# Preface

Dear readers,

This Introduction into Service Manual presents the new features in the 4-cylinder diesel engine 651 Blue TEC for model 166 (model 204.904 is similar). It provides additional information to supplement the information available in the Model 651 Introduction Manual available on Star TekInfo.

It allows you to familiarize yourself with the technical highlights of this new engine in advance of its market launch. This brochure is primarily intended to provide information for people employed in service, maintenance and repair as well as for aftersales staff. It is assumed that the reader is already familiar with the Mercedes-Benz model series and engines currently on the market.

In terms of the contents, the emphasis in this Introduction into Service Manual is on presenting new and modified components, systems, system components and their functions.

However, this Introduction into Service Manual is not intended as a basis for repair work or technical diagnosis.

For such needs, more extensive information is available in the Workshop Information System (WIS) and in the XENTRY Diagnostics system.

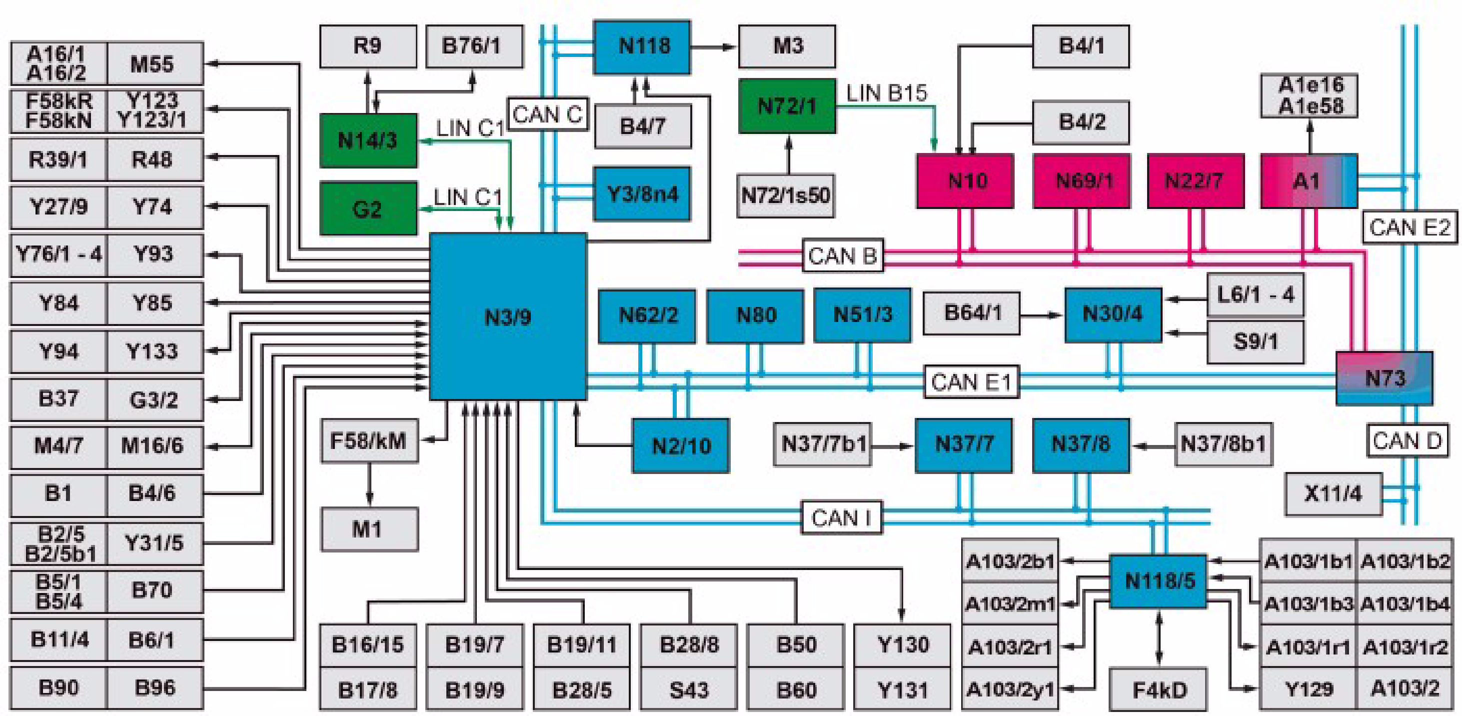
WIS is updated monthly. Therefore, the information available there reflects the latest technical status of our vehicles.

The contents of this brochure are not updated. No provision is made for supplements. We will publicize modifications and new features in the relevant WIS documents. The information presented in this Introduction into Service Manual may therefore differ from the more up-to-date information found in WIS.

All the information relating to specifications, equipment and options is valid as of the copy deadline in April 2013 and may therefore differ from the current production configuration.

# Common Rail Diesel Injection (CDI), function description

## Common rail diesel injection (CDI), function




*A1 Instrument cluster*
*A1e16 Preglow indicator lamp*
*A1e58 Engine diagnosis indicator lamp*
*A16/1 Knock sensor 1*
*A16/2 Knock sensor 2*
*A103/1b1 AdBlue® tank temperature sensor (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*A103/1b2 Fill level sensor full (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*A103/1b3 Fill level sensor reserve (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*A103/1b4 Fill level sensor empty (with code (U42) BlueTEC (SCR) diesel exhaust treatment*
*A103/1r1 AdBlue® container heating element (with code (U42) BlueTEC (SCR) diesel exhaust treatment*
*A103/1r2 AdBlue® pressure line heating element (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*A103/2 AdBlue® delivery module (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*A103/2b1 AdBlue® pressure sensor (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*A103/2m1 AdBlue® delivery pump (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*A103/2r1 AdBlue® delivery module heating element (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*A103/2y1 AdBlue® switchover valve (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*B1 Engine oil temperature sensor*
*B2/5 Hot film mass air flow sensor*
*B2/5b1 Intake air temperature sensor*
*B4/1 Fuel tank fuel level indicator fill level sensor, left*
*B4/2 Fuel tank fuel level indicator fill level sensor, right*
*B4/6 Fuel pressure sensor*
*B4/7 Fuel pressure sensor*
*B5/1 Boost pressure sensor*
*B5/4 Lowpressure turbocharger boost pressure sensor*
*B6/1 Camshaft Hall sensor*
*B11/4 Coolant temperature sensor*
*B16/15 Temperature sensor upstream of SCR catalytic converter (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*B17/8 Charge air temperature sensor*
*B19/7 Temperature sensor upstream of catalytic converter (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*B19/9 Temperature sensor upstream of diesel particulate filter (with code (474) Particulate filter)*
*B19/11 Temperature sensor upstream of turbocharger*
*B28/5 Pressure sensor downstream of air filter*
*B28/8 DPF differential pressure sensor (with code (474) Particulate filter)*
*B37 Accelerator pedal sensor*
*B50 Fuel temperature sensor*
*B60 Exhaust back pressure sensor*
*B64/1 Brake vacuum sensor*
*B70 Crankshaft Hall sensor*

## Common Rail Diesel Injection (CDI), function description

*B76/1 Condensation sensor for fuel filter with heating element*
*B90 Exhaust gas recirculation cooling bypass flap Hall sensor (with code (U42) BlueTEC diesel exhaust system (SCR) and code (494) USA version)*
*B96 Intake port shutoff Hall sensor (with code (U42) BlueTEC (SCR) diesel exhaust treatment and code (494) USA version)*
*CAN B Interior CAN*
*CAN C Drive train CAN*
*CAN D Diagnostic CAN*
*CAN E1 Chassis CAN 1*
*E2 Chassis CAN 2*
*CAN I Drive train sensor CAN*
*F4kD AdBlue® supply relay (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*F58kMSFI Starter circuit 50 relay*
*F58kN Circuit 87M relay*
*F58kR Circuit 15 relay*
*G2 Alternator*
*G3/2 Oxygen sensor upstream of catalytic converter*
*LIN B15 Battery sensor LIN*
*LIN C1 Drive train LIN*
*L6/1 Left front axle speed sensor*
*L6/2 Front axle rpm sensor Right*
*L6/3 Left rear axle speed sensor*
*L6/4 Rear axle rpm sensor Right*
*M1 Starter*
*M3 Fuel pump*
*M4/7 Fan motor*
*M16/6 Throttle valve actuator*
*M55 Intake port shutoff actuator motor*
*N2/10 Supplemental restraint system control unit*
*N3/9 CDI control unit*
*N10 SAM control unit*
*N14/3 Glow output stage*
*N22/7 Automatic air conditioning control and operating unit*
*N30/4 Electronic Stability Program control unit*
*N37/7 NOx sensor control unit downstream of diesel particulate filter (for code (U42) BlueTEC (SCR) diesel exhaust treatment*
*N37/7b1 NOx sensor downstream of the diesel particulate filter (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*N37/8 NOx sensor control unit downstream of SCR catalytic converter (for code (U42) BlueTEC (SCR) diesel exhaust treatment*
*N37/8b1 NOx sensor downstream of the SCR catalytic converter (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*N51/3 AIRMATIC control unit*
*N62/2 Video and radar sensor system control unit*
*N69/1 Left front door control unit*
*N72/1 Upper control panel control unit*
*N72/1s50 ECO start/stop function button*
*N73 Electronic ignition switch control unit*
*N80 Steering column module control unit*
*N118 Fuel pump control unit*
*N118/5 AdBlue® control unit (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*R9 Glow plugs*
*R39/1 Vent line heater element*
*R48 Coolant thermostat heating element*
*S9/1 Stop lamp switch*
*S43 Oil level check switch*
*X11/4 Diagnostic connector*
*Y3/8n4 Fully integrated transmission control control unit*
*Y27/9 Exhaust gas recirculation actuator*
*Y31/5 Boost pressure control pressure transducer*
*Y74 Pressure control valve*
*Y76/1 Cylinder 1 fuel injector*
*Y76/2 Cylinder 2 fuel injector*
*Y76/3 Cylinder 3 fuel injector*
*Y76/4 Cylinder 4 fuel injector*
*Y84 Radiator shutters actuator (except code (550) Trailer hitch)*
*Y85 Exhaust gas recirculation cooler bypass switchover valve*
*Y93 Boost pressure control flap pressure transducer*
*Y94 Quantity control valve*
*Y123 Left switchable engine mount*
*Y123/1 Right switchable engine mount*
*Y129 AdBlue® metering valve (with code (U42) BlueTEC (SCR) diesel exhaust treatment*
*Y130 Engine oil pump valve*
*Y131 Oil spray nozzle shutoff valve*
*Y133 Coolant pump switchover valve*

# Common Rail Diesel Injection (CDI), function description

## Common rail diesel injection (CDI), general

The **C**ommonRail **D**iesel **I**njection (CDI) system forms an electrical network with the sensors and actuators of engine 651 to make up the "CRDIII" engine control system.

The abbreviated designation "CRDIII" means:

**CR** = **C**ommon **r**ail

**D** = **D**elphi (injection system manufacturer)

**III** = 3rd generation

The "common rail" is the line shared by all injectors for fuel delivery. The fuel upstream of the injection is stored in this common line. Therefore a common rail system is also called "storage injection".

The entire engine control system is located in the CDI control unit (N3/9). Sensor data is directly read in from the engine control and indirectly via the CAN network and actuates the control elements as required. The individual functions and systems of the engine control system are controlled and coordinated by the CDI control unit.

The engine control is subdivided into the following systems:

- **Basic functions**
- **Engine system**
- **Injection system**
- **Air control system**
- **Exhaust system**

### Basic functions

- Control unit diagnosis
- Fault memory
- Onboard diagnosis II (OBD II)
- Diagnosis via the **C**ontroller **A**rea **N**etwork (CAN)
- CAN network
- Flash programming and variant coding
- Drive authorization system stage 3 (DAS 3)
- Torque coordination
- Heat management
- Alternator interface
- Synchronization
- Load determination

### Note: Diagnosis

For diagnostic purposes, the fault codes from the engine control can be read off and deleted with Xentry Diagnostics, and specific diagnostic functions initiated.

### Note: Transport mode

In transport mode various functions of the engine timing are limited. Further information is available in the energy management function. If the kilometer reading of the vehicle is more than 250 km the system condition "vehicle transport mode" is automatically deactivated and can also not be reactivated by means of the diagnostic tester.

### Note: Variant coding

Using variant coding the following vehicle versions and equipment can be coded using Xentry Diagnostics:

- Vehicle model
- National version
- Exhaust
- Transmission version

### Note: Flash programming

The engine control in the CDI control unit is flash programmable, that is the complete software in the control unit can be exchanged (replaced) using Xentry Diagnostics. The software required for control unit programming can be found on the Star Diagnosis Update DVD.

### Note: CAN network

The CDI control unit exchanges data over the attached drive train CAN (CAN C), chassis CAN 1 (CAN E1) and drive train sensor CAN (CAN I) (with code (U42) BlueTEC (SCR) diesel exhaust treatment with other control units, which is integrated the CAN network. The CDI control unit also acts as the interface (gateway) between the three CAN bus systems. The CDI control unit is also connected to the drivetrain LIN (LIN C1) and exchanges data over it.

# Common Rail Diesel Injection (CDI), function description

**Engine system**

- Start relay actuation
- Throttle valve control
- Safety fuel shutoff
- Transmission overload protection
- Electronic Stability Program support
- Fully integrated transmission control support
- Drive off torque limitation and antijerk
- control
- Fan operation
- Alternator regulation and glow time control
- Engine timing start stop function (for code (B03) ECO start/stop function)

**Injection system**

- Pre, main and post injection
- Idle speed control
- Rpm limitation
- Smooth running control
- Limp-home function
- Speed increase for air conditioning
- Inertia fuel shutoff
- Rail pressure regulation
- Fuel pump control
- High pressure pump control
- Altitude adaptation

**Air control system**

- Exhaust gas recirculation (EGR)
- Charge pressure control
- Intake air throttling through intake port shutoff (EKAS)

**Exhaust system**

- Catalytic converter heating
- Oxygen sensor heater control
- Exhaust aftertreatment, DPF regeneration (**D**iesel **P**articulate **F**ilter) with code (474) Particulate filter
- Exhaust aftertreatment, **i**njection of the reducing agent AdBlue® with code (U42) BlueTEC (SCR) diesel exhaust gas treatment

**Note:** Exhaust emission standards
Engine 651.9 complies with the EU5 exhaust emission standards. Vehicles with code (U42) BlueTEC (SCR) diesel exhaust treatment fulfill the EU6 exhaust emissions standard or the BIN5 LEVII exhaust emissions standard for the USA.

Engine 651 is characterized by the following components:

- Two Lanchester balance shafts
- The oil pump integrated in the crankcase
- Gear drive in combination with a drive chain on the flywheel side for driving the high-pressure pump, oil pump, Lanchester balance shafts and the two camshafts
- Oil spray nozzle shutoff valve (Y131) for controlling the oil spray nozzles for piston crown cooling
- Switchable coolant pump
- Exhaust gas recirculation (EGR) with coolant-cooled precooler and EGR cooler with switchable bypass duct
- Cylinder head with 2-piece water jacket
- Rapid glowing system with glow output stage (N14/3)
- Load-level controlled preinjection and postinjection
- Fuel injectors with piezotechnology, 2 in series of engaged turbocharger with a vacuum-controlled charge pressure flap, a wastegate, a charge air bypass flap and an additional low pressure turbocharger boost pressure sensor (B5/4)

# Common Rail Diesel Injection (CDI), function description

## Starting, function

### Starting function requirements, general points

- Circuit 87M (engine control ON)
- Engine OFF
- Start enable for DAS stage 3 (FBS 3)
- Engaged gear range "P" or "N"

### Starting, general

The starter control system in the CDI control unit (N3/9) is responsible for the actuation and shutoff of the starter (M1).
For starting, the CDI control unit reads the following sensors and signals:

- Engine oil temperature sensor (B1)
- Crankshaft Hall sensor (B70), for engine speed
- Atmospheric pressure sensor, for measuring the atmospheric pressure
- Fuel pressure sensor (B4/6)
- Camshaft Hall sensor (B6/1)
- Coolant temperature sensor (B11/4)
- Alternator (G2), status
- Electronic ignition lock control unit (N73), "circuit 50 signal" via chassis CAN 1 (CAN E1)
- AdBlue ® control unit (N118/5) with code (U42) BlueTEC (SCR) diesel exhaust treatment, start enable via the drive train sensor
- CAN (CAN I)
- Fully integrated transmission control unit (Y3/8n4), gear range via drive train CAN (CAN C)

The CDI control unit actuates the following components to start the engine:

- Starter
- Pressure regulator valve (Y74)
- Fuel injectors (Y76)
- Quantity control valve (Y94)
- Fuel pump (M3) via the drive train CAN and the FSCU (N118)

The start quantity control in the CDI control unit serves to calculate a specific start quantity at engine start irrespective of the position of the accelerator pedal sensor (B37).

