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N55 Engine

Model: All with N55

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the features of the N55B30M0 engine
- Describe the specifications of the N55 engine
- Identify the internal and external components of the N55 engine
- Understand the function of the crankcase ventilation on the N55 engine
- Understand the function of the electronic volume control oil pump

Introduction

The N55 engine is the successor to the N54. Re-engineering and modifications have made it possible to now use only one exhaust turbocharger. Against the backdrop of reduced costs and improved quality, the technical data have remained virtually the same.

N55 Engine



Engine Components/Systems Overview

The following provides an overview of the features of the N55 engine:

Crankcase:

- Large longitudinal ventilation holes inter-connect the crankcase lower chambers and relieve unwanted crankcase pressure between cylinders.
- Modified oil galleries enhance the supply of oil to vacuum pump.

Crankshaft: Is light weight design and has an asymmetric counterweight arrangement.

Pistons and connecting rods:

- A specially formed bushing/bore in small end of the connecting rods evenly distributes the force of the pistons on the power stroke.
- Lead-free bearing shells are installed on the big-end of the connecting rods.

Cylinder head:

- Specially designed water passages intergraded into the cylinder head enhance injector cooling.
- The combustion chambers are machined to work in conjunction with the Valvetronic III system with regard to promoting air turbulence and mixture formation.

Crankcase ventilation:

- In contrast to the N54, the N55 crankcase ventilation does not use cyclone separators.
- The cylinder and head cover have integrated blow-by passages that connect the crankcase ventilation directly to the intake ports.

VANOS:

- The N55 VANOS oil passages are simplified compared to the N54 engine.
- The solenoid valves have integrated non-return valve and 3 screen filters.
- The VANOS units are of a lightweight design for increased adjustment speed and have a reduced susceptibility to soiling.

Valvetrain:

- The N55 is the first BMW turbo engine to incorporate Valvetronic.
- The valvetrain is a new designed that combines Valvetronic III with Double VANOS.
- With Valvetronic III the 3rd generation brushless servomotor is introduced.
- The position detection sensor of eccentric shaft is now integrated in the servomotor.

Oil supply:

- An enhanced and simplified oil circuit design is used.
- The inlet pipe, oil deflector, and oil collector are combined in one component.
- Oil pump uses a Duroplast slide valve and it is electronically controlled based on a characteristic map within the engine management.

Forced induction:

- The N55 uses a single twin scroll turbocharger with vacuum operated, electronically controlled wastegate valve.
- The electric diverter valve is intergraded into the turbocharger compressor housing.

Air intake and exhaust system:

- Air intake system is similar in configuration as the N54 with the exception of the intake manifold and the use of a single turbo.
- The intercooler is an air to air type mounted in the lower area of the front bumper cover.
- The exhaust system uses no underbody catalytic converter.

Vacuum system:

- The N55 engine has a two-stage vacuum pump as on the N54.
- The vacuum system has the vacuum reservoir built into the cylinder head cover.

Fuel injection:

- HDE (high pressure fuel injection) system is installed on the N55.
- The HDE system uses solenoid valve fuel injectors instead of the piezoelectric type used on HPI.
- The high pressure pump and pressure sensors are similar in design and function in both the HDE and HPI systems.

Digital Motor Electronics (DME):

- The DME is mounted on the intake manifold and cooled by intake air.
- The location of the DME facilitates the installation of the N55 engine in several current BMW platforms/models.

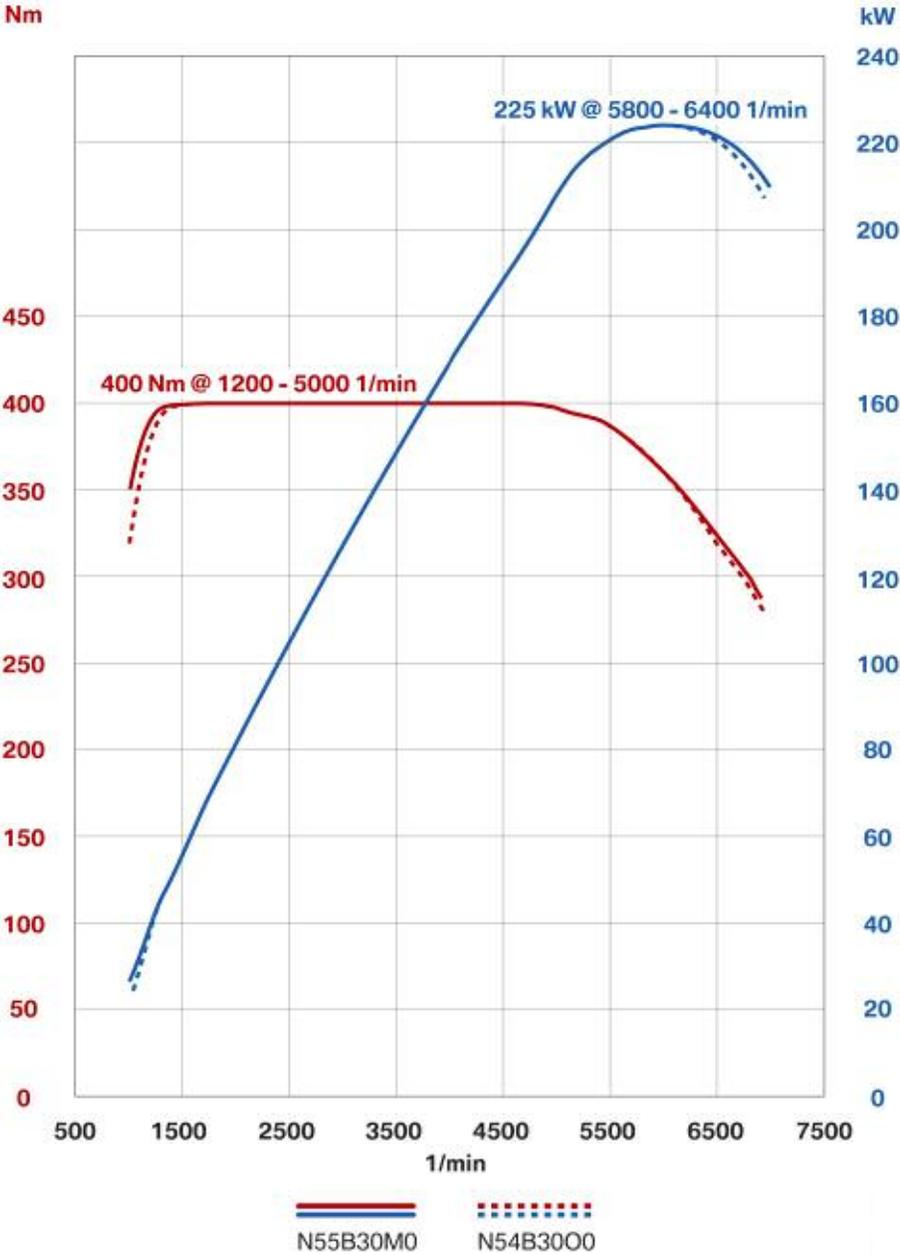
Technical Data

	Unit	N54B3000 (E71/X6 xDrive35i)	N55B30M0 (F07/535i)
Configuration		6 inline	6 inline
Cylinder capacity	[cm ³]	2979	2979
Bore/stroke	[mm]	84.0/89.6	84.0/89.6
Power output at engine speed	[kW/bhp] [rpm]	225/306 5800 - 6250	225/306 5800 - 6400
Power output per liter	[kW/l]	75.53	75.53
Torque at engine speed	[Nm] [rpm]	400 1300 - 5000	400 1200 - 5000
Compression ratio	[ε]	10.2	10.2
Valves/cylinder		4	4
Fuel consumption, EU combined	[l/100 km]	10.9	8.9
CO2 emission	g/km	262	209
Digital Motor Electronics		MSD81	MEVD17.2
Exhaust emission legislation, US		ULEV	ULEV II
Engine oil specification		BMW Longlife-01 BMW Longlife-01 FE BMW Longlife-04	-
Top speed	[km/h]	240	250
Acceleration 0 - 100 km/h/62mph	[s]	6.7	6.3
Vehicle curb weight DIN/EU	[kg]	2070/2145	1940/2015
* = Electronically governed			

Full Load Diagram

Compared to its predecessor, the N55 engine is characterized by lower fuel consumption with the same power output and torque data.

Full load diagram E90 335i with N54B3000 engine compared to the F07 535i with N55B30M0 engine



Current Models

N54B3000 engine variants

Model	Version	Series	Displacement in cm ³	Stroke/bore in mm	Power output in kW/bhp at rpm	Torque in Nm at rpm
135i	US	E82, E88	2979	89.6/84.0	300 SAE hp 5800 - 6250	407 (300 ft-lbs) 1400 - 5000
335i	US	E90, E92, E93	2979	89.6/84.0	300 SAE hp 5800 - 6250	407 (300 ft-lbs) 1400 - 5000
335i xDrive	US	E90, E92	2979	89.6/84.0	300 SAE hp 5800 - 6250	407 (300 ft-lbs) 1400 - 5000
335is	US	E92, E93	2979	89.6/84.0	320 SAE hp 5800 - 6250	450 (332 ft-lbs) 1400 - 5000
Z4 sDrive35i	US	E89	2979	89.6/84.0	300 SAE hp 5800 - 6250	407 (300 ft-lbs) 1400 - 5000
Z4 sDrive35is	US	E89	2979	89.6/84.0	335 SAE hp 5800 - 6250	450 (332/369 ft-lbs) *1400 - 5000
535i	US	E60	2979	89.6/84.0	300 SAE hp 5800 - 6250	407 (300 ft-lbs) 1400 - 5000
535i xDrive	US	E60, E61	2979	89.6/84.0	300 SAE hp 5800 - 6250	407 (300 ft-lbs) 1400 - 5000
X6 xDrive35i	US	E71	2979	89.6/84.0	300 SAE hp 5800 - 6250	407 (300 ft-lbs) 1400 - 5000
740i	US	F01, F02	2979	89.6/84.0	315 SAE hp 5800 - 6250	450 (330 ft-lbs) 1600 - 4500

*** The enhanced engine management system of the BMW Z4 sDrive35is and the 335is include an electronically controlled overboost function to briefly increase torque under full load by another 37 ft-lbs. This temporary torque peak of 369 ft-lbs gives the car a significant increase in acceleration for approximately 5 seconds.**

Engine Designation and Engine Identification

Engine Designation

This training material describes the N55B30M0 in detail.

In the technical documentation, the engine designation is used for unique identification of the engine. In the technical documentation you will also find the abbreviated engine designation, i.e. N55, that only indicates the engine type.

Item	Meaning	Index / explanation
1	Engine developer	M, N = BMW Group P = BMW Motorsport S = BMW M mbH W = Non-BMW engines
2	Engine type	1 = R4 (e.g. N12) 4 = R4 (e.g. N43) 5 = R6 (e.g. N55) 6 = V8 (e.g. N63) 7 = V12 (e.g. N73) 8 = V10 (e.g. S85)
3	Change to the basic engine concept	0 = basic engine 1 – 9 = changes, e.g. combustion process
4	Working method or fuel type and possibly installation position	B = Gasoline, longitudinal installation D = Diesel, longitudinal installation H = Hydrogen
5	Displacement in liters	1 = 1 liter (whole number of liters)
6	Displacement in 1/10 liter	8 = 0.8 liter (tenth of liter)
7	Performance class	K = Smallest U = Lower M = Middle O = Upper (standard) T = Top S = Super
8	Revision relevant to approval	0 = New development 1 – 9 = Revision

Breakdown of N55 Engine Designation

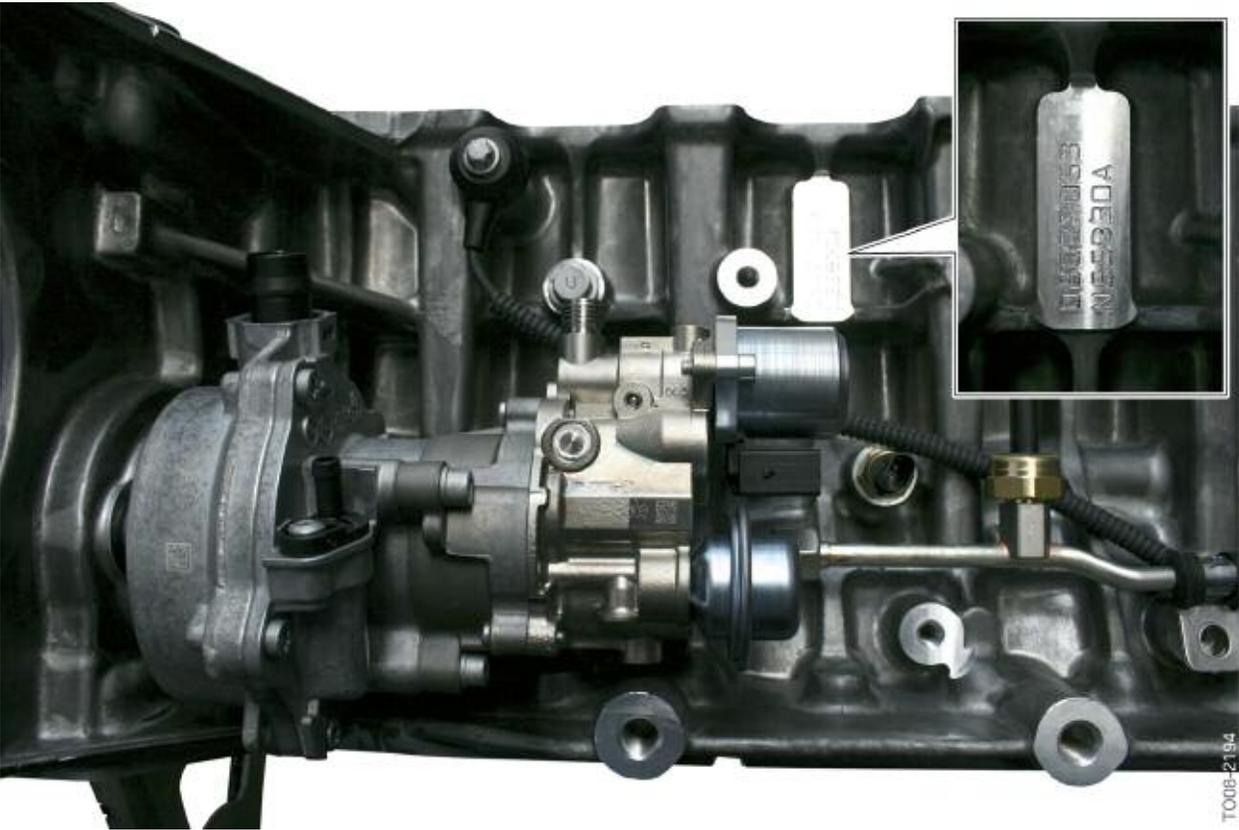
Index	Explanation
N	BMW Group Development
5	Straight 6 engine
5	Engine with direct injection, Valvetronic and exhaust turbocharger
B	Gasoline engine, longitudinal
30	3.0-liter capacity
M	Medium performance class
0	New development

Engine Identification

The engines are marked on the crankcase with an engine identification code for unique identification. This engine identifier is also required for approval by the authorities. The N55 engine further develops this identification system and the code has been reduced from previously eight to seven characters. The engine serial number can be found under the engine identifier on the engine. Together with the engine identifier, this consecutive number enables unique identification of each individual engine.

Item	Meaning	Index / explanation
1	Engine developer	M, N = BMW Group P = BMW Motorsport S = BMW M GmbH W = Non-BMW engines
2	Engine type	1 = R4 (e.g. N12) 4 = R4 (e.g. N43) 5 = R6 (e.g. N55) 6 = V8 (e.g. N63) 7 = V12 (e.g. N73) 8 = V10 (e.g. S85)
3	Change to the basic engine concept	0 = basic engine 1 – 9 = changes, e.g. combustion process
4	Working method or fuel type and possibly installation position	B = Gasoline, longitudinal installation D = diesel, longitudinal installation H = hydrogen
5	Displacement in liters	1 = 1 liter (whole number of liters)
6	Displacement in 1/10 liter	8 = 0.8 liter (tenth of liter)
7	Type test concerns (changes that require a new type test)	A = Standard B – Z = Depending on requirement, e.g. RON 87

N55 engine, engine identification and engine serial number



Index	Explanation
08027053	Individual consecutive engine serial number
N	Engine developer, BMW Group
5	Engine type, straight 6
5	Change to basic engine concept, turbocharging, Valvetronic, direct fuel injection
B	Operating principle or fuel supply and installation position, petrol engine longitudinal
30	Displacement in 1/10 liter, 3 liter
A	Type approval requirements, standard

Engine Components

Engine Housing

The engine housing consists of the engine block (crankcase and bedplate), cylinder head, cylinder head cover, oil pan and gaskets.

Engine Block

The engine block is made from an aluminum die-casting and consists of the crankcase with bedplate.

Crankcase and Bedplate

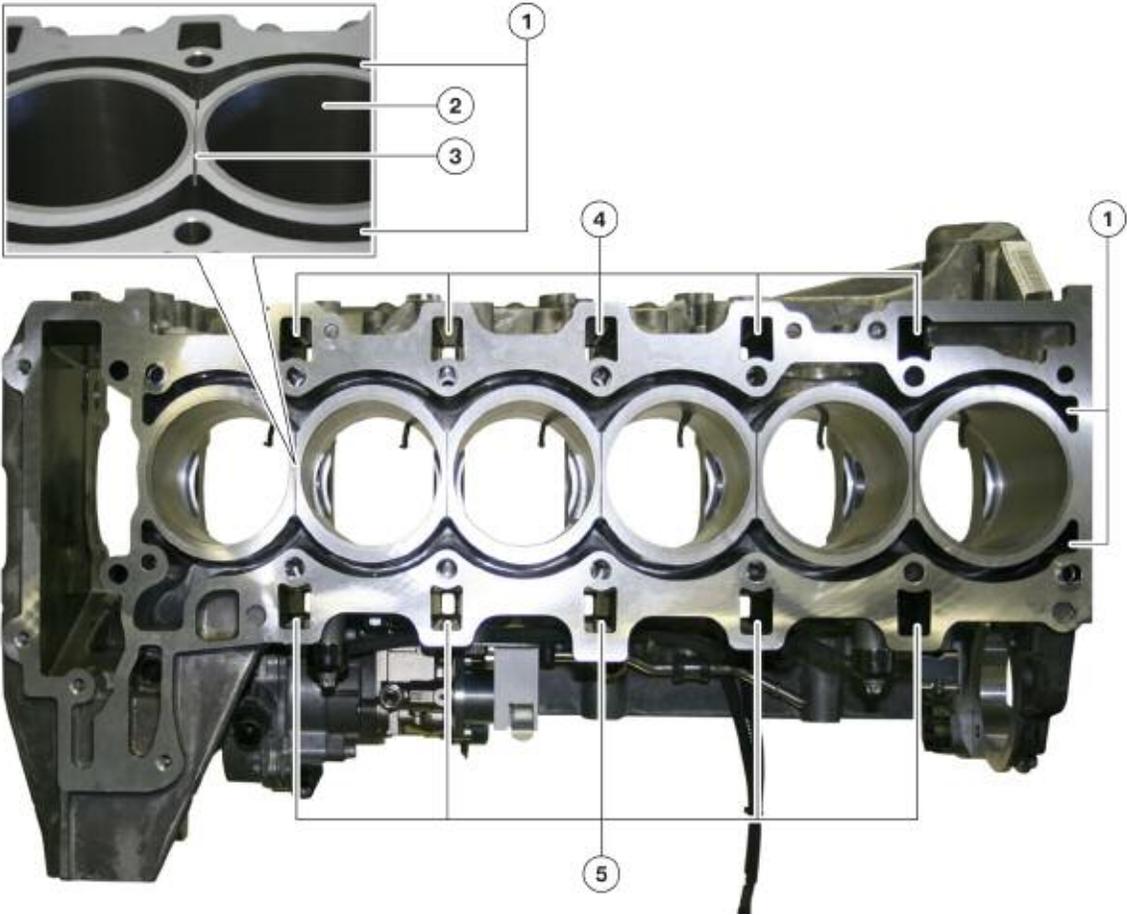
The crankcase features cast iron cylinder liners (2). A new feature is that the webs between two cylinders on the deck of the block now have a grooved cooling passage (3). Coolant can flow along these grooves from one side of the crankcase to the other, thus enhancing cooling of this area.

Five oil return ducts on the exhaust side (4) now permit oil to return from the cylinder head into the oil pan. These oil return channels extend into the bedplate up to below the oil deflector. They help reduce churning losses as the returning engine oil can no longer reach the crankshaft even at high transverse acceleration.

Five oil return channels on the intake side (5) also ensure that the blow-by gasses can flow unobstructed from the crankshaft area into the cylinder head and to the crankcase breather in the cylinder head cover.

The cooling duct (1) in the engine block is split and coolant flows directly through it.

N55, crankcase with web cooling



Index	Explanation
1	Cooling duct
2	Cylinder liner
3	Grooved cooling passage
4	Oil return ducts, exhaust side
5	Oil return ducts, intake side

The crankcase has large longitudinal ventilation holes bored between the lower chambers of the cylinders. The longitudinal ventilation holes improve the pressure equalization, between the oscillating air columns that are created in the crankcase, by the up and down movement of the pistons.

This enhances power by relieving the unwanted pressure that acts against the downward movement of the pistons. It also enhances crankcase ventilation and adds to oil service life by promoting the movement of blow-by gasses within the engine.



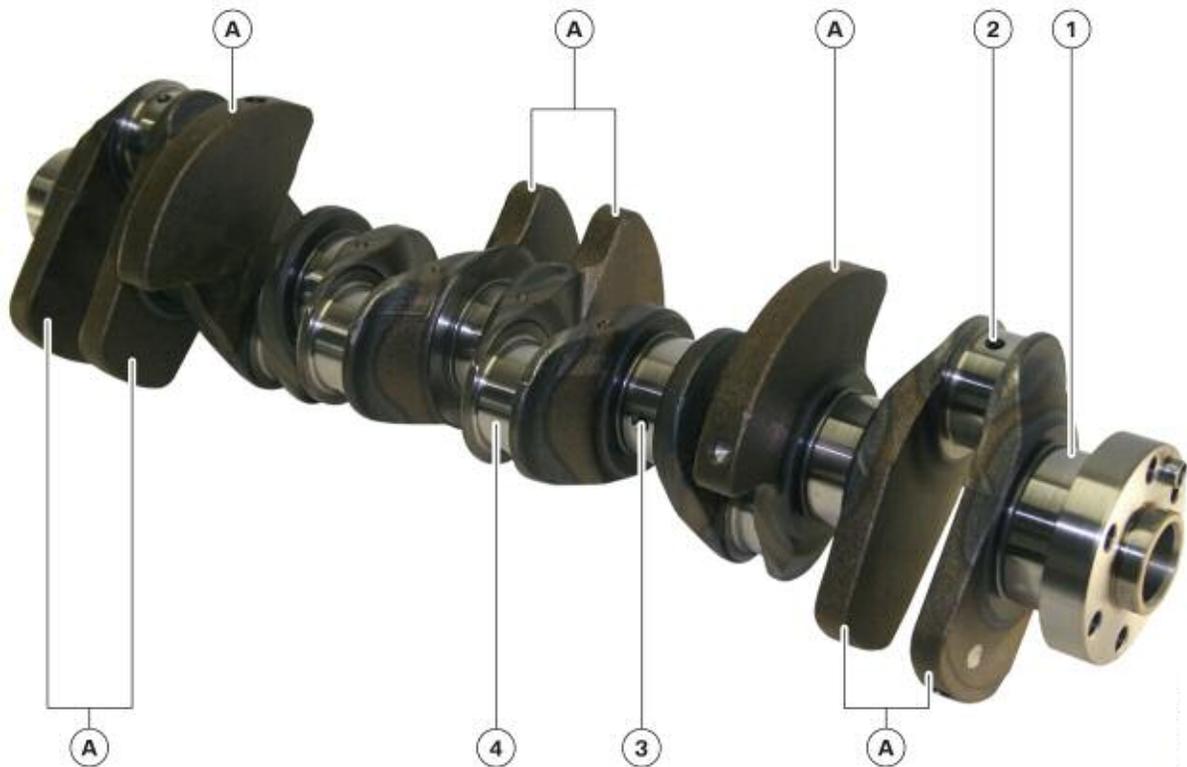
N55, ventilation holes in crankcase

Crankshaft

The crankshaft of the N55 is of lightweight design, at 20.3 kg it's approximately 3 kg lighter than the crankshaft in the N54 engine.

The crankshaft is made from cast iron (GGG70). The counterweights are arranged asymmetrically. There is no incremental wheel installed on the crankshaft. The timing chains are mounted by means of an M18 central bolt.

N55 Crankshaft



Index	Explanation
A	Counterweights
1	Main bearing journal 7
2	Oil hole from big-end bearing to main bearing
3	Oil hole from main bearing to big-end bearing
4	Big-end bearing journal, cylinder 4

Crankshaft Main Bearings

As on the N54 engine, the main bearings on the crankshaft are designed as two component bearings free of lead. The thrust bearing is mounted at the fourth bearing position.

Pistons and Rings

A full slipper skirt type piston with a diameter of 82.5 mm is used. The first piston ring is a plain rectangular compression ring with a chrome-ceramic coating on the contact surface. The second piston ring is a tapered faced Napier type ring. The oil scrape ring is designed as a steel band ring with spring that is also known as VF system.

N55 piston with piston rings

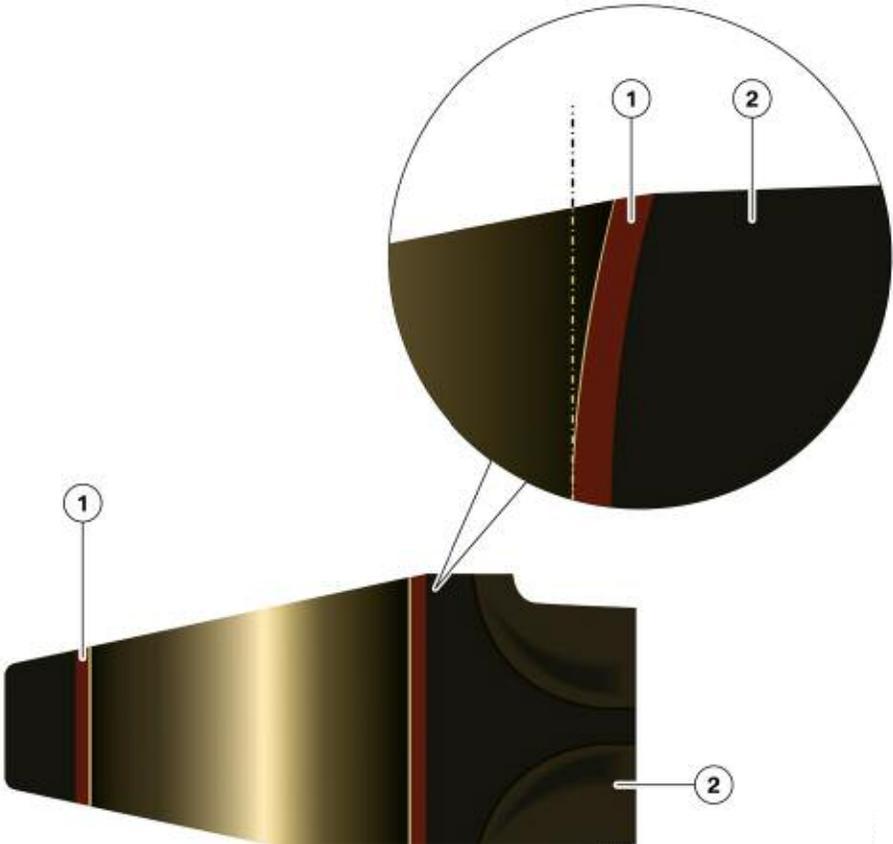


Index	Explanation
1	Plain rectangular compression ring
2	Tapered faced Napier ring
3	VF system ring
4	Steel inlay for first piston ring
5	Groove for first piston ring
6	Groove for second piston ring
7	Groove for oil scraper ring
8	Hole for lubricating oil drain
9	Graphite coating

Connecting Rod and Bearings

The size of the connecting rod of the N55 engine is 144.35 mm. A new feature is the specially formed hole in the small end of the connecting rod. This formed hole is machined wider on the lower edges of the wrist pin bushing/bore. This design evenly distributes the force acting on the wrist pin over the entire surface of the rod bushing and reduces the load at the edges, as the piston is forced downward on the power stroke.

