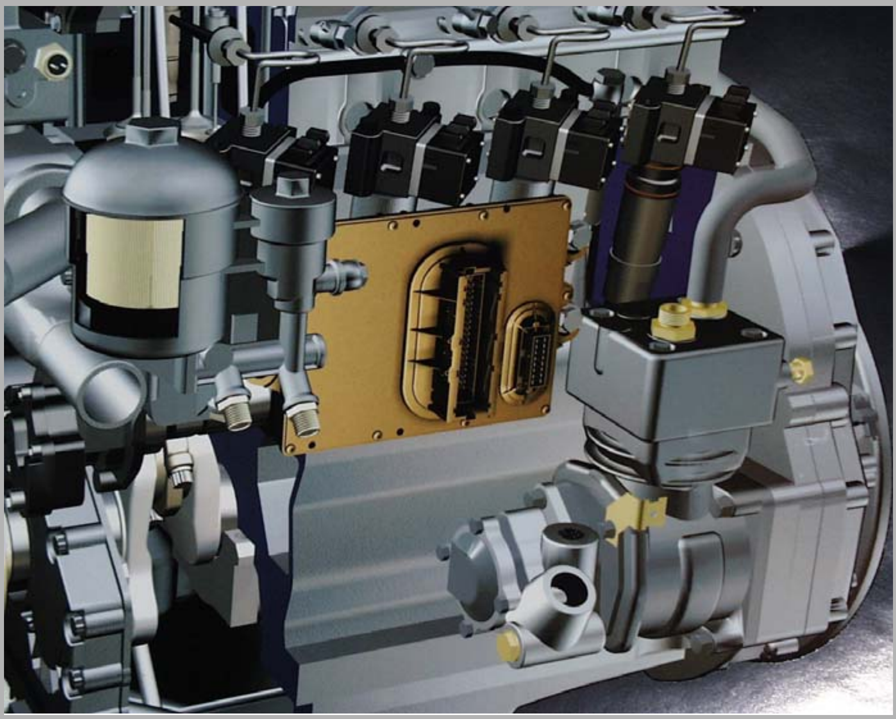
Mercedes-Benz



Operating Instructions for Engine Control Unit MR2A/MR2B

Document information

Applicability

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List of versions

Version	Date	Compiled by	Comments/description
1.0	14.09.2007	Vornberger	Preliminary version (draft)

Revision levels

Version	Date	Compiled by	Amendment

H**Environmental protection**

Daimler's declared policy is one of integrated environmental protection that begins at the roots of the factors which affect the environment and takes all the ecological effects of its production processes and its products into account in corporate decision-making.

The objectives are for the natural resources which form the basis of our existence on this planet to be used sparingly and in a manner which takes the requirements of both nature and humanity into account.

Thank you for choosing a Mercedes-Benz product.

These Operating Instructions describe the MR2A and MR2B engine control units and are intended to help you understand the technology contained in these control units. It also provides you with important information regarding diagnosis and any troubleshooting procedures that you may need to carry out.

You can obtain assistance and advice at any time from a Mercedes-Benz Service Center.

These Operating Instructions also make reference to the Operating Instructions for the "MR-PLD engine control unit“. Please keep these accessible.

Mercedes-Benz is constantly updating its engine control units to the state of the art and therefore reserves the right to introduce changes in design, equipment and technical features. You cannot, therefore, base any claims on the data, illustrations or descriptions in these Operating Instructions.

Mercedes-Benz AG

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Key to symbols

The following symbols are used in this document to indicate different types of information notices.

GRisk of injury

This symbol is used for all safety notices where there is a direct risk of injury or death to humans should these notices be disregarded.

Important

This symbol is used for all safety notices where there is a principal risk of material and functional damage should these notices be disregarded.

Note

This symbol is used for tips and notes.

HEnvironmental notice

This symbol is used for tips and information on environmental protection.

General

GRisk of injury

Incorrect changes to parameters or work carried out incorrectly on the wiring may change the behavior of the engine or the vehicle substantially. Persons could be injured or property damaged as a result.

The engine control unit, as engine control system MR2, determines how the engine and vehicle operate. Functions such as the precise electrical actuation of the unit pumps by means of solenoid valves, fuel injection, fault detection, engine protection, limp-home mode, diagnosis, etc. are critical to safety.

The MR2 control unit has been developed and tested in accordance with the Mercedes-Benz Guidelines for Operational Reliability and EMC Performance. The vehicle manufacturer or other user has sole responsibility for observing and checking regulations and legal conditions applicable to the vehicle or the application.

Proper use

The Mercedes-Benz engine and control unit MR2 are exclusively intended for the purpose that has been specified in the contract. Any use that differs from or goes beyond the intended use is regarded as improper use.

Mercedes-Benz Truck Group accepts no liability for any damage caused as a result.

The manufacturer of the complete machine/vehicle bears sole responsibility for any damage resulting from such use.

This Operating Instructions for the MR2 and the vehicle Owner's Manual must be observed.

Requirements of personnel

Work on the electrical system and parameter setting operations may only be carried out by suitably trained personnel or personnel who have been trained by Mercedes-Benz and by specialist personnel in workshops authorized by Mercedes-Benz.

Converting and modifying the MR2 control unit

Unauthorized modifications to the MR2 control unit may impair the function and safety of the engine or vehicle/machine. No liability is accepted for any resulting damage.

Installation

The installation guidelines and notes from Mercedes-Benz must be followed.

Organizational actions

These Operating Instructions are to be issued to personnel working on the MR2 and, where possible, should be kept readily accessible.

With the aid of these Operating Instructions, personnel should be shown how to handle the MR2 control unit. In particular, the safety instructions relating to the engine must be explained. This particularly applies to personnel who only carry out occasional work on the engine and the MR2.

In addition to these Operating Instructions, the generally applicable national, legal and otherwise binding regulations relating to accident prevention and environmental protection must be observed.

Safety precautions for engines with electronic control units

GRisk of accident and injury

When first commissioning the engine electrical system, the drive train must be open, i.e. the transmission must be shifted to neutral.

Wiring faults or inappropriate parameter settings could cause the engine to start unintentionally. If the drive train is closed (i.e. if the transmission is not in neutral), the vehicle could be inadvertently set in motion or the working machinery could start operating as a result, thereby endangering human life.

Important

The following safety precautions must be followed in order to avoid damage to the engine, components and wiring harness and to prevent personal injury:

- **Only start the engine if the batteries are securely connected.**
- **Do not disconnect the batteries with the engine running.**
- **Only start the engine if the speed sensor is connected.**
- **Do not start the engine using a rapid charging device. Always use separate batteries when jump-starting.**
- **When rapid-charging the batteries, the battery cable terminals must be disconnected. Follow the operating instructions for the rapid charging device.**
- **When carrying out electric welding work, the batteries must be disconnected and the two cables (+ and -) must be securely connected to each other.**
- **The electrical system must be switched off when carrying out any work on the wiring and when connecting and disconnecting connectors.**
- **When first commissioning the engine, it must be possible to switch off the power supply to the engine control (MR) and the vehicle electronic control system (MR2 or FRE) in the event of an emergency.**
- **Due to wiring faults, it might not be possible to switch off an engine when it is running.**
- **If the control unit supply voltage has incorrect polarity (caused, for example, by incorrect polarity of the batteries), the control units may be destroyed.**
- **Ensure that connections to the injection system are tightened to the specified tightening torque.**
- **When carrying out measurements at connections, ensure that the appropriate test cables (Mercedes-Benz connection set) are used.**

Important

If temperatures over 80 °C are expected (such as the temperatures encountered in drying ovens), the control units must be removed, as they may be damaged at these temperatures.

Important

Telephones and two-way radio sets that are not connected to an external aerial may cause malfunctions in the vehicle electronics and thereby endanger the operational reliability of the engine.

Original Mercedes-Benz parts

Original Mercedes-Benz parts are subject to the strictest quality controls and guarantee optimum functionality, safety and value retention. Each part is specially designed, manufactured, selected and approved for Mercedes-Benz.

Therefore Mercedes-Benz accepts no responsibility whatsoever for any damage caused as a result of the use of parts and accessories that do not meet these requirements.

In the Federal Republic of Germany and in some other countries, certain parts, for example safety-related parts, are only approved for installation and conversion if they comply with legal regulations. Original Mercedes-Benz parts meet these requirements in every instance.

If other parts that have not been tested and approved by Mercedes-Benz are used, it is not possible, despite ongoing market investigations, to evaluate and guarantee these parts - even if, in individual cases, these parts have been accepted or officially approved. Mercedes-Benz may therefore unilaterally limit any warranty claims.

Under the legal warranty terms, any faulty units must be returned to the Mercedes-Benz field organization.

Safety and limp home program

The MR2 and FRE electronic control units monitor the engine and perform self-checks. As soon as a fault is detected an assessment of the fault is carried out and one of the following measures implemented automatically:

- Faults are displayed during operation by actuation of warning lamps.
- Switchover to a suitable substitute function that enables the engine to continue running, but in restricted mode (e.g. constant limp-home rpm).

Important

Have faults rectified immediately at an authorized Mercedes-Benz Service Station.

Fault codes

For a list of fault codes and remedial actions for the MR2 control unit, see Page 121 onwards.

Note

The diagnostic version DiagV9 is being replaced by diagnostic version DiagV28.

Note

Fault codes can be read out via the Daimler AG diagnostic tester (minidiag2) which is connected to the 14-pin diagnostic socket (unit side).

List of abbreviations

List of abbreviations

ADR	Working speed control (**A**rbeits**D**rehzahl**R**egelung)
AGN	Exhaust gas aftertreatment (**A**b**G**as**N**achbehandlung)
EGR	**E**xhaust **G**as **R**ecirculation
AKL	Exhaust flap (**A**uspuff**KL**appe)
ASP	Working cycle (**A**rbeits**SP**iel)
ATG	MB Mercedes-Benz automatic transmission (**A**u**T**omatik**G**etriebe)
AVD	Automatic compression detection (**A**utomatische **V**erdichtungs**D**etektion)
BK	Exhaust brake valve (**B**rems**K**lappe)
BR	(Engine) model series (**B**au**R**eihe)
CAN	**C**ontroller **A**rea **N**etwork
CONAS	**CON**figurable **A**pplication **S**ystem
CRT	**C**ontinuous **R**egeneration **T**rap
CS	**C**heck**S**um
DKL	Throttle flap (**D**rossel**kl**appe)
DOC	**D**iesel **O**xidation **C**atalyst
DPF	**D**iesel **P**articulate **F**ilter
ECU	**E**lectronic **C**ontrol **U**nit
EHM	**E**ngine **H**istory **M**ap
EMC	**E**lectro**M**agnetic **C**ompatibility
EOL	**E**nd **O**f **L**ine
EPW	Electropneumatic converter (**E**lektro**P**neumatischer **W**andler)
EZA	Individual cylinder adjustment (**E**inzel**Z**ylinder**A**bgleich)
FB	Start of delivery (**F**örder**B**eginn)
FDOK	Vehicle documentation system (**F**ahrzeug-**DOK**umentationssystem)
FLA	Flame starting system (**FL**amm**A**nlage)
FPS	Accelerator pedal sensor (**F**ahr**P**edal**S**ensor)
FR/FRE	Vehicle control electronics (**F**ahrzeug**R**egel**E**lektronik) (e.g. ADM, ADM2, VCU, FR/FMR, UCV, CPC)
FRT	Free running message (**F**ree **R**unning **T**elegramm)
FSP	Fault memory (**F**ehler**SP**eicher)
FW	Angle of delivery (**F**örder**W**inkel)
GMA	Base torque adaptation (**G**rund**M**oment**A**daption)
HB	**H**igh **B**yte
HFL	Heater flange (**H**eiz**FL**ansch)
HW	**H**ard**W**are
ID	**ID**entifier (CAN message)
IES	**I**ntegrated **E**lectronic **S**ystem
IMO	Industrial engines (**I**ndustrie**MO**toren)
INS	**INS**trument
KD/KDR	Constant throttle (**K**onstant**DR**ossel)
KF	Map (**K**enn**F**eld)
KL	Characteristic curve (**K**enn**L**inie)

KO	Constant (**KO**nstante)
K-line	Communications line (**K = K**ommunikation**)** (serial)
KW	Crankshaft (**K**urbel**w**elle)
LB	**L**ow **B**yte
LL / LLR	Idling/Idling speed control (**L**eer**L**auf/**L**eer **L**auf **R**egelung)
LRR	Smooth-running controller (**L**auf **R**uhe **R**egler)
LK	Lightweight (vehicle) class (of MB commercial vehicles) (**L**eichte **K**lasse)
LS	**L**ow **S**peed (CAN)
MBR	Engine brake (**M**otor**BR**emse)
MI	**M**alfunction **I**ndicator
MOS-FET	**Metal O**xide-**S**emiconductor **F**ield-**E**ffect-**T**ransistor
MR	Engine control (**M**otor**R**egelung) (e.g. MR2 or MR-PLD)
MS/MTS	Engine protection (**M**o**T**or**S**chutz)
MU	**M**onitoring **U**nit
MV	Solenoid valve (**M**agnet**V**entil)
MZA	Mechanical supplementary charging (**M**echanische **Z**usatz**A**ufladung)
NACK	**N**egative control unit **ACK**nowledge
n.d.	**n**ot **d**efined
CV	**C**ommercial **v**ehicle
NW	Camshaft (**N**ocken**W**elle)
OAB	Oil trap (**O**el**AB**scheider)
OM	Oil engine (**O**el**M**otor)
TDC	**T**op **D**ead **C**enter
PFA	Particulate filter system (**P**artikel**F**ilter**A**nlage)
PID	Parameter IDentifier (diagnostics) or Proportional Integral Differential controller
PLD	Pump-line-nozzle (**P**umpe-**L**eitung-**D**üse)
Prop/PV	**Prop**ortioning **V**alve (power output)
PWM	**P**ulse **W**idth **M**odulation
RM	Frame module (**R**ahmen**m**odul)
SCR	**S**elective **C**atalytic **R**eduction
SCR(CR)T	**S**elective **C**atalytic **R**eduction **T**rap
SRC	**S**ignal **R**ange **C**heck
SEG	**SEG**ment
SG / Stg.	Control unit (**St**euer**G**erät)
S.n.a.	**S**ignal **n**ot **a**vailable
SK	Heavy (vehicle) class (of MB commercial vehicles) (**S**chwere **K**lasse)
STG	Manual transmission (**S**chal**TG**etriebe)
SW	**S**oft**W**are
TG	Test device (**T**est**G**erät)
TN	(CAN) user (**T**eil**N**ehmer)

TPC	**T**rans**P**onder**C**ode
BDC	**B**ottom **D**ead **C**enter
VTG	**V**ariable **T**urbine **G**eometry
WS	Maintenance system (**W**artungs**S**ystem)
WSP	Immobilizer (**W**egfahr**SP**erre)
CYL	**CYL**inder

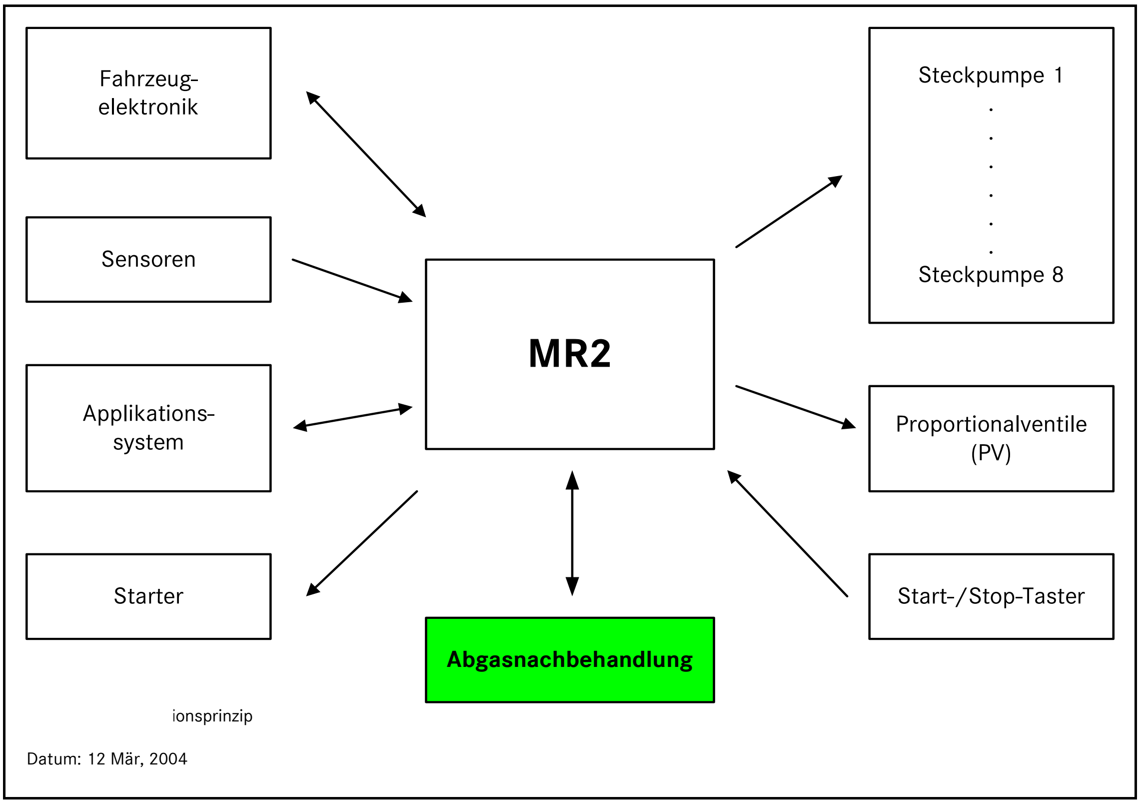
The MR2 diesel engine control unit

The MR2 control unit is an electronic diesel injection system for engine model series 500, 900 and 4000. The control unit's main task is the precise electrical actuation of the unit pumps. The optimum start of injection and optimum injection quantity are calculated as a function of engine and environmental conditions (such as requested torque, engine speed, atmospheric pressure, charge air pressure, oil pressure, coolant temperature, fuel temperature). The start and duration of injection are controlled cylinder-selectively by means of solenoid valves.

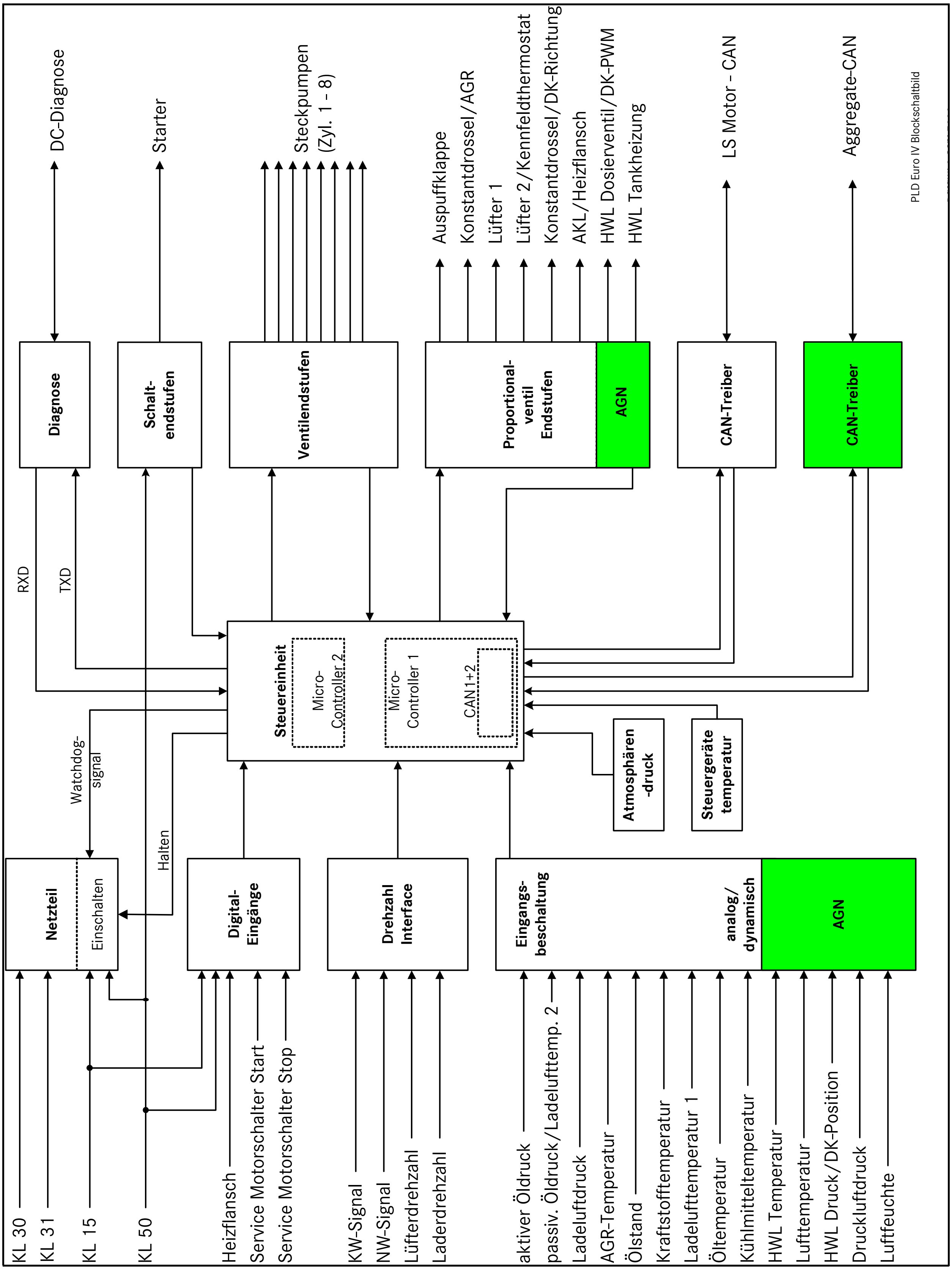
The control unit also provides functions such as fault detection, limp-home options, diagnosis and interfaces to other control systems. As of the MR2B1.2 hardware release, the control unit also incorporates exhaust gas aftertreatment control (SCR process), including communication with the SCR-RM control unit.

The MR2A (backward compatible with PLD-D3.1) and MR2B hardware versions have different pin assignments and functionalities; however, since most features are common to both, they are described jointly in these Operating Instructions and respective differences are pointed out separately.

Control unit operating principle

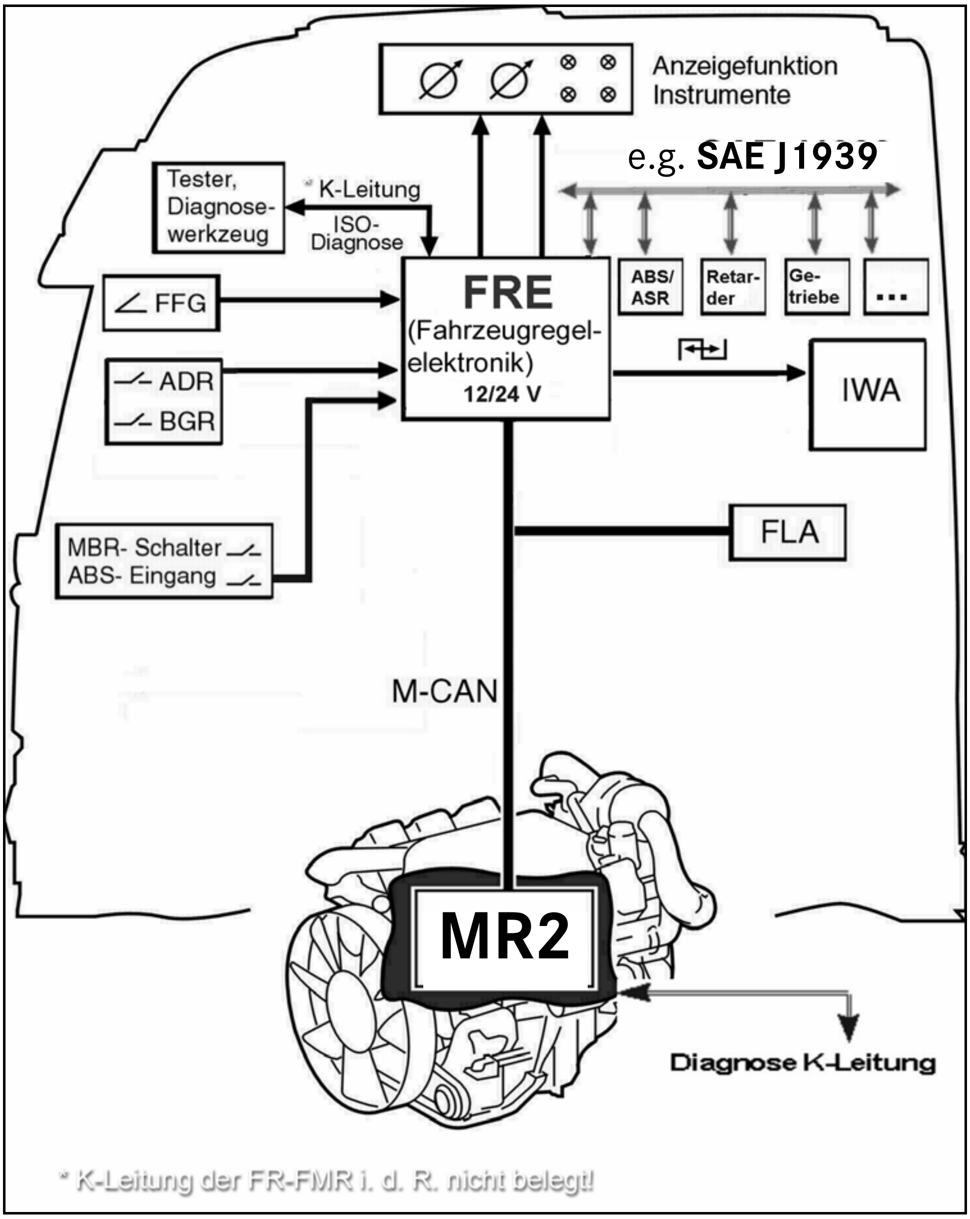


Block diagram of control unit



Connecting the MR2 control unit to the vehicle

ABS	Anti-lock braking system	FLA	Flame starting system
ADR	Working speed control	ISO	International Organisation for Standardization
FRE	Vehicle control electronics	IWA	Actual value output (for automatic transmissions, customer-specific electronics, etc.).
ASR	Acceleration skid control	MBR	Engine brake
BGR	Restrictions	MR2	Engine control 2 (pump-line-nozzle injection system)
FFG	Foot throttle actuator (driving or rpm instruction)	SAE J1939	High speed CAN (vehicle-side)



Note

For the purpose of clarity, the abbreviation "FRE" is used in this document to refer to various vehicle control systems (ADM/ADM2, VCU, FR-FMR, UCV, CPC etc.).

Configuration

The electronic system is split into two separate subsystems, each of which can be tested separately.

The *FRE* control unit mounted in the cab controls the sensors and actuators located in the cab or attached to the vehicle frame and contains all the functions relevant to the vehicle.

Control unit MR2, mounted on the engine, controls all the sensors and actuators attached to the engine and contains the functions that are critical for engine operation.

Both control units are connected with each other by means of a bus connection (CAN) with "single-wire capability". The respective FRE specifies setpoints and engine operating mode (e.g. idle speed increase, engine-speed regulated engine running characteristics in accordance with nominal speed, torque limitation, selectable control characteristics, engine braking torque, etc.) via the CAN.

In addition, information on the engine's instantaneous operating state (e.g. flame starting system) is sent in the opposite direction, from the MR2 control unit to the FRE.

Advantages:

- Precise electrical actuation of the unit pumps via solenoid valves
- The number of connections on the engine is reduced to the engine-related ones
- The vehicle connections are located in the less critical cab environment (high acceleration and temperature loads are encountered in the engine environment)
- Fewer connecting lines between engine and vehicle (reduced to the CAN connection which is less critical in terms of EMC) - particularly advantageous in buses because the controls are located a long way from the engine
- The computers are only occupied with the tasks and functions of the respective system (the MR2 computer is entirely dedicated to engine management and is not occupied with any vehicle functions)
- Modular expansion of the system's electronics is possible by means of additional modules connected via the bus system.

Concept flexibility

Since each subsystem is a self-contained system and can be tested as such, it is possible to replace the respective engine with a different design engine of the same power category (e.g. a PLD engine can be replaced with a common rail engine) without having to change the parameter settings in the vehicle control unit (FRE).

4, 5, 6 and 8-cylinder engines can be operated with the same MR2. Additional engine equipment, such as VTG, wastegate, high-speed fan drive, etc., can be closed-loop or open-loop controlled or switched via 6 PWM outputs on the MR2. An additional switch output is reserved for starter actuation.

The functional requirements of other electronic systems, such as ABS, ASR, EPB, electronic drive control, automatic transmission, retarder, etc., are managed via vehicle CANs, such as the IES CAN, and coordinated and processed for the engine electronics (MR2) in the FRE.

Safeguards/redundancy:

The MR2 is designed as a 2-computer system. This means that if the main computer fails, the emergency computer takes over the actuation of the solenoid valves on the unit pumps. Engine speed is then constant (at approx. 1300 rpm). This redundancy feature (namely that if a "functional component" should fail there is at least one other functional component available to take over) also applies to the solenoid valves (unit pumps), rpm sensors, starter actuation and engine CAN (single-wire capability). In addition, the electronics are fitted with a "watchdog" function, extensive self tests are continually being carried out and reciprocal monitoring with the FRE is also implemented.

Description of the inputs:

- 9 temp. inputs for coolant, oil, fuel, charge air 1 and 2, AdBlue, EGR, ambient air and control unit (internal sensor)
- 6 pressure inputs for atmospheric pressure (via internal sensor), charge air pressure, oil pressure (active and passive), compressed-air pressure and AdBlue pressure
- 1 input for oil level
- 1 input for air humidity
- 2 spare analogue inputs
- 2 binary inputs for -the service start and stop buttons in the engine compartment, see also "Engine start and stop“, Page 25
- 2 inputs for crank angle and cam angle measurement
- Holes, slots or teeth (spec. pulse wheel) and lugs can be used as engine marks (observe correct polarity).

Description of the outputs:

- 4/8 outputs for unit pumps (fewer are possible)
- 1 output for starter actuation
- 6 (8 for MR2B release) further PWM modulated multi-function outputs for actuating other components such as high-speed fan drive, wastegate, viscous clutch, etc
- The outputs can be assigned by parameter input, see also "Proportioning valve actuation“, Page 68.

Relationship between MR2 and FRE

Communication

The FRE sends requests to the MR2 via the CAN, such as:

- Torque request by means of accelerator pedal instruction (controlled mode, i.e. normal driving)
- Working speed governor type (total of 5 types)
- In the case of working speed regulation mode: nominal speed and max. torque.

The MR2 sends the following data to the FRE:

- Measurements (sensor values) such as rpm, temperature, pressure, etc.
- Feedback of operating mode.

Note

Should the CAN fail completely, e.g. if there is a line break, no communication between the FRE and MR2 is possible. In this case, MR2 switches to a limp home program. If just one of the two control/data lines fails, then communication can still be maintained via the remaining line and ground (single-wire operation).

MR2 <=> FRE coupled functions

Idle speed/engine speed/maximum speed control

- Selection of rpm governor:

  The FRE determines the operating mode of MR2 through selection of the rpm governor.

  Governor structures are implemented for idle speed control- (type 15 "LL") and for working speed control (type 0 - type 5; type 0 internal only). MR2 informs FRE of its current operating mode via the CAN.

- Idle speed control/driving:

  If the FRE does not request any working speed control, this means normal driving mode. The engine is controlled by the accelerator pedal. Idle speed and max. governed rpm are regulated by the idling speed governor and the maximum speed governor.

  The FRE is able to increase the idle speed setpoint by sending an "Increased idle speed" instruction. The instruction is restricted by the MR2's maximum governed rpm.

  The MR2 transmits the current idle speed via the CAN (16 rpm/bit).

- Working speed control:

  If the FRE requests a valid working speed governor and specifies a plausible rpm setpoint for this and a valid engine torque setpoint for limiting the governor, engine-ON mode will switch to working speed control.

  The control torque is limited by restricting the power output ("corrected limit torque"). The rpm setpoint is limited by the current idle rpm and the current maximum governed rpm.

- Maximum engine speed control:

  The FRE is able to reduce the configured max. governed rpm down as far as the MR2's internal idle speed by sending a valid "Maximum engine speed" instruction.

  The subsequently calculated engine speed is sent back to the FRE as the "current max. governed rpm". Maximum speed control limits the engine speed to the current maximum value regardless of operating mode.

Shutting off or throttling the engine via the FRE

Engine braking:

- Case 1:

  The constant throttle (MBR-KD) and exhaust brake valve (MBR-BK), if present and parameterized, are actuated primarily by the FRE. The FRE informs the MR2 of the status. The MR2 is able to request the constant throttle and/or the exhaust brake valve.

- Case 2

  The mechanical supercharger is actuated by the MR2. Here, the FRE requests the MR2 to operate the engine brake. The MR2 informs the FRE as to whether the mechanical supercharger is switched on or available.

In both cases, no fuel is injected when the brake is active; the controller is deactivated.

Once the braking function is no longer active, injection remains suppressed for a specific period of time. The FRE torque instruction is then enabled via a factory-set increase.

Engine stop, zero quantity:

If an engine stop request is sent to the MR2 via the CAN, fuel injection is suppressed.

Starter actuation starting lock, zero quantity:

If a starting lock is sent to the MR2 via the CAN, fuel injection is likewise suppressed and the starter is locked.

Engine start and stop

Essentially, there are two different forms of engine start actuation (starter types). Corresponding parameter setting determines which one is selected .

1. Starting by MR2 (default setting/JE starter)
1. External starting (not by MR2/KB starter)

Starter actuation (conditions)

If the appropriate parameters are set, the engine control unit (MR2) actuates the engine starter by means of a relay. A redundant output stage is provided for this purpose (multiple protection). Four input signals (start sources) are able to trigger starter actuation:

- Terminal 50 signal, engine control unit input
- Terminal 50 signal from engine CAN
- “External start” signal from engine CAN
- Service start button on engine, engine control unit input.

In addition, the following voltages must be applied or switched in parallel at the MR2 and FRE for an engine start:

- Terminal 30 supply voltage
- Terminal 15 ignition.

Once the minimum engine speed of 50 rpm is reached, fuel injection via the unit pumps is enabled. The starter demeshing speed varies depending on engine and temperature. When terminal 15 ignition is switched on, the controller initialization period is around 300 ms. The terminal 50 button should not be actuated beforehand. During the starting procedure, the voltage supply is permitted to drop to a certain "limit"; if it drops below this threshold, the starter reset jumper prevents the starter from being actuated (fuel injection is also suppressed).

Starter protection

For safety reasons, the starter is either locked, switched off or disengaged in the following conditions:

- The engine cannot be started when terminal 50 is actuated with terminal 15 ignition switched off
- The is automatically disengaged if the factory-set maximum engine speed for starter operation is exceeded, thereby protecting the starter from damage caused by overspeeding
- The maximum starting period is limited; consequently a starting lock is implemented when the permissible period is exceeded in order to prevent the starter from burning out. The starting procedure can commence again after a delay (at the earliest one second after the starter has been switched off)
- A starting lock is implemented for as long as engine speed remains above 50 rpm ("engine running" status)
- The engine is running and the starter is not engaged ("engine running" status)
- The starting lock from the CAN is active
- On a vehicle with automatic transmission, the engine can only be started if the "neutral" input is activated on the FRE
- The starter is also locked if the KB starter parameter is set in the engine control unit (MR2). In this case, the text "Starter type KB" will appear in the starter status display“.
- The starter cannot be activated if three short circuit events have been detected at the starter output stage output. In this case, the text "Starter short circuit" will have already appeared in the starter status display after the first event.

For safety reasons, the signal that triggered a start must be received back again before another start based on the same signal is possible (lock).

Driver start

Provided the starter is not locked a "Driver start" can be initiated via the terminal 50 signal at the engine control unit (MR2) input. A driver start has priority over all other start signals. If the MR2's terminal 50 signal is present but the "Terminal 50" signal from the CAN is not active, the fault "Terminal 50 inconsistent" is stored in the fault memory after one second and the start is delayed by this amount of time (see also the paragraph "Terminal 50 plausibility check"). MR2's terminal 50 signal is ignored if this has already been detected as ON during the control unit ramp-up. This prevents an uncontrolled start, for example if there is a conductor-to-conductor short circuit between the terminal 15 and terminal 50 lines. The exception to this is the starter reset jumper (see section of the same name).

CAN start

Provided the starter is not locked, a "CAN start" can be initiated via the "Terminal 50" or "External engine start" signals by the engine CAN. If the terminal 50 signal from the CAN is present, but the MR2 has not detected its own terminal 50 signal as ON, the fault "Terminal 50 inconsistent" is stored in the fault memory after one second and the start is delayed by this period of time; see also "Terminal 50 plausibility check" on Page 28. A start, e.g. via the "Programmable Special Module|" (PSM) can be initiated directly via the "External engine start" signal from the CAN.

Starter reset jumper

In cold starting conditions, particularly on 12 V systems, it is possible that the engine control unit (MR2) may execute a reset and start up again because of an excessive drop in starting voltage. To guarantee engine starting in this situation, a so-called starter reset jumper has been implemented.

If an engine start has been regularly initiated via the terminal 50 signal and no short circuit occurred, the engine control unit stores corresponding temporary starting information. If the engine control unit now detects a "warm start" (control unit starts up and detects that the power-down had not been ended previously) and if the temporary starting information is also detected, the starter's emergency branch is not locked, as is usually the case, but instead is enabled up to the "end of warm start". At that point, provided the start signal remains valid, starter actuation is switched to the main branch. The starter remains engaged and an engine start can now be performed. The starting information, along with the warm start ID, are deleted when control unit power-down is completed. Another item of information, likewise of a temporary nature, deactivates the immobilizer in the event of a starter reset jumpering, provided it was possible to deactivate it before the drop in starting voltage.

Starter output stage

The starter output stage has multiple redundancy. The so-called main branch consists of two transistors connected in series and supplied with voltage from the battery. In normal situations, the starter is actuated via this main branch.

The so-called emergency branch is fed via terminal 50 and may be enabled during a terminal 50 start if, for example, the main branch is faulty. The emergency branch is also used if the main computer of the engine control unit is faulty. As the emergency branch does not have any short-circuit protection on the hardware side, it is only ever used after the main branch has been activated and if no signal has been detected via the main branch.

The main computer is able to activate the main branch (STA1 und STA2) and lock or enable the emergency branch (STA-EMERG). Fault detection is done by means of level measurement at the starter output stage output (STA-level) and by short circuit detection (STA-short-circuit detection) in the main branch.

CAN start by the vehicle control electronics (FRE)

The FRE starts the engine directly via the CAN if it sends a start request to the MR2 via the CAN and if the MR2 has not received a signal from the service start button on the engine block or if it does not detect terminal 50 as ON. In this situation, the engine is started with a delay of 1 second, provided this is permitted (neutral).

Note

The FRE has a higher priority than the MR2 because it is located in the protected area of the cab and is therefore not exposed to any external influences (temperature, dirt, etc.).

The starter is disengaged if a condition is met or if terminal 50 or the service start button is switched ON and then OFF again.

Starting procedure

To ensure safe starting and keep emissions as low as possible, engine starting is performed regardless of the accelerator pedal position.

Start quantities and start of delivery are determined from maps as a function temperature and rpm.

The start quantity is increased if required. Likewise starting is aborted if the maximum starting period is exceeded (starter protection).

Service start button on engine block

GRisk of injury

For safety reasons, the engine cannot be started by the vehicle control electronics (FRE) via the service start button on the engine block if a gear is engaged. It is only possible to start the engine via the service start button on the engine block if the transmission is in neutral and the engine CAN is intact (starting is not possible in CAN limp home mode and when operating without a CAN).

If the starter is not locked (see Page 25), a "button start" can be initiated by the engine control unit (MR2) via the service start button on the engine block if the ignition is switched on.

When the service start button on the engine block is pressed, the MR2 requests an engine start via the CAN. The FRE checks if this is permissible (e.g. transmission in neutral, etc) and confirms the request. The MR2 then actuates the starter.

The starter is disengaged if the service start button on the engine block is released or the starter protection function is active (see Page 25). If the service start button on the engine block is released and the start request from the CAN (MR2 => FRE) is still active, this request is ignored until cancellation ("CAN start lock"). This prevents the starter function from being maintained.

Service stop button on the engine block

The engine can be switched off via the service stop button on the engine block. The FRE is informed of the engine stop (engine stop, zero quantity).

Cranking the engine via the service start and stop buttons

If the engine is started via the service start button and the service stop button is pressed at the same time, the engine can be cranked with the aid of the starter without injecting any fuel. Fuel injection is enabled again if either both buttons are released and the engine comes to a standstill or the service start button on the engine block is pressed for at least two more seconds after the stop button has been released.

Revving the engine via the service start button

The idle speed can be increased up to the current max. governed rpm via the service start button on the engine block. This requires the engine to have been started by pressing the service start button on the engine block and then releasing it again.

If the service start button on the engine block is then actuated again while the engine is running, the setpoint of the idling speed governor is increased from the current speed to the current maximum governed rpm via a configurable ramp.

When the button is release, the rpm setpoint immediately drops back to the actual idle speed. Once activated by a start via the service start button on the engine block, the function remains active until the engine stops (speed = 0 rpm). Pressing the service start button again on the engine block will again raise the setpoint from the current speed to the current maximum governed rpm. There is no lag after the button has been actuated, the operator can feel the engine's response immediately.

Stopping the engine

An engine stop can be initiated by the following two methods:

- Actuating the external stop button of the FRE:

  The button must remain pressed until the engine stops. If the engine speed is more than 50 rpm, the engine will start up again. As a result, the engine will not be stopped if you briefly press the engine stop button by accident.
- Terminal 15 ignition off (MR2 and FRE):

  After the terminal 15 control inputs from the MR2 and FRE have been switched off, the terminal 30 power supply must be present for approx. 10 more seconds. This enables the permanent fault memory to be written to in the power-down phase. If terminal 30 is disconnected immediately, the data in the fault memory may be defective or not current if a diagnosis is subsequently carried out on the controllers. When the engine is re-started, the controllers are checked for plausibility and any defective data are corrected.

Terminal 50 plausibility check

The fault "Terminal 50 inconsistent" indicates that the terminal 50 signal from the MR2 and the terminal 50 signal from the CAN have been different for longer than one second. Actuation of the starter is delayed by this length of time.

The check is not carried out:

- in CAN limp home mode
- if parameterized for operation without CAN
- if parameterized for the KB starter (starter not actuated by MR2)
- if there is a starting lock from the CAN
- if, within the first 500 ms after a control unit reset, one of the two terminal 50 signals is detected as "on"
- if the engine is started via the service start button on the engine block but has not (yet) been stopped via the service stop button on the engine block.

In these cases, starter actuation, where permitted, is not delayed.

Angle of delivery/start of delivery calculation

- Start of delivery calculation:

  Depending on the operating status, the start of delivery is calculated for starting mode or for engine ON operation as a function of the set torque.
- Start of delivery restriction:

  The calculated start of delivery is limited to the current maximum permissible and a minimum permissible value.
- Angle of delivery calculation:

  The angle of delivery is calculated from the pulse-width map as a function of the corrected set torque and, by means of the unit pump actuation period, is a measure for injection quantity. Cylinder-selective torque corrections (e.g. from the smooth-running controller, etc) are also carried out in this angularly aligned part of the torque controls.

The engine's torque output is controlled via the foot throttle actuator (FFG), taking into consideration the engine operating point.

To ensure that the engine is not overloaded, the torque request from the driver is subjected to a speed-dependent power restriction.

Further restrictions are also imposed by the maximum speed control, smoke limiting (in accordance with engine speed and calculated air mass) and engine protection functions. Finally, the fuel temperature and EOL detail correction are carried out.

The angle of delivery, which is a measure for the injected fuel quantity, is calculated from another map as a function of engine speed and the restricted torque request from the driver.

The start of delivery, from which the start of injection results, is calculated as a function of the engine speed and the torque request. Dynamic and static correction functions are implemented to ensure adaptation to the prevailing operating conditions.

EOL detail correction

To compensate for production tolerances during engine manufacture a torque EOL (end of line) detail correction is implemented in the MR2 engine control unit. A torque correction factor is calculated from an engine-speed dependent characteristic curve, the factor being limited to a minimum and maximum permissible value ("permissible scatter").

The set torque is evaluated using the resulting factor, with the correction having an effect across the entire map.

In case values are changed by an application, the EOL characteristic curve is stored permanently in the EEPROM by switching off terminal 15. As a safeguard, a checksum is generated and stored as well. If the EEPROM is written to or read incorrectly, the correction curve is reset.

Controls (PID controller)

Several controllers are implemented to regulate engine speed:

- Idle speed is regulated by a PID controller which is supported by a map
- Working speeds are regulated by other controllers with PID structures; their parameters are set in the data set (cannot be changed by parameterization)
- A PI controller, also with map support, is used to regulate maximum rpm.

Note

PID controllers are parameter-optimized controllers. Having fixed parameters, they can only be optimally set to one (linearized) operating point.

Type	Characteristics	Application
0	PID controller 1 set of parameters (fixed) Engine brake can be requested	Engine speed adjustment when gearshifting. Required for: - Exclusive DC development
1	PID controller 2 parameter sets (fixed) for large signal and small signal	Working speed control Standard working speed controller
2	PID controller Parameters are controlled by characteristic line 1 set of parameter characteristic curves	Very dynamic applications e.g. concrete pumps
3	PID controller 1 set parameters (fixed)	Working speed control 25 % more dynamic than type 1
4	Corresponds to type 3 working speed control	Working speed control 25 % weaker than type 1
5	Corresponds to type 1 working speed control	Working speed control 50 % weaker than type 1

Operating modes

Working speed control

Working speed control mode is specified by the vehicle control electronics (FRE). Different speed governors are required, depending on the application.

Controlled operation (normal operation)

If the engine receives signals from the accelerator pedal, this operating mode is referred to as "controlled operation".

Immobilizer

The immobilizer operates by means of so-called transponder codes that are programmed into the vehicle key. If the immobilizer is "active", please contact a Mercedes-Benz Service Center.

Tow-starting

If the ignition is on, the engine can also be tow-started. When the minimum engine speed of 50 rpm is reached, fuel injection via the unit pumps is enabled and the engine is able to start.

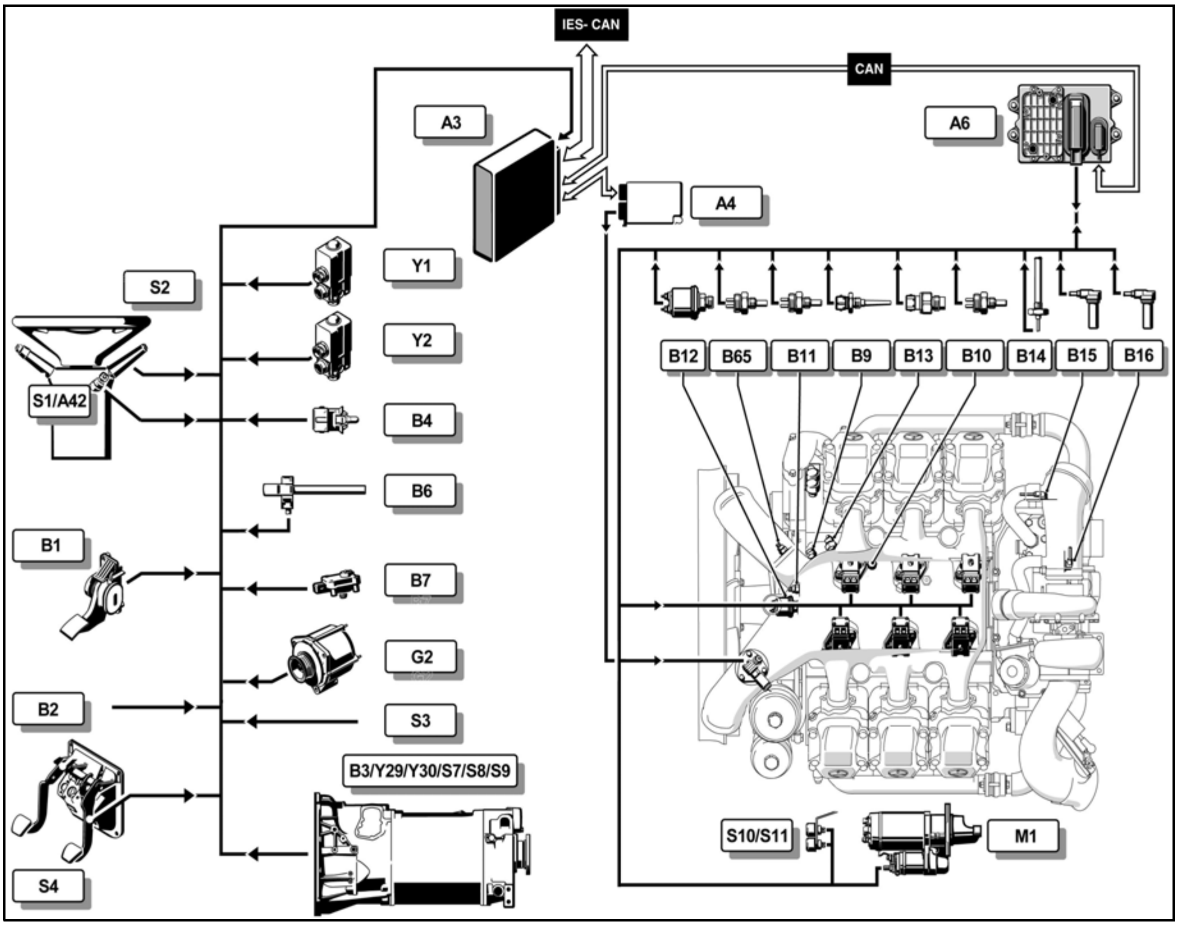
Emergency operation

If the control unit is faulty or the immobilizer is activated, it is still possible to move the vehicle with the starter. This function enables the vehicle to be moved out of a hazardous area (e.g. from a railway embankment) in an emergency.

