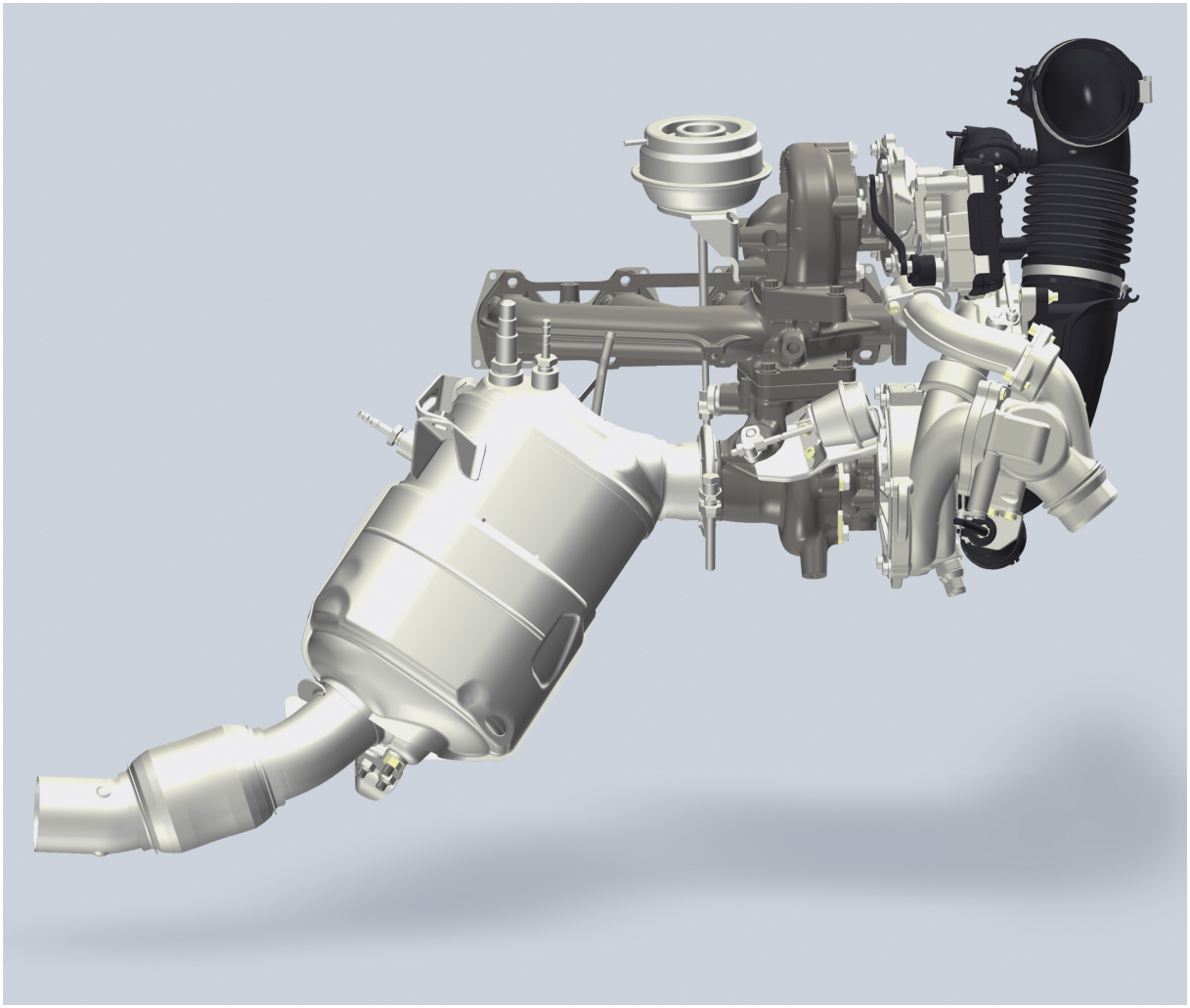
Technical training.
Product information.

N47TU top/N57TU top engine.



BMW Service

General information

Symbols used

The following symbol is used in this document to facilitate better comprehension or to draw attention to very important information:

Contains important safety information and information that needs to be observed strictly in order to guarantee the smooth operation of the system.

Information status and national-market versions

BMW Group vehicles meet the requirements of the highest safety and quality standards. Changes in requirements for environmental protection, customer benefits and design render necessary continuous development of systems and components. Consequently, there may be discrepancies between the contents of this document and the vehicles available in the training course.

This document basically relates to the European version of left hand drive vehicles. Some operating elements or components are arranged differently in right-hand drive vehicles than shown in the graphics in this document. Further differences may arise as the result of the equipment specification in specific markets or countries.

Additional sources of information

Further information on the individual topics can be found in the following:

- Owner's Handbook
- Integrated Service Technical Application.

Contact: conceptinfo@bmw.de

The information contained in this document forms an integral part of the technical training of the BMW Group and is intended for the trainer and participants in the seminar. Refer to the latest relevant information systems of the BMW Group for any changes/additions to the technical data.

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Information status: **May 2011**

N47TU top/N57TU top engine.

Contents.

N47TU top/N57TU top engine.

Contents.

N47TU top/N57TU top engine.

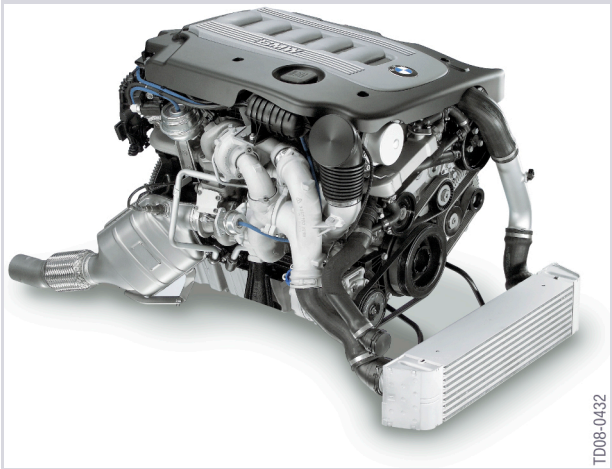
1. Models.

1.1. History

1.1.1. 4-cylinder top diesel engine

Engine	N47D20T0
Series	E81, E82, E84, E87, E88
Models	123d X1 xDrive23d
Power in [kW (PS)] at [rpm]	150 (204) rpm 4400
Torque in [Nm] at [rpm]	400 2000 – 2250
Design and number of cylinders	Row 4
Displacement in [cm³]	1995
Bore / stroke in [mm]	84/90
Compression ratio	16.5 : 1
Valves per cylinder	4
Deployment period	9/07–
Engine control	DDE7.1

1.1.2. 6-cylinder top diesel engine



Engine	M57D30T1
Series	E60, E61
Models	535d
Power in [kW (PS)] at [rpm]	200 (272) 4400
Torque in [Nm] at [rpm]	560 2000 – 2250
Design and number of cylinders	In-line 6
Displacement in [cm³]	2993
Bore / stroke in [mm]	84/90
Compression ratio	16.5 : 1
Valves per cylinder	4
Deployment period	09/04 – 03/07
Engine control	DDE606

N47TU top/N57TU top engine.

1. Models.

Engine	M57D30T2
Series	E60, E61, E63, E64, E70, E71, E83, E90, E92, E93
Models	535d* 635d X3/X5/ X6 xDrive35d, 335d
Power in [kW (PS)] at [rpm]	210 (286) 4400
Torque in [Nm] at [rpm]	580 2000 – 2250
Design and number of cylinders	In-line 6
Displacement in [cm³]	2993
Bore / stroke in [mm]	84/90
Compression ratio	16.5 : 1
Valves per cylinder	4
Deployment period	09/06 –
Engine control	DDE626

Engine	N57D30T0
Series	E70, E71, F01, F07, F10, F11
Models	X5/X6 xDrive40d 535d, 740d
Power in [kW (PS)] at [rpm]	220/225 (300/306) 4400
Torque in [Nm] at [rpm]	600 rpm 1500 – 2500
Design and number of cylinders	In-line 6
Displacement in [cm³]	2993
Bore / stroke in [mm]	84/90
Compression ratio	16.5 : 1
Valves per cylinder	4
Deployment period	09/09 –
Engine control	DDE7.3 DDE 7.3.1

N47TU top/N57TU top engine.

2. Introduction.

The N47TU top and the N57TU top engine will successively replace their predecessors, theN47 top and the N57 top engines.As expected, the new engines demonstrate much improved performance data with reduced fuel consumption and CO_2 emissions

The N47TU top and the N57TU top engines will be used in series production from September 2011 in the following models:

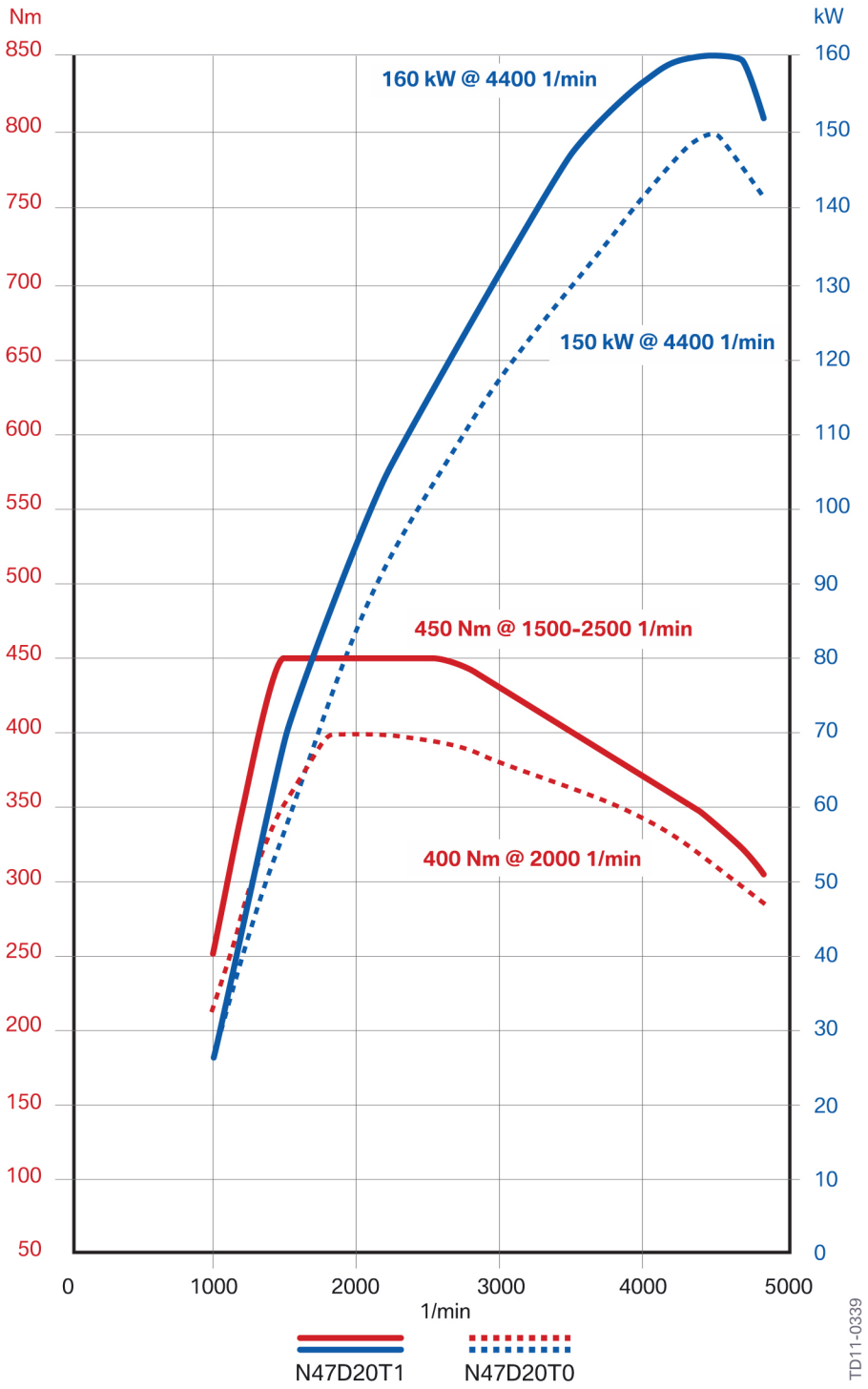
Series	N47D20T1	N57D30T1
E84	X1 xDrive25d	-
F10	525d	535d/535d xDrive
F11	525d	535d/535d xDrive
F12	-	640d
F13	-	640d
F25	-	X3 xDrive35d (10/2011)

2.1. Technical data

The tables below compare the N47 top engine with the N47TU top engine and the N57 top engine with the N57TU top engine of the 2011 model year.

N47TU top/N57TU top engine.
2. Introduction.

2.1.1. BMW X1 xDrive23d



Full load diagram of the E84, comparing N47D20T0 engine and N47D20T1 engine

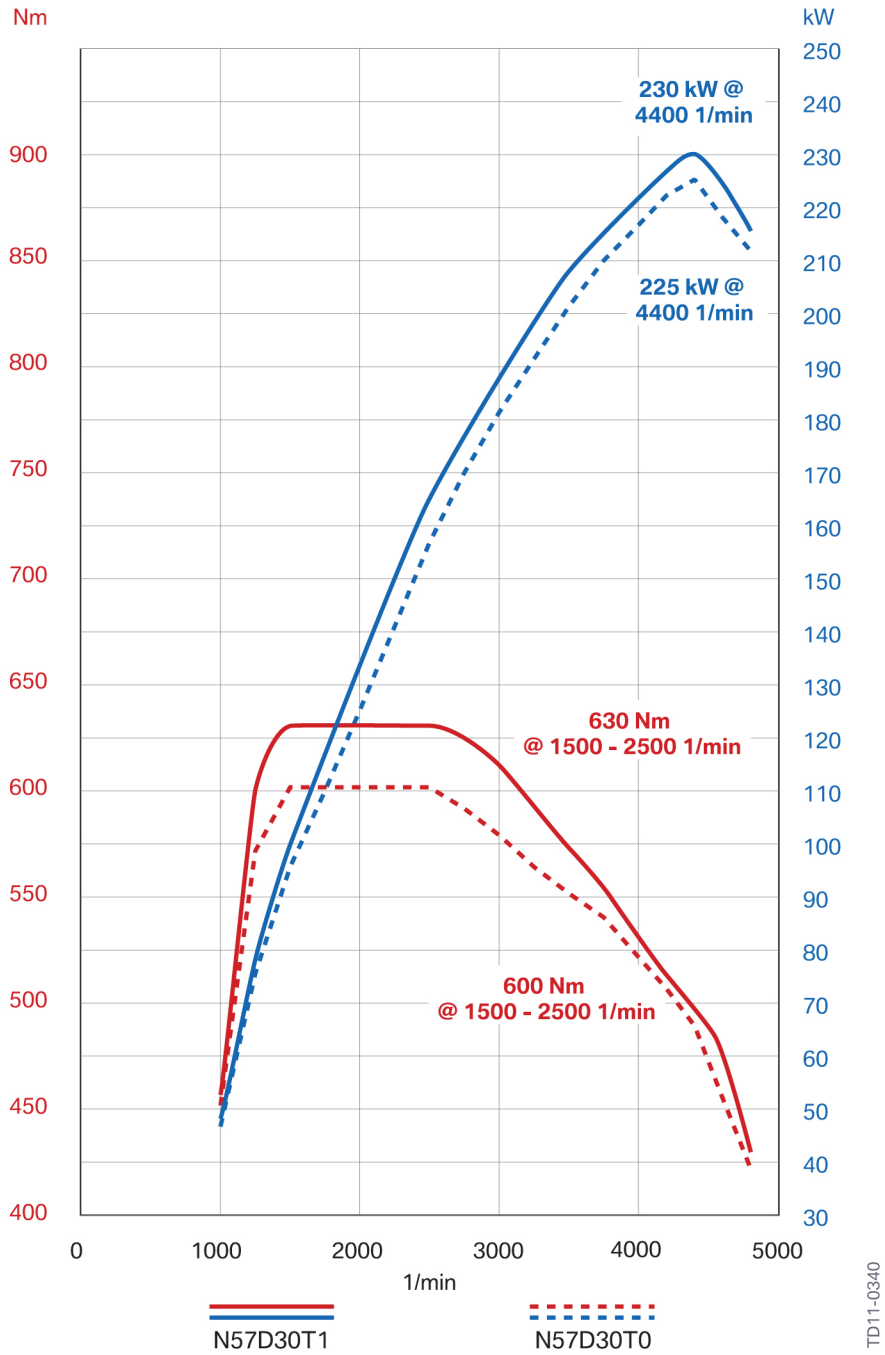
N47TU top/N57TU top engine.
2. Introduction.

	Unit	N47D20T0 (E84 X1 xDrive23d)	N47D20T1 (E84 X1 xDrive25d)
Design		R4	
Displacement	[cm³]	1995	
Bore/stroke	[mm]	84/90	
Power output at engine speed	[kW (HP)] [rpm]	150 (204) rpm 4400	160 (218) 4400
Power output per litre	[kW/l]	75,19	80.2
Torque at engine speed	[Nm] [rpm]	400 2000 – 2250	450 1500 – 2500
Compression ratio	[ε]	16.5 : 1	
Valves per cylinder		4	
Fuel consumption complying with EU	[l/100 km]	6.0	
CO_2 emissions	[g/km]	158	
Digital Motor Electronics		DDE7.1	DDE7.31
Exhaust emissions legislation		EURO 5	
Maximum speed	[km/h]	223	
Acceleration km/h	[s]	7,3	
Vehicle kerb weight DIN/EU	[kg]	1585/1660	

N47TU top/N57TU top engine.

2. Introduction.

2.1.2. BMW 535d



Full load diagram comparing F10 with N57D30T0 engine and N57D30T1 engine

N47TU top/N57TU top engine.
2. Introduction.

