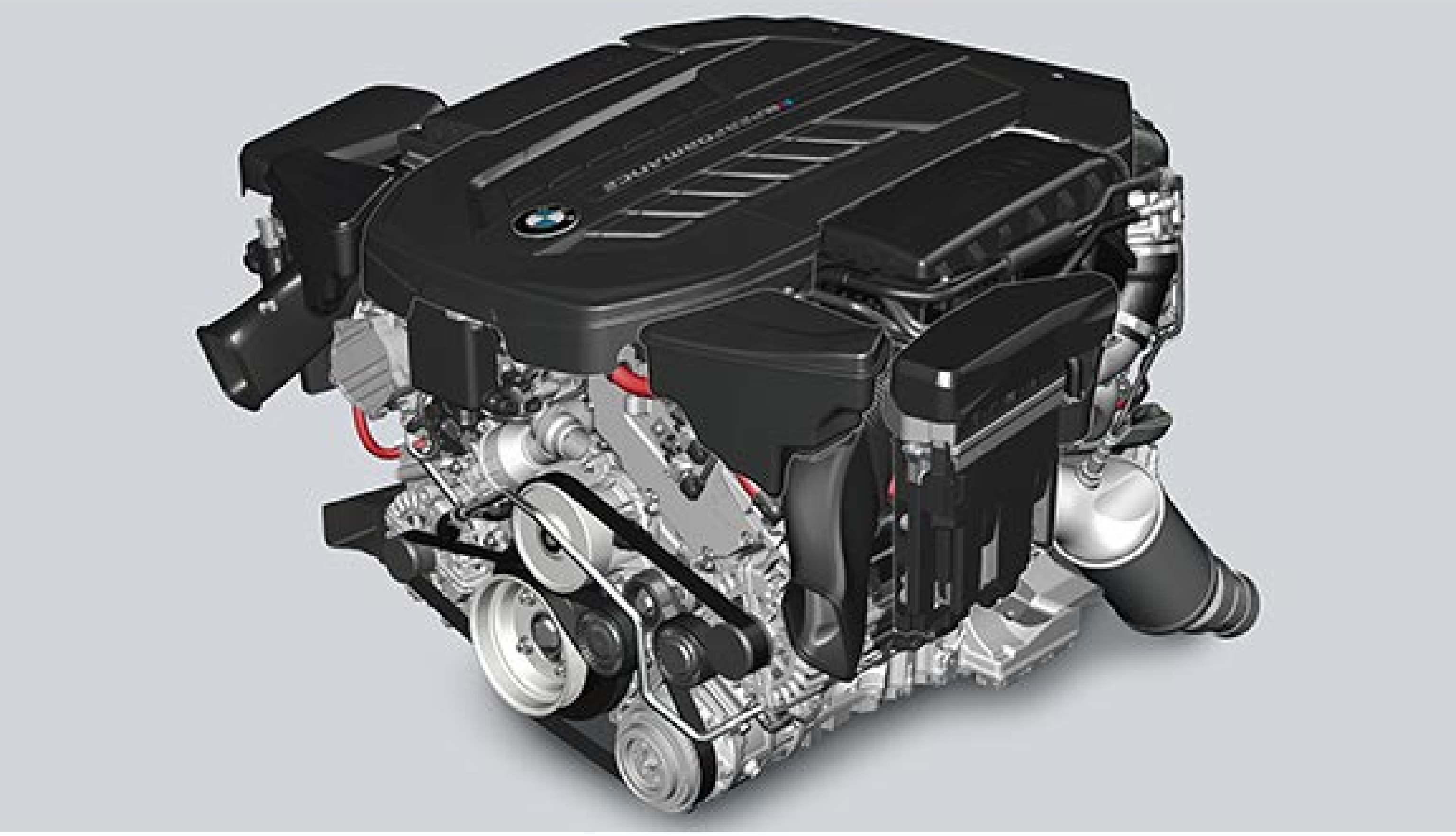
Reference Manual

N74TU ENGINE



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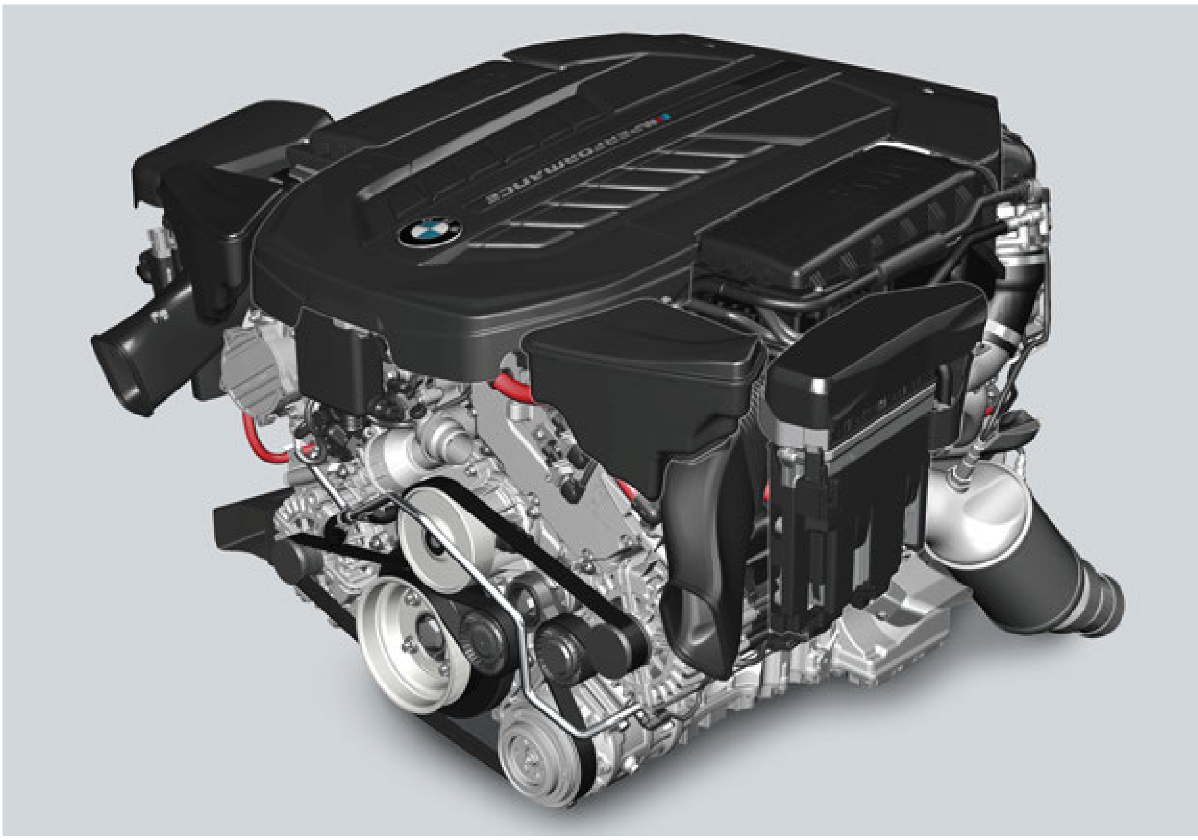
N74TU Engine



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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.

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The information contained in this document forms an integral part of the BMW Group Technical Qualification 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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Technical Training

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N74TU Engine
1. Introduction

The redesigned 12-cylinder N74TU engine with M Performance TwinPower Turbo technology in the G12 version will be launched in November 2016.

The N74TU engine is the successor to the N74 engine, but also shares many engineering features with the N63TU2 engine. The N74TU engine also features high pressure fuel injection (HDE) technology with inward-opening HDE5.2 solenoid valve injectors. These injectors are positioned centrally in the combustion chamber, equipped with Controlled Valve Operation (CVO) from Bosch, and biturbo charging with indirect charge air cooling. In this N74TU engine, the exhaust turbochargers are attached to the outside of the engine, unlike the N63TU2 engine, and use the mono scroll principle.

The N74TU engine's displacement was increased by 620 cc compared with the N74 engine.

1.1. Models

Models featuring N74TU engines to be launched in November 2016:

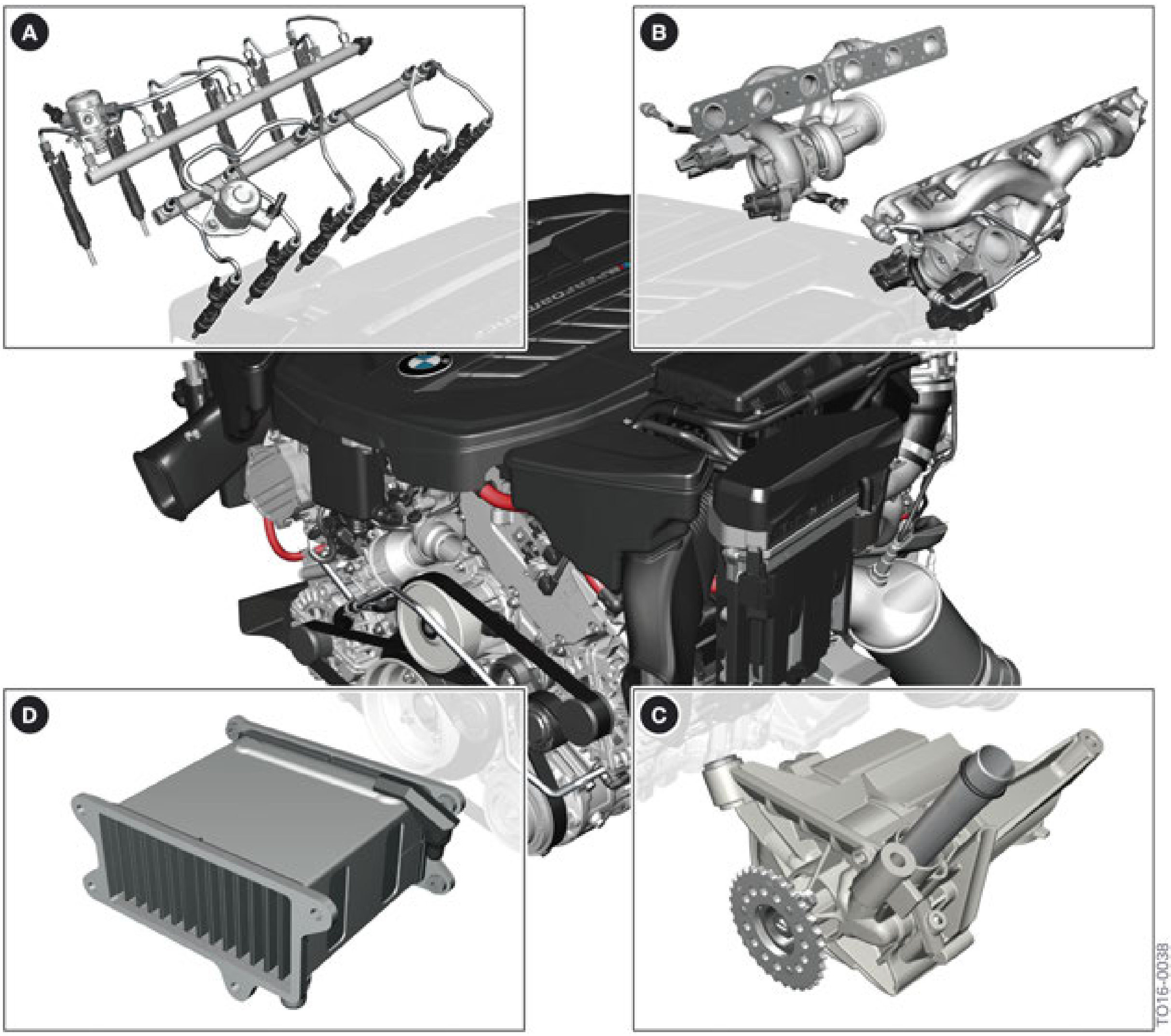
Model	Series	Engine	Power in kW/ HP	Torque in Nm/ rpm (lb-ft)
BMW M760i xDrive	G12	N74B66U1	448/610	800 (590) /1550-5000

1.2. History

BMW 12-cylinder gasoline engines:

Engine	Model	Series	Displacement in cc	Power output in kW/ hp	Torque in Nm	Engine control	First used	Last used
M70B50	750i	E32	4988	220/300	450	ME1.2	5/87	9/90
M70B50	850i	E31	4988	220/300	450	ME1.7	4/90	11/94
M70B50	750i	E32	4988	220/300	450	ME1.7	9/90	11/94
S70B56	850Csi	E31	5576	208/381	550	ME1.7.1	10/92	9/97
M73B54	750i	E32	5379	240/326	490	ME5.2	9/94	9/01
M73B54	850Ci	E31	5379	240/326	490	ME5.2	9/94	9/99
N73B60	760i	E65	5972	327/445	600	MED9.2.1 + HDEV	9/02	9/08
N73B60	760Li	E66	5972	327/445	600	MED9.2.1 + HDEV	9/02	9/08
N74B60	760i	F01	5972	400/544	750	2 x MSD87-12	9/09	06/15
N74B60	760Li	F02	5972	400/544	750	2 x MSD87-12	9/09	06/15

1.3. Highlights



N74TU engine highlights

Index	Explanation
A	HDE high-pressure injection with inward-opening solenoid valve injectors and CVO
B	Exhaust turbocharger (biturbo) with charging pressure control from electric wastegate and blow-off valves
C	Volume-flow-controlled oil pump with characteristic-map support
D	Charge air cooling equipped for indirect charge air cooling

The N74TU engine shares a number of features with the N63TU2 engine. These include a volume-flow-controlled oil pump supplemented by map control, and charging pressure control from electric wastegate valve controllers.

N74TU Engine
1. Introduction

The use of cutting-edge technology achieves a significant increase in performance coupled with reduced fuel consumption and improved emission behaviour.

1.3.1. Technical data

		F02/760Li N74B60U0	G12/M760i xDrive N74B66U1
Design		V12 60°	V12 60°
Firing order		1-7-5-11-3-9- 6-12-2-8-4-10	1-7-5-11-3-9- 6-12-2-8-4-10
Displacement	[cc]	5972	6592
Bore/stroke	[mm]	89/80	89/88.3
Power output at engine speed	[kW] (hp) [rpm]	400 (544) 5250-6000	448 (610) 5500
Torque at engine speed	[Nm] (lb-ft) [rpm]	750 (550) 1500-5000	800 (590) 1550-5000
Cutoff speed	[rpm]	6500	6500
Compression ratio	[ε]	10.0	10.0
Distance between cylinders	[mm]	98	98
Valves per cylinder		4	4
Intake valve diameter	[mm]	33.2	33.2
Exhaust valve diameter	[mm]	29	29
Diameter of crankshaft main bearing journals	[mm]	65	65
Diameter of crankshaft connecting rod bearing journals	[mm]	54	54
Fuel rating	[RON]	95	95
Fuel	[RON]	91-98	91-98
Engine control		2 x MSD87-12	2 x DME 8.C
Acceleration 0-100 kph / 0–62 mph	Seconds	4.6	3.7*
Maximum speed	km/h	250	250/305[1]
Fuel consumption/ total	l/100 km	13	12.8*
CO_2	g/km	303	294*
Exhaust emission standards US		Ultra Low Emission Vehicle (ULEV) II	Ultra Low Emission Vehicle (ULEV) II

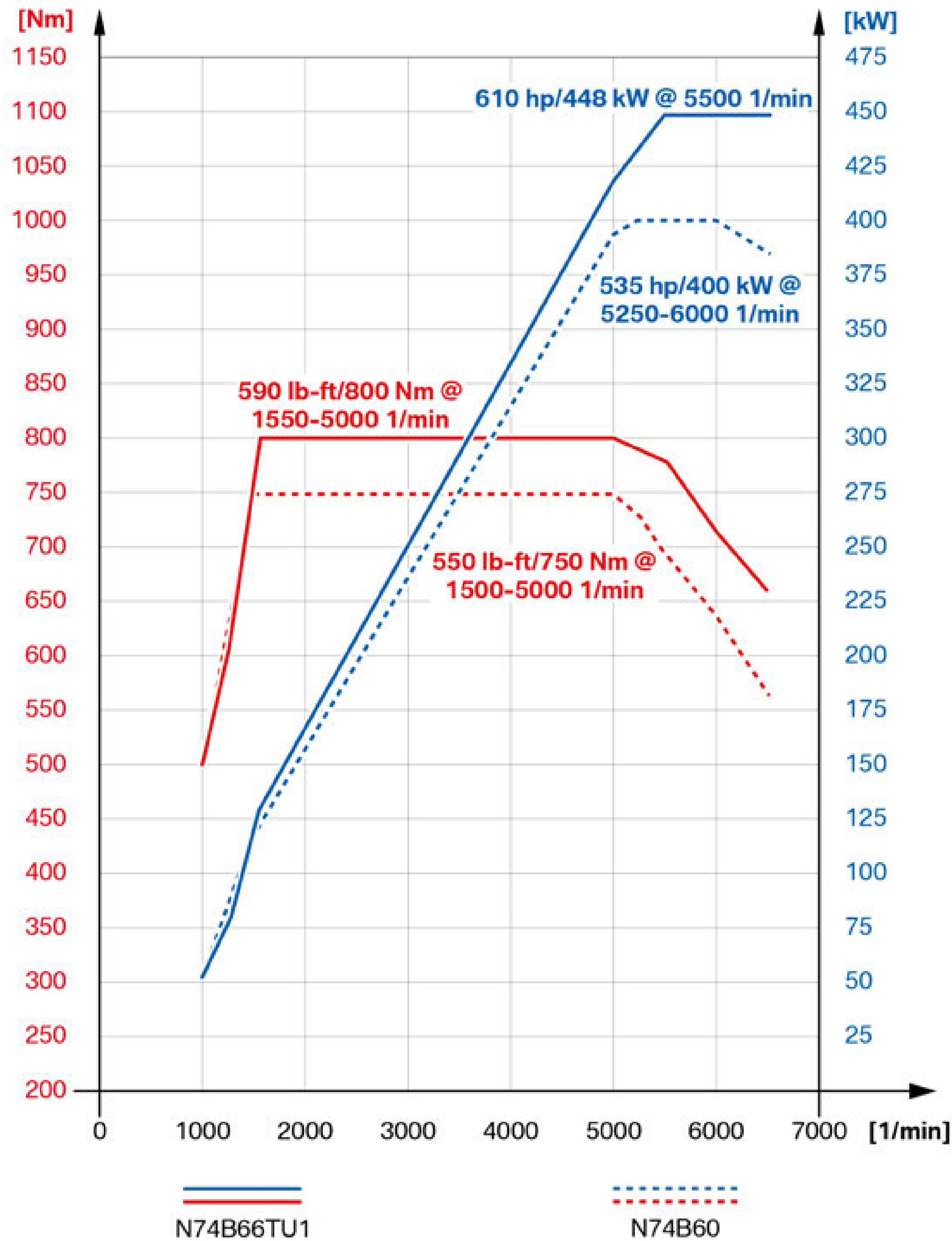
N74TU Engine

1. Introduction

* Provisional value/final values were not available at time of publication.

[1] In conjunction with M Driver's Package optional equipment (OE 7ME) (available for BMW M760i xDrive only).

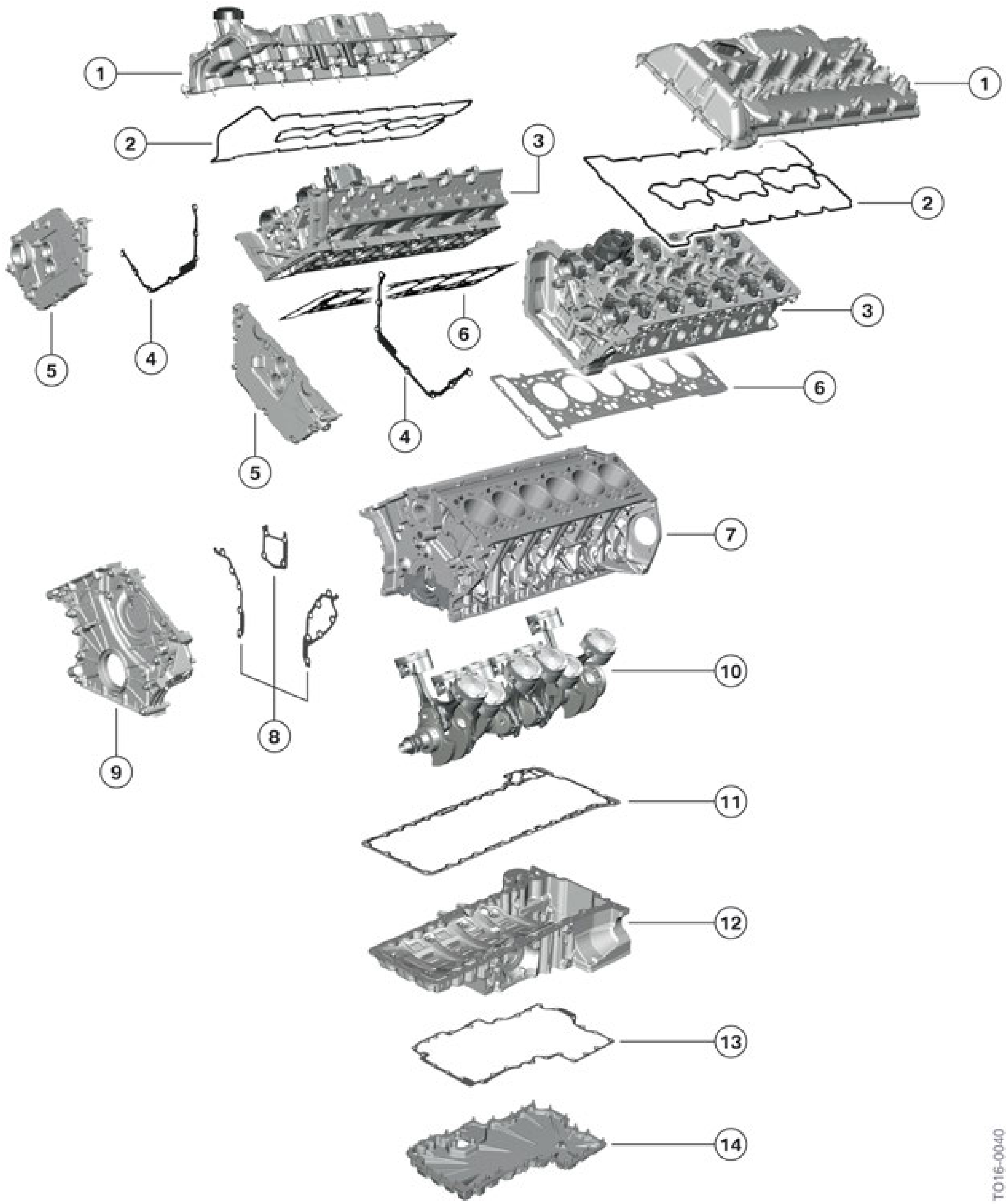
1.3.2. Full load diagram



N74TU engine, full load diagram compared with N74 engine

N74TU Engine
1. Introduction

1.3.3. Overview



N74TU engine, exploded diagram

N74TU Engine
1. Introduction

Index	Explanation
1	Cylinder head cover
2	Cylinder head cover gasket
3	Cylinder head
4	Timing case cover, top
5	Timing case cover
6	Cylinder head gasket
7	Crankcase
8	Timing case cover, bottom
9	Timing case cover
10	Crankshaft drive
11	Oil sump gasket, top
12	Oil sump, top
13	Oil sump gasket, bottom
14	Oil sump, bottom

The N74TU engine is clearly based on the BMW modular system. Though some parts have been redesigned, it largely matches the technical setup of the N74 and N63TU2 engines and uses a large number of their component parts.

1.3.4. N74TU engine components

The table below provides an overview of the new features and modifications made to the N74TU engine.