### Function sequence for start

The function sequence is subdivided into the following steps:

- **Function sequence for start begin**
- **Function sequence for start end**

### Function sequence for start begin

When the transmitter key (transmitter key (A8/1)) is moved to the start position, the CDI control unit receives the "circuit 50 signal" from the electronic ignition lock control unit via the chassis CAN 1. The CDI control unit actuates the circuit 50 starter relay (F58kM) by means of a ground signal. The power contact on the starter relay closes and the starter solenoid switch is supplied at "circuit 50" with voltage from "circuit 30".

**Note:**
If the CDI control unit detects that the engine is running via the crankshaft Hall sensor and the message "circuit 61 ON" and that the starting procedure has ended via the message "circuit 50 OFF", the driver will then be able to influence the injection quantity and thus the engine speed via the accelerator pedal sensor.

### Function sequence for start end

Starter control is carried out automatically by the CDI control unit (touch start). This means that once the start process is initiated, switching off "circuit 50" will have no further influence on the start procedure.

When the engine cranking speed has reached 700 to 850 rpm, or after a starting time of 7 to 10 s (depending on coolant temperature), the CDI control unit interrupts the negative activation of the circuit 50 starter relay and thus terminates the starting procedure.

The starting procedure can only be aborted by switching off the ignition.

**Note:** The starting procedure is inhibited for approximately 1.5 to 3 s before it can be repeated. This occurs so that the rotating pinion of the starter is prevented from meshing with the toothing on the engine clutch plate (ring gear protection).

**Note:** For vehicles with code (U42) BlueTEC (SCR) diesel exhaust treatment, no start enable is issued from the unit AdBlue® control if the AdBlue® tank is empty and the number of permissible engine starts with an empty AdBlue® tank is at zero.

# Common Rail Diesel Injection (CDI), function description

## Ignition Off, function

**Function requirements for ignition OFF, general points**

- Circuit 87M (engine control ON)
- Circuit 15

**Ignition OFF, general points**
When the ignition is switched off, first the engine and then the engine control function in the CDI control unit (N3/9) are switched off.

**Function sequence for ignition OFF**
When the ignition is switched off, the electronic ignition lock control unit (N73) switches off the circuit 15 relay (F58kR) via the interior CAN (CAN B).

If the CDI control unit receives the signal "circuit 15 OFF" via the circuit 15 relay, the following components will be switched off and the processor run-on started:

- The fuel pump (M3) via the drive train CAN (CAN C) and FSCU (N118)
- Pressure regulator valve (Y74)
- Fuel injectors (Y76)
- Quantity control valve (Y94)

**Note:**
For vehicles with code (U42) BlueTEC (SCR) diesel exhaust treatment, the run-on period of the AdBlue® control unit (N118/5) is started. The remaining AdBlue® reducing agent is suctioned by the AdBlue® delivery pump (A103/2m1) out of the AdBlue® pressure line via the AdBlue® switchover valve (A103/2y1) actuated by the AdBlue® control unit during the control unit power down. The AdBlue® metering valve (Y129) is opened at the same time so that no vacuum arises in the AdBlue® pressure line. The duration of the run-on period and the timing of reducing agent return are dependent on the exhaust temperature as detected by the temperature sensor upstream of the SCR catalytic converter (B16/15), since excessively hot exhaust can damage the AdBlue® pressure line and other system components.

The processor run-on period is determined by the CDI control unit and lasts about 4 s. It can, however, last for several minutes due to various functions (such as Onboard Diagnosis (OBD), Drive Authorization System (DAS), thermal management). When computer run-on is complete, the circuit relay 87M (F58kN) is switched off and the engine control system is disconnected from the vehicle electrical system (switched off).

**Note**:
System tests are conducted by the CDI control unit during the processor runon period and the fault memory is updated. The ground connection "circuit 31" takes place by the onboard electrical system battery (G1) via the onboard electrical system battery ground point at the front right (W10) and over a number of ground lines to the ground point at the front right for lamp unit (W2). When ignition is OFF, the CDI control unit is supplied with power from the onboard electrical system battery via "circuit 30 fused"

# Common Rail Diesel Injection (CDI), function description

## Onboard diagnosis, function

### Function requirements for OnBoard Diagnosis (OBD), general points

Circuit 87M (engine control ON)

### Onboard diagnosis, general points

An OnBoard Diagnosis system of the second generation is used (OBD II)). In Europe, the OBD II, with appropriate adaptation for the European market, is called European OnBoard Diagnosis (EOBD). The OBD system is integrated in the CDI control unit (N3/9) and has the following tasks:

- Monitoring emissions relevant components and systems during travel
- Determining and storing malfunctions
- Display of malfunctions via the engine diagnosis indicator lamp (A1e58)
- Detected faults are transmitted via a uniform interface (diagnostic connector (X11/4)) to a diagnostic unit (e.g. Xentry Diagnostics))

OBD pursues the follow objectives:

- Ensure permanently low exhaust emissions
- Protect components at risk (such as catalytic converters) against backfires

The following components and systems are monitored:

- Intake air path
- Fuel system
- Glow system
- Exhaust gas recirculation
- Smooth running control
- Oxygen sensor
- Oxygen sensor heater
- Diesel particulate filter with code (474) Particulate filter
- AdBlue ® system with code (U42) BlueTEC (SCR) diesel exhaust treatment
- Intake port shutoff (EKAS) by means of the intake port shutoff Hall sensor (B96) with code (U42) BlueTEC (SCR) diesel exhaust treatment and code (494) USA version
- Crankcase ventilation system
- Cooling system with code (494) USA version
- Other emissionrelevant components or components whose malfunctioning prevents the diagnosis of another component

### Function sequence for onboard diagnosis (OBD)

The OBD is described in the following steps:

- **Function sequence for fault detection**
- **Function sequence for test procedure**
- **Function sequence for cyclic monitoring**
- **Function sequence for continuous monitoring**
- **Function sequence for readiness code**
- **Function sequence for fault storage**
- **Function sequence for avoiding consequential faults**
- **Function sequence for saving the fault freeze frame data**
- **Function sequence for fault display**
- **Function sequence for reading out fault memory**
- **Function sequence for erasing faults**

### Function sequence for fault detection

The CDI control unit checks itself and its input and output signals for plausibility and detects possible malfunctions.

Malfunctions and the way they are stored are classified as follows:

- Malfunction permanently present
- Loose contact which occurred during travel

The following malfunctions are recognized in their frequency and duration:

- Signals above or below the limit value (for example, short circuit, open circuit, defective sensor)
- Illogical combination of various signals
- Closed-loop control circuit at lower or upper limit of the regulation interval
- Malfunctions in function chains (faulty test processes, e.g. for the smooth running control)
- Malfunction messages via the CAN data buses

# Common Rail Diesel Injection (CDI), function description

**Function sequence for test procedure**

For test procedures one differentiates between component testing and function chain testing.

**Component testing**

Component testing is direct testing of a component. It includes:

- Monitoring of the power supply and electric circuits
- Comparison of the sensor signals with other sensor signals and stored comparative values

The following three test results can occur:

- Signal present (test passed)
- Signal not present (malfunction)
- Signal present, but implausible (malfunction)

**Function chain test**

The function chain test is indirect testing of the effect of a controlled change.
In this process individual components and systems are checked which cannot be tested by means of component testing.
The function chain is a controlled process studying cause and effect.

The CDI control unit actuates one or more components (cause) and evaluates the resulting sensor signals (effect). In the process the CDI control unit compares the sensor signals with stored comparative values and thus recognizes troublefree or faulty functioning of components and systems.

The following are monitored by means of function chain tests:

- Smooth running control
- Exhaust gas recirculation
- Oxygen sensor heater

**Function sequence for cyclic monitoring**

Cyclic monitoring takes place for components and system which are not permanently active. Regeneration, for example, only takes place when the vehicle is being operated in the partialload range and can therefore only be monitored during this operating phase.

The following components and systems are monitored cyclically:

- Fuel system
- Exhaust gas recirculation
- Smooth running control
- Oxygen sensor
- Oxygen sensor heater
- Regeneration

**Function sequence for continuous monitoring-**
Continuous monitoring means constant monitoring from engine start up to "ignition OFF".
The following components and systems are monitored continuously:

- Intake air path
- Glow system
- Particulate filter AdBlue ® system
- Crankcase ventilation system
- Cooling system
- All other emission-relevant components

**Function sequence for readiness code**
In order to gain reliable information as to the trouble free status of cyclically monitored components and systems when reading out the fault memory, these components and systems must be test ready.

The test readiness of a component or a system is shown by the readiness code. The readiness code tells you whether malfunction detection tests have been run at least once, indicating that the component or the system is active.

Test readiness is checked at least once per driving cycle. If test readiness exists, the readiness code will be set. In order to set the readiness code it is sufficient if the vehicle has checked all of the components belonging to a system at least once.

The test result is not significant in setting the readiness code. This means that it is also set if a fault in the system or the component is found.

The readiness code is set for the following components and systems once they have been tested:

- Fuel system
- Exhaust gas recirculation
- Smooth running control
- Oxygen sensor
- Oxygen sensor heater
- Regeneration

## Common Rail Diesel Injection (CDI), function description

If test readiness does not exist for individual systems or components, it can be established using the diagnostic unit. To do this the function chain process is started manually using a menu item in the diagnostic software.

**Note:** All readiness codes are reset automatically when the fault code is deleted.

**Function sequence for fault storage**

Exhaust gas relevant malfunctions just found from the current and previous driving cycle are temporarily stored in the OBD until confirmed (through occurrence in two consecutive driving cycles) in the form of a fault code, also called a diagnostic trouble code or DTC.

If a found malfunction occurs in two consecutive driving cycles, the fault code is stored in the CDI control unit fault memory after the second driving cycle is completed.

**Note:** Driving cycle

A driving cycle consists of an engine start, vehicle journey and stopping the engine, whereby an increase in coolant temperature by at least 22°C up to at least 70°C must occur during travel.

**Function sequence for avoiding consequential faults**

If a faulty signal is detected and stored, all tests where this signal is required as a reference parameter are aborted (interlock). This prevents consequential faults from being stored.

**Function sequence for saving the fault freeze frame data**

Besides the malfunctions, the operating conditions under which they occurred are also stored (freeze frame data).

If the malfunction occurs a second time, the associated fault freeze frame data will again be stored. If the malfunction continues to occur then the last stored fault freeze frame data will be updated.

This means that the fault freeze frame data from the first and last occurrence of a malfunction can be read out.

Fault freeze frame data include:

- Vehicle speed
- Engine speed
- Coolant temperature
- Intake air temperature
- Charge air temperature and charge air pressure
- Supply voltage
- Engine load status
- Adaptation value for injection regulation

**Function sequence for fault display**

The engine diagnosis indicator lamp in the IC (A1) is actuated by the CDI control unit via chassis CAN 1 (CAN E1), the electronic ignition lock control unit (N73) and chassis CAN 2 (CAN E2). If a fault occurs in two driving cycles one after the other, the indicator lamp engine diagnosis lights up. In the case of catalytic converter damage caused by ignition misfires the engine diagnosis indicator lamp flashes for as long as the ignition misfires occur and then lights up permanently during the whole (remaining) driving cycle.
Fault indication by means of the engine diagnosis indicator lamp ceases automatically after 3 consecutive troublefree driving cycles.

**Function sequence for reading out fault memory**

The CDI control unit is connected via chassis CAN 1, the electronic ignition lock control unit and the diagnostic CAN (CAN D) with the diagnostic connector. Stored fault codes and their fault freeze frame data as well as the readiness codes can be read out with the ignition ON or engine running via the diagnostic connector using a commercially available diagnostic unit or Xentry Diagnostics.

**Function sequence for erasing faults**

The system will automatically erase any stored malfunctions from the fault memory only after 40 consecutive trouble-free driving cycles have occurred. They can, however, also be deleted (after repair work has been done) using commercially available diagnostic equipment or the Xentry Diagnostics system.

## Exhaust treatment, function

### Function requirements for exhaust treatment, general points

- Circuit 87M (engine control ON)
- Engine running

### Exhaust treatment, general

The task of exhaust treatment is to reduce the exhaust emissions:

- Nitrogen oxides (NOx)
- Hydrocarbons (HC)
- Carbon monoxide (CO)
- Soot particles

Pollutant reduction is supported by the following subfunctions:

- Intake port shutoff (EKAS)
- Diesel particulate filter (DPF) preheating (with code (474) Particulate filter)
- Exhaust gas recirculation (EGR)
- Injection of the reducing agent AdBlue® (with code (U42) BlueTEC (SCR) diesel exhaust treatment)

The CDI control unit (N3/9) reads in the following sensors:

- Temperature sensor upstream of SCR catalytic converter (B16/15) (with code (U42) BlueTEC (SCR) diesel exhaust treatment)
- Temperature sensor upstream of catalytic converter (B19/7) (with code (U42) BlueTEC (SCR) diesel exhaust treatment)
- Temperature sensor upstream of diesel particulate filter (B19/9), on vehicles with code (474) Particulate filter
- Temperature sensor upstream of turbocharger (B19/11)
- DPF differential pressure sensor (B28/8) with code (474) Particulate filter
- Oxygen sensor upstream of catalytic converter (G3/2)
- SAM control unit (N10), outside temperature via the body CAN (CAN B), electronic ignition lock control unit (N73) and chassis CAN 1 (CAN E1)
- NOx sensor control unit downstream of diesel particulate filter (N37/7), signal from NOx sensor downstream of diesel particulate filter (N37/7b1) via the drive train sensor CAN (CAN I) (with code (U42) BlueTEC (SCR) diesel exhaust treatment)
- NOx sensor control unit downstream of SCR catalytic converter (N37/8), signal from NOx sensor downstream of SCR catalytic converter(N37/8b1) via the drive train sensor CAN (with code (U42) BlueTEC (SCR) diesel exhaust treatment)

### Function sequence for exhaust treatment

The following subsystems are involved in exhaust treatment:

- **Function sequence for oxidation catalytic converter**
- **Function sequence for diesel particulate filter (DPF)**
- **Function sequence for SCR catalytic converter (with code (U42) BlueTec (SCR) diesel exhaust treatment)**
- **Function sequence for intake port shutoff**

### Function sequence for oxidation catalytic converter

The oxidation catalytic converter reduces the amount of hydrocarbon (HC), carbon monoxide (CO) and nitrogen oxides (NOx), and, on vehicles with code (474) Particulate filter, generates the required thermal energy for the DPF regeneration phase by afterburning.

### Function sequence for diesel particulate filter (DPF)

The diesel particulate filter consists of a ceramic honeycomb filter body made out of silicon carbide, which is coated with platinum. The passages of the diesel particulate filter are opened alternately at the front and rear and are separated from each other through the porous filter walls of the honeycomb filter body.