General overview of the Telligent engine system for the 500 model series

A3	FRE control unit (FR-FMR)	B65	Coolant temperature sensor
A4	Flame starting system control unit	G2	Generator
A6	MR2 control unit	M1	Starter
A42	Electronics for reading transponder code	P1	Speedometer/tachograph
B1	Foot throttle actuator	S1	Driving switch
B2	Clutch travel sensor	S2	Engine control/auxiliary brake actuation
B3	Layshaft speed sensor	S3	Splitter switch
B4	Ambient temperature sensor	S4	Stop lamp switch
B6	Coolant level switch	S7	Reverse gear switch
B7	Air filter monitoring sensor	S8	Range position switch
B9	Charge air temperature sensor	S9	Neutral switch
B10	Fuel temperature sensor	S10	Engine start[1] push-button switch
B11	Oil temperature sensor	S11	Engine stop[1] push-button switch
B12	Oil pressure pick-up	Y1	Constant throttle solenoid valve
B13	Charge pressure sensor	Y2	Engine brake solenoid valve
B14	Oil level sensor	Y29	MS2 solenoid valve
B15	Crank angle position sensor	Y30	MS1 solenoid valve
B16	TDC sensor, cylinder 1		

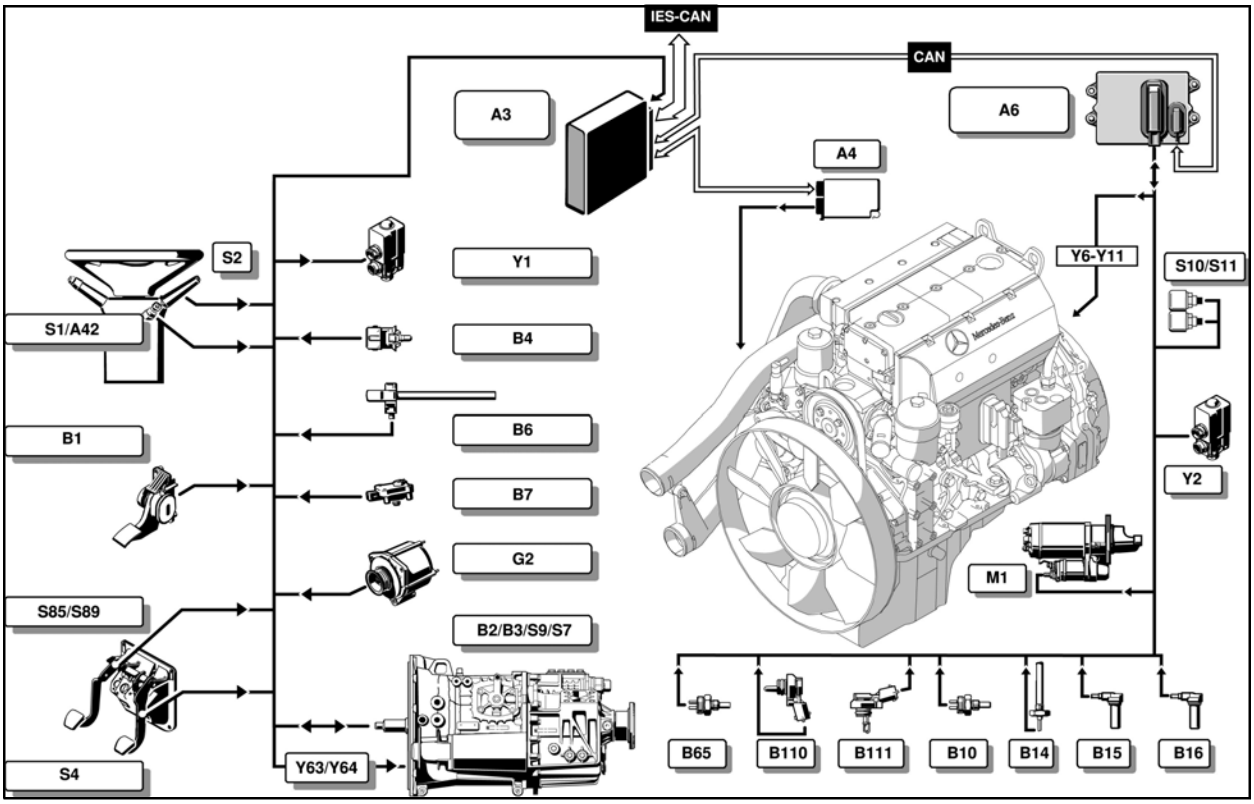
1: Depending on the control unit version, it is possible that just one button may be installed instead of the "Engine start/engine stop" push-button switches.



General overview of the Telligent engine system for the 900 model series

A3	FRE control unit (FR-FMR)	G2	Generator
A4	Flame starting system control unit	M1	Starter
A6	MR2 control unit	P1	Speedometer/tachograph
A42	Electronics for reading transponder code	S1	Driving switch
B1	Foot throttle actuator	S2	Engine control/auxiliary brake actuation
B2	Clutch travel sensor > 18 t	S4	Stop lamp switch
B3	Layshaft speed sensor	S7	Reverse gear switch
B4	Ambient temperature sensor	S8	Range position switch
B6	Coolant level switch	S9	Neutral switch
B7	Air filter switch < 15 t, sensor > 18 t	S10	Engine start[1] push-button switch
B9	Charge air temperature sensor	S11	Engine stop[1] push-button switch
B10	Fuel temperature sensor	S85	Switch 1, clutch pedal (KUP 1) < 15 t
B14	Oil level sensor	S89	Switch 2, clutch pedal (KUP 2) < 15 t
B15	Crank angle position sensor	Y1	Solenoid valve for engine brake (4-cyl.) or exhaust flap (6-cyl.)
B16	TDC sensor, cylinder 1	Y2	Constant throttle solenoid valve (6-cyl.)
B65	Coolant temperature sensor	Y6 to 11	Unit pump
B110	Combined oil pressure/temp. sensor.	Y63	Split solenoid valve
B110	Combined charge air pressure/temp. sensor.	Y64	Shift force assistance solenoid valve, G 100

1: Depending on the control unit version, it is possible that just one button may be installed instead of the "Engine start/engine stop" push-button switches.



Description of OBD system

The OBD system described in the following is based on the requirements placed on an "OBD stage 1", an OBD stage 2 and an NOx control monitoring system for a diesel engine with a DeNOx exhaust gas aftertreatment system or an SCRT exhaust gas aftertreatment system, as specified in Directives 2005/55/EC, 2005/78/EC and 2006/51/EC.

Drive cycle

A drive cycle includes starting the engine, running the engine, during which any malfunctions are noted, and stopping the engine.

Limp home mode

CAN limp home mode

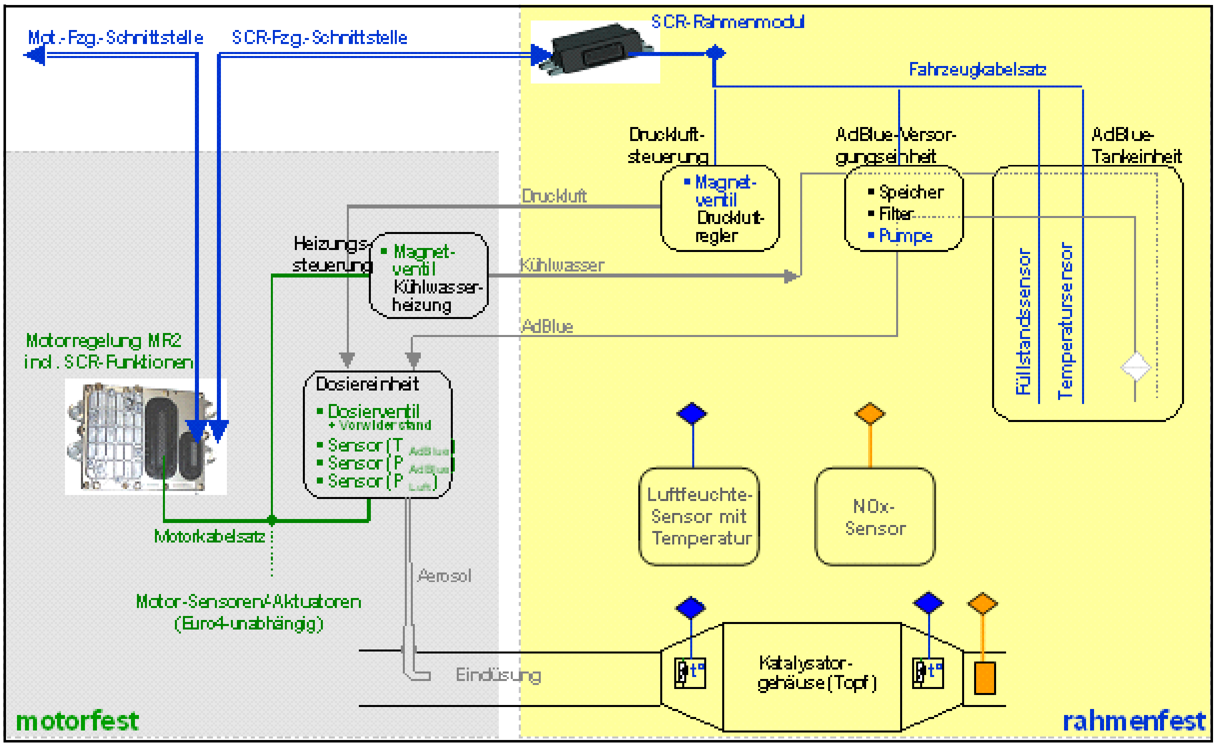
In normal conditions, the requested torque is derived from the current accelerator pedal position and transmitted via a CAN bus connection to the control unit.

In the CAN limp home mode (fixed engine speed control), default values are used instead of the data from the CAN bus. CAN limp home mode is executed in "engine on" mode, i.e. after leaving starting mode, provided that it is permissible to operate the engine. The engine speed is regulated to a configured nominal limp-home speed.

SCR exhaust gas aftertreatment system

Principle of exhaust gas aftertreatment

The SCR (Selective Catalytic Reduction) method is used to reduce oxides of nitrogen. In this system, the oxides of nitrogen are converted selectively by the SCR catalyst into nitrogen (N_2) and water (H_2O) by the addition of a reducing agent. The reducing agent is ammonia (NH_3) which is formed in the exhaust line by injecting an aqueous urea solution (AdBlue). ($NO + NO_2 + 2NH_3 \; 2N_2 + 3H_2O$)



Engine management and downstream exhaust gas aftertreatment system

Method

The diagram on the left shows how the exhaust gas aftertreatment system works in principle; the system consists of the following assemblies:

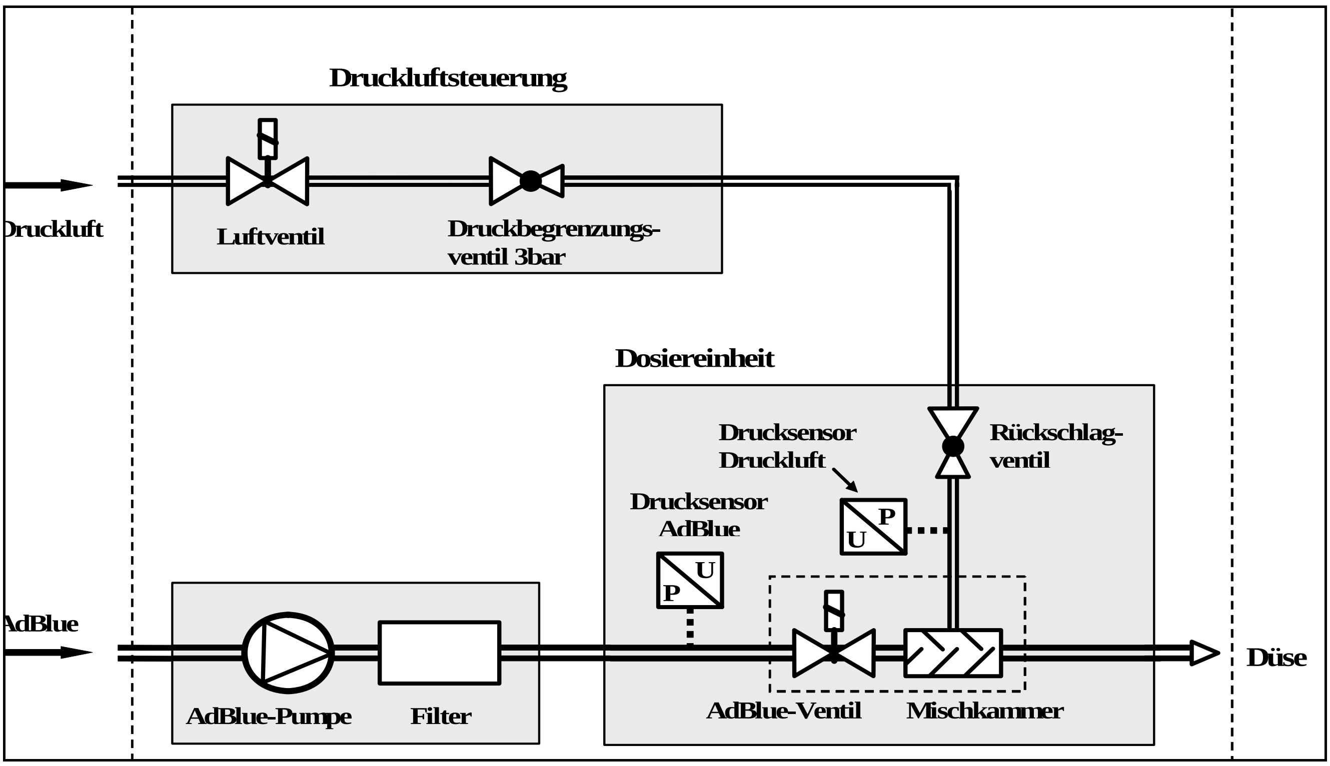
- Supply unit (with actuators and sensors)
- Metering unit (with actuators and sensors)
- AdBlue tank (with sensors),
- Catalyst system (with sensors).

All the control routines and calculations required for the exhaust gas aftertreatment system are performed by the MR2. The SCR frame module, which is networked with the engine control unit via a high-speed CAN, operates the "frame-mounted" sensors and actuators.

To ensure that sufficient quantities of nitrogen oxides (NOx) are converted, the metering of the reducing agent is controlled as a function of the NOx and exhaust gas mass flow rate as well as of the catalyst temperature. The NOx and exhaust gas mass are determined from current engine operating data such as engine speed, load, charge air pressure and air humidity, using corresponding maps. The catalyst temperature is calculated with the aid of two temperature sensors positioned at the catalyst inlet and outlet.

AdBlue is conveyed from a supply tank to an electromagnetic metering valve via a pressure pump. AdBlue is mixed with compressed air in a mixing chamber in the metering unit. The resulting aerosol is transported via a pipe to the nozzle and sprayed into the exhaust gas. The nozzle is screwed into the exhaust pipe connecting the engine with the catalytic converter.

A tank heater prevents the AdBlue from freezing or thaws out the system if it is already frozen. A tank heater valve is switched on and off as a function of the AdBlue temperature in the tank or the ambient air temperature. If the valve is actuated, coolant flows through a pipe from the engine via the supply unit, through a heat exchanger in the AdBlue tank and back to the engine. The coolant pipe is located parallel with the AdBlue pressure pipe.



Metering units

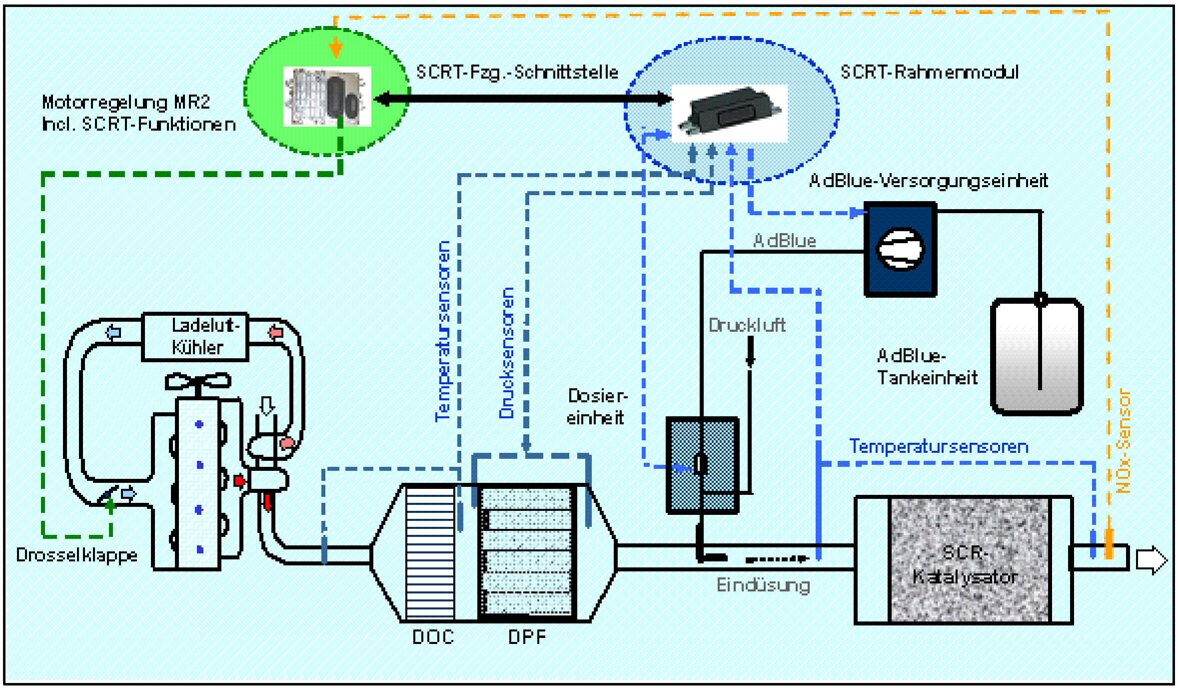
SCRT exhaust gas aftertreatment system

Principle of exhaust gas aftertreatment

The SCRT system is used to comply with EEV emissions limits. It contains the following components in one housing:

- Diesel oxidation catalyst (DOC)
- Diesel particulate filter (DPF)
- Denox system (SCR catalyst).

The SCR unit incorporates the AdBlue system for preparing an aqueous urea solution which is injected into the exhaust system and reacts completely to form NH3 which in turn is deployed in the SCR process. Various sensors for controlling and monitoring the system are also incorporated.



Engine management and downstream SCRT exhaust gas aftertreatment system

Function of the oxidation catalyst (DOC)

The diesel oxidation catalyst oxidizes carbon monoxide to form carbon dioxide and hydrocarbons to form carbon dioxide and water vapor. It also assists with the generation of nitrogen dioxide NO_2 for the following processes:

- Generation of NO_2 for the passive regeneration of the particulate filter
- Generation of NO_2 to improve the SCR reaction (particularly when exhaust gas temperatures are low).

Function of the diesel particulate filter (DPF)

The diesel particulate filter is used to filter out particulate emissions. The DPF can be removed from the underside of the vehicle or the SCRT system during a service to clean out the ash.

Function of the denox system (SCR catalyst)

In the SCR (Selective Catalytic Reduction) process, the oxides of nitrogen (NOx) are converted selectively by the SCR catalyst into nitrogen (N_2) and water (H_2O) by the addition of a reducing agent. The reducing agent is ammonia (NH_3) which is formed in the exhaust line by injecting an aqueous urea solution (AdBlue). ($NO + NO_2 + 2NH_3\ 2N_2 + 3H_2O$)

Page 33 describes the operating principle and structure of the "SCR exhaust gas aftertreatment system".

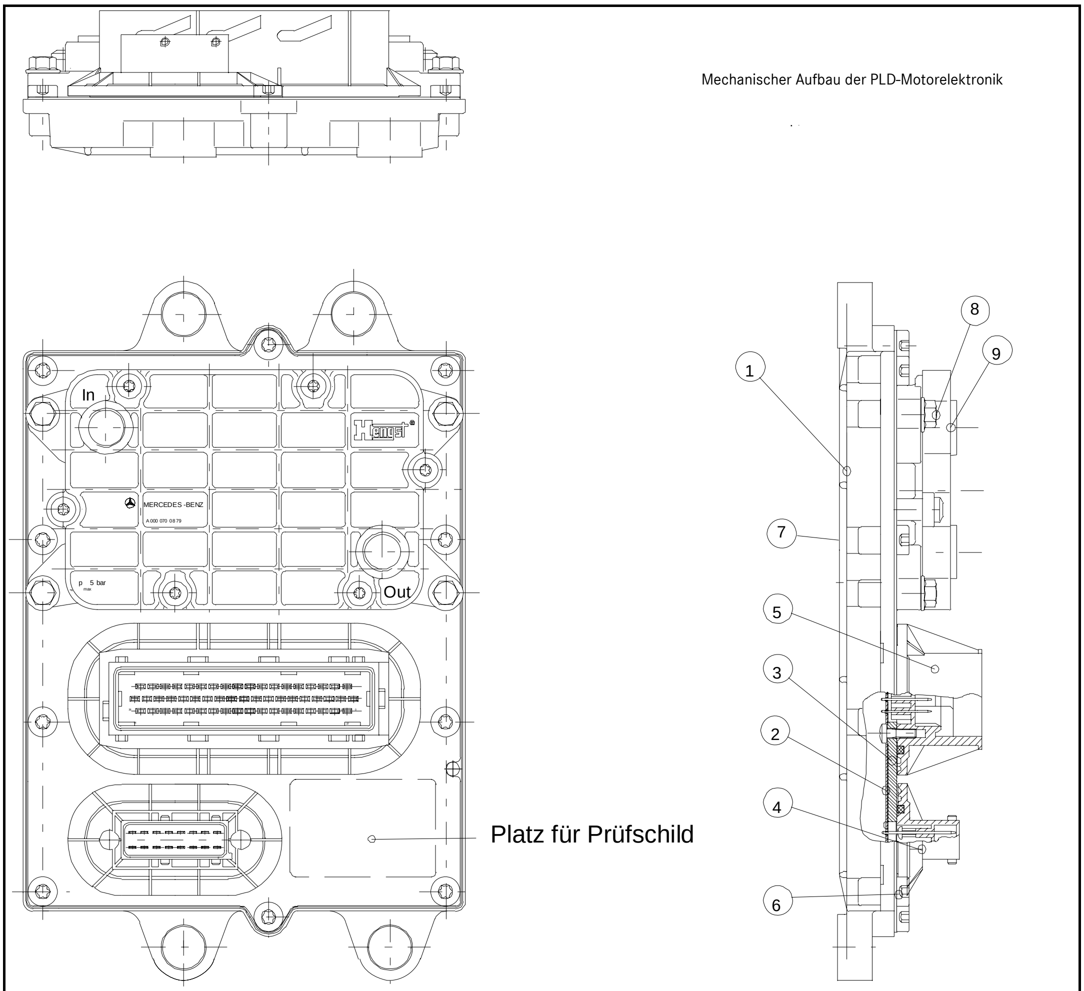
Notes

Description of mechanical components

Description of the control units for engine electronics

The entire MR2 engine electronics module consists of the MR2 control unit (MB number varies depending on the version) and the fuel cooling system; these two systems are bolted together by means of four fastening bolts.

MR2A and MR2B control unit

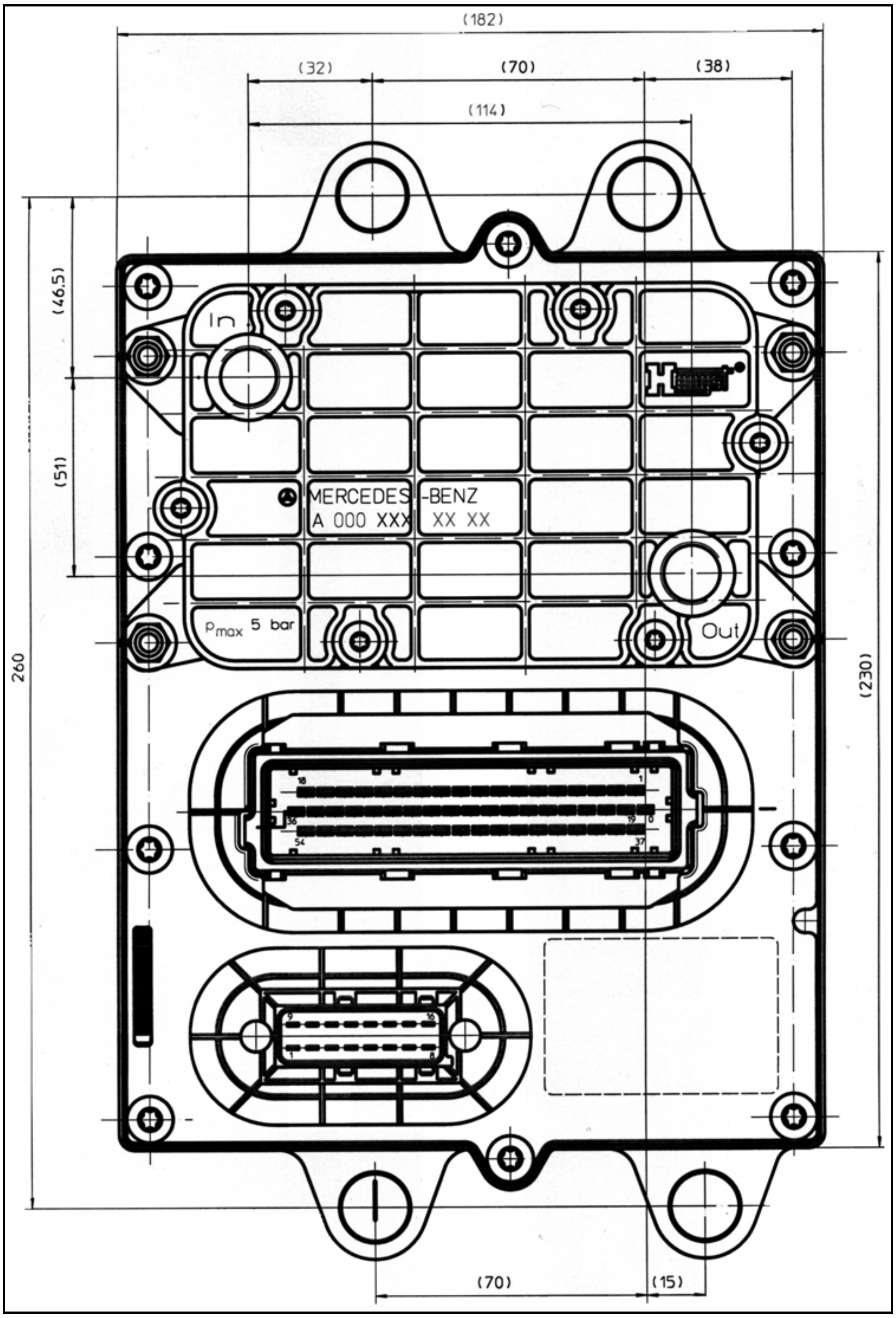


Pos. 1: Gehäuse
Pos. 2: Leiterplatte
Pos. 3: Trägerplatte
Pos. 4: 16-polige Messerleiste
Pos. 5: 55-polige Messerleiste
Pos. 6: Befestigungsschrauben
Pos. 7: Typenschild mit Barcode
Pos. 8: Befestigungsschrauben
Pos. 9: Kraftstoffkühlung

Fuel cooling system

On MR2 versions supplied with a fuel cooling system, the system is assembled by the supplier.

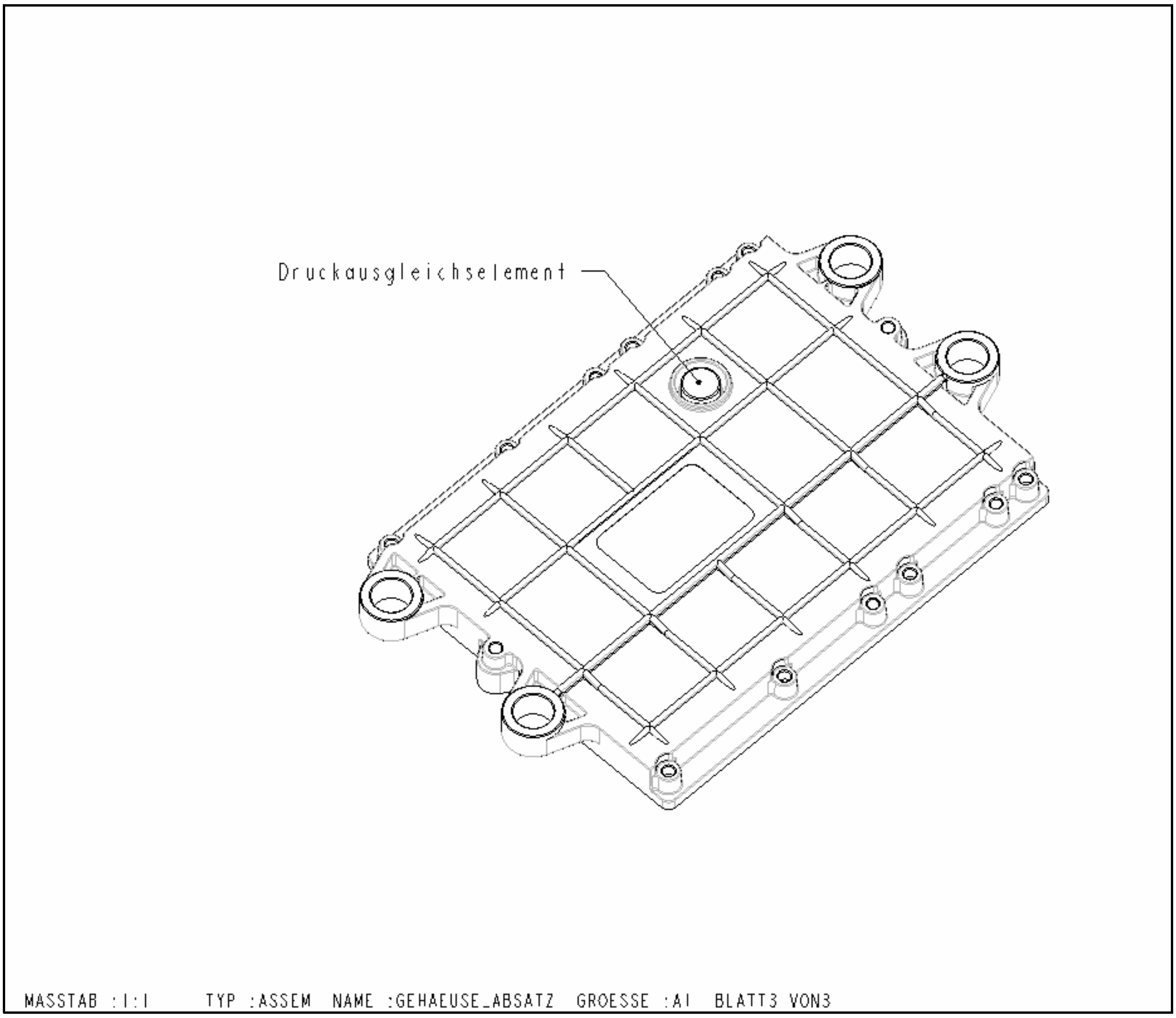
Specification:	The design, layout and testing of the fuel cooling system is the responsibility of the supplier or MB
Fastening bolts:	4 ea. M6 x 25 - 8.8
Design:	in accordance with MB standard 10 143
Tightening torque:	8 Nm ± 15 %



The MR2 control unit itself comprises a printed circuit board assembly with carrier plate and a zinc die-cast housing. The printed circuit board/carrier plate combination is bolted to the housing and sealed with liquid sealant. The seal between the multiple plug and the carrier place is achieved with triple-lipped silicone sealing rings and between the multiple plug and mating connector with sealing elements in the multiple plug or in the mating connector.

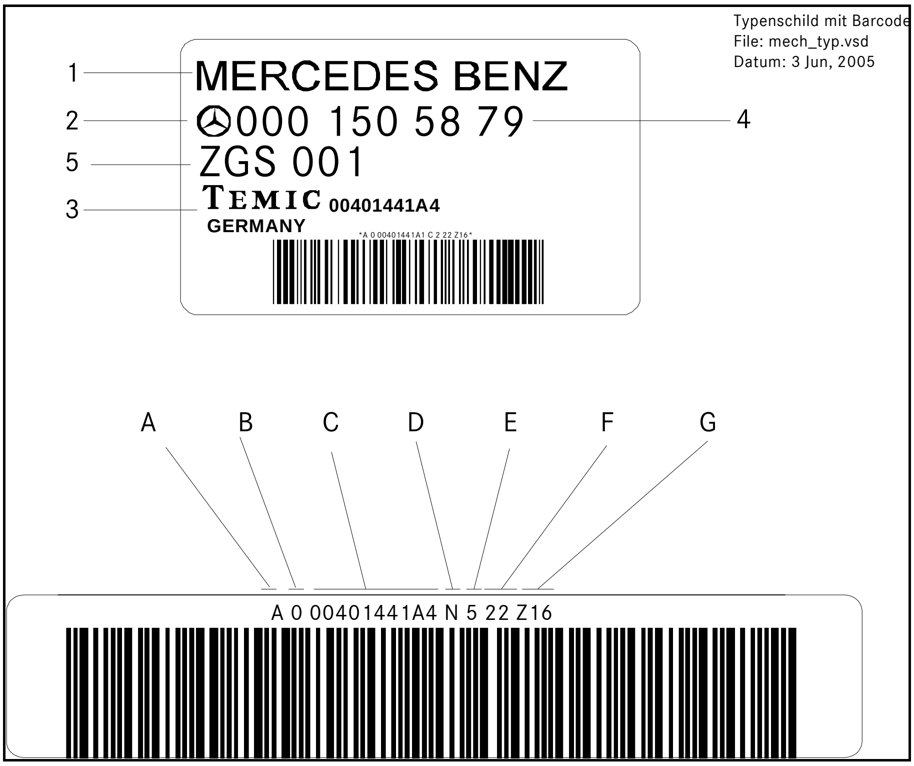
The external electrical connections are in the form of one 16-pin and one 55-pin multiple plug. The internal housing pressure is matched to the ambient pressure by means of a pressure-compensating membrane in the housing floor. Four lugs, which can be fitted with isolators, are provided for bolting the housing to the engine.

To match the internal housing pressure to the ambient air pressure, a pressure-compensating element is installed in the housing floor. The pressure-compensating element must be suitably protected when carrying out any subsequent painting, waxing or similar operations.



Example of model plate with barcode

1:	Mercedes Benz trademark
2:	MB star
3:	Supplier's trademark
4:	MB part number
5:	MB drawing geometry technical level (ZGS)
A:	Customer mark A-Z (A = Daimler AG)
B	Control unit type (0 = 12/24V
C:	Supplier ID number, see allocation table
D:	Software release (N = Software 04)
E:	Year of manufacture 0...9 (last digit of the year of manufacture)
F:	Week of manufacture 01...52
G:	Daily production number 1st position: letter A...Z 2nd position: number 0...9 3rd position: number 0...9 If capacities are exceeded, positions 1 and 3 are transposed



MR2 version allocation table

Designation (hardware: MR2A1.4)	12 V/24 V 6/8-cylinder version with cooling	12 V/24 V 6/8-cylinder version without cooling	12 V/24 V 4-cylinder version without cooling
Temic product no. with parts list index	00401430A7	00401431A7	00401436A7
MB part number for software release 06	A 000 150 65 79	A 004 446 71 40	A 004 446 72 40
MB ZGS for software release 06	001	001	001

Designation (hardware: MR2B1.4)	12 V/24 V 6/8-cylinder version with cooling	12 V/24 V 6/8-cylinder version without cooling	12 V/24 V 4-cylinder version without cooling
Temic product no. with parts list index	00401441A8	00401442A8	00401447A8
MB part number for software release 06	A 000 150 66 79	A 004 446 73 40	A 004 446 74 40
MB ZGS for software release 06	001	001	001

Ambient conditions for mechanical components

Installation location:	on the side of the engine
Mounting:	bolted to the engine block with isolators
Ambient temperature:	- 40 °C to + 125 °C (in accordance with MB standard 22 100)
Vibration load:	max. 3 g at 10 Hz – 1000 Hz with isolators
Environmental conditions:	resistance, in terms of function and leakproofness, to all liquids and harmful gases arising in the engine compartment

General test conditions

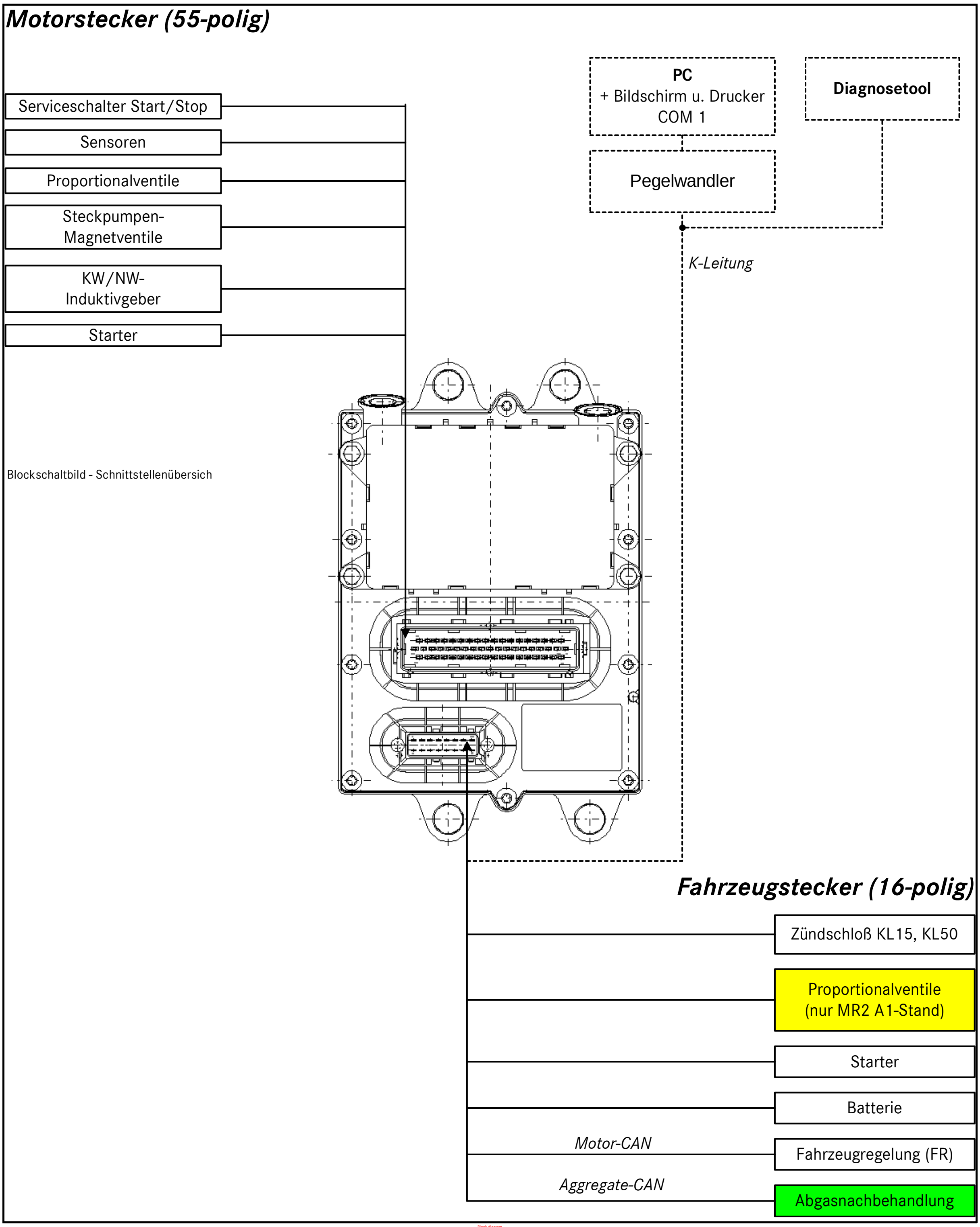
The general Mercedes Benz test specification MBN 22 100 of September 1992 forms the basis of the test conditions. This contains, amongst other things:

- Environmental and climate tests
- Mechanical test conditions
- Electrical test conditions.

Description of electrical components

Overview of system interfaces

The 55-pin and 16-pin multiple plugs form the interfaces. The following block diagram groups the modules into main groups.



55-pin engine connector for control unit MR2 A and B

55-pin multiple plug (engine connector)					
Pin no.	Assignment for MR2A	Type	In/ Out2	Assignment for MR2B	Type
0	Heater flange diagnosis	Signal	In	Heater flange diagnosis	Signal
1	Camshaft sensor (-)	Feedback	In	Camshaft sensor (-)	Feedback
2	Crankshaft sensor (-)	Feedback	In	Crankshaft sensor (-)	Feedback
3	Coolant temperature		In	Coolant and fuel temperature, AdBlue temperature	Feedback
4	Fuel temperature	Feedback	In	Air temperature	Signal
5	Passive oil pressure/turbocharger speed, fan speed	Feedback	In	Passive oil pressure/turbocharger speed, fan speed	Feedback
6	Active oil pressure sensor	Supply	Out	Active oil pressure sensor	Supply
7	Charge air pressure sensor	Supply	Out	Charge air pressure sensor, fan speed sensor	Supply
8	Not assigned	Signal	In	AdBlue temperature	Signal
9	Unit pump bank 2 (B-D-F-H)	Feedback	Out	Unit pump bank 2 (B-D-F-H)	Feedback
10	Active oil pressure sensor/Combined oil sensor	Feedback	In	Oil level, oil pressure, oil temperature	Feedback
11	Proportioning valve ground	Feedback	Out	Proportioning valve ground	Feedback
12	Proportioning valve bank (PV 1-4)1	Supply	Out	Proportioning valve bank (PV 1 - 4)1	Supply
13	Combined input (fuel pressure/FPS/ T6)	Supply	Out	Combined input (fuel pressure/FPS/ T6)	Supply
14	Fan speed sensor	Supply	Out	AdBlue pressure, air humidity, compressed air pressure	Supply
15	Oil temperature sensor	Feedback	In	Air humidity	Signal
16	Unit pump bank 1 (A-C-E-G)	Feedback	Out	Unit pump bank 1 (A-C-E-G)	Feedback
17	Fan speed sensor	Signal	In	Fan speed sensor	Signal
18	Starter1	High-side actuation	Out	Starter1	High-side actuation
19	Crankshaft sensor (+)	Signal	In	Crankshaft sensor (+)	Signal
20	Camshaft sensor (+)	Signal	In	Camshaft sensor (+)	Signal
21	Charge air temperature sensor	Feedback	In	Air temperature, air pressure	Feedback
22	Combined input (fuel pressure/FPS/ T6)	Feedback	In	AdBlue pressure/air humidity/compressed air pressure/EGR temperature	Feedback
23	Charge air pressure sensor	Feedback	In	Compressed air pressure	Signal
24	Turbocharger speed sensor	Signal	In	Turbocharger speed sensor	Signal
25	Engine service switch –start	Signal	In	Engine service switch –start	Signal
26	Passive oil pressure sensor/charge air temperature 2	Signal	In	Passive oil pressure sensor/charge air temperature 2	Signal
27	Proportioning valve 5	High-side actuation	Out	Proportioning valve 5	High-side actuation
28	Combined input (fuel pressure/FPS/ T6)	Signal	In	EGR temperature sensor	Signal
29	Charge air pressure sensor	Signal	In	Charge air pressure sensor	Signal
30	Engine service switch (start/stop)	Supply	In	Engine service switch (start/stop)	Supply
31	Not assigned	Signal	In	AdBlue pressure/throttle flap position	Signal

1: Signal also on vehicle connector

2: Input/output

Pin no.	Assignments for MR2A	Type	In/ Out[2]	Assignments for MR2B	Type
32	Active oil pressure sensor	Signal	In	Active oil pressure sensor	Signal
33	Oil level sensor	Signal	In	Oil level sensor	Signal
34	Coolant temperature sensor	Signal	In	Coolant temperature sensor	Signal
35	Engine service switch – stop	Signal	In	Engine service switch – stop	Signal
36	Fuel temperature sensor	Signal	In	Fuel temperature sensor	Signal
37	Unit pump solenoid valve H (bank 2)	High-side actuation	Out	Unit pump solenoid valve H (bank 2)	High-side actuation
38	Unit pump solenoid valve F (bank 2)	High-side actuation	Out	Unit pump solenoid valve F (bank 2)	High-side actuation
39	Oil temperature sensor	Signal	In	Oil temperature sensor	Signal
40	Proportioning valve 6	Low-side actuation	Out	Proportioning valve 6	Low-side actuation
41	Proportioning valve 3[1]	Low-side actuation	Out	Proportioning valve 3[1]	Low-side actuation
42	Proportioning valve PV6	Supply	Out	Proportioning valve bank (PV6-8)	Supply
43	Proportioning valve 4[1]	Low-side actuation	Out	Proportioning valve 4[1]	Low-side actuation
44	Unit pump solenoid valve D (bank 2)	High-side actuation	Out	Unit pump solenoid valve D (bank 2)	High-side actuation
45	Unit pump solenoid valve B (bank 2)	High-side actuation	Out	Unit pump solenoid valve B (bank 2)	High-side actuation
46	Unit pump solenoid valve G (bank 1)	High-side actuation	Out	Unit pump solenoid valve G (bank 1)	High-side actuation
47	Unit pump solenoid valve E (bank 1)	High-side actuation	Out	Unit pump solenoid valve E (bank 1)	High-side actuation
48	Charge air temperature sensor 1	Signal	In	Charge air temperature sensor 1	Signal
49	Oil level sensor	Feedback	In/ Out	Proportioning valve 7	Low-side actuation
50	Proportioning valve 2	Low-side actuation	Out	Proportioning valve 2	Low-side actuation
51	Proportioning valve 1	Low-side actuation	Out	Proportioning valve 1	Low-side actuation
52	Proportioning valve 2	Supply	Out	Proportioning valve 8	Low-side actuation
53	Unit pump solenoid valve C (bank 1)	High-side actuation	In	Unit pump solenoid valve C (bank 1)	High-side actuation
54	Unit pump solenoid valve A (bank 1)	High-side actuation	Out	Unit pump solenoid valve A (bank 1)	High-side actuation

1: Signal also on vehicle connector

2: Input/output

16-pin vehicle connector for control unit MR2A and MR2B

Pin no.	Assignments for MR2A	Type	In/ Out[2]	Assignments for MR2B	Type
1	CAN interface	High line	In/ Out	CAN interface	High line
2	CAN interface	Low line	In/ Out	CAN interface	Low line
3	CAN-HF	Ground		CAN-HF	Ground
4	CAN-HF	Ground		CAN-HF	Ground
5	Battery voltage	Battery positive		Battery voltage	Battery positive
6	Battery voltage	Battery positive		Battery voltage	Battery positive
7	Not assigned		Out	HS-CAN interface	High line
8	Terminal 50 (start)	Signal	In	Terminal 50 (start)	Signal
9	Ground (battery negative)			Ground (battery negative)	
10	Proportioning valve bank (PV1 - 4)[1]	Supply		HS-CAN interface	Low line
11	Ground (battery negative)			Ground (battery negative)	
12	Starter[1]	High-side actuation	Out	Starter[1]	High-side actuation
13	Diagnostics K–line (ISO)	Signal	In/ Out	Diagnostics K–line (ISO)	Signal
14	Proportioning valve 3[1]	Low-side actuation	Out	HS-CAN	HF Ground
15	Terminal 15	Ignition	In	Terminal 15	Ignition
16	Proportioning valve 4[1]	Low-side actuation	Out	HS-CAN	HF Ground

1: Signal also on engine connector

2: Input/output

Control unit power supply

Voltage variants	24 volt	12 volt
Supply voltage		
Rated voltage:	22 V ≤ U ≤ 30 V	11 V ≤ U ≤ 16 V
Undervoltage:	8 V ≤ U < 22 V limited operating range (see MB standard 22 100)	6.5 V ≤ U < 11 V limited operating range (see MB standard 22 100)
Overvoltage cut-off:	33 V < U_{max} < 37 V	33 V < U_{max} < 37 V
Reverse polarity protection, overvoltage protection		
Reverse polarity protection:	Sustained reversed polarity of terminal 30, terminal 31 without damage to system components	Sustained reversed polarity of terminal 30, terminal 31 and terminal 15 without damage to system components
Overvoltage resistance:	58 V (see MB standard 22 100	58 V (see MB standard 22 100
Overvoltage resistance:	100 V (see SAE J1455)	100 V (see SAE J1455)
Current consumption		
Peak current consumption (without proportional output stages):	36A, cyclical, dependent on engine model series and maximum engine speed	36A, cyclical, dependent on engine model series and maximum engine speed
Quiescent current consumption with terminal 15 off and after completion of power-down:	I < 1 mA	I < 1 mA
Short circuit detection thresholds		
Solenoid valve to ground	20 A	20 A
Starter to ground	2.5 A	2.5 A
Solenoid valve to return line	32 A	32 A
Proportioning valve supply to ground	11 A	11 A
Proportioning valve to return line	2 A	2 A

Sensor system

Internal sensors

Atmospheric pressure sensor

A pressure sensor is located in the control unit for evaluating the ambient air pressure. It is not possible to configure the characteristic curves for calculating the atmospheric pressure.

Accuracy is to ±15mbar in the range 0°...+85°C or ±30mbar over the entire temperature range of –40°C...+125°C, with the following calibrated reference values:

Sensor voltage:	2.0 V	4.7 V
Pressure:	550 mbar	1150 mbar
Sensor tolerance:	±30 mbar	±30 mbar
ACDC tolerance ±2LSB:	±9.76 mV	±9.76 mV
Worst case tolerances:	±32 mbar	±32 mbar

Control unit temperature recording

To record the maximum control unit temperature, the characteristic curve of two diode distances are recorded for the duration of the MR2 running time and the maximum value is stored in the EEPROM.

To restrict component tolerances, the reference value at an ambient temperature of approx. 20°C is calculated in the final test and also stored in the EEPROM; this is used for calibration when evaluating the maximum temperature.

Tolerance for control unit temperature recording is ±5°C. The maximum printed circuit board temperature may not exceed 125°C and may only be reached for brief periods. To guarantee the required service life of 20,000 hours, a mean printed circuit board temperature of < 75°C must be assured for the entire operating period.

External sensors

The calculation variables (characteristic curves, maps, low pass factors, fault thresholds) can be configured via the data set.

Active sensors

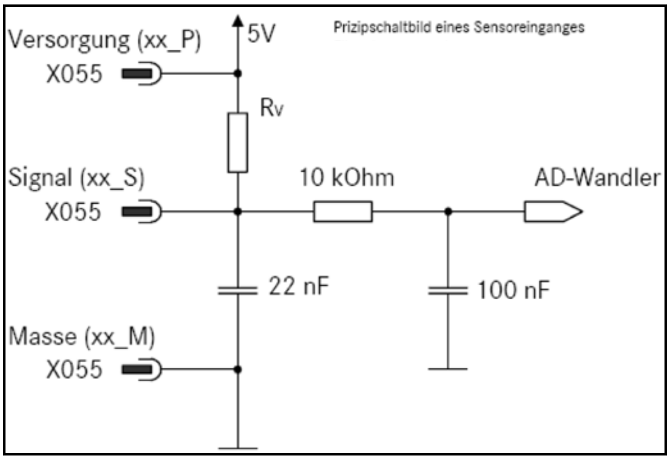
Requirements for sensor inputs of external sensors:

Active sensors with an operating voltage of 5 volts are used. The sensor inputs are able to draw a sink current to their 5 volt supply by means of a pull-up resistor. The sensors may consume a current of up to 20 mA from the voltage supply. There are two supply banks for the sensors, each designed to connect up to four sensors (overall current load per bank: max. 80 mA).

Sensor bank 1	Sensor bank 2
Charge air pressure	Compressed air pressure (MR2B release only)
Active oil pressure	Air humidity (MR2B release only)
Fuel pressure/T6 EGR temperature	AdBlue pressure (MR2B release only)
Fan speed	

A current-limiting function is implemented when the current exceeds 80 mA. Because the characteristic curve of the current-limiting function is falling, the short circuit current is approx. 10 mA. The sensor inputs are therefore short-circuit proof.