	Unit	N57D30T0 (F10, 535d)	N57D30T1 (F10, 535d)
Design		R6	
Displacement	[cm³]	2993	
Bore/stroke	[mm]	84/90	
Power output at engine speed	[kW (HP)] [rpm]	220 (300) 4400	230 (313) 4400
Power output per litre	[kW/l]	73,5	76,8
Torque at engine speed	[Nm] [rpm]	600 rpm 1500 – 2500	630 1500 – 2500
Compression ratio	[ε]	16.5 : 1	
Valves per cylinder		4	
Fuel consumption complying with EU	[l/100 km]	6.1	
CO_2 emissions	[g/km]	162	
Digital Motor Electronics		DDE7.3	DDE7.31
Exhaust emissions legislation		EURO 5	
Maximum speed	[km/h]	250	250
Acceleration km/h	[s]	7.3	
Vehicle kerb weight DIN/EU	[kg]	1585/1660	

2.2. Engine identification

2.2.1. Engine designation

In the technical documentation, the engine designation is used to ensure unambiguous identification of the engine. In frequent cases, however, only a short designation is used. The engine designation can be found in the usual places on the engine, and differs in positions 7 and 8. Now position 7 is a digit and position 8 no longer exists.

Breakdown of N47D20T1 engine designation

Index	Explanation
N	BMW Group Development
4	4-cylinder in-line engine
7	Direct fuel injection and exhaust turbocharger
D	Diesel engine longitudinal installation

Index	Explanation
20	2.0 litres displacement
T	Top performance class
1	1. Revision

Breakdown of N57D30T1 engine designation

Index	Explanation
N	BMW Group Development
5	6-cylinder in-line engine
7	Direct fuel injection and exhaust turbocharger
D	Diesel engine longitudinal installation
30	3.0 litres displacement
T	Top performance class
1	1. Revision

2.3. Modifications

2.3.1. N47TU top engine

System	Comment
Basic engine cf. also PI "N47TU engine"	Adopted from N47TU engine • Engine mechanics - Optimised crankcase - Modified cylinder head - New connecting rods and pistons • Belt drive - New component carrier with axial mounting of assemblies • Oil supply - New oil filter module with integrated transmission oil-to-coolant heat exchanger • Fuel preparation - Updated high-pressure pump CP4.1 technical update - New injectors deliver a fuel pressure of up to 1800 bar • Intake air system - Intake silencer adapted to revised geometry dependent on vehicle, and integration of snow valve and water drainage pipe for the cold country variant.
Air intake and exhaust emission systems	• Exhaust gas recirculation and charging stages upgraded • Cooling of low-pressure stage compressor housing • Low-pressure stage bypass plate.
Engine electrical system	• New sensors and modified control unit

2.3.2. N57TU top engine

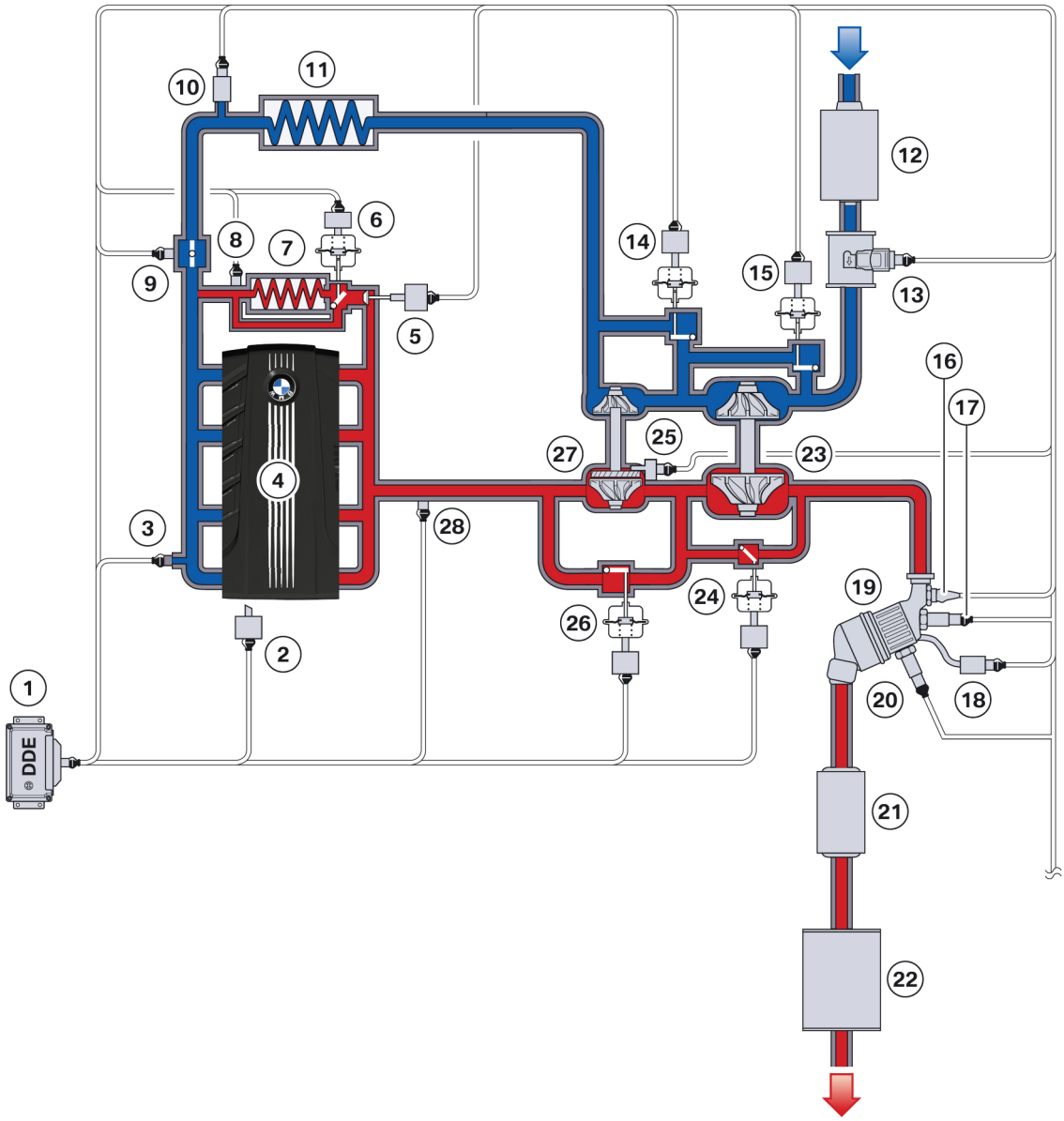
System	Comment
Basic engine cf. also PI "N57TU engine"	Adopted from N57TU engine • Engine mechanics - Optimised crankcase - Modified cylinder head - New connecting rods and pistons - Weight-optimised crankshaft • Belt drive - New low-friction belt drive with modified arrangement of components - New component carrier with axial mounting of assemblies • Oil supply - New oil filter module with integrated transmission oil-to-coolant heat exchanger • Fuel preparation - Updated high-pressure pump CP4.2 technical updates - New injectors deliver a fuel pressure of up to 2000 bar • Intake air system - New air ducts for all vehicles with similar build - Intake silencer adapted to lateral position on left in direction of travel, and integration of snow valve and water drainage pipe for the cold country variant.
Air intake and exhaust emission systems	• Intake silencer adapted to modified geometry dependent on vehicle, and integration of snow valve and water drainage pipe for the cold country variant. • Exhaust gas recirculation and charging stages upgraded • Cooling of low-pressure stage compressor housing • Low-pressure stage bypass plate.
Engine electrical system	• New sensors and modified control unit

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

The intake air system and exhaust emission system share a very similar basic design with the predecessor system.

3.1. N47TU top engine



N47TU top engine, intake air and exhaust emission system with EURO 5 in the E84

N47TU top/N57TU top engine.

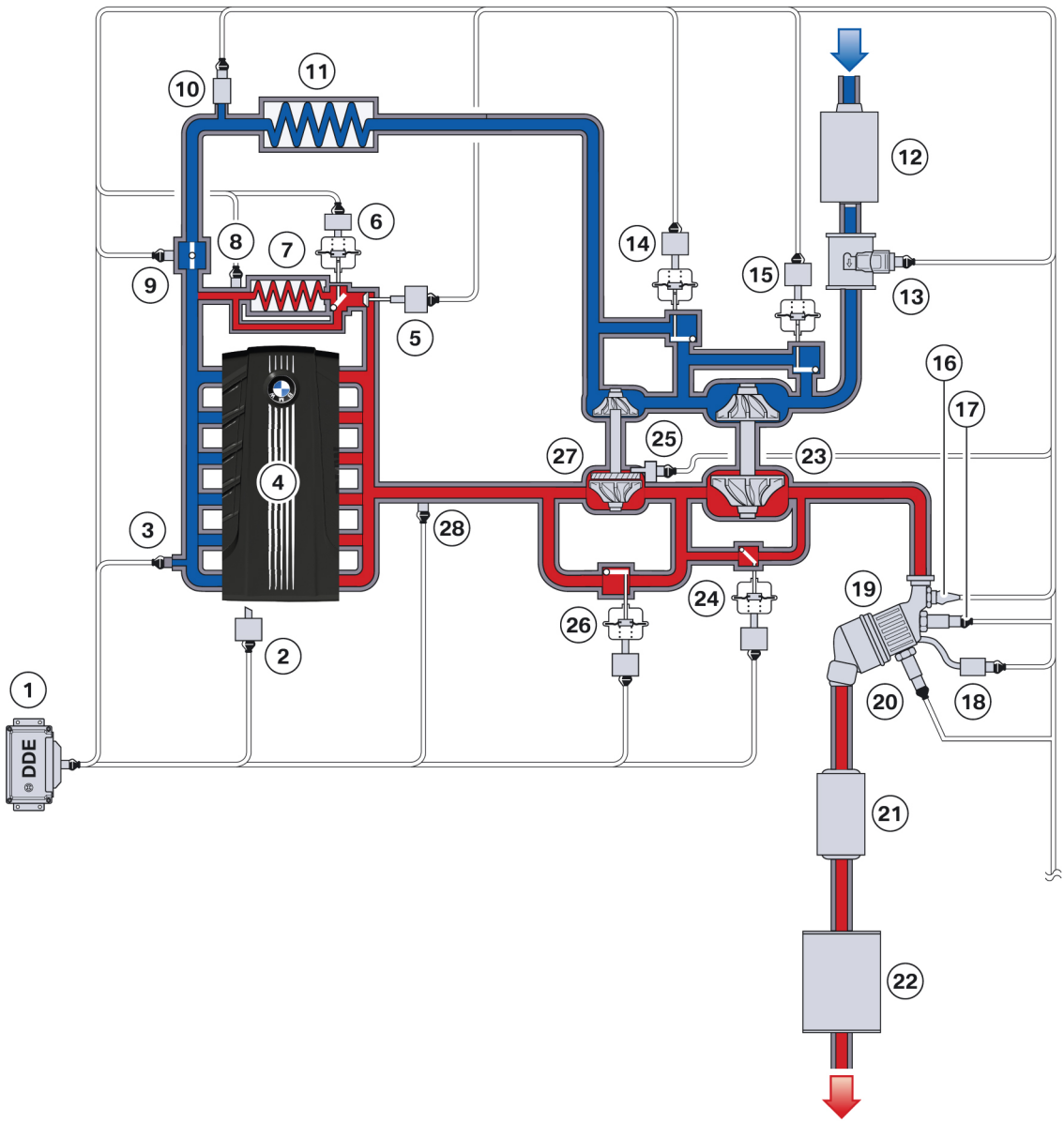
3. Intake air system and exhaust emission system.

Index	Explanation
1	Digital Diesel Electronics
2	Swirl-flap actuator
3	Charging pressure sensor
4	N47TU top engine
5	Exhaust-gas recirculation valve with position sensor
6	Exhaust-gas recirculation valve with bypass flap
7	Exhaust-gas recirculation cooler
8	Exhaust-gas recirculation temperature sensor
9	Throttle valve
10	Charge-air temperature sensor
11	Charge air cooler
12	Intake silencer
13	Hot film air mass meter
14	Bypass plate
15	Low-pressure stage bypass plate
16	Exhaust-gas temperature sensor upstream of oxidation catalytic converter
17	Oxygen sensor before oxidation catalytic converter
18	Exhaust backpressure sensor before oxidation catalytic converter
19	Oxidation catalytic converter and diesel particle filter
20	Exhaust-gas temperature sensor downstream of oxidation catalytic converter
21	Centre silencer
22	Rear silencer
23	Low-pressure stage
24	Wastegate valve
25	Charging pressure actuator
26	Turbine control flap
27	High-pressure stage
28	Exhaust backpressure sensor upstream of exhaust turbocharger

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

3.2. N57TU top engine



N57TU top engine, intake air and exhaust emission system with EURO 5 in the F10

Index	Explanation
1	Digital Diesel Electronics
2	Swirl-flap actuator
3	Charging pressure sensor
4	N57TU top engine
5	Exhaust-gas recirculation valve with position sensor
6	Exhaust-gas recirculation valve with bypass flap

Index	Explanation
7	Exhaust-gas recirculation cooler
8	Exhaust-gas recirculation temperature sensor
9	Throttle valve
10	Charge-air temperature sensor
11	Charge air cooler
12	Intake silencer
13	Hot film air mass meter
14	Bypass plate
15	Low-pressure stage bypass plate
16	Exhaust-gas temperature sensor upstream of oxidation catalytic converter
17	Oxygen sensor before oxidation catalytic converter
18	Exhaust backpressure sensor before oxidation catalytic converter
19	Oxidation catalytic converter and diesel particle filter
20	Exhaust-gas temperature sensor upstream of oxidation catalytic converter
21	Centre silencer
22	Rear silencer
23	Low-pressure stage
24	Wastegate valve
25	Charging pressure actuator
26	Turbine control flap
27	High-pressure stage
28	Exhaust backpressure sensor upstream of exhaust turbocharger

3.3. Intake air system

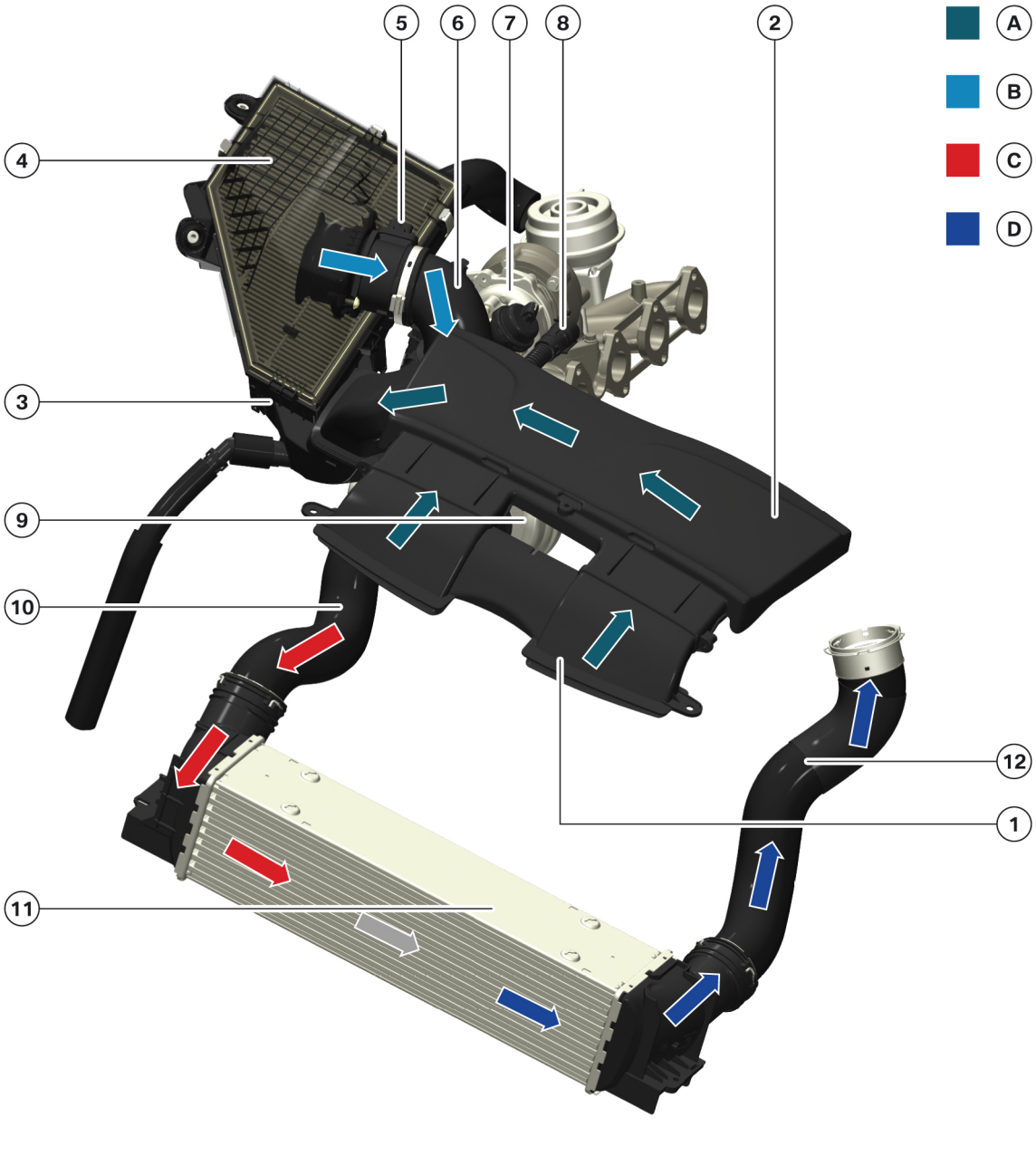
The most obvious changes are those that have been made to the intake air system. The throttle valve is now located at the front on the engine. Changing the air intake system has reduced hose length as the charge air from the charge air cooler is now fed into the air intake via the throttle valve, directly at the front of the engine. This modification has been adopted by the N47TU and N57TU engines

3.3.1. N47TU top engine

The following graphic shows the structure of the intake air system without intake plenum.The intake plenum is identical to the intake plenum of the N47TU engine.

