Technical training.
Product information.

N47TU Engine.

BMW Service

General information

Symbols used

The following symbol / sign is used in this document to facilitate better comprehension and to draw attention to particularly important information:

contains important safety guidance and information that is necessary for proper system functioning and which it is imperative to follow.

Current applicability and country-specific models

The BMW Group produces vehicles to meet the very highest standards of safety and quality. Changes in terms of environmental protection, customer benefits and design make it necessary to develop systems and components on a continuous basis. Consequently, this may result in differences between the content of this document and the vehicles available in the training course.

This document describes the fundamentals of left-hand drive vehicles in the European version. In vehicles with right-hand drive some operating elements or components are arranged differently than shown in the graphics of this document. Further discrepancies may arise from market-specific or country-specific equipment specifications.

Additional sources of information

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

- in the Owner's Handbook
- in the integrated service technical application.

Contact: conceptinfo@bmw.de

The information in the document is part of the BMW Group technical training course and is intended for its trainers and participants. Refer to the latest relevant BMW Group information systems for any changes/supplements to the technical data.

Information status: **February 2010**
VH-23/International Technical Training

N47TU Engine.

Contents

N47TU Engine.

Contents

N47TU Engine.

1. Models.

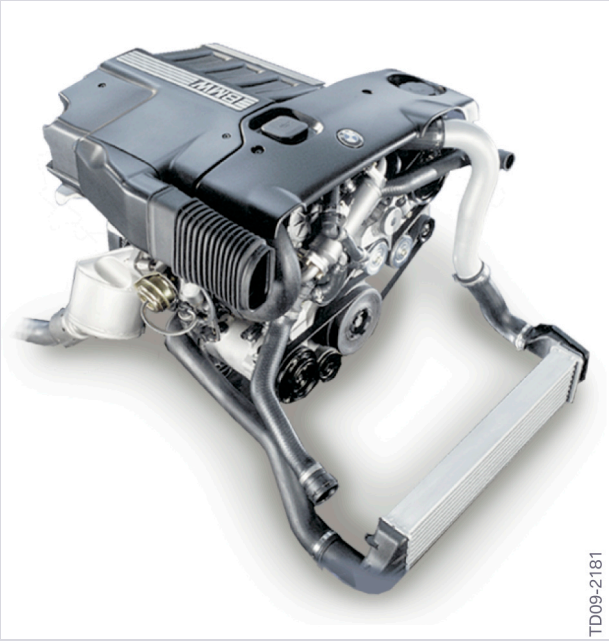
1.1. History

Engine	M41D17
Series	E36/3 E36/4 E35/5
Model	318tds
Power in [kW] at [rpm]	66 4000
Torque in [Nm] at [rpm]	190 2000
Design and number of cylinders	In-line 4
Displacement in [cm³]	1665
Bore/stroke in [mm]	82.8/80
Compression	22 : 1
Valves per cylinder	2
Period of service	09/94 – 09/00
Engine control	DDE2.1

Engine	M47D20U0
Series	E46/3 E46/4
Model	318d
Power in [kW] at [rpm]	85 4000
Torque in [Nm] at [rpm]	265 1750 – 2500
Design and number of cylinders	In-line 4
Displacement in [cm³]	1951
Bore/stroke in [mm]	84/88
Compression	19 : 1
Valves per cylinder	4
Period of service	09/01 – 03/03
Engine control	DDE3.0

N47TU Engine.

1. Models.



Engine	M47D20O0
Series	E46/3 E46/4 E46/5 E39/2
Model	320d 520d
Power in [kW] at [rpm]	100 4000
Torque in [Nm] at [rpm]	280 1750 – 2500
Design and number of cylinders	In-line 4
Displacement in [cm³]	1951
Bore/stroke in [mm]	84/88
Compression	19 : 1
Valves per cylinder	4
Period of service	04/98 – 04/04
Engine control	DDE3.0

Engine	M47D20U1
Series	E46/3 E46/4 E46/5 E39/2
Model	318d
Power in [kW] at [rpm]	85 4000
Torque in [Nm] at [rpm]	280 1750 – 2500
Design and number of cylinders	In-line 4
Displacement in [cm³]	1995
Bore/stroke in [mm]	84/90
Compression	17 : 1
Valves per cylinder	4
Period of service	03/03 – 03/05
Engine control	DDE5.0 DDE506

N47TU Engine.

1. Models.

Engine	M47D20O1
Series	E46/3 E46/4 E46/5 E39/2
Model	320d
Power in [kW] at [rpm]	110 4000
Torque in [Nm] at [rpm]	330 2000
Design and number of cylinders	In-line 4
Displacement in [cm³]	1995
Bore/stroke in [mm]	84/90
Compression	17 : 1
Valves per cylinder	4
Period of service	09/01– 09/06
Engine control	DDE5.0 DDE506

Engine	M47D20U2
Series	E87 E90 E91
Model	118d 318d
Power in [kW] at [rpm]	90 4000
Torque in [Nm] at [rpm]	280 1750 – 2000
Design and number of cylinders	In-line 4
Displacement in [cm³]	1995
Bore/stroke in [mm]	84/90
Compression	18 : 1
Valves per cylinder	4
Period of service	09/04 – 09/07
Engine control	DDE603

N47TU Engine.

1. Models.

Engine	M47D20O2
Series	E60 E61 E83 E87 E90 E91
Model	120d 320d 520d X3 xDrive20d*
Power in [kW] at [rpm]	120/110* 4000
Torque in [Nm] at [rpm]	340/330* 1750 – 2500
Design and number of cylinders	In-line 4
Displacement in [cm³]	1995
Bore/stroke in [mm]	84/90
Compression	18 : 1 17 : 1*
Valves per cylinder	4
Period of service	09/04 – 09/07
Engine control	DDE604 DDE506*

Engine	N47D20K0
Series	E81 E87 E90
Model	116d 316d
Power in [kW] at [rpm]	85 4000
Torque in [Nm] at [rpm]	260 1750 – 2500
Design and number of cylinders	In-line 4
Displacement in [cm³]	1995
Bore/stroke in [mm]	84/90
Compression	16 : 1
Valves per cylinder	4
Period of service	03/09 – present
Engine control	DDE7.1

N47TU Engine.

1. Models.

Engine	N47D20U0
Series	E81 E82 E84 E87 E88 E90 E91
Model	118d 318d X1 sDrive18d* X1 xDrive18d*
Power in [kW] at [rpm]	105 4000
Torque in [Nm] at [rpm]	300/320* 1750 – 2500
Design and number of cylinders	In-line 4
Displacement in [cm³]	1995
Bore/stroke in [mm]	84/90
Compression	16.5 : 1
Valves per cylinder	4
Period of service	03/07 – present
Engine control	DDE7.1

Engine	N47D20O0
Series	E60 E61 E81 E82 E83 E84 E87 E88 E90 E91 E92 E93
Model	520d 120d 320d X3 xDrive20d X3 xDrive18d*
Power in [kW] at [rpm]	130/105* 4000
Torque in [Nm] at [rpm]	350 1750 – 3000/ 1750 – 2750*
Design and number of cylinders	Reihe 4
Displacement in [cm³]	1995
Bore/stroke in [mm]	84/90
Compression	16.5 : 1

N47TU Engine.

1. Models.

	Engine	N47D20O0
	Valves per cylinder	4
	Period of service	03/07 – present
	Engine control	DDE7.1

	Engine	N47D20T0
 TD10-0015	Series	E81 E82 E84 E87 E88
	Model	123d X1 xDrive23d
	Power in [kW] at [rpm]	150 4400
	Torque in [Nm] at [rpm]	400 2000 – 2250
	Design and number of cylinders	In-line 4
	Displacement in [cm³]	1995
	Bore/stroke in [mm]	84/90
	Compression	16.0 : 1
	Valves per cylinder	4
	Period of service	9/07- present
	Engine control	DDE7.1

N47TU Engine.
2. Introduction.

The engine gradually replaces the engine. Since the engine is also designed for transverse installation, extensive modifications are necessary. This document is exclusively concerned with the adaptations/modifications of the longitudinally installed engine to the engine for BMW models.

The engine will be used series launch on 01.03.2010 in four versions. The following BMW models first receive the engine:

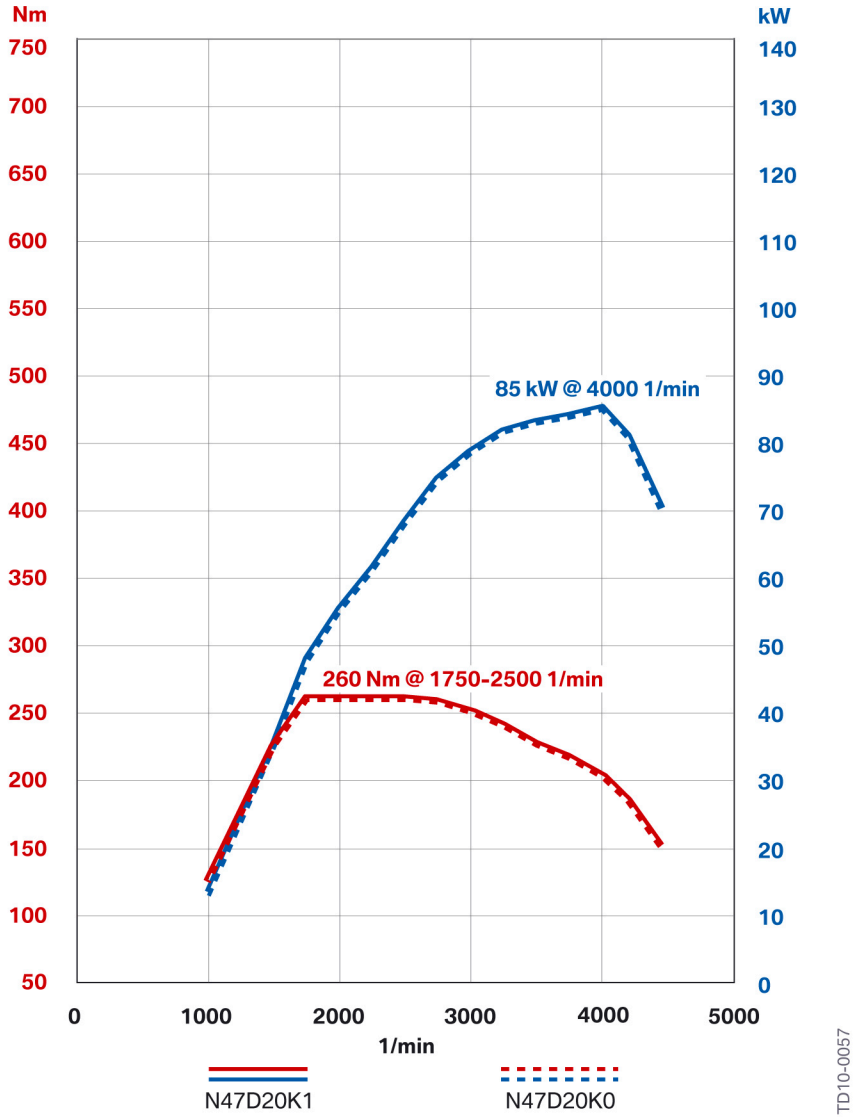
Series	N47D20K1	N47D20U1	N47D20O1
E90	316d	318d	320d 320d EfficientDynamics Edition
E91	316d	318d	320d
E92	-	-	320d
E93	-	-	320d
F10	-	-	520d (series launch 01.06.2010)

2.1. Technical data

The following tables show the comparison of the engines with the engines of model year 2010.

N47TU Engine.
2. Introduction.

2.1.1. BMW 316d



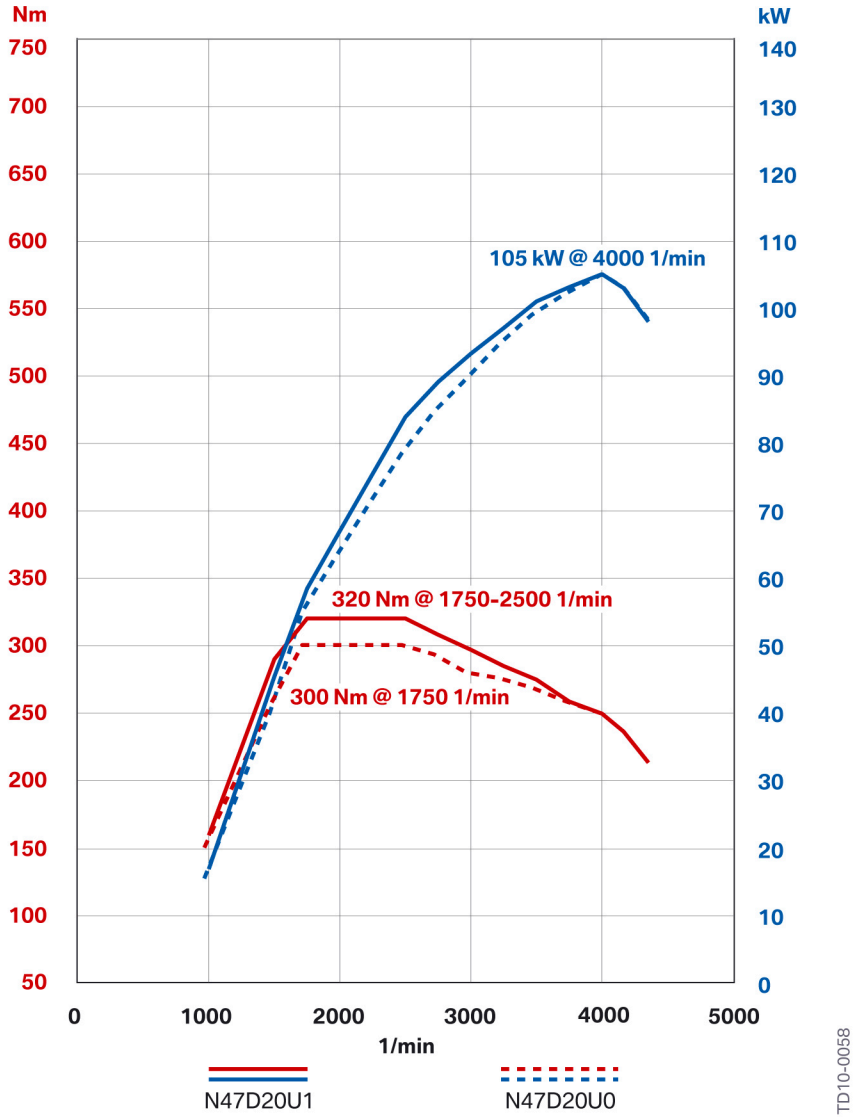
Full load diagram E90 BMW 316d with N47D20K0 engine in comparison with the N47D20K1 engine

	Unit	N47D20K0 (E90/316d)	N47D20K0 (E90/316d)
Design		R4	
Displacement	[cm³]	1995	
Bore/stroke	[mm]	84/90	
Power output at engine speed	[kW] [rpm]	85 4000	
Power output per litre	[kW/l]	42.61	
Torque at engine speed	[Nm] [rpm]	260 1750 – 2500	

N47TU Engine.
2. Introduction.