Pressure sensors



Basic circuit diagram of the active sensor inputs

The output voltage range (0.5...4.5 V) of the sensors used ensure diagnostics capability with regard to line breaks and short circuits to ground.

The following data refer to the sensor input circuits:

Control unit version MR2A and MR2B			
Measured quantity	**Charge air pressure**	**Active oil pressure**	**Fuel pressure/T6 EGR temperature**
Pull-up R_V	10 kΩ	3 kΩ	1 kΩ
R_V tolerance	5% ±250ppm/K	5% ±250ppm/K	5% ±25ppm/K
ADC tolerance ±2LSB	±9.76 mV	±9.76 mV	±9.76 mV
Worst case at 1 V signal voltage	±8.5%	±8.5%	±1.35%

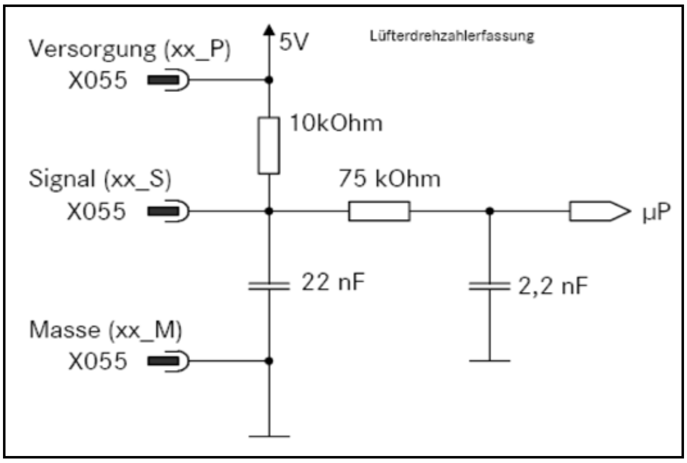
Due to the "fuel pressure" input having a dual assignment with the T6 temperature sensor, the resistive connection has been changed from 10kΩ/1% to 1kΩ/0.1%. For the MR2 B1.2 release, this input has been renamed EGR temperature.

MR2B only			
Measured quantity	**Compressed air pressure**	**Air humidity**	**AdBlue pressure**
Pull-up R_V	10 kΩ	22 kΩ	10 kΩ
R_V tolerance	5% ±250ppm/K	5% ±250ppm/K	5% ±250ppm/K
ADC tolerance ±2LSB	±9.76 mV	±9.76 mV	±9.76 mV
Worst case at 1 V signal voltage	±8.5%	±8.5%	±8.5%

Fan speed

The fan speed is recorded by means of a digital input with external ground keying (e.g. open collector).

Minimum speed:	125 rpm
Maximum speed:	5000 rpm
Maximum low voltage:	0.9 V
Minimum high voltage:	1.9 V

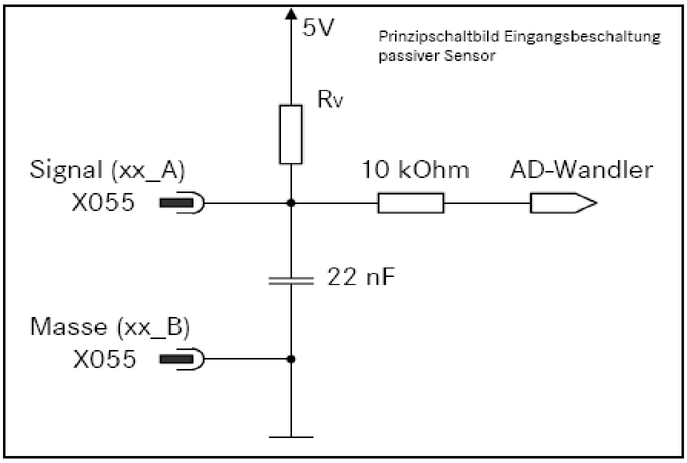


Basic circuit diagram for fan speed recording

<u>Passive sensors</u>

Requirement: temperature sensors based on NTC resistors and an (oil) pressure sensor based on a pressure-sensitive wire resistor are used as passive sensors.

The voltage drop at the sensor resistor is used for the evaluation; this is supplied with current by a pull-up resistor. Like the active inputs, these inputs are short-circuit proof and have diagnosis capability.



Basic circuit diagram of the passive sensor inputs

The following data refer to the sensor input circuits:

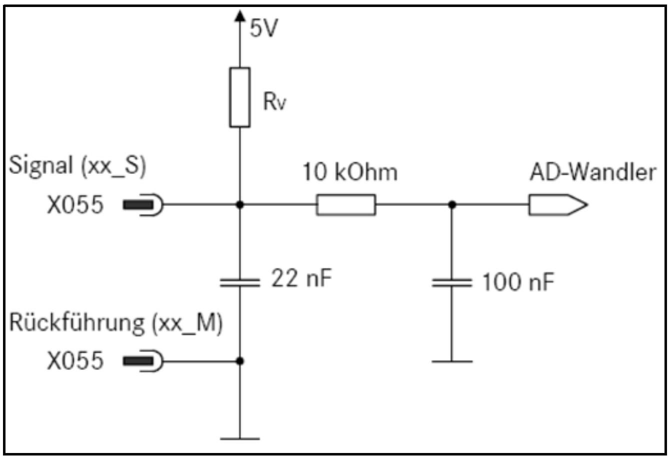
Control unit version MR2A and MR2B				
Measured quantity	**Oil temperature**	**Coolant temperature**	**Charge air temperature**	**Fuel temperature**
Pull-up R_V	1 kΩ	1 kΩ	2.2 kΩ	2.2 kΩ
R_V tolerance	1% ±250ppm/K	1% ±250ppm/K	5% ±250ppm/K	5% ±250ppm/K
ADC tolerance ±2LSB	±9.76 mV	±9.76 mV	±9.76 mV	±9.76 mV
Worst case at 1 V signal voltage	±4.5%	±4.5%	±8.5%	±8.5%

MR2B only		
Measured quantity	**AdBlue temperature**	**Air temperature**
Pull-up R_V	1 kΩ	10 kΩ
R_V tolerance	1% ±250ppm/K	0.1% ±250ppm/K
ADC tolerance ±2LSB	±9.76 mV	±9.76 mV
Worst case at 1 V signal voltage	±4.5%	±1.35%

As of MR2B1.3 release, the pull-up at the sensor input for air temperature has been changed from 1kΩ/ 1% to 10kΩ/ 0.1%.

The EGR temperature sensor is connected at the fuel pressure input (see Page 48).

Passive oil pressure



Basic circuit diagram of the "passive oil pressure" sensor input

Measured quantity	Oil temperature
Pull-up R_V	390 W
R_V tolerance	5% ±250ppm/K
ADC tolerance ±2LSB	±9.76 mV
Worst case at 1 V signal voltage	±8.5%

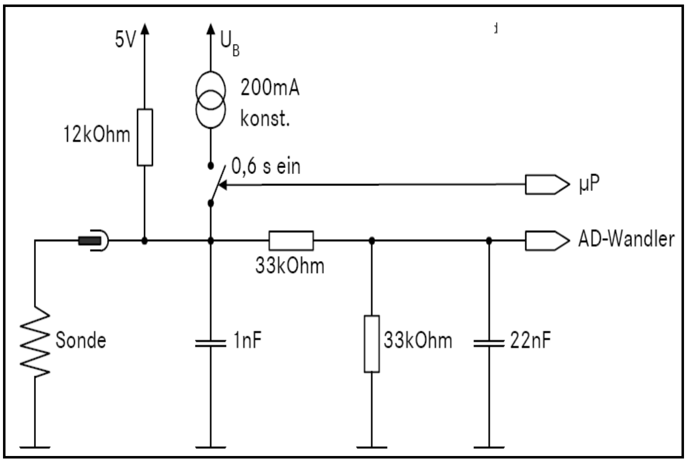
Note

Alternatively the charge air temperature sensor 2 can be connected to the "passive oil pressure" input

Oil level

The oil level sensor consists of a hot wire whose resistance changes depending on the temperature.

During the measurement, the sensor is heated for 0.6s with a 200 mA constant current. The voltage change at the sensor is measured during the "on" period. The amount of voltage change is the oil level measurement. The measurement is repeated every 6s.



Basic circuit diagram of oil level sensor

The oil level sensor must satisfy the following boundary conditions:

Heating current:	200 mA (constant current)
Resistance:	22.3 Ω (at room temperature)
Resistance after energizing (0.6 sec.):	
- at 100% fill level:	23.0 Ω
- at 0% fill level:	28.4 Ω

The tolerance of the constant current source in the control unit is < 5%.

With the introduction of software 56, a revised oil level sensor may be used. The applications are set using maps, the hardware connections, as described above, remain unchanged (Iheat = 200 mA for 0.6 sec). The internal resistance of the oil level sensor must not deviate substantially from the figures quoted above.

As of the MR2 release, the previous discrete circuit has been replaced by a current source IC; in addition, the voltage divider in front of the AD converter has been changed from 12k/12k to 33k/33k in order to ensure that line breaks in the shared oil level/oil temperature and oil pressure ground line are detected. At the same time, the capacitor in front of the AD converter has been reduced to 22nF (time constant of the low pass).

Turbocharger speed

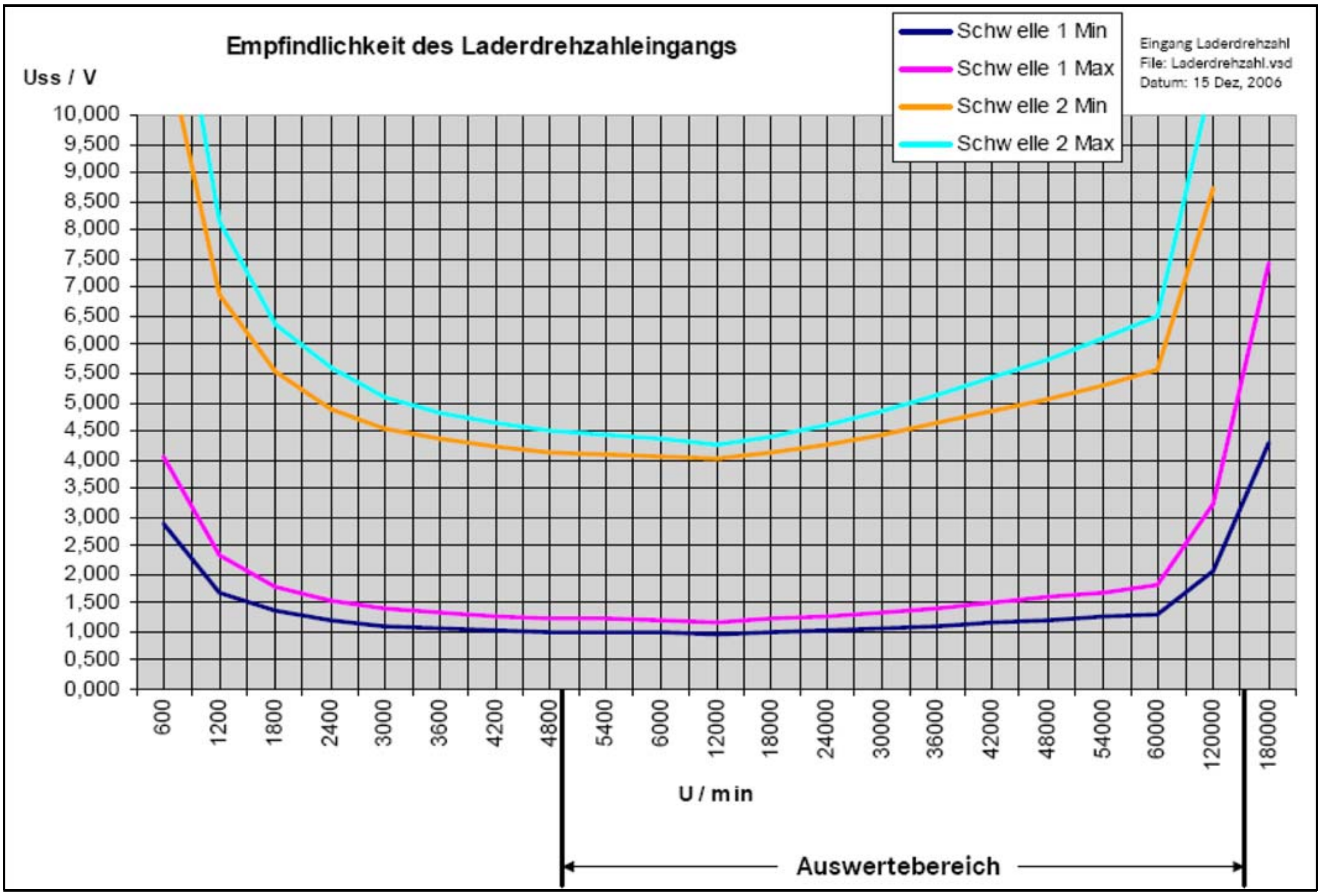
To record and evaluate the turbocharger speed, an inductive input signal is converted into a digital signal.

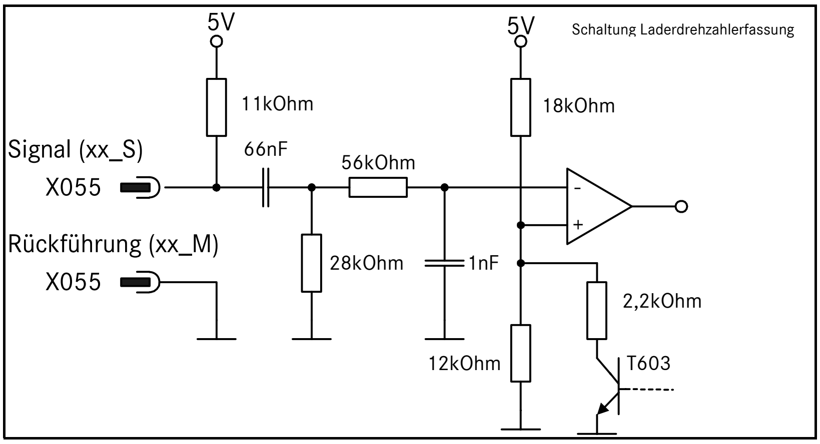
Minimum input voltage:	speed dependent, see diagram
Minimum input speed:	5000 rpm
Maximum input speed:	150,000 rpm

To increase interference immunity, the MR2 release features a switchable threshold for input sensitivity:

Threshold 1: evaluation of low signal levels at low speeds

Threshold 2: evaluation of high signal levels at high speeds



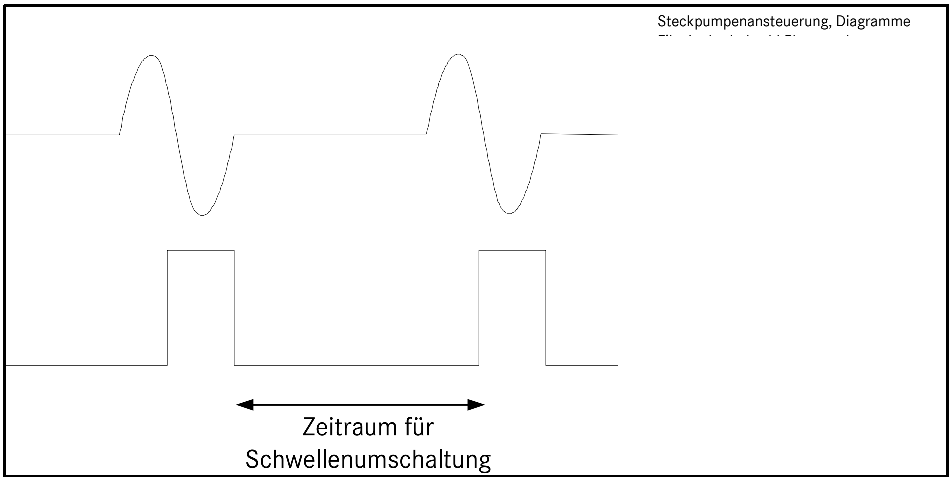


Recording turbocharger speed

At low speeds (configurable) the input sensitivity is increased by switching to threshold 1; this is done by actuating T603.

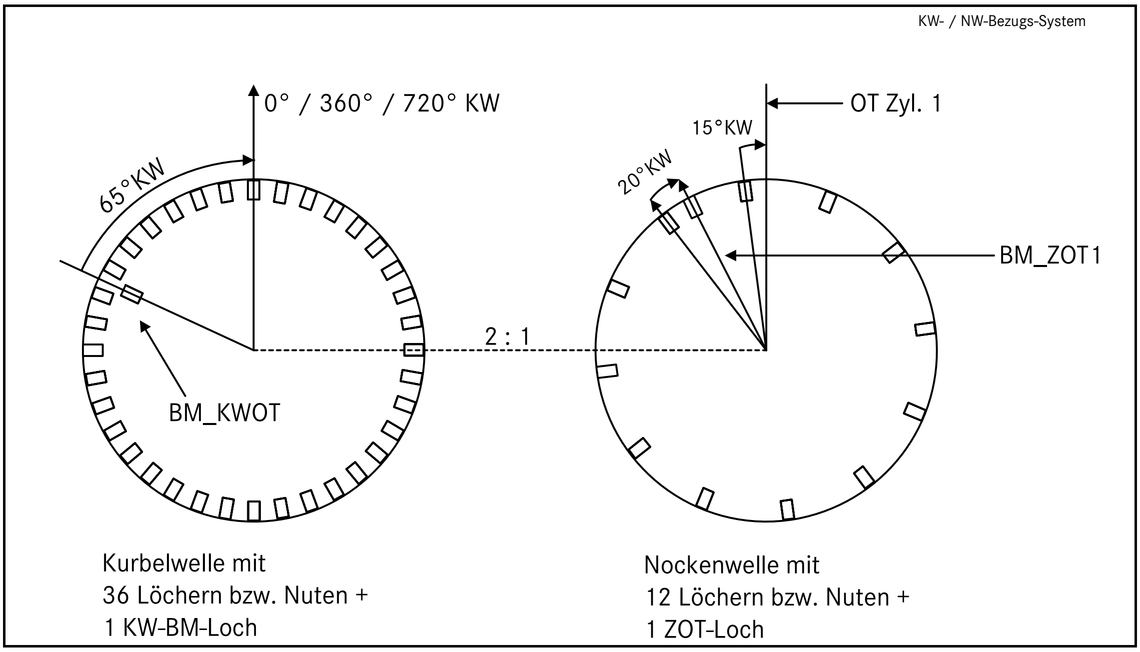
At high speeds the input sensitivity is decreased by switching to threshold 2; this is done by deactivating T603. Interference suppression is raised accordingly.

The switching of the thresholds must be done synchronous with the phases in order to avoid interference pulses; in other words it must not occur during the negative half-wave of the input signal.



Recording and evaluating the crankshaft/camshaft

Crankshaft/camshaft reference system



Mechanical crankshaft/camshaft coupling (principle)

Based on the ratio of two crankshaft revolutions to one camshaft revolution, a 720° crankshaft reference system has been established for the processing of one complete operating sequence of all cylinders .

This system is valid for all 4, 6 and 8-cylinder engines.

Crankshaft:

- Mark spacing 10 °CA
- Additional hole (BM_KWOT) is located between two 10 °CA marks at 65 °CA before TDC and at 295 °CA after TDC
-

Camshaft:

- Mark spacing 60 °CA (30 °cam angle)
- Additional hole (BM_ZOT) is located at 20 °CA after the previous 60 ° mark or at 55 °CA before cylinder 1 TDC

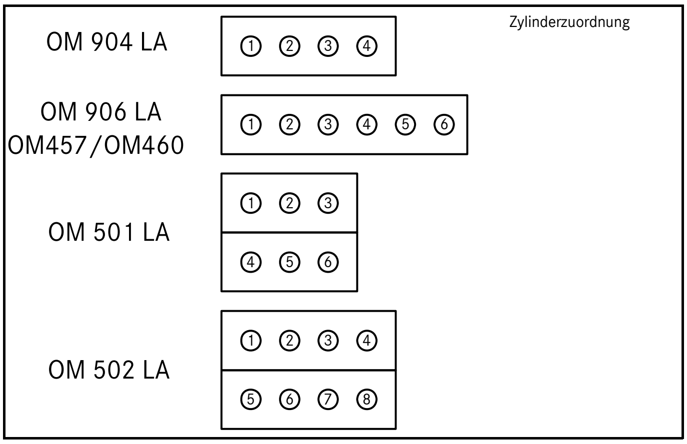
Cylinder actuation sequence

Solenoid valve/bank (electric)	Engine connector (55-pin)	Solenoid valve for cylinder (TDC position after BM_ZOT 1)			
	PIN number	R4 OM 904 LA	R6 OM 906 LA OM 457/OM 460	V6 OM 501	V8 OM 502
A/1	54				1 (0° CA)
B/2	45		1 (0° CA)	1 (0° CA)	5 (90° CA)
C/1	53	1 (0° CA)	5 (120° CA)	4 (120° CA)	7 (180° CA)
D/2	44	3 (180° CA)	3 (240° CA)	2 (240° CA)	2 (270° CA)
E/1	47	2 (540° CA)	6 (360° CA)	5 (360° CA)	8 (630° CA)
F/2	38	4 (360° CA)	2 (480° CA)	3 (480° CA)	4 (540° CA)
G/1	46		4 (600° CA)	6 (600° CA)	3 (450° CA)
H/2	37				6 (360° CA)
Feedback Bank 1 Bank 2	 16 9	(A-C-E-G) (B-D-F-H)			

Note

The cylinder table is not the same as the firing order!

Cylinder order



Cylinder order

Crank angle and TDC

Inductive sensors are used to detect the current crank angle and the rpm. These sensors contain a coil on a core of soft iron with permanent magnets connected to it such that the magnet's field lines penetrate the core of soft iron. The end of the soft iron core is located opposite the flywheel (sensor rotor) at a minimum distance from it.

Holes or ribs are used as markers. As a result of the change in flow, these markers induce a voltage in the coil of the inductive sensor. The marker geometry used produces, for each mark on the sensor rotor, one complete sine wave, whose zero-axis crossing represents the centre of the mark.

Where sensor polarity is concerned, care should be taken to ensure that the positive half wave appears first and then the negative (measured against ground), otherwise malfunctions can be expected. The amplitude level depends on the distance of the sensor from the sensor rotor and the rotational speed.

As of MR2 B1.3 release (and the introduction of the crankshaft/camshaft ASICs), the evaluation range of the sensor input voltage is $2.0\ V < U_{KW/NW} < 50\ V$.

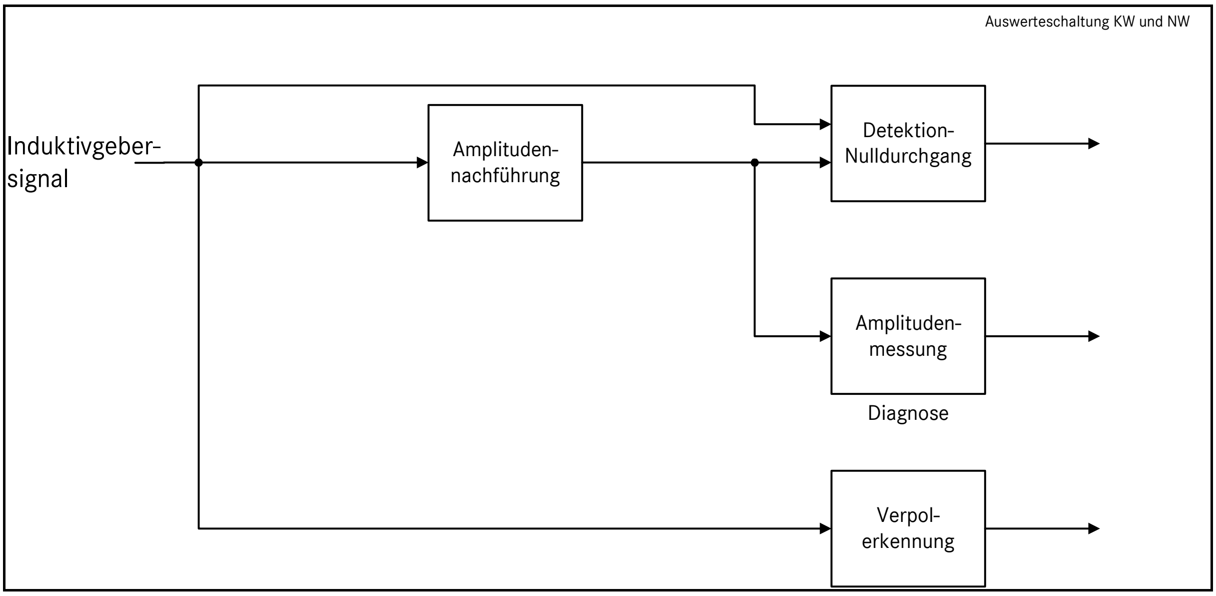
From an input voltage of > 50 V an amplitude limiting function is implemented to protect the evaluation circuit. The maximum signal amplitude of the crankshaft/camshaft sensor may not exceed ±100 V. Inductive sensor data:

L in mH	R in Ω
630 ±15%	1000 - 1385

To maintain interference immunity and avoid diagnosis malfunctions, the sensors' direct current resistance must be within the stated tolerances.

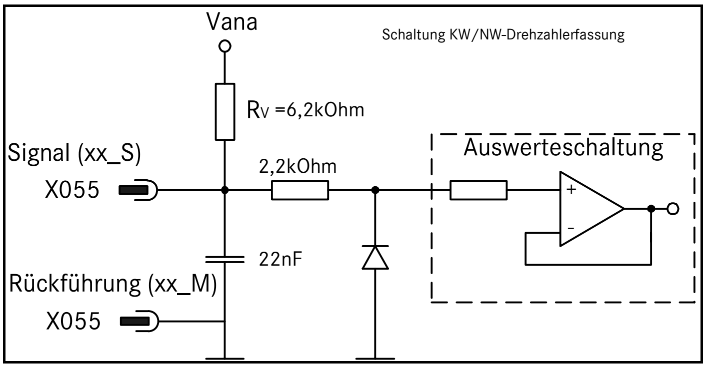
Any deviation from the specified inductance will result in inaccuracies in position detection; this will be reflected in the start of delivery.

Crankshaft and camshaft evaluation circuit



Block diagram of the crankshaft and camshaft evaluation circuit

Between the bores, the surface of the sensor rotor generates an interference voltage caused by surface roughness and changes in the distance (bearing play, eccentricity) between the sensor rotor and the sensor. At high rpm, this interference voltage may be quite high at times. So that these are not interpreted as useful signals, both input circuits (both the crankshaft and camshaft) work with adjusted thresholds. In each case, the response threshold is generated as a function of the level of the useful signal.



Basic circuit diagram of the crankshaft/camshaft input circuit

In the crankshaft evaluation circuit, the respective amplitude of the useful signal is stored and a value for the response threshold is generated from it. In the case of crankshaft evaluation, this is 50% of the last stored useful signal amplitude. As signal amplitudes steadily rise (as a result of rising engine speed), the new voltage value is transferred immediately to the memory.

In the case of decreasing amplitudes, the differences in signal levels continue to be transferred directly to the memory until they reach 75% of the previous value. If amplitudes continue to fall even further, the 75% value is retained in the memory. This prevents sporadic signal levels that are too small from being included in the threshold adjustment. As a result, the required signal to noise ratio is maintained.

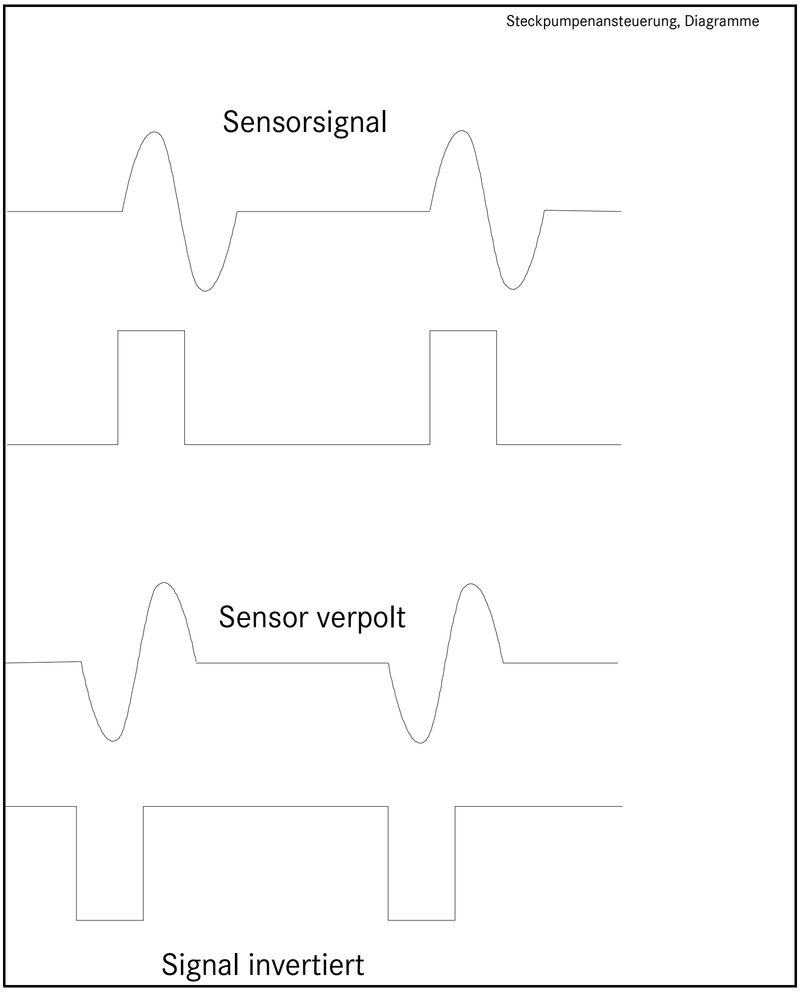
The camshaft evaluation circuit generates the response threshold value from a mean value of the useful signals prevailing at that time. This prevents the substantial fluctuations in level, which arise successively due to the camshaft end play, from affecting threshold adjustment. The stored value is a function of the mean signal amplitude and the pulse/pause ratio, as determined by the sensor rotor.

The response threshold for the useful signals is approximately 45% of the averaged signal amplitudes. As the sensitivity of the input circuit increases as the useful signal decreases, the input circuit for AC component voltages below 0.8 V is blocked in order to avoid the effects of interference. This has the result that smaller signal amplitudes are not detected. When the engine is stopped the DC voltage level at the sensor must be approx. 1.6 to 2.2 V if the sensor is connected correctly and terminal 15 is switched on.

To ensure that the system reliably detects any crankshaft or camshaft sensors with the wrong pole connections, the input pull-up resistance RV has been reduced from 10 kΩ to 6.2 kΩ with the introduction of MR2.

With the introduction of the MR2B1.3/A1 release, the evaluation of crankshaft/camshaft signals is performed by an ASIC.

With the introduction of the MR2, the previous analog reverse pole detection method for the crankshaft/camshaft sensors has been changed to a detection of the pulse/pause ratio (via the limp home controller):



Synchronization of solenoid valve actuation

There are three types of synchronization:

- Crankshaft sensor and camshaft sensor available:

  The system is synchronized at the latest at 50° CA before TDC with the aid of the binary combination for the additional markers. The first cylinder actuated is MV B. All actions are now coupled to the crankshaft. The camshaft is only used to check whether the camshaft and crankshaft marks are aligned. Priority is always given to the crankshaft. If the camshaft fails during operation (timeout or incorrect pulses), a switch is made to crankshaft limp home mode at 50° CA before TDC and the system continues to work trouble-free. If the crankshaft should fail during operation (timeout) a switch is made immediately to camshaft limp home mode. In this case, it is possible that a cylinder may not be actuated for a short time.

- Only crankshaft sensor available:

  The system is synchronized at the latest at 60° CA before TDC with the aid of the additional hole and a time check. The first cylinder actuated is MV B.

  The system status is set to engine protection. If starting is performed with just the crankshaft sensor, a "double firing" will be implemented; this means two cylinders, offset from each other by 360° CA, will be actuated electrically simultaneously. Start of injection precision may be minimally impaired by the presence of two impact signals.

- Only camshaft sensor available:

  The system is synchronized at the latest at 5 ° CA before TDC with the aid of the additional hole and a time check. The first cylinder actuated is MV B. The system status is set to engine protection. The precision of both the start of injection and the quantity is lower in the dynamic behavior on account of the larger tooth spacing. If one of the two sensors fails, it is possible to implement a limp home mode with just the one signal.

Digital inputs

Control unit MR2 has the following digital inputs:

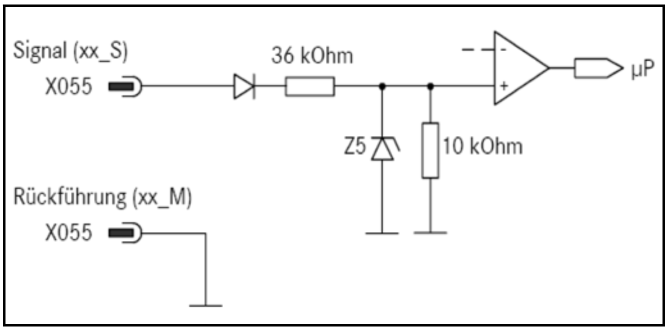
- Terminal 15
- Terminal 50
- Heater flange and
- Engine start/stop.

Terminal 15

When a voltage is applied to terminal 15 (terminal 15 ON), the engine control unit is awakened and ramps up. This voltage is converted into a digital signal by a comparator; this signal is then read in by the processor. The function software of the engine control unit works by using this terminal 15 signal from the comparator and the terminal 15 signal which arrives via the CAN bus.

The switching thresholds to ensure that the terminal 15 voltage is reliably detected at pin 15 of the 16-pin engine connector are as follows:

Terminal 15 ON	Terminal 15 OFF
> 0.56 to 0.77 U_b	< 0.30 to 0.42 U_b



Basic circuit diagram for terminal 15

Terminal 50

Switching on via terminal 50

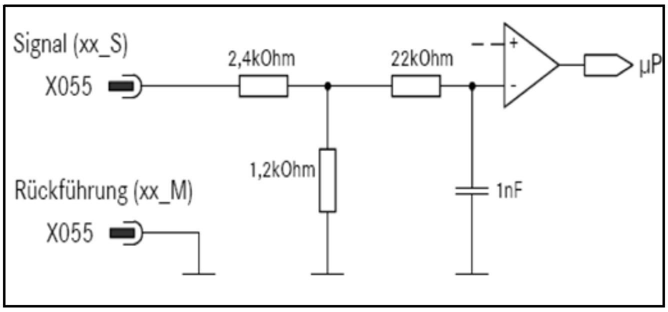
When a voltage is applied to terminal 50 (terminal 50 ON), the engine control unit is awakened and ramps up - even if there is no terminal 15 signal present. In order to avoid a repeat switch-on after a terminal 50 OFF (caused by the transponder signals on the terminal 50 line), the terminal 50 signal is low-pass filtered.

The switching threshold to wake up the control unit via terminal 50 is a minimum 9V.

Detection of transponder signal

The transponder signal is forwarded, unfiltered, to the main controller using a second terminal 50 input circuit. The switching thresholds to ensure reliable detection of terminal 50 voltage at pin 8 of the 16-pin engine connector are as follows:

Terminal 50 ON	Terminal 50 OFF
> 5.53 to 7.52 V	< 2.33 to 3.32 V



Basic circuit diagram for terminal 50

Start/stop service switch

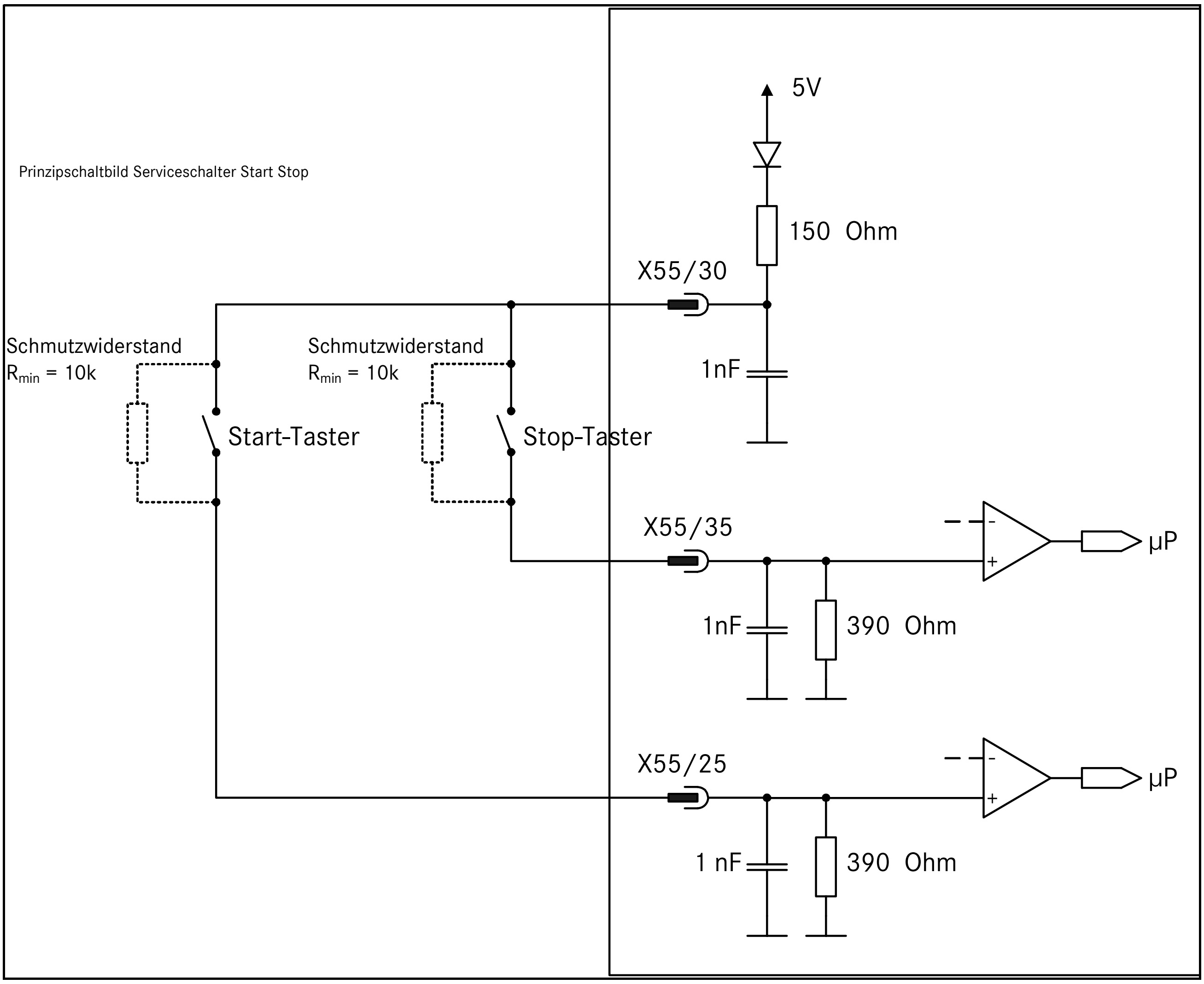
Note

Depending on the control unit, the two start/stop service switches may be replaced by one single switch.

There is provision for two digital inputs (resistant to short circuits to ground) that enable the start and stop service switch functions to be implemented via service buttons when the cab is raised. It is only possible to start the engine with the service button on the engine block in conjunction with the vehicle electronics and therefore it can only be done in the vehicle. The buttons are supplied with a 5 V voltage by the control unit. The following switching thresholds apply:

Terminal 50 OFF
1.60 to 2.01 V

The contact current when the button is actuated is approx. 10 mA. In addition, the inputs to the buttons are resistant to short circuits to ground and are insensitive to the slush resistors parallel to the buttons. The slush resistors can receive values down to kΩ.

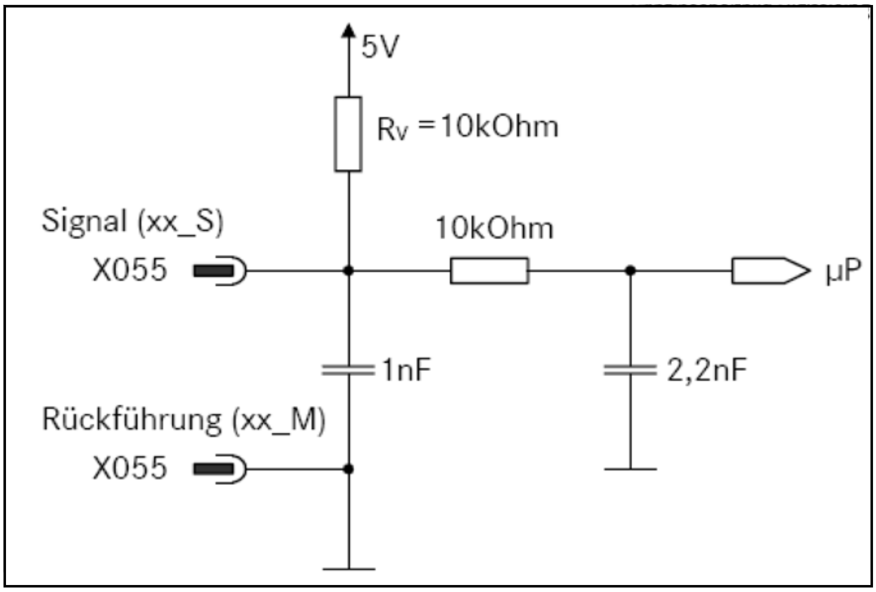


Basic circuit diagram of start/stop service switch

Heater flange

The control unit provides an input for diagnosing the heater flange. This enables a short circuit in the actuating line of the heater flange to be detected. The input circuit is supplied with a 5 V voltage by the control unit. The input signal is read in via the AD converter of the limp home controller and transmitted to the main controller; the switching thresholds are defined in the main controller software as follows:

U ON	U OFF
> 3.5 ±40 mV	< 1 ±40 mV



Basic circuit diagram of heater flange

Actuator system

Unit pump (solenoid valve) characteristics

Reference values for the unit pumps:

Resistance:	0.077Ω - 0.171 Ω at 20° C
Number of turns:	35.5
Inductance:	0.160 – 0.229 mH at 1 MHz
Inductance, valve open:	0.41 – 0.53 mH
Inductance, valve closed:	0.54 – 0.66 mH
Wiring harness resistance:	20 mΩ - 200 mΩ

Unit pump actuation

The purpose of the unit pump actuation system is to adjust the required start of delivery and angle of delivery (map-dependent) as accurately as possible and specifically for each cylinder. The key parameter for a valve is the impact time (electrical cut-in point until the valve opens). This time must be provided for any desired start of delivery. The remaining energization period is calculated from the rpm and angle of delivery.

The PWM of the individual phases can be adjusted.

Principle of unit pump actuation

Firstly, the valve is switched on fully. Once the starting current is reached (approx. 16 A for 24 V operation), the current is limited. The movement of the valve armature changes the coil's magnetic field and counteracts the current. As soon as the valve is fully open, a relative current minimum arises that signals the impact of the solenoid valve armature. During this phase, a high-frequency PWM is used to ensure that this relative current minimum can be detected. The impact can now be used to evaluate the start of injection. After the impact, a further current-limiting function is implemented on the holding current by means of PWM in order to prevent power loss.

The four actuation phases

The current-limiting function is implemented as a function of coil current. Four actuation phases arise as a result, the last one being the final valve shut-off.

<u>Phase A: push phase</u>

In order to reach the starting current of 16A, for 24V operation, and 9A for 12V operation as quickly as possible, the battery voltage is switched to the valve with a high PWM pulse duty factor, When the starting current threshold is reached, the valve armature starts to move. The flight phase begins.

<u>Phase B: flight phase</u>

During this period, the armature moves from its rest position towards the valve seat until the armature strikes in the end position. A different PWM pulse duty factor is required so that the valve is kept in the flight phase, but the armature is not accelerated any further. This minimizes bounce on impact. The key characteristic is the local current minimum when the armature strikes in the end position. This is the point at which impact is detected and enables start of injection to be determined accurately. As soon as impact is detected, the actuation is switched over.

<u>Phase C: holding phase</u>

In order to restrict the valve current and reduce power loss, a switch is made to a PWM in this phase. The enables the necessary holding current to be generated for the valve without letting the energy contained in the valve get too high. The holding current level of approx. 12 A is current-regulated by the hardware.

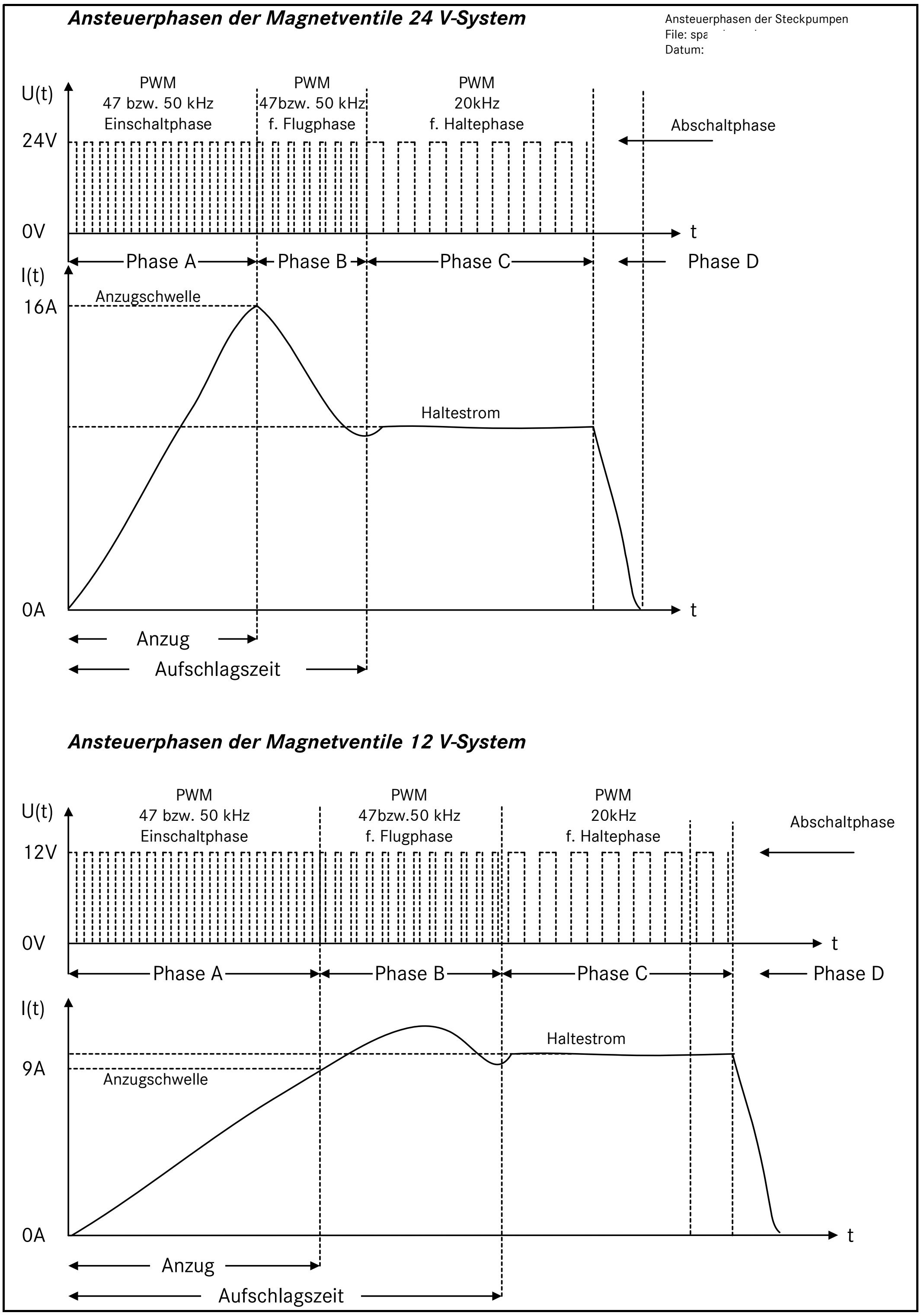
Phase D: switch-off phase

After the required injection period has ended, a signal to end the injection, in other words to switch off the valve, comes from the processor. The aim is to switch the valve off as quickly as possible.

The following graphics show the relationship between current and voltage in the four valve actuation phases for 24V and 12V operation.

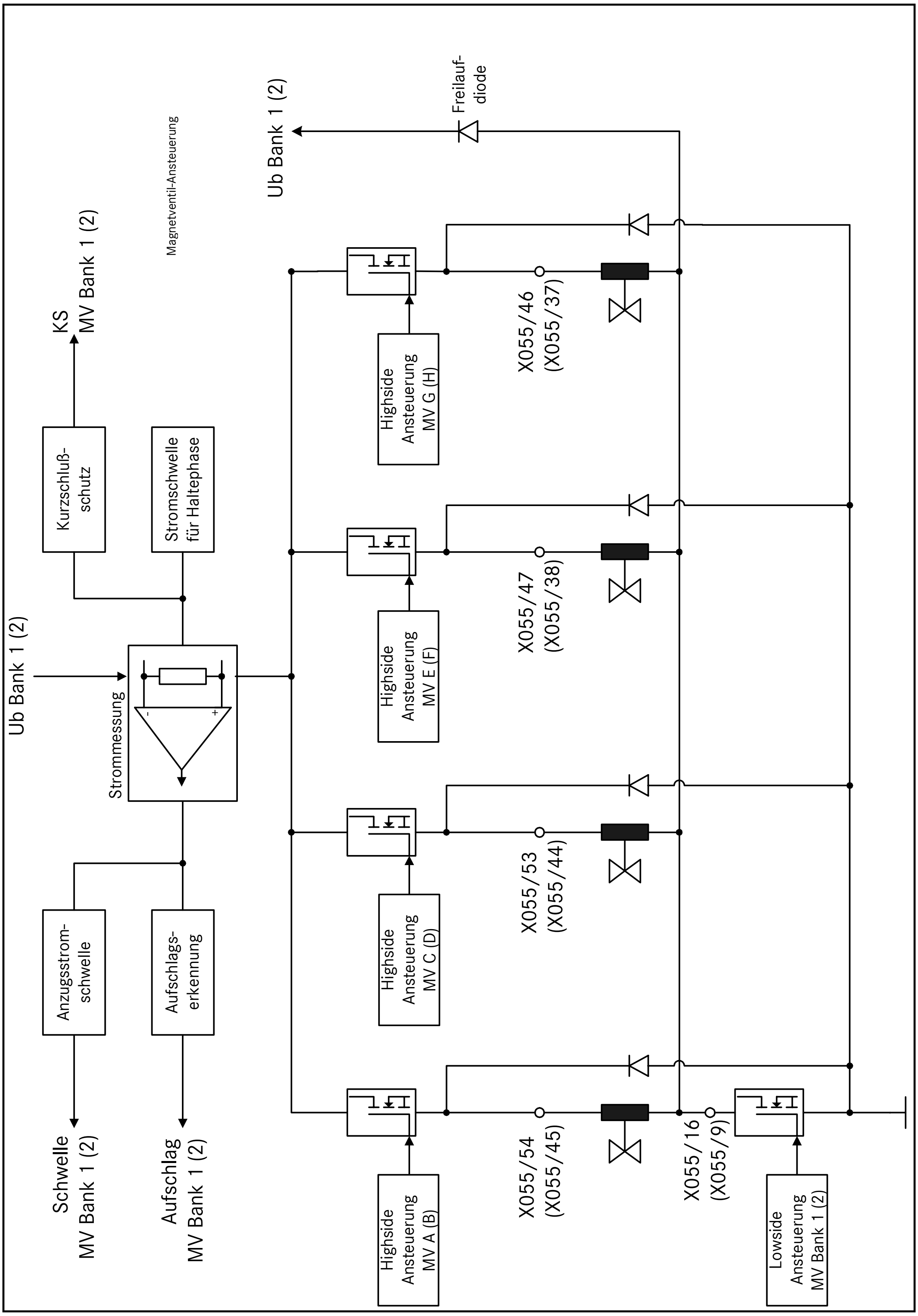
Note

All values in the graphics below are dependent on the data set and may vary according to the parameter settings.