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.



N47TU top engine, intake air system in the E84

Index	Explanation
A	Fresh air
B	Purified air
C	Heated charge air
D	Cooled charge air
1	Velocity stack

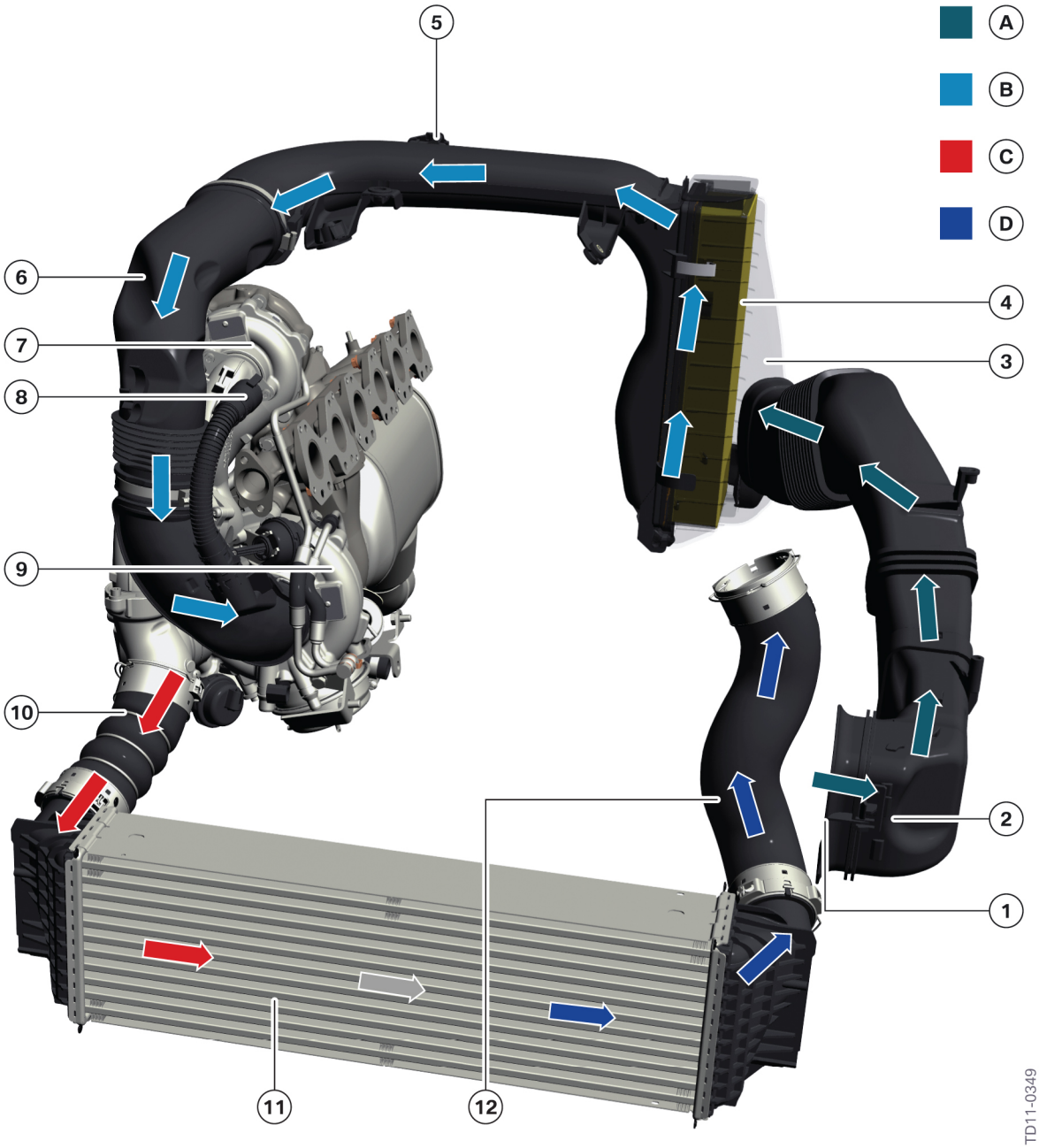
Index	Explanation
2	Intake neck
3	Fresh air area, intake silencer
4	Filter element
5	Hot film air mass meter
6	Clean air pipe
7	Exhaust turbocharger, high-pressure stage
8	Connection for blow-by gas
9	Exhaust turbocharger, low-pressure stage
10	Charge air pipe
11	Charge air cooler
12	Charge air pipe to air intake system

3.3.2. N57TU top engine

The following graphic shows the structure of the intake air system without intake plenum.The intake plenum is identical to the intake plenum of the N57TU engine.

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.



N57TU top engine, intake air system in the F10

Index	Explanation
A	Fresh air
B	Purified air
C	Heated charge air
D	Cooled charge air
1	Coarse filter/velocity stack

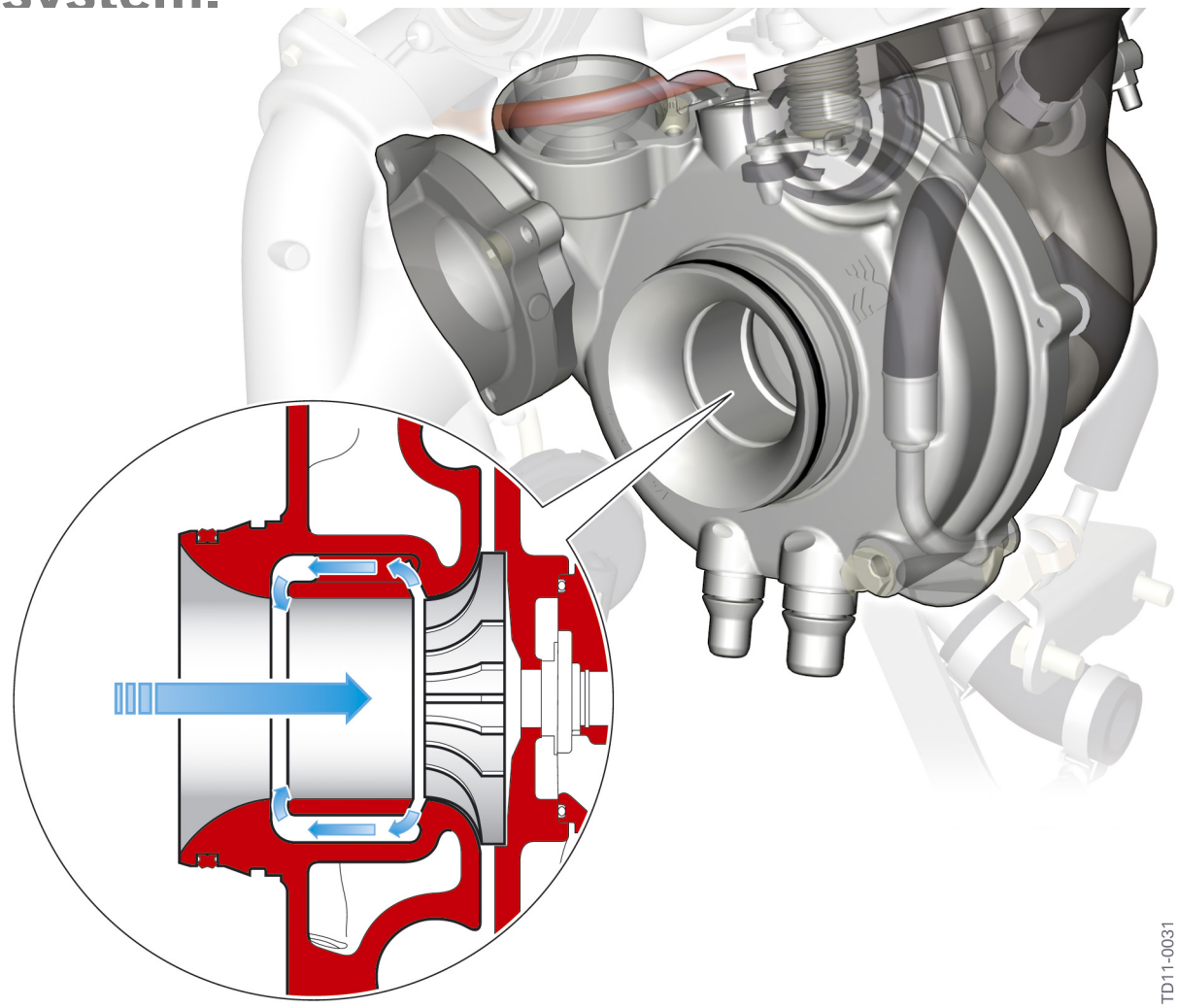
Index	Explanation
2	Intake neck
3	Fresh air area, intake silencer
4	Filter element
5	Hot film air mass meter
6	Clean air pipe
7	Exhaust turbocharger, high-pressure stage
8	Connection for blow-by gas
9	Exhaust turbocharger, low-pressure stage
10	Charge air pipe
11	Charge air cooler
12	Charge air pipe to air intake system

3.3.3. Low-pressure stage

The low-pressure stage exhaust turbocharger has a duct in the intake area.This duct enables the intake air to be recycled when it reaches the surge line without separating the airflow.This has made it possible to move the surge line and reduce noise levels when switching operation from two exhaust turbochargers (two stages) to one exhaust turbocharger (one stage).

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.



N47TU top engine low-pressure stage

3.4. Exhaust emission system

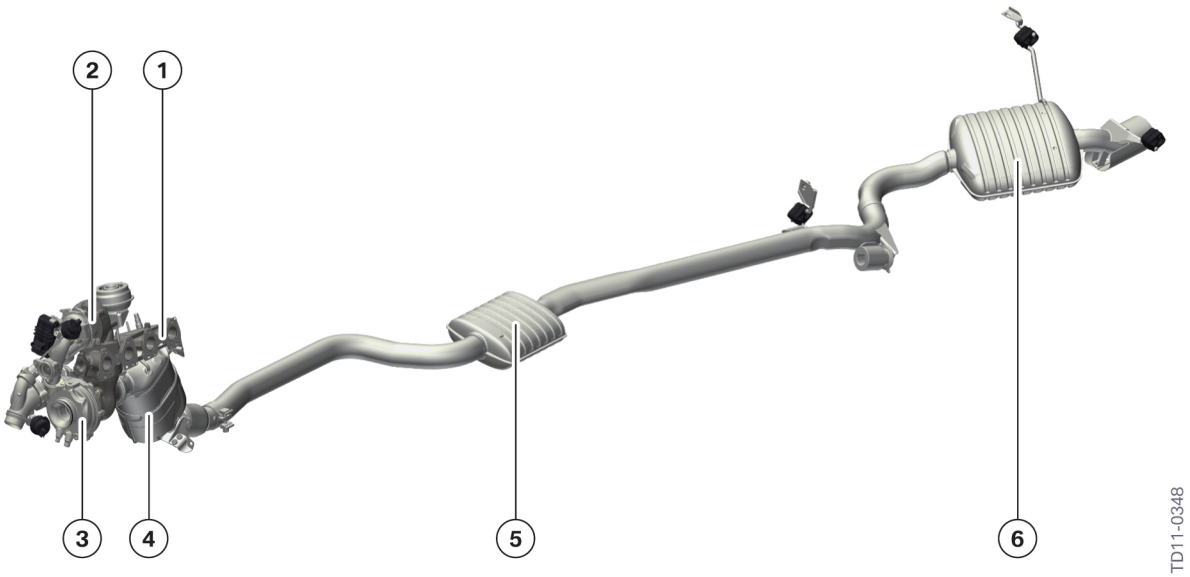
The N47TU top engine and the N57TU top engine are equipped with the familiar twin stage turbocharger.The charging unit has been optimised and has acquired some new features.For example the N47TU top and the N57TU top engines have a new component, the low-pressures stage bypass plate.And the low-pressure stage now also has a cooling system on the fresh air side for the first time to optimise performance.In the N47TU top engine the high-pressure stage is now fitted with a VNT exhaust turbocharger instead of an exhaust turbocharger with fixed turbine geometry.

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

3.4.1. N47TU top engine

Overview in the E84

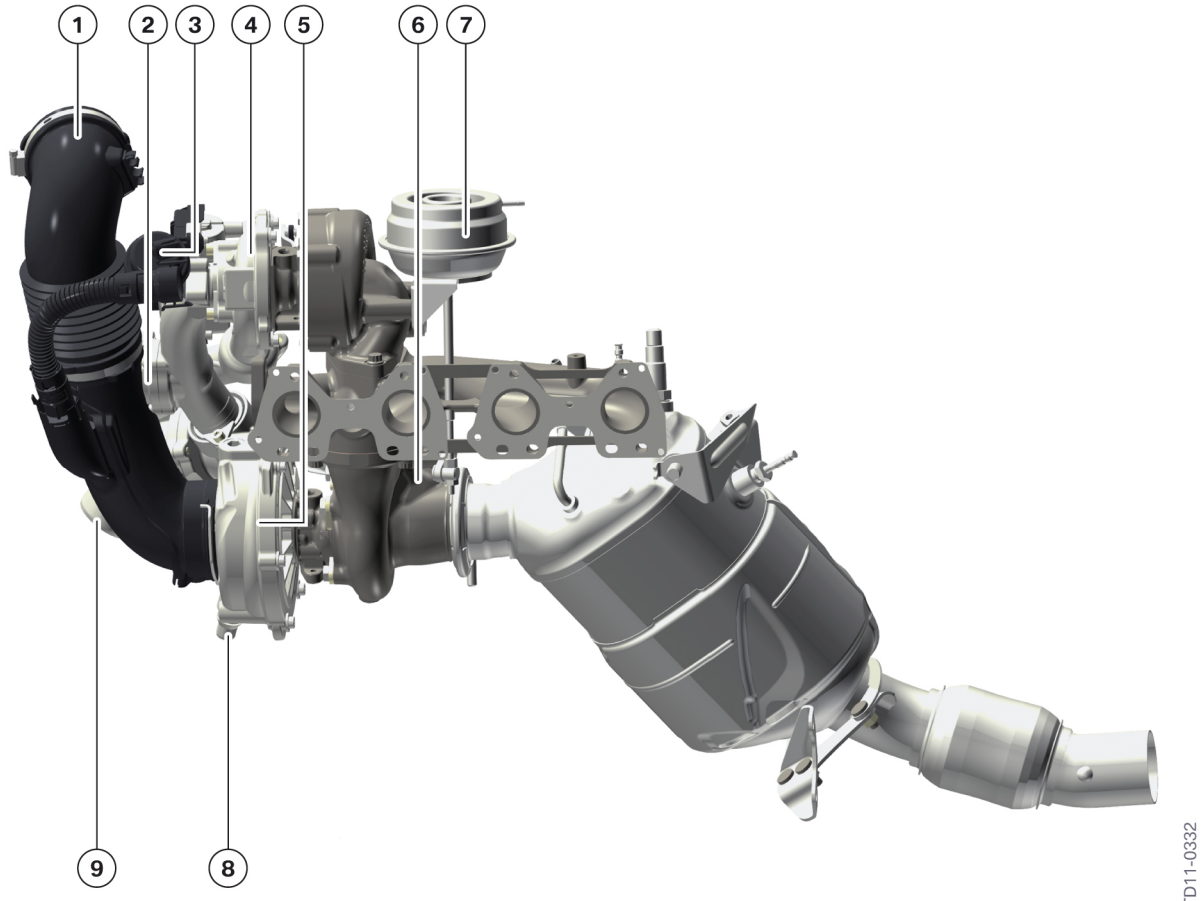


N47TU top engine exhaust system in the E84

Index	Explanation
1	Exhaust manifold
2	Exhaust turbocharger, high-pressure stage
3	Exhaust turbocharger, low-pressure stage
4	Catalytic converter and particle filter
5	Centre silencer
6	Rear silencer

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

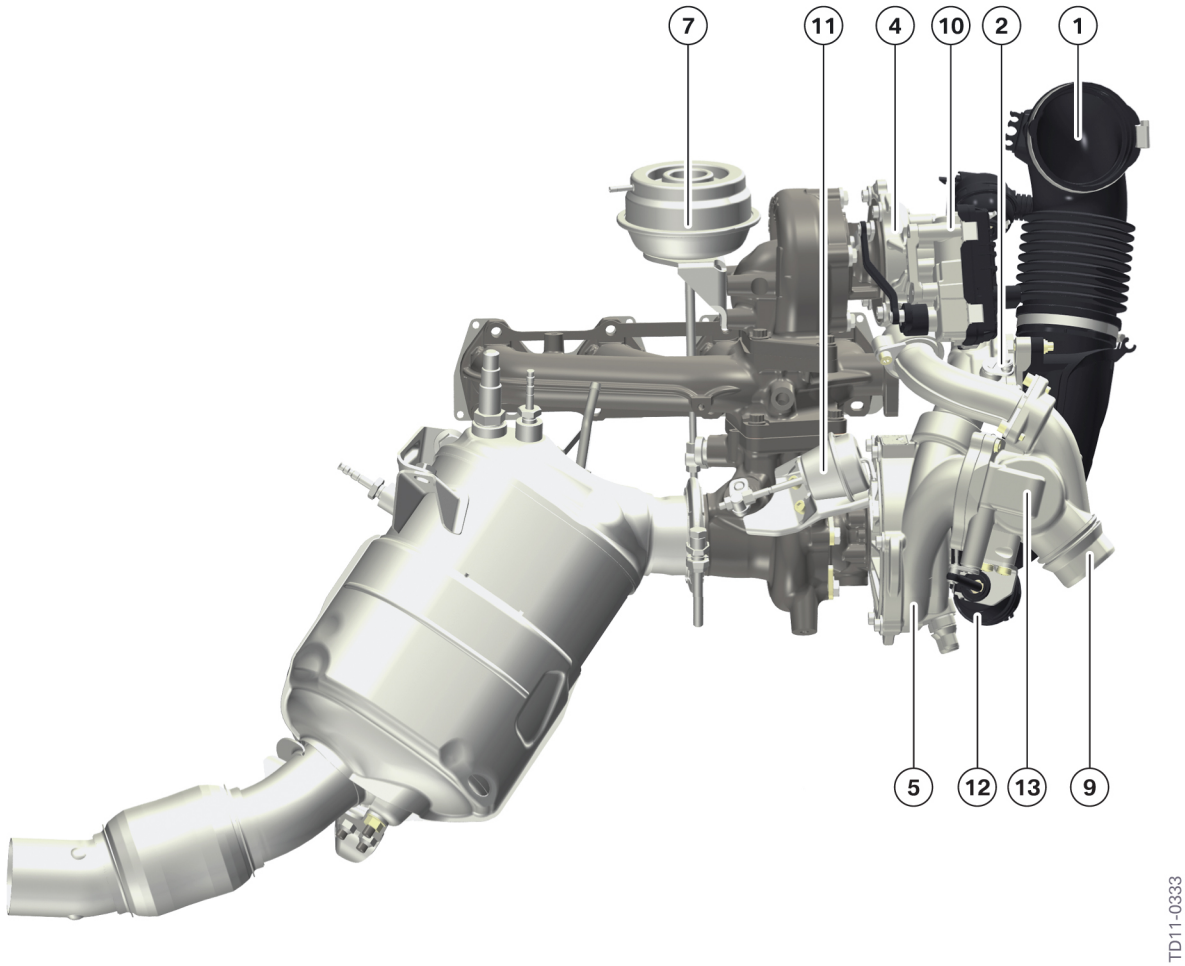


N47TU Top engine

Index	Explanation
1	Clean air pipe
2	Low-pressure stage bypass plate
3	Vacuum unit low-pressure stage bypass plate
4	High-pressure stage
5	Low-pressure stage
6	Turbine control flap
7	Turbine control flap vacuum unit
8	Low-pressure stage coolant connection, fresh air side
9	Charge air pipe to charge air cooler

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.