	Unit	N47D20K0 (E90/316d)	N47D20K0 (E90/316d)
Compression ratio	[ε]	16.5 : 1	
Valves per cylinder		4	
Fuel consumption in accordance with the EU	[l/100 km]	4.5	
CO_2 Emission	[g/km]	118	
Digital Engine Electronics		DDE7.1	
Exhaust emissions legislation		EURO 5	
Top speed	[km/h]	202	
Acceleration 0 –100 km/h	[s]	10.9	
Vehicle kerb weight DIN/EU	[kg]	1400/1475	

2.1.2. BMW 318d



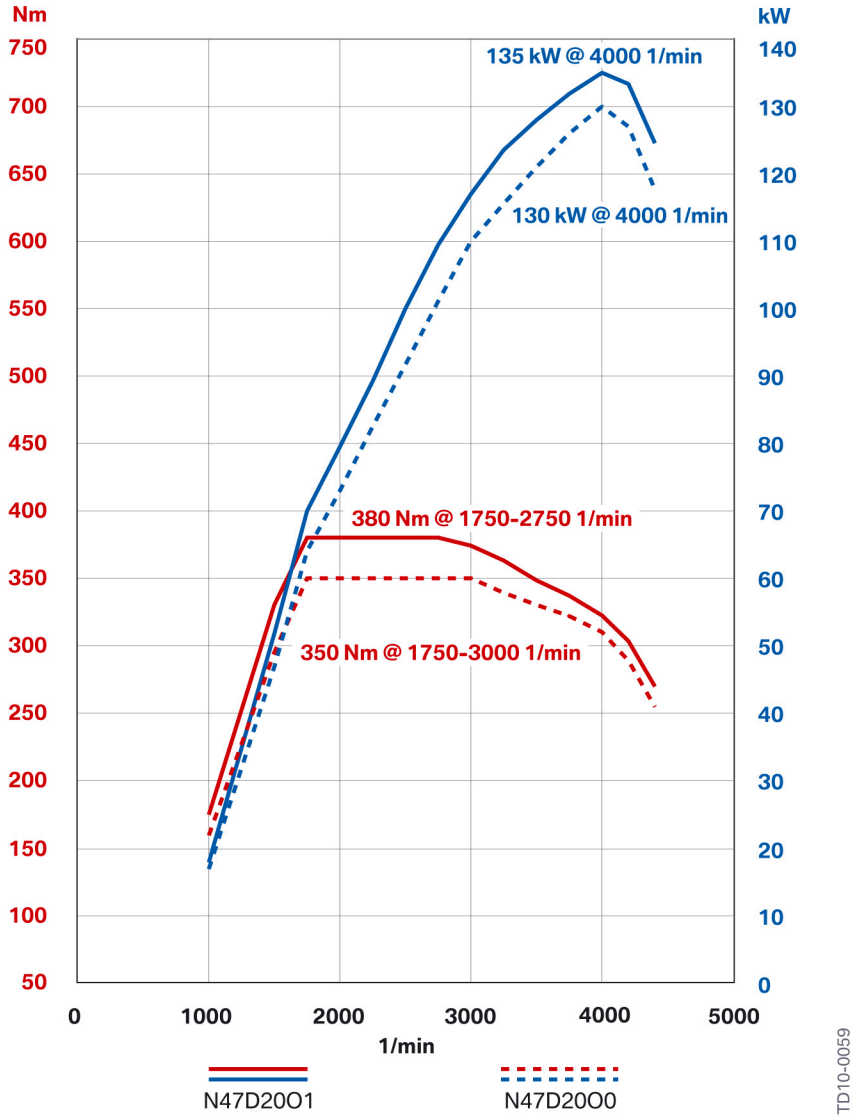
Full load diagram E90 BMW 316d with N47D20K0 engine in comparison with the N47D20K1 engine

	Unit	N47D20K0 (E90/316d)	N47D20K0 (E90/316d)
Design		R4	
Displacement	[cm³]	1995	
Bore/stroke	[mm]	84/90	
Power output at engine speed	[kW] [rpm]	105 4000	
Power output per litre	[kW/l]	52.63	
Torque at engine speed	[Nm] [rpm]	300 1750 – 2500	320 1750 – 2500

N47TU Engine.
2. Introduction.

	Unit	N47D20K0 (E90/316d)	N47D20K0 (E90/316d)
Compression ratio	[ε]	16.5 : 1	
Valves per cylinder		4	
Fuel consumption in accordance with the EU	[l/100 km]	4.7	4.5
CO_2 Emission	[g/km]	123	119
Digital Engine Electronics		DDE7.1	
Exhaust emissions legislation		EURO 5	
Top speed	[km/h]	210	
Acceleration 0 –100 km/h	[s]	9.3	9.1
Vehicle kerb weight DIN/EU	[kg]	1430/1505	1415/1490

2.1.3. BMW 320d



Full load diagram E90 BMW 316d with N47D20K0 engine in comparison with the N47D20K1 engine

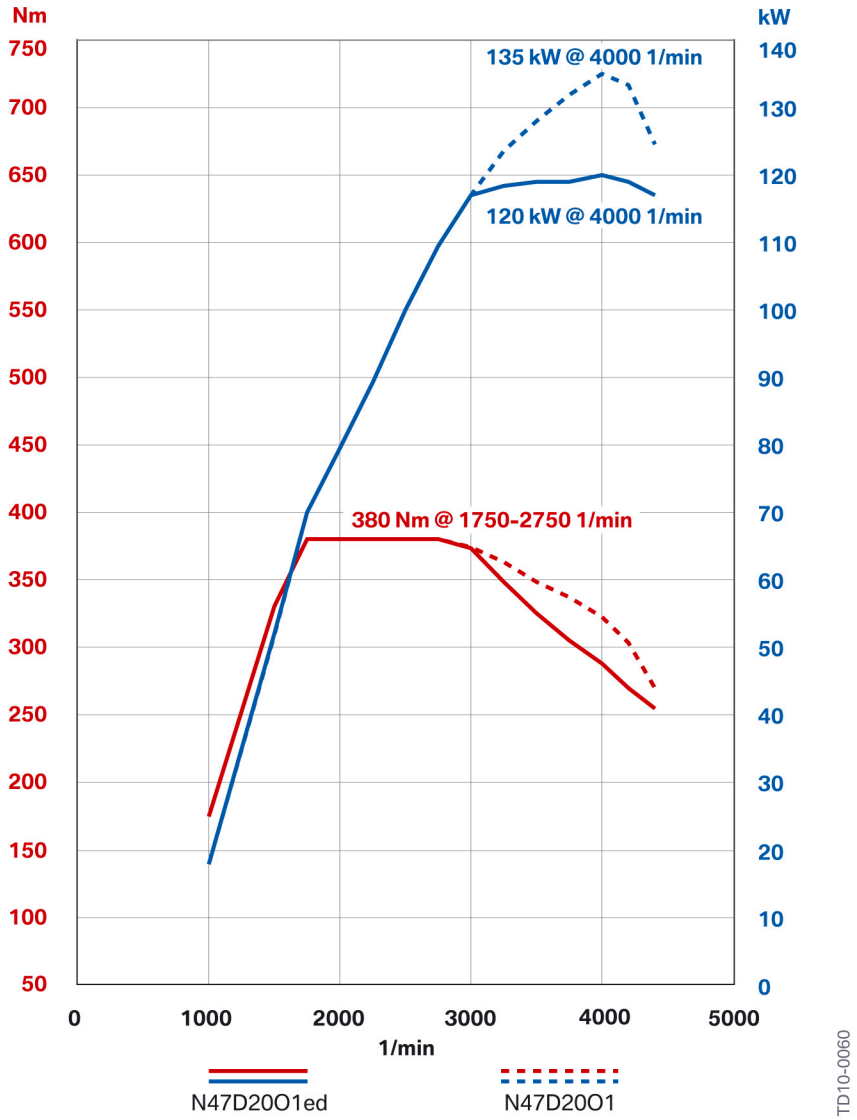
	Unit	N47D20K0 (E90/316d)	N47D20K0 (E90/316d)
Design		R4	
Displacement	[cm³]	1995	
Bore/stroke	[mm]	84/90	
Power output at engine speed	[kW] [rpm]	130 4000	135 4000
Power output per litre	[kW/l]	65.16	67.67
Torque at engine speed	[Nm] [rpm]	350 1750 – 3000	380 1900 – 2750

	Unit	N47D20K0 (E90/316d)	N47D20K0 (E90/316d)
Compression ratio	[ε]	16.0 : 1	16.5 : 1
Valves per cylinder		4	
Fuel consumption in accordance with the EU	[l/100 km]	4.8	4.7
CO_2 Emission	[g/km]	128	125
Digital Engine Electronics		DDE7.1	
Exhaust emissions legislation		EURO 5	
Top speed	[km/h]	230	235
Acceleration 0 –100 km/h	[s]	7.9	7.5
Vehicle kerb weight DIN/EU	[kg]	1430/1505	1420/1495

2.1.4. BMW 320d EfficientDynamics Edition

The BMW model for series introduction with the lowest fuel consumption and lowest emissions sets new environmental standards in mid-range vehicles. Parallelto BMW 320d,the BMW 320d EfficientDynamics Edition will be offered. The rpm level is reduced relative to the speed by a longer final drive ratio. In addition, the dual-mass flywheel with centrifugal force pendulum enables the engine to operate at even lower rpms.

N47TU Engine.
2. Introduction.



Full load diagram BMW 320d with engine in comparison to the BMW 320d EfficientDynamics Edition with engine

	Unit	N47D20K0 (E90/316d)	N47D20K0 (E90/316d)
Design		R4	
Displacement	[cm³]	1995	
Bore/stroke	[mm]	84/90	
Power output at engine speed	[kW] [rpm]	135 4000	120 4000
Power output per litre	[kW/l]	67.67	60.15
Torque at engine speed	[Nm] [rpm]	380 1900 – 2750	
Compression ratio	[ε]	16.5 : 1	

	Unit	N47D20K0 (E90/316d)	N47D20K0 (E90/316d)
Valves per cylinder		4	
Fuel consumption in accordance with the EU	[l/100 km]	4.7	4.1
CO_2 Emission	[g/km]	125	109
Digital Engine Electronics		DDE7.1	
Exhaust emissions legislation		EURO 5	
Top speed	[km/h]	235	228
Acceleration 0 –100 km/h	[s]	7.5	8.0
Vehicle kerb weight DIN/EU	[kg]	1420/1495	

2.2. Engine identification

2.2.1. Engine type

The engine type is used in technical documents for clear identification of the engine. However, often only an abbreviation is used.

This abbreviation is used to assign an engine to an engine family. Thus often the N47 engine family is mentioned, which consists of several engines, such as the N47D20T0, N47D20O0, N47D20U0 and the N47D20K0. The family is then named for the first revision.

Position	Meaning	Index	Explanation
1	Engine developer	M, N P S W	BMW Group BMW M Sport BMW M GmbH Supplied engines
2	Engine type	1 4 5 6 7 8	4-cylinder in-line engine (e.g.) 4-cylinder in-line engine (e.g.N47) 6-cylinder in-line engine (e.g.N57) -engine (e.g.N63) -engine (e.g.N74) -engine (e.g.S85)
3	Modifications to the engine block concept	0 1 – 9	Engine block Modifications, e.g. combustion process
4	Working process or fuel and if necessary installation position	B D H	Petrol engine, longitudinal installation Diesel engine, longitudinal installation Hydrogen engine, longitudinal installation

Position	Meaning	Index	Explanation
5+6	Displacement in 1/10 litre	20	2.0 litre displacement
7	Performance class	K U M O T	smallest lower middle TOP TOP
8	Release relevant revision	0 1 – 9	New development Revision

Itemisation of N47D20O1 engine type

Index	Explanation
N	BMW Group development
4	4-cylinder in-line engine
7	Direct fuel injection and exhaust turbocharger
D	Diesel engine, longitudinal installation
20	2.0 litre displacement
O	Upper performance class
1	1. Revision

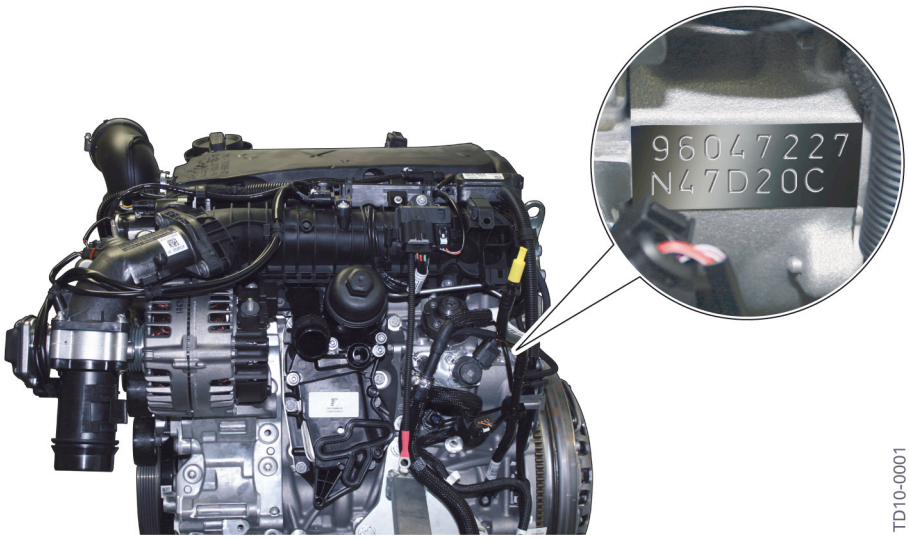
2.2.2. Engine identification

The engines have an identification on the crankcase for clear recognition and assignment. The engine identification is also required for approval by the authorities. By using the TOP engine there is a further development of this identification and a reduction from the previous eight to seven digits. The engine number is located over the engine identification on the motor. This sequential number in combination with the engine identification provides a unique identification of each individual engine. The first six digits correspond to the engine type.

Position	Meaning	Index	Explanation
1	Engine developer	M, N P S W	BMW Group BMW M Sport BMW M GmbH Supplied engines
2	Engine type	1 4 5 6 7 8	4-cylinder in-line engine (e.g.) 4-cylinder in-line engine (e.g.N47) 6-cylinder in-line engine (e.g.N57) -engine (e.g.N63) -engine (e.g.N74) -engine (e.g.S85)
3	Modifications to the engine block concept	0 1 – 9	Engine block Modifications, e.g. combustion process

N47TU Engine.
2. Introduction.

Position	Meaning	Index	Explanation
4	Working process or fuel and if necessary installation position	B D H	Petrol engine, longitudinal installation Diesel engine, longitudinal installation Hydrogen engine, longitudinal installation
5+6	Displacement in 1/10 litre	20	2.0 litre displacement
7	Type check issues (modifications which require a new type checking)	A B – Z	Standard As needed, e.g. ROZ87



engine, engine identification and engine number

Index	Explanation
96047227	Sequential engine number
N	BMW Group development
4	4-cylinder in-line engine
7	Direct fuel injection and exhaust turbocharger
D	Diesel engine, longitudinal installation
20	2.0 litre displacement
C	First technical revision EURO 5

2.3. Modifications

System	Remarks
Engine mechanics	• Optimised crankcase • Changed cylinder head • New connecting rod and piston
Belt drive	• New assembly carrier with axial mounting of the assembly
Oil supply	• New oil filter module with integrated transmission fluid-to-coolant heat exchanger
Intake plenum	• Adaptation of the intake silencer to modified geometry and integration of the snow valve and drainage line for water
Exhaust emission system	• Exhaust-gas recirculation revised
Fuel preparation	• Revised high pressure pump CP4.1 TU • New solenoid injectors with up to 1800 bar fuel pressure
Engine electrical system	• New sensors and modified control unit

N47TU Engine.
3. Engine mechanics.

3.1. Crankcase

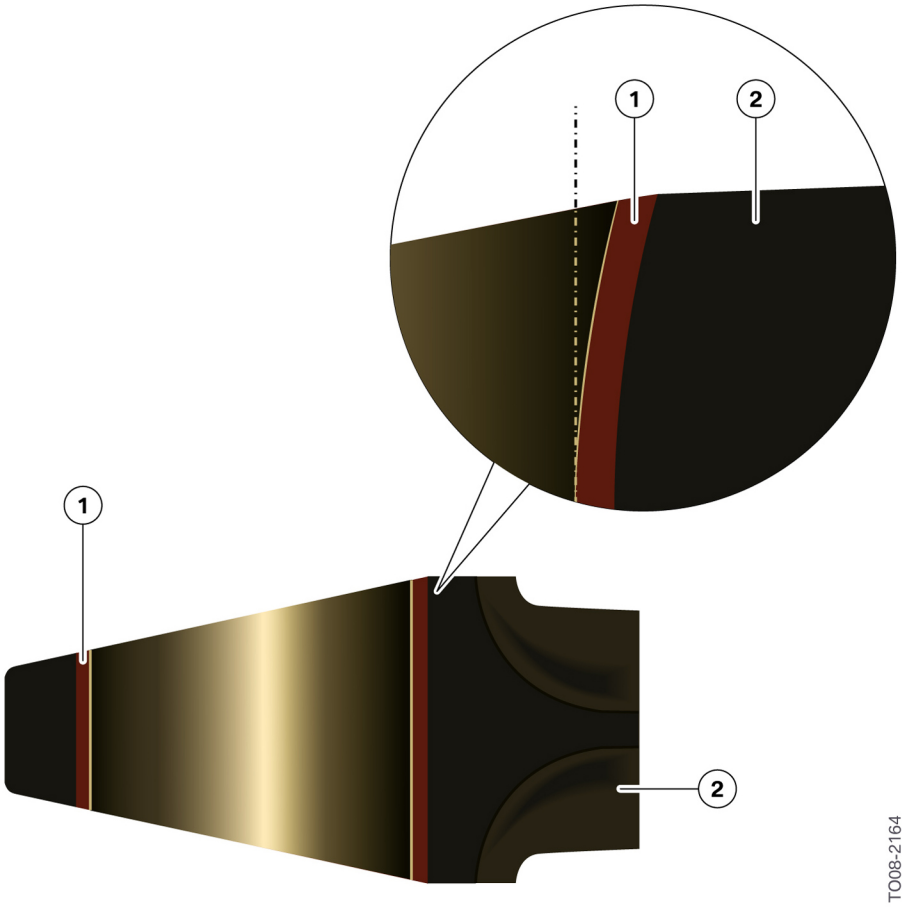
The aluminium crankcase of the N47TU engine is a new design, based on the crankcase of the N47 engine. New requirementssuch as additional connection points for engine supports, new positioningof the oil pressure switch and a new media routing for the supply of the oil module made these new designs necessary. In addition, highly loaded areas were also strength optimised for increasing loads due to increases in performance for the engine family, using comprehensive simulations through detail and geometry modifications. The oil filter module is new and will also be again found in other subsequent-diesel engines. More information available under oil supply.

3.2. Pistons

The pistons are adapted to the new requirements. Thus the combustion chamber is always adapted to the injectors.