The pulse duty factor in the activation, flight and holding phases is dependent on battery voltage. The frequency of the activation phase and the flight phase can be set to 47 and 50 kHz respectively by means of a map data set.

Structure of the solenoid valve banks



Basic circuit diagram of the structure of a solenoid valve bank

For reasons of redundancy, the eight locations for the unit pump solenoid valves are grouped into two banks (MVB). Ub bank 1 supplies unit pumps A, C, E and G and Ub bank 2 supplies unit pumps B, D, F and H.

For cost reasons, the 4 solenoid valve low-side transistors are not installed on the 4-cylinder version of the MR2 as they are not required.

High-side actuation

The solenoid valve to be actuated is selected with the high-side switch. The switch is switched on at the beginning of phase 1 and switched off at the end of phase 4.

Low-side actuation

The PWM is switched with the low-side switch.

Current measurement

The solenoid valve bank has a shared current measuring system for detecting the prevailing valve current. The measuring resistor is located between the voltage supply and the high-side drivers so that current can be recorded even in overrun.

Starting current threshold

The microprocessor is informed that the starting current threshold has been reached. As of MR2 B1.3/A1 release, the starting current threshold is evaluated by means of an ASIC.

Impact detection

This part of the circuit enables the solenoid valve impact to be accurately determined. The microprocessor is informed when impact has been detected. As of release MR2 B1.3/A1, impact detection is evaluated by means of an ASIC.

Short-circuit protection

Each solenoid valve bank is equipped with a short-circuit protection system. This switches off the output stage when excess current occurs. As of release MR2 B1.3/A1, short circuits will be detected by means of an ASIC. The short-circuit shut-down is not activated until the system has been switched back on 15 times by the logic IC (interference immunity).

Proportioning valve actuation

The MR2A1 control unit offers 6 power outputs (8 on the MR2B) for actuating proportioning valves. They are used to operate external actuating and switching elements:

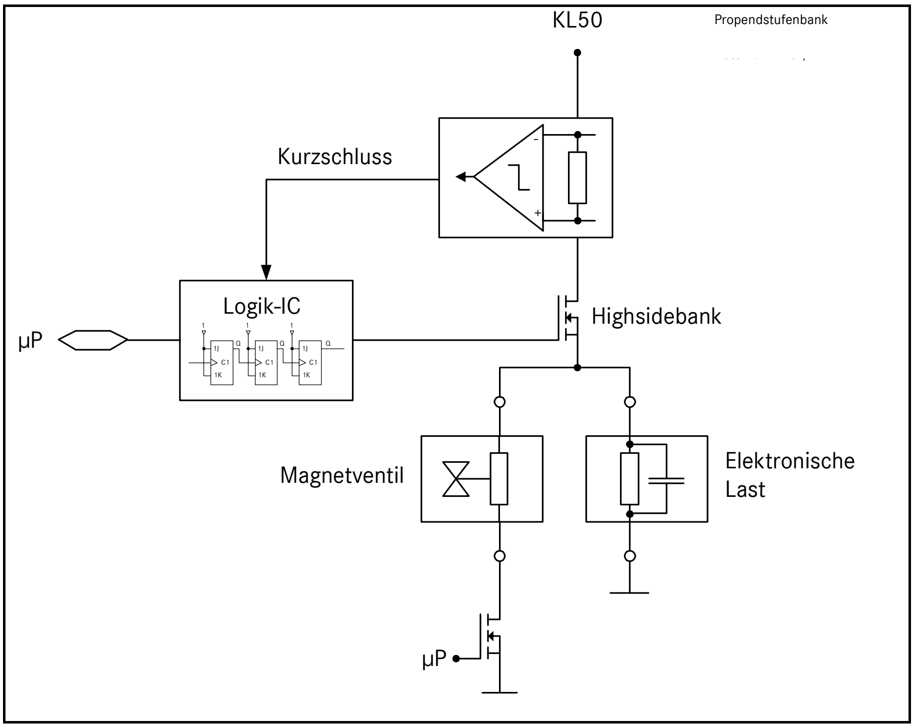
- Prop. 1: exhaust flap
- Prop. 2: constant throttle/EGR
- Prop. 3: fan 1
- Prop. 4: fan 2/map thermostat
- Prop. 5: constant throttle
- Prop. 6: exhaust flap / heater flange
- Prop. 7: AdBlue metering valve (MR2B release only)
- Prop. 8: AdBlue tank heater (MR2B release only).

No valve is permitted to be permanently energized if a high-side MOSFET fails.

The outputs are grouped into two: proportioning valve bank 1 (PVB1) and proportioning valve bank 2 (PVB2). The rated current per output stage and across the entire temperature range is: I_{MAX} = 2 A. The maximum rated current of one proportioning valve bank is I_{MAX} = 8 A (static) and I_{MAX} = 9 A (briefly).

The short circuit detection function is activated when a current of I_{MAX} = 11 A is reached. As of the MR2 release, after the short circuit threshold has been reached and the associated short circuit deactivation has been performed, the proportioning valve supply is guaranteed to be switched back on (up to 7 activation attempts) for the purposes of operating electronic loads and their capacitive input impedances. If, after 7 activation attempts, an overcurrent is still present, the proportioning valve bank is switched off by the logic IC and the fault is forwarded to the main controller.

The maximum capacitive load for the proportioning valve supply may not exceed 5μF for each bank. The proportioning valve bank is switched back on a total of three times via the software debounce function; only after a bank has been switched back on three times (with 7 actuation attempts by the logic IC each time) will a fault log be generated and the proportioning valve actuation will not be reactivated until after terminal 15 has been switched back on.



Proportioning valve bank 1:

Proportioning valves 1, 2, 3 and 4 are grouped into one valve bank (PVB1). The valve bank is supplied with battery voltage by a shared circuit. This circuit features short circuit and level detection functions. The valve bank is switched on if at least one of the proportioning valves in this bank has been parameterized.

The outputs of PV 1 to 4 are implemented by means of a low-side 6-channel driver with diagnosis capability (PV1 and PV2 each have 2 drivers switched in parallel, PV3 and PV4 are designed as single drivers). The proportioning valves are switched on for functioning via this low-side driver and the outputs are monitored for shorts to battery voltage, ground shorts (low-side) and line breaks. The detection threshold for line break detection requires the respective proportioning valve to have a maximum internal resistance of 10kΩ; where necessary, this has to be guaranteed by means of a corresponding parallel resistor in the proportioning valve.

Proportioning valve bank 2:

Proportioning valves 5 to 8 are grouped into one valve bank (PVB2). For version MR2A, only outputs PV5 and PV6 are available; version MR2B also has outputs PV7 and PV8.

The valve bank is likewise supplied with battery voltage via a shared circuit that features short circuit and level detection functions. The valve bank is activated if at least one of the proportioning valves in this bank has been parameterized.

The outputs of PV 6 to 8 are implemented by means of a low-side 4-channel driver with diagnosis capability (in version MR2A only output PV6 is wired). The proportioning valves are switched on for functioning via this low-side driver and the outputs are monitored for shorts to battery voltage, ground shorts (low-side) and line breaks. The detection threshold for line break detection requires the respective proportioning valve to have a maximum internal resistance of 10kΩ; where necessary, this has to be guaranteed by means of a corresponding parallel resistor in the proportioning valve.

PV 5 actuation is designed as a high-side switch. Open-load detection is guaranteed by means of a separate level detection function.

Output	Function	Current	Characteristics	Actuation	Supply or ground
PV1	Exhaust flap	≤ 2 A	PWM 120 Hz or switch output	Low-side PV1	UB PVB 1[1] Ground: PVM
PV2	Constant throttle or EGR	≤ 2 A	Switch output or PWM 120 Hz	Low-side PV2	PV2_P[3]
PV3	Fan 1	≤ 2 A	PWM 1 to 200 Hz or switch output	Low-side PV3	PVB 1[1]
PV4	Fan 2 or map thermostat	≤ 2 A	PWM 1 to 200 Hz or switch output	Low-side PV4	PVB 1[1]
PV5	Constant throttle	≤ 2 A	Switch output	High-side PV5	PV_M[2]
PV6	Exhaust flap or heater flange	≤ 2 A	PWM 5 to 200 Hz or switch output	Low-side PV6	PVB2 Ground: PV_M
PV7	AdBlue metering valve (MR2 B release only)	≤ 2 A	PWM 5 kHz	Low-side PV7	PVB2
PV8	AdBlue tank heater (MR2 B release only)	≤ 2 A	Switch output	Low-side PV8	PVB2

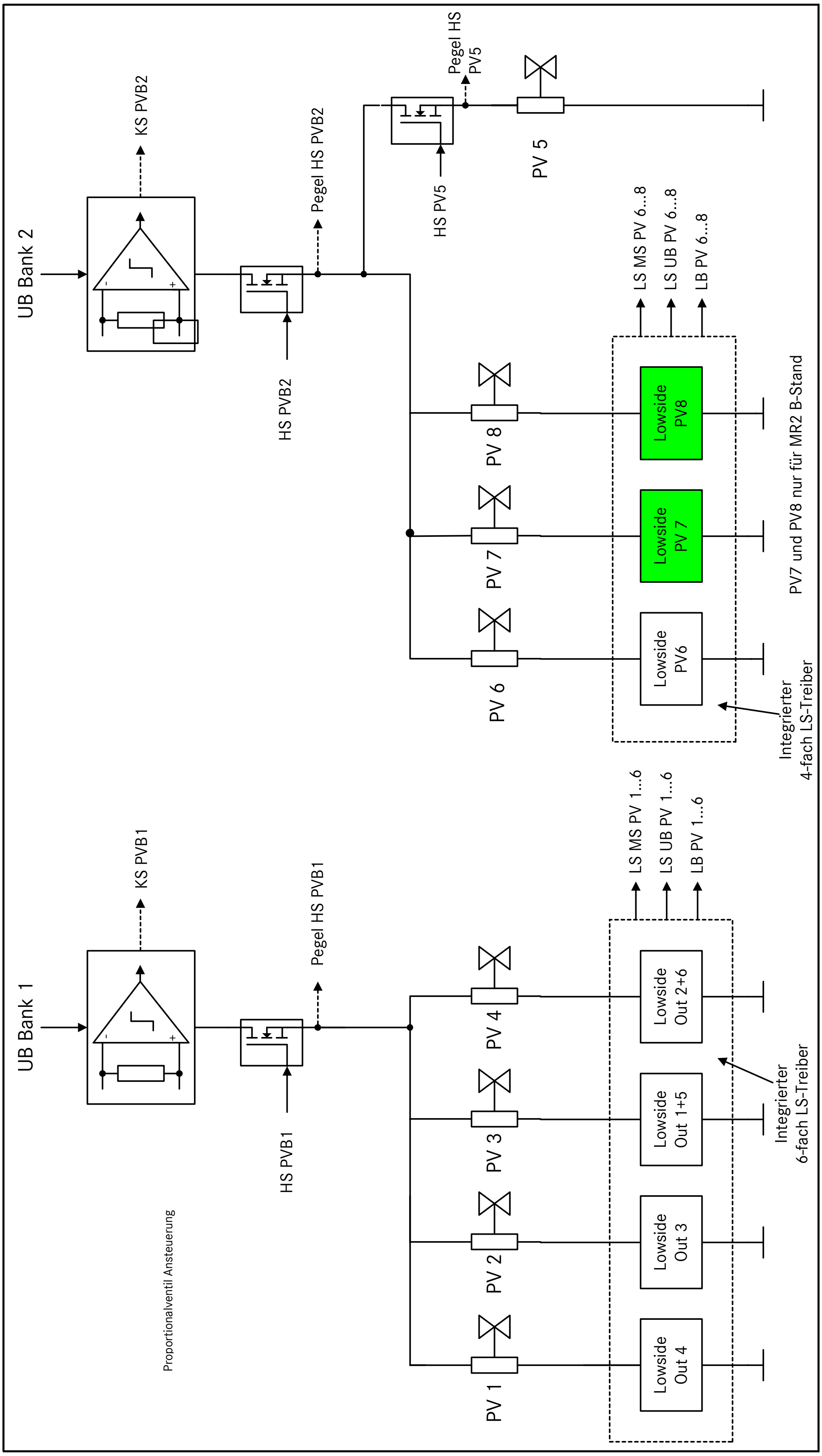
1: Low-side actuation, one common high-side driver. Lines grouped into wiring harness for each bank, connected to control unit via one common connector pin.

2: Shared line ground, not switched.

3: For MR2A release only, MR2B release does not have a separate PV2 supply on the vehicle connector.

Note

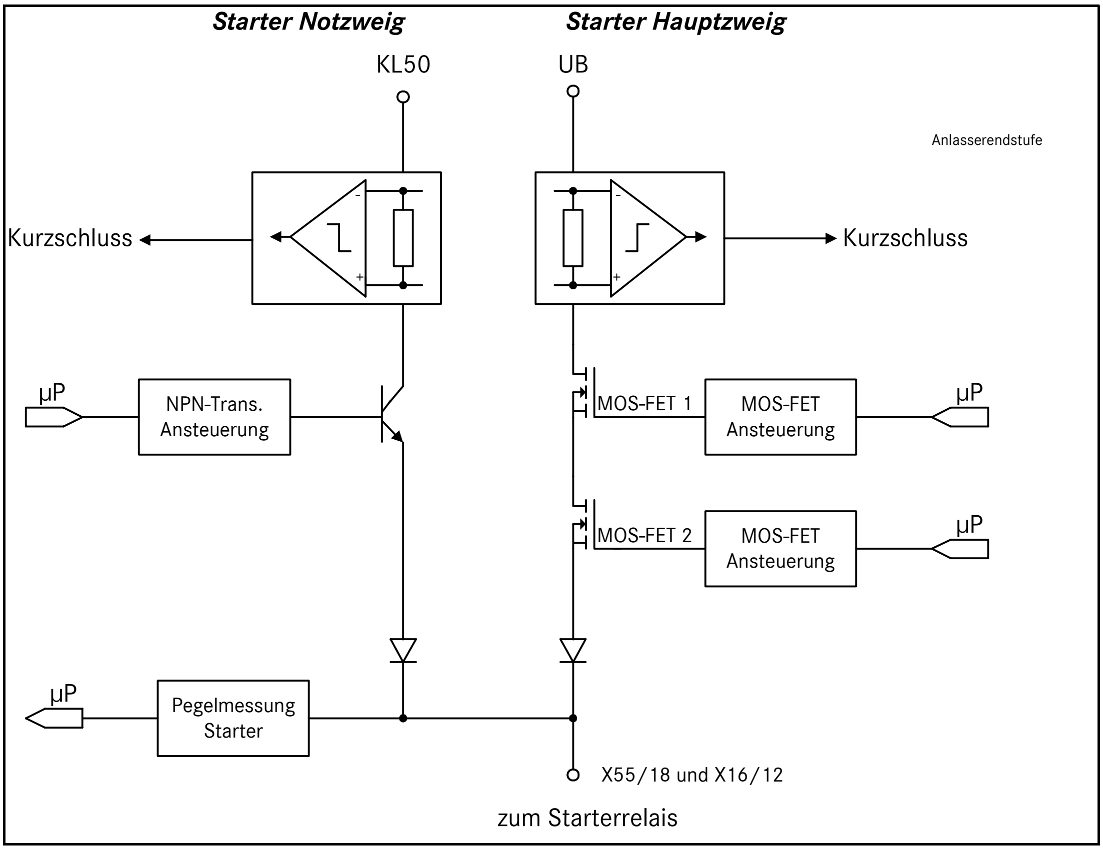
The maximum inductive load for switch outputs may not exceed 25 mH.



Basic circuit diagram for proportioning valve actuation

Starter actuation

The starter is actuated via a relay which in turn is actuated by the starter output stage of the MR2 control unit. The starter output stage is divided into two power stage branches that are connected in parallel, namely the main branch and the emergency branch.



Basic circuit diagram for starter actuation

Electrical data:

Maximum relay current: I_{MAX} = 2A voltage drop

Output stage: U_{End} = 2 V at I = 2A for the main branch

Main branch (self-locking)

The main branch is fed by Ub and consists of two MOSFETs (MOSFET 1 and 2) connected in series, each of which has its own actuation circuit. This ensures that the starter cannot be actuated unintentionally even if one MOSFET has failed. The operation of the output stage components can be tested independently of each other by separate actuation of the two MOSFETs.

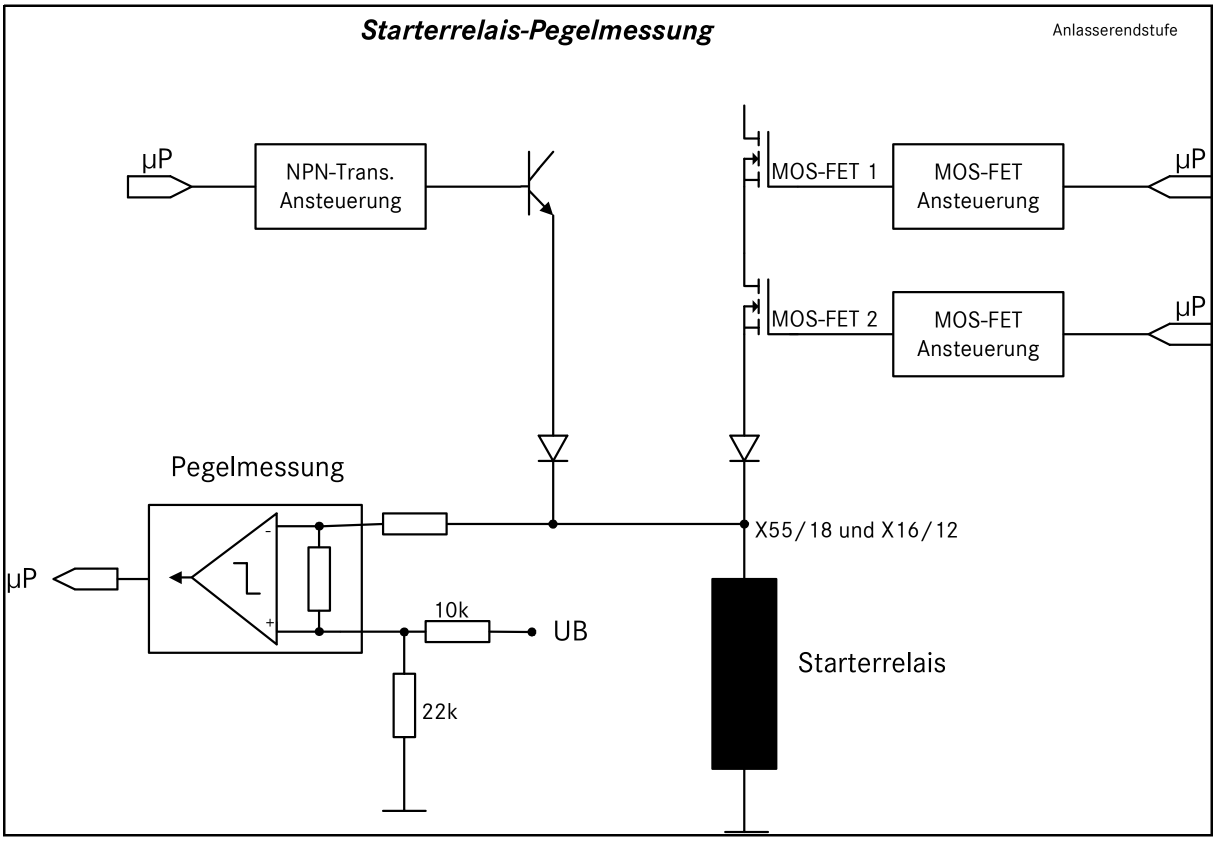
In addition, the main branch has a short circuit detection function in series with the two MOSFETs (I_{KS} > 2.5A); this triggers a software interrupt which locks both the main and emergency branches.

Emergency branch (self-conducting)

The emergency branch is fed by terminal 50 and can be switched off by the processor via integral bipolar actuation (NPN transistor). The starter emergency branch has a short circuit and overload detection function (I_{KS} > 2.5A) provided that control unit power supply via terminal 31 is assured.

Level measurement

A level measuring function is incorporated into the starter output stage to detect line breaks. The level is compared with a voltage derived from UB and graded as low or high (the switching point is 1/3 U_B).



Basic circuit diagram for starter relay level measurement

Starter relay

For level detection in the MR2 (checking of both FETs in the main branch and detection of line breaks during the start-up phase), the starter relay may not exceed specific limits regarding internal resistance (< 400Ω) and inductance (< 900 mH).

Diagnosis

The starter actuation circuit is checked in two stages:

- Firstly, after terminal 15 is switched on, MOSFET 1 is activated and the level read back. Then MOSFET 2 is activated and a level check performed.
- When terminal 50 is switched on for the first time, both FETs are actuated briefly and a level and short circuit check performed. The emergency branch transistor is then actuated and a level and short circuit check performed.

Starter actuation ensures the following:

- The starter can be operated by the MR2 control unit even if terminal 50 is not activated (operation of start button or operation via CAN message).
- If the control unit or wiring is faulty (e.g. no terminal 30 activation), the starter can be operated via terminal 50 (emergency branch).
- The starter can be deactivated by the control unit even when terminal 50 is activated.

Communications interfaces

The MR2 control unit features two interfaces for bi-directional communication:

- the engine CAN interface and the
- diagnostics interface (K-line)

The MR2 version has an additional CAN interface.

Engine CAN interface

This is used to communication with the LS engine CAN in the vehicle.

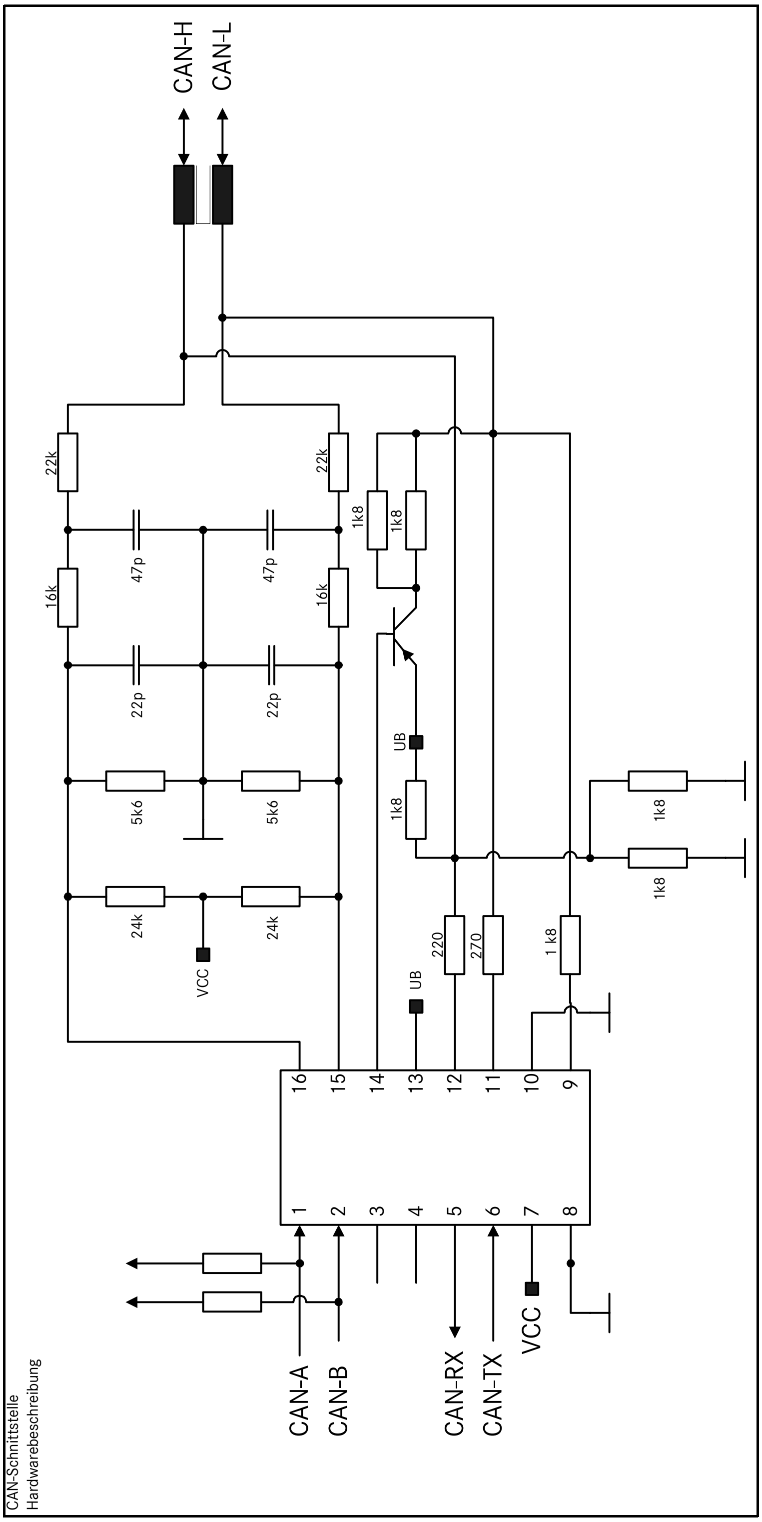
The CAN controller is incorporated in the Siemens microprocessor SAKC167CS. When the Siemens processor starts up, the CAN bus is also activated. The CAN software is called up within a ten millisecond time frame.

The CAN works with a low-speed, high-level interface that is operated with battery voltage.

The interface works with signal levels of 1/3 UB and 2/3 UB and is operated at 125 kbit/s.

The interface can be operated in the following operating modes by means of signals CAN-A and CAN-B.

ASEL	BSEL	Status
0	0	Mute
0	1	Single-wire CAN-L
1	0	Single-wire CAN-H
1	1	Two-wire



Basic circuit diagram of the CAN interface

Initialization

In the initialization phase, the registers required for operation of the CAN controller, are assigned. The data that are transmitted via the CAN are set to 0xFF (signal not available). The operating mode of the physical interface is set to two-wire operation.

Fault detection

If the ramp-up time of three hundred milliseconds is reached or the first identifier 594 has been received, the CAN software starts fault detection. In each cycle, a check is made to see whether identifiers 594 and 595 have been received from the vehicle electronics (FR). There is a fault counter for each identifier. If an identifier is missing, the respective fault counter is incremented. If the identifier is there, the fault counter is set to zero. If the fault range of fifteen (corresponding to 150 ms) is exceeded for one of the two identifiers, the CAN fault is set and the engine switches to CAN limp home mode. Only when both identifiers have been received again will the CAN fault be reset and the engine exit CAN limp home mode.

CAN single-wire capability

If a fault is detected when transmitting CAN messages, an attempt is made to re-establish the connection by means of just one of the two CAN lines. If this is successful, an attempt is made after ten seconds to switch back to two-wire operation. If the attempt is unsuccessful, the system is switched back to single-wire mode and another attempt to switch back is made after a further ten seconds. The switching to single-wire operation and switching back to two-wire operation happens so quickly that it is not possible for CAN limp home mode to be activated.

Monitoring the fault counter

If identifier 594 is not received for thirty milliseconds, the physical interface is switched back and forth between single-wire CAN_L and single-wire CAN_H mode in ten millisecond cycles. If identifier 594 is received on a wire, single-wire mode is retained until an attempt to switch back to two-wire mode is initiated by the vehicle electronics.

The vehicle electronics must initiate an attempt to switch back after ten seconds. If the attempt is not successful, the system switches back to the old single-wire mode and, after a further ten seconds, another attempt to switch back is made. If 10 attempts to switch back have been made in succession and were not successful, a CAN_L or CAN_H fault is stored in the fault memory, depending on which interface line is still working.

Monitoring the bus_{off}

If a BusOff is detected, the sending of identifiers will be locked and the CAN controller is initialized to 1 Mbit/sec. Once the BusOff status has ended, the CAN controller is re-set to 125 Kbit/sec. After that the system switches back and forth between single-wire CAN_L and single-wire CAN_H mode in ten millisecond cycles for a maximum period of eighty milliseconds. If identifier 594 has been successfully received on one wire, transmitting is enabled again and single-wire mode is retained until the attempt is made to switch back to two-wire mode.

If no identifier 594 has been received after eighty milliseconds, the system switches to two-wire mode and transmitting is enabled again.

Diagnostics interface (K-line)

ISO diagnosis and CONAS operation are performed via the K-line.

On the hardware side, the diagnostics interface of the MR2 control unit is implemented with bus driver IC SI 9241. The K-line level is dependent on the operating voltage of the MR2 control unit (e.g. +27 V); consequently, to ensure correct adaptation to an RS 232 interface (± 12V), a further external K-line adapter (e.g. level converter) is required.

Ground keying

Ground keying (i.e. the K-line level is connected to ground) enables switching between different K-line operating modes and deletion of the control unit's fault memory.

Fault memory: a ground keying of 1.9 ± 0.02 seconds is required to delete the fault memory; this has to be generated by an external testing device.

Operating modes:

- Free-running (monitor mode)

  After the fault memory is deleted, the system switches back to free-running mode. (see the following tables of free-running messages).
- ISO diagnostics (in accordance with the ISO standard)

  A ground keying of between 0.02s and 0.035s switches the system to dialog mode.
- CONAS (configurable application system)

  A ground keying of between 0.95s and 1.05s switches the system to CONAS mode.
- TDC output

  A ground keying of between 4s and 15s switches the K-line to TDC signal output. At each ignition TDC of the engine, the K-line level is set to "low" for a period of 10 °CA. Delete memory A ground keying of between 1.88s and 1.925s enables the fault memory to be deleted.

Major components CAN interface

The major components CAN interface is used to communicate with the control unit for exhaust gas aftertreatment in the vehicle and is only installed for the MR2B release.

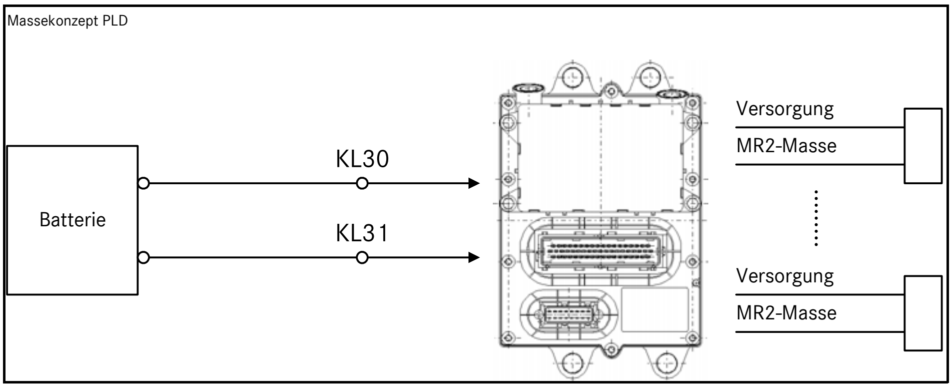
This second CAN controller is also incorporated in the Siemens microprocessor SAKC167CS. When the Siemens processor starts up, the CAN bus is also activated. The CAN software is called up within a twenty millisecond time frame.

The major components CAN works with a high-speed, low-level interface that is operated at a fixed level (with respect to a supply voltage of Vcc = 5 volts); fundamentally, it only operates in two-wire mode.

The interface works at signal levels of 1/3 Vcc and 2/3 Vcc and is operated at 250 kbit/s.

MR2 ground concept

To prevent ground loops and associated EMC coupling and ground voltage offsets, the sequential concept was selected for the MR2 control unit ground connection and all external connections. This ensures that current always flows back via the MR2's ground line to the battery.



MR2 ground concept

To prevent ESD malfunctions, the MR2's metal housing has a low-resistance connection to the control unit via a 940Ω resistor - it is therefore important to implement design measures to ensure that no external ground short is generated via the metal housing. To suppress rapid ESD interference pulses, a 1nF capacitor is installed parallel with the shunt resistor.

Safety concept

Single-wire capability of engine CAN

If a fault is detected when transmitting CAN messages on the engine CAN, an attempt is made to re-establish the connection by means of just one of the two CAN lines. If this is successful, an attempt is made after ten seconds to switch back to two-wire operation. If the attempt is unsuccessful, the system is switched back to the old single-wire mode and another attempt to switch back after a further ten seconds. The switching to single-wire operation and switching back to two-wire operation happens so quickly that that it is not possible for CAN limp home mode to be activated.

System limp home capability

Failure of microprocessor 2

If the limp home controller fails, the control unit retains full engine functionality, except for the following:

- Main controller check
- Reading in start/stop button
- Diagnosing sensor supply voltages Usens1 and Usens2
- Recording internal control unit temperature
- Diagnosis of turbocharger speed input
- Switching of turbocharger speed evaluation threshold to low sensitivity
- Heater flange diagnostics input
- Crankshaft/camshaft input diagnosis (line break, short circuit)
- Crankshaft/camshaft sensor polarity reversal detection

Crankshaft limp home mode

If the main computer does not detect a camshaft signal when starting, a switch is made to crankshaft limp home mode. This means that two cylinders, offset from each other by 360° are actuated simultaneously (double firing). Engine protection is activated once the starting procedure has been exited; both engine speed and output may be restricted as a result.

If the camshaft fails during engine operation, crankshaft limp home mode is detected. The system continues to work normally as synchronization has already been performed, engine protection is activated.

Camshaft limp home mode

If the main computer does not detect a crankshaft signal when starting, a switch is made to camshaft limp home mode. Engine protection mode is activated once the starting procedure has been exited.

If the crankshaft fails during engine operation, camshaft limp home mode is detected. Engine protection is activated.

LS-CAN limp home mode

If data are implausible or faulty or if the connection via the LS-CAN bus malfunctions, a switch is made to regulated CAN limp home mode.

Microprocessor 2 limp home mode

If the main computer in the MR2 control unit fails, the limp home computer (microprocessor 2) takes over the task of actuating the solenoid valves. The processor regulates engine speed to between 800 and 1300 rpm. The limp home rpm is programmed by the main computer. This status can only be exited by switching off the control unit.

Engine protection

In order to protect the engine against overload in certain operating states, various protective functions (e.g. power reduction) are implemented in the MR2 engine electronics; these functions may affect requested torque and start of delivery.

Control unit function monitoring (diagnosis)

Functions for monitoring the engine electronics (sensors, actuators, etc.) have been incorporated so that faults may be detected and appropriate remedial or substitute measures may be implemented.

Sensor monitoring

Temperature and pressure sensors

Fault detection: measuring range has been undershot or exceeded.

After the sensor voltages have been read in, a check is made to see whether the voltage values are within the valid range.

If a voltage value is outside the range, it is initially assumed that this is a sporadic fault and the last valid value is used for the subsequent calculations. A fault triggering counter is also incremented. If the trigger counter reaches its maximum value, the corresponding fault code is stored and a substitute value is used.

Measures implemented in the event of faults: use of substitute values.

Crankshaft sensor

A distinction is made between three types of fault:

- Crankshaft timeout
- Crankshaft sensor has wrong pole connection
- Crankshaft sensor ground short or line break

Camshaft sensor (cylinder 1 detection)

A distinction is made between three types of fault:

- Camshaft timeout
- Camshaft sensor has wrong pole connection
- Camshaft sensor ground short or line break

Substitute sensor values

If the sensor should fail or implausible sensor voltages arise, so-called substitute values are generated.

Monitoring the actuators

Solenoid valves

Fault detection: short circuit

The short-circuit statuses UBat short, ground short and valve short can be detected by the software. Here, the short circuit is determined by means of the rate of rise of the switch-on current.

If a U_{Bat} short or a valve short is detected during operation, the corresponding fault is logged in the fault memory. Ground shorts can only be detected in ramp-up mode. In this case, an impact fault is logged in the fault memory during operation. The fault is then detected as a ground short at the next ramp-up.

If the hardware detects a fault due to a short circuit threshold being exceeded, the hardware will be switched off to protect itself.

Measures in the event of a fault: solenoid valve in which the short circuit fault was detected is switched off. The valve remains switched off until the control unit is started again via terminal 15 or the fault is deleted from the fault memory.

Fault detection: no impact

The solenoid valves are not regarded as fully open until the armature impact (equal to the electrical start of delivery) has occurred. It is therefore necessary to calculate the time between electrical activation and the impact of the solenoid valve (impact time). The switch-on time must be ADVANCED by this amount of time to maintain the correct start of delivery. For this purpose, the time of impact is detected by the hardware and conveyed to the microprocessor. If the time is outside the defined time window, an impact fault is detected.

Measures in the event of a fault: if an impact fault is detected, the last valid impact time is used.

Fault detection: faulty solenoid valve actuation

After the solenoid valve is switched on, the valve current must have exceeded a specified current threshold after a specific period of time (= f (U_{Bat})). If this current threshold is still not exceeded after a configured period of time, an actuation fault is detected. .

Measures in the event of a fault: the unit pump in which the actuation fault occurred, continues to be actuated electrically.

Proportioning valves

Fault detection: ground short

If, when a proportioning valve is actuated, a short circuit occurs several times in succession at the actuating pin of one or more proportioning valves, a "short circuit" fault for the corresponding output (prop. valve 1 to 8) is stored in the fault memory.

Measures in the event of a fault: proportioning valve in which the short circuit fault was detected is switched off. The valve remains switched off until the control unit is started again via terminal 15 or the fault is deleted from the fault memory.

Starter actuation

Fault detection: ground short

If, when the starter is actuated, a short circuit occurs several times in succession at the actuating pins of the starter, a "starter actuation ground short" fault is stored in the fault memory.

Measures in the event of a fault: no further actuation of the starter until the next re-start via terminal 15 or until fault is deleted from the fault memory.

Fault detection: line break

If the starter is not actuated, the voltage level of the starter output stage is used to detect whether there is a line break. At the next start, the fault "line break" will then be logged in the fault memory.

Measures in the event of a fault: none

Fault memory

Fault detection is performed in the individual basic functions (sensor signal processing, actuator activation, etc.). Logging of the fault code in the fault memory and the updating of the fault counter are performed in the main program.

Detection of hardware

Detection of MR2A and MR2B hardware version

When the control unit is ramping up, the software checks to see whether the hardware used is an MR2A or MR2B control unit.

If it is not possible to say definitively which hardware is being used, it is assumed to be MR2B hardware in order to ensure the Euro 4 application. At the same time, the fault 40 50 "Internal control unit fault: incorrect hardware ID" is stored. This ensures that Euro 4 vehicles always get a fault log; this can result in the MIL coming on in the display.

Torque control

Structure/calculation of set torque

The key parameter for torque control in the engine control unit is the set torque. This relative indicated torque is the current engine load. The parameters "start of delivery" and "angle of delivery" are calculated from the set torque. They adjust the corresponding setpoint by means of unit pump actuation. In addition, the current absolute actual engine torque is calculated from the set torque and this is transmitted on the CAN. A state detection function distinguishes between various engine states and, for example, controls the torque calculation switch-over to starting mode, idle control mode, etc. (see section on "Detection of engine state", Page 85).

Another important input parameter for state detection and set torque calculation is the engine speed, although this does not feature any further here.

- Requested torque

  The requested torque is calculated from the absolute torque request from the CAN; this too is processed as a relative indicated torque. The requested torque is derived from the current accelerator pedal position. When operating without CAN, the requested torque can be specified directly as a relative indicated torque via an unused sensor input.

- Active vibration damper

  A vibration damper can be activated via the CAN to dampen any vibrations that have been induced by the powerplant. The filter counteracts any vibrations that arise, the filter output is therefore deducted from the requested torque.

- Requested torque gradient restriction

  In load-off conditions, the requested torque is forwarded with a delay. A minimum requested torque gradient can be activated for this purpose This occurs when a minimum requested torque is exceeded and a negative requested torque gradient threshold is not reached. The function is only activated in controlled engine-on mode.

- Limit torque

  The limit torque is the maximum engine torque permissible in the current operating state and is essentially determined by the full-load restriction and the smoke map. Engine protection functions may reduce this torque even further. The requested torque is always restricted to this value.

- Idling speed governor

  In engine-on mode, the idling speed governor limits the engine speed to a minimum necessary or minimum permissible value and is designed as a PID controller. The setpoint engine speed may be increased, for example, as a function of temperature or via the CAN. A max. logic gating of the controller output with any restricted requested torque ensures that the engine speed is observed. To prevent any accelerator free travel, this structure requires a start-off function to be implemented in the vehicle electronics. This enables the start-off behavior to be specified and adapted independently via the vehicle electronics.

- Working speed governor

  Switching to working speed control results in the operating state being regulated entirely by engine speed. Requested torque instructions and idling speed control do not have any effect in this mode. The working speed governor ensures that the idling speed is observed.

- Maximum engine speed control:

  A maximum speed governor ensures that the maximum permissible engine speed is observed in all operating states. The maximum speed governor is designed as a PI controller. The set torque can be reduced to zero (no injection) by means of a minimum logic gating. The maximum governed engine speed can be reduced by engine protection functions or via the CAN.

- Torque limiter

  When the torque limiter is activated, a min. logic gating ensures that specific torque limits are observed. The set torque after maximum speed control is controlled by the "torque limiter" function and min. logic gated with the maximum torque limiter torque.

- Engine protection functions

  A min. logic gating ensures that specific torque limits are observed in limp home mode. The set torque after torque limiter is controlled by the "engine protection - exhaust gas temperature" function, where it is min. logic gated with the maximum exhaust gas temperature torque and the maximum torque for crankshaft/camshaft faults (see Engine protection - exhaust gas temperature).

- Starting torque calculation

  In starting mode, the set torque is calculated by the starting function. In this purely time-controlled mode, requested torque, idling speed control and engine speed control do not have any effect.

- Set torque correction

  This function corrects the nominal set torque to compensate for the effects of temperature and engine variations.

- Start of delivery calculation

  Depending on the operating state, the start of delivery is calculated for starting mode or for engine ON operation as a function of the set torque.

- Start of delivery restriction

  The calculated start of delivery is restricted to the current maximum permissible and a minimum permissible value.

- Angle of delivery calculation

  The angle of delivery is calculated from the pulse width map as a function of the corrected set torque; the angle of delivery, by means of the duration of actuation of the unit pumps, is a measure for the injection quantity. Cylinder-selective torque corrections (e.g. from the smooth-running controller, etc) are also carried out in this angularly aligned part of the torque controls.

- Injection control

  The injection control system implements the specified angle for start of fuel delivery (start of delivery, electrical reference mark) and the specified duration of delivery (angle of delivery) by actuation of the unit pumps.

Injection control and angle of delivery are calculated at synchronized angles; all other functions of the set torque calculation are processed in a time window.

Map switching

The map switching function requires several power categories to be stored in the MR where they can be activated depending on requirements.

In principle, map switching supports the "CruiseControl", "PullAway" and "Regeneration" functions. The CruiseControl functions work exclusively with power categories 0 and 1. The PullAway function works exclusively with power categories 0 and 14, whereby the maps for power category 1 are accessed if power category 14 is requested. The Regeneration function works with power categories 0 and 13, whereby the maps for power category 1 are accessed if power category 13 is requested. Parallel operation of "CruiseControl", "PullAway" and Regeneration is not possible.

For the "CruiseControl" and "PullAway" functions, the different power categories are activated via the CAN-ID 1363, byte 3, bit 4...7. Depending on requirements, the switch to another power category may be done by means of a ramp. The duration of the ramp is transmitted in CAN-ID 1363, byte 4, bit 0...7.

For the "Regeneration" function, the different power classes are activated by means of the appropriate enable which is based on the regeneration strategy. Depending on requirements, the switch to another power category may be done by means of a configurable ramp in the data set.

For test purposes, map switching can also be activated by direct entry in the Marc Diagnostic GK. However, the respective test function must first be enabled in the map data set. Simultaneous activation of map switching via the test function and CAN is not possible. If power category 13 is requested with the regeneration test function, a regeneration cycle will take place automatically.

If map switching is not activated in the MR, or if a power category is requested that is not enabled or not implemented, the default power category is always activated (class 0).

Map switching process

<u>Switching via CruiseControl or PullAway:</u>

If power category switching has been activated via the CAN (standard CruiseControl or PullAway operation), the FR can request a power category with a specified switching duration. The power category request is made via CAN-ID 1363, byte 3, bit 4...7. The currently activated power category is shown in CAN-ID 1623, byte 4, bit 0...3. The switching duration is specified in CAN-ID 1363, byte 4, bit 0...7. After a specified power category has been requested, it will switch to being the new actual power category during the switching period. The switching is performed using a linear weighting function.

If power category 15 (s.n.a.), 14 or 13 is requested and the PullAway function is not activated, or if map switching is not activated in the map data set, no map switching is supported. In this case, the MR works with power category 0 only (default power category). Marc will display power category 15 as the current power category.

The default setting in the MR is power category 0. If, after control unit initialization, a power category other than the default power category is required, this must be requested by the FR.

After the switchover, the complete full-load characteristic curve of the now current power category is transferred from the MR-PLD.

The following also applies to activated map switching: if the switching period is not yet complete, the MR ignores any further map switching requests provided that no request with a switching duration of 0 s is made. If, during a map switching process with a switching duration > 0 s, the switching duration of 0 s is set (request via CAN-ID 1363, byte 4, bit 0 to 7), an immediate switch will be made to the map that is specified in the same request (CAN-ID 1363, byte 3, bit 4 to 7). This is the cancellation of a "soft" map switchover by a "hard" switchover to any map.

<u>Switchover via regeneration:</u>

The desired power category and duration is specified by the regeneration function. To show that map switching is taking place, the specified category is displayed via CAN-ID 1623, byte4, bit 4 to 7. It is only output if the regeneration function is enabled.

Map switching: test function

If the respective map switching test function is enabled in the data set, the specified power category and switching duration instructions are given via the application system. Requests via the CAN are not taken into account here.

Map switching: weighting function

A weighting factor (map data set factor) is calculated in relation to the switchover period. The factor is calculated in the 10ms time slice and acts on all quantities that are affected by the map switchover. At the start of a map switchover, the weighting factor is 1 and is reduced down to 0. Once 0 is reached, the current power category is set to the specified power category and the weighting factor jumps back to 1. To avoid unnecessarily long software run times, there is no weighting procedure after the switchover.

Detection of engine state

Engine state detection is the key torque control factor in the engine control unit and is used to determine the engine's current operating state. This is checked every 10 ms. The associated functions for calculating the set torque and thereby the angle of delivery and start of delivery, are processed on the basis of whichever operating state has been determined. In the current engine state, invalid functions are reset or remain in a defined state. The injection control strategy is considered to be the engine state. If the engine switches from one state to another, initialization is sometimes performed.

A distinction is made between the following engine states:

- Stop: no injection, switch off engine.
- Start: engine start, time-controlled calculations.
- Start abort: maximum starting period exceeded, no injection
- On - idle: engine idling, regulated operation with idling speed governor.
- On - working speed control: engine-speed regulated operation with working speed governor.
- On - controlled: controlled operation via torque request (requested torque)
- On - limp home: regulated operation in CAN limp home mode with limp home controller

"Stop" engine state

Torque control basic setting. In the "engine stop" state, injection is switched off, the engine is about to be stopped or is already off.

Conditions for transition to "stop":

The engine state remains in or switches from any of the other states to "stop" if:

- terminal 15 is switched off, or
- no engine speed is detected (0 rpm), or
- the engine speed is less than the configured stop rpm and the starter is switched off, or
- the stop button on the engine is actuated and available vehicle speed is less than/equal to the configurable threshold, or
- the start button has been released after a "start with the start button" and pressed again, or
- a "zero quantity" has been received via the CAN (ID 594, byte 4, bit 3 = 1), or
- the immobilizer has not been deactivated, or
- the engine control unit has detected and set a starting lock (ID 596, byte 3, bit 4 = 1), or
- the injection system has been locked (ID 8178 = 1 or PID 111, bit 0 = 1).

A starting lock is detected and output via the CAN (ID 596, byte 3, bit 4 = 1) if:

- "starting lock" is received via the CAN (ID 594, byte 4, bit 4 = 1) and the torque control system of the engine's electronics is not yet in "engine on" mode, or
- the engine electronics' starter actuation system detects an external, unintended starter actuation, or
- CAN limp home mode 2 is active, or
- the NOx commissioning routine is active or the remaining period of the NOx commissioning starting lock has not yet expired.

Actions in "Stop" state

All torque control functions as well as the main system parameters of angle of delivery (= -45 °CA), start of delivery (= 0 °CA before TDC) and set torque (= 0%) are reset.

To make engine coast-down as smooth as possible and prevent the engine from coming to a stop in the same position every time (causing wear on the starter ring gear), the constant throttle can be requested when stopping the engine in the "stop" engine state, provided the engine is still turning. In addition, any engine protection function that has been triggered due to excess turbocharger pressure will only be reset in the engine "stop" state when the engine is stationary.

Function	**Active**	**Inactive**
Limit torque calculation		X
Dynamic torque correction (load)		X
Transient state detection (start of delivery)		X
Engine protection functions (camshaft/crankshaft fault, oil pressure)		X
Maximum engine speed control:		X
Engine stop with constant throttle	X	

Exiting the "stop" state

If the "stop" state conditions are no longer valid, it is possible to switch to one of the other engine states, namely "start", "on - idling" or "on - working speed control".

"Start" engine state

The engine "start" state is a mode that is controlled in accordance with a fixed procedure; torque requests have no effect. Likewise the engine speed governor is inactive.

Conditions for switching to or remaining in the "start" state

The transition to the "start" state is only possible from the "stop" state and occurs if:

- the starter is switched on and the engine speed is greater than zero, but less than the configured starter demeshing speed or the engine speed is greater than the stop engine speed but less than the configured starter demeshing speed, and
- no conditions for a switch to the "stop" state are valid.

The starting torque calculation is initialized with the transition to the "start" state. Here, the starting ramp is reset and the point at which the start commences is recorded, provided this has not already occurred due to actuation of the starter. The starter demeshing speed is calculated from a characteristic curve as a function of coolant temperature.

Actions in the "start" engine state

The setpoint torque, and thereby the angle of delivery in starting mode, is calculated as a function of coolant temperature and the starting period by means of a fixed procedure (see Starting torque calculation). The engine speed governor is inactive, torque requests (requested torque) have no effect. In starting mode, the start of delivery is calculated in accordance with a dedicated strategy (see Start of delivery calculation).

Function	**Active**	**Inactive**
Limit torque calculation		X
Dynamic torque correction (load)		X
Transient state detection (start of delivery)		X
Engine protection functions (camshaft/crankshaft fault, oil pressure)		X
Maximum engine speed control:	X	
Engine stop with constant throttle		X

The "start" state remains for as long as the conditions for the transition to start are still valid and none of the conditions for leaving the state are valid.