N47TU top engine charger

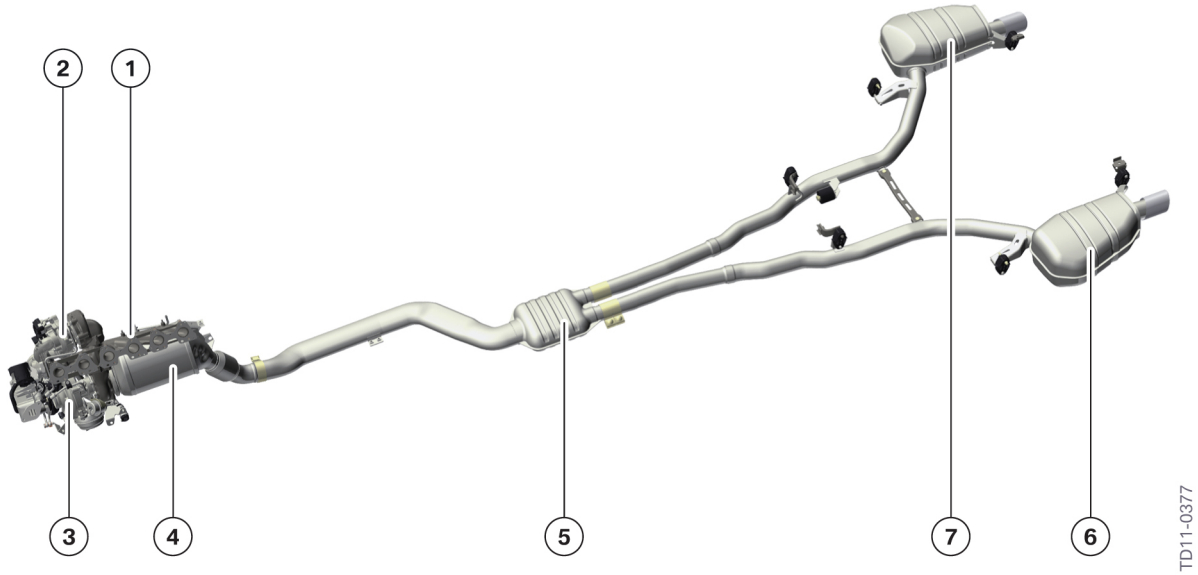
Index	Explanation
1	Clean air pipe
2	Low-pressure stage bypass plate
4	High-pressure stage
5	Low-pressure stage
7	Turbine control unit vacuum unit
9	Charge air pipe to charge air cooler
10	Charging pressure actuator
11	Vacuum unit, wastegate valve
12	Vacuum unit, bypass plate
13	Bypass plate

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

3.4.2. N57TU top engine

Overview in the F10

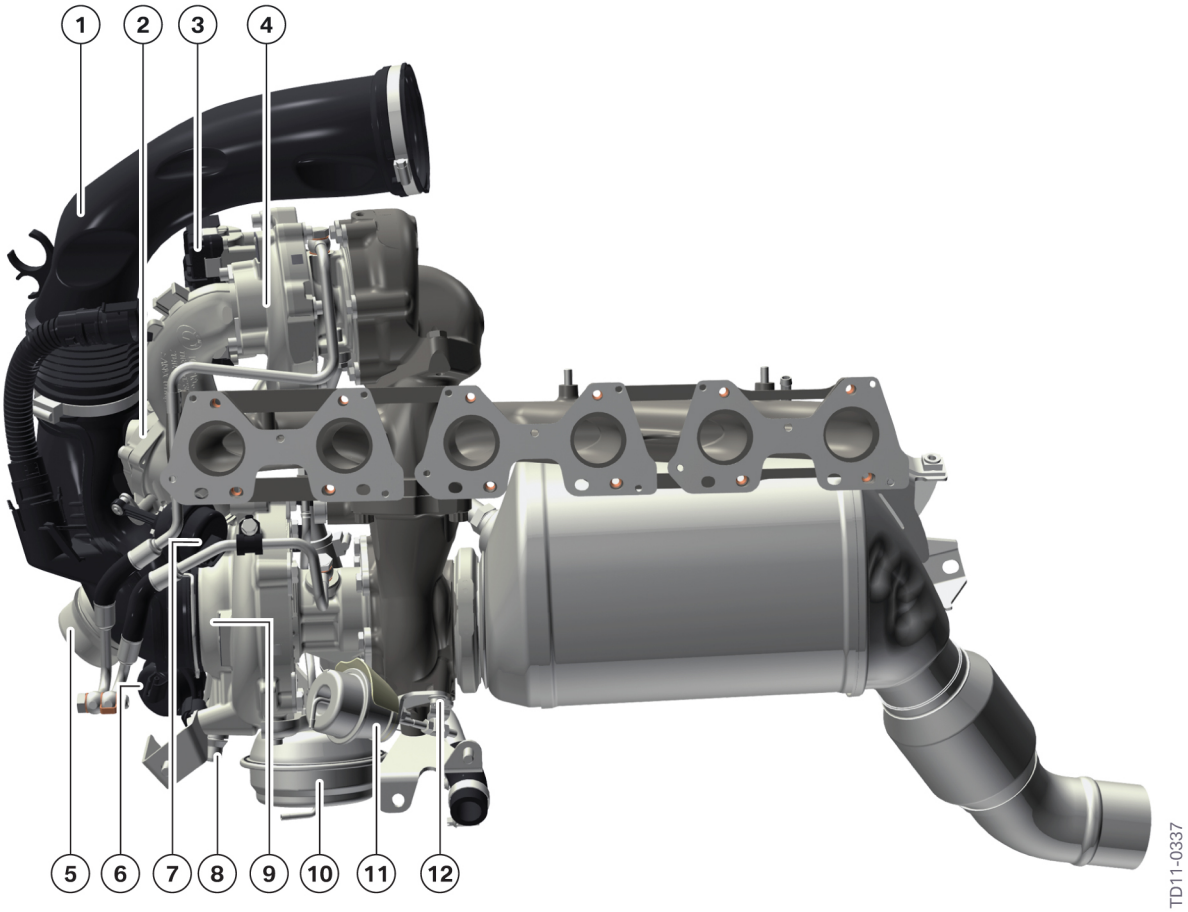


N57TU top engine exhaust system in the F10

Index	Explanation
1	Exhaust manifold
2	Exhaust turbocharger, high-pressure stage
3	Exhaust turbocharger, low-pressure stage
4	Catalytic converter and particle filter
5	Centre silencer
6	Rear silencer, left
7	Rear silencer, right

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

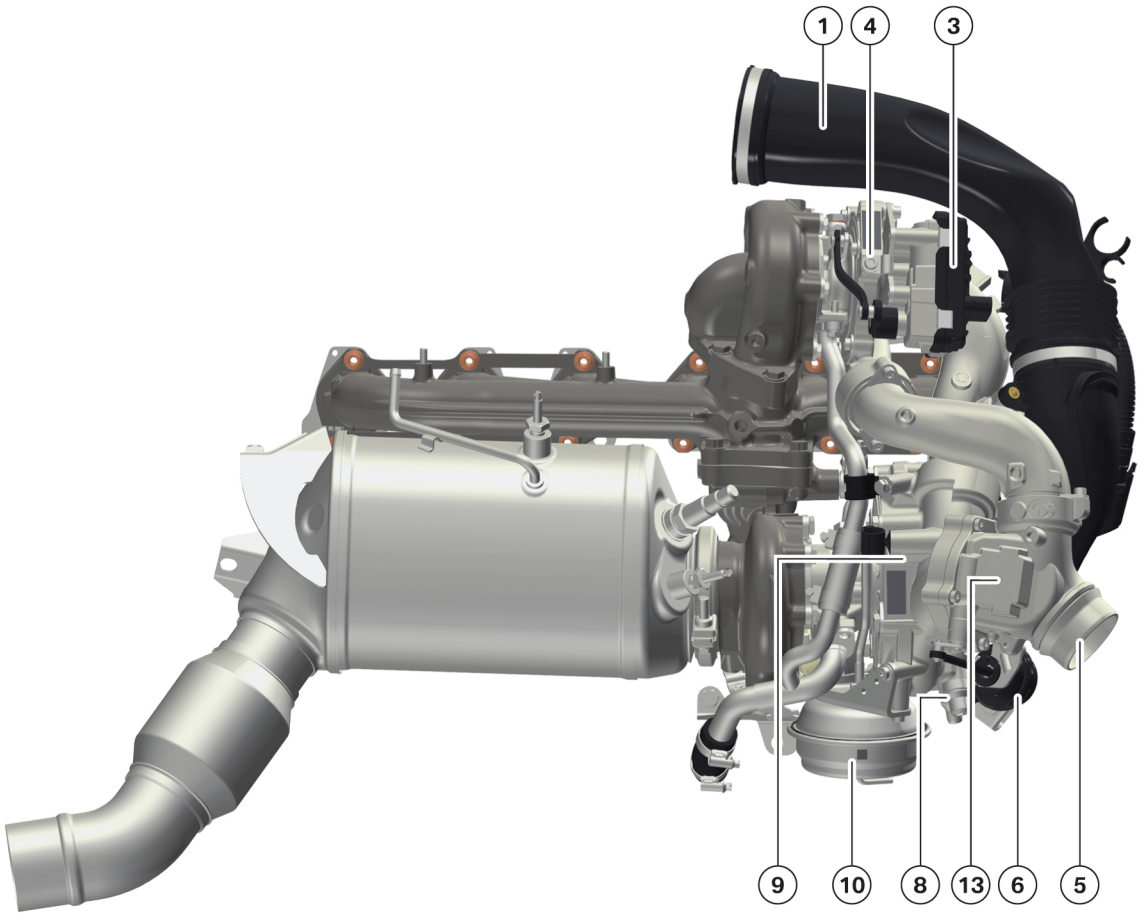


N57TU top engine charger

Index	Explanation
1	Clean air pipe
2	Low-pressure stage bypass plate
3	Charging pressure actuator
4	High-pressure stage
5	Charge air pipe to charge air cooler
6	Vacuum unit, bypass plate
7	Vacuum unit, low-pressure stage bypass plate
8	Low-pressure stage coolant connection, fresh air side
9	Low-pressure stage
10	Vacuum unit, turbine control flap
11	Vacuum unit, wastegate valve
12	Wastegate valve

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.



N57TU Top engine turbocharger

Index	Explanation
1	Clean air pipe
3	Charging pressure actuator
4	High-pressure stage
5	Charge air pipe to charge air cooler
6	Vacuum unit, bypass plate
8	Low-pressure stage coolant connection, fresh air side
9	Low-pressure stage
10	Vacuum unit, turbine control flap
13	Bypass plate

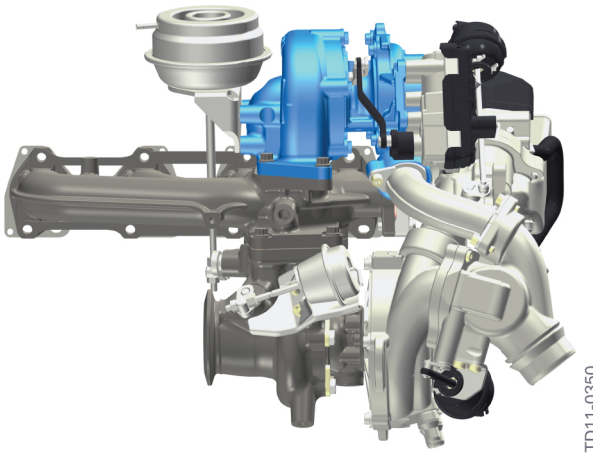
N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

3.4.3. Functions

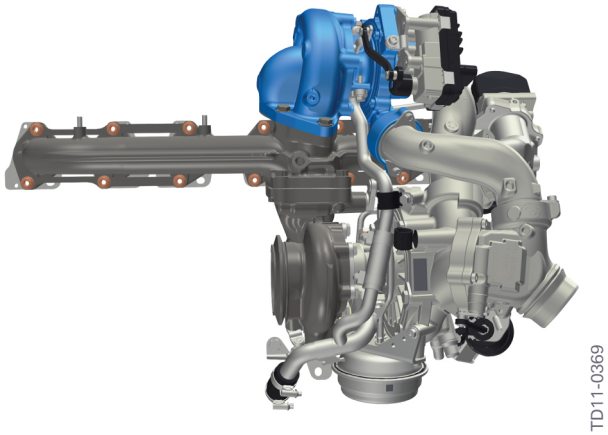
High-pressure stage

The high-pressure stage is the smaller of the two exhaust turbochargers. It is fitted to the exhaust manifold.A VNT exhaust turbocharger is used for the high-pressure stage.



TD11-0350

N47TU top engine high-pressure stage

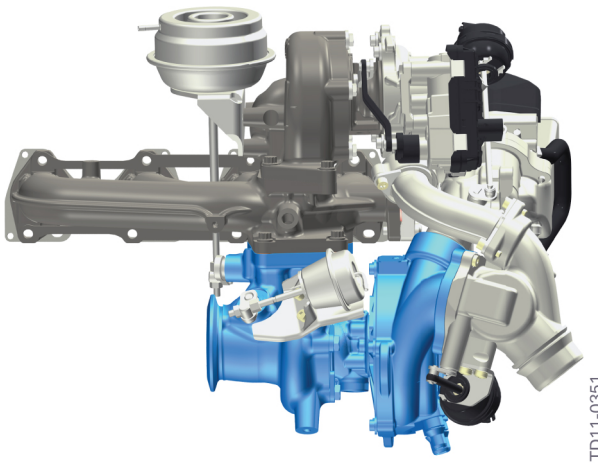


TD11-0369

N57TU top engine high-pressure stage

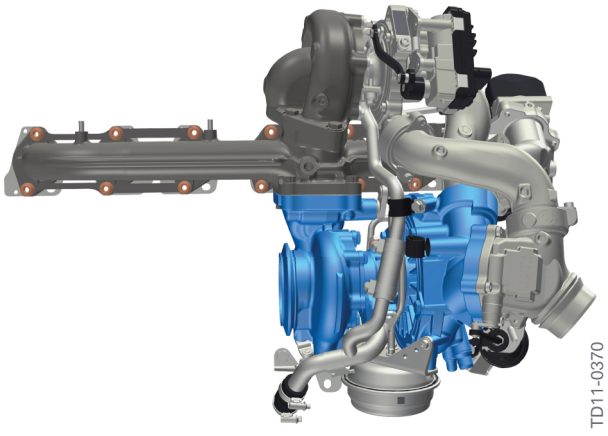
Low-pressure stage

The large exhaust turbocharger accommodates the turbine control flap and wastegate valve. It is attached to the exhaust manifold and is also supported by the crankcase. The low-pressure stage is cooled via coolant on the compressor case side for the first time.Cooling the compressor housing means compression power can be increased.The temperature of the compressed air during operation is over 150 °C.A reduction in the air temperature can therefore be achieved due to the coolant circuit.