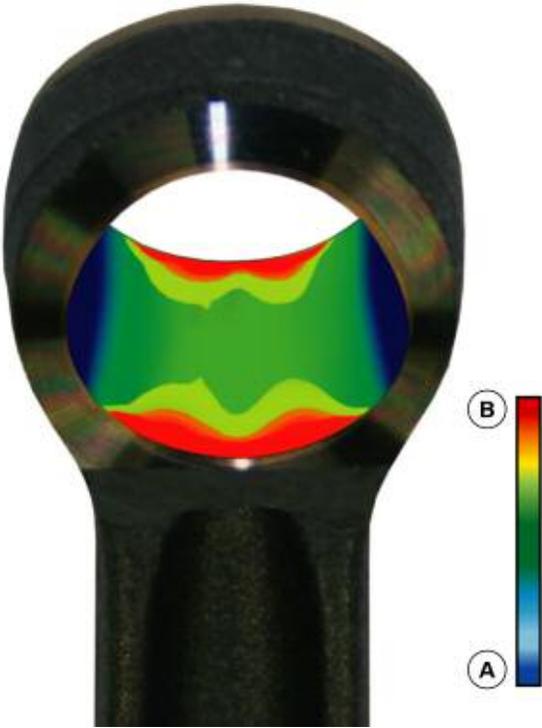
N55, small end of the connecting rod



Index	Explanation
1	Bushing
2	Connecting rod

The following graphic shows the surface load on a standard connecting rod without the formed hole. Due to combustion pressure, the force exerted by the piston via the wrist pin is mainly transmitted to the edges of the rod bushing.

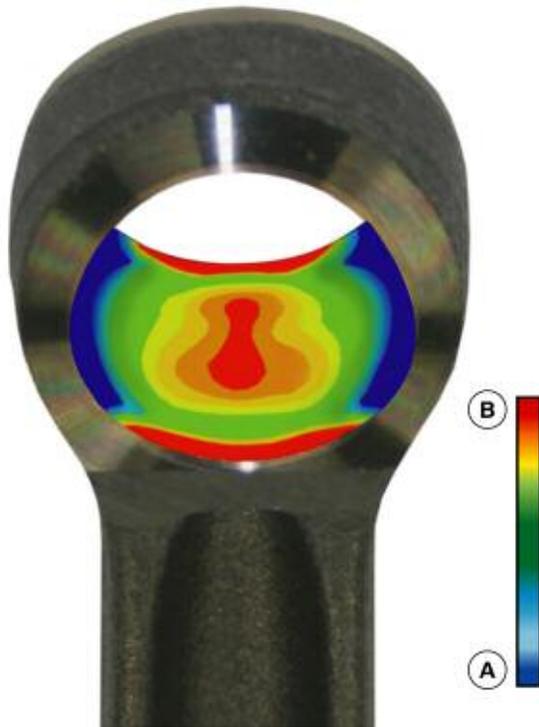
N54, connecting rod small end without formed hole



Index	Explanation
A	Low surface load
B	High surface load

The graphic below illustrates the small end of the connecting rod with a formed hole. The force is more evenly distributed over a larger area and the load on the edges of the rod bushing is reduced considerably.

N55, connecting rod small with formed hole



Index	Explanation
A	Low surface load
B	High surface load

Lead-free bearing shells are used on the large connecting rod end. The material G-488 is used on the connecting rod side and the material G-444 on the bearing cap side.

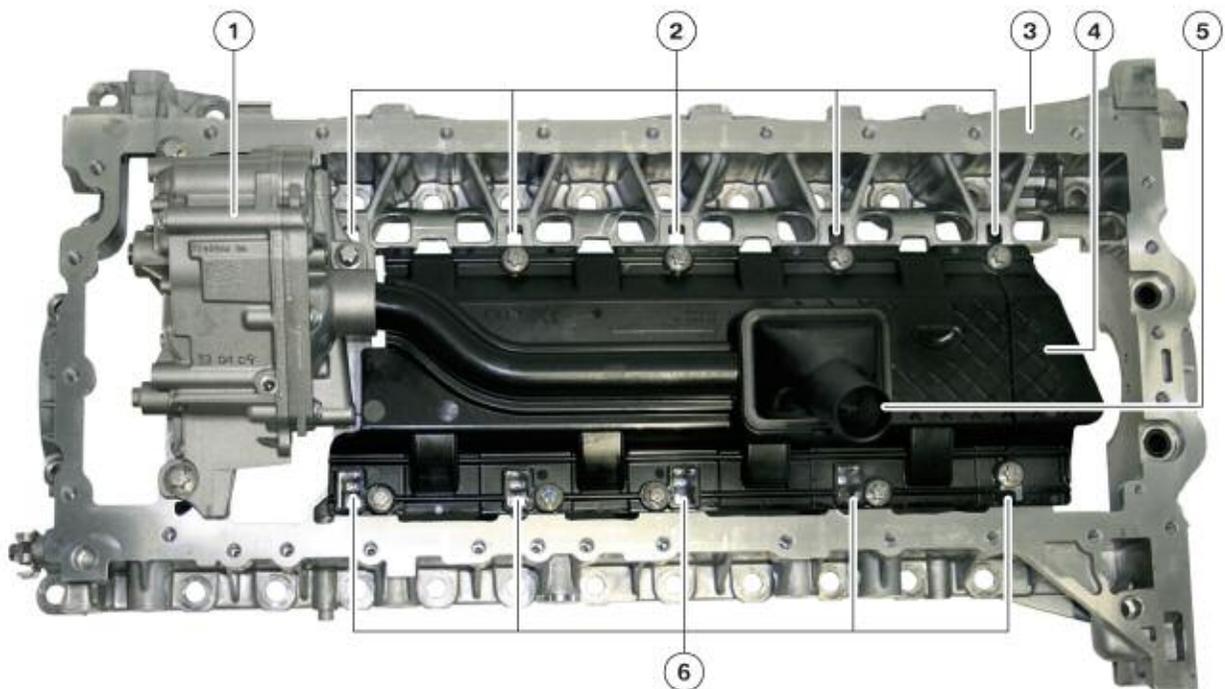
The size M9 x 47 connecting rod bolts are the same on the N55 and N54 connecting rod.

Oil Pan

The oil pan is made from an aluminum casting. The oil deflector and the intake pipe to the oil pump are designed as one component. To facilitate attachment to the bedplate, the oil return ducts are designed so that they extend over the oil deflector. Consequently, the oil return ducts end in the oil sump.

Ducts are provided for the oil supply to the vacuum pump as it is now lubricated by filtered oil and not by unfiltered oil as on the N54 engine.

N55, bedplate with oil pump and oil deflector



Index	Explanation
1	Oil pump
2	Oil return ducts, intake side
3	Bedplate
4	Oil deflector
5	Intake manifold with oil screen filter
6	Oil return ducts, exhaust side

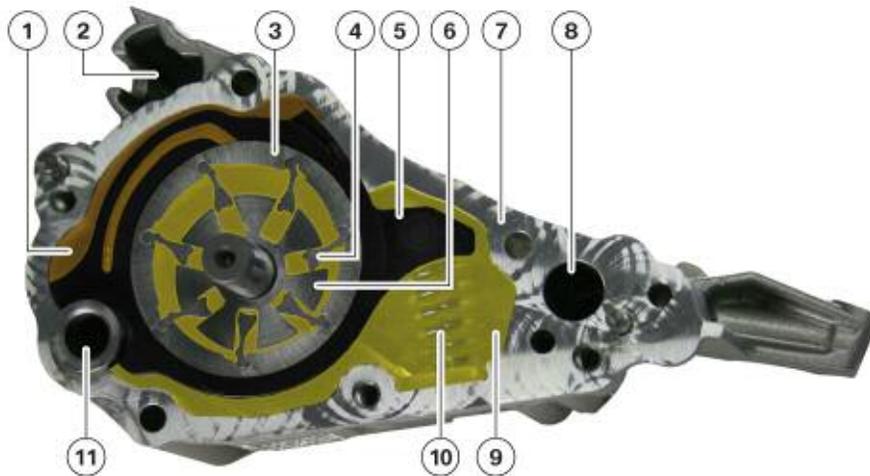
Electronic Volume-controlled Oil Pump

A modified version of the volume control oil pump of the N54 engine is used. For the first time a Duroplast reciprocating slide valve is installed. The volumetric flow control system operating principle of the oil pump is described in the E71 X6 training material under the "N63 Engine" available on TIS and ICP.

This type of pump delivers only as much oil as is necessary under the respective engine operating conditions. No surplus quantities of oil are delivered in low-load operating ranges. This operating mode reduces the pump work and therefore the fuel consumption of the engine while also slowing down the oil aging process. The pump is designed as a slide valve-type vane pump. In delivery mode, the pump shaft is positioned off-center in the housing and the vanes are displaced radially during rotation. As a result, the vanes form chambers of differing volume. The oil is drawn in as the volume increases and expelled into the oil galleries as the volume decreases.

The oil pressure in the system (downstream of the oil filter) acts on the slide against the force of a compression springs in the control oil chamber. The slide element rotates about a pivot axis.

N55, oil pump



Index	Explanation	Index	Explanation
1	Control oil chamber	7	Housing
2	Pressure limiting valve	8	Hole for pressure control valve
3	Rotor	9	Damping oil chamber
4	Vane	10	Compression spring (2x)
5	Duroplast slide valve	11	Pivot axis of rotation
6	Inner rotor		

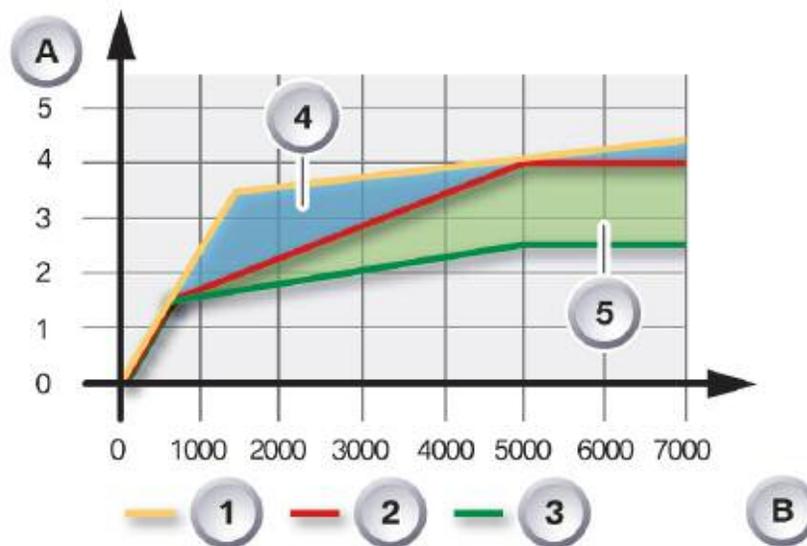
Oil Pump and Pressure Control

The oil pump has been redesigned with regard to the functionality and durability of the Duroplast reciprocating slide valve. The oil pump used in the N55 engine is a further development of the shuttle slide valve volume control oil pump. The activation of the oil pump is adapted by the engine management and controlled through an oil pressure control valve.

The delivered oil volume is controlled by means of the oil pressure, based on specific requirements. The modifications, compared to previous pumps, are primarily in the pump activation system. The oil pressure no longer acts directly on the control piston but rather directly on the slide valve. The engine management activates the electrohydraulic pressure control valve, which affects the oil pressure at the slide valve control mechanism within the oil pump, altering the pump output. This has the advantage of avoiding power losses by running the oil pump only when needed.

The electrohydraulic pressure control valve controls the pump output and is bolted to the front of the engine block. It is operated based on a characteristic map within the DME (ECM) which in turn is based on feedback from the oil pressure sensor. The N55 uses a special oil pressure sensor for this purpose which functions in the similar way as the HPI fuel pressure sensor.

Characteristic map-controlled oil pressure



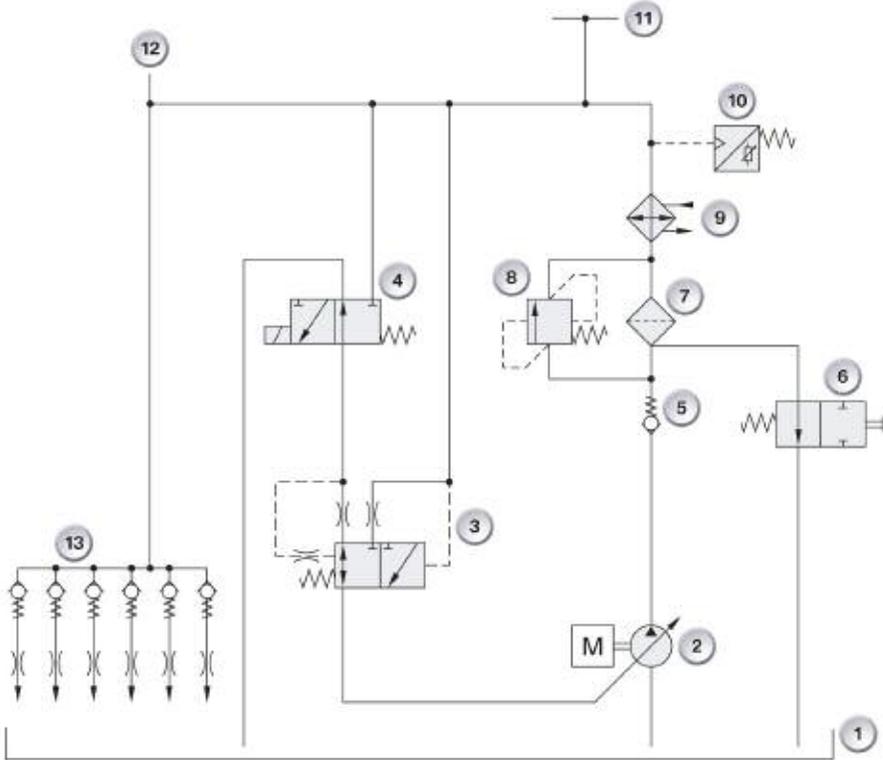
Index	Explanation	Index	Explanation
A	Oil pressure (bar)	3	Characteristic map-controlled oil pressure, no load
B	Engine speed (rpm)	4	Saving potential, full load
1	Oil pressure control, hydraulic/ mechanical	5	Saving potential, no load
2	Characteristic map-controlled oil pressure, full load		

The oil pressure generated by the oil pump (2) is delivered to the engine's lubricating points and hydraulic actuators. This system uses oil pressure feed back to control the desired operating oil pressure. For this purpose, the oil pressure downstream of the oil filter (7) and engine oil-to-coolant heat exchanger (9) is adjusted by the DME (map-controlled) via the pressure control valve (4) to the pressure control valve (3).

The actual generated oil pressure is registered by the oil pressure sensor (10) and recognized by the engine management.

In the event of an electrical malfunction, the oil pressure is set to the default control setting. The pump compression springs are allowed to expand, moving the slide valve to its maximum oil pressure position.

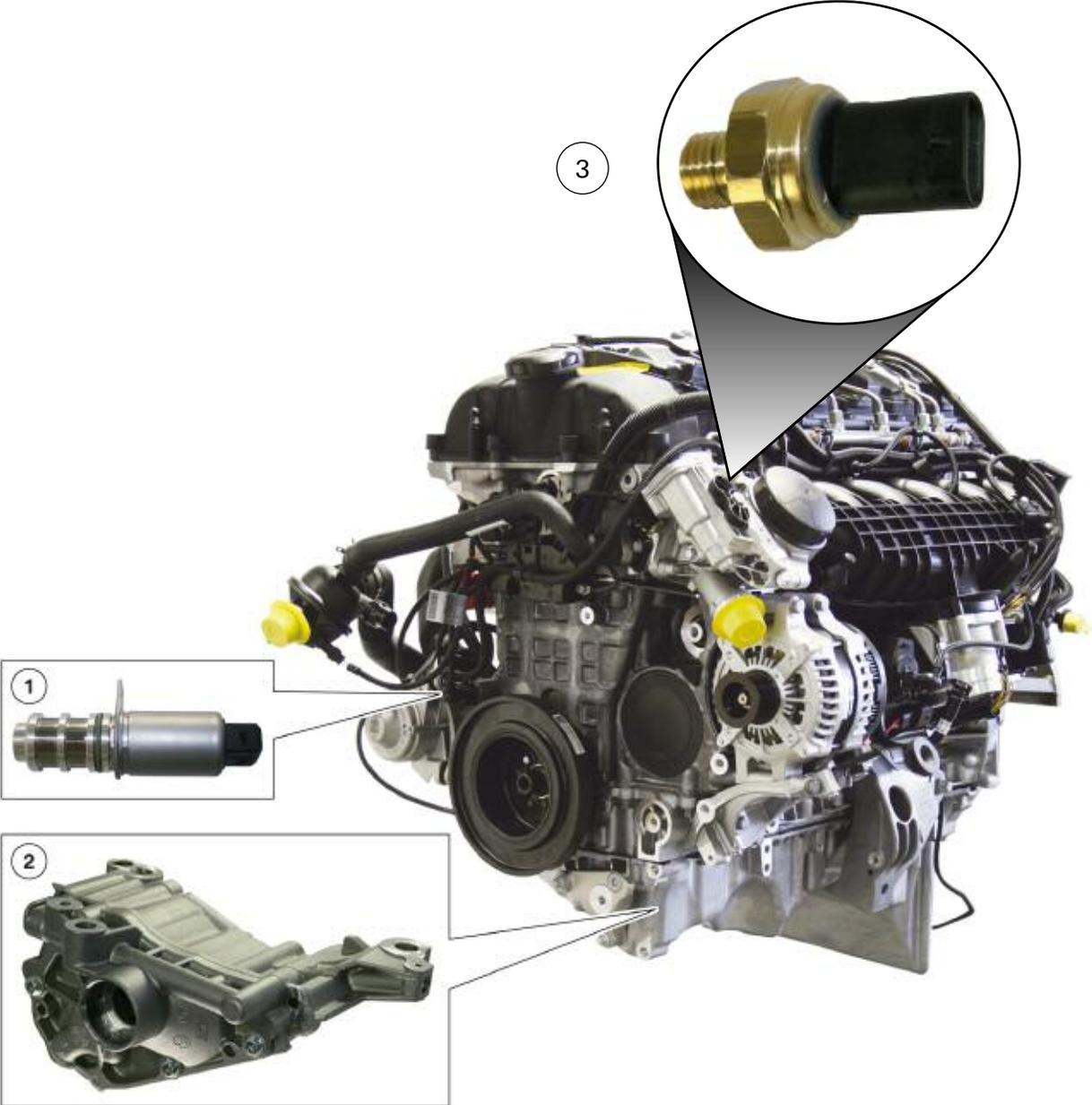
Hydraulic diagram of the N53 engine oil circuit with electronic pressure control



Index	Explanation	Index	Explanation
1	Oil Pan	8	Filter By-pass valve
2	Volume controlled oil pump	9	Engine oil to coolant heat exchanger
3	Pressure regulating valve	10	Oil Pressure sensor
4	Electro-hydraulic pressure regulating valve	11	Lubricating points, cylinder head
5	Non-return valve	12	Lubricating points, engine block
6	Outlet valve at the filter	13	Oil spray nozzles, piston crowns
7	Oil filter		

Note: The N53 hydraulic circuit diagram shown is for explanation of the oil pressure control only, and does not apply directly to the N55 engine.

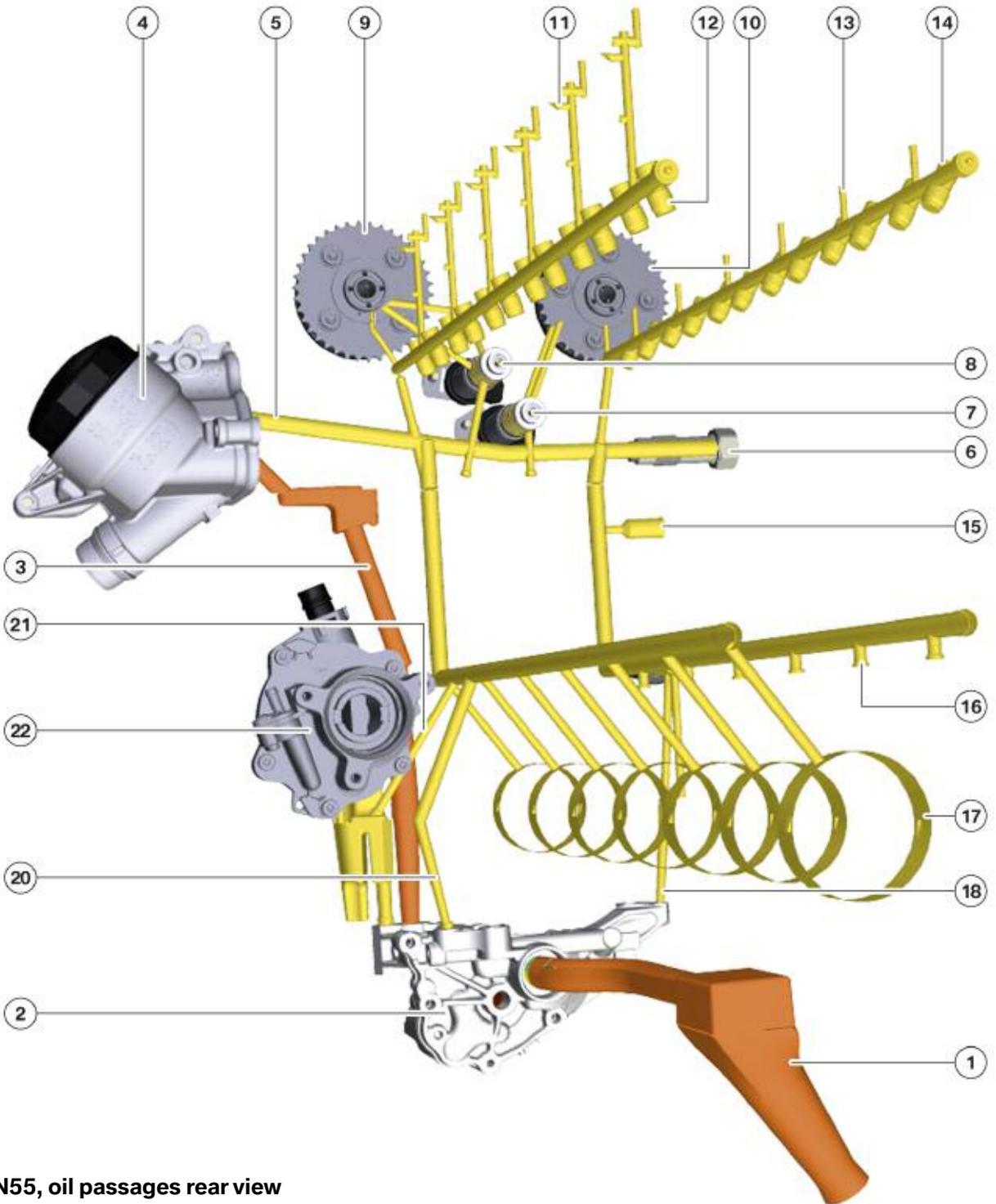
N55, oil pump and pressure control valve



Index	Explanation
1	Oil pressure control valve
2	Oil pump
3	Oil pressure sensor

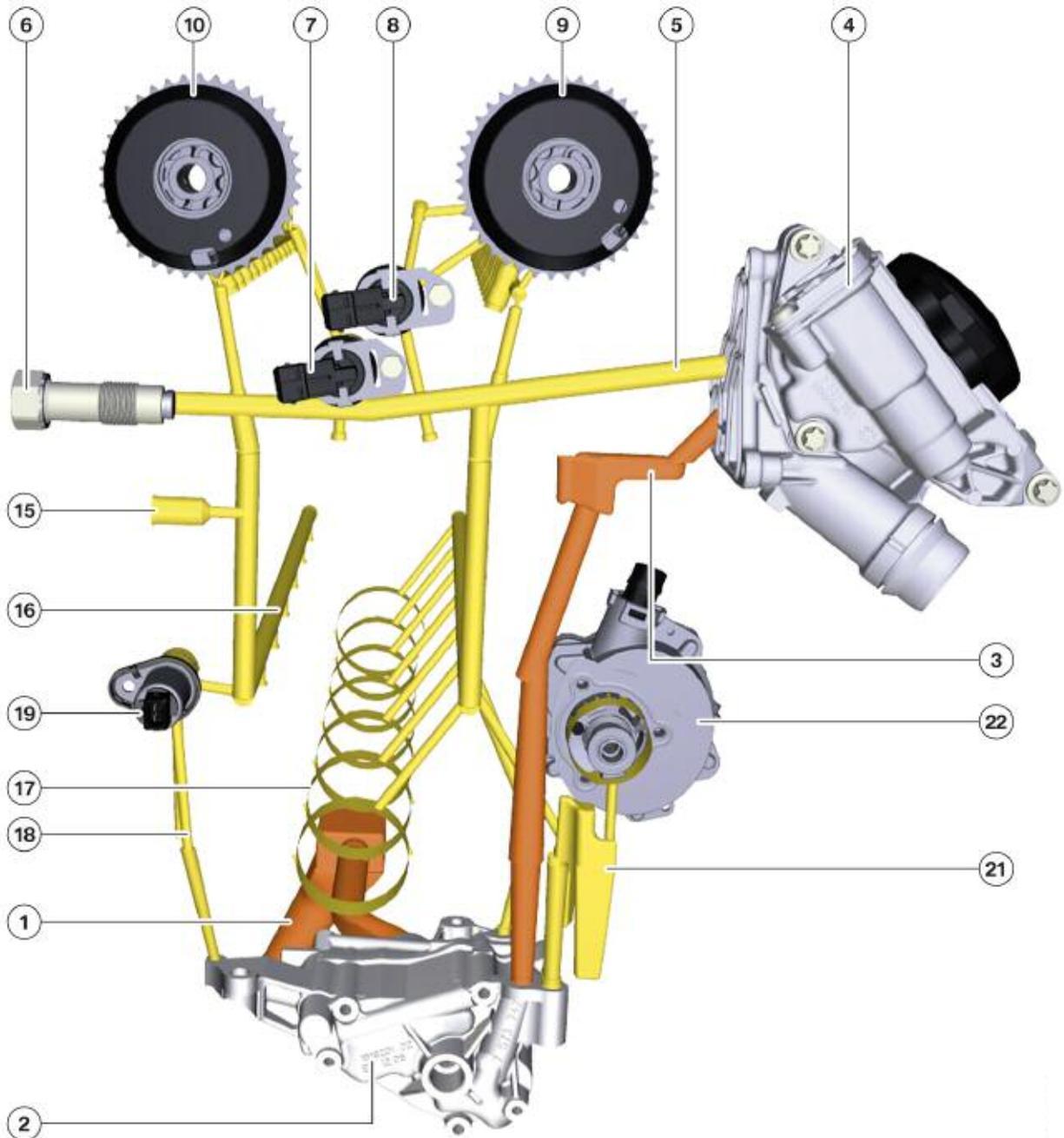
Oil Supply

The following graphics show an overview of the oil circuit of the N55. Compared to the N54 engine, there are considerably fewer oil ducts in the cylinder head. This is mainly due to the use of the new VANOS solenoid valves.



N55, oil passages rear view

Index	Explanation
1	Intake pipe
2	Oil pump
3	Unfiltered oil duct
4	Oil filter
5	Main oil duct (filtered oil duct)
6	Chain tensioner
7	VANOS solenoid valve, exhaust side
8	VANOS solenoid valve, intake side
9	VANOS adjustment unit, intake side
10	VANOS adjustment unit, exhaust side
11	Oil duct for intake camshaft and eccentric shaft lubrication
12	Hydraulic valve lash adjustment
13	Oil duct for exhaust camshaft lubrication
14	Hydraulic valve lash adjustment
15	Connection to exhaust turbocharger lubrication
16	Connection for oil spray nozzles
17	Crankshaft bearing
18	Oil duct for oil pressure control
20	Oil duct for oil pressure control
21	Oil duct for vacuum pump lubrication
22	Vacuum pump



N55, oil passages front view

Index	Explanation
1	Intake pipe
2	Oil pump
3	Unfiltered oil duct
4	Oil filter
5	Main oil duct (filtered oil duct)
6	Chain tensioner
7	VANOS solenoid valve, exhaust side
8	VANOS solenoid valve, intake side
9	VANOS adjustment unit, intake side
10	VANOS adjustment unit, exhaust side
15	Connection to exhaust turbocharger lubrication
16	Connection for oil spray nozzles
17	Crankshaft bearing
18	Oil duct for oil pressure control
19	Oil pressure control valve
21	Oil duct for vacuum pump lubrication
22	Vacuum pump

Oil Filtration and Oil Cooling

The oil filter housing is made from Duroplast. Based on the application, two types of engine oil coolers may be used. Depending on the oil temperature, a thermostat on the oil filter housing controls the oil flow through the oil cooler.

Oil Spray Nozzles

The N55 engine is equipped with oil spray nozzles for the purpose of cooling the piston crown. A special tool is required for positioning the oil spray nozzles.

Oil Pressure

Since the N55 engine has an oil pump with electronic volumetric flow control, it is necessary to measure the oil pressure precisely. For this reason, a new oil pressure sensor is installed.

Advantages of the new oil pressure sensor:

- It now measures absolute pressure (previous measured relative pressure).
- It is characteristic map control in all speed ranges.

Oil Level

The oil quality sensor is used for measuring the oil level as on previous BMW engines.