The precleaned exhaust which has passed though the oxidation catalytic converter flows into the ducts of the DPF which are open to the front and passes through the porous filter walls of the honeycomb filter body into the ducts which are open to the rear. After this, the cleaned and filtered exhaust is dissipated through the exhaust system. The soot particles are retained in the honeycomb filter body of the DPF.

# Common Rail Diesel Injection (CDI), function description

If the soot particle content exceeds a map-based value, the CDI control unit will start the regeneration phase provided the prerequisites for regeneration are given. The CDI control unit receives the information on soot particle content in the DPF via the DPF differential pressure sensor. Regeneration takes place by means of a periodical increase of the exhaust temperature. For this purpose, the following functions are initiated by the CDI control unit:

- One additional post injection via the fuel injectors (Y76)
- DPF glow function via the drivetrain LIN (LIN C1) over the glow output stage (N14/3) to the glow plugs (R9)
- Switching line shift via the drive train CAN (CAN C) by the fully integrated transmission control unit (Y3/8n4)

The soot particles retained in the DPF are mostly burnt off to produce carbon dioxide ($CO_2$) by increasing the exhaust temperature. The ash produced remains in the DPF. On vehicles with code (474) Particulate filter, the exhaust temperature is monitored during regeneration by the temperature sensor upstream of the turbocharger and by the temperature sensor upstream of the diesel particulate filter.
Through the exhaust gas pressure lines upstream and downstream of the DPF, the DPF differential pressure sensor determines the pressure differential between the exhaust gas pressure upstream and downstream of the DPF. The soot particle content in the DPF is determined using a characteristic map on the basis of the pressure differential and the exhaust mass calculated by the CDI control unit. Necessary maintenance of the DPF is signaled via chassis CAN 1, the electronic ignition lock control unit and chassis CAN 2 (CAN E2) by the engine diagnosis indicator lamp (A1e58) in the IC (A1).

**Note:**
On short trips, regeneration is interrupted and distributed over several driving cycles. Until the specified regeneration temperature is reached several heating-up phases are required. Regeneration occurs unnoticeably by the customer.

**Function sequence for SCR catalytic converter (with code (U42) BlueTec (SCR) diesel exhaust treatment)**

The exhaust gases expelled from the engine are cleaned in an oxidation catalytic converter, a diesel particulate filter (DPF) and a reduction catalytic converter (Selective Catalytic Reduction (SCR) catalytic converter).
By oxidation in the oxidation catalytic converter, the CO and HC are converted to $CO_2$ and water ($H_2O$). The diesel particulate filter consists of a ceramic honeycomb filter body made out of silicon carbide, which is coated with platinum.
The passages of the diesel particulate filter are opened alternately at the front and rear and are separated from each other through the porous filter walls of the honeycomb filter body.

The precleaned exhaust which has passed though the oxidation catalytic converter flows into the ducts of the DPF which are open to the front and passes through the porous filter walls of the honeycomb filter body into the ducts which are open to the rear. The soot particles are retained in the honeycomb filter body of the DPF. During the DPF regeneration phase, the exhaust temperature is raised to burn off the retained soot particles.

The AdBlue® reducing agent is injected upstream of the SCR catalytic converter, and is converted to ammonia ($NH_3$) through thermal decomposition (heat-induced chemical reaction ) and hydrolysis (water-induced chemical reaction).
Between the AdBlue® metering valve (Y129) and the SCR catalytic converter is a mixing element. This improves the hydrolysis of the AdBlue® reducing agent and ensures more uniform distribution of the AdBlue® upstream of the SCR catalytic converter. In the SCR catalytic converter, the $NO_X$ contained in the exhaust gas is converted with the $NH_3$ to nitrogen ($N_2$) and $H_2O$ molecules.

## Common Rail Diesel Injection (CDI), function description

The CDI control unit calculates the quantity of reducing agent required based on a characteristics map, and sends it over the drive train sensor CAN to the AdBlue® control unit (N118/5). This control unit then initiates map-based injection of the calculated quantity of AdBlue® reducing agent through the AdBlue® metering valve.

**Note:**
The conversion rate of the NOx portion in the exhaust is dependent on the temperature and can be up 80%. Soot content is reduced by approx. 99%.

The CDI control units determines the load condition of the DPF via the DPF differential pressure sensor. If the soot load exceeds the map based value, the CDI control unit will start the regeneration phase provided the prerequisites for regeneration are given. Regeneration is performed by periodically raising the exhaust temperature with another post injection.

By raising the exhaust temperature, the soot particles stored in the DPF are mostly burnt off to $CO_2$. The noncombustible ash remains in the DPF. During the regeneration, the exhaust temperature is monitored by the temperature sensor upstream of the turbocharger and the temperature sensor upstream of the diesel particulate filter. Necessary maintenance of the DPF is signaled by the engine diagnosis indicator lamp in the instrument cluster.

**Note:**
If the "Reserve" fill level in the AdBlue® tank is reached, the driver is informed parallel to an audible signal over the multifunction display (A1p13) that he must find a workshop and have the required maintenance work done.

**Note:**
If the "empty" level is reached in the AdBlue® container, the plausibility of the "empty" level is checked through a computer model. If the plausibility check also results in an "empty" fill level, an audible signal is given, an entry is made in the fault memory of the control unit (CDI), and the engine diagnosis indicator lamp is lit on the instrument cluster. The driver then has up to 20 engine starts available, with an assumed trip distance of 32 kilometers in each case. The number of remaining starts is displayed in the instrument cluster. The vehicle can no longer be started after the last remaining "Start".

**Function sequence for intake port shutoff**
The intake port shutoff (EKAS) achieves the best possible relation between air swirl and air mass in all load conditions of the engine.

The CDI control unit additionally reads the following sensors for intake port shutoff:

- Engine oil temperature sensor (B1)
- Atmospheric pressure sensor, for the atmospheric pressure
- Accelerator pedal sensor (B37), for load detection
- Crankshaft Hall sensor (B70), for the engine speed

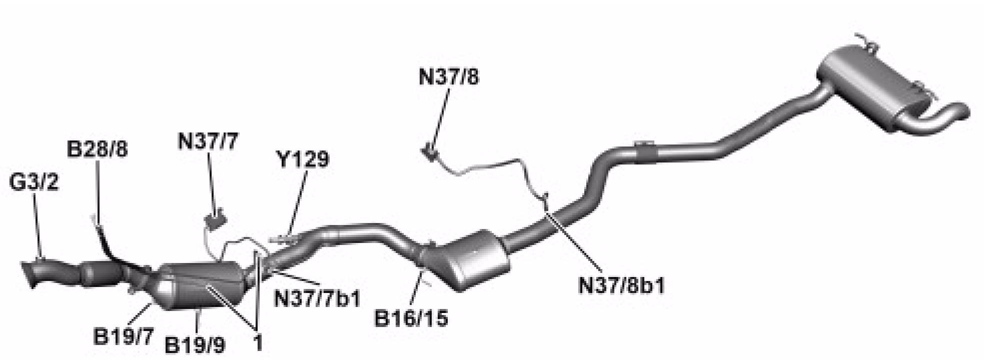
After evaluating the input signals, the CDI control unit actuates the intake port shutoff actuator motor (M55) by means of a pulse width modulated (PWM) signal. In the lower engine speed and engine load range, half of the intake ports (2 intake ports per cylinder available) are closed by means of the intake port shutoff flaps. In the open intake ports, the flow rate is thus increased. This leads to a higher swirl which creates a better vortex. This improves combustion and also contributes to reducing the soot particles in the exhaust gas.

As the engine speed and engine load increase, the closed intake ports are continuously opened so that the best possible relationship between air swirl and air mass is available for every operating phase of the engine. In this way, the exhaust characteristics and the engine performance are optimized.

**Note:**
If there is a fault or discontinuity in the supply voltage, the flaps are opened by spring force.

# Common Rail Diesel Injection (CDI), function description

## Component description for NOx sensor control unit




*Shown on model 166.0*
*N37/7 NOx sensor control unit downstream of diesel particulate filter*
*N37/7b1 NOx sensor downstream of diesel particulate filter*
*N37/8 NOx sensor control unit downstream of SCR catalytic converter*
*N37/8b1 NOx sensor downstream of SCR catalytic converter*

### Location

The NOx sensor downstream of the diesel particulate filter is located on the exhaust pipe downstream of the diesel particulate filter (DPF) and the NOx sensor downstream of the SCR catalytic converter is located on the exhaust pipe downstream of the SCR catalytic converter. The NOx sensors control units are located respectively on the underfloor.

### Task

The NOx control units are supplied by the company "VDO Automotive AG".
The NOx sensors detect the NOx and the O2 concentration in the exhaust downstream of the DPF and the SCR catalytic converter and pass this information on to the NOx sensors control units in the form of voltage pulses. These control units process the information and transmit it via the drive train sensor CAN (CAN I) to the CDI control unit (N3/9).

### Input and output signals

The nitrogen oxides sensors control units evaluate the following input signals and send the corresponding output signals:

- **Direct input signals**
- **CAN input signals from the CDI control unit**
- **CAN output signals to the CDI control unit**

**Direct input signals**
Circuit 87

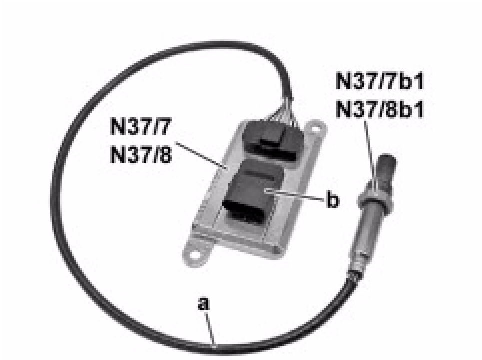
**CAN input signals from the CDI control unit**
Diagnosis requests

**CAN output signals to the CDI control unit**

- NOx concentration in the exhaust
- O2 concentration in the exhaust
- Diagnostic data

# Common Rail Diesel Injection (CDI), function description

## Design




*N37/7 NOx sensor control unit downstream of diesel particulate filter*
*N37/7b1 NOx sensor downstream of diesel particulate filter*
*N37/8 NOx sensor control unit downstream of SCR catalytic converter*
*N37/8b1 NOx sensor downstream of SCR catalytic converter*

*a Sensor cable*
*b Electrical connection*

Every NOx sensor (double chamber sensor with evaluation circuit) is inseparably connected via an 8-pin sensor line with the respective NOx sensor control unit.
An integral sensor heater which is controlled by the respective NOx sensor control unit ensures rapid readiness to operate of the NOx sensors.

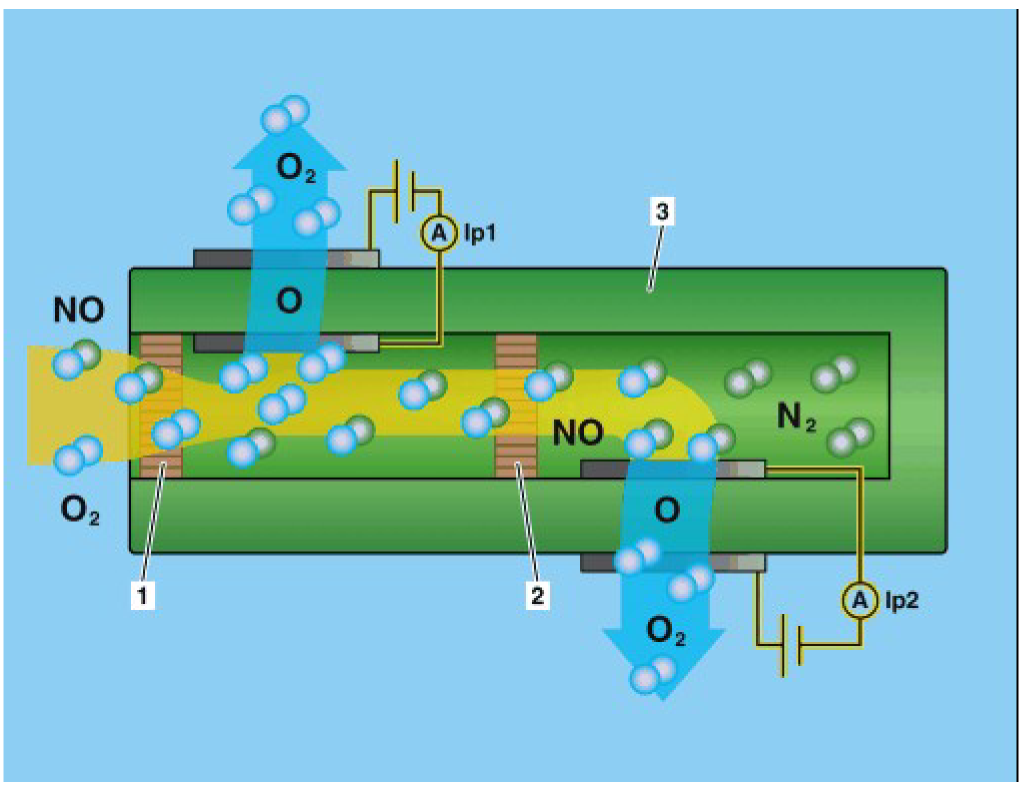
# Common Rail Diesel Injection (CDI), function description

## Function

The active ceramic probe bodies consist of many layers with two reaction chambers. The oxygen (O2) in the exhaust is detected in the first chamber, as in an oxygen sensor.
To do this, a pump voltage is applied to the electrodes in the first chamber. This causes the O2 molecules to be split into double charged oxygen ions and then pumped out of or into the first chamber (depending on whether richer or leaner exhaust gas is present) until a 450 mV voltage difference at the electrodes is reached. The oxygen concentration is calculated from the size of the required pump current "Ip1".

The nitrogen oxide is split at the earth electrode into nitrogen and oxygen in the second chamber if present. The oxygen is pumped out of the chamber again. The concentration of the nitrogen oxides in the exhaust is calculated from the resulting pump current "Ip2".

The voltage signals from NOx sensors are transmitted to the respective NOx sensor control unit and processed there. The NOx sensor control units send the NOx and the O2 concentration to the CDI control unit via the drive train sensor CAN.




***Schematic function diagram of the NOx sensor (double chamber sensors)***

*1 Diffusion gap 1*
*2 Diffusion gap 2*
*3 Solid electrolyte*

*Ip1 Pump current 1*
*Ip2 Pump current 2*

# Common Rail Diesel Injection (CDI), function description

## Exhaust gas recirculation, function

**Function requirements for exhaust gas recirculation (EGR), general points**

- Circuit 87M (engine control ON)
- Engine running
- Engine in load range from neutral to the upper partialload range

**Exhaust gas recirculation, general**
The EGR lowers the nitrogen oxide (NOx) portion in the exhaust.
This occurs by means of the following 3 processes:

- The oxygen (O2) concentration is reduced in the combustion chamber
- Reduction of the combustion temperature through reduction of the combustion speed
- Reduction of the combustion temperature through a higher heat capacity of the recirculated exhaust compared to the intake air

**Note:** Heat capacity
The heat capacity is a material property and indicates how much heat a substance can store per temperature change.

