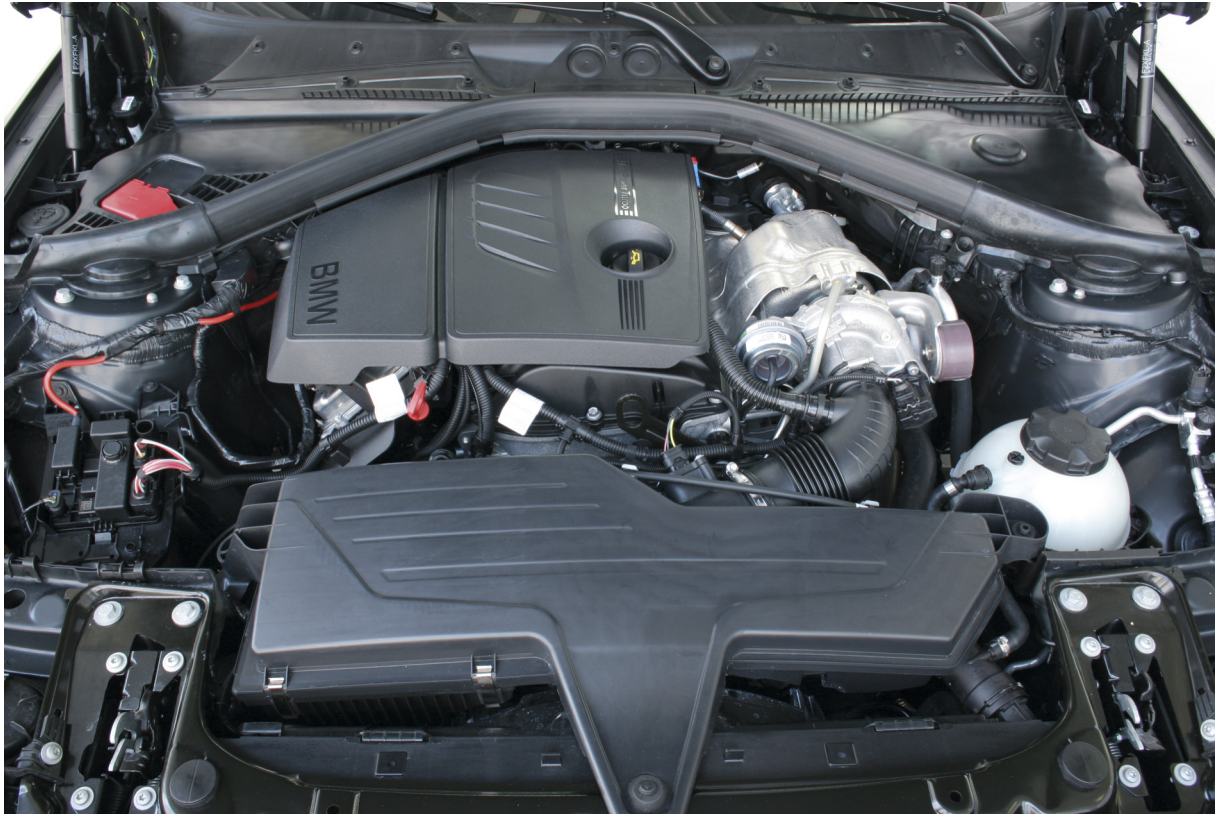


Technical training.
Product information.

N13 Engine.



BMW Service

General information

Symbols used

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



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

Information status and national-market versions

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

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

Additional sources of information

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

- Owner's Handbook
- Integrated Service Technical Application.

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

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Information status: **June 2011**

N13 Engine.

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N13 Engine.

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N13 Engine.

1. Introduction.

With the N13 engine Turbo-Valvetronic Direct Injection (TVDI) technology is making its first appearance in BMW's small 4-cylinder petrol engines. The N13 engine is gradually replacing the N46 and N43 4-cylinder engines in the performance classes below the x20i. A TwinScroll exhaust turbocharger optimises the response characteristics and delivers power already at low engine speeds. The N13 engine is closely related to the N18 engine, which drives the MINI COOPER S. The basic engine is essentially the same - with just minor modifications. The peripherals have been adapted to longitudinal installation in BMW models. A special feature for BMW is the switching of the intake and exhaust sides in the vehicle. Thus, for the first time in a BMW vehicle, the exhaust side is on the left side when viewed in the direction of travel.

This document only describes the two versions as are used as at September 2011 in the BMW 1 Series, F20.

1.1. Models

Model designation	Engine designation	Series introduction
BMW 116i	N13B16U0	09/2011
BMW 118i	N13B16M0	09/2011

1.2. Technical data

1.2.1. BMW 116i

	Unit	N45B16O2*	N43B16O0**	N43B20K0***	N13B16U0
Series		E87	E87	E87	F20
Model designation		116i	116i	116i	116i
Design		R4	R4	R4	R4
Displacement	[cm ³]	1596	1599	1995	1598
Bore/stroke	[mm]	84/72	82/75.7	84/90	77/85.8
Power output at engine speed	[kW (HP)] [rpm]	85 (115) 6000	90 (122) 6000	90 (122) 6000	100 (136) 4400
Power output per litre	[kW/l]	53.3	56.3	45.1	62.6
Torque at engine speed	[Nm] [rpm]	150 4300	160 4250	185 3000 - 4250	220 1350 - 4300
Overboost at engine speed	[Nm] [rpm]	- -	- -	- -	240 1500 - 3500
Compression ratio	[ε]	10.2 : 1	12.0 : 1	12.0 : 1	10.5 : 1
Valves per cylinder		4	4	4	4

N13 Engine.

1. Introduction.

	Unit	N45B16O2*	N43B16O0**	N43B20K0***	N13B16U0
Fuel consumption complying with EU	[l/100 km]	7.7	6.3	6.1	5.5
CO ₂ emissions	[g/km]	180	147	143	129
Digital Engine Electronics		ME9	MSD81.2	MSD81.2	MEVD17.2.5
Exhaust emissions legislation		EURO 5	EURO 5	EURO 5	EURO 5
Maximum speed	[km/h]	200	204	204	210
Acceleration 0–100 km/h	[s]	10.9	10.2	9.9	8.5
Vehicle kerb weight DIN/ EU	[kg]	1255/1330	1255/1330	1255/1330	1290/1365

* In all non-ACEA markets (Association des Constructeurs Européens d'Automobiles)

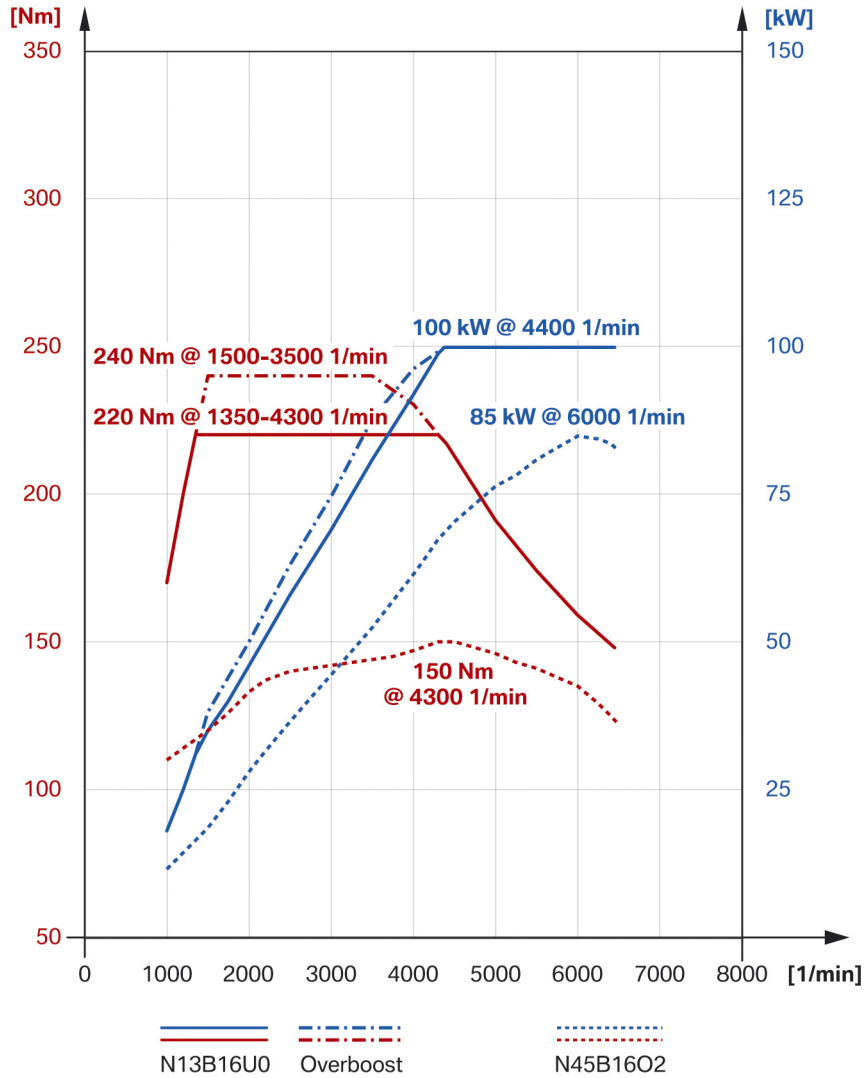
** Only in ACEA markets

*** From March 2009 in some ACEA markets

N13 Engine.

1. Introduction.

Full load diagram N13/N45 engine



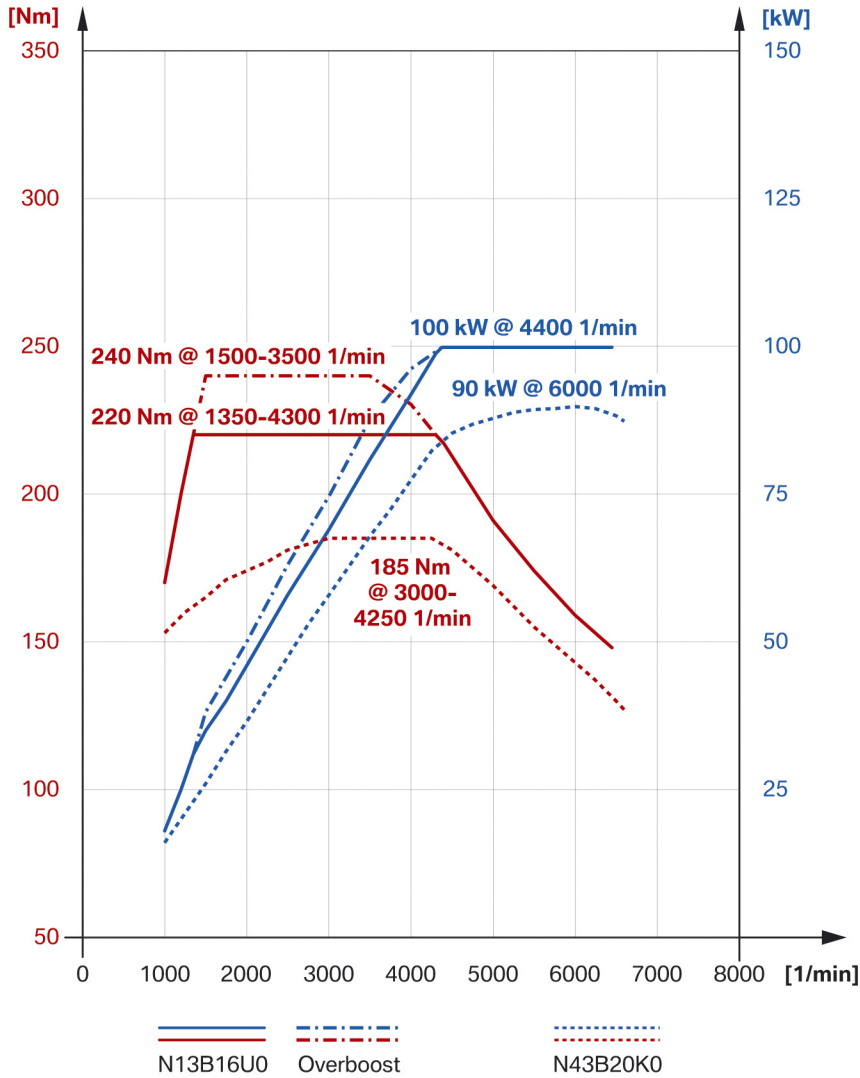
Full load diagram comparing N13B16U0 engine with N45B16O2 engine

TO11-0294

N13 Engine.

1. Introduction.

Full load diagram N13/N43 engine



Full load diagram comparing N13B16U0 engine with N43B20K0 engine

1.2.2. BMW 118i

	Unit	N46B20U2*	N43B2000**	N13B16M0
Series		E87	E87	F20
Model designation		118i	118i	118i
Design		R4	R4	R4
Displacement	[cm ³]	1995	1995	1598
Bore/stroke	[mm]	84/90	84/90	77/85.8
Power output at engine speed	[kW (HP)] [rpm]	100 (136) 5750	125 (170) 6700	125 (170) 4800

N13 Engine.

1. Introduction.

	Unit	N46B20U2*	N43B20O0**	N13B16M0
Power output per litre	[kW/l]	50.1	62.66	78.2
Torque	[Nm]	180	210	250
at engine speed	[rpm]	4300	4250	1500 – 4500
Compression ratio	[ε]	10.5 : 1	12.0 : 1	10.5 : 1
Valves per cylinder		4	4	4
Fuel consumption complying with EU	[l/100 km]	7.5	6.6	5.8
CO ₂ emissions	[g/km]	174	153	134
Digital Engine Electronics		MEV17	MSD81.2	MEVD17.2.5
Exhaust emissions legislation		EURO 5	EURO 5	EURO 5
Maximum speed	[km/h]	208	224	225
Acceleration 0–100 km/h	[s]	9.4	7.8	7.4
Vehicle kerb weight DIN/EU	[kg]	1275/1350	1300/1375	1295/1370

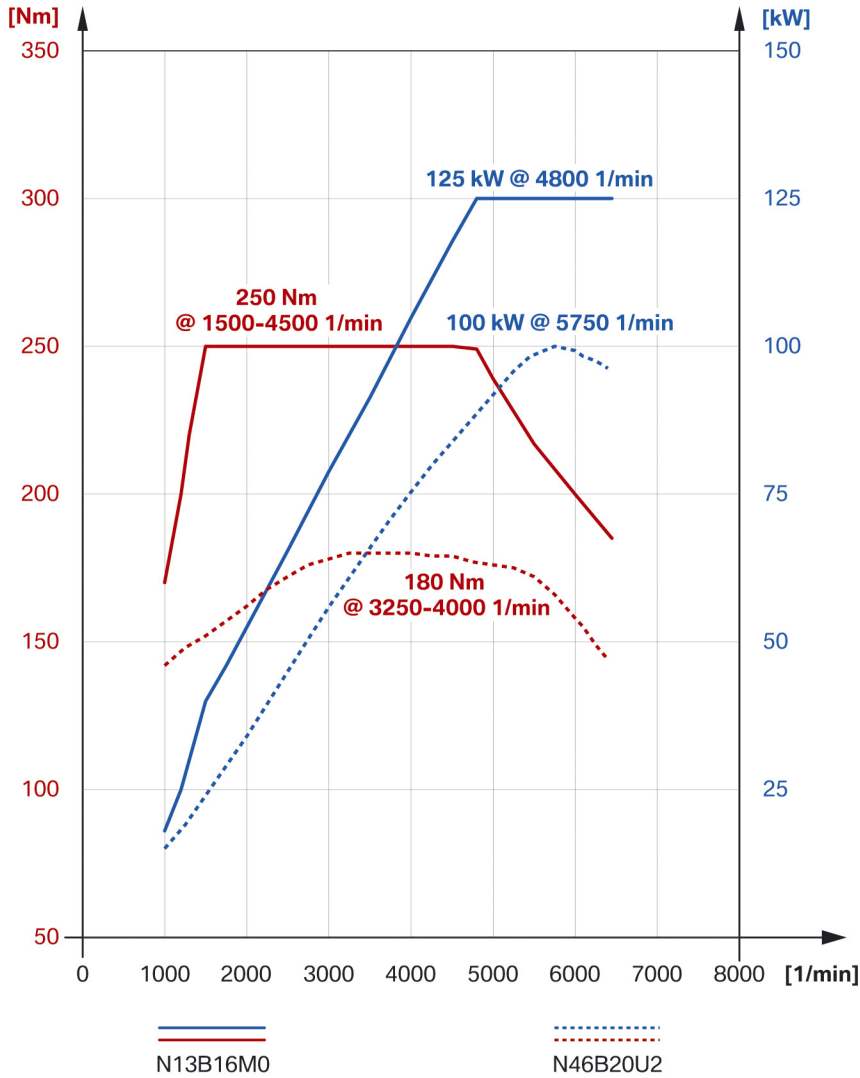
* In all non-ACEA markets (Association des Constructeurs Européens d'Automobiles)

** Only in ACEA markets

N13 Engine.

1. Introduction.

Full load diagram N13/N46 engine



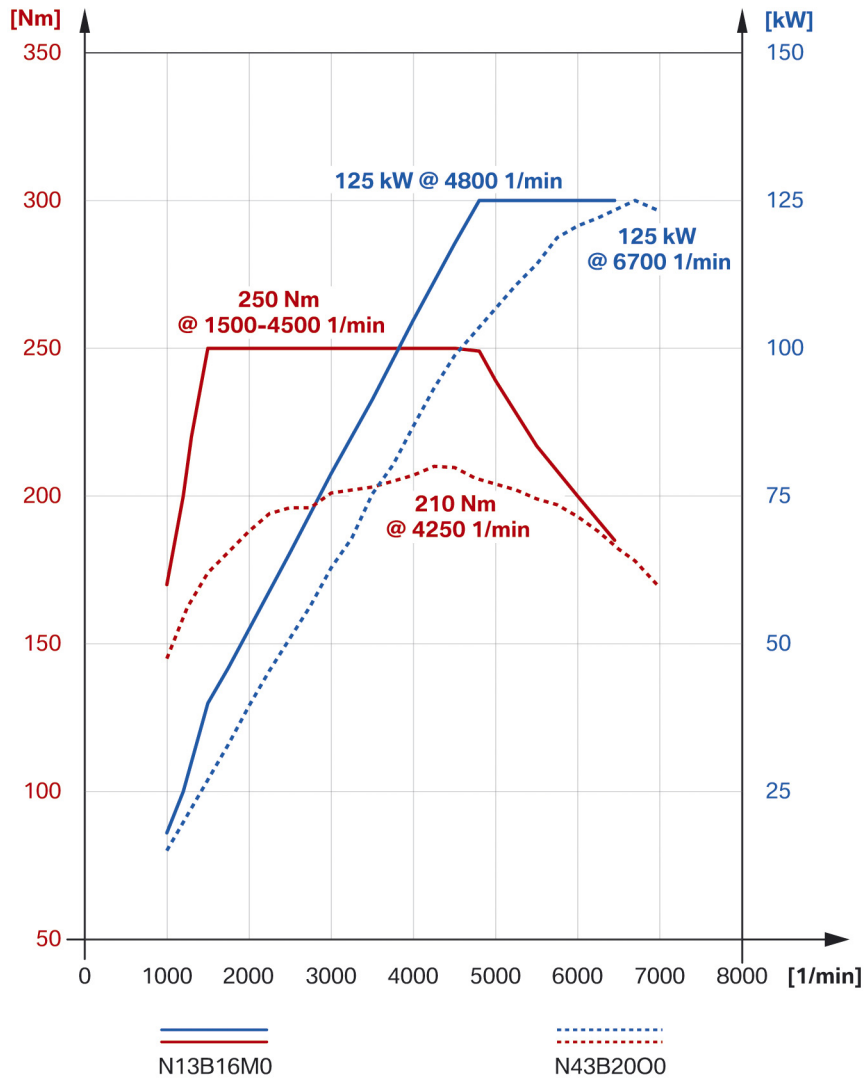
Full load diagram comparing N13B16M0 engine with N46B20U2 engine

TO11-0264

N13 Engine.

1. Introduction.

Full load diagram N13/N43 engine



Full load diagram comparing N13B16M0 engine with N43B2000 engine

TO11-0265

N13 Engine.

1. Introduction.

1.3. New features/changes

1.3.1. Overview

System	Comment
Engine mechanics	<ul style="list-style-type: none">Aluminium crankcase with cast-in grey cast iron linersOpen-deck designUse of the TVDI process3rd generation ValvetronicBuilt-up camshaftsTwo-part crankcase ventilationForged crankshaft
Oil supply	<ul style="list-style-type: none">Map-controlled oil pumpExternal gear pumpRaw oil cooling (N13B16M0 engine only)Oil pressure sensor.
Cooling	<ul style="list-style-type: none">Cutting-in coolant pumpEstablished heat management.
Air intake and exhaust emission systems	<ul style="list-style-type: none">TwinScroll exhaust turbochargerHot film air mass meter 7 in all engine versionsThree connections for crankcase ventilation.
Vacuum system	<ul style="list-style-type: none">Two-stage vacuum pumpVacuum reservoir for the wastegate valve integrated in the engine cover.
Fuel preparation	<ul style="list-style-type: none">High-pressure injection (like the N73 engine)Solenoid valve injectorsBosch high-pressure pumpNo fuel low-pressure sensor.
Engine electrical system	<ul style="list-style-type: none">Bosch MEVD17.2.4 engine control unit.

1.4. Engine identification

1.4.1. Engine designation

The N13 engine is described in the following versions: N13B16U0 and N13B16M0.

N13 Engine.

1. Introduction.

In the technical documentation, the engine designation is used to ensure unambiguous identification of the engine.

The technical documentation also contains the short form of the engine designation N13, which only indicates the engine type.

Breakdown of N13 engine designation

Index	Explanation
N	BMW Group Development
1	4-cylinder in-line engine
3	Engine with exhaust turbocharger, Valvetronic and direct fuel injection (TVDI)
B	Petrol engine, longitudinally installed
16	1.6 litres displacement
U/M	Lower/middle performance class
0	New development

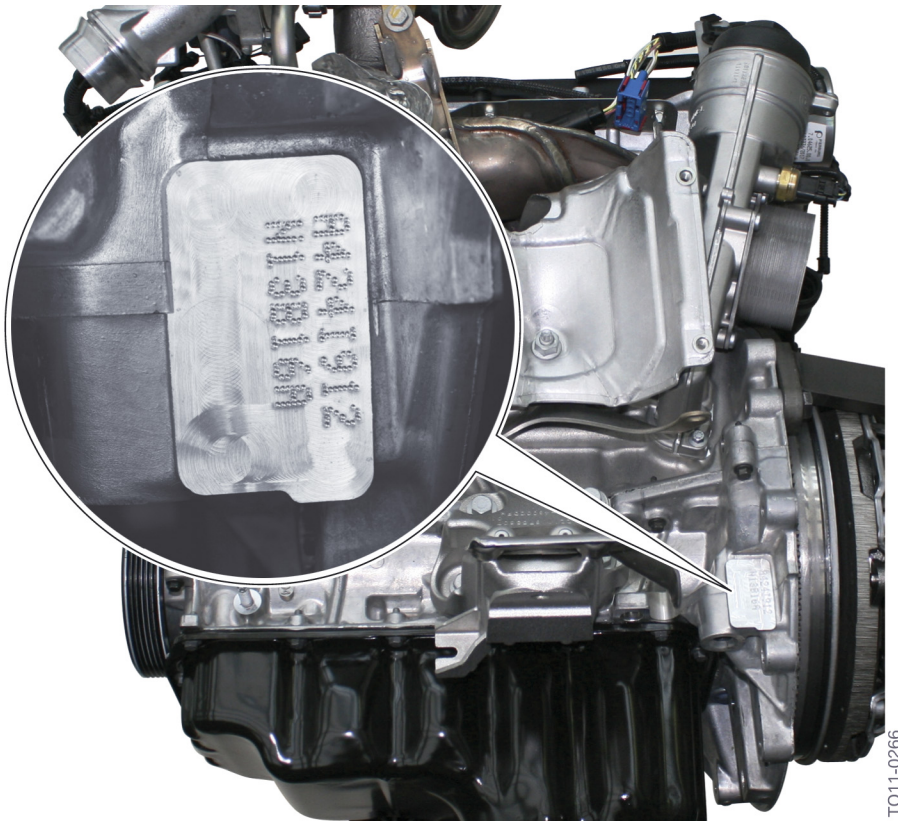
1.4.2. Engine identification

The engines have an identification mark on the crankcase to ensure unambiguous identification and classification. This engine identification is also necessary for approval by government authorities. The first six positions of the engine identification correspond to the engine designation.

With the N55 engine, this identification was subject to a further development, with the previous eight positions being reduced to seven. The engine number can be found on the engine below the engine identification. This consecutive number, in conjunction with the engine identification, permits unambiguous identification of each individual engine.

N13 Engine.

1. Introduction.



TO11-0266

N13 engine, engine identification and engine number

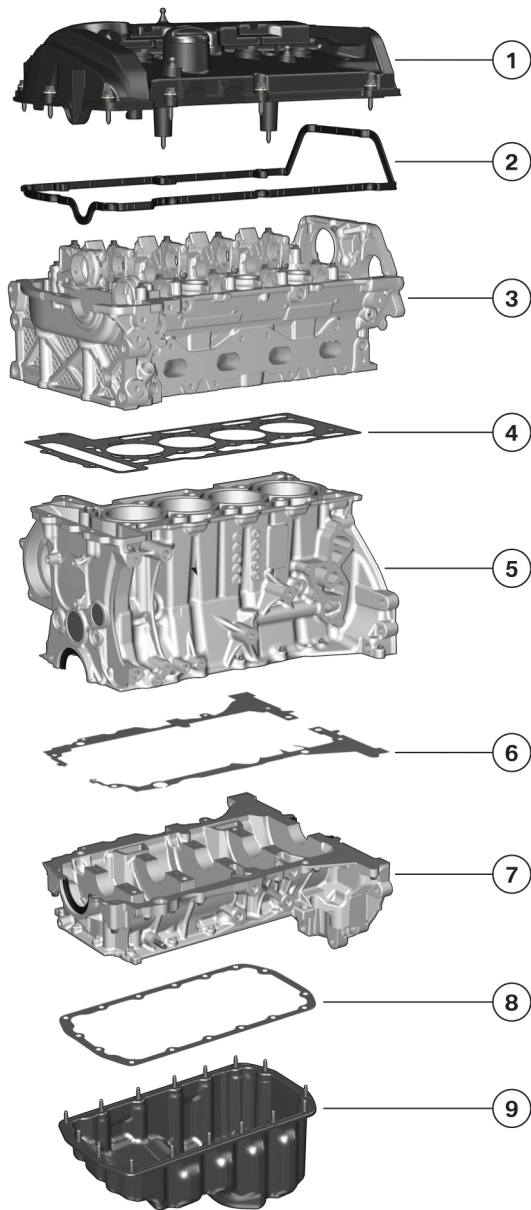
Index	Explanation
A4241912	Individual consecutive engine number
N	BMW Group Development
1	4-cylinder in-line engine
3	Engine with exhaust turbocharger, Valvetronic and direct fuel injection (TVDI)
B	Petrol engine, longitudinally installed
16	1.6 litres displacement
A	Type test concerns, standard

N13 Engine.

2. Engine Mechanics.

2.1. Engine housing

The engine housing comprises the engine block (crankcase and bedplate), the cylinder head, the cylinder head cover, the oil sump and the gaskets.



TO11-0267

N13 engine, structure of engine housing

Index	Explanation
1	Cylinder head cover
2	Cylinder head cover gasket
3	Cylinder head
4	Cylinder head gasket

N13 Engine.