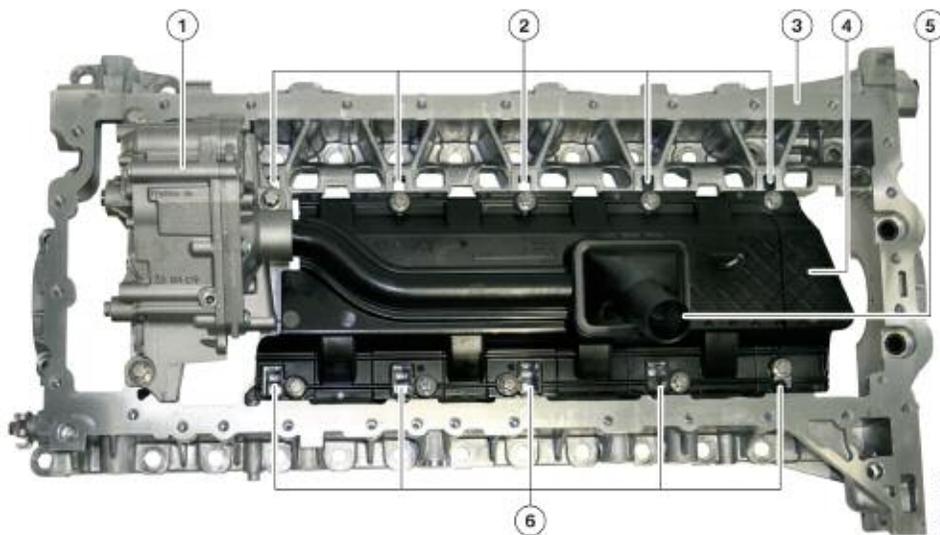
Oil Return

The following graphics show the integrated oil deflector. It combines the following components:

- Oil deflector (4)
- Intake snorkel (5)

The oil sump (1) and crankshaft are separated by the integrated oil deflector. Oil scraper edges are installed on the bedplate to direct the spray oil from the crankshaft.

Depending on the model, the oil pan can be adapted to different installation configurations by simply changing the intake snorkel. The oil, flowing back from the cylinder head (2, 6) is directed under the oil deflector. In this way, even under high transverse acceleration conditions, no returning oil can reach the crankshaft and cause churning losses .



Cylinder Head

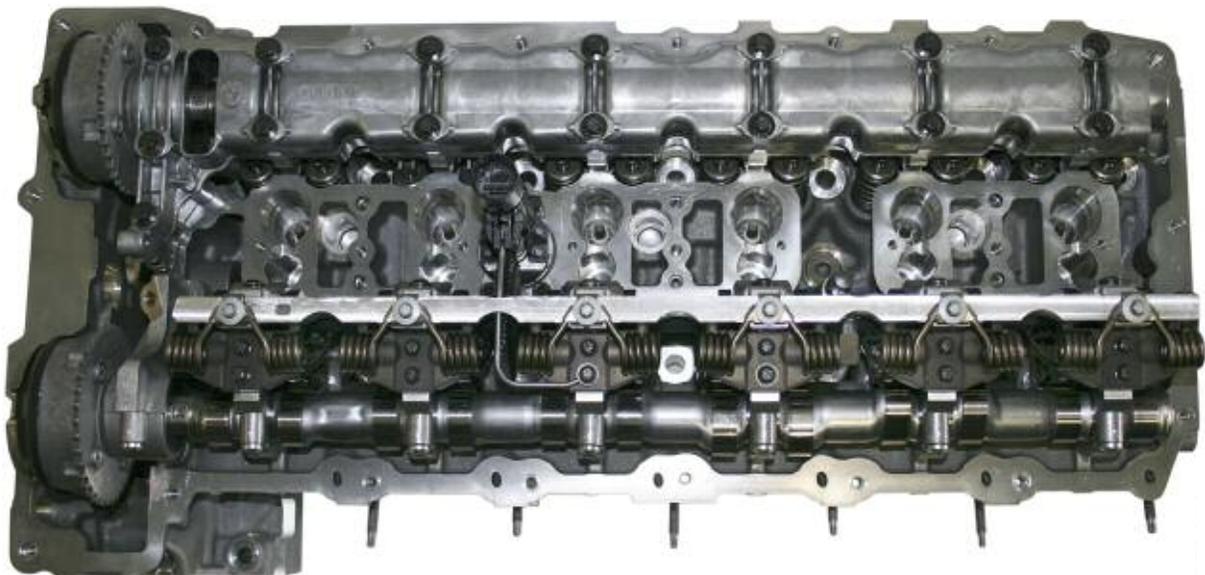
Direct fuel injection, turbocharging and Valvetronic systems are combined for the first time on a BMW 6-cylinder engine. The cylinder head of the N55 engine is a new development. It features a very compact design and is equipped with third generation Valvetronic.

The combination is referred to as Turbo-Valvetronic-Direct-Injection (TVDI).

This system reduces CO₂ emission and fuel consumption by 3 - 6%.

There are now no connections for the VANOS non-return valves as they have been integrated in the solenoid valves. The cylinder head also features cooling passages near the fuel injectors; providing indirect cooling.

N55, cylinder head



Cylinder Head Cover

The cylinder head cover is a new development. The accumulator for the vacuum system is built into the cylinder head cover.

All components for crankcase ventilation and the blow-by channels are also integrated into the cylinder head cover. The non-return valves ensure that the blow-by gasses are reliably added to the intake air in both engine modes (NA and Boost)

The N55 engine is equipped with a vacuum-controlled crankcase ventilation system; therefore, a regulated negative pressure of approximately 38 mbar is maintained.

N55, cylinder head cover with crankcase ventilation



Index	Explanation
1	Connection, blow-by gas to clean air pipe
2	Connection, vacuum line to vacuum pump
3	Reserve, vacuum connection
4	Vacuum connection to electropneumatic pressure converter EPDW for wastegate valve
5	Duct for blow-by gas feed into intake system with integrated non-return valve
6	Blow-by gas duct with settling chamber, impact plate, pressure control valve and non-return valves
7	Pressure regulating valve

Crankcase Ventilation

The blow-by gasses flow into the settling chamber of the cylinder head cover through an opening located in the rear of the cover. Here, the blow-by gasses are directed through holes on to an impact plate, against which the oil impacts at high speed, and drains off. The blow-by gasses, cleaned of oil, flow via the pressure control valve (depending on the operating mode) through the non-return valves into the inlet pipe upstream of the turbocharger, or via passages in the cylinder head ahead of the intake valves. The separated oil is drained via a return flow duct into the oil pan.

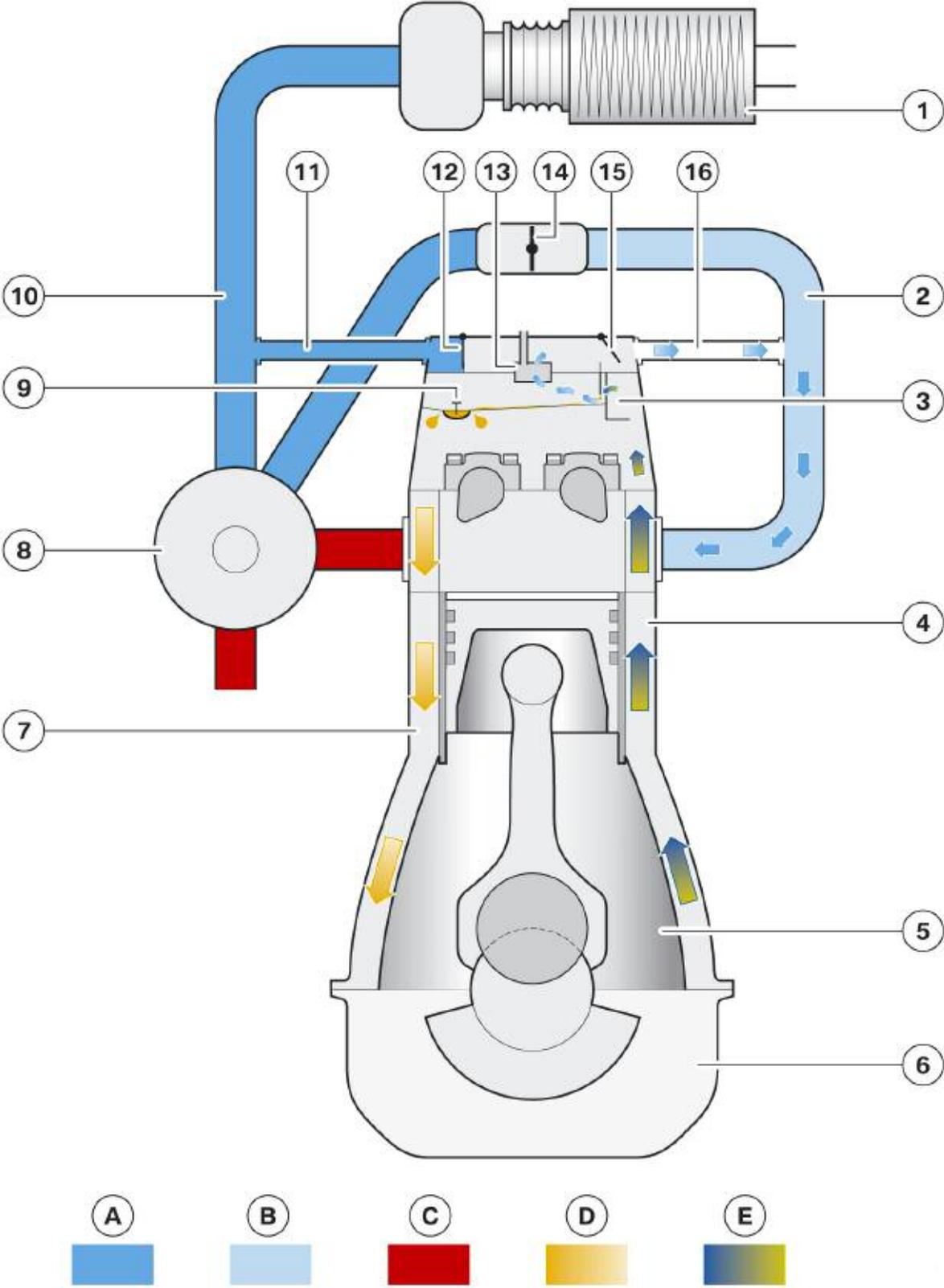
Naturally Aspirated Mode

The standard function can only be used as long as a vacuum prevails in the intake air manifold, i.e. in naturally-aspirated engine mode.

With the engine operating in naturally-aspirated mode, the vacuum in the intake air manifold opens the non-return valve (15) in the blow-by duct within the cylinder head cover. This draws off blow-by gasses via the pressure control valve. At the same time, the vacuum also closes the second non-return valve (12) in the duct to the charge air intake pipe.

The blow-by gasses flow via a distribution rail integrated in the cylinder head cover, through the intake passages (16) in the cylinder head, which lead directly into the intake ports, ahead of the valves.

N55, crankcase ventilation, naturally-aspirated mode



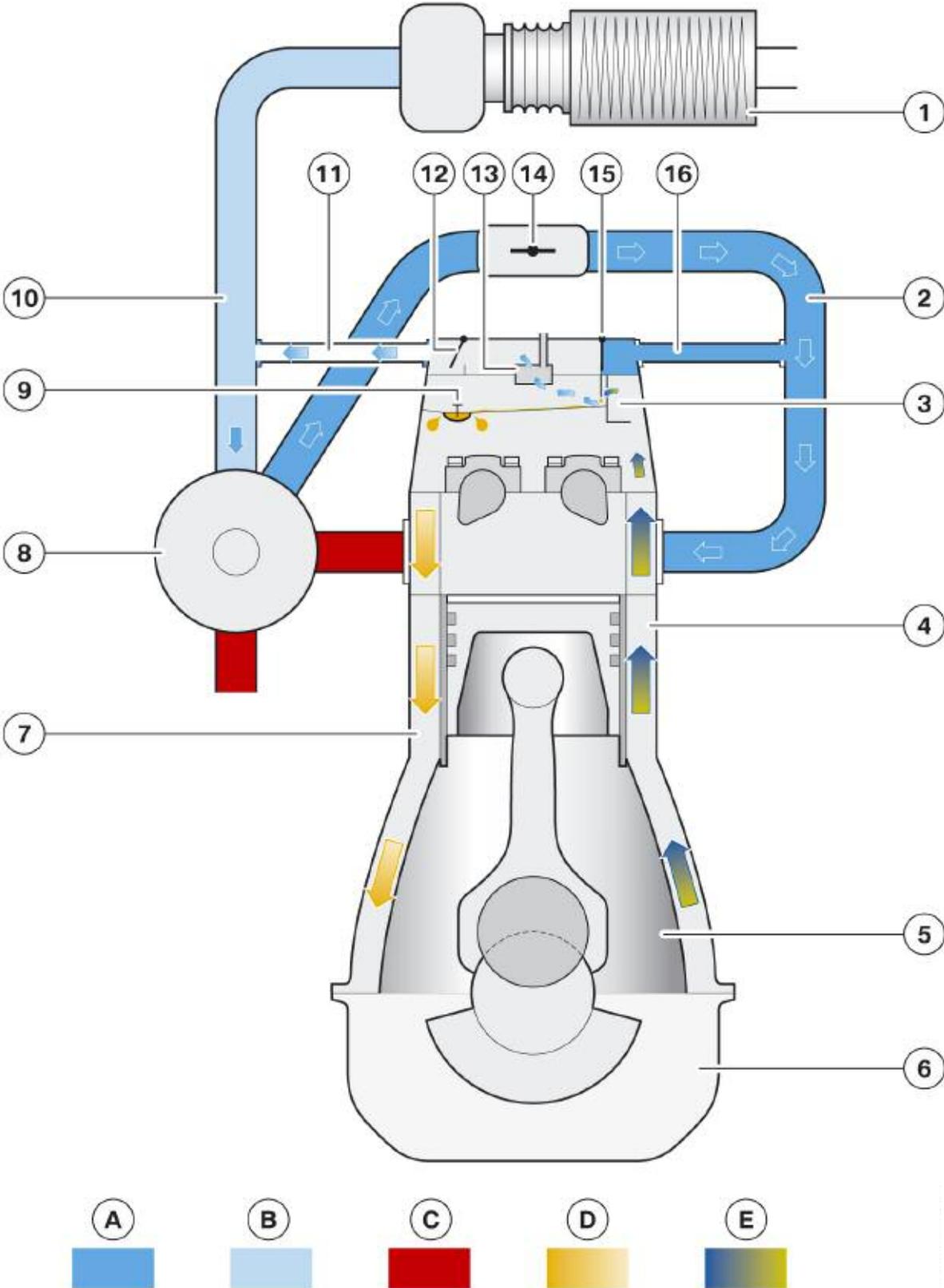
Index	Explanation
A	Ambient pressure
B	Vacuum
C	Exhaust gas
D	Oil
E	Blow-by gas
1	Air cleaner
2	Intake manifold
3	Impact plates
4	Oil return channel
5	Crankcase
6	Oil sump
7	Oil return channel
8	Exhaust turbocharger
9	Oil drain valve
10	Charge air intake line
11	Hose to charge air intake line
12	Non-return valve
13	Pressure regulating valve
14	Throttle valve
15	Non-return valve
16	Passages in cylinder head and cylinder head cover

Boost Mode

As the pressure in the intake air manifold increases in boost mode, blow-by gasses can no longer be introduced via the passages in the cylinder head, otherwise, the boost pressure could enter the crankcase. A non-return valve (15) in the blow-by channel within the cylinder head cover closes the connection (16) to the intake air manifold. This protects the crankcase from excess pressure.

The increased demand for fresh air creates a vacuum in the clean air pipe between the turbocharger and intake silencer. This vacuum is sufficient to open the non-return valve (12) and draw the blow-by gasses via the pressure control valve.

N55, crankcase ventilation, turbocharged (boost) mode



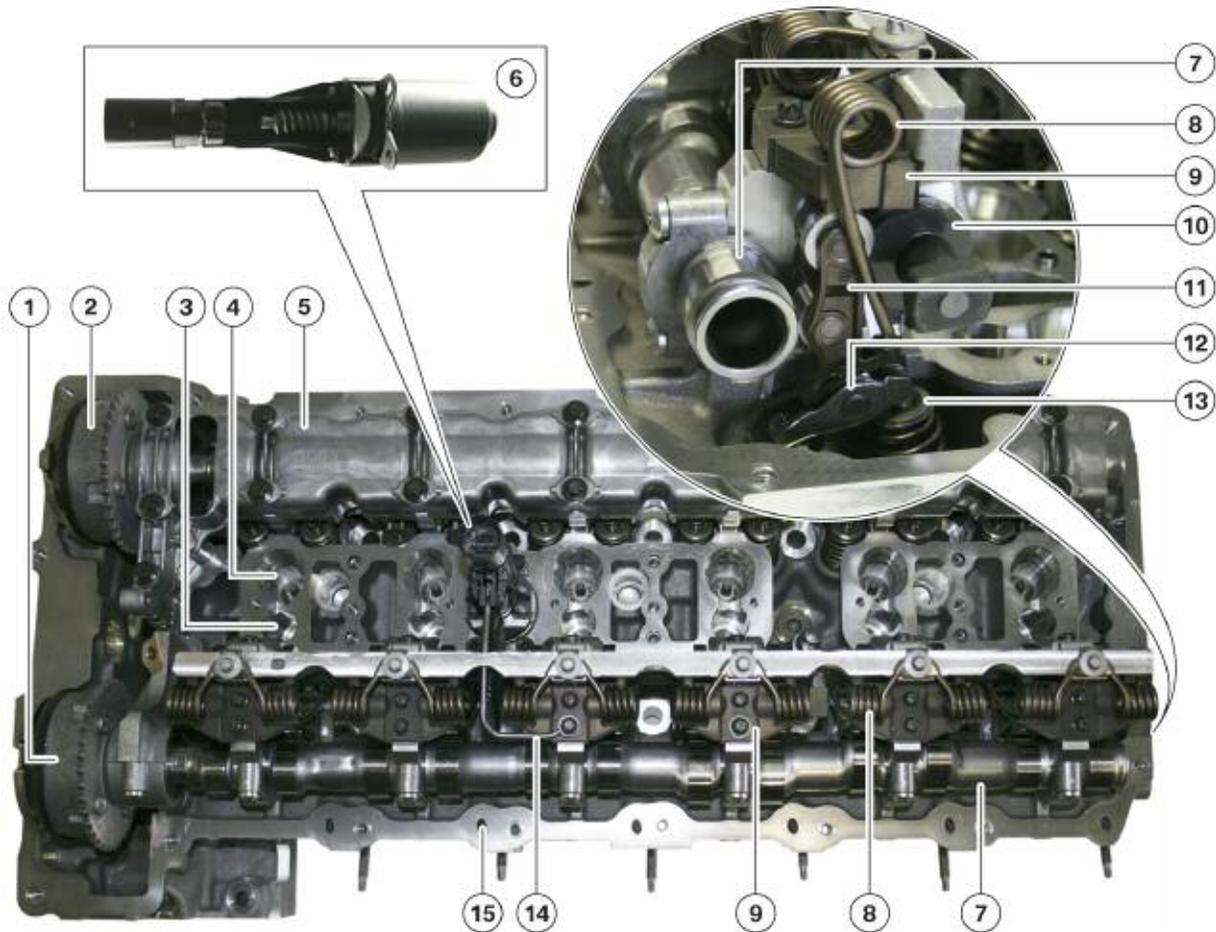
Index	Explanation
A	Excess pressure
B	Vacuum
C	Exhaust gas
D	Oil
E	Blow-by gas
1	Air cleaner
2	Intake manifold
3	Impact plates
4	Oil return channel
5	Crankcase
6	Oil sump
7	Oil return channel
8	Exhaust turbocharger
9	Oil drain valve
10	Charge air intake line
11	Hose to charge air intake line
12	Non-return valve
13	Pressure regulating valve
14	Throttle valve
15	Non-return valve
16	Passages in cylinder head and cylinder head cover

Note: If a customer complains about high oil consumption and oil is discovered in the turbocharger, it should not be immediately assumed that the turbocharger is defective. If the oil is present in the fresh air pipe (before the turbocharger) then the entire engine should be checked.

Valvetrain

The following graphic shows the design of the cylinder head on the N55 engine with Valvetronic III and direct fuel injection.

N55, overview of valvetrain



Note: Notice the hollow, lightweight design of the camshafts (7) and the blow-by passages leading into the intake ports (15).

Index	Explanation
1	VANOS unit, intake camshaft
2	VANOS unit, exhaust camshaft
3	Injector well
4	Spark plug well
5	Camshaft housing
6	Valvetronic servomotor
7	Inlet camshaft
8	Torsion spring
9	Gate
10	Eccentric shaft
11	Intermediate lever
12	Roller lever tappet
13	Valve head
14	Oil spray nozzle
15	Passages for introducing blow-by gas into the intake ports

Intake and Exhaust Valves

The valve stems have a diameter of 5 mm on the intake valve and 6 mm on the exhaust valve. The larger diameter exhaust valve are hollow and filled with sodium. In addition, the valve seat of the exhaust valves are reinforced.

Valve Springs

The valve springs are different for the intake side and exhaust side.

Camshafts

Lightweight camshafts as well as cast camshafts or a mixture of both were installed in N54 engines. Only lightweight construction camshafts are used on the N55 engine. The lightweight camshafts for the N55 are manufactured in an internal high pressure forming process called hydroforming. The exhaust camshaft features bearing races and is encapsulated in a camshaft housing. The camshaft housing reduces oil foaming during operation.

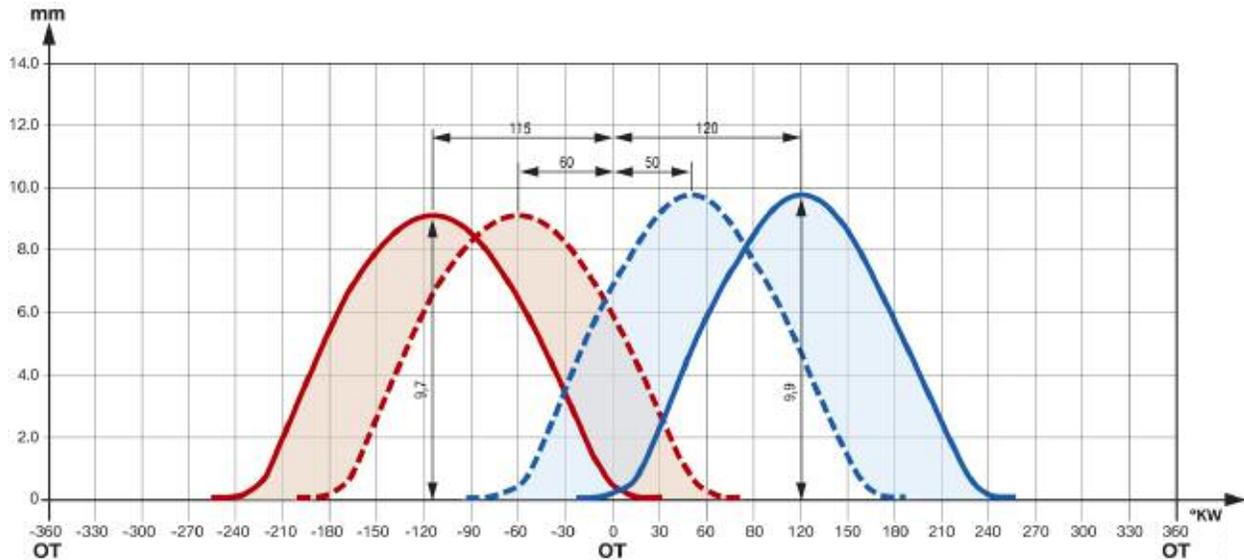
N55, assembled camshaft



Index	Explanation
1	Shell-shaped cam
2	Corrugated tube

Valve Timing

N55 valve timing diagram

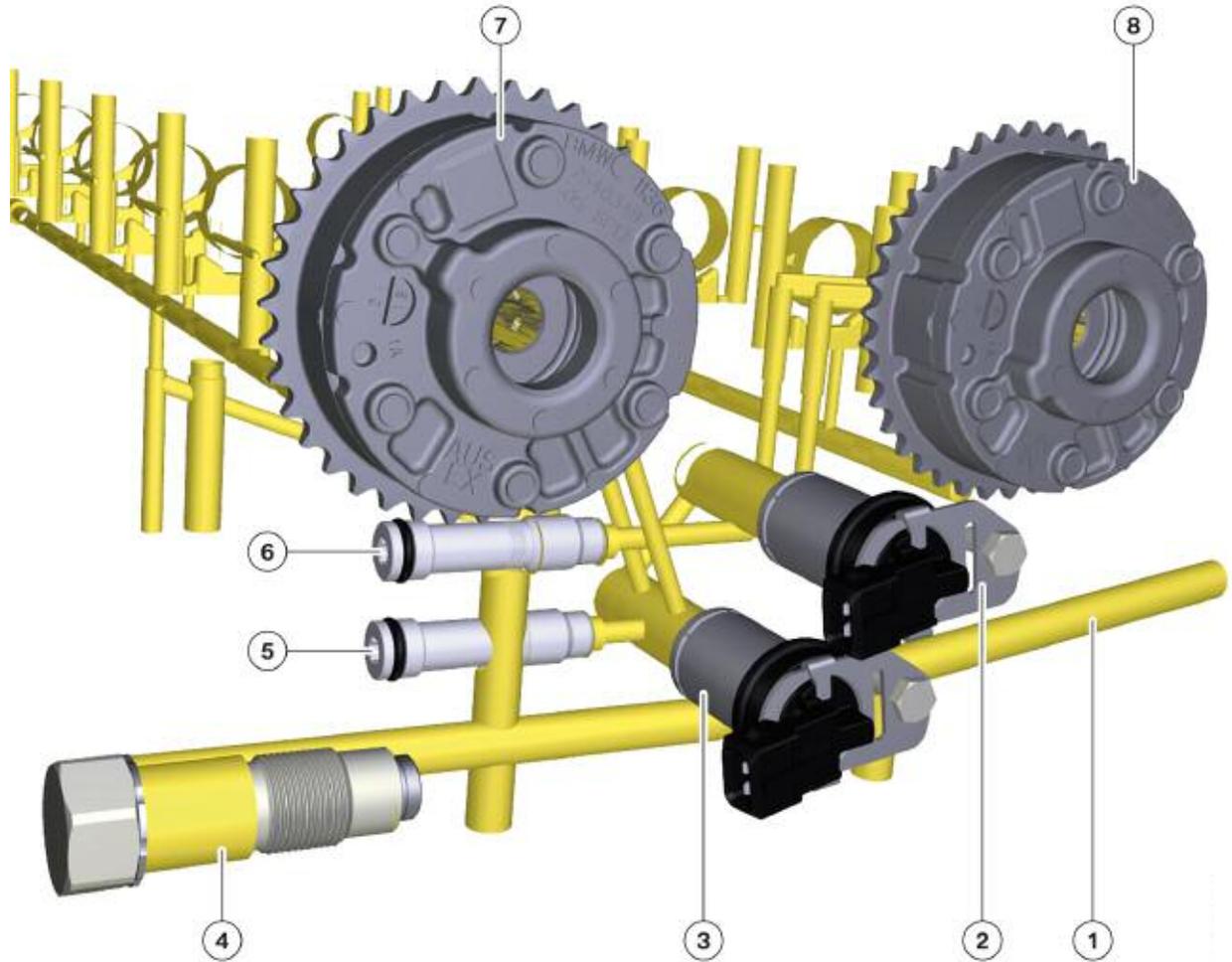


		N54B3000	N55B30M0
Intake valve Ø	[mm]	31.4	32
Exhaust valve Ø	[mm]	28	28
Maximum valve lift, intake valve/exhaust valve	[mm]	9.7/9.7	9.9/9.7
Intake camshaft spread (VANOS adjustment range)	[°crankshaft]	55	70
Exhaust camshaft spread (VANOS adjustment range)	[°crankshaft]	45	55
Intake camshaft opening angle (max.-min. spread)	[°crankshaft]	125 - 70	120 - 50
Exhaust camshaft opening angle (max.-min. spread)	[°crankshaft]	130 - 85	115 - 60
Opening period intake camshaft	[°crankshaft]	245	255
Opening period exhaust camshaft	[°crankshaft]	261	261

Note: The N55 has a larger intake and exhaust VANOS adjustment range as well as larger intake valve lift, and cam duration than the N54 engine.

