Workshop Service Manual

FENDT 900 Vario Gen6

FENDT 930 Vario Gen6
FENDT 933 Vario Gen6
FENDT 936 Vario Gen6
FENDT 939 Vario Gen6
FENDT 942 Vario Gen6

Marktoberdorf
AGCO GmbH - Johann-Georg-Fendt-Str. 4 - D-87616 Marktoberdorf
FENDT is a worldwide brand of AGCO

May 2019
X990005734011
5377
EAME
English

TABLE OF CONTENT

2 01-000 Engine, fuel and exhaust system

https://www.ebooklibonline.com

2.1 General

2.1.1 Assignment of FENDT - MAN component designations

FENDT component designation	MAN component designation
A151 - Nitrogen oxide sensor 2, downstream of SCR catalytic converter	B994 - NOx Sensor II diagnostics
A155 - AdBlue® supply module	A808 - Fördermodul
A156 - AdBlue® metering valve	A1279 - Dosiermodul
A170 - Nitrogen oxide sensor 1, upstream of SCR catalytic converter	B1055 - NOx Sensor I Rohemission
B086 - Rail pressure sensor	B487 - Raildrucksensor
B087 - Fuel low pressure sensor	B377 - Kraftstoffdrucksensor
B090 - Engine oil pressure sensor	B104 - Öldrucksensor
B092 - Charge air pressure/temperature sensor	B623 - Ladedruck- / Temperatursensor
B204 - Coolant temperature sensor	B124 - Temperatursensor Kühlmittel
B226 - Air mass sensor	B323 - Luftmassenmesser
B249 - Camshaft speed sensor	B489 - Drehzahlsegmentgeber
B250 - Crankshaft speed sensor	B488 - Drehzahlinkrementgeber
B270 - Lambda probe	B322 - Lambda probe
B276 - Intake manifold temperature sensor	B123 - Temperatursensor Ladeluft
Y095 - Injector 1	Y341 - Injektor Zylinder 1
Y096 - Injector 2	Y342 - Injektor Zylinder 2
Y097 - Injector 3	Y343 - Injektor Zylinder 3
Y098 - Injector 4	Y344 - Injektor Zylinder 4
Y100 - Injector 5	Y345 - Injektor Zylinder 5
Y101 - Injector 6	Y346 - Injektor Zylinder 6
Y169 - AdBlue® tank heater solenoid valve	Y437 - Tank-Heizungsventil (AdBlue®)

2.1.2 Calculation of engine power

The power (P) in [kW] is defined as the product of engine torque (M) and speed (n) divided by 9550*:

(1) $\mathbf{P\ [kW] = (M \cdot n) / 9550}$

The power (P) in [PS] is calculated by multiplying the performance in [kW] by a factor of 1.36:

(2) $\mathbf{P\ [PS] = P\ [kW] \cdot 1.36}$

Engine torque and speed can be read using, for example, the diagnostic tools:

- M = 1500 Nm
- n = 1900 1/min

If the values are substituted into equation (1), then:

$P\,[\mathrm{kW}] = (M \cdot n) / 9550$

$P = (1500\ \mathrm{Nm} \cdot 1900\ 1/\mathrm{min}) / 9550$

$\underline{P = 298\ \mathrm{kW}}$

Using equation (2), the power in [PS] can be calculated:

$P\,[\mathrm{PS}] = P\,[\mathrm{kW}] \cdot 1{,}36$

$P = 298\ \mathrm{kW} \cdot 1{,}36$

$\underline{P = 405\ \mathrm{PS}}$

*) The value 9550 includes the conversion of the speed per minute to an angular velocity per second and returns the result in [kW] instead of [W].

(1*) $P\,[\mathrm{W}] = M\,[\mathrm{Nm}] \cdot \omega\,[\mathrm{rps}]$

(2*) $\omega\,[\mathrm{rpm}] = 2\pi \cdot n\,[\mathrm{rpm}]$

$\omega\,[\mathrm{rps}] = (2\pi / 60) \cdot n\,[\mathrm{rpm}]$

$\omega = n / 9.55$

(3*) $P\,[\mathrm{W}] = M \cdot \omega\,[\mathrm{rps}]$

$P = M \cdot n / 9.55$

$P\,[\mathrm{kW}] = ((M \cdot n) / 9.55) / 1000$

$P\,[\mathrm{kW}] = (M \cdot n) / (9.55 * 1000)$

$P\,[\mathrm{kW}] = (M \cdot n) / \mathbf{9550}$

2.1.3 Engine horsepower: comparison of standards and directives

The engine horsepower of tractors and harvesters is determined on the test bench and can be specified in accordance with various standards. There can be significant differences in measured power depending on the test basis.

There is often a further distinction between gross and net performance. Only net performance offers a concrete value for the machine, since this involves testing the complete engine, including the fan. However, a temperature-controlled fan (Visco fan) need only run at minimum speed, meaning there are still deviations from actual power.

Gross power always measures the engine without the fan.

97/68 EG / 2000/25 EG

Determining engine power at the crankshaft on a test bench. All standard equipment is mounted apart from the fan.

DIN 70020

Determining the engine power at the crankshaft of an independently-functioning engine on the test bench. All standard equipment is mounted. The fan is running at maximum speed.

ECE R24

Determining engine power at the crankshaft on a test bench. All standard equipment is mounted. The fan does not have to run at maximum speed; instead it can work at minimum speed.

ECE R120

Determining engine power at the crankshaft on a test bench. All standard equipment is mounted apart from the cooling system and fan.

The engine is cooled by an external test bench cooling system.

EWG 80/1269

Determining engine power at the crankshaft on a test bench. All standard equipment is mounted.

ISO TR14396

See ECE R120

SAE J1995

Determination of the engine horsepower without ancillary units. Outdated American standard.

Comparison

	97/68 EG 2000/25 EG	DIN 70020	ECE R24	ECE R120 ISO TR14396	EWG 80/1269	SAE J1995
Power type	Gross	Net	Net	Gross	Net	Gross
Measurement location	Crankshaft	Crankshaft	Crankshaft	Crankshaft	Crankshaft	Crankshaft
Turbocharger	Yes	Yes	Yes	Yes	Yes	Yes
Intercooler	Yes	Yes	Yes	Yes	Yes	Yes
Injection pump	Yes	Yes	Yes	Yes	Yes	Yes
Water pump	Yes	Yes	Yes	Yes	Yes	No
Water cooler	Yes	Yes	Yes	No	Yes	No
Air filter	Yes	Yes	Yes	Yes	Yes	No
Exhaust	Yes	Yes	Yes	Yes	Yes	No
Fan	No	Yes Max. speed	Yes Min. speed	No	Yes	No
Additional devices	No	No	No	No	No	No
Temperature and air pressure considered	Yes	Yes	Yes	Yes	Yes	Yes

Application at FENDT

Originally, the engine performance was specified in accordance with DIN 70020. Power specifications always referred to the engine power output at rated engine speed.

With the introduction of Visco fans, power was quoted in accordance with ECE R24. Here, power specifications also always referred to the engine power output at rated engine speed.

Starting with the introduction of engines with extra power (in 1998), the maximum attainable power had to be entered into the vehicle documents in Germany.

For new tractor models on the road after 2002-07-01, directive 97/68/EC was used. Here, the engine power at rated engine speed is specified without the fan. In Germany, this information is entered in the vehicle documents.

2.1.4 General description of the common rail system

Old injection systems operated by generating the fuel injection pressure separately for each injection event. The injection pressure increases in principle with increasing fuel quantity and increasing engine speed. Between injection strokes, the pressure in the system is low.

In contrast to these injection systems, pressure generation and injection are decoupled in the storage injection or (Common-Rail) system. The generation of pressure bears no relation to either the engine speed or injection quantity; the pressure is instead freely selectable within limits and is continuously available from the high-pressure accumulator (Rail). The accumulator is comprised of a distribution rail and pipes to the injectors. The fuel quantity for the individual cylinders is taken from this accumulator.

One injector for each engine cylinder

The core of the system is a solenoid-activated injector for each engine cylinder. A pulse from the control unit to the solenoid valve in the injector initiates the injection process. The discharge cross-section of the injector, the opening duration of the solenoid and the accumulated pressure in the common rail system determine the fuel quantity.

Variable pressure in the accumulator

The accumulator pressure in the Common-Rail system is generated by at least one high-pressure pump controlled by the camshaft. This means that fuel is delivered into the rail by the pump every time an injector is opened. The exact quantity to be injected by the injector is released by the dispensing unit. This keeps the rail pressure constant.

In the Common-Rail system, pressure in the Rail is controlled by means of a pressure sensor. The rail pressure is freely programmable within a certain pressure range using a mapping field and can be adapted to suit the engine's operating conditions. The control unit, sensors and system functions of the Common-Rail system require more input signals than the standard single pump system.

Free selection of the injection pressure

The functional separation of pressure generation and injection opens up new possibilities in terms of the combustion process structure. Injection pressure is freely selectable in the mapping field and remains as constant as possible during injection.

Multi-point injection

A further reduction in exhaust gas and noise emissions is made possible by the multiple injection system. Depending on the operating conditions, multiple injection system consists of pre-injection, main injections and post-injection. These are triggered by multiple activation of quick-response solenoids. In addition, the injection process can be shaped by controlling the profile of the nozzle needle movement. Hydraulic pressure on closing the nozzle needle ensures an abrupt end to the injection process.

The multitude of possibilities for configuring the injection process opens up new paths towards further reductions in pollutant emissions and the fuel consumption of diesel engines.

No major changes to the design of the engine

The Common-Rail system can replace conventional injection systems without major changes to the engine. Instead of the injection pump, high-pressure pumps are fitted. The injectors are integrated into the cylinder head in a nozzle-holder combination.

Components

The electronically regulated diesel injection (EDC) is divided into three central system blocks.

- The sensors and switches (input information providers) record the operating conditions at the engine and convert the various physical variables into electronic signals.
- In the control unit (processing), the information and the output signals are calculated in accordance with the stored mapping fields and characteristic curve. The control unit contains microprocessors and memory units. The control unit incorporates self-monitoring, the emergency running program and self-diagnostics.