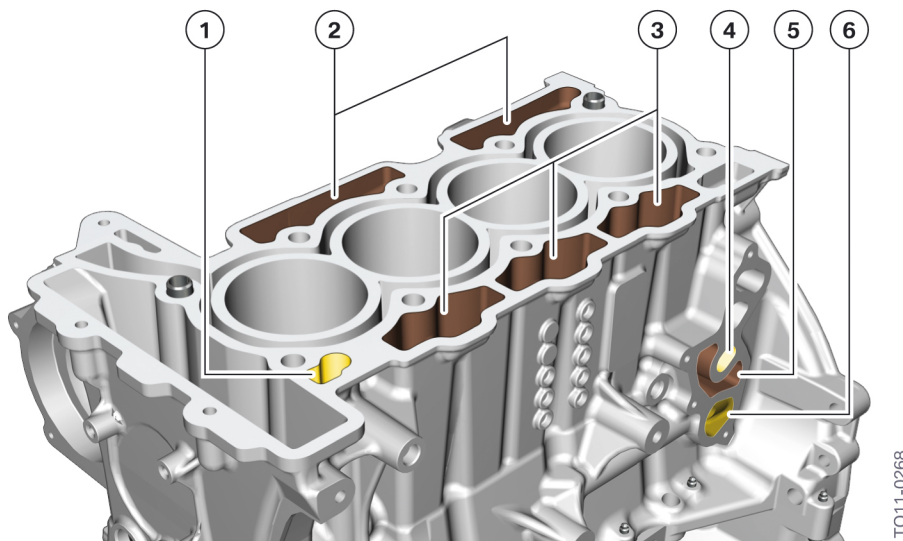
2. Engine Mechanics.

Index	Explanation
5	Crankcase
6	Sealant
7	Bedplate
8	Sealant
9	Oil sump

2.1.1. Engine block

The engine block is made from diecast aluminium AlSi9Cu3 and comprises the crankcase and the bedplate. The same material has already been used in the established 4-cylinder engines with aluminium crankcases.

Oil ducts



N13 engine, oil ducts

Index	Explanation
1	Clean oil duct
2	Oil return ducts
3	Blow-by ducts
4	Clean oil duct
5	Oil return (filter renewal)
6	Raw oil duct

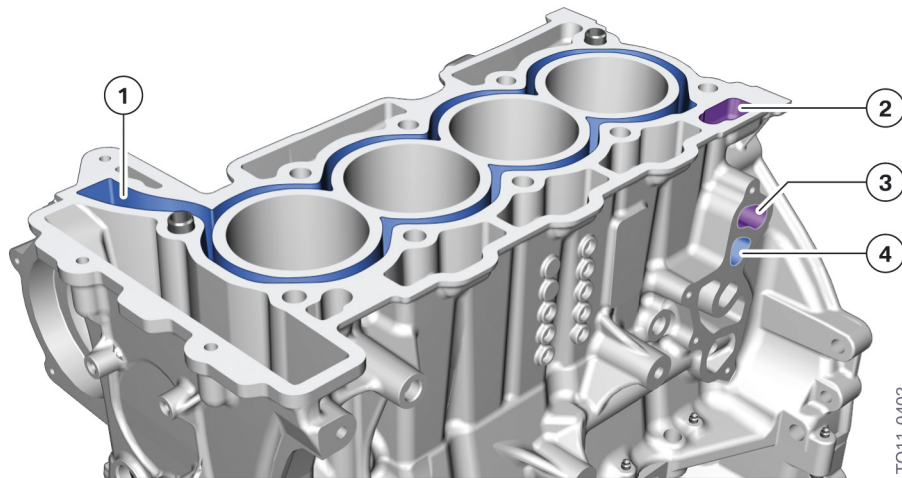
The oil flowing back through the oil return ducts (2) is routed directly into the oil sump and therefore cannot come into contact with the crankshaft. The blow-by channels (3) already end before the crankshaft and facilitate a good gas exchange to the cylinder head cover.

N13 Engine.

2. Engine Mechanics.

Coolant ducts

The engine block is an open-deck design. The coolant flows from the coolant pump to the right side of the engine block. The take-off from the cooling jacket to the oil-to-water heat exchanger is located on the fourth cylinder. The oil heated by the oil-to-water heat exchanger is routed via a duct from the crankcase into the cylinder head next to the coolant outlet.



N13 engine, cooling jacket and coolant ducts

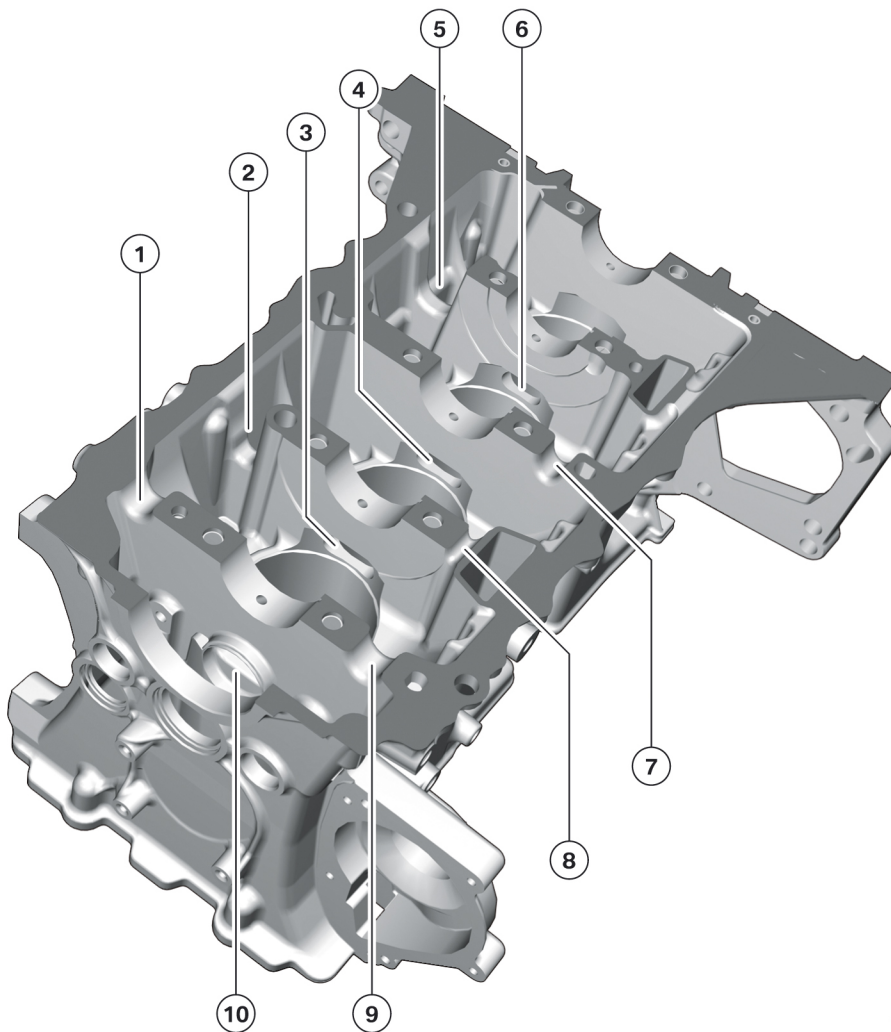
Index	Explanation
1	Cooling jacket
2 + 3	Coolant duct from coolant heat exchanger to cooling jacket in cylinder head
4	Coolant duct from cooling jacket to coolant heat exchanger

Compensation openings

The crankcase features large longitudinal ventilation openings which are both cast in and milled. These ventilation openings improve the pressure compensation of the oscillating air columns created by the up- and down-strokes of the pistons.

N13 Engine.

2. Engine Mechanics.



TO11-0269

N13 engine, compensation openings in the bearing seat

Index	Explanation
1, 2, 3, 6, 8, 9, 10	Apertures
4, 5, 7	Ventilation holes

Cylinder

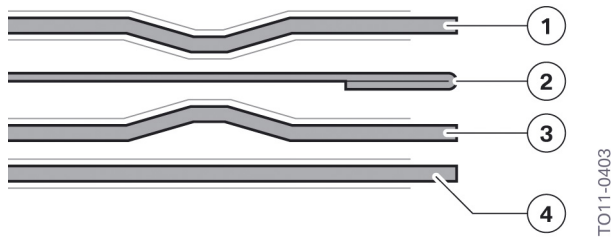
Cast-in dry cylinder liners are used in the N13 engine. The grey cast iron liners terminate at the top at the cylinder head gasket level.

2.1.2. Cylinder head gasket

A four-layer spring steel gasket is used for the cylinder head gasket. A stopper plate (2) is flanged in the area of the cylinder bores in order to achieve sufficient contact pressure for sealing. All the layers are coated, the contact surfaces with the cylinder head and the engine block having a partial fluorocautchouc coating with anti-stick coating.

N13 Engine.

2. Engine Mechanics.



N13 engine, cylinder head gasket

Index	Explanation
1	Top spring steel layer with anti-stick coating on both sides
2	Spring steel layer, stopper plate
3	Middle spring steel layer with coating on top side
4	Bottom spring steel layer with anti-stick coating on both sides

2.1.3. Cylinder head

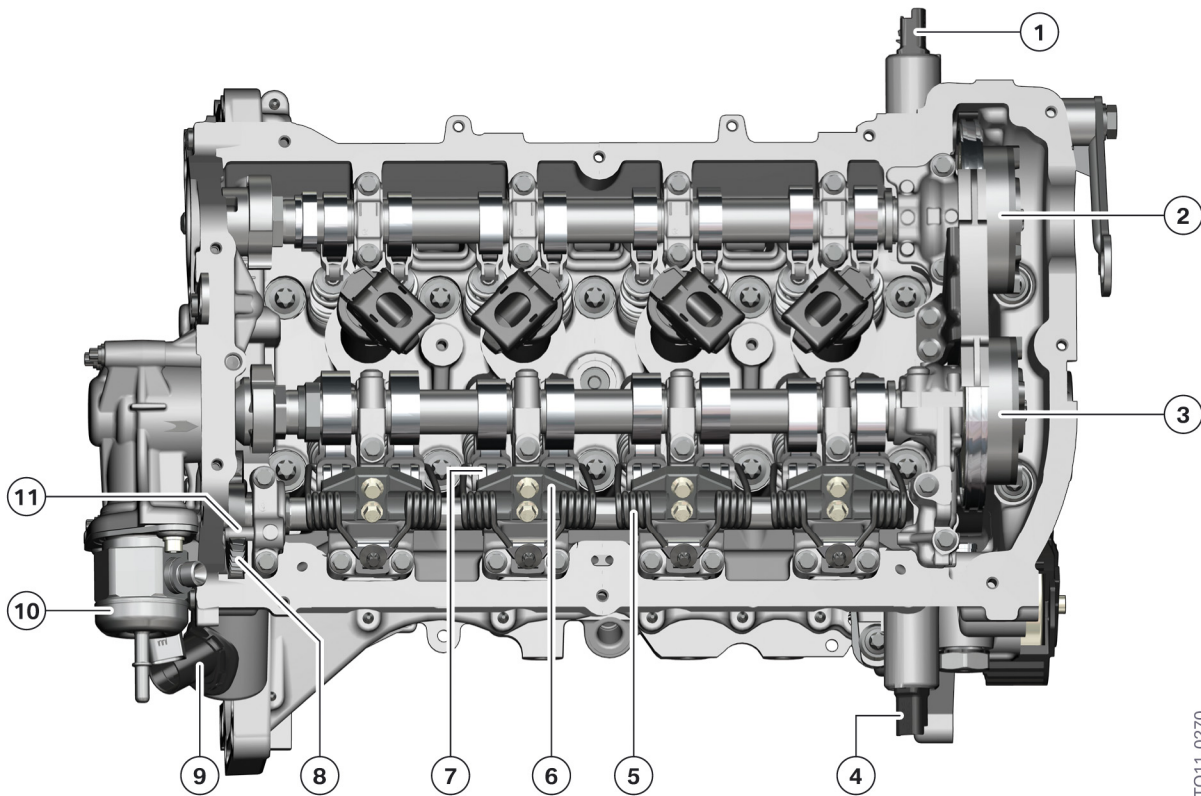
The cylinder head of the N13 engine is a derivation of the cylinder head of the N18 engine in the MINI. 3rd generation Valvetronic is also used in the N13 engine, as is already familiar from the N55 engine and the N18 engine.



The combination of exhaust turbocharger, Valvetronic and direct fuel injection is known as **Turbo-Valvetronic Direct Injection (TVDI)**.

N13 Engine.

2. Engine Mechanics.



TO11-0270

N13 engine, cylinder head

Index	Explanation
1	VANOS solenoid valve, exhaust side
2	VANOS, exhaust side
3	VANOS, intake side
4	VANOS solenoid valve, intake side
5	Spring
6	Gate
7	Intermediate lever
8	Partial ring gear, eccentric shaft
9	Valvetronic servomotor
10	High-pressure pump
11	Minimum and maximum stop, eccentric shaft

N13 Engine.

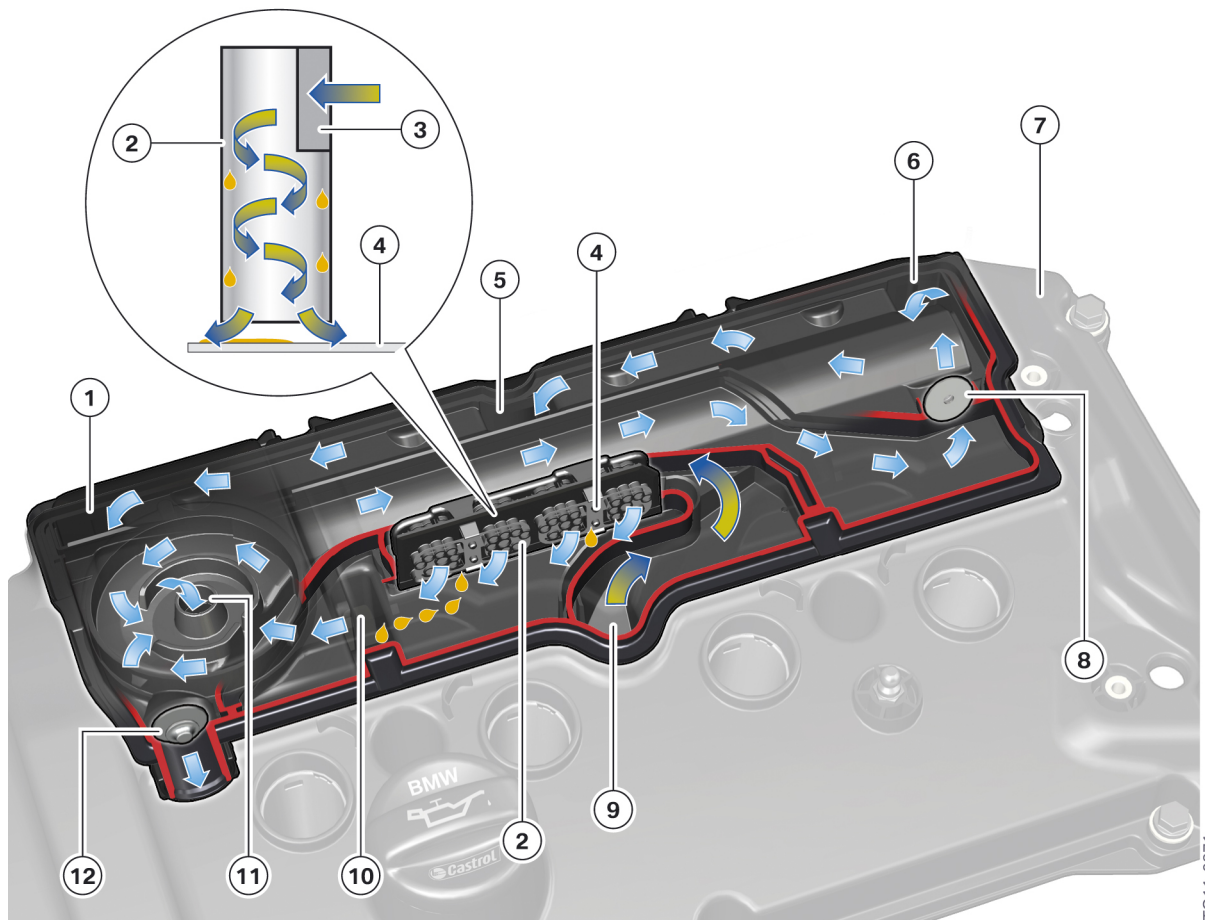
2. Engine Mechanics.

2.1.4. Cylinder head cover

Design

All the components for crankcase ventilation and the blow-by ducts are integrated in the cylinder head cover. A pressure control valve prevents an excessive vacuum from being generated in the crankcase. Because the engine is turbocharged, crankcase ventilation takes two different forms. Thus, ventilation is performed via different ducts depending on whether the engine is running in turbocharged or normal mode.

Pressure regulation is performed by the pressure control valve in both cases. The pressure control valve brings about a pressure reduction of approx. 38 mbar in the crankcase.



N13 engine, cylinder head cover with crankcase ventilation

Index	Explanation
1	Duct to cylinder head into intake port, cylinder 1
2	Cyclone flexible tongue separator
3	Side opening in cyclone separator
4	Flexible tongue
5	Duct to cylinder head into intake ports, cylinders 2 and 3

N13 Engine.

2. Engine Mechanics.

Index	Explanation
6	Duct to cylinder head into intake port, cylinder 4
7	Cylinder head cover
8	Non-return valve in duct to intake ports
9	Opening to cylinder head
10	Oil return duct
11	Pressure control bore in pressure control valve
12	Non-return valve in duct to charge-air suction line

The blow-by gases go via the central opening between cylinder two and three and a channel to the cyclone flexible tongue separator. The oil stuck to the blow-by gas is intercepted by the cyclone flexible tongue and flows back downwards along the walls via a non-return valve in the cylinder head. The blow-by gas cleaned by the oil now gets to the air intake system via the pressure control valve, depending on the operating condition.

Function

The standard function can only be utilised while the non-return valve in the intake plenum is opened by vacuum pressure, i.e. in naturally aspirated mode.

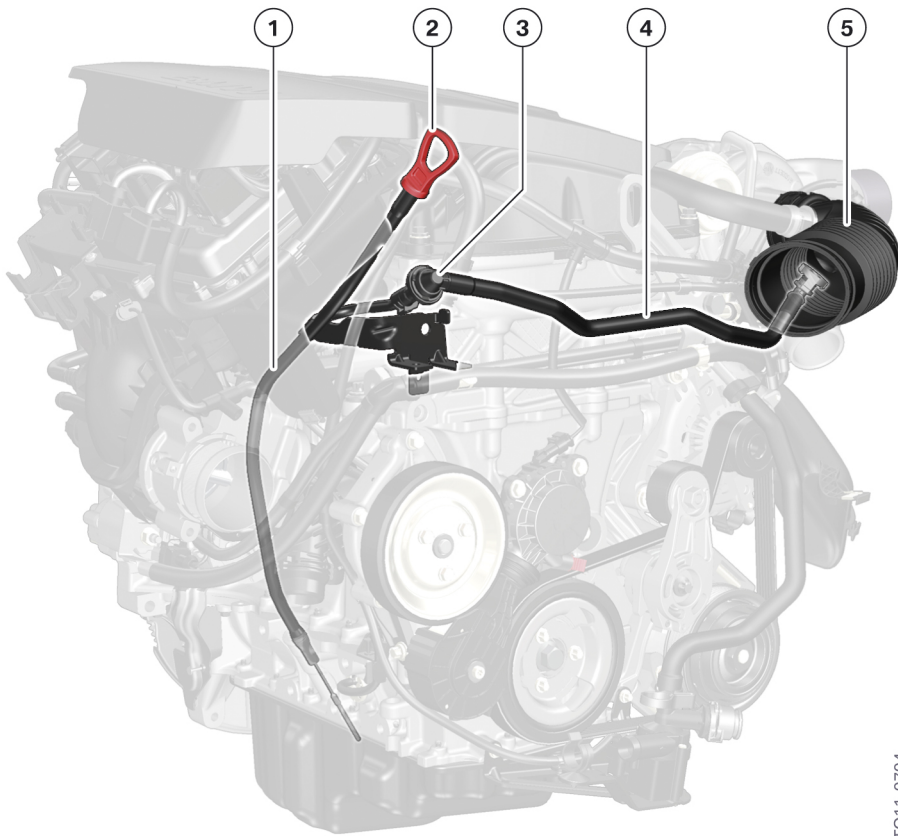
In naturally aspirated mode, the non-return valve in the blow-by duct of the cylinder head cover is opened by the vacuum pressure in the intake plenum and the blow-by gases are drawn off via the pressure control valve. The vacuum pressure simultaneously closes the second non-return valve in the duct to charge-air suction line.

The blow-by gases are routed via the rail integrated in the cylinder head cover directly into the cylinder head intake ports.

A purge air line, which is connected to the clean air pipe ahead of the exhaust turbocharger and to the crankcase, routes fresh air via a non-return valve and the oil dipstick into the crank chamber. The greater the vacuum in the crank chamber, the higher the air mass introduced into the crankcase. This purging reduces the entry of fuel and water, which in turn improves the oil quality.

N13 Engine.

2. Engine Mechanics.



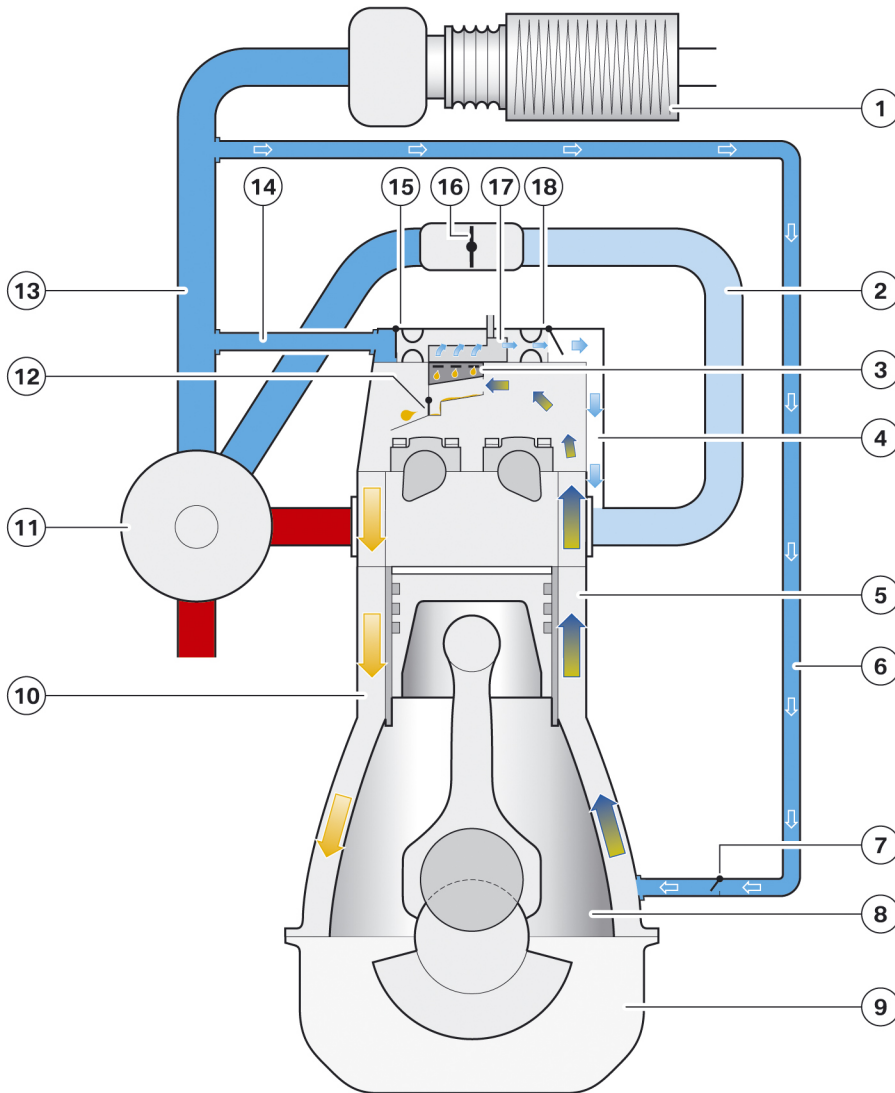
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N13 engine, purge air line

Index	Explanation
1	Oil dipstick guide tube
2	Oil dipstick
3	Non-return valve
4	Purge air line
5	Clean air pipe

N13 Engine.

2. Engine Mechanics.



TO11-0272

N13 engine, crankcase ventilation, naturally aspirated mode

Index	Explanation
B	Ambient pressure
C	Vacuum
D	Exhaust gas
E	Oil
F	Blow-by gas
1	Air filter
2	Intake plenum

N13 Engine.

2. Engine Mechanics.

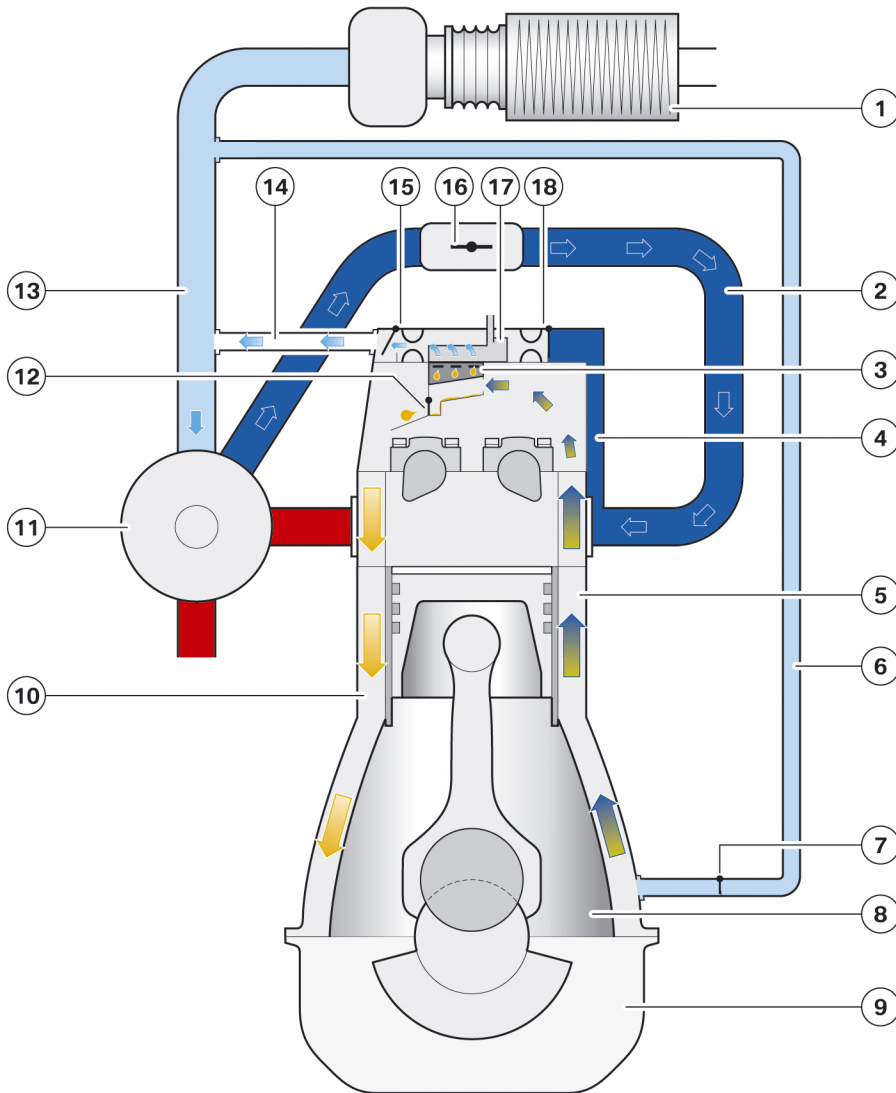
Index	Explanation
3	Cyclone flexible tongue separator
4	Duct in cylinder head and cylinder head cover
5	Blow-by duct
6	Purge air line
7	Non-return valve
8	Crank chamber
9	Oil sump
10	Oil return duct
11	Exhaust turbocharger
12	Non-return valve, oil return
13	Charge-air suction line
14	Duct to charge-air suction line
15	Non-return valve with restrictor
16	Throttle valve
17	Pressure control valve
18	Non-return valve with restrictor

Once the pressure in the intake plenum rises, it is no longer possible for the blow-by gases to be introduced via this route. This would otherwise create the risk of the charging pressure being introduced into the crankcase. A non-return valve in the blow-by duct of the cylinder head cover closes the duct to the intake plenum and thereby protects the crankcase against excess pressure.