VANOS System

N54, VANOS with oil supply

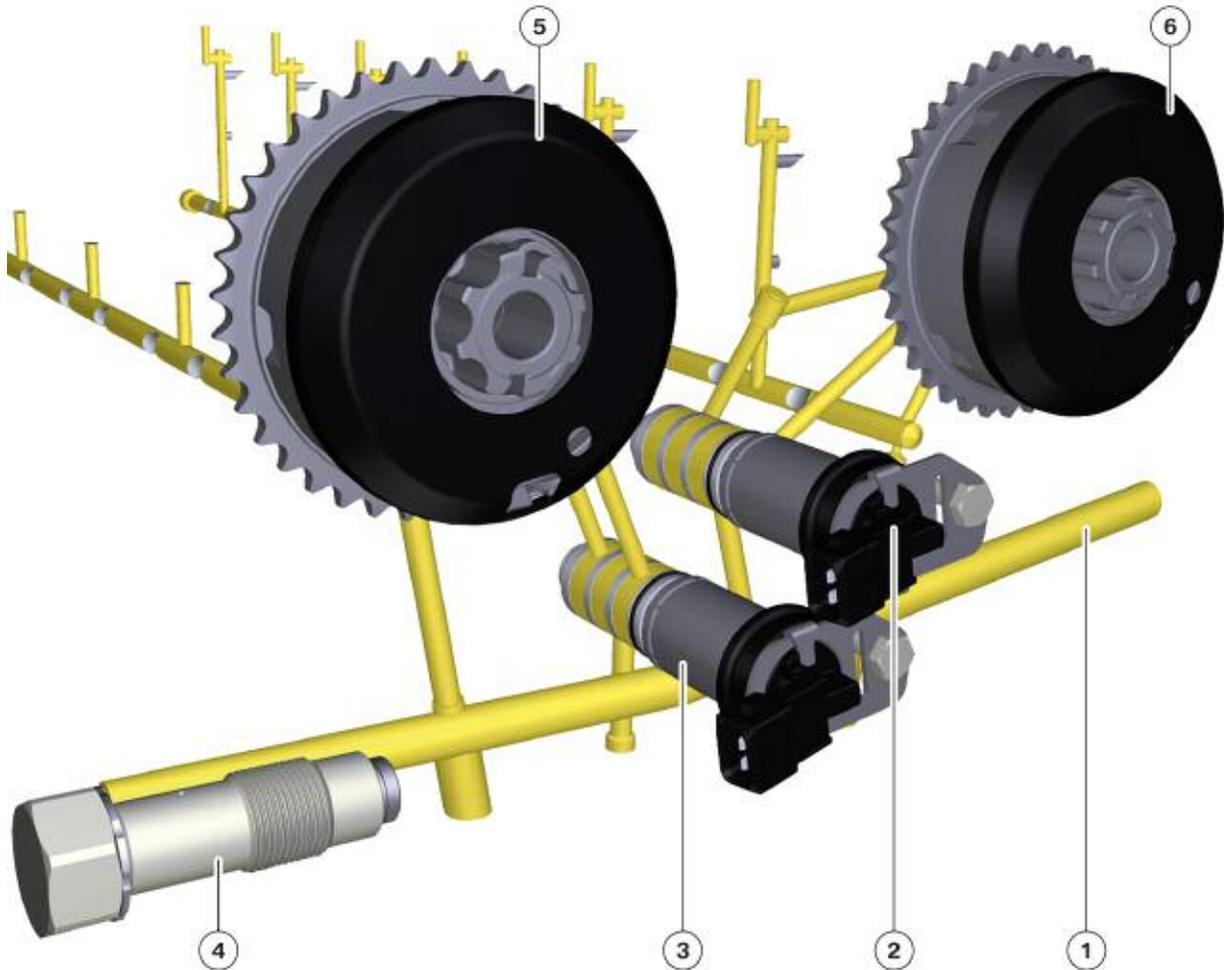


Index	Explanation
1	Main oil duct
2	VANOS solenoid valve, intake side
3	VANOS solenoid valve, exhaust side
4	Chain tensioner
5	Non return valve, exhaust side
6	Non return valve, intake side
7	VANOS adjustment unit, exhaust side
8	VANOS adjustment unit, intake side

Overview

The VANOS system has been optimized to provide even faster adjustment speeds of the VANOS units. The aluminum VANOS units are much lighter and are also less susceptible to soiling. It can be seen by comparing the N54 VANOS system with the N55 VANOS that fewer oil passages are required and that the non-return valves are no longer on the cylinder head but rather incorporated into the solenoid valves on N55.

N55, VANOS with oil supply



Index	Explanation
1	Main oil duct
2	VANOS solenoid valve, intake side
3	VANOS solenoid valve, exhaust side
4	Chain tensioner
5	VANOS adjustment unit, exhaust side
6	VANOS adjustment unit, intake side

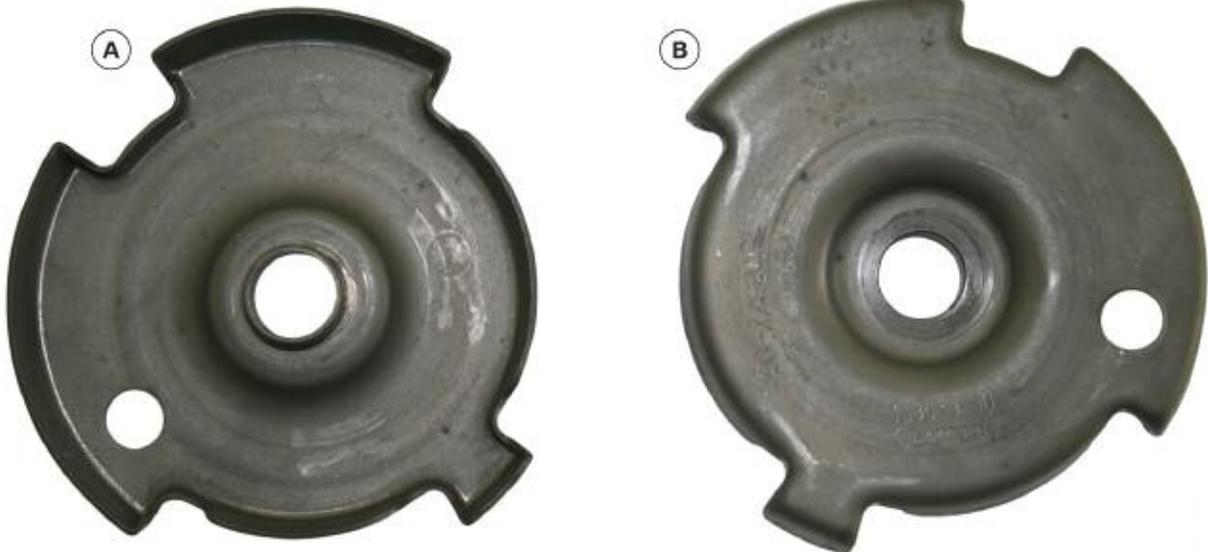
VANOS Solenoid Valves

The non-return valve with screen filter used on the N54 engine have now been integrated in the VANOS solenoid valves on the N55 engine. This measure has made it possible to reduce the number of oil ducts in the cylinder head. The screen filters on the VANOS solenoid valve ensure trouble-free operation and reliably prevent the VANOS solenoid valve from sticking due to dirt particles.

Cam Sensor Wheels

The sensor wheels are now “deep-drawn” sheet metal components and no longer made from two parts. This design increases production accuracy while reducing manufacturing costs.

N55, camshaft sensor wheel



Index	Explanation
A	Rear View
B	Front view

Valvetronic III

The main differences between Valvetronic III and Valvetronic II are in the arrangement of the Valvetronic servomotor and the Valvetronic sensor. As in Valvetronic II, the turbulence level is increased at the end of the compression cycle for the purpose of optimizing the mixture formation with the use of phasing and masking measures. This movement of the cylinder charge improves the combustion during partial load operation and in catalytic converter heating mode. The quench areas also contribute to mixture formation.

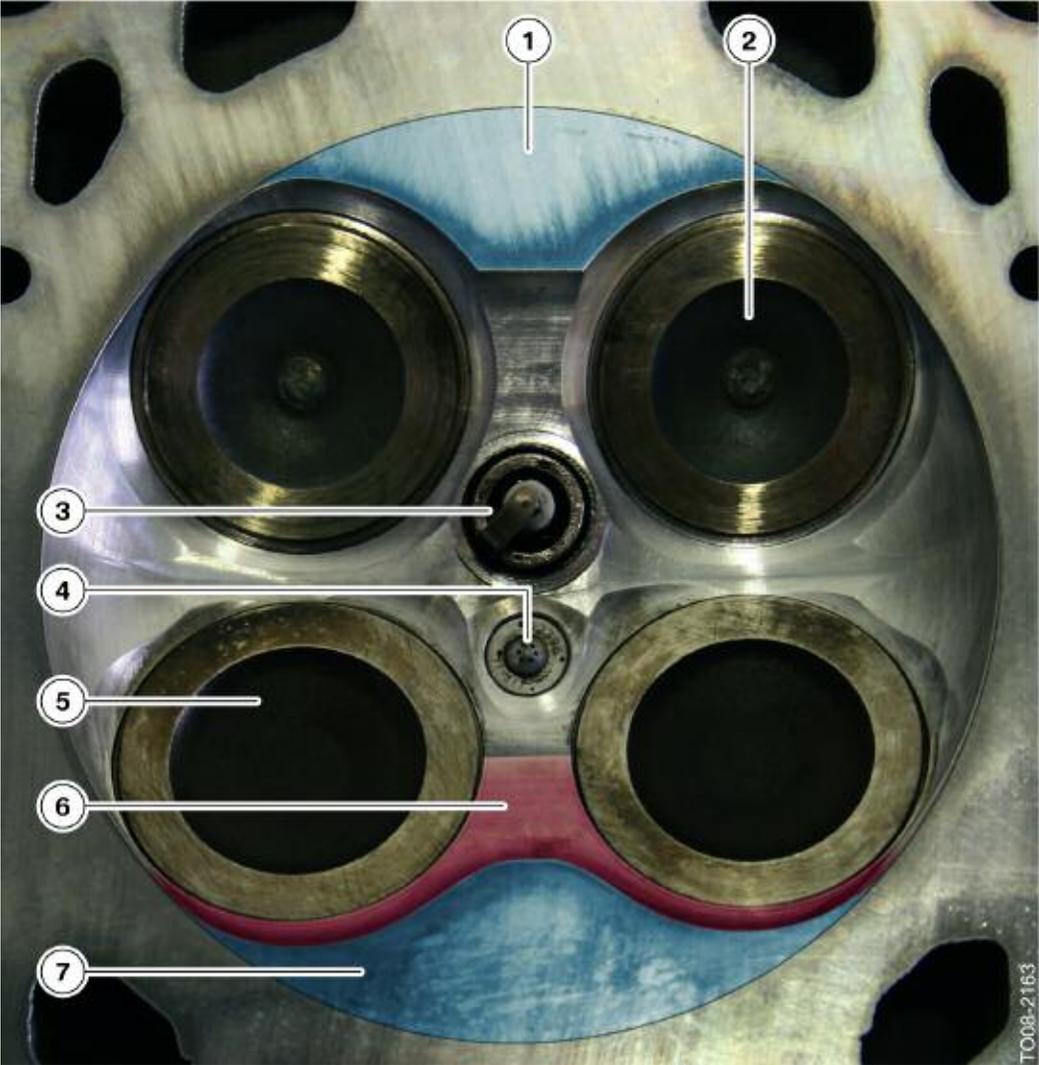
Phasing

Phasing results in a lift difference between both intake valves of up to 1.8 mm in the lower partial load range. Consequently, the flow of fresh air is distributed asymmetrically.

Masking

Masking refers to the design of the valve seats. This machining ensures that the incoming fresh air is aligned in such a way as to give rise to the required cylinder charge movement. The advantage of this measure is that the combustion retardation is reduced by approximately 10° of crankshaft rotation. The combustion process takes place faster and a larger valve overlap can be achieved, thus considerably reducing NOx emissions.

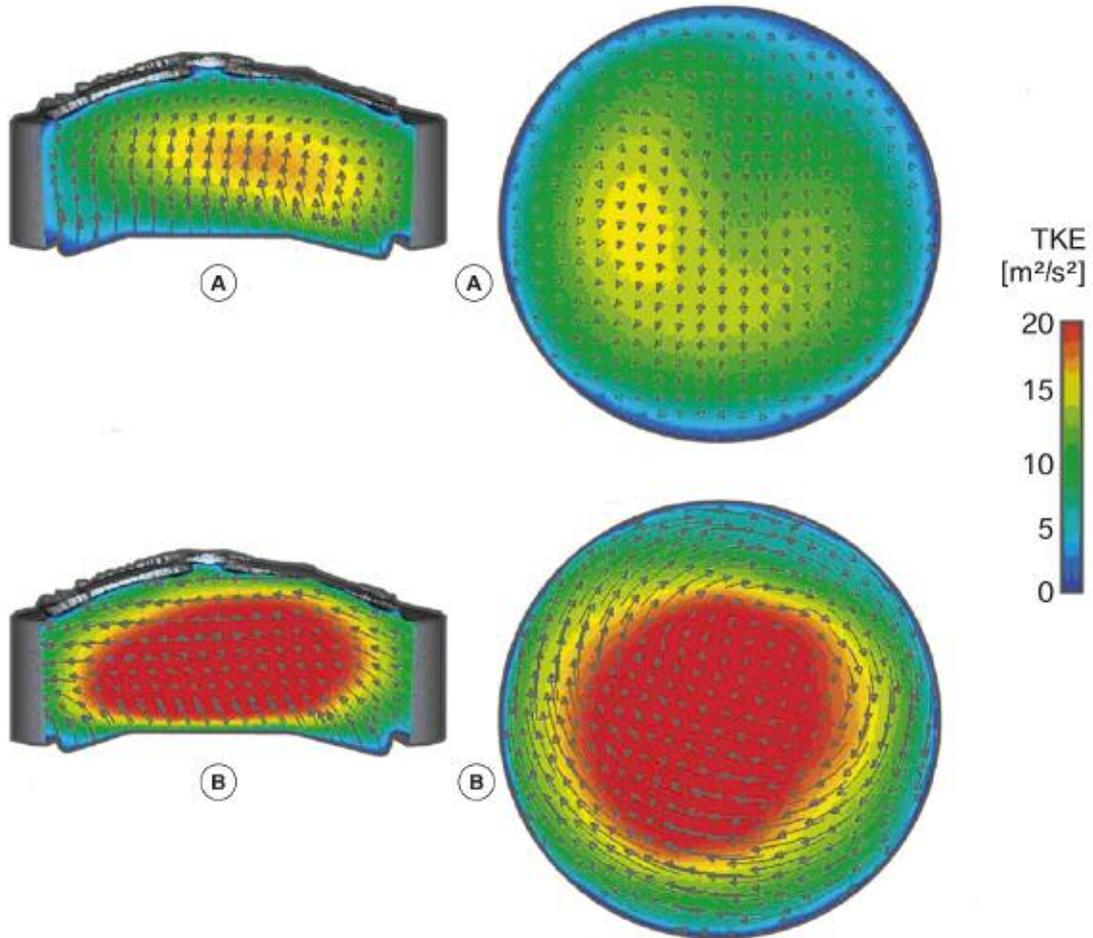
N55, Top of the combustion chamber



Index	Explanation
1	Quench area
2	Exhaust valves
3	Spark plug
4	Fuel injector
5	Intake valve
6	Masking
7	Quench area

The following graphic shows the effect of the previously described measures. These measures achieve improved and faster combustion in the red area. Technically, this is known as the turbulent kinetic energy.

Influence of phasing and masking on flow in the combustion chamber



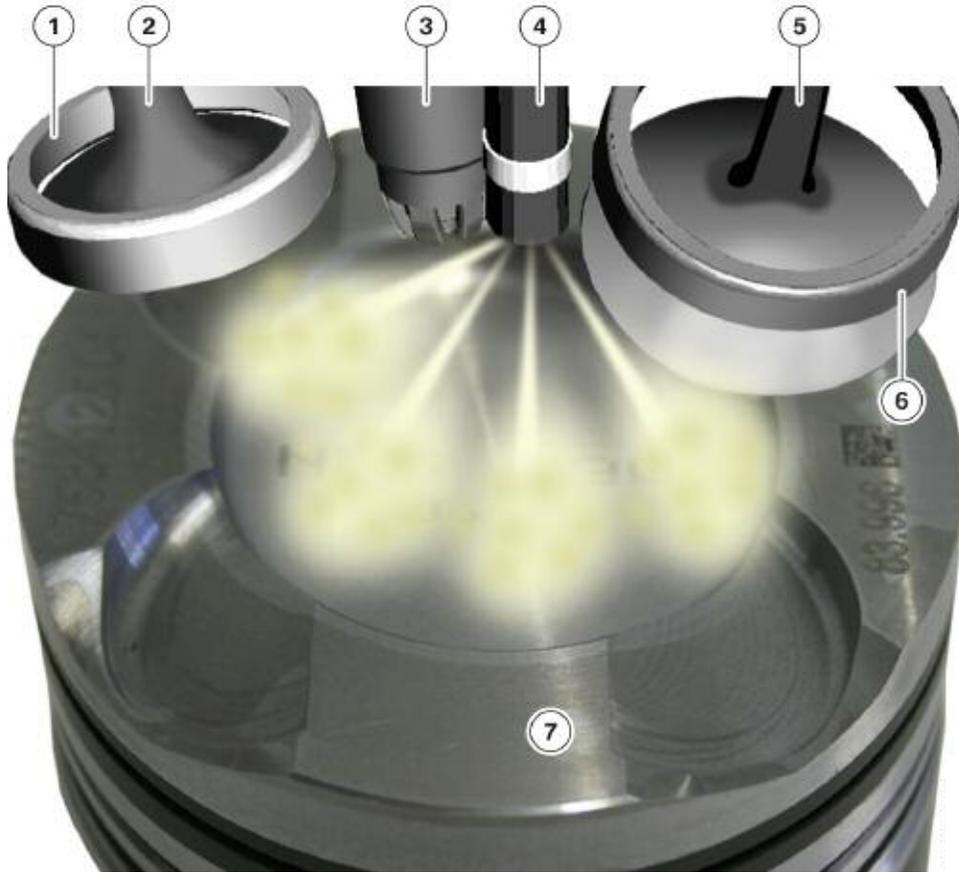
Index	Explanation
A	Valvetronic I
B	Valvetronic II and III with Phasing and masking
TKE	Turbulent kinetic energy

Engine response is improved by the combination of Valvetronic III, direct injection and turbocharging. The response up to naturally aspirated full load is shortened on a naturally aspirated engine with Valvetronic as there is now no need wait for the intake air manifold to be filled. The subsequent torque buildup as the turbocharger starts up can be accelerated with the partial lift setting at low engine speed. This effectively flushes out residual gas, thus resulting in faster torque build-up.

Combustion Chamber Geometry

The following graphic shows the arrangement of the individual components in the combustion chamber. It can be seen that the BMW (spray-guided) high precision injection (HPI) system is not used but rather a Bosch solenoid valve fuel injector with multi-hole nozzle. The fuel injection is specially adapted to the combination of Valvetronic III and turbocharging. For better illustration, a set of valves has been removed in the graphic.

N55, combustion chamber with components

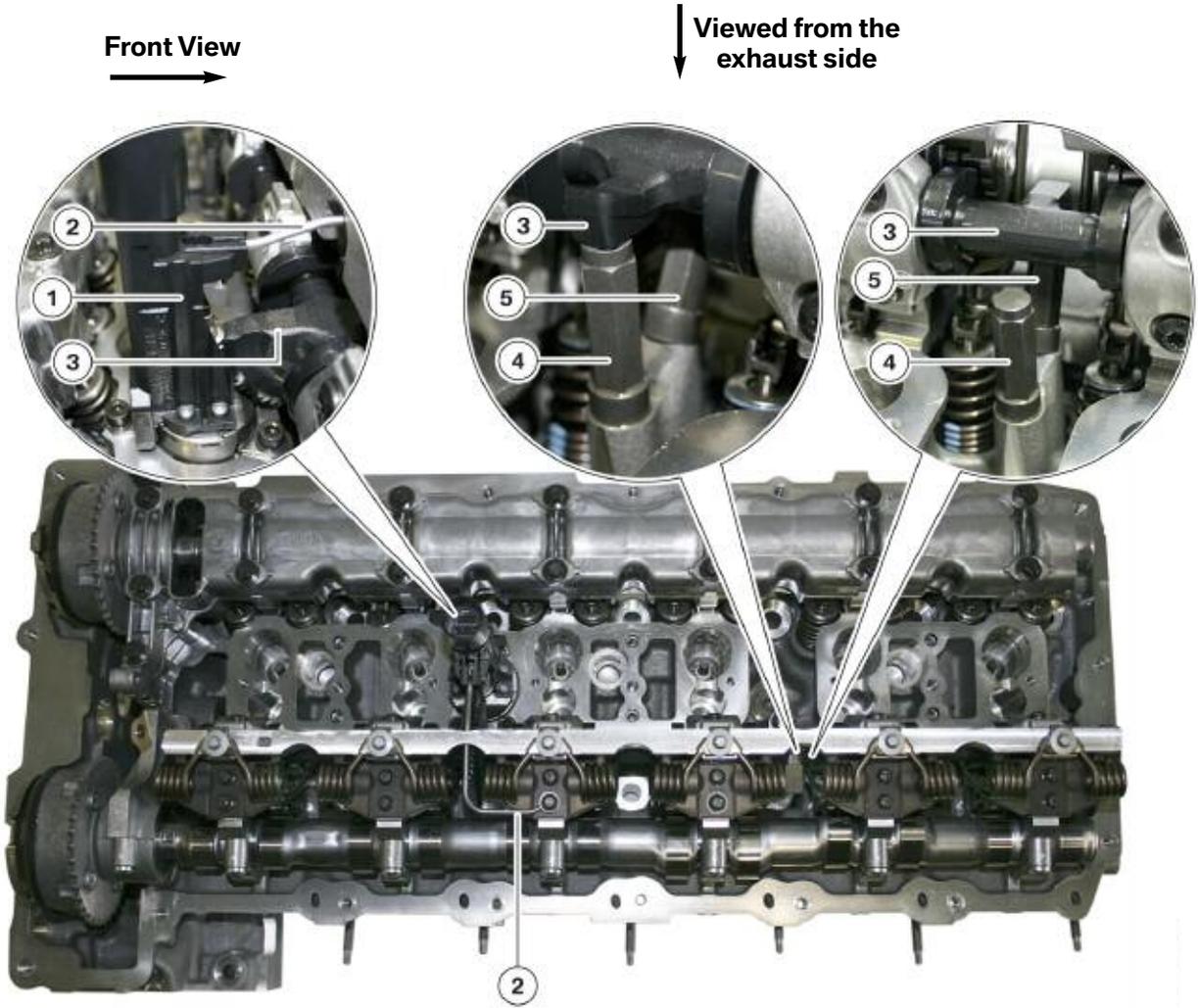


Index	Explanation
1	Valve seat, exhaust valve
2	Exhaust valve
3	Spark plug
4	Fuel injector
5	Intake valve
6	Valve seat, intake valve

Valve Lift Adjustment Overview

As can be seen from the following graphic, the installation location of the servomotor has changed with Valvetronic III. Another new feature is that the eccentric shaft sensor is no longer mounted on the eccentric shaft but has been integrated into the servomotor.

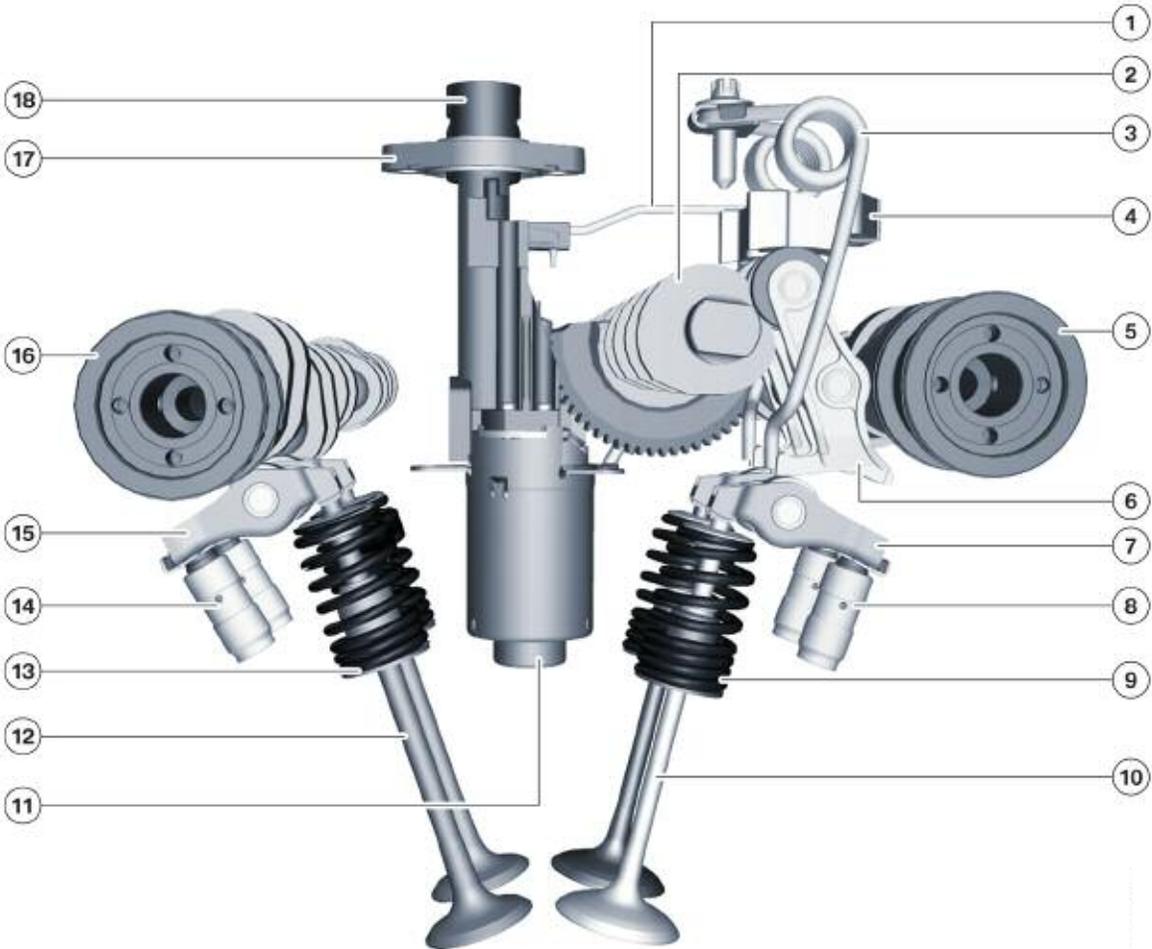
N55, valve lift adjustment



Index	Explanation
1	Valvetronic servomotor
2	Oil spray nozzle
3	Eccentric shaft
4	Eccentric shaft minimum stop
5	Eccentric shaft maximum stop

The Valvetronic III servomotor contains a sensor for determining the position of the motor and the eccentric shaft. The servomotor is lubricated with engine oil by means of an oil spray nozzle (1) aimed directly at the worm drive and the eccentric shaft mechanism.

N55, design of valve lift adjustment



Index	Explanation	Index	Explanation
1	Oil spray nozzle	10	Intake valve
2	Eccentric shaft	11	Valvetronic servomotor
3	Return spring	12	Exhaust valve
4	Gate block	13	Valve spring
5	Inlet camshaft	14	Hydraulic valve lash adjustment
6	Intermediate lever	15	Roller cam follower, exhaust
7	Roller cam follower, intake	16	Exhaust camshaft
8	Hydraulic valve lash adjustment	17	Sealing sleeve
9	Valve spring	18	Socket

Valvetronic Servomotor

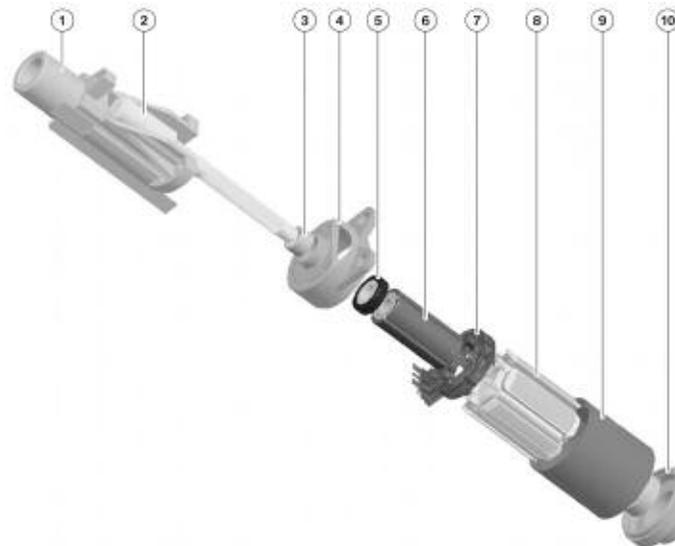
A brushless direct current motor (BLDC motor) is used. The BLCD motor is maintenance-free and very powerful, due to the contactless energy transfer system. The use of integrated electronic modules ensures precision control.

The Valvetronic servomotor has the following special features:

- Open concept (engine oil is directly supplied to the motor).
- The eccentric shaft angle is determined by angle increments from the integrated sensor system.
- Power consumption is reduced by about 50%.
- Higher actuating dynamics (e.g. cylinder-selective adjustment, idle speed control, etc.).
- Lightweight design is approximately 600 grams.

