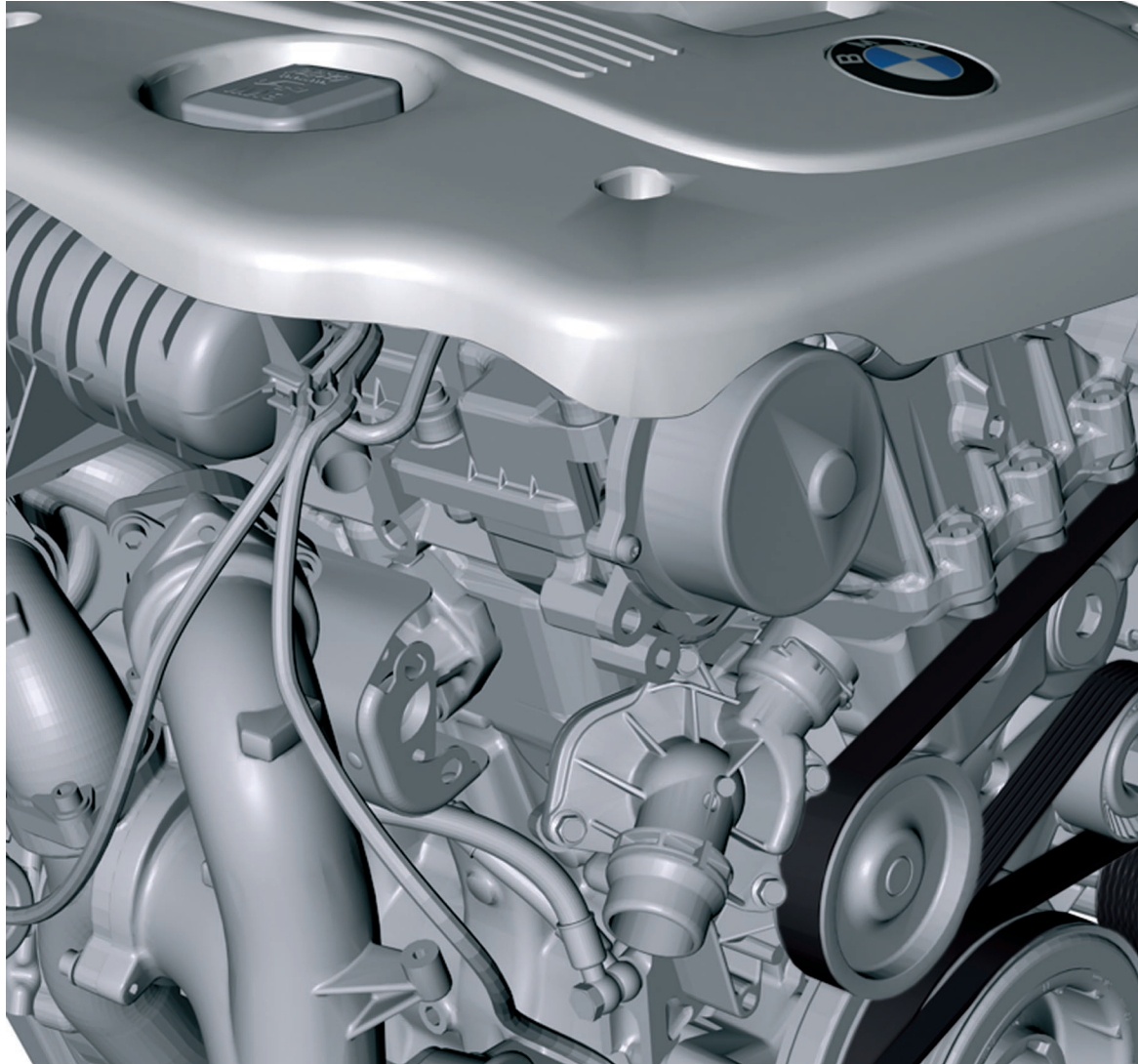


Participant's Manual

M57TU1-TOP Engine



BMW Service

The information contained in this Participant's Manual is intended solely for participants attending this seminar run by BMW Aftersales Training.

Refer to the latest relevant "BMW Service" information for any changes/supplements to the Technical Data.

Information status: April 2004

conceptinfo@bmw.de

© 2004 BMW AG

Aftersales Training, München, Germany.