The now greater fresh-air demand generates a vacuum in the clean air pipe between the exhaust turbocharger and the intake silencer. This vacuum is sufficient to open the non-return valve and via the connection on the cylinder head cover to draw off the blow-by gases via the pressure control valve.

N13 Engine.

2. Engine Mechanics.



TO11-0273

N13 engine, crankcase ventilation, turbocharged mode

Index	Explanation
A	Charging pressure
C	Vacuum
D	Exhaust gas
E	Oil
F	Blow-by gas
1	Air filter
2	Intake plenum

N13 Engine.

2. Engine Mechanics.

Index	Explanation
3	Cyclone flexible tongue separator
4	Duct in cylinder head and cylinder head cover
5	Blow-by duct
6	Purge air line
7	Non-return valve
8	Crank chamber
9	Oil sump
10	Oil return duct
11	Exhaust turbocharger
12	Non-return valve, oil return
13	Charge-air suction line
14	Duct to charge-air suction line
15	Non-return valve with restrictor
16	Throttle valve
17	Pressure control valve
18	Non-return valve with restrictor

2.1.5. Oil sump

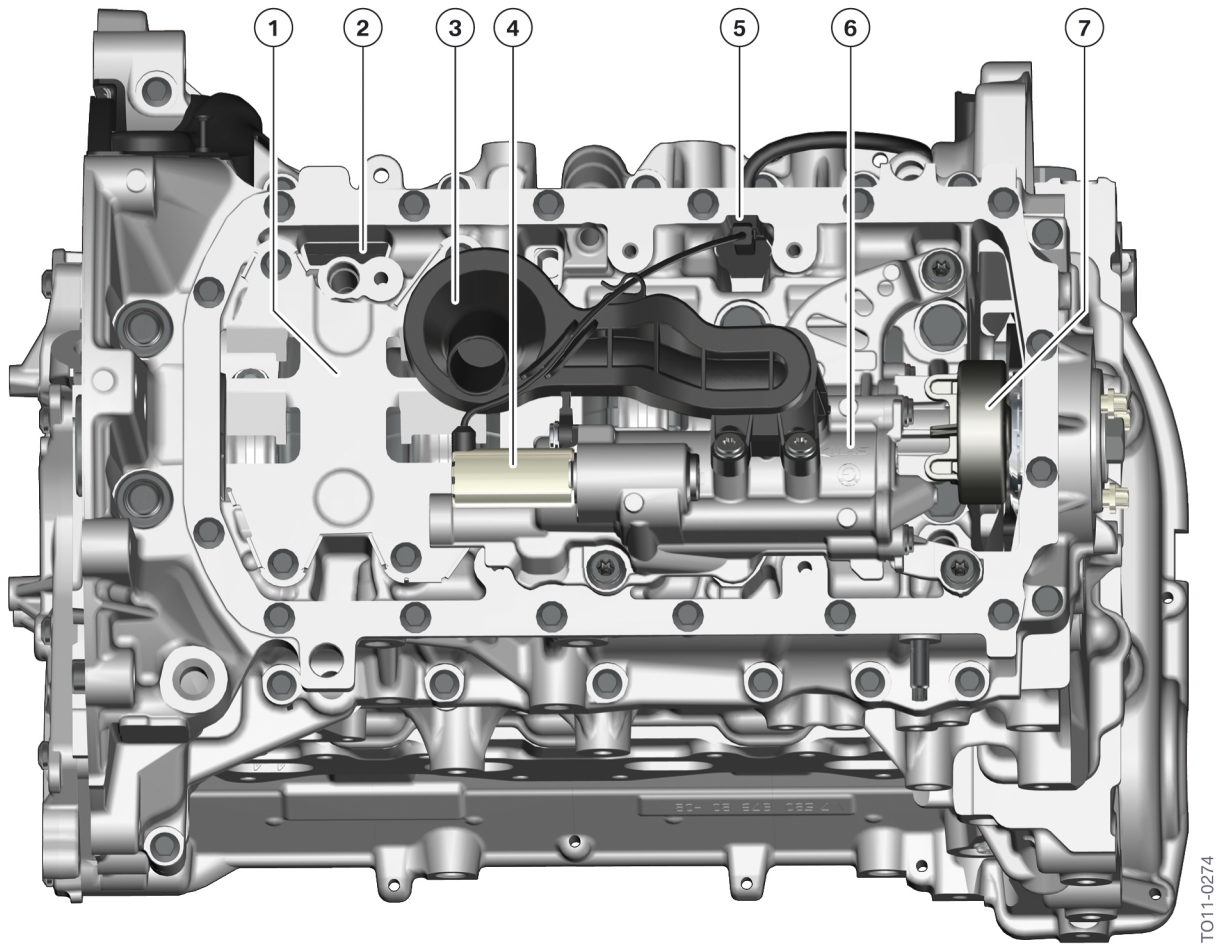
The oil sump of the N13 engine is made from single-layer sheet steel. The oil sump is sealed in production with a sealing compound in relation to the bedplate. In other BMW models the oil sump can be made from other materials; this is always dependent on the application. These different materials will not be discussed further here.



A rubber-metal gasket is used in service applications. The repair instructions must be followed. The adhesive sealing bead on the oil sump must not be removed!

N13 Engine.

2. Engine Mechanics.



TO11-0274

N13 engine, from below without oil sump

Index	Explanation
1	Oil deflector
2	Oil return duct
3	Intake snorkel
4	Oil pressure control valve
5	Cable duct, crankcase
6	Oil pump
7	Cover, oil pump sprocket

N13 Engine.

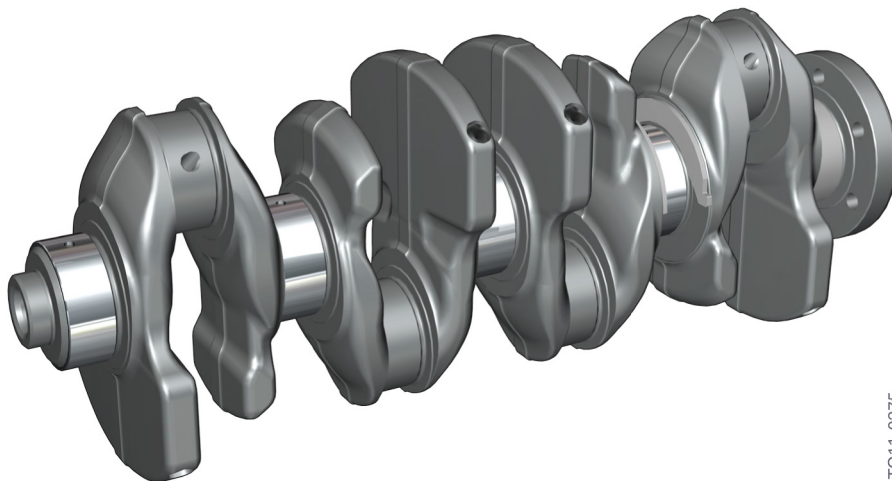
2. Engine Mechanics.

2.2. Crankshaft drive

2.2.1. Crankshaft with bearings

Crankshaft

The crankshaft of the N13 engine has a stroke of 85.8 mm and is made of the material 38MSV5. It is a forged crankshaft with four large and four small balance weights.

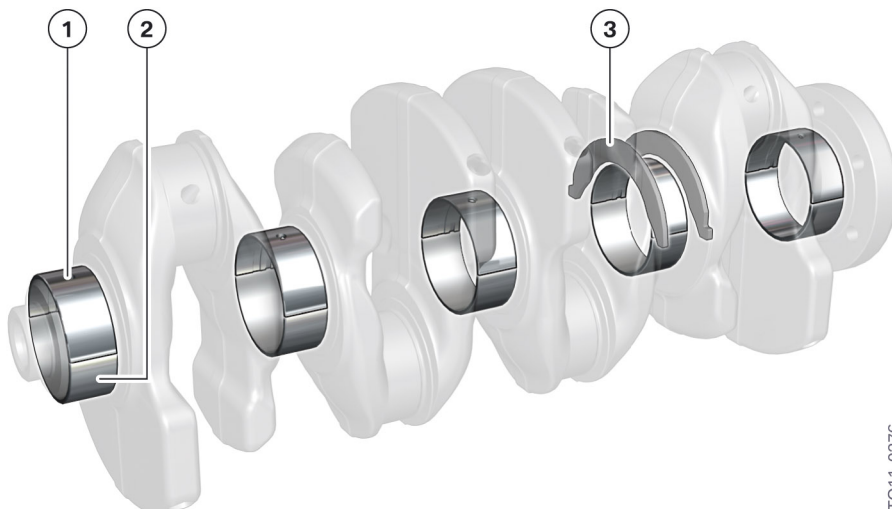


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N13 engine, crankshaft

Crankshaft bearings

The crankshaft is supported by five bearings. The thrust bearing is located in the middle at the third bearing position. The thrust bearing is only designed for 180° and is located in the bearing seat. The bearing in the bearing cap does not assume any axial guidance. Lead-free two-material bearings are used. Steel is used as the carrier layer. The aluminium liner is applied to the carrier layer; this liner is approx. 150 µm thick.



TO11-0276

N13 engine, crankshaft bearings

N13 Engine.

2. Engine Mechanics.

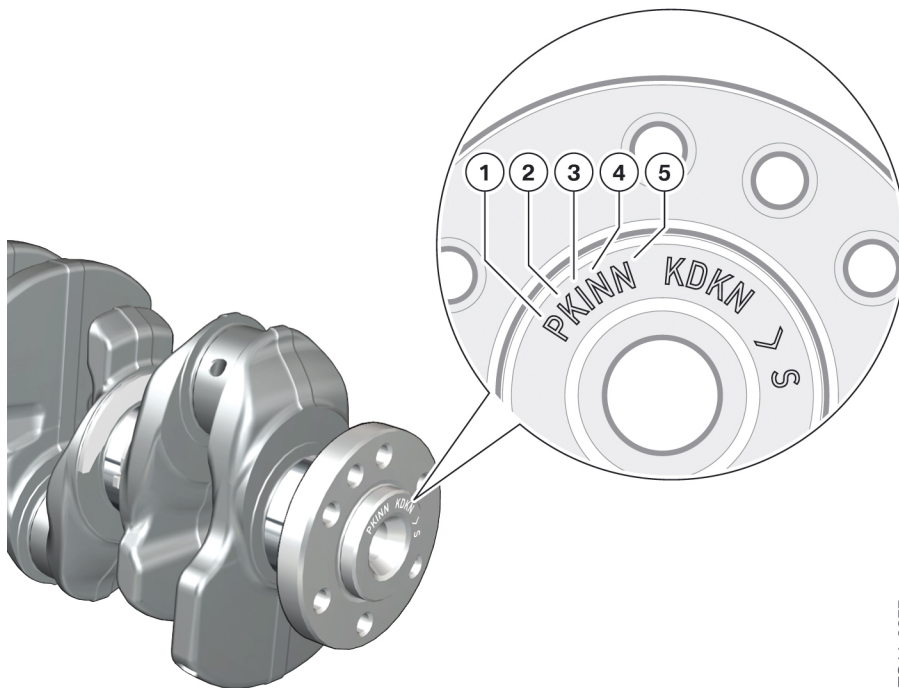
Index	Explanation
1	Upper bearing shell with groove and oil hole
2	Thrust bearing, bottom
3	Thrust washer for thrust bearing



The identifications for the bearings are engraved into the crankcase and into the crankshaft. Refer to the repair instructions if the crankshaft is to be fitted with new bearings.

Note: The designation of the bearing positions in the repair instructions may differ from the standard (bearing position 1 is always seated opposite the output end)!

This product information bulletin is based on the standard for the purpose of bearing designation.



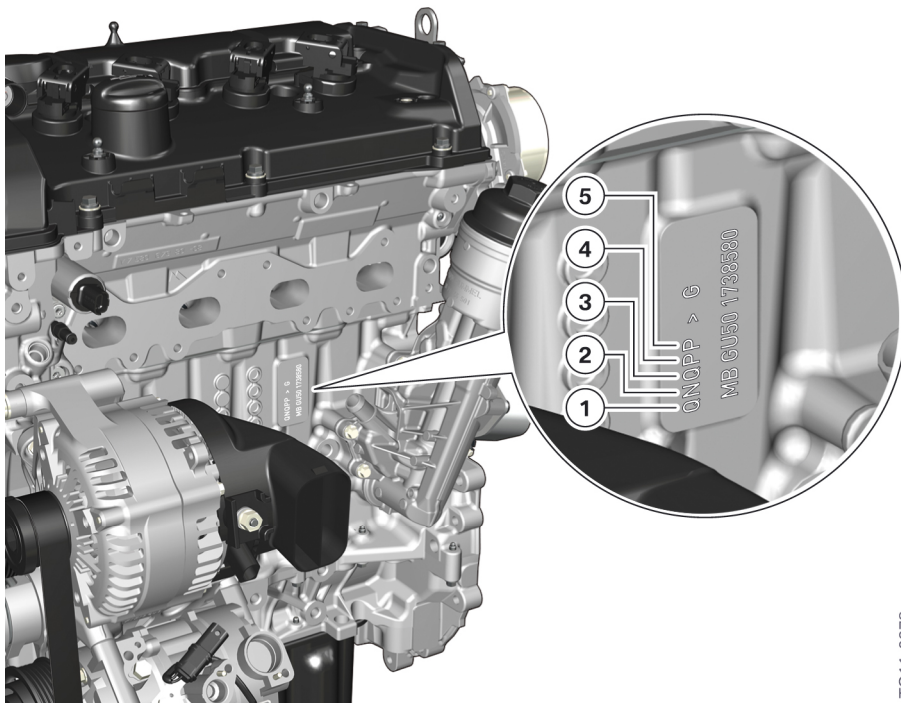
TO11-0277

N13 engine, bearing identification, crankshaft

Index	Explanation
1	Bearing 5 (clutch end)
2	Bearing 4
3	Bearing 3
4	Bearing 2
5	Bearing 1

N13 Engine.

2. Engine Mechanics.



N13 engine, bearing identification, crankcase

TO11-0278

Index	Explanation
1	Bearing 5 (clutch end)
2	Bearing 4
3	Bearing 3
4	Bearing 2
5	Bearing 1

The bearing opposite the flywheel is classified differently, as the bearing position of the crankshaft is expanded when the central bolt is tightened. The installation clearance at this bearing position is therefore altered by the tightening of the central bolt and then has the designated clearance.



Bearing classification on the N13 engine differs from that for the established BMW engines. Thus, the relevant bearing colours are determined from tables in the repair instructions on the basis of the identification on the crankshaft and the engine block. A feature of note is that bearing 1 is determined from a different table. This process requires a specific procedure and appropriate care.

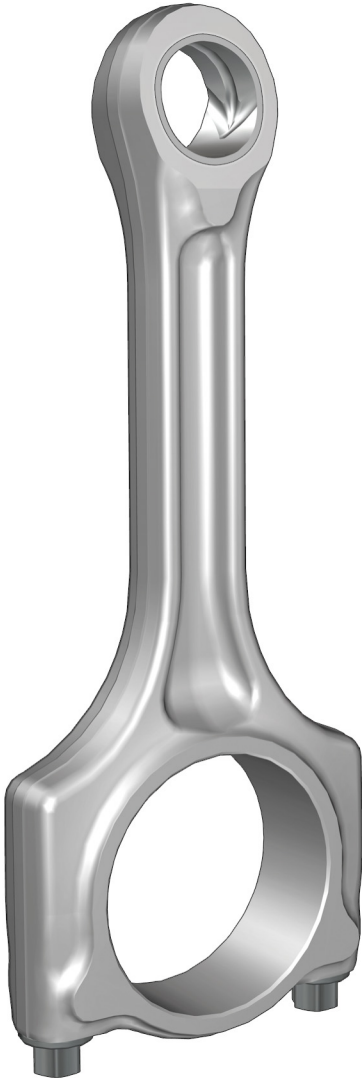
N13 Engine.

2. Engine Mechanics.

2.2.2. Connecting rod with bearing

Connecting rod

The connecting rod of the N13 engine has an inside diameter of 138.54. A feature of note is the grooves machined into the small connecting rod eye which serve to optimise the oil supply. This connecting rod design has already been used in the N18 engine.



TO11-0404

N13 engine, connecting rod

Bearings

The connecting rod bearing shells are lead-free in design. There is only one bearing shell which is used at the rod end and the cap end.

The bearing shells are common parts of the N18 and N16 engines.

N13 Engine.

2. Engine Mechanics.

2.2.3. Piston with piston rings

A full slipper skirt piston manufactured by the company Mahle is used. The piston diameter is 77 mm. The first piston ring is a steel-nitrided plain compression ring. The second piston ring is a stepped compression ring. The oil scraper ring is a steel band ring with spring, which is also known as a U-Flex ring.

The gudgeon pin axis is positively offset to the major thrust face by 0.8 mm.

The piston is designed for all BMW models with a compression ratio of 10.5 : 1.

The installation position of the piston can be easily identified by means of the asymmetrical layout of the piston recess. An installation position arrow is featured on the piston. This arrow always points on installation in the engine longitudinal direction forwards to the belt drive. It is necessary to install the piston in the correct position, since otherwise valve damage or slipper wall breakage may quickly ensue. The result would be total loss.

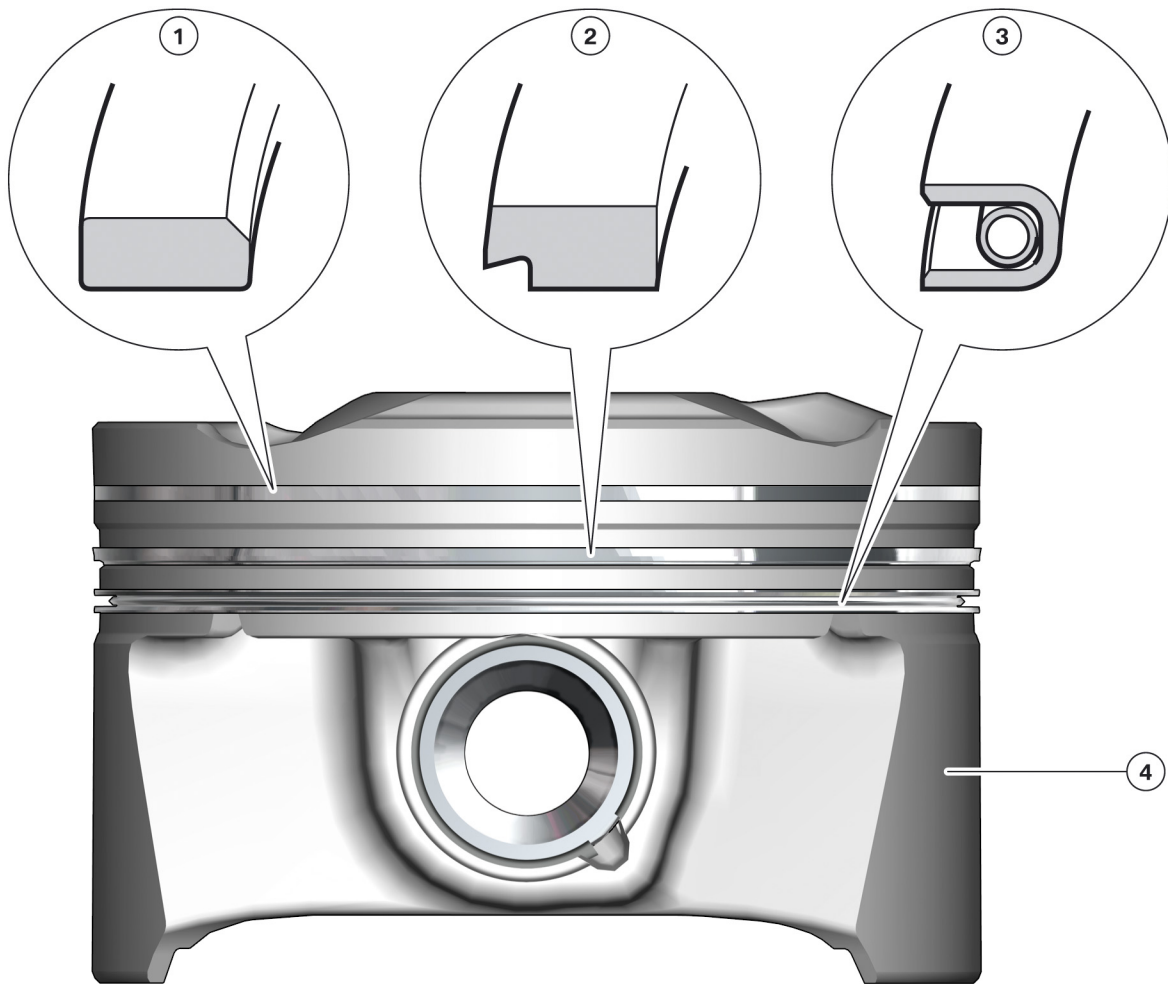


N13 engine, piston

TO11-0279

N13 Engine.

2. Engine Mechanics.



TO11-0280

N13 engine, piston rings

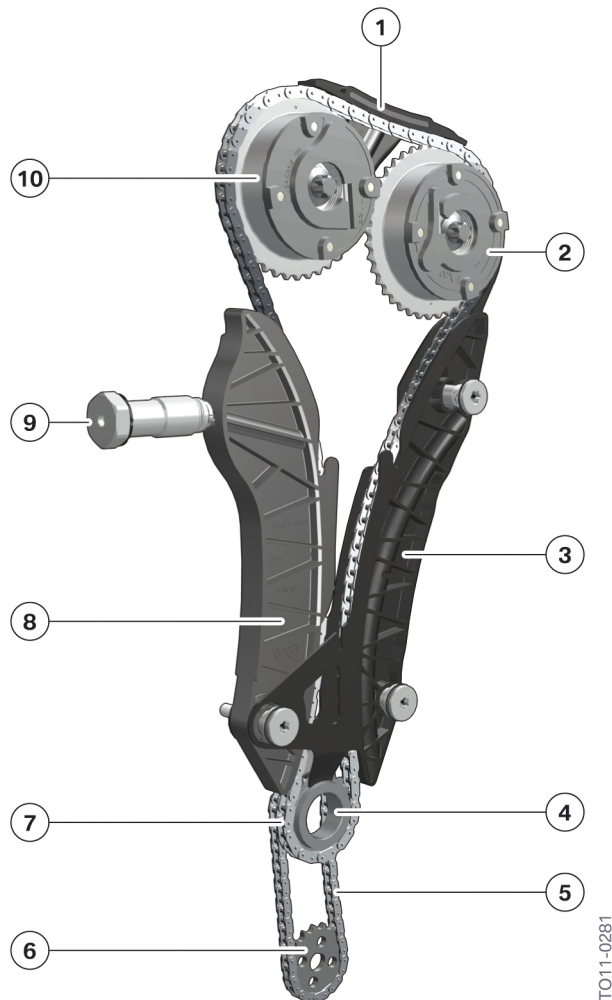
Index	Explanation
1	Plain compression ring
2	Stepped compression ring
3	U-Flex ring
4	Piston

2.3. Camshaft drive

The camshaft drive has an established design. The oil pump is driven via the secondary chain.

N13 Engine.

2. Engine Mechanics.



TO11-0281

N13 engine, camshaft drive

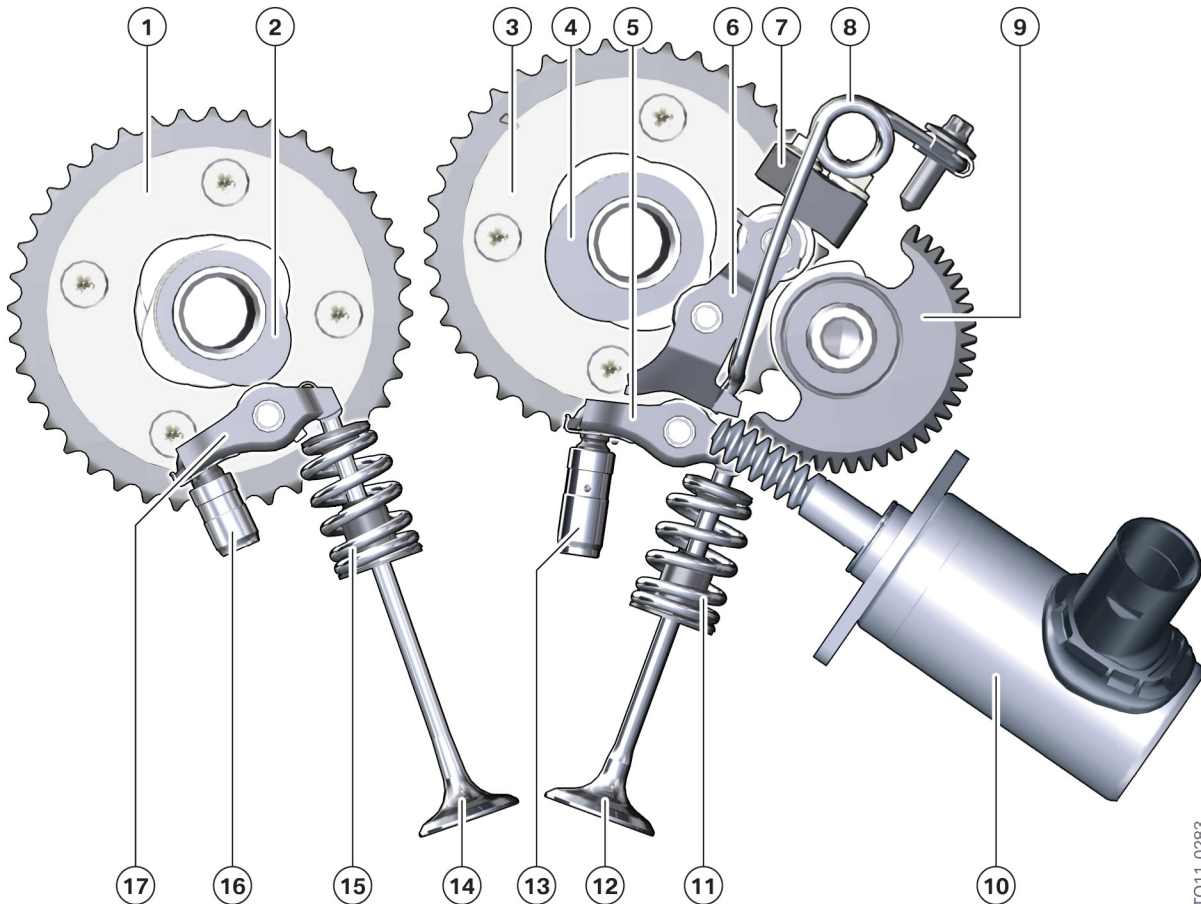
Index	Explanation
1	Chain guide rail
2	VANOS exhaust camshaft
3	Chain guide rail
4	Crankshaft sprocket
5	Secondary chain
6	Oil pump sprocket
7	Primary chain
8	Tensioning rail
9	Chain tensioner
10	VANOS intake camshaft

N13 Engine.