Component/ system	New development	Same concept	Carry-over part	Notes
Crank-case		●		The crankcase was adapted to the design of the engine mounting bracket. This was necessary because the N74TU engine is installed in all-wheel drive vehicles.
Crank-case ventilation			●	The principle of crankcase ventilation matches that of the N74 engine. In naturally aspirated mode, ventilation is restricted to cylinder bank 2. This is known as **register ventilation.** The oil separators now feature 4 cyclones per cylinder bank.
Crankshaft		●		A larger stroke (88.3 mm in the N74TU engine compared with 80 mm in the N74) generates an increase in overall engine capacity

Component/ system	New develop-ment	Same concept	Carry-over part	Notes
Pistons/ connecting rods			●	Piston and connecting rod designs have been carried over from the N63TU2 engine.
Valve gear			●	The valve gear is based on well-established BMW technology. The VANOS units and camshafts are taken from the N74 engine. VALVETRONIC technology is **not** used.
Camshaft drive			●	The inverted-tooth sleeve-type chain of the N74 engine is used here.
Belt drive		●		The design of the belt drive – incl. **belt tensioner** – matches that of the N74 engine. Two alternators are used.
Oil supply		●		Though designed specifically for the N74TU engine, the oil supply matches the operating principles of the N63TU2. This is why a **volume-flow-controlled pendulum cell control-sleeve pump with map control** is also used here.
Oil spray nozzles			●	The opening and closing pressure levels have been adapted.
Cooling			●	The cooling system design matches that of the N74 engine. **Two separate coolant circuits** are deployed. One for engine and turbocharger bearing-block cooling and one for charge air cooling, which also cools the engine control units.
Intake-air and exhaust emission system			●	The design of the intake-air and exhaust emission systems match those used in the N74 engine.
Exhaust turbocharger	●			Two **conventional exhaust turbochargers** are used. In contrast to the N74 engine, however, the exhaust turbochargers are equipped with electric wastegate valve controllers. The electric blow-off valves have been carried over. Zero-clearance multi-piece wastegate valves are being used in a BMW gasoline engine for the first time.
Vacuum system			●	Both the N74TU and N63TU2 engines are fitted with a single-stage vacuum pump
Fuel system		●		For the N74TU engine the high-pressure injection is used. It differs from high-precision injection HPI (used in the N74) in that it uses solenoid valve injectors with multi-hole nozzles.
Engine electrical system	●			The N74TU engine is equipped with Bosch Digital Motor Electronics (designation DME 8.C.0).

1. Introduction

Component/ system	New development	Same concept	Carry-over part	Notes
Oil pressure sensor	●			An oil pressure sensor is used in place of an oil pressure switch.
Oil-level sensor			●	The oil-level sensor is based on the sensor used in the N63TU2 engine.
Automatic start/stop		●		An automatic engine start/stop function (MSA) is being used in a 12-cylinder engine vehicle for the first time. The MSA 2.3 connected **"intelligent automatic start/stop function"** is deployed.

1.3.5. Engine identification

Engine designation

In the technical documentation the engine designation is used to ensure clear identification of engines.

The N74TU engine market launch has the following specifications: N74B66U1.

The technical documentation also contains the short form of the engine designation N74TU, which only indicates the engine type.

This is broken down as follows:

Index	Explanation
N	BMW Group "New Generation"
7	12-cylinder engine
4	Engine with high-pressure injection and turbocharging
B	Gasoline engine
66	6.6 liter capacity
U	Lower power stage
1	First revision

N74TU Engine
1. Introduction

Engine identification and number

The engines have an identification mark on the crankcase to ensure unambiguous identification and classification. Engine identification is also necessary for approval by the authorities. The first 7 characters are relevant here. The N74TU engine identification corresponds with the new standard, whereby the first 6 characters match those of the engine designation. The seventh character is a sequential letter that can be used for different distinctions, such as the power stage or exhaust emission standard. A fixed correlation is not possible – though an "A" generally refers to the basic model.

The engine number is a sequential number that permits unique identification of individual engines. Engine identification and number are located on the crankcase behind the mounting bracket for the air conditioning compressor.

N74TU Engine
2. Engine Mechanical

2.1. Engine housing

The engine housing comprises the cylinder head covers, cylinder heads, crankcase, oil sump and gaskets.

2.1.1. Cylinder head cover

The cylinder head covers are made of die-cast aluminium and have been re-adapted for the N74TU. They incorporate the oil separation of the crankcase ventilation. The oil separator is made of plastic and is the same as the one used in the N74 engine.

2.1.2. Cylinder head

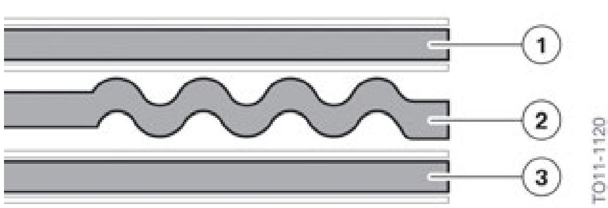
The design of the cylinder head in the N74TU engine is also characterized by the central location of the injector and spark plug in the combustion chamber. The cylinder head in the N74TU engine has the same design concept as that of the N74 engine, but has been re-adapted for the N74TU. The configuration of the high-pressure fuel pump has not changed compared with the N74 engine.

As already seen in the N74 engine, coolant flows across the cylinder head (from the engine exterior to the V-space), where the intake is outside at the rear and the outlet is inside at the front end. This is also called diagonal cooling.

As with the N74 engine, only one non-return valve for the oil circuit is now integrated in the cylinder head. The two non-return valves responsible for VANOS are now integrated in the VANOS units.

2.1.3. Cylinder head gasket

As on the N74 engine, a three-layer spring steel gasket is used for the cylinder head gasket. There is a stopper plate (2) in the area of the cylinder bores in order to achieve sufficient contact pressure for sealing.



N74TU engine, cylinder head gasket

Index	Explanation
1	Top spring steel layer with anti-stick coating
2	Stopper layer
3	Bottom spring steel layer with anti-stick coating

The same cylinder head gasket is used for cylinder bank 1 and cylinder bank 2.

N74TU Engine
2. Engine Mechanical

2.1.4. Crankcase

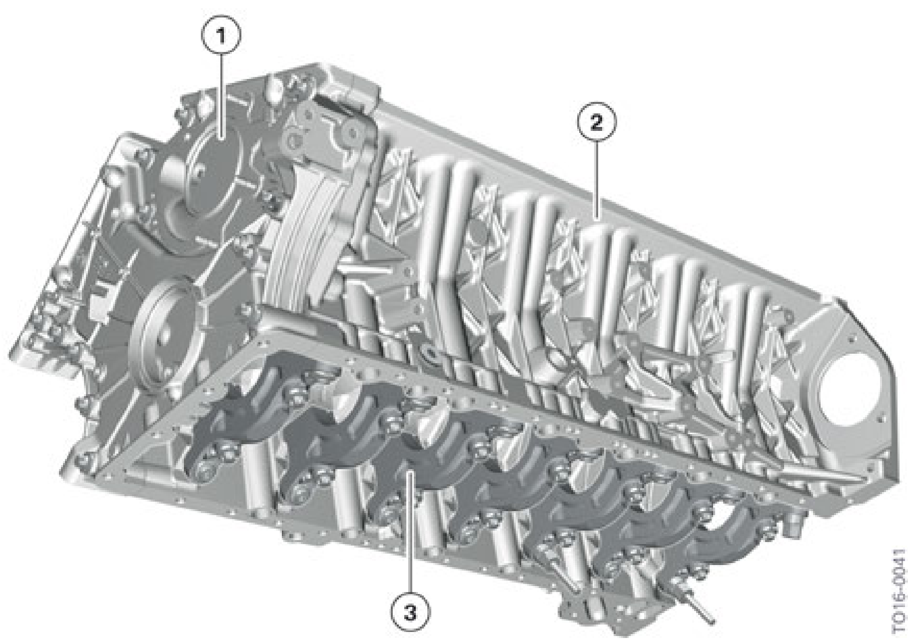
The crankcase of the N74TU engine has been upgraded. The design matches the one used in the N74 engine.

Design:

- Monoblock made from an aluminium alloy (Alusil)
- Closed deck
- Clearance-honed cylinder liners
- Deep-skirt side panels with main bearing caps
- Double main bearing screw connection with additional side panel connection

The crankcase on the N74TU engine has been redesigned and is made from low-pressure permanent mould casting AlSi9Cu3 (Fe). Mountings have also been inserted in the crankcase for connection to the engine mount in particular. This was necessary because the N74TU engine is installed in all-wheel drive vehicles. The cylinder barrels are made from Alusil. Like its predecessor in the N74 engine, the closed-deck crankcase in the N74TU engine is characterized by a double main bearing screw connection with side wall connection.

The crankcase cast part consists of the cylinder bores with Alusil raceways, the bearing ways with the bore holes for the crankshaft and associated bearings and the water jackets of the cylinders.



N74TU engine, crankcase

Index	Explanation
1	Coolant pump mounting
2	Crankcase
3	Double main bearing screw connection with side wall connection

In conjunction with the cylinder head screw connections in the bottom plates of the cylinder housing, the closed-deck design ensures high rigidity and low deformation of the clearance-honed cylinder liners. To absorb the considerable lateral forces from the crankshaft drive, the crankcase with deep-skirt side panels is fitted with a double main bearing screw connection with additional sidewall connection via threaded support sleeves and screws.

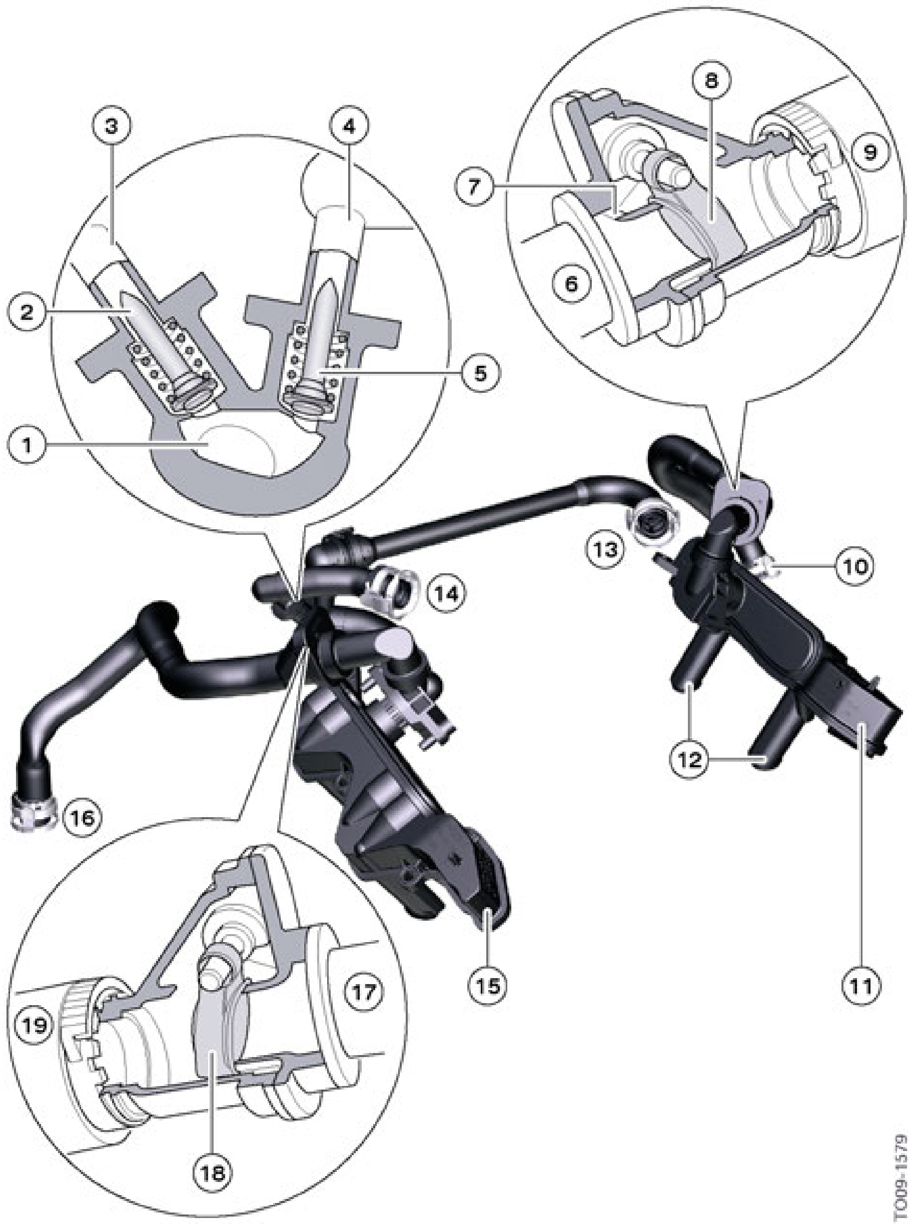
Coolant holes are used to cool the hot area of the wall between the cylinders. To keep the loss generated by pumping in the crankcase as low as possible, there are two ventilation holes in each of the bearing seats 1 to 7. The oil content of the blow-by gases has been reduced using separate channels for oil return from the cylinder heads and crankcase ventilation.

2.1.5. Crankcase venting components

The function of crankcase ventilation corresponds to that of the N74 engine.

General

Cleaned blow-by gas is added in naturally aspirated mode after the exhaust turbochargers and in supercharged mode after the exhaust turbochargers.



N74TU engine, crankcase ventilation

Index	Explanation
1	Oil separator inlet, cylinder bank 2
2	Non-return valve
3	Intake system outlet, cylinder bank 2
4	Intake system outlet, cylinder bank 1
5	Non-return valve
6	Oil separator inlet, cylinder bank 1
7	Bore hole for ventilation in counter-flow

Index	Explanation
8	Non-return valve
9	Clean air pipe outlet, cylinder bank 1
10	Connection to clean air pipe, cylinder bank 1
11	Oil separator, cylinder bank 1
12	Oil return ducts
13	Connection to intake system, cylinder bank 1
14	Connection to intake system, cylinder bank 2
15	Oil separator, cylinder bank 2
16	Connection to clean air pipe, cylinder bank 2
17	Oil separator inlet
18	Non-return valve
19	Outlet for clean air pipe, cylinder bank 2

Each cylinder bank has its own oil separator. In turbocharged mode, the blow-by gas is directed on each side to the respective clean air pipe before the exhaust turbocharger.

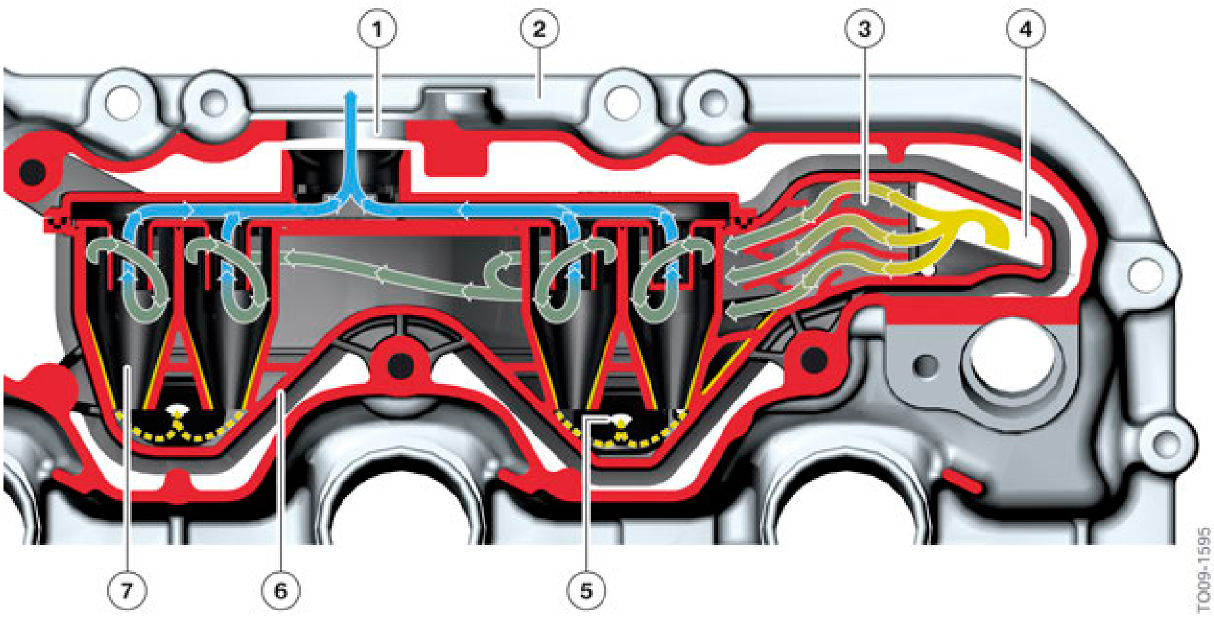
Register ventilation

As with the N74 engine, register ventilation is deployed here. In naturally aspirated mode, the crankcase is ventilated via the oil separator in cylinder bank 2 only (left). In doing so, the efficiency of the oil separator is increased in partial load operation. The crankcase is ventilated in the counter-flow via the separator in cylinder bank 1. Fresh air ventilation means that water and fuel components are discharged more effectively from the crankcase, which increases the service life of the oil and reduces moisture (emulsion formation) in the pipes. This also reduces the risk of freezing.

The N74TU engine does not require heating for crankcase ventilation. Ventilation takes place through a hole in the non-return valve of cylinder bank 1.

In standard engine operation, crankcase ventilation ensures a vacuum of max. 70 mbar in the crankcase. Higher vacuum levels may occur during catalytic converter heating.

Oil separation



N74TU engine, oil separation

Index	Explanation
1	Duct to air intake system
2	Cylinder head cover
3	Labyrinth
4	Ventilation duct from cylinder head
5	Oil return
6	Oil separator housing
7	Cyclone

The oil separator design is the same as the one used for the N74 engine. Labyrinth and cyclone oil separators are used. A labyrinth and 4 cyclones are integrated in the oil separator housing of each cylinder bank.

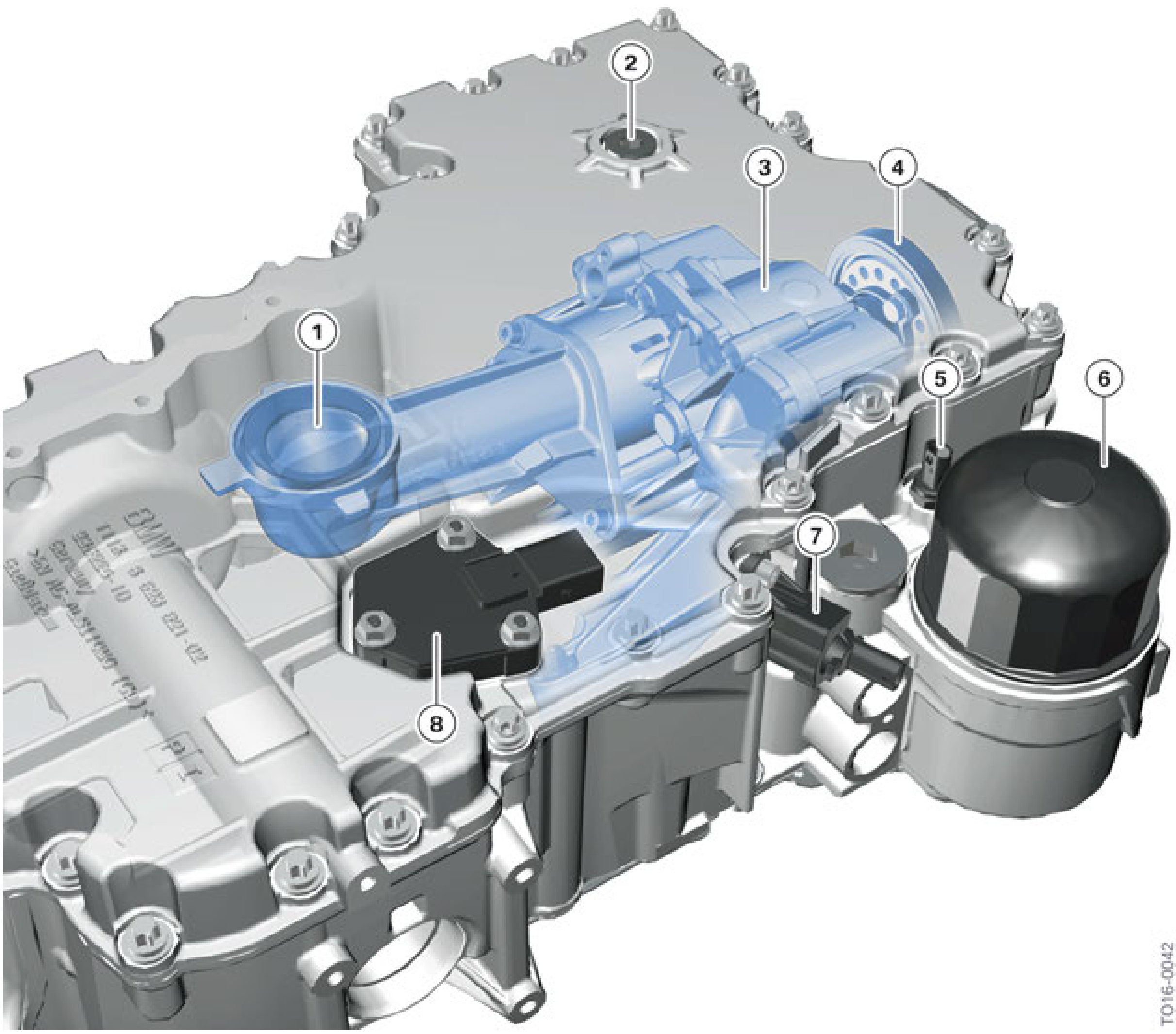
2.1.6. Oil sump

The oil sump is divided into two parts. The upper and lower sections of the oil sump are made from die-cast aluminium and have been optimized for rigidity and acoustics. A two-part oil deflector ensures particularly low oil foaming, even in extreme driving situations. A sump baffle ensures that a sufficient level of oil is achieved at high longitudinal and transverse dynamics.

The oil filter module is integrated in the upper oil sump section on the left-hand side of the engine. The oil temperature sensor, the thermostat for the engine oil cooler and the map-control valve for the map-controlled oil pump are screwed onto the oil filter module on the upper section of the oil sump.

The upper oil sump section is screwed to the crankcase using a beaded metal gasket. The lower oil sump section is likewise screwed to the upper oil sump section. The lower section of the oil sump houses the oil-level sensor and the oil drain plug.

The oil pump is screwed to the crankcase and is driven by the crankshaft via a chain. As on the N63TU engine, the oil deflector is integrated into the upper oil sump section and has been taken over from this model.



