ENGINES 900.9 in MODEL 970, 972, 975, 976 with CODE (MS4) BlueTec 4
ENGINES 900.9 in MODEL 970, 972, 975, 976 with CODE (MS5) BlueTec 5
ENGINES 902.9 in MODEL 970, 972, 974, 975, 976 with CODE (MS4) BlueTec 4
ENGINES 902.9 in MODEL 970, 972, 974, 975, 976 with CODE (MS5) BlueTec 5
ENGINES 924.9 in MODEL 970, 972, 974 with CODE (MS4) BlueTec 4
ENGINES 924.9 in MODEL 970, 972, 974 with CODE (MS5) BlueTec 5
ENGINES 902.9 in MODEL 950.5 /6, 952.5 /6, 953.6, 954.5, 957 with CODE (MS4) BlueTec 4
ENGINES 902.9 in MODEL 950.5 /6, 952.5 /6, 953.6, 954.5, 957 with CODE (MS5) BlueTec 5
ENGINES 926.9 in MODEL 950.5 /6, 952.5 /6, 953.6, 954.5, 957 with CODE (MS4) BlueTec 4
ENGINES 926.9 in MODEL 950.5 /6, 952.5 /6, 953.6, 954.5, 957 with CODE (MS5) BlueTec 5

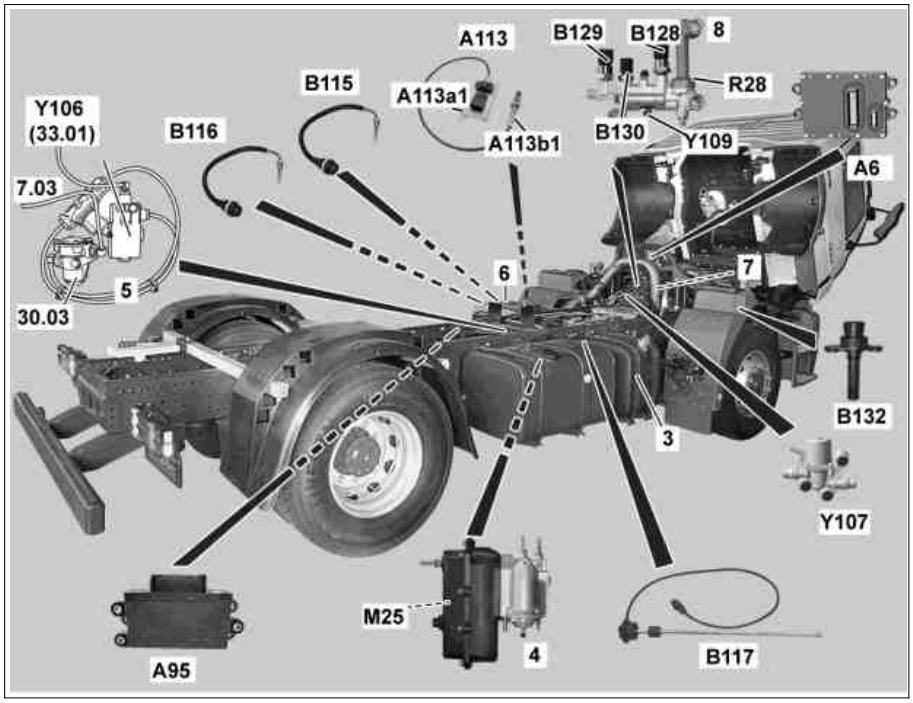
Basic components

Illustrated on model 950.5

3 *AdBlue tank*
4 *Pump module*
5 *Compressed air control unit*
6 *Muffler with reduction catalytic converter*
7 *Injection nozzle (in engine brake flap fitting)*
8 *Metering device*

7.03 *Overflow valve without return flow*
30.03 *Pressure limiting valve with vent*

A6 *Engine control (MR) control unit*
A95 *SCR frame module control unit*
A113 *NOx sensor with controller unit*
A113a1 *NOx sensor controller unit*