Exiting the "start" state

The "start" state switches to the "stop" state as soon as one condition for the transition to the "stop" state becomes valid. If this is not the case, a transition to one of the subsequent states of "start abort", "on - idling" or "on - working speed control" is possible.

In a transition to one of the regulated operating states ("on - idling", "on - working speed control" or "on - limp home"), the integrator is pre-controlled with a temperature-dependent torque (see also "Starting torque calculation"). The starter demeshing time is also stored.

"Start abort" engine state

The "start abort“ engine state is a sub-function of the "start" state.

Conditions for switching to or remaining in the "start abort" state

Conditions for "start" state valid and starting duration is longer than the configured maximum starting time.

Actions in the "start abort" engine state

The set torque is set to zero (= 0%), therefore no injection. Otherwise "start“ state.

Exiting the "start abort" state

The "start abort" state switches to the "stop" state as soon as one condition for the transition to the "stop" state becomes valid. If this is not the case, a transition to one of the subsequent states of "on - idling" or "on - working speed control" is possible.

"On - idling" engine state

In the "on - idling" engine state, the engine speed is adjusted by the idling speed governor. Idling mode, together with controlled mode, are the two driving states.

Conditions for switching to or remaining in the "on - idling" state

The engine state remains in or switches to the "on - idling" state if:

- the engine speed is greater than the starter demeshing speed and
- the engine speed is less than the governor demeshing threshold and
- the idling torque is greater than or equal to the requested torque and
- no CAN limp home is stored in the fault memory as an active fault and
- the conditions for switching to working speed control mode are invalid and
- no conditions for a switch to the "stop" state are valid.

The governor demeshing threshold is the difference between the specified governed speed at idle and the configured demeshing threshold. As with negative standard deviation, negative demeshing thresholds mean engine speeds above the nominal speed. There is also provision for a hysteresis. The transition from controlled mode to idling control mode occurs at 10 rpm below the demeshing threshold, the transition from idling to controlled mode at 10 rpm above the demeshing threshold.

If the torque condition for transition to controlled operation is not effective, the transition does not occur until the idling speed governor's integrator is fulfilled.

Actions in the "on - idling" engine state

The set torque is produced from the max. logic gating of the idling control torque and the requested torque (which may be limited). The start of delivery is calculated in accordance with the strategy for engine-on operation.

Function	Active	Inactive
Limit torque calculation	X	
Dynamic torque correction (load)	X	
Transient state detection (start of delivery)	X	
Engine protection functions (camshaft/crankshaft fault, oil pressure)	X	
Maximum engine speed control:	X	
Engine stop with constant throttle		X

Exiting the "on - idling" state

The "on - idling" state switches to the "stop" state as soon as one condition for the transition to the "stop" state becomes valid. If this is not the case, a transition to one of the subsequent states of "on - controlled", "on - working speed control" or "on - limp home" is possible.

"On - controlled" engine state

The "on - controlled" state is an operating state controlled by the torque instruction (requested torque).

Conditions for switching to or remaining in the "on - controlled" state

The engine state remains in or switches to the "on - controlled" state if:

- the engine speed is greater than the governor demeshing threshold or, in the "on - idling" state, the requested torque is greater than the idling torque, and
- no CAN limp home is stored in the fault memory as an active fault and
- the conditions for switching to working speed control mode are invalid and
- no conditions for a switch to the "stop" state are valid.

Actions in the "on - controlled" engine state

The set torque is determined by the requested torque, which may be restricted. The start of delivery is calculated in accordance with the "engine on mode" strategy.

Function	Active	Inactive
Limit torque calculation	X	
Dynamic torque correction (load)	X	
Transient state detection (start of delivery)	X	
Engine protection functions (camshaft/crankshaft fault, oil pressure)	X	
Maximum engine speed control:	X	
Engine stop with constant throttle		X

Exiting the "on - controlled" state

The "on - controlled" state switches to the "stop" state as soon as one condition for the transition to the "stop" state becomes valid. If this is not the case, a transition to one of the subsequent states of "on - idling", "on - working speed control" or "on - limp home" is possible.

In the transition to one of the regulated operating states of "on - working speed control" or "on - limp home", the integrator is pre-controlled with the last engine load. In the transition to the "on - idling" state, the last engine load is compared with a torque that is dependent on the coolant temperature and the time since starter demesh and the integrator is pre-controlled with the larger of the two values.

"On - working speed control" engine state

The "on - working speed control" engine operating state is controlled purely by engine speed. Governor type, nominal engine speed and additional torque restrictions can be specified via the CAN.

If operating without the CAN, the mode can be set via the data set; in every case, the switchover to working speed control is performed after starter demesh.

Conditions for switching to or remaining in the "on - working speed control" state

The engine state remains in or switches to the "on - working speed control" state if:

- in engine-on mode ("on - idling", "on - controlled", "on - limp home" state), the conditions for switching to working speed control mode are valid, and
- no CAN limp home is stored in the fault memory as an active fault and
- no conditions for a switch to the "stop" state are valid.

To switch to working speed control mode, a valid nominal speed and a valid torque restriction must have been received from the engine control unit, and one of the engine speed governor types 0 to 5 must have been selected.

Actions in the "on - working speed control" engine state

The set torque is calculated by the selected engine speed governor. The start of delivery is calculated in accordance with the "engine-on mode" strategy.

Function	Active	Inactive
Limit torque calculation	X	
Dynamic torque correction (load)		X
Transient state detection (start of delivery)		X
Engine protection functions (camshaft/crankshaft fault, oil pressure)	X	
Maximum engine speed control:	X	
Engine stop with constant throttle		X

Exiting the "on - working speed control" state

The "on - working speed control" state switches to the "stop" state as soon as one condition for the transition to the "stop" state becomes valid. If this is not the case, a transition to one of the subsequent states of "on - idling", or "on - limp home" is possible.

"On - limp home" engine state

The "on - limp home" engine state is a regulated operating state for when the engine is operated with CAN faults.

Conditions for switching to or remaining in the "on - limp home" state

The engine state switches from one of the "engine on" operating states to "on - limp home" if a CAN fault (mode 0 or 1) is logged as an active fault in the fault memory. If this is the case, and no conditions for the "stop" state are valid, the "on - limp home" state is retained.

Actions in the "on - limp home" engine state

The set torque is calculated by the limp home controller. The idling speed governor is used as the limp home controller; however the nominal speed and the maximum control torque are calculated in accordance with a different strategy (see "Idling speed governor, " Page 82). The start of delivery is calculated in accordance with the strategy for "engine on" mode.

Function	**Active**	**Inactive**
Limit torque calculation	X	
Dynamic torque correction (load)		X
Transient state detection (start of delivery)		X
Engine protection functions (camshaft/crankshaft fault, oil pressure)	X	
Maximum engine speed control:	X	
Engine stop with constant throttle		X

Exiting the "on - limp home" state

The "on - limp home" state switches to the "stop" state as soon as one condition for the transition to the "stop" state becomes valid. If this is not the case, a transition to one of the subsequent states of "on - idling", or "on - working speed control" is possible.

Requested torque gradient restriction

In load-off conditions, the requested torque is forwarded with a delay. A minimum requested torque gradient as a function of engine speed and the rpm gradient can be activated for this purpose This occurs when a minimum requested torque as a function of engine speed is exceeded and a negative requested torque gradient threshold as a function of engine speed is not reached. The function is only activated in controlled engine-on mode.

Limit torque calculation

The "limit torque" calculation function calculates the maximum engine torque that is permissible at the current engine operating point and in the current ambient conditions.

The calculated limit torque is used to restrict the torque request (requested torque), the working speed governors, the idling speed governor and the controller in the CAN limp home mode. The starting torque calculation is limited by its own dedicated restrictions. The limit torque is also used to calculate the maximum possible instantaneous engine torque.

The limit torque calculation is made up of the following:

- Full-load restriction

  The maximum permissible engine torque for the current engine speed is calculated from the "power restriction" characteristic curve. This characteristic curve corresponds to the engine's full-load torque curve and describes the maximum permissible steady-state engine torque and the desired torque characteristic as a function of engine speed.

- Altitude correction for full-load restriction

  The maximum permissible torque for operation at high altitudes is calculated from a map as a function of engine speed and atmospheric pressure. This value can be used to reduce the current full-load torque by means of a min. logic gating.

- Dynamic torque correction load

  The result of this function is added to the result of the full-load torque/altitude correction MIN logic gating. This enables the permissible full-load torque for the current engine operating point to be increased or reduced as a function of the change in the torque request.

- Engine protection - charge air temperature

  A further MIN logic gating is implemented to reduce the maximum permissible engine torque if charge air temperatures are too high. More information on this can be found in the section "Engine protection - charge air temperature".

- Engine protection - charge air pressure

  This engine protection function enables the maximum available torque to be reduced by multiplying the interim results with the charge air pressure limit factor (see "Engine protection - charge air pressure" and "Charge air pressure control").

- Engine speed gradient restriction

  A correction torque can be entered into a map as a function of engine speed and the engine speed gradient. This will then reduce the limit torque by the respective amount. This helps to prevent high levels of engine acceleration that, amongst other things, can result in inadmissible turbocharger speed overshoots.

- Engine protection - coolant temperature

  The result of this engine protection function reduces the available engine torque by multiplying the interim result with the coolant temperature limit factor.

- Engine protection - exhaust gas recirculation

  The result of this engine protection function reduces the available engine torque when operating with continuously variable exhaust gas recirculation. This is done by multiplying the interim result with the exhaust gas recirculation limit factor (see "Engine protection - exhaust gas recirculation").

- Reduced EGR regulation

  When operating with continuously variable exhaust gas recirculation, the available engine torque is reduced by multiplying with the "reduced EGR limit factor" as a function of engine speed and the difference between the EGR specified PWM and the EGR actual PWM.

- Smoke limiting

  Smoke limiting is implemented as a function of the selected EGR mode (see also the section on exhaust gas recirculation):

  EGR mode: EGR control for VTG scavenging gradient

  The maximum permissible torque for ensuring smoke-free engine operation and acceptable driveability is calculated for the current engine speed and available air mass from the smoke map.

  To improve the engine's dynamic performance at higher altitudes and prevent increased smoke emissions when the engine is cold, the smoke torque is corrected with the product of the correction factors "smoke torque, altitude" and "smoke torque, cold". The previous interim result of the limit torque calculation is restricted to the corrected smoke torque.

  EGR mode: stepless EGR control

  In parallel with the smoke torque, the maximum permissible torque with EGR for ensuring smoke-free engine operation and acceptable driveability is calculated for the current engine speed and available air mass from the "smoke limiting with EGR" map. The "weighting factor lambda a2 with EGR" is applied between the smoke torque and the smoke torque with EGR. To improve the dynamic engine performance at higher altitudes and prevent increased smoke emissions when the engine is cold, the result of the smoke torque weighting is corrected with the product of the correction factors "smoke torque, altitude" and "smoke torque, cold". The previous interim result of the limit torque calculation is restricted to the corrected result of the smoke torque weighting.

- Limit torque cold test

  When the cold test (diagnostic request) is activated and the vehicle is stationary (v = 0 km/h), the limit torque calculation is bypassed and the engine torque is restricted only by an engine-speed dependent characteristic curve. The cold test mode is used for recording the acceleration characteristics of an engine at the manufacturing plant under reproducible conditions and for verifying engine characteristics during servicing.

- Catalyst temperature

  The result of this engine protection function reduces the available engine torque by multiplying the interim result with the "temperature in front of catalyst" limit factor (see "Engine protection - catalyst").

- Engine protection - exhaust gas turbocharger

  The result of this engine protection function reduces the available engine torque by multiplying the interim result with the "T4 exhaust gas temperature" limit factor (see "Engine protection - exhaust gas turbocharger").

The return value is the maximum torque permissible at the current engine operating point and is available as the limit torque for further calculations.

Notes

This chapter shows the programming interface between the MR2 control unit and a tool connected to the CAN bus. The request and response messages are presented from the "perspective" of the tool. Diagnostic functions can be requested on the K-line or the CAN bus. The section entitled "Scope of control unit diagnostic functions" contains detailed descriptions.

The diagnostic statuses that form the basis of the chapter correspond to the hardware as follows:

- Diagnostic status 33 – MR2B hardware
- Diagnostic status 34 – MR2A hardware.

Only the corresponding hardware designation (MR2A or MR2B) is referred to in the following.

Scope of control unit diagnostic functions

Function mode	**Subfunctions**	**Executable via**
Access authorization	Request access authorization for security area 1/security area 2	K-line/CAN
Write to memory (locally valid PIDs)	Write security area 1/security area 2 access data	K-line/CAN
Read memory (locally valid PIDs)	Read out keywords Read out A part number Read out test program number/date of manufacture/engine variant Read out control unit abbreviation of test device ID with software version access data Read out diagnostic status Read out hardware ID Read software version boot sector Read VIN	K-line/CAN
On-board checking/text information	Read out checking/text information	CAN
Read out measurements	Read out all measurements together Read out each measurement individually	K-line/CAN
Read out binary values	Read out binary values all together Read out each binary value individually	K-line/CAN
Read out fault memory	Read out entire fault memory Read out current faults Read out each fault storage location individually	K-line/CAN
Delete fault memory		K-line/CAN

Function mode	Subfunctions	Executable via
Diagnostic routines	Voltmeter function Individual cylinder shut-off Read status of individual cylinder shut-off KW/NW polarity reversal detection TDC output via K-line Read/write service counter Switch Motorola limp home processor on/off NOx sensor commissioning routine Permit repeated writing of EOL parameters Permit repeated writing of KW TDC calibration Switch EZA on/off Adopt EZA values for basic adjustment Switch on AVD, read out compression values for cylinders 1 to 4 Read out compression values for cylinders 5 to 8 Delete fault memory in power-down Oil quantity in power-down to 0 liters Read out map switching quantities Request random number Read out ID code, request transponder code Program key provisionally	K-line/CAN K-line
Diagnostic routines	Delete all provisionally programmed keys Read out provisionally programmed keys Program another key with X1 factor Program key as only key with X2 factor Deactivate immobilizer with X3 factor Program previously stored key with X4 factor Deactivate immobilizer with X5 factor Read out number of keys in SG Switch to CONAS mode Cold test: activate/deactivate function Cold test: activate/deactivate TDC signal output Cold test: permit repeated writing of charge air pressure values Lock/unlock the flash memory Read out map set name and full-load curve Request engine configuration	K-line K-line/CAN
Upload/download functions	see upload/download table	K-line/CAN
Read/write parameters	Read number of parameter groups Read number of parameters Read/write parameters	K-line/CAN
Initialize/end diagnosis	Diagnosis, initializing diagnosis Ending diagnosis	K-line/CAN
Read data	Read fan type map from vehicle electronics	CAN

Reading measurements

The following tables contain measurements that are transferred to the TG by the SG (MR2A/MR2B) (diagnosis mode 0x22). Their corresponding physical units and resolution are also given. The tables also list reasons why measurements may be unavailable. If a measurement is not available, 0xFFFF is output.

Note

The sensors described in the following sections may be mounted on the engine (engine-mounted) or on the vehicle (frame-mounted). Their respective installation location is denoted by an X or Y and is explained in a footnote below the tables.

Table of measurements for MR2A hardware

No.	Measurements	Unit	Resolution	Reason why measurement not available
1	Set engine torque (CAN)	Nm	1 Nm	CAN limp home mode
2	Maximum instantaneous engine torque	Nm	1 Nm	-
3	Actual engine torque	Nm	1 Nm	-
4	Angle of delivery (mean value for all cylinders)	°CA	0.1 °CA	-
5	Start of delivery (mean value for all cylinders with start of delivery offset)	°CA BTDC	0.1 °CA	-
6	Current governed rpm	rpm	1 rpm	-
7	Current maximum governed rpm	rpm	1 rpm	-
8	Governed rpm setpoint from CAN	rpm	1 rpm	CAN limp home mode or value on CAN s.n.a.
9	Redundant rpm (terminal W) from CAN	rpm	1 rpm	CAN limp home mode or value on CAN s.n.a.
10	Engine speed	rpm	1 rpm	-
11	CAN rpm gradient restriction	rpm/s	1 rpm/s	CAN limp home mode or value on CAN s.n.a.
12	Vehicle speed from CAN	km/h	1 km/h	CAN limp home mode or value on CAN s.n.a.
13	Coolant temperature	°C	1 °C	Faulty sensor
14	Fuel temperature	°C	1 °C	Sensor faulty or not installed
15	Missing oil quantity$_X$	l	0.1l	Sensor faulty or not installed
16	Oil temperature$_X$	°C	1 °C	Sensor faulty or not installed
17	Charge air temperature$_X$	°C	1 °C	Faulty sensor
18	Charge air pressure$_X$	mbar	1 mbar	Faulty sensor
19	Atmospheric pressure$_X$	mbar	1 mbar	Faulty sensor
20	Oil pressure$_X$	mbar	1 mbar	Faulty sensor
21	Battery voltage	mV	1 mV	-

X: Sensor on engine

Y: Sensor on vehicle/frame

No.	Measurements	Unit	Resolution	Reason why measurement not available
22	Governor type	1	0...6, 8...11: ADR governor 15: idling speed governor	
23	Engine status	1	0 = Engine stop 1 = Start abort 2 = Engine start 3 = Idling speed control 4 = Working speed control 5 = Controlled mode 6 = CAN limp home mode	
24	Fuel pressure$_X$	mbar	1 mbar	Sensor faulty or not installed
25	Scavenging gradient (P2S-P3) no longer available; value: 0xFFFF			
26	Fan speed	rpm	1 rpm	Time-out error or fan system without rpm recording
27	Turbocharger speed 1	rpm	10 rpm	Time-out error or no turbocharger speed sensor installed
28	Turbocharger speed 2 no longer available; value: 0xFFFF			
29	Charge air temperature 2$_X$	°C	1 °C	Sensor faulty or not installed
30	Temperature after EGR cooler (T6)$_X$	°C	1 °C	Sensor faulty or not installed
44	Generator speed pulse duration (from software release V06)	µs	10 µs	Turbocharger speed input not parameterized for generator rpm recording
50	T4 temperature$_X$ (from software release V07)	°C	1 °C	Sensor faulty or not installed

X: Sensor on engine

Y: Sensor on vehicle/frame

Table of measurements for MR2B hardware

No.	Measurements	Unit	Resolution	Reason why measurement not available
1	Set engine torque (CAN)	Nm	1 Nm	CAN limp home mode
2	Maximum instantaneous engine torque	Nm	1 Nm	-
3	Actual engine torque	Nm	1 Nm	-
4	Angle of delivery (mean value for all cylinders)	°CA	0.1 °CA	-
5	Start of delivery (mean value for all cylinders with start of delivery offset)	°CA BTDC	0.1 °CA	-
6	Current governed rpm	rpm	1 rpm	-
7	Current maximum governed rpm	rpm	1 rpm	-
8	Governed rpm setpoint from CAN	rpm	1 rpm	CAN limp home mode or value on CAN s.n.a.
9	Redundant rpm (terminal W) from CAN	rpm	1 rpm	CAN limp home mode or value on CAN s.n.a.
10	Engine speed	rpm	1 rpm	-
11	CAN rpm gradient restriction	rpm/s	1 rpm/s	CAN limp home mode or value on CAN s.n.a.
12	Vehicle speed from CAN	km/h	1 km/h	CAN limp home mode or value on CAN s.n.a.
13	Coolant temperature	°C	1 °C	Faulty sensor
14	Fuel temperature	°C	1 °C	Sensor faulty or not installed
15	Missing oil quantity$_X$	l	0.1l	Sensor faulty or not installed
16	Oil temperature$_X$	°C	1 °C	Sensor faulty or not installed
17	Charge air temperature$_X$	°C	1 °C	Faulty sensor
18	Charge air pressure$_X$	mbar	1 mbar	Faulty sensor
19	Atmospheric pressure$_X$	mbar	1 mbar	Faulty sensor
20	Oil pressure$_X$	mbar	1 mbar	Faulty sensor
21	Battery voltage	mV	1 mV	-
22	Governor type	1	0...6, 8...11: ADR governor 15: idling speed governor	
23	Engine status	1	0 = Engine stop 1 = Start abort 2 = Engine start 3 = Idling speed control 4 = Working speed control 5 = Controlled mode 6 = CAN limp home mode	
24	Fuel pressure$_X$	mbar	1 mbar	Sensor faulty or not installed
25	Scavenging gradient (P2S-P3) no longer available; value: 0xFFFF			
26	Fan speed	rpm	1 rpm	Time-out error or fan system without rpm recording
27	Turbocharger speed 1	rpm	10 rpm	Time-out error or no turbocharger speed sensor installed

28	Turbocharger speed 2 no longer available; value: 0xFFFF			

X: Sensor on engine

Y: Sensor on vehicle/frame

No.	Measurements	Unit	Resolution	Reason why measurement not available
29	Charge air temperature 2_X	°C	1 °C	Sensor faulty or not installed
30	Temperature after EGR cooler $(T6)_X$	°C	1 °C	Sensor faulty or not installed
31	Urea temperature_Y	°C	1 °C	Sensor faulty or not installed
32	Urea pressure	mbar	1 mbar	Sensor faulty or not installed
33	Urea tank fill level_Y	%	1%	Sensor faulty or not installed
34	Temperature of urea tank_Y	°C	1 °C	Sensor faulty or not installed
35	Temperature before catalyst_Y	°C	1 °C	"T-Kat1" or "T-Kat2" sensor faulty or not installed
36	Temperature after catalyst_Y	°C	1 °C	"T-Kat1" or "T-Kat2" sensor faulty or not installed
37	Compressed air pressure_Y	mbar	1 mbar	Sensor faulty or not installed
38	Relative air humidity_Y	%	1%	Sensor faulty or not installed
39	Air temperature (humidity $\text{sensor})_Y$	°C	1 °C	Sensor faulty or not installed
40	Intake air humidity_X	g/kg	0.1 g/kg	Sensor faulty, not installed or AGN not active
41	Current urea metering quantity	g/h	0.5 g/h	AGN not active
42	Cumulative urea consumption	kg	0.15 kg	AGN not active
43	Temperature in catalyst_Y	°C	4 °C	"T-Kat1" or "T-Kat2" sensor faulty or not installed or AGN not active
44	Generator speed pulse duration (from software release V06)	µs	10 µs	Turbocharger speed input not parameterized for generator rpm recording
45	DOC $\text{temperature}^{-1}{}_Y$ (from software release V07)	°C	1 °C	Sensor faulty or not installed
46	DOC temperature-2_Y	°C	1 °C	Sensor faulty or not installed
47	Temperature in DOC_Y (from software release V07)	°C	4 °C	Sensor for DOC temperature 1 or DOC temperature 2 faulty or not installed
48	Pressure before particulate filter_Y (from software release V07)	mbar	1 mbar	Sensor faulty or not installed
49	Pressure after particulate filter_Y (from software release V07)	mbar	1 mbar	Sensor faulty or not installed
50	T4 temperature_X (from software release V07)	°C	1 °C	Sensor faulty or not installed
51	NOx sensor temperature, filtered_Y (from software release V08)	°C	1 °C	AGN function deactivated, Mannheim function active, NOx dew point enable active, sensor not installed or CAN fault
52	NOx concentration, filtered_Y (If NOx start-up active: NOx concentration start-up filtered) (from software release V08)	ppm	1 ppm	AGN function deactivated, Mannheim function active, sensor not installed, faulty sensor or CAN fault

X: Sensor on engine

Y: Sensor on vehicle frame

Reading binary values

Table of binary values for MR2A

Note
For location of sensors, please refer to "Table of measurements for MR2A hardware“, Page 96.

No.	Information	Bit	Coding	Remarks
1	Equipment features	1...0	00 = w/o variable brake 01 = with variable brake 10 = n.d. 11 = s.n.a.	
		7...2	free	reserved for other future equipment features
2	Warning buzzer	1...0	00 = not requested 01 = requested 10 = n.d. 11 = s.n.a.	For two-wire CAN operation: Bit 5...4 = 01 Bit 7...6 = 01
	Stop lamp	3...2	00 = not requested 01 = requested 10 = n.d. 11 = s.n.a.	
	Status of CAN-LOW line	5...4	00 = no communication 01 = communication 10 = n.d. 11 = s.n.a.	
	Status of CAN-HIGH line	7...6	00 = no communication 01 = communication 10 = n.d. 11 = s.n.a.	
3	Terminal 15 status (MR)	1...0	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	Terminal 15 hardware input
	Terminal 15 info (CAN)	3...2	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Terminal 50 status (MR)	5...4	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Terminal 50 status (CAN)	7...6	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	

n.d. not defined
s.n.a. signal not available

No.	Information	Bit	Coding	Remarks
4	Start button on engine	1...0	00 = not actuated 01 = actuated 10 = n.d. 11 = s.n.a.	
	Stop button on engine	3...2	00 = not actuated 01 = actuated 10 = n.d. 11 = s.n.a.	
	Starter actuation	5...4	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	MR2 starting lock	7...6	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
5	PV1 status	1...0	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	PV2 status	3...2	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	PV3 status	5...4	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	PV4 status	7...6	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
6	Engine braking stage 2	1.0	00 = not requested 01 = requested 10 = n.d. 11 = s.n.a.	
	Engine braking stage 1	3,2	00 = not requested 01 = requested 10 = n.d.	
		7...4	1111 = s.n.a.	

n.d. not defined
s.n.a. signal not available

No.	Information	Bit	Coding	Remarks
7	Torque limiting by: engine protection	1...0	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Full load	3...2	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Maximum speed control	5...4	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Smoke limitation	7...6	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
8	PV5 status	1...0	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	PV6 status	3...2	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	s.n.a	7...4	1111 = s.n.a.	

n.d. not defined
s.n.a. signal not available

Table of binary values for MR2B

Note
For location of sensors, please refer to "Table of measurements for MR2B hardware“, Page 98.

No.	Information	Bit	Coding	Remarks
1	Equipment features	1...0	00 = w/o variable brake 01 = with variable brake 10 = n.d. 11 = s.n.a.	
		7...2	free	reserved for other future equipment features
2	Warning buzzer	1...0	00 = not requested 01 = requested 10 = n.d. 11 = s.n.a.	
	Stop lamp	3...2	00 = not requested 01 = requested 10 = n.d. 11 = s.n.a.	
	Status of CAN-LOW line	5...4	00 = no communication 01 = communication 10 = n.d. 11 = s.n.a.	For two-wire CAN operation: Bit 5...4 = 01 Bit 7...6 = 01
	Status of CAN-HIGH line	7...6	00 = no communication 01 = communication 10 = n.d. 11 = s.n.a.	
3	Terminal 15 status (MR)	1...0	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	Terminal 15 hardware input
	Terminal 15 info (CAN)	3...2	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Terminal 50 status (MR)	5...4	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Terminal 50 status (CAN)	7...6	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	

n.d. not defined
s.n.a. signal not available

No.	Information	Bit	Coding	Remarks
4	Start button on engine	1...0	00 = not actuated 01 = actuated 10 = n.d. 11 = s.n.a.	
	Stop button on engine	3...2	00 = not actuated 01 = actuated 10 = n.d. 11 = s.n.a.	
	Starter actuation	5...4	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	MR2 starting lock	7...6	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
5	PV1 status	1...0	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	PV2 status	3...2	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	PV3 status	5...4	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	PV4 status	7...6	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
6	Engine braking stage 2	1.0	00 = not requested 01 = requested 10 = n.d. 11 = s.n.a.	
	Engine braking stage 1	3.2	00 = not requested 01 = requested 10 = n.d.	
		7...4	1111 = s.n.a.	

n.d. not defined
s.n.a. signal not available

No.	Information	Bit	Coding	Remarks
7	Torque limiting by: engine protection	1...0	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Full load	3...2	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Maximum speed control	5...4	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Smoke limitation	7...6	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
8	PV5 status	1...0	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	PV6 status	3...2	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	PV7 status	5...4	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	PV8 status	7...6	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
9	Status of NOxCare pump	1...0	00 = off 01 = on 10 = n.d. 11 = s.n.a.	Takes electrical actuation into account
	Status of compressed air control valve (from software release V05)	3...2	00 = not actuated 01 = actuated 10 = n.d. 11 = s.n.a.	
	Status of el. line heater	5...4	00 = off 01 = on 10 = n.d. 11 = s.n.a.	
	Ventilation mode	7...6	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	

n.d. not defined

s.n.a. signal not available

No.	Information	Bit	Coding	Remarks
10	UPS enable	1...0	00 = withdrawn 01 = issued 10 = n.d. 11 = s.n.a.	
	APS enable	3...2	00 = withdrawn 01 = issued 10 = n.d. 11 = s.n.a.	
	Ambient enable	5...4	00 = withdrawn 01 = issued 10 = n.d. 11 = s.n.a.	
	Component enable	7...6	00 = withdrawn 01 = issued 10 = n.d. 11 = s.n.a.	
11	Metering enable	1...0	00 = withdrawn 01 = issued 10 = n.d. 11 = s.n.a.	Takes electrical actuation into account
	Metering	3...2	00 = inactive 01 = active 10 = n.d. 11 = s.n.a.	
	Status of SCR compressed air shut-off valve (from software release V05)	5...4	00 = not actuated 01 = actuated 10 = n.d. 11 = s.n.a.	
	Diffusor heater (from software release V07)	7...6	00 = inactive 01 = active (on demand) 10 = active (cycl. operation) 11 = s.n.a.	
12	EGR protection function: function (from software release V06)	1...0	00 = deactivated 01 = primed 10 = activated 11 = s.n.a.	If the protection function is locked by the rpm sensing parameter (ID 2759) all bits 5...0 go to s.n.a.
	EGR protection function: evaluation (from software release V06)	3...2	00 = enabled 01 = locked 10 = n.d. 11 = s.n.a.	
	EGR protection function fault response (from software release V06)	5...4	00 = no fault response 01 = close EGR valve 10 = close EGR valve and reduce torque 11 = s.n.a.	
	Torque limiter (from software release V07)	7...6	00 = inactive 01 = active 10 = active with next vehicle stop 11 = s.n.a.	

n.d. not defined

s.n.a. signal not available

No.	Information	Bit	Coding	Remarks
13	Status of temperature sensor (from software release V08)	1...0	00 = not valid 01 = valid 10 = error 11 = s.n.a.	
	Status of lambda sensor (from software release V08)	3...2	00 = not valid 01 = valid 10 = error 11 = s.n.a.	
	Status of NOx signal (from software release V08)	5...4	00 = not valid 01 = valid 10 = error 11 = s.n.a.	
	Status of sensor supply (from software release V08)	7...6	00 = not valid 01 = valid 10 = error 11 = s.n.a.	
14	Open wire check (from software release V08)	1...0	00 = no error 01 = error detected 10 = not used 11 = s.n.a.	
		3...2	free	
	Short circuit check (from software release V08)	5...4	00 = no error 01 = error detected 10 = not used 11 = s.n.a.	
		7...6	free	
15	NOx sensor temperature enable (from software release V08)	1...0	00 = not issued 01 = issued 10 = n.d. 11 = s.n.a.	
	NOx signal enable (from software release V08)	3...2	00 = not issued 01 = issued 10 = n.d. 11 = s.n.a.	
	Status of NOx sensor communica- tion (from software release V08)	5...4	00 = no communication 01 = communication 10 = n.d. 11 = s.n.a.	
		7...6	free	

n.d. not defined

s.n.a. signal not available

Table of parameters

Note

For the location of the sensors, please refer to the "Table of measurements for the MR2A hardware“, Page 96, or the "Table of measurements for the MR2B hardware“, Page 98.

P1	P2	Designation	Value range/bit assignment	Reso-lution	Access
Parameter group 1: engine identification					
0xE1	0x01	Engine number	0 (default)...65535	1	St. III
0xE1	0x02	Manual transmission (STG)/ automatic transmission (ATG) selection	0: STG (default) 1: ATG	1	St. III
0xE1	0x03	Type of starter	0: JE (actuation, default) 1: KB (no actuation)	1	St. III
0xE1	0x04	Add start of delivery offset for engines with constant throttle?	0: Do not add offset (default) 1: Add offset	1	St. III
0xE1	0x05	Charge air pressure sensor characteristic curve	0: curve 1 (3.5 bar sensor) 1: curve 2 (4 bar sensor)	1	St. III
0xE1	0x06	Charge air temperature sensor after compressor	0: Sensor not installed 1: Sensor installed	1	St. III
0xE1 2)	0x07	INS2004	0: No INS2004 installed 1: INS2004 installed	1	St. III
0xE1 2)	0x08	Dual-mass flywheel	0: Transmission of inertia torque 1 1: Transmission of inertia torque 2	1	St. III
0xE1 2)	0x09	EGR protection function (from software release V06)	0: EGR protection function deactivated 1: EGR protection function primed 2: EGR protection function activated	1	St. III
Parameter group 2: CAN configuration					
0xE2	0x01	Engine management via CAN	0: switched off 1: switched on (default)	1	St. III
0xE2	0x02	CAN single-wire capability	0: not possible 1: possible (default)	1	St. III
0xE2	0x03	CAN extended	0: 11 bit ID (default) 1: 29 bit ID	1	St. III
0xE2	0x04	Temporary measuring identifier(CAN low speed) (from software release V08)	0: deactivated (default) 1: activated	1	St. III
Parameter group 3: proportioning valves					
0xE3	0x01	Proportioning valve 1 (from software release V07)	0: no function (default) 1: charge air pressure control/ turbocharger 1 2: currently free 3: exhaust flap 4: Diffusor heater (only MR2B)	1	St. III

0xE3	0x02	Proportioning valve 2	0: no function (default) 1: EGR valve 2: currently free 3: constant throttle	1	St. III

P1	P2	Designation	Value range/bit assignment	Reso-lution	Access
Parameter group 3: proportioning valves					
0xE3	0x03	Proportioning valve 3	0: no function (default) 1: fan 1 2: currently free 3: currently free	1	St. III
0xE3	0x04	Proportioning valve 4	0: no function (default) 1: fan 2 2: currently free 3: Map thermostat	1	St. III
0xE3	0x05	Proportioning valve 5	0: no function (default) 1: oil trap 2: currently free 3: constant throttle** 4: throttle flap direction of actuation	1	St. III
0xE3	0x06	Proportioning valve 6 (from software release V07)	0: no function (default) 1: currently free 2: currently free 3: exhaust flap* 4: heater flange 5: diffusor heater (only MR2B)	1	St. III
0xE3 1)	0x07	Proportioning valve 7	0: no function (default) 1: metering valve 2: currently free 3: throttle flap actuating torque	1	St. III
0xE3 1)	0x08	Proportioning valve 8	0: no function (default) 1: line heater	1	St. III
0xE3 1)2)	0x09	SCR	0: no function (default) 1: metering valve 2: currently free 3: currently free 4: Tank heater 5: SCR function activated (PV7 = metering valve, PV8 = tank heater)	1	St. III
0xE3 1)2)	0x0A	SCR-RM proportioning valves (from software release V05)	0: no function 1: compressed air shut-off valve 2: currently free 3: currently free	1	St. III
0xE3 1)2)	0x0B	SCR combined system	0: SCR combined system reset 1: metering valve on RM 2: SCR combined system 3: activate SCRT combined system without throttle flap 4: activate SCRT combined system with throttle flap	1	St. III
0xE3 1)2)	0x0C	Diffusor heater on RM (Only MR2B from software release V07)	0: no function 1: Diffusor heater on RM 2: currently free 3: currently free	1	St. III

*: alternative to PV1 if PV1 required for charge air pressure control

**: alternative to PV2 if PV2 required for EGR

P1	P2	Designation	Value range/bit assignment	Resolution	Access
Parameter group 4: fan					
0xE4	0x01	Fan type	0 (default)...11	1	St. III
0xE4	0x02	Coolant temperature activation threshold for fan stage 1	0 (default)... 150	1°C/bit	St. III
0xE4	0x03	Charge air temperature activation threshold for fan stage 1	0 (default)... 150	1°C/bit	St. III
0xE4	0x04	Coolant temperature activation threshold for fan stage 2	0 (default)... 150	1°C/bit	St. III
0xE4	0x05	Charge air temperature activation threshold for fan stage 2	0 (default)... 150	1°C/bit	St. III
0xE4	0x06	Fan charge air diff. temp. (sys 1)	0 (default)... 150	1°C/bit	St. III
0xE4	0x07	Charge air temperature activation threshold, fan stage 1 in engine braking mode	0 (default)... 150	1°C/bit	St. III
0xE4	0x08	Charge air temperature activation threshold, fan stage 2 in engine braking mode	0 (default)... 150	1°C/bit	St. III
0xE4	0x09	Charge air temperature differential threshold in engine braking mode	0 (default)... 150	1°C/bit	St. III
0xE4 2)	0x0A	Negate fan output, type 7	0 (default)... 1	1	St. III
0xE4 2)	0x0B	Negate fan output, type 4	0 (default)... 1	1	St. III
0xE4 2)	0x0C	Negate fan output, type 1	0 (default)... 1	1	St. III
Parameter group 5: unit pump classes					
0xE5	0x01	Segment 0	0 (default)...6	1	St. III
0xE5	0x02	Segment 1	0 (default)...6	1	St. III
0xE5	0x03	Segment 2	0 (default)...6	1	St. III
0xE5	0x04	Segment 3	0 (default)...6	1	St. III
0xE5	0x05	Segment 4	0 (default)...6	1	St. III
0xE5	0x06	Segment 5	0 (default)...6	1	St. III
0xE5	0x07	Segment 6	0 (default)...6	1	St. III
0xE5	0x08	Segment 7	0 (default)...6	1	St. III
Parameter group 6: oil sensing					
0xE6	0x01	Oil temperature sensor present	0: no sensor present 1: sensor present (default)	1	St. III
0xE6	0x02	Oil level sensor/type of sensing	0: no function (default) 1: measurement with engine running 2: measurement with engine running and stationary 3: measurement with engine stationary	1	St. III
0xE6	0x03	Oil pan type	0 (default)...7	1	St. III
0xE6	0x04	Oil pressure sensor	0: absolute pressure sensor (default) 1: relative pressure sensor		St. III
0xE6	0x05	Oil pressure switch	0: no oil pressure switch (default) 1:oil pressure switch present	1	St. III
0xE6	0x06	Oil pan configuration data in EEPROM valid?	0: configuration data invalid (def.) 1: configuration data valid	1	St. III
0xE6	0x07	locked (due to previous assignment)			
0xE6	0x08	locked (due to previous assignment)			

0xE6	0x09	locked (due to previous assignment)			

P1	P2	Designation	Value range/bit assignment	Resolution	Access
Parameter group 6: oil sensing					
0xE6	0x0A	locked (due to previous assignment)			
0xE6	0x0B	MIN/MAX fill	1...9 (0: default)	0.1 l/bit	St. III
0xE6	0x0C	Pre-warning threshold for underfill (1)	0 (default)...12.7	0.1 l/bit	St. III
0xE6	0x0D	Warning threshold for underfill (2)	0 (default)...12.7	0.1 l/bit	St. III
0xE6	0x0E	Warning buzzer/stop lamp threshold for underfill (3)	0 (default)...12.7	0.1 l/bit	St. III
0xE6	0x0F	On-board diagnosis threshold	0 (default)...12.7	0.1 l/bit	St. III
0xE6	0x10	Threshold for oil top-up request	0 (default)...12.7	0.1 l/bit	St. III
0xE6	0x11	Threshold for EHM minute counter	0 (default)...12.7	0.1 l/bit	St. III
0xE6	0x12	Warning threshold for overfill	-12.7 ... 0 (default) l	0.1 l/bit	St. III
0xE6	0x13	Selection of oil level sensor	0 (default): old sensor 1: new sensor	1	St. III
0xE6	0x14	1st oil level characteristic point (on)	0 (default) .. 100%	0.1 l/bit	St. III
		Top-up oil quantity for 1st CP	-12.7... 0 (default).. + 12.7 l	0.1 l/bit	
0xE6	0x15	2nd oil level characteristic point (on) Top-up oil quantity for 2nd CP	0 (default) .. 100% -12.7 .. 0 (default).. + 12.7 l	0.1 l/bit	St. III
0xE6	0x16	3rd oil level characteristic point (on) Top-up oil quantity for 3rd CP	0 (default) .. 100% -12.7 .. 0 (default).. + 12.7 l	1% / bit 0.1 l/bit	St. III
0xE6	0x17	4th oil level characteristic point (on) Top-up oil quantity for 4th CP	0 (default) .. 100% -12.7 .. 0 (default).. + 12.7 l	1% / bit 0.1 l/bit	St. III
0xE6	0x18	5th oil level characteristic point (on) Top-up oil quantity for 5th CP	0 (default) .. 100% -12.7 .. 0 (default).. + 12.7 l	1% / bit 0.1 l/bit	St. III
0xE6	0x19	1st oil level characteristic point (OFF) Top-up oil quantity for 1st CP	0 (default) .. 100% -12.7 .. 0 (default).. + 12.7 l	1% / bit 0.1 l/bit	St. III
0xE6	0x1A	2nd oil level characteristic point (OFF) Top-up oil quantity for 2nd CP	0 (default) .. 100% -12.7 .. 0 (default).. + 12.7 l	1% / bit 0.1 l/bit	St. III
0xE6	0x1B	3rd oil level characteristic point (OFF) Top-up oil quantity for 3rd CP	0 (default) .. 100% -12.7 .. 0 (default).. + 12.7 l	1% / bit 0.1 l/bit	St. III
0xE6	0x1C	4th oil level characteristic point (OFF) Top-up oil quantity for 4th CP	0 (default) .. 100% -12.7 .. 0 (default).. + 12.7 l	1% / bit 0.1 l/bit	St. III
0xE6	0x1D	5th oil level characteristic point (OFF) Top-up oil quantity for 5th CP	0 (default) .. 100% -12.7 .. 0 (default).. + 12.7 l	1% / bit 0.1 l/bit	St. III
		OFF: characteristic curve for engine-off ON: characteristic curve for engine-on (from software release V05)			
Parameter group 7: EOL characteristic curve					
0xE7	0x01	1st rpm characteristic point Correction factor for 1st rpm SP	0 (default)...5000 0.9...1.1 (1.0: default)	1 rotation/bit 0.001/bit	St. III
0xE7	0x02	2nd rpm characteristic point Correction factor for 2nd rpm SP	0 (default)...5000 0.9...1.1 (1.0: default)	1 rotation/bit 0.001/bit	St. III
0xE7	0x03	3rd rpm characteristic point Correction factor for 3rd rpm SP	0 (default)...5000 0.9...1.1 (1.0: default)	1 rotation/bit 0.001/bit	St. III
0xE7	0x04	4th rpm characteristic point Correction factor for 4th rpm SP	0 (default)...5000 0.9...1.1 (1.0: default)	1 rotation/bit 0.001/bit	St. III

P1	P2	Designation	Value range/bit assignment	Resolution	Ac-cess
Parameter group 8: other factors					
0xE8	0x01	FB offset EOL TDC adjustment	-20...20 (0: default)	0.01 °CA/bit	St. III
0xE8	0x02	Starting torque multiplier	0...3.5 (1.0: default)	0.01/bit	St. III
0xE8	0x03	Torque temperature compensation	0: no torque temp. comp. 1: Temp. comp. (default)	1	St. III
0xE8	0x04	Turbocharger class	0...9 (0: default)	1	St. III
0xE8 2)	0x05	EOL: speed droop, ADR governor TYPE4	0...25%	0.006103515	St. III
0xE8 2)	0x06	EOL: P component, ADR governor TYPE4	0...2%/rpm	0.000076295	St. III
0xE8 2)	0x07	EOL: I component, ADR governor TYPE4	0...1.5%/s*rpm	0.000059605	St. III
0xE8 2)	0x08	EOL: D component, ADR governor TYPE4	0...0.5%*s/rpm	0,000019074	St. III
0xE8 2)	0x09	Validity ID of EOL parameters for ADR governor TYPE4	0...1 (0 default)	1	St. III
0xE8 2)	0x0A	Smooth running controller locked (1: yes/ 0:no) (from software release V09)	0...1 (0 default)	1	St. III
Parameter group 9: engine service counter					
0xE9	0x01	Engine service counter, hours	0 (default)...65535	1h/bit	St. III
0xE9	0x02	Engine service counter, minutes	0 (default)...60	1min/bit	St. III
0xE9	0x03	Engine service counter, seconds	0 (default)...60	1s/bit	St. III
0xE9	0x04	Operating hours, thermal management stage 1 (from software release V08)	0 (default)...65535	1h/bit	St. III
0xE9	0x05	Operating hours, thermal management stage 1 (from software release V08)	0 (default)...60	1min/bit	St. III
0xE9	0x06	Operating hours, thermal management stage 1 (from software release V08)	0 (default)...60	1s/bit	St. III
0xE9	0x07	Operating hours, thermal management stage 2 (from software release V08)	0 (default)...65535	1h/bit	St. III
0xE9	0x08	Operating hours, thermal management stage 2 (from software release V08)	0 (default)...60	1min/bit	St. III
0xE9	0x09	Operating hours, thermal management stage 2 (from software release V08)	0 default)...60	1s/bit	St. III
Parameter group 10: routine parameters					
0xEA	0x01	PV actuation test	0 (default)...255 Bit 0: PV1 Bit 1: PV2 Bit 2: PV3 Bit 3: PV4 Bit 4: PV5 Bit 5: PV6 Bit 6: PV7 (function locked) 1) Bit 7: PV8 1)	1	St. III
0xEA	0x02	Delete GMA	1: delete GMA**	1	St. III
0xEA	0x03	Delete LRR	1: delete LLR**	1	St. III
0xEA	0x04	locked (due to previous assignment)			
0xEA	0x05	Reset impact times	1: Reset impact times**	1	St. III
** Delete flags are automatically reset by the control unit software					

P1	P2	Designation	Value range/bit assignment	Resolution	Access
Parameter group 11: AGN AdBlue range calculation [1)]					
0xEB [2)]	0x01	Correction factor for AdBlue consumption	0...200% default: 0x64	1%	St. III
0xEB [2)]	0x02	Min. value for AdBlue consumption	0...20000 ml/100km	0.4 ml/100km	St. III
0xEB [2)]	0x03	Max. value for AdBlue consumption	0...20000 ml/100km	0.4 ml/100km	St. III
0xEB [2)]	0x04	Correction factor for diesel consumption	0...200% default: 0x64	1%	St. III
0xEB [2)]	0x05	Min. value for diesel consumption	0...200000 ml/100km default: 0x64	0.4 ml/100km	St. III
0xEB [2)]	0x06	Max. value for diesel consumption	0...200000 ml/100km default: 0x64	0.4 ml/100km	St. III
0xEB	0x07	Type of line for line heater	0...255	1%	St. III
0xEB [2)]	0x08	Initial value of damped AdBlue consumption	0...20000 ml/100km	0.4 ml/100km	St. III
0xEB [2)]	0x09	Initial value of damped diesel consumption	0...200000 ml/100km	0.4 ml/100km	St. III
0xEB [2)]	0x0A	Air humidity and temperature sensor (from software release V06)	0: Sensor installed on SCR-RM 1: Sensor installed on MR	1	St. III
0xEB [2)]	0x0B	Internal value (from software release V09)	-	-	-

Notes on parameterization

Each function has a unique assignment to the proportioning valve (PV). Because of internal technical factors, however, not every proportioning valve is able to serve every function. In the case of new functions (such as EGR), it may be necessary, therefore, to re-assign functions to different proportioning valves. However, it must still be possible to achieve the previous configuration in order to remain compatible with previous engines.

There are a few rules to follow to ensure that the functions are parameterized in the correct sequence:

- EGR:

  Must always be parameterized BEFORE a constant throttle. EGR is then assigned to PV2 and the constant throttle to PV5, if this valve is still free.

- Constant throttle:

  The MR software assumes that if the constant throttle is parameterized in the MR, it is always a hydraulic type. A KD parameterized in the vehicle electronics is regarded as a pneumatic system. When parameterizing a constant throttle, software releases up to SW56 always assign it to proportioning valve 2.

  From software release 57, however, this output may be occupied by EGR (for EPA04 engines). If this is the case, the software automatically shifts the constant throttle to PV5. If this is already occupied, the parameterization attempt fails. The PV5 or PV2 assignment then has to be reset so that the constant throttle can be parameterized. (A standard manufactured engine wiring harness takes this differing assignment into consideration as a matter of course).

- Turbocharger control ("Turbocharger1“ used for an electronically controlled wastegate or VTG):

  Always parameterize BEFORE an exhaust brake valve or a turbo-brake guide vane. PV1 is thus assigned to turbocharger control and an exhaust brake valve or guide vane to PV6, if this is still free.

- Exhaust brake valve:

  Select this function if a) an exhaust brake valve or b) a turbo brake guide vane is connected. When the exhaust brake valve is parameterized, it is assigned to proportioning valve 1 if no turbocharger control ("VTG") is parameterized. However, if turbocharger control has been parameterized beforehand, the software automatically shifts the exhaust brake valve or turbo brake guide vane to PV6.

- Turbo brake (guide vane):

  Where necessary parameterize as "exhaust brake valve" or "exhaust flap". Since the turbo brake guide vane is only installed in conjunction with an electronically controlled wastegate, which, by necessity, has to be assigned to PV1, the turbo brake guide vane can only be operated via proportioning valve 6. This means that the turbo brake function must always be parameterized AFTER turbocharger control (electr. wastegate).

- Heater flange:

  This function is only possible with proportioning valve 6. Any previously parameterized exhaust brake valve must be deleted beforehand. The two functions are mutually exclusive. (However, if PV1 is not required for turbocharger control, an exhaust brake valve can be operated in parallel via PV1 and the heater flange via PV6.)

- Fan:

  Only assigned to proportioning valves 3 and 4. On MB trucks and EvoBus, Unimog and Econic vehicles, parameterization is done via the FR, with the MR requesting the set fan type from the FR. In other vehicles, the fan type is parameterized directly in the MR.

- Map thermostat (EvoBus):

  Only possible with proportioning valve 4. Various fan types (0,1,4,6) also require PV4, with the result that these combinations are mutually exclusive.

- Metering valve:
  This function can be parameterized in the MR or on the corresponding proportioning valve of the frame module. The software rules out any parallel parameterization to ensure definitive electrical diagnosis.

- Tank heater:
  This function can only be parameterized on the MR.

- SCR system:
  For this function, the metering valve and tank heater are parameterized in parallel in the MR.

- Combined system without throttle flap:
  For this function, the metering valve is parameterized in the frame module in parallel with the tank heater which is parameterized in the MR.

- Combined system with throttle flap:
  For this function, the metering valve is parameterized in the frame module, in parallel with the throttle flap and the tank heater which are parameterized in the MR.

Monitoring of parameter settings

The parameter settings are reset without parameterization errors in the following cases:

- MR2A+B: the oil trap is parameterized with the high-tech heater flange ID set.
- MR2A+B: a function is parameterized for two or more proportioning valves simultaneously.
- MR2B: a function parameterized in the frame module is not supported there.
- MR2A: an AGN function has been parameterized.

General

In general, a function can only ever be parameterized if the corresponding proportioning valve is not already occupied. Any previously set functions have to be reset first before the function that's actually required can be assigned to the proportioning valve in question. This also applies to combined SCR systems. After setting a parameter, it should be read out again to ensure that the desired function has been activated.