N74TU engine, oil sump with oil pump

Index	Explanation
1	Suction pipe
2	Oil drain plug
3	Map-controlled pendulum slide cell pump
4	Chain drive of the crankshaft

Index	Explanation
5	Oil temperature sensor
6	Oil filter cover
7	Map control valve
8	Oil-level sensor

2.2. Crankshaft drive

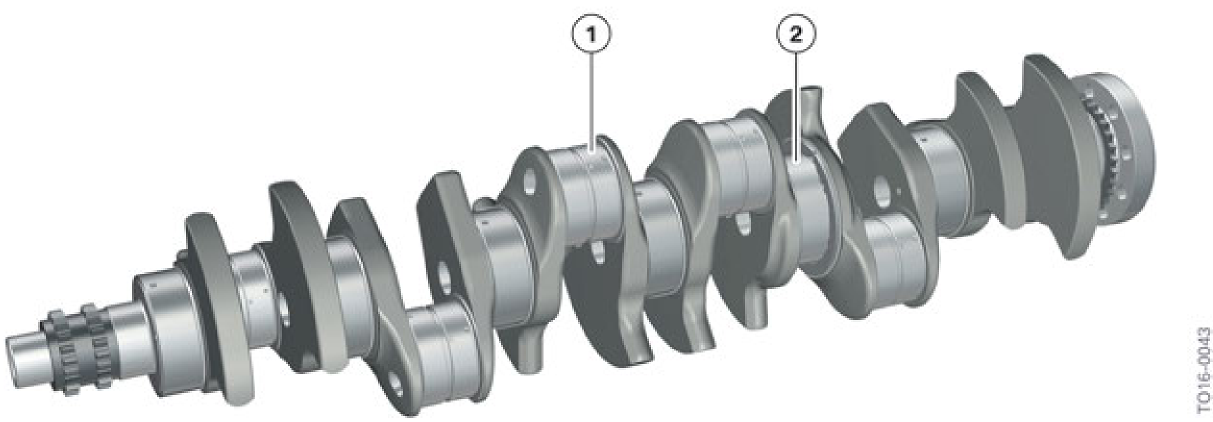
2.2.1. Crankshaft

The crankshaft of the N74TU engine has an 88.3 mm stroke, in contrast to the N74 engine, which has an 80 mm stroke and is made of C38 material. It is a case-hardened forged crankshaft with 9 balance weights. 1st and 2nd order inertia forces are balanced 100% – as with the predecessor twelve-cylinder engines.

The diameter of the crankshaft main bearing is 65 mm – as with the N74 engine. It also enables a main bearing double screw connection without enlarging the crankcase. As is already the case with the N74 engine, the oil pump is driven by the crankshaft at the flywheel end. The chain sprocket is directly incorporated in the crankshaft.

Crankshaft bearings

The crankshaft of the N74TU engine has seven bearings. The crankshaft bearing of the N74TU engine has been converted (in comparison with the N74 engine). Crankshaft bearings based on a bronze two-component bearing and red IROX bonded coating are installed.



N74TU engine, crankshaft bearings

Index	Explanation
1	Crankshaft connecting rod bearing
2	Crankshaft axial bearing

2.2.2. Connecting rod

Connecting rod

The connecting rod on the N74TU engine has been taken from the N63TU2 engine. This is a cracking forged connecting rod with a straight split (the N74 engine has a diagonal split). The small connecting rod eye is drilled into the forged, trapezoidal connecting rod head, undergoes precise surface treatment, is hardened and therefore has no bearing. The force acting from the piston via the wrist pin is optimally distributed to the bearing surface by this shaped bore and the edge load.

N74TU engine, cracked connecting rod with even pitch

Bearings

The connecting rod bearing shells are unleaded and have been converted from electroplated bearings used in the N74 engine to steel/aluminium connecting rod bearing shells with bonded coating in the N74TU engine. A G-411 bearing is installed on the side of the connecting rod. This comprises an aluminium two-component bearing and red IROX bonded coating. A G-488 bearing is used for the connecting rod bearing cap, as used already in the N63TU2 engine.

IROX coating

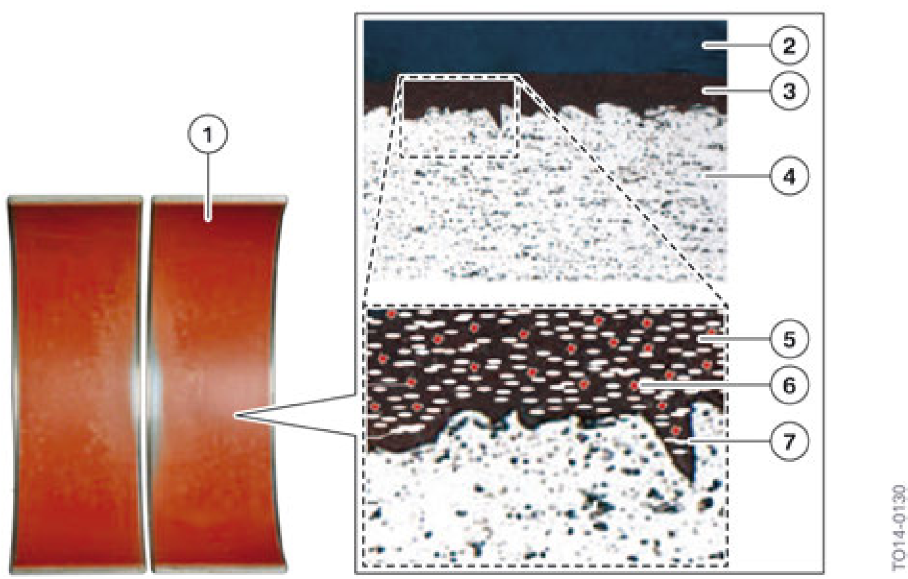
To comply with increasingly stringent exhaust emission regulations, almost all internal combustion engines are now equipped with an automatic engine start/stop system. This has led to a huge increase in starting cycles.

To ensure the engine runs smoothly, it is important that sufficient lubricating oil is supplied to the bearing positions of the crankshaft. If the oil supply can be ensured, solid body contact will not occur between the connecting rod bearing journal and connecting rod bearing shell due to the thin lubricating film.

If the engine is now stopped, it will not be possible for the mechanically driven oil pump to maintain the oil supply. The oil film between the bearing positions flows off. Solid body contact occurs between the connecting rod bearing journal and connecting rod bearing shell. Once the engine is restarted, it takes a certain amount of time for the lubricating film to fully re-establish itself. The connecting rod bearing shell may be subject to wear in this short period. The IROX coating reduces this wear to a minimum.

The IROX-coated bearing shells are only located on the connecting rod side as here the load acts mainly on the bearing shells. The bearing shell caps are equipped with a bearing shell without IROX coating.

The IROX bearings are red due to their special coating.



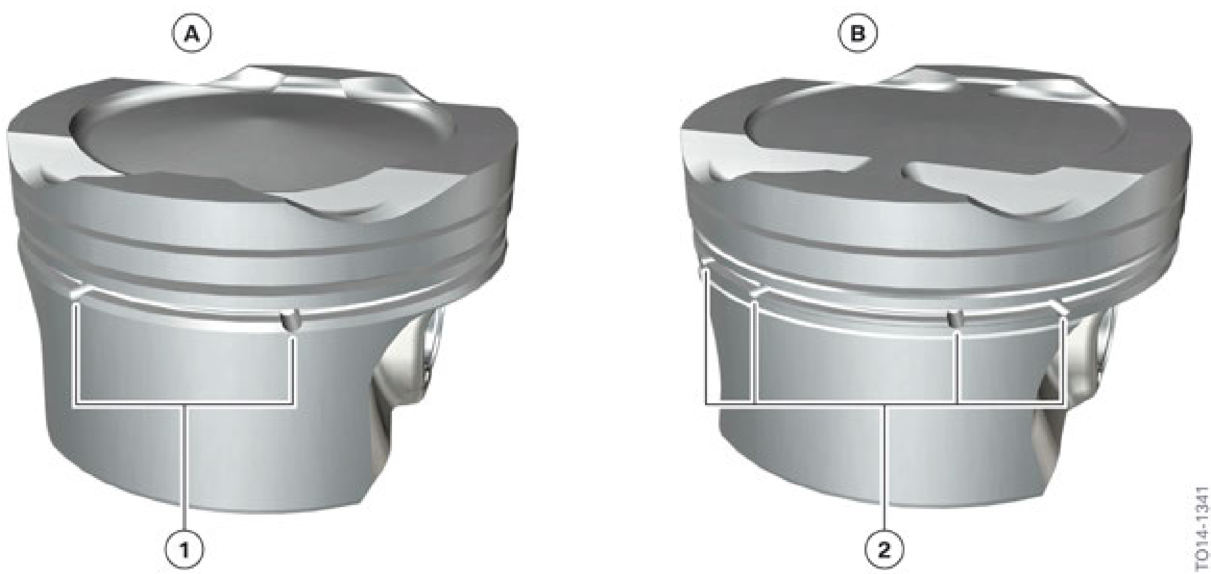
N74TU engine, detailed magnification of the IROX coating

Index	Explanation
1	IROX-coated bearing shell
2	Oil film
3	IROX coating
4	Bearing shell
5	Binding resin
6	Hard particle
7	Solid lubricant

The IROX coating is applied to a conventional bearing shell. It consists of a binding resin matrix made of polyamide-imide with embedded hard particles and solid lubricants. The polyamide-imide ensures, in combination with the hard particles, that the bearing shell surface is so hard that material abrasion is no longer possible. The solid lubricants reduce surface friction and replace the oil film which briefly no longer exists between the bearing shell and the connecting rod bearing journal during the starting phase.

2.2.3. Piston

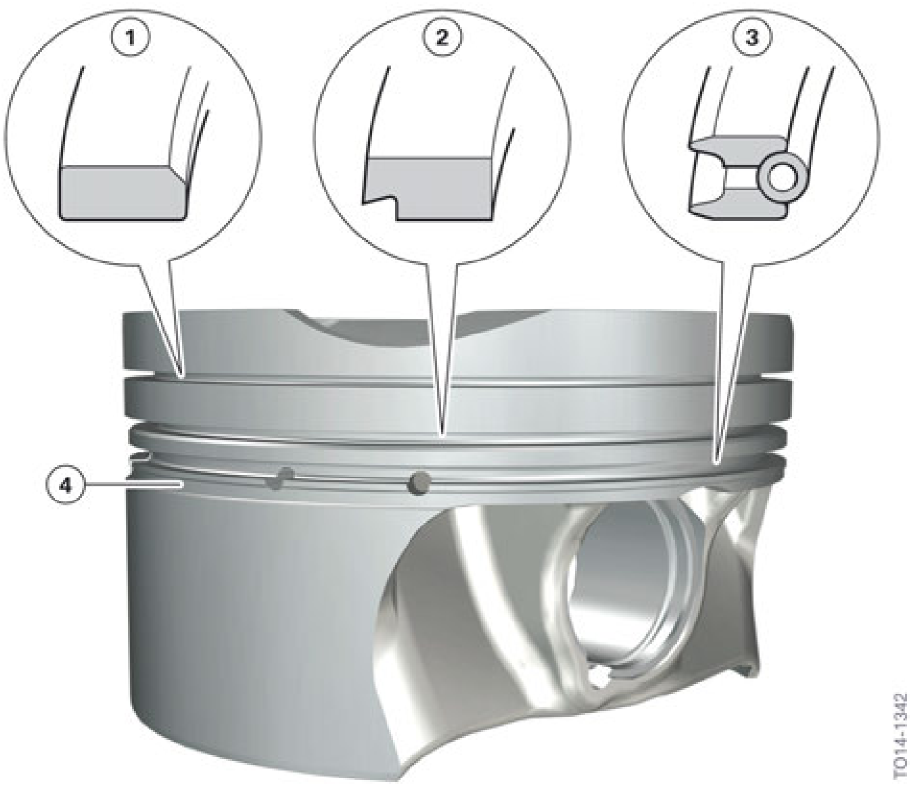
The N74TU engine pistons have been carried over from the N63TU2.



N74TU engine, piston comparison

Index	Explanation
A	N74 Piston
B	N74TU Piston
1	4 oil drains
2	8 oil drains

In order to improve the drainage of oil in the N74TU engine, the piston was fitted with an additional oil groove underneath the oil scraper ring groove, as on the N63TU2 engine. The additional oil groove works with 8 oil outlets in the piston skirt to help remove oil pushed down by the oil scraper ring during the piston's downward motion. This prevents the oil from being carried past the piston rings, in particular when the engine is in coasting overrun mode (during which a vacuum is generated in the combustion chamber).



N74TU engine, cast pistons with piston rings

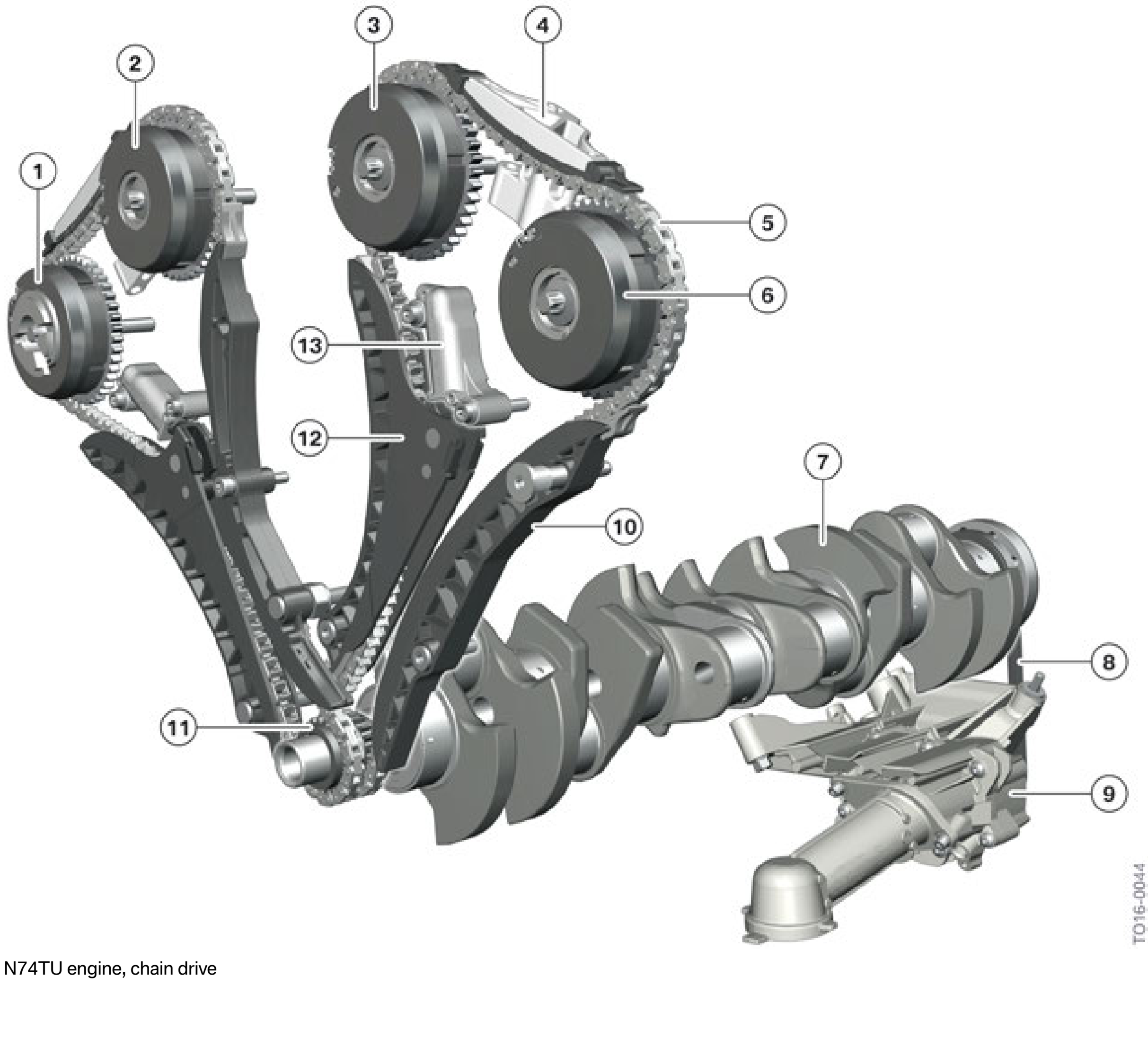
Index	Explanation
1	Plain rectangular compression ring
2	Taper faced piston ring (NM-ring)
3	Oil scraper ring with spiral expander (DSF ring)
4	Additional oil groove

2. Engine Mechanical

2.3. Camshaft drive/chain drive

The entire chain drive for driving the camshafts on the N74TU engine has been taken over from the N74 engine. An inverted-tooth sleeve-type chain for each cylinder bank is used to drive the camshafts, as is the case with the N74 engine. The inverted-tooth sleeve-type chain combines the benefits of the inverted-tooth and sleeve-type chains: high wear resistance and low noise emissions. This is supplied with oil via the oil spray nozzle in the chain tensioner. Tensioning rail, guide and slide rails are now different parts for both banks. The tensioning rail with an integrated thrust piece is made completely from plastic.

The N74TU engine, as seen already in the N74 engine and in contrast to the N63TU2, is secured to the firing TDC of the first cylinders. The same special tool is required for securing, however. It is placed on the torsional vibration damper and is the reference point for the crankcase alignment pin.



N74TU engine, chain drive

Index	Explanation
1	VANOS unit, exhaust side
2	VANOS unit, intake side
3	VANOS unit, intake side
4	Slide rail with oil supply
5	Sleeve-type chain for camshaft drive
6	VANOS unit, exhaust side
7	Crankshaft
8	Sleeve-type chain for oil pump drive
9	Characteristic map-controlled oil pump
10	Slide rail
11	Crankshaft gear
12	Tensioning rail
13	Chain tensioner

2.3.1. Chain tensioner

The hydraulic chain tensioners are the same as those used in the N74 engine. The N74TU engine features one chain tensioner for each cylinder bank. This is a hydraulic chain tensioner used on a tensioning rail. It is positioned in a space-saving configuration inside the chain track.

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Prior to removal, the chain tensioner must be fully retracted and secured using the relevant special tool. Refer to the procedure in the repair instructions.

N74TU Engine

2. Engine Mechanical

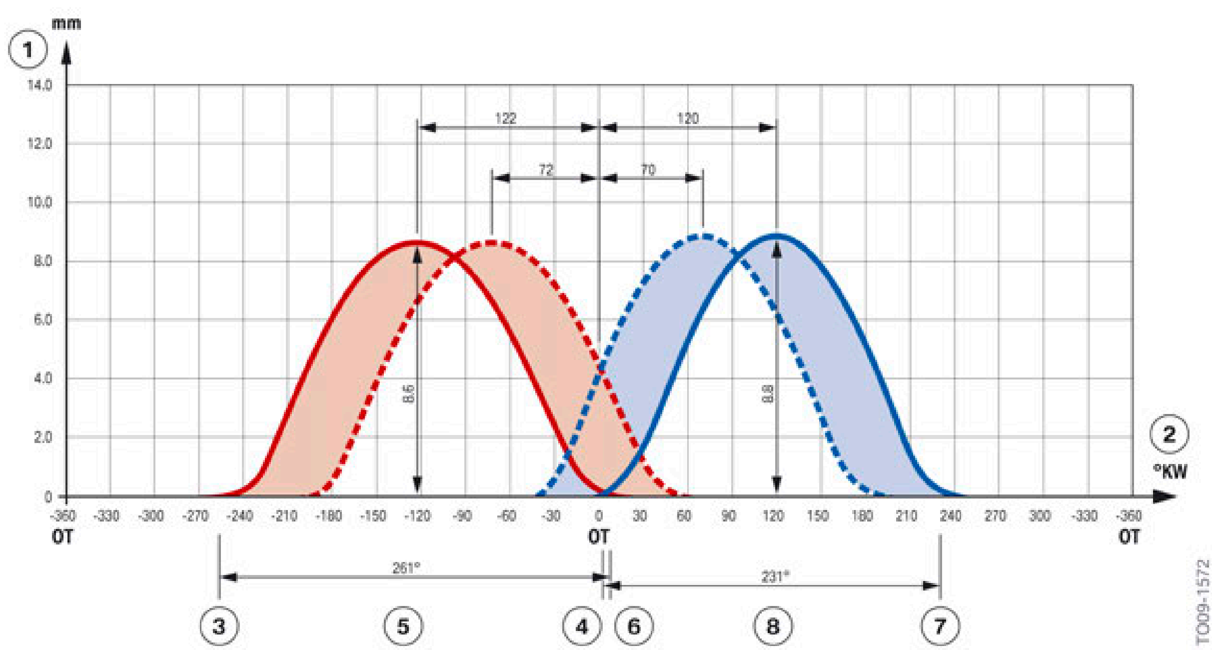
2.4. Valve gear

2.4.1. Camshafts

The N74TU engine possesses the known camshafts in a lightweight construction. All cams are forced onto knurled points. As with the N63TU2 engine, the camshafts are thermally joined and have forged cams, a steel flange for the VANOS units (including AF and mounting flats for the special tool) and a toothed wheel as a reference for the camshaft sensor. The intake camshafts also each have one triple cam to drive the high pressure pumps.

2.4.2. Valve opening times

In the context of gas exchange, the valve opening times have been optimized for this mixture preparation.



N74TU engine, valve cams

Index	Explanation
1	Valve lift [mm]
2	Crankshaft degrees [°KW]
3	Exhaust valve open
4	Intake valve open
5	Opening period of exhaust valve
6	Exhaust valve closes
7	Intake valve closes
8	Opening period of intake valve

2.4.3. Technical data of valve gear

		N74B66U1
Intake valve dia. / Shaft diameter	[mm]	33.2/6
Exhaust valve dia. / stem dia.	[mm]	29/6
Valve lift intake / exhaust valve	[mm]	8.8/8.6
VANOS adjustment range, intake	[crankshaft degrees]	50
VANOS adjustment range, exhaust	[crankshaft degrees]	50
Spread, intake camshaft	[crankshaft degrees]	55-125
Spread, exhaust camshaft	[crankshaft degrees]	60-115
Opening period, intake camshaft	[crankshaft degrees]	231
Opening period, exhaust camshaft	[crankshaft degrees]	261

2.4.4. VANOS

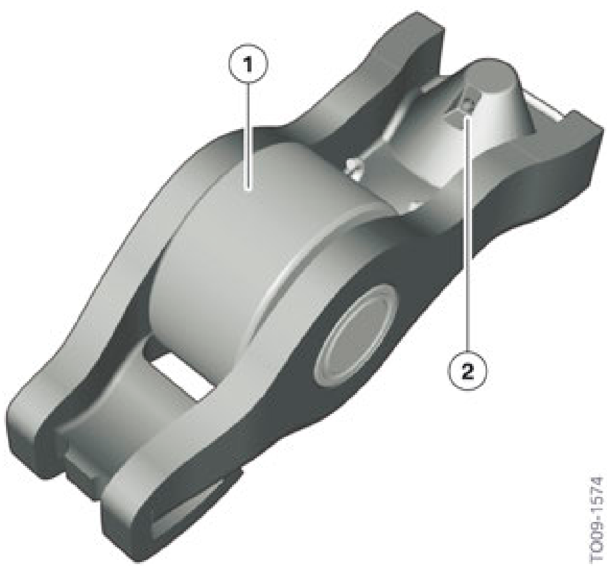
The N74TU is equipped with a continuously variable double VANOS unit. The VANOS units feature the same parts found in the N74 engine. The VANOS units have the following timing angles.

VANOS timing angles:

- VANOS unit intake: 50° crank angle
- VANOS unit exhaust: 50° crank angle

2.4.5. Roller cam follower

Roller cam followers are also used as a transmission element for the movement of the cam on the valves with the N74TU engine. A targeted oil spray bore in the contact surface of the roller cam follower on the hydraulic valve clearance compensating element ensures efficient lubrication. The oil from the hydraulic valve clearance compensating element sprays exactly onto the contact surface between the cam and roller cam follower. In this way, the roller and cam are supplied with oil for cooling and lubrication.