TD11-0351

N47TU top engine low-pressure stage



TD11-0370

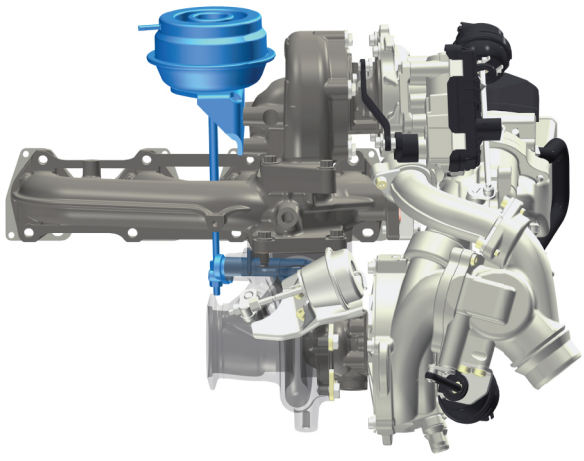
N57TU top engine low-pressure stage

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

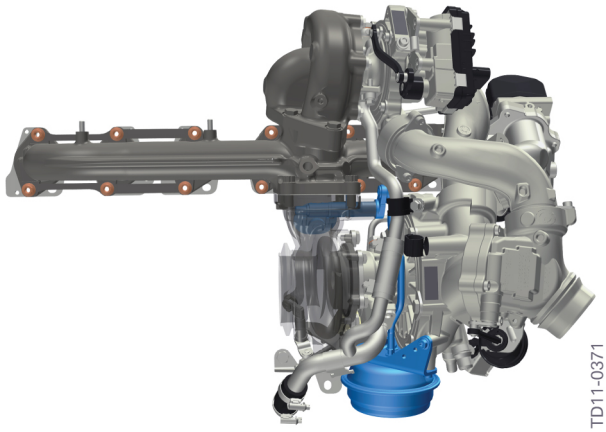
Turbine control flap

The turbine control flap on the exhaust gas side opens the flow port to the low-pressure stage, thus reducing the flow of exhaust gas past the high-pressure stage. It is operated pneumatically from a vacuum unit and can be variably adjusted.An electropneumatic pressure converter creates a vacuum in the vacuum unit, which closes on the application of the vacuum.



TD11-0352

N47TU top engine turbine control flap

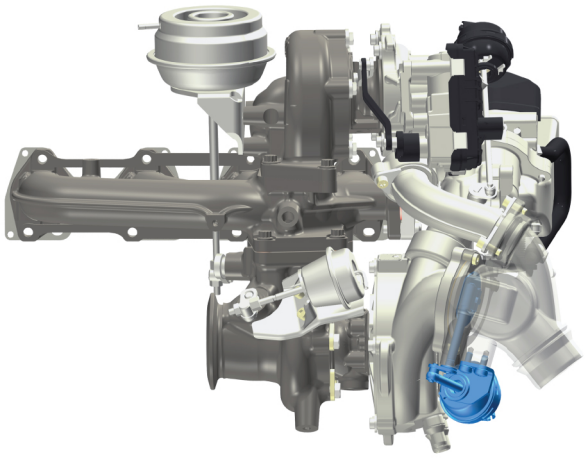


TD11-0371

N57TU top engine turbine control flap

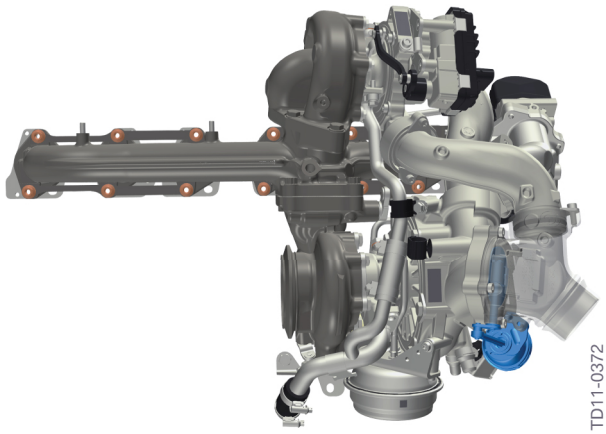
Bypass plate

The bypass plate on air side enables the high-pressure stage to be bypassed. It is operated pneumatically by a vacuum unit. The bypass plate is either fully opened or fully closed. A vacuum is created in the vacuum unit by an electric changeover valve, and it opens when a vacuum is applied.



TD11-0352

N47TU top engine bypass plate



TD11-0372

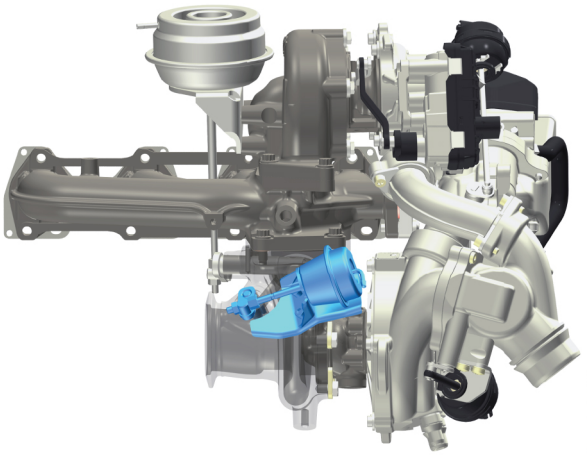
N57TU top engine bypass plate

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

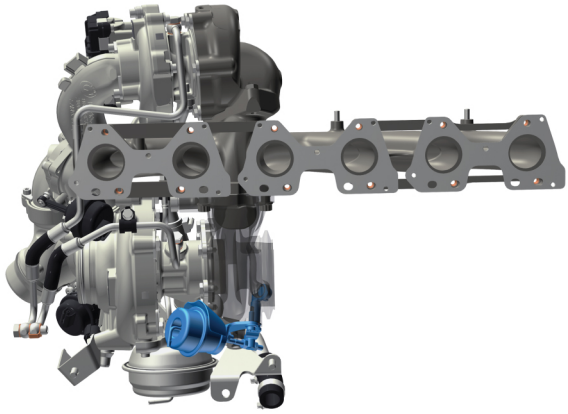
Wastegate valve

At engine speeds above approx. 3000 rpm the wastegate valve is gradually opened to prevent the build up of excessive charging pressures and turbine pressures.A portion of the exhaust gas is fed via the wastegate valve past the low-pressure stage turbine. The wastegate valve is operated by an electropneumatic vacuum unit and can be variably adjusted.It is controlled via an electropneumatic pressure converter.If a vacuum is applied to the vacuum unit the wastegate valve opens.



TD11-0354

N47TU top engine wastegate valve

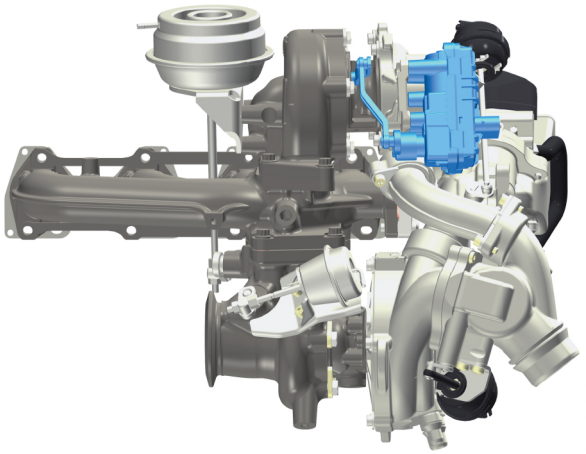


TD11-0373

N57TU top engine wastegate valve

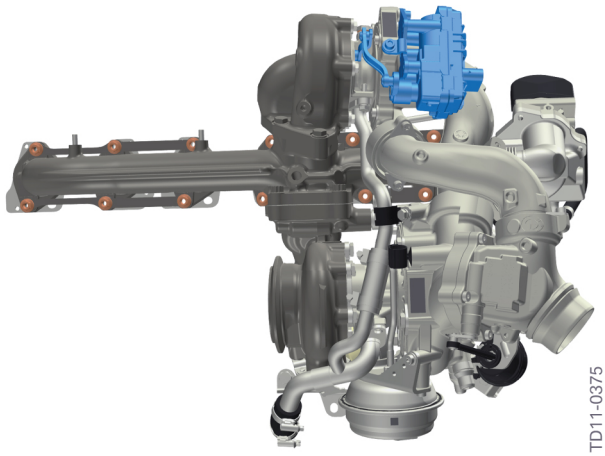
Charging pressure actuator

The charging pressure actuator enables regulation that is particularly well in line with requirements, as the operating principle with the variable turbine geometry of the high-pressure stage enables even better and more precise regulation. The VNT exhaust turbocharger responds even at low engine speeds and can be adapted to the exhaust flow by adjusting the guide vanes. The entire exhaust gas energy can be used until it is taken over by the low-pressure stage.



TD11-0355

N47TU top engine charge actuator

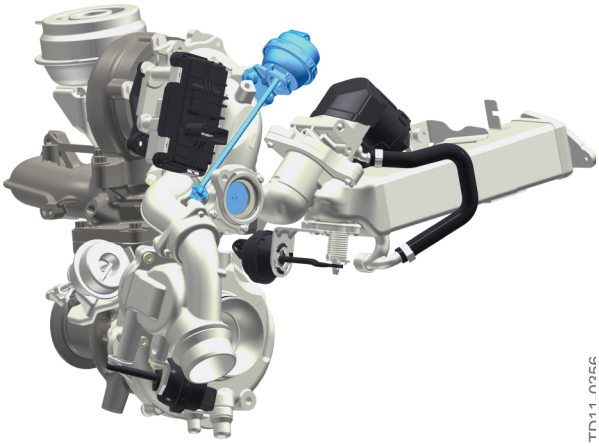


TD11-0375

N57TU top engine charge actuator

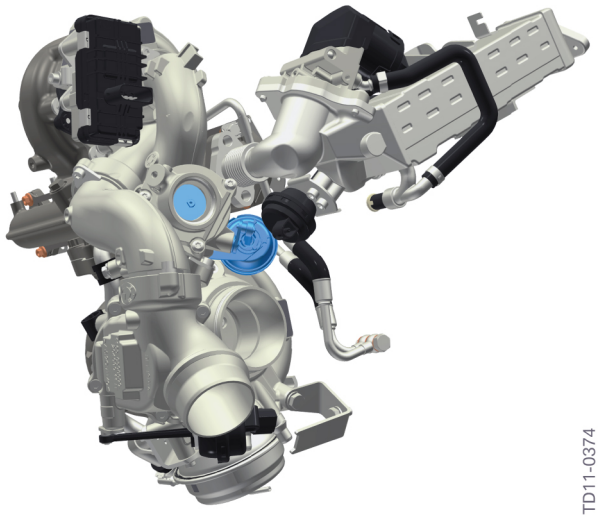
Low-pressure stage bypass plate

The low-pressure stage bypass plate enables the charge pressure to build up more quickly from idle.In the predecessor system the fresh air has to be sucked into the high-pressure stage via the low-pressure stage from idle.With the low-pressure stage bypass plate the intake path is considerably shorter, improving the dynamics of the build-up of charge pressure. The low-pressure stage bypass plate is operated via a vacuum unit.A vacuum is created in the vacuum unit by an electronic changeover valve, and it opens when a vacuum is applied.



N47TU top engine low-pressure stage bypass plate

TD11-0256



TD11-0374

N57TU top engine low-pressure stage bypass plate

3.4.4. Switching points

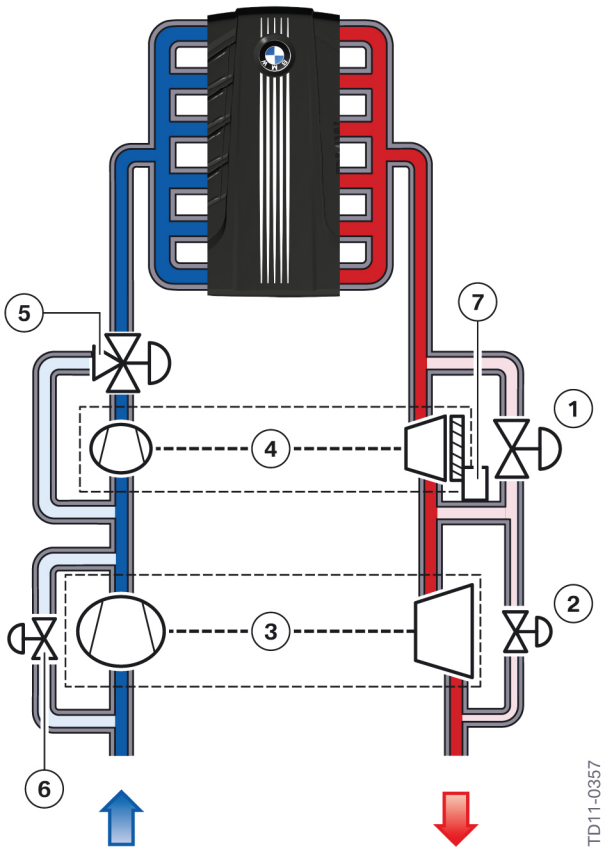
For optimal charging over the entire operating range of the engine, the flaps are controlled by the DDE. The switching points are stored in a characteristic map that depends primarily on the engine speed and load. There is a flowing transition between the switching points. A hysteresis also ensures that there is no nervous switching back and forth at the switching points. The (greatly simplified) diagrams show the different switch positions of the multi-stage turbocharging at full load.

Simplified diagram

The switching points are shown in more detail in the following graphics, using the N57TU top engine as an example.The text also applies equally to the N47TU top engine.

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.



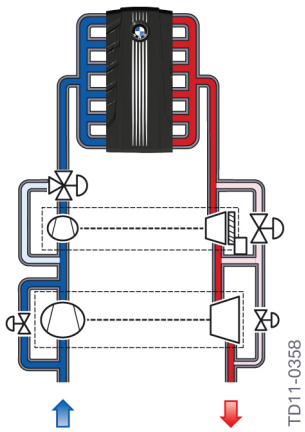
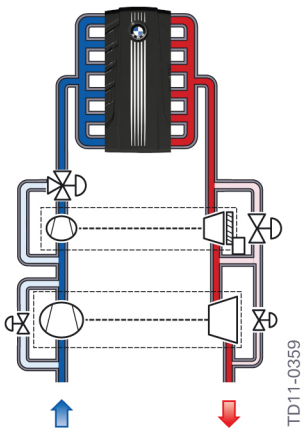
N57TU top engine, simplified diagram of turbocharging system

Index	Explanation
1	Turbine control flap
2	Wastegate valve
3	Low-pressure stage
4	High-pressure stage
5	Bypass plate
6	Low-pressure stage bypass plate
7	Charging pressure actuator

N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

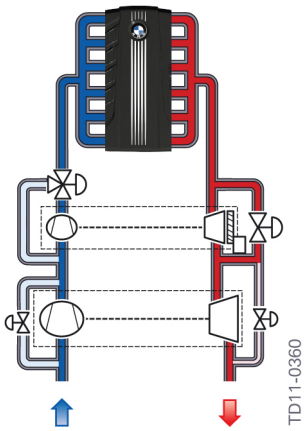
Driving off and accelerating from low engine speeds

Speed of rotation	up to 1500 rpm
Flap position	• Low-pressure stage bypass plate is briefly opened • VNT guide vanes are opened up to approx 25% • Turbine control flap closed • Bypass plate closed • Wastegate valve closed.
Description of the charging	The exhaust flow is fed via the turbine wheels of the high-pressure stage and low-pressure stage. At this low speed, it is above all the high-pressure stage that is working; it charges the engine. As the exhaust flow increases, the charging pressure actuator opens the flow area to keep the turbine operating to optimum efficiency. The low-pressure compressor is bypassed until the point when it can establish a pressure ratio itself. This reduces the vacuum in the intake area for the high-pressure compressor and creates a quicker build up of charging pressure.
Operating characteristics of the exhaust turbocharger	The high-pressure stage automatically accelerates to its optimum efficiency range.The low-pressure stage begins to work.
Diagram	 

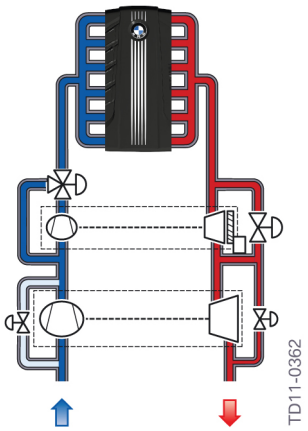
N47TU top/N57TU top engine.

3. Intake air system and exhaust emission system.

Middle engine speed range

Speed of rotation	**1500 to 3000 rpm**
Flap position	• Low-pressure stage bypass plate is closed • VNT guide vanes are opened continuously • Turbine control flap opens continuously with increasing engine speed • Bypass plate closed • Wastegate valve closed.
Description of the charging	The charging pressure actuator opens the flow area to maximum.When maximum is reached the turbine control flap is gradually opened to its full position, and the high-pressure stage is increasingly bypassed.
Operating characteristics of the exhaust turbocharger	The high-pressure stage now gets closer to its choke line.The turbine control flap also functions like a wastegate valve for the high-pressure stage. However, the exhaust gas that is fed past is not lost, as it is fed back into the normal exhaust flow before the low-pressure stage.
Diagram	

Upper engine speed range

Speed of rotation	from 3000 rpm
Flap position	• Low-pressure stage bypass plate is closed • VNT guide vanes completely opened • Turbine control flap opened • Bypass plate opened • Wastegate valve is held open
Description of the charging	For the most part, the high-pressure stage is bypassed by the exhaust flow. The charge air is fed past the compressor of the high-pressure stage. The engine is charged exclusively by the low-pressure stage.
Operating characteristics of the exhaust turbocharger	The high-pressure stage is at the choke limit, therefore the air is fed past it. If this were not to occur, the possible volumetric flow of the charge air would be limited. The low-pressure stage works here in its optimal operating range. As engine speed increases the low-pressure stage must be increasingly bypassed via the wastegate valve to protect the engine from excessive charging pressures and the exhaust turbocharger from excessive speeds.
Diagram	

Emergency operation

If the vacuum system fails, spring force moves the turbocharge group to the following position:

- Low-pressure stage bypass plate closed
- Turbine control flap opened
- Bypass plate closed
- Wastegate valve closed.

This corresponds to the position for the middle engine speed range (1500 to 3000 rpm), i.e. the range in which a diesel engine is normally operated. Although this contradicts the BMW strategy of establishing the conditions for maximum power output during emergency operation, it makes good sense in this case, as the vehicle remains in a state in which it is much easier to drive. If the vacuum system fails at high engine speeds and load conditions the increased charging pressure in the low-pressure stage automatically forces the bypass plate, so that no immediate damage to components can occur.Protection against any damage resulting from the closed wastegate valve is ensured as the electronic engine control monitors the charging pressure and reduces engine power by a non-critical amount in the event of excessive pressures.