MR parameterization for typical vehicle configurations:

	PV1	PV2	PV3	PV4	PV5	PV6
MB truck with pneumatic KD, BK			Fan_1			
Euro 3 MB truck with fan and hydr. KD		KD	Fan_1	Fan_1		
Typical Unimog, EvoBus, Econic parameter setting		KD	Fan_1			
Axor with $TurboBrake_2$ and hydr. KD	Wastegate	KD	Fan_1	Fan_1		
FTL EPA98	BK	KD	Fan	Fan		
FTL EPA04 (EGR) model series 900		1_3: EGR	3_3: Fan	3_3: Fan	2_3: KD	
FTL EPA04 (EGR) where applicable OM460	1_3: Wastegate	2_3: EGR	4_3: fan	4_3: fan	3_3: KD	5_3: turbobrake

1: in MB trucks and Unimog, EvoBus and Econic vehicles, the fan is parameterized in the FR.

2: turbo brake (guide vane) is parameterized in the FR on the Axor.

3: the numbered cells indicate that the correct parameter setting sequence must be observed.

Fault code tables

Remarks:

- 1) Fault code that is transmitted during a CAN diagnosis (LOW byte = fault type, HIGH byte = fault path).

- 2) Fault code transmitted in the free-running log. Fault number of the internal fault management system. Only fault numbers that are not relevant for OBD are transmitted. The output fault number is made up of the MU ID minus an offset of 65.

The fault code sent on the CAN comprises the fault ranking (w), the fault path (pp) and the fault type (aa): **w pp aa**

In the MR2A, the ranking (0 -> fault with the lowest ranking ... 2 -> fault with the highest ranking) is added based on the fault number used internally by the diagnostics interface (see table on following page).

In the MR2B, the ranking is specified by means of the configuration parameters. Fault path and fault type are read out from a decoding table likewise based on the internally managed fault number. At present, they are used as shown in the following tables.

Priority	Low	Medium	High
MU ID	66 – 164	165 - 285	286 - 315

Assigning fault paths and fault types to new faults:

If a new fault is generated, a check should be made to see whether the fault type is not already generally defined. A ground short at a control unit pin, for example, is always a ground short, regardless of which pin is affected. Furthermore, introducing new fault paths only makes sense where new add-on engine components or new control unit hardware functions have been used or implemented and should otherwise be avoided. If, however, it becomes necessary to introduce new fault paths or fault types, a generally applicable formulation should be applied, particularly where the fault type is concerned. There has been considerable proliferation in this regard in the past and this should be avoided in the future.

If fault path 42 is used (container), the fault type no longer corresponds to that shown in the generally applicable table.

Note

For the location of the sensors, please refer to the "Table of measurements for the MR2A hardware“, Page 96, or the "Table of measurements for the MR2B hardware“, Page 98.

Fault paths

Sub-code (pp)	Fault path	Remarks/use
00	Reserved	Do not use; here is where a fault output is detected
01	CAN low speed	
02	CAN high speed	
03	Crankshaft sensor	
04	Camshaft sensor	
05	Engine	General
06	Fan	
07	SCR catalyst	
08	SCR catalyst temperature sensor - 1	
09	SCR catalyst temperature sensor - 2	
10	Engine oil temperature sensor	
11	Fuel temperature sensor	
12	Charge air temperature sensor	
13	Atmospheric pressure sensor	
14	Charge air pressure sensor	
15	Coolant temperature sensor	
16	Engine oil pressure sensor	
17	Fuel pressure sensor	
18	Turbocharger circuit / charge pressure control	Air ducting, wastegate, VTG, etc.
19	Fuel circuit	
20	Engine oil circuit	Oil pump, etc.
21	Coolant circuit	Water pump, etc.
22	Terminal 15 detection	
23	Terminal 50 detection	
24	Locked	Scavenging gradient sensor (P2S-P3) in PLD
25	Engine oil level sensor	
26	Turbocharger speed sensor 1	Charge air pressure control
27	Generator timeout	Previously: turbocharger speed sensor 2 in PLD
28	NOx sensor	
29	NOx emissions	
30	Free	Previously: fuel pressure sensor
31	Charge air temperature sensor 2	Charge air temperature after compressor
32	T6 temperature sensor (EGR temperature)	Temperature after EGR cooler
33	EGR system	Fault in EGR system
34	Intake air humidity sensor	
35	Intake air temperature sensor	
36	Ambient air temperature sensor	
37	SCR air valve	
38	SCR catalyst temperature sensors	
39	Urea pump	
40	Control unit internal fault	Warning: replace control unit!!!
41	Engine brakes	Parameter setting not OK

Sub-code (pp)	Fault path	Remarks/use
42	Container	Do not take fault type from table; this fault is compiled in accordance with the container principle.
43	Free	
44	T4 temperature sensor	
45	Free	
46	Free	
47	Free	
48	Actuation of MV bank 1	Electrical circuit
49	Actuation of MV bank 2	Electrical circuit
50	Actuation of cylinder 1	Electrical circuit
51	Actuation of cylinder 2	Electrical circuit
52	Actuation of cylinder 3	Electrical circuit
53	Actuation of cylinder 4	Electrical circuit
54	Actuation of cylinder 5	Electrical circuit
55	Actuation of cylinder 6	Electrical circuit
56	Actuation of cylinder 7	Electrical circuit
57	Actuation of cylinder 8	Electrical circuit
58	SCR line heater	
59	Proportioning valve 8 (tank heater valve)	
60	Urea tank fill level sensor	
61	Urea tank temperature sensor	
62	Control unit internal fault, SCR frame module	
63	OBD lamp (MI)	
64	Heater flange	
65	Oil trap	
66	EGR valve	Fault in EGR actuator
67	Urea pressure system (UPS)	
68	SCR compressed air system (APS)	
69	SCR system, general	
70	Proportioning valve 1	Electrical circuit
71	Proportioning valve 2	Electrical circuit
72	Proportioning valve 3	Electrical circuit
73	Proportioning valve 4	Electrical circuit
74	Proportioning valve 5	Electrical circuit
75	Control unit voltage supply	
76	Proportioning valve 6	Electrical circuit
77	Proportioning valve bank 1	Electrical circuit
78	Proportioning valve bank 2	Electrical circuit
79	Proportioning valve bank, SCR frame module	Electrical circuit
80	Starter/starter actuation	
81	Compressed air shut-off valve	
82	Proportioning valve 7 (urea metering valve)	
83	Urea temperature sensor	
84	Urea pressure sensor	
85	SCR compressed air pressure sensor (MDU)	
86	Current urea consumption	

Sub-code (pp)	Fault path	Remarks/use
87	Average urea consumption	
88	SCR accumulator	
89	Metering valve on frame module	
90	Cylinder 1	Mechanical/hydraulic fault, e.g. LRR, EZA
91	Cylinder 2	Mechanical/hydraulic fault, e.g. LRR, EZA
92	Cylinder 3	Mechanical/hydraulic fault, e.g. LRR, EZA
93	Cylinder 4	Mechanical/hydraulic fault, e.g. LRR, EZA
94	Cylinder 5	Mechanical/hydraulic fault, e.g. LRR, EZA
95	Cylinder 6	Mechanical/hydraulic fault, e.g. LRR, EZA
96	Cylinder 7	Mechanical/hydraulic fault, e.g. LRR, EZA
97	Cylinder 8	Mechanical/hydraulic fault, e.g. LRR, EZA
98	Single cylinder adjustment, overall	
99	Immobilizer	

Fault types

Sub-code (aa)	Fault type	Remarks/use
00	Communications line 1 faulty	Communications interface (e.g. CAN)
01	Communications line 2 faulty	Communications interface (e.g. CAN)
02	Implausible data	Communications interface (e.g. CAN)
03	Free	
04	No communication	Communications interface (e.g. CAN)
05	Short to battery voltage (+cable)	Positive cable short to battery voltage (e.g. terminal 30)
06	Ground short (-cable)	Negative cable short to terminal 31
07	Short to battery voltage (-cable)	Negative cable short to battery voltage (e.g. terminal 30)
08	Ground short (+cable)	Positive cable short to terminal 31
09	Line break	Generally open line
10	Signal level too low	KW/NW
11	Signal assignment implausible	KW/NW
12	Signal timeout	Generally rpm sensor
13	Signal polarity incorrect	KW/NW
14	Free	
15	Measuring range exceeded	Analog sensor voltage signal
16	Measuring range undershot	Analog sensor voltage signal
17	Implausible measurement	Analog sensor
18	Faulty turbocharger circuit	
19	Signal inconsistent	
20	Pressure too high	
21	Pressure too low	
22	Temperature too high	
23	Temperature too low	
24	Limp home computer/microcontroller2 faulty	Internal fault only
25	Free	Previously: fill level too high
26	Incorrect fill level / impact detection	
27	Faulty actuation	Unit pumps only
28	Unit pump valve short circuit	Unit pumps only
29	Fill level too low	
30	rpm too high	
31	rpm too low	
32	General fault	e.g. EGR
33	Starter relay hangs up	Starter only
34	High-side transistor has high resistance	Internal fault, PV bank 1 only
35	High-side transistor has high resistance	Internal fault, PV bank 2 only
36	High-side transistor has high resistance	Internal fault, PV5 only
37	Cylinder number implausible	Internal fault
38	Starter output stage has high resistance	Internal fault
39	Starter output stage has low resistance	Internal fault
40	Starter level detection faulty	Internal fault, starter only
41	Free	Previously: transistor failed (internal fault, proportioning valves only)

Sub-code (aa)	Fault type	Remarks/use
42	Nominal range exceeded	e.g. battery voltage
43	Nominal range undershot	e.g. battery voltage
44	Limit reached	Smooth-running controller only
45	Limit reached	Single-cylinder adjustment only
46	EZA timeout	Single-cylinder adjustment only
47	Map data set faulty	Internal fault
48	Free	Previously: cylinder number <>firing order implausible (internal fault)
49	Parameter setting fault	
50	Incorrect hardware ID	Internal fault
51	EEPROM read error 1	Internal fault
52	EEPROM read error 2	Internal fault
53	EEPROM read error 3	Internal fault
54	CAN data sector faulty (low-speed)	Internal fault
55	Free	Previously: A/D recording faulty (internal fault)
56	Power-down control faulty	Internal fault
57	Free	Previously: voltage supply faulty (internal fault)
58	Map data set has been tampered with	Internal fault
59	Free	
60	Number of keys limited to 8	WSP only: attempt to program more than 8 keys
61	Counter overflow	WSP only: max. number of FDOK access attempts exceeded
62	X5 cancelled	WSP only: control unit with X5 installed on vehicle with immobilizer (TPC or FR with WSP)
63	No signal from redundant source	e.g. WSP, TPC via CAN
64	No signal from signal source	e.g. WSP: TPC via terminal 50, e.g. OAB diag.
65	Valid but incorrect signal code	e.g. WSP: wrong key
66	Free	
67	Free	Previously: sensor supply
68	Free	Previously: terminal 15 plausibility
69	Component faulty, relevant for emissions	
70	Pressure drop in power-down too small	
71	Threshold 1 exceeded	
72	Threshold 2 exceeded	
73	Free	Previously: limit reached (turbocharger synchronization controller only)
74	Control variable deviation too high	Integrator monitoring (e.g. turbocharger), with power reduction
75	Control deviation too high	Control deviation monitoring (e.g. turbocharger)
76	Limit not reached	e.g. charge air pressure in turbocharger braking mode
77	Actuating current outside tolerance	e.g. CNG, throttle flap actuating forces too high
78	General actuator fault	e.g. CNG, mechanical DK fault
79	Fault, temperature diagnosis	e.g. EGR, T6 plausibility (EGR temperature)
80	Free	Previously: combustion knock (CNG: gas quality problem)
81	Free	Previously: combustion with misfiring
82	Component not present	Here: catalytic converter

Sub-code (aa)	Fault type	Remarks/use
83	Air supply faulty (APS)	Previously: minor leak (pressure drop too great)
84	Free	Previously: major leak (pressure too low)
85	Free	Previously: system blocked (pressure too low)
86	Starter does not engage	Starter only
87	Free	Previously: ventilation failure
88	Temperature in front of catalyst too high, threshold 1 exceeded	
89	Temperature in front of catalyst too high, threshold 2 exceeded	
90	Urea consumption too high	
91	Urea consumption too low	
92	CAN data sector faulty (high-speed)	Internal fault
93	High-side transistor has high resistance	Internal fault, SCR frame module
94	AGN switched off, Mannheim function	
95	AGN switched off, Wörth function	
96	Pressure outside permissible range	e.g. SCR
97	Temperature in front of catalyst too high	
98	Free	
99	Free	

Overview of fault MU IDs – MR2B fault memory

MU ID	FP	FT	DTC number (ISO 15031	Automatic debounce	Fault text	Fault condition	Monitoring condition	Parameter configuration	Scanning time
0	84	16	P204C	Y	Urea pressure sensor, measuring range undershot	F1	Ü1 ^ (Ü2 v (Ü3 ^ Ü4 ^ Ü5))	P1 ^ (P2 v (P3 ^ P4 ^ P5))	T2
1	84	15	P204D	Y	Urea pressure sensor, measuring range exceeded	F2	Ü1 ^ (Ü2 v (Ü3 ^ Ü4 ^ Ü5))	P1 ^ (P2 v (P3 ^ P4 ^ P5))	T2
2	83	16	P2044	Y	Urea pressure sensor, measuring range undershot	F1	Ü1 ^ (Ü2 v (Ü3 ^ Ü4 ^ Ü5))	P1 ^ (P2 v (P3 ^ P4 ^ P5))	T3
3	83	15	P2045	Y	Urea pressure sensor, measuring range exceeded	F2	Ü1 ^ (Ü2 v (Ü3 ^ Ü4 ^ Ü5))	P1 ^ (P2 v (P3 ^ P4 ^ P5))	T3
4	85	16	P2039	Y	SCR compressed air pressure sensor (MDU), measuring range undershot	F1	Ü1 ^ Ü6 ^ (Ü2 v (Ü3 ^ Ü4 ^ Ü5))	P1 ^ P6 ^ (P2 v (P3 ^ P4 ^ P5))	T2
5	85	15	P2040	Y	SCR compressed air pressure sensor (MDU), measuring range exceeded	F2	Ü1 ^ Ü3 ^ Ü4 ^ Ü5	P1 ^ P6 ^ (P2 v (P3 ^ P4 ^ P5))	T2
6	61	16	P205C	Y	Urea tank temperature sensor, measuring range undershot	F1	Ü1 ^ Ü3 ^ Ü4 ^ Ü5	P1 ^ P3 ^ P4 ^ P5	T3
7	61	15	P205D	Y	Urea tank temperature sensor, measuring range exceeded	F2	Ü1 ^ Ü3 ^ Ü4 ^ Ü5 ^ Ü7	P1 ^ P3 ^ P4 ^ P5	T3
8	60	16	P203C	Y	Urea tank fill level sensor, measuring range undershot	F1	Ü1 ^ Ü3 ^ Ü4 ^ Ü5 ^ Ü7	P1 ^ P3 ^ P4 ^ P5 ^ P7	T3
9	60	15	P203D	Y	Urea tank fill level sensor, measuring range exceeded	F2	Ü1 ^ Ü3 ^ Ü4 ^ Ü5	P1 ^ P3 ^ P4 ^ P5 ^ P7	T3
10	08	16	P0427	Y	SCR catalyst temperature sensor – 1, measuring range undershot	F1	Ü1 ^ Ü3 ^ Ü4 ^ Ü5	P1 ^ P3 ^ P4 ^ P5	T3
11	08	15	P0428	Y	SCR catalyst temperature sensor – 1, measuring range exceeded	F2	Ü1 ^ Ü3 ^ Ü4 ^ Ü5	P1 ^ P3 ^ P4 ^ P5	T3
12	09	16	P042C	Y	SCR catalyst temperature sensor – 2, measuring range undershot	F1	Ü1 ^ Ü3 ^ Ü4 ^ Ü5	P1 ^ P3 ^ P4 ^ P5	T3
13	09	15	P042D	Y	SCR catalyst temperature sensor – 2, measuring range exceeded	F2	Ü1 ^ Ü3 ^ Ü4 ^ Ü5	P1 ^ P3 ^ P4 ^ P5	T3
14	34	16	P1431	Y	Intake air humidity sensor, measuring range undershot	F1	Ü1 ^ (Ü2 ^ (Ü3 ^ Ü4 ^ Ü5))	P1 ^ (P2 ^ (P3 ^ P4 ^ P5))	T3
15	34	15	P1430	Y	Intake air humidity sensor, measuring range exceeded	F2	Ü1 ^ (Ü2 ^ (Ü3 ^ Ü4 ^ Ü5))	P1 ^ (P2 ^ (P3 ^ P4 ^ P5))	T3
16	35	16	P1433	Y	Intake air temperature sensor, measuring range undershot	F1	Ü1 ^ (Ü2 ^ (Ü3 ^ Ü4 ^ Ü5))	P1 ^ (P2 ^ (P3 ^ P4 ^ P5))	T3
17	35	15	P1432	Y	Intake air temperature sensor, measuring range exceeded	F2	Ü1 ^ (Ü2 ^ (Ü3 ^ Ü4 ^ Ü5))	P1 ^ (P2 ^ (P3 ^ P4 ^ P5))	T3
18	68	83	P145D	Y	SCR compressed air system (APS), faulty air supply	F155	Ü23 ^ Ü136 ^ Ü137 ^ (Ü138 v Ü139 v Ü140 v Ü141)	P1 ^ P5 ^ P10 ^ P26	T9
19	68	20	P146D	Y	SCR compressed air system (APS), pressure too high	F156 ^ F157	Ü27 v Ü24 v (Ü25 ^ Ü26 ^ Ü111)	P1 ^ P5 ^ P10	T9
20	67	77	P1465	Y	Urea pressure system (UPS), actuating current outside tolerance	F161	(Ü30 ^ Ü31) v Ü32	P1 ^ P5 ^ P10	T8

MU ID	FP	FT	DTC number (ISO 15031	Automatic debounce	Fault text	Fault condition	Monitoring condition	Parameter configuration	Scanning time
21	84	17	P204B	Y	Urea pressure sensor, implausible measurement	F3 ^ F4	Ü1 ^ Ü8 ^ Ü9 ^ (Ü2 v (Ü3 ^ Ü4 ^ Ü5)) ^ Ü135	P1 ^ ((P2 ^ ¬P22) v (P3 ^ P4 ^ P5))	T2
22	85	17	P2038	Y	SCR compressed air pressure sensor (MDU), implausible measurement	F3 ^ F4 ^ ¬F1 ^ ¬F2 ^ F307	(Ü1 ^ Ü6 ^ Ü8 ^ Ü9 ^ (Ü2 v (Ü3 ^ Ü4 ^ Ü5))) ^ ((Ü108 ^ Ü109 ^ Ü110) v ¬Ü109 v ¬Ü110)	P1 ^ P6 ^ (P2 v (P3 ^ P4 ^ P5))	T2
23	38	17	P1434	Y	SCR catalyst temperature sensors, implausible measurement	F148 ^ F149	Ü18 ^ ¬Ü95 ^ ¬Ü96 ^ ¬Ü97 ^ ¬Ü98 ^ Ü4 ^ Ü21	P1 ^ P5	T8-> T6
24	07	97	P14A5	Y	SCR catalyst, temperature in front of catalyst too high	(F286 ^ (F140 v F141)) v (F305 ^ F306)	Ü18 ^ ¬Ü95 ^ ¬Ü96 ^ ¬Ü97 ^ ¬Ü98	P1 ^ P5	T2
25	67	21	P1460	Y	Urea pressure system (UPS), pressure too low	F167	Ü32 v Ü34	P1 ^ P5 ^ P10	T8
26	07	82	P14A1	Y	SCR catalyst, component (catalyst) not present	F154	Ü22	P1 ^ P5 ^ ¬P30	T8-> T6
27	07	22	P14A2	Y	SCR catalyst, temperature after catalyst too high	F150	Ü18 ^ ¬Ü95 ^ ¬Ü96 ^ ¬Ü97 ^ ¬Ü98	P1 ^ P5	T8-> T6
28	07	88	P14A3	Y	SCR catalyst, temperature in front of catalyst too high, threshold 1 exceeded	F150	Ü18 ^ ¬Ü95 ^ ¬Ü96 ^ ¬Ü97 ^ ¬Ü98	P1 ^ P5	T8-> T6
29	07	89	P14A4	Y	SCR catalyst, temperature in front of catalyst too high, threshold 2 exceeded	F150	Ü18 ^ ¬Ü95 ^ ¬Ü96 ^ ¬Ü97 ^ ¬Ü98	P1 ^ P5	T8-> T6
30	61	69	P204A	Y	Urea tank temperature sensor, component faulty, relevant for emissions	(F66 v F67) ^ F127 ^ ¬F68 ^ ¬F69 ^ F60	Ü1 ^ Ü3 ^ Ü4 ^ Ü5	P1 ^ P3 ^ P4 ^ P5	T3
31	39	06	P2063	Y	Urea pump, ground short (- cable)	F5	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5	T2
32	39	09	P2062	Y	Urea pump, line break	F6	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5	T2
33	39	07	P2064	Y	Urea pump, short to battery voltage (- cable)	F7	Ü4 ^ Ü10 ^ Ü14 ^ Ü93	P1 ^ P5	T2
34	37	06	P1440	Y	SCR air control valve, ground short (- cable)	F5	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5 ^ P6	T2
35	37	09	P1441	Y	SCR air control valve, line break	F6	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5 ^ P6	T2
36	37	07	P1442	Y	SCR air control valve, short to battery voltage (- cable)	F7	Ü4 ^ Ü10 ^ Ü14 ^ Ü93	P1 ^ P5 ^ P6	T2
37	58	06	P1443	Y	SCR line heater, ground short (- cable)	F5	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5 ^ P8	T2
38	58	09	P1444	Y	SCR line heater, line break	F6	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5 ^ P8	T2

MU ID	FP	FT	DTC number (ISO 15031	Automatic debounce	Fault text	Fault condition	Monitoring condition	Parameter configuration	Scanning time
39	58	07	P1445	Y	SCR line heater, short to battery voltage (- cable)	F7	Ü4 ^ Ü10 ^ Ü14 ^ Ü93	P1 ^ P5 ^ P8	T2
40	58	69	P1446	Y	SCR line heater, faulty component, relevant for emissions	F127 ^ ¬F68 ^ ¬F69 ^ F60 ^ (F70 ^ F71 ^ F72)	true	P1 ^ P5 ^ P8	T2
41	79	08	P144B	Y	Proportioning valve bank, SCR frame module, ground short (+cable)	F8	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5	T2
42	79	05	P144A	Y	Proportioning valve bank, SCR frame module, short to battery voltage (+cable)	F9	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5	T2
43	62	93	P14D0	Y	Control unit internal fault, SCR frame module, high-side transistor has high resistance	F10	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5	T2
44	59	69	P168D	Y	Proportioning valve 8 (tank heater valve), component faulty, relevant for emissions	F126 ^ (F73 ^ F74 ^ F75)	true	P9	T2
45	82	06	P2048	Y	Proportioning valve 7, ground short (- cable) (metering valve)	F11	Ü10 ^ Ü14 ^ ¬Ü94 ^ Ü15	P9	T2
46	82	09	P2047	Y	Proportioning valve 7, line break (metering valve)	F12	Ü10 ^ Ü14 ^ ¬Ü94 ^ Ü15	P9	T2
47	82	07	P2049	Y	Proportioning valve 7, short to battery voltage (-cable) (metering valve)	F13	Ü10 ^ Ü14 ^ ¬Ü94 ^ Ü93 ^ Ü16	P9	T2
48	59	06	P168A	Y	Proportioning valve 8 (tank heater valve), ground short (- cable)	F11	Ü10 ^ Ü14 ^ ¬Ü94	P9	T2
49	59	09	P168B	Y	Proportioning valve 8 (tank heater valve), line break	F12	Ü10 ^ Ü14 ^ ¬Ü94	P9	T2
50	59	07	P168C	Y	Proportioning valve 8 (tank heater valve), short to battery voltage (- cable)	F13	Ü10 ^ Ü14 ^ ¬Ü94 ^ Ü93	P9	T2
51	78	08	P160D	Y	Proportioning valve bank 2, ground short (+cable)	F22	Ü10 ^ Ü14	P11 v P12	T2
52	78	05	P160C	Y	Proportioning valve bank 2, short to battery voltage (+cable)	F21	Ü10 ^ Ü14	P11 v P12	T8 -> T2, T10
53	40	35	P0607	Y	Control unit internal fault, PVB2 high-side transistor has high resistance	F20	Ü10 ^ Ü17	P11 v P12	T2
54	02	04	U0001	Y	CAN high speed, no communication	F296	Ü10 ^ Ü17	P1 ^ P5	T2
55	40	92	P0607	Y	Control unit internal fault, CAN data sector faulty (high-speed)	F56	Ü10 ^ Ü17	P1 ^ P5	T2

MU ID	FP	FT	DTC number (ISO 15031	Automatic debounce	Fault text	Fault condition	Monitoring condition	Parameter configuration	Scanning time
56	88	96	P14F1	Y	SCR accumulator, pressure outside permissible range	F158 v F159 v F160	Ü28 v Ü29	P1 ^ P5 ^ P10	T8
57	88	20	P14F2	Y	Discontinued. Replaced by MU-ID 56.	false	false	false	T5
58	67	70	P1466	Y	Urea pressure system (UPS), pressure drop in power-down too small	F162	true	P1 ^ P5 ^ P10	T8 -> T6
59	86	91	P14C2	Y	Current urea consumption, urea consumption too low	F163	Ü33	P1 ^ P5 ^ P10	T8 -> T6
60	86	90	P14C1	Y	Current urea consumption, urea consumption too high	F164	Ü33	P1 ^ P5 ^ P10	T8 -> T6
61	87	91	P14C4	Y	Average urea consumption, urea consumption too low	F165	Ü33	P1 ^ P5 ^ P10	T8 -> T6
62	87	90	P14C3	Y	Average urea consumption, urea consumption too high	F166	Ü33	P1 ^ P5 ^ P10	T8 -> T6
63	60	29	P203F	Y	Urea tank level sensor, level too low	F168	Ü17	P1 ^ P5	T8
64	69	94	P14E0	Y	SCR system general, AGN switched off, Mannheim function	F152	true	P1	T8 -> T12
65	69	95	P14E1	Y	SCR system general, AGN switched off, Wörth function	F153	true	P1	T8 -> T12
316	36	04	U110E	Y	Ambient air temperature sensor, no communication	F64 ^ F60 ^ ¬F61 ^ (F57 v F58)	Ü43 ^ Ü17	P1	T8 -> T6
317	36	17	P0071	Y	Ambient air temperature sensor, measurement implausible	F174 ^ ¬F64	Ü43 ^ Ü17 ^ Ü44	P1	T8 -> T6
318	63	27	P0650	Y	OBD lamp (MI), faulty actuation	F173	Ü43 ^ ¬Ü101 ^ ¬Ü102 ^ Ü18	P1	
319	69	49	P14E2	Y	SCR system general, parameterization fault	(F303 ^ (¬F317 ^ ¬(F28 ^ F29 ^ ¬F318))v (F317 ^ ¬(¬F28 ^ F29 ^ F318))) v (¬F303 ^ (F28 v F29 v F318))	Ü107	P13	
320	81	06	P1437	Y	SCR air shut-off valve, ground short (- cable)	F5	Ü4 ^ Ü10 ^ Ü14 ^ Ü93	P1 ^ P5 ^ P6 ^ P14	
321	81	09	P1438	Y	SCR air shut-off valve, line break	F6	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5 ^ P6 ^ P14	
322	81	07	P1439	Y	SCR air shut-off valve, short to battery voltage (- cable)	F7	Ü4 ^ Ü10 ^ Ü14 ^ Ü93	P1 ^ P5 ^ P6 ^ P14	T2

MU ID	FP	FT	DTC number (ISO 15031	Automatic debounce	Fault text	Fault condition	Monitoring condition	Parameter configuration	Scanning time
323	06	31	P0494	Y	Fan, speed too low	F311	Ü112 ^ Ü113 ^ Ü114 ^ Ü115 ^ Ü116 ^ Ü117 ^ Ü170 ^ Ü118 ^ Ü119	P15 ^ P36 ^ P16 ^ P17	T2
324	28	04	U1140	Y	NOx sensor, no communication	F312	Ü10 ^ Ü17 ^ Ü121 ^ Ü4	P18 ^ P1 ^ P5	T1
325	28	16	P2202	Y	NOx sensor, measuring range undershot	F313	Ü120	P18 ^ P1 ^ P5	T1
326	28	15	P2203	Y	NOx sensor, measuring range exceeded	F314	Ü120	P18 ^ P1 ^ P5	T1
327	29	71	P14AA	Y	NOx emissions, threshold 1 exceeded	(¬F343 ^ F315) v (F343 ^ ¬F344 ^ ¬F356 ^ F349 ^ ¬F350)	(¬Ü171 ^ Ü18 ^ Ü169 ^ Ü22) v (Ü171 ^ (Ü172 v Ü173))	P18 ^ P1 ^ P5	T8
328	29	72	P14AB	Y	NOx emissions, threshold 2 exceeded	(¬F343 ^ F316) v (F343 ^ ¬F344 ^ ¬F356 ^ F351 ^ ¬F352)	(¬Ü171 ^ Ü18 ^ Ü169 ^ Ü22) v (Ü171 ^ (Ü174 v Ü175))	P18 ^ P1 ^ P5 ^ (¬P31 v P37)	T8
329	42	08	P1541	Y	DOC temperature sensor – 1, measuring range undershot	F1	Ü1 ^ Ü3 ^ Ü4 . Ü5	P1 ^ P3 ^ P4 ^ P5 ^ P30	T3
330	42	07	P1540	Y	DOC temperature sensor – 1, measuring range exceeded	F2	Ü1 ^ Ü3 ^ Ü4 . Ü5	P1 ^ P3 ^ P4 ^ P5 ^ P30	T3
331	42	10	P1543	Y	DOC temperature sensor – 2, measuring range undershot	F1	Ü1 ^ Ü3 ^ Ü4 . Ü5	P1 ^ P3 ^ P4 ^ P5 ^ P30	T3
332	42	9	P1542	Y	DOC temperature sensor – 2, measuring range exceeded	F2	Ü1 ^ Ü3 ^ Ü4 . Ü5	P1 ^ P3 ^ P4 ^ P5 ^ P30	T3
333	42	12	P1545	Y	Pressure sensor in front of particulate filter, measuring range undershot	F1	Ü1 ^ Ü3 ^ Ü4 . Ü5	P1 ^ P3 ^ P4 ^ P5 ^ P30	T2
334	42	11	P1544	Y	Pressure sensor in front of particulate filter, measuring range exceeded	F2	Ü1 ^ Ü3 ^ Ü4 . Ü5	P1 ^ P3 ^ P4 ^ P5 ^ P30	T2
335	42	14	P1547	Y	Pressure sensor after particulate filter, measuring range undershot	F1	Ü1 ^ Ü3 ^ Ü4 . Ü5	P1 ^ P3 ^ P4 ^ P5 ^ P30	T2
336	42	13	P1546	Y	Pressure sensor after particulate filter, measuring range exceeded	F2	Ü1 ^ Ü3 ^ Ü4 . Ü5	P1 ^ P3 ^ P4 ^ P5 ^ P30	T2
337	89	06	P2048	Y	RM metering valve, ground short (- cable)	F5	Ü4 ^ Ü10 ^ Ü14 ^ Ü93	P1 ^ P5 ^ P19	T2
338	89	09	P2047	Y	RM metering valve, line break	F6	Ü4 ^ Ü10 ^ Ü14	P1 ^ P5 ^ P19	T2
339	89	07	P2049	Y	RM metering valve, short to battery voltage (- cable)	F7	Ü4 ^ Ü10 ^ Ü14 ^ Ü93	P1 ^ P5 ^ P19	T2
340	44	15	P0546	Y	T4 temp sensor, measuring range exceeded	F2	-	P20	T1
341	44	16	P0545	Y	T4 temp sensor, measuring range undershot	F1	(¬Ü37 ^ Ü38) v Ü109 v ¬Ü37	P20	T1

342	44	22	P2428	Y	T4 temp. sensor, temperature too high	F319	Ü18	P20 ^ P21	T3

MU ID	FP	FT	DTC number (ISO 15031	Automatic debounce	Fault text	Fault condition	Monitoring condition	Parameter configuration	Scanning time
343	42	15	P1548	Y	Particulate filter, differential pressure too high	F322	Ü148^ Ü149 ^Ü150 ^ (Ü152 v (Ü151 ^ Ü154))	P1 ^ P30 ^ P32 ^ P5	T8
344	42	16	P1549	Y	Particulate filter, differential pressure too low	F323	Ü148 ^ Ü149 ^Ü150 ^ (Ü151 v (Ü152 ^ Ü153))	P1 ^ P30 ^ P33 ^ P5	T8
345	42	17	P1459	Y	Throttle flap, control deviation too high	F324	Ü131	P10	T2
346	42	18	P145A	Y	Throttle flap, reference search routine not successful	F325	Ü132 v Ü133	P10	T8
347	42	05	P1452	Y	Throttle flap position sensor, measuring range exceeded	F3	Ü2 ^ ¬Ü134	(P2 ^ P30) ^ ¬ P24	T2
348	42	06	P1451	Y	Throttle flap position sensor, measuring range undershot	F4	Ü2 ^ ¬Ü134	(P2 ^ P30) ^ ¬ P24	T2
349	42	00	P1454	Y	Proportioning valve 5, short to battery voltage (+ cable) (DKL-R)	F15	Ü56 ^ Ü13 ^ Ü91 ^ Ü92 ^ ¬Ü167	P1 ^ P22	T2
350	42	01	P1455	Y	Proportioning valve 5, ground short (+ cable) (DKL-R)	F22 ^ F33	Ü56 ^ Ü13 ^ Ü91	P1 ^ P22	T8
351	42	02	P1456	Y	Proportioning valve 7, ground short (- cable) (DKL)	F11	Ü10 ^ Ü14 ^ ¬Ü94 ^ Ü129 ^ Ü17	P1 ^ P23	T8 -> T6
352	42	03	P1457	Y	Proportioning valve 7, line break (DKL)	F12	Ü10 ^ Ü14 ^ ¬Ü94 ^ Ü129 ^ Ü17	P1 ^ P23	T8 -> T6
353	42	04	P1458	Y	Proportioning valve 7, short to battery voltage (- cable) (DKL)	F13	Ü10 ^ Ü14 ^ ¬Ü94 ^ Ü93 ^ Ü130 ^ Ü17	P1 ^ P23	T8 -> T6
354	42	24	P0607	Y	Internal fault, PV5 HS transistor has high resistance (DKL-R)	F16	Ü56 ^ Ü13 ^ Ü91 ^ Ü92 ^ Ü167	P1 ^ P22	T2
355	42	20	P145C	Y	SCR metering unit: pressure duct clogged	F155	Ü23 ^ Ü136 ^ Ü137 ^ (Ü143 ^ Ü139)	P1 ^ P5 ^ P28 ^ P29	T9
356	42	19	P145B	Y	SCR metering unit: air path clogged	F155	Ü23 ^ Ü136 ^ Ü137 ^ (Ü142 ^ Ü139)	P1 ^ P5 ^ P27 ^ P28	T9
357	42	21	P1448	Y	Diffusor heater: line break	F12	Ü13 ^ Ü14 ^ Ü106	P25	T2
358	42	22	P1447	Y	Diffusor heater: ground short (- cable)	F11	Ü13 ^ Ü14 ^ Ü106	P25	T2
359	42	23	P1449	Y	Diffusor heater, short to battery voltage (- cable)	F13	Ü13 ^ Ü14 ^ Ü106	P25	T2
360	42	25	P160A	Y	Proportioning valve bank 1, short to battery voltage (+cable)	F18	Ü13 ^ Ü17 ^ Ü104	P25	T8

MU ID	FP	FT	DTC number (ISO 15031	Automatic debounce	Fault text	Fault condition	Monitoring condition	Parameter configuration	Scanning time
361	42	26	P160B	Y	Proportioning valve bank 1, ground short (+cable)	F19	Ü13 ^ Ü14	P25	T8
362	42	27	P0607	Y	Control unit internal fault: high-side transistor has high resistance (PVB1)	F17	Ü13 ^ Ü14 ^ Ü17	P25	T8
363	42	28	P1555	Y	SCRT system: component not present	F154	Ü22	P1 ^ P5 ^ P30	T8 -> T6
364	42	29	P1556	Y	SCRT temperature sensors, pair A (T-DOC-1, T-Kat-2): measurement implausible	F149 ^ F328	Ü18 ^ ¬Ü144 ^ ¬Ü145 ^ ¬Ü97 ^ ¬Ü98 ^ Ü4 ^ Ü21	P1 ^ P5	T8 -> T6
365	42	30	P1557	Y	SCRT temperature sensors, pair B (T-DOC-2, T-Kat-1): measurement implausible	F329 ^ F148	Ü18 ^ ¬Ü95 ^ ¬Ü96 ^ ¬Ü146 ^ ¬Ü147 ^ Ü4 ^ Ü21	P1 ^ P5	T8 -> T6
366	42	31	P1558	Y	DPF: not present	F154	Ü22	P1 ^ P5 ^ P30	T8 -> T6
367	42	31	P1559	Y	DPF pressure sensor 1, measurement implausible	F333 v (F335 ^ Ü166 ^ Ü17)	(Ü165 ^ (¬Ü159 v (Ü159 ^ Ü160)) ^ ¬Ü161 ^ ¬Ü162) v (Ü166 ^ Ü17)	P1 ^ P3 ^ P4 ^ P5 ^ P30	T2
368	42	33	P1560	Y	DPF pressure sensor 2, measurement implausible	F334 v (F336 ^ Ü166 ^ Ü17)	(Ü165 ^ (¬Ü159 v (Ü159 ^ Ü160)) ^ ¬Ü163 ^ ¬Ü164) v (Ü166 ^ Ü17)	P1 ^ P3 ^ P4 ^ P5 ^ P30	T2
369	42	34	P14AC	Y	NOx emissions, threshold 2 exceeded, cause unknown	F316 ^ (F330v ¬340)	Ü18 ^ Ü169 ^ Ü22	P18 ^ P1 ^ P5 ^ P31 ^ ¬P37	T8
370	42	35	P14AD	Y	NOx emissions, urea quality	(¬F343 ^ F316 ^ ¬F330 ^ F340 ^ (F164 ^ F166)) v (F343 ^ ((F353 ^ F346 ^ ¬F347 ^ (F349 v F351)) v ¬((F353 ^ ¬F346) v (F354 ^ F350 ^ F352)))	(¬Ü171 ^ Ü18 ^ Ü169 ^ Ü22) v (Ü171 ^ Ü173 v Ü175 v (Ü176 ^ (Ü172 v Ü174)))	P18 ^ P1 ^ P5 ^ (P31 v P37)	T8
371	42	36	P14AE	Y	NOx emissions, insufficient metering	(¬F343 ^ F316 ^ ¬F330 ^ F340 ^ ¬(F164 ^ F166)) v (F343 ^ ((F353 ^ ¬F346 ^ F347 ^ (F349 v F351)) v ¬((F353 ^ ¬F347) v (F350 ^ F352 ^ (F354 v F355))))	(¬Ü171 ^ Ü18 ^ Ü169 ^ Ü22) v (Ü171 ^ Ü173 v Ü175 v (Ü176 ^ (Ü172 v Ü174)))	P18 ^ P1 ^ P5 ^ (P31 v P37)	T8
372	42	38	P1563	Y	DPF: temperature too low	F331	Ü155 ^ Ü156	P1 ^ P34 ^ P35	T8 -> T6

MU ID	FP	FT	DTC number (ISO 15031	Automatic debounce	Fault text	Fault condition	Monitoring condition	Parameter configuration	Scanning time
373	42	37	P2201	Y	NOx sensor: measurement implausible	F332	Ü157	P18 ^ P1 ^ P5	T8
374	42	39	P1621	Y	MR sensor bank 1: measurement exceeded/undershot	F142 v F143	Ü83	-	T2
375	42	40	P1622	Y	MR sensor bank 2: measurement exceeded/undershot	F142 v F143	Ü83	-	T2
376	42	41	P0641	Y	SCR-RM sensor bank 1: measurement exceeded/undershot	F337	Ü168	P1	T2
377	42	42	P0651	Y	SCR-RM sensor bank 2: measurement exceeded/undershot	F338	Ü168	P1	T2
378	42	43	P0697	Y	SCR-RM sensor bank 3: measurement exceeded/undershot	F339	Ü168	P1	T2
379	42	44	P14AF	Y	NOx sensor: readiness fault				T8
380	42	45	P14B1	Y	NOx emissions: NOx sensor faulty	F344 ^ F353 ^ (F349 v F351) ^ ¬(F353 ^ ¬F344 v (F350 ^ F352))	Ü173 v Ü175 v (Ü176 ^ (Ü172 v Ü174))	P18 ^ P1 ^ P5 ^ P37	T8
381	42	46	P14B2	Y	NOx emissions: raised untreated emissions	F345 ^ F353 ^ (F349 v F351) ^ ¬(F353 ^ ¬F345 v (F354 ^ F350 ^ F352))	Ü173 v Ü175 v (Ü176 ^ (Ü172 v Ü174))	P18 ^ P1 ^ P5 ^ P37	T8
382	42	47	P14B3	Y	NOx emissions: faulty SCR cat	F353 ^ F348 ^ (F349 v F351) ^ ¬(F346 ^ F347) v ¬(F353 ^ ¬F348 v (F350 ^ F352))	Ü173 v Ü175 v (Ü176 ^ (Ü172 v Ü174))	P18 ^ P1 ^ P5 ^ P37	T8
383	42	48	P14B4	Y	NOx emissions: urea quality/insufficient metering	(F353 ^ F346 ^ F347 ^ ¬F348 ^ (F349 v F351)) v ¬((F353 ^ (F348 v ¬F347 v ¬F346)) v (F354 ^ F350 ^ F352))	Ü173 v Ü175 v (Ü176 ^ (Ü172 v Ü174))	P18 ^ P1 ^ P5 ^ P37	T8
384	42	49	P14B5	Y	NOx emissions: urea quality/insufficient metering, faulty SCR cat	(F353 ^ F346 ^ F347 ^ F348 ^ (F349 v F351)) v ¬((F353 ^ (¬F348 v ¬F347 v ¬F346)) v (F354 ^ F350 ^ F352))	Ü173 v Ü175 v (Ü176 ^ (Ü172 v Ü174))	P18 ^ P1 ^ P5 ^ P37	T8

Key:

FP	FT	^	v	¬	Scanning time: e.g. T8 -> T6
Fault path	Fault type	Logic AND	Logic OR	Logic NOT	MU is parameterized as "event controlled" but is called up in the 1000 ms scan cycle

Overview of fault MU IDs – MR2A and MR2B fault memory

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitoring condition	Fault clearing condition	Monitoring condition		
66	40	37	P0610	N	Control unit internal fault, number of cylinders implausible	F169	¬Ü99 ^ ¬Ü100	-	-	T10	E3
67	40	38	P0607	N	Control unit internal fault, starter output stage has high resistance (redundant (emergency) branch)	F255 ^ (¬F259 v (F271 ^ F263))	Ü35	–¬(F255 ^ (¬F259 v (F271 ^ F263)))	Ü35	T2	E6
68	40	40	P16F1	N	Control unit internal fault, starter level detection faulty	(F270 ^ F256) v (¬F255 ^ ¬F261)	Ü35	¬((F270 ^ F256) v (¬F255 ^ ¬F261))	Ü35	T2	E5
70–74	-	-	-	-	Free	-	-	-	-	-	-
75	10	15	P0198	N	Oil temperature sensor, measuring range exceeded	F2	Ü36 ^ Ü47	F1 v ¬F2	Ü36 ^ Ü47	T3	E10
76	10	16	P0197	N	Oil temperature sensor, measuring range undershot	F1	Ü36 ^ Ü47	¬F1v F2	Ü36 ^ Ü47	T3	E10
77–84	-	-	-	-	Free	-	-	-	-	-	-
85	18	74	P0299	N	Turbocharger circuit/ charge air pressure control, controlled variable deviation too great	(F130 v F131) ^ F172 ^ F109 ^ F227 ^ F115 ^ F220 ^ ¬(F221 v (F222 ^ F223)) ^ (¬F216 v ¬F217)	-	(¬(F109 ^ F227 ^ F115 ^ F220 ^ ¬(F221 v (F222 ^ F223)) ^ (¬F216 v ¬F217)) ^ ¬F38) v ¬(F130 v F131) v ¬F172	-	T2	E1
86	18	22	P0127	N	Turbocharger circuit/ charge air pressure control, temperature too high	F192 ^ F230 ^ F50	Ü71 ^ Ü72	¬(F192 ^ F230 ^ F50)	-	T3	E1
87–89	-	-	-	-	Free	-	-	-	-	-	-
90	65	64	P1677	N	Oil trap, no signal from signal source	F231 ^ F232	Ü104 ^ Ü105 ^ Ü106	¬(F231 ^ F232)	Ü104 ^ Ü105 ^ Ü106	T2	E16
91	65	06	P1676	N	Oil trap, ground short (- cable)	F233 ^ F234	Ü104 ^ Ü105 ^ Ü106	¬(F233 ^ F234)	Ü104 ^ Ü105 ^ Ü106	T2	E8
92–94	-	-	-	-	Free	-	-	-	-	-	-

95	25	16	P250C	N	Engine oil level sensor, measuring range undershot	F1 ^ F51	¬Ü73	¬F1 v F2 v ¬F51	¬Ü73	T1	E25

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log: Fault condition	Fault log: Monitoring condition	Fault cancellation: Fault clearing condition	Fault cancellation: Monitoring condition	Scanning time	Debounce time
96	25	15	P250D	N	Engine oil level sensor, measuring range exceeded	F2 ^ F51	¬Ü73	¬F1 v F2 v ¬F51	¬Ü73	T1	E25
97	25	09	P250A	N	Engine oil level sensor, line break	F3 ^ F4 ^ F51	Ü73	¬(F3 ^ F4 ^ F51)	-	T1	E6
98-109	-	-	-	-	Free	-	-	-	-	-	-
110	75	42	P0563	N	Control unit voltage supply, nominal range exceeded	F142 ^ F235 ^ F236 ^ F237 ^ (F238 v F38)	-	¬F142 v F143 v (¬(F235 ^ F236 ^ F237 ^ (F238 v F38)) ^ F65)	-	T1	E12
111	75	43	P0562	N	Control unit voltage supply, nominal range undershot	F143 ^ F235 ^ F236 ^ F237 ^ (F238 v F38)	-	¬F143 v F142 v (¬(F235 ^ F236 ^ F237 ^ (F238 v F38)) ^ F65)	-	T1	E12
112	40	47	P0602	N	Internal fault, map data set faulty	F239 v F240 v F304 v F326 v (F327 ^ F317 ^ F303)	-	¬((F239 v F240 v F304 v F326 v F327) v (F327 ^ F317 ^ F303))	-	T1, T10	E3
113-119	-	-	-	-	Free	-	-	-	-	-	-
120	13	15	P2229	N	Atmospheric pressure sensor, measuring range exceeded	F2	-	F1 v ¬F2	-	T3	E10
121	13	16	P2228	N	Atmospheric pressure sensor, measuring range undershot	F1	-	¬F1 v F2	-	T3	E10
122-124	-	-	-	-	Free	-	-	-	-	-	-
125	20	26	P1574	N	Engine oil circuit, fill level too high	(F241 v F242 v F243) ^ F55	-	¬((F241 v F242 v F243) ^ F55)	-	T3	E1
126	20	21	P0524	N	Engine oil circuit, pressure too low	(F136 v F137) ^ F244 ^ F192	-	¬((F136 v F137) ^ F244 ^ F192)	-	T1	E1
127	21	22	P0217	N	Coolant circuit, temperature too high	(F138 v F139) ^ F47	-	¬((F138 v F139) ^ F47)	-	T3	E1
128-139	-	-	-	-	Free	-	-	-	-	-	-
140	90	44	P0263	N	Cylinder 1, limit reached (smooth-running controller restriction)	F245 v F246	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	¬(F245 v F246)	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	T5	E12
141	91	44	P0266	N	Cylinder 2, limit reached (smooth-running controller restriction)	F245 v F246	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	¬(F245 v F246)	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	T5	E12

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitoring condition	Fault clearing condition	Monitoring condition		
142	92	44	P0269	N	Cylinder 3, limit reached (smooth-running controller restriction)	F245 v F246	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	¬(F245 v F246)	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	T5	E12
143	93	44	P0272	N	Cylinder 4, limit reached (smooth-running controller restriction)	F245 v F246	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	¬(F245 v F246)	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	T5	E12
144	94	44	P0275	N	Cylinder 5, limit reached (smooth-running controller restriction)	F245 v F246	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	¬(F245 v F246)	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	T5	E12
145	95	44	P0278	N	Cylinder 6, limit reached (smooth-running controller restriction)	F245 v F246	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	¬(F245 v F246)	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	T5	E12
146	96	44	P0281	N	Cylinder 7, limit reached (smooth-running controller restriction)	F245 v F246	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	¬(F245 v F246)	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	T5	E12
147	97	44	P0284	N	Cylinder 8, limit reached (smooth-running controller restriction)	F245 v F246	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	¬(F245 v F246)	Ü74 ^ Ü75 ^ (Ü19 v Ü20) ^ Ü103	T5	E12
148	90	45	P0263	N	Cylinder 1, limit reached (EZA restriction)	F245 v F246	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	¬(F245 v F246)	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	T5	E12
149	91	45	P0266	N	Cylinder 2, limit reached (EZA restriction)	F245 v F246	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	¬(F245 v F246)	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	T5	E12
150	92	45	P0269	N	Cylinder 3, limit reached (EZA restriction)	F245 v F246	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	¬(F245 v F246)	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	T5	E12
151	93	45	P0272	N	Cylinder 4, limit reached (EZA restriction)	F245 v F246	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	¬(F245 v F246)	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	T5	E12
152	94	45	P0275	N	Cylinder 5, limit reached (EZA restriction)	F245 v F246	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	¬(F245 v F246)	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	T5	E12
153	95	45	P0278	N	Cylinder 6, limit reached (EZA restriction)	F245 v F246	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	¬(F245 v F246)	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	T5	E12
154	96	45	P0281	N	Cylinder 7, limit reached (EZA restriction)	F245 v F246	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	¬(F245 v F246)	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	T5	E12

155	97	45	P0284	N	Cylinder 8, limit reached (EZA restriction)	F245 v F246	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	¬(F245 v F246)	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	T5	E12
156	98	46	P1371	N	Single-cylinder adjustment, overall, EZA timeout	F247	Ü75 ^ Ü76 ^ Ü77 ^ Ü78	-	-	T5	E1
157	40	51	P0607	N	Internal fault, EEPROM read error 1	F96 ^ ¬F97 ^ F98 ^ F99 ^ F100	-	-	-	T10	E26