N74TU engine, roller cam follower

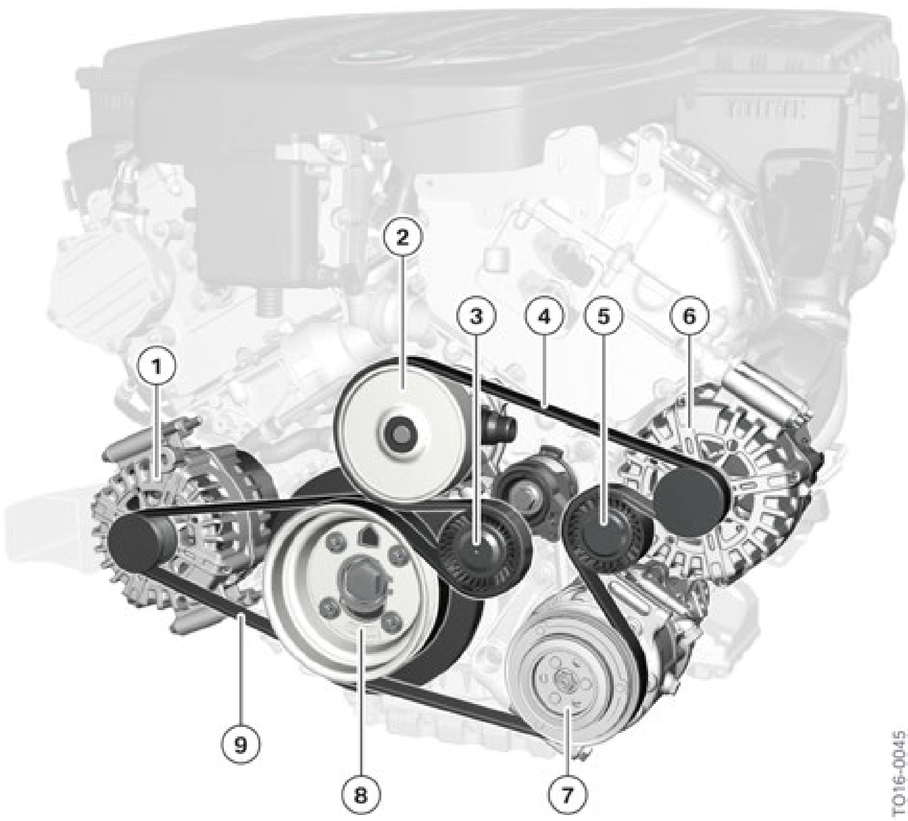
Index	Explanation
1	Roller
2	Oil spray hole

2.4.6. Valves

The intake and exhaust valves both have a shaft diameter of 6 mm. The valve stems in the N74TU engine are not chrome-plated. The exhaust valves are hollow and filled with sodium. This results in improved and quicker heat dissipation.

2.5. Belt drive

The belt drive concept was carried over from the N74 engine. The elimination of the power steering pump means that it was possible to install the air conditioning compressor on the right-hand side of the engine. The belt drive encloses the alternators, coolant pump and air conditioning compressor.



N74TU engine, belt drive

Index	Explanation
1	Alternator
2	Coolant pump
3	Tensioning pulley
4	Ribbed V-belt
5	Idler pulley
6	Alternator
7	Air conditioning compressor
8	Belt pulley at torsional vibration damper
9	Alternator drive belt

The main belt drive has a mechanical tensioning pulley, which provides the necessary tension on the drive belt. The use of a non-toothed belt pulley for the coolant pump drive enables part of the belt wear to be relocated to the tips of the belt ribs. This has a positive effect on the service life of the belt. A patented drainage system on the crankshaft belt pulleys drains off water from between the belt and pulley when there is high water accumulation and water flow.

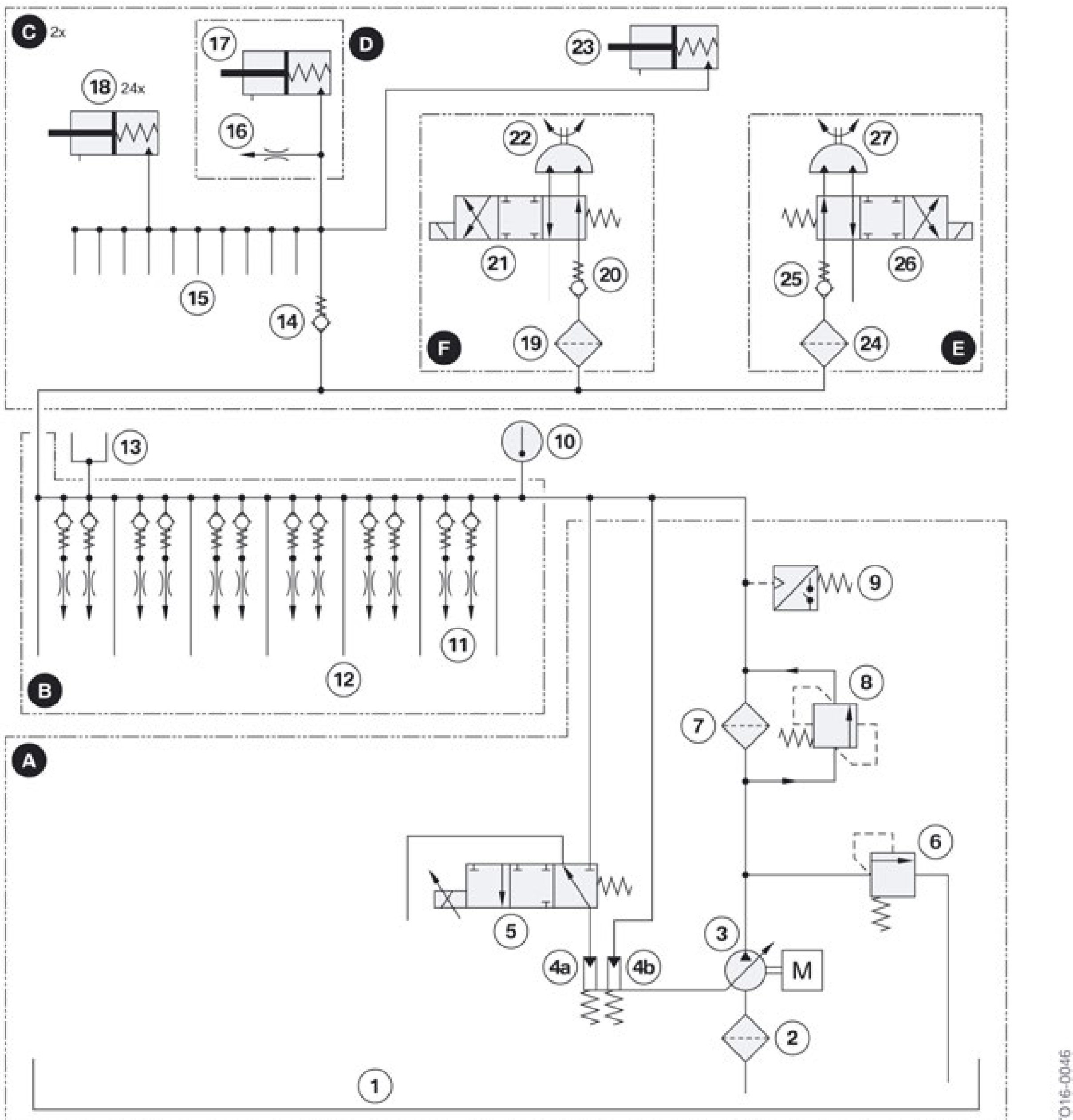
The auxiliary drive for the second alternator also uses a drive belt. The drive belt does not use a mechanical tensioner but is held in place by the torsional vibration damper, similar to the N63TU2. The belt pulley on the torsional vibration damper can be shifted in the direction of the second alternator and makes it possible to remove the ELAST drive belt without the need for special tools. This is made possible by an eccentric slot in the belt pulley, which allows the pulley to be shifted after the four mounting bolts have been removed.

3. Oil Supply

3.1. Overview

The following graphics provide an overview of the oil supply and show the hydraulic circuit diagram and the actual layout of the oil ducts in the engine.

3.1.1. Hydraulic circuit diagram



N74TU engine, hydraulic circuit diagram

N74TU Engine
3. Oil Supply

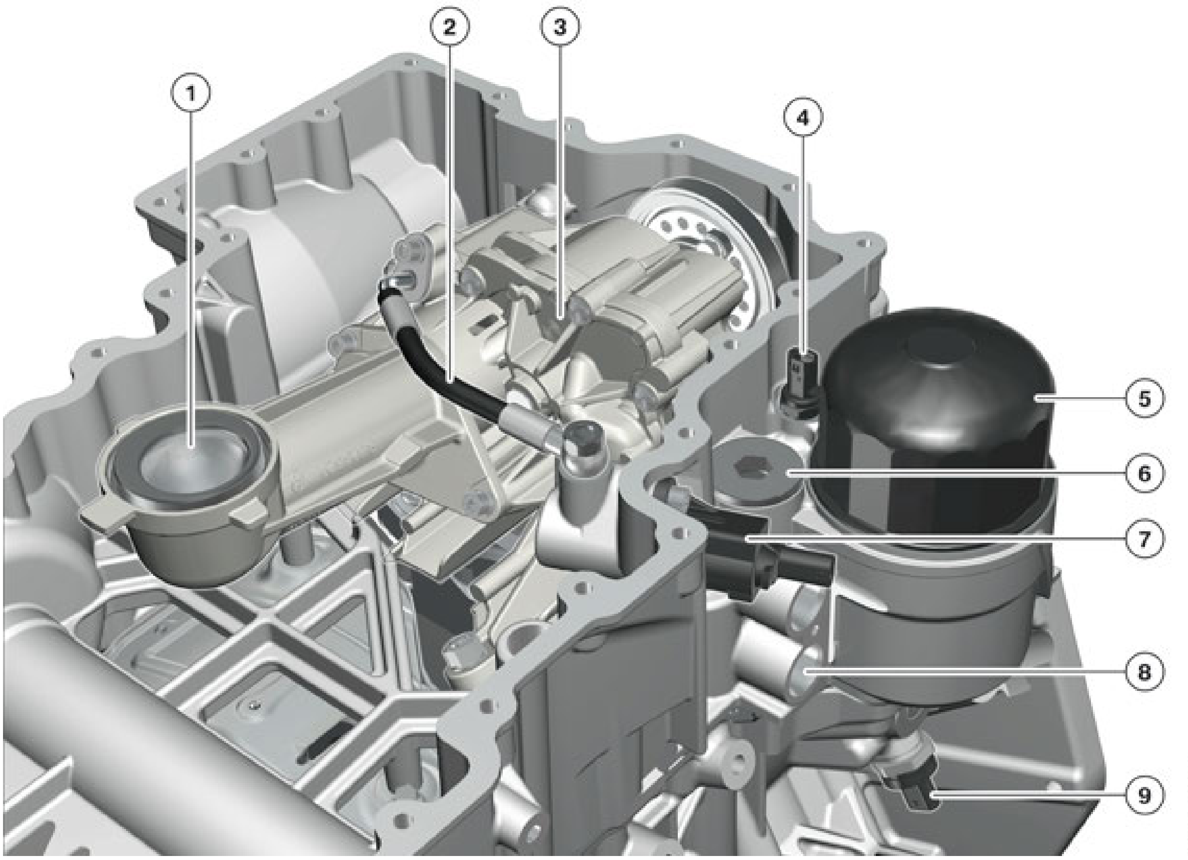
Index	Explanation
A	Oil sump
B	Crankcase
C	Cylinder head 2 x
D	Chain tensioner
E	VANOS valve, intake
F	VANOS valve, exhaust
1	Oil sump
2	Strainer
3	Map-controlled pendulum slide cell pump
4a	Map-controlled control chamber (normal operation)
4b	Second-level control chamber (emergency operation)
5	Map control valve
6	Pressure-limiting valve
7	Oil filter
8	Filter bypass valve
9	Oil pressure sensor
10	Oil temperature sensor
11	Oil spray nozzles for piston crown cooling
12	Lubrication point on crankshaft main bearing
13	Lubrication points on exhaust turbocharger
14	Non-return valve, cylinder head
15	Lubrication points on camshaft bearing
16	Oil spray nozzle for timing chain
17	Chain tensioner
18	Hydraulic valve clearance compensating elements (48 x)
19	Strainer
20	Non-return valve
21	VANOS solenoid valve
22	Swivel motor
23	Slide rail lubrication
24	Strainer
25	Non-return valve
26	VANOS solenoid valve
27	Swivel motor

3.2. Oil pump and pressure control

The N74 engine has a volume-flow-controlled pendulum slide cell pump. In the N74TU, this is supplemented by the familiar characteristic map control from other BMW engines.

The volume-flow-controlled pendulum slide pump (supplemented by the characteristic map control) is driven at the rear by the crankshaft via a sleeve-type chain.

The actual oil pressure is recorded via an oil pressure sensor and forwarded to the Digital Motor Electronics (DME). A target/actual comparison takes place in the DME on the basis of stored characteristic maps. The map-controlled valve is activated by means of a pulse-width modulated signal until the nominal pressure stored in the characteristic map has been reached. During this process, the delivery rate of the oil pump varies according to the oil pressure in the oil duct to the map-controlled chamber. However, the main function of the volume-flow-controlled pendulum slide cell pump is identical to the existing pendulum slide cell pump.



N74TU engine, map control for components

Index	Explanation
1	Intake neck
2	Map-control line
3	Oil pump
4	Oil temperature sensor

Index	Explanation
5	Oil filter
6	Engine oil cooling thermostat
7	Map control valve
8	Connections to engine oil cooler
9	Oil pressure sensor

Information on the operating principle of a volume-flow-controlled oil pump can be found in ST501 Engine Technology "N63 Engine" reference material available on TIS.

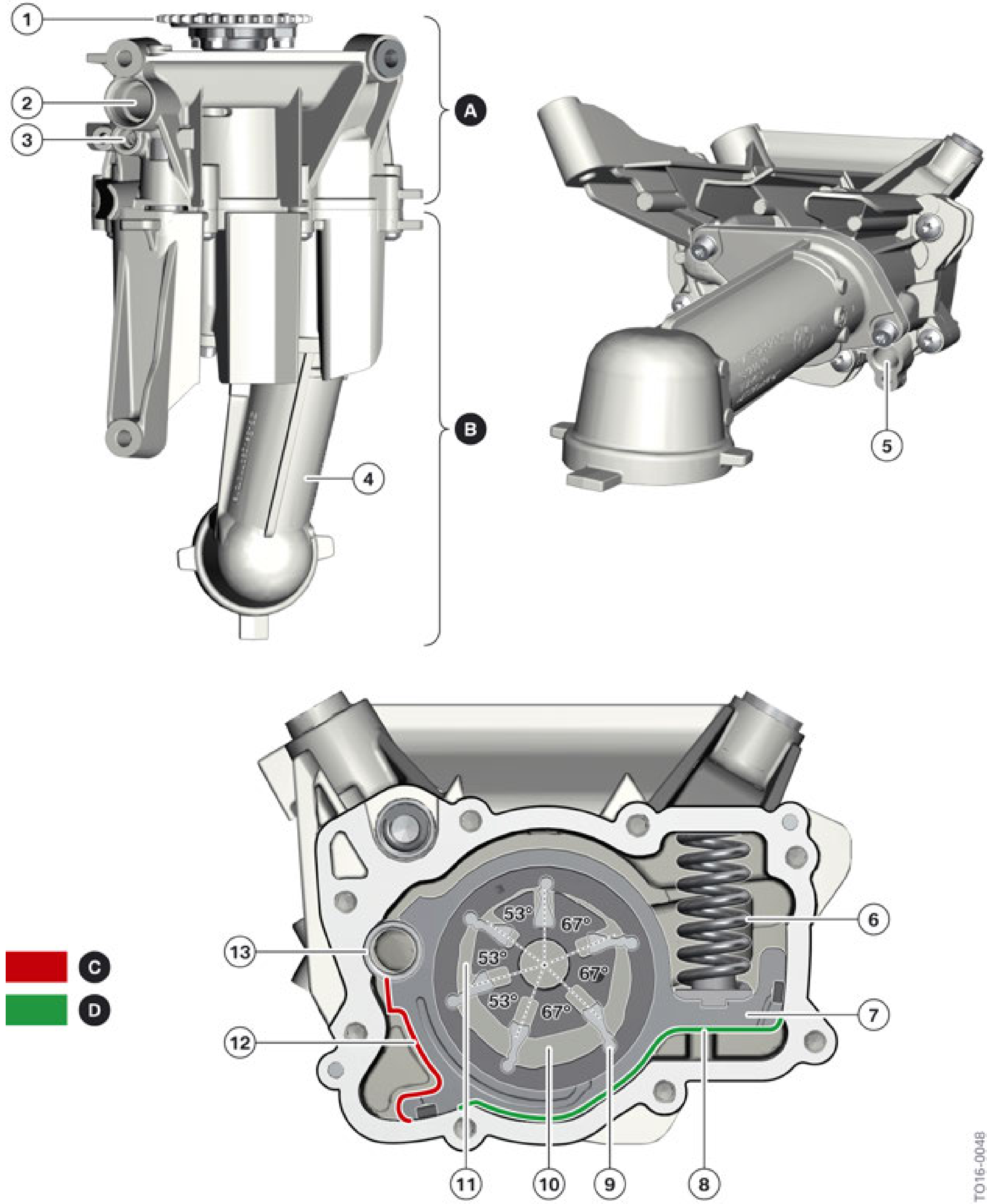
3.2.1. Oil pump

The oil pump plays a central role in modern combustion engines. Due to the high power and enormous torque present even at low engine speeds, it is necessary to ensure a reliable oil supply. This is necessary on account of the high component temperatures and heavily loaded bearings. To minimize fuel consumption, the delivery rate of the oil pump must be adapted to the demand.

Compared against the simple volume flow control provided by the pendulum slide cell pump in the N74 engine, on the N74TU engine this volume flow control has been supplemented with a characteristic map.

In order to meet acoustic requirements, the oil pump is designed as an asymmetrical 6-chamber pendulum slide cell pump. This has been made possible as the chamber sizes are different. The chamber sizes vary from chamber to chamber and have different angles. As such, 3 chambers each with 53° and 3 chambers with 67° are used. The difference in chamber size causes irregular pulsations from the oil pressure (which are otherwise regular). This measure has improved the acoustic characteristics of the oil pump.

N74TU Engine
3. Oil Supply



N74TU engine, oil pump design

N74TU Engine

3. Oil Supply

Index	Explanation
A	Oil pump
B	Oil pump cover
C	Second-level control area (emergency operation)
D	Map-controlled control area (normal operation)
1	Oil pump drive
2	Oil pressure channel, pump output
3	Oil duct to second-level control chamber
4	Intake pipe with filter
5	Oil duct to map-controlled chamber
6	Adjusting ring spring
7	Adjusting ring
8	Map-controlled sensing area
9	Rotor with pendulum
10	Suction side
11	Major thrust face
12	Second level control surface
13	Bearing tube (center of rotation)

A rotor with pendulum rotates as shown in the graphic on the pump shaft. A crescent-shaped cavity arises through the eccentric position. During this process, the oil is drawn into the expanding chamber (intake side) and is delivered via the contracting chamber (pressure side).

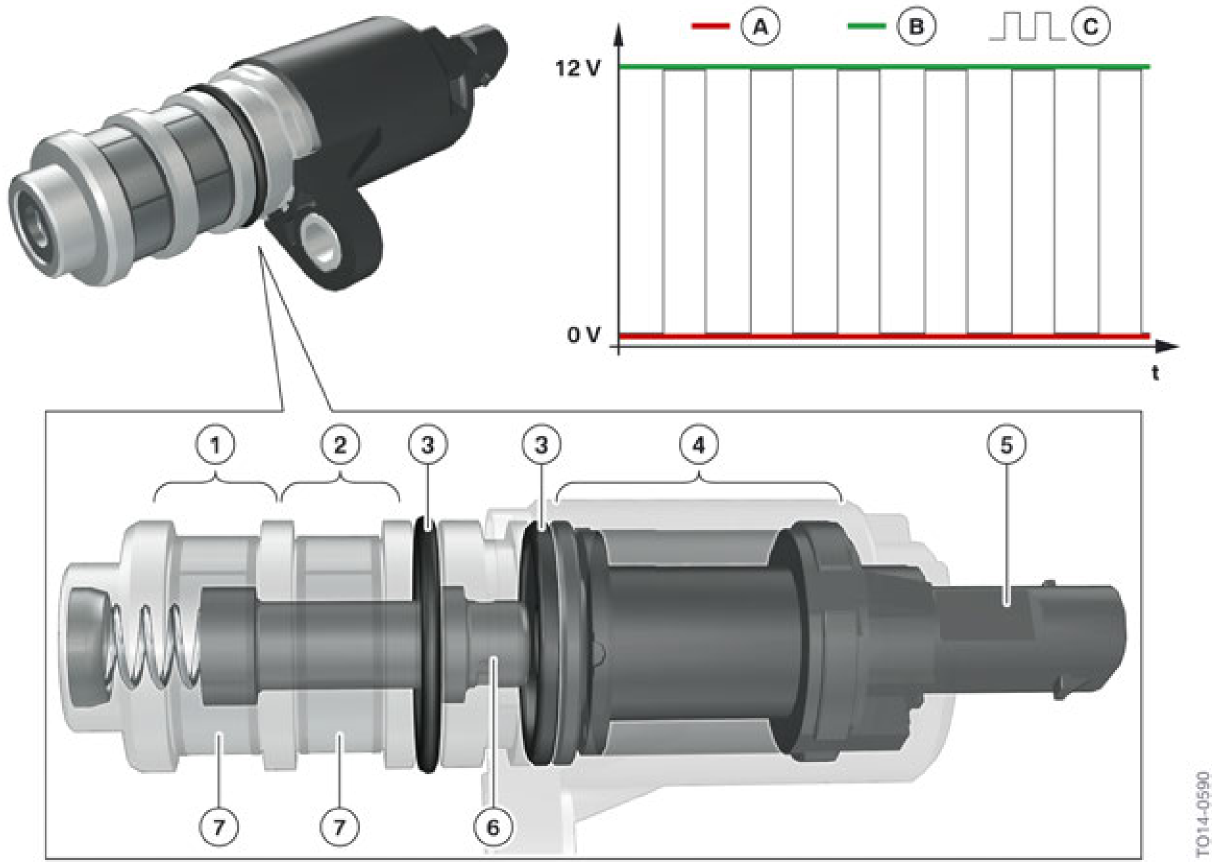
When the engine is in operation, oil pressure is applied to the map-controlled surface and the second-level control surface of the oil pump. Depending on the oil pressure, the adjusting ring is pushed via the center of rotation at the bearing tube to varying degrees of force against the adjusting ring springs. The change in eccentric position of the adjusting ring changes the size of the chamber, and therefore also the intake and pressure power of the oil pump.

To prevent overloading of the oil pump, a filter is installed upstream of the pump inlet. The maximum oil pressure of the oil circuit at the pump outlet is restricted by a pressure limiting valve. The opening pressure of the pressure limiting valve is 23 +/- 1 bar.

3.2.2. Map control valve

The map-control valve in the N74TU engine is installed externally on the upper oil sump section and connected to the oil pump via the map-control line in the oil sump. This design negates the need for interference-prone cable ducts into the oil sump.

The map-controlled valve is a proportional valve which can control the oil pressure steplessly.