**Function sequence for exhaust gas recirculation**
EGR is active from idle through to the upper partial-load range. Determination of the EGR rate takes place depending on the following variables:

- Engine temperature, engine load and engine rpm
- Ambient conditions such as the air intake or the charge air temperature
- Exhaust temperature and exhaust back pressure
- Diesel particulate filter status (with code (474) Particulate filter)
- Time limitation (in idle)
- Boost pressure
- Coolant temperature

For this purpose, the CDI control unit (N3/9) reads signals from the following components:

- Engine oil temperature sensor (B1)
- Hot film mass air flow sensor (B2/5)
- Intake air temperature sensor (B2/5b1)
- Boost pressure sensor (B5/1)
- Coolant temperature sensor (B11/4)
- Charge air temperature sensor (B17/8)
- Temperature sensor upstream of catalytic converter (B19/7) (with code (U42) BlueTEC (SCR) diesel exhaust treatment)
- Temperature sensor upstream of diesel particulate filter (B19/9) (with code (474) Particulate filter)
- Temperature sensor upstream of turbocharger (B19/11)
- Pressure sensor downstream of air filter (B28/5)
- DPF differential pressure sensor (B28/8) (with code (474) Particulate filter)
- Accelerator pedal sensor (B37)
- Exhaust back pressure sensor (B60)
- Crankshaft Hall sensor (B70)
- Exhaust gas recirculation bypass flap Hall sensor (B90) (with code (U42) Blue TEC diesel exhaust treatment (SCR) and code (494) USA version)
- Actual value potentiometer 1 (M16/6r1), throttle valve

After evaluating the input signals, the CDI control unit uses a stored characteristic map to actuate the exhaust gas recirculation actuator (Y27/9) by means of a pulse width modulated (PWM) signal. The exhaust gas recirculation actuator increases or decreases, depending on its actuation, the quantity of recirculated exhaust which is directed into the charge air manifold via a mixing tube downstream of the throttle valve actuator (M16/6).

To increase the effect of EGR, the exhaust gas is passed through the exhaust gas recirculation cooler where it is cooled. If the temperature of the recirculated exhaust gas is too low, the recirculated exhaust gas can be guided past the exhaust gas recirculation cooler via a bypass duct.

# Common Rail Diesel Injection (CDI), function description

If the exhaust gas recirculation cooler bypass switchover valve (Y85) is actuated by the CDI control unit by means of a ground signal based on a characteristics map, then the vacuum stored in the vacuum reservoir acts on the exhaust gas recirculation cooler bypass vacuum unit and opens the bypass in the exhaust gas recirculation cooler via a linkage.

**Note:** Exhaust emission standards
Vehicles with code (U42) BlueTEC (SCR) diesel exhaust treatment fulfill the EU6 exhaust emissions standard.

## Forced induction, function

### Function requirements for charging general

- Circuit 87M (engine control ON)
- Engine running

### Forced induction, general

The cylinder charging efficiency is improved as a result of forced induction. As a result, the engine torque and power output are boosted. For forced induction, the flow energy of the exhaust gases is used to drive both turbochargers. Forced induction is performed by 2 inline exhaust gas turbochargers of different size which function together in different ways depending on the operating range.

The turbocharger suctions in fresh air through the air filter on the compressor inlet and feeds it through the compressor outlet into the charge air pipe upstream of the charge air cooler.
The high speed of the compressor turbine wheel and the resultant high volume flow compresses the air in the charge air pipe. Compression heats the charge air, which now flows through the charge air pipe to the charge air cooler. This cools off the charge air and feeds it through the charge air pipe to the charge air manifold.

Turbocharging is regulated by the boost pressure control. The boost pressure is regulated by the CDI control unit (N3/9) depending on the following values and associated components:

- Atmospheric pressure sensor, for measuring the atmospheric pressure
- Charge air temperature sensor (B17/8)
- Temperatur sensor upstream of turbocharger (B19/11)
- The injection quantity which is determined via the injection time of fuel injectors (Y76) and the fuel pressure in the rail. The fuel pressure in the rail is detected by the fuel pressure sensor (B4/6)
- Boost pressure control flap pressure transducer (Y93)
- Boost pressure control transducer (Y31/5)

The CDI control unit actuates the pressure transducer dependent on the following sensor signals by means of a pulse width modulated signal (PWM signal) :

- Coolant temperature, via the coolant temperature sensor (B11/4)
- Atmospheric pressure, via the atmospheric pressure sensor in the CDI control unit
- Intake air pressure, via the pressure sensor downstream of the air filter (B28/5)
- Engine speed, via the crankshaft Hall sensor (B70)
- Boost pressure, via the low-pressure turbocharger boost pressure sensor (B5/4) and the boost pressure sensor (B5/1)
- Exhaust pressure, via the exhaust back pressure sensor (B60)
- Intake air mass, from the hot film MAF sensor (B2/5)
- DPF differential pressure sensor (B28/8) with code (474) Particulate filter, soot content of the diesel particulate filter (DPF)

### Function sequence for charging

The function sequence is described in the following steps:

- **Function sequence for boost pressure with wide open throttle operation up to 1200 rpm**
- **Function sequence for boost pressure with wide open throttle operation as of 1200 rpm**
- **Function sequence for boost pressure with wide open throttle operation as of 2800 rpm**

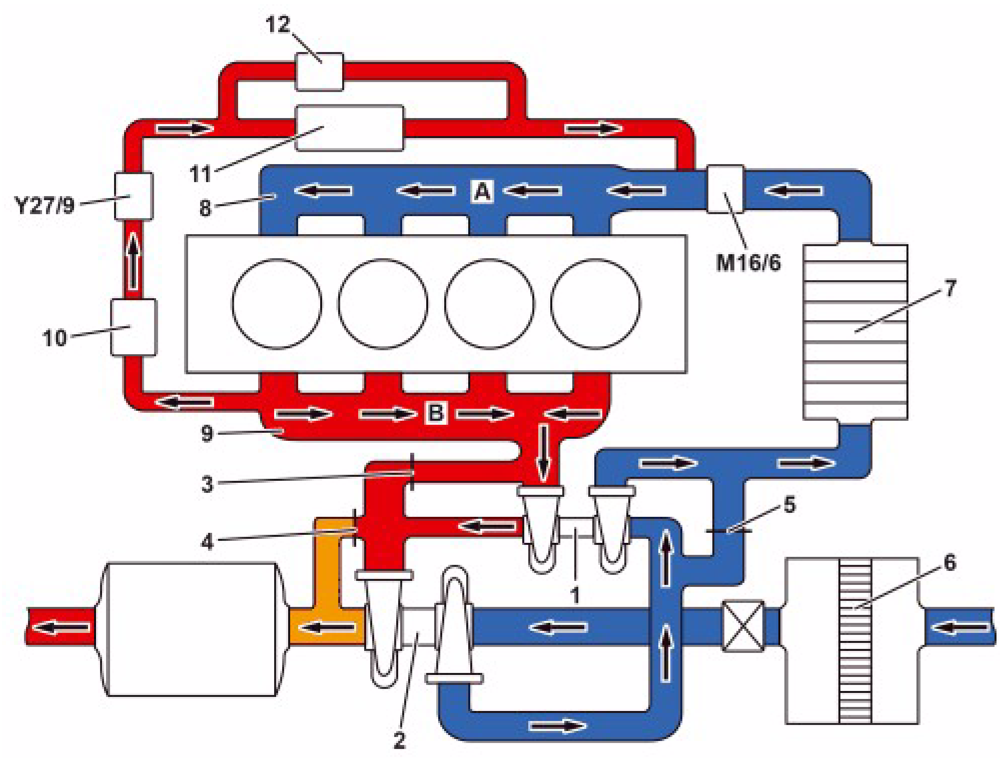
# Common Rail Diesel Injection (CDI), function description

**Function sequence for boost pressure control with wide open throttle operation up to 1200 rpm**

Up to an engine speed of 1200 rpm in wide open throttle operation, the exhaust flap is closed and the entire flow of exhaust gas flows via the turbine wheel of the high-pressure turbocharger to the turbine wheel of the low-pressure turbocharger and then to the exhaust system.

The largest part of the exhaust gas energy acts on the turbine wheel of the high-pressure turbocharger which thereby generates the main part of the necessary boost pressure.

The remaining exhaust gas energy acts on the turbine wheel of the low-pressure turbocharger which drives the compressor wheel via the supercharger shaft. The low-pressure turbocharger does not therefore act as a hydrodynamic retarder. The wastegate actuated by the boost pressure control pressure transducer and the compressor bypass are closed.




***Schematic representation showing wide open throttle operation boost pressure control up to 1200 rpm***

*1 High-pressure turbocharger*
*2 Low-pressure turbocharger*
*3 Exhaust flap*
*4 Wastegate*
*5 Compressor bypass*
*6 Air filter*
*7 Charge air cooler*
*8 Intake manifold*
*9 Exhaust manifold*
*10 Exhaust gas recirculation (EGR) precooler*
*11 Exhaust gas recirculation cooler*
*12 EGR bypass flap*

*M16/6 Throttle valve actuator*
*Y27/9 Exhaust gas recirculation actuator*

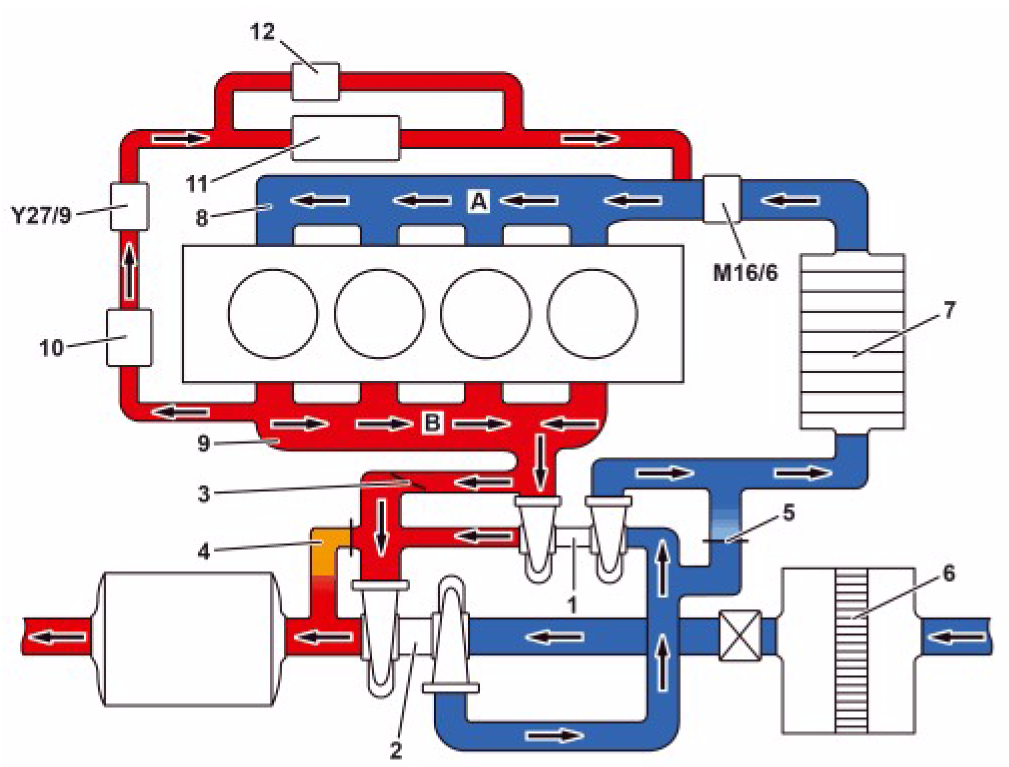
*A Intake air*
*B Exhaust flow*

# Common Rail Diesel Injection (CDI), function description

### Function sequence for boost pressure control with wide open throttle operation as of 1200 rpm

As of an engine speed of 1200 rpm in wide open throttle operation, the exhaust flap is opened depending on the required boost pressure.
The larger part of the exhaust flow continues to flow via the turbine wheel of the high-pressure turbocharger to the turbine wheel of the low-pressure turbocharger and then to the exhaust system. The largest part of the generated boost pressure is provided by the high-pressure turbocharger.

The low-pressure turbocharger is continuously activated and precompresses the drawn-in clean air.
As of an engine speed of approx. 2800 rpm, the exhaust flap is fully open.
The wastegate actuated by the boost pressure control pressure transducer and the compressor bypass continue to be closed.




***Schematic representation showing wide open throttle operation boost pressure control as of 1200 rpm***

*1 High-pressure turbocharger*
*2 Low-pressure turbocharger*
*3 Exhaust flap*
*4 Wastegate*
*5 Compressor bypass*
*6 Air filter*
*7 Charge air cooler*
*8 Intake manifold*
*9 Exhaust manifold*
*10 Exhaust gas recirculation (EGR) precooler*
*11 Exhaust gas recirculation cooler*
*12 EGR bypass flap*

*M16/6 Throttle valve actuator*
*Y27/9 Exhaust gas recirculation actuator*

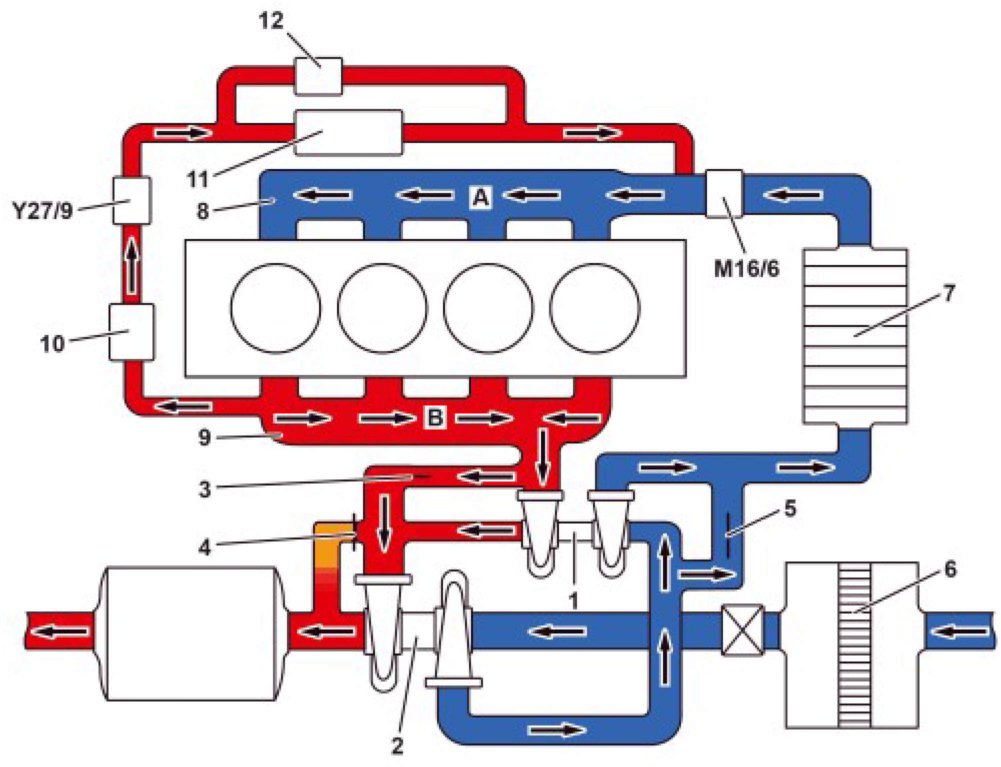
*A Intake air*
*B Exhaust flow*

# Common Rail Diesel Injection (CDI), function description

### Function sequence for boost pressure control with wide open throttle operation as of 2800 rpm

As of an engine speed of 2800 rpm, the compressor bypass and the exhaust flap are opened. The largest part of the charge air generated by the low-pressure turbocharger flows in front of the compressor housing of the high-pressure turbocharger via the charge air pipes to the charge air cooler and charge air manifold.
The low-pressure turbocharger thus generates the necessary boost pressure. Part of the exhaust flow drives the turbine wheel of the high-pressure turbocharger.The boost pressure generated is regulated by the wastegate actuated by the boost pressure control pressure transducer. The CDI control unit uses the boost pressure sensor to monitor theboost pressure actually generated.
The low-pressure turbocharger boost pressure sensor detects the boost pressure downstream of the low-pressure turbocharger. By comparing the boost pressure actually generated with the boost pressure stored in the characteristic map and the boost pressure downstream of the low-pressure turbocharger, it is possible to detect faults at the high-pressure and low-pressure turbocharger.

**Note:** The compressor bypass is self regulating dependent on the pressure, whereby the spring-loaded check valve takes the high-pressure turbocharger out of the delivery stream at high loads.