2. Engine Mechanics.

2.4. Valve gear

2.4.1. Design



TO11-0283

N13 engine, valve gear

Index	Explanation
1	VANOS, exhaust side
2	Exhaust camshaft
3	VANOS, intake side
4	Intake camshaft
5	Roller cam follower
6	Intermediate lever
7	Gate
8	Torsion spring
9	Eccentric shaft
10	Valvetronic servomotor

N13 Engine.

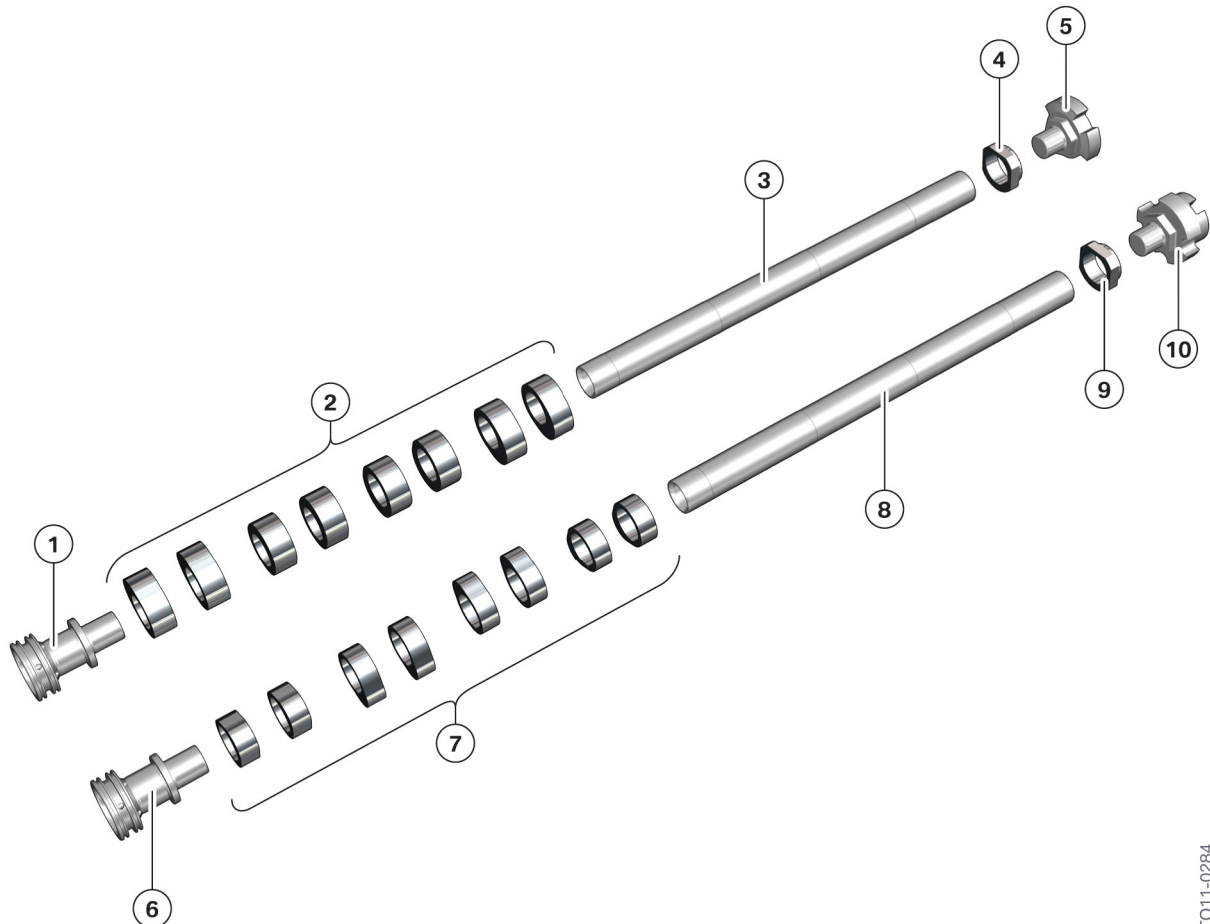
2. Engine Mechanics.

Index	Explanation
11	Valve spring
12	Intake valve
13	Hydraulic valve clearance compensating element
14	Exhaust valve
15	Valve spring
16	Hydraulic valve clearance compensating element
17	Roller cam follower

The roller cam followers on the intake side are made from sheet metal and subdivided into five classes, Class "1" to Class "5". The intermediate levers are now likewise made from sheet metal and subdivided into six classes, Class "00" to Class "05".

Camshafts

The N13 engine is fitted with the built-up camshafts familiar from the MINI N12/N14 and N16/N18 engines. The camshafts are manufactured in the so-called Presta process.



N13 engine, built-up camshafts

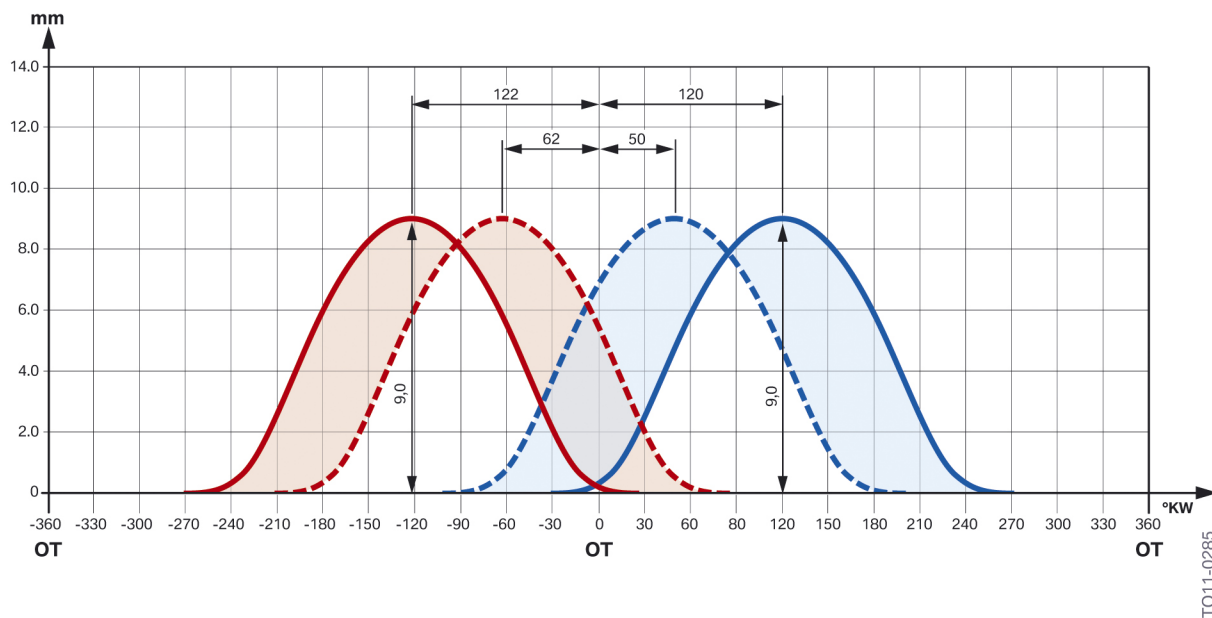
TO11-02B4

N13 Engine.

2. Engine Mechanics.

Index	Explanation
1	Flange for VANOS unit, intake
2	Cam
3	Pipe
4	Square
5	Camshaft sensor wheel with tothing for high-pressure pump drive
6	Flange for VANOS unit, exhaust
7	Cam
8	Pipe
9	Square
10	Camshaft sensor wheel with tothing for vacuum pump drive

Timing



N13 engine, timing diagram

		N43B2000	N55B30M0	N13B16M0
Intake valve dia./stem dia.	[mm]	31.4/6	32/5	29.7/5
Exhaust valve dia./stem dia.	[mm]	28/6	28/6	26.2/5
Maximum valve lift, intake/exhaust valve	[mm]	9.9/9.7	9.9/9.7	9.0/9.0
VANOS adjustment range, intake	[cranksha degrees]	45	70	70
VANOS adjustment range, exhaust	[cranksha degrees]	45	55	60

N13 Engine.

2. Engine Mechanics.

Spread, intake camshaft	[cranksha degrees]	125 – 80	120 – 50	120 – 50
Spread, exhaust camshaft	[cranksha degrees]	125 – 80	115 – 60	122 – 62
Opening period, intake camshaft	[cranksha degrees]	255	258	253
Opening period, exhaust camshaft	[cranksha degrees]	271	261	252

Intake valves

The intake valves are carry-over parts from the MINI N18 engine and are of identical construction. The intake valves have a stem diameter of 5 mm and are made from solid material. The intake valve seat is induction-hardened.

Exhaust valves

The exhaust valves are carry-over parts from the MINI N14/N18 engine and are of identical construction. They have a stem diameter of 5 mm, are hollow-drilled and filled with sodium. The exhaust valve seat is armoured (harder material).

Valve springs

The springs for the intake and exhaust valves are identical and have already been used in the MINI N14/N18 engine.

2.4.2. Valvetronic



The Valvetronic comprises fully variable valve lift control and variable camshaft control (double VANOS), which makes the closing time of the intake valves freely selectable.

Valve lift control is performed on the intake side, while camshaft control is performed on both the intake and exhaust sides.

Throttle-free load control is only possible if:

- the lift of the intake valve
- and camshaft adjustment of the intake and exhaust camshafts are variably controllable.

Result:

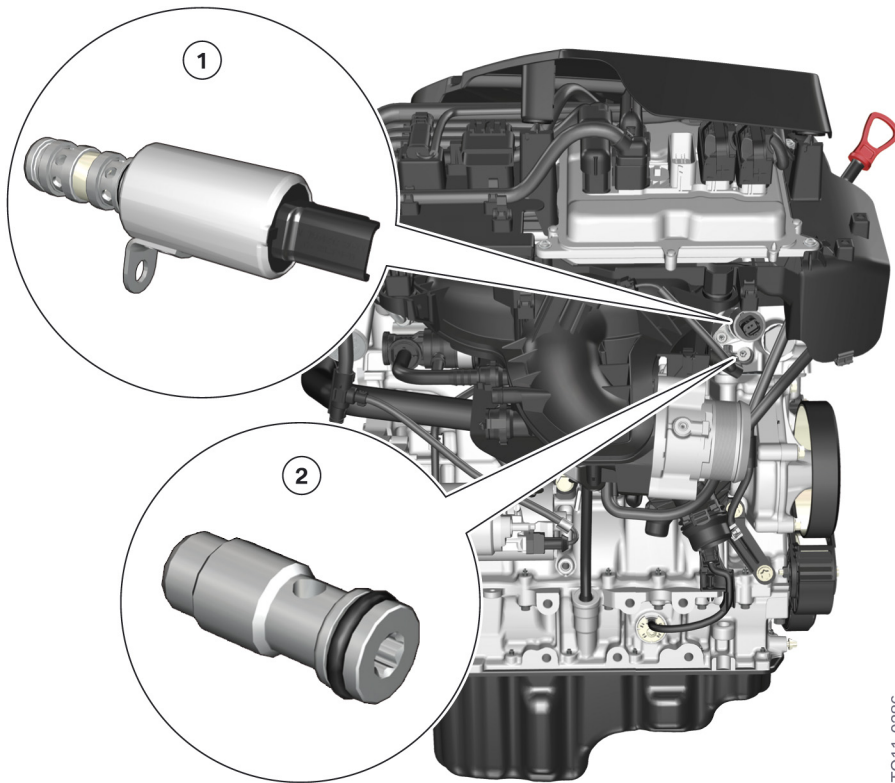
The opening and closing times and thus the opening period and the lift of the intake valves are freely selectable.

VANOS

The VANOS system has been carried over from the MINI N18 engine.

N13 Engine.

2. Engine Mechanics.



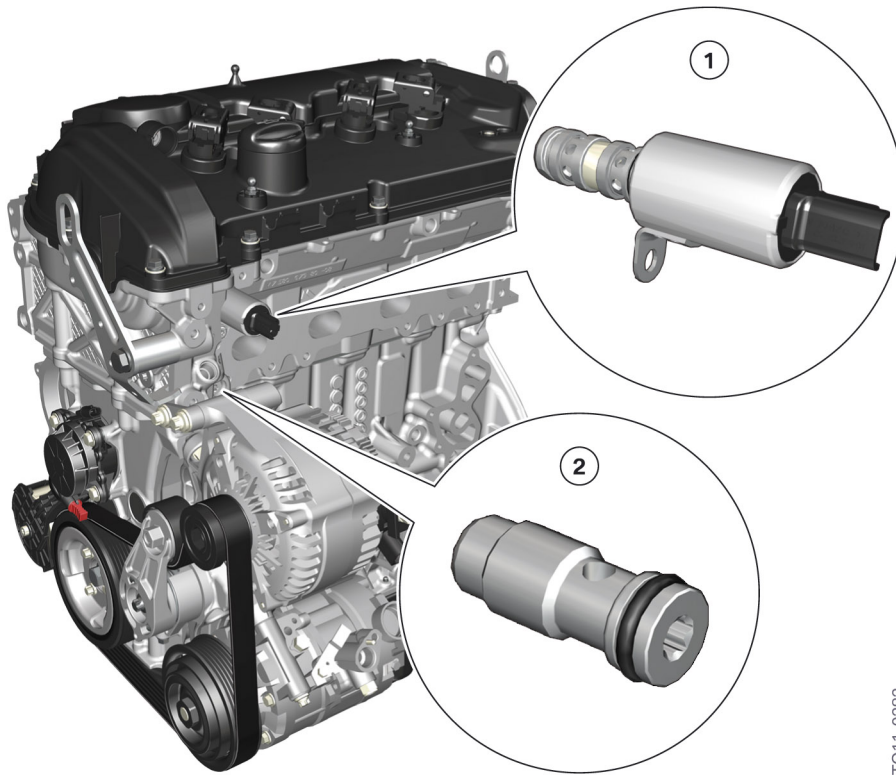
TO11-0286

N13 engine, VANOS solenoid valve and non-return valve

Index	Explanation
1	VANOS solenoid valve, intake side
2	Non-return valve

N13 Engine.

2. Engine Mechanics.



TO11-0282

N13 engine, VANOS solenoid valve and non-return valve

Index	Explanation
1	VANOS solenoid valve, exhaust side
2	Non-return valve

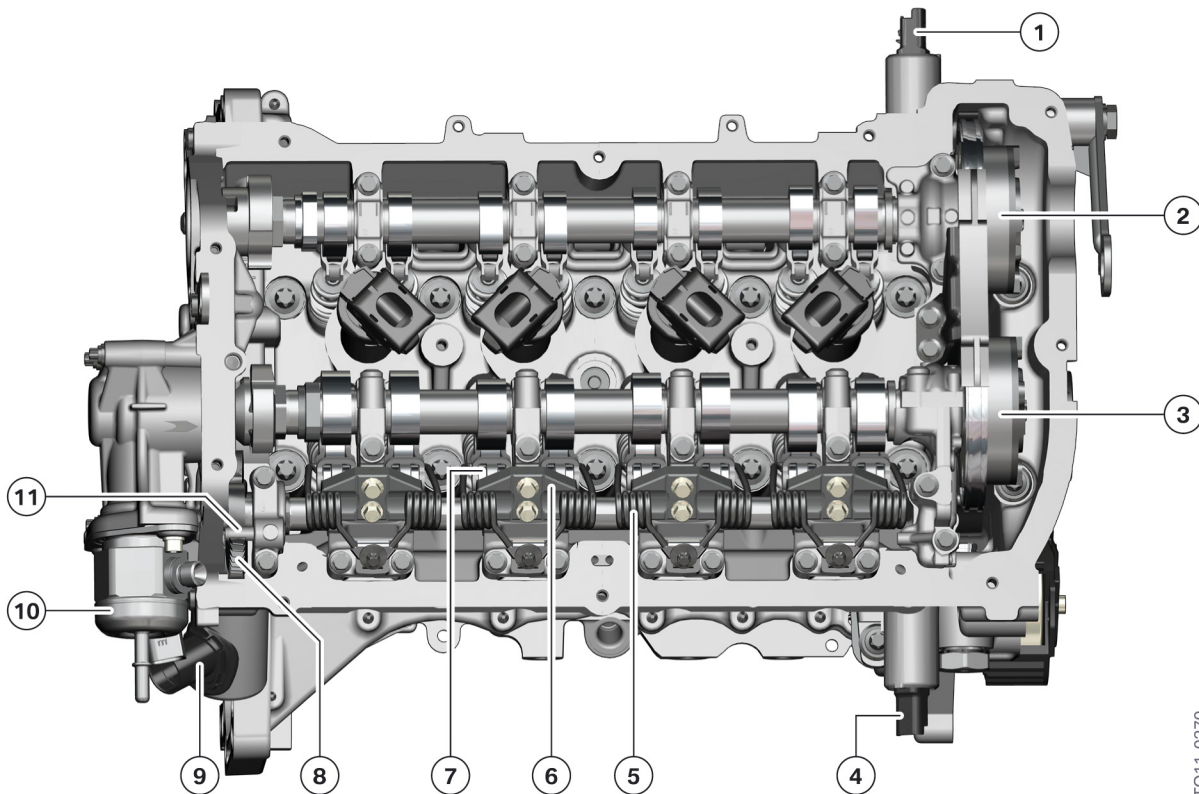
Valve lift control

As can be seen from the following graphic, valve lift control with the Valvetronic servomotor is identical in terms of design to that of the MINI N18 engine. The eccentric shaft sensor is integrated in the Valvetronic servomotor.

The system used is Valvetronic III, which already features in the MINI N18 and the BMW N20 and BMW N55 engines.

N13 Engine.

2. Engine Mechanics.



TO11-0270

N13 engine, cylinder head

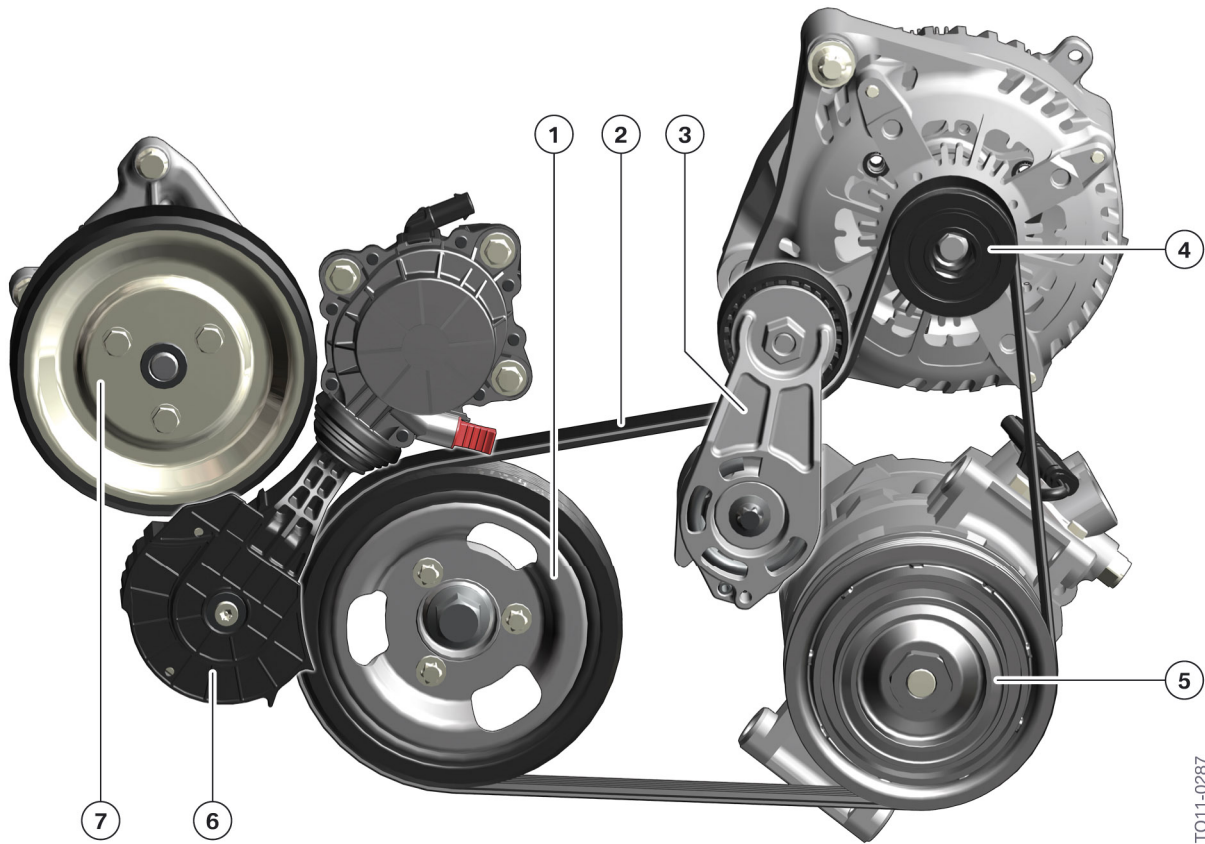
Index	Explanation
1	VANOS solenoid valve, exhaust side
2	VANOS, exhaust side
3	VANOS, intake side
4	VANOS solenoid valve, intake side
5	Spring
6	Gate
7	Intermediate lever
8	Partial ring gear, eccentric shaft
9	Valvetronic servomotor
10	High-pressure pump
11	Minimum and maximum stop, eccentric shaft

2.5. Belt drive

The belt drive consists of a main belt drive with alternator and A/C compressor and a friction gear auxiliary belt drive with the coolant pump. The main belt drive is equipped with a belt tensioner; the friction gear auxiliary belt drive, on account of its design, does not require a belt tensioner.

N13 Engine.

2. Engine Mechanics.



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N13 engine, belt drive

Index	Explanation
1	Belt pulley, crankshaft
2	Belt
3	Belt tensioner
4	Belt pulley, alternator
5	Belt pulley, A/C compressor
6	Friction gear drive
7	Coolant pump

The coolant pump of the N13 engine is driven by a friction gear. When the friction gear servodrive is at zero current, the friction gear is pressed by a spring in the direction of the crankshaft belt pulley and the coolant pump. For drive purposes the coolant pump has a friction gear which looks like a belt pulley with an attached belt.

The back of the belt on the crankshaft belt pulley drives the friction gear. The friction gear in turn drives the coolant pump. This design means that there is no need for a second belt drive. The space can be better utilised and therefore kept short and compact. Because of the lower lateral forces acting on the coolant pump shaft, the housing of the coolant pump can be made entirely from plastic. The design of the plastic housing has a positive effect on the flow performance and the delivery rate of the coolant pump.

N13 Engine.

3. Oil Supply.

The oil supply in the N13 engine is similar to that in the N55 engine. However, very different components are used to implement the oil supply. One of the biggest differences is the oil pump. A map-controlled gear-type oil pump is used in the N13 engine.

The special features of the oil supply in the N13 engine are:

- Map-controlled gear-type oil pump
- Raw oil cooling (in the N13B16M0 engine only)
- Oil pressure sensor (familiar from the N52TU engine).

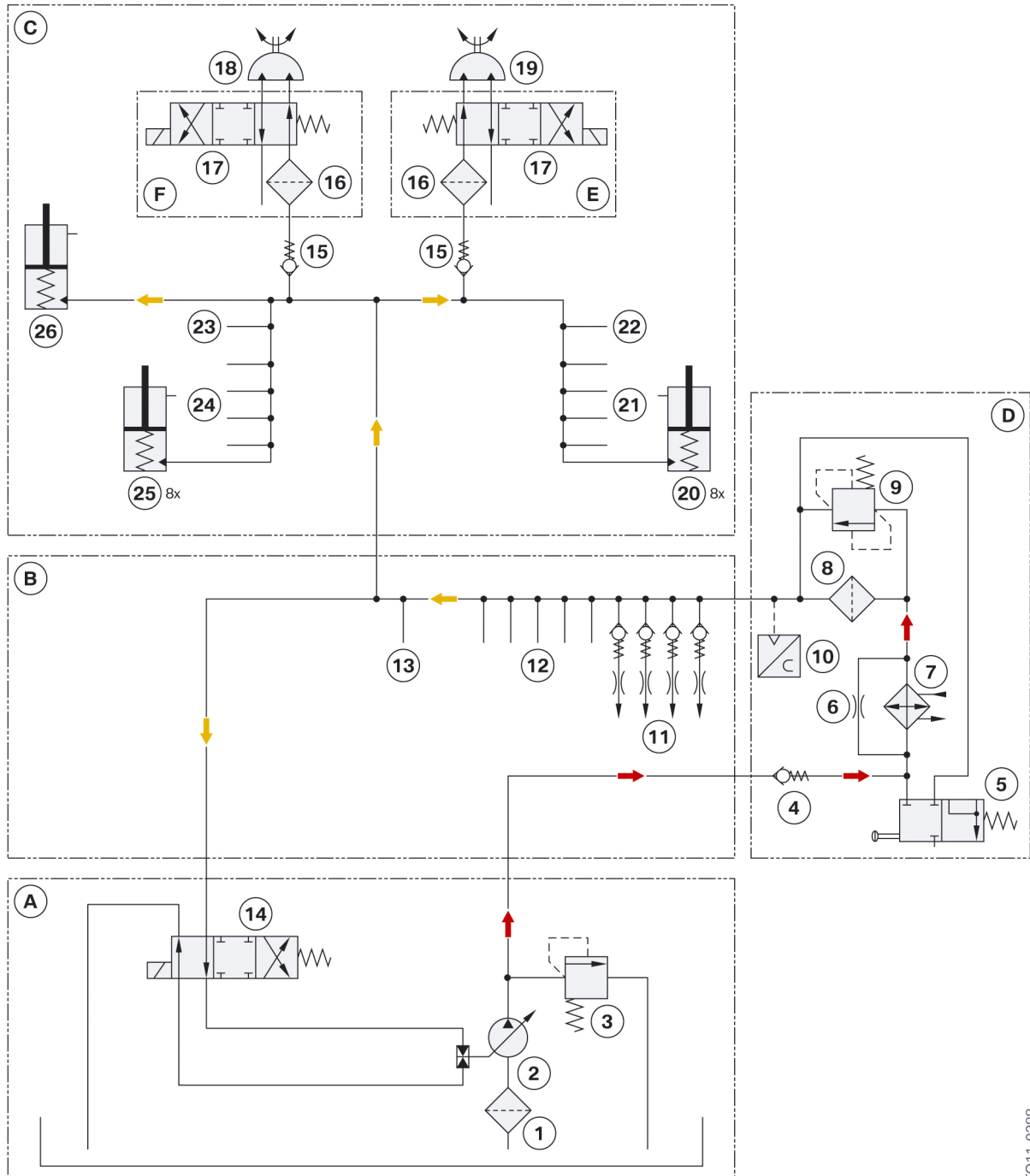
3.1. Overview

The following graphics provide an overview of the oil supply and show the hydraulic circuit diagram and the design of the oil pump.

N13 Engine.

3. Oil Supply.

3.1.1. Hydraulic circuit diagram



N13 engine, hydraulic circuit diagram

TO11-0288

N13 Engine.

