lines to the control rod position transducer are realized by.

4.2Manufacture of wiring harnesses

Wiring harnesses are manufactured in accordance with customer-specific guidelines.
Line and insulation crimping must take place together with the correct tools, where machine crimping is to be preferred. The notes provided in Annex 3 under Point A2 – A13 must be observed when producing the wiring harness.

4.3Installation of wiring harnesses

The EDC wiring harness must be installed separately from other wiring harnesses. If spatial separation is not possible, suitable measures must be implemented to ensure that no interfering pulses can penetrate the system from the outside.
Avoid sharp bends and kinks during installation. Protect the wiring harness from direct water spray.
The quotation drawings should also be used as part of the installation instructions for the relevant wiring harnesses. The information provided under Points B1 – B10 must also be complied with (Annex 3).

5. Physical limits

5.1Resistance

Permissible resistance for supply and return conductors of the fuel-delivery actuating solenoid

at 20 °C 200 mΩ

For all other supply lines, a line resistance should be selected such that the voltage cannot drop below the minimum setpoint even under extreme conditions.

The leakage resistance R_A at plug connections of sensors and actuators must not exceed a specified limit over the entire service life. The R_A limit values are specified in the TKUs for the sensors and controllers.

5.2Inductance

Permissible mutual inductance between measuring power circuits and actuator power circuits

$$M_K < 1\ \mu H$$

Explanations

- Interference sources:
  Pulsed actuator line with rates of current rise more than 5000 A/s.

- Faulty lines:
  Sensor supply lines and signal lines, particularly from the control rod position transducer

- Measuring method:
  Impressing a delta or sinusoidal current with current rise rates of approx. 50 000 A/s ($\triangleq$ dI/dt) on two conductors with short-circuited ends. Measurement of the induced voltage U_{ind} at a second loop made up from two conductors with short-circuited ends.

  Mutual inductance:
  $$M_K = \left| \frac{U_{ind}}{dI/dt} \right|$$

- Mutual inductance scatter:
  Random scatter of the mutual inductance occurs on cable harnesses made up of non-sorted individual conductors. The maximum possible mutual inductance must therefore be determined by way of statistical evaluation.

- Measurement can be dispensed with if the requirements stipulated in Section 4.1 (wiring harnesses) are fulfilled.

- Special measures for very long wiring harnesses:
  In the case of very long wiring harnesses, the following wiring arrangement of supply and return lines of interference sources ensure that the upper limits are complied with:

  – Bundling of conductors every 50 cm
  – Use of twisted-pair lines
  – Twisting at a rate of approx. 10/m

5.3Capacitance

Maximum permissible coupling capacitance C_K between interfering and interfered line during EDC operation $C_K \leq 200$ pF

Explanations:

- Interference sources:
  Lines whose signals exceed voltage rise rates of approx. 0.1 V/µs (e.g. pulsed actuator lines, speed sensors)

- Interfered lines:
  Sensor supply lines and other signal lines, in particular the lines leading to
  – control rod position transducer (RWG Y line)
  – rpm sensor (particularly when measuring at flywheel)

- Effective coupling capacitance during EDC operation:
  With the EDC system active (sensor, actuator and control unit connected), low-resistance terminated conductors (e.g. ground lines, actuator lines) act as a shield. For this reason, the coupling capacitance measured during EDC operation is less than the coupling capacitance measured at the non-connected wiring harness (between two conductors).

- Measurement of effective coupling capacitance in the vehicle during EDC operation
  To ensure effective results, measurements in vehicles should be carried out in accordance with the following procedure.

  – Measurement instruments: Capacitance bridge with a measuring frequency of 1...10 kHz

  – Adapter (matching EDC system), e.g.
    EDC 53.1 (M(S)5) Y 462 U00 101

– Measurement arrangement and procedure

  a) Disconnect system from power supply.

  b) All sensors and actuators remain connected.
     Disconnect the plug connector at the injection pump.
     (Measurements in laboratory: The wiring harness is connected only on the control unit end. The other lines remain open.)

  c) Connect system-dependent test adapter between control unit and wiring harness.

  d) Connect control unit signal ground with signal ground of capacitance bridge.