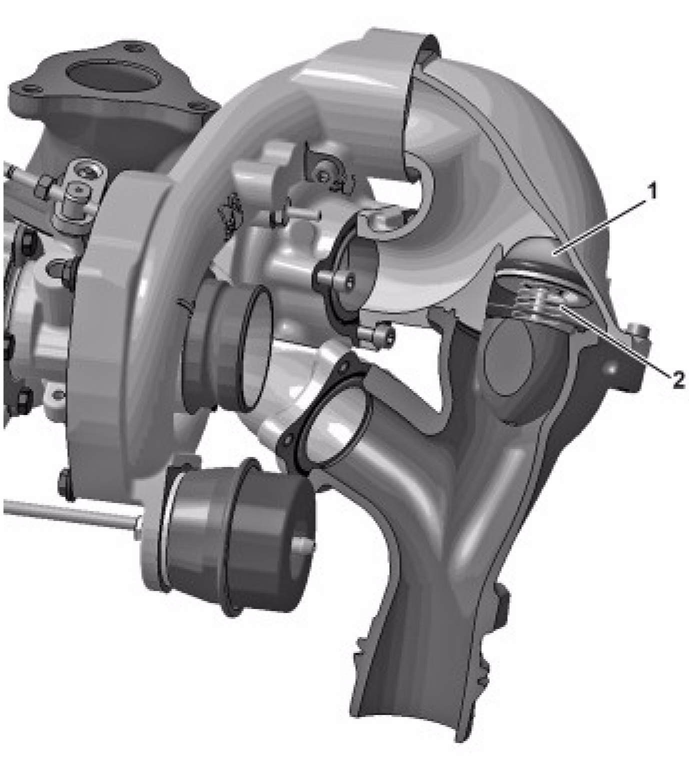

***Schematic representation showing wide open throttle operation boost pressure control as of 2800 rpm***

*1 High-pressure turbocharger*
*2 Low-pressure turbocharger*
*3 Exhaust flap*
*4 Wastegate*
*5 Compressor bypass*
*6 Air filter*
*7 Charge air cooler*
*8 Intake manifold*
*9 Exhaust manifold*
*10 Exhaust gas recirculation (EGR) precooler*
*11 Exhaust gas recirculation cooler*
*12 EGR bypass flap*

*M16/6 Throttle valve actuator*
*Y27/9 Exhaust gas recirculation actuator*

*A Intake air*
*B Exhaust flow*

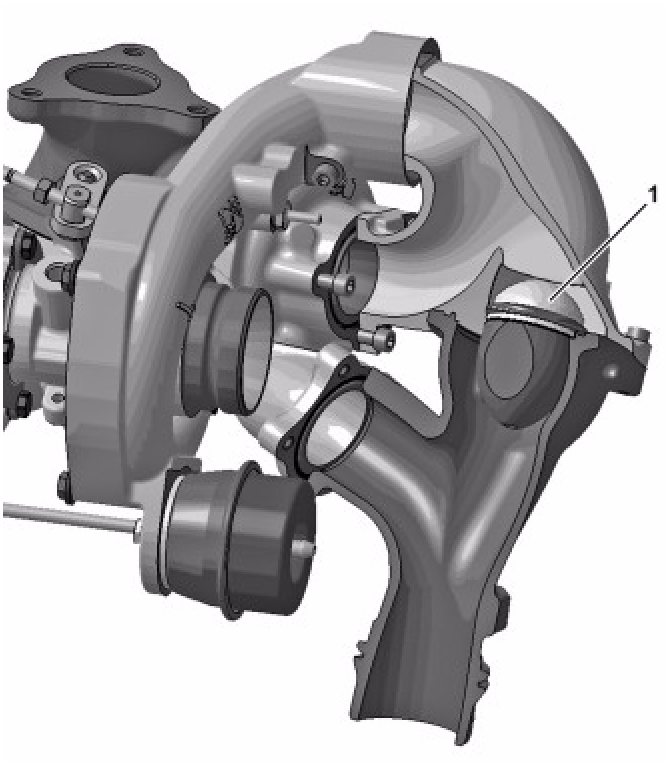
# Common Rail Diesel Injection (CDI), function description




***Shown: turbocharger with closed compressor by-pass***

*1 Check valve*
*2 Return spring*

# Common Rail Diesel Injection (CDI), function description

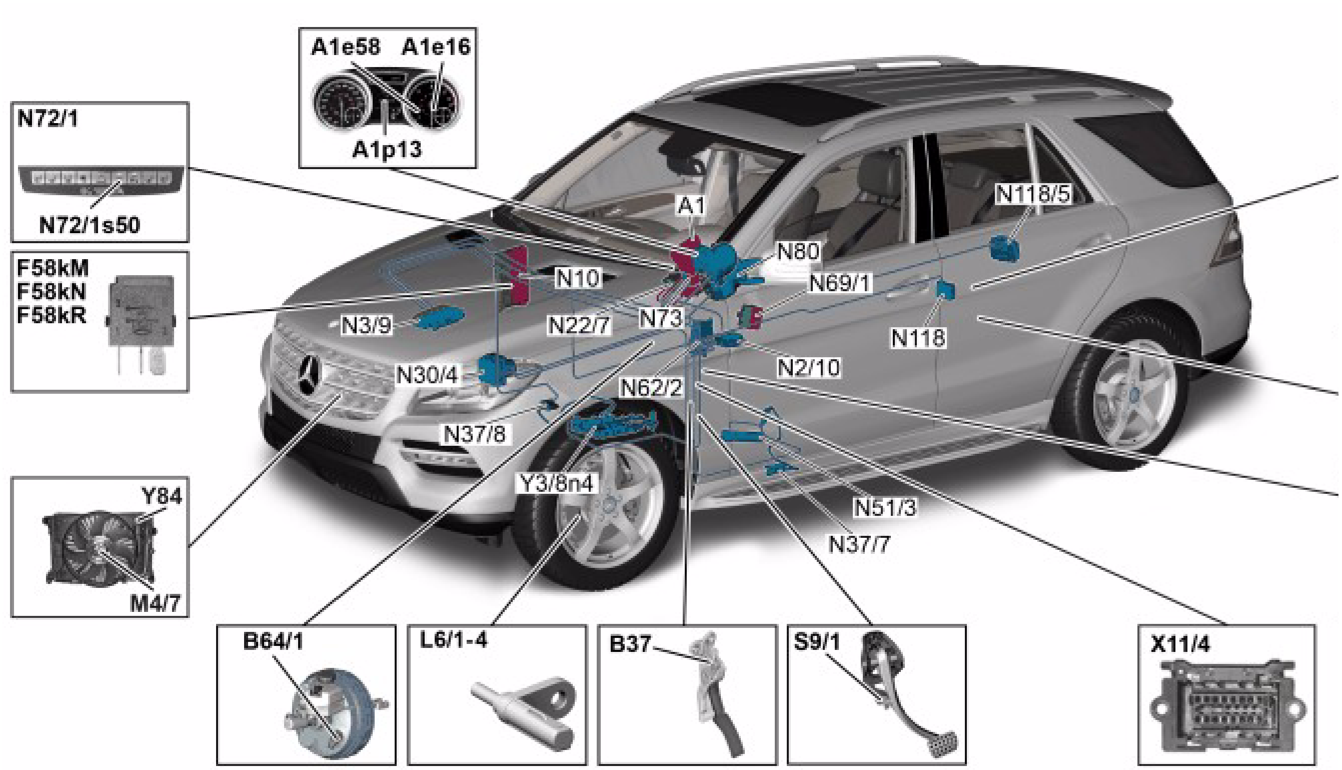



***Shown: turbocharger with opened compressor by-pass***

*1 Check valve*

# Common Rail Diesel Injection (CDI), function description

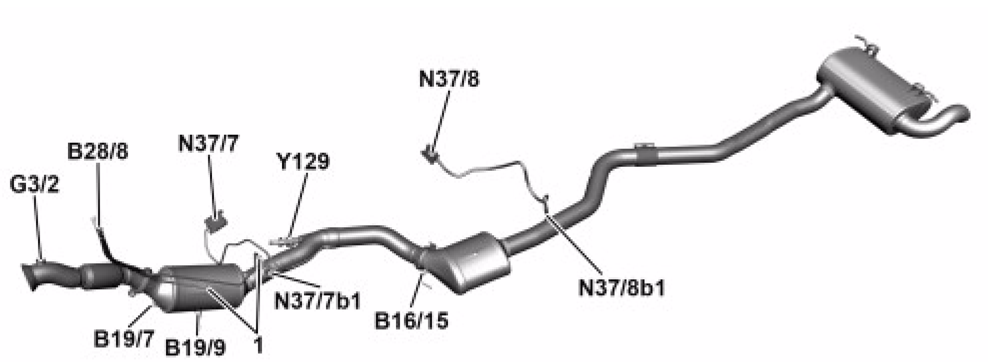
## Overview of system components, for common rail diesel injection (CDI)




(shown on model 166.0)

A1 Instrument cluster
A1e16 Preglow indicator lamp
A1e58 Engine diagnosis indicator lamp
A1p13 Multifunction display
B4/1 Fuel tank fuel level indicator fill level sensor, left
B4/2 Fuel tank fuel level indicator fill level sensor, right
B37 Accelerator pedal sensor
B64/1 Brake vacuum sensor
F4kD AdBlue® relay
F58kM-SFI Starter circuit 50 relay
F58kN Circuit relay 87M
F58kR Circuit 15 relay
G1 Onboard electrical system battery
L6/1 Left front axle speed sensor
L6/2 Right front axle speed sensor
L6/3 Left rear axle speed sensor
L6/4 Right rear axle speed sensor
M3 Fuel pump
M4/7 Fan motor
N2/10 Supplemental restraint system control unit
N3/9 CDI control unit
N10 SAM control unit
N22/7 Automatic air conditioning control and operating unit
N30/4 Electronic Stability Program control unit
N37/7 NOx sensor control unit downstream of diesel particulate filter (for code (U42) BlueTec (SCR) diesel exhaust treatment
N37/8 NOx sensor control unit downstream of SCR catalytic converter (for code (U42) BlueTec (SCR) diesel exhaust treatment
N51/3 AIRMATIC control unit (with code (489) Airmatic (air suspension with level adjustment and adaptive damping system (ADS))
N62/2 Video and radar sensor system control unit (with code (233) DISTRONIC PLUS, with code (237) Active Blind Spot Assist, with code (238) Active Lane Keeping Assist)
N69/1 Left front door control unit
N72/1 Upper control panel control unit
N72/1s50 ECO start/stop function button
N73 Electronic ignition switch control unit
N80 Steering column module control unit
N118 Fuel pump control unit
N118/5 AdBlue® control unit (with code (U42) BlueTEC (SCR) diesel exhaust treatment)
S9/1 Stop lamp switch
X11/4 Diagnostic connect
Y3/8n4 Fully integrated transmission control control unit
Y84 Radiator shutters actuator (except code (550) Trailer hitch)

# Common Rail Diesel Injection (CDI), function description

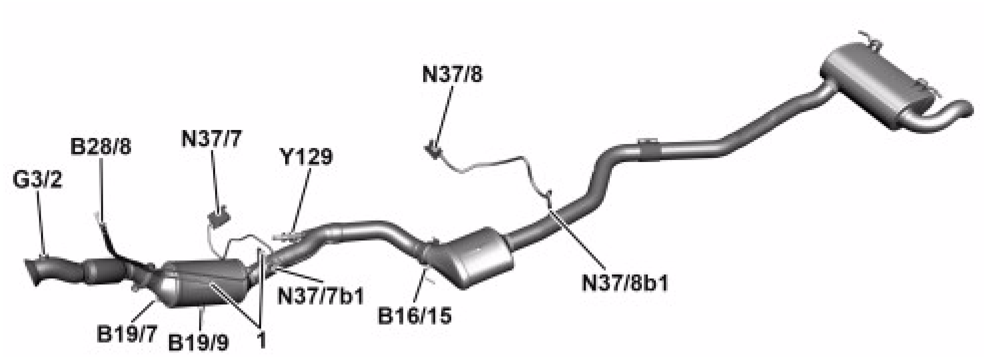



***View of exhaust system (shown on model 166.0)***

*1 Pressure lines*
*B16/15 Temperature sensor upstream of SCR catalytic converter (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*B19/7 Temperature sensor upstream of catalytic converter (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*B19/9 Temperature sensor upstream of diesel particulate filter (with code (474) Particulate filter)*
*B28/8 DPF differential pressure sensor (with code (474) Particulate filter)*
*G3/2 Oxygen sensor upstream of catalytic converter*
*N37/7 NOx sensor control unit downstream of diesel particulate filter (for code (U42) BlueTec (SCR) diesel exhaust treatment*
*N37/7b1 NOx sensor downstream of the diesel particulate filter (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*N37/8 NOx sensor control unit downstream of SCR catalytic converter (for code (U42) BlueTec (SCR) diesel exhaust treatment*
*N37/8b1 NOx sensor downstream of the SCR catalytic converter (with code (U42) BlueTEC (SCR) diesel exhaust treatment)*
*Y129 AdBlue® metering valve*

# Common Rail Diesel Injection (CDI), function description

## Component description for AdBlue® metering valve




*Shown on model 166.0*
*Y129 AdBlue® metering valve*

### Location

The AdBlue® metering valve is located in the underfloor, and is screwed into the exhaust system upstream of the SCR catalytic converter.

**Note:**

About 10 cm downstream of the AdBlue® metering valve there is a mixing element. This improves the hydrolysis of the AdBlue® reducing agent and ensures more uniform distribution of the AdBlue® upstream of the SCR catalytic converter. This is an important precondition for obtaining a high rate of conversion of the nitrogen oxides (NOx).

### Task

The tasks of the AdBlue® metering valve are subdivided into the following partial tasks:

- **Fuel injection**
- **Ventilation and deventilation of the pressure line**

### Fuel injection

The AdBlue® metering valve sprays in the reducing agent AdBlue® to reduce the NOx.

### Ventilation and deventilation of the pressure line

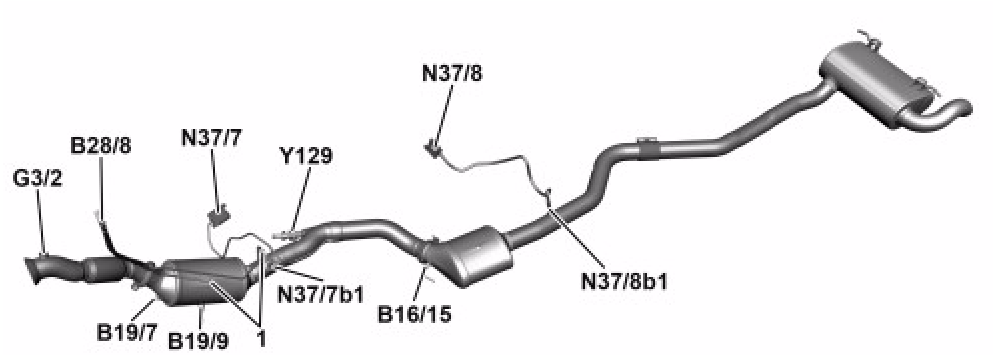
- Actuation of the AdBlue® metering valve to prevent the formation of an air cushion in the AdBlue® pressure line when filling the AdBlue® pressure line
- Actuation of the AdBlue® metering valve to prevent the formation of a vacuum during the return flow of residual AdBlue® reducing agent with "circuit 15 OFF" during powerdown of the AdBlue® control unit (N118/5)

**Note:**

- The duration of the return flow of the AdBlue® reducing agent and the duration of the pressure line filling depend on the length of the pressure line.
- The AdBlue® control unit sends the injected quantity of reducing agent over the drive train sensor CAN (CAN I) to the CDI control unit (N3/9). This quantity is taken into account in the next computation of the quantity of reducing agent by the CDI control unit.