N74TU engine, characteristic map control valve

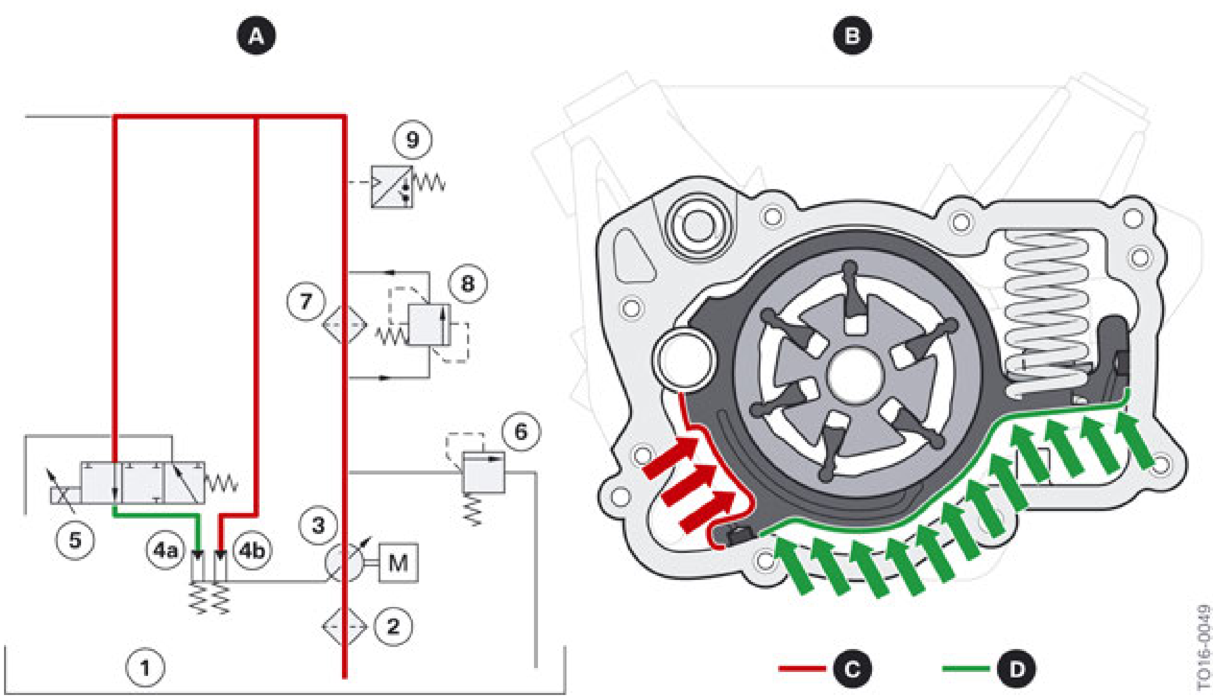
Index	Explanation
A	Voltage value, maximum actuation for control chamber, maximum pressure
B	Voltage value, minimum actuation for control chamber, depressurized
C	Voltage value at 50% actuation
1	Oil duct to oil pump
2	Oil duct from the oil filter
3	Sealing ring

Index	Explanation
4	Solenoid coil
5	Electrical connection
6	Valve spool
7	Filter

The oil pressure sensor is connected to the main oil duct and delivers the actual oil pressure at the Digital Motor Electronics (DME). The DME calculates the required target oil pressure based on the engine's operating point and the temperature. A pulse-width modulated signal is sent to the map-controlled valve based on the determined setpoint deviation. Depending on the pulse-width modulated signal, the width of the valve spool opening in the map-controlled valve varies. Depending on the available opening cross-section, more or less engine oil can flow from the oil duct of the oil filter into the oil duct and to the oil pump. This oil flow changes the position of the adjusting ring in the oil pump, and therefore the delivery rate of the pump.

3.2.3. Normal operation

The oil pump has two separate control loops to ensure both normal operation (standard map control) and emergency operation (second-level control).

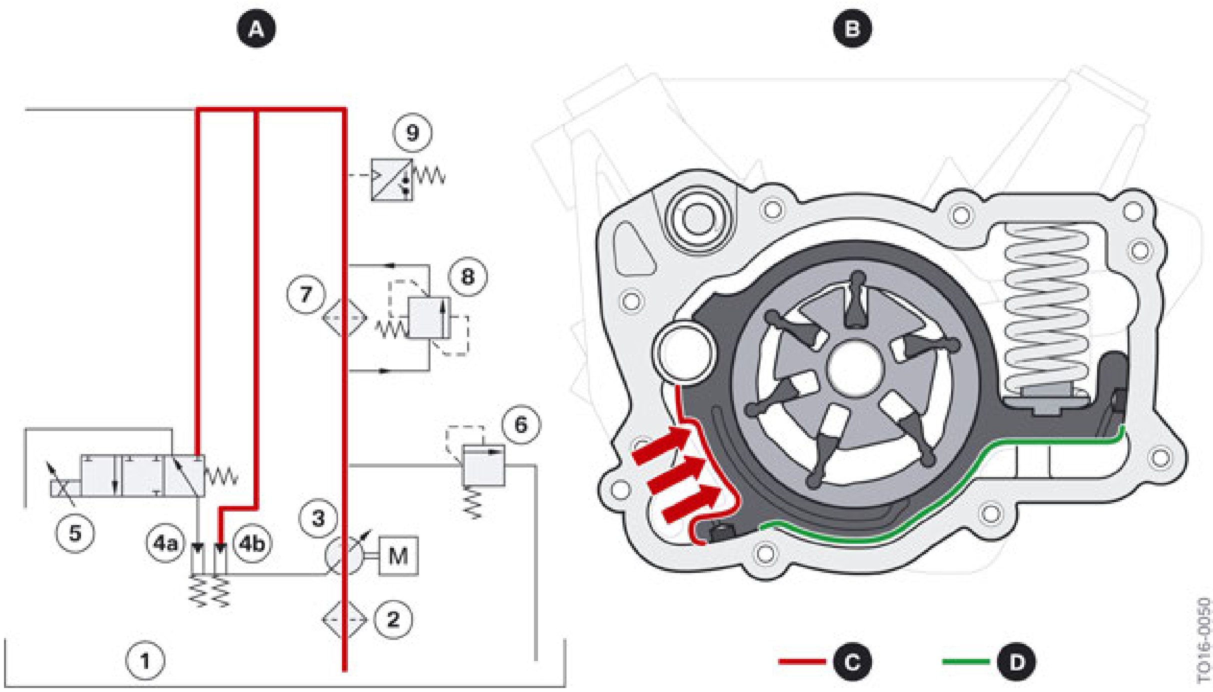


N74TU engine, oil circuit in normal operation

Index	Explanation
A	Hydraulic circuit diagram for normal operation
B	Oil pump in characteristic map control operation (normal operation)
C	Volume-flow-controlled oil pressure, oil pump
D	Characteristic map-controlled oil pressure
1	Oil sump
2	Strainer
3	Characteristic map-controlled pendulum slide cell pump
4a	Map-controlled chamber (normal operation)
4b	Second-level control chamber (emergency operation)
5	Map control valve
6	Pressure-limiting valve
7	Oil filter
8	Filter bypass valve
9	Oil pressure sensor

This control loop operates with an external map-controlled valve. The characteristic map control valve controls the oil pressure in the characteristic map control chamber using software in the DME. If the oil pressure in the characteristic map control chamber increases, the surface difference in the control chambers presses the adjusting ring further against the adjusting ring spring, and the pump eccentricity is reduced. This results in a lower volumetric flow.

3.2.4. Emergency operation



N74TU engine, oil circuit in emergency operation

Index	Explanation
A	Hydraulic circuit diagram for emergency operation
B	Oil pump in emergency operation (second level operation)
C	Volume-flow-controlled oil pressure, oil pump
D	Characteristic map-controlled oil pressure
1	Oil sump
2	Strainer
3	Characteristic map-controlled pendulum slide cell pump
4a	Map-controlled chamber (normal operation)
4b	Second-level control chamber (emergency operation)
5	Map control valve
6	Pressure-limiting valve
7	Oil filter
8	Filter bypass valve
9	Oil pressure sensor

During emergency operation, the system operates without the map control by the Digital Motor Electronics (DME). In this operating condition the characteristic map control valve is de-energized and releases the oil duct from the characteristic map control chamber to the oil sump. The purpose of emergency operation is to keep the oil pump at a constant, volume-flow-controlled oil pressure level. For this purpose, the oil pressure is guided directly from the main oil duct into the second-level control chamber. This then corresponds to the principle of a volume-flow-controlled oil pump without characteristic map control, as on the N74 predecessor engine.

3.3. Oil filter

The N74TU engine has a standard full-flow oil filter. Made from synthetic fleece, the oil filter, like the predecessor model, is screwed in from below into the oil sump. This configuration means that a discharge valve and non-return valve are not required. The filter bypass valve is located in the oil filter cover.

3.4. Oil cooling

The thermostat for engine oil cooling is also integrated in the oil sump. It only allows oil to flow through the oil cooler when a specific oil temperature has been reached. This ensures that the engine oil is warmed quickly. An engine oil heat exchanger is used to cool the oil. This is positioned behind the lining of the front bumper to the front right of the wheel arch.

3.5. Oil spray nozzles

Oil spray nozzles are always used when it is not possible to feed an oil duct directly to the lubricating or cooling points. In the N74TU engine these are the standard positions, namely the oil spray nozzles for piston-head cooling and timing chain lubrication.

3.5.1. Oil spray nozzles for piston crown cooling

The oil spray nozzles used for piston-head cooling in the N74TU engine are the same as those used in the N63TU2 engine. A non-return valve is integrated here to enable it to open and close from a specific oil pressure. The opening pressure and closing pressure have been adjusted compared with the N74 engine. Each cylinder has its own oil spray nozzle, which obtains the correct installation position through its styling. In addition to the piston crown cooling, these are also responsible for the lubrication of the wrist pins.

Function

	N74 engine	N74TU Motor
Opening pressure	1.55-1.85 bar	3.3-3.7 bar
Closing pressure	1.5 bar	3.0 bar

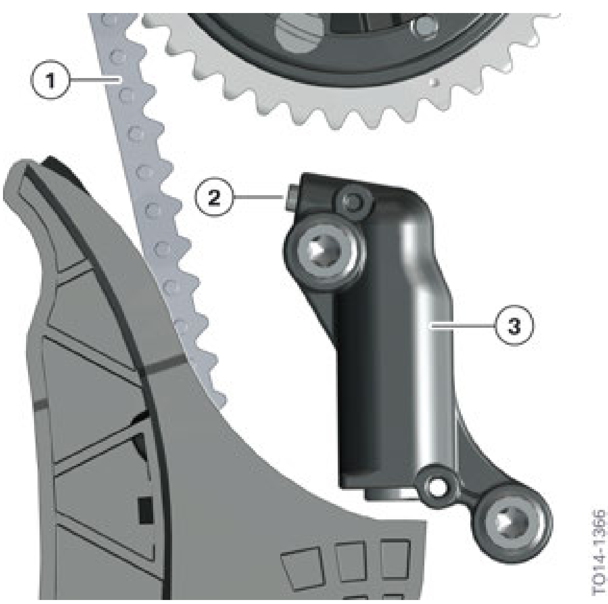
On the N63TU2 engine, the characteristic map control of the volume-flow-controlled oil pump is a key factor in ensuring compliance with the ULEV II particle limit values. Thanks to the volume-flow-controlled oil pump, supplemented by the characteristic map control, the oil pressure can be reduced to under 3.3 bar in the warm-up phase. As a result of this reduction, there is insufficient oil pressure at the oil spray nozzles to open the nozzles. This measure also suppresses the intended function of the oil spray nozzles, namely to cool the piston crowns in the warm-up phase. The effect of this is that the piston crowns heat up faster and thus less fuel is condensed at the cold piston crowns in the warm-up phase, resulting in higher particle values as a result of unburned fuel. When a certain operating temperature is reached, the oil pressure is increased by the characteristic map control of the volume-flow-controlled oil pump, which raises the oil pressure to above the opening pressure for the oil spray nozzles and thus activates the piston crown cooling.

3.5.2. Chain drive

The chain drive in the N74TU engine is divided into an upper section, the camshaft drive, and a lower section, the oil pump drive.

Camshaft drive

The oil spray nozzles for the lubrication of the timing chains are integrated in the respective chain tensioner of the banks. They spray the oil directly onto the timing chain. A throttle in the oil spray nozzle limits the emerging oil. The timing chain of the camshaft drive is designed as a toothed sleeve-type chain.



N74TU engine, chain tensioner with oil spray nozzle for timing chain

Index	Explanation
1	Toothed sleeve-type chain with 142 elements
2	Oil spray nozzle
3	Chain tensioner

Oil pump drive

The oil pump is driven via a sleeve-type chain by the crankshaft. The sleeve-type chain is kept tensioned by a tensioning rail. The secondary drive is lubricated via the oil sump.

3.5.3. Camshaft

The oil supply of the chain tensioner, the hydraulic valve clearance compensating elements and the bearing positions in the cylinder head is effected via a rising pipe from the engine housing in the cylinder head. A non-return valve in the cylinder head in the rising pipe prevents the oil duct idling.

3.6. Oil monitoring

3.6.1. Oil level

The latest-generation oil-level sensor is used in the N74TU engine to monitor the oil level. The oil-level sensor is a PULS 3 oil-level sensor. The PULS 3 oil-level sensor is characterized by new control electronics with faster and more robust starting characteristics. The abbreviation "PULS" stands for "Packaged Ultrasonic Level Sensor" and, as the name implies, ultrasonic measuring technology is used as the basis. The oil-level sensor is screwed into the oil sump from below and, in addition to the oil level, also measures the oil temperature using an ultrasonic method. The measuring range of the oil-level sensor is 18 mm to 95.8 mm. If engine oil is temporarily over-filled, an air bubble in the cap area stops any engine oil from entering the oil-level sensor.

⚠

In addition to the oil-level sensor, an oil dipstick is installed in the N74TU engine and can be identified by a protective cap in the engine compartment.

3.6.2. Oil pressure sensor

When it comes to monitoring oil pressure, in contrast to the oil pressure switch used in the N74 engine, an oil pressure sensor is used. This is installed above the oil filter module.

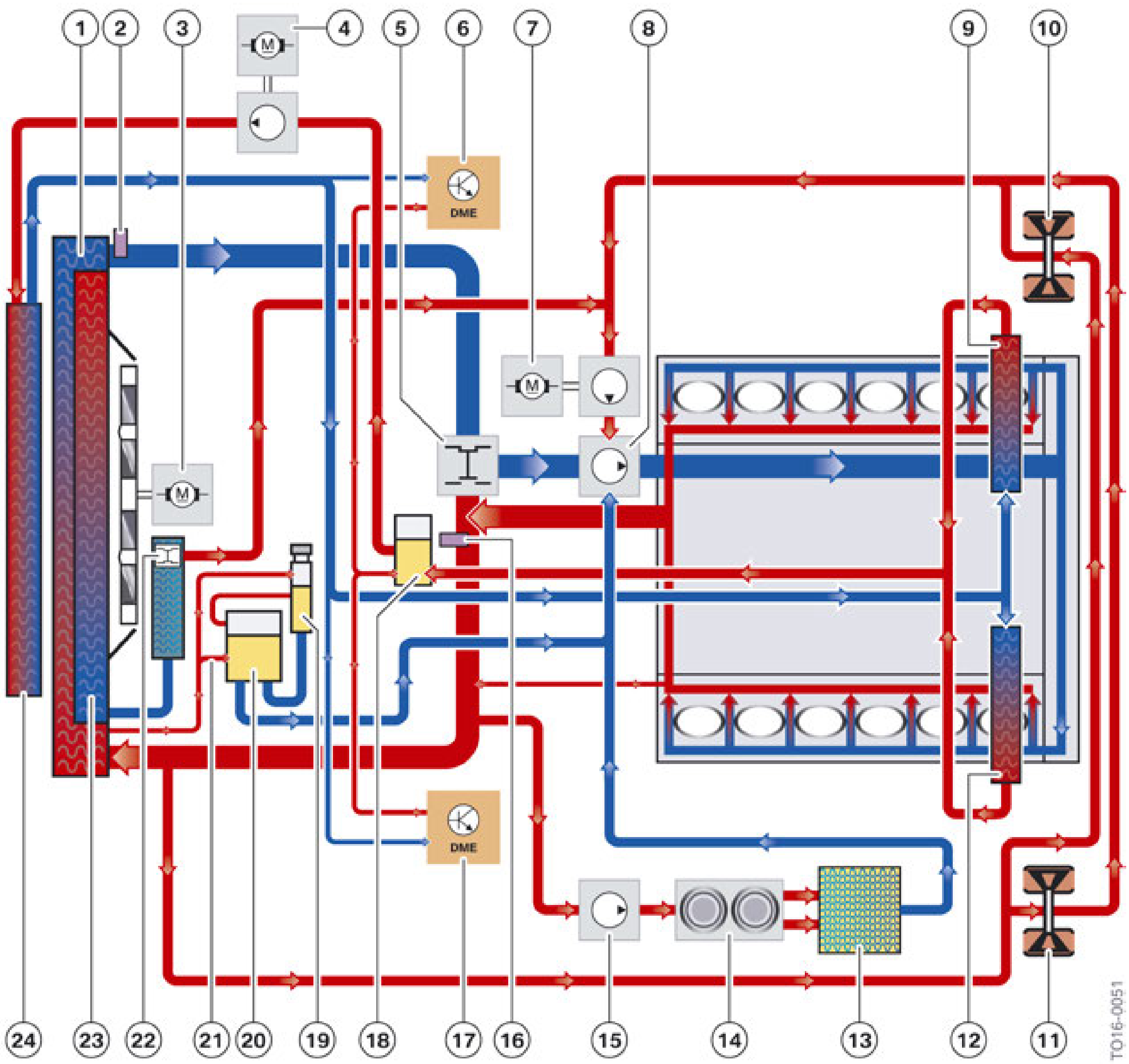
3.6.3. Oil temperature sensor

In addition to the oil temperature sensor in the oil-level sensor, an oil temperature sensor in installed in the pressure oil duct. This engine oil temperature sensor is a new part for the N74TU engine. In contrast, on the N74 engine the engine oil temperature was modelled using various parameters. The engine oil temperature sensor is used to monitor the oil temperature once it leaves the engine oil air heat exchanger. Based on the temperature reading, dynamic heat transfer is adjusted using the thermostat to warm up or cool the engine oil.

4. Cooling System

The N74TU engine also has separate coolant circuits for engine and charge air cooling. The cooling of both control units of the Digital Motor Electronics (DME) has been integrated into the coolant circuit of the charge air cooling. The coolant circuit for the engine and exhaust turbochargers is also called the high-temperature coolant circuit. The coolant circuit for the charge air cooling and DME control units is known as the low-temperature coolant circuit.

4.1. System overview



N74TU engine, cooling circuit

Index	Explanation
1	Radiator
2	Coolant temperature sensor at radiator outlet
3	Electric fan
4	Electric coolant pump for the cooling circuit of the charge air and DME
5	Map thermostat with heating element
6	Digital Motor Electronics (DME 1)
7	Electric auxiliary water pump for exhaust turbocharger cooling
8	Coolant pump
9	Charge air cooler, bank 1
10	Turbocharger, cylinder bank 1
11	Turbocharger, cylinder bank 2
12	Charge air cooler, bank 2
13	Heat exchanger
14	Duo valve
15	Electric auxiliary coolant pump for vehicle heating
16	Coolant temperature sensor at engine outlet
17	Digital Motor Electronics (DME 2)
18	Expansion tank, low-temperature circuit
19	Filling cup
20	Expansion tank, high-temperature circuit
21	Ventilation line, high-temperature circuit
22	Thermostat for transmission oil cooling
23	Radiator for transmission oil cooling
24	Cross-flow cooler for the cooling circuit of charge air and DME

4.2. Cooling circuit, engine

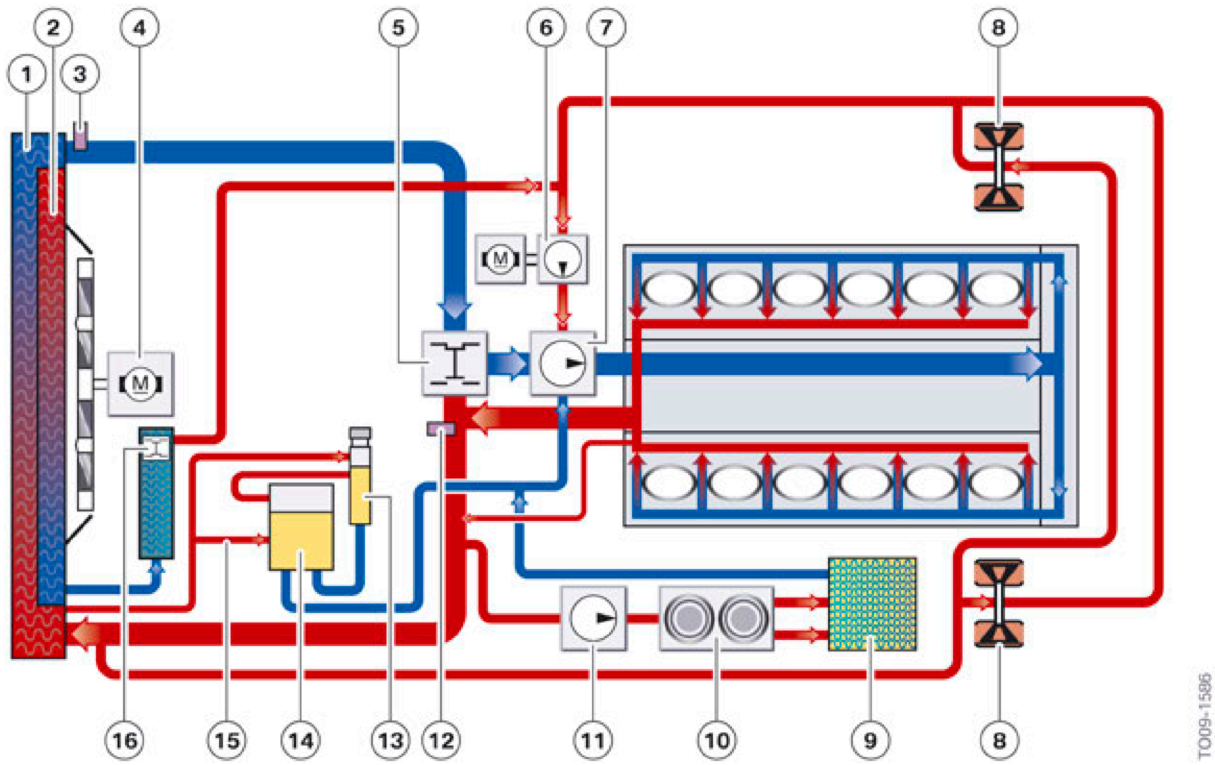
The engine cooling system is an independent coolant circuit known as the **"high-temperature circuit"**. It comprises the conventional engine cooling and cooling of the turbochargers. Even the vehicle interior heating is supplied by the coolant circuit of the engine cooling system.

An external radiator is connected on the left and right in the direction of travel, parallel to the coolant circuit. The additional radiator is equipped with a non-return valve with compression spring to prevent a return by the electric auxiliary water pump in the case of a low volumetric flow of the coolant.

The electric fan has a nominal power of 1000 W.

The following graphics show the installation locations and layout of the components.

N74TU Engine
4. Cooling System



N74TU engine, coolant circuit for engine cooling

Index	Explanation
1	Radiator
2	Radiator for transmission cooling
3	Coolant temperature sensor at radiator outlet
4	Electric fan
5	Map thermostat with heating element
6	Electric auxiliary coolant pump for exhaust turbocharger cooling
7	Coolant pump
8	Exhaust turbocharger
9	Heat exchanger
10	Duo valve
11	Electric auxiliary coolant pump for vehicle heating
12	Coolant temperature sensor at engine outlet
13	Filling cup
14	Expansion tank
15	Ventilation line, high-temperature circuit
16	Thermostat

4. Cooling System

With the N74TU engine, the coolant guides are usually integrated in the crankcase, as is already the case with the N74 engine.

The coolant inlet after the coolant pump in the engine is located directly next to the main oil duct. The oil in the main oil duct flows contrary to the coolant flow. This ensures excellent heat exchange between the two media, which has a positive impact on the engine oil temperature. The effect is comparable to that of an engine oil coolant heat exchanger.

The coolant in the cylinder heads flows across from the outside to the inside, whereby the coolant flows from the rear (outside) to the front (inside). This is also referred to as diagonal cooling.

4.2.1. Coolant pumps

Engine coolant pump

The engine cooling is ensured using a conventional mechanical coolant pump with characteristic map thermostat. The impeller diameter is 70 mm.

Auxiliary coolant pump for the exhaust turbocharger

As the mechanical coolant pump is driven by a belt, it cannot be used to cool the exhaust turbochargers after the engine has shut down. For this reason, there is also an auxiliary electric coolant pump for this coolant circuit. The pump operates at 15 W and is controlled via the DME with a pulse-width modulated signal. During engine operation, taking into account the coolant temperature at the engine outlet, the auxiliary electric coolant pump is also activated from 93 °C / 199 °F.