3.3. Connecting rods

In the two different connecting rods are used, depending on the power stage. The connecting rod of the engine has a gauge of 138 mm. A new connecting rod was designed for the and engines with a gauge of 143 mm. The shaped hole in the small connecting rod eye is a special characteristic. Through these shaped holes, the force acting from the pistons via gudgeon pins is optimally distributed over the sleeve surface and reduces the edge load.

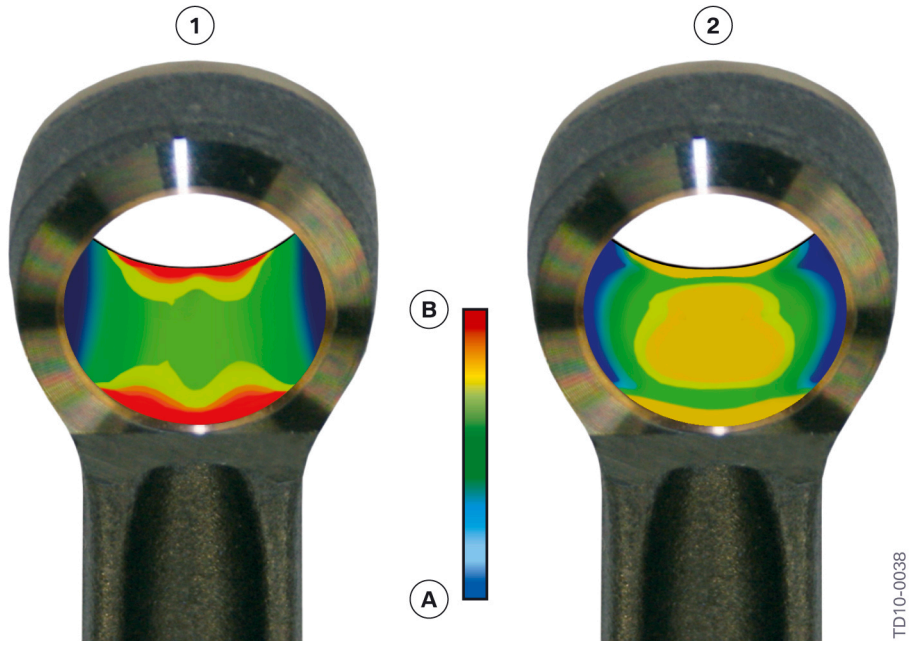


engine, no connecting rod eye

Index	Explanation
1	Bush
2	Connecting rods

The following illustrations show the surface load on the left side for a connecting rod without a shaped hole. By the pressure on the pistons, the force is transferred via the gudgeon pins primarily on the edges of the bush of the small connecting rod eye.

If a shaped hole is made in the small connecting rod eye (right illustration), then the force is distributed on a larger area and the loadon the edge of the sleeve is reduced significantly. The force is then transferredover a larger surface.



engine, no connecting rod eye

Index	Explanation
A	Low surface load
B	High surface load
1	Without shaped hole
2	With shaped hole

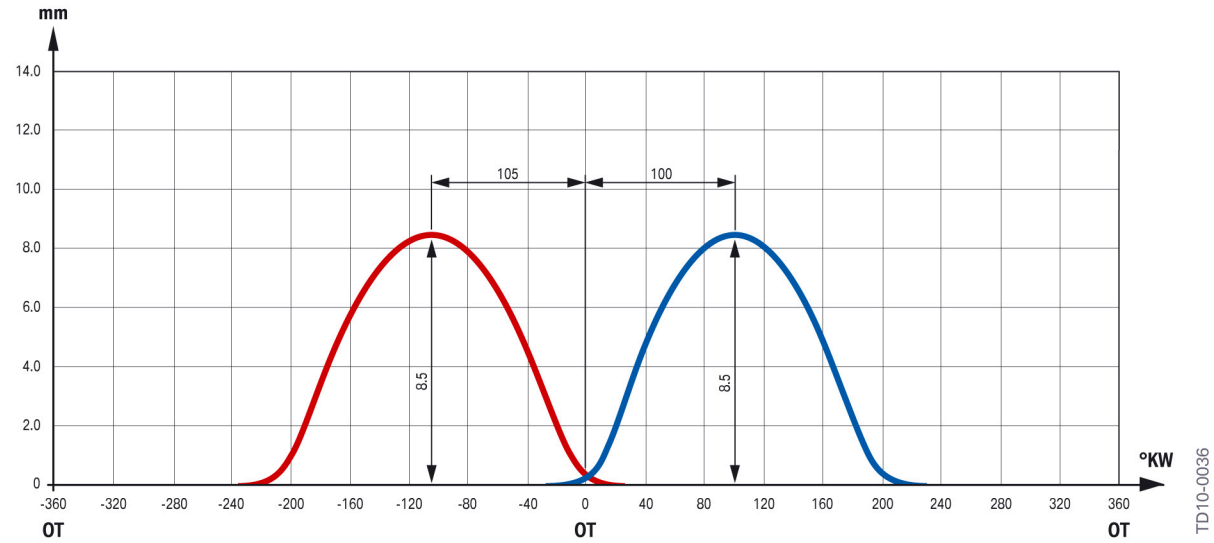
3.4. Valve gear

3.4.1. Timing

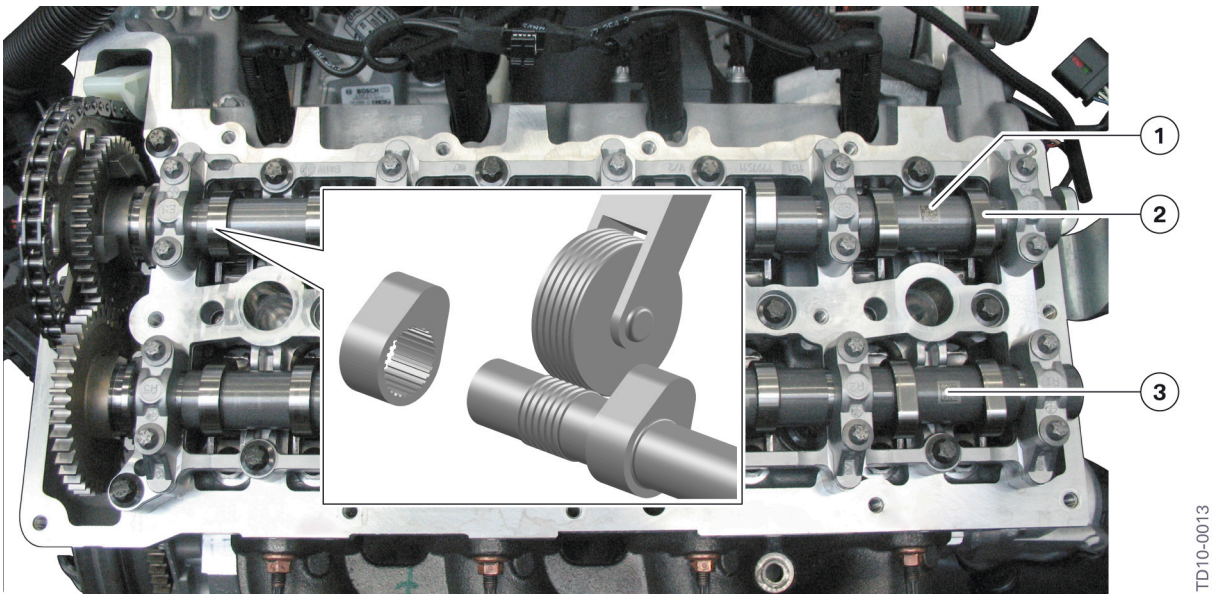
The timing of the engine was modified. The camshaftsare correspondingly new. The discharge valves are also new.

		N47 intake	N47 intake	N47 exhaust	N47 exhaust
Valve diameter	[mm]	27.2	27.2	24.6	24.6
Max. valve lift	[mm]	7.5	8.5	8.0	8.5
Spread	[°KW]	100	100	108	105
Valve opens	[°KW]	352.0	352.4	140.7	140.7
Valve closes	[°KW]	568.0	567.1	362.5	363.9
Valve opening period	[°KW]	216.0	214.7	221.8	223.1

N47TU Engine.
3. Engine mechanics.



N47TU engine, timing diagram



N47TU engine, cylinder head with attached camshafts

Index	Explanation
1	Intake camshaft
2	Cam
3	Exhaust camshaft

As seen in the graph, the known installed camshafts from the N47 engine are used.

N47TU Engine.

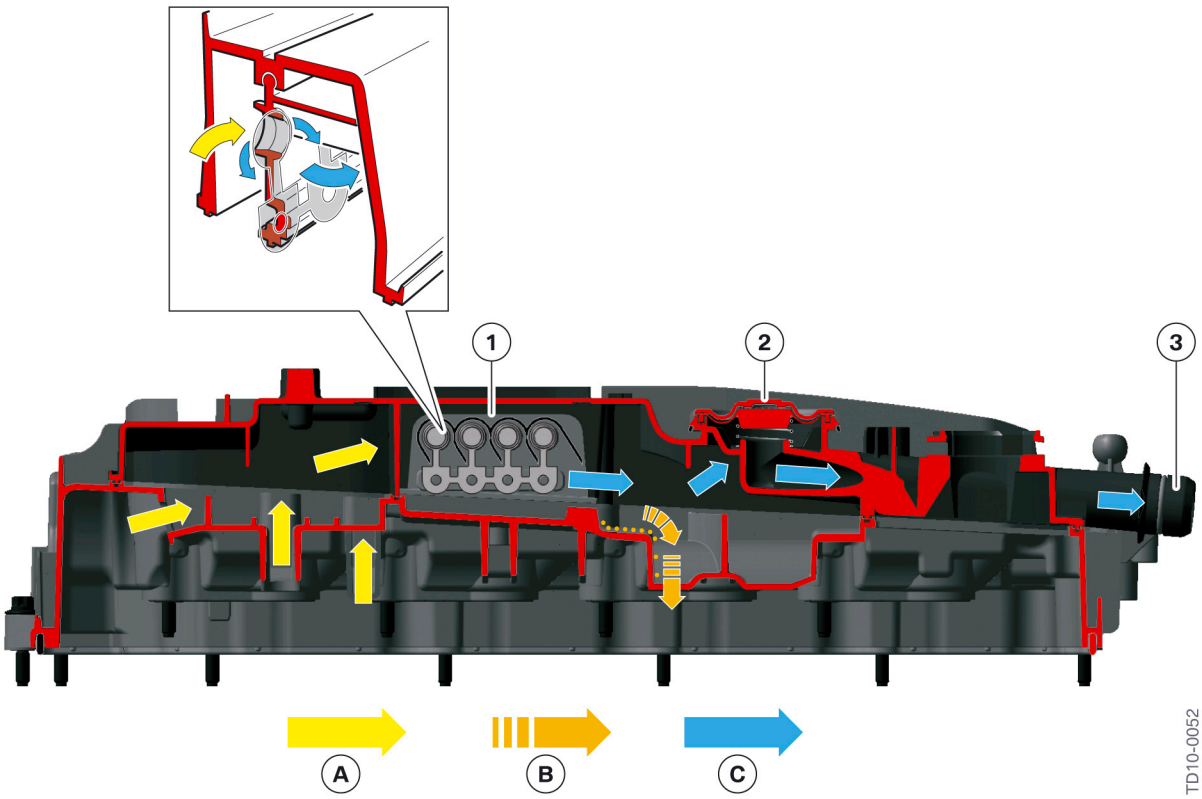
3. Engine mechanics.

3.5. Crankcase ventilation

The crankcase ventilation function was taken over from the engine.N57. Thus the so-called "spring tongues" are now used, as they are already in the engine. There are four of these installed in the engine. The blow-by gases cleaned from oil end up finally via the pressure control valvein the clean air pipe in front of the exhaust turbocharger.

The engine is equipped with a vacuum controlled crankcase ventilation. A vacuum of approx. 38 mbar is regulated. Prestressed spring tongues made of metal (so-called gap separator)regulate the speed of the air mass flow and thus ensure with this an optimum oil separation of blow-by gas in every operating point.. A vacuum exists in the clean air pipe due to the suction power of the exhaust turbocharger. The blow-by gas is sucked into the cylinder head due to the pressure difference to the crankcase.

The blow-by gas ends up first in the calming chamber of the cylinder head. The calming chamber makes sure that no oil spray, e.g. from thecamshafts, gets into the crankcase ventilation. A first preseparation is done already in the calmingchamber. The oil that coats the walls there, flows back into the cylinder head. The blow-by gasflows from the calming chamber to the spring tongue separator. These spring tongues are pressed down by the blow-by gas flow and the blow-by gas can then flow by. Since the opening cross-section is relatively small,the blow-by gas flowing by is strongly accelerated. The blow-by gasis finally diverted by approx. 180 ° whereby the liquid contained in the blow-by gasis hurled on the surrounding walls and flows along these via a bore hole back into the oil sump. Depending on the blow-by gas quantity the spring tongues are opened more or lessstrongly, whereby there is an optimum oil separation independent of blow-by gas volume flow. The separation quality in all operating conditions can be increased with the spring tongue separator, especially with low blow-by gas volume flow. The cleaned blow-by gasthrough the pressure control valve into the clean air pipe in front of the exhaust turbocharger.

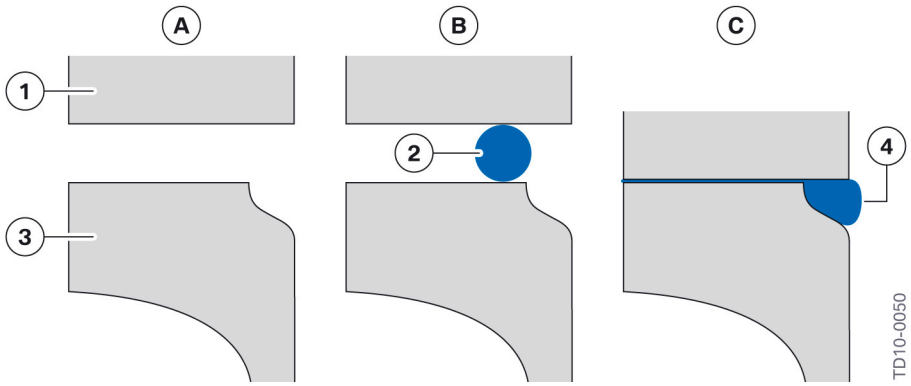


N47TU engine, timing diagram

Index	Explanation
A	Blow-by gas mixed with oil
B	Oil drips
C	Blow-by gas cleaned of oil
1	Spring tongue separator
2	Pressure control valve
3	Blow-by gas inlet to clean air pipe

3.6. Oil sump

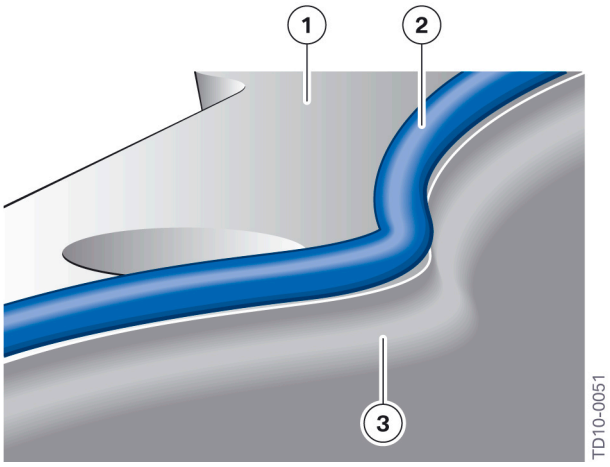
The gasket of the oil sump of the engine will be converted step-by-step from the metal elastomer gasket to a silicone Loctite gasket 5970. The oil sump must be adapted for the silicone gasket. This is recognised by the chamfer located on the inside of the flange, which serves as a defined reservoir for the excess silicone.



Schematic diagram of oil sump gasket

Index	Explanation
A	Components without silicone bead
B	Components with silicone bead
C	Components screwed with silicone gasket
1	Crankcase
2	Silicone bead
3	Oil sump with chamfer
4	Silicone exit through the screwed connection in the prepared space in the oil sump

A chamfer is necessary with a surface gasket so that excesssealing compound can accumulate in the space prepared in a controlled manner, where it can not be dissolved later by the oil plunging.