# Common Rail Diesel Injection (CDI), function description

### Component description for temperature sensor upstream of diesel particulate filter




*(Shown on model 166.0)*

*B19/9 Temperature sensor upstream of diesel particulate filter*

#### Location

The temperature sensor upstream of the diesel particulate filter is in the component which consists of an oxicat and a diesel particulate filter (DPF), located upstream of the DPF.

#### Task

The temperature sensor upstream of diesel particulate filter detects the current exhaust temperature upstream of the diesel particulate filter.

#### Design

The temperature sensor upstream of diesel particulate filter consists of a metal housing with a positive temperature coefficient resistance.

#### Function

The installed PTC precision resistor changes its electrical resistance according to the exhaust temperature. The electrical resistance increases as temperature increases. The change in resistance results in a voltage signal, which is used by the CDI control unit (N3/9) to compute the exhaust temperature.

**Note:** PTC

PTC stands for "**P**ositive **T**emperature **C**oefficient", in other words, the electrical resistance increases as the temperature increases (PTC thermistor).

### Temperature sensor upstream of SCR catalytic converter, component description

*B16/15 Temperature sensor upstream of SCR catalytic converter*

#### Location

The temperature sensor upstream of SCR catalytic converter is located in the exhaust system upstream of the SCR catalytic converter.

#### Design

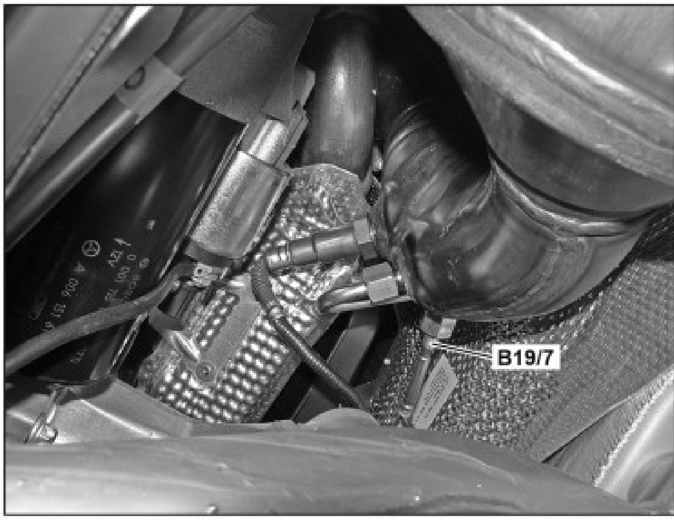
The temperature sensor upstream of SCR catalytic converter consists of a metal housing with a PTC precision resistor.

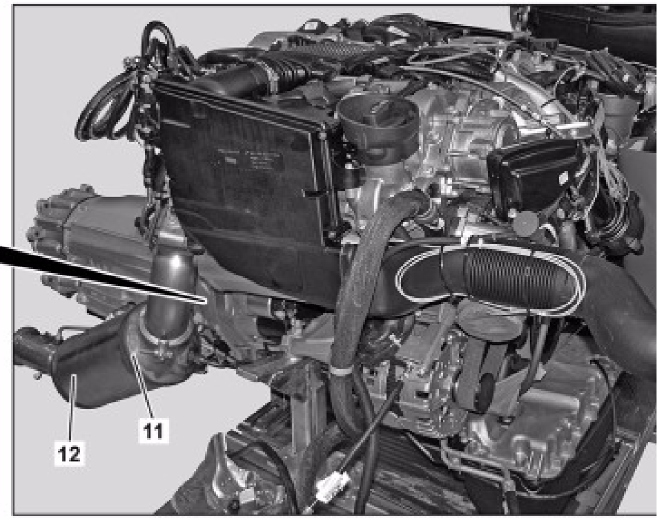
#### Function

The installed PTC precision resistor changes its electrical resistance according to the exhaust temperature. The electrical resistance increases as temperature increases.
The change in resistance results in a voltage signal, which is used by the CDI control unit (N3/9) to compute the exhaust temperature.

# Common Rail Diesel Injection (CDI), function description

## Component description for temperature sensor upstream of CAT




*(View of engine from right, shown on model 166.0)*

*11 Oxidation catalytic converter*
*12 Diesel particulate filter (DPF)*

*B19/7 Temperature sensor upstream of catalytic converter*

### Location

The temperature sensor upstream of catalytic converter is located before the oxidation catalytic converter.

### Task

The temperature sensor upstream of catalytic converter detects the exhaust temperature upstream of the oxidation catalytic converter.

### Design

The temperature sensor upstream of the catalytic converter consists of a metal housing with a PTC resistance.

### Function

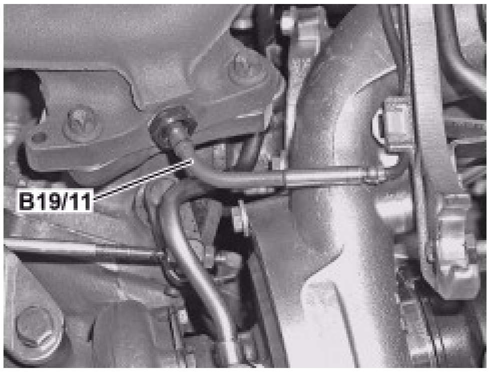
The integral PTC resistor integrated into the temperature sensor changes its electrical resistance according to the exhaust gas temperature. The electrical resistance increases as temperature increases.

**Note:**

- The CDI control unit (N3/9) monitors the function of the oxidation catalytic converter with the temperature sensor upstream of diesel particulate filter (B19/9) (with code (474) Particulate filter) and temperature sensor upstream of catalytic convert within the onboard diagnosis (OBD).
- PTC stands for "**P**ositive **T**emperature **C**oefficient", in other words, the electrical resistance increases as the temperature increases (PTC thermistor).

# Common Rail Diesel Injection (CDI), function description

## Component description for temperature sensor upstream of turbocharger




*View of engine from top right, shown on model 166.0*

*B19/11 Temperature sensor upstream of turbocharger*

### Location

The temperature sensor upstream of the turbocharger is located on the exhaust manifold flange upstream of the turbocharger.

### Task

The temperature sensor upstream of turbocharger determines the exhaust gas temperature upstream of the turbocharger.

### Note:

The determined exhaust gas temperature is used by the CDI control unit (N3/9) to protect the engine and turbocharger against thermal overloading.

### Design

The temperature sensor upstream of the turbocharger consists of a metal housing with an integral positive temperature coefficient resistance.

### Function

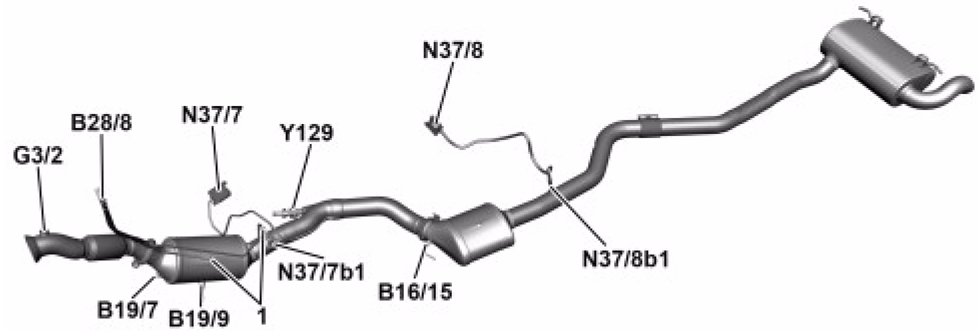
The electrical resistance of the PTC resistor integrated in the temperature sensor upstream of the turbocharger varies according to the exhaust temperature. Electrical resistance increases as temperature increases. The change in resistance results in a voltage which is used by the CDI control unit to compute the exhaust temperature upstream of the turbocharger.

### Note:

PTC stands for "**P**ositive **T**emperature **C**oefficient", in other words, the electrical resistance increases as the temperature increases (PTC thermistor).

# Common Rail Diesel Injection (CDI), function description

### Component description for an oxygen sensor



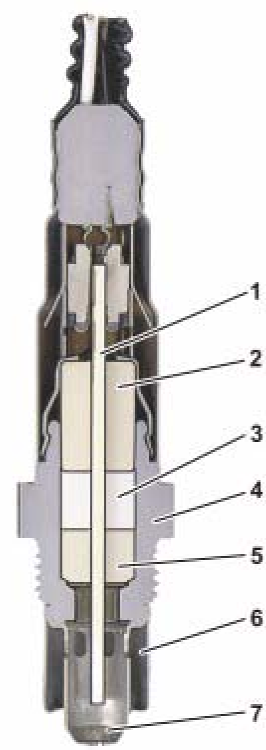

*Shown on model 166.0*

*G3/2 Oxygen sensor upstream of catalytic converter*

### Task

The oxygen sensor upstream of CAT detects the residual oxygen content in the exhaust upstream of the oxidation catalytic converter for the following tasks:

- Injection control
- Zero quantity calibration
- Injection quantity correction
- Emission control
- Function chain tests (for onboard diagnosis (OBD))




### Design

1 Sensor element (combination of Nernst concentration cell and oxygen pump cell)
2 Upper isolator bushing
3 Sealing package
4 Sensor housing
5 Lower isolator bushing
6 Outer protective tube
7 Inner protective tube

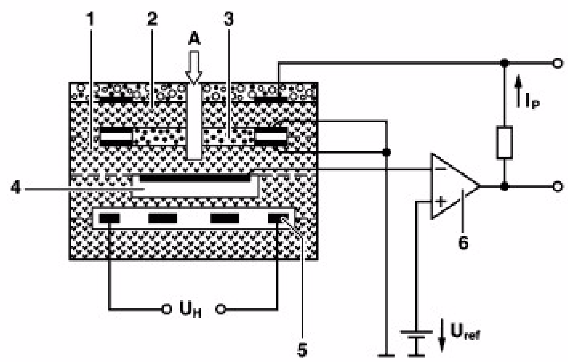
# Common Rail Diesel Injection (CDI), function description

The oxygen sensor upstream of CAT is designed as a wideband oxygen sensor. It consists of a pump cell, a concentration cell and a heating element. The pump cell is connected with the concentration cell via a diffusion gap. The concentration cell is connected via the reference air duct with the ambient atmosphere.

**Function of the wideband oxygen sensor (schematic)**

*1 Nernst concentration cell*
*2 Oxygen pump cell*
*3 Diffusion gap*
*4 Reference air duct*
*5 Sensor heater*
*6 Regulator circuit*
*A Exhaust*

*IP Pump current*
*UH Heater voltage*
*Uref Reference voltage*




**Function**

The exhaust in the measuring chamber for the concentration cell passes through the diffusion gap. Through application of the supply voltage to the platinum electrodes of the pump cell, oxygen is pumped into or out of the reference chamber. If lambda = 1 is already available in the measuring chamber no oxygen needs to be transported. In this case, the pump current is 0 mA. The CDI control unit (N3/9) subsequently regulates the voltage in such a way that the mixture composition in the measuring housing is held constant at the value Lamda = 1. If the exhaust gas is lean, oxygen is pumped out of the measuring chamber through the pump cell.

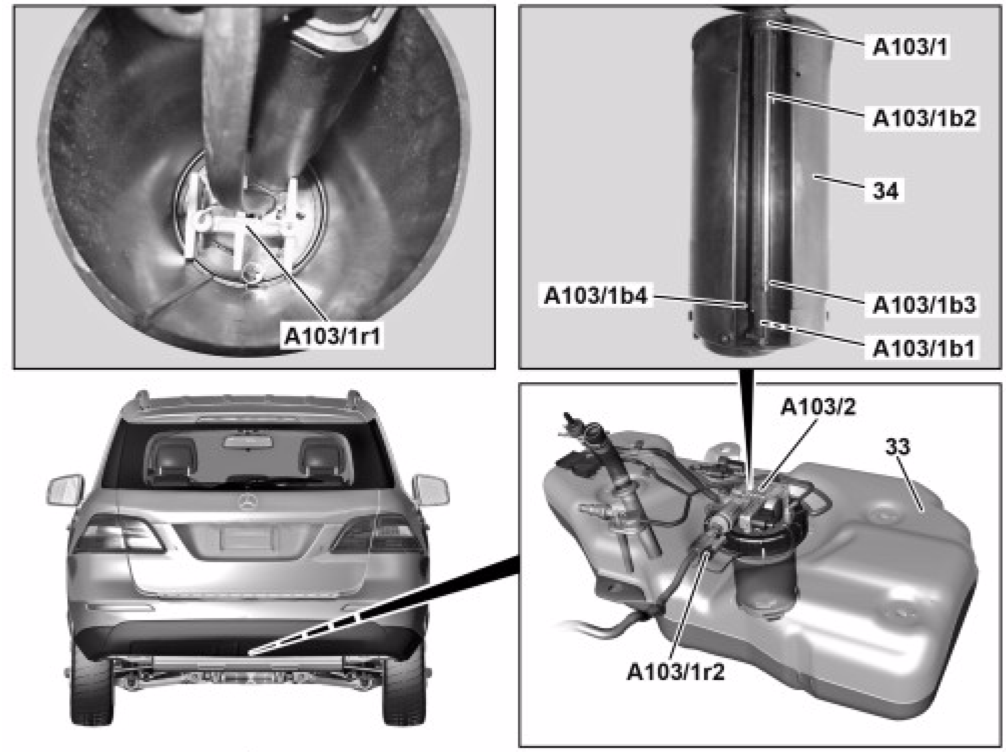
This process is recognized by the CDI control unit based on the negative pump current. If the exhaust gas is rich, oxygen is pumped into the measuring chamber. The oxygen is generated by the catalytic decomposition of carbon dioxide (CO2) and water. This process is recognized by the CDI control unit based on the positive pump current. Thus the pump current required in each case is a measure for the Lambda air/fuel ratio.
The integral heating element is actuated as required by the CDI control unit in order to bring the oxygen sensor upstream of catalytic converter up to the operating temperature of about 600°C.

**Note:**

Diesel engines operate with a lean mixture (excess air) of 1.3 < Lambda< 6.