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A113b1 *NOx sensor*
B115 *Temperature sensor upstream of SCR catalytic converter*
B116 *Temperature sensor downstream of SCR catalytic converter*
B117 *Fill level and SCR AdBlue temperature combination sensor*
B128 *SCR compressed air pressure sensor*
B129 *SCR AdBlue pressure sensor*
B130 *SCR AdBlue temperature sensor*
B132 *SCR air temperature and air humidity combination sensor*
M25 *SCR AdBlue pump*
R28 *Heating element*
Y106 *SCR air pressure limiter solenoid valve (33.01)*
Y107 *SCR tank heater solenoid valve*
Y109 *SCR AdBlue metering valve*

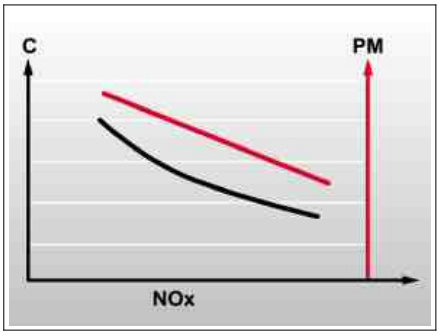
General information

Exhaust aftertreatment with BlueTec diesel technology is used to reduce pollutant emissions in the exhaust gas of diesel engines. The technology is based on a procedure known as "Selective Catalytic Reduction" (SCR), in which by means of aftertreatment of the exhaust gas, toxic nitrogen oxides contained in the exhaust gas (NOx) are specifically reduced to harmless nitrogen (N_2) and water vapor (H_2O).

Vehicles with BlueTec diesel technology have special system components and are fitted with an engine developed for this purpose, with combustion designed for maximum efficiency and low output of soot particles.

Background: When optimizing the engine to increase its efficiency and therefore to produce the best possible performance with low fuel consumption (C), the result is that more nitrogen oxide (NOx) is produced. If combustion is to be designed with a low output of nitrogen oxides (NOx) in mind then increased fuel consumption (C) and thus a higher output of soot particles (PM), which are nothing more than non-combusted fuel, must be taken into account.

Optimizing the engine to simultaneously reduce NOx and soot particles, in order to comply with future legal standards, is thus not possible due this inverse relationship. This means that the exhaust gas must be aftertreated.



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Vehicles equipped with BlueTec diesel technology are thus not only installed with more advanced engines, but they are also fitted with components which are used to remove the nitrogen oxides that are generated by combustion after combustion has taken place. These components are designed as detachable parts.
In addition, the vehicles require an extra operating fluid: the NOx reducing agent AdBlue^{TM}, which consists of a urea solution and is supplied in a separate tank.

Function of Overall System
After engine is started, the engine control (MR) control unit (A6) first checks the operational readiness of the BlueTec system in an automatic test routine.

After the successful authorization of the system, the SCR pressure limiting solenoid valve (Y106) is switched at the compressed air controller unit (5) and compressed air is branched out of the electrical accessories circuit 4, which flows into the compressed air inlet at the metering device (8) and through the subsequent injection line and injection nozzle (7). The compressed air is also supplied to the compressed air inlet of the pump module (4). Here, the air ensures that the pneumatic pressure relief valve closes the AdBlue return line which leads from the pump module (4) into the AdBlue tank (3) and that AdBlue pressure build up at the metering device (8) is facilitated.
This takes place irrespective of whether AdBlue is injected or not.
The continuous flow through the metering device (8) and the subsequent injection line and injection nozzle (7) ensures that the metered AdBlue is always fully supplied to the injection nozzle (7) located at the engine brake flap fitting.