N47TU top/N57TU top engine.

4. Vacuum System.

For activation of the turbocharge group, the vacuum system of the N47TU top and the N57TU top engine contains the following components:

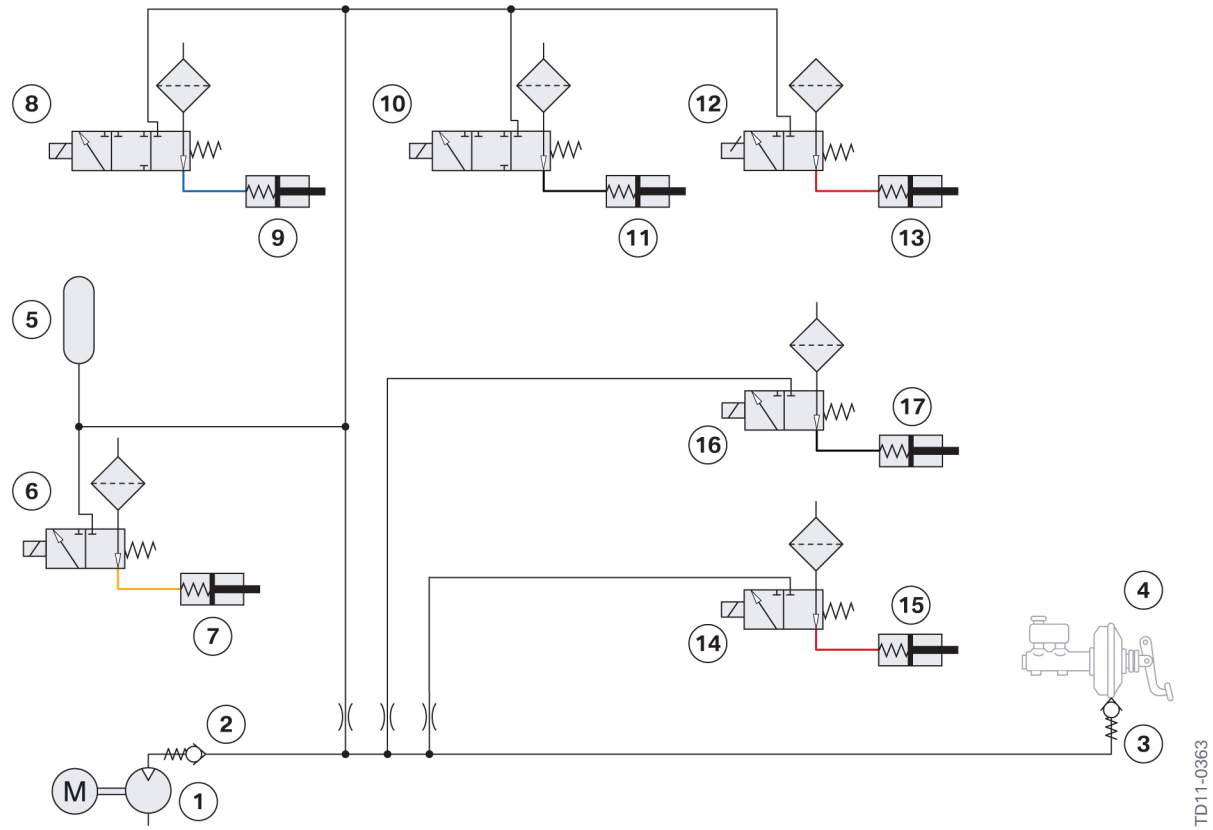
- Vacuum units for:
  - Low-pressure stage bypass plate
  - Turbine control flap
  - Bypass plate
  - Wastegate valve
- Electropneumatic pressure converter for:
  - Turbine control flap
  - Wastegate valve
- Electric changeover valve for:
  - Low-pressure stage bypass plate
  - Bypass plate
- Vacuum reservoir.

There are throttles at the junction point from the main vacuum line to the consumer units. The throttles have a diameter of 1.1 mm.In the N47TU top engine one junction remains unused, dependent on model, and is fitted with a rubber cap. In the N57TU top engine the vacuum supply for the switchable engine mount is connected to this junction.The delivery lines from the solenoid valves (electric changeover valve and electropneumatic pressure converter) to the vacuum units are marked by coloured fabric hoses.

Component	Colour
Low-pressure stage bypass plate	Red
Turbine control flap	Blue
Bypass plate	white
Wastegate valve	Black
EGR bypass valve	Red
Switchable engine mount (N47TU top engine model dependent, N57TU top engine)	Black

N47TU top/N57TU top engine.

4. Vacuum System.



N47TU top and N57TU top engine vacuum system

Index	Explanation
1	Vacuum pump
2	Non-return valve
3	Non-return valve
4	Brake servo
5	Vacuum reservoir
6	Electric changeover valve
7	Vacuum unit, bypass plate (white vacuum hose)
8	Electropneumatic pressure converter
9	Vacuum unit, turbine control flap (blue vacuum hose)
10	Electropneumatic pressure converter
11	Vacuum unit, wastegate valve
12	Electric changeover valve
13	Vacuum unit, low-pressure stage bypass plate (red vacuum hose)

N47TU top/N57TU top engine.
4. Vacuum System.

Index	Explanation
14	Electric changeover valve
15	Vacuum unit, EGR bypass valve (red vacuum hose)
16	Electric changeover valve (N57TU top engine only)
17	Switchable engine mount (N57TU top engine only, black vacuum hose)

4.1. Electropneumatic pressure converter

In addition to the exhaust gas recirculation valve, electropneumatic pressure converters are used in the N47TU top and N57TU top engine to control the turbine control flap and wastegate valve. The electropneumatic pressure converter uses the vacuum in the system and the ambient pressure to create a control pressure (mixed pressure), which it then applies to the vacuum unit. This enables any variable position between opened and closed to be set. The DDE delivers the electrical signal on which the control pressure setting is based. This means that the turbine control flap and wastegate valve can be variably adjusted.

4.2. Electric changeover valve

Three electric changeover valves are used in the N47TU top engine.These are required to activate the EGR bypass valve, the bypass flap and the low-pressure stage bypass plate. In contrast to the electropneumatic pressure converter, no control pressure is set here; the vacuum in the system is merely switched through to the vacuum unit. There no option here of an adjustable position, only the open and closed positions.There is the addition of a switchable engine mount and with it another electric changeover valve in the N57TU top.

4.3. Throttle

The vacuum consumers are provided with the vacuum from the vacuum pump.The supply of vacuum gives priority to the brake servo.The throttles between the vacuum pump and the additional loads ensure that even if there is a leak in the vacuum system (for example due to a disconnected or damaged vacuum line) sufficient vacuum is always available to the brake server.

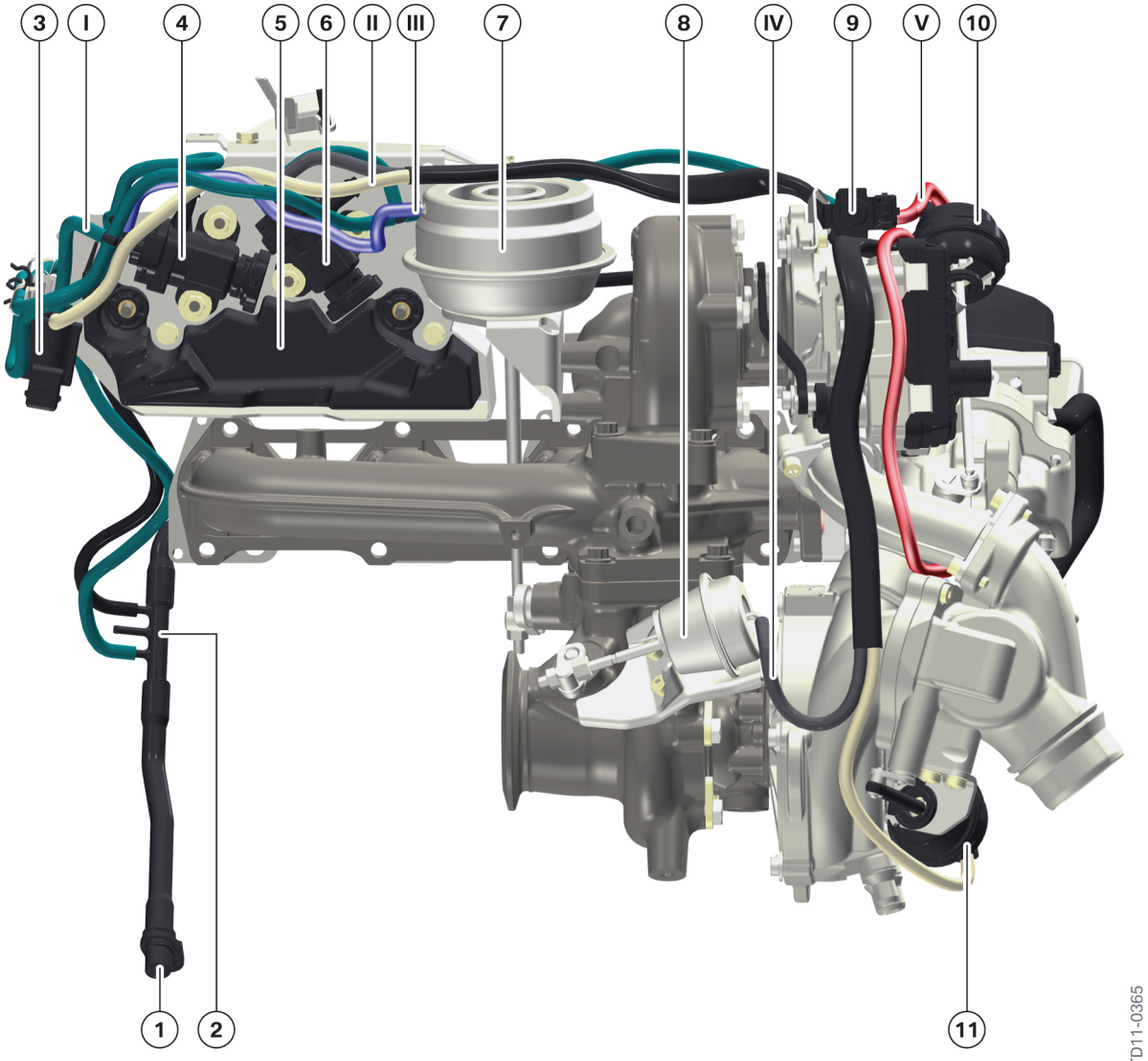
4.4. Vacuum reservoir

The vacuum reservoir is necessary to offset requirements at peaks of usage.As only a certain vacuum flow can pass through the throttle, the vacuum reservoir provides sufficient vacuum to control the turbocharger during peaks of use.

Without a vacuum reservoir, the vacuum pump would have to be significantly bigger to be able to provide sufficient vacuum for the brake servo with the larger throttle diamater and if there were a leak in the system.

N47TU top/N57TU top engine.

4. Vacuum System.



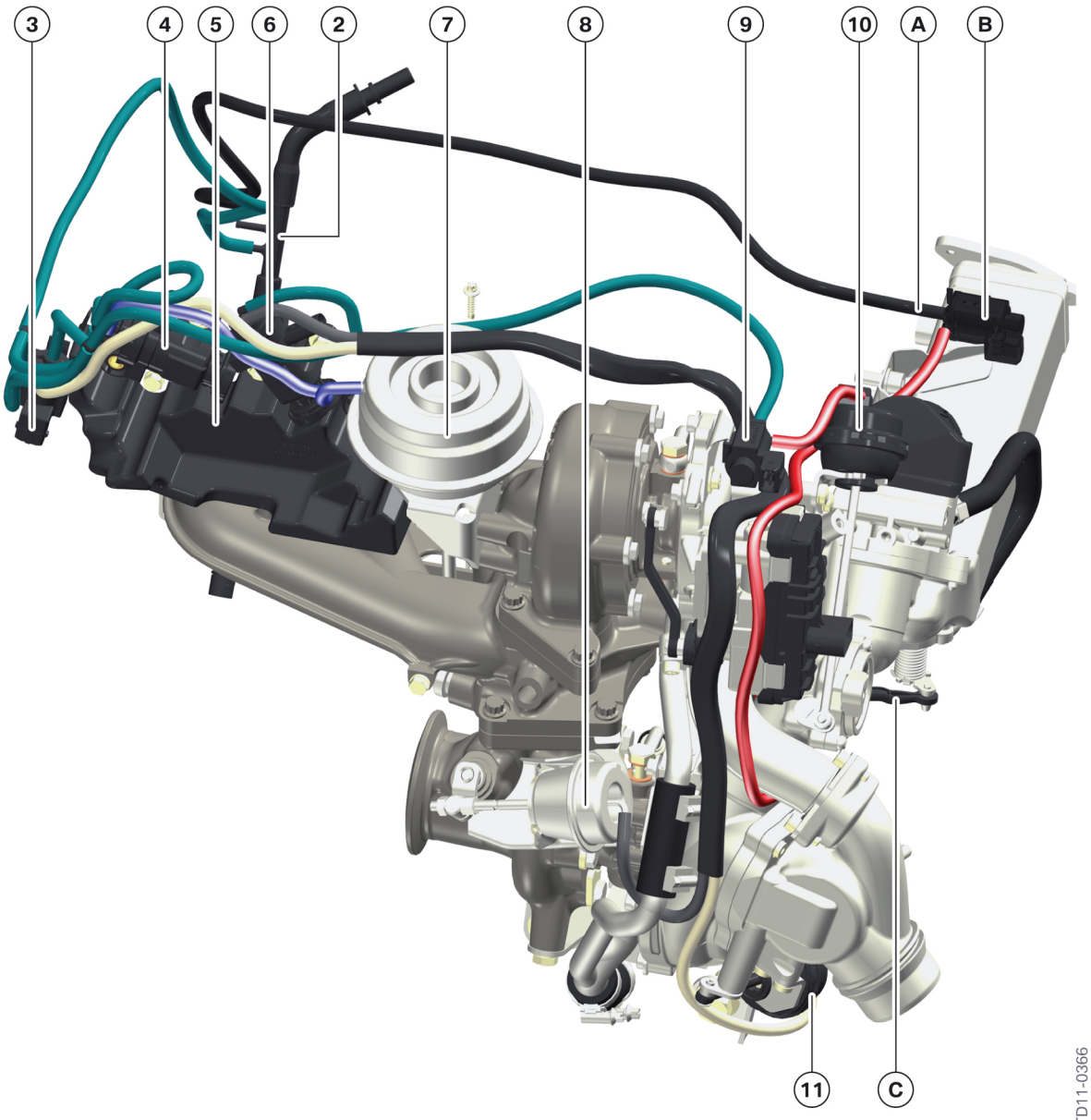
Vacuum system, N47TU top engine

Index	Explanation
I	Vacuum supply lines (highlighted in petrol blue)
II	Vacuum line for activation of bypass plate (white)
III	Vacuum line for activation of turbine control flap (blue)
IV	Vacuum line for activation of wastegate valve (black)
V	Vacuum line for activation of low-pressure stage bypass plate (red)
1	Non-return valve for compressor B
2	Vacuum distributor with throttle
3	Electric changeover valve for bypass plate
4	Electropneumatic pressure converter for turbine control flap

N47TU top/N57TU top engine.

4. Vacuum System.

Index	Explanation
5	Vacuum reservoir
6	Electropneumatic pressure converter for wastegate valve
7	Vacuum unit, turbine control flap
8	Vacuum unit, wastegate valve
9	Electric changeover valve for low-pressure bypass plate
10	Vacuum unit, low-pressure stage bypass plate
11	Vacuum unit, bypass plate



Vacuum system, N47TU top engine

N47TU top/N57TU top engine.

4. Vacuum System.

Index	Explanation
2	Vacuum distributor with throttle
3	Electric changeover valve for bypass plate
4	Electropneumatic pressure converter for turbine control flap
5	Vacuum reservoir
6	Electropneumatic pressure converter for wastegate valve
7	Vacuum unit, turbine control flap
8	Vacuum unit, wastegate valve
9	Electric changeover valve for low-pressure bypass plate
10	Vacuum unit low-pressure stage bypass plate
11	Vacuum unit, bypass plate
A	Vacuum supply lines
B	Electric changeover valve for EGR bypass flap.
C	Vacuum unit, EGR bypass valve

N47TU top/N57TU top engine.