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitoring condition	Fault clearing condition	Monitoring condition		
158	40	50	P0610	N	Internal fault, incorrect hardware ID	F101 ^ (F248 v F297 v F298 v F299 v F300 v F301 v F302)	-	-	-	T10	E3
159	40	56	P0607	N	Internal fault, power-down control faulty	F250 ^ F251 ^ F252 ^ F253 ^ F254 ^ F102 ^ ¬F40 ^ F249 ^ ¬F38	Ü79 ^ Ü80	¬(F250 ^ F251 ^ F252 ^ F253 ^ F254 ^ F102 ^ ¬F40 ^ F249 ^ ¬F38)	Ü79 ^ Ü80	T2	E14
160	40	24	P0607	N	Internal fault, limp home computer/ microcontroller2 faulty	F116 ^ F117	Ü81	¬(F116 ^ F117)	-	T1	E26
161-164	-	-	-	-	Free	-	-	-	-	-	-
165	03	10	P0336	N	Crankshaft sensor, amplitude too low	F118 ^ ¬F119 ^ ¬F120	Ü82 ^ Ü83	¬(F118 ^ ¬F119 ^ ¬F120)	Ü82 ^ Ü83	T1	E9
166	03	11	P0016	N	Crankshaft sensor, signal assignment implausible	F121	-	-	-	T11	E1
167	03	12	P0335	N	Crankshaft sensor, timeout (no KW signal)	F122	Ü84 ^ Ü85	¬F122	Ü84 ^ Ü85	T11	E9
168	03	13	P1351	N	Crankshaft sensor, signal has wrong pole connection	F124		¬F124	Ü86	T1	E3
169	03	08	P0337	N	Crankshaft sensor, ground short	F2 ^ F120	Ü82 ^ Ü83	F1 v ¬F2 v ¬F120	Ü82 ^ Ü83	T1	E9
170	03	09	P0335	N	Crankshaft sensor, line break	F1 ^ F120	Ü82 ^ Ü83	F1 v ¬F2 v ¬F120	Ü82 ^ Ü83	T1	E12
171	04	13	P1352	N	Camshaft sensor, signal has wrong pole connection	F125	Ü86	¬F125	Ü86	T1	E3
172	04	09	P0340	N	Camshaft sensor, line break	F1 ^ F120	Ü82 ^ Ü83	F1 v ¬F2 v ¬F120	Ü82 ^ Ü83	T1	E12
173	04	04	P0340	N	Camshaft sensor, timeout (no NW signal)	F123	Ü84 ^ Ü85	¬F123	Ü84 ^ Ü85	T11	E9
174	04	04	P0342	N	Camshaft sensor, ground short	F2 ^ F120	Ü82 ^ Ü83	F1 v ¬F2 v ¬F120	Ü82 ^ Ü83	T1	E9
175	15	15	P0118	N	Coolant temperature sensor, measuring range exceeded	F2	-	F1 v ¬F2	-	T3	E10

176	15	16	P0117	N	Coolant temperature sensor, measuring range undershot	F1	-	F1 v ¬F2	-	T3	E10
177	40	52	P0607	N	Internal fault, EE-PROM read error 2	F96 ^ F97 ^ F100	-	-	-	T10	E3

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitoring condition	Fault clearing condition	Monitoring condition		
178	77	05	P160A	N	Proportioning valve bank 1, short to battery voltage (+cable)	F38 ^ F215 ^ F18 ^ F24	-	¬(F38 ^ F215 ^ F18 ^ F24)	-	T10	E2
179	77	08	P160B	N	Proportioning valve bank 1, ground short (+cable)	F215 ^ F36 ^ F19	-	-	-	T2	E19
180[1]	78	05	P160C	N	Proportioning valve bank 2, short to battery voltage (+cable)	F38 ^ F215 ^ F21 ^ F25	-	¬(F38 ^ F215 ^ F21 ^ F25)	-	T10	E2
181[1]	78	08	P160D	N	Proportioning valve bank 2, ground short (+cable)	F215 ^ F36 ^ F22	-	-	-	T2	E20
182	80	86	P16E2	N	Starter actuation, starter does not engage	F257 ^ F260	-	-	-	T2	E16
183	80	33	P16E1	N	Starter actuation, starter relay hangs up	F255 ^ F107 ^ F256 ^ F257 ^ F258 ^ F108 ^ F259	¬Ü87	¬(F255 ^ F107 ^ F256 ^ F257 ^ F258 ^ F108 ^ F259)	¬Ü87	T2	E11
184	80	05	P0617	N	Starter actuation, starter relay energized externally	¬F255 ^ F107 ^ F256 ^ F257 ^ F258 ^ F108 ^ F259	¬Ü87	¬(F255 ^ F107 ^ F256 ^ F257 ^ F258 ^ F108 ^ F259)	¬Ü87	T2	E11
185	80	08	P0616	N	Starter actuation, ground short	F255 ^ F261	-	F261 ^ F262	-	T10	E17
186	80	09	P0615	N	Starter actuation, line break	¬F261 ^ F257 ^ F263 ^ F38 ^ ¬F255 ^ F264 ^ F265	-	¬(¬F261 ^ F257 ^ F263 ^ F38 ^ ¬F255 ^ F264 ^ F265) v F266	-	T2	E6
187	40	38	P0607	N	Control unit internal fault, starter output stage has high resistance (main branch)	F255 ^ F267	Ü87 ^ Ü89 ^ Ü90	¬(F255 ^ F267)	Ü87 ^ Ü89 ^ Ü90	T2	E6
188	80	39	P0615	N	Starter actuation, output stage has low resistance (main branch or emergency branch)	F257 ^ ((F255 ^ F268 ^ F269) v (¬F261 ^ F263 ^F38 ^ ¬F255 ^ ¬F264 ^ F41)	-	-	-	T2, T10	E3

189	64	32	P0540	N	Heater flange, general malfunction	F274 ^ (F275 ^ F276 ^ (F277 v F278)) v (F279 ^ F280 ^ F281 ^ F282 ^ ((F276 ^ ¬F277 ^ F283) v (¬F276)) v (¬F284 ^ ¬F275 ^ ¬F279 ^ F285 ^ F276 ^ F277)	-	-	-	T2	E7

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitoring condition	Fault clearing condition	Monitoring condition		
190	40	34	P0607	N	Internal fault, PVB1 HS transistor has high resistance	F17 ^ F215 ^ F34	-	¬(F17 ^ F215 ^ F34)	-	T10	E8
191[1]	40	35	P0607	N	Internal fault, PVB2 HS transistor has high resistance[1]	F20 ^ F215 ^ F34	-	¬(F20 ^ F215 ^ F34)	-	T10	E8
192	40	49	P0610	N	Internal fault, parameterization fault	F272	-	-	-	T5	E3
193	40	36	P0607	N	Internal fault, PV5 HS transistor has high resistance	F16 ^ F215 ^ F34 ^ F35 ^ F30 ^ F31	-	¬(F16 ^ F215 ^ F34 ^ F35) v ((¬F30 v ¬F31) ^ F65)	-	T2	E8
194	40	54	P0607	N	Internal fault, CAN data sector faulty	F56	-	-	-	T10	E3
195	40	58	P0602	N	Internal fault, data set tampered with	F273	-	-	-	T5	E3
196	-	-	-	-	Free	-	-	-	-	-	-
197	19	17	P1170	N	Fuel circuit, measurement implausible	(F132 v F133) ^ F115 ^ F105 ^ F54 ^ F49 ^ ((F228 ^ F53 ^ F48) v (F229 ^ F47))	-	¬((F132v F133) ^ F115 ^ F105. F54 ^ F49 ^ ((F228 ^ F53 ^ F48) v (F229 ^ F47)))	-	T3	E1
198	-	-	-	-	-	-	-	-	-	-	-
199	16	17	P0521	N	Oil pressure sensor, measurement implausible	F289 ^ ((F102 ^ F287 ^ F288 ^ F290) v (F104 ^ F291))	-	¬(F289^ ((F102 ^ F287 ^ F288 ^ F290) v (F104 ^ F291)))	-	T1	E1
200	16	15	P0523	N	Oil pressure sensor, measuring range exceeded	F2	-	F1 v ¬F2	-	T1	E10
201	16	16	P0522	N	Oil pressure sensor, measuring range undershot	F1	-	¬F1v F2	-	T1	E10
202	05	30	P0219	N	Engine, speed to high	F106	-	¬F106	-	T1	E3
203	18	20	P0234	N	Turbocharger circuit, pressure too high	F128	Ü39 ^ Ü40 ^ Ü41 ^ Ü42	¬F128	Ü39 ^ Ü40 ^ Ü41 ^ Ü42	T3	E1
204	18	18	P2263	N	Turbocharger circuit, turbocharger circuit faulty	F50 ^ F288 ^ F225 ^ ¬F286 ^ F115 ^ F105 ^ F292	-	¬(F50 ^ F288 ^ F225 ^ ¬F286 ^ F115 ^ F105 ^ F292)	-	T3	E1
205	11	15	P0183	N	Fuel temp. sensor, measuring range exceeded	F2 ^ F51	-	F1 v ¬F2 v ¬F51	-	T3	E10

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitoring condition	Fault clearing condition	Monitoring condition		
206	11	16	P0182	N	Fuel temp. sensor, measuring range undershot	F1 ^ F51	-	¬F1v F2 v ¬F51	-	T3	E10
207	12	15	P0113	N	Charge air temperature sensor, measuring range exceeded	F2	-	F1 v ¬F2	-	T3	E10
208	12	16	P0112	N	Charge air temperature sensor, measuring range undershot	F1	-	¬F1v F2	-	T3	E10
209	22	19	P1561	N	Terminal 15 detection, signal inconsistent	F44 ^ ¬F61 ^ F59 ^ F60	-	¬(F44 ^ ¬F61 ^ F59 ^ F60)	-	T2	E10
210	23	19	P1562	N	Terminal 50 detection, signal inconsistent	F45 ^ F59 ^ F42 ^ F212 ^ F213 ^ F214 ^ ¬F63	-	¬(F45 ^ F59 ^ F42 ^ F212 ^ F213 ^ F214 ^ ¬F63)	-	T2	E8
211	14	15	P0238	N	Charge air pressure sensor, measuring range exceeded	F2	-	F1 v ¬F2	-	T1	E10
212	14	16	P0237	N	Charge air pressure sensor, measuring range undershot	F1	-	¬F1v F2	-	T1	E10
213	14	17	P0236	N	Charge air pressure sensor, measuring range implausible	F50 ^ F288 ^ F293 ^ F294 ^ F295	-	¬(F50 ^ F288 ^ F293 ^ F294 ^ F295)	-	T1	E1
214	-	-	-	-	Free	-	-	-	-	-	
215	50	26	P020A	N	Cylinder 1 actuation, impact detection	(F93 v F94 v F95) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92	-	¬(¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92)	-	T11	E21
216	51	26	P020B	N	Cylinder 2 actuation, impact detection	(F93 v F94 v F95) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92	-	¬(¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92)	-	T11	E21
217	52	26	P020C	N	Cylinder 3 actuation, impact detection	(F93 v F94 v F95) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92	-	¬(¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92)	-	T11	E21
218	53	26	P020D	N	Cylinder 4 actuation, impact detection	(F93 v F94 v F95) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92	-	¬(¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92)	-	T11	E21

219	54	26	P020E	N	Cylinder 5 actuation, impact detection	(F93 v F94 v F95) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92	-	¬(¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92)	-	T11	E21

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitoring condition	Fault clearing condition	Monitoring condition		
220	55	26	P020F	N	Cylinder 6 actuation, impact detection	(F93 v F94 v F95) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92	-	¬(¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92)	-	T11	E21
221	56	26	P021A	N	Cylinder 7 actuation, impact detection	(F93 v F94 v F95) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92	-	¬(¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92)	-	T11	E21
222	57	26	P021B	N	Cylinder 8 actuation, impact detection	(F93 v F94 v F95) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92	-	¬(¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90 ^ F85 ^ F91 ^ F92)	-	T11	E21
223	76	06	P166A	N	Proportioning valve 6, ground short (-cable)	F11 ^ F23 ^ F215 ^ F34 ^ F35	-	(¬F11 ^ F65) v ¬(F23 ^ F215 ^ F34 ^ F35)	-	T2	E8
224	76	09	P166B	N	Proportioning valve 6, line break	F12 ^ F23 ^ F215 ^ F34 ^ F35	-	¬(F12 ^ F23 ^ F215 ^ F34 ^ F35)	-	T2	E8
225	71	06	P163A	N	Proportioning valve 3, ground short	F11 ^ F23 ^ F215 ^ F36 ^ F37	-	¬(F11 ^F65) v ¬(F23 ^ F215 ^ F36 ^ F37)	-	T2	E8
226	71	07	P163C	N	Proportioning valve 3, short to battery voltage (- cable)	F13 ^ F23 ^ F215 ^ F36 ^ F37	-	(¬F13 ^ F65) v ¬(F23 ^ F215 ^ F36 ^ F37)	-	T2	E8
227	71	09	P163B	N	Proportioning valve 3, line break	F12 ^ F23 ^ F215 ^ F36 ^ F37	-	¬(F12 ^ F23 ^ F215 ^ F36 ^ F37)	-	T2	E8
228	06	12	P0528	N	Fan, signal timeout	F79 ^ ¬F102 ^ F80 ^ F81 ^ (F82 v F83 v F341 v F342)	Ü69 ^ Ü70	¬(F79 ^ ¬F102 ^ F80 ^ F81 ^ (F82 v F83 v F341 v F342))	Ü69 ^ Ü70	T7	E13
229	72	06	P164A	N	Proportioning valve 4, ground short (-cable)	F12 ^ F23 ^ F215 ^ F36 ^ F37	-	¬(F11 ^F65) v ¬(F23 ^ F215 ^ F36 ^ F37)	-	T2	E8
230	72	07	P164C	N	Proportioning valve 4, short to battery voltage (- cable)	F12 ^ F23 ^ F215 ^ F36 ^ F37	-	(¬F13 ^ F65) v ¬(F23 ^ F215 ^ F36 ^ F37)	-	T2	E8
231	72	09	P164B	N	Proportioning valve 4, line break	F12 ^ F23 ^ F215 ^ F36 ^ F37	-	¬(F12 ^ F23 ^ F215 ^ F36 ^ F37)	-	T2	E8
232	17	15	P2542	N	Fuel pressure sensor, measuring range exceeded	F2 ^ F51	-	F1 v ¬F2 v ¬F51	-	T1	E10
233	17	16	P2541	N	Fuel pressure sensor, measuring range undershot	F1 ^ F51	-	¬F1 v F2 v ¬F51	-	T1	E10

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitor-ing condition	Fault clearing condi-tion	Monitor-ing condition		
234	17	17	P2540	N	Fuel pressure sensor, signal implausible	F224 ^ F144 ^ F145 ^ F104 ^ ¬F76 ^ ¬F77 ^ F51	-	¬(F224 ^ F144 ^ F145 ^ F104 ^ ¬F76 ^ ¬F77 ^ F51)	-	T1	E1
235	50	27	P0201	N	Cylinder 1 actuation, actuation malfunction	(¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90	-	¬((¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90)	-	T11	E21
236	51	27	P0202	N	Cylinder 2 actuation, actuation malfunction	(¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90	-	¬((¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90)	-	T11	E21
237	52	27	P0203	N	Cylinder 3 actuation, actuation malfunction	(¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90	-	¬((¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90)	-	T11	E21
238	53	27	P0204	N	Cylinder 4 actuation, actuation malfunction	(¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90	-	¬((¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90)	-	T11	E21
239	54	27	P0205	N	Cylinder 5 actuation, actuation malfunction	(¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90	-	¬((¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90)	-	T11	E21
240	55	27	P0206	N	Cylinder 6 actuation, actuation malfunction	(¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90	-	¬((¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90)	-	T11	E21
241	56	27	P0207	N	Cylinder 7 actuation, actuation malfunction	(¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90	-	¬((¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90)	-	T11	E21
242	57	27	P0208	N	Cylinder 8 actuation, actuation malfunction	(¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90	-	¬((¬(F85 ^ F91 ^ F92)) ^ ¬F87 ^ F84 ^ ¬F88 ^ F89 ^ ¬F90)	-	T11	E21
243	18	74	P0299	N	Turbocharger circuit/ charge air pressure control, controlled variable deviation too great	(F130 v F131) ^ F171 ^ F109 ^ F227 ^ F115 ^ F220 ^ ¬(F221 v (F222 ^ F223)) ^ (¬F216 v ¬F217)	-	¬(F109 ^ F227 ^ F115 ^ F220 ^ ¬(F221 v (F222 ^ F223)) ^ (¬F216 v ¬F217)) ^ ¬F38	-	T2	E1
244	18	75	P2263	N	Turbocharger circuit/ charge air pressure control, charge pres-sure deviation too great	(F130 v F131) ^ F115 ^ F227 ^ F109	-	(F216 ^ F217) v ((¬F216 v ¬F217) ^ (F218 v F219 v ¬F220) ^ ¬F38)	-	T2	E1
245	18	76	P2263	N	Turbocharger circuit/ charge air pressure control, brake power too low	(F134 v F135) ^ F115 ^ F227 ^ F109	-	¬((F134 v F135) ^ F115 ^ F227 ^ F109)	-	T2	E1
246	70	06	P161A	N	Proportioning valve 1, ground short	F11 ^ F23 ^ F215 ^ F36 ^ F37	Ü56	¬(F11 ^F65) v ¬(F23 ^ F215 ^ F36 ^ F37)	Ü56	T2	E8
247	70	07	P161C	N	Proportioning valve 1, short to battery volt-age (- cable)	F13 ^ F23 ^ F215 ^ F36 ^ F37	Ü56	(¬F13 ^ F65) v ¬(F23 ^ F215 ^ F36 ^ F37)	Ü56	T2	E8

248	70	09	P161B	N	Proportioning valve 1, line break	F12 ^ F23 ^ F215 ^ F36 ^ F37	Ü56	¬(F12 ^ F23 ^ F215 ^ F36 ^ F37)	Ü56	T2	E8

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitor-ing condition	Fault clearing condi-tion	Monitor-ing condition		
249	76	07	P166C	N	Proportioning valve 6, short to battery volt-age (- cable)	F23 ^ F13 ^ F215 ^ F34 ^ F35	Ü56	(¬F13 ^ F65) ^ ¬(F23 ^ F215 ^ F34 ^ F35)	Ü56	T2	E8
250	73	06	P162A	N	Proportioning valve 2, ground short	F23 ^ F11 ^ F215 ^ ((¬F27 ^ F36 ^ F37) v (F27 ^ F34 ^ F35))	Ü56	(¬F11 ^ F65) v ¬(F23 ^ F215 ^ ((¬F27 ^ F36 ^ F37) v (F27 ^ F34 ^ F35)))	Ü56	T2	E15
251	73	07	P162C	N	Proportioning valve 2, short to battery volt-age (- cable)	F23 ^ F13 ^ F215 ^ ((¬F27 ^ F36 ^ F37) v (F27 ^ F34 ^ F35))	Ü56	(¬F13 ^ F65) v ¬(F23 ^ F215 ^ ((¬F27 ^ F36 ^ F37) v (F27 ^F34 ^ F35)))	Ü56	T2	E8
252	73	09	P162B	N	Proportioning valve 2, line break	F23 ^ F12 ^ F215 ^ ((¬F27 ^ F36 ^ F37) v (F27 ^ F34 ^ F35))	Ü56	¬(F23 ^ F12 ^ F215 ^ ((¬F27^ F36 ^ F37) v (F27 ^ F34 ^ F35)))	Ü56	T2	E8
253	74	05	P165C	N	Proportioning valve 5, short to battery volt-age (+ cable)	F15 ^ F32	Ü56 ^ Ü13 ^ Ü91 ^Ü92	¬(F15 ^ F32)	Ü56 ^ Ü13 ^ Ü91 ^Ü92	T2	E8
254	74	08	P165A	N	Proportioning valve 5, ground short (+ cable)	F22 ^ F33	Ü56 ^ Ü13 ^ Ü91	-	-	T2	E19
255	01	02	U0400	N	CAN low speed, data implausible	F38 ^ F59 ^ F60 ^ F61	-	¬(F38 ^ F59 ^ F60 ^ F61)	-	T1	E23
256	01	49	P0610	N	CAN low speed, pa-rameterization fault	F78	-	¬F78	-	T5	E3
257	01	04	U0019	N	CAN low speed, no communication	F38 ^ F59 ^ F211	-	¬(F38 ^ F59 ^ F211)	-	T1	E23
258	01	01	U1001	N	CAN low speed, com-munications line 2 faulty (low line)	¬F62 ^ F210 ^ F38 ^ ((F209 ^ F207) v (F208 ^ ¬F207)	-	F207 ^ ¬F209	-	T1	E22
259	01	00	U1000	N	CAN low speed, com-munications line 1 faulty (high line)	¬F62 ^ F210 ^ F38 ^ ((F209 ^ F207) v (F208 ^ ¬F207)	-	F207 ^ ¬F209	-	T1	E22
260	99	61	P1551	N	Immobilizer, counter overrun	F206	-	-	-	T12	E3
261	99	64	P1554	N	Immobilizer, no TPC via terminal 50	¬F201 ^ ¬F203 ^ ¬F204 ^ F43	-	-	-	T1	E3
262	99	63	P1553	N	Immobilizer, no TPC via CAN	(¬F201 ^ F43 ^ ¬F203 ^ ¬F204 ^ F205) v (F203 ^ F204 ^ ¬F205)	Ü53 ^ Ü54 ^ Ü55	-	-	T1	E4
263	99	62	P1552	N	Immobilizer, X5 can-celled	F203 ^ ¬F204	Ü48 ^ Ü51 ^ Ü53 ^ Ü54	¬F203 ^ ¬F204	-	T1, T12	E3

264	99	60	P1550	N	Immobilizer, number of keys limited to 8	F199 ^ F200 ^F201 ^ F202	-	-	-	T12	E3

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitor-ing condition	Fault clearing con-dition	Monitor-ing condition		
265	26	12	P1575	N	Turbocharger speed sensor 1, signal timeout	F112 ^ F198 ^ F104 ^ ((F113 ^ ¬F197) v (F114 ^ F197)) ^F110 ^ F103 ^ F26	-	F112 ^ F198 ^ F104 ^ ((F113 ^ ¬F197) v (F114 ^ F197)) ^F110 ^ F103 ^ F26	-	T2	E1
266-267	-	-	-	-	Free	-	-	-	-	-	-
268	18	78	P2261	N	Turbocharger cir-cuit/charge air pressure control, general actuator fault	F26 ^ F192 ^ F193 ^ F194 ^ F195 ^ F196 ^ F111	-	F39	-	T2	E1
269	06	31	P0431	N	Fan, speed too low	F311 (sawtooth de-bounce)	Ü112 ^ Ü113 ^ Ü114 ^ Ü115 ^ Ü116 ^ Ü117 ^ Ü118 ^ Ü119	¬F311 (sawtooth debounce)	Ü112 ^ Ü113 ^ Ü114 ^ Ü115 ^ Ü116 ^ Ü117 ^ Ü118 ^ Ü119	T2	E1
270-272	-	-	-	-	Free	-	-	-	-	-	-
273	64	09	P0543	N	Heater flange, line break	F191	Ü63 ^ Ü12 ^ Ü64 ^ Ü65 ^ Ü68 ^ ((Ü66 ^ Ü61 ^Ü62) v Ü67)	¬F191	Ü63 ^ Ü12 ^ Ü64 ^ Ü65 ^ Ü68 ^ ((Ü66 ^ Ü61 ^Ü62) v Ü67)	T2	E3
274	66	78	P2413	N	EGR valve, gener-al actuator fault	F27 ^ F190 ^ F187	-	¬(F27 ^ F190 ^ F187)	-	T2	E1
275	31	15	P0098	N	Charge air tem-perature sensor 2, measuring range exceeded	F2	Ü36 ^ ¬Ü37 ^ Ü38	F1 v ¬F2	Ü36 ^ ¬Ü37 ^ Ü38	T1	E10
276	31	31	P0097	N	Charge air tem-perature sensor 2, measuring range undershot	F1	Ü36 ^ ¬Ü37 ^ Ü38	¬F1v F2	Ü36 ^ ¬Ü37 ^ Ü38	T1	E10
277	32	32	P040D	N	T6 temperature sensor (EGR tem-perature), mea-suring range exceeded	F2	Ü36 ^ ¬Ü37 ^ Ü38	F1 v ¬F2	Ü36 ^ ¬Ü37 ^ Ü38	T1	E10

278	32	32	P040C	N	T6 temperature sensor (EGR temperature), measuring range undershot	F1	Ü36 ^ ¬Ü37 ^ Ü38	¬F1v F2	Ü36 ^ ¬Ü37 ^ Ü38	T1	E10

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitor-ing condition	Fault clearing con-dition	Monitor-ing condition		
279	33	33	P1453	N	EGR system, gen-eral malfunction	(F146 v F147) ^ F183 ^ F104 ^ F115 ^ F46 ^ F47 ^ F185 ^ F52 ^ F186 ^ F187 ^ F27 ^F188 ^ F189	-	¬((F146 v F147) ^ F183 ^ F104 ^ F115 ^ F46 ^ F47 ^ F185 ^ F52 ^ F186 ^ F187 ^ F27 ^F188 ^ F189)	-	T2	E1
280	66	79	P2413	N	EGR valve, tem-perature diagno-sis fault	F129 ^ F183 ^ F104 ^ F115 ^ F184 ^ F46 ^ F47 ^ F185 ^ F52 ^ F186 ^ F187 ^ F27	-	¬(F129 ^ F183 ^ F104 ^ F115 ^ F184 ^ F46 ^ F47 ^ F185 ^ F52 ^ F186 ^ F187 ^ F27)	-	T2	E1
281	26	15	P2581	N	Turbocharger speed sensor 1, measuring range exceeded	F2 ^ F182 ^ F26 ^ ((F180 ^ F102) v F181)	-	¬(F2 ^ F182 ^ F26 ^ ((F180 ^ F102) v F181))	-	T2	E1
282	26	16	P2580	N	Turbocharger speed sensor 1, measuring range undershot	F1 ^ F182 ^ F26 ^ ((F180 ^ F102) v F181)	-	¬(F1 ^ F182 ^ F26 ^ ((F180 ^ F102) v F181))	-	T2	E1
283	27	12	P14B0	N	Generator speed timeout	F308 ^ F309 ^ F310	Ü18 ^ Ü23 ^ Ü71	¬ (F308 ^ F309 ^ F310)	Ü18 ^ Ü23 ^ Ü71	T2	E1
284	-	-	-	-	Free	-	-	-	-	-	-
285	41	49	P0610	N	Engine brakes, parameterization fault	F177 ^ ¬F178 ^ F179	-	¬(F177 ^ ¬F178 ^ F179)	-	T1	E3
286	44	15	P0546	N	T4 temp sensor, measuring range exceeded	F2	Ü36	F1 v ¬F2	Ü36 ^ ¬Ü37 ^ Ü38	T3	E1
287	44	15	P0545	N	T4 temp sensor, measuring range undershot	F1	(¬Ü37 ^ Ü38) v Ü109 v ¬Ü37	¬F1v F2	-	T3	E1
288	44	22	P2428	N	T4 temp. sensor, temperature too high	F319	Ü18 ^ Ü128 ^ Ü2	¬F150 ^ ¬F319) v ¬F51 v ¬F321	Ü18	T3	E1
289	-	-	-	-	Free	-	-	-	-	-	-
290	50	28	P0201	N	Cylinder 1 actua-tion, short circuit	F85 ^ F86	-	¬(F85 ^ F86)	-	T11, T10	E24
291	51	28	P0202	N	Cylinder 2 actua-tion, short circuit	F85 ^ F86	-	¬(F85 ^ F86)	-	T11, T10	E24
292	52	28	P0203	N	Cylinder 3 actua-tion, short circuit	F85 ^ F86	-	¬(F85 ^ F86)	-	T11, T10	E24
293	53	28	P0204	N	Cylinder 4 actua-tion, short circuit	F85 ^ F86	-	¬(F85 ^ F86)	-	T11, T10	E24

MU ID	FP	FT	DTC numbers (ISO 15031)	Automatic debounce	Fault text	Fault log		Fault cancellation		Scanning time	Debounce time
						Fault condition	Monitor-ing condition	Fault clearing con-dition	Monitor-ing condition		
294	54	28	P0205	N	Cylinder 5 actua-tion, short circuit	F85 ^ F86	-	¬(F85 ^ F86)	-	T11, T10	E24
295	55	28	P0206	N	Cylinder 6 actua-tion, short circuit	F85 ^ F86	-	¬(F85 ^ F86)	-	T11, T10	E24
296	56	28	P0207	N	Cylinder 7 actua-tion, short circuit	F85 ^ F86	-	¬(F85 ^ F86)	-	T11, T10	E24
297	57	28	P0208	N	Cylinder 8 actua-tion, short circuit	F85 ^ F86	-	¬(F85 ^ F86)	-	T11, T10	E24
298	48	06	P2147	N	MV bank1 actua-tion, ground short, low side	F85	Ü57 ^ Ü58 ^ ¬Ü59	-	-	T10	E19
299	49	06	P2150	N	MV bank2 actua-tion, ground short, low side	F85	Ü57 ^ Ü58 ^ ¬Ü60	-	-	T10	E19
300	48	05	P2148	N	MV bank1 actua-tion, short to bat-tery voltage, high side	F14	Ü11 ^ Ü56	-	-	T2	E18
301	49	05	P2151	N	MV bank2 actua-tion, short to bat-tery voltage, high side	F14	Ü11 ^ Ü56	-	-	T2	E18
302-313	-	-	-	-	Free	-	-	-	-	-	-
314	40	53	P0607	N	Internal fault, EE-PROM read error 3	F96 ^ F97 ^ F98	-	-	-	T10	E3
315	99	65	P0513	N	Immobilizer, valid but incorrect sig-nal code	F175 ^ F176	Ü48 ^ Ü49 ^ Ü50 ^ Ü51 ^ Ü52 ^ Ü53 ^ Ü54 ^ Ü55 ^ ¬Ü101 ^ (Ü44 v Ü45) ^ Ü46	-	-	T1	E20
						F175 ^ F176	¬Ü49 ^ Ü50 ^ Ü52	-	-	T10	E22

1: MR2A control unit only

Key:

FP	FT	^	v	¬
Fault path	Fault type	Logic AND	Logic OR	Logic NOT

Overview of fault conditions

Seq. no.	**Fault condition/Fault clearing condition**
F1	Sensor voltage < minimum permissible voltage
F2	Sensor voltage > maximum permissible voltage
F3	Sensor voltage > lower plausibility limit
F4	Sensor voltage < upper plausibility limit
F5	Status message, frame module proportioning valve ground short
F6	Status message, frame module proportioning valve line break
F7	Status message, frame module proportioning valve short circuit to battery voltage
F8	Status message, frame module proportioning valve bank ground short
F9	Status message, frame module proportioning valve bank short circuit to battery voltage
F10	Status message, frame module proportioning valve bank high resistance
F11	Status message, MR proportioning valve low-side driver ground short
F12	Status message, MR proportioning valve low-side driver line break
F13	Status message, MR proportioning valve low-side driver short circuit to battery voltage
F14	EPLD status message, MV bank high side short circuit to battery voltage, Prerequisite: detection of a high level at the output of a valve in the bank when the bank is switched off (low and high-side transistor)
F15	EPLD status message, PV5 HS level high
F16	EPLD status message, PV5 HS high resistance
F17	EPLD status message, PVB1 high resistance
F18	EPLD status message, PVB1 short circuit to battery voltage
F19	EPLD status message, PVB1 ground short
F20	EPLD status message, PVB2 high resistance
F21	EPLD status message, PVB2 short circuit to battery voltage
F22	EPLD status message, PVB2 ground short
F23	PV parameterized
F24	PV1 or PV2 or PV3 or PV4 parameterized
F25	PV5 or PV6 parameterized
F26	PV1 parameterized to VTG
F27	PV2 parameterized to EGR
F28	PV7 parameterized to metering valve
F29	PV8 parameterized to tank heater
F30	PV on
F31	PV not s.n.a.
F32	PV5 off
F33	PV5 off -> no PVB2 HS short
F34	PVB2 HS on
F35	PVB2 HS not high resistance
F36	PVB1 HS on
F37	PVB2 HS not high resistance
F38	Terminal 15 on
F39	Terminal 15 off, was previously on
F40	Terminal 50 on
F41	Terminal 50 level change
F42	Terminal 50 test not blocked
F43	Terminal 50 OK
F44	Status of terminal 15 port <> Terminal 15 CAN status
F45	Status of terminal 50 port <> Terminal 50 CAN status

Seq. no.	Fault condition/Fault clearing condition
F46	No T6 sensor error
F47	No coolant temperature sensor error
F48	No fuel temperature sensor error
F49	No fuel pressure sensor error
F50	No charge air temperature sensor error
F51	Sensor installed
F52	T6 temp. sensor installed
F53	Fuel temperature sensor installed
F54	Fuel pressure sensor installed
F55	Oil level sensor installed
F56	CAN data sector faulty: test patterns written in the CAN RAM sector could not be read back without error; fault results in CAN limp home mode
F57	First ID received via low-speed CAN
F58	Low-speed CAN ramp-up time expired
F59	CAN parameterized and not switched off
F60	No CAN error
F61	CAN data implausible
F62	CAN-LOW operation (¬CAN-HIGH operation)
F63	CAN limp home mode
F64	CAN-ID 1616 faulty
F65	Fault not active in fault memory
F66	Urea tank temperature sensor, measuring range exceeded (MU ID 7) – fault active
F67	Urea tank temperature sensor, measuring range undershot (MU ID 6) – fault active
F68	Ambient air temperature sensor, no communication (MU ID 316) – fault active
F69	Ambient air temperature sensor, measurement implausible (MU ID 317) – fault active
F70	SCR line heater, ground short (-cable) (MU ID 37) – fault active
F71	SCR line heater, line break (MU ID 38) – fault active
F72	SCR line heater, short circuit to battery voltage (- cable) (MU ID 39) – fault active
F73	Proportioning valve 8 (tank heater valve), ground short (- cable) (MU ID 48) – fault active
F74	Proportioning valve 8 (tank heater valve), line break (MU ID 49) – fault active
F75	Proportioning valve 8 (tank heater valve), short circuit to battery voltage (- cable) (MU ID 50) – fault active
F76	Fuel pressure sensor, measuring range exceeded (MU ID 232) – fault active
F77	Fuel pressure sensor, measuring range undershot (MU ID 233) – fault active
F78	Fan type CAN <> Fan type MR EEPROM The fan type request sent to the FR is answered with an invalid value: • the configured fan data of the parameterized fan type are not flagged as valid in the data set, • or a fan system that requires two outputs is parameterized but only one output is activated, • or a fan system that requires one output is parameterized and two outputs are activated, • or an attempt has been made to parameterize a fan system but the output it requires is already assigned to another function, • or a non-defined fan system is to be parameterized.
F79	Fan speed = 0
F80	Fan driving speed > 600 rpm
F81	Fan speed control active
F82	Fan type 2 parameterized
F83	Fan type 8 parameterized
F84	Operating voltage > Impact pre-control battery voltage limit

Seq. no.	Fault condition/Fault clearing condition
F85	Pull-in performed
F86	Pull-in time < MV short circuit pull-in time (150 μs)
F87	Unit pump short circuit
F88	Double firing
F89	Angle of delivery and effective angle of delivery > 0.1 °
F90	Actuation by limp home computer
F91	Pull-up time <= Maximum pull-up time
F92	Pull-up time > Minimum pull-up time
F93	Impact time <= Minimum impact time
F94	Impact time > Maximum impact time
F95	Impact time <= Pull-up time + minimum delta for impact time
F96	Checksum error when reading EEPROM block
F97	Checksum error when reading EEPROM block copy
F98	EEPROM block 1 (WSP data), 2 (WSP key)
F99	EEPROM block 0 (standard parameters), 3 (individual cylinder basic adjustment values), 8 (fault memory), 9 (hand-held tester ID)
F100	EEPROM block 4 (vehicle parameter 2), 5 (operating parameter 1), 6 (vehicle parameter 1), 7 (operating parameter 2), 13 (vehicle parameter 3), 14 (operating parameter 3),17 (operating parameter 4), 18 (vehicle parameter 4)
F101	No fault in EEPROM block 0 (standard parameter)
F102	Engine speed =
F103	Engine speed > Starter demeshing speed
F104	Engine speed > conf. threshold
F105	Engine speed in conf. range
F106	Engine speed > Warning threshold
F107	Engine speed > Starter diagnosis limit
F108	Engine speed < Limit for unintentional starter actuation
F109	rpm gradient < rpm gradient threshold
F110	Turbocharger speed sensors =
F111	Turbocharger speed > conf. limit
F112	Turbocharger speed < conf. lower threshold
F113	Set torque > lower set torque threshold
F114	Set torque < upper set torque threshold (engine braking mode)
F115	Set torque > conf. torque threshold
F116	Missing message or faulty checksum in the communication between limp home processor and main processor
F117	Re-initialization of communication between limp home processor and main computer has failed
F118	KW sensor voltage < Limit
F119	KW-NW status not synchronized
F120	KW-NW status initialization
F121	KW-NW assignment defective: • System in KW limp home mode: camshaft cannot synchronize (additional tooth on NW is not recognized), but NW sensor is sending pulses -> after 36 NW pulses a flag is set. If this flag is present for the duration of the debounce period, the fault is logged. • System in NW limp home mode: crankshaft cannot synchronize (additional tooth on KW is not recognized), but KW sensor is sending pulses -> after 108 pulses a flag is set. If this flag is present for the duration of the debounce period, the fault is logged.

Seq. no.	Fault condition/Fault clearing condition
F122	KW timeout: a new KW event does not occur within the expectation window. The expectation window is generated dynamically from the last valid interpulse period. For this, the camshaft system must be synchronized and calculate a rotational speed greater than 400 rpm.
F123	NW timeout: a new NW event does not occur within the expectation window. The expectation window is generated dynamically from the last valid interpulse period. For this, the camshaft system must be synchronized and calculate a rotational speed greater than 400 rpm.
F124	KW has wrong pole connection: detection of sensor with wrong pole connection if the enable condition for activation and for the duration of the test is met.
F125	Camshaft has wrong pole connection: detection of sensor with wrong pole connection if the enable condition for activation and for the duration of the test is met.
F126	AdBlue tank temperature < AdBlue tank temperature limit
F127	Ambient air temperature < Ambient air temperature limit
F128	(Charge air pressure – Ambient pressure) > Limit
F129	(T6 temp. – T engine) > conf. limit
F130	Integrator < minimum limit
F131	Integrator > maximum limit
F132	Fuel pressure > conf. max. limit
F133	Fuel pressure < conf. min. limit
F134	Charge air pressure deviation < minimum limit
F135	Charge air pressure deviation > maximum limit
F136	Oil pressure < conf. warning threshold
F137	Oil pressure < conf. pre-warning threshold
F138	Coolant temperature > conf. warning threshold
F139	Coolant temperature > conf. pre-warning threshold
F140	Temperature before catalyst > Warning threshold
F141	Temperature before catalyst > Warning buzzer threshold
F142	Voltage > Maximum value of nominal range
F143	Voltage < Minimum value of nominal range
F144	Fuel pressure > Min. plausibility limit
F145	Fuel pressure < Max. plausibility limit
F146	(T6 temp. – T engine) > Max. plausibility limit
F147	(T6 temp. – T engine) > Min. plausibility limit
F148	Catalyst temperature 1 < Temperature threshold
F149	Catalyst temperature 2 < Temperature threshold
F150	Accumulated time of temperature overshoot > Time limit
F151	Air temperature < conf. limit
F152	Diagnosis service routine, "Mannheim" function activated
F153	Diagnosis service routine, "Wörth" function mode 0x01 or 0x02 activated
F154	Catalyst temperature signals cannot be uniquely assigned to location
F155	Compressed air pressure too low
F156	Temperature in front of catalyst high enough
F157	Compressed air pressure too high
F158	Mean urea pressure at turning point > Upper fault limit
F159	Mean urea pressure at turning point > Lower fault limit
F160	Turning point was not detected during monitoring
F161	Current consumption of pump is continually too high
F162	Fault counter from EEPROM reaches configured maximum limit
F163	Current consumption < Lower fault limit

Seq. no.	**Fault condition/Fault clearing condition**
F164	Current consumption > Upper fault limit
F165	Mean consumption < Lower fault limit
F166	Mean consumption > Upper fault limit
F167	Not possible to generate urea pressure
F168	Urea tank fill level = Empty level
F169	Configurable cylinder number <> Cylinder number in accordance with HW identifier
F170	Starter level detection implausible
F171	Fault ranking 0
F172	Fault ranking 1
F173	MIL actuation (CAN-ID 1696) not equal to MIL request (CAN-ID 1631)
F174	Measurement > Permissible value
F175	Failed attempts > Minimum number
F176	Failed attempts < Maximum number
F177	Engine braking stage 2 requested
F178	Variable engine brake requested
F179	Turbobrake parameterized
F180	Diagnosis activated with engine off
F181	Diagnosis always activated
F182	Number of charge air pressure sensors = 1
F183	Mean value formulation completed
F184	Mean value formulation completed
F185	No general actuator fault
F186	No general actuator fault
F187	EGR parameterized for continually adjustable control
F188	EGR stepless PWM = EGR stepless PWM warm
F189	EGR stepless PWM warm > EGR stepless PWM Off
F190	Cyclic ground keying of EGR valve detected
F191	(HFL battery voltage off – HFL battery voltage on) < conf. limit
F192	Engine status ON
F193	No VTG limp home mode
F194	Turbobrake parameterized and activated
F195	Turbocharger braking mode parameterized and available
F196	Variable engine brake request from CAN or MR
F197	Active turbocharger braking mode
F198	VTG status steady-state
F199	Max. number of keys reached
F200	Key not yet programmed
F201	Permissible transponder code
F202	Transponder valid
F203	WSP is deactivated with X5
F204	WSP is deactivated with X3
F205	WSP active and FMR parameterized with WSP
F206	Number of challenges exceeded
F207	ID 594 received and FMR in two-wire mode
F208	Waiting time in single-wire mode after switch back > Limit
F209	MR in single-wire mode (¬ MR in two-wire mode)
F210	Fault counter for failed switch-back attempts > Limit

Seq. no.	Fault condition/Fault clearing condition
F211	Number of messages not received > Limit
F212	Waiting time for consistency test expired
F213	Starter actuation parameterized
F214	No starting lock via CAN
F215	Battery voltage > 10V
F216	Turbocharger braking mode active
F217	Turbocharger braking mode not s.n.a.
F218	VTG transient mode
F219	VTG EGR mode
F220	VTG closed/open-loop control
F221	Engine braking stage 1 request valid
F222	Engine braking stage 2 request valid
F223	Guide vane not requested
F224	Fuel pressure tolerance range < Max. tolerance range
F225	No drive control (ADR) active
F226	Charge air pressure plausible
F227	Ambient pressure > Ambient pressure threshold
F228	Fuel temperature > conf. temperature threshold
F229	Coolant temperature > conf. temperature threshold
F230	Charge air temperature torque regulation active
F231	Number of diagnostics line faults > conf. number
F232	Oil trap line break detected
F233	Diagnostics line level = Low
F234	Oil trap not actuated
F235	Starter not actuated
F236	Engine status not equal to start
F237	Heater flange not actuated
F238	Power-down control on
F239	Characteristic points, smoke limiting map (ID 5 or 223) and smoke limiting with EGR (ID 129 or 226) not equal
F240	Checksum error, map data set
F241	Underfill warning threshold reached
F242	Underfill pre-warning threshold reached
F243	Overfill warning threshold reached
F244	Lock time expired
F245	Cylinder-specific integrator value < Negative maximum controller restriction
F246	Cylinder-specific integrator value > Positive maximum controller restriction
F247	EZA adjustment time > conf. EZA timeout
F248	Incorrect hardware ID
F249	No extension of power-down via CAN
F250	EEPROM writing completed
F251	Oil level plausibility check finished
F252	Oil level measurement lock time expired
F253	Power-down of various users expired
F254	Heater flange protection expired
F255	Starter diagnosis level low
F256	Engine turning

Seq. no.	Fault condition/Fault clearing condition
F257	Starter type JE
F258	Starter on with engine turning
F259	Starter parallel branch locked
F260	Time since commencement of starting > rpm waiting time
F261	Starter actuated
F262	No starter short circuit
F263	Parallel branch locked
F264	No starter diagnosis level change
F265	Parallel branch not faulty
F266	Level detection circuit faulty
F267	Level detection plausible
F268	Battery voltage > Diagnostics limit
F269	Starter main branch transistor STA1 or STA2 failed
F270	Starter output stage has high resistance
F271	Starter main branch on
F272	Parameterization fault detected, is stored when parameterizing the control unit with a test device if: • the configured fan data of the parameterized fan type are not flagged as valid in the data set, • the configured oil pan data of the parameterized oil pan are not flagged as valid in the data set, • the parameterization of the proportioning valves does not corerespond to what is installed, or • an invalid unit pump class (>6 is set to 0) is parameterized, or • a fan system that requires two outputs is parameterized by only one output is activated, or • a fan system that requires one output is parameterized and two outputs are activated, or • an attempt has been made to parameterize a fan system but the output it requires is already assigned to another function, or • a non-defined fan system is to be parameterized.
F273	Map data set tampering detected
F274	High-tech heater flange parameterized
F275	Diagnosis phase 1 active
F276	Diagnosis signal debounce OK
F277	HFL diagnosis level = low
F278	Timeout diagnosis signal
F279	Diagnosis phase 2 active
F280	Diagnosis and debounce time expired
F281	No undervoltage
F282	Coolant temperature < Max. value for diagnosis
F283	Voltage excursion OK
F284	Enable phase
F285	HFL off
F286	Torque limitation active
F287	Oil temperature > Limit
F288	No atmospheric pressure sensor error
F289	No oil pressure sensor error
F290	Oil pressure > Max. pressure difference
F291	Tolerance range < conf. tolerance
F292	(Charge air pressure – atmospheric air pressure) outside the conf. range

Seq. no.	Fault condition/Fault clearing condition
F293	Engine speed < conf. threshold
F294	Set torque < conf. threshold
F295	(Charge air pressure – Atmospheric air pressure) > conf. error range
F296	At least one of the CAN messages received in the 20 ms scan cycle is absent
F297	Hardware version ID in EEPROM is not equal to "A" or "B"
F298	Hardware coding (voltage level) cannot be definitively read
F299	Hardware version: EEPROM = "MR2A" and hardware coding = "MR2B"
F300	Hardware version: EEPROM = "MR2B" and hardware coding = "MR2A"
F301	ASIC: EEPROM = "ASIC installed" and hardware coding = "ASIC not installed"
F302	ASIC: EEPROM = "ASIC not installed" and hardware coding = "ASIC installed"
F303	AGN ID set in data set
F304	"PullAway" function is activated via CAN or test and at the same time the power categories 0 and 14 are not exclusively enabled in the data set
F305	Catalyst temperature protection active in braking mode (-> Opening of exhaust brake valve)
F306	Fault log in data set enabled
F307	Tolerance range < Voltage delta
F308	Turbocharger speed input parameterized to generator rpm recording
F309	EGR protective function activated
F310	Generator pulse time > conf. limit
F311	Fan speed < conf. factor * Fan driving speed
F312	ID 0x08FF2DD3F not received from NOx sensor
F313	"NOx sensor short circuit" error message received
F314	"NOx sensor line break" error message received
F315	(MIL conversion ratio delta + 1) > MIL threshold
F316	(Torque limiter conversion ratio delta + 1) > Torque limiter threshold
F317	SCRT ID set in data set
F318	Metering valve on frame module parameterized
F319	T4 limit factor < 1
F320	Engine protection information for exhaust gas turbocharger T4 enabled
F321	T4 function activated (max. change of limit factor T4 > 0)
F322	k-factor equal to 3
F323	k-factor equal to -2
F324	Control deviation too high
F325	Timeout expired
F326	"Regeneration" function is activated and at the same time the power categories 0 and 13 are not exclusively enabled in the data set
F327	P_AdBlue sensor and throttle flap position sensor simultaneously parameterized on the MR
F328	Oxidation catalyst temperature 1 < Temperature threshold
F329	Oxidation catalyst temperature 2 < Temperature threshold
F330	Urea fill level sensor faulty
F331	Regeneration strategy controlled variable less than conf. limit
F332	NOx concentration filtered < Limit [over the entire recording period (10 events)]
F333	Pressure in front of particulate filter > Limit (± hysteresis)
F334	Pressure after particulate filter > Limit (± hysteresis)
F335	EEPROM flag set: F333 was detected during last power-down
F336	EEPROM flag set: F334 was detected during last power-down
F337	SCR-RM sensor bank 1 fault via HS-CAN

Seq. no.	Fault condition/Fault clearing condition
F338	SCR-RM sensor bank 2 fault via HS-CAN
F339	SCR-RM sensor bank 3 fault via HS-CAN
F340	Values for current/mean urea consumption are valid
F341	Fan type 10 parameterized
F342	Fan type 11 parameterized
F343	Fault identifier V09 parameterized
F344	"Faulty NOx sensor“ fault detected by fault identifier V09
F345	"Raised untreated NOx emissions" fault detected by fault identifier V09
F346	"Reduced AdBlue quality" fault detected by fault identifier V09
F347	"Insufficient metering" fault detected by fault identifier V09
F348	"Faulty SCR catalyst“ fault detected by fault identifier V09
F349	Interim bad event threshold 1 of NOx preliminary debounce
F350	Interim good event threshold 1 of NOx preliminary debounce
F351	Interim bad event threshold 2 of NOx preliminary debounce
F352	Interim good event threshold 2 of NOx preliminary debounce
F353	Fault identifier V09 finished
F354	K4 is freely debounced in corrective action
F355	Corrective action 6 active (FB map switchover without metering stop)
F356	"Defective NOx sensor" fault logged in FSP

Overview of monitoring conditions

Seq. no.	Monitoring condition
Ü1	AGN function activated
Ü2	Sensor connected to the MR
Ü3	Sensor connected to the SCR-RM
Ü4	Error-free communication with SCR-RM (high-speed CAN)
Ü5	SCR-RM not locked (diagnosis service routine "Mannheim" function) not active
Ü6	Compressed air assistance activated
Ü7	Sensor characteristic curve valid
Ü8	Sensor voltage < Maximum permissible voltage
Ü9	Sensor voltage > Minimum permissible voltage
Ü10	Battery voltage > Minimum permitted battery voltage
Ü11	Operating voltage > Impact pre-control battery voltage limit
Ü12	No undervoltage
Ü13	Battery voltage > 10V
Ü14	PVB high side switched on
Ü15	Metering PWM phase off
Ü16	Metering PWM short circuit to battery voltage test phase active
Ü17	Terminal 15 on
Ü18	Engine status ON
Ü19	Engine status ON LLR
Ü20	Engine status ON, ADR
Ü21	Set torque greater than torque threshold for long enough
Ü22	Sufficient number of loops have been run through for summation
Ü23	Engine speed > Engine speed threshold
Ü24	Air valve locked
Ü25	Air valve on
Ü26	Compressed air pressure enable issued
Ü27	Temperature in front of catalyst too low
Ü28	Turning point of accumulator characteristic curve detected
Ü29	Turning point was not detected during monitoring
Ü30	Current consumption of pump is continually too high
Ü31	Monitoring condition is enabled
Ü32	Urea pressure > Pump switch-off threshold
Ü33	Specified urea consumption > Limit
Ü34	It was not possible to generate urea pressure, pump power consumption was normal, urea pressure greater than limit for a major leak, monitoring condition is enabled and permitted
Ü35	Starter actuated
Ü36	Sensor installed and parameterized
Ü37	Coolant temperature sensor faulty
Ü38	Coolant temperature > Coolant temperature limit
Ü39	No turbocharger overpressure (wastegate jamming)
Ü40	Charge air pressure control integrator not conspicuous
Ü41	Charge air pressure control deviation not conspicuous
Ü42	Charge air pressure reached in braking mode
Ü43	Low-speed CAN parameterized
Ü44	Low-speed CAN first ID received
Ü45	Low-speed CAN ramp-up time expired