Function

Actuation of the Valvetronic servomotor is limited to a maximum of 40 amps. A maximum of 20 amps are available over a period of > 200 milliseconds. The Valvetronic servomotor is actuated by a pulse width modulated signal. The duty cycle is between 5% and 98%.

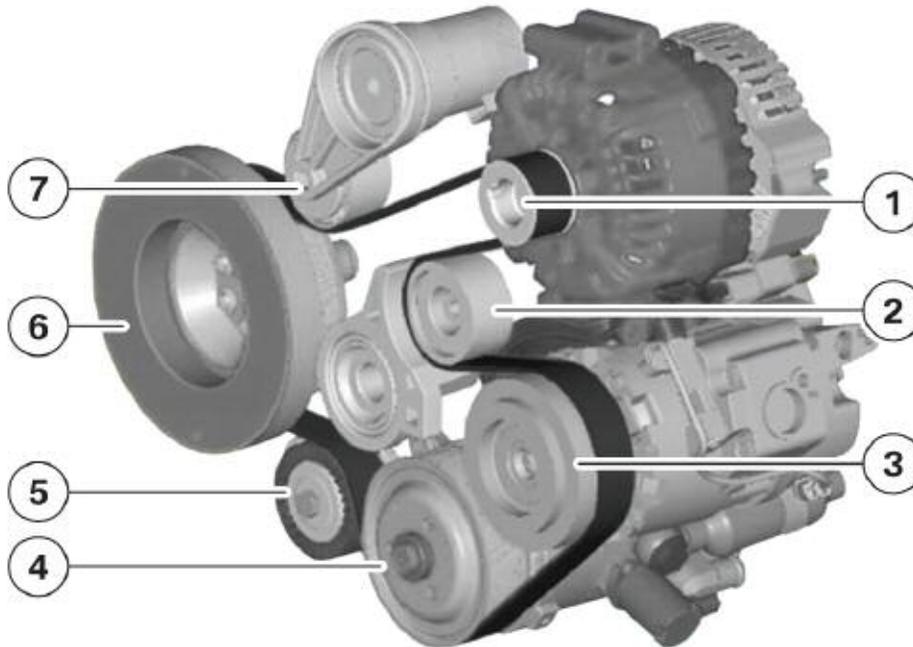


Index	Explanation	Index	Explanation
1	Socket	6	Rotor with four magnets
2	Worm shaft	7	Sensor
3	Needle bearing	8	Stator
4	Bearing cover	9	Housing
5	Magnetic sensor wheel	10	Bearing

Belt Drive and Auxiliary Components

The belt drive has two deflection pulleys and one double ribbed belt.

N55, Belt drive

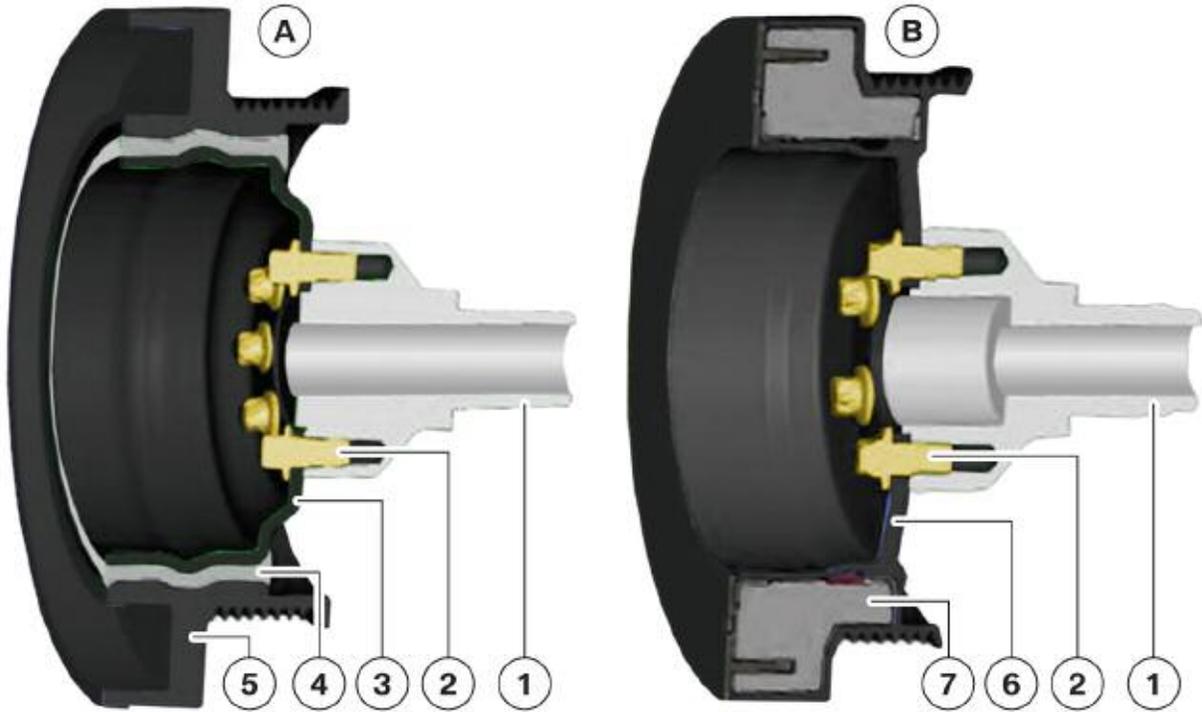


Index	Explanation	Index	Explanation
1	Belt pulley, alternator	5	Deflection pulley
2	Deflection pulley	6	Vibration absorber with belt pulley
3	Belt pulley, A/C compressor	7	Belt tensioner
4	Belt pulley, power steering pump		

Vibration Damper

A single-mass vibration damper is used on the N55 engine. The belt pulley is mounted on the secondary pulley. Compared to the N54 engine, this design layout additionally reduces the belt load as the vulcanization decouples the belt pulley with flywheel mass from the crankshaft.

N54, vibration damper



Index	Explanation
A	Vibration damper, N55 engine
B	Vibration damper, N54 engine
1	Crankshaft
2	Bolts
3	Primary pulley
4	Vulcanization
5	Secondary belt pulley with flywheel mass
6	Primary belt pulley
7	Flywheel mass

N55, vibration damper



Index	Explanation
1	Secondary belt pulley with flywheel mass
2	Flange
3	Vulcanization

Air Intake and Exhaust System

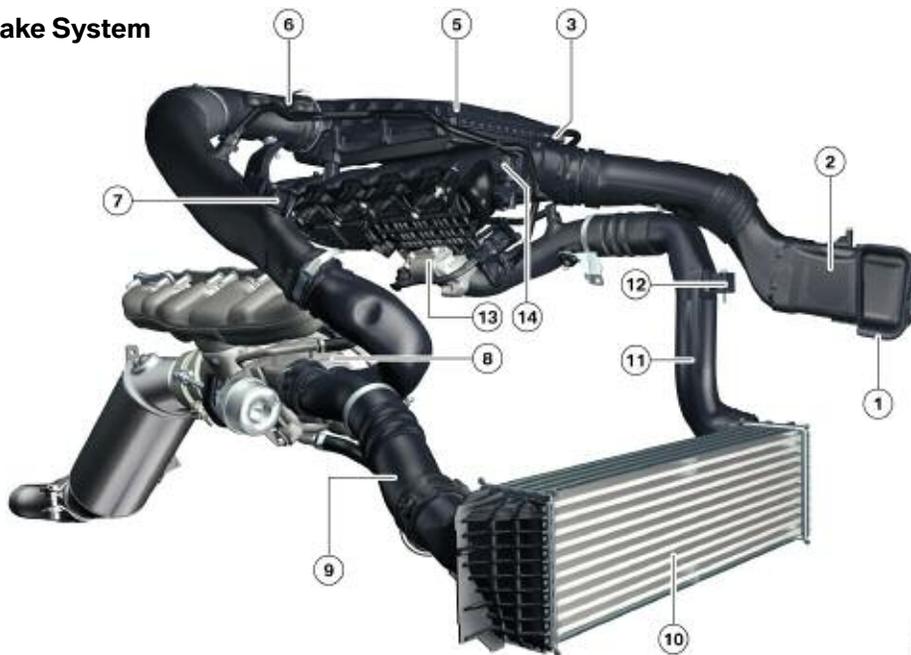
Air Intake System

Several functions of the air intake system have been optimized for the N55 engine:

- The unfiltered air is routed up to the intake silencer (similar to the N54 engine).
- The filtered air duct is completely new and simplified to accommodate the new turbocharger.
- The crankcase ventilation system has been redesigned.
- The diverter valve has been integrated into the compressor housing of the turbocharger.
- The fuel tank ventilation has been correspondingly adapted.

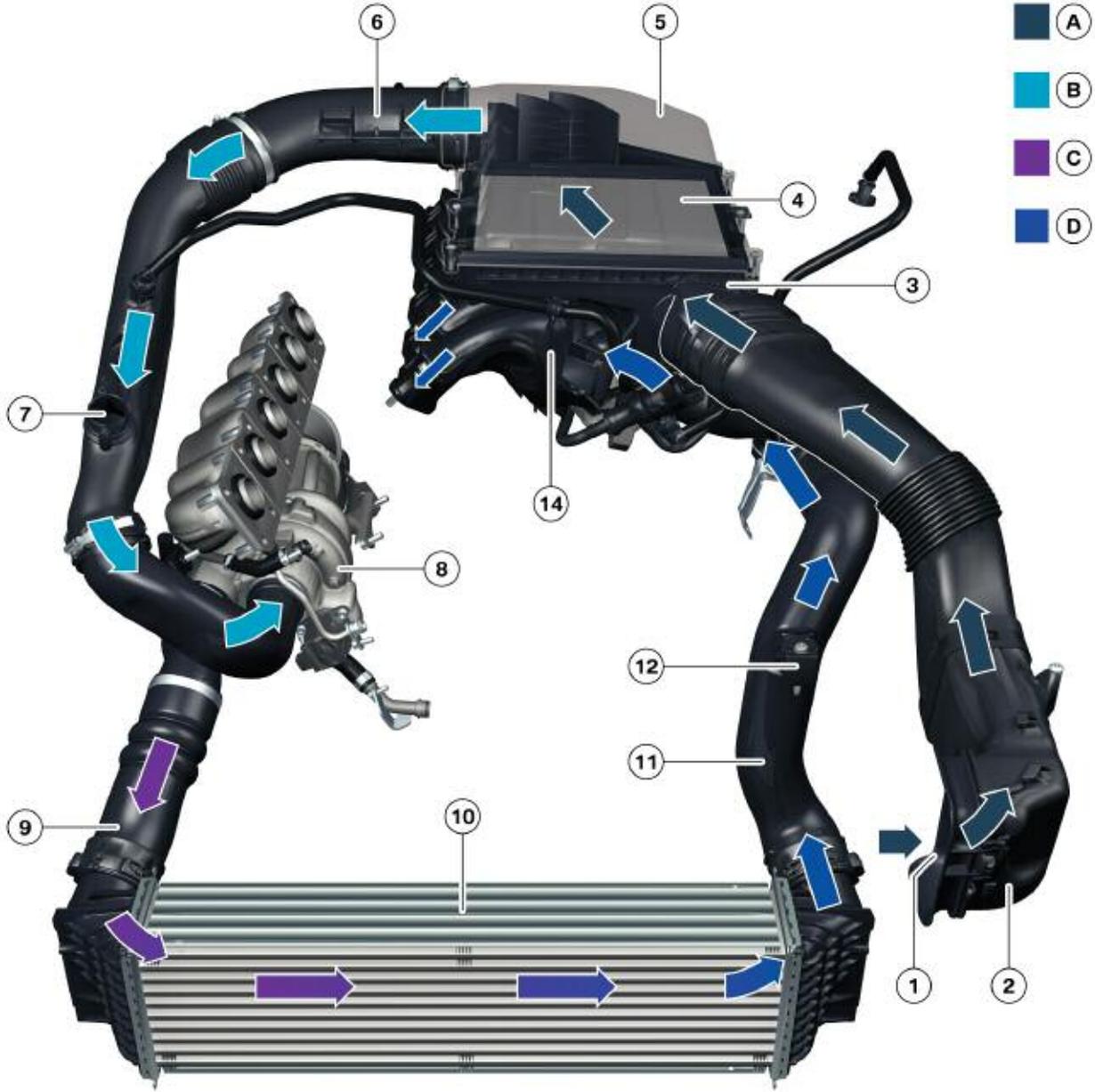
The design layout of the air intake system has been simplified, compared to the dual turbocharger set up of the N54.

N55, Air Intake System



Index	Explanation	Index	Explanation
1	Intake snorkel	9	Charge-air pipe
2	Unfiltered air pipe	10	Intercooler
3	Intake silencer	11	Charge-air pipe
5	Air intake silencer cover	12	Boost pressure-temperature sensor
6	Hot-film air mass meter	13	Throttle valve
7	Crankcase ventilation connection	14	Intake manifold
8	Exhaust turbocharger		

N55, Air Intake and Exhaust System



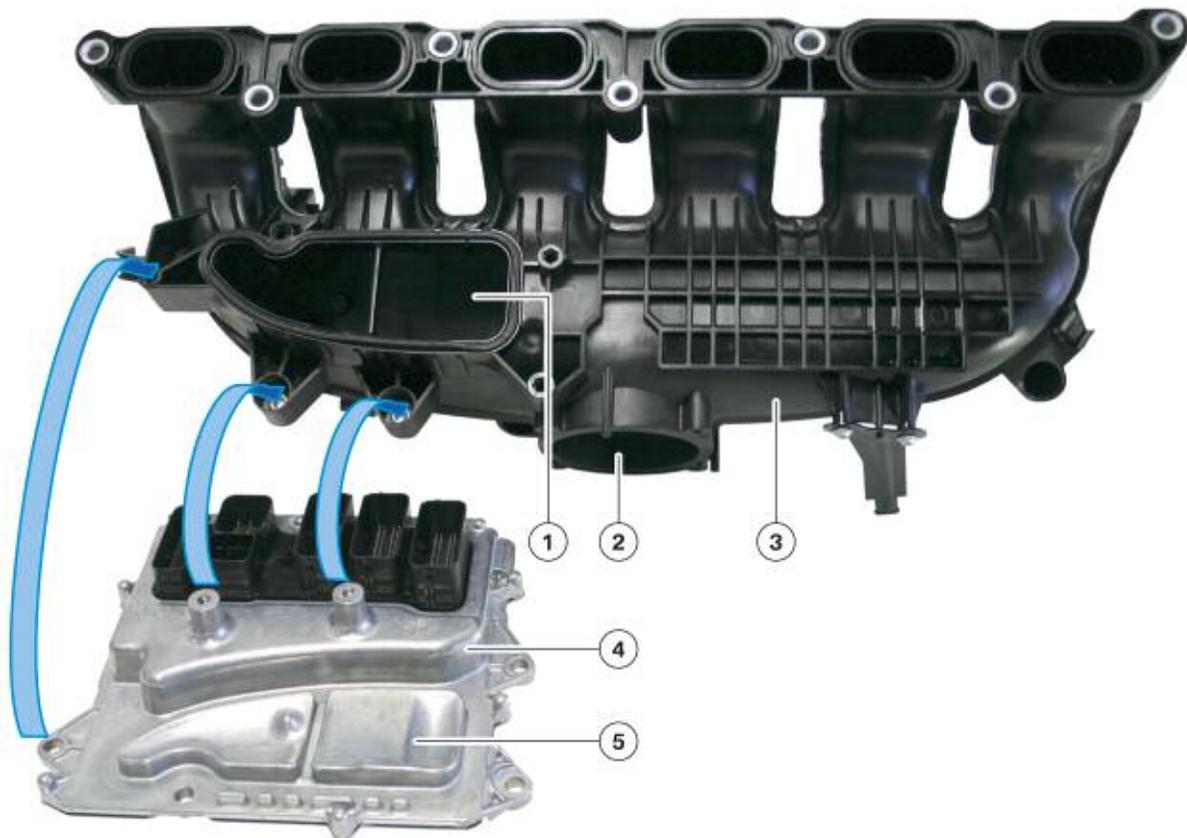
Index	Explanation
A	Unfiltered air
B	Purified air
C	Heated charge air
D	Cooled charge air
1	Intake snorkel
2	Unfiltered air pipe
3	Intake silencer
4	Filter element
5	Air intake silencer cover
6	Hot-film air mass meter
7	Crankcase ventilation connection
8	Exhaust turbocharger
9	Charge-air pipe
10	Intercooler
11	Charge air pipe
12	Boost pressure-temperature sensor
14	Intake air manifold

Intake Manifold

The engine control unit is mounted on the intake manifold. The intake air is used to cool the engine control unit.

Thanks to this arrangement, the engine comes down the assembly line completely assembled with the control unit, the sensors, and actuators already connected.

N55, intake system with DME control unit



Index	Explanation	Index	Explanation
1	Mounting flange for engine control unit cooling	4	Engine control unit
2	Mounting flange for throttle valve	5	Cooling fins
3	Air intake system		

Fuel Tank Ventilation System

The fuel vapors are stored in a charcoal canister and then fed via the fuel tank vent valve to the combustion process. It was also necessary to adapt this system to all the given conditions related to turbocharging.

N55, fuel tank ventilation system

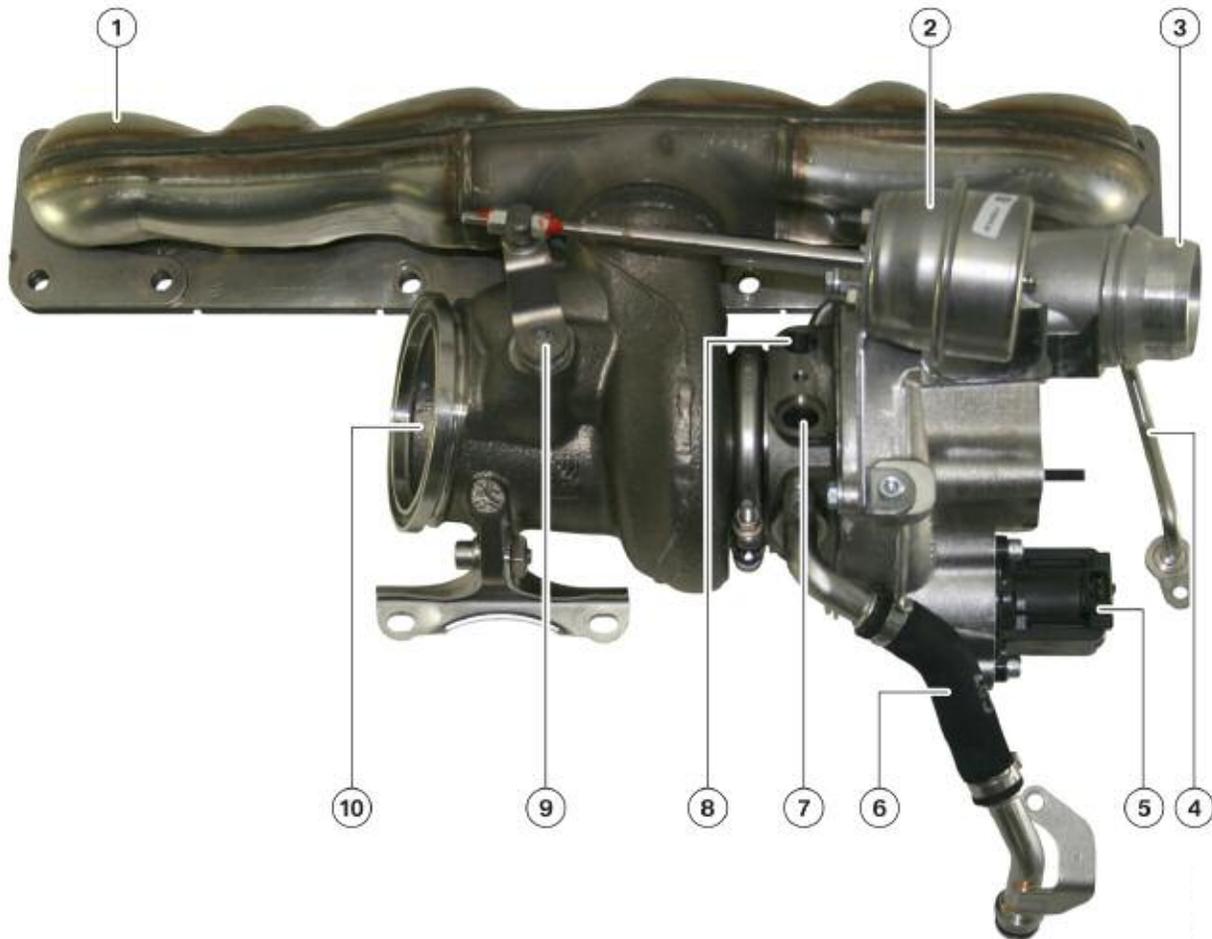


Index	Explanation
1	Connection to ventilation line from charcoal canister
2	Connection upstream of throttle valve
3	Fuel tank vent valve
4	Connection downstream of throttle valve
5	Connection upstream of turbocharger

Exhaust Manifold

The exhaust manifold is air-gap insulated and designed as a six ports into two chamber manifold. Dividing six exhaust ports into two exhaust chambers is necessary in order to ensure optimum flow to the twin scroll turbocharger. The exhaust pulses from the first three cylinders (1-3) feed one scroll (duct 1) of the turbo, while the last three (4-6) feed the second scroll (duct 2). The exhaust manifold and turbocharger are welded together to form one component.

N55, attachment of exhaust manifold and turbocharger to engine block

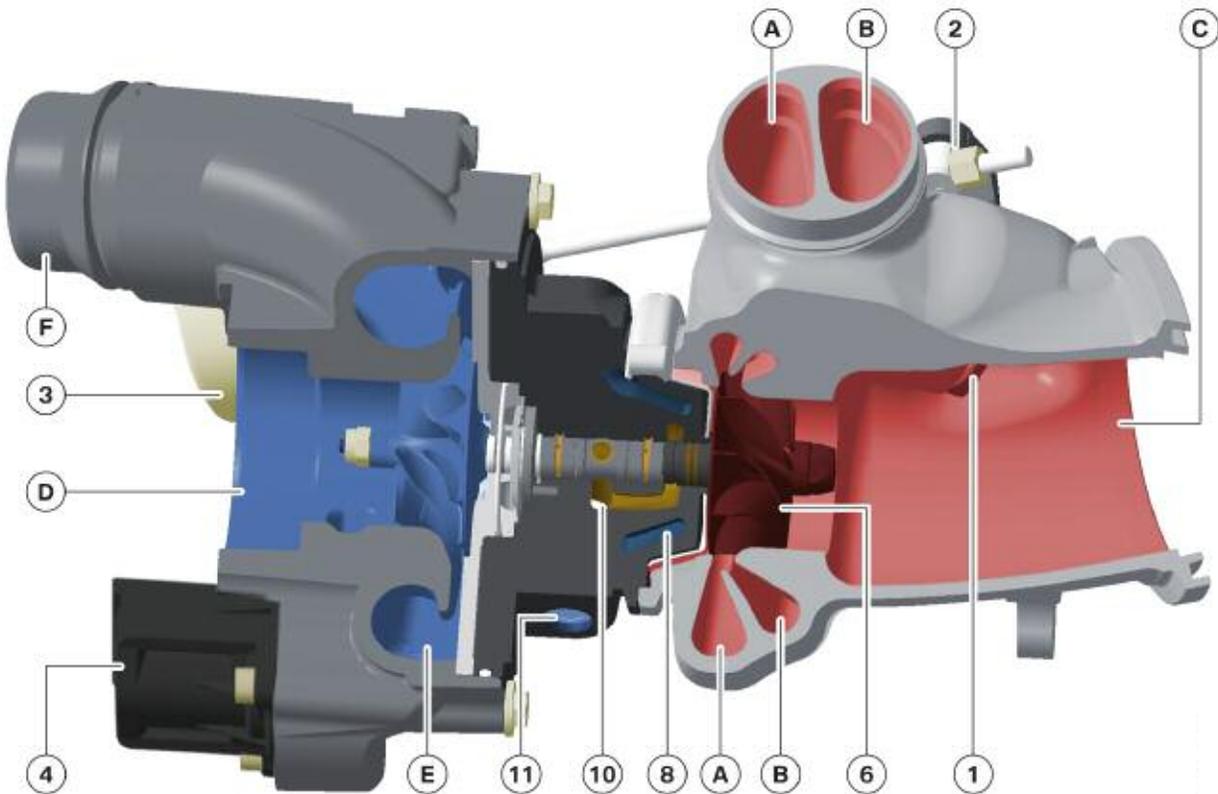


Index	Explanation	Index	Explanation
1	Exhaust manifold	6	Oil return line
2	Vacuum unit	7	Coolant infeed
3	Connection to intercooler	8	Coolant return
4	Oil feed line	9	Shaft, wastegate valve
5	Diverter valve	10	Connection to exhaust system

Turbocharger

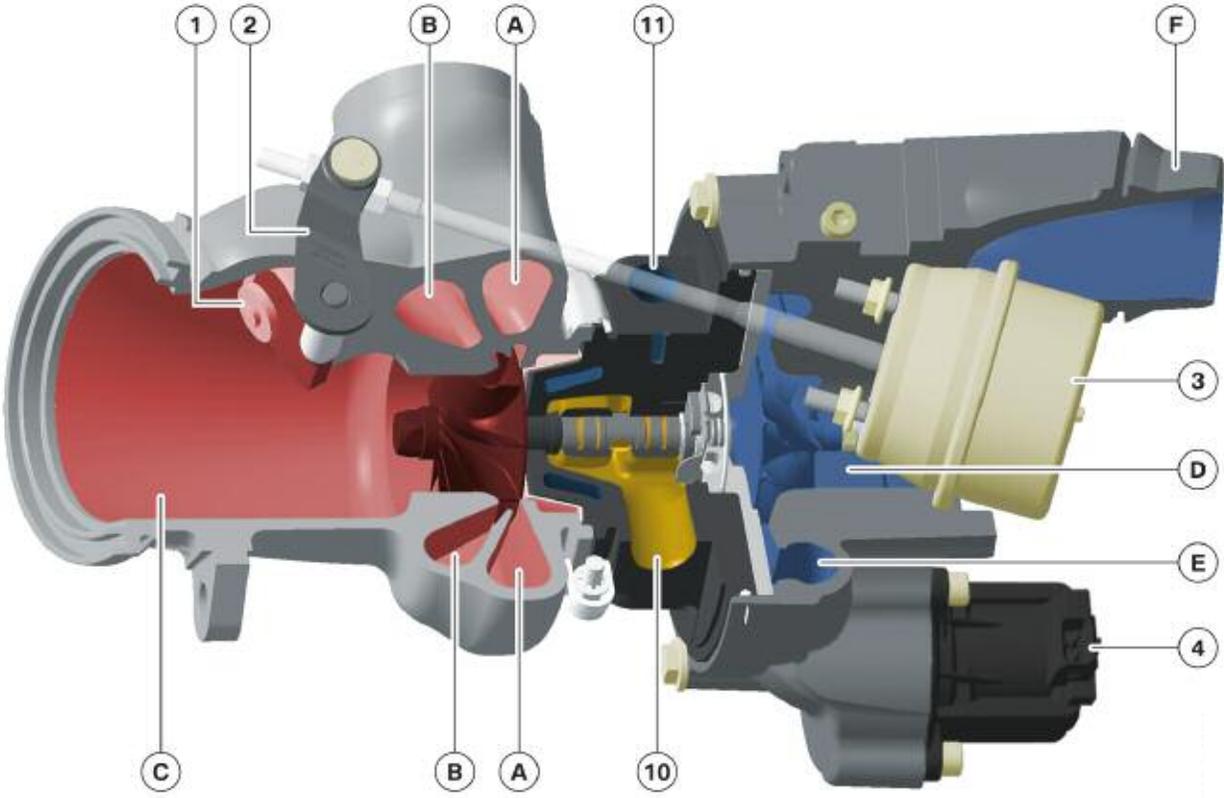
The N55 is equipped with a single twin scroll turbocharger instead of two separate small turbochargers as on the N54 engine. The following graphics shows the operating principle of the twin scroll turbocharger.