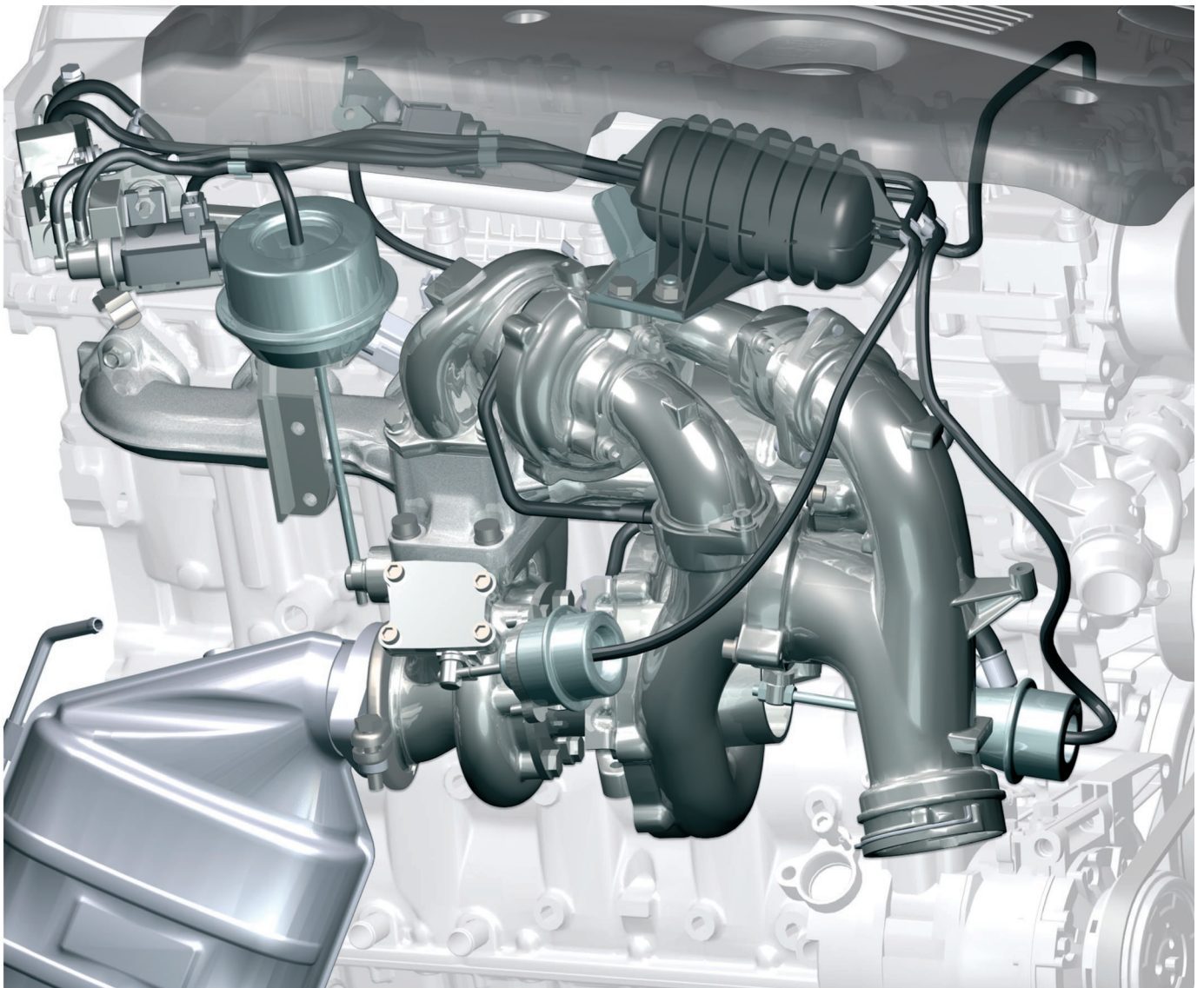
Reprints of this manual or its parts require the written approval of BMW AG, München.

Participant's Manual

M57TU1-TOP Engine

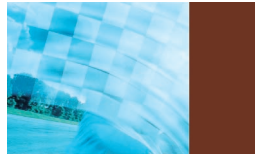
**Diesel engine with two-stage
supercharging**

Digital Diesel Electronics DDE 606



Contents

M57TU1-TOP Engine

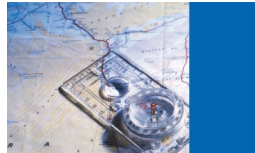


Objectives

1

Purpose of this Participant's Manual

1



Introduction

3

Diesel engine with two-stage supercharging

3

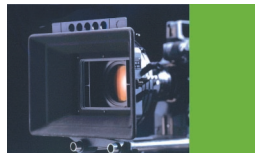


System components

7

Modified components

7



Functional principle

11

Two-stage supercharging

11



Objectives

M57TU1-TOP Engine

Purpose of this Participant's Manual

The Participant's Manual is a document designed to accompany a seminar while at the same time serving as a source of reference.

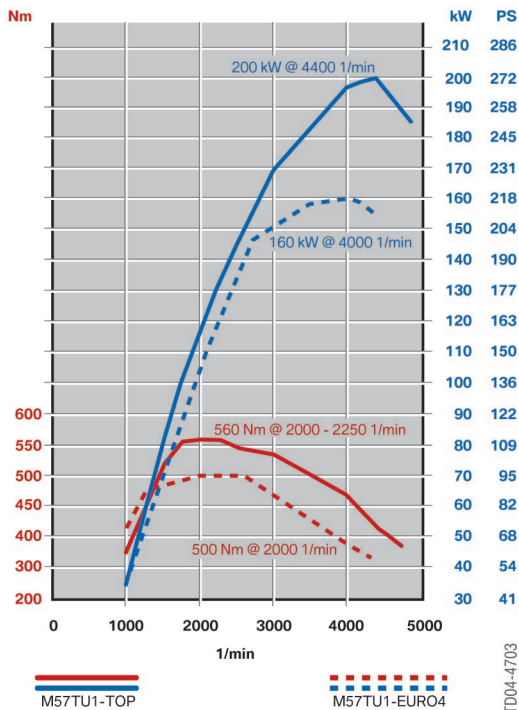
It deals with all new features and changes of the M57TU1-TOP engine compared to the M57TU1-EURO 4 engine.



Introduction

M57TU1-TOP Engine

Diesel engine with two-stage supercharging



1 - Comparison between M57TU1-EURO 4 and M57TU1-TOP

The most powerful diesel engine used in the E60 will be the M57D30TU1-TOP (model designation 535d).

The engine is characterized by outstanding power output characteristics. The power output is 200 kW/272 bhp. The maximum torque of 560 Nm is developed at 2000 rpm. A torque of 500 Nm is available at an engine speed of 1500 rpm.

Changes

Compared to the M57TU1-EURO 4 engine, the following changes and new developments have been implemented on the following components:

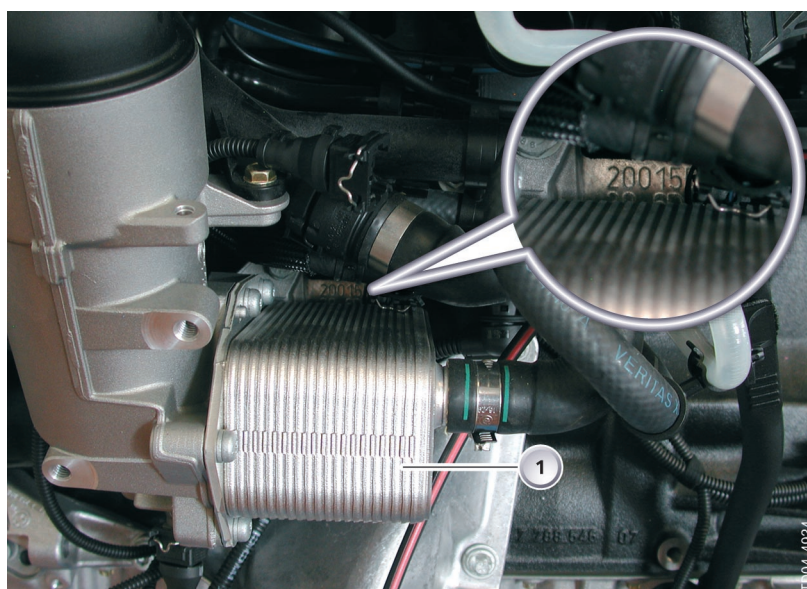
- Exhaust turbocharger
- Exhaust system
- Intake air control
- Pistons and connecting rods
- Camshafts
- Belt drive
- Reduced compression ratio
- Increased fuel injector cross section
- Digital diesel electronics DDE 606

Technical data

Description	M57D30 TU1 EURO 4	M57D30 TU1 TOP
Type	6-cylinder in-line engine	6-cylinder in-line engine
Displacement (cm ³)	2993	2993
Stroke/bore (mm)	90/84	90/84
Output (kW/bhp) at engine speed (rpm)	160/218 4000	200/272 4400
Torque (Nm) at engine speed (rpm)	500 2000-2750	560 2000-2250
Governed cutoff speed (rpm)	4600	5000
Compression ratio	17.0	16.5
Valves/cylinder	4	4
Digital diesel electronics	DDE 509	DDE 606
Compliant with exhaust emission requirement	EURO 4	EURO 4
Exhaust gas treatment	Oxidation catalytic converter and diesel particle filter	Oxidation catalytic converter and diesel particle filter

Engine number

The engine number is located on the engine block above the engine oil cooler.



2 - Item 1: Engine oil cooler

History

To date, the M57D30TU engine has been installed in the following model series:

Engine	Series	kW/bhp at rpm	Nm at/rpm	Exhaust emission stage	Engine control
M57D30 TU	E46	150/204 4000	410 1500-3250	LHD = EURO3 RHD = EURO3	DDE 5.0
M57D30 TU1	E46	150/204 4000	410 1500-3250	LHD = EURO4 RHD = EURO4	DDE 506
M57D30 TU1	E83	150/204 4000	410 1500-3250	LHD = EURO3 RHD = ---	DDE 506
M57D30 TU	E53	160/218 4000	500 2000-2750	LHD = EURO3 RHD = EURO3	DDE 506
M57D30 TU	E65	160/218 4000	500 2000-2750	LHD = EURO3 RHD = EURO3	DDE 506
M57D30 TU1	E60	160/218 4000	500 2000-2750	LHD = EURO3 RHD = EURO3	DDE 508
M57D30 TU1 EURO 4	E60	160/218 4000	500 2000-2750	LHD = EURO4 RHD = EURO4	DDE 509
M57D30 TU1 TOP	E 60 (as from 09/04)	200/272 4400	560 2000-2250	LHD = EURO4 RHD = EURO4	DDE 606

LHD = Left-hand drive
RHD = Right-hand drive



System components

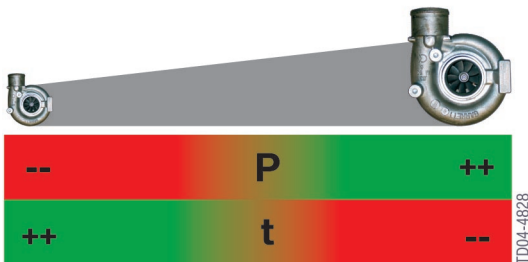
M57TU1-TOP Engine

Modified components

Exhaust turbocharger

Two-stage turbocharging solves the conflict of interest between response at low engine speeds and the availability of high power reserves during motorway driving.

Two series-connected turbochargers are used. A small turbocharger for the high pressure stage and a larger turbocharger for the low pressure stage. Both turbochargers have a rigid turbine geometry without adjustable turbine blades.



1 - Advantages of two-stage turbocharging

The smaller exhaust turbocharger (high pressure stage) develops high torque and good response characteristics (t) at low engine speeds. The larger exhaust turbocharger (low pressure stage) is responsible for high engine power output (P).

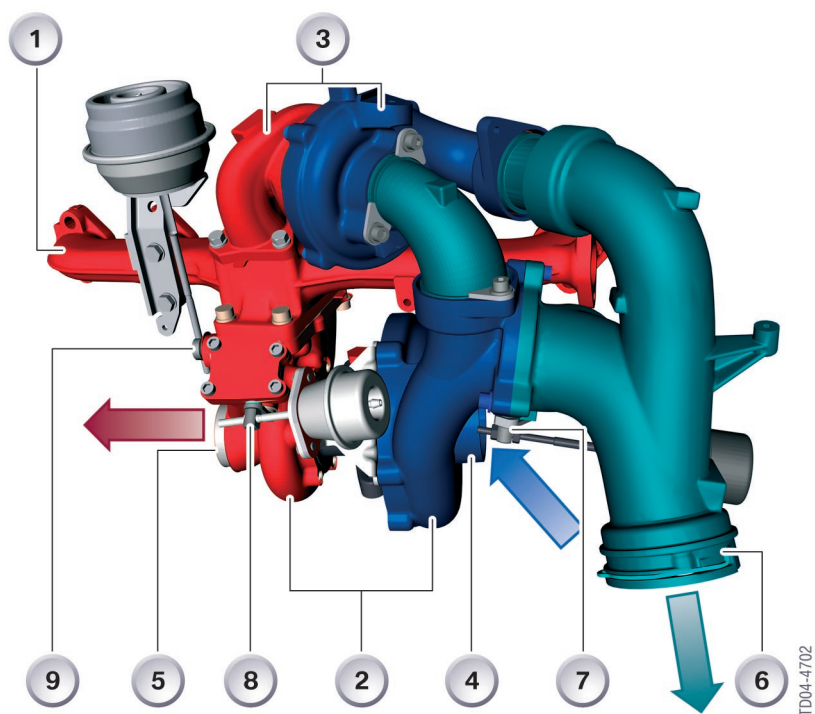
The max. boost pressure of the overall system is 2.85 bar (M57TU = max. 2.5 bar). The turbine speeds are max. 230,000 rpm for the high pressure stage and max. 170,000 rpm in the low pressure stage.