# Common Rail Diesel Injection (CDI), function description

### View of AdBlue® container (with code(U42) BlueTec (SCR) diesel exhaust

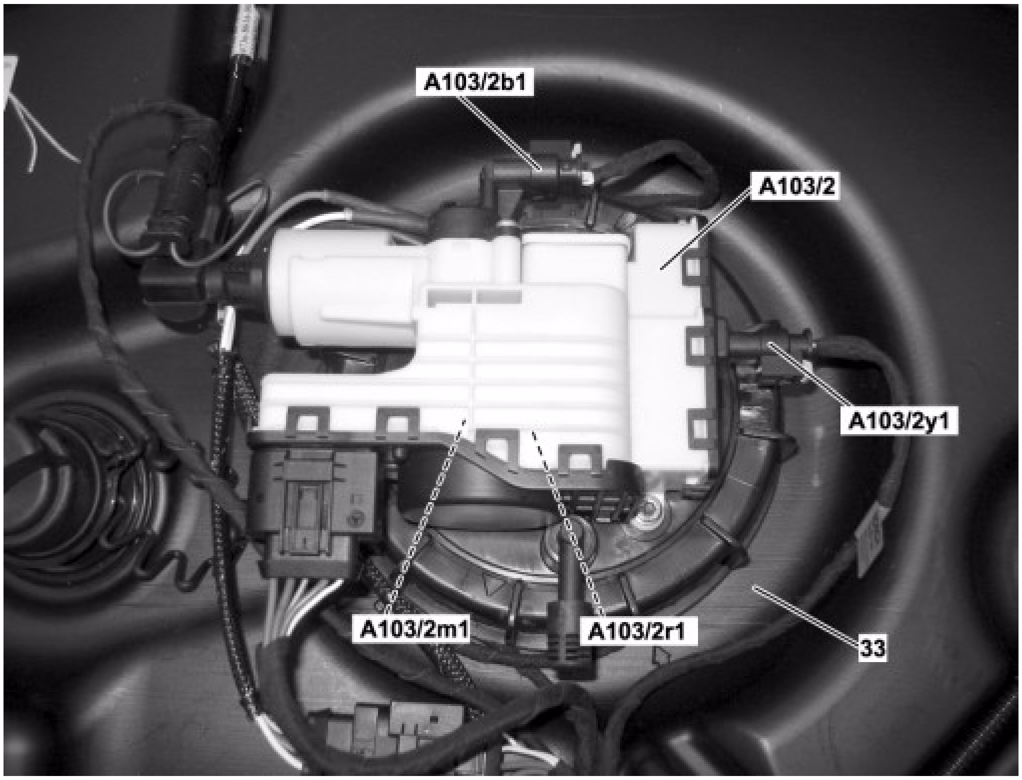



*(Shown on model 166.0)*

*33 AdBlue® tank*
*34 AdBlue® extraction tank*
*A103/1 AdBlue® tank module*
*A103/1b1 AdBlue® tank temperature sensor*
*A103/1b2 Fill level sensor (full)*
*A103/1b3 Fill level sensor (reserve)*
*A103/1b4 Fill level sensor (empty)*
*A103/1r1 AdBlue® tank heating element*
*A103/1r2 AdBlue® pressure line heating element*
*A103/2 AdBlue® delivery module*

# Common Rail Diesel Injection (CDI), function description

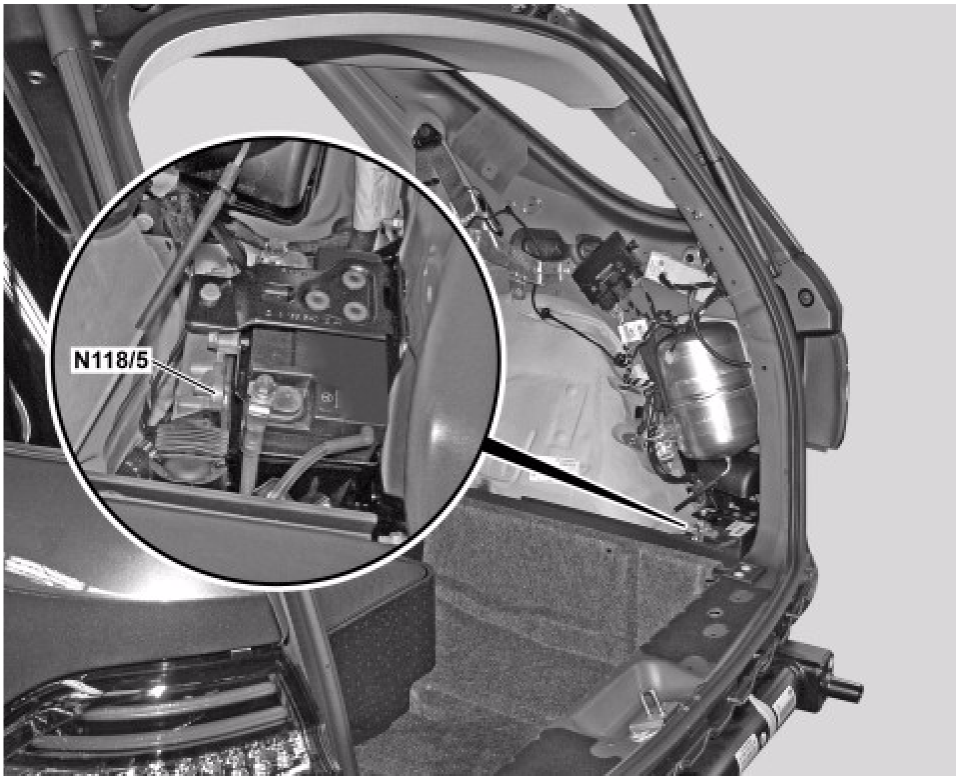
***View of AdBlue® container (with code (U42) BlueTec (SCR) diesel exhaust*** **treatment**




*(Shown on model 166.0)*
*33 AdBlue® tank*
*A103/2 AdBlue® delivery module*
*A103/2b1 AdBlue® pressure sensor*
*A103/2m1 AdBlue® delivery pump*
*A103/2r1 AdBlue® delivery module heating element*
*A103/2y1 AdBlue® switchover valve*

# Common Rail Diesel Injection (CDI), function description

## Component description for exhaust after-treatment control unit




*(Shown on model 166.0 from the rear)*

*N118/5 AdBlue® control unit*

### Location

The AdBlue® control unit is located at the rear right.

### Task

The AdBlue® control unit controls the following functions based on a characteristics map:
- AdBlue ® delivery
- Fuel injection
- Antifreeze and recycling

### Input and output signals

The following input signals are evaluated by the AdBlue® control unit and the corresponding output signals issued:
- **Direct input signals**
- **Direct output signals**
- **CAN input signals**
- **CAN output signals**

### Direct input signals

- Circuit 31
- Circuit 30, via circuit 87 for the AdBlue® supply relay (K27/7)
- Sensor signal from AdBlue® pressure sensor (A103/2b1)
- “Full“ level sensor signal (A103/1b2)
- “Reserve” level sensor signal (A103/1b3)
- “Empty" level sensor signal (A103/1b4)
- AdBlue ® tank temperature sensor signal (A103/1b1)
- Sensing of the power consumption for diagnosis of the AdBlue® delivery pump (A103/2m1)

### Direct output signals

- Supply for circuit 31 for the AdBlue® supply relay
- Joint supply of circuit 30 for AdBlue® delivery pump and AdBlue® switchover valve (A103/2y1
- Supply of circuit 31 for the AdBlue® delivery pump
- Pulse width modulated (PWM) signal for actuation of the AdBlue® delivery pump

## Common Rail Diesel Injection (CDI), function description

- Control signal circuit 31 for actuation of AdBlue® switchover valve
- PWM sigal for actuation of the AdBlue® metering valve (Y129)
- Power supply for the AdBlue® tank heating element (A103/1r1)
- Power supply for AdBlue® delivery module heating element (A103/2r1)
- Power supply for AdBlue® pressure line heating element (A103/1r2)

**CAN input signals**
*CDI control unit (N3/9)*

- Request for reduction agent injection
- Specification of the reduction agent quantity to be injected
- Specification of the run-on period of the control units
- Diagnosis request

**CAN output signals**
*CDI control unit (N3/9)*

- Reduction agent quantity to be injected for NOx reduction
- Reduction agent quantity to be injected for cooling the AdBlue® metering valve
- Fill level status in the AdBlue® tank
- Requested diagnostic data

**AdBlue delivery**

- Feed to the AdBlue® delivery pump to obtain the operating current consumption as a basis for the diagnosis of the AdBlue® delivery pump
- Actuation of AdBlue® delivery pump, to generate a pressure of 5 bar before and during the injection of reducing agent for nitrogen oxide (NOx) reduction. The delivery pressure can be set with the control unit software and may differ according to the particular variant.
- Actuation of the AdBlue® delivery pump to generate a pressure of 5 bar before and during injection of the reducing agent for cooling the AdBlue® metering valve
- Actuation of the AdBlue® metering valve for ventilation of the AdBlue® pressure line when filling the AdBlue® pressure line

**Fuel injection**

Actuation of the AdBlue® metering valve during injection of the reducing agent for NOx reduction and for cooling the AdBlue® metering valve

**Antifreeze and recycling**

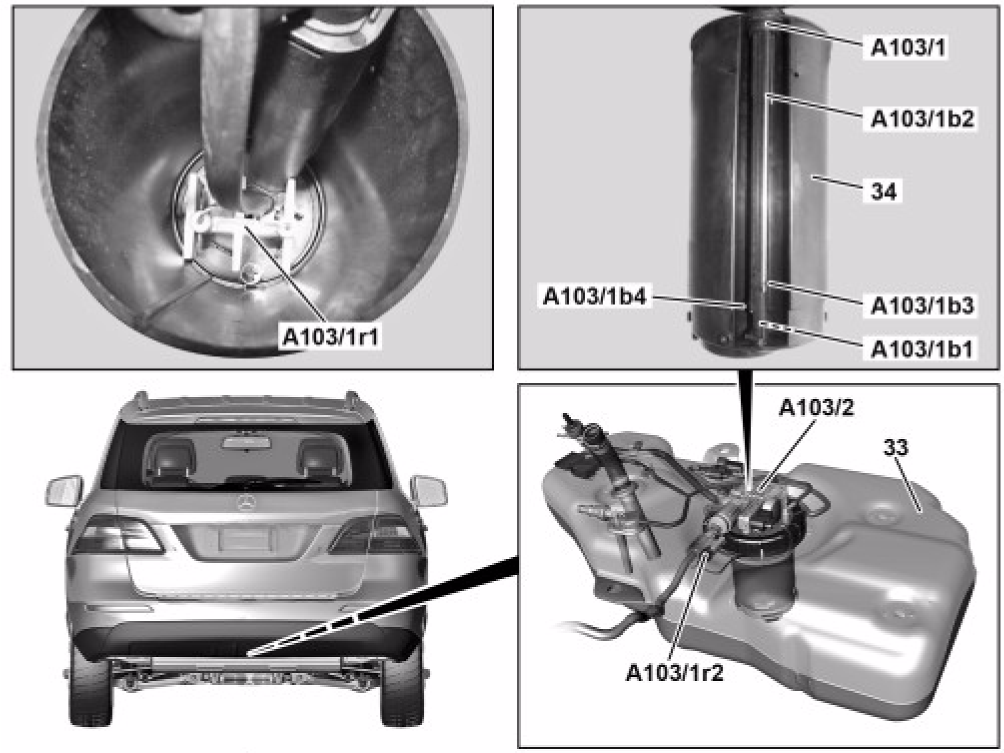
- After "circuit 15 ON", the pump is given an initial run (warmup) if the weather is cold. The initial run serves to remove the friction in cold weather, so that the required compression can be made available as soon as possible when pressure is requested.
- Actuation of the AdBlue® tank heating element to liquefy the AdBlue® reducing agent in the AdBlue® tank, which freezes at about -10° C
- Actuation of the AdBlue® delivery module heating element and AdBlue® pressure line heating element to ensure flowability of the AdBlue® reducing agent (which freezes at about -10° C ) in the AdBlue® feed module (A103/2) and in the pressure line to the AdBlue® metering valve
- Actuation of the AdBlue® delivery pump, AdBlue® switchover valve and AdBlue® metering valve to return the AdBlue® reducing agent from the pressure line to the AdBlue® tank during powerdown of the AdBlue® control unit after "circuit 15 OFF"

**Note:**

- The duration of the return flow of the AdBlue® reducing agent and the duration of the pressure line filling depend on the length of the pressure line.
- The quantity of reducing agent injected by the AdBlue® metering valve is sent by the AdBlue® control unit over the drive train sensor CAN to the CDI control unit. This quantity is taken into account in the next computation of the quantity of reducing agent by the CDI control unit.

# Common Rail Diesel Injection (CDI), function description

### Component description for AdBlue tank temperature sensor




*(Shown on model 166.0)*

*A103/1b1 AdBlue® tank temperature sensor*

#### Location

The AdBlue® container temperature sensor is located in the AdBlue® tank module. The AdBlue® tank module is inserted in the AdBlue® tank together with the AdBlue® extraction tank.

#### Task

The AdBlue® tank temperature sensor detects the temperature of the reducing agent AdBlue® in the AdBlue® tank.

#### Design

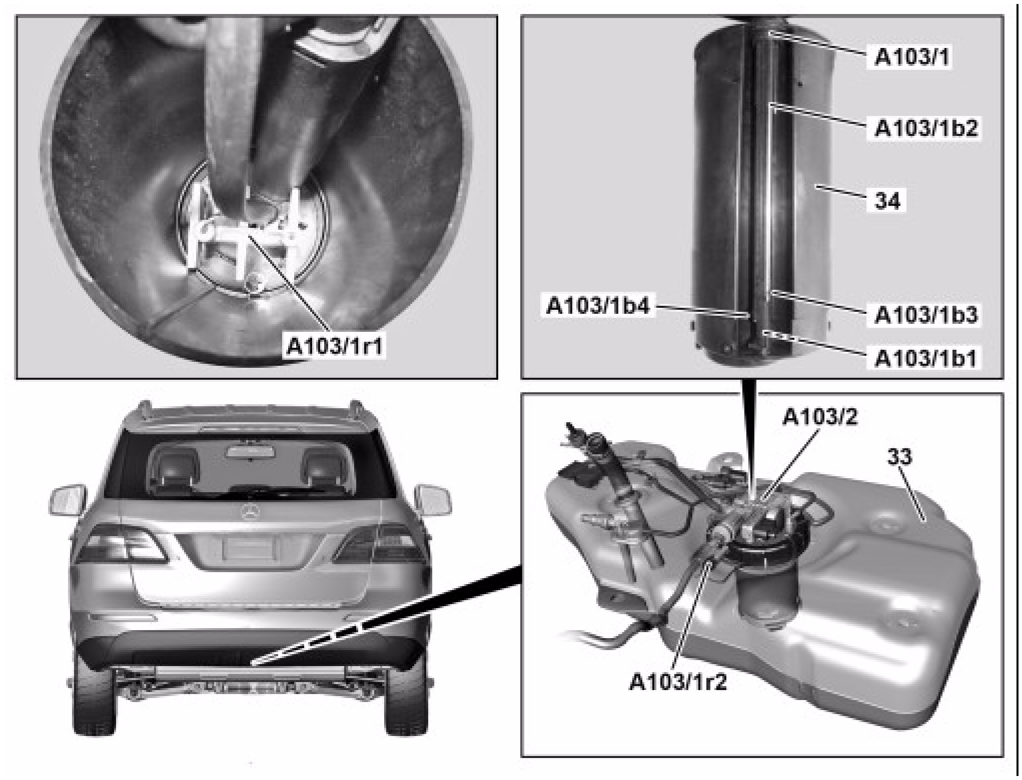
The AdBlue® tank temperature sensor has an integrated measuring resistor with negative temperature coefficient (NTC).

#### Function

The NTC measuring resistor changes its electrical resistance according to the temperature of the AdBlue® reducing agent. Electrical resistance decreases as temperature increases. The variation in resistance causes a voltage signal to be generated, and this is used by the AdBlue® control unit (N118/5) to calculate the temperature of the reducing agent.

# Common Rail Diesel Injection (CDI), function description

### Component description for fill level sensor




*(Shown on model 166.0)*

*33 AdBlue® tank*
*34 AdBlue® extraction tank*
*A103/1 AdBlue® tank module*
*A103/1b1 AdBlue® tank temperature sensor*
*A103/1b2 Fill level sensor (full)*
*A103/1b3 Fill level sensor (reserve)*
*A103/1b4 Fill level sensor (empty)*
*A103/2 AdBlue® delivery module*

#### Location

The fill level sensor, reserve level sensor and empty level sensor are positioned one above the other and are located together with the AdBlue® tank temperature sensor in the AdBlue® tank module, which is inserted in the AdBlue® tank together with the AdBlue® extraction tank.

#### Task

The fill level sensors detect the fill level height of the reducing agent AdBlue® in the AdBlue® tank.

#### Design

Each of the fill level sensors has an electrode. Another electrode at the end of the AdBlue® tank module is used as a common reference electrode.

#### Function

The AdBlue® control unit (N118/5) actuates the fill level sensors one after another by means of a pulse width modulated (PWM) signal.
If the electrodes of all fill level sensors and the reference electrode are moistened with AdBlue® reducing agent, the AdBlue® control unit detects through the sensor signals that the AdBlue® tank is "Full".
If the electrodes of the Reserve level sensor, Empty level sensor and the reference electrode are moistened with AdBlue® reducing agent, the AdBlue® control unit detects that the fill level is between "Full" and "Reserve".