3. Oil Supply.

Index	Explanation
A	Oil pump with oil sump
B	Crankcase
C	Cylinder head
D	Oil filter module
E	VANOS solenoid valve, exhaust camshaft
F	VANOS solenoid valve, intake camshaft
1	Strainer
2	Oil pump
3	Pressure-limiting valve (cold start valve)
4	Non-return valve
5	Discharge valve
6	Permanent bypass
7	Engine oil-to-coolant heat exchanger
8	Oil filter
9	Filter bypass valve
10	Oil pressure sensor
11	Oil spray nozzles for piston crown cooling
12	Lubrication points, crankshaft and connecting rods
13	Lubrication point, exhaust turbocharger
14	Oil pressure control valve
15	Non-return valve
16	Filter
17	VANOS solenoid valve
18	VANOS unit, intake camshaft
19	VANOS unit, exhaust camshaft
20	Hydraulic valve clearance compensation (HVCC), exhaust side
21	Lubrication points, bearings, exhaust camshaft
22	Lubrication point, vacuum pump
23	Lubrication point, high-pressure pump
24	Lubrication point, bearing, intake camshaft
25	Hydraulic valve clearance compensation (HVCC), intake side
26	Chain tensioner, timing chain

Many of the components such as the intermediate levers, roller cam followers, eccentric shaft and the Valvetronic servomotor are lubricated by oil spray in the cylinder head coming from the camshaft bearings. There are therefore no oil spray lines in the cylinder head.

N13 Engine.

3. Oil Supply.

3.2. Oil pump and pressure control

Control of the delivery rate of all the pumps, also those in the oil supply, plays a crucial role above all with the BMW EfficientDynamics strategy. Essentially, engineers attempt to dimension a pump with regard to its power input as small as possible in order to keep engine losses as low as possible. On the other hand, however, the pump must also be designed in such a way as to deliver the relevant medium at sufficient volume and pressure under all conceivable circumstances. A conventional, non-variable pump would therefore have to be designed in accordance with the second standpoint, i.e. large enough to be able to deliver sufficient amounts of the medium at all times. However, this means that the pump may deliver far too much medium over a large proportion of its service life and thereby draw more energy than necessary from the powertrain. For this reason, more and more pumps are now variable in design and their control is becoming increasingly more fine-tuned. In the case of the oil supply, the conventional oil pump was followed by volumetric flow control, which was subsequently extended to include map control.

The oil pump of the N13 engine is derived from the gear-type oil pump. This volume-flow-controlled oil pump was used for the first time in the N12 and N14 engines of the MINI. It was expanded into the map-controlled oil pump in the N16 and N18 engines of the MINI. The N13 engine adopts this concept of the map-controlled oil pump, but is a new development adapted to the complete system.

3.2.1. Oil pump

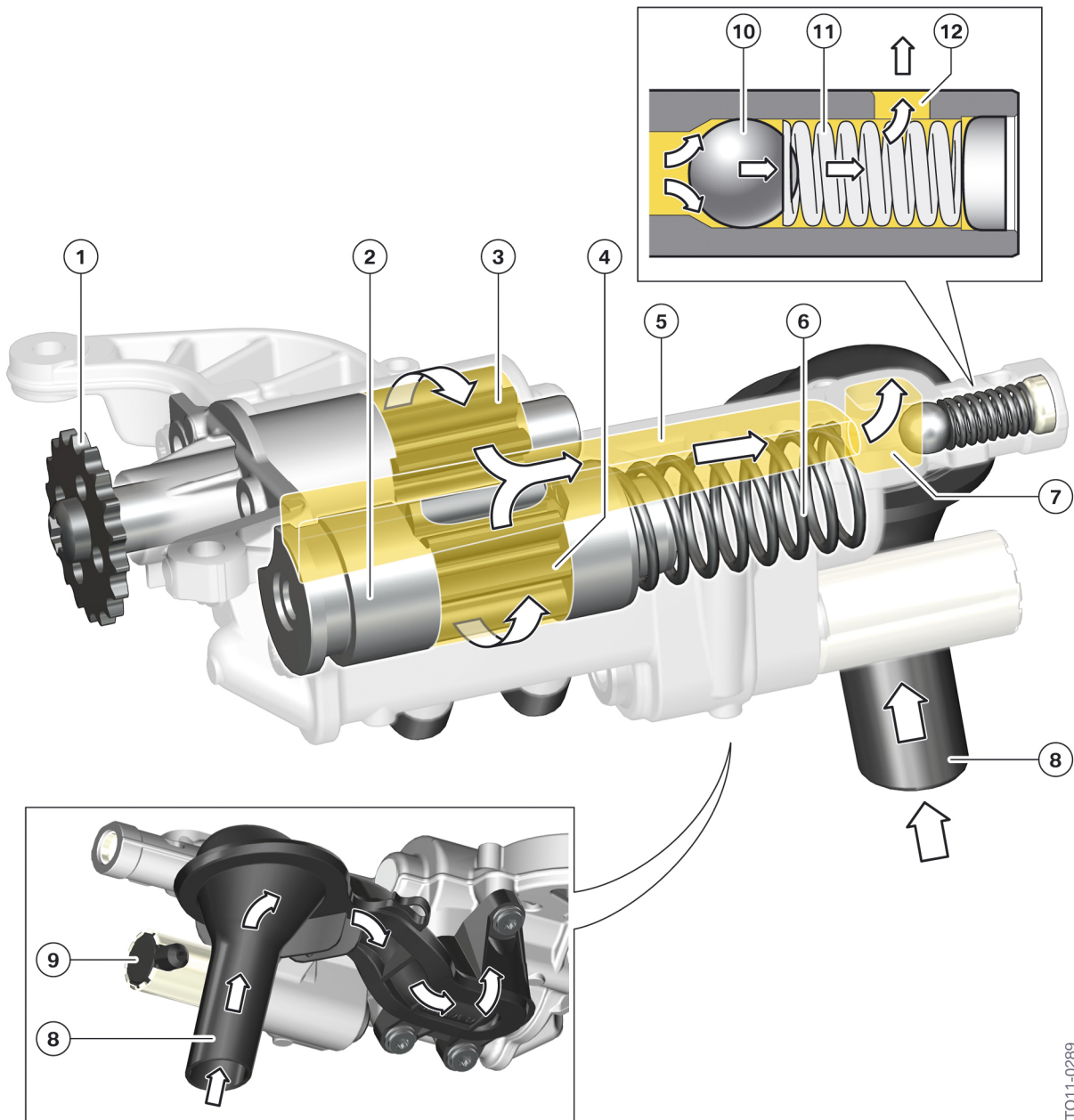
The oil pump is driven via a chain by the crankshaft. The gear ratio of the oil pump to the crankshaft is dependent on the number of teeth on the respective sprockets. The crankshaft has a gear with 20 teeth for driving the secondary chain, the sprocket on the oil pump shaft has 18 teeth. The gear ratio is therefore 20 : 18, i.e. 1.11 : 1. The oil pump therefore rotates 1.11 times with each crankshaft rotation.

From the intake snorkel (8) the oil is routed via the gears (3 + 4) from the oil pump into the raw oil duct (5) in the engine block and to the oil filter.

The non-driven oil pump gear (4) can be axially shifted in this pump, thereby varying the delivery rate. Axial shifting is effected by the oil pressure from the clean oil duct from the main oil duct, which can be varied by means of an oil pressure control valve. The operating principle of the oil pump ensures that the required oil quantity in each case and the oil pressure are supplied.

N13 Engine.

3. Oil Supply.



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N13 engine, oil pump

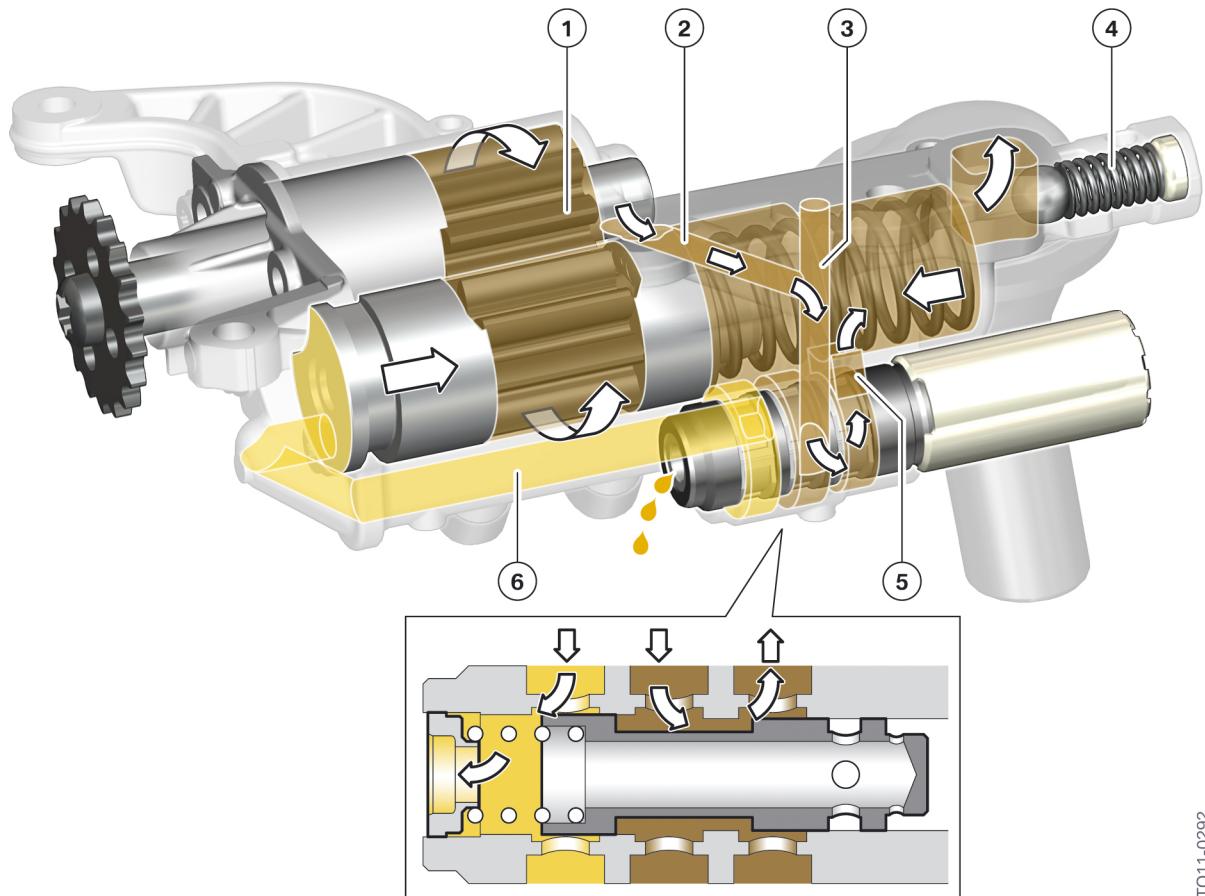
Index	Explanation
1	Sprocket
2	Control plunger
3	Gear, oil pump
4	Gear, oil pump
5	Raw oil duct
6	Compression spring

N13 Engine.

3. Oil Supply.

Index	Explanation
7	Raw oil duct to bedplate
8	Intake snorkel
9	Oil pressure control valve
10	Steel ball
11	Compression spring
12	Opening

Maximum delivery



N13 engine, oil pump maximum delivery

TO11-0292

N13 Engine.

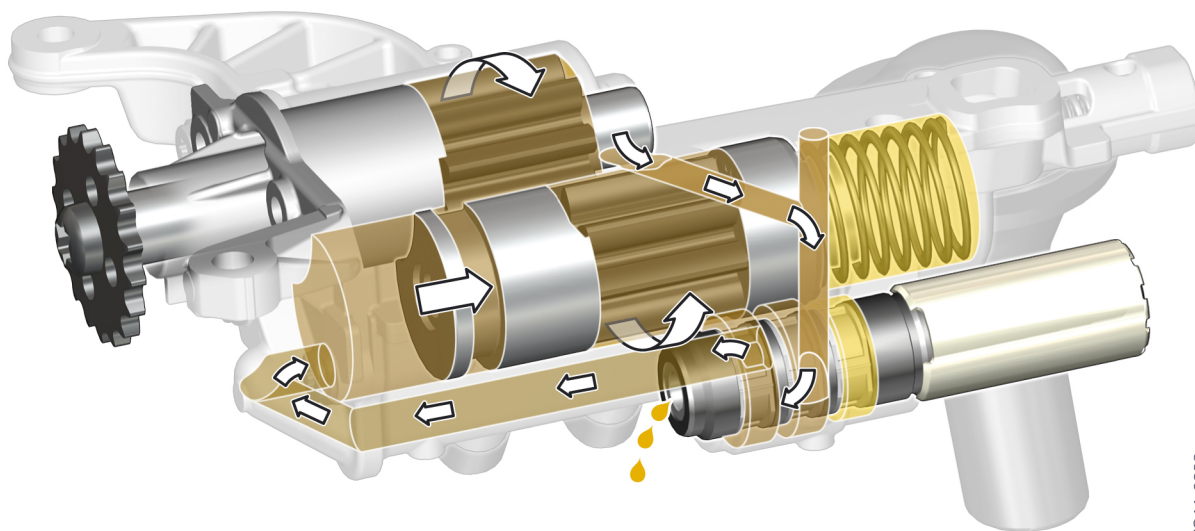
3. Oil Supply.

Index	Explanation
1	Gear, oil pump
2	Clean oil duct, coming from main oil duct
3	Clean oil duct
4	Pressure-limiting valve
5	Oil duct to rear end of control plunger
6	Oil duct to front end of control plunger

The oil pump is held in its basic setting by the compression spring in the maximum delivery position. This position can also be approached via the oil pressure control valve from the minimum delivery active position. For this purpose the oil pressure control valve is switched in such a way that the oil can flow off via the oil duct to the front end of the control plunger (6) through the oil pressure control valve into the oil sump. With the oil pressure control valve in this position, the oil pressure is simultaneously routed from the clean oil ducts (2 + 3) via the pressure control valve and via the oil duct to the rear end of the control plunger (5). This oil pressure now supports the spring and forces the control plunger into the maximum delivery position.

Minimum delivery

If the oil pressure is routed via the oil pressure control valve from the clean oil ducts (2 + 3) to the oil duct to the front end of the control plunger (6), the oil forces the control plunger against the spring and moves it in the minimum delivery direction. The oil pressure control valve simultaneously opens a connection from the rear end of the control plunger to drain the oil into the oil sump.



TO11-0293

N13 engine, oil pump minimum delivery

N13 Engine.

3. Oil Supply.

3.2.2. Pressure control

Map control

The oil pressure control valve enables the oil pressure to be controlled to suit the situation. The oil delivery quantity can be influenced accordingly by the Digital Engine Electronics (DME) through actuation of the oil pressure control valve.

The oil pressure control valve is located on the oil pump on the left side of the engine and engages the oil ducts in the oil pump to increase or reduce the oil delivery quantity.

An oil pressure sensor, familiar from the N52TU engine, senses this and transmits the data to the DME. The DME can thus set any oil delivery quantity with the oil pressure control valve, sense with the oil pressure sensor, and adjust in accordance with the characteristic map stored in the DME.

The delivery quantity is dependent on the engine speed and the position of the oil pressure control valve.

Operating state	Oil pressure
Engine at operating temperature and idle	min. 0.7 bar
Engine at operating temperature, control pressure at 3000 rpm	1.15 – 6.45 bar

Explanation	Delivery quantity
Engine at idle at 700 rpm, 110°C	approx. 6 – 11 l/min
Engine at maximum speed 6500 rpm, 110 °C	approx. 23 – 33 l/min

Explanation	Data
Supply voltage	12 V
Activation signal	200 – 256 Hz
Resistance	10.5 Ω ± 10 %



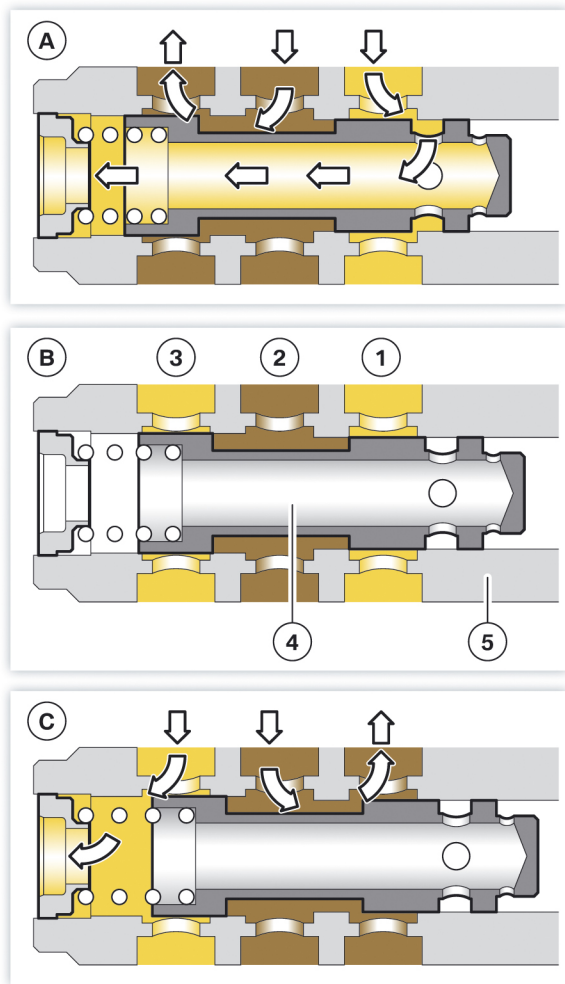
N13 engine, oil pressure control valve

The control plunger in the oil pressure control valve is shaped in such a way as to integrate an limp-home-mode function. If the cable is damaged or cut through, oil pressure control continues to function subject to limitations. The execution of this function is shown in the following graphics. The arrows represent the direction of the oil flow.

N13 Engine.

3. Oil Supply.

The control plunger in the oil pressure control valve has a larger diameter at the spring end than at the solenoid valve end. As the oil pressure increases, so too the force acting against the spring increases to force the control plunger in the valve against the spring. The oil duct from the clean oil duct to the front end of the oil pump control plunger is opened to allow the oil to move the oil pump control plunger in the minimum delivery direction. At the same time the control plunger in the oil pressure control valve opens the oil duct from the rear end of the control plunger to the oil sump. The oil at the rear end of the control plunger can now flow back to the oil sump.



TO11-0291

N13 engine, oil pressure control valve

Index	Explanation
A	Reduce delivery quantity
B	Hold delivery quantity
C	Increase delivery quantity
1	Oil duct to rear end of control plunger in oil pump

N13 Engine.

3. Oil Supply.

Index	Explanation
2	Clean oil duct
3	Oil duct to front end of control plunger in oil pump
4	Control plunger, oil pressure control valve
5	Housing, oil pressure control valve

3.2.3. Pressure-limiting valve

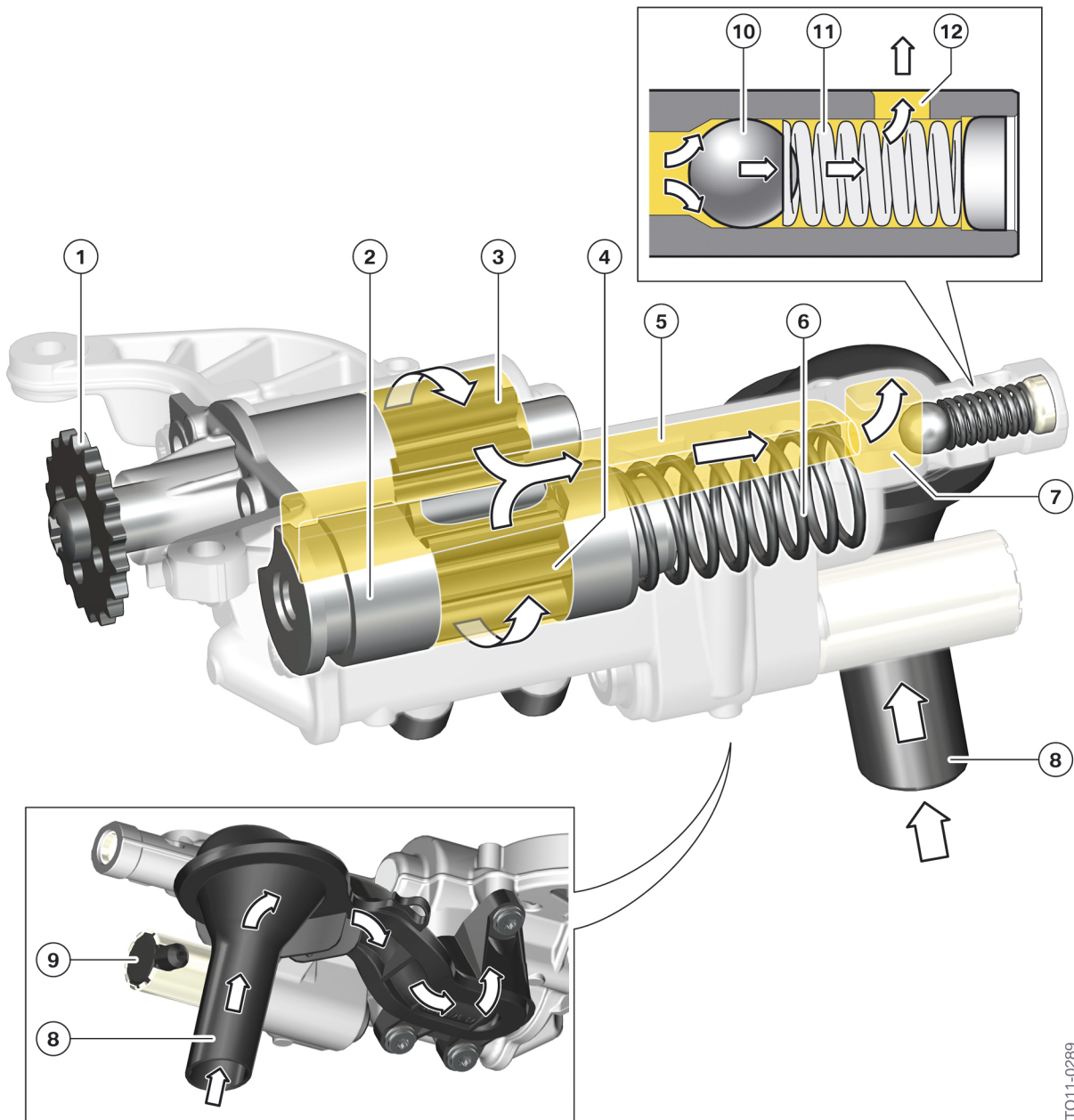
Additionally available to control the oil pump is a pressure-limiting valve, which is often also known as a cold-start valve.

The pressure-limiting valve is located as the first component after the pump in the oil pump housing and in the oil circuit. It opens at a pressure of roughly 10 to 13 bar and discharges the oil directly into the oil sump. This is necessary above all at low temperatures and when the oil is viscous. In these situations the pressure-limiting valve prevents damage to components, in particular to the oil filter module and its seals. This is relevant above all at temperatures of below -20 °C, since map control is already active above this temperature.

The pressure in the raw oil duct (5) forces the steel ball (10) against the spring (11). If the pressure rises above 10 to 13 bar, the steel ball is lifted off its seat and the oil can flow through the opening (12) directly into the oil sump.

N13 Engine.

3. Oil Supply.



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N13 engine, oil pump

Index	Explanation
1	Sprocket
2	Control plunger
3	Gear, oil pump
4	Gear, oil pump
5	Raw oil duct
6	Compression spring

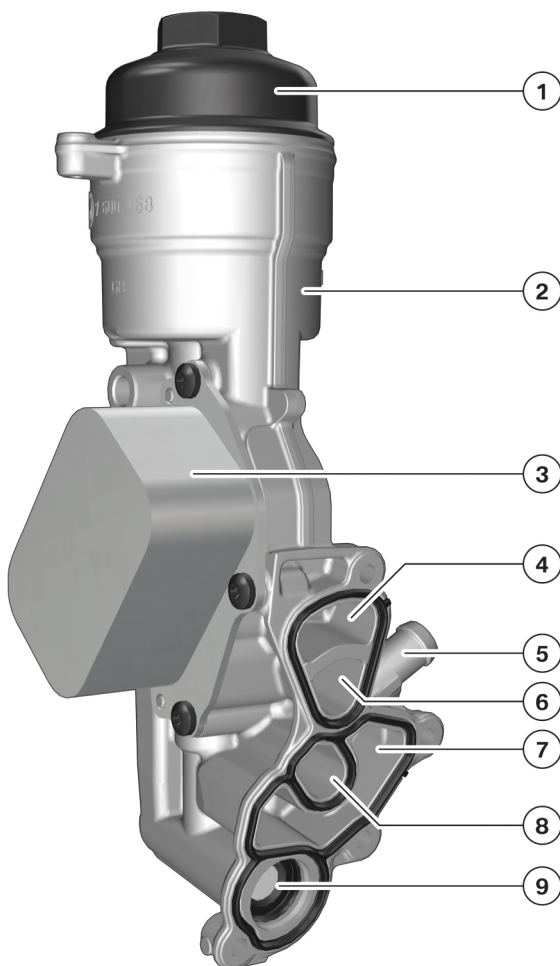
N13 Engine.

3. Oil Supply.

Index	Explanation
7	Raw oil duct to bedplate
8	Intake snorkel
9	Oil pressure control valve
10	Steel ball
11	Compression spring
12	Opening

3.3. Cooling and filtering

The N13 engine has an aluminium oil filter housing, to which the engine oil-to-coolant heat exchanger is directly mounted. This entire unit is known as the oil filter module.



N13 engine, oil filter module

TO11-0408

N13 Engine.

3. Oil Supply.

Index	Explanation
1	Oil filter cover with oil filter bypass valve
2	Oil filter housing
3	Engine oil-to-coolant heat exchanger
4	Coolant supply to oil filter module
5	Oil return from exhaust turbocharger
6	Coolant discharge from oil filter module
7	Oil return (filter renewal)
8	Clean oil duct
9	Raw oil duct from oil pump

3.3.1. Cooling

In the N13B16M0 engine the engine oil-to-coolant heat exchanger is located in the oil circuit ahead of the oil filter. This arrangement is known as raw oil cooling and has its roots in the lead-free crankshaft and connecting rod bearings. Because these are extremely sensitive to dirt particles, this arrangement brings the oil filter even closer to just before the bearing positions. There is no engine oil-to-coolant heat exchanger in the N13B16U0 engine.

Permanent bypass

The N13 engine does not have a heat exchanger bypass valve. Instead, like the N55 engine, it has a so-called permanent bypass. This is a permanently open bypass around the engine oil-to-coolant heat exchanger. The bypass incorporates a flow restrictor to ensure that the majority of the oil nevertheless flows through the engine oil-to-coolant heat exchanger.

3.3.2. Filtering

A paper oil filter element is used. The design is familiar from the BMW engines.

A non-return valve is integrated in the raw oil duct of the oil filter housing to prevent the oil filter housing from running dry when the engine is switched off. This non-return valve opens at an oil pressure of max. 0.15 bar.

Naturally the N13 engine has a filter bypass valve which can open a bypass round the filter if, for example, the engine oil is cold and viscous. This arises if the pressure difference before and after the filter exceeds 2.5 ± 0.5 bar. The permissible pressure difference has been increased from 2.0 to 2.5 bar in order to protect the lead-free crankshaft and connecting rod bearings. This ensures that the filter is bypassed much less frequently and any dirt particles are reliably filtered out.