A flexible combination of both turbochargers is possible. Components both on the exhaust and air intake sides control the variable interaction of both exhaust turbochargers:

- Turbine control valve (exhaust side)
- Compressor bypass valve (air side)
- Wastegate (exhaust side)

Index	Description
-------	-------------

P	Engine output
t	Response characteristic



2 - Exhaust turbocharger

Index	Description	Index	Description
1	Exhaust manifold	6	Outlet of compressed intake air to intercooler
2	Exhaust turbocharger (low pressure stage)	7	Compressor bypass valve
3	Exhaust turbocharger (high pressure stage)	8	Wastegate
4	Intake air inlet from air cleaner	9	Turbine control valve
5	Exhaust system connection	---	



Exhaust system

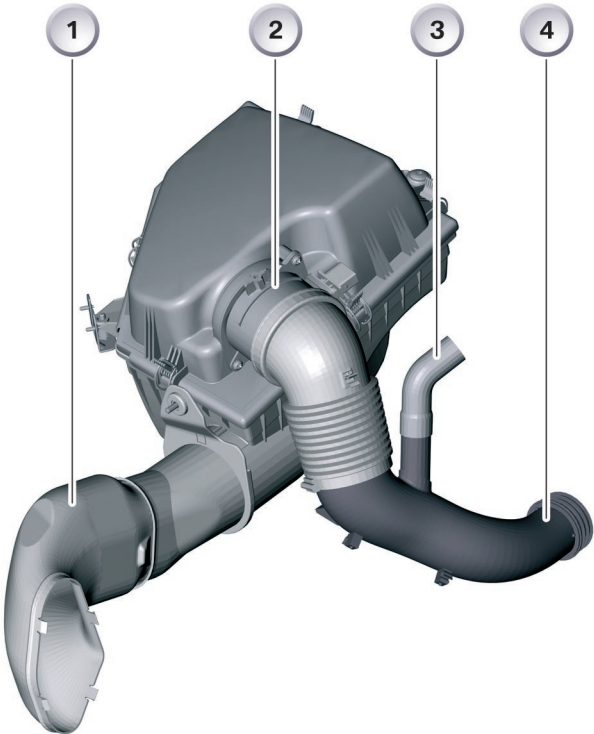
The exhaust system has been adapted to the higher volumetric throughput of the M57TU1-TOP engine compared to the M57TU1 engine.

For this purpose, the exhaust system is designed as a dual-flow system between the diesel particle filter and the rear silencer.

Intake air control

The near-engine arrangement of the intake silencer is no longer possible due to the increased demand for space for the exhaust turbochargers and due to the higher air intake

requirement of the M57TU1-TOP engine. The intake silencer together with the air cleaner has therefore been relocated from the engine to the right-hand wheel arch.



TD04-4717

3 - Intake air control

Index	Description	Index	Description
1	Intake snorkel	3	Line to engine breather
2	Hot-film air mass meter	4	Filtered air gaiter





Pistons and connecting rods

The connecting rods are trapezoidal in the area of the upper connecting rod eye. Due to the trapezoidal shape, it has been possible to make the bearing half on the rod side of the upper connecting rod eye wider, providing more favourable force input conditions. The

cracked connecting rod is made from forged steel. The pistons have been adapted to the trapezoidal shape of the connecting rod. The geometry of the piston crown bowl has been slightly modified to adapt to the modified power output and exhaust requirements.

Camshafts

Built-in camshafts are used. The non-separable drive gear is connected to the camshaft. Compared to the previous

camshafts made of clear chill casting, the built-in camshafts offer a considerable weight advantage.

Belt drive

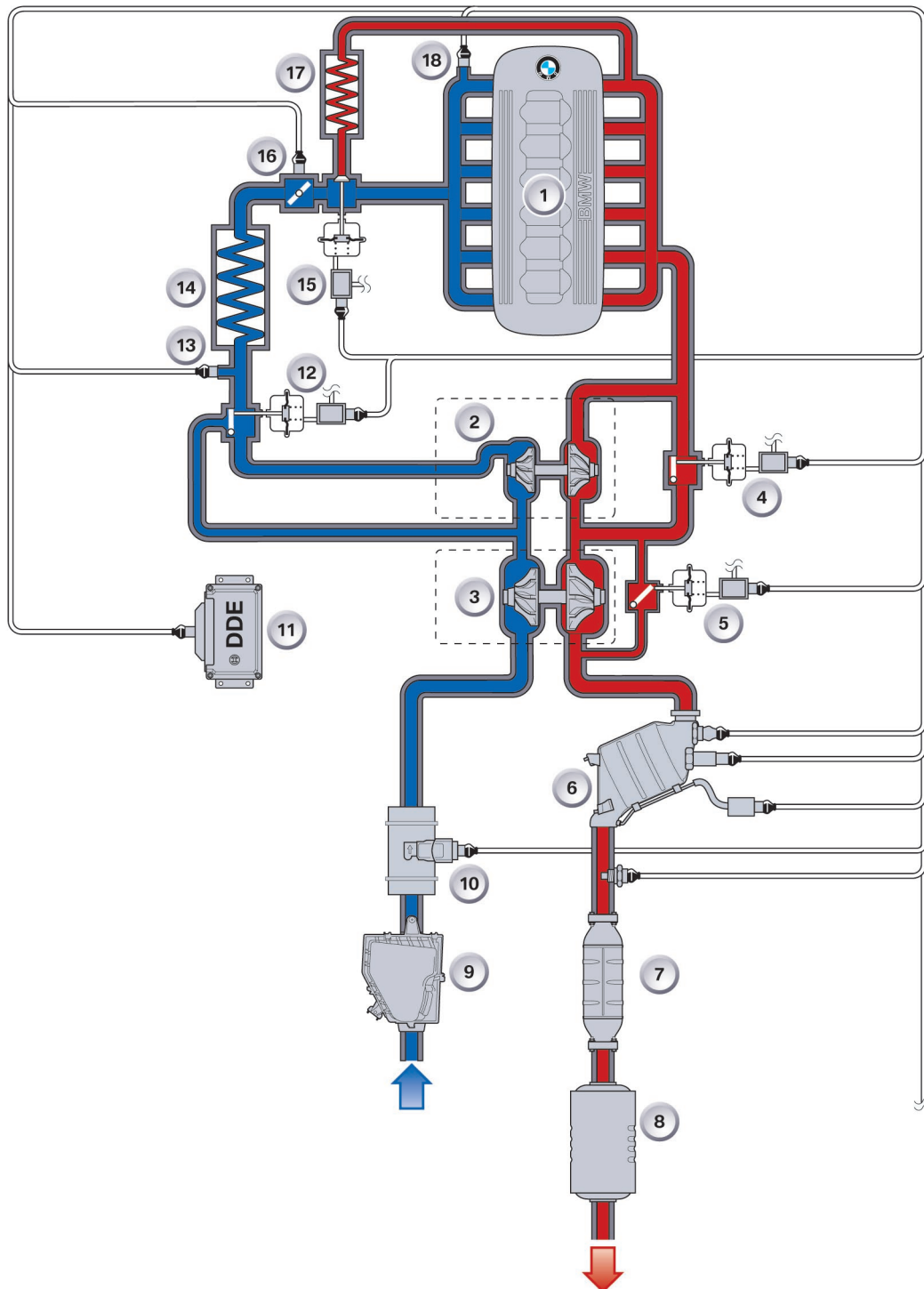
A 6 ribbed V-belt assembly with a mechanical tensioning pulley is used for the main drive. The A/C compressor is driven by an Elast-belt. The Elast-belt (4-ribbed belt) is