- The actuators (outputs) convert the electronic output signals into mechanical variables.

Power supply:

A stable power supply is required, so that the control unit can operate reliably. This comprises:

- Continuous current supply KL30
- Switched voltage KL15
- Earth supply KL31

The control unit is also connected to the CAN bus system of the tractor.

- Sensor signals are used for several purposes, e.g. engine temperature
- Transmission Control System (TMS)
- Diagnostics
- programming

2.1.5 Combustion air ratio

The combustion air ratio λ (Lambda) is the ratio of combustion air to fuel.

$\lambda = 1$

The supplied air mass corresponds to the air mass that is theoretically required to burn all of the fuel. It leads to complete combustion. This is known as the stoichiometric combustion air ratio.

$\lambda < 1$

There is a lack of air. This is called a rich mixture.

$\lambda > 1$

There is excess air. This is called a lean mixture.

Diesel engines usually work with lean mixtures. The Lambda values of turbocharged diesel engines are:

- At full load: $\lambda = 1.15$ to 2.0
- In neutral: $\lambda > 10$

With the help of a Lambda sensor, it is possible to measure the residual oxygen content in the combustion gas (upstream of the catalytic converter). From this, the combustion air ratio can be determined and set.

2.1.6 Immobilizer

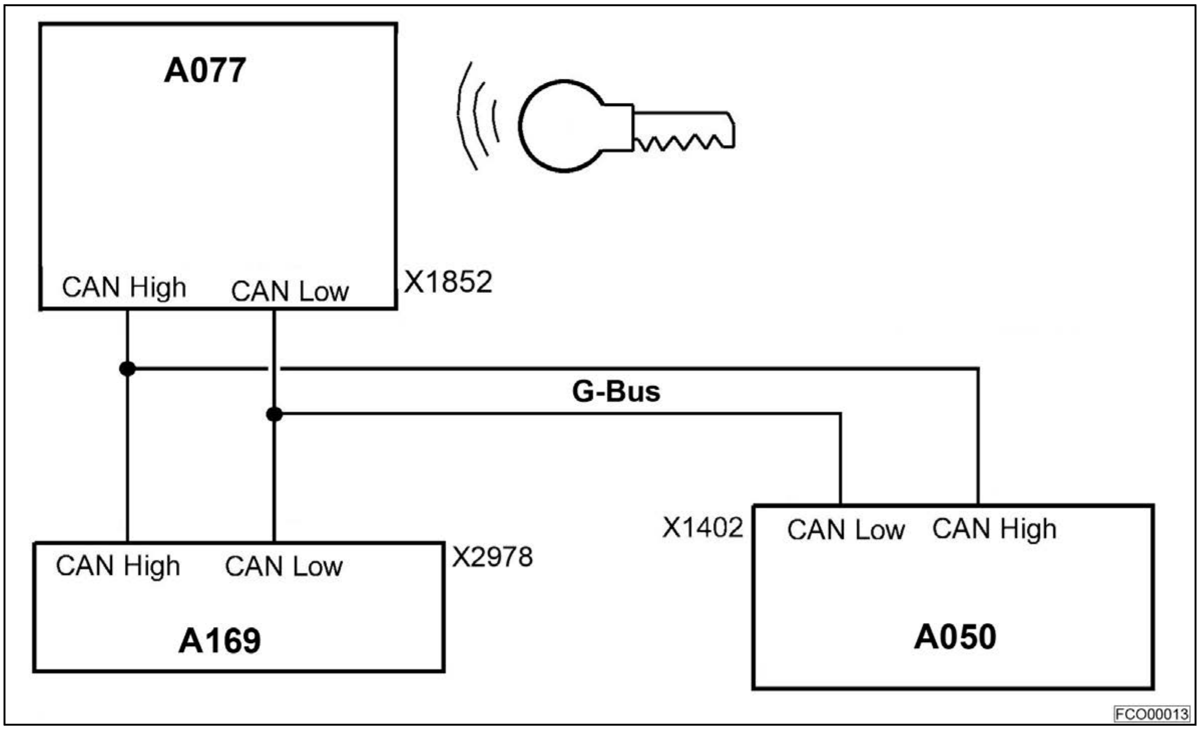

Fig. 1

A050 - Basic control unit ECU (EXT)
A077 - Immobilizer ECU
A169 - Engine control unit ECU (EDC 17)

Each ignition key has a unique key number. The key number is transmitted to the immobilizer (receiver) via a transponder (transmitter). If the immobilizer detects a key, a connection is established from the immobilizer to the basic control unit and the engine control unit.

- The **A077** - Immobilizer ECU and the engine control unit compare their data (serial number, performance curve etc.).
- The **A077** - Immobilizer ECU and **A050** - Basic control unit ECU (EXT) compare their data (tractor equipment, communication on the gearbox bus etc.)

If all comparison points are OK, the starting quantity is released at the engine control unit, and the vehicle starts.

When replacing components

If components—engine immobilizer and/or engine control unit—are replaced, the immobilizer and the engine control unit must recognize each other.

Diagram: teaching the ignition key

- The immobilizer must recognise **its own** vehicle keys.
- The immobilizer can recognize a maximum of three keys.
- When the immobilizer is replaced, the new unit must again be taught to recognize the vehicle keys (up to 3).

Teaching process:

- Connect a laptop with EOL to the transmission bus and to the comfort bus
- Read in ignition keys

- Unlock the vehicle keys online

  See also Service Bulletin 22/2015

2.1.7 Exhaust gas system

2.1.7.1 Combustion gases from a diesel engine

When diesel fuel is combusted in a diesel engine, a huge variety of residues form depending on a range of factors, including the engine design and engine horsepower. The non-toxic components of the exhaust gas are mainly water, nitrogen and carbon dioxide. Just 0.1 percent of the exhaust gases are formed from partially hazardous components such as:

- Carbon monoxide
- Unburned hydrocarbons
- Nitrogen oxide (nitrogen monoxide and nitrogen dioxide)
- Sulfur dioxide
- Particle

The composition of diesel exhaust emissions

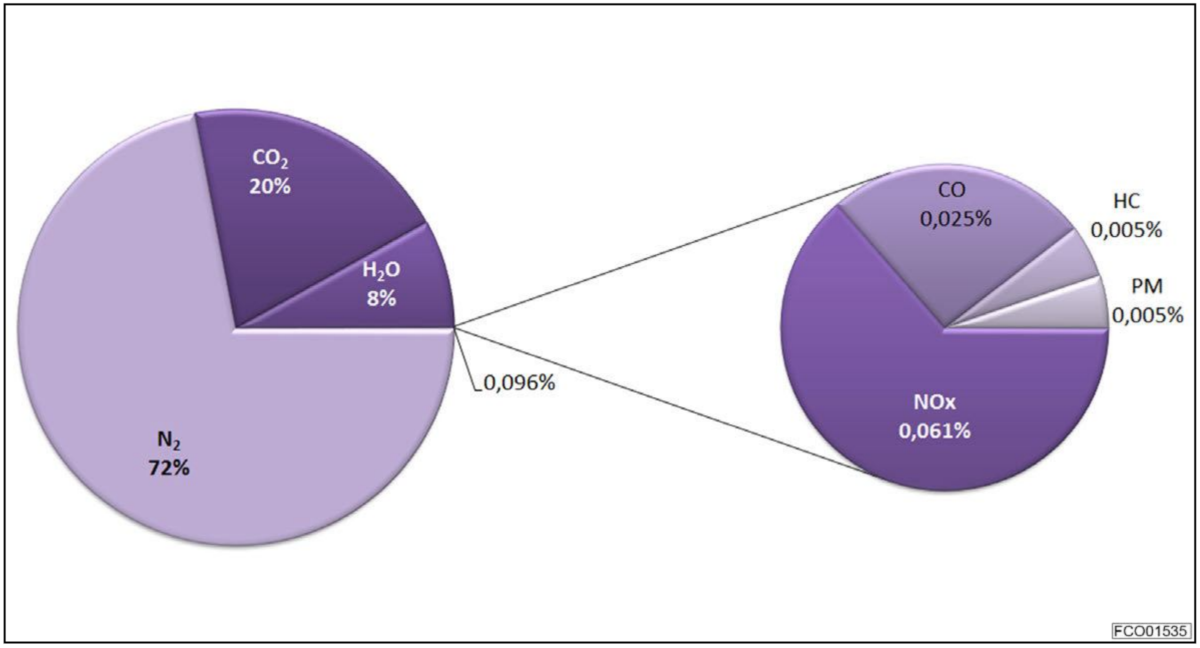

Fig. 2

CO	carbon monoxide	N_2	Nitrogen
CO_2	Carbon dioxide	NO_x	Nitrogen oxide
HC	Unburned hydrocarbons	PM	Particle
H_2O	Water		

2.1.7.2 Exhaust gas components

Nitrogen oxide NO_x

Definition:

- Nitrogen oxide (NOx) describes the mixture of nitrogen monoxide (NO), nitrogen dioxide (NO_2) and dinitrogen tetroxide (N_2O_4).

Source:

- The most prominent source of nitrogen monoxide is from the combustion in a diesel engine.
- This nitrogen monoxide reacts with oxygen to create noxious nitrogen dioxide.

Danger:

- Nitrogen dioxide can irritate mucous membranes and the eyes, cause inflammation of the respiratory tract and, over long periods of time, can also lead to asthma, allergies and cardiovascular diseases.
- Levels of 100 ppm in the air we breathe can result in death after being breathed in for one hour.
- The effects of UV light can also create summer smog from nitrogen oxides.

Possibilities for reduction:

- NO_x storage catalysts
- SCR catalytic converter
- Low combustion temperature
- High exhaust gas recirculation rate

Carbon dioxide CO_2

Source:

- CO_2 is a greenhouse gas that constitutes a natural component of the atmosphere in very low concentrations.
- It is produced by any form of combustion, including when organisms burn glucose as part of the respiration process.

Danger:

- As carbon dioxide is diluted by air, it poses no direct risk to humans. However, it does increase the naturally occurring greenhouse effect.