– Measurements:

  Measure the capacitance between following lines:
  e.g.:

NKW systems

Interference source		Interfered line
a) DZG 1	➞	RWG M
b) DZG 1	➞	RWG R
c) DZG 1	➞	RWG Y
d) MES 0	➞	DZG 1
e) MES 0	➞	RWG M
f) MES 0	➞	RWG R
g) MES 0	➞	RWG Y

The test temperature should be T_U = 20 °C ambient cable temperature. The values given above must not be exceeded during these measurements.

Capacitance scatter:

Random scatter of the capacitance occurs on cable harnesses made up of non-sorted individual conductors. Several wiring harnesses should therefore be measured.

Special measures for very long wiring harnesses:

Separate bundling of actuator lines (sources of interference) and sensor lines (interfered lines) reduces coupling capacitance.

In view of capacitive coupling in very sensitive signal lines due to the shield effect of ground lines, it may be appropriate to route the signal line and corresponding signal ground very close to each other (twisted-pair or twisted line). The coupled voltage of sources of interference is reduced in this way.

5.3.1 Requirements relating to supply lines to the inductive control rod position transducer

Permissible capacitive load of supply lines to the control rod position transducer in the wiring harness

Measurement must be conducted in order to determine the permissible capacitive load to the control rod position transducer. The test setup is the same as described under Section 5.3 but the pump connector is connected and the capacitance measuring instrument can be dispensed with. An additional capacitance is connected at the control unit plug connector between the RWG Y line and the signal ground in order to simulate increased capacitive load in the wiring harness. All lines which are routed parallel to the supply lines to the control rod position transducer both at the control unit as well as at the corresponding sensors, actuators etc. must be connected.

- Measurement

  Switch on the EDC system, the additional capacitance is set to 0 pF, the U_{actual} value is approx. 0.5 V.

  Continuously increase the additional capacitance until the U_{actual} value is greater than 1.0 V. The additional capacitance $C_{additional}$ must not drop below following values:

Wiring harness at = 25 °C dry	Wiring harness at = 70 °C dry	Wiring harness at 25 °C, but moist or oily as far as possible in practical applications
$C_{additional}$ = 400 pF	$C_{additional}$ = 300 pF	$C_{additional}$ = 300 pF

- Capacitance scatter:

  The capacitance is subject to strong scatter from wiring harness to wiring harness when the wiring harness is made up of individual conductors. Statistical evaluation is therefore necessary.

- Remedy for excessively high capacitive load of supply lines to the control rod position transducer

  – Twisting of the three individual conductors at a minimum rate of 20/m
  – Use of a 3-core low-capacitance cable

Accuracy of control position evaluation

An evaluation error is caused by the asymmetrical wiring harness capacitance at a fixed control or slide valve position.

This control or slide valve position error is dependent on the evaluator circuit and must be determined for each project.

- Explanations

  – Test
  Measurement of a representative batch of wiring harnesses in accordance with 5.3.
  The effective capacitance during EDC operation and its scatter (statistical evaluation) must be determined.

- Remedy for excessively high scatter of the capacitive loads between the supply lines to the control rod position transducer

  – Twisting of the three individual conductors at a minimum rate of 20/m

  – Use of a 3-core low-capacitance cable

6. Voltage supply

The EDC systems should be connected to the general vehicle electrical system in accordance with the terminal connection diagram. Three criteria must be taken into consideration when connecting the supply voltage:

– Low line resistance in the supply and return lines. If this point is disregarded, cold starting difficulties can arise as the minimum voltage of the control unit is below specified values.
The ground lead should be routed separately and not over the body as high contact resistances can occur at the transition points which change negatively due to ageing and environmental influences.

– Routing EDC supply currents and starter current via common cables/body sections can also result in starting difficulties.

– Major interfering influences caused by switching peaks of motors, switches and relays which can cause malfunctions in the control unit.

The following guidelines should be complied with to ensure these criteria do not have negative effects on the system:

– The supply voltage should be connected directly to the battery at positive and negative terminals.