Twin scroll turbocharger rear view



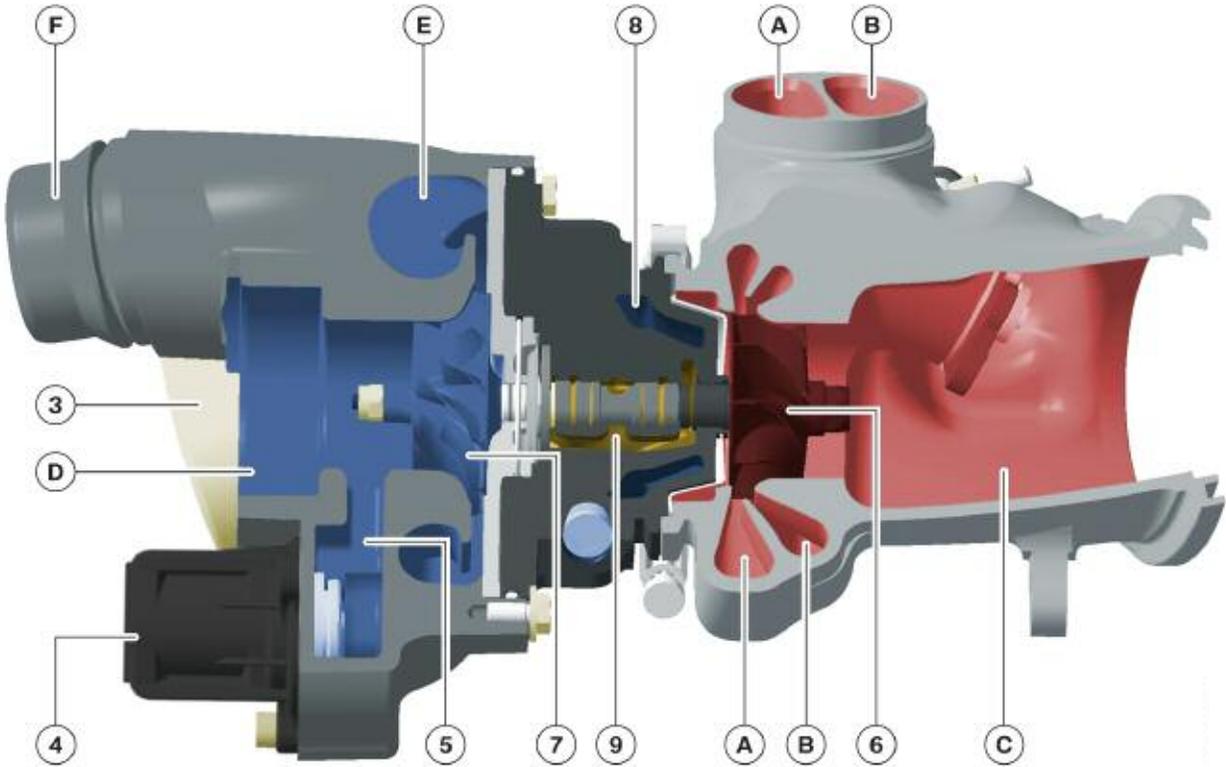
Index	Explanation	Index	Explanation
A	Exhaust duct 1 (cylinders 1 - 3)	2	Lever arm, wastegate valve
B	Exhaust duct 2 (cylinders 4 - 6)	3	Vacuum unit for wastegate valve
C	Connection to catalytic converter	4	Diverter valve
D	Inlet from intake silencer	6	Turbine wheel
E	Ring channel	8	Cooling duct
F	Outlet to intercooler	10	Oil return
1	Wastegate valve	11	Coolant return

Twin scroll turbocharger front view



Index	Explanation	Index	Explanation
A	Exhaust duct 1 (cylinders 1 - 3)	1	Wastegate valve
B	Exhaust duct 2 (cylinders 4 - 6)	2	Lever arm, wastegate valve
C	Connection to catalytic converter	3	Vacuum unit for wastegate valve
D	Inlet from intake silencer	4	Diverter valve
E	Ring channel	10	Oil return
F	Outlet to intercooler	11	Coolant return

Twin scroll turbocharger



Index	Explanation	Index	Explanation
A	Exhaust duct 1 (cylinders 1 - 3)	3	Vacuum unit for wastegate valve
B	Exhaust duct 2 (cylinders 4 - 6)	4	Diverter valve
C	Connection to catalytic converter	5	By-pass
D	Inlet from intake silencer	6	Turbine wheel
E	Ring channel	7	Compressor wheel
F	Outlet to intercooler	8	Cooling duct
1	Wastegate valve	9	Turbine shaft
2	Lever arm, wastegate valve		

■ **Function of the twin scroll turbocharger**

The system is designed so that constant exhaust gas pressure is rarely applied to the turbocharger. At low engine speeds, the exhaust reaches the turbine in tuned pulsed form. Due to this pulsation, a higher pressure ratio is temporarily reached in the turbine. Since the efficiency increases as the pressure rises, the pulsation improves the boost pressure progression and thus the torque progression of the engine. This is the case particularly at low engine speeds.

To limit the back pressure and ensure that the individual cylinders do not mutually influence each other during the cylinder charging process, cylinders 1 - 3 (bank 1) and cylinders 4 - 6 (bank 2) are combined to form two exhaust channels. The exhaust gas pulses in the exhaust channels (1 and 2) are directed into two scrolls (spirals) within the turbocharger to drive the turbine wheel. This design layout makes it possible to optimally use the exhaust pulsations for generating boost pressure based on the firing order of the engine. This improves engine efficiency by enhancing throttle response and limiting unwanted turbo lag.

The wastegate valve is used for the purpose of limiting the boost pressure and is already known from previous BMW turbo engines. It is vacuum operated and electronically controlled through a vacuum control solenoid by the DME (ECM).

■ **Diverter valve**

The basic function of the diverter valve remains the same. The difference compared to the N54 engine is that the diverter valve is not operated pneumatically. The diverter valve on the N55 engine is an electric actuator that is controlled directly by the DME. The number of components has been greatly reduced by positioning the diverter valve on the turbocharger compressor housing.

The diverter valve is designed to release unwanted pressure in the intake by connecting the pressure side of the induction system to the inlet side under deceleration. The undesirable peaks in the boost pressure that can occur when the throttle valve is quickly closed are reduced. This means the diverter valve plays an important role in terms of the engine acoustics while protecting the components of the turbocharger.

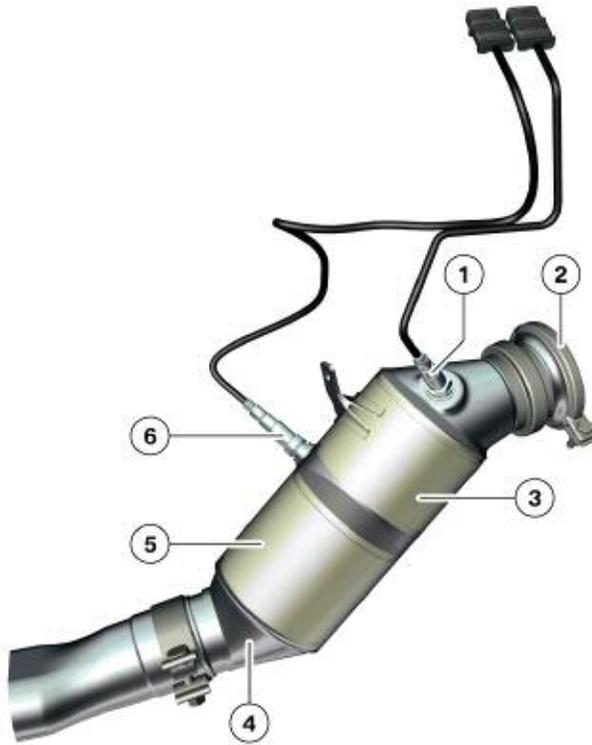
Catalytic Converter

Two ceramic honeycomb structures are contained in the catalytic converter housing. The catalytic converter has a volume of 2.7 liters. Depending on the type of vehicle the ceramic structures have different coatings.

Ceramic structure 1 has a volume of 1.2 liters, a diameter of 125 mm, and contains 600 cells.

Ceramic structure 2 has a volume of 1.5 liters, a diameter of 125 mm, and contains 400 cells.

N55, catalytic converter



Index	Explanation	Index	Explanation
1	Oxygen sensor upstream of catalytic converter	4	Catalytic converter outlet funnel
2	Connection to the turbocharger	5	Ceramic structure 2
3	Ceramic structure 1	6	Oxygen sensor after ceramic structure 1

Exhaust System

With the single twin scroll turbocharger, the design of the exhaust system is less complicated than that of the N54 engine, with two turbochargers. In addition to a “near-engine” catalytic converter design, the exhaust system also features a center silencer and two rear silencers.

N55, exhaust system F07



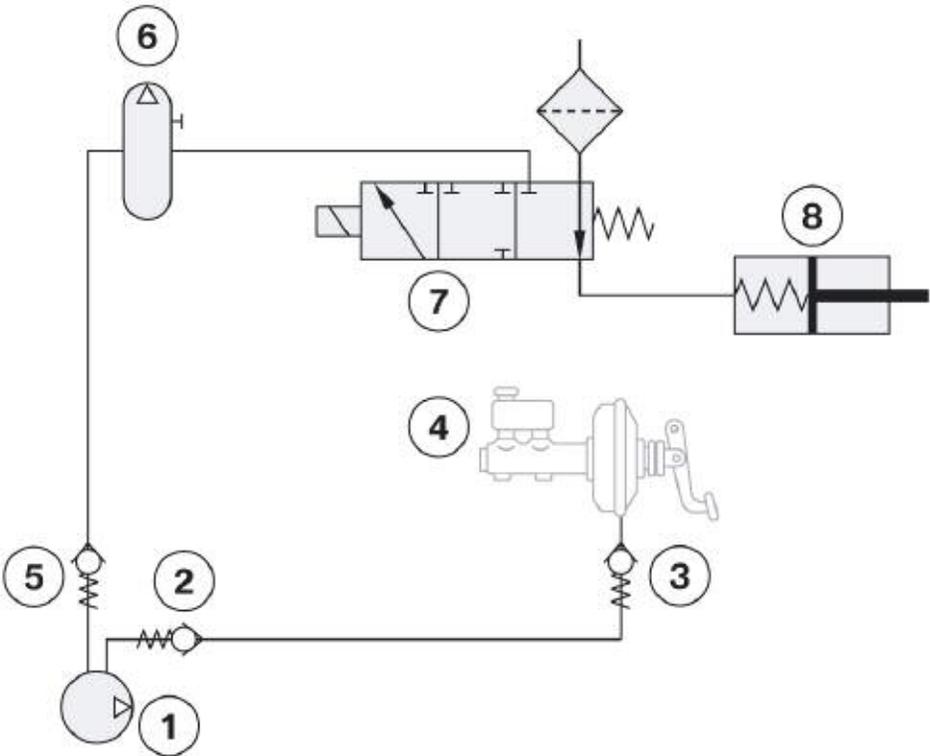
Index	Explanation
1	Exhaust manifold
2	Exhaust turbocharger
3	Catalytic converter
4	Center silencer
5	Rear silencer, right
6	Rear silencer, left

Note: Due to the high efficiency of the “near engine” three way catalytic converter, no additional catalytic converters are necessary.

Vacuum System

The N55 engine is equipped with a vacuum pump for generating the vacuum required by the brake booster and the auxiliary consumers (exhaust flaps and wastegate). A vacuum accumulator (built into the cylinder head cover) is used to ensure there is sufficient vacuum for the wastegate valve at all times.

N55, vacuum system

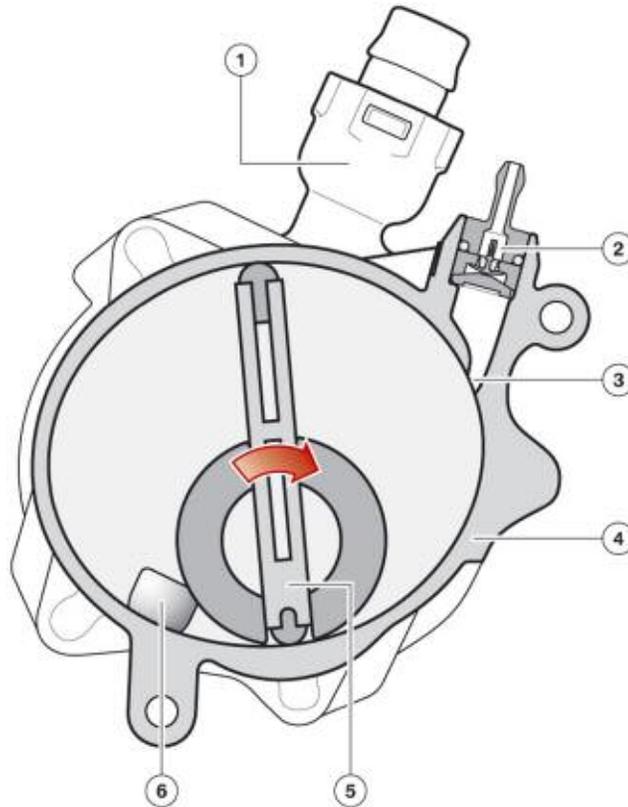


Index	Explanation	Index	Explanation
1	Vacuum pump	5	Non-return valve
2	Non-return valve	6	Vacuum accumulator (Integrated into the cylinder head cover)
3	Non-return valve	7	Electropneumatic pressure converter (Vacuum solenoid)
4	Brake servo unit	8	Vacuum unit, wastegate valve

Vacuum Pump

The vacuum pump is similar to that used on the N63 engine. It is a two-stage pump and therefore has two connections. The first stage is for the brake booster and the second for the auxiliary consumers.

N55, vacuum pump

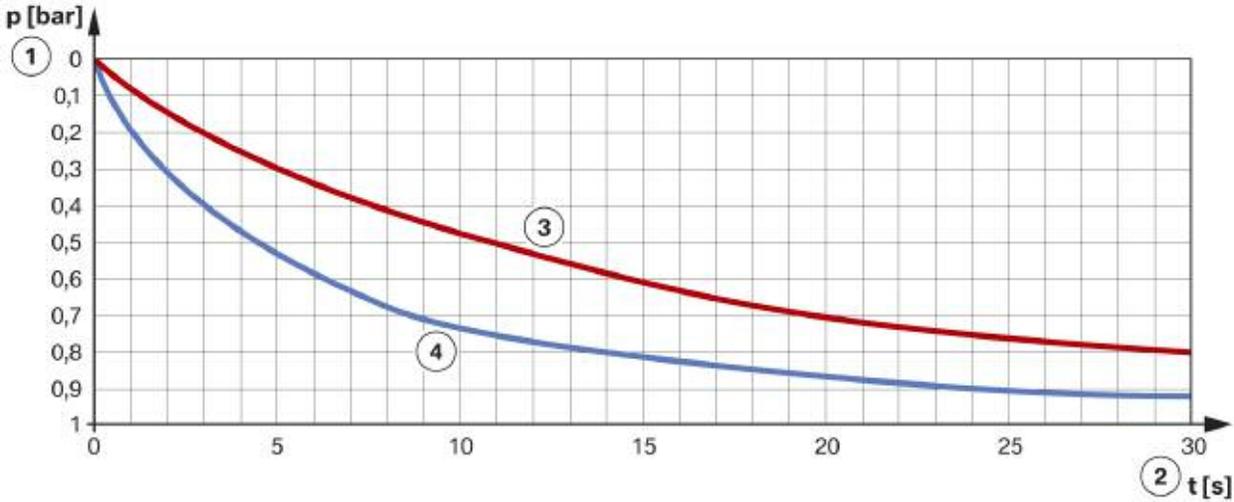


Index	Explanation
1	Non-return valve for brake booster
2	Non-return valve for auxiliary consumer
3	Connection opening for auxiliary consumers
4	Vacuum pump housing
5	Vane
6	Connection opening for brake booster

The largest area is used for the first stage, ensuring vacuum is built up at a rapid rate for the brake booster. The last section is the opening stage for the auxiliary consumers. It therefore takes longer to build up the vacuum here, as shown in the following diagram.

This solution takes into account the different requirements for the brake booster and the auxiliary consumers.

N55, delivery rate of the two-stage vacuum pump



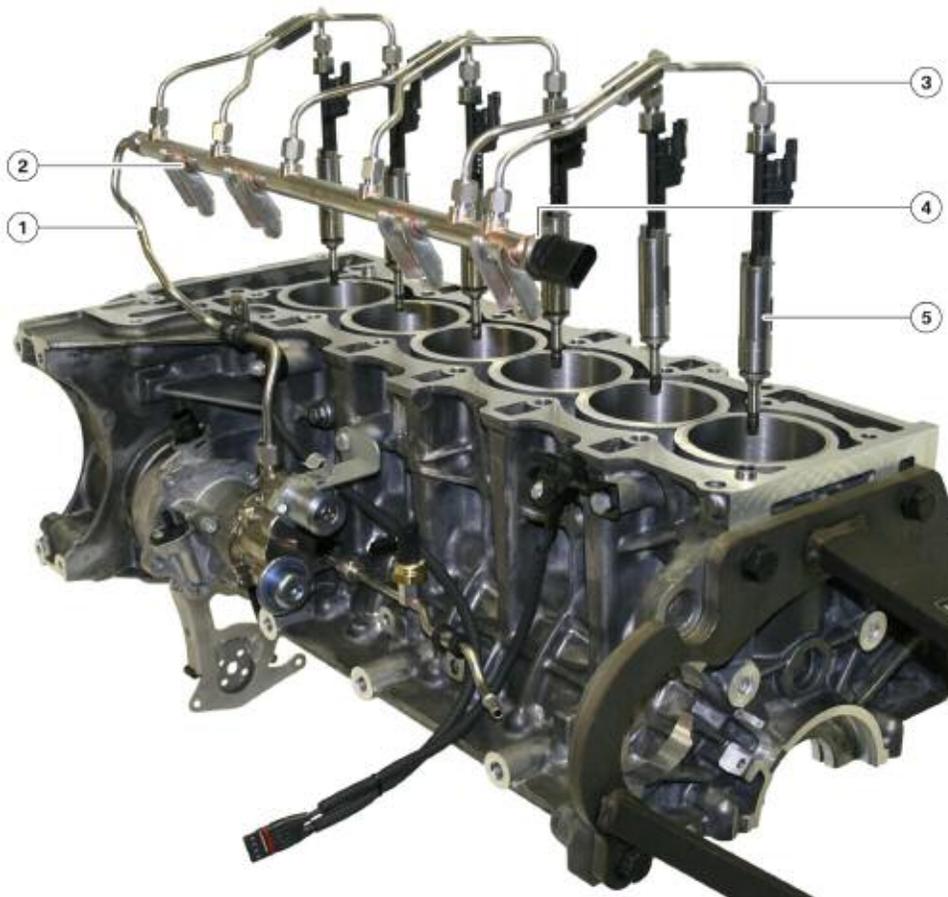
Index	Explanation
1	Vacuum
2	Time
3	Delivery rate for auxiliary consumers
4	Delivery rate for brake booster

Fuel Injection

The high pressure fuel injection system (HDE) is used on the N55 engine. In contrast to high precision injection (HPI), HDE uses solenoid fuel injectors with multi-hole nozzles.

The following overview shows the complete fuel injection system. The system is similar to the N54 fuel injection. Although the same high pressure pump, pressure sensor, and fuel rail are used, the high pressure fuel injection valves are new. The HDE system uses Bosch high pressure solenoid type fuel injection valves with the designation HDEV5.2.

N55, overview of high pressure fuel injection system



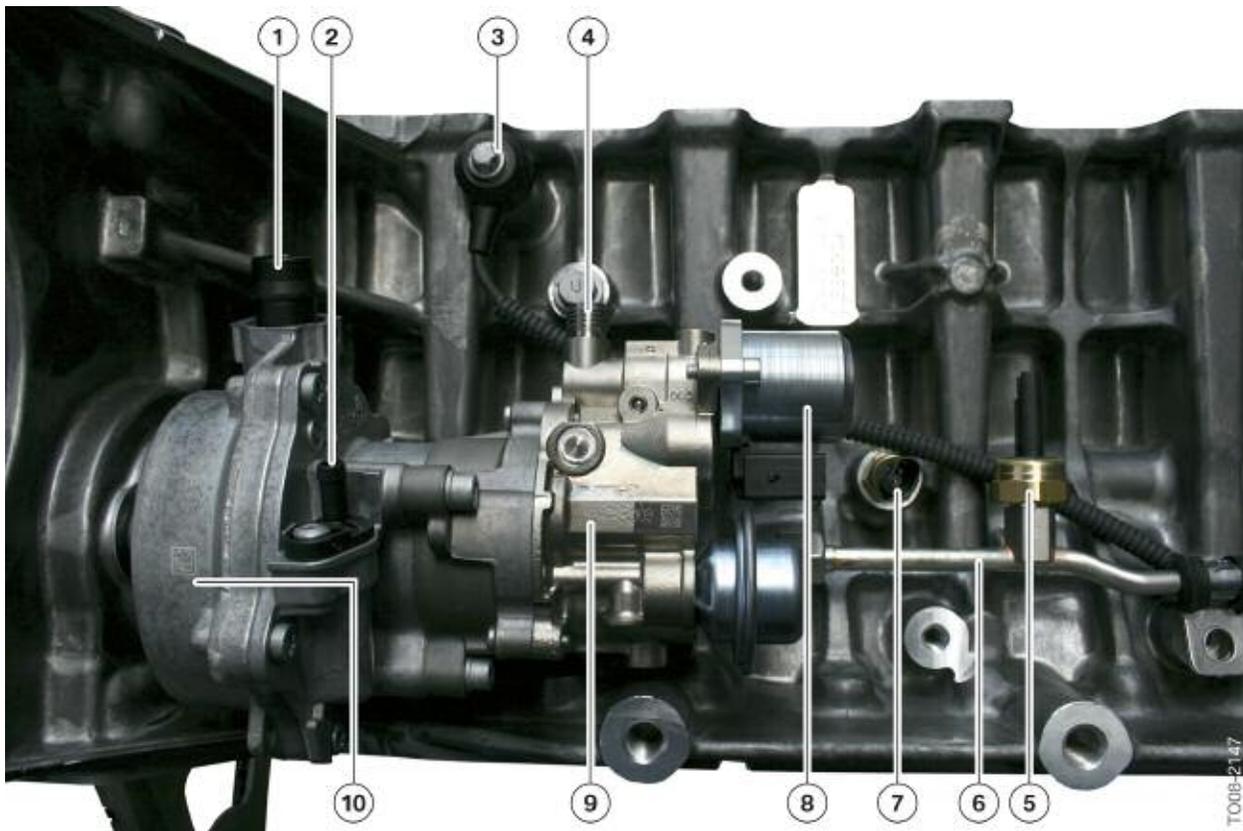
Index	Explanation
1	High pressure line
2	Rail
3	High pressure line
4	Fuel rail pressure sensor
5	Solenoid valve fuel injector

Fuel Pressure Sensor

The fuel is supplied at a primary pressure of 5 bar by the electric fuel pump from the fuel tank via the supply line to the high pressure pump. The primary pressure is monitored by the fuel pressure sensor (5). The fuel is delivered by the electric fuel pump corresponding to engine requirements. The fuel pressure sensor known from the N54 and N63 is used.

In the event of the fuel pressure sensor failing, the electric fuel pump continues operation at 100% delivery rate as from terminal 15 ON.

N55 Engine

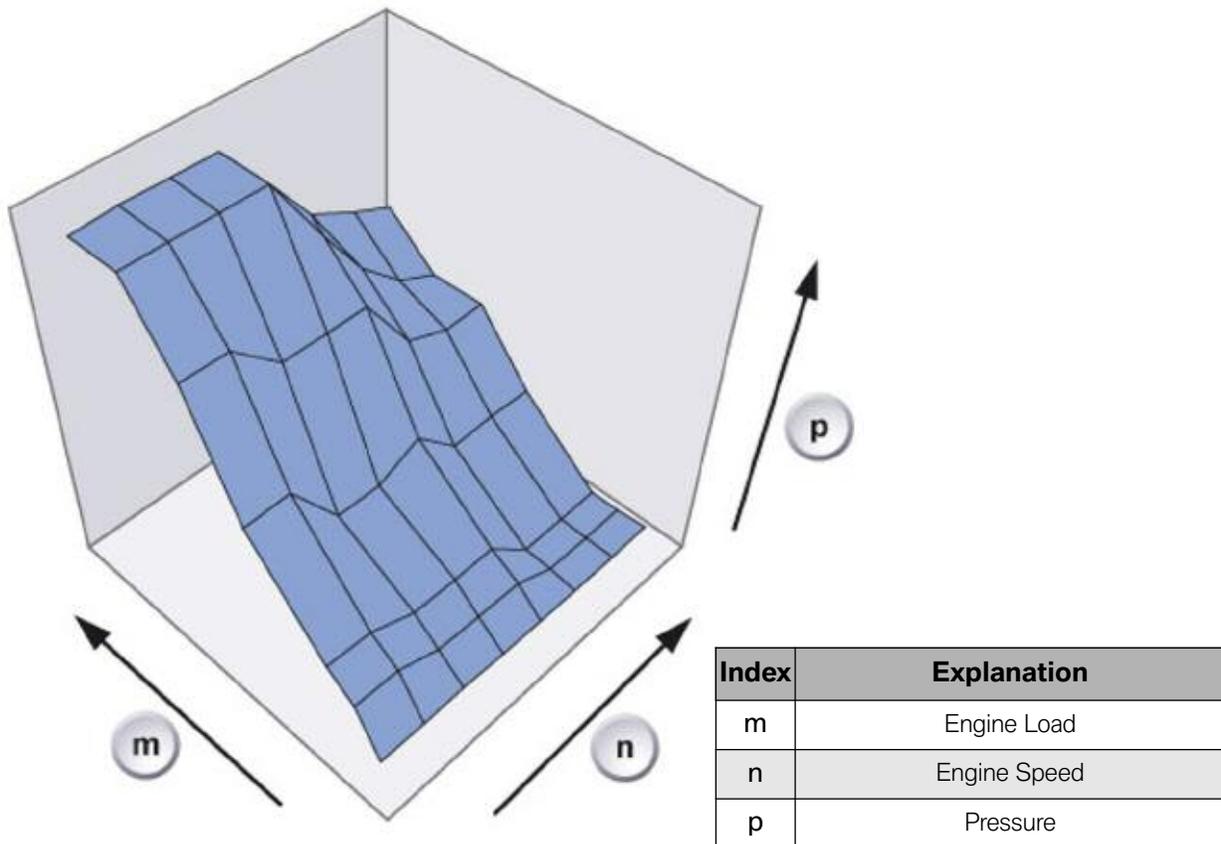


Index	Explanation	Index	Explanation
1	Non-return valve for brake booster	6	Fuel supply line
2	Non-return valve for auxiliary consumers	7	Oil pressure sensor
3	Knock sensor	8	Quantity control valve
4	Connection, high pressure line to fuel rail	9	High pressure pump
5	Fuel pressure sensor	10	Vacuum pump

High Pressure Fuel Pump

The fuel is pressurized in the permanently driven three-piston high pressure pump and delivered to the fuel rail via the high pressure line. The fuel stored under pressure in the fuel rail is distributed via the high pressure lines to the high pressure fuel injection valves. The required fuel pressure is determined by the engine management as a function of the engine load and engine speed. The pressure level is registered by the rail pressure sensor and sent to the engine control unit. The fuel is regulated by the quantity control valve based on a target/actual value comparison of the rail pressure. The pressure level is configured such to achieve the smoothest running properties with the best possible fuel consumption. A pressure of 200 bar is only required at high load and low engine speed. The high pressure pump is of the same design as the high pressure pump used on the N54 engine.

N55, fuel pressure diagram



Fuel Injectors

The high pressure fuel injection valve Bosch HDEV5.2 is a solenoid type injector. In contrast to the piezo-electric injectors used on the current BMW engines, the solenoid valve fuel injectors are designed as inward-opening multi-hole valves with highly variable jet angle and form. They operate at a system pressure of up to 200 bar.

CAUTION!!!

Do not open the fuel system if the coolant temperature is above 40°C/104°F. The residual pressure in the high pressure fuel system could cause bodily injury.

It is essential to observe the utmost cleanliness when working on the high pressure fuel system and to follow the proper working procedures described in the repair instructions. Even minute soiling or damage at the thread connections of the high pressure lines could cause leaks.

Note: Special tool # 13 0 270 must be used to remove the HDEV5.2 high pressure injector valves from the engine. Damage to the injector or the related components may occur otherwise. See the Service Information section in this training material for more information.