self-tensioning. It is fitted with a special tool as part of servicing operations. No other tensioning facility is provided on the engine.

Functions

M57TU1-TOP Engine

Two-stage supercharging



TD04-4684

1 - Overview of two-stage supercharging on the M57TU1-TOP engine (valves/flaps shown at engine OFF)

Index	Description	Index	Description
1	M57TU1-TOP engine	10	Hot-film air mass meter (HFM)
2	Exhaust turbocharger (high pressure stage)	11	Digital diesel electronics (DDE)
3	Exhaust turbocharger (low pressure stage)	12	Compressor bypass valve with electric changeover valve (EUV)
4	Turbine control valve with electropneumatic pressure converter (EPDW)	13	Intake air temperature sensor
5	Wastegate with electropneumatic pressure converter (EPDW)	14	Intercooler
6	Oxidation catalytic converter	15	Exhaust gas recirculation (EGR valve)
7	Diesel particle filter	16	Throttle valve
8	Rear silencer	17	EGR cooler
9	Intake silencer (AGD) with air cleaner	18	Boost pressure sensor

Turbine control valve

The turbine control valve (4) routes the exhaust gas through the bypass duct past the high pressure stage (2) to the low pressure stage (3). It is operated pneumatically by a diaphragm unit and can be variably adjusted.

An electropneumatic pressure converter (high speed EPDW) applies vacuum to the diaphragm unit.

Compressor bypass valve

The compressor bypass valve (12) controls the bypass of the high pressure stage (2) on the air intake side. It is operated pneumatically by a diaphragm unit. The compressor bypass

valve is either fully opened or completely closed.

An electric changeover valve (EUV) applies vacuum to the diaphragm unit.

Wastegate

On reaching the nominal engine output, the wastegate (5) opens to avoid high boost and turbine pressures.

An electropneumatic pressure converter (EPDW) applies vacuum to the diaphragm unit.

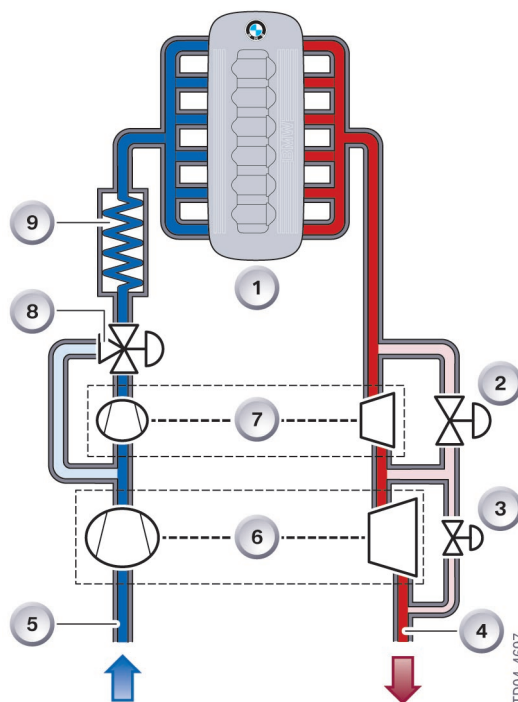
A part of the exhaust gas flows via the tailgate past the turbine of the low pressure stage (3). It is operated pneumatically by a diaphragm unit. The wastegate can be variable adjusted.

Switching points

The DDE controls the supercharging dependent on the engine load and speed. The switching points stored in a characteristic map take place in a smooth transition (hysteresis). The following illustrations show the functions of the two-stage turbocharging system at full load:

Lower engine speed range (up to 1500 rpm)

The turbine wheels of the high pressure and low pressure stages (6+7) are driven by exhaust gas. The engine is supercharged primarily by the high pressure stage (7).