– If this type of connection cannot be implemented, care must be taken to ensure that the distance between the alternator and battery is as small as possible. This ensures reduced residual ripple in the vehicle electrical system.

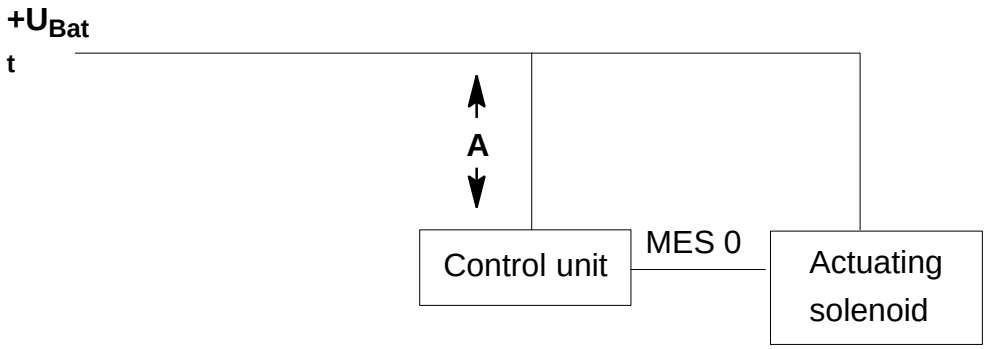
– The supply and return lines should be kept short in order to avoid excessive voltage drops.

Further measures are suggested in order to ensure effective and trouble-free operation with the EDC system:

– The sensor or actuator ground must not be coupled with the vehicle ground otherwise interference voltages can flow into the system.

– The control unit features a no-lead diode for the actuating solenoid. The positive supply line of the actuating solenoid should therefore be positioned electrically “close” to the control unit and electrically “far from” the EDC power supply. Otherwise, the self-induction peak of the solenoid coil can spread relatively unhindered in the vehicle electrical system.

The distance “A” must be small:



– Inductive loads must not be disconnected by switches, relays etc. from the EDC control unit or battery positive terminal if it cannot be ensured that the inductance is canceled by suitable means. Otherwise, when the switch is opened, contact sparkover would occur which would couple interference onto all neighbouring lines of the wiring harness. The interference could cause the control unit to fail.

If the EDC system is connected to another system (e.g. traction control), a system-dependent coupling ground must be used to ensure that the effects do not cause mutual interferences. These interferences can be triggered by large potential offsets at the ground and pulse peaks.