The familiar system is also used for filter renewal. Thus, a piston rod is pulled upwards during filter renewal, opening a connecting between the raw oil duct, the clean oil duct and the oil return duct, and allowing the engine oil to flow from the filter housing back into the oil sump.

N13 Engine.

3. Oil Supply.

3.4. Monitoring

3.4.1. Oil pressure sensor



N13 engine, oil pressure sensor

The oil pressure sensor familiar from the N52TU engine and the N55 engine is used. The pressure signal is required for map control of the oil pump.

The sensor is seated on the oil filter housing in the oil duct after the oil filter (main oil duct) and is subjected to the prevailing oil pressure there. The sensor is supplied by the DME with ground (earth) and a voltage of 5 V. A voltage signal is sent via a data line to the DME, which in turn evaluates the signal. The oil pressure sensor can sense an oil pressure of 50 kPa (0.5 bar) to 1050 kPa (10.5 bar). At 50 kPa the output voltage is approx. 0.5 V, at 1050 kPa approx. 4.6 V.

3.4.2. Oil level monitoring

Permanent oil level monitoring is not used. The engine oil level can only be checked using the oil dipstick. For further information, please refer to the Owner's Handbook.

3.5. Oil spray nozzles

In the N13 engine too, some components which cannot be reached directly by an oil duct are lubricated and/or cooled by oil spray nozzles.

3.5.1. Piston crown cooling

The oil spray nozzles for piston crown cooling, as used in the N13 engine, are in principle familiar from the MINI N14 engine. They incorporate a non-return valve to enable them to open and close only from a specific oil pressure.

As well as cooling the piston crowns, they are also responsible for lubricating the gudgeon pins, which is why it is very important for them to be aligned. For this reason the oil spray nozzles are positioned in the crankcase in such a way that they are aligned automatically and without the need for special tools. A milled chamfer on the crankcase facilitates this alignment.

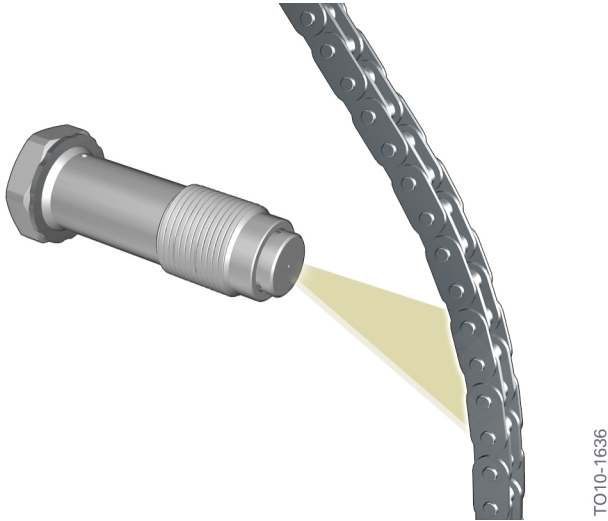
Opening pressure	2.2 – 2.8 bar
Closing pressure	2.0 bar

N13 Engine.

3. Oil Supply.

3.5.2. Timing chain lubrication

The timing chain is lubricated by an oil spray nozzle located in the chain tensioner. There is an opening in the tensioning rail through which the oil can be sprayed for this purpose.



TO10-1636

N13 engine, chain tensioner with oil spray nozzle for timing chain

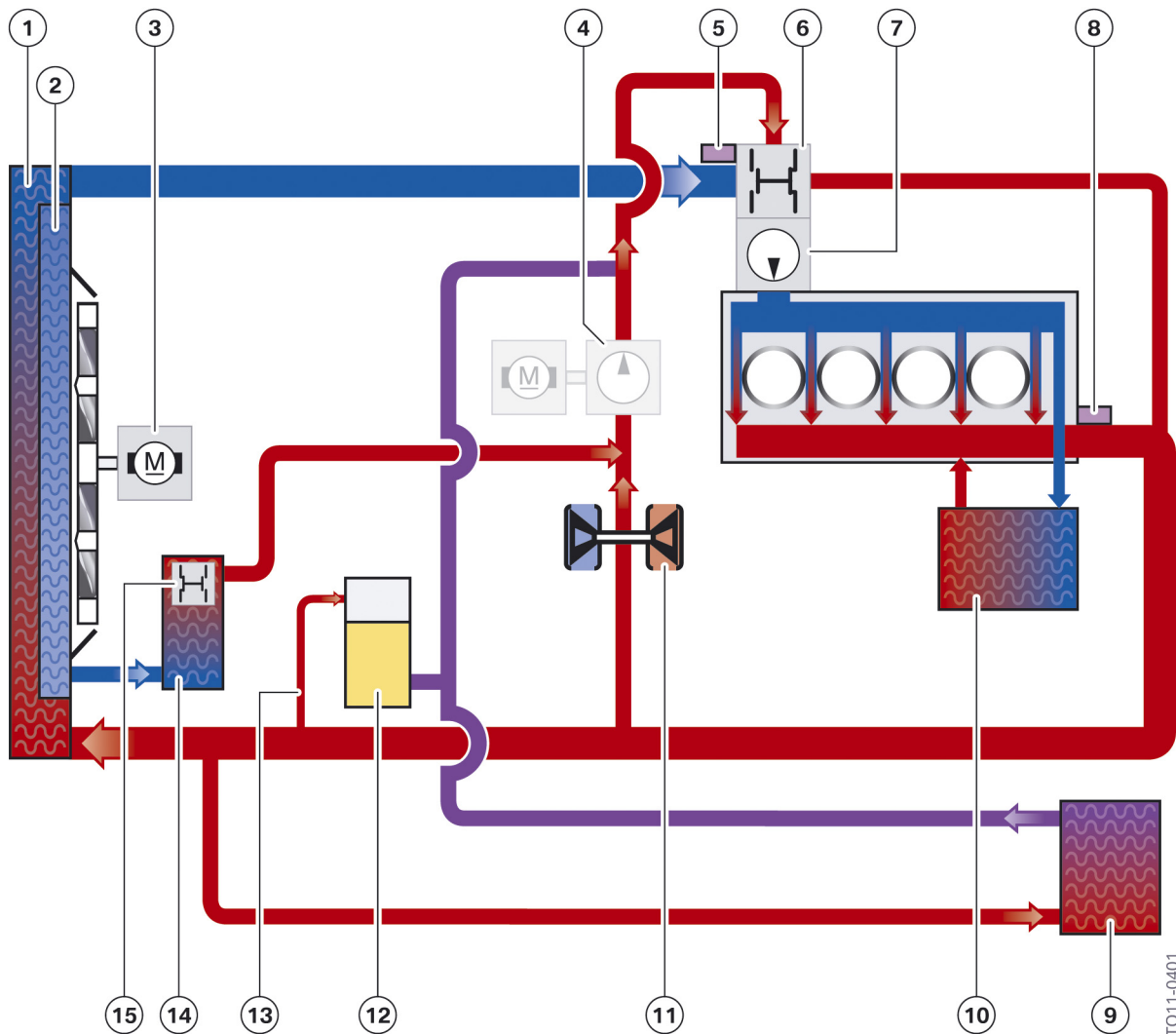
N13 Engine.

4. Cooling.

In the N13B16M0 engine an engine oil-to-coolant heat exchanger is used to cool the engine oil. The N13B16U0 engine does not have an engine oil-to-coolant heat exchanger. The cooling system is controlled (e.g. friction gear servodrives, map thermostat and electric fan) by the heat management coordinator in the DME.

The cooling module itself only comes in one variant. The electric fan has a nominal power of 300 W.

4.1. Overview



N13 engine, cooling circuit

TO11-0401

N13 Engine.

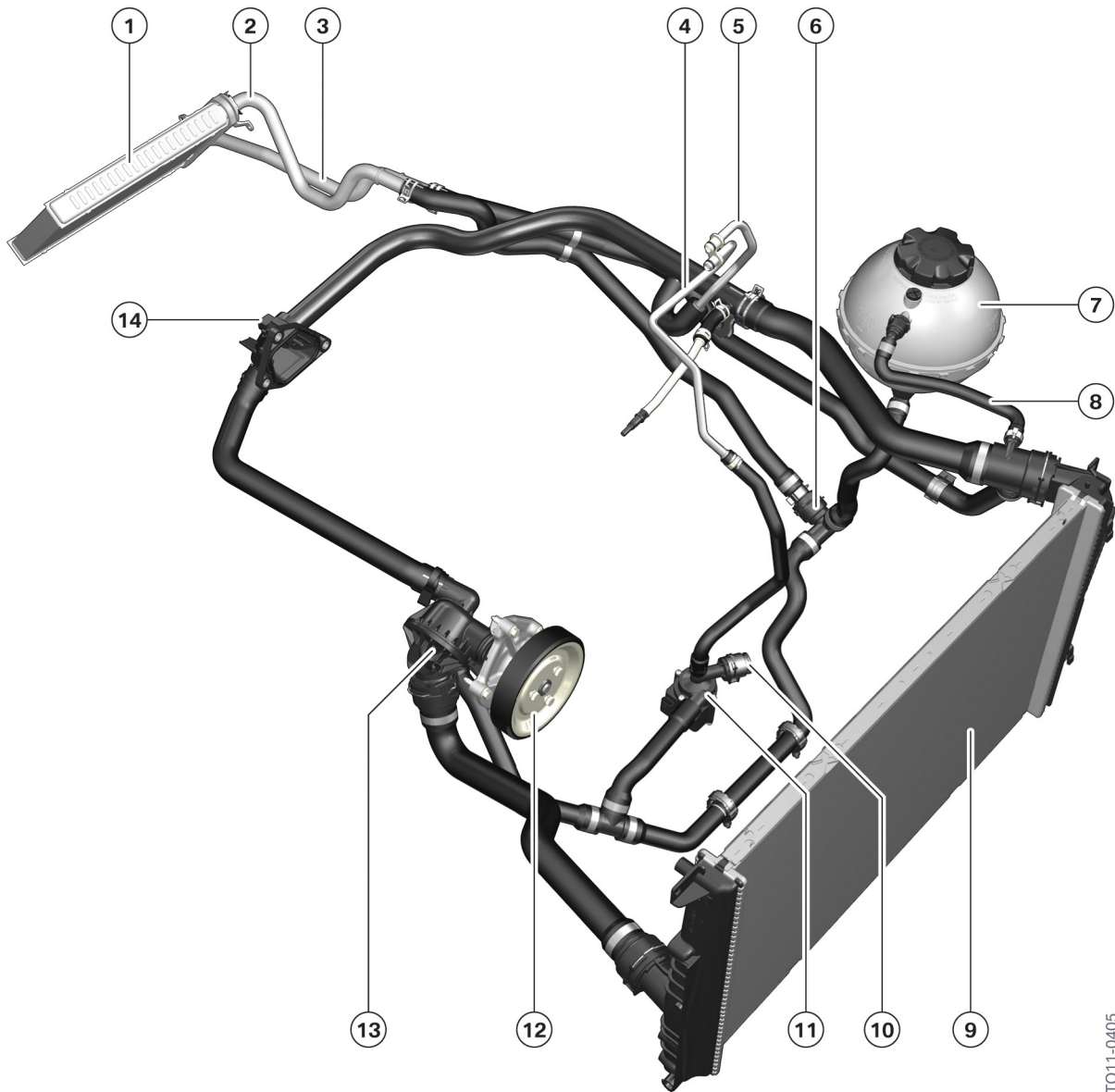
4. Cooling.

Index	Explanation
1	Radiator
2	Radiator, low temperature range
3	Electric fan
4	Auxiliary water pump
5	Heater for map thermostat
6	Map thermostat
7	Coolant pump
8	Coolant temperature sensor
9	Heat exchanger
10	Engine oil-to-coolant heat exchanger
11	Exhaust turbocharger
12	Expansion tank
13	Tank ventilation line
14	Transmission oil-to-coolant heat exchanger
15	Thermostat for transmission oil

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

N13 Engine.

4. Cooling.



TO11-0405

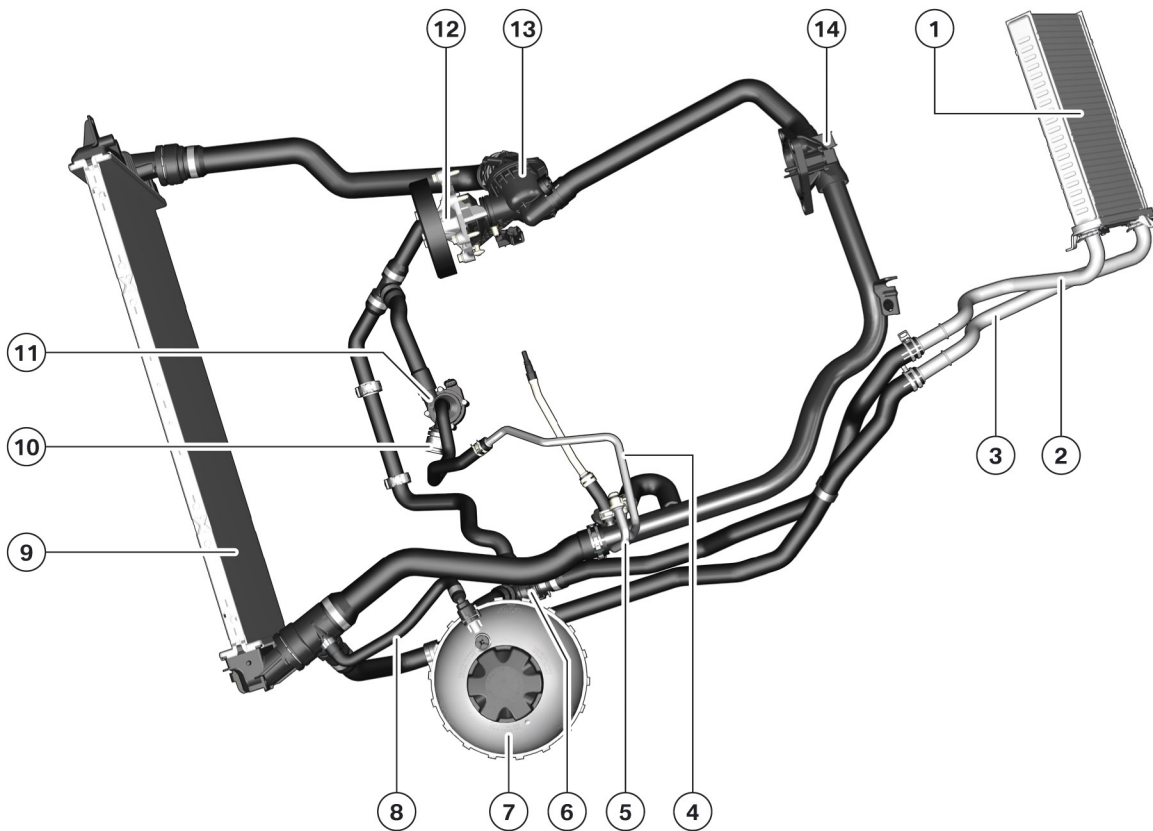
N13 engine, cooling system components from rear (here BMW F20 118i with manual gearbox)

Index	Explanation
1	Heat exchanger
2	Return, heater matrix
3	Feed, heater matrix
4	Feed, exhaust turbocharger cooling
5	Return, exhaust turbocharger cooling
6	Connection, return, heater matrix
7	Expansion tank
8	Tank ventilation line

N13 Engine.

4. Cooling.

Index	Explanation
9	Radiator
10	Connection for coolant-to-gearbox oil heat exchanger
11	Electric auxiliary water pump
12	Coolant pump
13	Map thermostat
14	Coolant temperature sensor



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N13 engine, cooling system components on engine from front (here BMW F20 118i with manual gearbox)

Index	Explanation
1	Heat exchanger
2	Return, heater matrix
3	Feed, heater matrix
4	Feed, exhaust turbocharger cooling
5	Return, exhaust turbocharger cooling
6	Connection, return, heater matrix
7	Expansion tank
8	Tank ventilation line

N13 Engine.

4. Cooling.

Index	Explanation
9	Radiator
10	Connection for gearbox oil-to-coolant heat exchanger
11	Electric auxiliary water pump
12	Coolant pump
13	Map thermostat
14	Coolant temperature sensor

4.2. Heat management

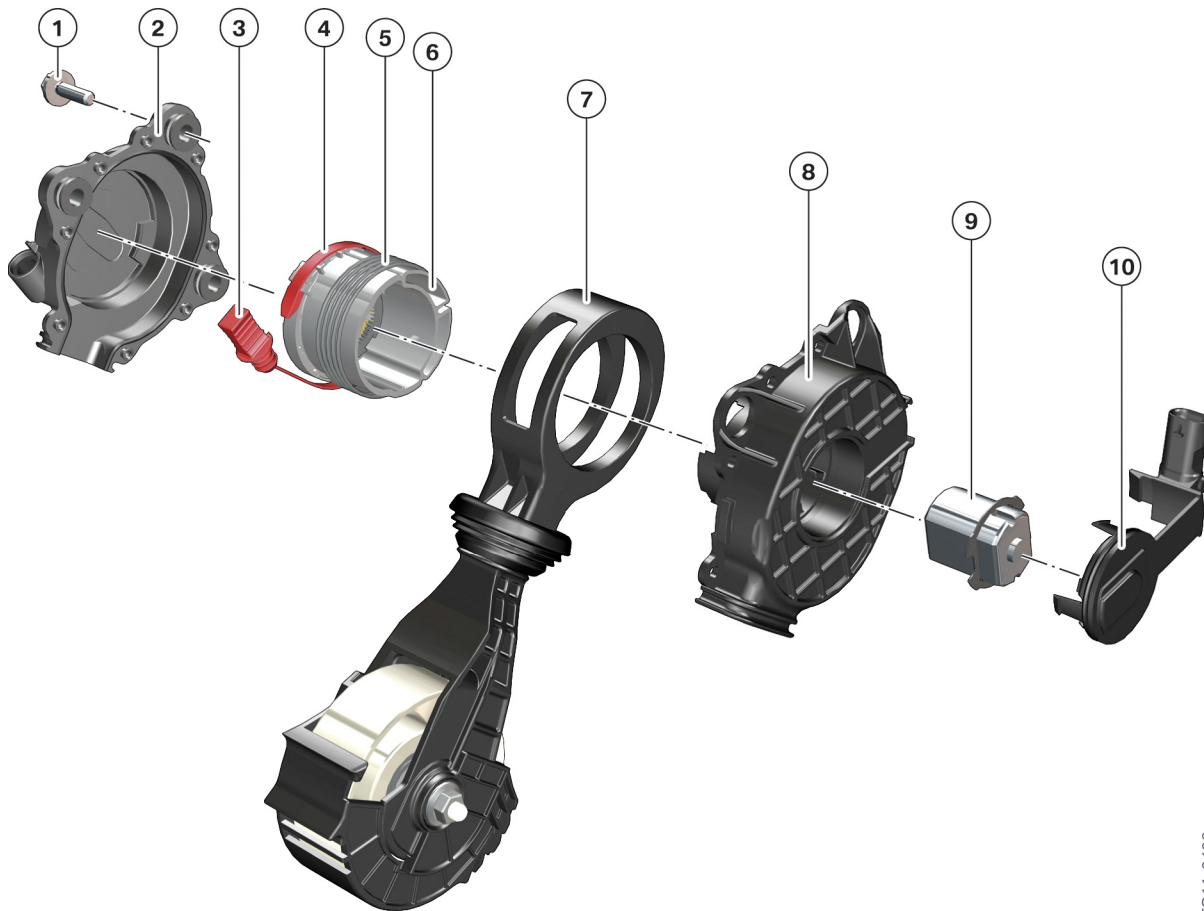
The N13 engine features a heat management function in the DME. The heat management function has been newly developed in its entirety for the N13 and differs significantly from the established function. This comprises independent control of the electric cooling components of electric fan, map thermostat and (with limitations) coolant pump. What is new to this function is that the auxiliary water pump, which is required to cool the exhaust turbocharger, alone ensures that cooling is maintained in certain operating ranges.

4.2.1. Friction gear servodrive

In the N13 engine the coolant pump is driven by a friction gear.

N13 Engine.

4. Cooling.



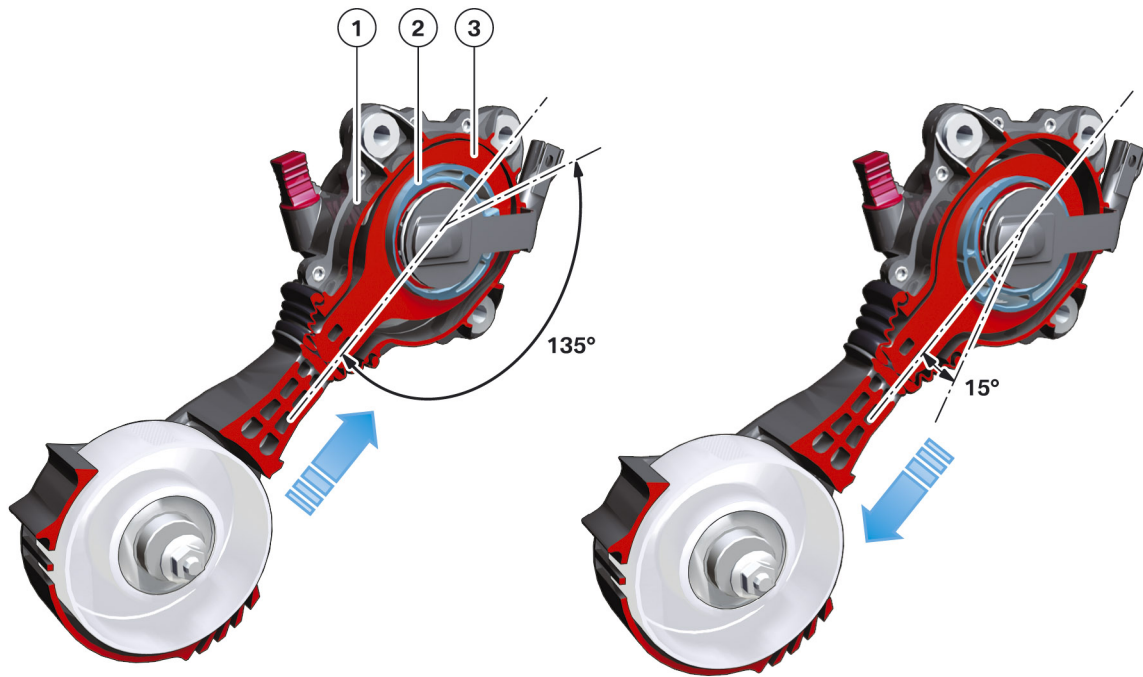
TO11-0406

N13 engine, friction gear servodrives - exploded view

Index	Explanation
1	Mounting bolt
2	Housing shell
3	Service handle
4	Service band
5	Spring
6	Eccentric element
7	Pull arm
8	Housing shell
9	Electric motor
10	Contact with plug connection

N13 Engine.

4. Cooling.



N13 engine, friction gear servodrive - exploded view

To remove the belt, the user pulls on the service handle and hangs the tab on the housing shell from a designated hook.

4.2.2. Map thermostat

The N13 engine is fitted with a conventional map thermostat which has the following technical data in non-electrically controlled mode:

Setting of map thermostat	Coolant temperature
Starts to open	97 ± 2 °C
Fully open	109 °C

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

4.2.3. Heat management function

The heat management determines the current cooling requirement and controls the cooling system accordingly. In certain operating states the coolant pump is shut down entirely, for example in order to heat the coolant more quickly in the warm-up phase. The auxiliary water pump, which is responsible for cooling the exhaust turbocharger, can also be switched on and off. The cooling output can therefore be requested independently of the engine speed. The heat management function is able to activate and deactivate both the mechanical coolant pump and the electric auxiliary water pump to suit demand, and to regulate the map thermostat accordingly. The engine management is thus able to adapt the coolant temperature to the driving situation. A further reduction in consumption has been achieved by the implementation of these measures.

N13 Engine.

4. Cooling.

The following temperature ranges are adjusted by the engine management:

- 109 °C = Economy operation
- 106 °C = Normal operation
- 80 °C = High operation and current supply to the map thermostat.

If the engine control unit identifies the "Economy" operating range on the basis of running performance, the engine management adjusts to a higher temperature (109 °C). In this temperature range the engine is to be operated with a relatively low fuel requirement. Internal engine friction is reduced at higher temperature. The temperature increase therefore favours the lower fuel consumption in the low load range. In "High and current supply to the map thermostat" operation the driver would like to utilise the engine's optimum power development. The temperature in the cylinder head is reduced to 80 °C for this purpose. This reduction improves volumetric efficiency, which results in an engine torque increase. The engine control unit can now, adapted to the relevant driving situation, adjust a specific operating range. It is therefore possible to influence consumption and power output via the cooling system.

System protection

If the coolant or engine oil is subject to excessive temperatures during engine operation, certain functions in the vehicle are influenced in such a way that more energy is made available for engine cooling.

The measures are split into two operating modes:

- Component protection
 - Coolant temperature from 117 °C
 - Engine oil temperature from 143 °C at the oil pressure and oil temperature sensor in the main oil duct
 - Measure: e.g. power reduction of passenger compartment climate control and of engine
- Emergency
 - Coolant temperature from 122 °C
 - Engine oil temperature from 151 °C at the oil pressure and oil temperature sensor in the main oil duct
 - Measure: e.g. power reduction of engine (up to approx. 90 %).

Example

No coolant pump is running when the engine is started at 20 °C. The auxiliary water pump is switched on when the engine reaches a temperature of 30 °C. It is only necessary to activate the coolant pump from a coolant temperature of approx. 90 °C. The heat management monitors the engine coolant temperature and power requirement and activates the components accordingly. It is therefore not possible to say precisely whether and when which coolant pump must be running.