Positioning of the silicone bead

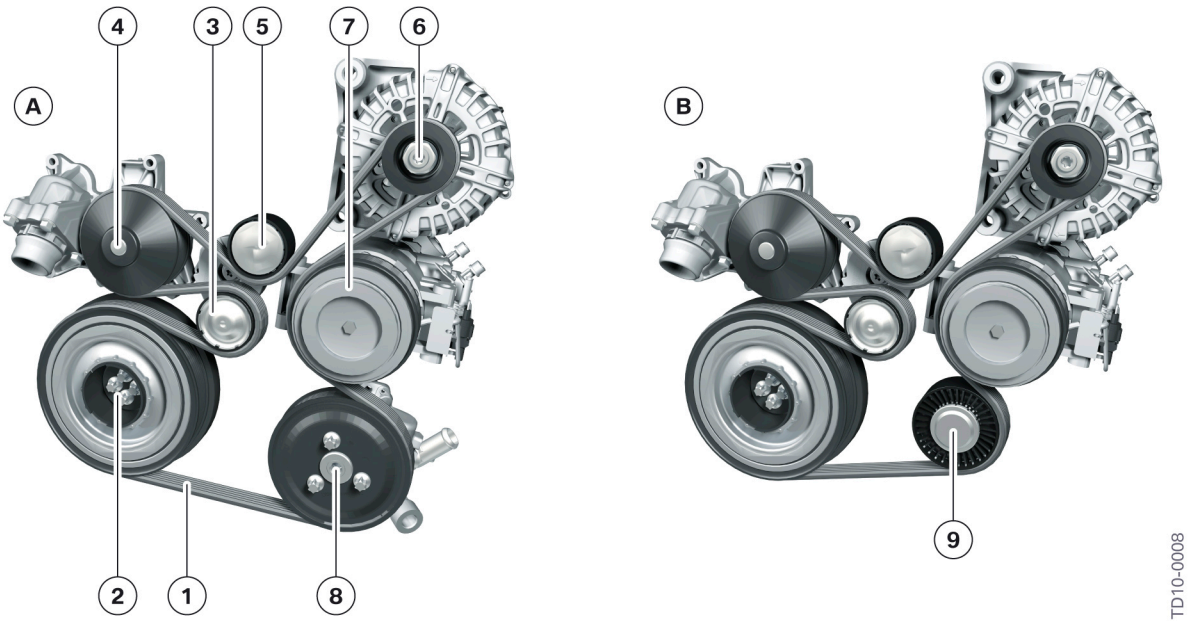
Index	Explanation
1	Oil sump sealing surface
2	Silicone bead
3	Chamfer on the inside of the oil sump

For perfect tightness in the case of service, the repair instructions must be followed exactly.

N47TU Engine.
4. Belt drive.

The arrangement of the belt drive and the assembly was revised.

4.1. N47TU Engine.

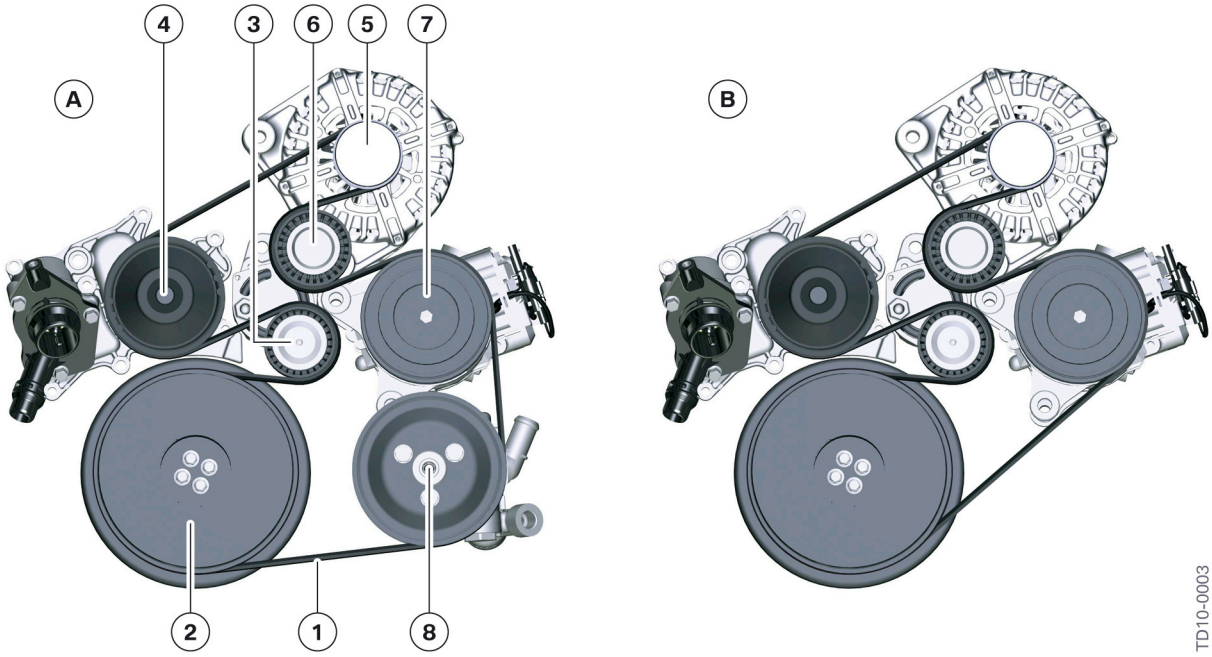


engine, belt drive variants

Index	Explanation
A	With air conditioning system and hydraulic steering
B	With air conditioning system and electromechanical power steering
1	Double-sided poly-V belt
2	Torsional vibration damper
3	Tensioning pulley
4	Coolant pump
5	Deflecting roller
6	Alternator
7	Air conditioning compressor
8	Power steering pump
9	Deflecting roller

N47TU Engine.
4. Belt drive.

4.2. N47TU Engine.



engine, belt drive variants

Index	Explanation
A	With hydraulic steering
B	Without hydraulic steering
1	Single-sided poly-V belts
2	Torsional vibration damper
3	Tensioning pulley
4	Coolant pump
5	Alternator
6	Deflecting roller
7	Air conditioning compressor
8	Power steering pump

The component carrier with optimised connection on crankcaseis also new. Based on the modification of the differentiated air intake system intaketowards the front of the engine, the assembly must be moved downwards. Due to moving downwards, the packaging space for the belt tensionerand the assembly became tighter.

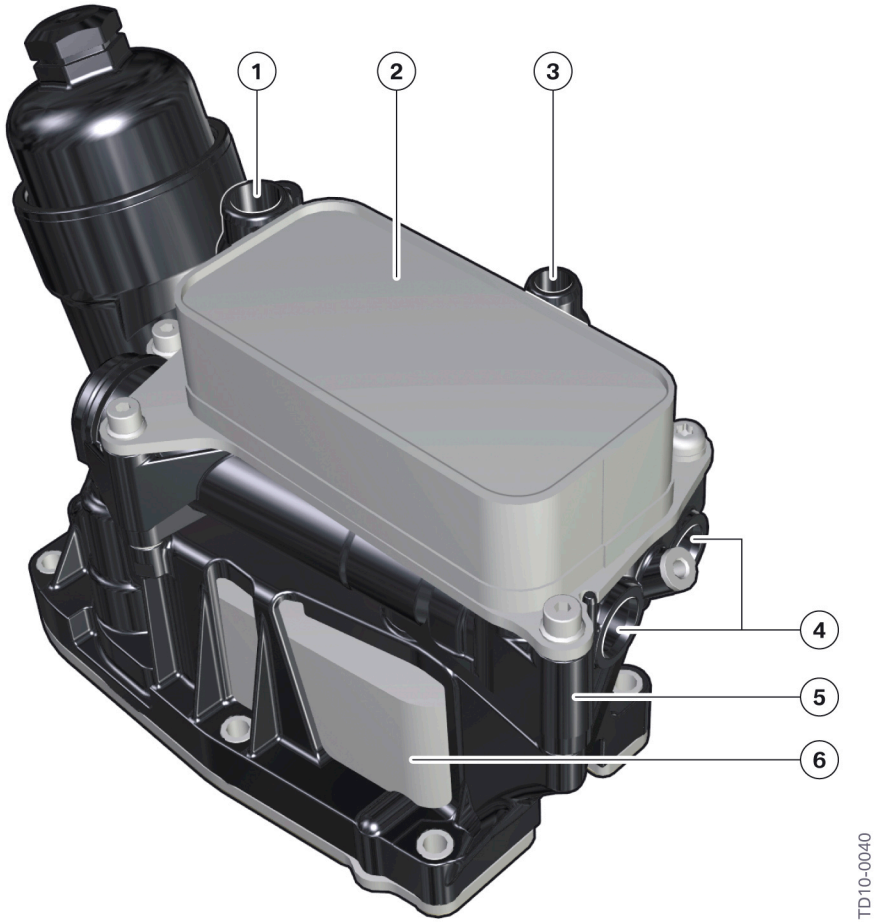
The direction of rotation of the air conditioning compressor is also reversed by these modifications. The deflecting roller is mounted on the belt tensioner. The belt tensioner requires a hexagon head for locking and unlocking. The belt guide is new due to these modifications and the belts bear only on one side. The belt tensioning force can also be reduced to approx. 100 N. The alternator has a belt pulley freewheel for reduction of belt squealing when starting the engine.

N47TU Engine.

5. Oil supply.

5.1. Oil filter module

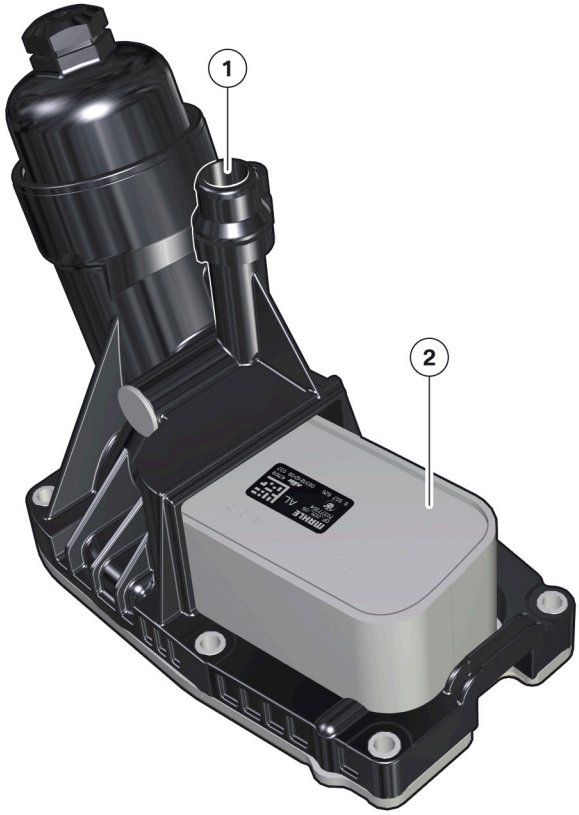
The road to common parts is completed with the oil filter module. Thus this module is again found even in future diesel engines. The difference to other engine versions is then shownonly by the different engine oil-to-coolant heat exchangers or transmission fluid-to-coolant heat exchangers in the oil filter module. The housing with all valves, filter elements, gaskets and retaining elements is the same. In addition the transmission fluid-to-coolant heat exchanger is integrated for the first time.



engine, oil filter module with transmission fluid-to-coolant heat exchanger

Index	Explanation
1	Connecting branch for heater return
2	Transmission fluid-to-coolant heat exchanger
3	Coolant connection from radiator
4	Connection for transmission oil lines
5	Oil filter module housing
6	Engine oil-to-coolant heat exchanger

N47TU Engine.
5. Oil supply.



engine, belt drive variants

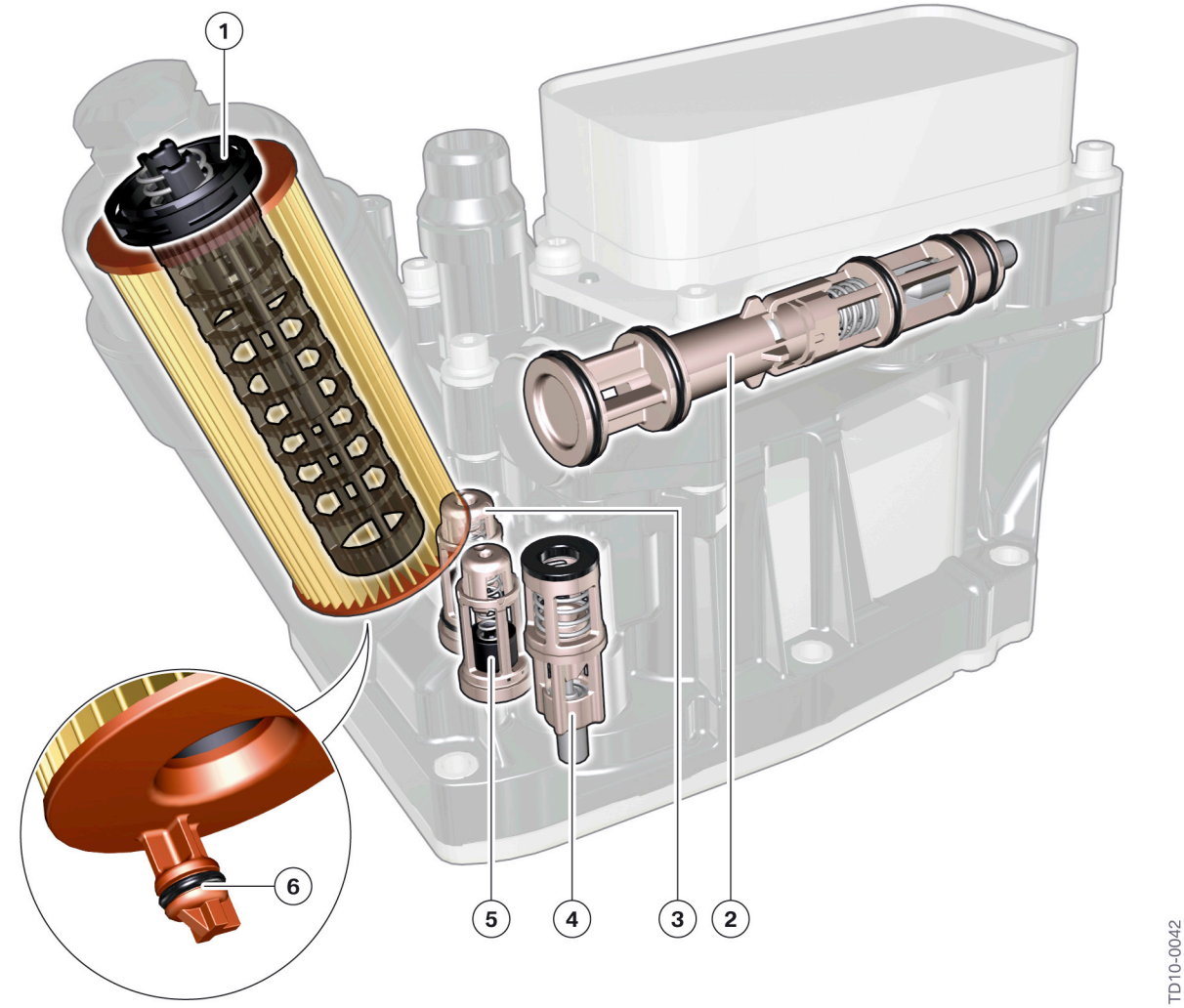
Index	Explanation
1	Connecting branch for heater return
2	Engine oil-to-coolant heat exchanger

5.1.1. Transmission oil cooling

With automatic transmission vehicles, the transmission fluid coolingis used. Comprehensive modifications were made on the transmission fluid cooling, which will be described in detail in the following.

N47TU Engine.

5. Oil supply.



engine, valves and thermostats

Index	Explanation
1	Filter by-pass valve
2	Thermostat for transmission fluid cooling
3	Non-return valve
4	Heat generator thermostat for transmission fluid
5	Heat exchanger by-pass valve
6	Discharge valve

Filter by-pass valve

The filter by-pass valve ensures that with a plugged filter, the engine oil gets to the lubrication points of the engine. It opens before and after the oil filter at a differential pressure of 2.5 bar ± 0.3 bar.

N47TU Engine.
5. Oil supply.

Thermostat for transmission fluid

A thermostat for the transmission fluid temperature control is also integrated in the oil filter module. Transmission fluid flows through the thermostat for transmission oil. Transmission fluid flows through the thermostat for transmission oil. If the temperature of the transmission oil increases to >≥ 88 °C, the thermostat for transmission fluid opens and releases the coolant flow from the low temperature cooler of the cooling system in the transmission fluid-to-coolant heat exchanger. Simultaneously the thermostat for transmission oil closes the cooling circuit from the cylinder crankcase via the heat generator thermostat for transmission fluid. The transmission fluid will now be cooled.

Non-return valve

The non-return valve that the engine oil channels and the oil filter housing does not run empty during engine standstill. It opens the inlet from the oil pump at 0.1 bar ± 0.03 bar.

Heat generator thermostat for transmission fluid

An important new feature is the heat generator thermostat integrated in the oil filter housing for faster heating up of the transmission fluid. The heat generator thermostat for transmission fluid is closed up to a coolant temperature of the engine of < 80 °C. A coolant flow does not take place through the transmission fluid-to-coolant heat exchanger.

If the coolant temperature of the engine reaches ≥ 80 °C, then theheat generator thermostat for transmission fluid opens and releases the coolant flow from the engine via the thermostat for transmission fluid.

Advantages for the transmission:

- Is heated up with excess engine heat
- Faster warm-up
- Lower friction loss
- A better shifting comfort is available faster.

Heat exchanger by-pass valve

The heat exchanger by-pass valve has the same function as the filter by-pass valve If the oil pressure increases because of a plugged oil-to-coolant heat exchanger, the heat exchanger by-pass valve opens at a pressure of 2.5 ± 0.3 bar and the lubricating oil can get to the lubricating points uncooled.