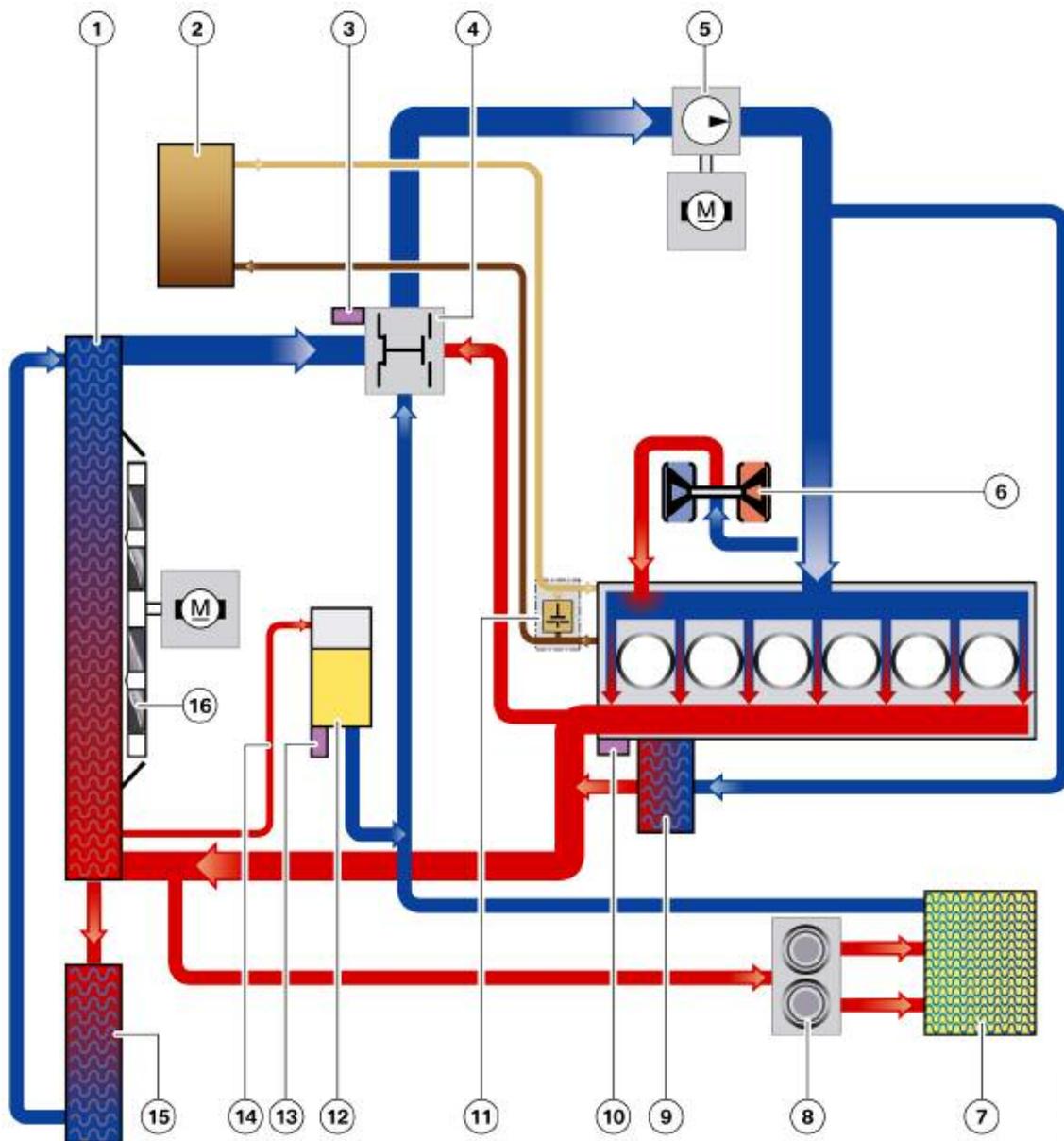
Particular care must be taken when working on the fuel system of the N55 engine to ensure that the ignition coils are not wet with fuel. The resistance of the silicone insulating material of the coils is greatly reduced by the contact with fuel. This could result in arcking at the top of the spark plug and misfiring. See the Service Information section and repair instructions for more information.

Cooling System

The cooling system of the N55 is enhanced with additional oil cooling.

Two different types of oil cooling systems are used depending on the model and application. In the “hot climate” version, heat transfer from the engine oil to the engine coolant is avoided by separating the oil cooler from the engine coolant circuit. The other version uses an auxiliary radiator in combination with an oil to coolant heat exchanger bolted to the oil filter housing. The auxiliary radiator enhances cooling efficiency by adding surface area to the cooling system.

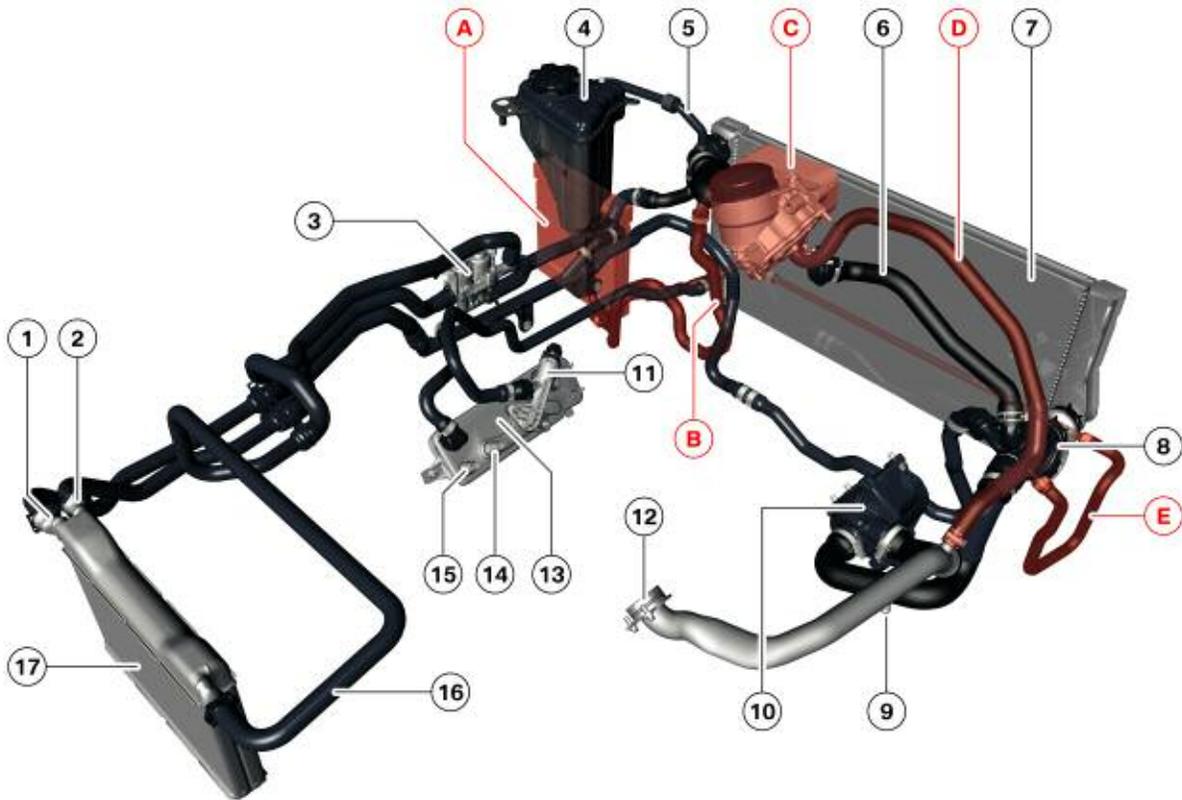
N55, cooling system



Index	Explanation
1	Radiator
2	Engine oil to air cooler (hot climate version)
3	Heater coil
4	Characteristic map thermostat
5	Electric coolant pump
6	Exhaust turbocharger
7	Heating heat exchanger
8	Coolant valve
9	Oil-to-coolant heat exchanger
10	Coolant temperature sensor
11	Engine oil thermostat (hot climate version)
12	Expansion tank
13	Coolant level switch
14	Equalization line
15	Auxiliary radiator
16	Electric fan

Components

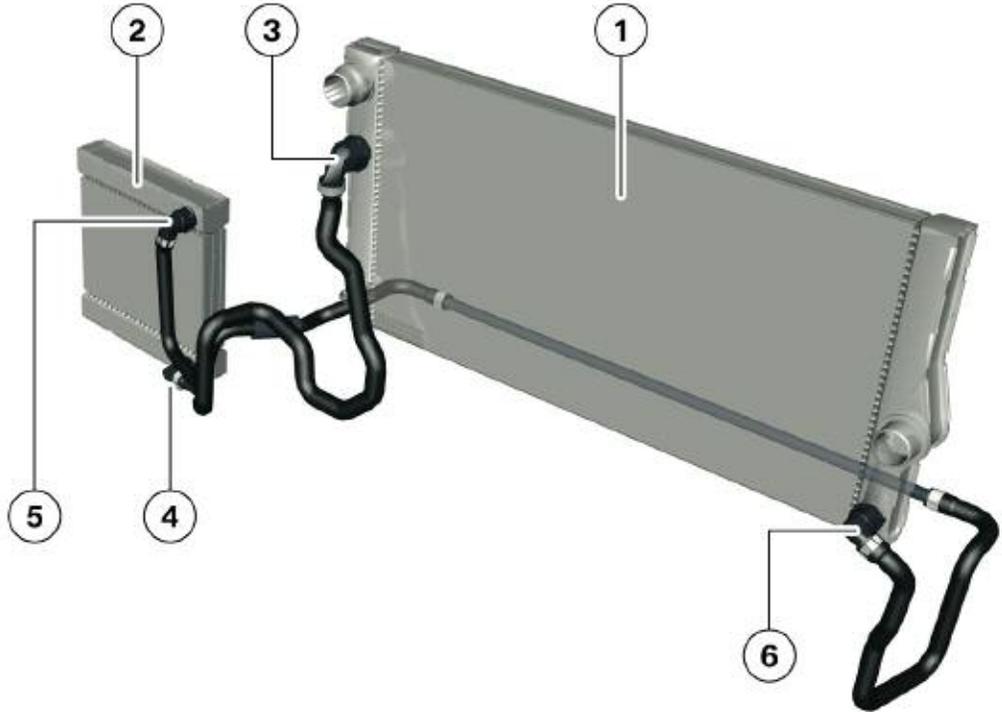
N55, Cooling System Components



Index	Explanation	Index	Explanation
A	Auxiliary radiator	7	Bypass line for small cooling circuit
B	Coolant feed line to auxiliary radiator	8	Thermostat
C	Oil-to-coolant heat exchanger	9	Electric coolant pump
D	Coolant feed line to oil-to-coolant heat exchanger	10	Exhaust turbocharger supply line
E	Coolant return line from auxiliary radiator	11	Thermostat for transmission oil cooling
1	Zone 1 feed line, heating heat exchanger	12	Coolant feed line to engine block
2	Zone 2 feed line, heating heat exchanger	14	Transmission oil-to-coolant heat exchanger
3	Coolant valve	15	Connection, transmission oil line
4	Expansion tank	16	Connection, transmission oil line
5	Equalization line	17	Return, heating heat exchanger
6	Radiator		

The following graphic shows the connection of the auxiliary radiator to the cooling system. The auxiliary radiator is connected to the radiator by means of parallel coolant lines, thus increasing the cooling surface area. This system is combined with an oil-to-coolant heat exchanger mounted on the oil filter housing. (See component “C” in the previous graphic.)

N55, auxiliary radiator



Index	Explanation
1	Radiator
2	Auxiliary Radiator
3	Feed connection to the auxiliary radiator
4	Feed connection at the auxiliary radiator
5	Return connection to the auxiliary radiator
6	Return connection from the auxiliary radiator

Note: If a separate oil to air cooler is not installed, an auxiliary radiator in conjunction with an oil to coolant heat exchanger is used to cool the engine oil.

Oil Cooler

N55, engine oil cooling, "hot climate"



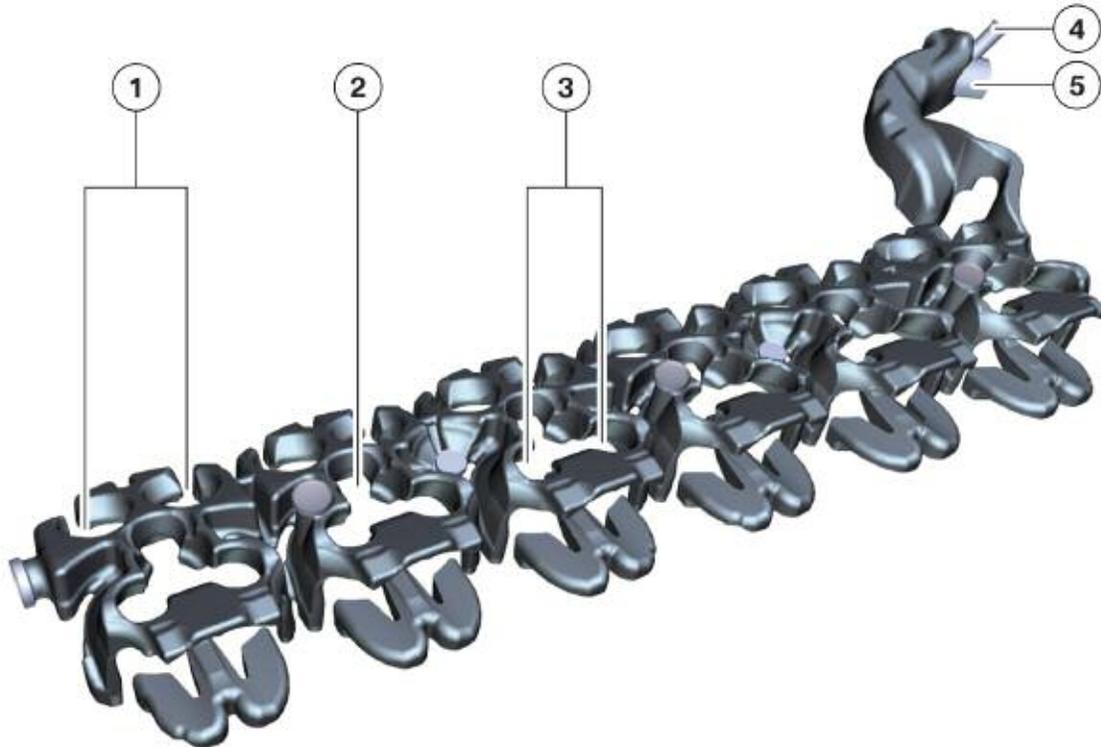
Index	Explanation
1	Oil filter module
2	Thermostat
3	Oil cooler lines
4	Engine oil to air heat exchanger (oil cooler)

Note: Most current US vehicles use a separate engine oil to air heat exchanger to cool the engine oil (hot climate version).

Coolant Passages

The coolant passages in the cylinder head are also used for indirect cooling of the fuel injectors. The following graphic clearly shows that the coolant flows over the valves and the fuel injectors, thus reducing the heat transfer to the components to a minimum.

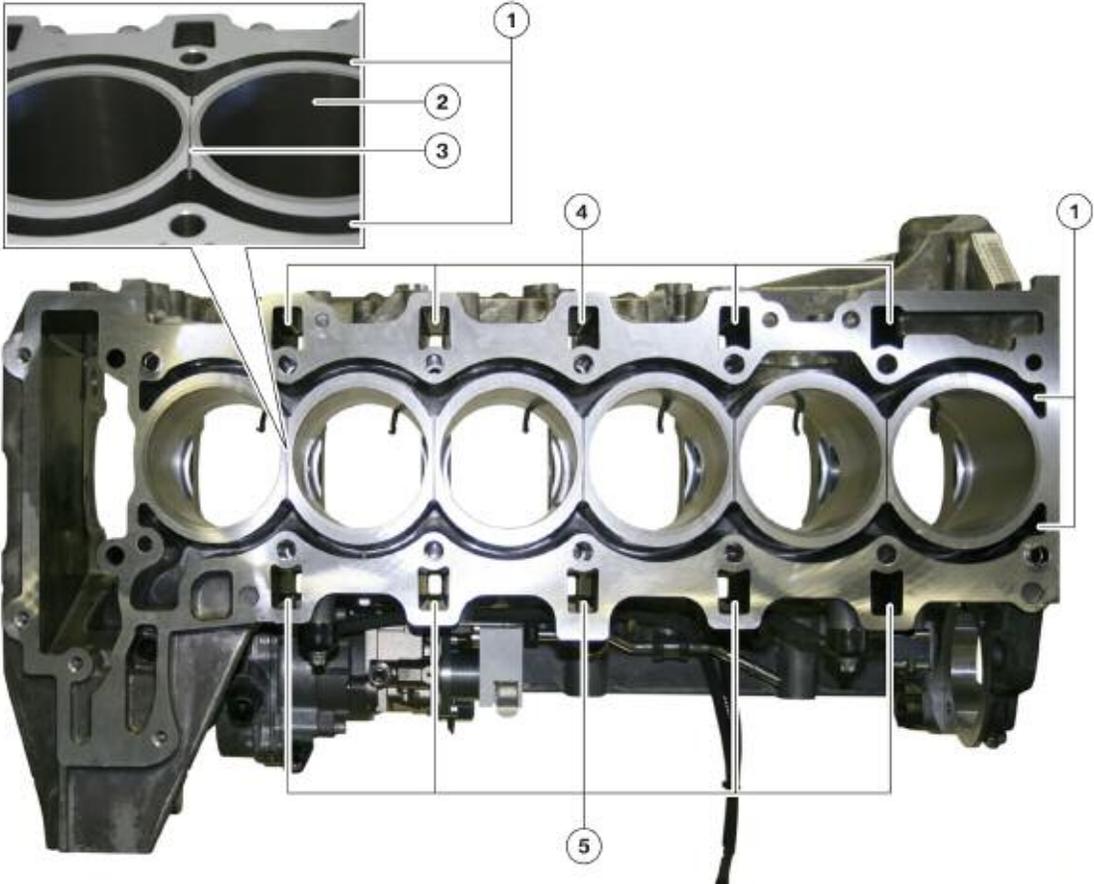
N55, casting of the coolant passages in cylinder head



Index	Explanation
1	Channel, intake valves
2	Channel, fuel injectors
3	Channel, exhaust valves
4	Connection, coolant hose to thermostat (small cooling circuit)
5	Connection, coolant hose to radiator (large cooling circuit)

The cast iron cylinder liners are cast into the aluminum die-casting. The deck area (webs) between the cylinders have grooved coolant passages. Coolant can flow along these grooves from one side of the block to the other, thus cooling the deck area between the cylinders.

N55, coolant passages and web cooling of the engine block



Index	Explanation
1	Cooling duct
2	Cylinder liner
3	Grooved coolant passage
4	Oil return ducts, exhaust side
5	Oil return ducts, intake side

Engine Electrical System

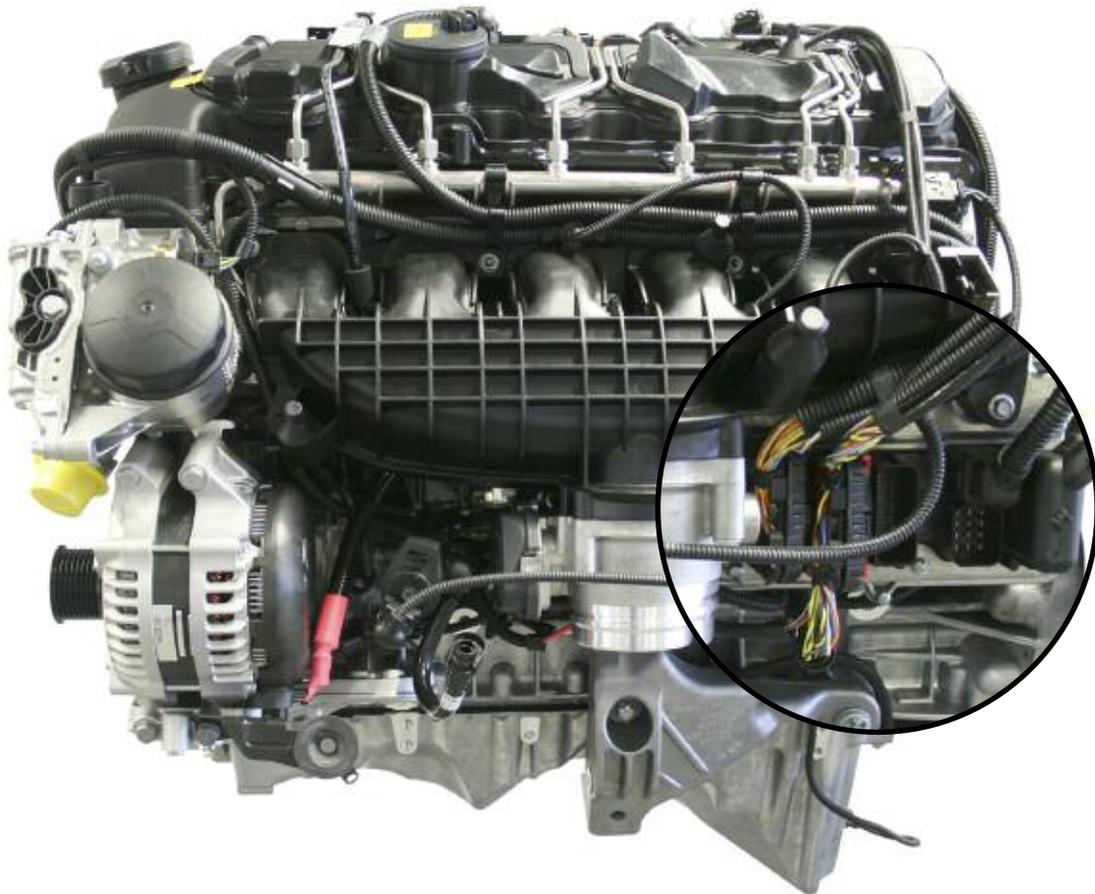
Connection to vehicle electrical system

For the first time, an engine-mounted Digital Motor Electronics (DME) module is used. The DME is bolted to the intake manifold and is cooled by the intake air.

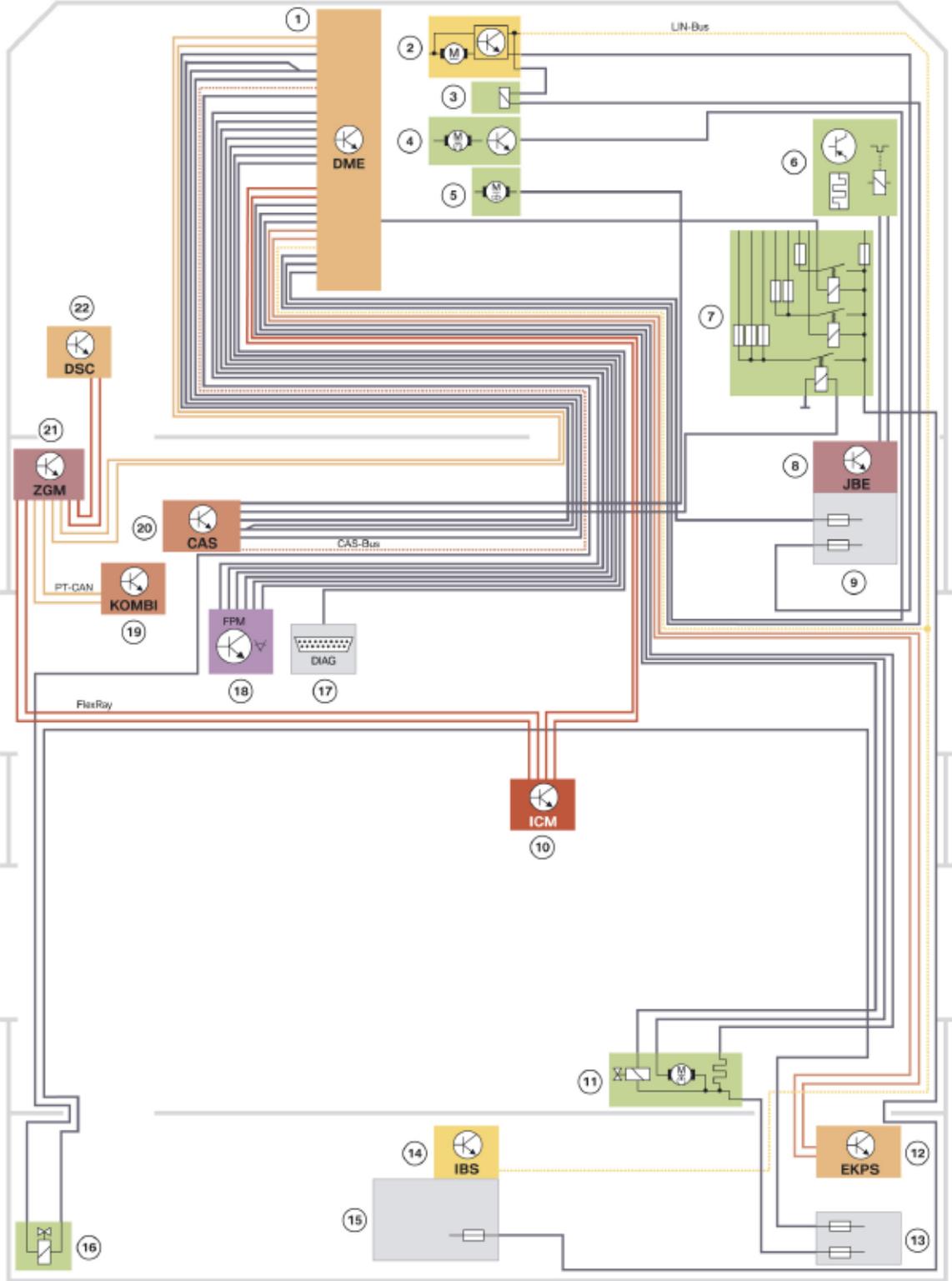
The engine mounted DME has the following advantages:

- Engine wiring harness is divided into six individual modules
- All electrical components on the engine are supplied directly via the DME
- The E-box is no longer need
- 211 pins are available
- The plug-in connectors are water-tight

N55, wiring harness routing



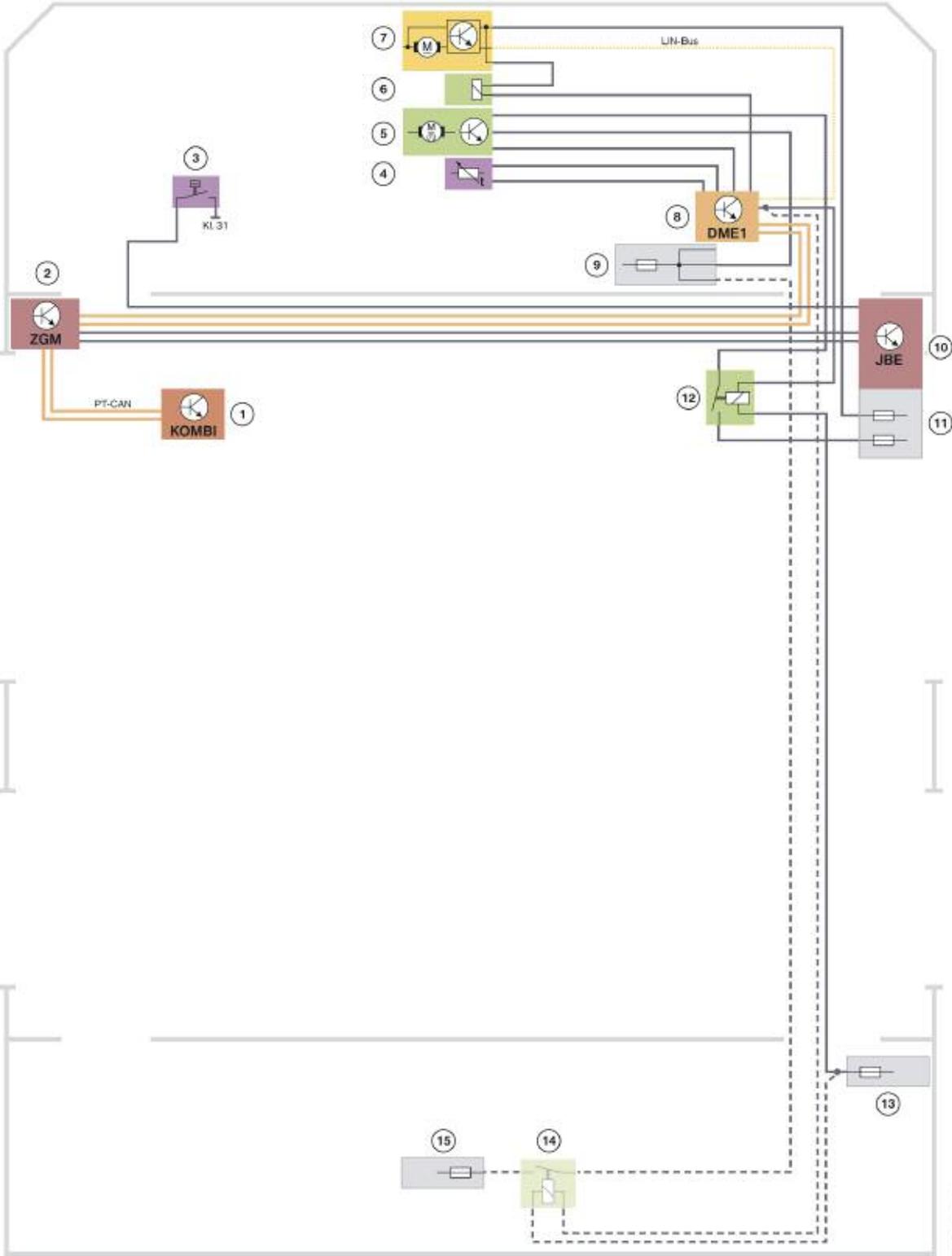
Circuit Diagram



N55, circuit diagram, connection to vehicle electrical system

Index	Explanation
1	Digital Motor Electronics
2	Electric air flap control
3	Mechanical air flap control
4	Electric fan
5	Starter
6	A/C compressor
7	Front power distribution box
8	Junction box electronics
9	Junction box
10	Integrated Chassis Management
11	Fuel tank leak diagnostic module
12	Electronic fuel pump controller
14	Rear power distribution box
15	Intelligent battery sensor
16	Battery power distribution box
17	Exhaust flap changeover valve
18	Diagnosis socket (engine speed signal)
19	Accelerator pedal module
20	Instrument cluster
21	Car Access System
22	Central Gateway Module

Engine Cooling Circuit Diagram



N55, circuit diagram, engine cooling

Index	Explanation
1	Instrument cluster
2	Central Gateway Module
3	Coolant level switch
4	Coolant temperature sensor
5	Electric fan
6	Mechanical air flap control
7	Electric air flap control
8	Digital Motor Electronics
9	Front power distribution box
10	Junction box electronics
11	Junction box
12	Electric fan relay
14	Rear power distribution box
15	Electric fan relay (only for 850 Watt and 1000 Watt electric fan)

Digital Motor Electronics (DME/ECM)

The N55 engine is equipped with the Bosch engine management MEVD17.2 :

- The MEVD17.2 is integrated in the intake system and is cooled by the intake air.
- The MEVD17.2 is FlexRay-compatible and directly supplies voltage to the sensors and actuators.