Possibilities for reduction:

- There is a direct correlation between CO_2 emissions and fuel consumption

Carbon monoxide CO

Source:

- Carbon monoxide is produced by the incomplete combustion of fuels, in particular after an engine has started up or when it is idling.

Danger:

- Carbon monoxide can be deadly even in small quantities, as it deprives the bloodstream of oxygen, resulting in suffocation.
- Long-term exposure to carbon monoxide, even in very small quantities, can lead to health problems related to the heart and nervous system.

Possibilities for reduction:

- Oxidation catalytic converter

Particulate matter/particles PM

Definition:

- The term PM10 describes the concentration of particles that are invisible to the naked eye and are less than one hundredth of a millimetre in diameter.

Source:

- These tiny particles are produced by fuel combustion, as well as by tire and brake wear, forest fires, cigarettes, Saharan dust etc.

Danger:

- The smaller the particles are, the deeper they can penetrate into the lungs. Once there, it is even possible for them to enter the bloodstream via the alveoli.
- Inhaling the particles can cause damage to the respiratory system and can even lead to cancer.

Possibilities for reduction:

- Using a particulate filter
- High combustion temperature
- Low rate of exhaust gas recirculation or none at all

Unburned hydrocarbons HC

Definition:

- The term hydrocarbons does not refer to a single compound, but rather to a variety of different compounds.

Source:

- Unburned hydrocarbons are produced during incomplete combustion if there is insufficient oxygen in the combustion mixture or the combustion temperature is too low.

Danger:

- A reaction between unburned hydrocarbons and nitrogen oxides that is stimulated by sunlight can result in a compound that irritates mucous membranes and constitutes a major part of summer smog.
- Some types can also be carcinogenic

Possibilities for reduction:

- Oxidation catalytic converter

2.1.7.3 Overview of measures for reducing exhaust gases

As a result of increasingly strict legal requirements, manufacturers are obliged to further reduce dangerous exhaust gas components on a continual basis. There are several basic ways to do this.

Diesel fuel:

The fuel quality has a decisive influence on the number of resulting particles. The higher the cetane number, the fewer particles are emitted. A low sulfur content in the diesel reduces the formation of sulfur dioxide.

The combustion process:

An efficient and low-emission combustion of fuel is the basic prerequisite for producing low volumes of pollutants. Turbocharging, combustion chamber design, air supply to the combustion chamber and injection technology can reduce emissions. In addition, an exhaust gas recirculation system can be used, whereby some of the exhaust gas is added to the clean intake air.

Exhaust after-treatment:

Exhaust gas after-treatment is an effective way to reduce the number of harmful components in exhaust gas. For example, particle filters can significantly reduce existing particles. Oxidation catalytic converters can oxidize hydrocarbons and carbon monoxide turning them into non-toxic carbon dioxide and water. Using ammonia, SCR catalytic converters can deoxidize harmful nitrogen oxide into nitrogen and water.

Conflict of objectives

The problem with regard to reducing exhaust gases by controlling the combustion processes is the opposing behavior of nitrogen oxides and soot. For example, a high exhaust gas recirculation rate certainly reduces the emission of nitrogen oxides to a significant extent; however, at the same time, a considerably higher number of soot particles are formed. The same applies to combustion conditions that have a beneficial effect on nitrogen oxide reduction while at the same time increasing particle emissions — and vice versa.

Similarly, the highest possible performance in terms of nitrogen oxide emissions cannot be achieved. An SCR catalytic converter is the solution in this case as it enables the eingine to be optimized for maximum performance and minimum soot formation.

Effect of exhaust gas after-treatment systems on harmful diesel engine exhaust emissions

	CO[1]	HC[2]	NO_x[3]	PM[4]
Oxidation catalytic converter	Lower	Lower	-	-
SCR catalytic converter	-	-	Lower	-
Particulate filter	-	-	-	Lower
Exhaust gas recirculation	-	-	Lower	Higher

[1] Carbon monoxide
[2] Unburned hydrocarbons
[3] Nitrogen oxide
[4] Particle

2.1.7.4 Emission levels: an overview

In 1999, the EU introduced the first emission stage for non-road mobile machinery to regulate the emission of carbon monoxide, nitrogen oxide, particles and unburned hydrocarbons. Around the same time, emission standards for this type of vehicle were also introduced in the United States to ensure that Stage 1 (EU) and Tier 1 (USA) are roughly equivalent.

The following diagrams show the limit values of different exhaust gases in the 130 kW-560 kW (177 HP-760 HP) performance class. The diagrams are all to the same scale to provide a direct comparison.

Stage 1

- Effective from 1999
- Roughly corresponds to**Tier 1** (USA)
- Designation at FENDT: COM 1

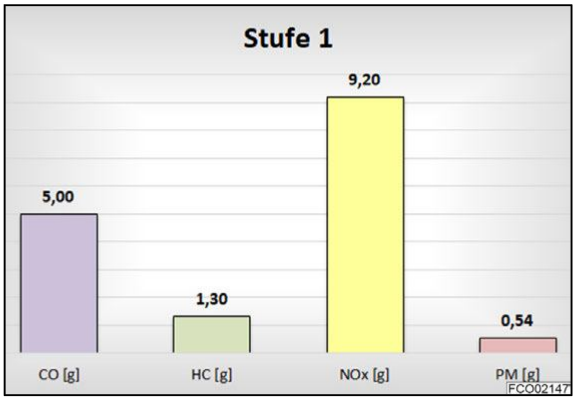

Fig. 3

Limit values for Stage 1:

Power [kW]	CO	HC	NOx	PM
37–75	6.50	1.30	9.20	0.85
75–130	5.00	1.30	9.20	0.70
130–560	5.00	1.30	9.20	0.54

Stage 2

- Effective from 2001 to 2004 (depending on the performance class)
- Roughly corresponds to**Tier 2** (USA)
- Designation at FENDT: COM 2

Limit values for Stage 2:

Power [kW]	CO	HC	NOx	PM
18–37	5.50	1.50	8.00	0.80
37–75	5.00	1.30	7.00	0.40
75–130	5.00	1.00	6.00	0.30
130–560	3.50	1.00	6.00	0.20

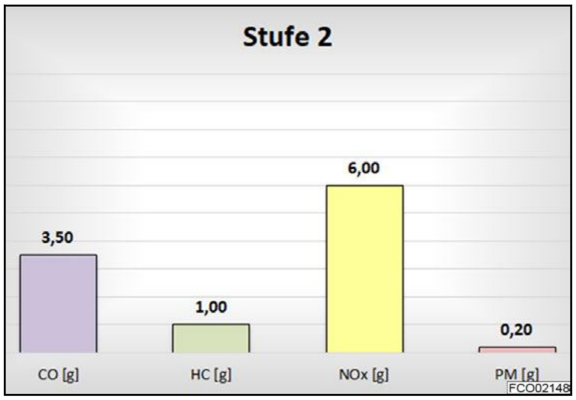

Fig. 4

Stage 3a

- Valid from 2006 to 2008 (depending on the performance class)
- Roughly corresponds to**Tier 3** (USA)
- Designation at FENDT: COM 3

Limit values for Stage 3a:

Power [kW]	CO	HC	NOx	PM
19–37	5.5	7.50*		0.60
37–75	5.0	4.70*		0.40
75–130	5.0	4.00*		0.30
130–560	3.5	4.00*		0.20

*) Total amount of HC and NOx is combined

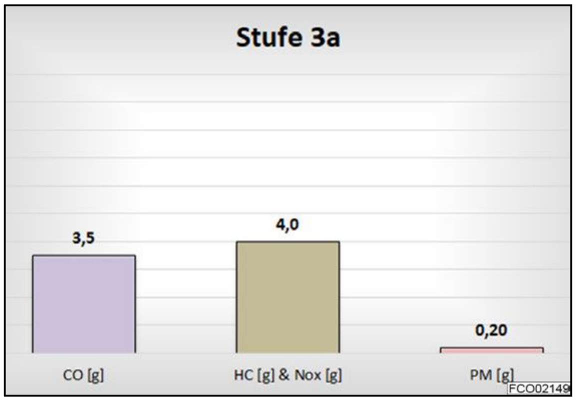

Fig. 5

Stage 3b

- Valid from 2011 to 2013 (depending on the performance class)
- Roughly corresponds to**Tier 4 interim** (USA)
- Significant restrictions for the limit value of particle emissions compared to Stage 3a
- Designation at FENDT: SCR or Stage 3b

Limit values for Stage 3b:

Power [kW]	CO	HC	NOx	PM
37–56	5.0	4.70*		0.025
56–75	5.0	0.19	3.30	0.025
75–130	5.0	0.19	3.30	0.025
130–560	3.5	0.19	2.00	0.025

*) Total amount of HC and NOx is combined

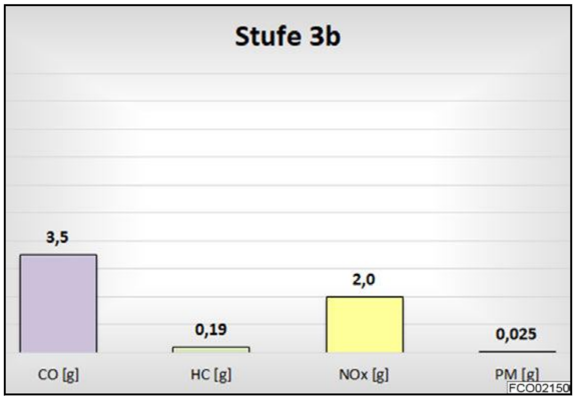

Fig. 6

Stage 4

- Effective from 2014
- Roughly corresponds to**Tier 4 final** (USA)
- Huge restrictions for the limit value of NOx compared to Level 3b
- Designation at FENDT: Stage 4 (S4)

Limit values for Stage 4:

Power [kW]	CO	HC	NOx	PM
56–130	5.0	0.19	0.40	0.025
130–560	3.5	0.19	0.40	0.025

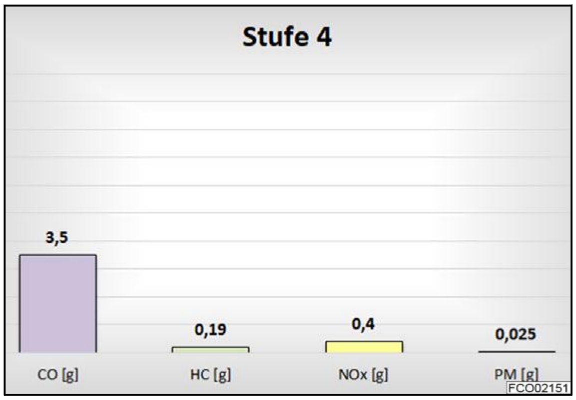

Fig. 7

Setting 5

- Effective from 2019 or 2020 (depending on the performance class)
- No further restrictions on limit values in the United States
- Stage 5 is the first level in which all performance classes will be regulated.
- FENDT designation: depends on vehicle
- The number of particles per kWh is limited in some performance classes for the first time

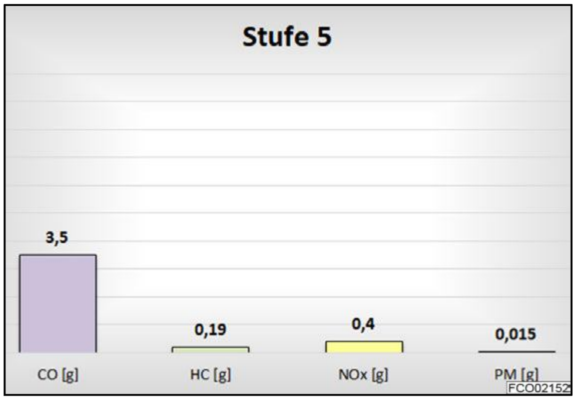

Fig. 8

Limit values for Stage 5:

Power [kW]	CO	HC	NOx	PM	Number PM
0–8	8,0	7.50*		0.400	-
8–19	6.6	7.50*		0.400	-
19–37	5.0	4.70*		0.015	$1*10^{12}$
37–56	5.0	4.70*		0.015	$1*10^{12}$
56–130	5.0	0.19	0.40	0.015	$1*10^{12}$
130–560	3.5	0.19	0.40	0.015	$1*10^{12}$
560+	3.5	0.19	3.50	0.045	-

*) Total amount of HC and NOx is combined

2.1.7.5 Boosting

The engine charging system represents an internal measure to reduce pollutant emissions as well as to increase the performance of an internal combustion engine. The engine is fed with air at increased pressure, which improves the level of filling. More air increases the work achieved per cycle.

Important components of the boosting system are, amongst others, the intercooler and the exhaust turbocharger.

Intercooler

If the intake air is compressed by a turbocharger or compressor; the air becomes significantly warmer, thereby greatly reducing its density. Cooling this air with an intercooler increases the density level as cold air is denser than warm air. This means that more oxygen can be stored in the same volume. More oxygen means that more fuel can be burned, which in turn increases performance and efficiency.

Intercoolers are heat exchangers that are located in the intake system of a turbocharged internal combustion engine between the compressor and the intake valve. They are air or water-cooled.

Exhaust turbocharger

The basic principle of an exhaust turbocharger is to use part of the exhaust-gas energy to carry more outside air into the cylinder. Exhaust gas drives an exhaust gas turbine, which in turn drives the intake air compressor positioned on a common shaft.

Simple unregulated turbochargers are most efficient in a narrow operating range. In order not to overheat, they must be designed so that they work just at their performance limits when at full load. As a result, there is no compression in the low speed range, causing what is known as a large turbo lag. A turbocharger with boost control remedies this. The usual rules operate via a wastegate or adjustable vanes.

Wastegate

On this type of boost pressure control, a by-pass valve - called the wastegate - is located in the exhaust gas flow. The turbocharger is designed in such a way that a high boost pressure is reached even at low speeds. If the speed of the diesel engine and hence the turbocharger increases, the bypass valve opens and diverts a portion of the exhaust gas past the turbine. As a result, the turbocharger is protected against overloading.

Adjustable vanes - VTG loader

A variable turbine geometry loader (VTG loader) is an exhaust turbocharger that features adjustable guide vanes on the exhaust side. The underlying principle is increased air velocity with a restricted cross-section. At low speeds, the flow cross-section of the turbine is decreased by closing the guide vanes. This increases the exhaust gas flow speed, resulting in the turbine wheel rotating more quickly and a larger volume of conveyed fresh air. The boost pressure builds up and increases. With the increasing volume of exhaust gas, the guide vanes are set to a higher angle so as to increase the inlet cross-section. The turbine rotates at a slower rate and the boost pressure is limited.

2.1.7.6 Exhaust gas recirculation

The combustion temperature in the diesel engine has a decisive influence on the formation of soot particles and nitrogen oxides. However, there is a conflict of objectives here, as the higher the temperature, the less soot particles are formed and the more environmentally harmful nitrogen oxides NO_x are formed. Therefore, if NO_x emissions are to be reduced as a priority, the combustion temperature must be decreased, which can be achieved via an exhaust gas recirculation system (EGR). The EGR is a means of reducing the amount of pollutants from within the engine.

In the case of external exhaust gas recirculation, a defined amount of hot exhaust gas is removed at the exhaust manifold and re-added to the intake air. Exhaust gas is low in oxygen and rich in carbon dioxide, and therefore reduces the proportion of oxygen in the intake pipe. Lower levels of oxygen reduce the combustion temperature.

At the same time, the higher heat capacity of the exhaust gas compared to fresh air reduces the combustion temperature, since the carbon dioxide absorbs part of the heat. Simply put, the exhaust gas does not take part in the combustion process, but it must be heated, which reduces the combustion temperature.

A further reduction of the combustion temperature can be achieved if the exhaust gas is cooled prior to re-entry. This increases the density of the exhaust gas, resulting in a higher return rate. At the same time, the temperature of the exhaust gas is reduced, which leads to a further reduction of the combustion temperature. The recirculated exhaust gas cooler is a heat exchanger that uses the engine coolant.

The lack of air during combustion, caused by the recirculated exhaust gas, does however lead to an increase in soot particles. Generation of these particles increases under higher load in particular, which is why little to no exhaust gas is recirculated in this range. The amount of recirculated exhaust gas must be controlled according to the load on the engine. As is the case at full load, during warm-up, exhaust gas recirculation is not appropriate. The exhaust gas recirculation system in the combustion chamber is controlled by the engine control unit and is adjusted via a butterfly valve.

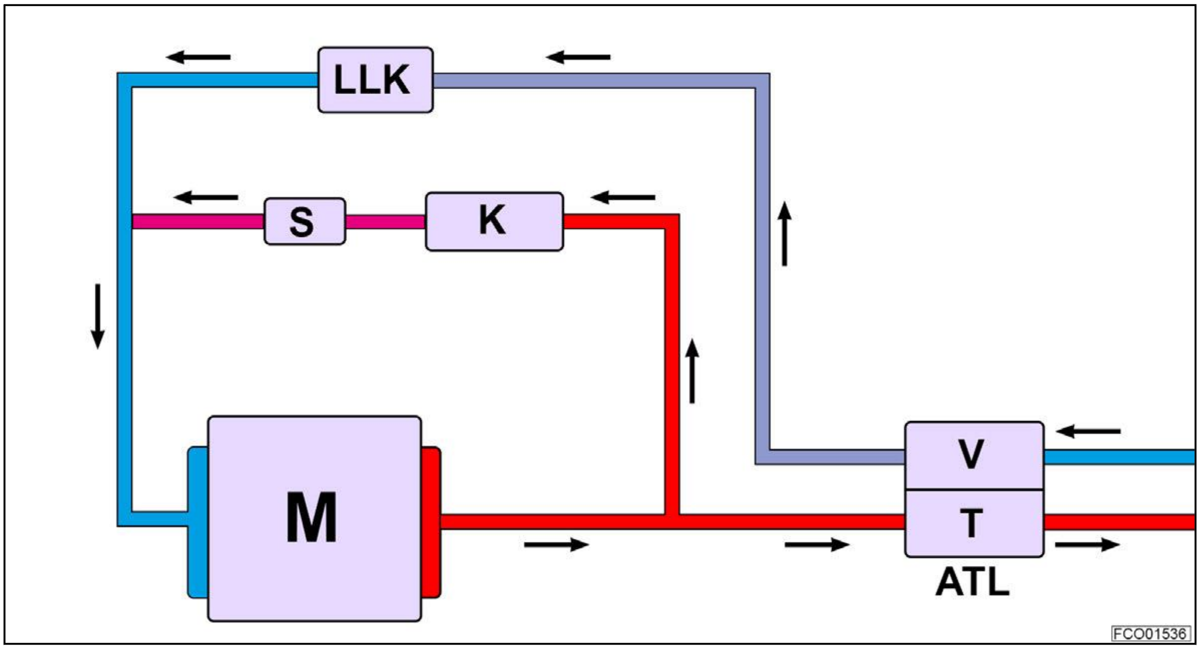

Fig. 9

(ATL)	Exhaust turbocharger
(K)	Exhaust gas recirculation cooler
(LLK)	Intercooler
(M)	Diesel engine
(S)	Exhaust gas recirculation actuator
(T)	Turbocharger turbines
(V)	Turbocharger compressor

2.1.7.7 Particulate filter and oxidation catalytic converter

One way to reduce harmful emissions being emitted from a diesel engine is to use diesel particulate filters and/or diesel oxidation catalytic converters. There are various systems that can be implemented.

Diesel oxidation catalytic converter DOC

As diesel engines generally work with excess air, they have a high proportion of residual oxygen in the exhaust gas they produce, meaning that a diesel oxidation catalyst converter can be used. In a chemical reaction, carbon monoxide and unburned hydrocarbons are converted into non-toxic carbon dioxide and water by means of oxygen. In order to accelerate this oxidation process, catalytic elements such as platinum or palladium are used.

$$2\ CO + O_2 \rightarrow 2\ CO_2$$

Carbon monoxide + oxygen → carbon dioxide

$$C_nH_m + (n+m/4)\ O_2 \rightarrow n\ CO_2 + m/2\ H_2O$$

Hydrocarbon + oxygen → carbon dioxide + water

At the same time, the nitrogen monoxide in the exhaust gas is oxidized into nitrogen dioxide in the diesel oxidation catalytic converter.