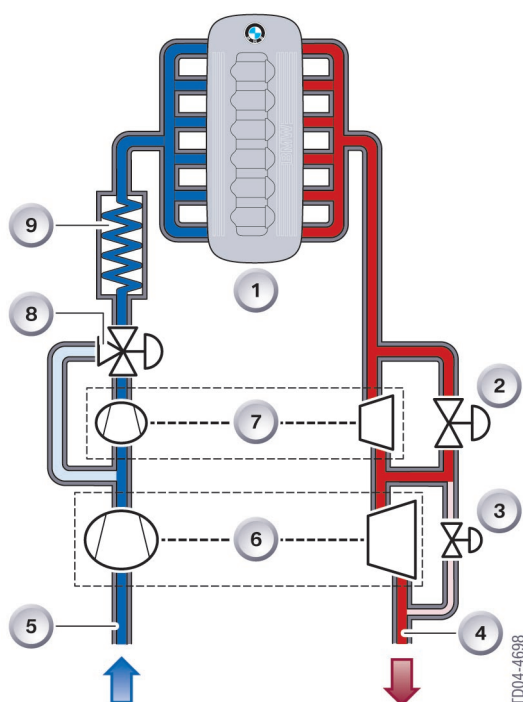


2 - Supercharging function at engine speeds up to 1500 rpm

Index	Description
1	M57TU1-TOP engine
2	Turbine control valve with electropneumatic pressure converter (EPDW)
3	Wastegate with electropneumatic pressure converter (EPDW)
4	Exhaust gas, to exhaust system
5	Fresh air, from air cleaner
6	Exhaust turbocharger (low pressure stage)
7	Exhaust turbocharger (high pressure stage)
8	Compressor bypass valve with electric changeover valve (EUV)
9	Intercooler

Medium engine speed range (from 1500 to 3250 rpm)

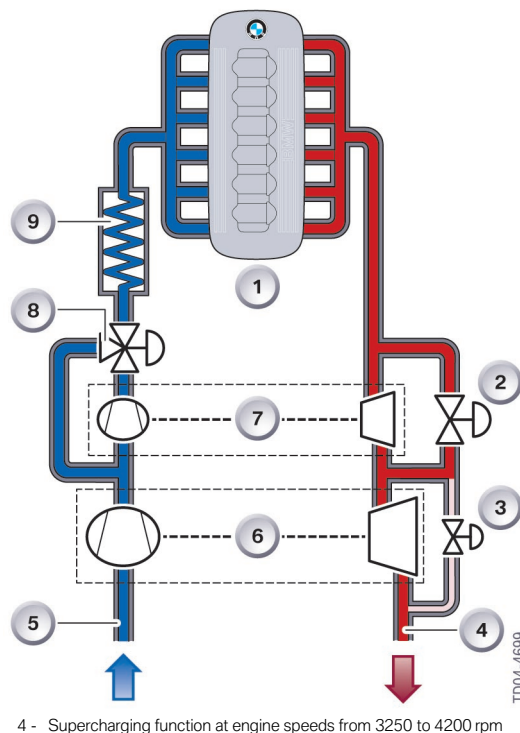
The turbine control valve (2) opens continuously as the engine speed increases. Consequently, the flow of exhaust gas increasingly bypasses the turbine wheel of the high pressure stage (7). As the engine speed increases, the engine is supercharged more and more by the low pressure stage (6).



3 - Supercharging function at engine speeds from 1500 to 3250 rpm

Upper engine speed range (from 3250 to 4200 rpm)

The turbine control valve (2) is completely open. The flow of exhaust gas largely bypasses the turbine wheel of the high pressure stage (7). The compressor bypass valve (8) is open. The engine is supercharged only by the low pressure stage (6).

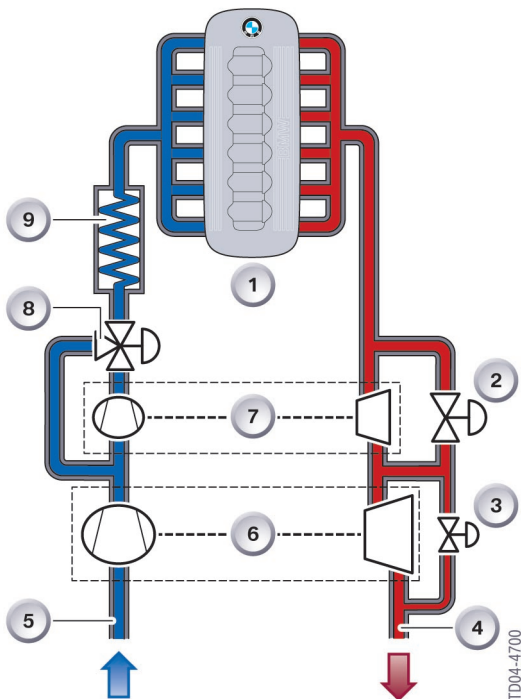


4 - Supercharging function at engine speeds from 3250 to 4200 rpm

Index	Description
1	M57TU1-TOP engine
2	Turbine control valve with electropneumatic pressure converter (EPDW)
3	Wastegate with electropneumatic pressure converter (EPDW)
4	Exhaust gas, to exhaust system
5	Fresh air, from air cleaner
6	Exhaust turbocharger (low pressure stage)
7	Exhaust turbocharger (high pressure stage)
8	Compressor bypass valve with electric changeover valve (EUV)
9	Intercooler

Nominal output range (as from 4200 rpm)

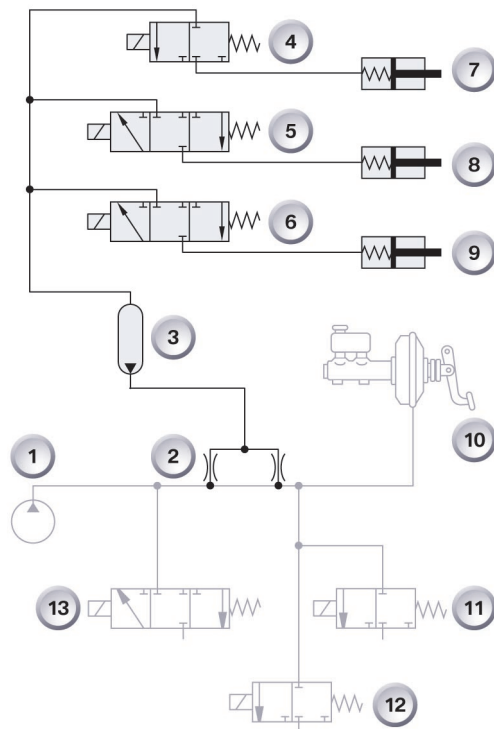
The engine is supercharged by the low pressure stage (6). The wastegate (3) opens as the engine speed increases. A part of the exhaust gas therefore bypasses the turbine wheel of the low pressure stage, thus limiting the turbine speed.