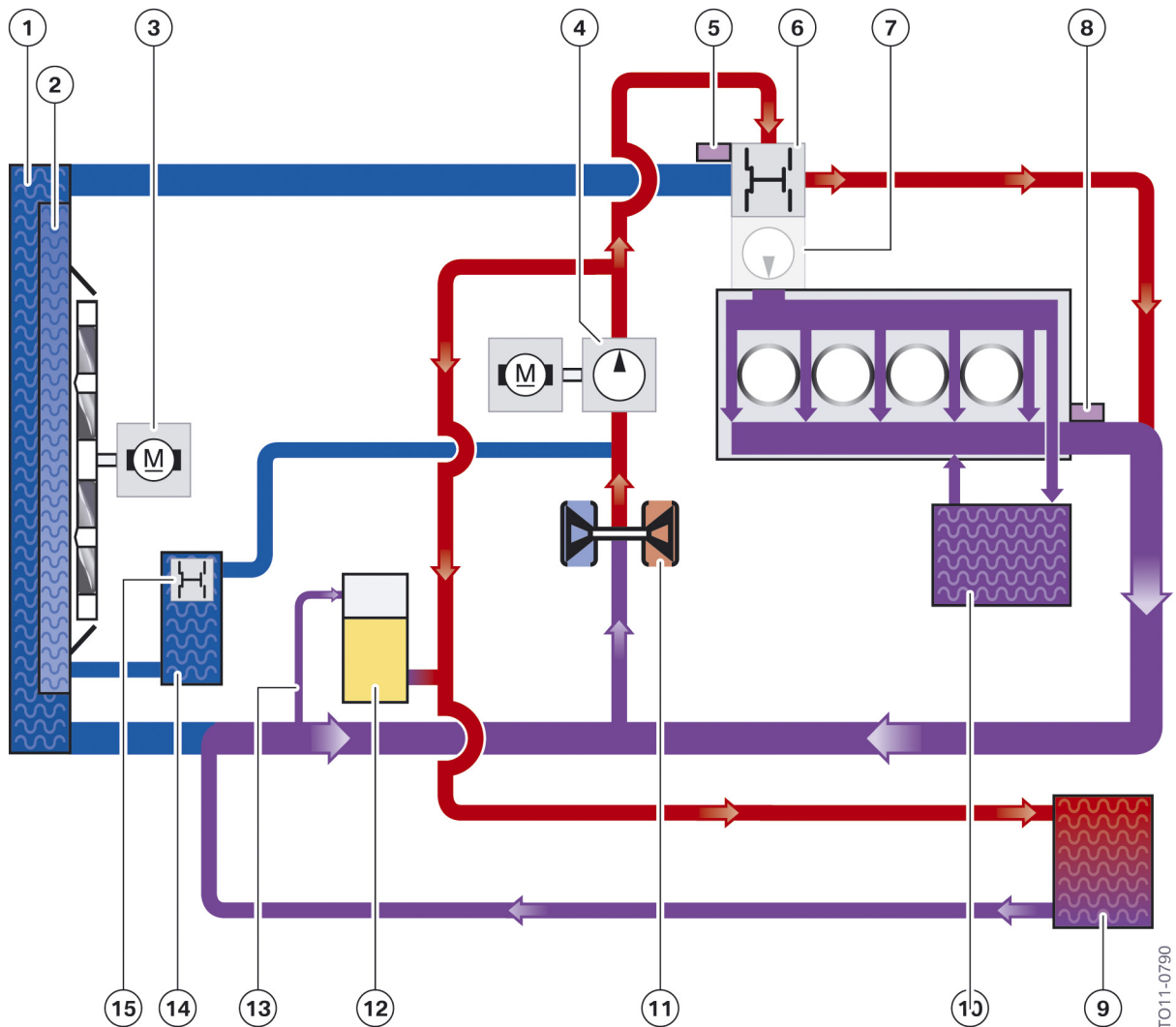
Warm-up phase

Considering the cooling circuit in the warm-up phase, coolant temperature < 105 °C

N13 Engine.

4. Cooling.

- Coolant pump off
- Auxiliary water pump on.



N13 engine, cooling circuit in the warm-up phase

Index	Explanation
1	Radiator
2	Radiator, low temperature range
3	Electric fan
4	Auxiliary water pump
5	Heater for map thermostat
6	Map thermostat
7	Coolant pump
8	Coolant temperature sensor

N13 Engine.

4. Cooling.

Index	Explanation
9	Heat exchanger
10	Engine oil-to-coolant heat exchanger
11	Exhaust turbocharger
12	Expansion tank
13	Tank ventilation line
14	Transmission oil-to-coolant heat exchanger
15	Thermostat for transmission oil

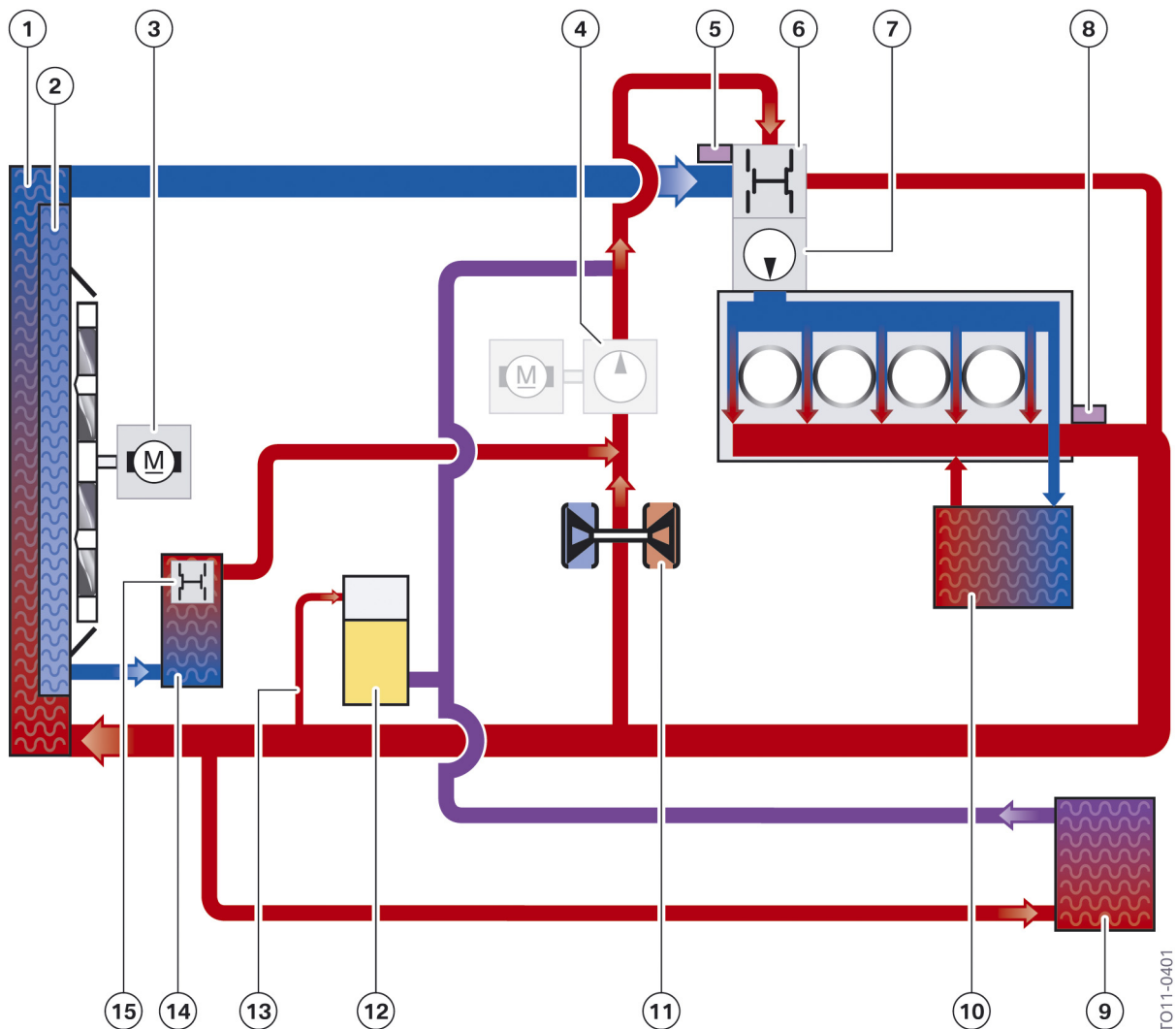
At operating temperature

Considering the cooling circuit at operating temperature, coolant temperature > 105 °C

- Coolant pump on
- Auxiliary water pump off.

N13 Engine.

4. Cooling.



N13 engine, cooling circuit in the warm-up phase

Index	Explanation
1	Radiator
2	Radiator, low temperature range
3	Electric fan
4	Auxiliary water pump
5	Heater for map thermostat
6	Map thermostat
7	Coolant pump
8	Coolant temperature sensor
9	Heat exchanger
10	Engine oil-to-coolant heat exchanger

N13 Engine.

4. Cooling.

Index	Explanation
11	Exhaust turbocharger
12	Expansion tank
13	Tank ventilation line
14	Transmission oil-to-coolant heat exchanger
15	Thermostat for transmission oil

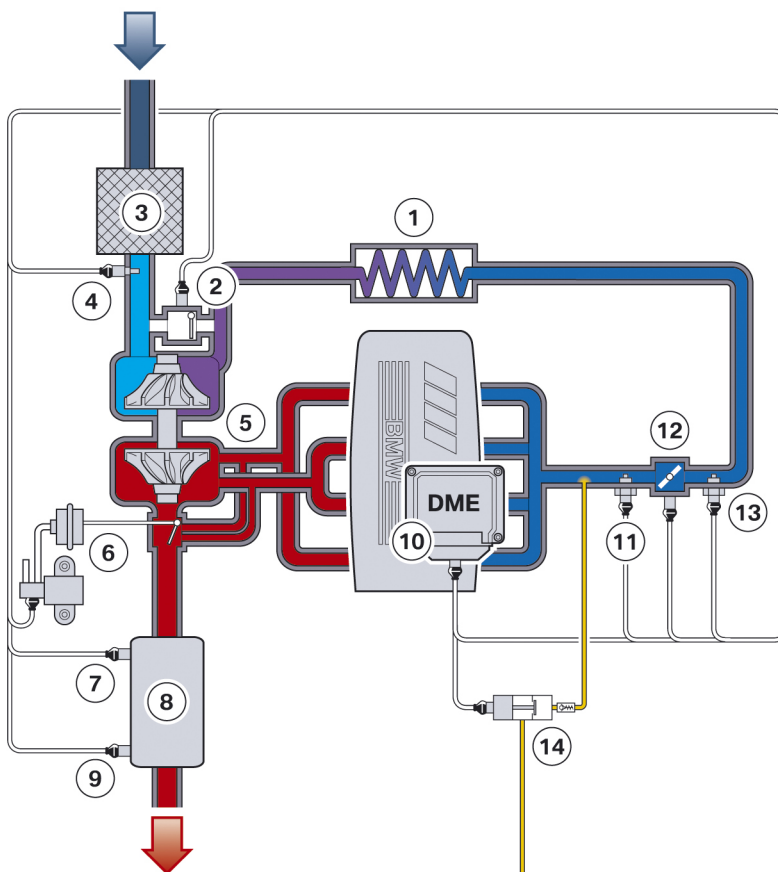
N13 Engine.

5. Air Intake/Exhaust Emission Syst.

The air intake and exhaust emission systems are in principle comparable with those in the N55 engine. The list below itemises the most important features of the air intake and exhaust emission systems:

- Permanently attached intake silencer
- Hot film air mass meter 7 in all engine versions
- TwinScroll exhaust turbocharger with integrated wastegate and blow-off valves
- Three connections for crankcase ventilation
- Connection for tank ventilation.

5.1. Overview



TO11-0410

N13 engine, air intake and exhaust emission systems

Index	Explanation
1	Charge air cooler
2	Blow-off valve
3	Intake silencer
4	Hot film air mass meter

N13 Engine.

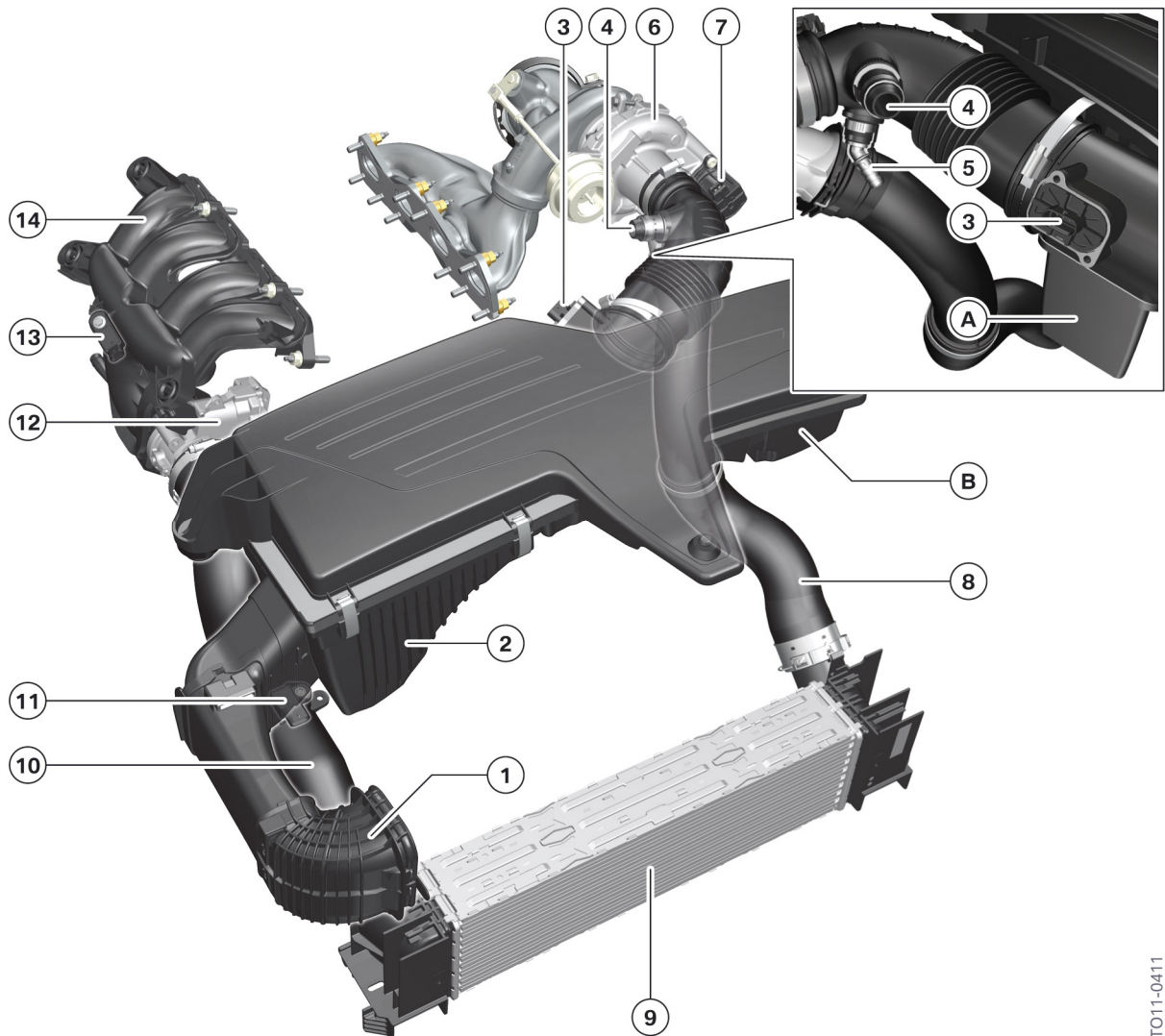
5. Air Intake/Exhaust Emission Syst.

Index	Explanation
5	Exhaust turbocharger
6	Wastegate valve
7	Oxygen sensor before catalytic converter (control sensor)
8	Catalytic converter
9	Oxygen sensor after catalytic converter (monitoring sensor)
10	DME
11	Intake manifold pressure sensor
12	Throttle valve
13	Charge-air temperature and charge-air pressure sensor
14	Tank vent valve

N13 Engine.

5. Air Intake/Exhaust Emission Syst.

5.2. Air intake system



N13 engine, air intake system

TO11-0411

Index	Explanation
A	Resonator on hot film air mass meter housing
B	Resonator on air filter housing
1	Unfiltered air intake
2	Intake silencer
3	Hot film air mass meter
4	Crankcase ventilation (turbocharged mode)
5	Purge air line
6	Exhaust turbocharger

N13 Engine.

5. Air Intake/Exhaust Emission Syst.

Index	Explanation
7	Blow-off valve
8	Charge air pipe
9	Charge air cooler
10	Charge air pipe
11	Charge-air temperature and charge-air pressure sensor
12	Throttle valve
13	Intake manifold pressure sensor
14	Intake manifold

5.2.1. Hot film air mass meter

The N13 engine is fitted with the hot film air mass meter 7, which is very similar to the one in the N74 engine. The N13 engine has a hot film air mass meter in all its versions, as is state-of-the-art technology in TVDI engines.

It can generally be said that the quality of air mass determination by measurement using a hot film air mass meter and by calculation of the substitute value (of intake air temperature, charging pressure, engine speed, etc.) is to be considered as equal in the current state of development. The calculated substitute value is nevertheless used for engine load control. This value is however regularly adjusted with the value of the hot film air mass meter in order to compensate for tolerances which arise on account of the complex flow mechanics conditions in the air intake system. The more sophisticated the mixture preparation method (Turbo-Valvetronic Direct fuel Injection - TVDI), the more important it is to adjust the substitute value with the hot film air mass meter. TVDI is currently the most sophisticated mixture preparation method. For this reason, all TVDI engines are also equipped with a hot film air mass meter.

The use of a hot-film air mass meter also offers the opportunity of extended diagnoses, e.g. for tank or crankcase ventilation, as these systems create a deviation in the air mass. This is particularly important for the US version, as it is required by US exhaust emissions legislation.



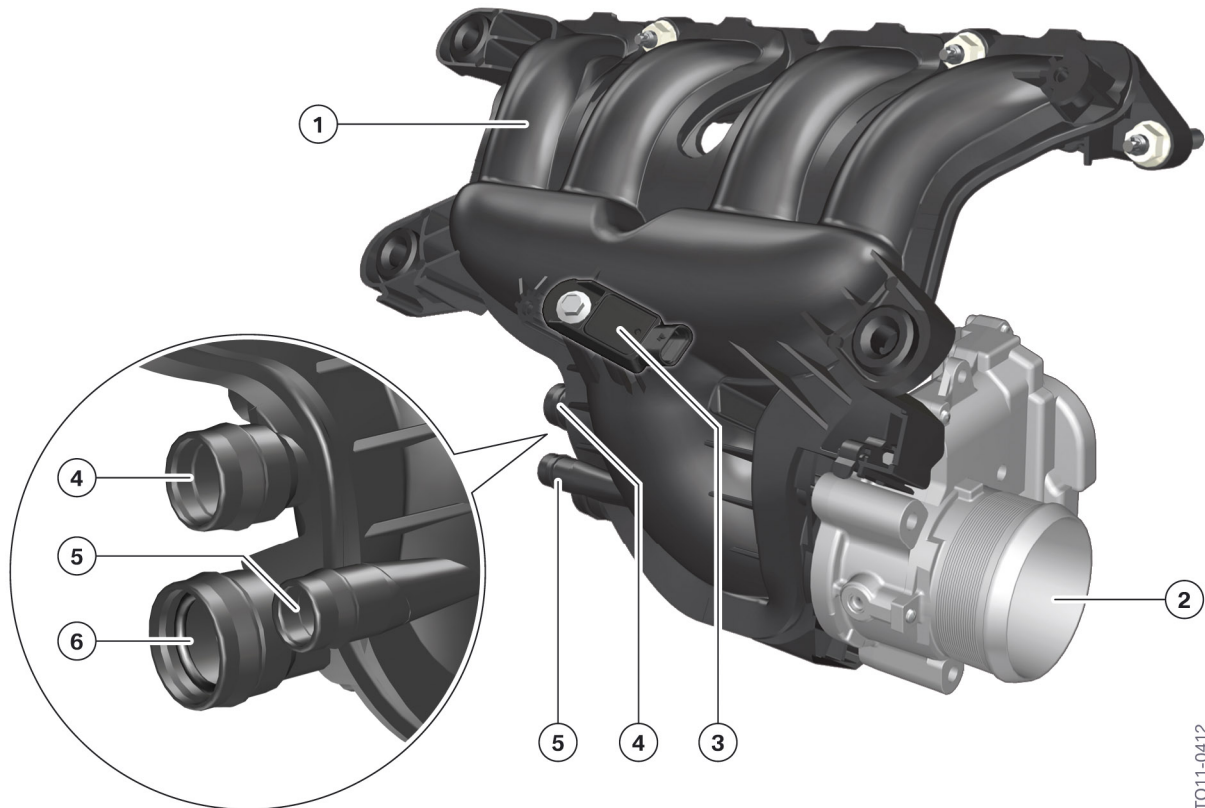
Failure or disconnection of the hot film air mass meter does not immediately result in emergency engine operation. However, impaired mixture preparation and therefore poorer emission values are possible, which is why the emissions warning lamp lights up.

5.2.2. Intake manifold

The intake manifold is very simple in design (on account of the turbocharging arrangement) and is largely comparable to that of the N20 engine.

N13 Engine.

5. Air Intake/Exhaust Emission Syst.



N13 engine, intake manifold with throttle valve

TO11-0412

Index	Explanation
1	Intake manifold
2	Throttle valve
3	Intake manifold pressure sensor
4	Tank ventilation connection
5	Not in use
6	Crankcase ventilation connection in naturally aspirated mode

Intake manifold pressure sensor

Located directly after the throttle valve, at the entry to the intake manifold, is the intake manifold pressure sensor. The sensor can sense pressures ranging between 0 kPa and 250 kPa (0 bar and 2.5 bar). The sensor has three connections and is supplied by the DME with ground (earth) and a voltage of 5 V. A voltage signal is output via the third connection and a data line to the DME. 0.5 V corresponds to 20 kPa (0.2 bar) and 4.5 V to 250 kPa (2.5 bar).

Charge-air temperature and charge-air pressure sensor

The charge-air temperature and charge-air pressure sensor is located in the charge air pipe ahead of the throttle valve. The sensor has four connections and like the intake manifold pressure sensor is supplied by the DME with ground (earth) and a voltage of 5 V. The pressure and the temperature

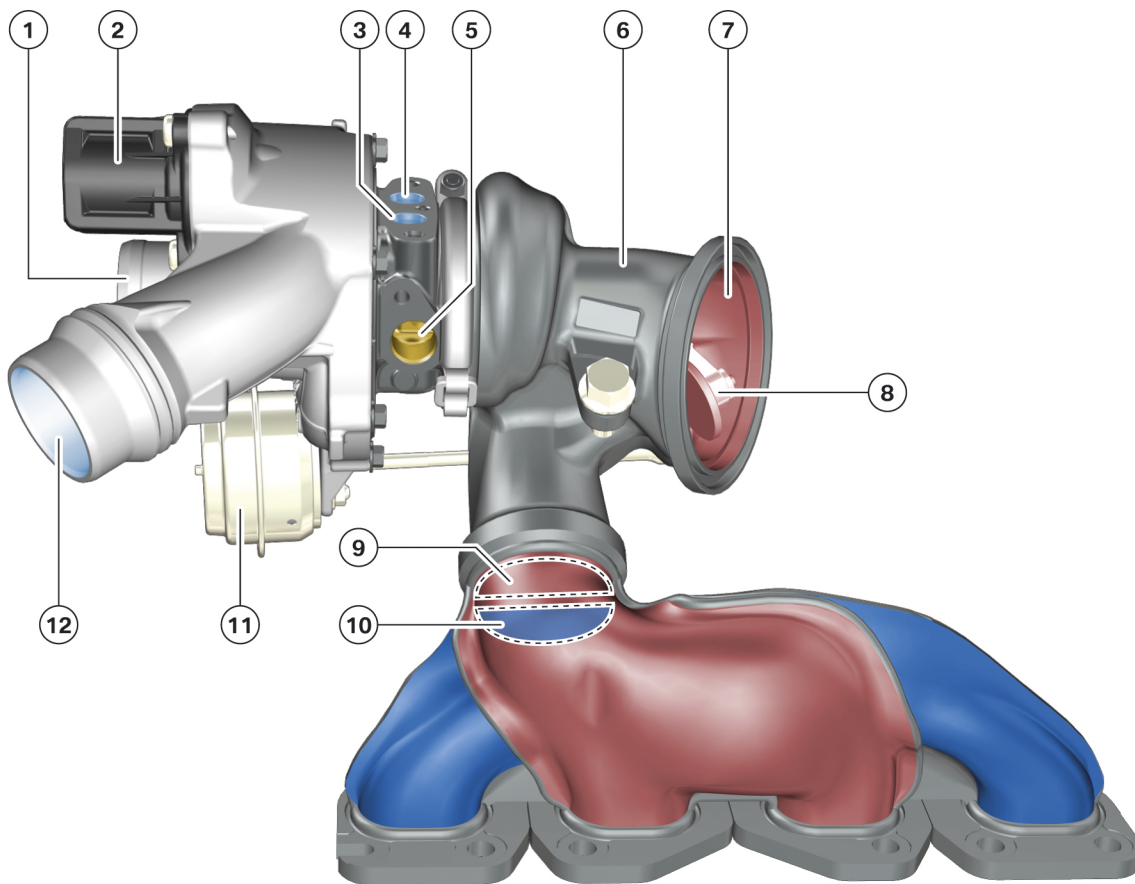
N13 Engine.

5. Air Intake/Exhaust Emission Syst.

of the intake air are transmitted via a connection and a further connection respectively to the DME. The pressure signal is transmitted in the same way as in the intake manifold pressure sensor. The temperature signal is transmitted in the same way. An NTC thermistor alters the voltage signal, by means of which the DME senses the charge-air temperature. At an air temperature of 25 °C the resistance is approx. 2063 Ω, at 100 °C approx. 186 Ω.

5.3. Exhaust turbocharger

The N13 engine features an exhaust turbocharger with TwinScroll technology. It includes at the turbine inlet two separate ducts in which the exhaust gas is routed from two cylinders to the turbine vanes.



TO11-0413

N13 engine, exhaust turbocharger

Index	Explanation
1	Inlet from intake silencer
2	Blow-off valve
3	Coolant feed
4	Coolant return
5	Oil return

N13 Engine.

5. Air Intake/Exhaust Emission Syst.

Index	Explanation
6	Turbine housing
7	Outlet to catalytic converter
8	Wastegate valve
9	Exhaust ports, cylinders 2 and 3
10	Exhaust ports, cylinders 1 and 4
11	Vacuum unit for wastegate valve
12	Outlet to charge air cooler

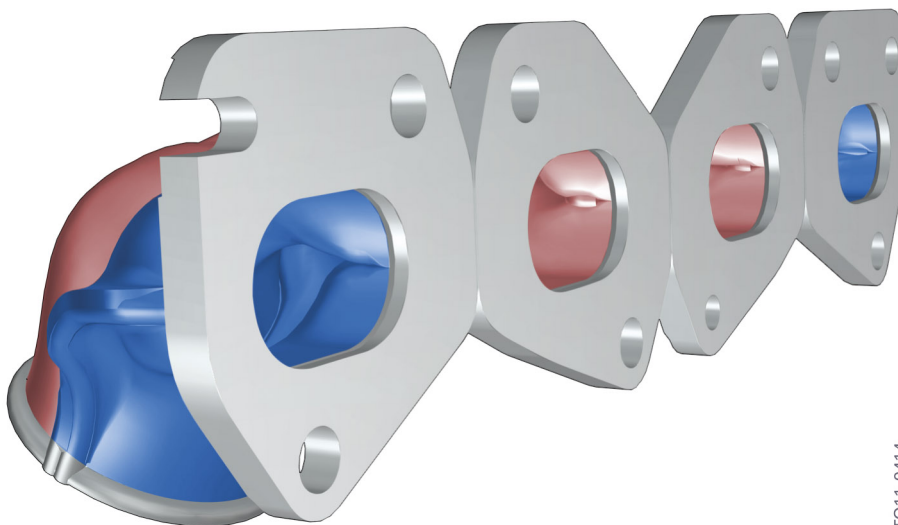
The exhaust turbocharger has a familiar design with an electric blow-off valve and a vacuum-controlled wastegate valve.

5.4. Exhaust emission system

5.4.1. Exhaust manifold

The exhaust manifold of the N13 has a unitary design. The exhaust manifold in the N13 engine is a four-into-two type, which is necessary for the special function of the TwinScroll turbocharger. Here the exhaust ports of cylinders 1 and 4 and 2 and 3 are brought together in each case into one port.

It consists of three individual units which are welded to each other. The middle unit forms one part of all four exhaust ports, one outer unit forms the other part of exhaust ports 2 and 3, and the other outer unit forms one part of exhaust ports 1 and 4.