The AdBlue-air mixture first decomposes into ammonia (NH_3) in the hot exhaust gas stream. Along with the nitrogen oxide molecules generated during combustion, the ammonia generated flows on towards the muffler with reduction catalytic converter (6).
The reduction catalytic converter contains a coated ceramic honeycomb body. The second stage of the reduction process takes place here.
The nitrogen oxide molecules encounter the ammonia molecules, energy in the form of heat is released and only nitrogen (N_2) and water vapor (H_2O) remain as a byproduct of the chemical reaction, which are not harmful to the environment.
So that with each working cycle the correct amount of AdBlue is injected at the right time, and continuous exchange of information between the BlueTec sensor system and the engine control (MR) control unit (A6) is necessary.

In the engine control (MR) control unit (A6), calculations of the opening times of the SCR AdBlue metering valve (Y109) and the SCR tank heater solenoid valve (Y107) take place continually, with consideration of the actual engine data and the values stored in the performance maps. Calculation are also performed here that the SCR frame module control module (A95) requires to actuate the SCR AdBlue pump (M25) and the SCR pressure limiter solenoid valve (Y106).
After the ignition is switched off, the metering device (8) is purged to prevent frost damage.

In addition to the actual system components and to ensure that the system operates properly, the following two subsystems are integrated into the overall system:

- AdBlue heater
- Compressed-air supply

This also ensures that no AdBlue deposits are left in the metering device (8), the injection nozzle (7) and the injection line located between them.

When the engine control (MR) control unit (A6) activates the pump based on particular sensor values, the AdBlue supplied by the SCR AdBlue pump () in the AdBlue tank (3) is drawn into the pump module (4), filtered and then pumped back towards the metering device (8).

Once it arrives at the metering device (8) the AdBlue is at its operating pressure with the SCR AdBlue metering valve (Y109) closed. When this valve opens at the intervals calculated by the engine control (MR) control unit (A6), the AdBlue flows through it pushed and pulled by a combination of the difference in pressure and the flow of the exhaust and is carried along towards the injection line and injection nozzle (7).
The injection nozzle (7) is located at the engine brake flap fitting. Thus AdBlue is injected directly into the hot exhaust gas stream.

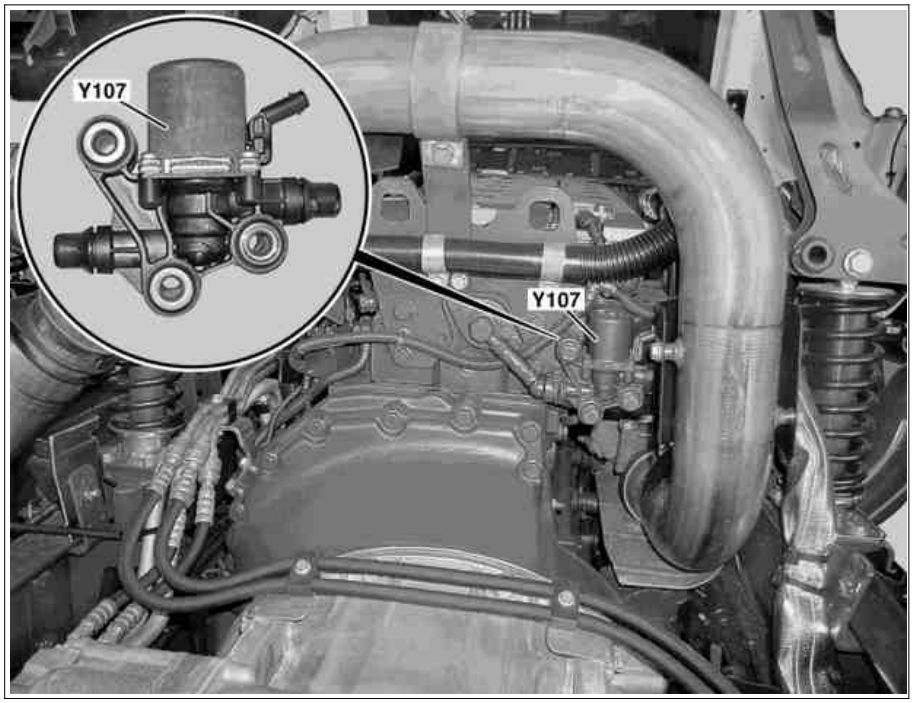
For this purpose, the sensors on the metering device (8) provide, for example, continuous information on AdBlue pressure, AdBlue temperature and the pressure of the compressed air. Additional sensors provide information on the exhaust gas temperature at the catalytic converter inlet and outlet.
In order to take into consideration the influence of the humidity and the temperature of the intake air on the nitrogen oxide emissions, there are also SCR air humidity and air temperature combination sensors (B132).
The analog data from the frame-side sensors is sent to the SCR frame module control module (A95), where it is digitized and forwarded by the CAN bus to the engine control (MR) control unit (A6).
The engine control (MR) control unit (A6) also obtains information about the NOx concentration in the exhaust via the NOx sensor with controller unit (A113).