5 - Supercharging function at engine speeds as from 4200 rpm

Index	Description
1	M57TU1-TOP engine
2	Turbine control valve with electropneumatic pressure converter (EPDW)
3	Wastegate with electropneumatic pressure converter (EPDW)
4	Exhaust gas, to exhaust system
5	Fresh air, from air cleaner
6	Exhaust turbocharger (low pressure stage)
7	Exhaust turbocharger (high pressure stage)
8	Compressor bypass valve with electric changeover valve (EUV)
9	Intercooler

Vacuum system



The vacuum is routed from the vacuum pump (1) via a distributor to the near-engine vacuum accumulator (3). From the vacuum accumulator, the vacuum is applied to both electropneumatic pressure converters (EPDW) (5+6) and to the electric changeover valve (EUV) (4).

6 - Overview of vacuum system M57TU-TOP

Index	Description	Index	Description
1	Vacuum pump	8	Diaphragm unit for turbine control valve
2	Throttle	9	Diaphragm unit for wastegate
3	Vacuum accumulator	10	Brake booster
4	Electric changeover valve (EUV) for compressor bypass valve	11	Electric changeover valve (EUV) for engine mount control
5	Electropneumatic pressure converter (EPDW) for turbine control valve	12	Electric changeover valve (EUV) for swirl flaps in intake system
6	Electropneumatic pressure converter (EPDW) for wastegate	13	Electropneumatic pressure converter (EPDW) for EGR valve
7	Diaphragm unit for compressor bypass valve	---	

The colour coding and the different hose lengths ensures the hoses cannot be interchanged at the vacuum units.

Black braided-sheath hoses are used for the supply lines from the vacuum pump to the solenoid valves (EUV and EPDW) and to the vacuum accumulator. Colour-coded braided-sheath hoses are used for the controlled supply lines:

Component	Identification
Turbine control valve	Short, blue braided-sheath hose
Wastegate	Long, blue braided-sheath hose
Compressor bypass valve	Black braided-sheath hose with red stripes

Nevertheless, should the vacuum hoses be confused, the result will be an acute loss of power.

 A distributor with four connections is connected in the vacuum line at the vacuum pump (1). Three of the connections feature a Ø 0.8 mm throttle (2). Only the connection to the electric changeover valves for the engine mounts and swirl flaps (11+12) has a Ø 0.5 mm throttle. To avoid confusion, this connection is shorter than the other three. ◀



Contents

DDE 606

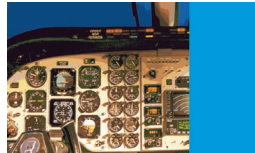


Introduction

DDE 606

1

1



System overview

Input/Output

3

3



System components

Sensors/actuators

5

5



Service information

7

Introduction

Digital Diesel Electronics

DDE 606

The DDE 606 is used in connection with the M57TU1-TOP engine.

Changes

Compared to the DDE 509 system (M57 TU1 EURO 4), the following actuators have been added for the two-stage supercharging:

- Electropneumatic pressure converter (EPDW) for turbine control valve
- Electropneumatic pressure converter (EPDW) for wastegate
- Electric changeover valve (EUV) for compressor bypass valve

Performance data:

- Clock frequency: 56 MHz (DDE 509: 40 MHz)
- EEPROM: 8 kB (DDE 509: 2 kB)
- RAM: 32 kB (DDE 509: 32 kB)

There is no air flap control (LKS) on the E60 with the M57TU1-TOP engine.

History

The following engine control systems are used for the M57TU engine:

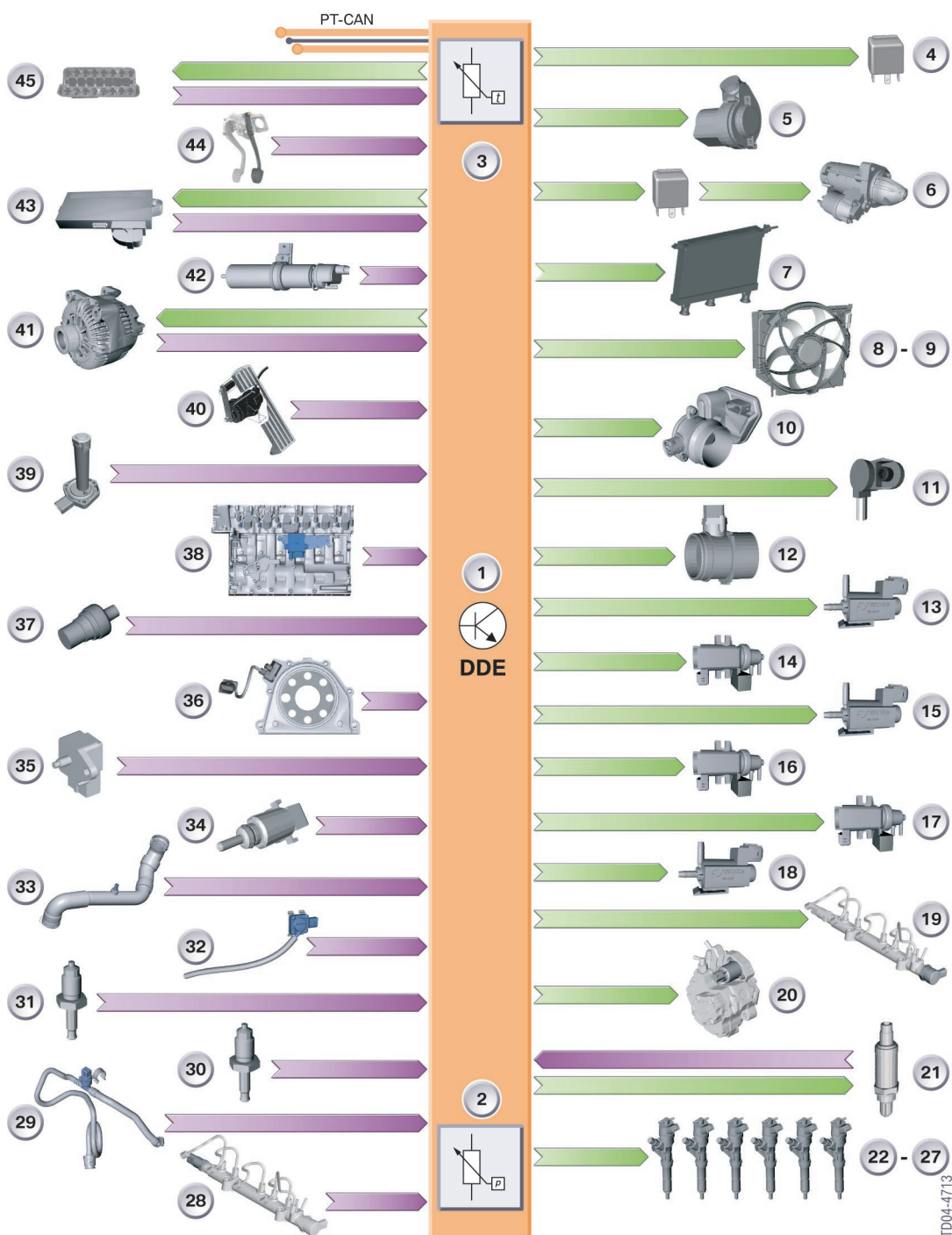
Series	Engine	Engine control
E46	M57D30 TU	DDE 506
E83	M57D30 TU	DDE 506
E53	M57D30 TU	DDE 506
E65	M57D30 TU	DDE 506
E60	M57D30 TU1	DDE 508
E60	M57D30 TU1 EURO 4	DDE 509
E60 (as from 09/04)	M57D30 TU1 TOP	DDE 606



System overview

Digital diesel electronics

Input/Output



1 - System overview DDE 606 for M57TU1-TOP engine

Index	Description	Index	Description
1	Digital diesel electronics	22-27	Fuel injectors
2	Ambient pressure sensor in control unit	28	Rail pressure sensor
3	Temperature sensor in control unit	29	Fuel temperature sensor
4	DDE main relay	30	Exhaust gas temperature sensor 1
5	E-box fan	31	Exhaust gas temperature sensor 2
6	Starting relay with starter	32	Exhaust pressure sensor
7	Auxiliary heater	33	Intake air temperature sensor
8-9	Electric fan and electric fan control	34	Coolant temperature sensor
10	Throttle valve actuator	35	Boost pressure sensor
11	Camshaft position sensor	36	Crankshaft position sensor (KWG)
12	Hot-film air mass meter (HFM)	37	Oil pressure switch
13	Electric changeover valve (EUV) for engine mount control	38	Preheating control unit
14	Electropneumatic pressure converter (EPDW) for exhaust gas recirculation (EGR)	39	Thermal oil level sensor
15	Electropneumatic pressure converter (EPDW) for turbine control valve	40	Accelerator pedal module (FPM)
16	Electropneumatic pressure converter (EPDW) for wastegate	41	Alternator
17	Electric changeover valve (EUV) for compressor bypass valve	42	Diagnosis line for fuel filter heating
18	Electric changeover valve (EUV) for swirl flaps	43	Car access system (CAS)
19	Rail pressure control valve	44	Brake light switch
20	Volume control valve	45	On-board diagnostics socket
21	Broadband oxygen sensor (LSU 4.9)	46	Ground connection

Sensors/actuators

Sensors

- Accelerator pedal module
- Hot-film air mass meter (HFM)
- Boost pressure sensor
- Coolant temperature sensor
- Fuel temperature sensor
- Rail pressure sensor
- Charge air temperature sensor
- Camshaft position sensor (NWG)
- Thermal oil level sensor (TÖNS)
- Crankshaft position sensor (KWG)
- Exhaust pressure sensor
- Exhaust gas temperature sensor upstream of oxidation catalytic converter
- Exhaust gas temperature sensor upstream of diesel particle filter (DPF)
- Oxygen sensor (Bosch LSU 4.9 with constant characteristic)
- Electric changeover valve (EUV) for swirl flaps
- Electric changeover valve (EUV) for engine mounts
- E-box fan
- Electric motor throttle valve actuator
- Electropneumatic pressure converter (EPDW) for turbine control valve
- Electropneumatic pressure converter (EPDW) for wastegate
- Electric changeover valve (EUV) for compressor bypass valve

Switches

- Brake light switch/brake light test switch
- Oil pressure switch
- Clutch switch

Relays

- DDE main relay
- Starter relay

Interfaces

- Bit-serial data interface BSD (alternator, preheating control unit)
- PT-CAN

Actuators

- Fuel injectors 1-6
- Volume control valve
- Pressure control valve
- Electric changeover valve (EUV) for exhaust gas recirculation

Electropneumatic pressure converter (EPDW)

Electropneumatic pressure converters (EPDW) apply vacuum to the diaphragm units of the turbine control valve and wastegate.

The DDE uses a PWM signal (300 Hz) to actuate the EPDW. The nominal voltage is 12 V.

Electric changeover valve (EUV)

An electric changeover valve (EUV) applies vacuum to the diaphragm unit of the

compressor bypass valve. The DDE controls the EUV. The nominal voltage is 12 V.



Service information

Digital Diesel Electronics

Summary

Vacuum system

⚠ A distributor with four connections is connected in the vacuum line at the vacuum pump (1). Three of the connections feature a Ø 0.8 mm throttle (2). Only the connection to

the electric changeover valves for the engine mounts and swirl flaps (11+12) has a Ø 0.5 mm throttle. To avoid confusion, this connection is shorter than the other three. ◀