Pin No.	Abbreviation	Description		
1	MES O	Activation for fuel-delivery actuator	Output, fuel-delivery control circuit f=variable, pulse-width modulated	I_{max} 11 A temporarily, on average 4.5 A, against batt.+, pulsded,
2	MES O	Activation for fuel-delivery actuator	Output, fuel-delivery control circuit	
3	VHS O	Pre-stroke actuator activation	Output, start of delivery control circuit f approx. 200 Hz, pulse-width modulated	I_{max} 6 A temporarily, on average 3 A, against batt.+, pulsed,
4	VHS O	Pre-stroke actuator activation	Output, start of delivery control circuit	
5	MBR 1	Engine brake actuator	Output (switch)	I_{max} 2 A, $U_{batt.}$ against batt. –,
6	LEB 1	Air injection	Output (switch)	I_{max} 2 A, $U_{batt.}$ against batt. –,
7	WGS 1	Waste gate	Output (switch)	I_{max} 1 A, $U_{batt.}$ against batt. –,
8	LKS 1	Intercooler bypass	Output (switch)	I_{max} 1 A, $U_{batt.}$ against batt. –,
9	RWG M	Control rod position transducer measuring coil (RWG 2)	Control rod position evaluator circuit	
10	RWG R	Control rod position transducer reference coil (RWG O)	Control rod position evaluator circuit	
11	RWG Y	Control rod position transducer centre pick–off (RWG 1)	Control rod position evaluator circuit	
12	CAN O	Reference ground for CAN H/L		
13	GND-A	Sensor ground		
14	EAB 1	Electrical shut-down	Output (switch)	I_{max} 1 A, $U_{batt.}$ against batt. –,
15	Batt.+	Batt. + via main relay	Input battery +	I with engine stationary 0.9 A, idle speed 1.5 A, operation 4.5 A, temporarily 16 A
16	Batt.+	Batt. + via main relay	Input battery +	
17	NBF 0, HZGO	Needle movement sensor and auxiliary rpm sensor	Reference ground:	
18	Batt.–	Battery negative	Input battery –	I Same as batt.+ (terminals 15 and 16)
19	Batt.–	Battery negative	Input battery –	
20	DIA-B	Diagnosis lamp	Output (switch)	I_{max} 1 A, $U_{batt.}$ against batt. –,
21	DZG 1	RPM sensor signal	Input, dynamic N sec.$^{-1}$	Alternating voltage U_{pp} idle speed approx. 2 V, max. 80 V, f=number of cyl. X
22	HZG 1	Auxiliary rpm sensor signal	Input, dynamic	Alternating voltage U_{pp} idle speed approx. 2 V, max. 80 V, f=number of cyl. X N sec.$^{-1}$
23	ZDR-E1	Intermediate engine speed control 1	Input, static	Batt. +
24	BRK-E	Brake switch signal	Input, static	Batt. +
25	FMS-E	Function-mode switch FGR/FGB	Input, static	Batt. +
26	KUP-E	Clutch switch signal	Input, static	Batt. +
27	PWG 1	Pedal position sensor signal	Input, analog	Direct voltage, U approx. 0.4 to 4 V
28	TDS-A	Engine speed signal	Output	$U_{batt.}$ against batt. –, square-wave signal, f=number of cyl. X N sec.$^{-1}$
29	MPS-A	Multiplex signal	Interfaces	
30	CAN-L	Controller Area Network	Interfaces	
31	CAN-H	Controller Area Network	Interfaces	
32	NBF 1	Needle movement sensor	Input, dynamic	U_{pp} approx. 2 V
33	LDF 2	Turbo pressure sensor	Output, supply	Controlled direct voltage, U approx. 5 V
34	KTF 1	Fuel temperature sensor (used for charge air temperature)	Input, analog	
35	MDB 1	Multi-stage input (torque limitation)	Input, analog	Input by change in resistance
36	LDF 1	Turbo pressure sensor signal	Input, analog	
37	FGB 1	Driving speed limit lamp	Output (switch)	I_{max} 1 A, $U_{batt.}$ against batt. –
38	EOL E	Input, static		
39	LGS-E	Idle speed switch signal	Input, static	against GND-O (terminal 13)

Pin No.	Abbreviation	Description		
40	KIK-E	Kick-down switch	Input, static	Batt. +
41	ZDR-E2	Intermediate engine speed control 2	Input, static	Batt. +
42	MBR-E	Engine brake signal	Input, static	Batt. +
43	BRE-E	Brake switch signal	Input, static	Batt. +
44	FGR 1	Analog driving speed operating unit	Input	Input by change in resistance
45	PWG 2	Pedal position sensor	Output, supply	Controlled direct voltage, U approx. 5 V
46	HRL O	Main relay	Output (switch)	I_{max} 0.3 A, batt. – against batt.+
47	K15-E	Terminal 15, digit. Data for control unit	Input, static	Batt. +
48	ISO-K	ISO-K link to ISO protocol	Interfaces	
49	ISO-L	ISO-L link to ISO protocol	Interfaces	
50	TKS-E	Door contact switch	Input, static	Batt.+
51	FGG 1	Driving speed sensor signal	Input, dynamic	Square-wave voltage U_{pp} 8.5 V, f=variable
52	PB1-E	Pulse-width modulated input signal 1	Interface	
53	WTF 1	Coolant temperature sensor	Input, analog	
54	HGB 1	Multi-stage input, maximum speed limitation	Input, analog	Input by change in resistance

A. Manufacture

1. Contacts

1.01 Contact material : Tin bronze
Surface : Tinned

1.1 All contacts must be fitted in the correct position in the chambers and locked in a floating arrangement in the connector housings.
Optionally, the contacts can be fitted turned through 180 degrees in the 2-pin to 7-pin connector housings with manual release and not featuring options for ultrasonic caulking (see Page 5).