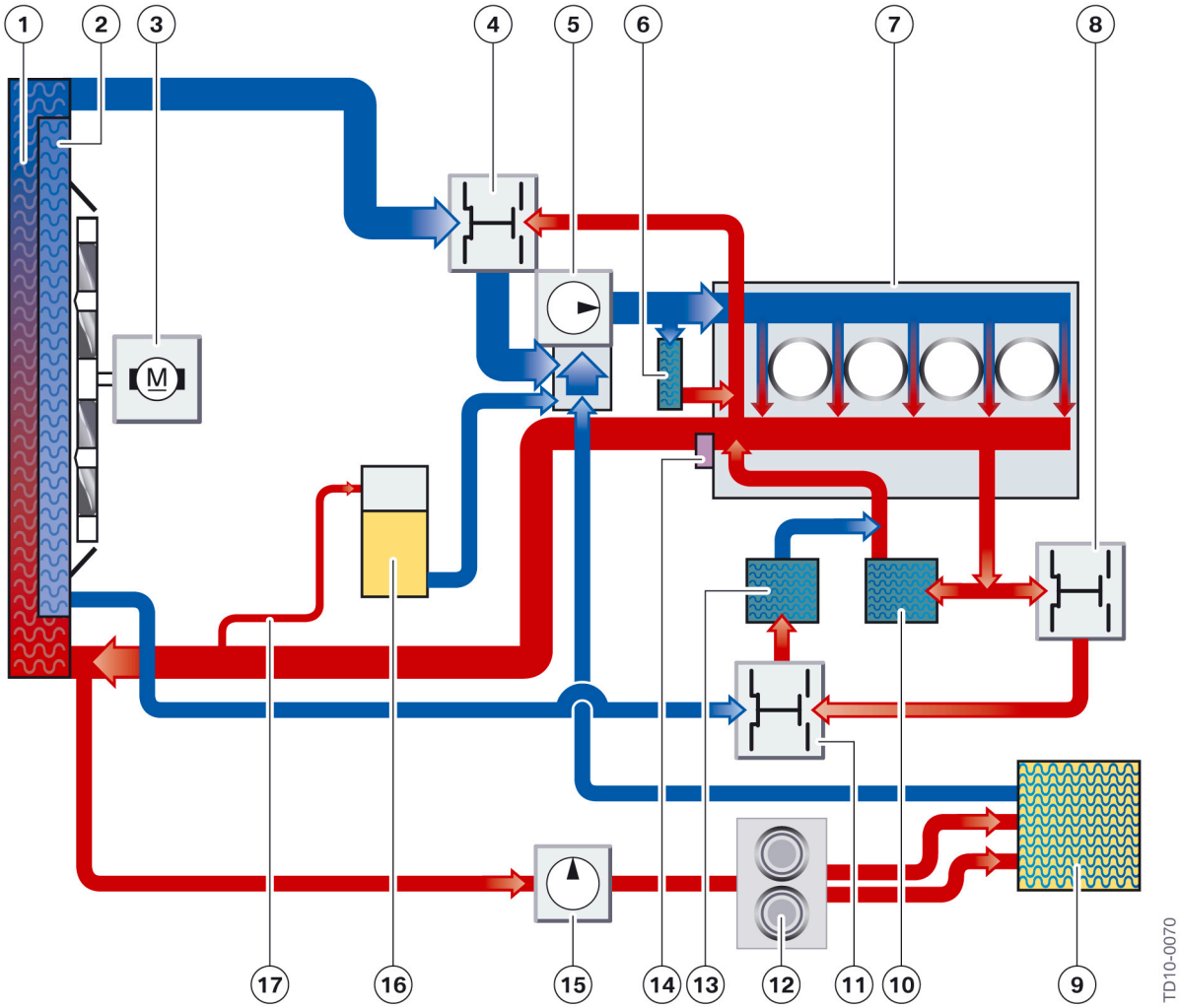
Discharge valve

The discharge valve is integrated in the oil filter and is replaced when the oil filter is replaced.

N47TU Engine.

5. Oil supply.

Function of the cooling circuit



engine, belt drive variants

Index	Explanation
1	Radiator
2	Radiator low temperature range
3	Electric fan
4	Thermostat
5	Coolant pump
6	Exhaust-gas recirculation cooler
7	Engine housing
8	Heat generator thermostat for transmission fluid
9	Heater matrix
10	Engine oil-to-coolant heat exchanger

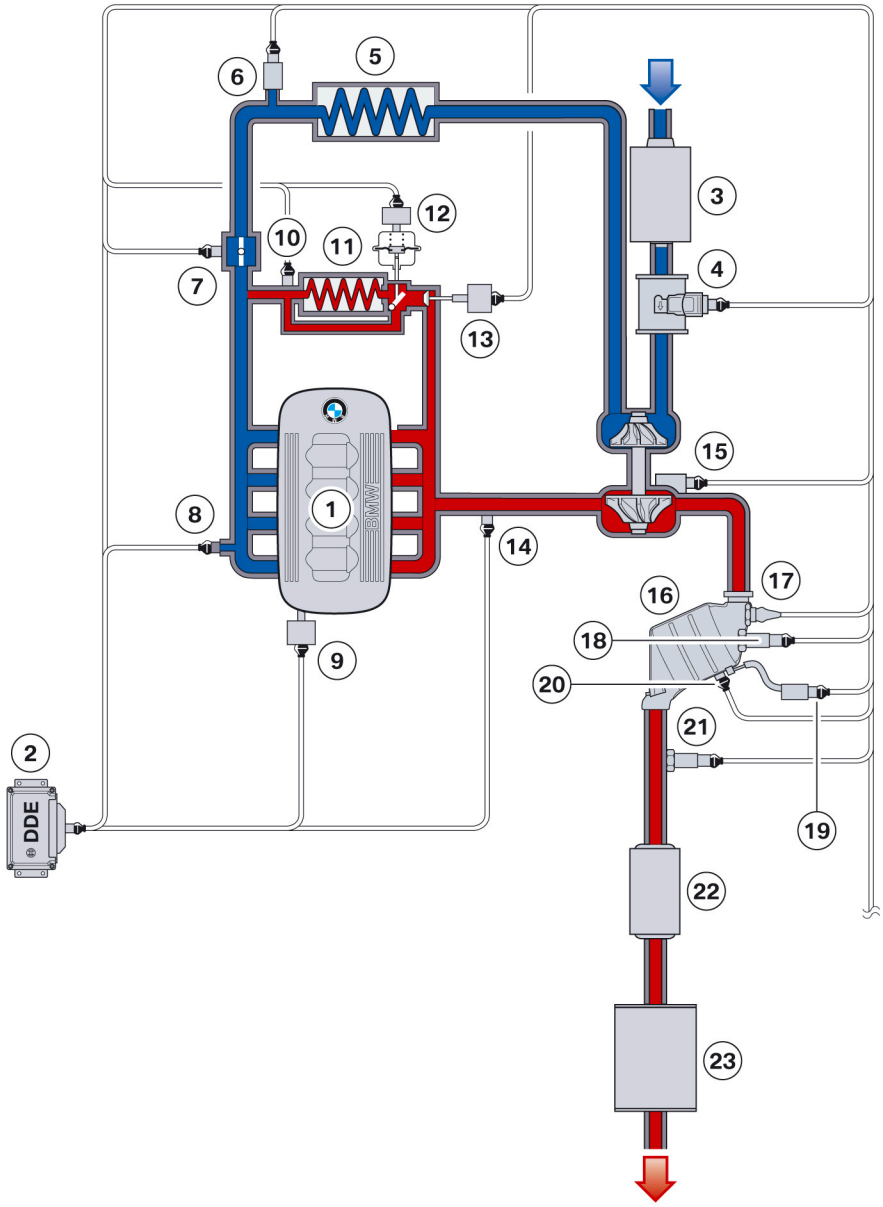
N47TU Engine.
5. Oil supply.

Index	Explanation
11	Thermostat for transmission fluid
12	Coolant valve
13	Transmission fluid-to-coolant heat exchanger
14	Coolant temperature sensor
15	Auxiliary water pump
16	Expansion tank
17	Ventilation line

N47TU Engine.

6. Intake and exhaust emission system.

The basic design of the intake and exhaust emission system is very similar to the previous system. However, there are very comprehensive modifications.



engine, intake air and exhaust emission system with EURO 6 in the ##

Index	Explanation
1	N47TU Engine.
2	Digital Diesel Electronics
3	Intake silencer
4	Hot film air mass meter
5	Charge air cooler

N47TU Engine.
6. Intake and exhaust emission system.

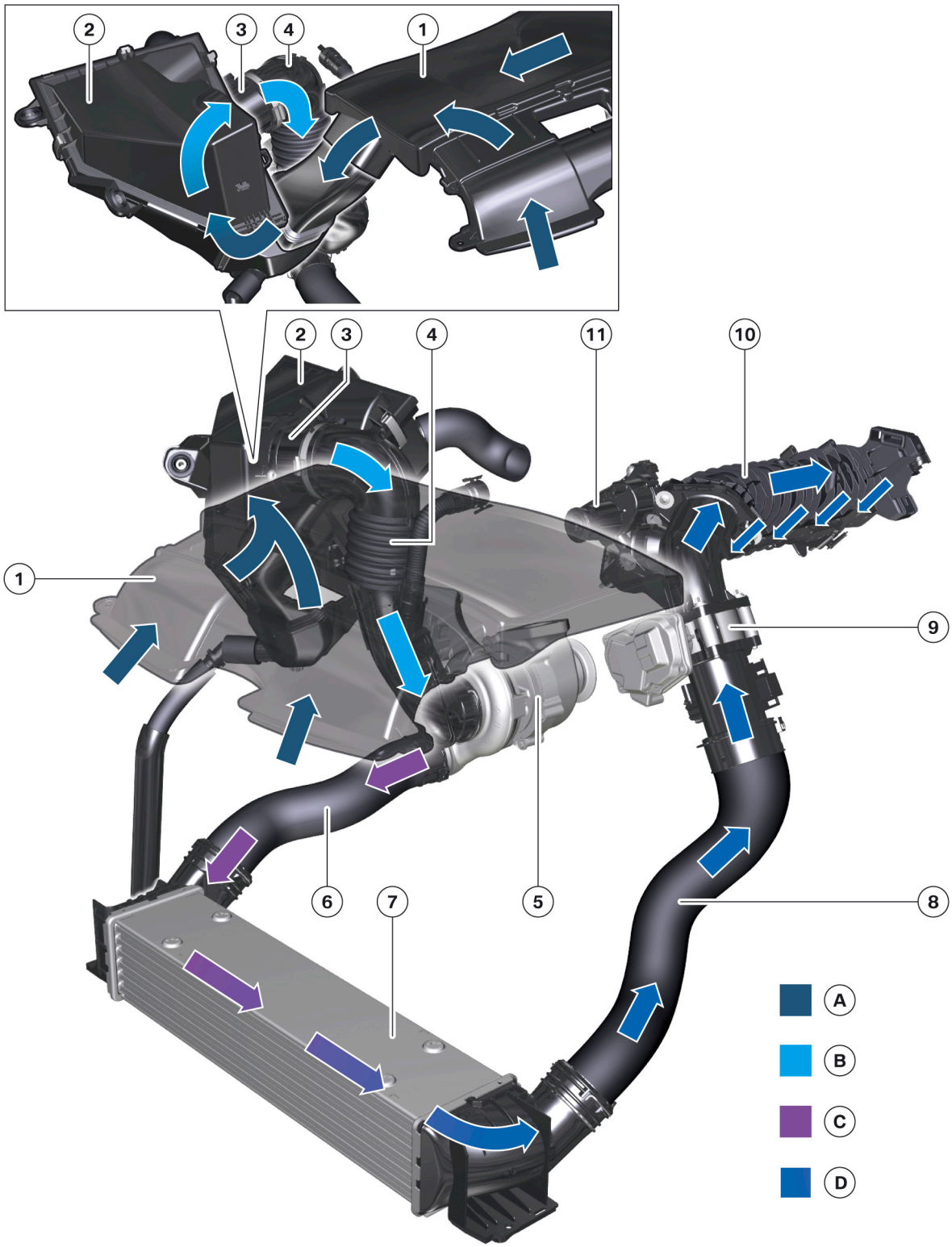
Index	Explanation
6	Charge-air temperature sensor
7	Throttle valve
8	Charging pressure sensor
9	Swirl-flap actuator
10	Exhaust-gas recirculation temperature sensor
11	Exhaust-gas recirculation cooler
12	Bypass plate
13	Exhaust-gas recirculation valve with position sensor
14	Exhaust backpressure sensor before the exhaust turbocharger
15	Charging pressure actuator
16	NO_x storage catalytic converter and diesel particle filter (for EURO 5, oxidation catalytic converter and diesel particle filter)
17	Exhaust-gas temperature sensor before NO_x storage catalytic converter (forEURO 5, exhaust-gas temperature sensor before the oxidation catalytic converter)
18	Oxygen sensor before the NO_x storage catalytic converter (for EURO 5,oxygen sensor before oxidation catalytic converter)
19	Exhaust backpressure sensor after NO_x storage catalytic converter (forEURO 5, exhaust backpressure sensor after oxidation catalytic converter)
20	Exhaust-gas temperature sensor after NO_x storage catalytic converter(not present for EURO 5)
21	Oxygen sensor after diesel particle filter (not present for EURO 5)
22	H_2S-trap catalytic converter (for EURO 5, centre silencer)
23	Rear silencer

6.1. Intake plenum

The intake plenum was modified most noticeably. Now the throttle valve sits forward on the engine. Through the modification of the intake plenum,the line length could be reduced, since the charge air from the charge air cooleris now fed directly forward on the engine via the throttle valve (2) and the mixing tube(3) in the differentiated air intake system (4).

N47TU Engine.

6. Intake and exhaust emission system.



N47TU engine, intake plenum

N47TU Engine.
6. Intake and exhaust emission system.

Index	Explanation
A	Raw air
B	Clean air
C	Warmed charge air
D	Cooled charge air
1	Intake snorkel
2	Intake silencer
3	Hot film air mass meter
4	Clean air pipe
5	Exhaust turbocharger
6	Charge air pipe
7	Charge air cooler
8	Charge air pipe
9	Throttle valve
10	Differentiated air intake system
11	Swirl-flap actuator

6.1.1. Intake silencer

The intake silencer is a new part. A snow valve and a drainage line for water is integrated in the intake silencer.

N47TU Engine.

6. Intake and exhaust emission system.

N47TU engine, timing diagram

Index	Explanation
1	Intake silencer
2	Snow valve
3	Drainage line for water

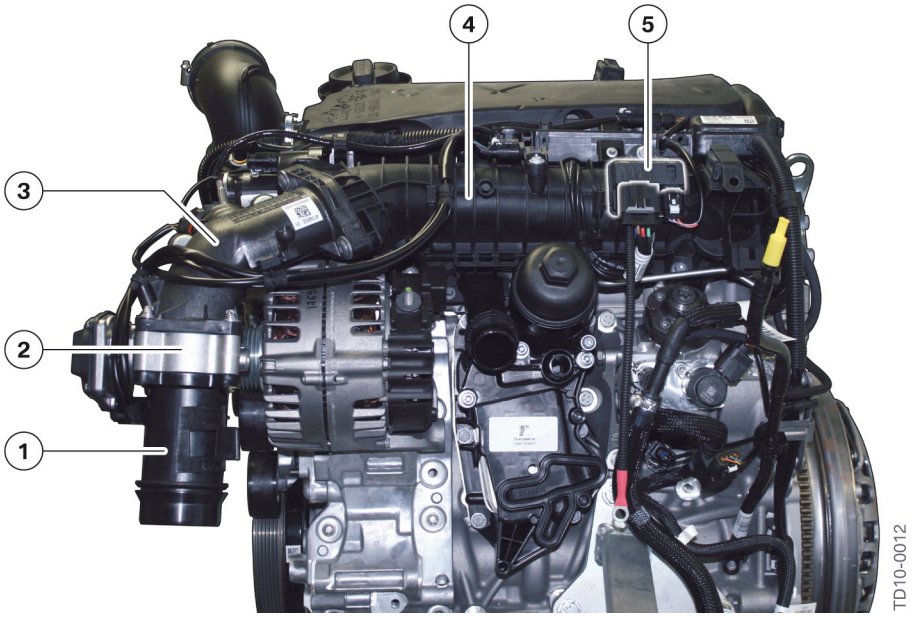
Snow valve

The snow valve is opened by a vacuum in the intake silencerand enables fresh air supply even with ice and snow clogged intake openings in the radiator grille.

Drainage line for water

During strong rainfall or spray water loading, also some spray water is drawn in. So that the spray water does not collect in the intake silencer, a drainage line for water is integrated in the bottom of the intake silencer. The water can flow out via the drainage line from the intake silencer. So that no air or water can be drawn in via the drainage line when there is a vacuum in the intake silencer, this is closed at the lower end with a diaphragm valve.