This takes place during control unit run-on (max. 300 s) by opening and closing the SCR pressure limiter solenoid valve (Y106) and the SCR AdBlue metering valve (Y109) at defined intervals. The basic variables for the duration of the purging procedure are the pressure present at the SCR AdBlue pressure sensor (B129) and the pressure at the SCR compressed air pressure sensor (B128). Ventilation is only stopped only when the engine control (MR) control unit (A6) recognizes that the metering device was adequately filled with air based on these values.

AdBlue heater

Illustrated on model 950.5
Y107 SCR tank heater solenoid valve

The AdBlue heater consists of the SCR tank heater solenoid valve (Y107), which is located at the rear of the engine and a cooling line system from the engine to the AdBlue tank.



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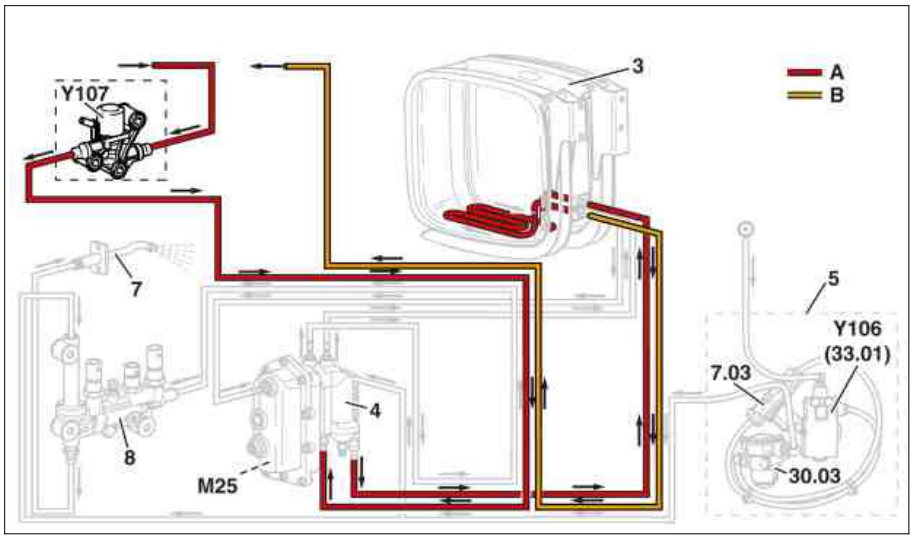
Function schematic for AdBlue heater

3 AdBlue tank
4 Pump module
5 Compressed air control unit
7 Injection nozzle
8 Metering device

7.03 Overflow valve without return flow
30.03 Pressure limiting valve with vent

M25 SCR AdBlue pump
Y106 SCR air pressure limiter solenoid valve (33.01)
Y107 SCR tank heater solenoid valve

A Coolant supply (from engine)
B Coolant return (to engine)



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Individual BlueTec components such as the pump module (4) have coolant flowing through them directly through ducts or lines.