$2\ NO + O_2 \rightarrow 2\ NO_2$

Nitrogen monoxide + oxygen → nitrogen dioxide

The resulting nitrogen dioxide is of considerable importance for many of the downstream exhaust gas after-treatment systems such as SCR or CSF.

Diesel particulate filter DPF

This is a device for reducing particles present in exhaust gas — particularly soot particles. The filtering process involves exhaust gas offset with particles permeating a filter wall: exhaust gas must diffuse through the porous duct walls in the filter. In the process, particles cling to the porous walls (depth filtration) depending on their respective size or accumulate on the surface of the duct wall in the form of a layer of soot (surface filtering).

A large proportion of soot particles and the hydrocarbon compounds adhered to them can be removed with the aid of particulate filters. The biggest problem with using filters is regeneration, as filters become clogged with particles over time. The thicker the soot layer is, the greater the exhaust gas back pressure. Performance decreases and consumption increases. If a defined threshold value is reached, regeneration is essential. As in this case, regeneration is actively initiated, the process is referred to as "active regeneration".

Today, concepts have been established which continuously regenerate at a reduced regeneration temperature, such as the catalysed soot filter CSF. This process is referred to as "passive regeneration" or the "CRTeffect".

Catalysed soot filter CSF

In the Catalysed Soot Filter (CSF) — also referred to as the "Coated DPF" - soot is continuously burned off in accordance with the CRT principle (passive regeneration). Soot,which primarily consists of carbon, reacts with nitrogen dioxide to form nitrogen monoxide and carbon dioxide at temperatures from 280°C to 450°C:

$2\ NO_2 + C \rightarrow 2\ NO + CO_2$

Nitrogen dioxide + carbon → nitrogen monoxide + carbon dioxide

A sufficient concentration of nitrogen dioxide is needed for this. An upstream oxidation catalytic converter or the catalytic filter coating therefore converts the nitrogen monoxide with the residual oxygen in the exhaust gas into nitrogen dioxide.

$2\ NO + O_2 \rightarrow 2\ NO_2$

Nitrogen monoxide + oxygen → nitrogen dioxide

It is also possible to combine an oxidation catalytic converter and catalytic surface. In this case, nitrogen monoxide formed together with the soot is oxidized back into nitrogen dioxide and can be used to help reduce the volume of soot particles again.

Even with continuously regenerating systems, active regeneration may be required from time to time. This applies, for example, if it was not possible to maintain the required temperature range for a long time, meaning that the filter was not able to sufficiently regenerate.

Active regeneration

The exhaust gas temperature for active regeneration must be increased substantially to approximately 600 °C. This is achieved, for example, by partially closing the butterfly valve in the suction manifold. An upstream diesel oxidation catalytic converter can also increase the temperature. In addition, diesel can be injected into the combustion chamber at a later point, so that unburned diesel passes into the particulate filter.

Due to the high temperature, soot is burned off in the filter. As some unburned fuel passes into the engine oil as a result of active regeneration, engine oil must be replaced after active regeneration has taken place five times.

Soot burn-off results in ash, which is deposited in the filter. If there is too much ash, the filter must be replaced.

Passive regeneration/CRT

Passive regeneration takes place continuously and passively, i.e. without a preliminary measure. The process is based on the fact that soot, which primarily consists of carbon, is burned off with nitrogen dioxide at exhaust gas temperatures in the range of 280 °C up to 450 °C. This is also referred to as the "CRTeffect" (Continuous Regeneration Trap). This type of soot combustion is very slow, but takes place continuously, provided that the soot is kept within the respective temperature range.

2.1.7.8 General description of the SCR reaction

The SCR reaction is based on the fact that nitrogen oxides react with ammonia to form water and nitrogen. This process enables a significant proportion of nitrogen oxides in exhaust gas to be eliminated.

The ammonia required to reduce the nitrogen oxides itself is very toxic and pungent-smelling, which is why it is further processed to form urea. It is used as an aqueous solution with a urea proportion of 32.5 percent and is referred to as "AdBlue®". The urea mixture is converted back into ammonia just upstream of the SCR reaction. Urea is a white, crystalline, non-toxic solid matter that is highly soluble in water.

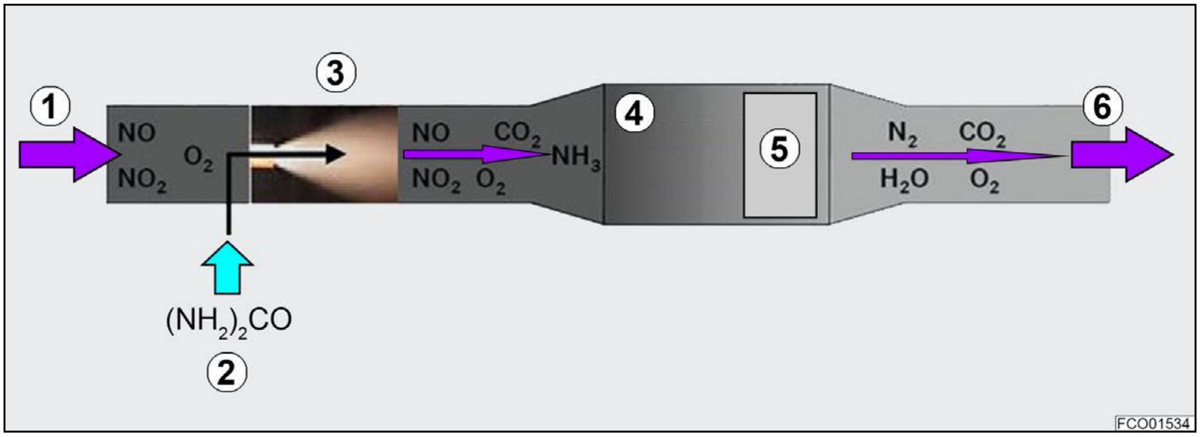

Fig. 10

(1) Exhaust gas from the diesel engine
(2) AdBlue® injection
(3) Thermal decomposition and hydrolysis for the production of ammonia
(4) SCR catalytic converter
(5)5 Oxidation catalytic converter to eliminate ammonia
(6) Exhaust gas downstream of the catalytic converter

Thermal decomposition and hydrolysis

An aqueous solution consisting of 32.5 percent urea and water is used. This solution is referred to as "AdBlue®" and is injected into the exhaust gas system upstream of the SCR catalytic converter. Under the influence of temperature, the first reaction — thermal decomposition — involving the urea-water mixture results in the formation of isocyanic acid and ammonia:

$$(NH_2)_2CO \leftrightarrow HNCO + NH_3$$

AdBlue® ↔ Isocyanic acid + ammonia

The colorless, gaseous isocyanic acid that is released is extremely reactive. The second reaction — hydrolysis — involves isocyanic acid reacting with water vapor to form ammonia and carbon dioxide:

$HNCO + H_2O \leftrightarrow NH_3 + CO_2$

Isocyanic acid + water ↔ ammonia + carbon dioxide

This reaction — which takes place in the gas phase — requires a catalytic converter so that a significant reaction speed is generated. This is the only way that undesirable secondary reactions can be prevented. If the thermal decomposition of the urea is delayed due to the heat supply being too slow or a catalytic converter that is not ideal is used, substantial amounts of unwanted by-products can sometimes form.

Undesirable secondary reactions

The most common undesirable by-products are biuret, cyanuric acid, ammeline, ammelide and melamine. These can form in a variety of ways.

At a temperature of 150 °C up to 190 °C, remaining urea can react with the isocyanic acid formed during the thermal decomposition process to form biuret:

$(NH_2)_2CO + HNCO \rightarrow C_2H_5N_3O_2$

AdBlue® + Isocyanic acid → biuret

Biuret is a colorless solid matter consisting of hygroscopic crystals that can accumulate on the surface of the catalytic converter as a yellowish deposit. At temperatures of 175 °C up to 190 °C, biuret can react with isocyanic acid to form cyanuric acid by removing ammonia

$C_2H_5N_3O_2 + HNCO \rightarrow (HNCO)_3 + NH_3$

Biuret + isocyanic acid → cyanuric acid + ammonia

or form ammelide by removing water:

$C_2H_5N_3O_2 + HNCO \rightarrow C_3H_4N_4O_2 + H_2O$

Biuret + isocyanic acid → ammelide + water

From temperatures of 225 °C, biuret and isocyanic acid can form ammeline by removing water:

$C_2H_5N_3O_2 + HNCO \rightarrow C_3H_5N_5O + 2H_2O$

Biuret + isocyanic acid → ammeline + water

However, it is possible for many of these unwanted by-products to not only as described above form by means of biuret reacting with isocyanic acid, but also via trimerization or amination. Trimerization denotes the process of three of the same molecules joining together to form a new molecule. Amination refers to a reaction with an ammonia molecule.

In a temperature range of 200 °C to 280 °C, cyanuric acid can form through the trimerization of isocyanic acid:

$3\ HNCO \rightarrow (HNCO)_3$

Isocyanic acid → cyanuric acid

At high temperatures, ammelide can form as a result of water being removed during the amination of cyanuric acid:

$(HNCO)_3 + NH_3 \rightarrow C_3H_4N_4O_2 + H_2O$

Cyanuric acid + ammonia → ammelide + water

The amination of ammelide can then form ammeline with the removal of water:

$C_3H_4N_4O_2 + NH_3 \rightarrow C_3H_5N_5O + H_2O$

Ammelide + ammonia → ammeline + water

Repeated amination can create melamine with the removal of water:

$C_3H_5N_5O + NH_3 \rightarrow C_3H_6N_6 + H_2O$

Ammeline + ammonia → melamine + water

The formation of crystalline structures via undesirable secondary reactions results in the specific surface area of the catalytic converter being obscured.

SCR reaction

If the thermal decomposition and hydrolysis processes take place in an optimal manner, the maximum amount of ammonia will be produced for the reduction of nitrogen oxides. Depending on the SCR type, there are three possible reactions. The end products are pure nitrogen and water in each case.