Seq. no.	**Monitoring condition**
Ü46	Low-speed CAN not switched off in power-down
Ü47	Oil level sensor not energized
Ü48	Transponder code not equal to 0xFF 0xFF 0xFF 0xFF 0xFF
Ü49	Transponder code could not be read in via terminal 50 MR
Ü50	Keycompare failed
Ü51	FMR has read in valid TPC
Ü52	WSP is not deactivated with X3 or X5
Ü53	WSP active and FMR parameterized with WSP
Ü54	Data received successfully via CAN
Ü55	TPC requested via CAN
Ü56	Diagnostic modules or EPLD could not be read out
Ü57	MV LowSide off
Ü58	Cylinder shows valve short
Ü59	MV bank1 actuation, low-side ground short (MU ID 298) – fault active
Ü60	MV bank2 actuation, low-side ground short (MU ID 299) – fault active
Ü61	HFL diagnosis level = High
Ü62	HFL diagnosis level debounced
Ü63	Coolant temperature < Coolant temperature limit
Ü64	Diagnosis time expired
Ü65	Diagnosis phase 2 active
Ü66	Hightech heater flange parameterized
Ü67	Heater flange SW parameterized
Ü68	Proportioning valve parameterized to HFL
Ü69	Specified fan speed <> Max. fan speed
Ü70	Specified fan speed > 600 rpm
Ü71	Lock time expired
Ü72	Charge air temperature > conf. limit
Ü73	Measurement not running (cool-off phase)
Ü74	Smooth-running controller status - steady-state
Ü75	No cylinder fault active
Ü76	(Adaptation rpm – rpm window) < rpm < (Adaptation rpm + rpm window)
Ü77	Set torque > conf. lower load limit
Ü78	EZA active
Ü79	Maximum power-down time expired
Ü80	Maintained function deactivated
Ü81	Control unit activated 3 times
Ü82	Cylinder number OK
Ü83	Error-free communication with limp home processor
Ü84	Engine speed < 1000 rpm
Ü85	Torque < 50%
Ü86	KW/NW polarity reversal detection activated
Ü87	Starter actuated
Ü88	No starter short circuit
Ü89	Parallel branch OK
Ü90	Main branch active
Ü91	PVB2 HS on
Ü92	PVB2 HS not high resistance

Seq. no.	**Monitoring condition**
Ü93	Fault not active
Ü94	Internal control unit fault, PVB2 high-side transistor has high resistance (MU ID 53) – fault active
Ü95	SCR catalyst temperature sensor - 1, measuring range undershot (MU ID 10) – fault active
Ü96	SCR catalyst temperature sensor - 1, measuring range exceeded (MU ID 11) – fault active
Ü97	SCR catalyst temperature sensor - 2, measuring range undershot (MU-ID 12) – fault active
Ü98	SCR catalyst temperature sensor - 2, measuring range exceeded (MU-ID 13) – fault active
Ü99	Internal fault, EEPROM rear error 1(MU ID 157) – fault active
Ü100	Internal fault, incorrect hardware ID (MU ID 158) – fault active
Ü101	CAN low speed, data implausible (MU ID 255) – fault active
Ü102	CAN low speed, no communication (MU ID 257) – fault active
Ü103	LLR active
Ü104	PV parameterized
Ü105	No electrical fault at PV
Ü106	No electrical fault at PVB
Ü107	MR2-B hardware (¬ hardware MR2-A)
Ü108	Metering pulse duty factor > 0
Ü109	Sensor voltage > Lower plausibility limit
Ü110	Sensor voltage < Upper plausibility limit
Ü111	Waiting time after switch-on of air valve has expired
Ü112	Vehicle speed < conf. value
Ü113	Vehicle speed not equal to s.n.a.
Ü114	Engine speed < conf. value
Ü115	Fan request via CAN 100%
Ü116	Fan timeout (MU ID228) detected or debounce is running
Ü117	Fan type 2 or 8 parameterized
Ü118	No CAN error
Ü119	No fan parameterization error
Ü120	NOx sensor, no communication "not active"
Ü121	1st ID 0x08FF2DD3F received from sensor or ramp-up time expired
Ü122	Atmospheric pressure sensor faulty
Ü123	Atmospheric pressure > Atmospheric pressure limit
Ü124	Ambient temperature sensor faulty
Ü125	Ambient temperature in valid range
Ü126	Enable issued for evaluation
Ü127	Exhaust gas temperature T4 sensor fault
Ü128	T4 function activated (max. change of T4 limit factor > 0)
Ü129	PV7switched off for at least 200us with 0% pulse duty factor
Ü130	PV7switched on for at least 200us with 100% pulse duty factor
Ü131	Controller in control mode
Ü132	Timeout expired
Ü133	Reference search routine successful
Ü134	Input assigned differently
Ü135	(AdBlue tank temperature > Threshold and no substitute value and AdBlue temperature > Threshold and no substitute value) or (AdBlue tank temperature > Threshold and no substitute value and AdBlue temperature substitute value) or (AdBlue temperature > Threshold and no substitute value and AdBlue tank temperature substitute value)
Ü136	Ambient enable for urea pump issued
Ü137	"Pressure duct clogged" fault is not active

Seq. no.	Monitoring condition
Ü138	Air valve open time has expired and urea pressure when air valve was open was too low
Ü139	Air valve is open and enable for compressed air pressure is issued
Ü140	Monitoring for "pressure duct clogged" is deactivated and AdBlue pressure reduction time has expired and AdBlue pressure is below the lower threshold and AdBlue pressure was greater than the upper threshold when the air valve was open
Ü141	Monitoring for "diffusor clogged" is deactivated and AdBlue pressure reduction time has expired and AdBlue pressure is greater than the lower threshold and AdBlue pressure was greater than the upper threshold when the air valve was open
Ü142	AdBlue pressure reduction time has expired and AdBlue pressure is greater than lower threshold and AdBlue pressure was high enough when the air valve was open and clogging was confirmed (fault)
Ü143	AdBlue pressure reduction time has expired and AdBlue pressure is less than the lower threshold and AdBlue pressure was high enough when the air valve was open and "diffusor clogged" fault is not active and clogging is confirmed (fault)
Ü144	Oxidation catalyst temperature sensor - 1, measuring range undershot (MU ID 329) – fault active
Ü145	Oxidation catalyst temperature sensor - 1, measuring range exceeded (MU ID 330) – fault active
Ü146	Oxidation catalyst temperature sensor - 2, measuring range undershot (MU ID 331) – fault active
Ü147	Oxidation catalyst temperature sensor - 2, measuring range exceeded (MU ID 332) – fault active
Ü148	Pressure before DPF, pressure after DPF, ambient air pressure, temperature after oxidation cat., temperature before SCR cat., charge air pressure and charge air temperature available
Ü149	Exhaust gas mass flow rate greater than conf. limit
Ü150	Preliminary debounce time expired
Ü151	k-factor > conf. limit
Ü152	k-factor < conf. limit
Ü153	k-factor status equal to -2
Ü154	k-factor status equal to 3
Ü155	Set engine torque > conf. threshold
Ü156	No catalyst temperature sensor fault^{-1}
Ü157	[Status of NOx auto. plaus. check: NOx sensor value monitoring] and [engine status on] and [set torque >= enable threshold] and [values for limit check available] and {NOx target emissions >= enable threshold] and [number of monitoring events = 10]
Ü158	Engine status STOP
Ü159	Engine status was already ON or START in the same drive cycle
Ü160	Delay counter for DPF plausibility check has expired
Ü161	Pressure sensor in front of particulate filter, measuring range undershot (MU ID 333) – fault active
Ü162	Pressure sensor in front of particulate filter, measuring range exceeded (MU ID 334) – fault active
Ü163	Pressure sensor after particulate filter, measuring range undershot (MU ID 335) – fault active
Ü164	Pressure sensor after particulate filter, measuring range exceeded (MU ID 336) – fault active
Ü165	Engine speed =
Ü166	MU debounce in power-down completed
Ü167	PV5 On
Ü168	No HS-CAN error, 1st IDs 0xCFF233d and 0x14FF273d received, SW version for SCR-RM > 0x05
Ü169	Monitoring enable issued
Ü170	Fan type 10 or 11 parameterized
Ü171	Fault identifier V09 parameterized
Ü172	Interim bad event threshold 1 of NOx preliminary debounce
Ü173	Interim good event threshold 1 of NOx preliminary debounce
Ü174	Interim bad event threshold 2 of NOx preliminary debounce
Ü175	Interim good event threshold 2 of NOx preliminary debounce

Ü176	Fault in fault identifier V09 not equal to 31 and 0 (all possible faults and no possible faults)

Overview of parameter configurations

Seq. no.	**Parameter configuration**
P1	AGN function activated
P2	Sensor connected to the MR
P3	Sensor connected to the SCR-RM
P4	Correct communication with SCR-RM (high-speed CAN)
P5	SCR-RM not locked ("Mannheim" function diagnosis service routine) not active
P6	Compressed air assistance activated
P7	Sensor characteristic curve valid
P8	Line heater parameterized
P9	Proportioning valve parameterized
P10	Function activated
P11	PV5 or PV6 or PV7 or PV8 parameterized
P12	EGR parameterized to PVB2
P13	MR2-B hardware (¬ hardware MR2-A)
P14	Compressed air shut-off valve parameterized
P15	Fan type 2 or 8 parameterized
P16	CAN parameterized
P17	No fan parameterization error
P18	NOx function activated
P19	Metering valve on frame module parameterized
P20	T4 sensor parameterized
P21	T4 function activated (max. change of T4 limit factor > 0)
P22	Throttle flap direction parameterized to PV5
P23	Throttle flap parameterized to PV7
P24	Input assigned differently
P25	Diffusor heater parameterized
P26	Air supply monitoring malfunction is activated
P27	Monitoring of clogged diffusor is activated
P28	Air valve control is activated
P29	Monitoring of clogged pressure duct is activated
P30	SCRT function activated
P31	Fault differentiation activated
P32	"k-factor too high" monitoring is activated
P33	"k-factor too low" monitoring is activated
P34	SCRT function with throttle flap is activated
P35	Throttle flap is parameterized
P36	Fan type 10 or 11 parameterized
P37	Fault identifier V09 parameterized

Overview of scan cycles

Seq. no.	Scan cycle	Seq. no.	Scan cycle
T1	10 ms	T7	Variable (40/80/120/... /200) ms
T2	20 ms	T8	Event controlled
T3	40 ms	T9	Fault: event controlled, fault-free operation: 20 ms
T4	100 ms	T10	For control unit ramp-up
T5	200 ms	T11	Speed-dependent
T6	1000 ms	T12	Idle task

Overview of debounce time

Seq. no.	Debounce time	Seq. no.	Debounce time
E1	Configurable time	E14	15 s
E2	300 us	E15	In the case of parameterized functions with ground keying: 1 s; otherwise: 0.1 s
E3	0.2 s	E16	Configurable number of events
E4	0.3 s	E17	3 events
E5	0.4 s	E18	5 events
E6	0.6 s	E19	3 events in succession
E7	0.8 s	E20	5 events in succession
E8	1 s	E21	10 events
E9	1.2 s	E22	10 events (switch-back attempts) 10s per attempt
E10	2 s	E23	15 messages at 10 ms each message
E11	3 s	E24	Initialization: 3 events in succession; operation: 5 events
E12	5 s	E25	After 3 activation cycles in succession (18 s)
E13	10 s	E26	After 3 control unit activation cycles

Causes of faults/pin assignments

MR2A: 55-pin multiple plug (engine connector)

Pin no.	Assignment or name	Abbre-viation	In, out	MU ID	Description	Cause
0	Oil trap/heater flange diagnosis signal	OAB_S	I	90 91	Oil trap faulty, ground short Oil trap diagnosis	Oil trap line break Oil trap ground short
1_X	Camshaft sensor (-)	NW_B	I	173 172 171	NW signal timeout NW signal line break NW sensor wrong pole connected	Sensors faulty or loose, malfunctioning sensor signals Faulty cable (cable break), faulty sensor Connecting lines have wrong pole connection
2_X	Crankshaft sensor (-)	KW_B	I	167 170 168 166	KW signal timeout KW signal line break KW sensor has wrong pole connection, KW/ NW assignment implausible	Sensors faulty or loose, malfunctioning sensor signals Faulty cable (cable break), faulty sensor Connecting lines have wrong pole connection Sensors (KW and/or NW) faulty, mark holes wrong or dirty, malfunctioning sensor signals
3_X	Coolant temp. sensor feedback	TMOT_B	I	175 176	T-ENG sensor MAX T-ENG sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
4_X	Fuel temp. sensor feedback	TFUEL_B	I	205 206	T-FUEL sensor MAX T-FUEL sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
5_X	Passive oil pressure sensor / turbocharger speed sensor/ fan speed sensor feedback	POEL_M	I	200 201 265 281 282 228 275 276	P-OIL sensor MAX P-OIL sensor MIN No turbocharger speed 1 Turbocharger speed sensor MAX Turbocharger speed sensor MIN No fan speed T-CHARGE2 sensor MAX T-CHARGE2 sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable, faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable, faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (short circuit), faulty sensor
6_X	Active oil pressure sensor supply	POELAKT_P	O	200 201 199	P-OIL sensor MAX P-OIL sensor MIN P-OIL implausible	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break
7_X	Charge air pressure sensor supply	P2_P	I	211 212 213	P-CHARGE sensor MAX P-CHARGE sensor MIN P-CHARGE implausible	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break
8	NC					

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbre-viation	In, out	MU ID	Description	Cause
9	Unit pump bank 2 feed-back (B-D-F-H)	MVB2	O	OM904: 237,239 292,294 299 OM906: 238,239,240 293,294,295 299 OM501: 238,239,240 293,294,295 299 OM502: 236,238,239,240 291,293,294,295 299	Faulty actuation Short circuit Faulty actuation Short circuit Faulty actuation Short circuit Faulty actuation Short circuit	Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short)
10_X	Active oil pres-sure sensor/ Combined oil sensor feed-back	POELAKT_M	I	200 201 199 75 76	P-OIL sensor MAX P-OIL sensor MIN P-OIL implausible T-OIL sensor MAX T-OIL sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
11	Proportioning valve ground	PV_M	O	90	Oil trap faulty	Faulty cable (cable break)
12	Proportioning valve bank 1 (PV 1...4) sup-ply	PVB_P	O	178 179 248 252 227 231	Short to battery volt-age (+cable) Ground short (+ca-ble) Line break, PV1 Line break, PV2 Line break, PV3 Line break, PV4	Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (ground short), faulty solenoid valve Faulty cable (cable break) Faulty cable (cable break) Faulty cable (cable break) Faulty cable (cable break)
13_X	Combined in-put (fuel pres-sure/ accelerator/ T6 temp. sen-sor (T-EGR sensor)) sup-ply	PDK_P	I	232 233 234 277 278	P-FUEL sensor MAX P-FUEL sensor MIN P-FUEL sensor impl. T-T6 sensor MAX (T-EGR sensor) T-T6 sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
14_X	Fan speed sensor supply	P23_P	O	228	No fan speed	Faulty cable (cable break), faulty sensor
15_X	Oil tempera-ture sensor feedback	TOEL_B	I	75 76	T-OIL sensor MAX T-OIL sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbre-viation	In, out	MU ID	Description	Cause
16	Unit pump bank 1 feed-back (A-C-E-G)	MVB1	O	OM904: 235,236 290,291 298 OM906: 235,236,237 290,291,292 298 OM501: 235,236,237 290,291,292 298 OM502: 235,237,241,242 290,292,296,297 298	Faulty actuation Short circuit Faulty actuation Short circuit Faulty actuation Short circuit Faulty actuation Short circuit	Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short)
17X	Fan speed sensor signal	NLUE_S	I	228	No fan speed	Faulty cable, faulty sensor
18	Starter actua-tion, high-side	ANLA	O	184 185 186	Starter short to bat-tery voltage Starter short circuit Starter interruption	Faulty cable (short to battery voltage) Faulty cable (ground short) Faulty cable (cable break)
19X	Crankshaft sensor (+)	KW_A	I	169 167 170 168 166	KW signal ground short KW signal timeout KW signal line break KW sensor has wrong pole connection KW/NW assignment impl.	Faulty cable (ground short), faulty sensor Faulty sensor, sensor loose, malfunctioning sensor signals Faulty cable (cable break), faulty sensor Connecting lines have wrong pole connect-ed, sensors (KW and/or NW) faulty, mark holes wrong or dirty, malfunctioning sensor signals
20X	Camshaft sen-sor (+)	NW_A	I	174 173 172 171	NW signal ground short NW signal timeout NW signal line break NW sensor has wrong pole connection	Faulty cable (ground short), faulty sensor Faulty sensor, sensor loose, malfunctioning sensor signals Faulty cable (cable break), faulty sensor Connecting lines have wrong pole connec-tion
21X	Charge air temperature sensor feed-back	T2_B	I	207 208	T-CHARGE sensor MAX T-CHARGE sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor

22_X	Combined input (fuel pressure/ accelerator/ T6 temp. sensor (T-EGR sensor)) feedback	PDK_M	I	232 233 234 277 278	P-FUEL sensor MAX P-FUEL sensor MIN P-FUEL sensor impl. T-T6 sensor MAX (T-EGR sensor) T-T6 sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbre-viation	In, out	MU ID	Description	Cause
23_X	Charge air pressure sensor feedback	P2_M	I	211 212 213	P-CHARGE sensor MAX P-CHARGE sensor MIN P-CHARGE implausible	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor
24_X	Turbocharger speed sensor signal	NTL1_S	I	265 281 282 283	No turbocharger speed 1 Turbocharger speed sensor MAX Turbocharger speed sensor MIN Generator speed timeout	Faulty cable, faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (cable break), faulty sensor
25	Engine service switch – start	MSST_S	I	-		Status can be checked via free-running
26_X	Passive oil/ charge air pressure 2 sensor signal	POEL_S	I	200 201 275 276	P-OIL sensor MAX P-OIL sensor MIN T-CHARGE2 sensor MAX T-CHARGE2 sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (short circuit), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (short circuit), faulty sensor
27	Proportioning valve 5, high-side actuation	PV5	O	253 254	Short to battery voltage (+cable) Ground short (+cable)	Faulty cable (short to battery voltage) Faulty cable (ground short), faulty solenoid valve
28_X	Combined input (fuel pressure/ accelerator/T6 temp. sensor (T-EGR sensor)) signal	PDK_S	I	232 233 234 277 278	P-FUEL sensor MAX P-FUEL sensor MIN P-FUEL sensor impl. T-T6 sensor MAX (T-EGR sensor) T-T6 sensor MIN (T-EGR sensor)	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
29_X	Charge air pressure sensor signal	P2_S	I	211 212 213	P-CHARGE sensor MAX P-CHARGE sensor MIN P-CHARGE implausible	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor
30	Engine service switch supply	MSS_P	I	-	-	Status can be checked via free-running
31	NC					
32_X	Active oil pressure sensor signal	POELAKT_S	I	200 201 199	P-OIL sensor MAX P-OIL sensor MIN P-OIL implausible	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor
33_X	Oil level sensor input	HOEL_S	I	95 96 97	Oil level sensor MIN Oil level sensor MAX Oil level cable break	Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (cable break), faulty sensor
34_X	Coolant temp. sensor signal	TMOT_A	I	175 176	T-ENG sensor MAX T-ENG sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
35	Engine service switch - stop	MSSP_S	I	-		Status can be checked via free-running
36_X	Fuel temp. sensor signal	TFUEL_A	I	205 206	T-FUEL sensor MAX T-FUEL sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbre-viation	In, out	MU ID	Description	Cause
37	Unit pump solenoid valve H (bank 2)	MVH	O	OM 502: 295 240 220 301	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short), Faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)
38	Unit pump solenoid valve F (bank 2)	MVF	O	OM502/ 502: 295,293 240,238 220,218 301	Short circuit Faulty actuation No impact Short circuit	Faulty cable(ground short), faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)
39_X	Oil temperature sensor signal	TOEL_A	I	75 76	T-OIL sensor MAX T-OIL sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
40	Proportioning valve 6 low-side actuation	PV6	O	223 224 249	Ground short, PV6 Line break, PV6 Short to battery voltage, PV6	Faulty cable (ground short), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve
41	Proportioning valve 3 low-side actuation	PV3	O	225 226 227	Ground short, PV3 Short to battery voltage, PV3 Line break, PV3	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve
42	Proportioning valve bank 2 ($PV2_1$, PV 6) supply	PV6_P	O	180 181 224 250_1	Short to battery voltage (+cable) Ground short (+cable) Line break, PV6 Ground short, PV2	Faulty cable (short to battery voltage) Faulty cable (ground short), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve Faulty cable (PV2 cable break), faulty solenoid valve
43	Proportioning valve 4 low-side actuation	PV4	O	229 230 231	Ground short, PV4 Short to battery voltage, PV4 Line break, PV4	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve

44	Unit pump solenoid valve ID (bank 2)	MVD	O	<u>OM 904/906/501/502:</u> 293, 295, 294, 291 238, 240, 239, 236 218, 220, 219, 216, 301	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short), faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)

X: Sensor on engine
Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbre-viation	In, out	MU ID	Description	Cause
45	Unit pump solenoid valve B (bank 2)	MVB	O	OM 904/906/501/502: 292, 294, 293, 291 237, 239, 238, 236 217, 219, 218, 216, 301	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short), faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)
46	Unit pump solenoid valve G (bank 1)	MVG	O	OM 502: 292 237 217 300	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short), faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)
47	Unit pump solenoid valve E (bank 1)	MVE	O	OM 906/501/502: 291, 292, 297 236, 237, 242 216, 217, 222 300	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short), faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)
48_X	Charge air temp. sensor signal	T2_A	I	207 208	T-CHARGE sensor MAX T-CHARGE sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
49_X	Oil level sensor feedback	HOEL_M	I	95 96 97	Oil level sensor MIN Oil level sensor MAX Oil level cable break	Faulty sensor, short circuit to ground Faulty sensor, faulty cable, cable break Faulty sensor
50	Proportioning valve 2 low-side actuation	PV2	O	250 251 252	Ground short, PV2 Short to battery voltage, PV2 Line break, PV2	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve
51	Proportioning valve 1 low-side actuation	PV1	O	146 147 148	Ground short, PV1 Short to battery voltage, PV1 Line break, PV1	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve
52	Proportioning valve bank 1 (here PV2) supply	PVB_P	O	178 179 252_2)	Short to battery voltage (+cable) Ground short (+cable) Line break, PV2	Faulty cable (short to battery voltage) Faulty cable (ground short), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbre-viation	In, out	MU ID	Description	Cause
53	Unit pump solenoid valve C (bank 1)	MVC	O	OM 904/906/501/502: 291, 292, 291, 296 236, 237, 236, 241 216, 217, 216, 221 300	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short), faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)
54	Unit pump solenoid valve A (bank 1)	MVA	O	OM 904/906/501/502: 290, 290, 290, 290 235, 235, 235, 235 215, 215, 215, 215 300	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short), faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)

1: Only with EGR (Wahler valve) at PV2

2: Only with EGR not at PV2

X: Sensor on engine

Y: Sensor on vehicle/frame

MR2A: 16-pin multiple plug (vehicle connector)

Pin no.	Assignment or name	Abbrevi-ation	In, out	MU ID	Description	Cause
1	CAN interface (high line)	CAN-H	I/O	257, 259	CAN-HIGH line faulty	Faulty cable (cable break) Faulty cable (ground short) Faulty cable (short to battery voltage)
2	CAN interface (low line)	CAN-L	I/O	257, 258	CAN-LOW line faulty	Faulty cable (cable break) Faulty cable (ground short) Faulty cable (short to battery voltage)
3	CAN - HF ground	HF-GND		-	-	-
4	CAN - HF ground	HF-GND		-	-	-
5	Battery voltage (battery positive, battery voltage)	KL30	I	110 111	Overvoltage Undervoltage	Generator or battery faulty Generator or battery faulty
6	Battery voltage (battery positive, battery voltage)	KL30	I	110 111	Overvoltage Undervoltage	Generator or battery faulty Generator or battery faulty
7	NC	-	-	-	-	-
8	Start actuation signal	KL50	I	210 261	Terminal 50 inconsistent No transponder code received via terminal 50	Faulty cable (cable break) Faulty cable (cable break), faulty transponder electronics
9	Ground (battery negative)	KL31		-	-	-
10	Proportioning valve bank 1 (PV1, 3, 4) supply $_1$	PVB_P	O	178 179 227 231 248	Short to battery voltage (+cable) Ground short (+cable) Line break, PV3 Line break, PV4 Line break, PV1	Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (ground short), faulty solenoid valve Faulty cable (cable break) Faulty cable (cable break) Faulty cable (cable break)
11	Ground (battery negative)	KL31		-	-	-
12	Starter actuation, high-side $_1$	ANLA	O	184 185 186	Starter short to battery voltage Starter short circuit Starter interruption	Faulty cable (short to battery voltage) Faulty cable (ground short) Faulty cable (cable break)
13	Diagnostics K-line (ISO)	DIAG-K	I/O	-	-	-
14	Proportioning valve 3, low-side actuation $_1$	PV3	O	225 226 227	Ground short, PV3 Short to battery voltage, PV3 Line break, PV3	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve
15	Battery voltage switched (ignition)	KL15	I	209	Terminal 15 inconsistent	Faulty cable (cable break), faulty fuse

16	Proportioning valve 4, low-side actuation[1]	PV4	O	229	Ground short, PV4	Faulty cable (ground short), faulty solenoid valve
				230	Short to battery voltage, PV4	Faulty cable (short to battery voltage), faulty solenoid valve
				231	Line break, PV4	Faulty cable (cable break), faulty solenoid valve

1: Signal also on engine connector

MR2B: 55-pin multiple plug (engine connector)

Pin no.	Assignment or name	Abbreviation	In, out	MU ID	Description	Cause
0	Oil trap/heater flange diagnosis signal	OAB_S	I	90 91	Oil trap faulty Ground short, oil trap diagnosis	Oil trap line break Oil trap ground short
1X	Camshaft sensor (-)	NW_B	I	173 172 171	NW signal timeout NW signal line break NW sensor has wrong pole connection	Sensors faulty or loose, malfunctioning sensor signals Faulty cable (cable break), faulty sensor Connecting lines have wrong pole connection
2X	Crankshaft sensor (-)	KW_B	I	167 170 168 166	KW signal timeout KW signal line break KW sensor has wrong pole connection KW/NW assignment impl.	Sensors faulty or loose, malfunctioning sensor signals Faulty cable (cable break), faulty sensor Connecting lines have wrong pole connection Sensors (KW and/or NW) faulty, mark holes wrong or dirty, malfunctioning sensor signals
3X	Coolant temperature sensor/ Fuel temperature sensor/ AdBlue temp. sensor feedback	TMOT_B	I	175 176 205 206 3 2	T-ENG sensor MAX T-ENG sensor MIN T-FUEL sensor MAX T-FUEL sensor MIN T-AdBlue sensor MAX T-AdBlue sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
4X	Intake air temp. sensor signal	TLUFT_S	I	17 16	T-AIR sensor MAX T-AIR sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
5X	Passive oil pressure sensor/ Turbocharger speed sensor/ Fan speed sensor feedback	POEL_M	I	200 201 265 281 282 228 275 276	P-OIL sensor MAX P-OIL sensor MIN No turbocharger speed 1 Turbocharger speed sensor MAX Turbocharger speed sensor MIN No fan speed T-CHARGE2 sensor MAX T-CHARGE2 sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable, faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable, faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (short circuit), faulty sensor

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbrevi-ation	In, out	MU ID	Description	Cause
6_X	Active oil pressure sensor supply	POELAKT_P	O	200 201 199	P-OIL sensor MAX P-OIL sensor MIN P-OIL implausible	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break
7_X	Charge air pressure sensor/ Fan speed sensor supply	P2_P	I	211 212 213 228	P-CHARGE sensor MAX P-CHARGE sensor MIN P-CHARGE implausible No fan speed	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break Faulty cable (cable break), faulty sensor
8_X	AdBlue temperature sensor signal	THWL_S	I	3 2	T-AdBlue sensor MAX T-AdBlue sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
9	Unit pump bank 2 feedback (B-D-F-H)	MVB2	O	OM904: 237, 239 292, 294, 299 OM906: 238, 239, 240 293, 294, 295, 299 OM501: 238, 239, 240 293, 294, 295 299 OM502: 236, 238, 239, 240 291, 293, 294, 295, 299	 Faulty actuation Short circuit Faulty actuation Short circuit Faulty actuation Short circuit Faulty actuation Short circuit	 Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short, faulty cable (ground short)

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbreviation	In, out	MU ID	Description	Cause
10_X	Active oil pressure sensor/ Combined oil sensor/ Oil level sensor/ Oil temperature sensor/Feedback	POELAK T_M	I	200 201 199 75 76 95 96 97	P-OIL sensor MAX P-OIL sensor MIN P-OIL implausible T-OIL sensor MAX T-OIL sensor MIN Oil level sensor MIN Oil level sensor MAX Oil level cable break	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (cable break), faulty sensor
11	Proportioning valve ground	PV_M	O	90	Oil trap faulty	Faulty cable (cable break)
12	Proportioning valve bank 1 (PV 1...4) supply	PVB_P	O	178 179 248 252_2 227 231	Short to battery voltage (+cable) Ground short (+cable) Line break, PV1 Line break, PV2 Line break, PV3 Line break, PV4	Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (ground short), faulty solenoid valve Faulty cable (cable break) Faulty cable (cable break) Faulty cable (cable break) Faulty cable (cable break)
13_X	Combined input (fuel pressure/accelerator/ T6 temp. sensor (T EGR sensor)) supply	PDK_P	I	232 233 234 277 278	P-FUEL sensor MAX P-FUEL sensor MIN P-FUEL sensor impl. T-T6 sensor MAX (T-EGR sensor) T-T6 sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
14_Y	AdBlue pressure sensor/Air humidity sensor/Compressed air pressure sensor supply	PHWL_P	O	1 0 21 15 14 5 4 22	P-AdBlue sensor MAX P-AdBlue sensor MIN P-AdBlue implausible H-AIR sensor MAX H-AIR sensor MIN P-COMPAIR sensor MAX P-COMPAIR sensor MIN P-COMPAIR implausible	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbreviation	In, out	MU ID	Description	Cause
15Y	Air humidity sensor signal	HLUFT_S	I	15 14	H-AIR sensor MAX H-AIR sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
16	Feedback, unit pump bank 1 (A-C-E-G)	MVB1	O	OM904: 235, 236 290, 291 298 OM906: 235, 236, 237 290, 291, 292 298 OM501: 235, 236, 237 290, 291, 292 298 OM502: 235, 237, 241, 242 290, 292, 296, 297 298	Faulty actuation Short circuit Faulty actuation Short circuit Faulty actuation Short circuit Faulty actuation Short circuit	Faulty cable (cable break), faulty SG, faulty unit pump Valve short Faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short Faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short Faulty cable (ground short) Faulty cable (cable break), faulty SG, faulty unit pump Valve short Faulty cable (ground short)
17X	Fan speed sensor signal	NLUE_S	I	228	No fan speed	Faulty cable, faulty sensor
18	Starter actuation, high-side	ANLA	O	184 185 186	Starter short to battery voltage Starter short circuit Starter interruption	Faulty cable (short to battery voltage) Faulty cable (ground short) Faulty cable (cable break)
19X	Crankshaft sensor (+)	KW_A	I	169 167 170 168 166	KW signal ground short KW signal timeout KW signal line break KW sensor has wrong pole connection KW/NW assignment impl.	Faulty cable (ground short), faulty sensor Faulty sensor, sensor loose, malfunctioning sensor signals Faulty cable (cable break), faulty sensor Connecting lines have wrong pole connection Sensors (KW and/or NW) faulty, mark holes wrong or dirty, malfunctioning sensor signals
20X	Camshaft sensor (+)	NW_A	I	174 173 172 171	NW signal ground short NW signal timeout NW signal line break NW sensor has wrong pole connection	Faulty cable (ground short), faulty sensor Faulty sensor, sensor loose, malfunctioning sensor signals Faulty cable (cable break), faulty sensor Connecting lines have wrong pole connection

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbreviation	In, out	MU ID	Description	Cause
21_X	Charge air temperature sensor/ Charge air pressure sensor feedback	T2_B	I	207	T-CHARGE sensor MAX	Faulty cable (cable break), faulty sensor
				208	T-CHARGE sensor MIN	Faulty cable (ground short), faulty sensor
				211	P-CHARGE sensor MAX	Faulty cable (cable break), faulty sensor
				212	P-CHARGE sensor MIN	Faulty cable (ground short), faulty sensor
				213	P-CHARGE implausible	Faulty cable (cable break), faulty sensor
22 Y/X	AdBlue pressure sensor/Air humidity/Air temperature sensor/ Compressed air pressure sensor Combined input (fuel pressure/ accelerator/ T6 temp. sensor (T-EGR sensor)) feedback	PDK_M	I	1	P-AdBlue sensor MAX	Faulty cable (cable break), faulty sensor
				0	P-AdBlue sensor MIN	Faulty cable (ground short), faulty sensor
				21	P-AdBlue implausible	Faulty sensor, cable break
				15	H-AIR sensor MAX	Faulty cable (cable break), faulty sensor
				14	H-AIR sensor MIN	Faulty cable (ground short), faulty sensor
				17	T-AIR sensor MAX	Faulty cable (cable break), faulty sensor
				16	T-AIR sensor MIN	Faulty cable (ground short), faulty sensor
				5	P-COMPAIR sensor MAX	Faulty cable (cable break), faulty sensor
				4	P-COMPAIR sensor MIN	Faulty cable (ground short), faulty sensor
				22	P-COMPAIR implausible	Faulty sensor, cable break
				232	P-FUEL sensor MAX	Faulty cable (cable break), faulty sensor
				233	P-FUEL sensor MIN	Faulty cable (ground short), faulty sensor
				234	P-FUEL sensor impl.	Faulty sensor, cable break
				277	T-T6 sensor MAX (T EGR sensor)	Faulty cable (cable break), faulty sensor
				278	T-T6 sensor MIN (T EGR sensor)	Faulty cable (ground short), faulty sensor
23_Y	Compressed air pressure signal	PCOMPAIR_S	I	5	P-COMPAIR sensor MAX	Faulty cable (cable break), faulty sensor
				4	P-COMPAIR sensor MIN	Faulty cable (ground short), faulty sensor
				22	P-COMPAIR implausible	Faulty sensor, cable break
24_X	Turbocharger speed sensor signal	NTL1_S	I	265	No turbocharger speed 1	Faulty cable, faulty sensor
				281	Turbocharger speed sensor MAX	Faulty cable (ground short), faulty sensor
				282	Turbocharger speed sensor MIN	Faulty cable (cable break), faulty sensor
				283	Generator speed timeout	Faulty cable (cable break), faulty sensor

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbrevi-ation	In, out	MU ID	Description	Cause
25	Engine service switch – start	MSST_S	I	-	-	Status can be checked via free-running
26_X	Passive oil pressure/charge air pressure 2 sensor signal	POEL_S	I	200 201 275 276	P-OIL sensor MAX P-OIL sensor MIN T-CHARGE2 sensor MAX T-CHARGE2 sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (short circuit), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (short circuit), faulty sensor
27	Proportioning valve 5 high-side actuation	PV5	O	253 254	Short to battery voltage (+cable) Ground short (+cable)	Faulty cable (short to battery voltage) Faulty cable (ground short), faulty solenoid valve
28_X	Combined input (fuel pressure/ accelerator/ T6 temp. sensor (T EGR sensor)) signal	PDK_S	I	232 233 234 277 278	P-FUEL sensor MAX P-FUEL sensor MIN P-FUEL sensor impl. T T6 sensor MAX (T EGR sensor) T T6 sensor MIN (T EGR sensor)	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
29_X	Charge air pressure sensor signal	P2_S	I	211 212 213	P-CHARGE sensor MAX P-CHARGE sensor MIN P-CHARGE implausible	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor
30	Engine service switch supply	MSS_P	I	-	-	Status can be checked via free-running
31_X	AdBlue pressure sensor signal	PHWL_S	I	1 0 21	P-AdBlue sensor MAX P-AdBlue sensor MIN P-AdBlue implausible	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty sensor, cable break
32_X	Active oil pressure sensor signal	POELAKT_S	I	200 201 199	P-OIL sensor MAX P-OIL sensor MIN P-OIL implausible	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor
33_X	Oil level sensor input	HOEL_S	I	95 96 97	Oil level sensor MIN Oil level sensor MAX Oil level cable break	Faulty cable (ground short), faulty sensor Faulty cable (cable break), faulty sensor Faulty cable (cable break), faulty sensor

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbreviation	In, out	MU ID	Description	Cause
34X	Coolant temp. sensor signal	TMOT_A	I	175 176	T-ENG sensor MAX T-ENG sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
35	Engine service switch stop	MSSP_S	I	-		Status can be checked via free-running
36X	Fuel temperature sensor signal	TFUEL_A	I	205 206	T-FUEL sensor MAX T-FUEL sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
37	Unit pump solenoid valve H (bank 2)	MVH	O	OM502: 295 240 220 301	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short) Faulty cable (cable break) Faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)
38	Unit pump solenoid valve F (bank 2)	MVF	O	OM501,502: 295, 293 240, 238 220, 218 301	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short) Faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)
39X	Oil temperature sensor signal	TOIL_A	I	75 76	T-OIL sensor MAX T-OIL sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
40	Proportioning valve 6 low-side actuation	PV6	O	223 224 249	Ground short, PV6 Line break, PV6 Short to battery voltage, PV6	Faulty cable (ground short), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve
41	Proportioning valve 3 low-side actuation	PV3	O	225 226 227	Ground short, PV3 Short to battery voltage, PV3 Line break, PV3	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve

X: Sensor on engine

Y: Sensor on vehicle/frame

Pin no.	Assignment or name	Abbreviation	In, out	MU ID	Description	Cause
42	Proportioning valve bank 2 ($PV2_1$, PV6...8) supply	PV6_P	O	52 51 224 46 49 44 250_1	Short to battery voltage (+cable) Ground short (+cable) Line break, PV6 Line break, PV7 Line break, PV8 PV8 component faulty, relevant for emissions Ground short, PV2	Faulty cable (short to battery voltage) Faulty cable (ground short), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve Cable break, faulty solenoid valve Faulty cable (PV2 cable break), faulty solenoid valve
43	Proportioning valve 4 low-side actuation	PV4	O	229 230 231	Ground short, PV4 Short to battery voltage, PV4 Line break, PV4	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve
44	Unit pump solenoid valve D (bank 2)	MVD	O	OM904/ 906/ 501/502: 293, 295, 294, 291 238, 240, 239, 236 218, 220, 219, 216 301	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short), faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)
45	Unit pump solenoid valve B (bank 2)	MVB	O	OM904/ 906/ 501/502: 292, 294, 293, 291 237, 239, 238, 236 217, 219, 218, 216 301	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short) Faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)
46	Unit pump solenoid valve G (bank 1)	MVG	O	OM502: 292 237 217 300	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short) Faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)

X: Sensor on engine
Y: Sensor on vehicle frame

47	Unit pump solenoid valve E (bank 1)	MVE	O	OM906/501/502: 291, 292, 297 236, 237, 242 216, 217, 222 300	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short) Faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)

Pin no.	Assignment or name	Abbreviation	In, out	MU ID	Description	Cause
48x	Charge air temp. sensor signal	T2_A	I	207 208	T-CHARGE sensor MAX T-CHARGE sensor MIN	Faulty cable (cable break), faulty sensor Faulty cable (ground short), faulty sensor
49	Proportioning valve 7 low-side actuation	PV7	O	45 47 46	Ground short, PV7 Short to battery voltage, PV7 Line break, PV7	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve
50	Proportioning valve 2 low-side actuation	PV2	O	250 251 252	Ground short, PV2 Short to battery voltage, PV2 Line break, PV2	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve
51	Proportioning valve 1 low-side actuation	PV1	O	146 147 148	Ground short, PV1 Short to battery voltage, PV1 Line break, PV1	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve
52	Proportioning valve 8 low-side actuation	PV8	O	48 50 49 44	Ground short, PV8 Short to battery voltage, PV8 Line break, PV8 PV8 component faulty, relevant for emissions	Faulty cable (ground short), faulty solenoid valve Faulty cable (short to battery voltage), faulty solenoid valve Faulty cable (cable break), faulty solenoid valve Ground short, short to battery voltage, cable break, faulty solenoid valve
53	Unit pump solenoid valve C (bank 1)	MVC	O	OM904/ 906/ 501/502: 291, 292, 291, 296 236, 237, 236, 241 216, 217, 216, 221 300	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short) Faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)

Y54	Unit pump solenoid valve A (bank 1)	MVA	O	OM904/ 906/ 501/502: 290, 290, 290, 290 235, 235, 235, 235 215, 215, 215, 215 300	Short circuit Faulty actuation No impact Short circuit	Faulty cable (ground short) Faulty cable (cable break), faulty unit pump, faulty SG Faulty unit pump, faulty SG Faulty cable (short to battery voltage)

1: Only with EGR (Wahler valve) at PV2
2: Only with EGR not at PV2
X: Sensor on engine
Y: Sensor on vehicle/frame

MR2B: 16-pin multiple plug (vehicle connector)

Pin no.	Assignment or name	Abbrevi-ation	In, out	MU ID	Description	Cause
1	CAN interface, low speed (high line)	CAN-H	I/O	257 259	CAN-HIGH line faulty	Faulty cable (cable break) Faulty cable (ground short) Faulty cable (short to battery voltage)
2	CAN interface, low speed (low line)	CAN-L	I/O	257 258		
3	CAN-HF ground, low speed	HF-GND		-	-	-
4	CAN-HF ground, low speed	HF-GND		-	-	-
5	Battery voltage (battery positive, battery voltage)	KL30	I	110 111	Overvoltage Undervoltage	Generator or battery faulty Generator or battery faulty
6	Battery voltage (battery positive, battery voltage)	KL30	I	110 111	Overvoltage Undervoltage	Generator or battery faulty Generator or battery faulty
7	CAN interface, high speed (high line)		I/O	54	CAN high speed, no communication	Faulty cable (cable break) Faulty cable (ground short) Faulty cable (short to battery voltage)
8	Start actuation signal	KL50	I	210 261	Terminal 50 inconsistent No transponder code received via terminal 50	Faulty cable (cable break) Faulty cable (cable break), faulty transponder electronics
9	Ground (battery negative)	KL31		-	-	-
10	CAN interface, high speed (low line)		I/O		CAN high speed, no communication	Faulty cable (cable break) Faulty cable (ground short) Faulty cable (short to battery voltage)
11	Ground (battery negative)	KL31		-	-	-
12	Starter actuation, high-side	ANLA	O	184 185 186	Starter short to battery voltage Starter short circuit Starter interruption	Faulty cable (short to battery voltage) Faulty cable (ground short) Faulty cable (cable break)
13	Diagnostics K–line (ISO)	DIAG-K		-	-	-
14	CAN-HF ground, high speed	HF-GND		-	-	-
15	Battery voltage, switched (ignition)	KL15	I	209	Terminal 15 inconsistent	Faulty cable (cable break), faulty fuse
16	CAN-HF ground, high speed	HF-GND		-	-	-

OBD system

Monitored components/systems and fault codes

For the fault codes of the monitored components, please see the tables on Page 128 and Page 138.

Storing the fault codes

A provisional fault code is stored the first time that an emissions-related fault occurs. The fault code is normally output via ISO 15031 MODE $03 if the provisional fault has been confirmed for x successive drive cycles.

The fault code is automatically deleted if the fault does not occur for at least 40 "warm-up cycles" or 200 operating hours.

Cumulative fault memory

Faults that cannot be deleted in accordance with §3.9.2 2006/51/EC are grouped together in a cumulative fault. A cumulative fault consists of an MI time counter and fault code details. At present, a distinction is made between 8 cumulative faults, according to the cause of the fault.

If an individual fault that is assigned to a specific cumulative fault is confirmed, the corresponding fault code details are activated and, if the MI is flashing, the MI time counter (which can be read out with Star Diagnosis) is incremented for as long as the underlying fault is active. However, the corresponding P code is only output if the associated MI time counter is not equal to zero. The cumulative fault memory cannot be deleted with a service tool. If the MI time counter of a cumulative fault has reached the threshold of 9600 hours, it is removed from the cumulative fault memory.

FSP location	Meaning	MI time counter	Fault code
1	Empty AdBlue tank	Hours/minutes	P1950
2	AdBlue metering interruption	Hours/minutes	P1951
3	Insufficient urea quality	Hours/minutes	P1952
4	AdBlue reduced consumption	Hours/minutes	P1953
5	High NOx emissions, cause unknown	Hours/minutes	P1956
6	Fault in emissions monitoring system	Hours/minutes	P1957
7	Spare (free)	Hours/minutes	Pxxxx
8	Spare (free)	Hours/minutes	Pxxxx

Freeze frame data

When a component or system malfunctions for the first time, the engine operating conditions prevailing at the time the fault occurred ("freeze frame" data) are stored in the engine control unit. Only one "freeze frame" data set is stored.

- Coolant temperature
- Charge air pressure
- Vehicle speed
- Engine speed
- Engine torque
- OBD fault code that resulted in the freeze frame being stored.

Readiness status

The readiness status (readiness code) indicates whether a diagnosis result is available for all individual systems since the last time the fault memory was deleted. The readiness status is supported for the following groups of components/systems:

- Fuel system monitoring
- Comprehensive components monitoring
- Catalyst monitoring

Tester communication

The "tester communication" is implemented in accordance with ISO 15765/ISO 15031.

Malfunction indicator (MI)

The purpose of the malfunction indicator (MI) is to display malfunctions in emissions-related systems.

<u>Condition and properties of the MI</u>

When activated, the MI symbol in the vehicle display corresponds to symbol F01 of ISO standard 2575.

<u>MI activation</u>

The malfunction indicator lights up if:

- an emissions-related fault that results in the OBD limits being exceeded has occurred for x successive drive cycles,
- a "major functional failure" of the exhaust gas aftertreatment system has been detected for x successive drive cycles,
- the system is not able to execute OBD routines,
- if there is no reagent in the deNOx exhaust aftertreatment system (flashes in warning mode),
- the ignition key is in position II (key-on/bulb check function before engine start).

<u>MI deactivation</u>

The malfunction indicator goes out if the fault that caused its activation does not occur for x-1 complete drive cycles in succession.

If the MI has been activated because there is no reducing agent for the deNOx system, the MI will be switched back to its previous status after the reducing agent tank has been filled.

<u>Warning mode</u>

In the case of faults that result in an increase in NOx emissions, the driver is warned by a display (warning mode), depending on the severity of the fault.

The warning mode lights up if an emissions-related fault that will lead to the NOx limits being exceeded occurs for x successive drive cycles.

If an emissions-related fault causing NOx limits to be exceeded is no longer active, warning mode is deactivated provided the torque limiter is also inactive. Any further actuation of the lamp depends on how relevant the faults stored in the fault memory are to OBD.

Torque limiter

In the case of faults that lead to an increase in NOx emissions, a torque limiting function is implemented, in accordance with the severity of the fault, to encourage the driver to have the fault repaired as soon as possible. The degree of torque limiting depends on the vehicle type (permissible gross weight).

OBD component monitoring

The following table presents an overview of the components to be monitored and the associated fault detection routines.

Component/system	**Short circuit to ground**	**Short circuit to battery voltage**	**Line break**	**Plausibility**
Exhaust gas aftertreatment				
Temperature sensor in front of SCR catalyst	X	X	X	
Temperature sensor after SCR catalyst	X	X	X	
Plausibility check of catalyst temperature sensors				X
Detection of presence of a catalyst				X
AdBlue tank fill level sensor	X	X	X	
Monitoring of AdBlue tank fill level			X	X
Temperature sensor in AdBlue tank	X	X	X	
AdBlue temperature sensor in metering unit	X	X	X	
Intake air temperature sensor	X	X	X	
Intake air humidity sensor	X	X	X	
Ambient air temperature sensor		X	X	
AdBlue pressure sensor	X	X	X	X
Compressed air pressure sensor	X	X	X	X
Valve for engine coolant (tank heater)	X	X	X	
SCR line heater	X	X	X	
AdBlue valve	X	X	X	
Compressed air supply Compressed air supply with an air control valve Compressed air supply for de-energized post-injection with air control valve and air shut-off valve	X	X	X	
AdBlue pump	X	X	X	
AdBlue pressure system monitoring (pressure too low/pump current too high)				X
Air system monitoring • Compressed air pressure too high • Compressed air pressure too low Air supply malfunction Air path clogged				X
NOx sensor	X	X	X	X
NOx emissions				X
SCR system, general • Diagnosis service routine "AGN switched off, Mannheim function" • Diagnosis service routine "AGN switched off, Wörth function" • SCR system general - parameterization fault				X
SCR frame module	X	X	X	

Component/system	Short circuit to ground	Short circuit to battery voltage	Line break	Plausibility
SCRT exhaust gas aftertreatment system				
Temperature sensor in front of DOC catalyst	X	X	X	
Temperature sensor after DOC catalyst	X	X	X	
Plausibility check of SCRT temperature sensors, pair A				X
Plausibility check of SCRT temperature sensors, pair B				X
Detection of the presence of an SCR-T system				X
Detection of the presence of a diesel particulate filter				X
Throttle flap direction signal	X	X	X	
Throttle flap PWM signal	X	X	X	
Throttle flap position sensor	X	X	X	
Throttle flap • Control deviation too high • Reference search routine not successful				X
PLD injection system				
Solenoid valve	X	X	X	
Other systems and components (sensor system)				
Charge air pressure sensor	X	X	X	X
Atmospheric pressure sensor	X	X	X	X
Charge air temperature sensor	X	X	X	
Crank angle position sensor	X	X	X	X
Camshaft position sensor	X	X	X	X
Coolant temperature sensor	X	X	X	
Fuel temperature sensor	X	X	X	
Other systems and components				
MI (Malfunction Indicator)				X
ECU (internal fault)				
CAN data sector monitoring (low-speed)				X
CAN data sector monitoring (high-speed)				X
Data set tampered with				X
Error reading out EEPROM				X
Error writing to EEPROM				X
Proportioning valve bank 2	X	X	X	
CAN (Controller Area Network)				
High speed CAN - no communication				X
Low speed CAN - no communication (engine CAN)				X
Low speed CAN - data implausible (engine CAN)				X

Notes