1.2 Careful handling of the contacts is necessary
Protection against damage is not provided before being fitted in the connector housing.
Damaged contacts: Contact points bent
Latching springs bent
must not be used.

1.3 The specified additional latching elements must be used on multiple connector housings.

2. Line and insulation crimping must take place together with the correct tools. Particular care must be taken to ensure that the fixing tool and the contact match the reduced insulation thickness.

2.1 Withdrawal force of individual conductor out of the crimp connection:

1.0 mm^2	min.	160 N
1.5 mm^2	min.	200 N
2.5 mm^2	min.	250 N
4.0 mm^2	min.	350 N
6.0 mm^2	min.	500 N

3. There must be no insulation in the conductor crimping.

4. The conductor must be crimped over the entire connection point.
4.1 Protruding individual wires only in permissible area (not up to contact point).

5. Insulation crimping of the lines must be continuous (important as protection against bending and as strain-relief).
5.1 The insulation must be crimped over the entire connection point.

6. Cable shoes which are not capable of being crimped must be additionally soldered after connection. The insulation must not be damaged.
6.1 Additionally solder crimp connection if specified in the drawing.

7. Insulating sleeves must be firmly interconnected at the branch points.
Length of overlap approx. 20 mm
7.1 The transition point must be tightly bonded.

8. The insulating sleeves must be fitted in the rubber grommets up to approx. 20 mm.

8. The insulator sleeve must be secured with the clip on 15-pin, 25-pin, 35-pin, 55-pin and 88-pin connector housings (strain relief).

10. Folds and creases in the diameter between the insulating tube and rubber grommet are not permitted.

11. Protective caps must be fitted in the connector housing.

12. Cable straps must be provided and firmly tightened at the specified points.

13. Refer to page 4 for general information.

B. Installation

1. Preferred position: Connector output facing downward

2. Water ingress in the wiring harness (insulating conduit) must be prevented.

3. Water is not permitted in the area of the plug connector.

4. Protect openings in the wiring harness from direct water.

5. Do not arrange wiring harness branches which could under certain circumstances against the spray direction of water.

6. Implement the following measures if water ingress in the wiring harness cannot be avoided.

6.1 The wiring harness must be set lower in the vicinity of the plug connection.

6.2 In addition, an interruption in the insulating tube is necessary at the lowest point (drip-off point).
– Interruption: approx. 30 – 60 mm.
– Perforation over a length of: approx. 30 – 60 mm.

6.3 Ensure sufficient spacing from the interruption up to the plug connection.

6.4 Protect interruption from direct water.

6.5 A rubber grommet with individual core leadthroughs is required for conditions subject to extreme water load.

7. The fit of the rubber grommet of the plug connection must not be subject to impermissible load when installing the wiring harness.
7.1 Use angled grommets if necessary (more difficult to install).

8. The rubber grommet must not be inclined at the cable outlet.

9. The following points must be observed when using cable cross sections < 0.5 mm^2 (e.g. 0.35 mm^2, 0.5 mm^2):

Only protected cables should be installed in the engine compartment (e.g. in insulating conduit)
A right-angled (r < 5 cm) arrangement of the wiring harness is not permitted as, in extreme cases, the maximum permissible tensile force (100 N) may be exceeded at the outer lines.

10. The cable must not be subject to tensile load (e.g. connection to a fixed part) when installing the plug connectors otherwise there may be a risk of chafing corrosion at the plug connection (contact to blade).
The plug connection must be arranged such that the contacts have sufficient clearance, i.e. “float”.