$4\ NH_3 + 4\ NO + O_2 \rightarrow 4\ N_2 + 6\ H_2O$

Ammonia + nitrogen monoxide + oxygen → nitrogen + water

$2\ NH_3 + NO + NO_2 \rightarrow 2\ N_2 + 3\ H_2O$

Ammonia + nitrogen monoxide + nitrogen dioxide → nitrogen + water

$8\ NH_3 + 6\ NO_2 \rightarrow 7\ N_2 + 12\ H_2O$

Ammonia + nitrogen dioxide → nitrogen + water

Elimination of ammonia

The correct AdBlue®quantity is essential for the SCR reaction to take place in an optimal manner: too little ammonia reduces the level of efficiency. Too much ammonia cannot react fully and enters the surrounding area. Therefore, an oxidation catalytic converter is often installed in the catalytic converter housing downstream of the SCR catalytic converter; in the event of too much ammonia being dosed, the oxidation catalytic converter converts the excess ammonia back into nitrogen and water.

$4\ NH_3 + 3\ O_2 \rightarrow 2\ N_2 + 6\ H_2O$

Ammonia + oxygen → nitrogen + water

Decrystallization

Depending on the temperature in the SCR catalytic converter, many unwanted by-products can form during the production of ammonia from urea. Up to a certain volume, these deposits do not affect the functionality of the system. However, if the deposits increase and also affect the dosing module, functionality can be severely restricted, with further deposits forming even faster and more intensely.

Most deposits can be thermally removed at temperatures of 350 °C and above. The decrystallization function is used for this purpose.

Component	Note
Urea	**Starts to form deposits:** Solid at room temperature **Removal:** from 132.7 °C **Appearance:** white, crystalline solid matter
Isocyanic acid	**Base product:** From the decomposition of urea **Starts to form:** from 80 °C **Removal:** from boiling point of23.5 °C **Appearance:** Colorless, gaseous, irritating
Biuret	**Base product:** Reaction of urea with isocyanic acid **Starts to form:** Slowly from 100 °C; quickly from 152 °C **Removal:** from 193 °C **Process:** Decomposition process to form urea and isocyanic acid **Appearance:** White, jelly-like matter similar to wallpaper paste
Cyanuric acid	**Base product:** Reaction of biuret with isocyanic acid or trimerization of isocyanic acid **Formation:**175 °C to 190 °C or 200 °C to 280 °C **Removal:** from 350 °C to 420 °C **Process:** Decomposition
Ammelide	**Base product:** Reaction of biuret with isocyanic acid or amination of cyanic acid **Formation:**175 °C to 190 °C or from 325 °C **Removal:** from 420 °C **Process:** Decomposition
Ammeline	**Base product:** Reaction of biuret with isocyanic acid or amination of ammelide **Formation:** From 225 °C or from 325 °C **Removal:** from 435 °C **Process:** Decomposition
Melamine	**Base product:** Amination of ammeline **Formation:** From 325 °C **Removal:** From approximately 350 °C up to 420 °C

2.2 Engine

2.2.1 PTO power and fuel consumption

2.2.1.1 Measurement of the PTO power in accordance with ISO1585

1. Net PTO power

Corresponds to the measured power on the test bench from the standard PTO fitting

2. Corrected PTO power

Corrected PTO power = measured PTO power multiplied by correction factor

3. Correction factor in accordance with ISO1585 in relation to ambient temperature and air pressure

The correction factor reduces the measured power by reference to the standard atmospheric values:

- Air pressure: 99 kPa
- Ambient temperature: 25 °C

Correction factor for turbo-charged engines:

Parameters	Correction factor in accordance with ISO 1585					
Ambient air pressure (hPa)	990	970	950	930	910	890
Ambient temperature (°C)						
0	0.979	0.982	0.985	0.988	0.991	0.994
10	0.988	0.991	0.993	0.996	0.999	1.003
20	0.996	0.999	1.002	1.005	1.008	1.011
25	1	1.003	1.006	1.009	1.012	1.015
30	1.004	1.007	1.010	1.013	1.016	1.019
35	1.008	1.011	1.014	1.017	1.020	1.023
40	1.012	1.015	1.018	1.021	1.024	1.027

4. Standard tractor equipment

Pursuant to ISO1585, the standard equipment of the tractor includes all standard equipment that is required for normal operation of the tractor engine, such as:

- Intake system with air filter, intake air guidance and rain cap
- Exhaust system with silencer, exhaust brake and tail pipe
- Injection equipment complete with feed pump and prefilter
- Cooling system with water pump, thermostat and fan (fixed/controllable; for controllable fans the power consumption of the fan is taken as that at maximum slip)
- Electrical equipment with alternator unloaded
- Compressed air system (if this cannot be switched off)
- Turbocharger with intercooler

5. Measuring accuracy of test equipment

- Torque ± 1%

- Engine speed ± 0.5%
- Fuel consumption ± 1%
- Fuel temperature ± 2 K
- Ambient temperature ± 2 K
- Air pressure ±100 Pa
- Exhaust gas back pressure ±200 Pa
- Intake vacuum ±50 Pa
- Charge air pressure in the intake pipe ±2 %

The tolerances refer to the maximum measuring range of the test equipment.

6. Preparation of the tractor for power measurement

Before performing power measurement, the tractor must have undergone normal maintenance work, such as:

- Oil level → engine, transmission, hydraulics
- Coolant → engine cooling
- Cleaning → air filter and radiator, where necessary replacement of fuel filter
- Leak tightness → fuel system
- Checking the speed setting (stop)
- Checking the engine cut-off speed and setting the target value

7. Performing PTO power measurement

At ambient temperatures of 20 °C to 25 °C, the tractor must be operated for at least 15 minutes at full load. During this time, the engine, transmission and hydraulic system will reach temperatures that will ensure a PTO power output value that can be taken as a sufficiently accurate representation of the sustained value.

At ambient temperatures less than 10 °C, the warm-up time must be extended to at least 30 minutes.

The measured values must remain constant for at least a minute before being recorded, and the engine speed must not drop below 1% of the set value.

During the measurement the auxiliaries such as

- Air compressor
- Alternator
- Hydraulic pumps
- Air conditioning compressor

must remain unloaded.

8. Fuel consumption measurement

In the event of a complaint regarding fuel consumption, consumption can be measured in two ways:

1. Complete a consumption log

- The oil consumption log from Service Bulletin 22/05 can be used as a template.

2. Perform a measurement at the exhaust brake

- Engine at operating temperature
- Fill the tank to capacity
- Run for at least half an hour under full load at the exhaust brake
- Fill the tank to capacity
- Determine consumption

NOTE: *The consumption values can also be read on the terminal.*

2.2.2 Engine control

The engine control unit manages and controls the engine. It has the following management functions:

- **Speed control**

  The engine control unit keeps the engine speed under load set by the foot throttle, hand throttle and memory key (target value) constant as long as the engine is capable of providing the necessary power. If necessary, the maximum speed is limited (cut-off speed).

- **Torque restriction**

  Restriction of the maximum torque (maximum injection volume)

- **Rail pressure control**

  The engine control unit dispenses the exact fuel quantity to the rail corresponding to the quantity that will be discharged by the injectors. Control is exercised by the rail pressure sensor, which reports the actual pressure to the engine control unit.

- **Multi-point injection**

  To reduce the exhaust gas and noise emissions, the injectors are activated up to three times by the engine control unit per working cycle.

- **Cylinder switch-off**

  If the engine control unit detects a short circuit (short circuit low - high) of an injector, this injector is no longer activated and thus switched off.

- **Engine start**

  If all input signals are present the start procedure is initiated.

  If the speed signals (camshaft, crankshaft) are not present after 5 seconds, the start process is aborted.

- **Engine stop**

  The injectors cease to be activated.

- **Monitoring and signal output functions**

  Coolant temperature and charge air temperature → error display and/or power reduction

- **Boost pressure-dependent engine management (LDA function)**

  If the charge-air temperature increases, the injection quantity will be restricted. If the boost pressure drops, the injection quantity will be restricted. This will avoid the formation of smoke.

  NOTE:
  An atmospheric pressure sensor is located in the engine control unit
  Boost pressure (overpressure) = absolute pressure (sensor) - atmospheric pressure (engine control unit)
  Height correction to avoid smoke plumes due to low air density
  Engine protection due to low air density: at great heights (Andes, Himalayas etc.) the maximum engine power is restricted

- **Temperature-dependent start control**

  Improved starting characteristics; engine protection at cold start without smoke plumes

- **Actuation of the injectors**

  Supplying the injector with current causes fuel to be injected. The duration determines the quantity that is injected. Fuel is injected up to three times per working cycle.

- **Emergency mode/engine shut-off if necessary**

- **Error memory in the engine control unit**

  The engine control unit sends the EDC error to the instrument cluster where the error messages are output on the display as an error code (FENDT error code).

- **Error diagnostics with engine diagnostics program**

  All sensors and the engine control unit can be read out. Measured values can be displayed graphically. Engine-specific error code can be read out. Check the function of all actuators.

- **Load engine data set with engine diagnostics program**

  For optimum management of the diesel engine by the engine control unit, the reference data (maximum power, cut-off speed, engine mapping field (injection volume at a specific operating point), maximum permissible operating temperature etc.) must be read into the engine control unit.

- **Engine data set**

  The engine data set (consisting of the reference data, engine-specific data such as mechanical tolerances, fittings (power pack engine or vehicle engine)) is read into the engine control unit.

  NOTE:
  If an engine data set is installed or an engine control unit that does not match the chassis number of the tractor is fitted, this will invalidate any claims under warranty, and also the general operating licence (ABE) and hence also the insurance cover!
  If an engine control unit that does not match the chassis number of the tractor is fitted, the power of the tractor will be restricted. The chassis number and engine number of the tractor, and also the interface serial number (interface cable for the engine diagnostics program) are recorded in the engine control unit.

- **Calculated fuel consumption**

  The fuel consumption of the diesel engine is calculated in the engine control unit in litres per hour (l/h) and displayed on the Varioterminal.

- **Control of the SCR system**

  The engine control unit controls AdBlue® injection depending on the engine load and exhaust temperature.