AdBlue heater, function

The AdBlue heater ensures that any AdBlue that has frozen during periods of non-operation is heated and reliquified and prevents AdBlue from freezing while driving in cold outside temperatures.

The SCR tank heater solenoid valve (Y107) is actuated by the engine control MR control unit (A6). From the fill level and SCR temperature combination sensor (B117) integrated in the AdBlue tank (3) it detects when the temperature of the tank contents is approaching the defined limit value of approx. 8 °C. As soon as the coolant reaches a temperature of ≥65 °C, the SCR tank heater solenoid valve (Y107) receives the signal to open from the engine control (MR) control unit (A6), so that coolant is branched off from the engine coolant circuit.

The heat supply to the AdBlue lines is provided by a bundled line installation and insulating tubing.

After opening the coolant flows through the lines in the direction of the pump module (4). The pump module (4) and the AdBlue tank (3) contain a duct, via which coolant flows directly through the component. The coolant then returns back to the engine.

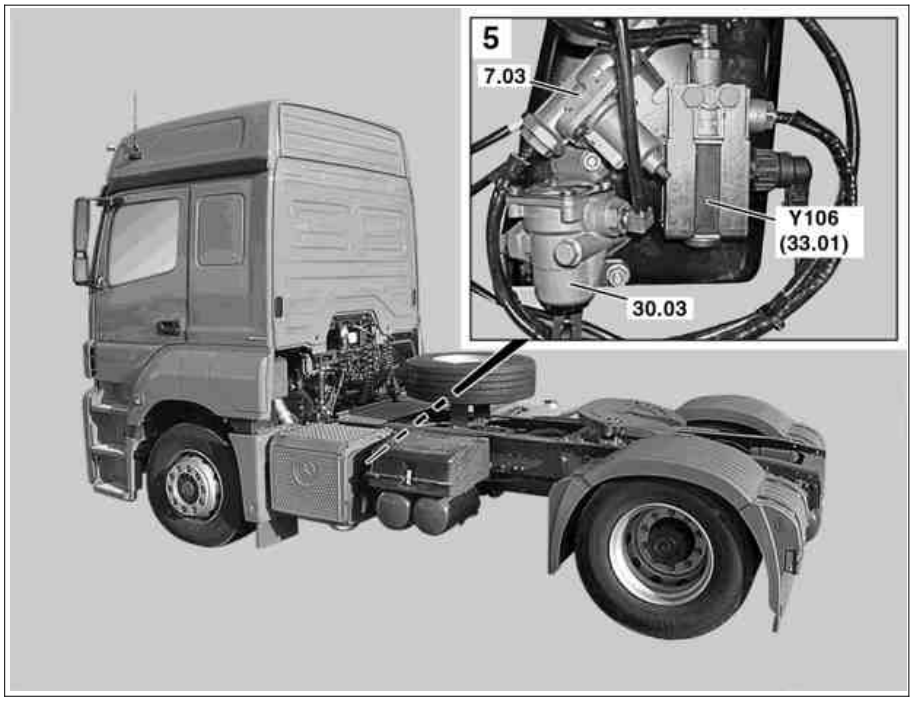
Compressed-air supply

5 *Compressed air control unit*

7.03 *Overflow valve without return flow*
30.03 *Pressure limiting valve with vent*

Y106 *SCR air pressure limiter solenoid valve (33.01)*

The compressed air is supplied via the compressed air controller unit (5), which is secured to the inside of the left frame longitudinal member at the level of the muffler, and a line system, from the pump module (4) to the metering device (8).