N13 engine, unitary-design exhaust manifold

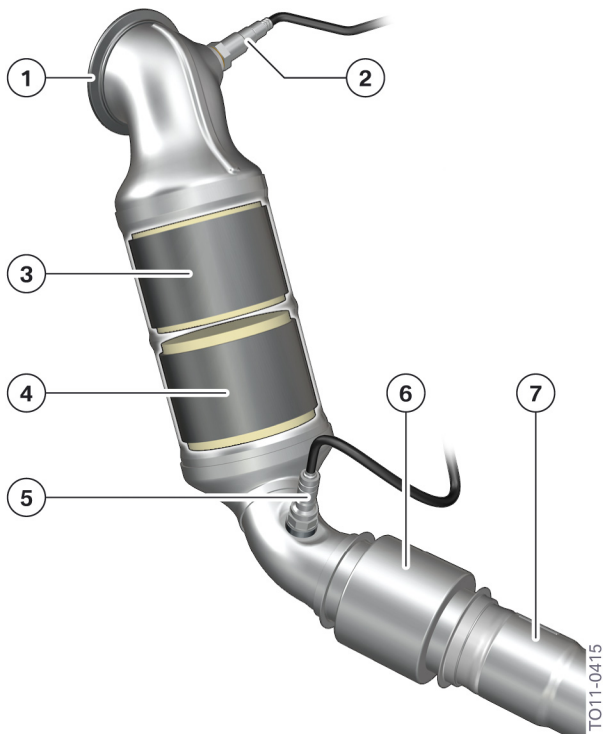
TO11-0414

5.4.2. Catalytic converter

The N13 engine has an upstream single-scroll catalytic converter with two ceramic monoliths.

N13 Engine.

5. Air Intake/Exhaust Emission Syst.



N13 engine in BMW 118i, sectional view of catalytic converter

Index	Explanation
1	Connection, exhaust turbocharger
2	Control sensor
3	Ceramic monolith 1
4	Ceramic monolith 2
5	Monitoring sensor
6	Decoupling element
7	Connection to exhaust system

	Volume in [litres]	Diameter in [mm]	Number of cells in [cells/inch]
Ceramic monolith 1	0.80	110	600
Ceramic monolith 2	0.86	110	400

Oxygen sensors

The established Bosch oxygen sensors are used:

- Control sensor: LSU ADV
- Monitoring sensor: LSF4.2.

N13 Engine.

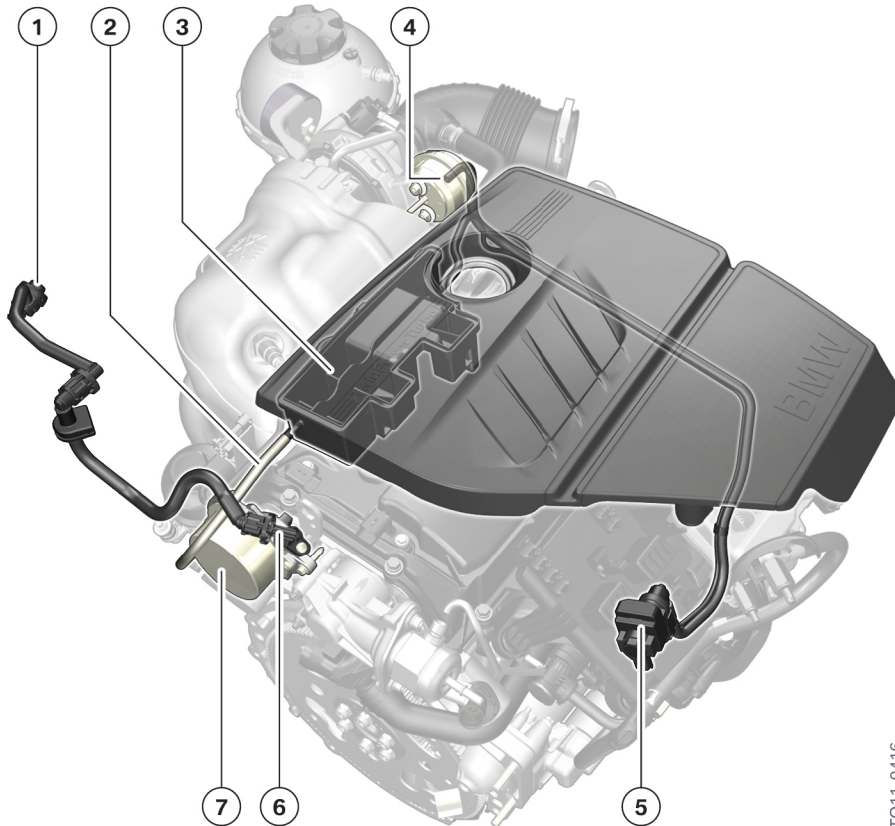
5. Air Intake/Exhaust Emission Syst.

The control sensor is located ahead of the primary catalytic converter, as close as possible to the turbine outlet. Its position has been chosen so that all the cylinders can be recorded separately. The monitoring sensor is positioned after the second ceramic monolith.

N13 Engine.

6. Vacuum System.

The vacuum system of the N13 engine is comparable with that of the N55 engine. As well as supplying the brake servo, it is needed primarily to activate the wastegate valve on the exhaust turbocharger.



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N13 engine, vacuum system

Index	Explanation
1	Connection, brake servo
2	Vacuum line
3	Vacuum reservoir
4	Vacuum unit, wastegate valve
5	Electropneumatic pressure converter for wastegate valve
6	Non-return valve
7	Vacuum pump

The vacuum pump as usual is designed to have two stages so that the majority of the generated vacuum is made available to the brake servo. A vacuum reservoir is used to provide sufficient vacuum for actuating the wastegate valve. This reservoir is permanently attached to the engine cover.



Disconnect the vacuum line before removing the engine cover, as otherwise there is a risk of damage.

N13 Engine.

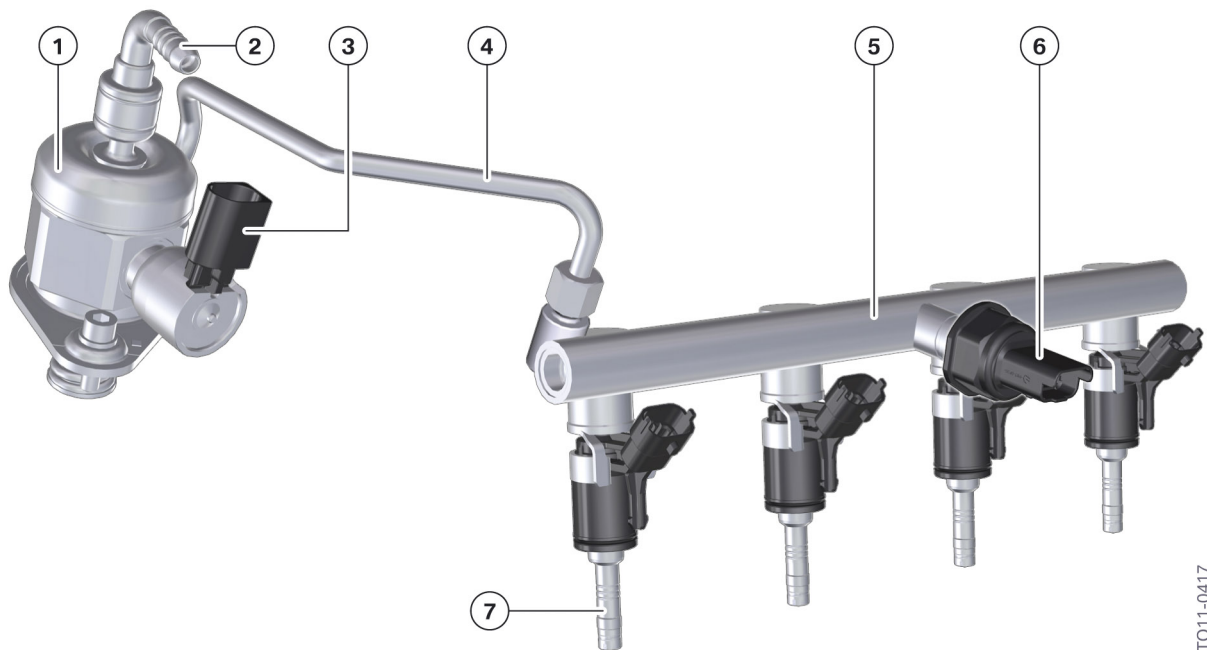
7. Fuel Preparation.

The N13 engine makes use of high-pressure injection, which was introduced in the N55 engine. It differs from high-precision injection (HPI) in that it uses solenoid valve injectors with multihole nozzles.

High-pressure injection is similar to the N74 engine and is operated in wide ranges in the N13 engine with 120 bar injection pressure.

7.1. Overview

The following overview shows the fuel preparation system of the N13 engine. It essentially corresponds to the systems with direct fuel injection familiar in BMW models.



N13 engine, fuel preparation

TO11-0417

Index	Explanation
1	High-pressure pump
2	Connection, low-pressure line
3	Connection, quantity control valve
4	High-pressure line, high-pressure pump - rail
5	Rail
6	Rail pressure sensor
7	Solenoid valve injector

Bosch high-pressure fuel injectors with the designation HDEV5.1 are used. These fuel injectors are a further development of the fuel injectors already familiar from the N73 engine. The N14 and N18 engines in the MINI also have these fuel injectors. The high-pressure pump is already known from the 4-, 8- and 12-cylinder engines.

N13 Engine.

7. Fuel Preparation.

Another feature of note when compared with established BMW systems is the omission of the fuel low-pressure sensor.



Work on the fuel system is only permitted after the engine has cooled down and the battery has been disconnected. The coolant temperature must not exceed 40 °C. This stipulation 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. A full face guard and protective gloves must be worn for protection purposes.

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.

- No dirt particles or foreign bodies are allowed to get into the system
 - Remove all dirt contamination before removing lines and separate components
 - Use only fluff-free cloths
 - Seal off all fuel system openings with protective caps and plugs.
-

7.2. Fuel pump control

As already mentioned, there is no fuel low-pressure sensor in the N13 engine. The fuel pump is supplied with voltage by a relay and always runs during operation at maximum delivery. There is no fuel quantity control.

7.3. High-pressure pump

The Bosch high-pressure pump, already familiar from the N43, N63 and N74 engines, is used. This is a single-plunger pump which is driven from the intake camshaft via a triple cam.

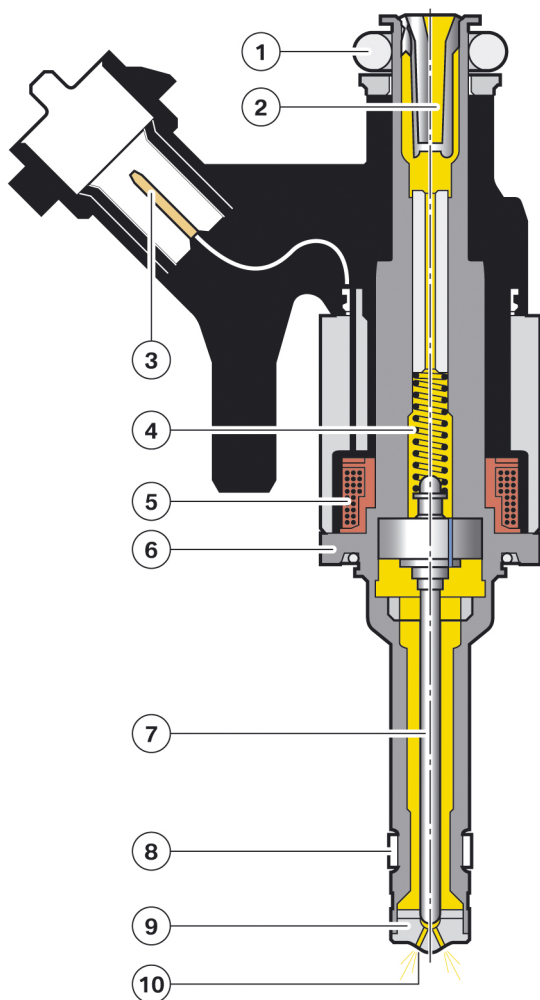
For further information on the high-pressure pump, please refer to the “N74 Engine” product information bulletin.

7.4. Injectors

The Bosch HDEV5.1 solenoid valve injector is an inward-opening multihole valve – unlike the outward-opening piezo injector used in HPI engines. The HDEV5.1 too is characterised by high variability with regard to spray angle and spray shape, and is configured for a system pressure of up to 200 bar.

N13 Engine.

7. Fuel Preparation.



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N13 engine, injector

Index	Explanation
1	Sealing ring
2	Fine-mesh strainer
3	Electrical connection
4	Spring
5	Solenoid coil
6	Housing
7	Nozzle needle with armature
8	Teflon ring
9	Valve seat
10	Valve outlet bores

N13 Engine.

7. Fuel Preparation.

The injector is located on the side of the cylinder and projects into the combustion chamber. In the course of fully sequential fuel injection each injector is activated by the DME via its own output stage. Here, the moment of injection of the respective cylinder is adapted to the operating state (engine speed, load and engine temperature).

The higher pressures are necessary, as the fuel quantity required for combustion must be injected in a much shorter period of time.

The solenoid coil (5), through which current passes, generates a magnetic field. This lifts the nozzle needle with armature (7) against the pressure of the spring (4) off the valve seat (9) and opens the valve outlet bores (10). Fuel is now forced into the combustion chamber as a result of the pressure difference between rail pressure and combustion chamber pressure. When the current is switched off, the nozzle needle is pressed by the spring (4) into the valve seat and interrupts the fuel flow.

The injected fuel quantity is thus dependent on the rail pressure, the counterpressure in the combustion chamber and the opening period of the injector. The fuel is injected faster, more accurately and with a better fuel spray shape than is the case with manifold (intake pipe) injection.

The incoming vehicle voltage is transformed upwards to 85 to 100 V by the use of a clocked output stage with high-power capacitors.

A current flows in the output stage up to a specific cutoff value. The cutoff generates an induction voltage, e.g. 85 V, which then charges the high-power capacitors (booster function).

The injectors are supplied by the capacitor current with a current level of 2.8 to 16 A. The DME activates the injectors at the ground (earth) end.

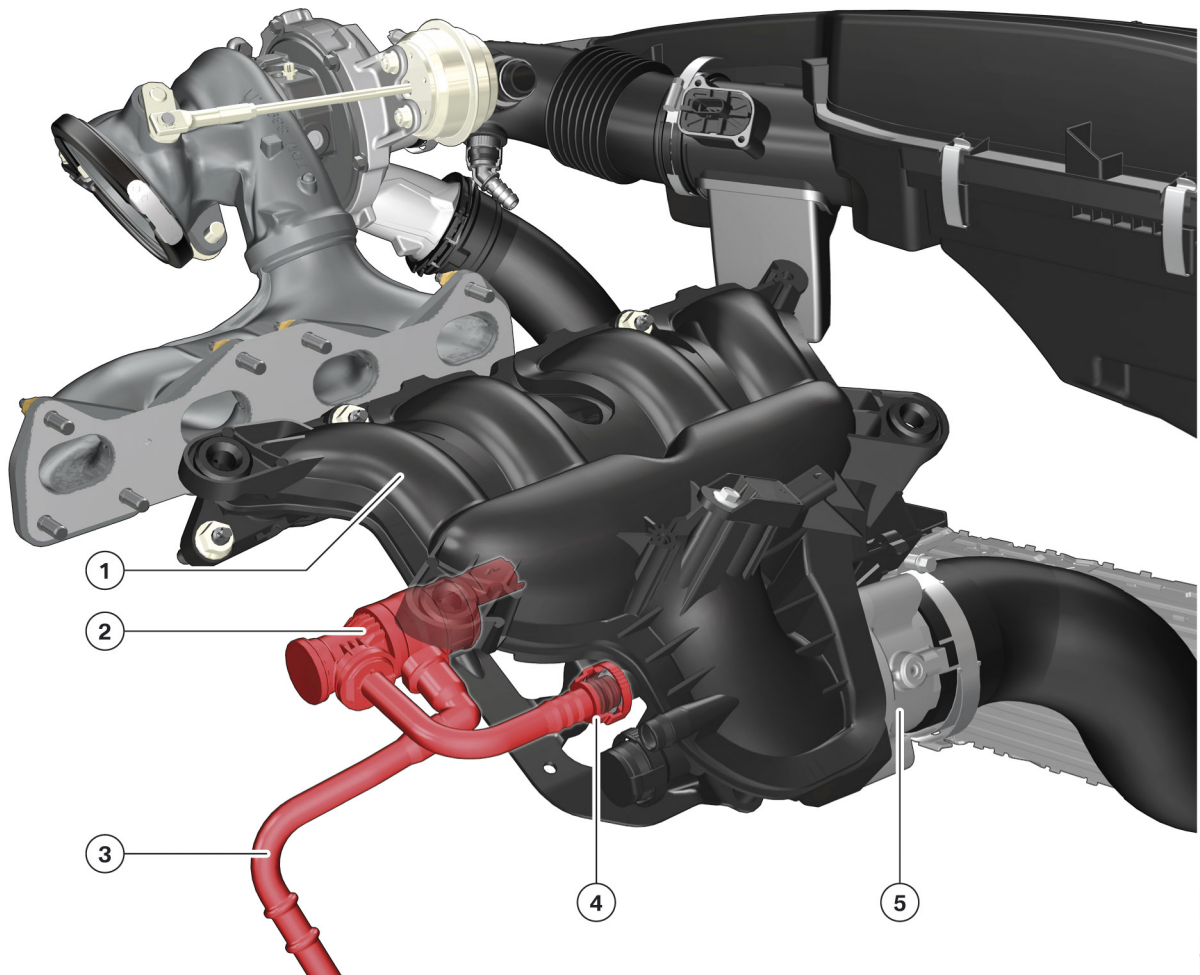
N13 Engine.

8. Fuel Supply.

The fuel supply is vehicle-specific. Hardly any changes have been made to the already existing models. Therefore only the tank ventilation system on the engine will be described in greater detail here. For the layout of the fuel supply, please refer to the “F20 Powertrain” product information bulletin.

8.1. Tank ventilation

The tank ventilation system in the N13 engine has a familiar design. It features an electrical tank vent valve and a connection for the purge air line to the intake manifold, directly after the throttle valve.



N13 engine, tank ventilation

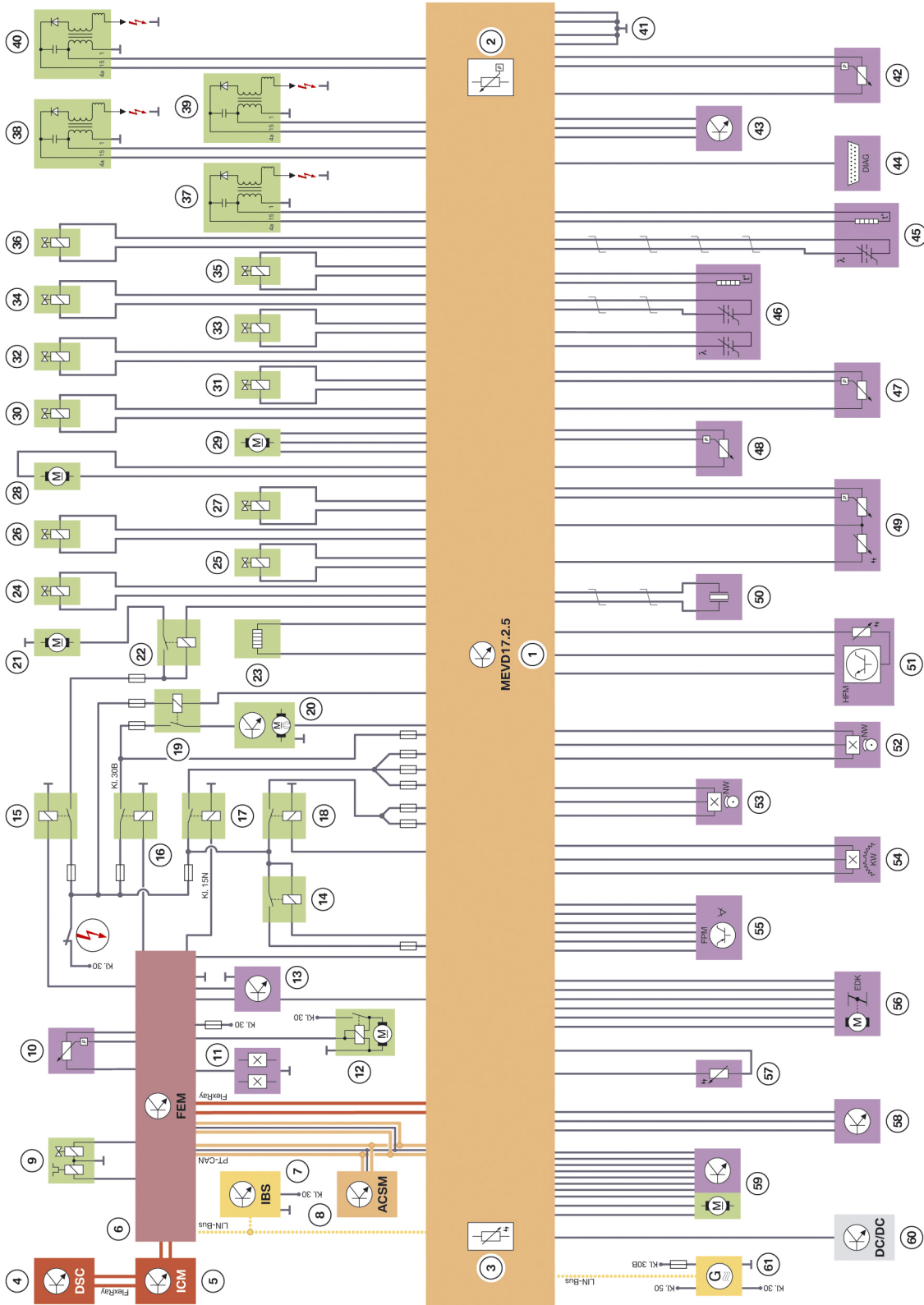
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Index	Explanation
1	Intake manifold
2	Tank vent valve
3	Line from carbon canister of tank ventilation system
4	Connection of tank ventilation after throttle valve
5	Throttle valve

N13 Engine.

9. Engine Electrical System.

9.1. Overview



N13 engine, system wiring diagram MEVD17.2.5
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N13 Engine.

9. Engine Electrical System.

Index	Explanation
1	Engine electronics Valvetronic direct injection MEVD17.2.5
2	Ambient pressure sensor
3	Temperature sensor
4	Dynamic Stability Control (DSC)
5	Integrated Chassis Management (ICM)
6	Front Electronic Module (FEM)
7	Intelligent battery sensor (IBS)
8	Crash Safety Module (ACSM)
9	Air conditioning compressor
10	Refrigerant pressure sensor
11	Brake light switch
12	Starter motor
13	Clutch module
14	Relay, Valvetronic
15	Relay, terminal 30B, power distribution box, rear
16	Relay, terminal 30B, power distribution box, front
17	DME main relay
18	Relay, ignition and injectors
19	Relay for electric fan
20	Electric fan
21	Relay, electric fuel pump
22	Electric fuel pump
23	Map thermostat
24	Blow-off valve
25	Tank vent valve
26	VANOS solenoid actuator, intake camshaft
27	VANOS solenoid actuator, exhaust camshaft
28	Friction gear servodrive
29	Auxiliary water pump
30	Oil pressure control valve
31	Electropneumatic pressure converter for wastegate valve
32	Quantity control valve
33 – 36	Injectors
37 – 40	Ignition coils
41	Ground (earth) connections

N13 Engine.

9. Engine Electrical System.

Index	Explanation
42	Brake vacuum sensor (only for automatic engine start-stop with manual gearbox)
43	Zero-gear sensor (only for automatic engine start-stop with manual gearbox)
44	Diagnostic socket (speed signal)
45	Oxygen sensor after catalytic converter (monitoring sensor, LSF 4.2)
46	Oxygen sensor before catalytic converter (control sensor, LSU ADV)
47	Intake manifold pressure sensor
48	Rail pressure sensor
49	Charge-air temperature and charge-air pressure sensor
50	Knock sensor
51	Hot film air mass meter
52	Camshaft sensor, intake camshaft
53	Camshaft sensor, exhaust camshaft
54	Crankshaft sensor
55	Accelerator pedal module
56	Throttle valve
57	Coolant temperature sensor
58	Oil pressure sensor
59	Valvetronic servomotor
60	DC/DC converter
61	Alternator

9.2. Engine control unit

The N13 engine has a Bosch DME with the designation MEVD17.2.4. It is closely related to the DME of the N55 engine (MEVD17.2) and is likewise engine-mounted on the intake manifold.



Do not attempt any trial replacement of control units.

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

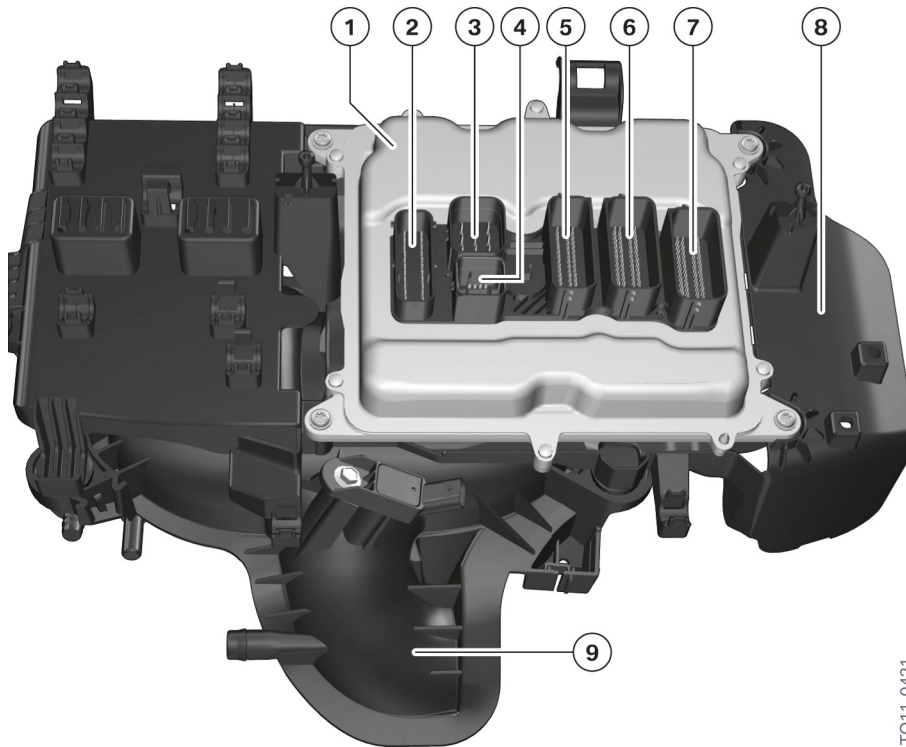
The N13 engine DME (MEVD17.2.4) is designed in such a way that it can be attached on an intermediate plate to the intake manifold.

The N13 engine will be offered as from September 2011 in the F20; the layout for the vehicle electrical system 2020 is therefore shown here.

N13 Engine.

9. Engine Electrical System.

The plug concept is identical to the MEVD17.2 in the N55 engine. There is a logical division into six modules.



N13 engine, connections MEVD17.2.4

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Index	Explanation
1	Engine control unit
2	Module 600, fuel injection and ignition, 24 pins
3	Module 500, DME supply, 12 pins
4	Module 400, Valvetronic servomotor, 11 pins
5	Module 100, vehicle connection, 48 pins
6	Module 200, sensors and actuators 1, 58 pins
7	Module 300, sensors and actuators 2, 58 pins
8	Intake manifold cover
9	Intake manifold

9.2.1. Overall function

The DME is the computing and switching centre of the engine management 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.

N13 Engine.

9. Engine Electrical System.

The DME control unit is woken up via the wake-up line (terminal 15 Wake up) by the Front Electronic Module (FEM).

The after-run starts after terminal 15 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 five seconds later.

The board in the DME control unit accommodates two 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.



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