6.1.2. Differentiated air intake system



N47TU engine, intake plenum

Index	Explanation
1	Charge air pipe
2	Throttle valve
3	Mixing tube
4	Differentiated air intake system
5	Preheating control unit

The differentiated air intake system is a new development to meet the requirements of the modified charge air inlet. Now the exhaust-gas recirculation cooler is now contacted to the differentiated air intake system via a direct connection. With the engine the exhaust-gas recirculation is still fed via the cylinder head in the differentiated air intake system.

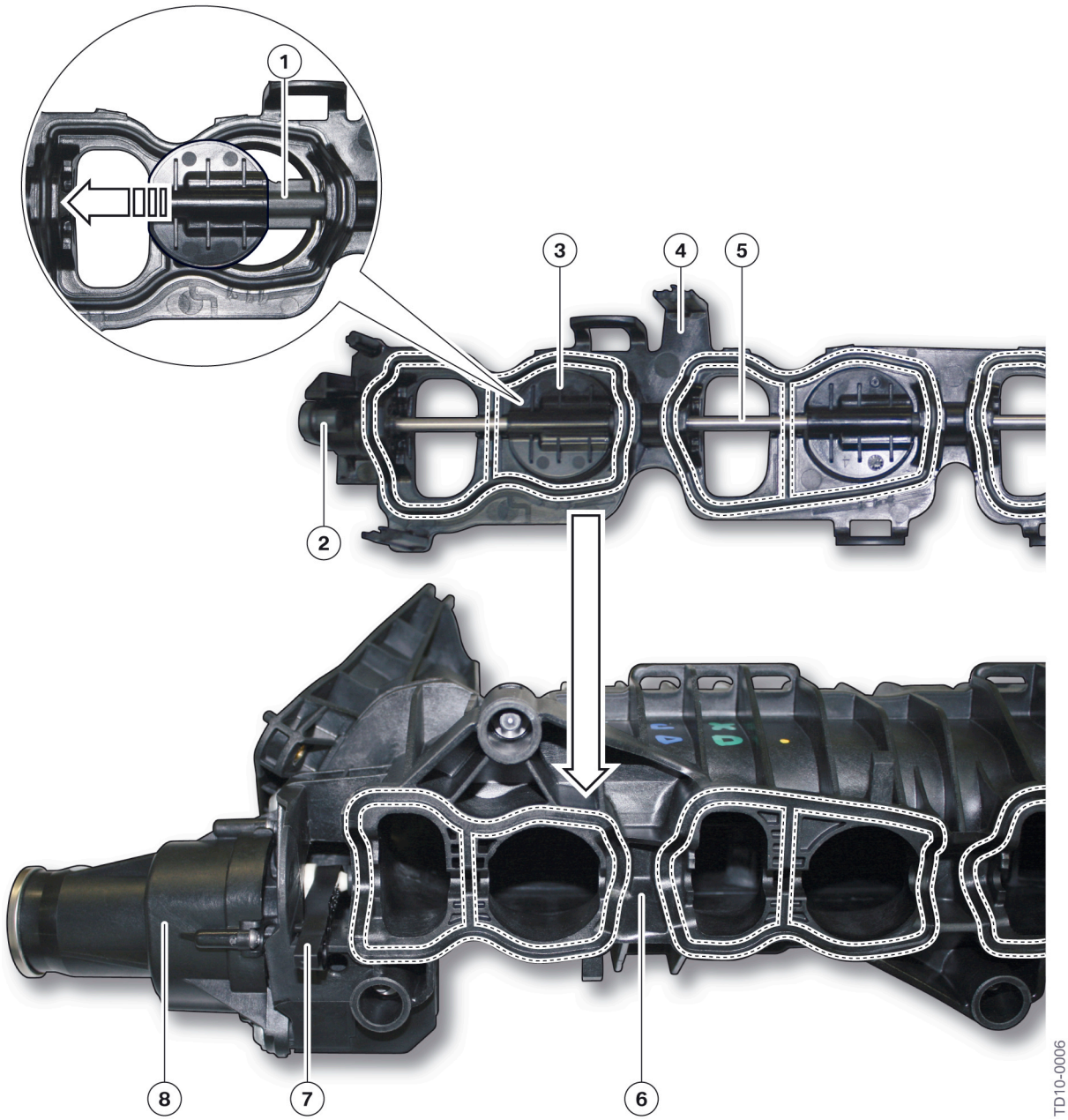
Another modification effects the swirl flaps. The swirl flaps were previously integrated in the differentiated air intake system. In the case of faults or damage of the swirl flaps or the swirl flap mechanism the entire differentiated air intake system had to be replaced.

The swirl flaps are now integrated in the gasket between the differentiated air intake systemand the cylinder head. The gasket is designed in three-dimensions and is clipped onto the differentiated air intake system.

N47TU Engine.

6. Intake and exhaust emission system.

When installing the gasket the swirl flaps must be in the correct position, since otherwise these will be damaged during the mounting of the intake plenum on the cylinder head.



N47TU enginedifferentiated air intake system with gasket

Index	Explanation
1	Flap support (visible when the loose swirl flap is moved)
2	Lever
3	Swirl-flap
4	Gasket support
5	Shaft
6	Differentiated air intake system
7	Connection lever
8	Swirl-flap actuator

6.2. Exhaust emission system

6.2.1. Exhaust turbocharger

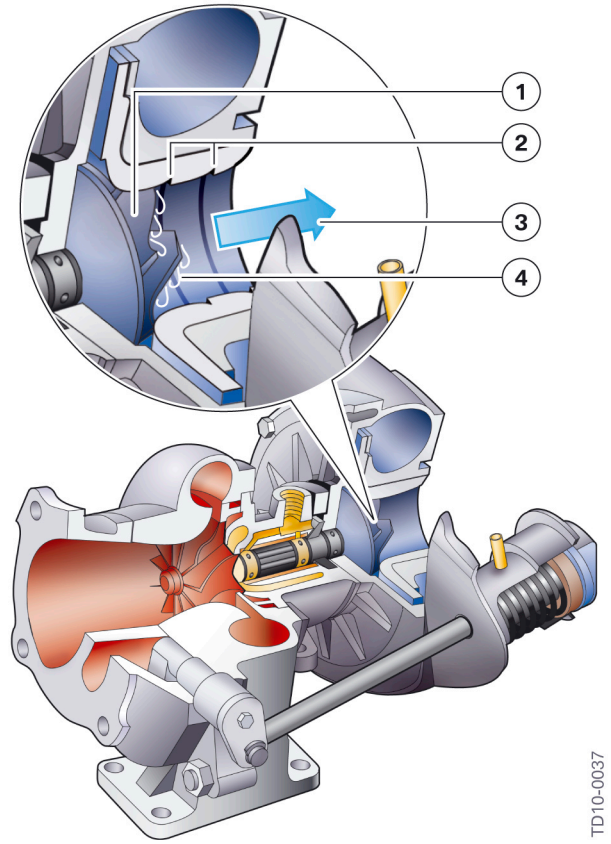
A new exhaust turbocharger with modifications on the intake sidesupplements the adaptations of the engine. Thus the behaviour on the surge limit and the charging pressure control is optimised.

Fresh air inlet

One of the physical limits of an exhaust turbocharger is the surge limit. This is reached if the flow loosens from the compressor blades (3) with too low volumetric flow and too high pressure ratio. The delivery is interrupted by this. The air flows based on the vacuum on the intake side reverse through the compressor (2), until a stable pressure ratio is adjusted and the air again flows forwards. So-called "nuclei" in the exhaust turbocharger inlet counteract the "pumping". The "nuclei" have no influence on the normal flow of the intake air.

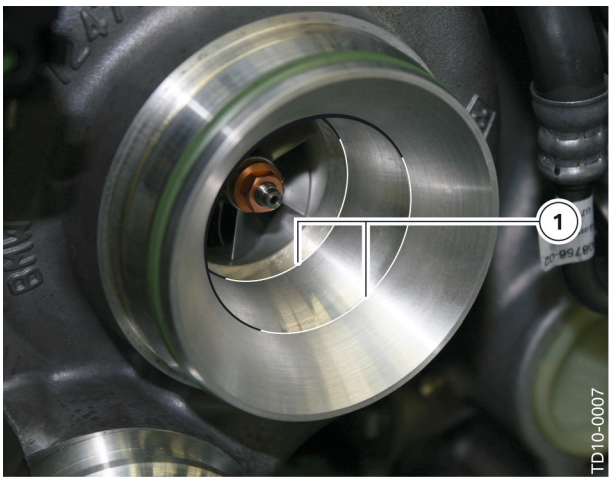
N47TU Engine.

6. Intake and exhaust emission system.



Pumps in the exhaust turbocharger with "nuclei"

Index	Explanation
1	Impeller
2	Nuclei
3	Air flow
4	Stall

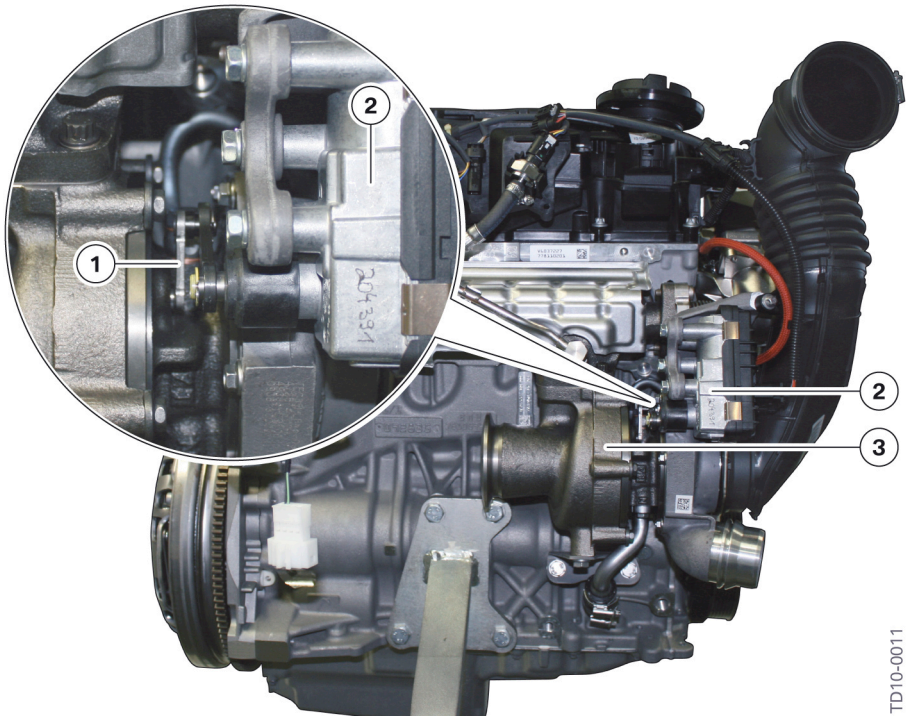


engine, nuclei in exhaust turbocharger inlet fresh air side

Index	Explanation
1	Nuclei

Charging pressure control

The connection of the VNT actuator to the exhaust turbocharger was also revised. The control rod is not designed to be adjustable. The control rod lies on an axis from the adjustment lever for the VNT vanes and the VNT actuator. The tendency for clogging or stiff movement can be reduced to a minimum through this.



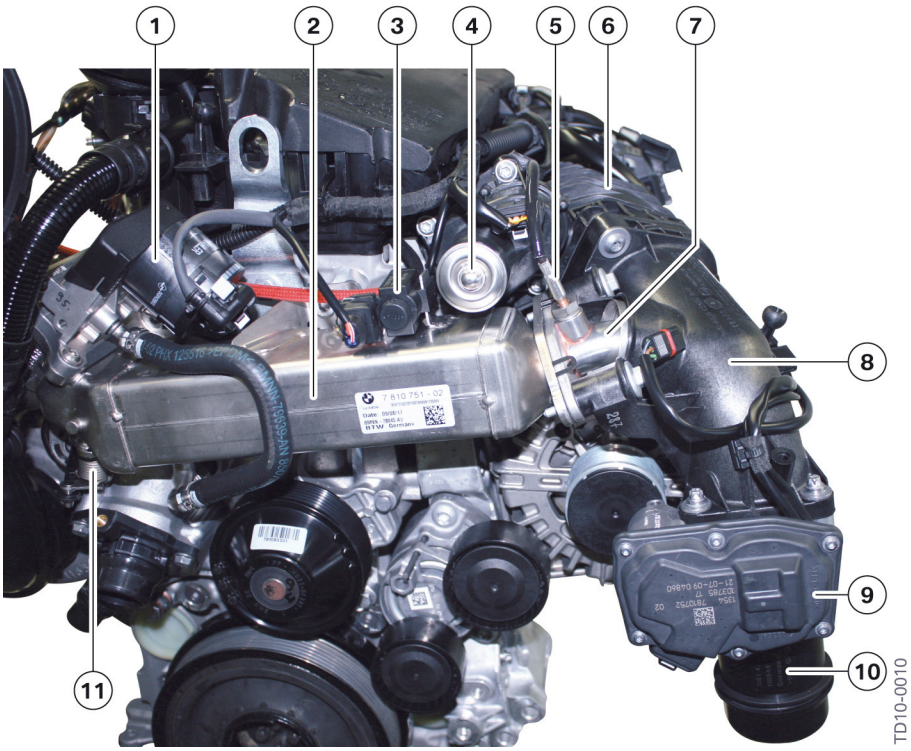
N47TU engine, timing diagram

Index	Explanation
1	Control rod
2	VNT actuator
3	Exhaust turbocharger

N47TU Engine.

6. Intake and exhaust emission system.

6.2.2. Exhaust-gas recirculation



N47TU engine, timing diagram

Index	Explanation
1	Coolant cooled exhaust-gas recirculation valve
2	Exhaust-gas recirculation cooler with integrated bypass
3	Electropneumatic changeover valve for bypass plate
4	Swirl-flap actuator
5	Exhaust-gas recirculation temperature sensor
6	Differentiated air intake system
7	Exhaust-gas recirculation pipe
8	Mixing tube
9	Throttle valve
10	Charge air pipe
11	Bypass plate

The exhaust-gas recirculation was optimised and the geometry adapted. Thus the exhaust will be fed into the differentiated air intake system either cooled or uncooled as it already is with the engine. Feeding into the differentiated air intake system is done via an exhaust-gas recirculation pipe, which extends into the mixing tube and is provided at the end with a plate, so that hot exhaust gas does not damage the mixing tube.

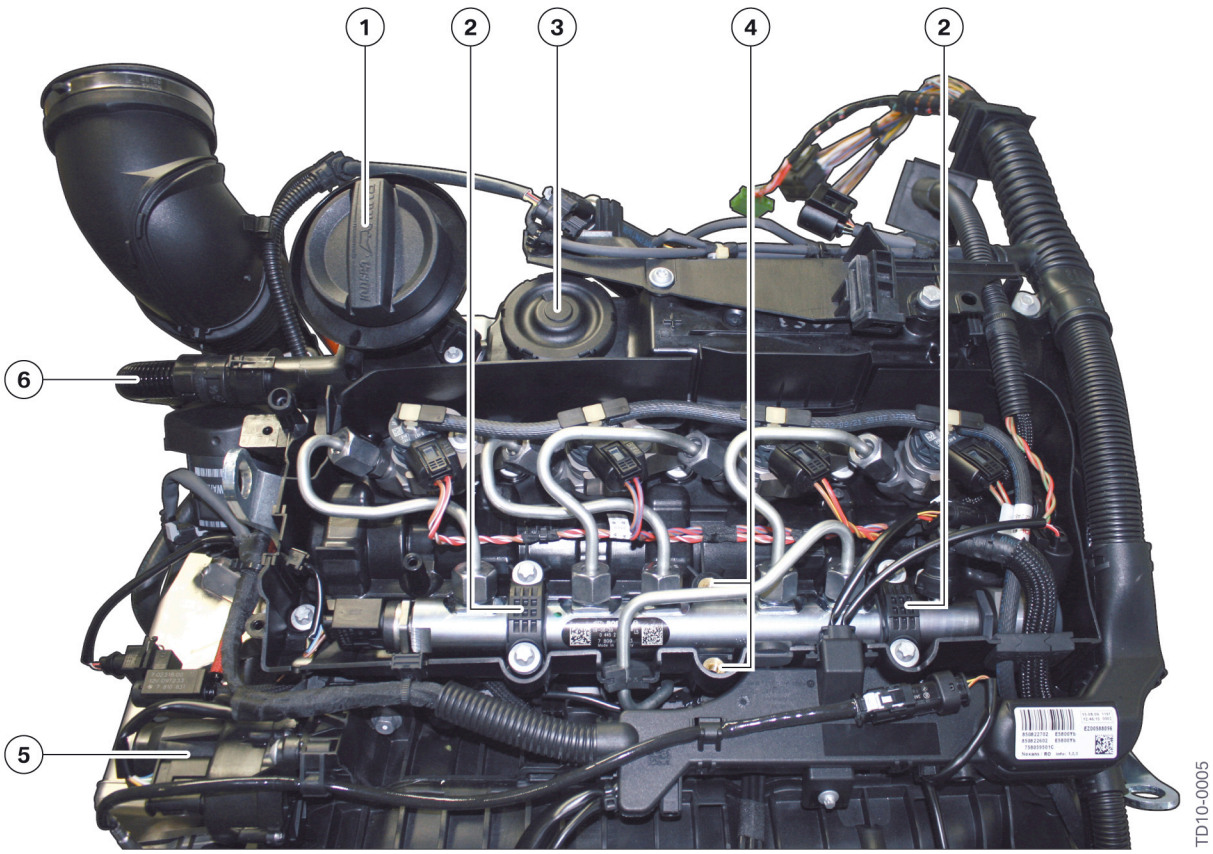
N47TU Engine.