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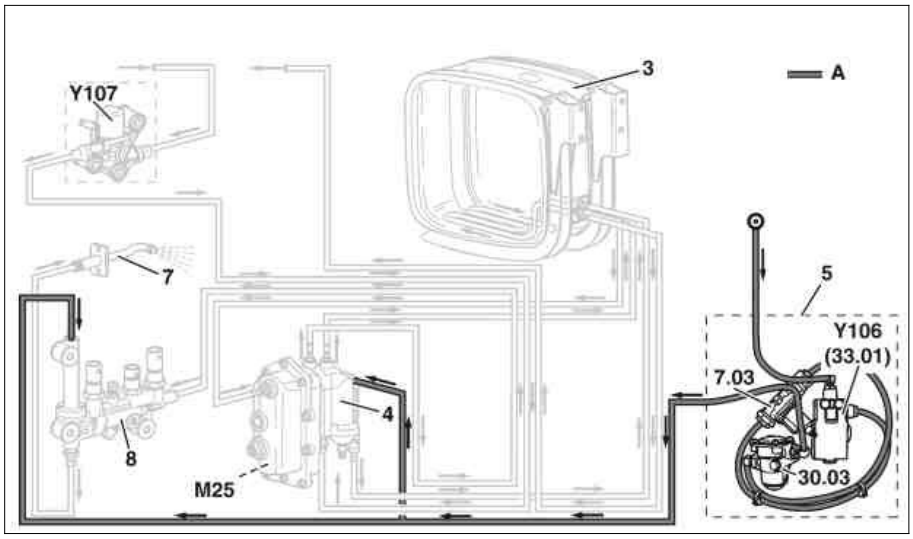
Function Diagram for the Supply of Compressed Air

3 *AdBlue tank*
4 *Pump module*
5 *Compressed air control unit*
7 *Injection nozzle*
8 *Metering device*

7.03 *Overflow valve without return flow*
30.03 *Pressure limiting valve with vent*

M25 *SCR AdBlue pump*
Y106 *SCR air pressure limiter solenoid valve (33.01)*
Y107 *SCR tank heater solenoid valve*

A *Compressed air*



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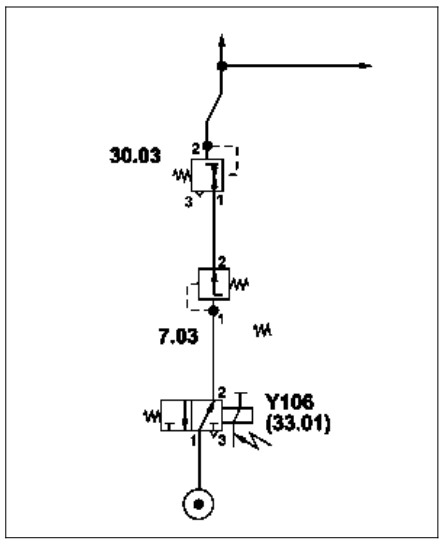
Function of the Supply of Compressed Air

Compressed air ensures transportation of the AdBlue from the metering device (8) to the injection nozzle (7) and return of the AdBlue from the pump module (4) to the AdBlue tank (3).

After the engine is started, the MR control unit (A6) activates the SCR pressure limiting solenoid valve (A95) via the SCR frame module control module (Y106).

Opening causes compressed air to be branched off from the ancillary consumer circuit 4. The compressed air flows through the SCR pressure limiting solenoid valve (Y106), then flows through the overflow valve without return flow (7.03) and the pressure limiting valve with ventilation (30.03). In the pressure limiting valve with ventilation (30.03), the original pressure of approx. 8 bar from electrical accessories circuit 4 is reduced to the operating pressure of the compressed air supply of approx. 5.5 bar.
The compressed air from the ancillary consumer circuit then flows via a compressed air line through the metering device (8) and then through the injection nozzle (7). The compressed air is also supplied to the compressed air connection of the pump module (4). Here, the compressed air ensures that a pneumatic switching valve blocks the AdBlue return from the pump module (4) into the AdBlue tank (3). This valve is closed when it is filled with compressed air.