2.2.3 Starting process

Ignition switch in "Start" position: Batteries in series

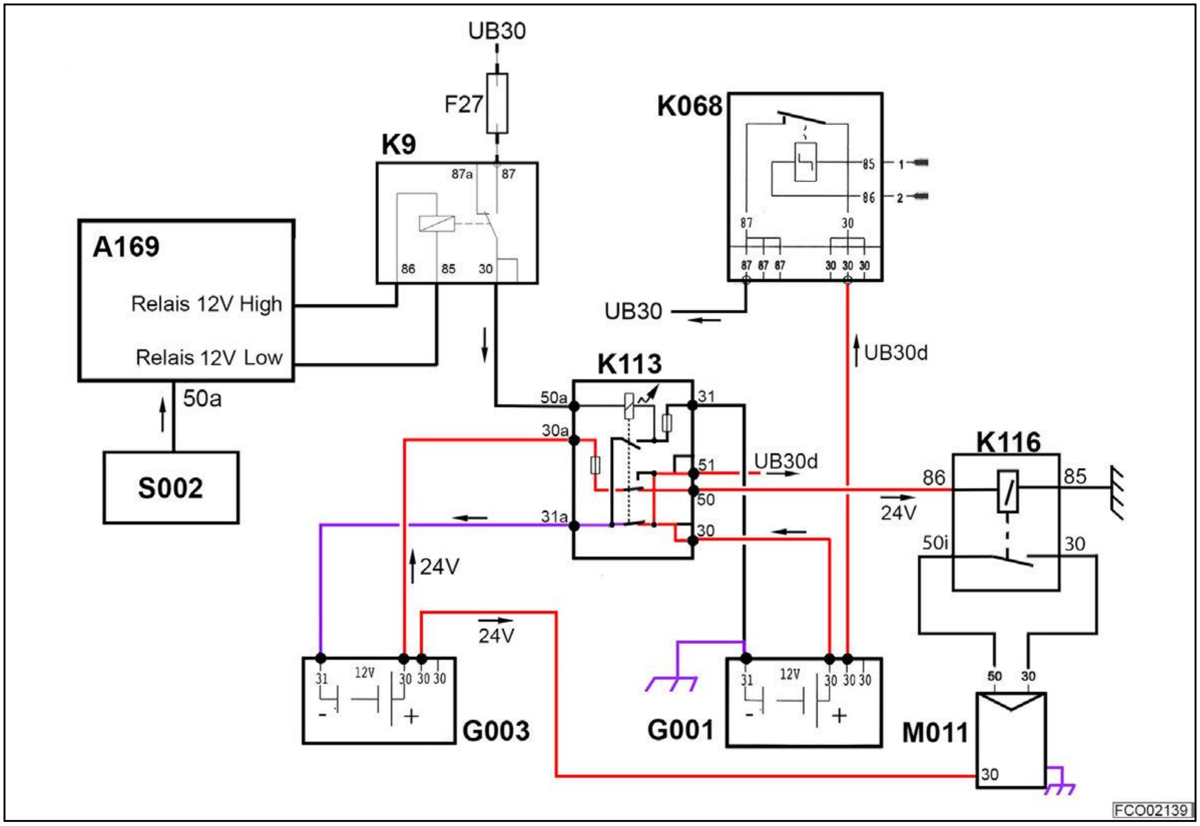

Fig. 11

A169 - Engine control unit ECU (EDC 17)
G001 - Battery 1
G003 - Battery 2
K9 - Relay for 12 V/24 V battery switchover
K068 - Battery isolation relay
K113 - 12-V/24-V battery switchover relay
K116 - 24-V starter relay
M011 - 24 V starter
S002 - Ignition switch

If **S002** - Ignition switch is set to the "Start" position, relay K9 is actuated via the engine control unit, which in turn switches relay K113. As a result, current flows from the positive terminal of **G001** - Battery 1 to the negative terminal of **G003** - Battery 2. The two batteries are connected in series. Current flows from **G003** - Battery 2 to **M011** - 24 V starter and - via relay K113 - to relay K116. Through connection in series, 24 V is supplied in each case.

As soon as 24 V is measurable at relay K116, the **M011** - 24 V starter is supplied. The starter starts the diesel engine.

Ignition ON / engine running: Batteries in parallel

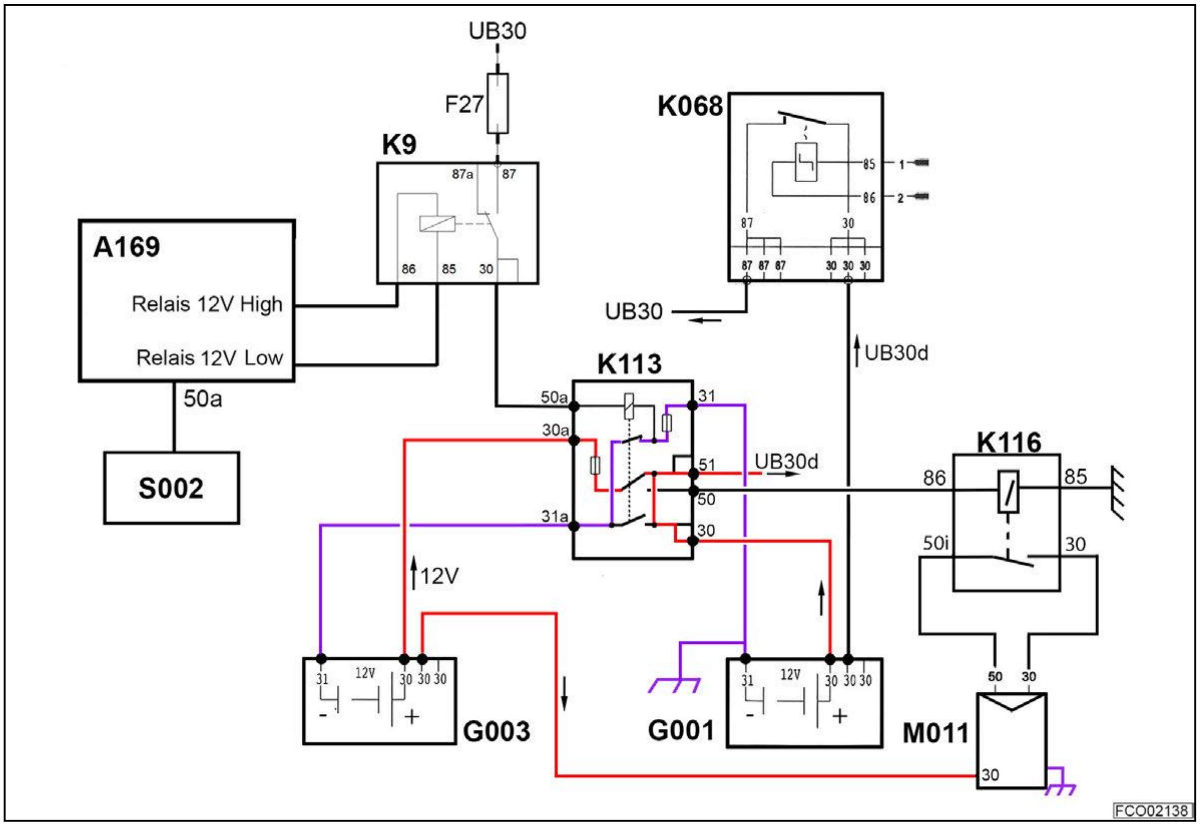

Fig. 12

A169 - Engine control unit ECU (EDC 17)
G001 - Battery 1
G003 - Battery 2
K9 - Relay for 12 V/24 V battery switchover
K068 - Battery isolation relay
K113 - 12-V/24-V battery switchover relay
K116 - 24-V starter relay
M011 - 24 V starter
S002 - Ignition switch

If the start process is ended, relay K113 no longer receives a signal. Current flows both from the positive terminal of **G001** - Battery 1 and from the positive terminal of **G003** - Battery 2 to relay K113. The two batteries are connected in parallel. 12 volts are measurable at the output of the relay.

2.2.4 Crankcase breather

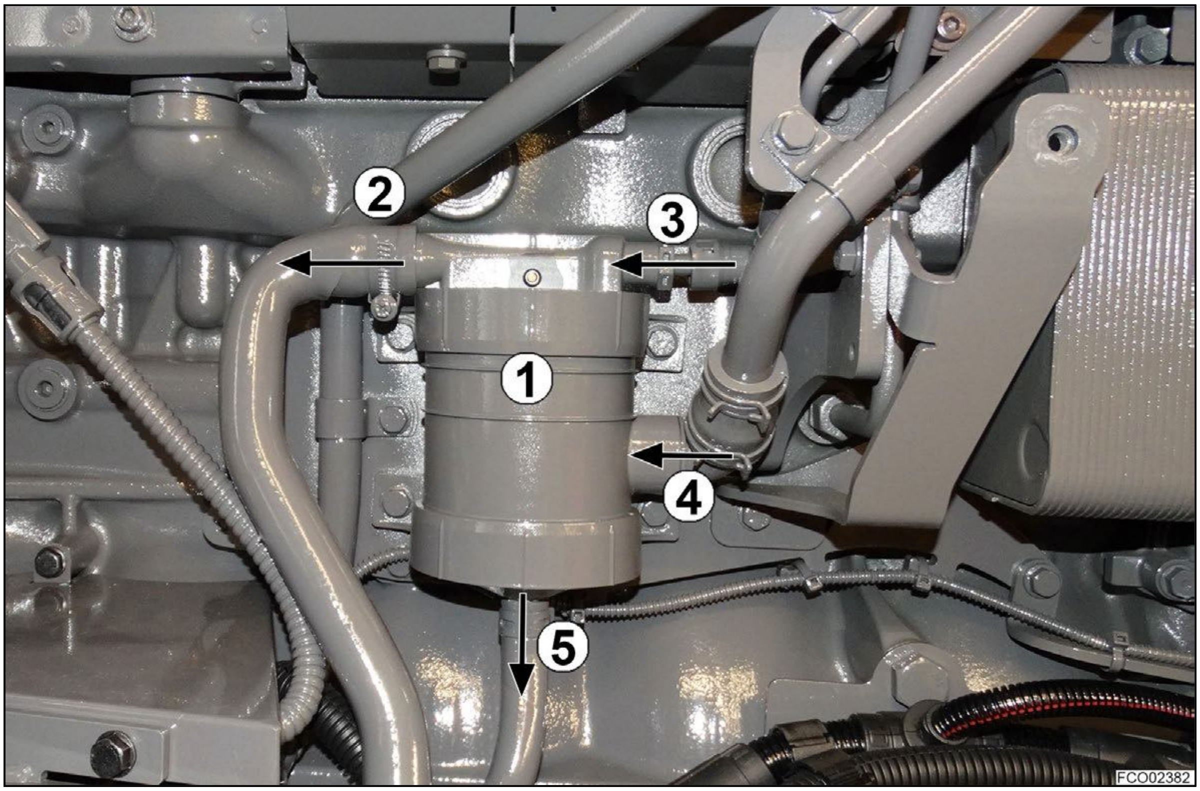

Fig. 13

(1)	Crankcase breather filter
(2)	Output to the outside
(3)	Pressure input (charge air from suction manifold)
(4)	Input from crankcase
(5)	Output to oil sump

The crankcase breather is a closed crankcase ventilation (Closed Crankcase Ventilation, CCV). Oil mist and soot are separated and returned to the sump via hose (5).