7. Fuel preparation.

The fuel preparation is only slightly adapted. The rail now has only two instead of three brackets,the centre one is omitted.

Other modifications concern:

- Leakage oil line
- High pressure pump
- Injectors.



engine, belt drive variants

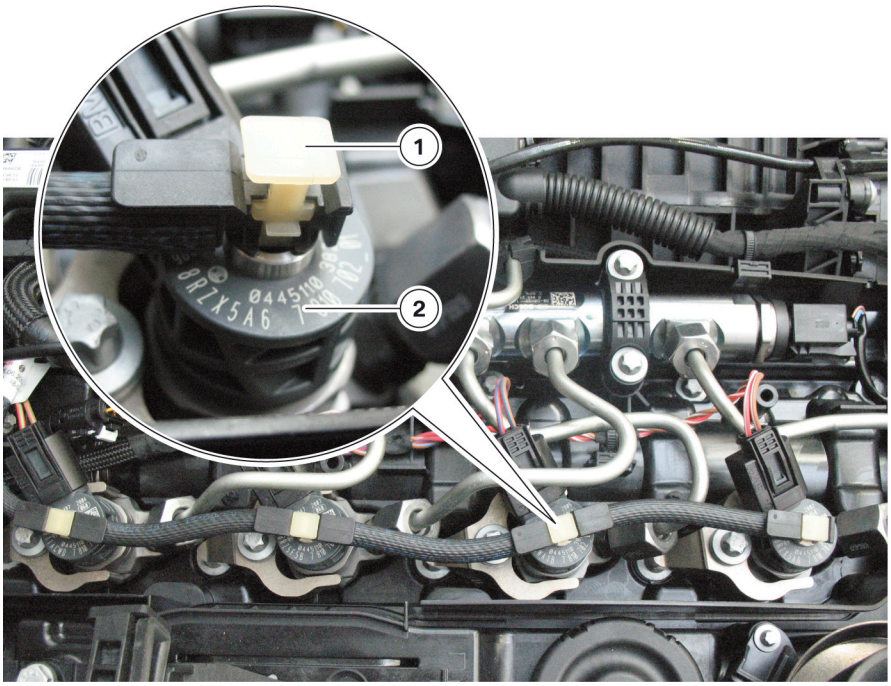
Index	Explanation
1	Uniform oil filler cap
2	High-pressure accumulator (rail) bracket
3	Crankcase vent valve
4	Bolting points for center high pressure accumulator bracket
5	Swirl-flap actuator
6	Blow-by pipe

N47TU Engine.

7. Fuel preparation.

7.1. Leakage oil line

The leakage oil line and the return connection of the engine are new. In order to connect the leakage oil line with the injectors the return connection must be in the open position. The connector is then plugged in the injector return and the latch mechanism pressed in. The return connector is with this secured against being pushed out. To open it the return connector must be opened (see illustration).



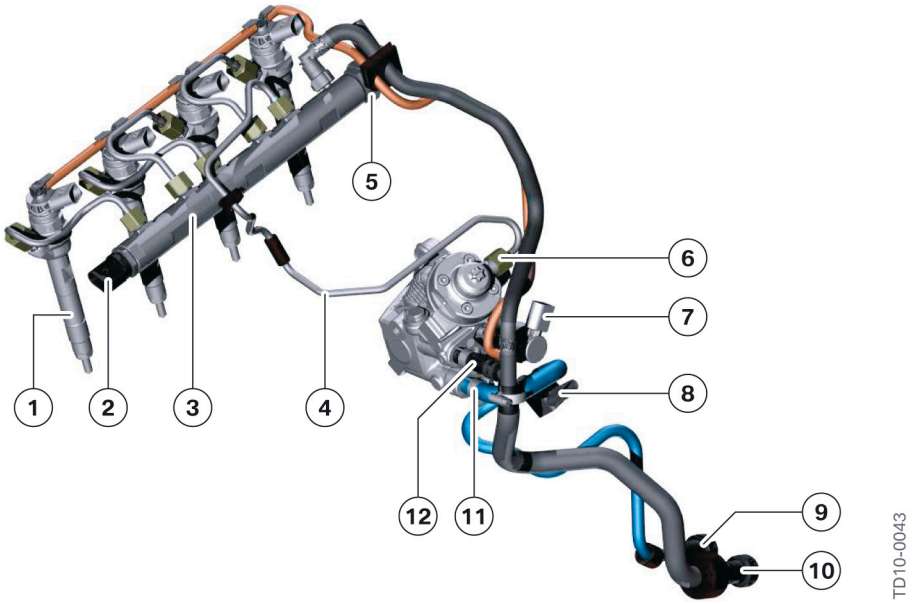
engine, belt drive variants

Index	Explanation
1	Return connector opened
2	Injector

7.2. High pressure pump

The high pressure pump .1 TU received a modification of the camshaft in order to increase the fuel delivery rate. The high pressure outlet was adapted to the modified high pressure line.

N47TU Engine.
7. Fuel preparation.



N47TU engine, high pressure pump and connection

Index	Explanation
1	Solenoid injector
2	Rail pressure sensor
3	Rail
4	High pressure line
5	rail pressure regulating valve
6	High pressure line connection to the high pressure pump
7	Fuel quantity control valve
8	Fuel pressure temperature sensor
9	Fuel feed forward fuel filter
10	Fuel return line
11	Fuel feed in the high pressure pump
12	Fuel return line from the high pressure pump

7.3. Injector

The new solenoid injector (common rail injector .5)is operated with up to 1800 bar fuel pressure. The solenoid injector isproduced by Bosch and represents the further development of the familiar solenoid injector .2. Along with the increased maximum pressure, the number of possible switching actions over the service life was also increased by 50%. The multiple injection capability and very short switching times could also be implemented. The new solenoid injector enables the same power andconsumption data as the 1800 bar piezo injector and this with improvedHC and CO emissions. An important advantage of the solenoid injectorlies in the low manufacturing costs.

N47TU Engine.

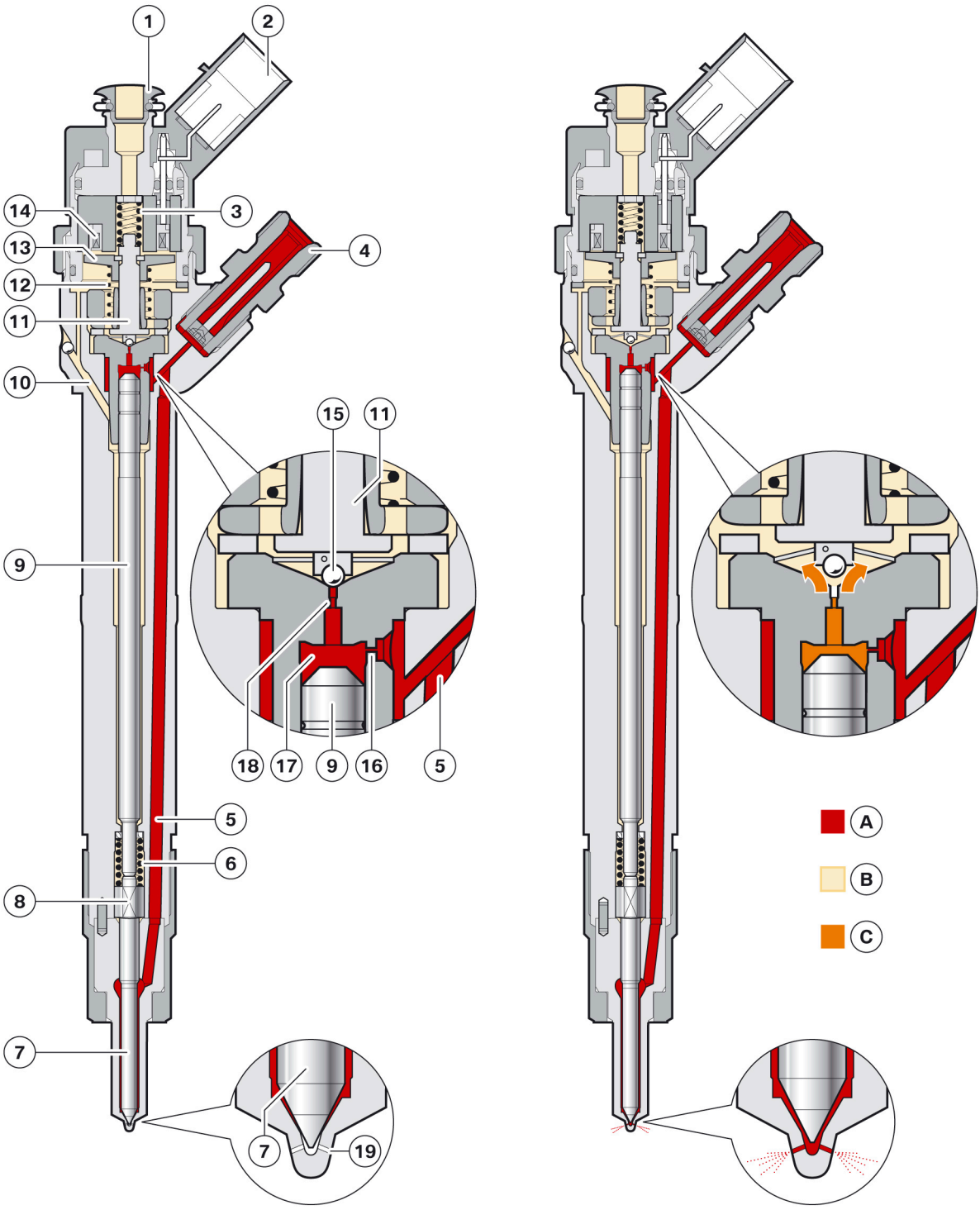
7. Fuel preparation.

An adaptation of the nozzle geometry to meet increased requirements from emission regulations is also completed.

N47TU Engine.

7. Fuel preparation.

7.3.1. Solenoid injector CRI2.2



Solenoid injector CRI2.2

Index	Explanation
A	Fuel high pressure
B	Fuel return line
C	Reduced fuel high pressure
1	Fuel return line connection
2	Electrical connector
3	Control piston spring
4	High-pressure connection with filter
5	Fuel delivery line
6	Nozzle needle spring
7	Nozzle needle
8	Coupler
9	Valve control piston
10	Leakage oil line
11	Solenoid control piston
12	Armature spring
13	Armature
14	Solenoid coil
15	Valve ball
16	Inlet throttle
17	Control chamber
18	Outlet throttle
19	Perforated nozzle

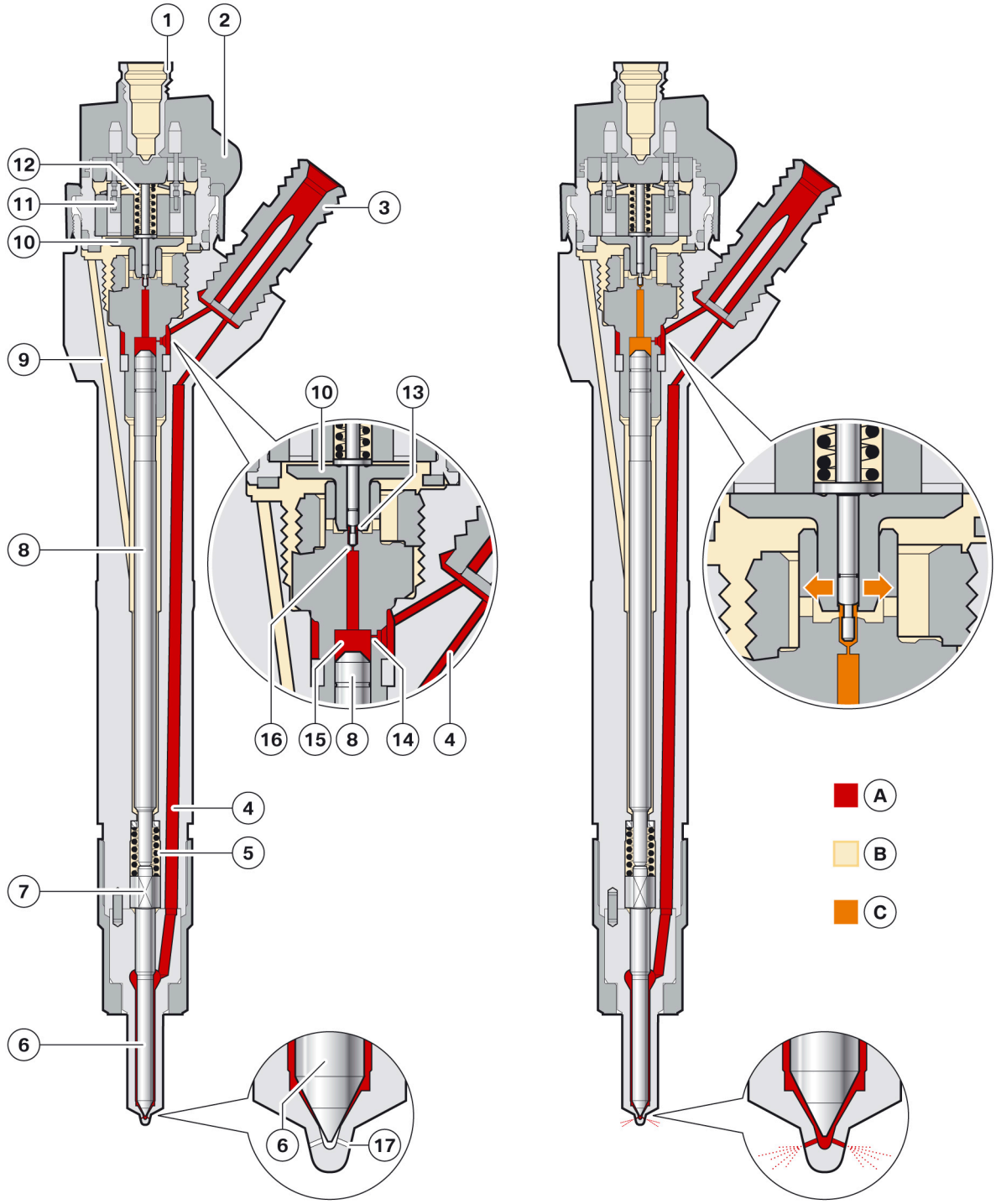
7.3.2. Solenoid injector CRI2.5

Design

The important modifications were done on the solenoid valve. Now a valve is used with a ring shape instead of a ball shape. Here is concerns the so-called pressure compensated valve, which has a side effect of permanent leakage. Through the new shape a larger valve lift is achieved with low opening cross-section.

N47TU Engine.

7. Fuel preparation.



Solenoid injector CRI2.5

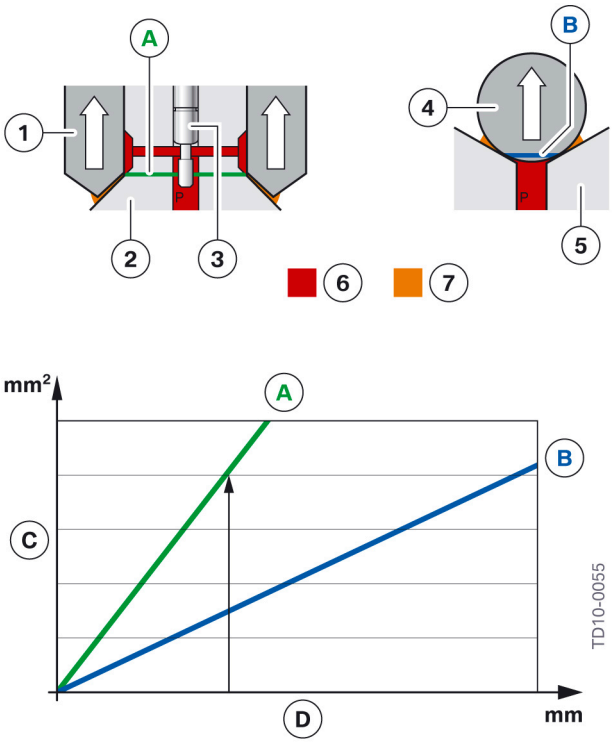
N47TU Engine.
7. Fuel preparation.