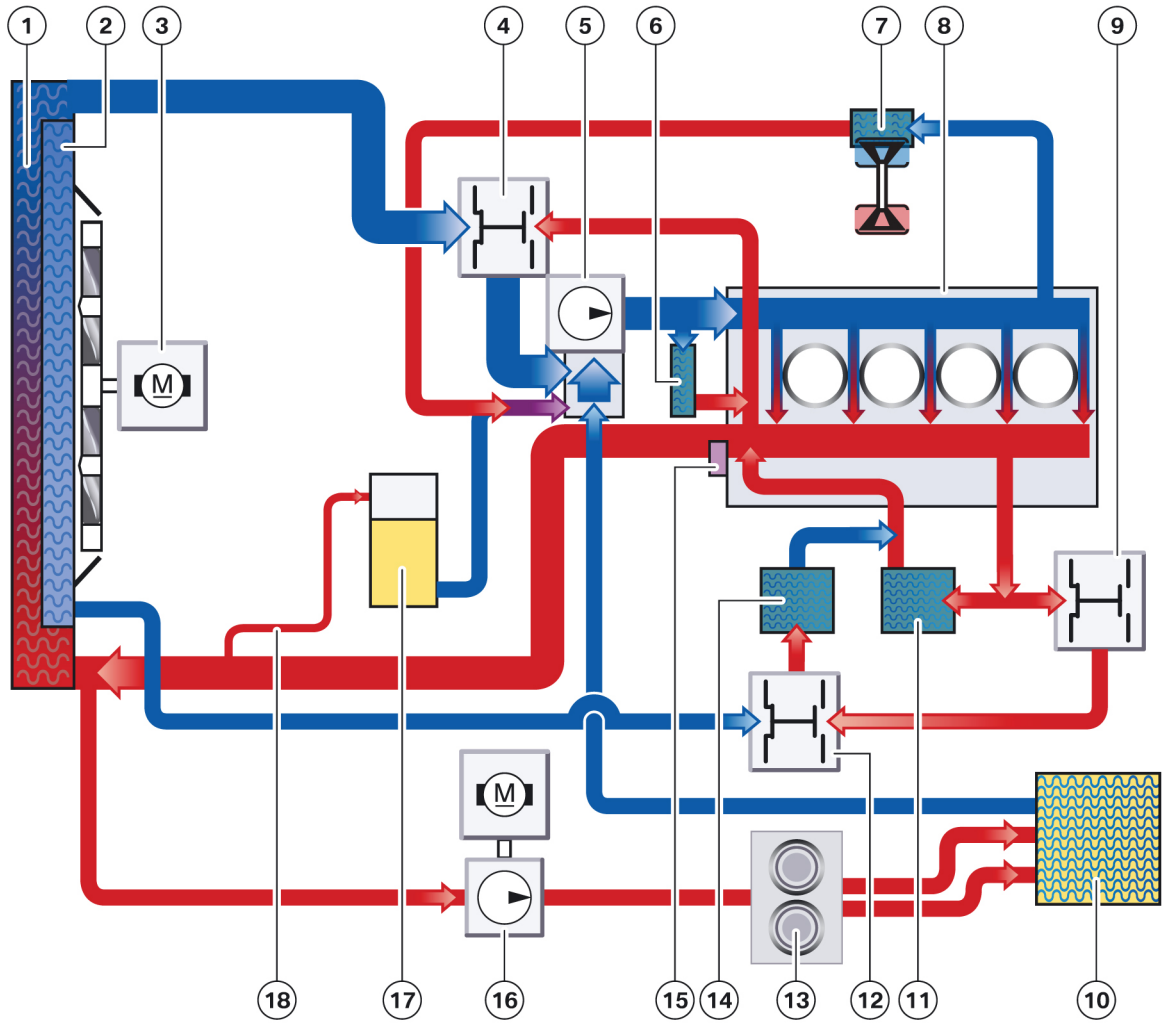
5. Cooling System.

The cooling system has been adapted to the modified conditions, such as the cooling of the low-pressure stage.The following system overviews illustrate the modified sizes.

5.1. Cooling circuit

The following cooling circuits show how the cooling system incorporates the low-pressure stage. This measure enables the intake air temperature to be lowered further.At the air outlet to the charge air cooler temperatures of approximately 150 °C can occur, which can be reduced thanks to the cooling jacket in the turbine housing.This makes it possible to optimise the charging effect.

5.1.1. N47TU top engine



N47TU top engine cooling circuit

N47TU top/N57TU top engine.

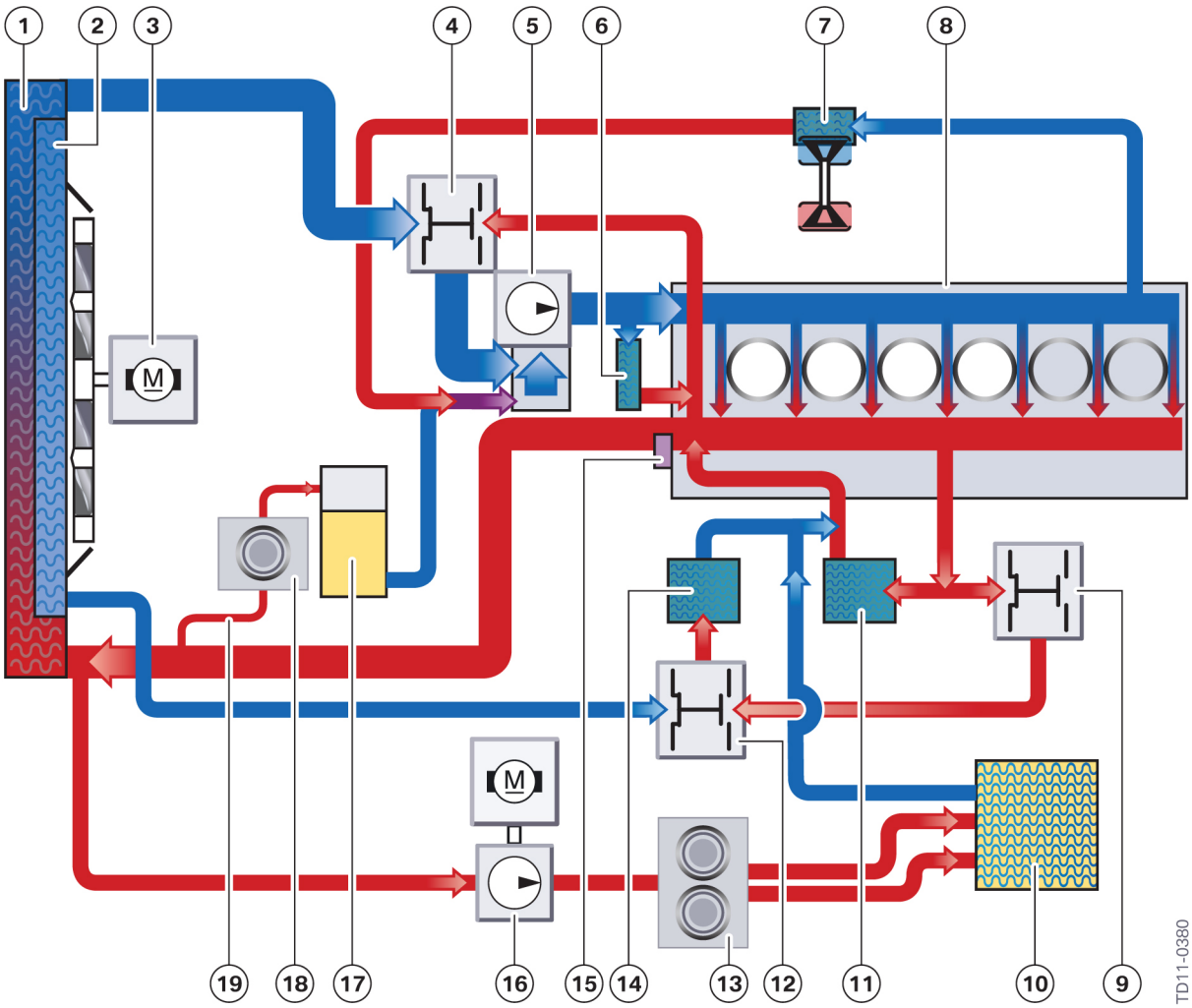
5. Cooling System.

Index	Explanation
1	Radiator
2	Radiator, low temperature range
3	Electric fan
4	Thermostat
5	Coolant pump
6	Exhaust-gas recirculation cooler
7	Exhaust turbocharger, low-pressure stage
8	Engine housing
9	Auxiliary heating thermostat for transmission oil
10	Heat exchanger
11	Engine oil-to-coolant heat exchanger
12	Thermostat for transmission oil
13	Coolant valve
14	Transmission oil-to-coolant heat exchanger
15	Coolant temperature sensor
16	Auxiliary water pump
17	Coolant expansion tank
18	Tank ventilation line

N47TU top/N57TU top engine.

5. Cooling System.

5.1.2. N57TU top engine



N57TU top engine cooling circuit

Index	Explanation
1	Radiator
2	Radiator, low temperature range
3	Electric fan
4	Thermostat
5	Coolant pump
6	Exhaust-gas recirculation cooler
7	Exhaust turbocharger, low-pressure stage
8	Engine housing
9	Auxiliary heating thermostat for transmission oil
10	Heat exchanger

Index	Explanation
11	Engine oil-to-coolant heat exchanger
12	Thermostat for transmission oil
13	Coolant valve
14	Transmission oil-to-coolant heat exchanger
15	Coolant temperature sensor
16	Auxiliary water pump
17	Coolant expansion tank
18	Electronic shutoff valve (to be introduced starting 03/2012)
19	Tank ventilation line

Electronic shutoff valve

The electronic shutoff valve is located in the tank ventilation line to the coolant expansion reservoir.The electronic shutoff valve is closed during the warm-up phase of the engine so that the coolant does not heat up in the expansion reservoir.This measure has made it possible to increase efficiency and reduce CO_2 emissions.When the engine is at operating temperature the electronic shutoff valve is open.

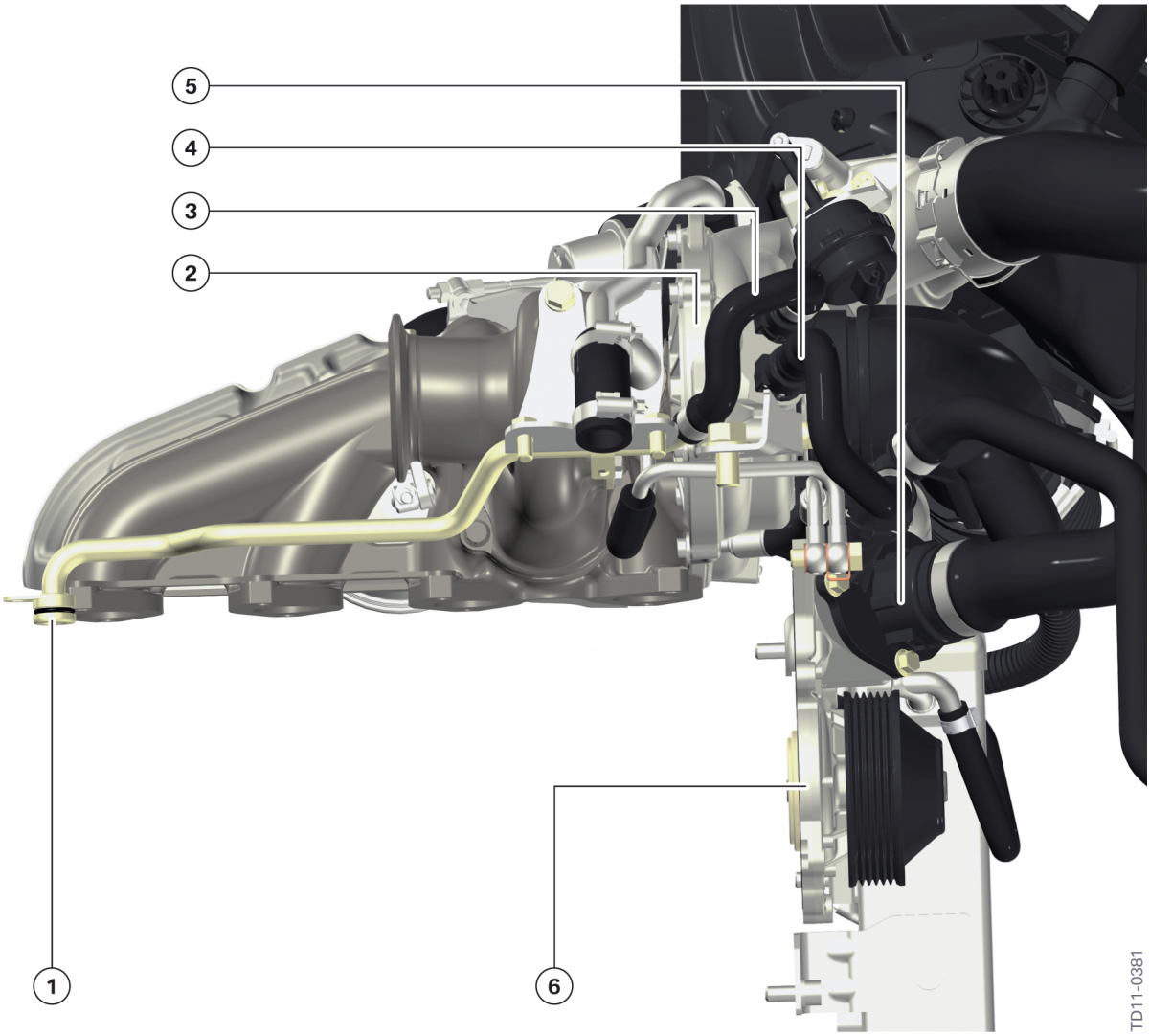
5.2. Low-pressure stage

5.2.1. N47TU top engine

The coolant is delivered from the engine block to the low-pressure stage via a line.A connection takes the coolant which has heated up in the low-pressure stage in front of the thermostat housing to reach the coolant pump.

N47TU top/N57TU top engine.

5. Cooling System.



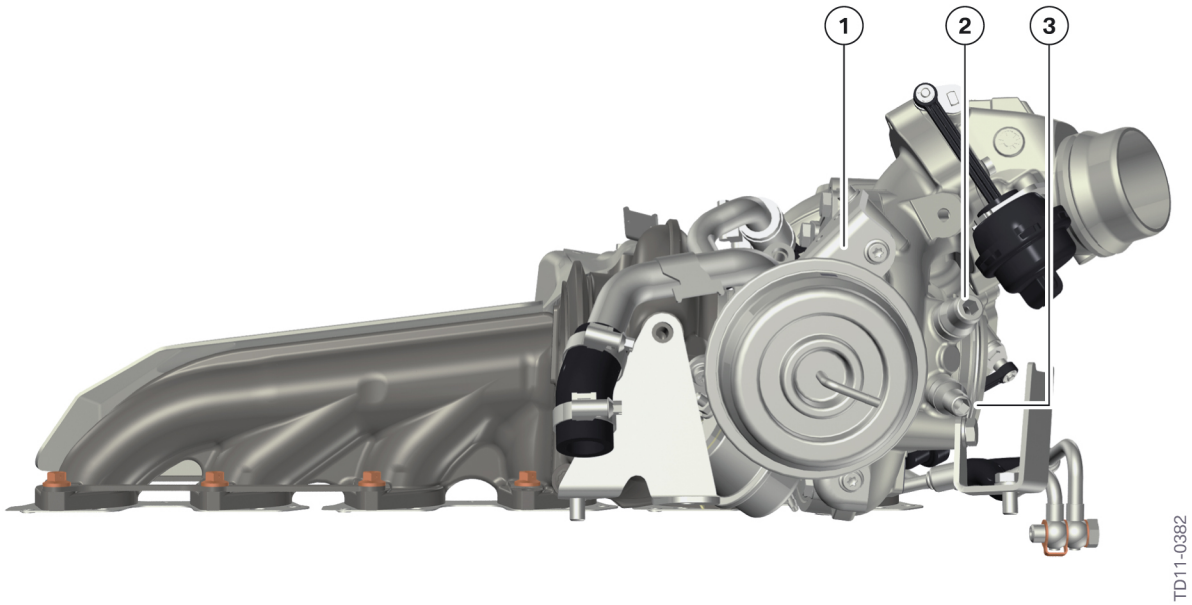
N47TU top engine low-pressure stage

Index	Explanation
1	Coolant connection on the crankcase
2	Exhaust turbocharger, low-pressure stage
3	Coolant intake
4	Coolant outlet
5	Thermostat housing
6	Coolant pump

N47TU top/N57TU top engine.

5. Cooling System.

5.2.2. N57TU top engine



N57TU top engine low-pressure stage

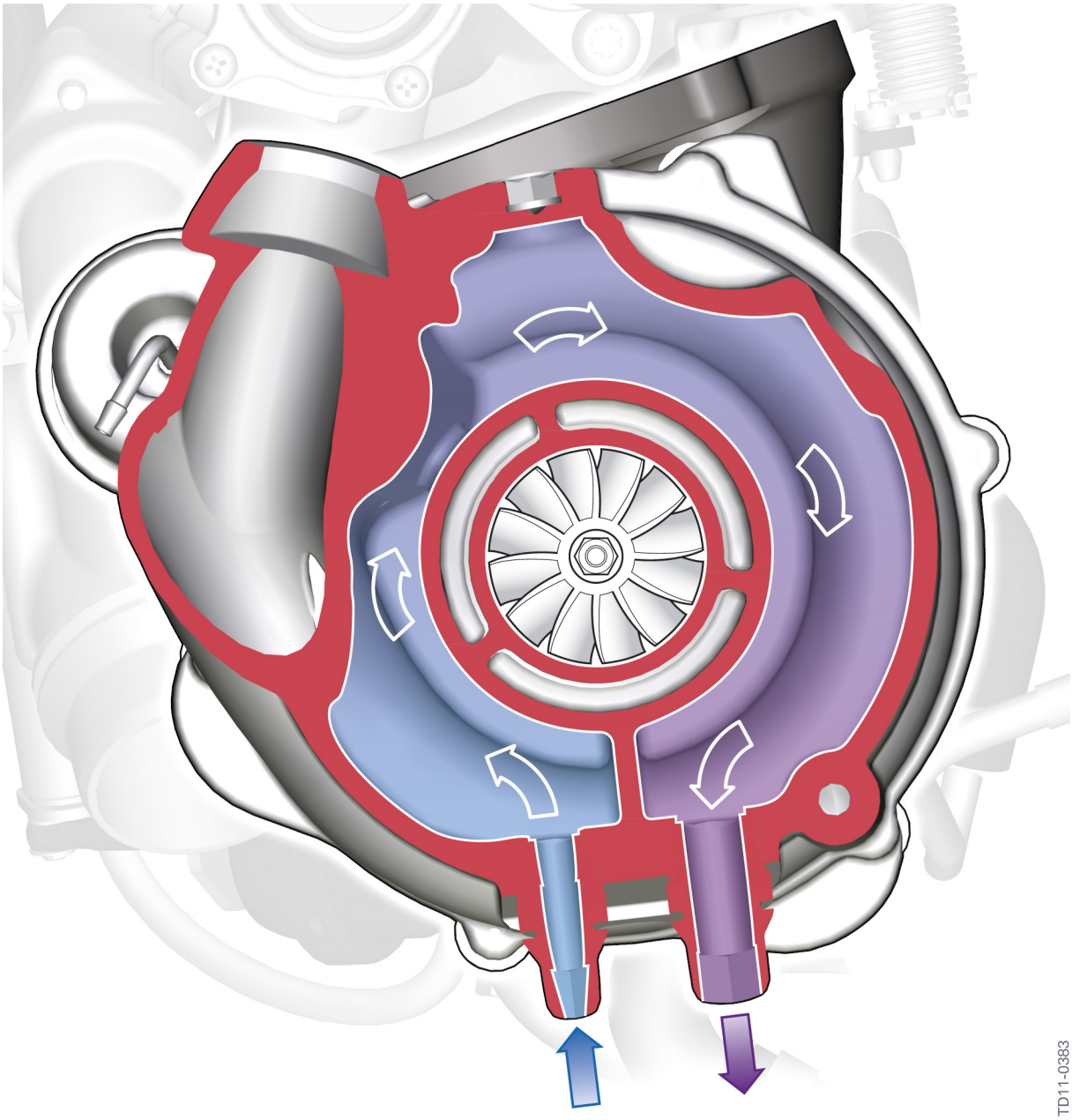
Index	Explanation
1	Exhaust turbocharger, low-pressure stage
2	Coolant intake from engine block
3	Coolant outlet to coolant pump

5.2.3. Design

Additional reduction of the intake air temperature is achieved by a cooling jacket in the turbine housing.More cold coolant in fed via the coolant circuit from the engine block (1) into the cooling jacket (3) of the exhaust turbocharger.From the cooling jacket the coolant is fed via the coolant outlet connection (2) to the coolant pump into the thermostat housing directly in front of the coolant pump and back to the engine block.