The after-run of the electric auxiliary coolant pump can last up to 30 minutes for a stationary engine and when the ignition is turned off. This is calculated on the basis of the following values.

Calculated values:

- Engine oil temperature
- Injected fuel quantity
- Intake air temperature
- Exhaust-gas temperature
- Fuel temperature

The electric fan can continue running for up to 11 minutes.

⚠

The auxiliary coolant pump for the turbocharger must not be dropped. Auxiliary coolant pumps that have been dropped may not be installed and must be replaced.

⚠

The cooling system (high-temperature coolant circuit) can be filled using the familiar vacuum filler device. Please consult the repair instructions in the ISTA workshop information system for details of other approved methods of ventilation.

4.2.2. Data-map thermostat

The N74TU engine is equipped with a map-controlled thermostat.

The functionality of the map-controlled thermostat is unchanged from the N74 engine. In non-electrically regulated operation, the thermostat's technical data is as follows.

Thermostat technical data:

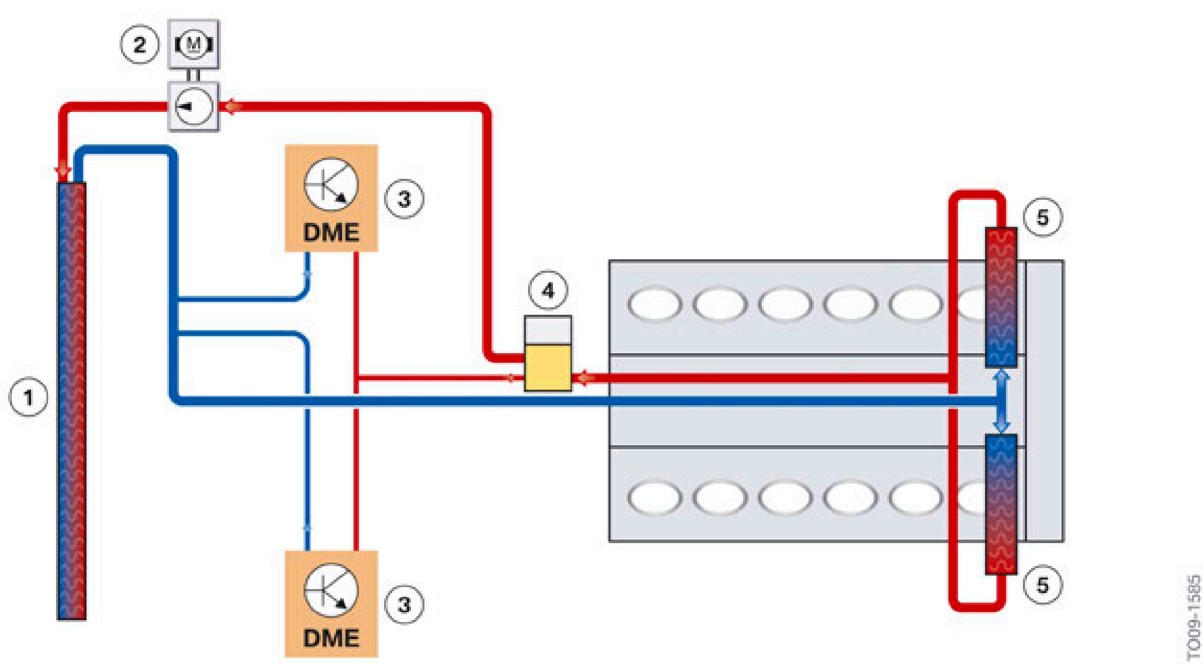
- Opening start at 105 °C / 221 °F
- Complete opening at 120 °C / 248 °F

In addition, an electric heater in the map thermostat can be used to make the thermostat open at a lower coolant temperature.

4.3. Cooling circuit of charge air cooler and DME

For charge air cooling, the system again makes use **"indirect"** charge air cooling, which is cooled by a separate coolant circuit, the **"low-temperature circuit"**.

An electric coolant pump is used for the coolant circuit of the charge air coolers and DME control units with an independent cooling system. The coolant circuit for the charge air cooling and Digital Motor Electronics (DME) contains a cross-flow radiator and 2 indirect charge air coolers.



N74TU engine, coolant circuit for charge air cooling

Index	Explanation
1	Radiator for the charge air cooling
2	Electric coolant pump for charge air cooling
3	Digital Motor Electronics (DME)
4	Expansion tank
5	Charge air cooler

4.3.1. Auxiliary coolant pump for charge air cooling

The coolant circuit for charge air cooling is powered by an 80 W pump, which is controlled via the DME using a pulse-width modulated signal. It does not operate automatically when the engine is ON. The following values are used for activation.

Activation values:

- Ambient temperature.
- Difference between charge air temperature and ambient temperature.

The 80 W pump has a self-diagnosis function and dry-run protection. If the engine speed is increased by 15 minutes over a period, the auxiliary water pumps are switched off and a fault code is stored in the DME. The expansion tank does not have a coolant level switch and does not automatically detect when the fluid level is too low.

⚠

If the coolant pump is removed and then to be reused, it is important to ensure that it is set down still filled with coolant. Drying out may cause the bearing positions to stick. Failure to follow this procedure may result in the coolant pump possibly not starting, which in turn may result in engine damage.

Before installing, turn the impeller manually to ensure that it moves freely.

4.3.2. Charge air cooler

The charge air coolers are installed at the rear end of the cylinder heads. They operate according to the counter-flow principle and enable efficient charge air cooling.

4.3.3. Engine control unit

Both engine control units are also cooled between the coolant circuit and charge air cooling. This is possible thanks to a cooling loop located on the control unit housing. This is connected to the low-temperature cooling circuit used for charge air cooling.

⚠

For details of the workflows for filling and bleeding the low-temperature coolant circuit, please see the repair instructions in the ISTA workshop information system.

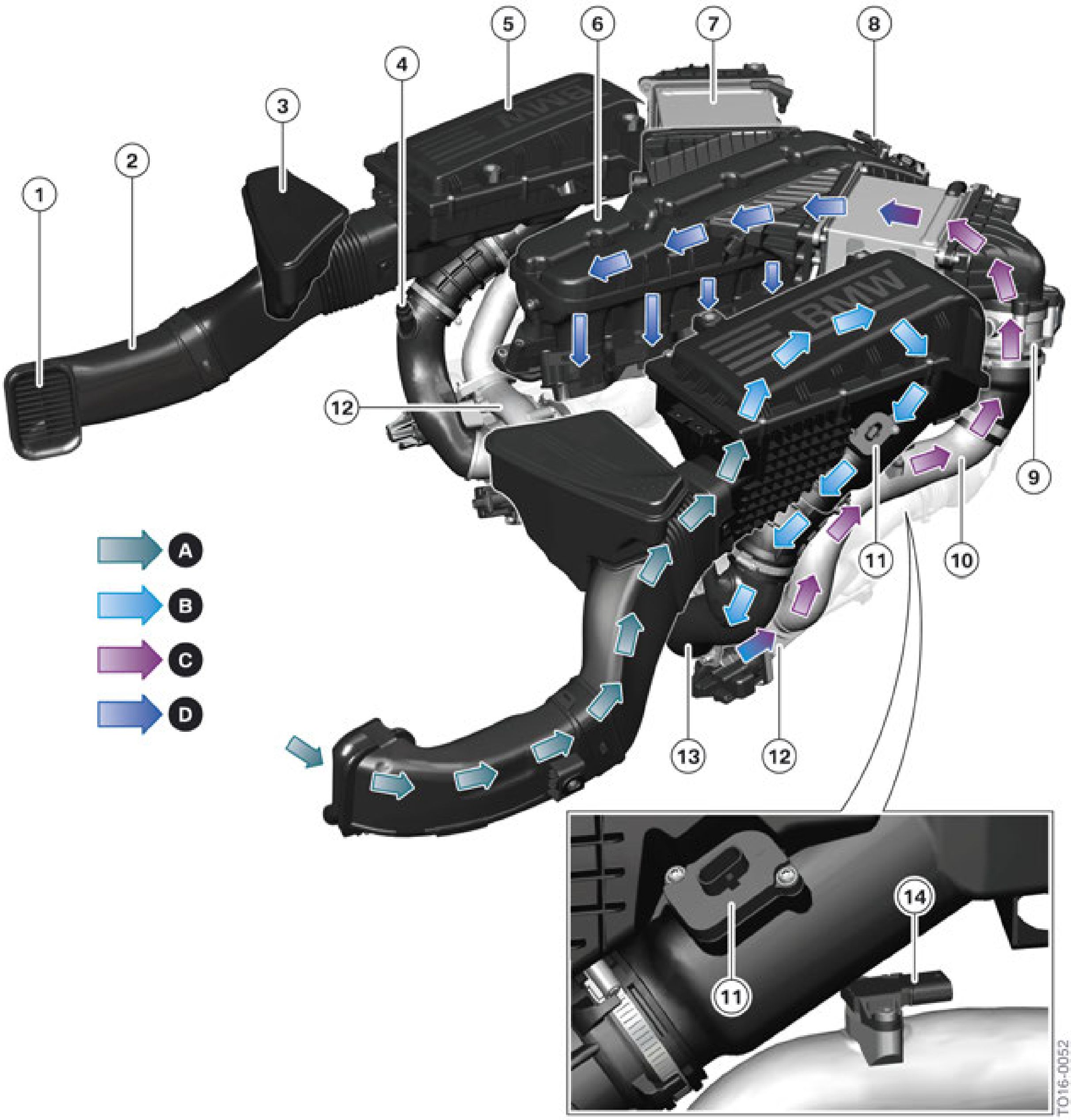
N74TU Engine

5. Intake Air and Exhaust System

The intake and exhaust emission systems are in principle comparable with those in the N74 engine. The following list summarizes the most important modifications made to the intake air and exhaust emission system.

Modifications:

- Hot film air mass meter 7.
- Four identical temperature pressure sensors, whereby in the intake system only the charging pressure is measured and in the charge air pipe the pressure and temperature values are measured.
- Monitoring sensor changed over to LSF Xfour.
- Biturbocharging using two conventional turbochargers with electric wastegate valve controllers.
- Use of electrical exhaust flaps in the rear silencer.



N74TU engine, intake air system

Index	Explanation
A	Fresh air
B	Purified air
C	Clean air warmed
D	Clean air cooled
1	Unfiltered air intake
2	Unfiltered air pipe

5. Intake Air and Exhaust System

Index	Explanation
3	Raw air resonator
4	Connection, crankcase ventilation, turbocharged mode
5	Intake silencer
6	Intake manifold
7	Charge air cooler
8	Charging pressure sensor
9	Throttle valve
10	Charge air pipe
11	Hot film air mass meter
12	Exhaust turbocharger
13	Clean air pipe
14	Charge air temperature charging pressure sensor

5.1. Air intake duct

The air intake duct is dual-flow with engine-mounted intake silencers. This configuration boasts minimum pressure losses on the intake and pressure sides. The air is sucked in on both sides behind the BMW radiator grille. A raw air resonator on each side optimizes the system's acoustic characteristics.

The throttle valves are located directly in front of the charge air coolers. As with the N74 engine, the N74TU features indirect charge air cooling.

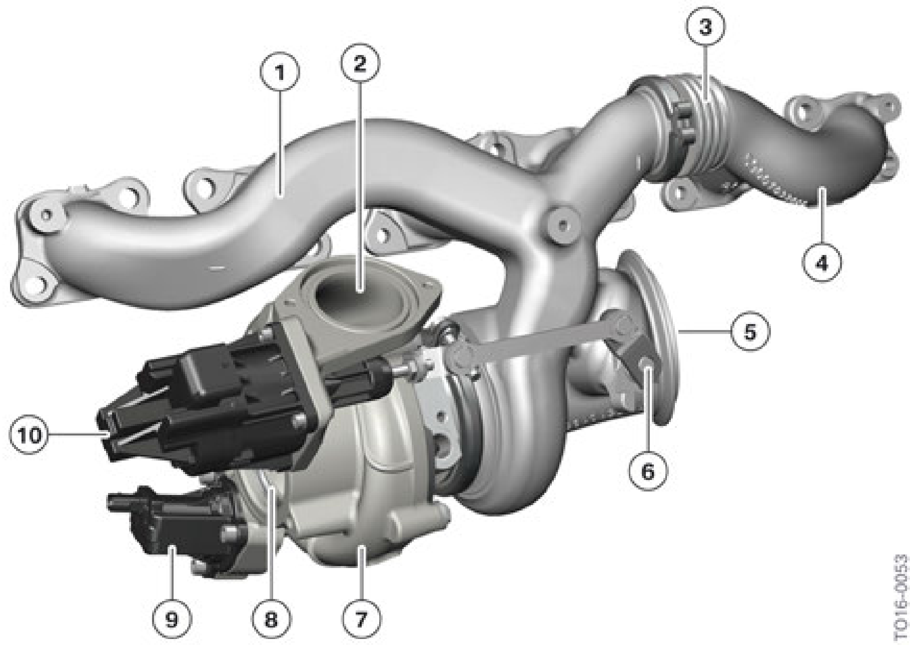
5.2. Intake manifold

The plastic intake system is located in the engine V-space. The left and rights sides are separated. This is also why there are two charge air temperature and charging pressure sensors located at the rear end of the intake system.

5.3. Exhaust turbocharger

The N74TU engine has two conventional exhaust turbochargers provided by system supplier BorgWarner Turbo Systems. The turbochargers used in the N74TU engine are mounted externally. For a V 12-cylinder engine with 60° cylinder angle, this represents the optimum configuration of the charging system and all the peripherals. The exhaust turbochargers feature a mono scroll design. The turbine housing is directly integrated in the cast steel exhaust manifold. This has enabled the exhaust turbocharger to be installed even closer to the engine. This configuration means that the exhaust gas turbocharger and exhaust manifold are one component. Charging pressure is controlled using a multi-piece wastegate valve via the electric wastegate valve controller. To prevent the possibility of interference with the multi-piece wastegate valve, a spring fastener is installed between the wastegate lever and flap plate – as is an additional disc spring between the wastegate bearing and outer lever. This design is being used for the first time in a BMW gasoline engine.

5. Intake Air and Exhaust System



N74TU engine, exhaust turbocharger

Index	Explanation
1	Exhaust manifold turbine housing
2	Compressor output
3	Decoupling element
4	Exhaust manifold
5	Turbine output
6	Wastegate valve
7	Compressor housing
8	Compressor input
9	Electric blow-off valve
10	Electric wastegate valve controller

The decoupling elements absorb material movements at hot/cold alternating loads between the exhaust manifold turbine housing and the exhaust manifold and ensure a stress-free connection. The decoupling elements are welded on one side with the exhaust manifolds and are connected to the exhaust manifold turbine housing using a band-type clamp. The correct installation bracket must be used here to ensure damage-free installation in the engine plant and disassembly in the vehicle or on the removed engine. This ensures a rigid connection of the exhaust manifold turbine housing with the exhaust manifold. This also prevents damage to the decoupling element and ensures easy handling. The transport protection caps supplied must be used when the vehicle is being serviced. During installation it is also important to note the tightening sequence for screw connections.

⚠

If repair is necessary, the replacement turbocharger must be installed on the cylinder head with the assembled installation bracket. Only then can it be removed. (The same applies to the supplied transport protection caps.) If repair procedures require the turbocharger to be removed and refitted, the correct special tool must be used. Refer to the repair instructions in the ISTA workshop information system for more details.

5.3.1. Charging pressure control

Charging pressure is controlled in the N74TU engine using a multi-piece wastegate valve via the electric wastegate valve controller.

Electrified adjustment

Compared with vacuum-actuated charging pressure control, the following components are not required.

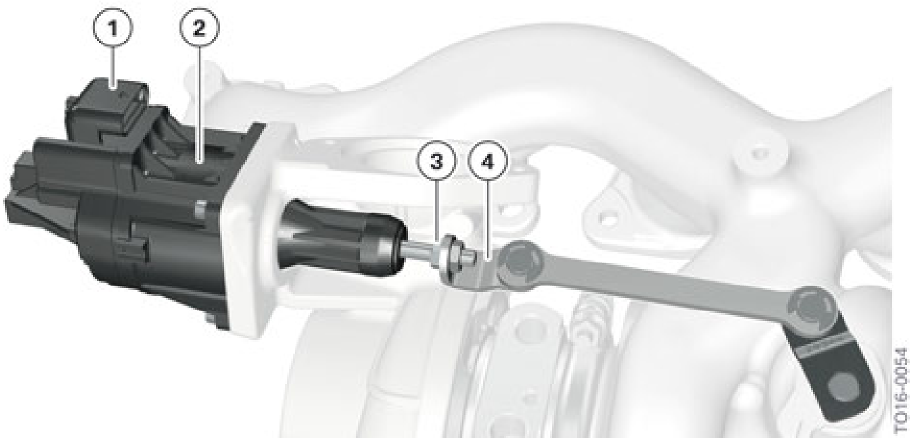
Components:

- Vacuum unit
- Vacuum lines
- Electro-pneumatic pressure converter
- Vacuum reservoir

Benefits of electric control:

- Faster control speed
- More precise control
- Simpler diagnosis
- Fewer components
- Larger opening angle of wastegate valve

Operating principle



N74TU engine, electric wastegate valve controller

Index	Explanation
1	Electrical connection
2	Actuator
3	Adjusting linkage
4	Stroke linkage

A direct current motor and a sensor are located in the electric wastegate valve controller resulting in a total of 5 electrical connections on the component. The wastegate valve is opened or closed by a lifting movement of the linkage.

The electric wastegate valve controller can be replaced separately at service. Each time the adjusting linkage is activated, the system must be re-adjusted with the assistance of the BMW diagnosis system ISTA. This measure is not required when replacing the entire exhaust turbocharger as the linkage is supplied preset.

⚠

If the electric wastegate valve controller is replaced individually, a teach-in routine must be performed using the BMW diagnosis system ISTA.

The sensor is used to determine the position of the wastegate valve. The wastegate valve can move to any required position between maximum open and maximum closed. When the sensor signal or actuator drops out, the wastegate valve adopts the open position to allow charging pressure to build up. This ensures the journey continues with reduced engine performance.

⚠

As the position sensor is a linear Hall sensor, a resistance measurement for testing the sensor is not permitted.

5.3.2. Blow-off control

The blow-off valves in the N74TU engine serve to reduce unwanted charging pressure peaks that can occur when the throttle valve is closed quickly. They play an important role in terms of the engine acoustics and contribute to the component protection of the exhaust turbocharger.

If the throttle valve is closed at high engine speeds, a vacuum arises in the intake pipe. Behind the compressor a high amount of ram pressure builds up, which cannot escape as the path to the intake pipe is locked. The consequence of this would be to "pump up" the charger. This means that:

- a very noticeable and annoying pump noise occurs,
- along with this pump noise, a load which has a damaging effect on the exhaust turbocharger, as high-frequency pressure waves put pressure on the bearings of the exhaust turbocharger in an axial direction.

The blow-off valves are electrically operated. If the throttle valve is closed, the charging pressure (before the throttle valve) and its increase can be compared to stored setpoint values. If the actual values are above the setpoint, the blow-off valves are opened. The charging pressure is thus directed to the intake side of the compressor. This process means that no annoying and damaging pressure pumps arise.

5.3.3. Charge air cooling

Both the N74TU and N74 engines feature indirect charge air cooling. The heat is extracted from the charge air by means of an air-to-coolant heat exchanger. This heat is then released to the ambient air across a coolant-to-air heat exchanger. This system enables the line length of the charge air system to be kept very short, resulting in lower pressure losses.

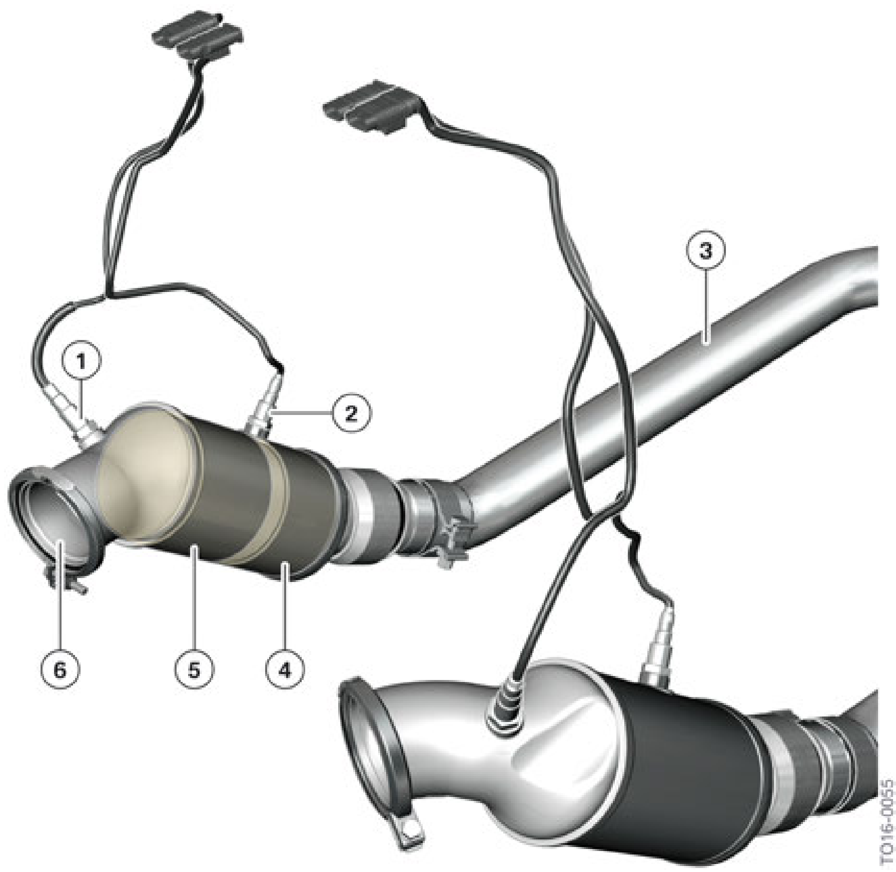
The charge air coolers are screwed on to the cylinder head covers and directly connected with the intake system.

5.4. Exhaust emission system

5.4.1. Catalytic converter

The N74TU engine has one catalytic converter per bank. The output funnels are single-walled (N74 engine, air-gap-insulated/double-walled).The catalytic converter near the engine comprises a 1st and a 2nd monolith. The catalytic converters have decoupling elements which are also described as expansion elements.

N74TU Engine
5. Intake Air and Exhaust System



N74TU engine, sectional view of the catalytic converter

Index	Explanation
1	Control sensor
2	Monitoring sensor
3	Exhaust pipe
4	Ceramic monolith 2
5	Ceramic monolith 1
6	Connection of the turbine

Exhaust emission system	
3-way catalytic converter	2-monolith system
Cell density of ceramic monolith 1	600 cpsi
Cell density of ceramic monolith 2	400 cpsi

5. Intake Air and Exhaust System

Oxygen sensor before catalytic converter

The oxygen sensor (LSU ADV) from Bosch is used as a control sensor before the catalytic converter. The function is comparable to the oxygen sensor (LSU 4.9) and therefore is not described in detail here. This oxygen sensor is already used in the N63TU engine. The abbreviation LSU stands for universal oxygen sensor and ADV for Advanced.

The oxygen sensor before catalytic converter (LSU ADV) has the following benefits.

Benefits:

- High signal running, especially in charged operation due to lower dynamic pressure dependence.
- Increased durability thanks to reduced pump voltage.
- Improved precision (vis-a-vis LSU 4.9 by 1.7).
- Faster operating readiness < 5 s.
- Increased temperature compatibility.
- Improved system connector with better contact properties.