Index	Explanation
A	Fuel high pressure
B	Fuel return line
C	Reduced fuel high pressure
1	Fuel return line connection
2	Electrical connector
3	High-pressure connection with filter
4	Fuel delivery line
5	Nozzle needle spring
6	Nozzle needle
7	Coupler
8	Valve control piston
9	Leakage oil line
10	Armature
11	Solenoid coil
12	Armature spring
13	Control valve
14	Inlet throttle
15	Control chamber
16	Outlet throttle
17	Perforated nozzle

The behaviour of the .5 injector is determined decisively by the control valve (13). The new injector should enable higher valve dynamics and simultaneously higher pressures. With the conventional ball valve this was not possible, because a reduction of the valve seat diameter to increase the operating pressure, lower valve opening cross-sections resulted for the control of the nozzle needle. Therefor the valve lift must be enlarged at the cost of the dynamics, which is not goal directed in regards to injection rate and multiple fuel injection.

So that future goals, such as higher fuel injection pressure with simultaneously increasing dynamics (multiple fuel injection) can be achieved, a pressure compensating valve was developed. Through this design the hydraulic forces within the seat diameter are captured by a fixed element. The advantage of this valve is an opening cross-section three times as large with the same valve lift.

In this way very short switching times can be implemented with a small valve lift and simultaneously several injection processes in very short time intervals. These modifications were necessary, since up to three pre-injections for emissions and noise reduction were required. For the exhaust re-treatment currently there are up to four post-injectionsbeing used.



Comparison of valve opening cross-section for .CRI2.2 and CRI2.5

Index	Explanation
A	Pressure compensating valve CR12.5
B	Ball valve CRI2.2
C	Opening cross-section
D	Valve lift
1	Control valve
2	Valve seat
3	Anchor bolts
4	Ball
5	Valve seat
6	Fuel high pressure
7	Reduced fuel high pressure (discharged fuel)

7.3.3. Injection quantity compensation

Due to the tolerance during manufacture of the injectors, the actual injected fuel quantity deviates only slightly from the calculated fuel quantity. This deviation is determined after manufacture for each injector by measurements in several operating points. For each injector an adjustment value (code) is generated from the measurements. For vehicle assembly the compensation value of each injector is stored in the control unit after the installation of the Digital Diesel Electronics. The compensation val-

ues are assigned to the individual cylinders according to the installation of the injectors. The DDE corrects the calculated injection quantities slightly with these compensation values and so reduces the cylinder specific deviations of the injection quantity.

Injection quantity compensation EURO 5 solenoid injector .5

Index	Explanation
1	Seven digit code (compensation value)

If injectors are renewed or replaced, it must be ensured that the imprinted alphanumeric code of each injector is assigned in the Digital Diesel Electronics to the correct cylinder.

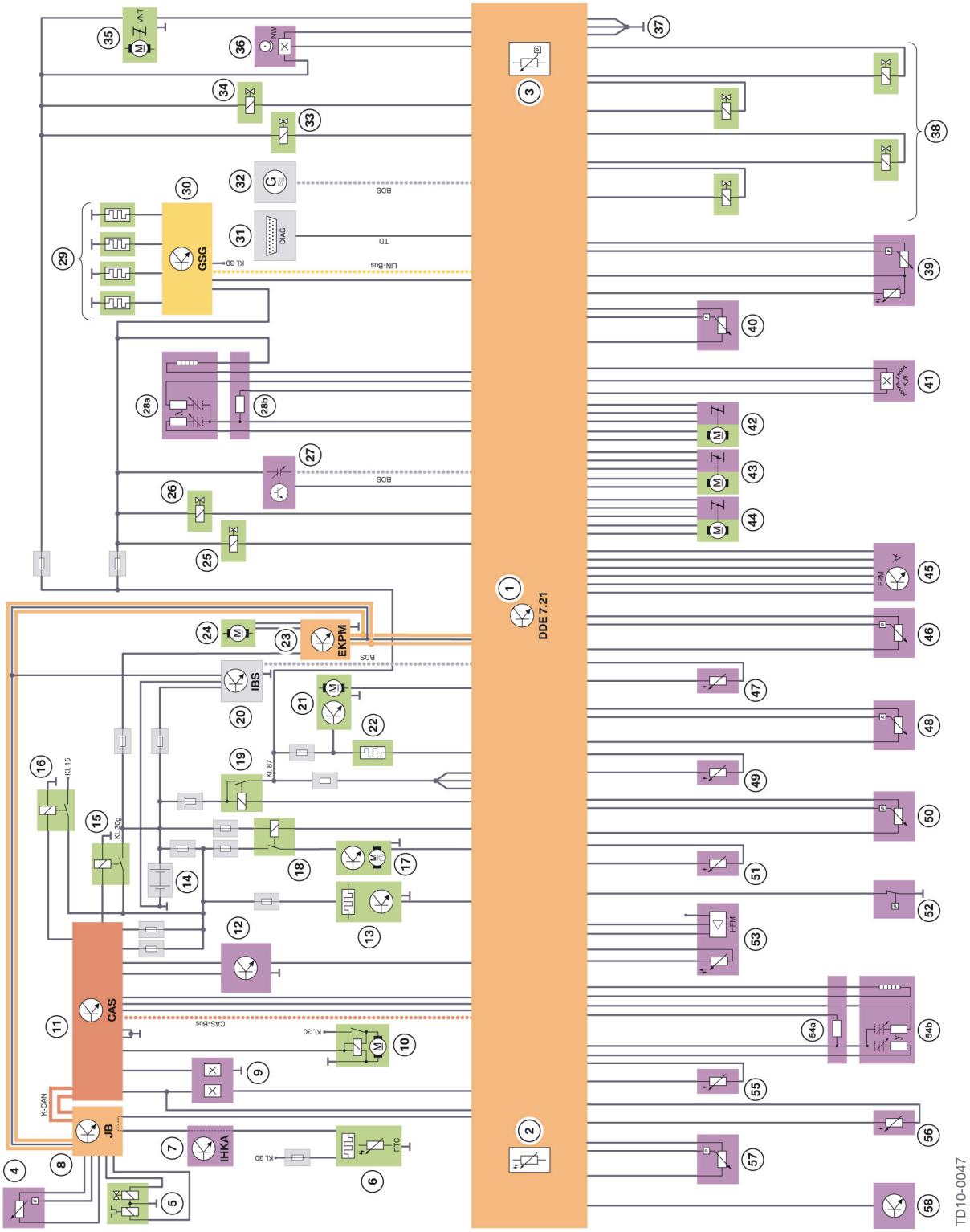
N47TU Engine.

8. Engine electrical system.

The engine electrical system was slightly revised. Some new sensors will be used, which correspond to the sensors of the engine in their function and operating principle. The following system overview shows the components of the EURO 6 version. The components for the version with automatic engine start-stop function are shown in the table and are specially marked for the EURO 5 version. The .21takes over the activation and evaluation of the sensors and actuators.

N47TU Engine.

8. Engine electrical system.



engine, system wiring diagram with EURO 6

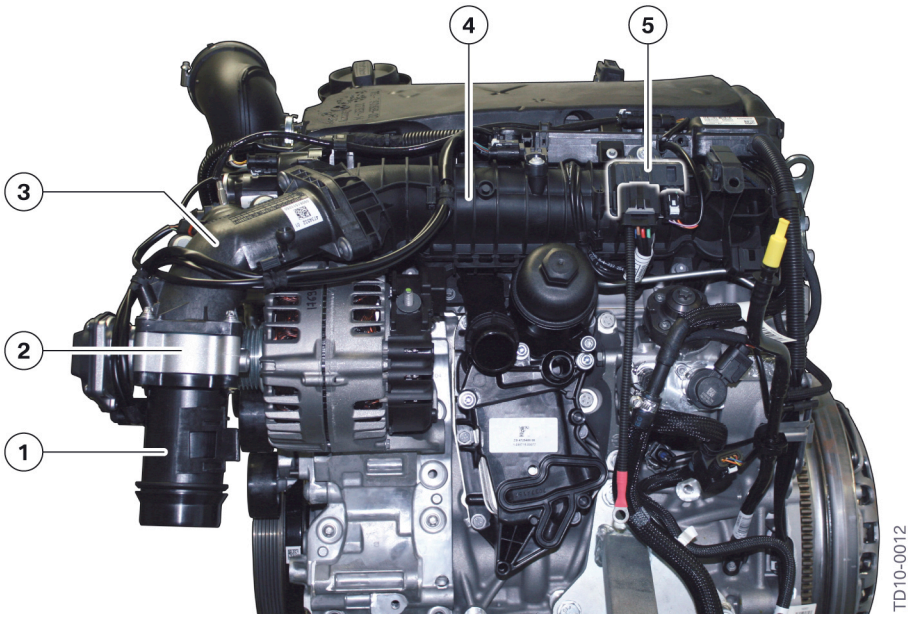
N47TU Engine.
8. Engine electrical system.

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 system
8	Junction box
9	Brake light switch
10	Starter
11	Car Access System
12	Clutch module
13	Fuel filter heating
14	Battery
15	Terminal 30 switched relay
16	Terminal 15 relay
17	Electric fan
18	Electric fan relay
19	DDE main relay
20	Intelligent battery sensor
21	Air flap
22	Blow-by heater
23	Electronic fuel pump control
24	Electronic fuel pump
25	Electropneumatic changeover valve engine mount
26	Electropneumatic changeover valve bypass flap exhaust-gas recirculation
27	Oil level sensor
28a	oxygen sensor before the NO_x storage catalytic converter (for EURO 5,oxygen sensor before oxidation catalytic converter) [control sensor with constant characteristic curve]
28b	Oxygen sensor connector
29	Glow element
30	Preheating control unit
31	Diagnostic socket
32	Alternator
33	rail pressure regulating valve

Index	Explanation
34	Fuel quantity control valve
35	Charging pressure actuator
36	Camshaft sensor
37	Earth connection
38	Solenoid injectors
39	Fuel pressure temperature sensor
40	Rail pressure sensor
41	Crankshaft sensor
42	Exhaust-gas recirculation valve and exhaust recirculation sensor
43	Bypass controller and throttle valve sensor
44	Swirl-flap actuator and swirl-flap sensor (not for lower power stage)
45	Accelerator pedal module
46	Exhaust backpressure sensor before the exhaust turbocharger
47	Coolant temperature sensor
48	Fuel differential-pressure sensor (for EURO 5, exhaust backpressure sensor before the oxidation catalytic converter)
49	Charge-air temperature sensor
50	Charging pressure sensor
51	Exhaust-gas temperature sensor before NO_x storage catalytic converter (for EURO 5, exhaust-gas temperature sensor before the oxidation catalytic converter)
52	Oil pressure switch
53	Hot film air mass meter
54 a	Oxygen sensor after the diesel particle filter (not present in EURO 5)[control sensor with constant characteristic curve]
54b	Oxygen sensor connector
55	Exhaust-gas temperature sensor after NO_x storage catalytic converter(not present for EURO 5)
56	Exhaust-gas recirculation temperature sensor
57	Brake vacuum-pressure sensor (only for automatic engine start-stop function)
58	Zero-gear sensor (only with automatic engine start-stop function)

8.1. Preheating control unit

The preheating control unit is now fastened on the differentiated air intake system. The accessibility-could be significantly improved by this.



engine, belt drive variants

Index	Explanation
1	Charge air pipe
2	Throttle valve
3	Mixing tube
4	Differentiated air intake system
5	Preheating control unit

The glow element detection must be performed when renewing of the preheating control unitor glow elements.

8.2. Sensors

8.2.1. Exhaust backpressure sensor before the exhaust turbocharger

The exhaust backpressure sensor before the exhaust turbocharger is new. The newexhaust backpressure sensor is from Denso.

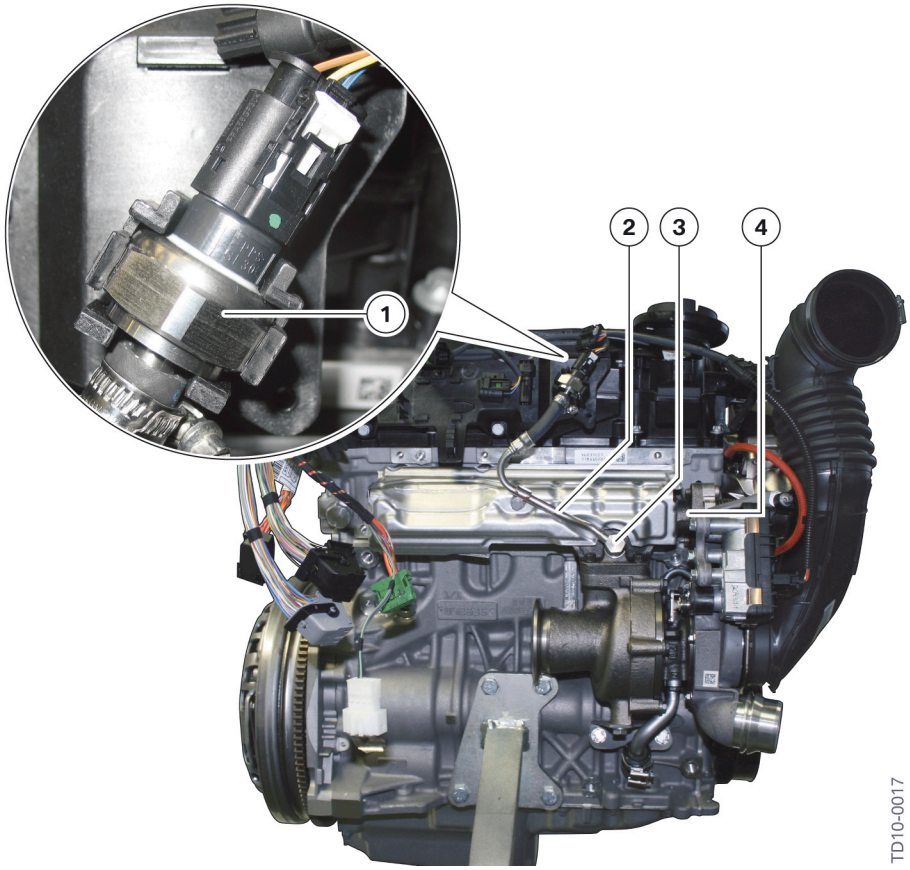
The exhaust backpressure sensor measures the pressure in the exhaust system before the exhaust turbocharger. This information is necessary for optimum control of the exhaust-gas recirculation rate. Using the exhaust backpressure sensor and the exhaust-gas temperature sensorthe Digital Diesel Electronics DDE can regulate the exhaust-gas recirculation rate even more precisely and efficiently.

N47TU Engine.

8. Engine electrical system.

The exhaust backpressure sensor is connected with the exhaust manifold via a pipe and a hose. The reason for the clearance to the exhaust manifold is the possible high temperature of the exhaust emission system and dirt contamination,which otherwise could get onto the sensor element. The connection to the hose must point downward. The exhaust backpressure sensor is connected with the Digital Diesel Electronics DDE with three pins. The DDEsupplies them with earth and a voltage of 5 Volt. The voltage signal gets to the DDE via the third pin.

Absolute pressure	Voltage
100 kPa (1.0 bar)	approx. 1.0 volt
500 kPa (5.0 bar)	approx. 4.5 volt



engine, belt drive variants

Index	Explanation
1	Exhaust backpressure sensor
2	Connecting pipe
3	Connection to the exhaust manifold
4	Exhaust manifold

8.2.2. Glow element

The glow element detection must be performed when renewing of the preheating control unitor glow elements.

The service function offers two functions, which are necessary during repairs on the preheating system:

- Before replacing glow element: Activate safety data record. **Activate safety data record.**
  Before replacing glow elements the service function of the safety data record must be activated. This is necessary to ensure that the preheating control unit during terminal change controls the new glow elements for safety reasons with the safety data record.
- After replacing glow elements or the preheating control unit: Perform glow element detection. **Perform glow element detection.**
  After replacing the glow elements or preheating control unit, the glow element detection must be performed with the service function.
  The service function ensures that the correct data record is activated in the preheating control unit for the installed glow elements. If the glow element detection is not performed, an incorrect data record could possible remain active. The result of this could be functional restrictions during glowing or damage to the glow elements.
  During this the following is checked:
  - Does the preheating control unit detect all glow elements?
  - Are the correct glow elements installed?
  - Is the correct data record activated in the preheating control unit?

Reasons

Different glow element types are used for the engines depending on power variations.

So that the different glow element types can be activated with the correct respective voltage profile, there are different data records for the preheating control unit. In addition to the data records for the correct operation of the glow elements there are also the so-called safety data record contained in the preheating control unit. The safety data record is laid out so that in case of a fault or with incorrect installation, all glow element types can be supplied with current without danger of damage. There are two methods for detecting the glow element type in the preheating control unit:

1 For each full heating cycle after a terminal changethe detection is automatically initiated. During this the preheating control unitcan only differentiate between metallic and ceramic glow elements. If the preheating control unit detects a voltage fluctuation that is too large or if the signal for the starter intervention is active, the detection is aborted. If more than one glow element of the wrong type is detected, the preheating control unit activates the safety data record. If only one glow element of the wrong type is detected, the preheating control unit takes this glow element from further preheating processes in the current driving cycleand does not activate the safety data record.

2 A special test preheating can be activated via the service function. During this the safety data record is always activated with unclear detection of all glow elements.

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