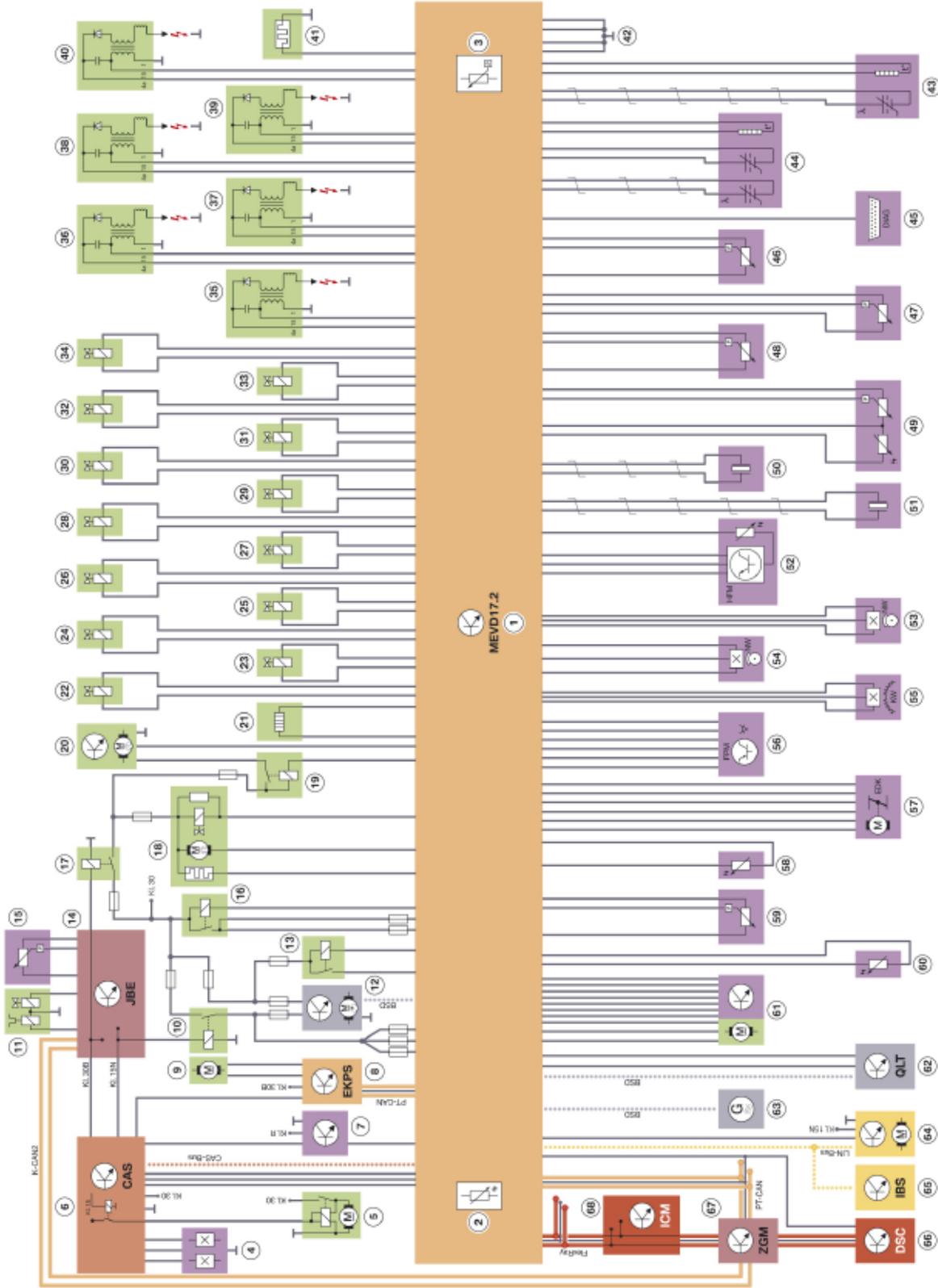
The top side of the DME housing also serves as the bottom section of the intake manifold. The housing is contoured in the area of the intake manifold to ensure optimum air flow. An O ring type seal is installed between the DME housing and the intake. The plug connections between the wiring harness and DME are water-tight.

N55, engine management MEVD17.2



Index	Explanation
1	Engine wiring harness, sensor 1 (Module 100)
2	Engine wiring harness, sensor 2 (Module 200)
3	Connection, vehicle wiring harness (Module 300)
4	Engine wiring harness, Valvetronic (Module 400)
5	Connection, voltage supply (Module 500)
6	Engine wiring harness, injection and ignition (Module 600)

Digital Motor Electronics Circuit Diagram



N55, MEVD17.2 Circuit Diagram

Index	Explanation	Index	Explanation
1	Engine electronics Valvetronic, direct injection 17.2 MEVD17.2	35-40	Ignition coils
2	Ambient pressure sensor	41	Engine breather heater
3	Temperature sensor	42	Ground connections
4	Brake light switch	43	Oxygen sensor after catalytic converter
5	Starter	44	Oxygen sensor before catalytic converter
6	Car Access System (CAS)	45	Diagnostic socket
7	Clutch module	46	Low-pressure fuel sensor
8	Electronic fuel pump control (EKPS)	47	Intake manifold pressure sensor after throttle valve
9	Electric fuel pump	48	Fuel rail pressure sensor
10	Terminal 15N relay	49	Charge air temperature and pressure sensor
11	A/C compressor	50	Knock sensor, cylinders 1 - 3
12	Coolant pump	51	Knock sensor, cylinders 4 - 6
13	Valvetronic relay	52	Hot-film air mass meter (HFM)
14	Junction Box Electronics (JBE)	53	Intake camshaft sensor
15	Refrigerant pressure sensor	54	Exhaust camshaft sensor
16	Relay, ignition and injection	55	Crankshaft sensor
17	Terminal 30B relay	56	Accelerator Pedal Module (FPM)
18	Fuel tank leak diagnosis module (DMTL)	57	Throttle valve (MDK)
19	Electric fan relay	58	Coolant temperature sensor at engine outlet
20	Electric fan	59	Oil pressure sensor
21	Characteristic map thermostat	60	Oil temperature sensor
22	Diverter valve	61	Valvetronic servomotor
23	Fuel tank vent valve	62	Oil condition sensor
24	VANOS solenoid valve, intake camshaft	63	Alternator
25	VANOS solenoid valve, exhaust camshaft	64	Active cooling air flap control
26	Oil pressure control valve	65	Intelligent battery sensor (IBS)
27	Electropneumatic pressure converter (EPDW) for wastegate valve	66	Dynamic stability control (DSC)
28	Quantity control valve	67	Central Gateway Module (ZGM)
29-34	Fuel injectors	68	Integrated Chassis Management (ICM)

Functions

■ Fuel supply system

The fuel pressure sensor sends a voltage signal, corresponding to the system pressure applied between the fuel pump and the high pressure pump, to the engine control unit (DME/ECM). The system pressure (fuel pressure) is determined with the fuel pressure sensor upstream of the high pressure pump. The target pressure is constantly compared to the actual pressure in the DME.

If the target pressure deviates from the actual pressure, the engine control unit increases or decreases the voltage for the electric fuel pump. This voltage is sent in the form of a message via the PT-CAN to the EKP control unit.

The electric fuel pump (EKP) control unit converts the message into an output voltage for the electric fuel pump, thus regulating the required delivery pressure for the engine (or high pressure pump). The electric fuel pump is pilot-controlled in the event of signal failure (fuel pressure sensor). Should the CAN bus fail the EKP control unit operates the electric fuel pump with the applied system voltage. The fuel flows via the high pressure line to the fuel rail. The fuel is buffered in the fuel rail and distributed to the fuel injectors.

■ Fuel quantity control

The rail pressure sensor measures the current fuel pressure in the rail. The excess fuel is returned to the inlet of the high pressure pump when the quantity control valve in the high pressure pump opens. Vehicle operation is restricted in the event of the high pressure pump failing.

The quantity control valve controls the fuel pressure in the rail. The engine management actuates the quantity control valve with a pulse width-modulated signal. Depending on the pulse width, a variable throttle cross section is released, thus providing the quantity of fuel required for the current load status of the engine. It is also possible to reduce the pressure in the rail.

■ Boost pressure control

The engine management controls the boost pressure with the wastegate valve at the turbocharger. An electropneumatic pressure converter (vacuum solenoid) receives the signals from the engine management and supplies vacuum to open the wastegate valve when the specified maximum boost pressure is reached.

A diverter valve is installed on the compressor housing of the turbocharger. It connects the pressure side to the inlet side of the induction system and is controlled directly by the engine management. The diverter valve eliminates undesirable peaks in the boost pressure that can occur when the throttle valve is quickly closed. Therefore it has a decisive influence on the engine acoustics while protecting the turbocharger and its related components.

A pressure wave is built up from the throttle valve to the turbocharger compressor wheel when the throttle valve is closed. This pressure wave acts against the throttle plate and the compressor blades pressing them against the bearings. The diverter valve reduces this pressure wave and thus the load on these components by “diverting” air pressure from the pressure side to the suction side of the compressor housing. This also maintains the turbocharger spooled (up to speed) for the next acceleration and reduces turbo lag.

■ Engine cooling

The engine cooling system utilizes an electric coolant pump. The heat management determines the current cooling requirement and controls the cooling system accordingly. Under certain circumstances, the coolant pump can be completely switched off, e.g. to rapidly heat up the coolant during the warm-up phase. The coolant pump continues to operate when the hot engine is shut down. The coolant capacity can therefore be varied regardless of the engine speed. In addition to the characteristic map thermostat, the heat management makes it possible to use various characteristic maps for controlling the coolant pump. In this way the engine control unit can adapt the engine temperature to the driving conditions.

The engine control unit regulates the following temperature ranges:

- 108°C/226°F = Economy mode
- 104°C/219°F = Normal mode
- 95°C/203°F = High mode
- 90°C/194°F = High mode and control with characteristic map thermostat

The engine management sets a higher temperature (108°C) when, based on vehicle operation, the engine control unit detects “Economy” mode. The engine is operated with relatively low fuel requirements in this temperature range. The internal engine friction is reduced at higher temperatures. The increase in temperature therefore results in low fuel consumption in the low load range. The driver wishes to utilize the optimum power developed by the engine in “High and control with characteristic map thermostat” mode. For this purpose, the temperature in the cylinder head is reduced to 90°C. This temperature reduction promotes improved volumetric efficiency, thus resulting in an increased engine torque. Adapted to the relevant driving situation, the engine control unit can now regulate a defined operating range. In this way it is possible to influence the fuel consumption and power output through the cooling system.

■ System Protection

If the coolant or the engine oil overheat during operation, certain vehicle functions are influenced to the effect that more energy is available to the engine cooling system.

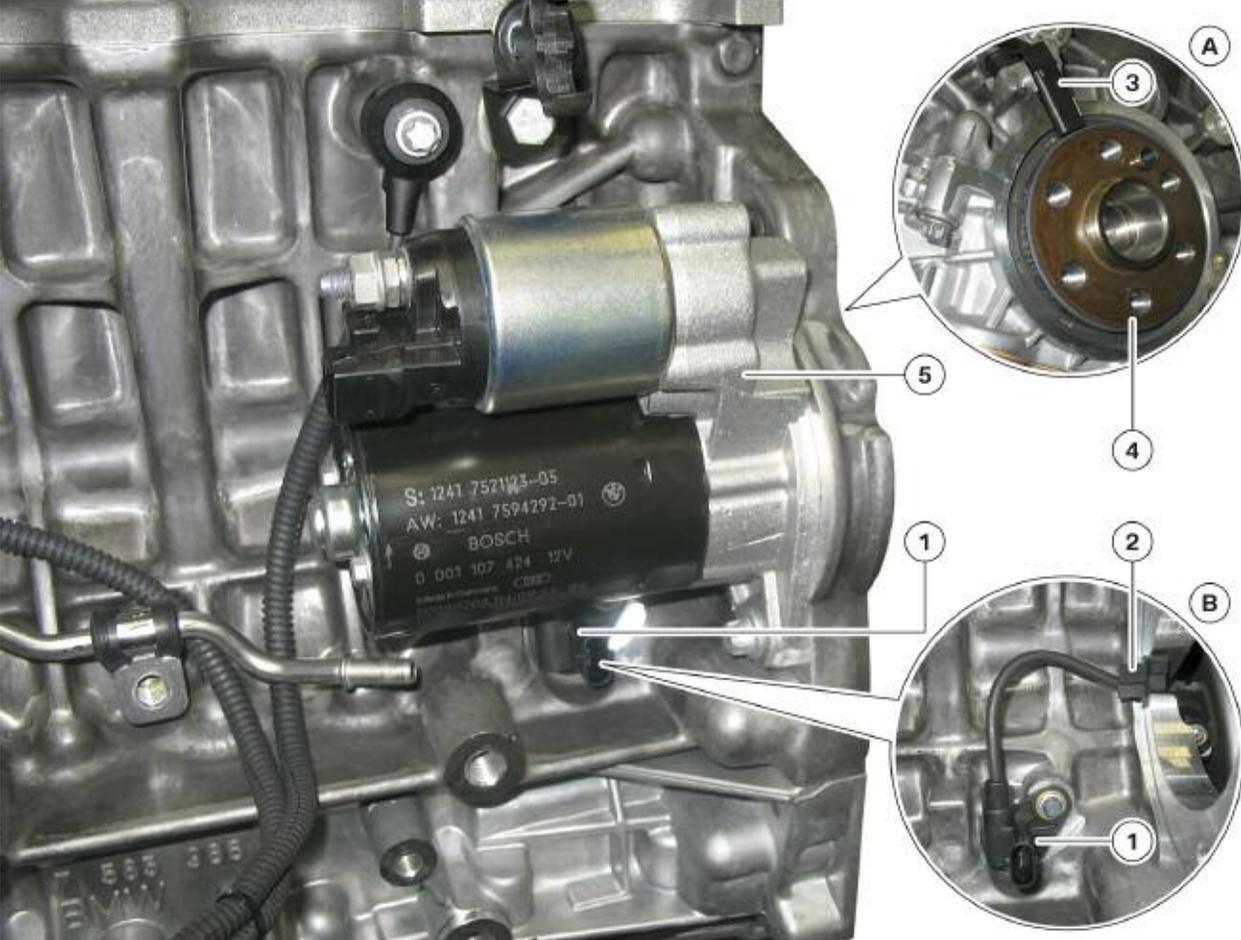
These measures are divided over two operating modes:

- Component protection
 - Coolant temperature between 117°C/242°F and 124°C/255°F
 - Engine oil temperature between 150°C/300°F and 157°C/314°F
 - Result: The output of the air conditioning system (up to 100%) and of the engine is reduced
- Emergency
 - Coolant temperature between 125°C/257°F and 129°C/264°F
 - Engine oil temperature between 158°C/316°F and 163°C/325°F
 - Result: The power output of the engine is reduced (up to 90%)

Crankshaft Sensor

The function of the new crankshaft sensor is identical to that of the crankshaft sensors used for the automatic engine start-stop function (MSA). The engine reversal detection is required for the MSA function. (MSA is not currently offered in the US.)

N55, location of crankshaft sensor



Index	Explanation
A	Direction of view towards crankshaft
B	Same view without starter
1	Connector
2	Dust seal
3	Sensor
4	Multi-pole trigger wheel

N55, crankshaft sensor with multipole sensor wheel



Index	Explanation
1	Connector
2	Dust seal
3	Sensor

Ignition Coil

New ignition coils have been developed for the N55 engine. The ignition coils have improved electromagnetic compatibility and are sturdier. The insulation has been reinforced with silicone and a metal collar shielding compared to the coils used on previous engines. See the Service Information section of this training material for more details.

CAUTION!!!

Always remove the ignition coils before opening the fuel system. Gasoline may damage the silicone insulation on the coils which may lead to arcking and subsequent engine misfiring.

Oil Pressure Sensor

The new oil pressure sensor can now determine the absolute pressure.

The sensor delivers a more accurate pressure reading which is required for the electronic volume control oil pump function.

The sensor design is identical to that of the (high) fuel pressure sensor. The DME supplies a voltage of 5 Volt to the oil pressure sensor.

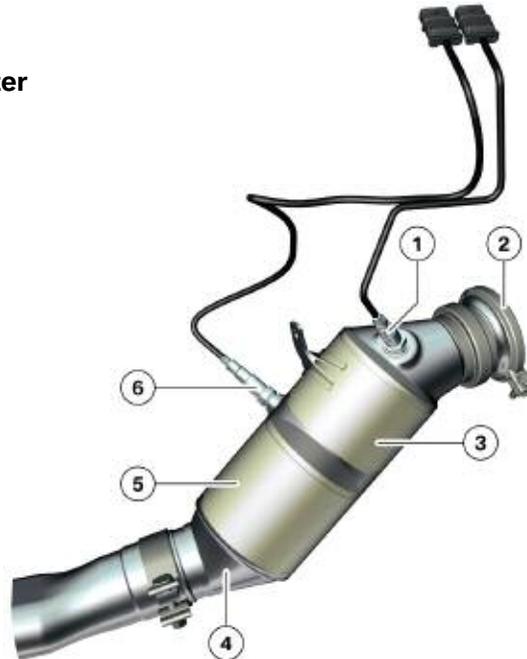


N55, oil pressure sensor

Oxygen Sensors

A new connector is used for the oxygen sensors. The new connector system provides greatly improved contacting properties and eliminates "background noise".

N55 engine, catalytic converter



Index	Explanation
1	Oxygen sensor upstream of catalytic converter
2	Connection at exhaust turbocharger
3	Ceramic monolith 1
4	Catalytic converter
5	Ceramic monolith 2
6	Oxygen sensor after catalytic converter

■ Oxygen sensor before catalytic converter

The Bosch oxygen sensor LSU ADV is used as the control sensor before the catalytic converter. The abbreviation LSU stands for “Lambdasonde Universal” and ADV for “Advanced”. The function is similar to that of the LSU 4.9 oxygen sensor and is therefore described in detail in the E71 X6 training material under “N63 engine” available in TIS and ICP.

The oxygen sensor before catalytic converter (LSU ADV) offers the following advantages:

- High signal stability specially during turbocharged operation due to low dynamic pressure dependence.
- Increased durability due to reduced pump voltage.
- Increased accuracy (by a factor of 1.7 compared to LSU 4.9).
- Ready for operation in < 5 seconds.
- Greater temperature compatibility.
- Improved connector with more effective contacting properties.

The LSU ADV has an extended measuring range, making it possible to measure precisely from lambda 0.65. The new oxygen sensor is ready for operation faster so that exact measured values are available within 5 seconds of start up.

The higher measuring dynamics of the sensor makes it possible to more effectively determine and control the fuel-air ratio separately for each cylinder. This results in a homogeneous exhaust flow that reduces emissions while also having a favorable effect on long-term emission characteristics.

■ Oxygen sensor after catalytic converter

The oxygen sensor after catalytic converter is also known as the monitoring sensor. The familiar Bosch LSF 4.2 monitoring sensor is used.

■ Hot-film air mass meter

The Siemens SIMAF GT2 hot-film air mass meter is used. This sensor is equipped with planar metal resistors on glass. Based on the tried and tested sensor technology used in the SIMAF GT1 for more than 15 years, the SIMAF GT2 represents a further-development and optimization with higher vibration resistance, improved accuracy (at all operating temperatures), and lower sensitivity to air pulsations and water.



Hot-film air mass meter

High Pressure Fuel Injector Valve

The HDEV5.2 solenoid type injector valves used on the N55 engine are a new development.

1 Booster phase:

Opening of the HDEV5.2 is initiated in the booster phase by a high booster voltage from the DME. The booster phase ends on reaching approximately 10 amps. The high current is achieved by a voltage of up to approximately 65 Volt.

2 Energizing phase:

In the energizing phase, the HDEV5.2 is completely opened by controlling the current to approximately 6.2 amps. At the end of the energizing phase, the current is reduced to the holding current level of approximately 2.5 amps.

3 Hold phase:

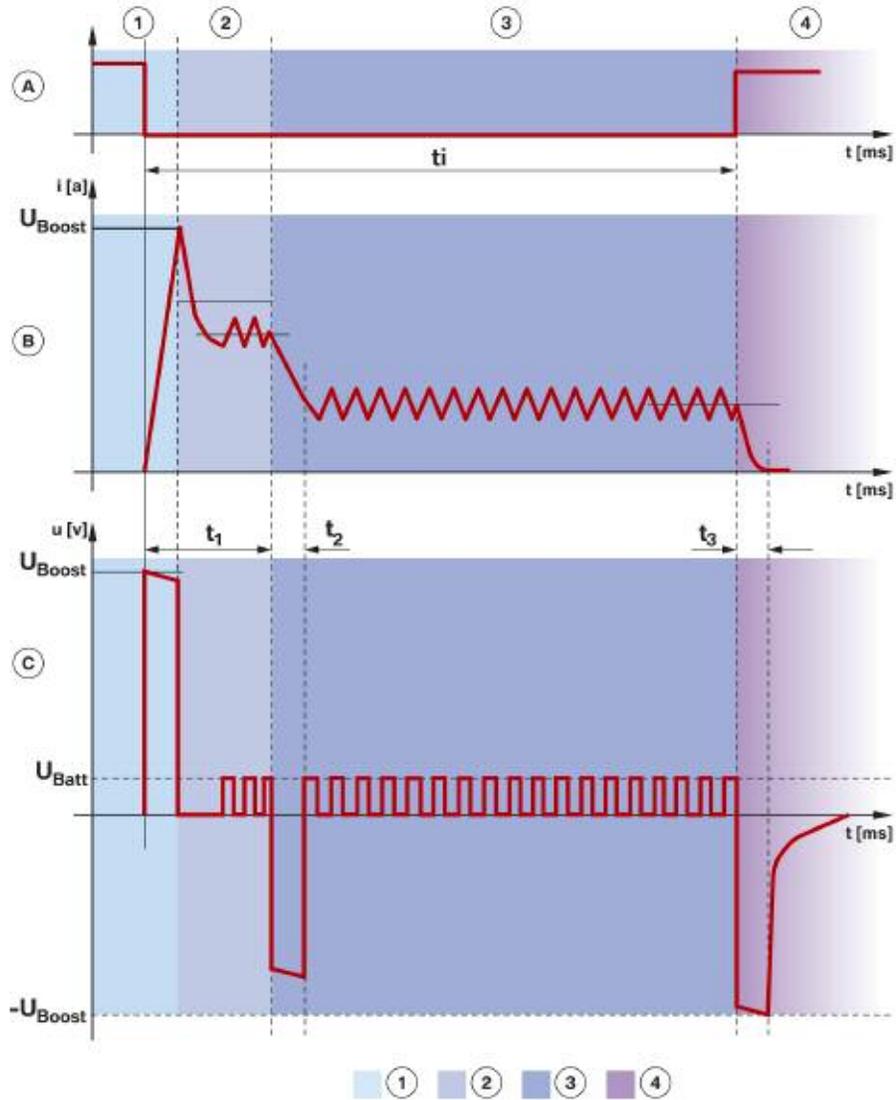
The energized HDEV5.2 is kept open by controlling the current at approximately 2.5 amps in the hold phase.

4 Switch off phase:

The current is switched off at the end of the injection time (in the switch off phase). At least 2 milliseconds elapse between two injection cycles.

Function

N55, actuation phases of the HDEV5.2



Index	Explanation	Index	Explanation
A	DME actuation signal	1	Booster phase
B	Current flow HDEV5.2	2	Energizing phase
C	Voltage at HDEV5.2	3	Hold phase
		4	Switch off phase

Service Information

Cylinder Head

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

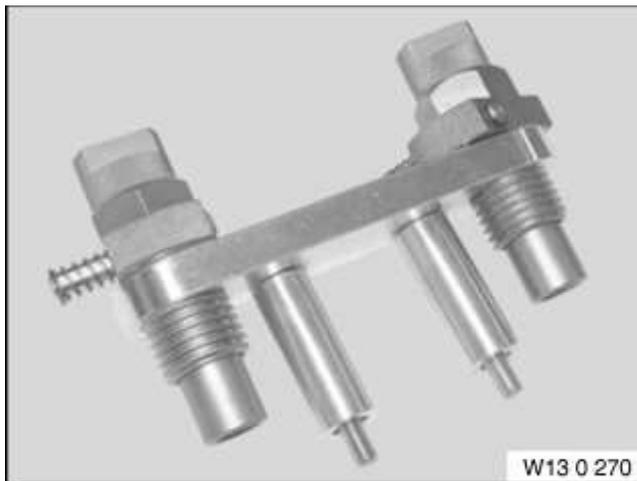
Cylinder Head Cover

Note: If a customer complains about high oil consumption and oil is discovered in the turbocharger, it should not be immediately assumed that the turbocharger is defective.

If the oil is present in the fresh air pipe after the introduction of the blow-by gasses then the entire engine should be checked for leaks. Defective gaskets or crankshaft seals may be the cause of excessively high blow-by gas output.

Fuel Injectors

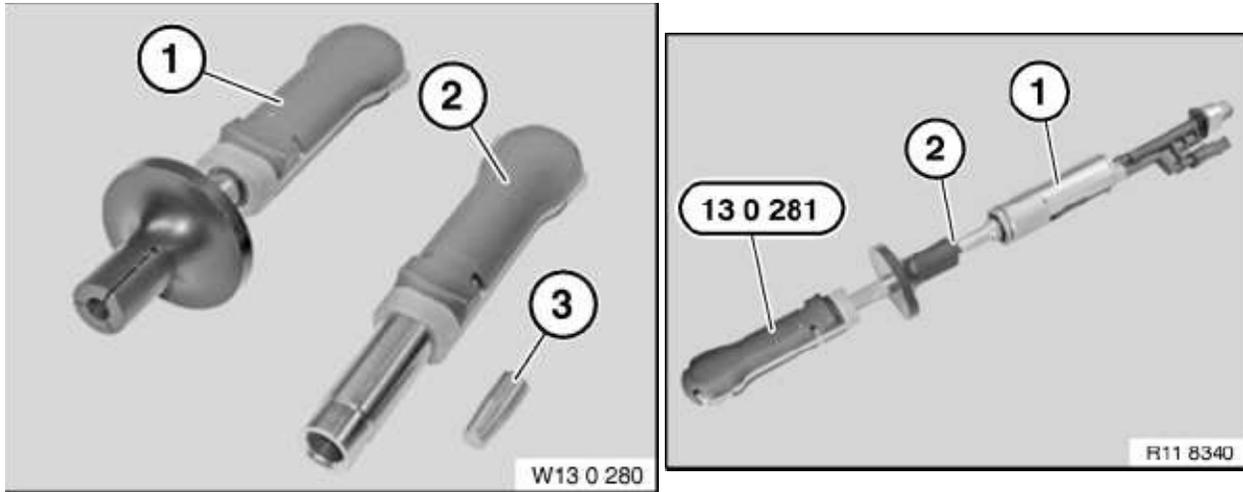
In order to remove the N55 fuel injectors from the cylinder head, special tool #13 0 270 must be utilized. Failure to use the special tool will result in damage to the injectors.



Note: Do not open the high pressure fuel injection system if the coolant temperature is above 40°C . The residual pressure in the high pressure fuel system could cause bodily injury.

Note: It is essential to follow the repair instructions and observe the utmost cleanliness when working on the high pressure fuel system. Even minute soiling or damage at the connections of the high pressure lines and cause leaks.

There is a new tool # 13 0 280 that must be used when replacing the PTFE seals on the tips of the solenoid valve injectors. As with piezoelectric injectors these seals must be replaced if and when the injectors are being re-installed.



Ignition Coils

The ignition coils of the N55 have been redesigned for better rigidity and durability. Particular care must be taken when working on the fuel system to ensure that the ignition coils are not wet with fuel. The resistance of the silicone material is greatly reduced by contact with fuel. This could compromise the coils insulation and result in arcking at the top of the spark plug causing a misfire.

- The ignition coils must be removed before working on the fuel system.
- When installing new solenoid valve fuel injectors utmost cleanliness must be observed.
- After removing the ignition coils use a rag to prevent fuel from entering the spark plug well.
- Ignition coils that have been saturated with fuel must be replaced.