The LSU ADV has an extended measuring range. It is possible to measure 0.65 precisely from the oxygen sensor. The new oxygen sensor is operational earlier, meaning exact measured values are available after only 5 s.

The measuring dynamics of the sensor is higher, whereby it is possible to determine the air/fuel ratio in each cylinder separately and thus also control it. As a result, a homogeneous exhaust flow can be adjusted, the emission levels lowered and the long-term emission behavior optimized.

Oxygen sensor after catalytic converter

The oxygen sensor after catalytic converter is also called a monitoring sensor. The monitoring sensor LSF XFOUR from Bosch is used which is the successor sensor to the LSF 4.2.

The LSF Xfour requires the DME 8.C for signal evaluation and has the following characteristics.

Characteristics:

- To achieve quicker response characteristics after engine start (half of the LSF 4.2 value), a stronger controlled heater has been integrated in the LSF Xfour.
- This improves signal stability.
- Less space is required for installation.

The control sensor is located as close as possible to the turbine outlet ahead of the first ceramic monolith. Its position has been chosen so that all the cylinders can be recorded separately. The monitoring sensor is positioned between the first and second ceramic monoliths.

N74TU Engine

5. Intake Air and Exhaust System

5.4.2. Exhaust system

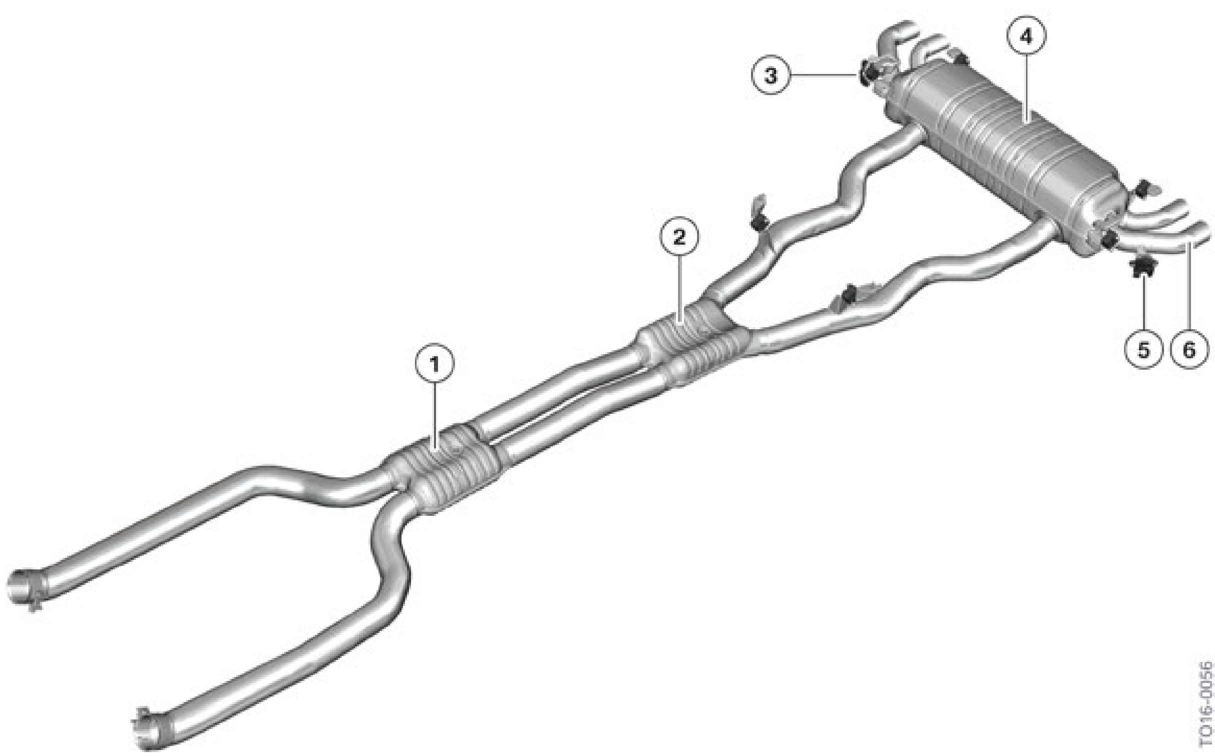
Main differences between exhaust systems used in the N74 and N74TU engines

- Pneumatic exhaust flaps replaced by electrical exhaust flaps.

The exhaust system of the N74TU engine in the G11/12 comprises the following components.

Components:

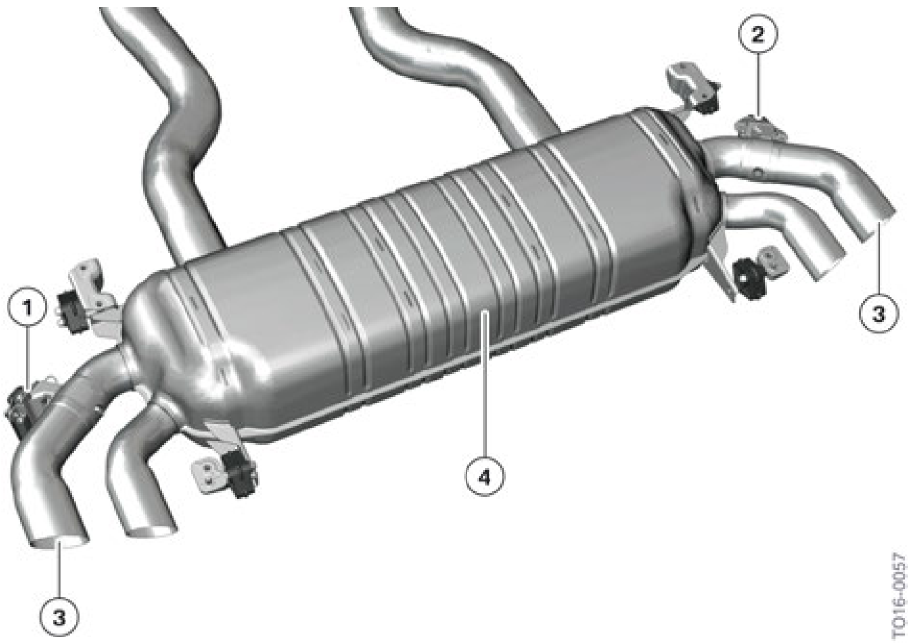
- 1 shell front silencer with 5 liter volume
- 1 shell center silencer with 5 liter volume
- 1 shell rear silencer with 44 liter volume
- 2 twin tailpipes with tailpipe trim attached to the body



N74TU engine, exhaust emission system

Index	Explanation
1	Front silencer
2	Center silencer
3	Electrical exhaust flap actuator (EAKS), right
4	Rear silencer
5	Electrical exhaust flap actuator (EAKS), left
3	Twin tailpipe

On the N74TU engine, the pneumatic exhaust flap controller has been replaced with an electrical exhaust flap controller.



N74TU engine, exhaust flap controller

Index	Explanation
1	Electrical exhaust flap actuator (EAKS), left
2	Electrical exhaust flap actuator (EAKS), right
3	Twin tailpipe
4	Rear silencer

5.4.3. Electrically controlled exhaust flaps

Electrically controlled exhaust flap(s)

The exhaust flap is integrated in the exhaust tailpipe. The exhaust flap is operated by an axially arranged electric motor with integrated gears and electronics. The electric controller for the adjustable exhaust flap has the following electric connections.

Connections:

- Voltage supply (+)
- Ground (-)
- Actuating wire (signal line)

At low engine speeds and low loads, the noise level can be significantly reduced by closing the exhaust flap. At high engine speeds and high loads, the exhaust gas counterpressure can be reduced by opening the exhaust flap.

The exhaust flap is activated (using pulse width modulation) by the Digital Motor Electronics (DME). The input variables are as follows.

Input variables:

- Engine speed
- Load
- Driving speed

The exhaust flap cannot adopt an intermediate setting; it is either fully opened or closed. The flap is moved to the respective mechanical end stops by means of pulse-width modulated signals (PWM signals). If faults are detected or the actuation stops, or after the engine has been stopped, the preferred position is the closed position.

Electrical exhaust flap	N74TU Motor
Installation location	right and left
PWM signal open	10% duty cycle
PWM signal closed	90% duty cycle

⚠

The controller of the electrical exhaust flap can be replaced separately. The controller can be placed in an installation position with the help of the BMW diagnosis system ISTA.

The exact position of the exhaust flap is stored in a characteristic map in the Digital Motor Electronics. The following table merely provides a rough overview of the various exhaust flap states.

Engine operating points	Exhaust flap opened	Exhaust flap closed
Idling	X	X
Low load		X
Coasting (overrun) mode		X
Constant-speed driving with partial load		X
Acceleration with high load	X	
Full load	X	

⚠

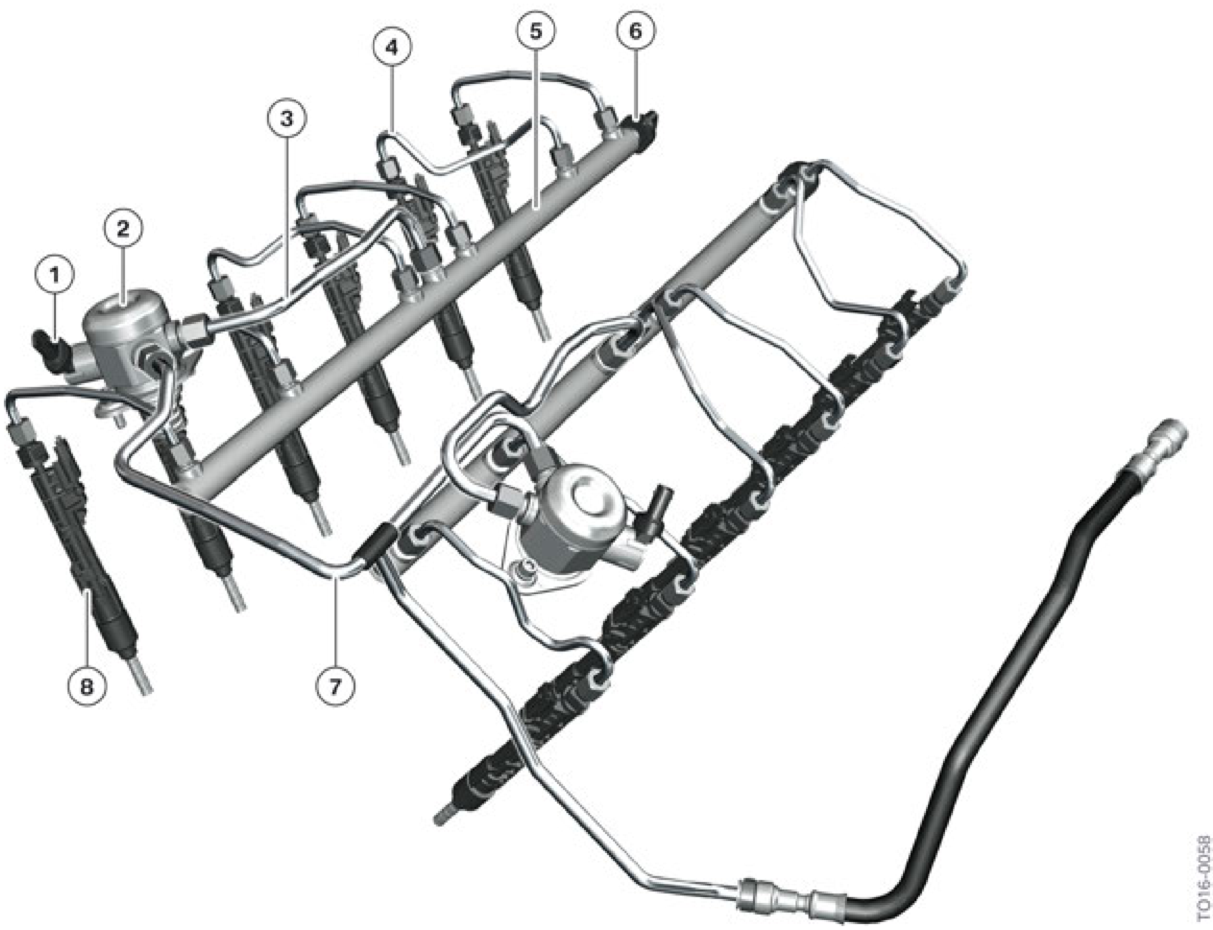
Please note that an exhaust tailpipe flap of the N74TU engine may be closed when idling. This would mean that emission measurements cannot be taken at this tailpipe with closed exhaust flap.

N74TU Engine
6. Fuel Supply System

For the N74TU engine the high-pressure injection is used. It differs from high-pressure injection (HPI), as used with the N74 engine, through the use of solenoid valve injectors with multi-hole nozzles.

6.1. Overview

The following overview shows the fuel preparation of the N74TU engine. It essentially corresponds to the systems with direct fuel injection familiar in BMW models.



N74TU engine, fuel preparation

Index	Explanation
1	Fuel quantity control valve
2	High pressure pump
3	High pressure line, high pressure pump to rail
4	High pressure line rail to the injector

Index	Explanation
5	Rail
6	Rail pressure sensor
7	Fuel supply line
8	Injector

Bosch high-pressure fuel injection valves with the designation HDEV5.2 with CVO are used. The high pressure pump is already established in the predecessor 4 and 8-cylinder engines.

⚠

Work on the fuel system is only permitted after the engine has cooled down. The coolant temperature must not exceed 40 °C / 104 °F. This must be observed without fail, as otherwise there is a risk of fuel being sprayed back on account of the residual pressure in the high-pressure fuel system.

When working on the high-pressure fuel system, it is essential to adhere to conditions of absolute cleanliness and to observe the work sequences described in the repair instructions. Even the slightest contamination and damage to the screwed fittings of the high-pressure lines can cause leaks.

When working on the fuel system of the N74TU engine, it is important to ensure that the ignition coils are not fouled with fuel. The resistance of the silicone material is greatly reduced by sustained contact with fuel. This may result in flashovers on the spark plug head and thus in misfires.

Notes:

- Before making any repairs to the fuel system, it is essential to remove the ignition coils and protect the spark plug shaft against the ingress of fuel by covering with a cloth.
- Prior to a new installation of the solenoid valve injectors, the ignition coils must be disassembled and the highest possible level of cleanliness ensured.
- Ignition coils heavily fouled by fuel must be replaced.

6.2. Fuel pump control

The electric fuel pump delivers the fuel from the fuel tank via the feed line to the high pressure pump at a primary pressure of 5.9 bar. The on-load speed control is effected via the DME. The low-pressure sensor is dispensed with.

6.3. High pressure pump

The well-known Bosch high pressure pump (HDP 5) is used. This is a single-piston pump driven from the exhaust camshaft via a triple cam. So that sufficient fuel pressure is guaranteed in each load condition of the engine, a high pressure pump is used in the N74TU engine for each bank.

For further information on the high pressure pump, please refer to ST501 Engine Technology "N63 Engine" training material available on DRIFT and TIS.

6.4. Injectors

The Bosch solenoid valve injector HDEV5.2 with CVO support is an inward-opening multi-hole valve – unlike the outward-opening piezo injector used in HPI engines. The HDEV5.2 too is characterized by a high degree of variability with regard to spray angle and spray shape, and is designed for a system pressure of up to 200 bar.

These injectors have already been in operation in the N55 and N63TU engines and B48/58 engine.

N74TU engine, injector

⚠

The stems of the solenoid valve injectors can only withstand a certain tensile force and a certain torque. When removing and refitting the injectors, it is essential that the specific procedure described in the repair instructions is followed and the designated special tools are used. Damage to the injectors may otherwise result.

Depending on design, dirt particles, grains of sand etc. can get into in the injector holes and spark plugs during operation – especially in dusty environments with poor roads. Before disassembly, the holes must be blown out with a strong jet of compressed air from all possible angles and positions using the longest available extension. After removing the injector or spark plug, the base of the hole should also be blown clean.

With the new generation of solenoid valve injectors with CVO, no adaptation values are required for injector flow adjustments. Digital Motor Electronics (DME) establishes the adaptation values independently.

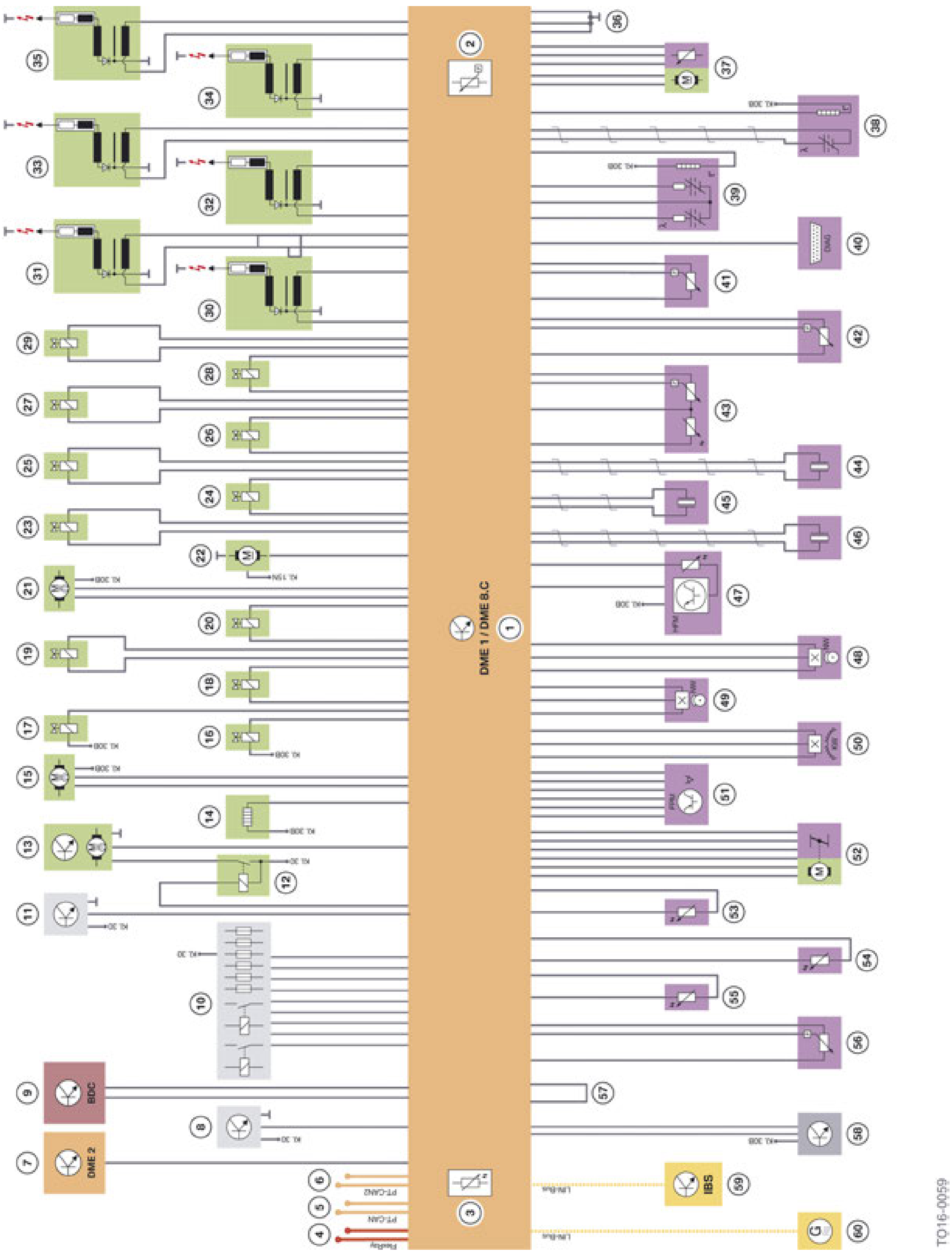
The solenoid valve injector is secured to the rail using a retaining bridge. With the aid of the bore hole on the cylinder head, a retaining pin on the solenoid valve injector is used to align the solenoid valve injector relative to the spark plug. The high-pressure connection to the rail is set up using a ball-cone connection.

N74TU Engine

7. Engine Electrical System

7.1. Overview

7.1.1. Engine control, cylinder bank 1

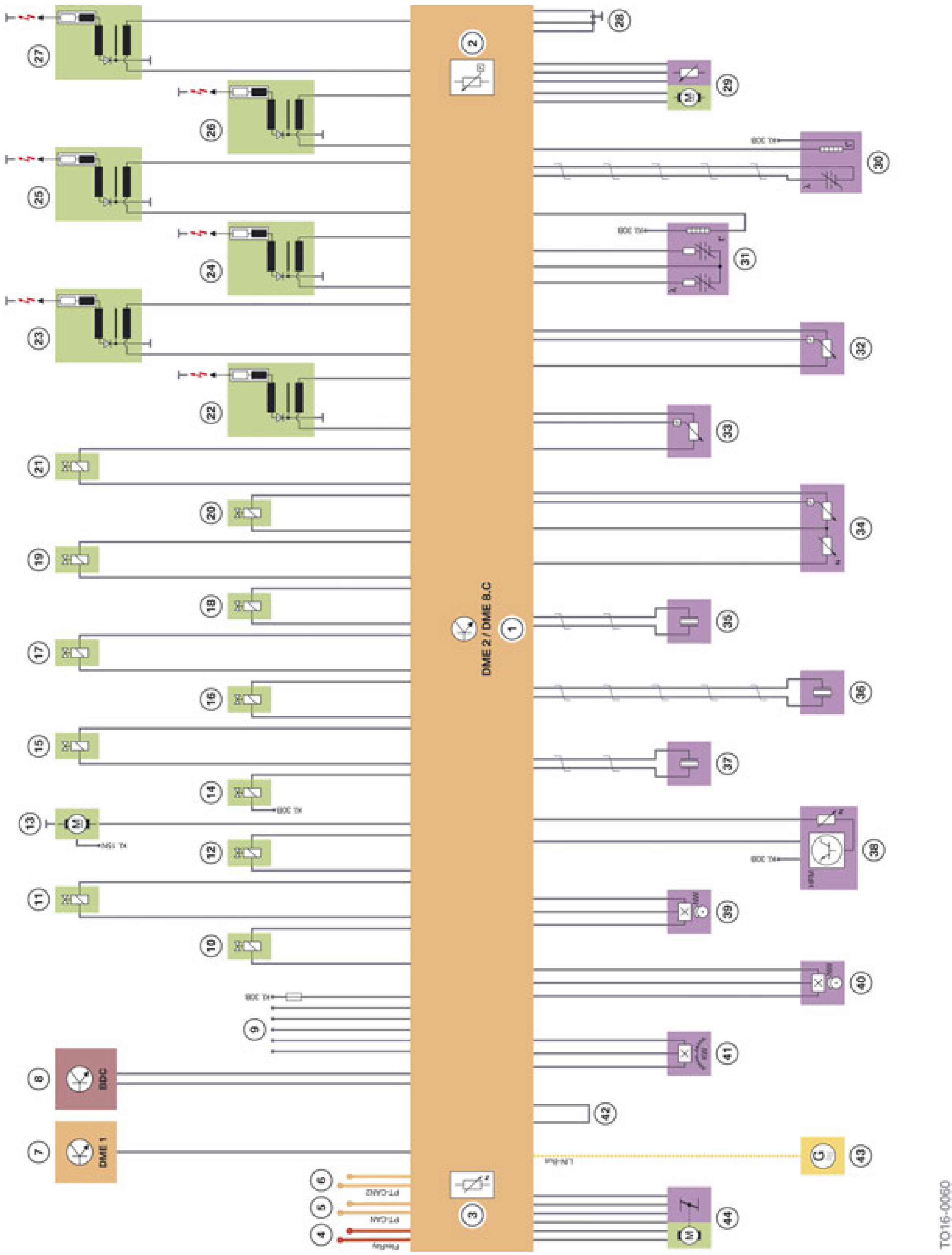


N74TU engine, DME 1 system wiring diagram DME 8.C.0

Index	Explanation
1	Digital Motor Electronics 1
2	Ambient pressure sensor
3	Temperature sensor
4	FlexRay
5	PT-CAN
6	PT-CAN 2
7	Coupler CAN
8	Tank leak diagnosis, Natural Vacuum Leak Detection (NVLD)
9	Body Domain Controller (BDC)
10	Power distribution box
11	Fuel pump control module (EKPS)
12	Relay for electric fan
13	Electric fan
14	Data-map thermostat
15	Electric coolant pump, charge air cooler
16	Oil pressure control valve
17	Blow-off valve
18	Tank vent valve
19	VANOS solenoid valve, intake camshaft
20	VANOS solenoid valve, exhaust camshaft
21	Electric coolant pump, exhaust turbocharger
22	Electrical exhaust flap controller (EAKS)
23	Quantity control valve
24-29	Injectors (cylinders 1-6)
30-35	Ignition coils (cylinders 1-6)
36	Ground
37	Electric wastegate valve controller
38	Oxygen sensor (LSF 4.2)
39	Oxygen sensor (LSU ADV)
40	Diagnostic connector
41	Charging pressure sensor after throttle valve
42	Rail pressure sensor
43	Charge air temperature and charging pressure sensor upstream of throttle valve
44	Knock sensors 1-2