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Purging and pressure reduction of individual BlueTec components

After the ignition is switched off the metering device (8) is purged to prevent damage from frost. This takes place during the control unit run-on (max. 300 s) by the opening and closing of the SCR pressure limiting solenoid valve (Y106) and the SCR AdBlue metering valve (Y109) at the metering device (8) at defined and agreed intervals.
When the SCR pressure limiting solenoid valve (Y106) closes, it cuts off the supply of compressed air to the pneumatic pressure relief valve which then also opens at the pump module (4).
This results in the opening of the return duct to the AdBlue tank (3) in the pump module (4).

The basic variables for the duration of purging of the metering device (8) are the pressure present at the SCR AdBlue pressure sensor (B129) and the pressure at the SCR compressed air pressure sensor (B128).

First, the pressure at the SCR compressed air pressure sensor (B128) and the pressure at the AdBlue pressure sensor B129) are measured.

The AdBlue can therefore flows back into the AdBlue tank (3) and the pressure in the AdBlue line system is reduced to almost atmospheric pressure.

The AdBlue line between the pump module (4) and the metering device (8) is an elastics hose line. This hose line can carry additional volumes that arise due to freezing of the remaining AdBlue in the line.

These alternate opening and closing movements of the valves involved are executed until the measured pressure at the SCR compressed air pressure sensor (B128) is greater than the pressure applied at the SCR AdBlue pressure sensor (B129).

If the pressure differential is above an established threshold, or the measured AdBlue pressure is greater than the measured compressed air pressure, the SCR pressure limiting solenoid valve opens (Y106).
The compressed air flows out of the ancillary consumer circuit 4 to the metering device (8) and then against the direction of flow of the SCR AdBlue metering valve (Y109) through the metering device (8) and forces the remaining AdBlue back into the line between the metering device (8) and the pump module (4).

During the following interval, the SCR pressure limiting solenoid valve (Y106) closes. Now no further compressed air flows through the metering device (8) and to the pneumatic switching valve at the pump module (4).
The SCR AdBlue metering valve (Y109) is closed and AdBlue cannot flow back. The built up AdBlue pressure in the AdBlue line is reduced via the now open return duct to the AdBlue tank (3), as the pneumatic switching valve at the pump module (4) is now no longer filled with compressed air.

If the engine control (MR) control unit (A6) then detects, from the sensor signals, that the metering device (8) has filled sufficiently with air and the pressure in the AdBlue line system has decreased sufficiently, purging is complete.

Purging of the metering device (8) and the pump module (4), after the engine is switched off, is audible until the end of the purging procedure.

	Function schematic/networking for exhaust aftertreatment		GF14.40-W-0002-03C
	Component description for SCR frame module control unit		GF14.40-W-3000C
	Component description for AdBlue tank		GF14.40-W-3001C
	Component description for fill level and SCR AdBlue temperature combination sensor		GF14.40-W-3002C
	Component description for pump module		GF14.40-W-3003C
	Component description for metering device		GF14.40-W-3004C
	Component description for SCR AdBlue pressure sensor		GF14.40-W-3005C
	Component description for SCR AdBlue temperature sensor		GF14.40-W-3006C
	Component description for SCR compressed air pressure sensor		GF14.40-W-3007C
	Component description for SCR AdBlue metering valve		GF14.40-W-3008C
	Component description for injection nozzle		GF14.40-W-3009C
	Component description for SCR air pressure limiter solenoid valve		GF14.40-W-3010C
	Component description for pressure limiting valve		GF14.40-W-3011C
	Component description for overflow valve		GF14.40-W-3012C
	Component description for SCR tank heater solenoid valve		GF14.40-W-3014C
	Component description for muffler with reduction catalytic converter		GF14.40-W-3015C
	Component description for temperature sensor upstream of SCR catalytic converter		GF14.40-W-3016C
	Component description for temperature sensor downstream of the SCR catalytic converter		GF14.40-W-3017C

	Component description for SCR air humidity and air temperature combination sensor		GF14.40-W-3018C
	Component description for the NOx sensor with controller unit		GF14.40-W-3021C