The continuous air flow between boost air connector (3) and suction hose (4) enhances the filter function.

The crankcase breather is maintenance-free.

NOTE: *While the engine is running, oil cannot flow back to the sump, as the valve is completely closed. Only once more oil has collected in hose* (5) *thereby increasing the pressure, does the valve open enabling oil to flow back. When the engine is switched off, the oil similarly flows back.*

2.3 Intake system

2.3.1 Description B092 - Charge air pressure/temperature sensor

Description

The **B092** - Charge air pressure/temperature sensor is a combination sensor, which means that in a component there are two sensors with the same power supply but different functions. The sensor reports the boost pressure and charge air temperature to the engine control unit

(1) Earth
(2) Signal
(3) UB 5.0 V_{DC}
(4) Signal

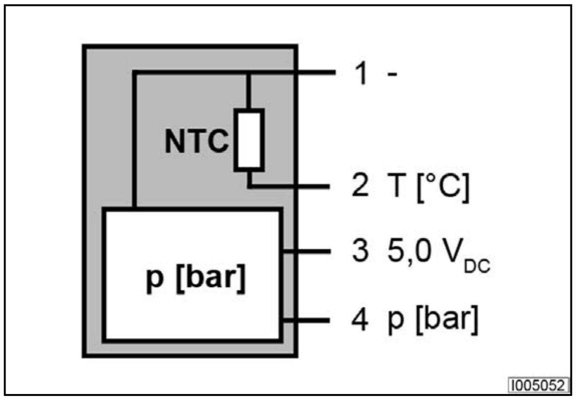

Fig. 14

Function of the pressure sensor:

The charge pressure (physical variable) is converted into a voltage signal (electrical variable). The pressure and the signal voltage are proportional, so that as the charge pressure increases, the signal voltage increases proportionately. The variable is used to control the engine (LDA function).

Function of the temperature sensor:

The resistance of the temperature sensor changes depending on the temperature. Basically, NTC sensors (negative temperature coefficient) or PTC sensors (positive temperature coefficient) can be used for temperature measurement.

The temperature sensor in **B092** - Charge air pressure/temperature sensor is a NTC sensor. As the temperature increases, the resistance in the sensor decreases.

Charge air temperature warning message:

The engine control unit picks up the charge air temperature from the **B092** - Charge air pressure/temperature sensor and forwards it to the **A050** - Basic control unit ECU (EXT) via the G-Bus. This is the storage location of the warning threshold for the charge air temperature. If the charge air temperature rises above the warning threshold, the **A050** - Basic control unit ECU (EXT) issues an error message. The error message is send to the instrument panel via the comfort BUS and appears in the display.

2.4 Fuel system

2.4.1 Rail pressure sensor

2.4.1.1 B086 - Rail pressure sensor Remove

Procedure

1. Remove the connector
2. **B086** - Rail pressure sensor Unscrew .

   Collect any escaping fuel
3. To avoid electrostatic discharge, do not touch the contact pins on the B086 with bare hands.

2.4.1.2 B086 - Rail pressure sensor Install the

Procedure

1. **NOTE**: *To avoid electrostatic discharge, do not touch the contact pins on the B086 with bare hands.*

   Check the thread and sealing lip for damage (see arrows)
2. Apply a thin coat of X902002472000 high-pressure grease for long-term lubrication to the thread and sealing lip of the **B086** - Rail pressure sensor

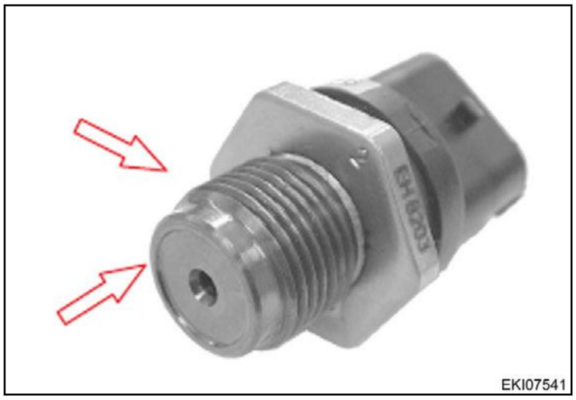

Fig. 15

3. Screw in B086 (M18x1.5) and tighten

   Tightening torque: **75 Nm**
4. Connect the plug connector

2.4.2 Injectors

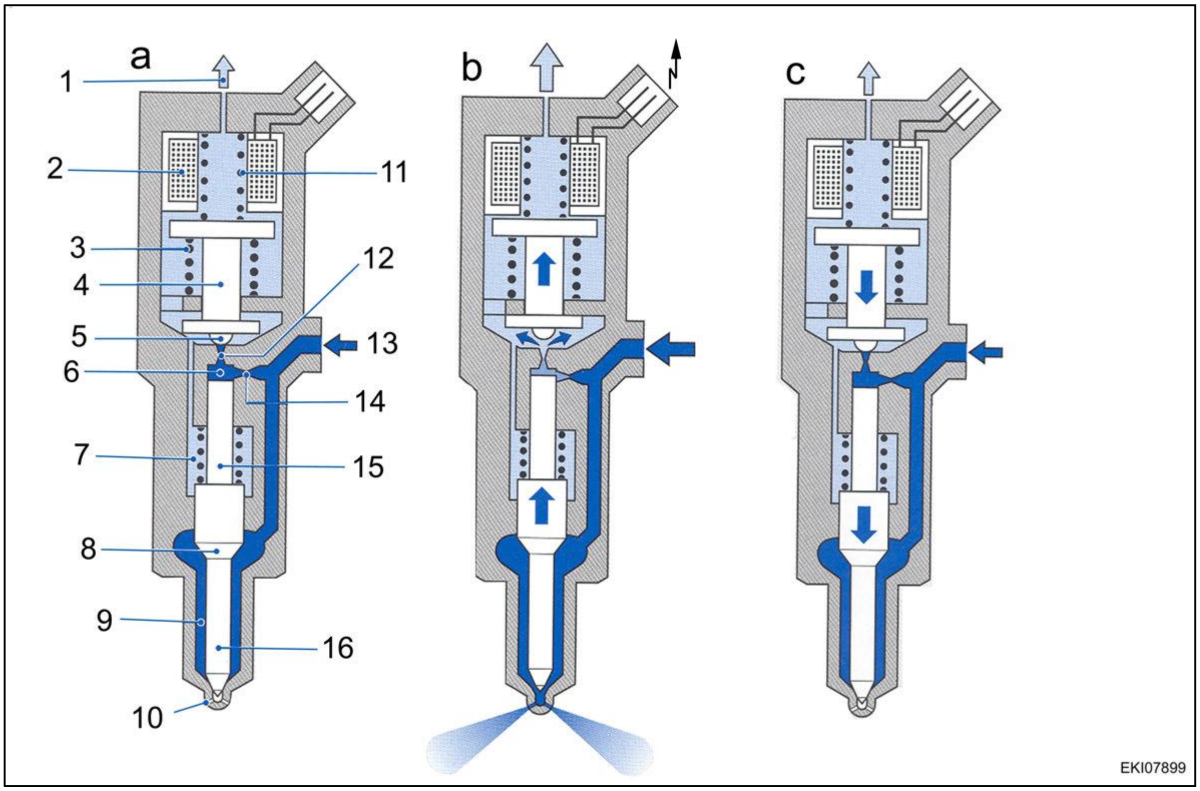

Fig. 16

(a) Idle state
(b) Injector valve opens: injection begins
(c) Injector valve closes: end of injection
(1) Fuel return
(2) Solenoid coil
(3) Overstroke spring
(4) Ignition armature
(5) Valve ball
(6) Valve actuation chamber
(7) Injection nozzle spring
(8) Exposed annular surface of the injection nozzle needle
(9) Chamber volume
(10) Injection nozzle hole (multi-hole nozzle)
(11) Solenoid valve spring
(12) Outlet restrictor
(13) High-pressure connection
(14) Inlet restrictor
(15) Valve piston (control piston)
(16) Injector needle

Layout and function

The fuel is fed from the high-pressure connection (13) via a feed channel to the injection nozzle and via an inlet restrictor (14) into the valve actuation chamber (6). The valve actuation chamber is connected to the fuel return (1) via the outlet restrictor (12), which can be opened by a solenoid valve.

<u>Injector closed: idle state (a)</u>

The injector is not actuated when it is in the idle state. The solenoid valve spring (11) presses the valve ball (5) into the outlet restrictor seat (12). The rail high-pressure builds up in the valve actuation chamber. The same pressure is also present in the chamber volume (9). The force applied on the front of the control piston (15) by the rail pressure and the force from the injection nozzle springs (7) hold the injection nozzle needle (16) closed.

<u>Injector valve opens: injection begins (b)</u>

The injector is in the rest position. The solenoid coil (2) is energized. The valve ball (5) is raised from its seat against the spring force (11). As a result, the pressure in the valve actuation chamber (6) is released to the

https://www.ebooklibonline.com