Index	Explanation
45	Knock sensors 3-4
46	Knock sensors 5-6
47	Hot film air mass meter (HFM 7)
48	Camshaft sensor, intake camshaft
49	Camshaft sensor, exhaust camshaft
50	Crankshaft sensor (Y-cabling at DME 1 and DME 2)
51	Accelerator pedal module
52	Throttle valve
53	Engine temperature (sensor at housing of coolant pump)
54	Coolant temperature sensor at radiator outlet
55	Oil temperature sensor
56	Oil pressure sensor
57	DME 1–DME 2 encoding
58	Oil-level sensor
59	Intelligent Battery Sensor (IBS)
60	Alternator

7.1.2. Engine control, cylinder bank 2

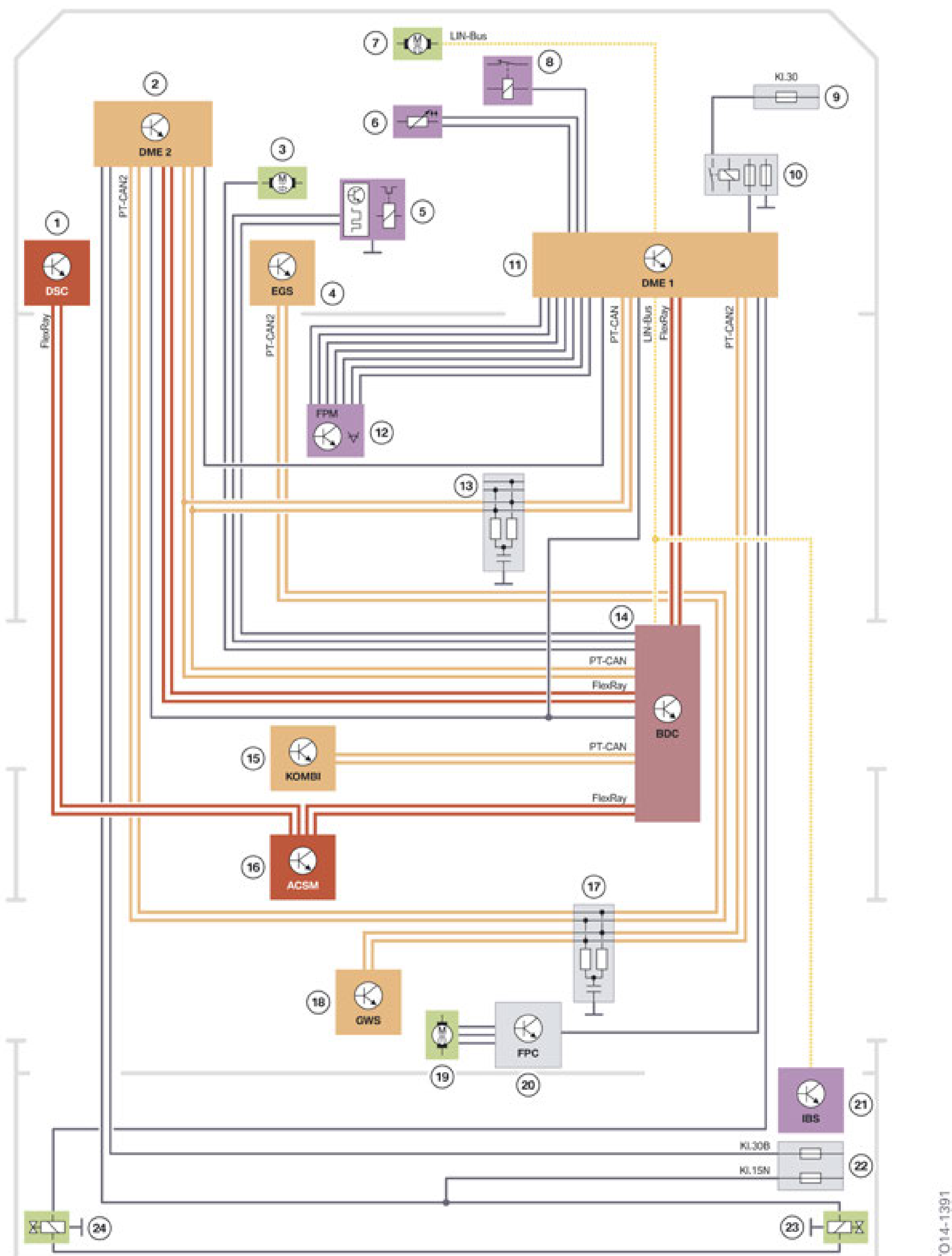


N74TU engine, DME 2 system wiring diagram DME 8.C.0

7. Engine Electrical System

Index	Explanation
1	Digital Motor Electronics 2
2	Ambient pressure sensor
3	Temperature sensor
4	FlexRay
5	PT-CAN
6	PT-CAN 2
7	Coupler CAN
8	Body Domain Controller (BDC)
9	Power distribution box
10	VANOS solenoid valve, intake camshaft
11	VANOS solenoid valve, exhaust camshaft
12	Quantity control valve
13	Electrical exhaust flap controller (EAKS)
14	Blow-off valve
15	Tank vent valve
16-21	Injectors (cylinders 7-12)
22-27	Ignition coils (cylinders 7-12)
28	Ground
29	Electric wastegate valve controller
30	Oxygen sensor (LSF 4.2)
31	Oxygen sensor (LSU ADV)
32	Charging pressure sensor after throttle valve
33	Rail pressure sensor
34	Charge air temperature and charging pressure sensor upstream of throttle valve
35	Knock sensors 7 - 8
36	Knock sensors 9 -10
37	Knock sensors 11-12
38	Hot film air mass meter (HFM 7)
39	Camshaft sensor, intake camshaft
40	Camshaft sensor, exhaust camshaft
41	Crankshaft sensor (Y-cabling at DME 2 and DME 1)
42	DME 1 – DME 2 encoding
43	Alternator
44	Throttle valve

7.1.3. Engine control, vehicle connection



N74TU engine, vehicle connection module 100 of DME 1 and DME 2

N74TU Engine
7. Engine Electrical System

Index	Explanation
1	Dynamic Stability Control (DSC)
2	Digital Motor Electronics (DME 2)
3	Starter motor
4	Electronic transmission control (EGS)
5	Air conditioning compressor
6	Coolant temperature sensor at radiator outlet
7	Electric fan
8	Relay for electric fan
9	Fuse, terminal 30
10	Power distribution box, front
11	Digital Motor Electronics (DME 1)
12	Accelerator pedal module
13	CAN terminator 4
14	Body Domain Controller (BDC)
15	Instrument cluster (KOMBI)
16	Advanced Crash Safety Module (ACSM)
17	CAN terminator 5
18	Gear Selector Switch (GWS)
19	Electric fuel pump
20	Fuel Pump Control (FPC)
21	Intelligent Battery Sensor (IBS)
22	Power distribution box, rear
23	Electrical exhaust flap actuator (EAKS), right
24	Electrical exhaust flap actuator (EAKS), left

7.2. Engine control unit

A new generation of Bosch engine control units is used in the G12. 8th-generation engine electronics features a common control unit platform that is already used with the B48/58 engines. Its appearance is characterized by a uniform housing and a uniform connector strip. However, the hardware inside has been adapted to the various applications.

The control unit code (DME 8.x.yH) can be broken down as follows.

N74TU Engine
7. Engine Electrical System

Abbreviation	Meaning
DME	Digital Motor Electronics
8	Control unit generation
X	Number of cylinders as a hexadecimal figure
y	Vehicle electrical system architecture
H	Hybrid version

Number of cylinders as a hexadecimal figure:

- 4 = 4-cylinder engine
- 6 = 6-cylinder engine
- 8 = 8-cylinder engine
- C = 12-cylinder engine

Vehicle electrical system architecture:

- 0 = vehicle electrical system 1 (large series)
- 1 = vehicle electrical system 2 (small series)

Examples for gasoline engines:

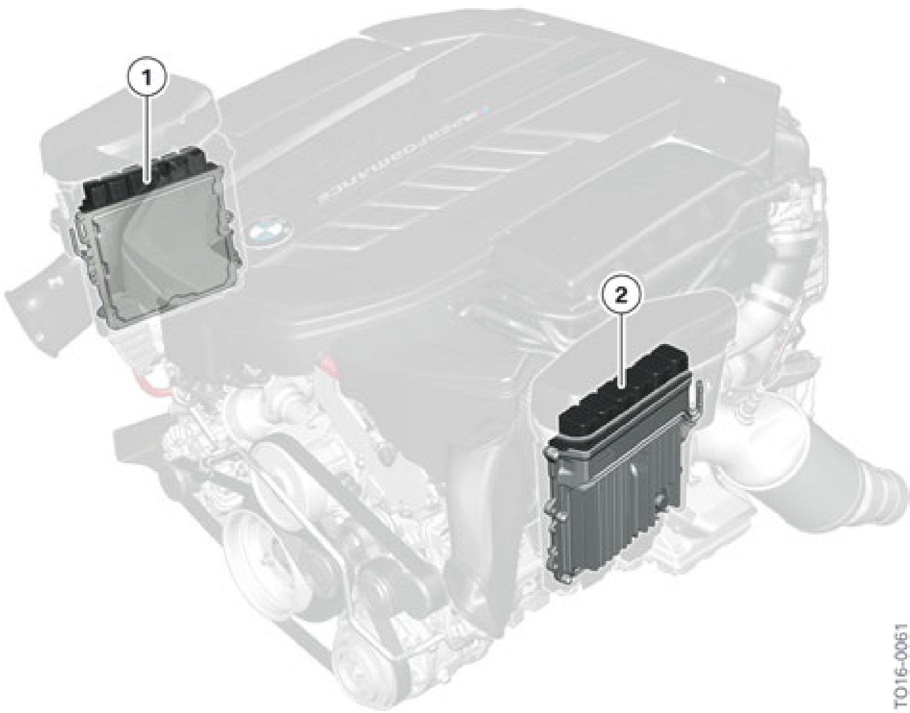
- DME 8.4.0H = B48 PHEV* (vehicle electrical system 1)
- DME 8.6.1 = B58 (vehicle electrical system 2)
- DME 8.8.0 = N63TU2 (vehicle electrical system 1)
- DME 8.C.0 = N74TU (vehicle electrical system 1)

*PHEV = Plug-in Hybrid Electric Vehicle.

This is why the N74TU engine features Bosch Digital Motor Electronics with designation DME 8.C.0. There is a separate water-cooled engine control unit fixed to the engine for every bank. The actuators and sensors of cylinder bank 1 are assigned to the DME 1 control unit; accordingly, the DME 2 control unit is responsible for the functions of cylinder bank 2. The DME 1 is the primary control unit. It also handles all information relating to the entire engine, for example the crankshaft sensor. It makes this data available to the DME 2 control unit directly or via the BUS system. Due to the variety of sensors and actuators it was deemed necessary to use 2 control units.

N74TU Engine

7. Engine Electrical System



N74TU engine, Digital Motor Electronics

Index	Explanation
1	DME control unit, cylinder bank 1
2	DME control unit, cylinder bank 2

⚠

Do not attempt any trial replacement of control units.

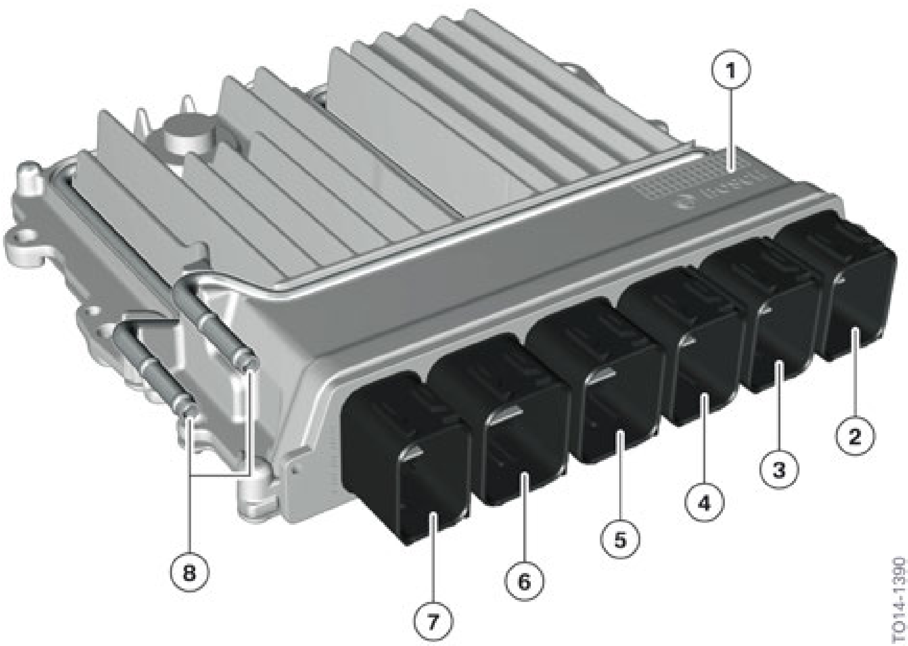
Because of the electronic immobilizer, a trial replacement of control units from other vehicles must not be attempted under any circumstances. An immobilizer adjustment cannot be reversed.

The cooling of the two DME control units in the N74TU engine is done by a connection to the cooling circuit of the charge air cooling. In this system, an aluminium cooling loop is integrated into the housing of the control units.

The connector concept is identical to that on the B48/58 engines and features a Nano MQS connector system (Micro Quadlok System). There is a logical division into 6 modules.

⚠

Wiring harness measurements must be performed using BMW approved measuring procedures. Use of the incorrect tools, such as measuring probes, can damage the plug-in contacts.



N74TU engine, DME 8.C.0 connections

Index	Explanation
1	Engine control unit DME 8.C
2	Module 100, vehicle connection
3	Module 200, sensors and actuators 1
4	Module 300, sensors and actuators 2
5	Module 400, Valvetronic servomotor
6	Module 500, DME supply
7	Module 600, injection and ignition
8	Coolant connections

7.2.1. Overall function

The Digital Motor Electronics (DME) is the computing and switching center of the engine control system. Sensors on the engine and the vehicle deliver the input signals. The signals for activating the actuators are calculated from the input signals, the nominal values calculated using a computing model in the DME control unit and the stored program maps. The DME control unit activates the actuators directly or via relays.

The DME control unit is triggered via the wake-up line (terminal 15 wake-up) from the Body Domain Controller (BDC).

The after-run begins once the terminal is switched to OFF. The adaptation values are stored during the after-run. The DME control unit uses a bus signal to signal its readiness to “go to sleep”. When all the participating control units have signalled their readiness to "go to sleep", the bus master outputs a bus signal and the control units terminate communication 5 seconds later.

The printed circuit board in the DME control unit accommodates 2 sensors: A temperature sensor and an ambient pressure sensor. The temperature sensor is used to monitor the temperature of the components in the DME control unit. The ambient pressure is required for calculating the mixture composition.

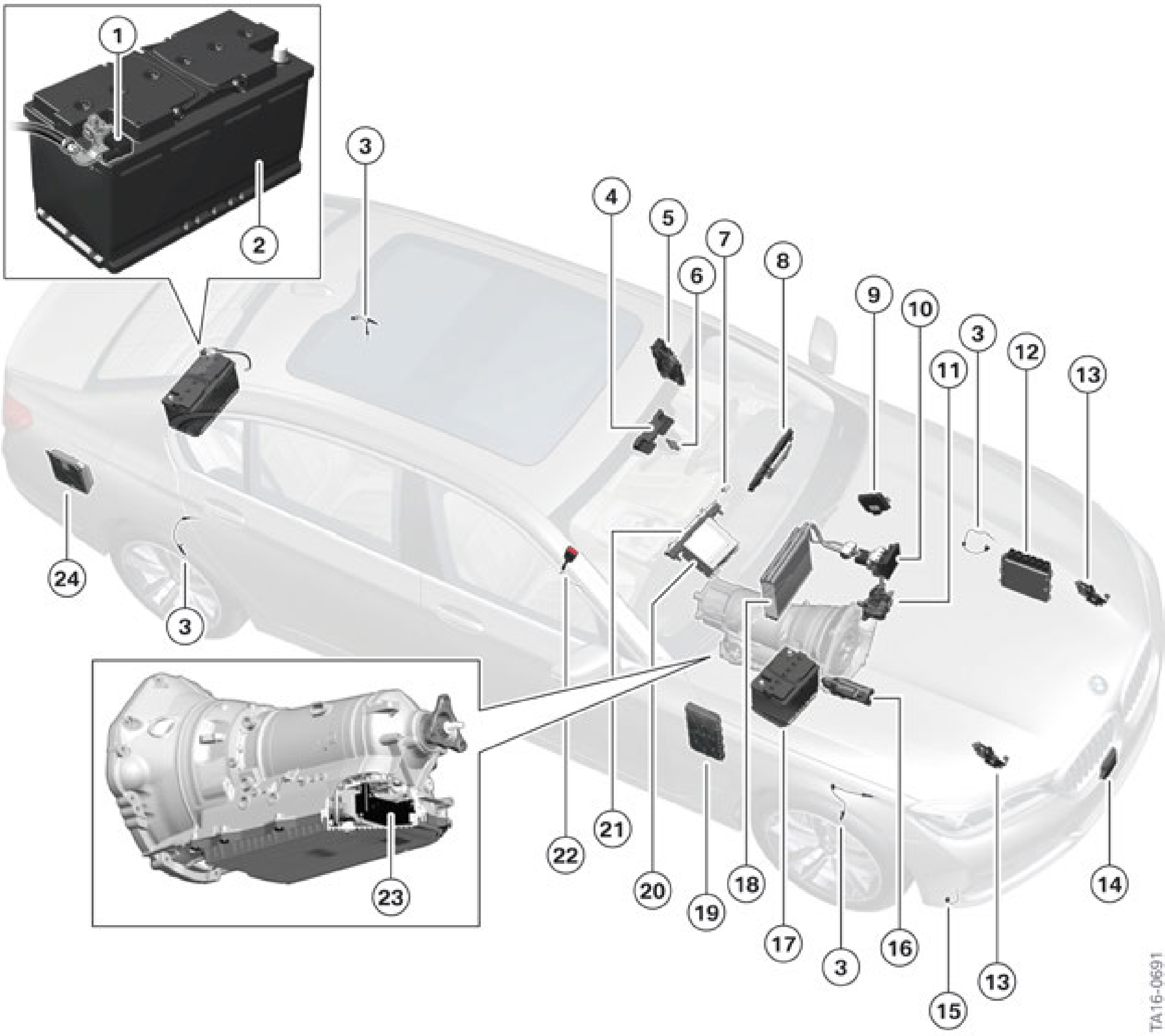
7.3. Alternator

Two alternators operating at 180 A are used with the N74TU engine. A software function in the DME is used to regulate and balance the two alternators. This ensures that the alternators are utilized to the same capacity.

7.4. MSA 2.3 connected/intelligent automatic start/stop function

In the N74TU an automatic start/stop function (MSA) is used for the first time in conjunction with a 12-cylinder engine.

N74TU Engine
7. Engine Electrical System



N74TU engine, MSA 2.3 system components/model

Index	Explanation
1	Intelligent Battery Sensor (IBS)
2	AGM battery 105 Ah
3	Wheel speed sensor
4	Camera-based driver support systems (KAFAS)
5	Door contact
6	Condensation sensor
7	START/STOP button
8	Instrument panel (KOMBI)
9	Optional equipment system (SAS)
10	Dynamic Stability Control (DSC)

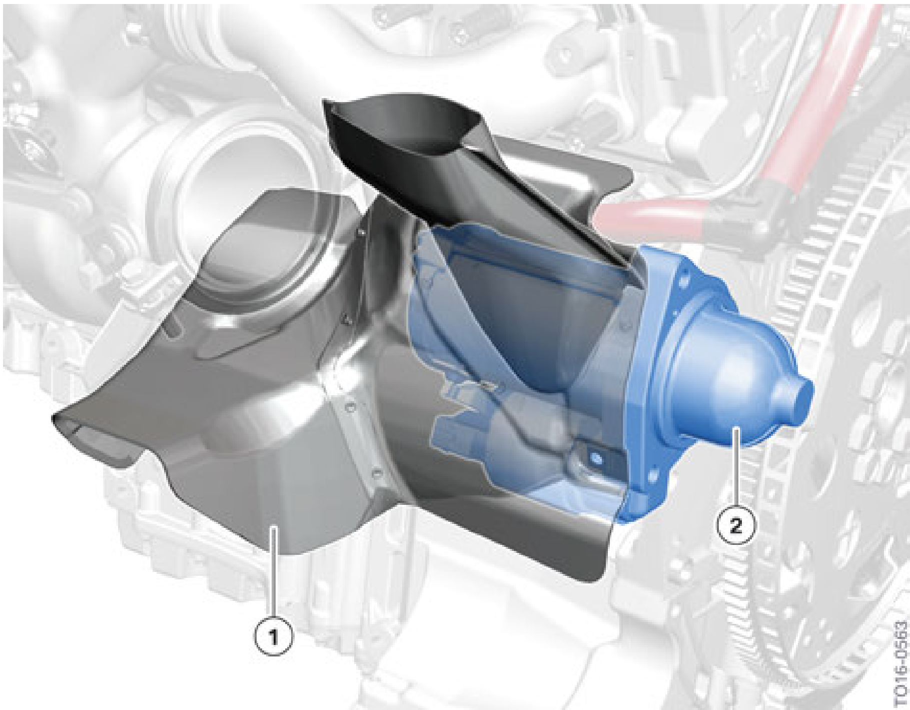
Index	Explanation
11	High pressure pump
12	Digital Motor Electronics (DME)
13	Engine compartment lid contact switch
14	ACC sensor
15	Outside temperature sensor
16	Starter KSopt150
17	AGM battery, 60 Ah (depending on optional equipment)
18	Accumulator evaporator
19	Body Domain Controller (BDC)
20	Head unit (HU)
21	Integrated automatic heating / air conditioning (IHKA)
22	Seat belt buckle switch
23	Hydraulic impulse storage
24	Power Control Unit (PCU) (DC/DC converter)

7.4.1. Starter motor

A so-called conventional optimized starter (KSopt150), which has been established since MSA 2.3, is used.

An elaborate heat shield with air ducts has been developed to protect the starter due to high thermal loads on the starter following an increased number of starting operations through the MSA.

N74TU Engine
7. Engine Electrical System



N74TU engine, heat shield starter motor

Index	Explanation
1	Heat shield
2	Starter motor

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