C. General information

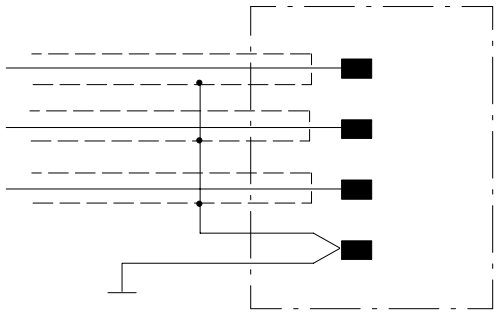
The following remedial measures are recommended in the case of little space in the recessed grip:

1. Use lines with an outside diameter of 0.35 mm^2.

2. Use, multi-pole shielded lines (number of lines 2, e.g. joining several knock sensor lines), min. line cross section 0.35 mm^2.

3. Join the shield potentials outside the recessed grip by means of a connector and lead single feeder line into recessed grip (see diagram).

Block diagram



The proposed measures should always be coordinated with the corresponding circuit and application department (e.g. due to EMC).

Pin No.	Abbreviation	Description	Minimum cable cross-section to Bosch Y462 U04 015 (mm^2)
1	MES O	Activation for fuel-delivery actuator	2,5 I_{max} = 11 A
2	MES O	Activation for fuel-delivery actuator	2,5
3	VHS O	Control-slide mechanism	2,5 I_{max} = 6 A
4	VHS O	Control-slide mechanism	2,5
5	MBR 1	Not used	
6	LEB 1	Not used	
7	WGS 1	Not used	
8	LKS 1	Not used	
9	RWG M	Control rod position transducer measuring coil (RWG 2)	0,75
10	RWG R	Control rod position transducer reference coil (RWG O)	0,75
11	RWG Y	Control rod position transducer centre pick-off (RWG 1)	0,75
12	CAN O	Not used	
13	GND A	Sensor ground	0,75
14	EAB 1	Electrical shut-down	1,5 I_{max} = 1 A
15	Bat +	Batt.+ via main relay	2,5
16	Bat +	Batt.+ via main relay	2,5
17	NBF 0, HZGO	Needle movement sensor and auxiliary rpm sensor	0,75
18	Bat –	Battery negative	2,5
19	Bat –	Battery negative	2,5
20	DIA-B	Diagnosis lamp	0,75
21	DZG 1	RPM sensor signal	0,75
22	HZG 1	Auxiliary rpm sensor signal	0,75
23	ZDR-E1	Intermediate engine speed control 1	0,75
24	BRK-E	Not used	
25	FMS-E	Not used	
26	KUP-E	Not used	
27	PWG 1	Pedal travel sensor signal	0,75
28	TDS-A	Engine speed signal	0,75
29	MPS-A	Multiplex signal	0,75
30	CAN-L	Controller Area Network	1,0 (CAN-cabels twisted)
31	CAN–H	Controller Area Network	1,0 (CAN-cabels twisted)
32	NBF 1	Needle movement sensor	0,75
33	LDF 2	– boost pressure sensor	0,75
34	KTF 1	Fuel temperature sensor	0,75
35	MDB 1	Multi-stage input (torque limitation)	0,75
36	LDF 1	Boost pressure sensor signal	0,75
37	FGB 1	Not used	
38	EOL E	Not used	
39	LGS-E	Idle speed switch signal	0,75
40	MST-E	External engine cut–out	0,75
41	ZDR-E2	Intermediate engine speed control 2	0,75
42	MBR-E	Not used	
43	BRE-E	Not used	
44	FGR 1	Speed control device	0,75
45	PWG 2	Pedal travel sensor	0,75
46	HRL O	Main relay	1,0 I_{max} = 1 A
47	K15-E	Terminal 15, digit. Data for control unit	0,75
48	ISO-K	ISO-K link to ISO protocol	0,75
49	ISO-L	ISO-L link to ISO protocol	0,75
50	TKS-E	Door contact switch	0,75

Pin No.	Abbreviation	Description	Minimum cable cross-section to Bosch Y462 U04 015 (mm^2)
51	FGG 1	Driving speed sensor signal	0,75
52	PB1-E	Pulse-width modulated input signal 1	0,75
53	WTF 1	Coolant temperature sensor	0,75
54	HGB 1	Multi-stage input, maximum speed limitation	0,75
55	LTF 1	Charge-air temperature sensor	0,75

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