N47TU top/N57TU top engine.

5. Cooling System.



N47TU top engine low-pressure stage

A cooling jacket is integrated in the low-pressure stage in the fresh air side, and is separated on the connection side into coolant intake and coolant outlet.Therefore the coolant which has entered the cooling jacket via the coolant cycle has to flow through it so that on the outlet side it can reach the coolant pump via the coolant outlet.

N47TU top/N57TU top engine.

6. Engine electrical system.

The engine electrical system has been slightly redesigned. Some new sensors have been used, but these are the same as the sensors used in the predecessor engine in terms of their function and operating principle. The following system overviews show the components of the EURO 5 versions.Components for the versions with automatic engine start-stop function are marked specially in the tables.The DDE7.31 assumes the function of activating and evaluating the sensors and actuators.

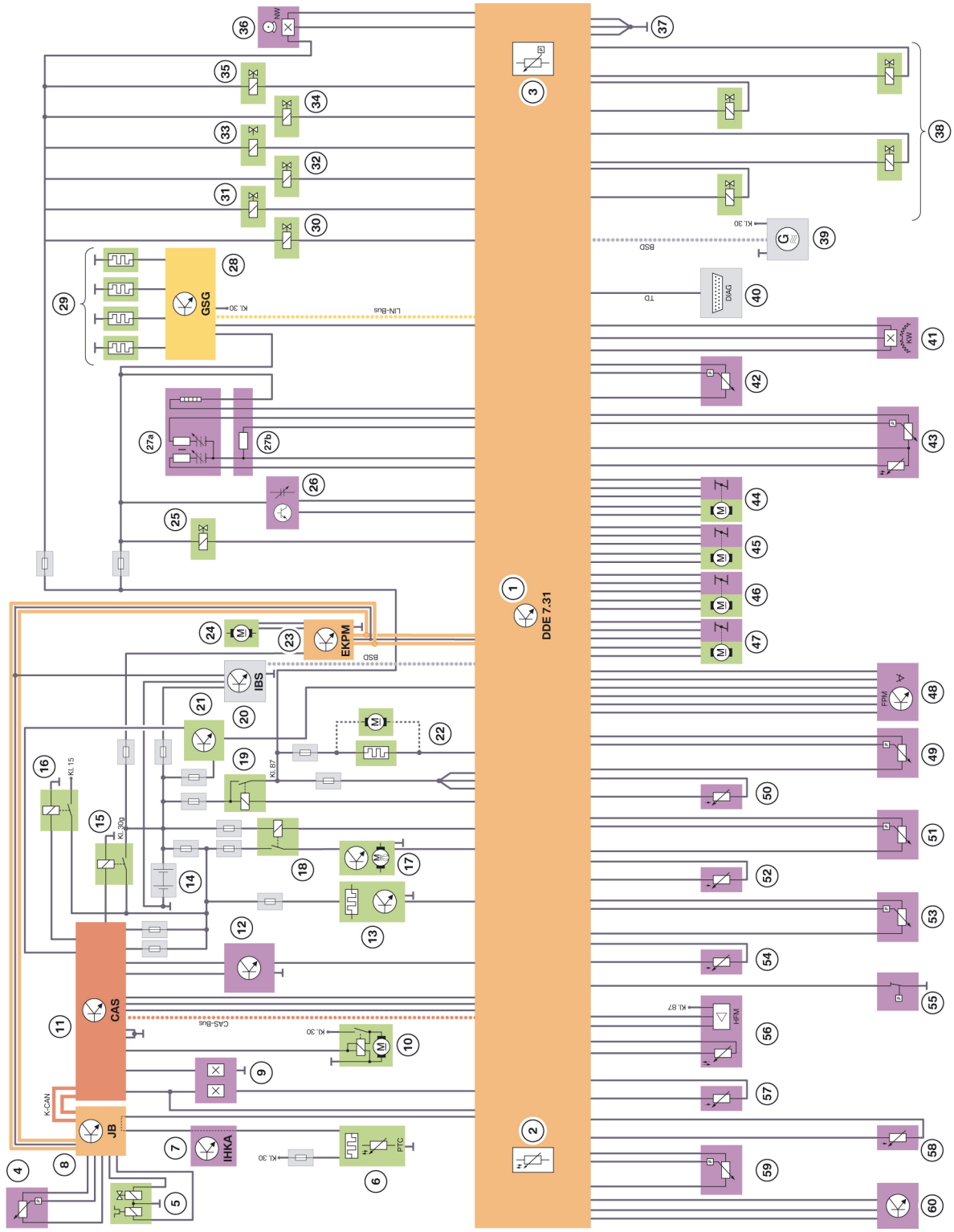
6.1. N47TU top engine

The N47TU top engine differs from the engine with regard to the connection to the vehicle network and in the system overview only in respect of the following components:

- Electric changeover valve for low-pressure bypass plate
- Exhaust-gas temperature sensor upstream of oxidation catalytic converter
- EGR temperature sensor
- Oil level sensor

N47TU top/N57TU top engine.

6. Engine electrical system.



N47TU top engine, system wiring diagram with EURO 5

N47TU top/N57TU top engine.
6. Engine electrical system.

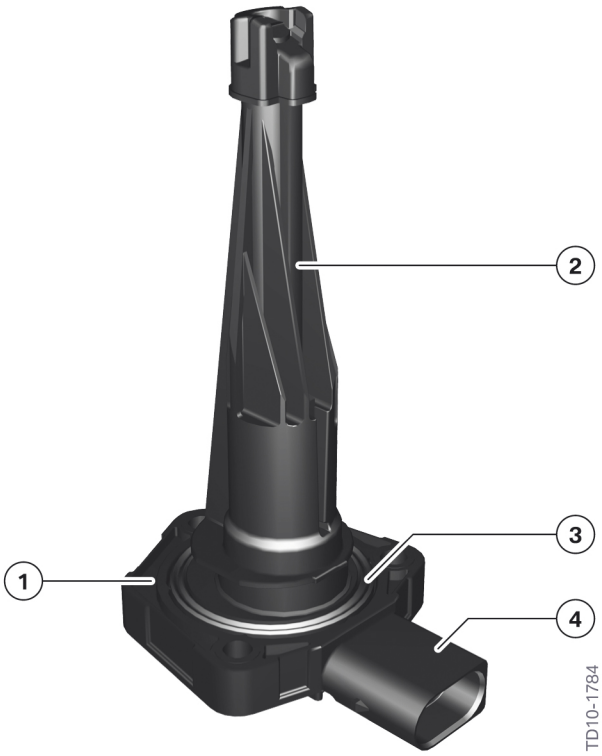
Index	Explanation
1	Digital Diesel Electronics DDE
2	Temperature sensor in the DDE control unit
3	Ambient pressure sensor in the DDE control unit
4	Refrigerant pressure sensor
5	Air conditioning compressor
6	Electric auxiliary heater
7	Integrated automatic heating / air conditioning
8	Junction box
9	Brake light switch
10	Starter motor
11	Car Access System
12	Clutch module
13	Fuel filter heating
14	Battery
15	Relay, terminal 30g
16	Relay, terminal 15
17	Electric fan
18	Relay for electric fan
19	DDE main relay
20	Intelligent battery sensor
21	Oil level sensor
22	Blow-by heating in cold country variant, E-box fan in hot country variant
23	Electronic fuel pump control
24	Electric fuel pump
25	Electropneumatic changeover valve, exhaust-gas recirculation bypass flap
26	Oil level sensor
27a	Oxygen sensor before oxidation catalytic converter (control sensor with continuous characteristic curve)
27b	Connector, oxygen sensor
28	Preheating control unit
29	Glow elements
30	Electropneumatic pressure converter for turbine control flap
31	Electropneumatic pressure converter for wastegate valve
32	Electric changeover valve for bypass plate
33	Electric changeover valve for low-pressure bypass plate

Index	Explanation
34	Rail pressure regulating valve
35	Fuel quantity control valve
36	Camshaft sensor
37	Ground connection
38	Solenoid valve injectors
39	Alternator
40	Diagnostic socket
41	Crankshaft sensor
42	Rail pressure sensor
43	Fuel pressure and temperature sensor
44	Charging pressure actuator
45	Exhaust gas recirculation valve and exhaust recirculation sensor
46	Throttle-valve actuator and throttle valve sensor
47	Swirl-flap actuator and swirl-flap sensor
48	Accelerator pedal module
49	Exhaust backpressure sensor upstream of exhaust turbocharger
50	Coolant temperature sensor
51	Exhaust backpressure sensor before oxidation catalytic converter
52	Charge-air temperature sensor
53	Charging pressure sensor
54	Exhaust-gas temperature sensor upstream of oxidation catalytic converter
55	Oil pressure switch
56	Hot film air mass meter
57	Exhaust-gas temperature sensor upstream of oxidation catalytic converter
58	Exhaust-gas recirculation temperature sensor
59	Brake vacuum sensor (only with automatic engine start-stop function)
60	Zero-gear sensor (only with automatic engine start-stop function)

6.1.1. Oil level sensor

The N47TU top engine is the first BMW engine to be equipped with an oil level sensor which works by ultrasound measurement.It is connected to the Digital Diesel Electronics via a pulse-width modulated signal.The sensor itself is supplied with vehicle voltage and earth.The sensor has a measuring range of 18 mm to 132.8 mm above the sensor base.The sensor base contains the electronics for evaluating the measured values and producing the PWM signal.

N47TU top/N57TU top engine.
6. Engine electrical system.



N47TU top engine oil level sensor

Index	Explanation
1	Sensor base
2	Sensor tube
3	Oil sump gasket
4	Electrical connection

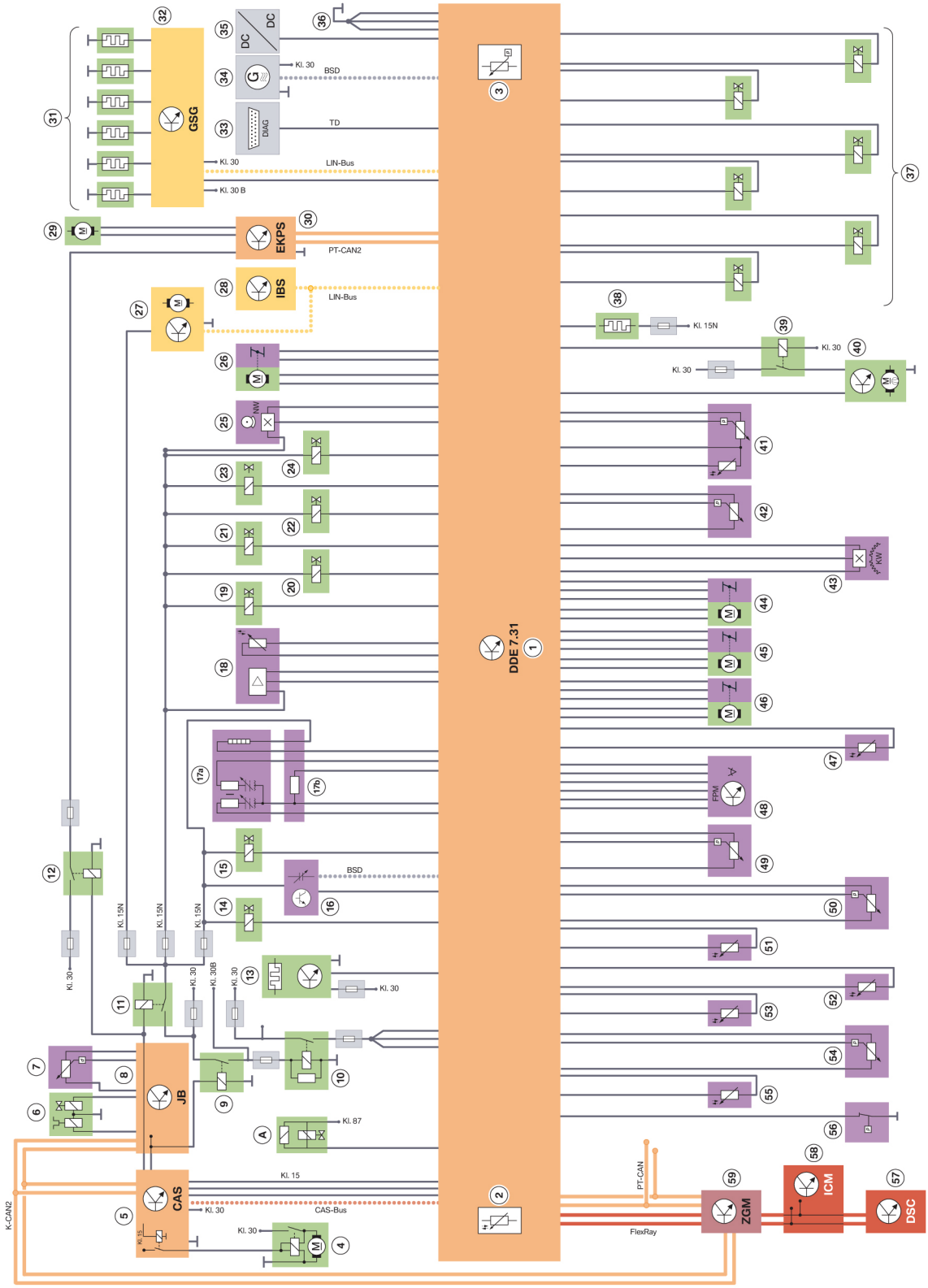
6.2. N57TU top engine

The N57TU top engine differs from the N57 top engine with regard to the connection to the vehicle network and in the system overview in respect of the following components:

- Electric changeover valve for low-pressure bypass plate
- Exhaust-gas temperature sensor upstream of oxidation catalytic converter
- EGR temperature sensor
- Electronic shutoff valve for the tank ventilation line to the coolant expansion reservoir (to be introduced starting 03/2012).

N47TU top/N57TU top engine.

6. Engine electrical system.



N57TU top engine, system wiring diagram with EURO 5

N47TU top/N57TU top engine.
6. Engine electrical system.

Index	Explanation
A	Electronic shutoff valve (to be introduced starting 03/2012)
1	DDE control unit (Digital Diesel Electronics)
2	Temperature sensor in the DDE control unit
3	Ambient pressure sensor in the DDE control unit
4	Starter motor
5	Car Access System (CAS)
6	Air conditioning compressor
7	Refrigerant pressure sensor
8	Junction box
9	Terminal 30B relay
10	DDE main relay
11	Relay, terminal 15N
12	Relay, terminal 15N
13	Fuel filter heating
14	Electric changeover valve, engine mount
15	Electric changeover valve, EGR bypass flap
16	Oil condition sensor
17a	Lambda oxygen sensor (control sensor with constant characteristic curve)
17b	Connector, oxygen sensor
18	Hot film air mass meter
19	Rail pressure regulating valve
20	Fuel quantity control valve
21	Electropneumatic pressure converter for turbine control flap
22	Electropneumatic pressure converter for wastegate valve
23	Electric changeover valve for bypass plate
24	Electric changeover valve for low-pressure bypass plate
25	Camshaft sensor
26	Charging pressure actuator
27	Air flaps
28	Intelligent battery sensor
29	Electric fuel pump
30	Electronic fuel pump control
31	Glow elements
32	Preheating control unit
33	DC/DC converter

Index	Explanation
34	Diagnosis connector (only speed signal)
35	Alternator
36	Ground connection
37	Solenoid valve injectors
38	Engine ventilation heating
39	Relay for electric fan
40	Electric fan
41	Fuel pressure and temperature sensor
42	Rail pressure sensor
43	Crankshaft sensor
44	EGR valve and exhaust recirculation sensor
45	Throttle-valve actuator and throttle valve sensor
46	Swirl-flap actuator and swirl-flap sensor
47	Coolant temperature sensor
48	Accelerator pedal module
49	Exhaust backpressure sensor before exhaust turbocharger
50	Charging pressure sensor
51	Charge-air temperature sensor
52	Exhaust-gas temperature sensor upstream of oxidation catalytic converter
53	Exhaust-gas temperature sensor upstream of oxidation catalytic converter
54	Exhaust backpressure sensor after oxidation catalytic converter
55	EGR temperature sensor
56	Oil pressure switch
57	Dynamic Stability Control
58	Integrated Chassis Management
59	Central gateway module

6.2.1. Electronic shutoff valve

The electric shutoff valve is controlled by pulse-width modulation and supplied with voltage via terminal 87Activation is prompted by the Digital Diesel Electronics.Only the open and closed positions are used.

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