# Common Rail Diesel Injection (CDI), function description

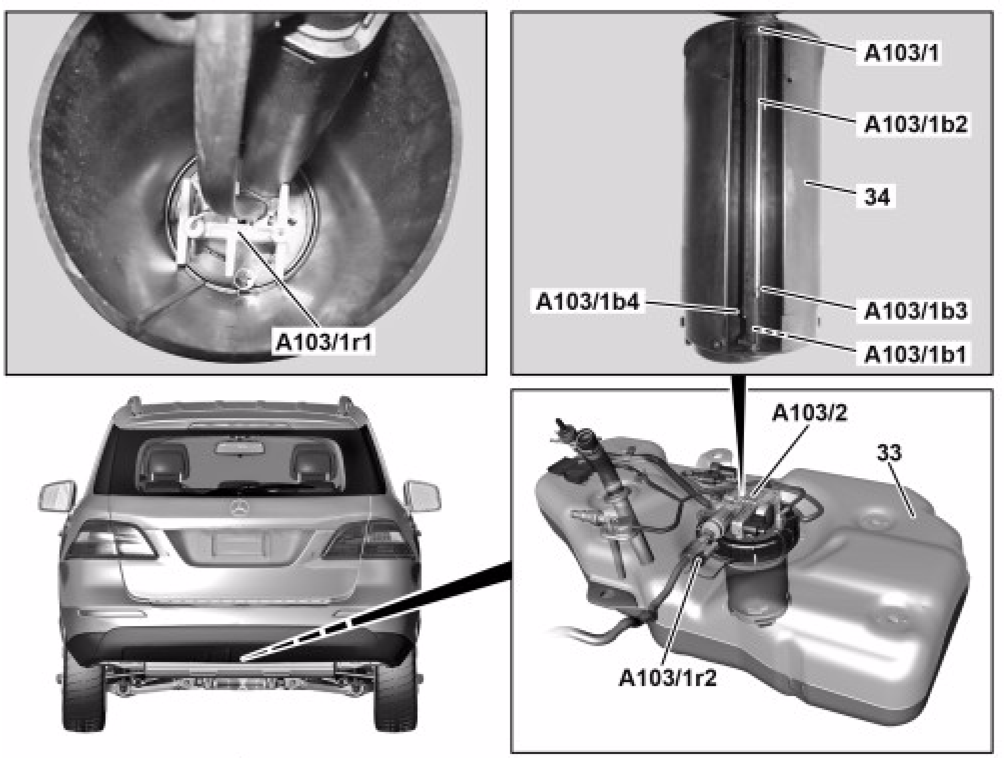
If only the electrode of the Empty level sensor and the reference electrode are moistened with reducing agent, the control unit detects the "Reserve" fill level.

If only the reference electrode is moistened with AdBlue® reducing agent, the fill level is "Empty". The AdBlue® control unit sends the corresponding fill level signal over the drive train sensor CAN (CAN I) to the CDI control unit (N3/9) and over the drive train CAN to the instrument cluster (A1). Depending on the fill level (Full, Reserve or Empty), a message is issued by the instrument cluster which is supported in the case of fill level "Reserve" and fill level "Empty" by an acoustic signal. After each fill level recognition, the possible range which can be achieved with the stocks of reducing agent available is determined by a computer model.

**Note:**

- When the "Reserve" fill level is reached, the driver is informed by means of an audible and a message on the multifunction display (A1p13) that he should find a workshop and have the required maintenance work done.
- If the "empty" level is reached in the AdBlue® container, the plausibility of the "empty" level is checked through a computer model. If the plausibility check also results in an "empty" fill level, an audible signal is given, an entry is made in the fault memory of the control unit (CDI), and the engine diagnosis indicator lamp (A1e58) is lit on the instrument cluster. The driver then has up to 20 engine starts available, with an assumed trip distance of 32 kilometers or 20 miles in each case. The number of remaining starts is displayed in the instrument cluster. The vehicle can no longer be started after the last remaining "Start".
- Fluctuations in the fill level due to particular driving situations are compensated for by a damping function in the AdBlue® control unit.

### Component description for AdBlue tank heating element




*(Shown on model 166.0)*

*A103/1r1 AdBlue® tank heating element*

**Location**

The AdBlue® tank heating element is located in the AdBlue® extraction tank.

**Task**

The AdBlue® tank heating element warms the reducing agent AdBlue® at low temperatures.

**Function**

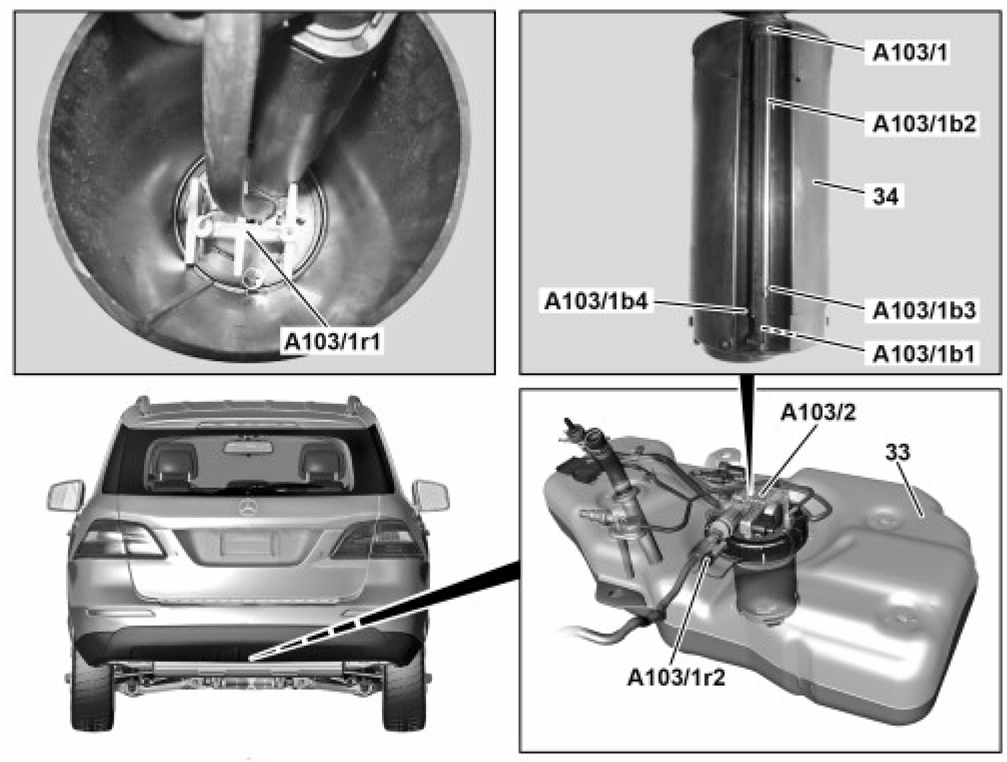
The AdBlue® tank heating element consists of a positive temperature coefficient (PTC) heating element and is actuated depending on the temperature determined by the AdBlue ® container temperature sensor (A103/1b1) by the AdBlue® control unit (N118/5). The power consumption is self-regulated via the PTC behavior of the heating element.

**Note:**

PTC stands for "**P**ositive **T**emperature **C**oefficient", in other words, the electrical resistance increases as the temperature increases (PTC thermistor).

# Common Rail Diesel Injection (CDI), function description

### Component description for AdBlue pressure line heater




*(Shown on model 166.0)*

*A103/1r2 AdBlue® pressure line heating element*

**Location**

The AdBlue® pressure line heating element (A103/2) runs spirally around the AdBlue® pressure line, from the AdBlue® feed module to the AdBlue® metering valve (Y129).

**Task**

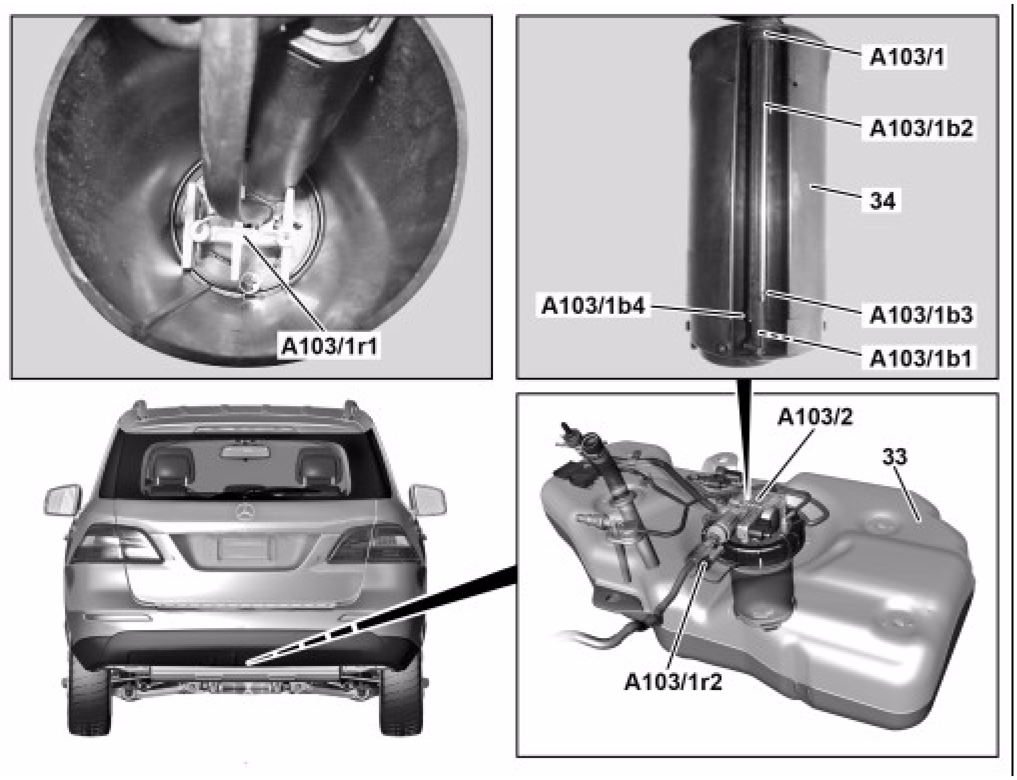
The AdBlue® pressure line heating element warms the AdBlue® pressure line and thus the reducing agent AdBlue®.

**Note:**

The AdBlue® pressure line heating element has a number of connectors and can therefore not be checked using a resistance measurement.

# Common Rail Diesel Injection (CDI), function description

### Component description for AdBlue delivery module




*(Shown on model 166.0)*

*A103/2 AdBlue® delivery module*

### Location

The AdBlue® delivery module is located on the AdBlue® tank.

### Task

The function of the AdBlue® feed module is divided into the following subfunctions:

- **Pressure generation**
- **Pressure measurement**
- **Flow reversal**
- **Antifreeze protection**

### Pressure generation

The AdBlue control unit (N118/5) actuates the AdBlue delivery pump (A103/2m1) by means of a pulse width modulated (PWM) signal according to a characteristic map. Part of the suctioned in AdBlue® reducing agent is passed back via a bypass in the AdBlue® delivery module into the 2-tank system (AdBlue® tank with AdBlue® removal tank). This ensures that the AdBlue® removal tank is always filled and no air is suctioned in otherwise the required system pressure of 5 bar cannot be generated.

# Common Rail Diesel Injection (CDI), function description

### Pressure measurement

Over the AdBlue® pressure sensor (A103/2b1), the AdBlue® control unit detects the system pressure generated by the AdBlue® delivery pump.
If the system pressure of 5 bar is not reached, the AdBlue system is shut down, an entry is made in the fault memory of the CDI control unit (N3/9) and a message is shown on the multifunction display (A1p13) of the instrument cluster (A1).

### Flow reversal

Powerdown of the AdBlue control unit is started for "circuit 15 OFF".
During powerdown of the control unit, residual AdBlue® reducing agent is pumped out of the pressure line by the AdBlue® delivery pump through the AdBlue® reversing valve (A103/2y1), which is actuated by the AdBlue® control unit. The AdBlue® metering valve (Y129) is opened at the same time so that no vacuum arises.
The duration of powerdown and the timing of the reducing agent return flow depend on the exhaust temperature, since exhaust the AdBlue® pressure line and other system components can be damaged if the exhaust gas is too hot.

### Antifreeze protection

The AdBlue® tank heating element (A103/1r1) ensures that the AdBlue® reducing agent pumped out of the 2-tank system remains fluid even in cold temperatures.
In cold temperatures, the AdBlue® delivery module and the AdBlue® reducing agent are also warmed up by the AdBlue® delivery module heating element (A103/2r1) according to a characteristic map. The pressure line is also warmed up by the AdBlue® (A103/1r2) heating element pressure line, according to a characteristic map.

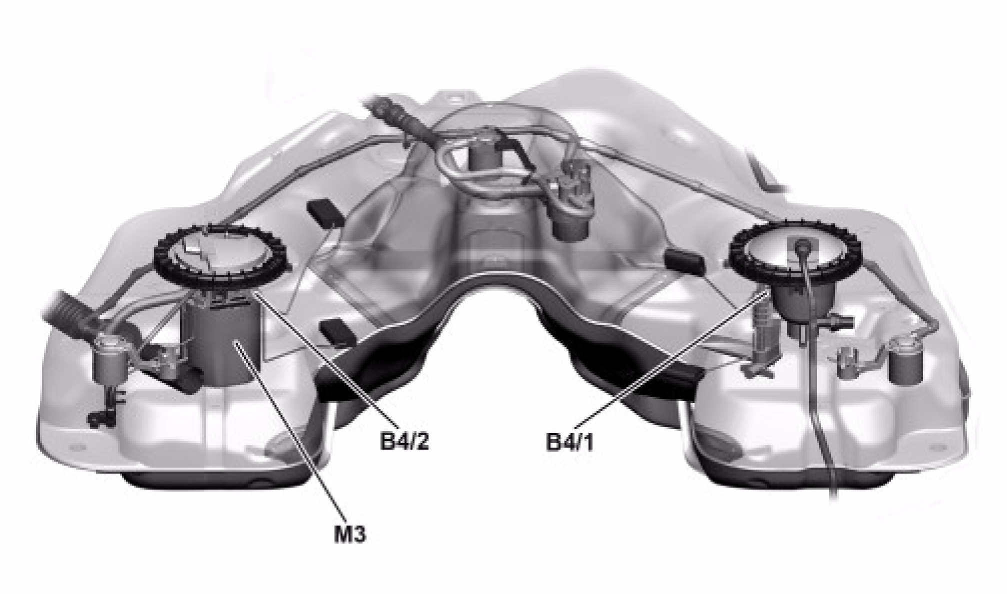
Pumping back the residual AdBlue® reducing agent prevents the AdBlue® pressure line and AdBlue® feed module from being damaged if the reducing agent freezes at about 10° C.

The AdBlue® feed module is made up of the following components:

- AdBlue ® delivery pump
- AdBlue ® switchover valve (4-2 directional control valve)
- AdBlue ® pressure sensor
- AdBlue ® delivery module heating element

# Common Rail Diesel Injection (CDI), function description

## Component description for fuel pump




*Shown on model 166.0*
*M3 Fuel pump*

### Location

The fuel pump is integrated in the fuel feed module. The fuel feed module is integrated in turn in the fuel tank.

### Task

The fuel pump makes the fuel available to the high-pressure pump in sufficient quantity and at the required pressure.

### Design

The fuel pump is a single-stage positive-displacement pump. A fuel strainer is installed at the bottom as a coarse filter for the fuel pump feed.

### Function

The fuel pump draws the fuel from the fuel feed module through a fuel strainer. The fuel pump then pumps the suctioned fuel through the fuel filter to the high-pressure pump.

### Note:

The generated fuel pump pressure is monitored over the fuel pressure sensor (B4/7) by the FSCU (N118).