

Technical training.
Product information.

S55 Engine



BMW Service

Edited for the U.S. market by:
BMW Group University
Technical Training

ST1404

6/1/2014

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 a result of the equipment specification in specific markets or countries.

Additional sources of information

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

- Owner's Handbook
- Integrated Service Technical Application

Contact: conceptinfo@bmw.de

©2014 BMW AG, Munich

Reprints of this publication or its parts require the written approval of BMW AG, Munich

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.

Information status: **March 2014**
BV-72/Technical Training

S55 Engine

Contents

1.	Introduction.....	1
1.1.	Highlights.....	1
1.1.1.	Technical data.....	2
1.1.2.	Full load diagram.....	4
1.2.	S55/N55 new features/changes.....	5
1.2.1.	Overview.....	5
1.2.2.	Comparison of the N55 engine/S55 engine.....	6
2.	Engine History.....	10
2.1.	Variants of the BMW M3 engines.....	10
3.	Engine Identification.....	11
3.1.	Engine designation and engine identification.....	11
3.1.1.	Engine designation.....	11
4.	Engine Mechanical.....	13
4.1.	Engine housing.....	13
4.1.1.	Engine block.....	13
4.1.2.	Cylinder head.....	17
4.1.3.	Cylinder head cover.....	18
4.1.4.	Engine cover.....	24
4.1.5.	Oil pan.....	25
4.2.	Crankshaft.....	26
4.2.1.	Crankshaft with bearings.....	26
4.2.2.	Connecting rod with bearing.....	27
4.2.3.	Piston and piston rings.....	31
4.3.	Camshaft drive.....	33
5.	Valvetrain.....	34
5.1.	Design.....	34
5.1.1.	Camshafts.....	35
5.1.2.	Timing.....	36
5.1.3.	Intake and exhaust valves.....	37
5.1.4.	Valve springs.....	37
5.2.	Valvetronic.....	38
5.2.1.	VANOS.....	38
5.2.2.	Valve lift control.....	40
6.	Belt Drive & Auxiliary Components.....	46
6.1.	Belt drive.....	46
6.1.1.	Vibration damper.....	47

S55 Engine

Contents

7. Oil Supply	48
7.1. Oil circuit	48
7.1.1. Oil passages	48
7.1.2. Oil return	52
7.1.3. Oil pump and pressure control	54
7.1.4. Suction pump	55
7.1.5. Oil filter and engine oil cooling	60
7.1.6. Oil spray nozzles	61
7.1.7. Engine oil pressure monitoring	61
8. Air Intake & Exhaust Emission Systems	62
8.1. Air intake system	62
8.1.1. Overview	62
8.1.2. Intake manifold	66
8.1.3. Tank ventilation system	67
8.2. Exhaust emission system	68
8.2.1. Overview	68
8.2.2. Exhaust manifold	70
8.2.3. Lightweight construction of heat shields for exhaust manifold	72
8.2.4. Exhaust turbocharger	73
8.2.5. Catalytic converter	75
9. Vacuum System	76
9.1. Design	76
9.1.1. Vacuum pump	77
10. Fuel System	78
10.1. Overview	78
10.1.1. Low pressure fuel sensor	79
10.1.2. High pressure fuel pumps	80
10.1.3. Fuel Injectors	82
11. Cooling System	87
11.1. Overview	87
11.2. Engine cooling	90
11.2.1. Coolant passages	92
11.2.2. Cooling circuit, exhaust turbochargers	93
11.3. Charge air cooling	95
12. Engine Electrical System	97
12.1. Electrical system connection	97

S55 Engine

Contents

12.1.1.	Overview.....	97
12.1.2.	System wiring diagrams.....	98
12.1.3.	Engine control unit.....	101
12.2.	Functions.....	101
12.2.1.	Fuel supply.....	101
12.2.2.	Charging pressure control.....	101
12.3.	Sensors.....	102
12.3.1.	Crankshaft sensor.....	102
12.3.2.	Ignition coil and spark plug.....	103
12.3.3.	Oil pressure sensor.....	104
12.3.4.	Oxygen sensors.....	104
12.3.5.	Hot film air mass meter.....	106
12.4.	Actuators.....	106
12.4.1.	Valvetronic servomotor.....	106
12.4.2.	High-pressure fuel injection valve.....	108
13.	Service Information.....	111
13.1.	Engine mechanics.....	111
13.1.1.	Engine housing.....	111
13.2.	Fuel preparation.....	112
13.2.1.	Overview.....	112

S55 Engine

1. Introduction

1.1. Highlights

The S55 engine is the successor to the S65 engine. Similar to the engines in the X5M, X6M, F1x M5/M6 and F06 M6 with S63 engine, the S55 is based on a production engine of BMW AG. As the engine identification highlights, the S55 engine is based on the N55 engine.

In contrast to the previous model, with its V8 naturally aspirated engine, the new BMW M3 and M4 Coupé are driven by a 3.0 liter, 6 cylinder gasoline engine with M TwinPower turbo technology. Technical updates and M GmbH modifications make the engine suitable for motor racing.

Thanks to turbocharging and the high-speed concept, the new M engine impresses with an unforeseen power development of 317 kW/425 HP and, in contrast to the S65, is readily available at considerably lower engine speeds. The maximum torque, a sign of the power development felt by the driver, increased by 37% from 400 Nm/295 lb-ft to 550 Nm/406 lb-ft, and is available across almost the entire usable engine speed range. Even though the S55 has increased power output, with the help of BMW EfficientDynamics measures, fuel consumption and CO₂ emissions were reduced by 28% and 26% respectively.

As the S55 engine is based on the N55 engine, 75% of the engine components were adopted from the N55 production engine and the other 25% of the engine components are new developments. All the technical data is above that of the predecessor.

The S55 engine also contributes to the overall concept of intelligent lightweight construction in the F80/F82. Through the intelligent use of material, the weight of the S55 engine was reduced by 3% in comparison to the S65 engine.

S55 Engine

1. Introduction

1.1.1. Technical data



T014-0192

S55 engine, overall view

Model	Unit	E92 M3***	F80/F82***
Engine		S65B4000	S55B30T0
Design		V8	R6
Displacement	[cm ³]	3,999	2,979
Bore hole/Stroke	[mm]	92/75.2	84.0/89.6
Power at speed	[kW / HP] [rpm]	309 / 414 8,300	317 / 425 5,500 - 7,300
Power output per liter	[kW/l]	77.3	106.4
Torque at speed	[Nm/lb-ft] [rpm]	400 / 295 3,900	550 / 406 1,850 - 5,500
Compression ratio	[ε]	12 : 1	10.2 : 1
Valves per cylinder		4	4
Fuel consumption	[l/100 km]	11.2	8.8 8.3***
CO₂ emissions	[grams per kilometre]	263	204 194***

S55 Engine

1. Introduction

Model	Unit	E92 M3***	F80/F82***
Digital Engine Electronics		MS S60	MEVD17.2.G
Exhaust emissions legislation		LEV II	ULEV 2
Engine weight	[kg/lbs]	212 / 467	205 / 452
Maximum speed	[km/h / mph]	250* / 155*	250* / 155*
Acceleration 0–60 mph	[s]	4.6	4.1 3.9***
Vehicle curb weight US Vehicle	[kg/lbs]	1,600 / 2527 1,675 / 3692	F80 1,606 / 3540** 1,631 / 3595*** F82 1,601 / 3529** 1,626 / 3584 ***

* = Electronically regulated

** = Manual gearbox

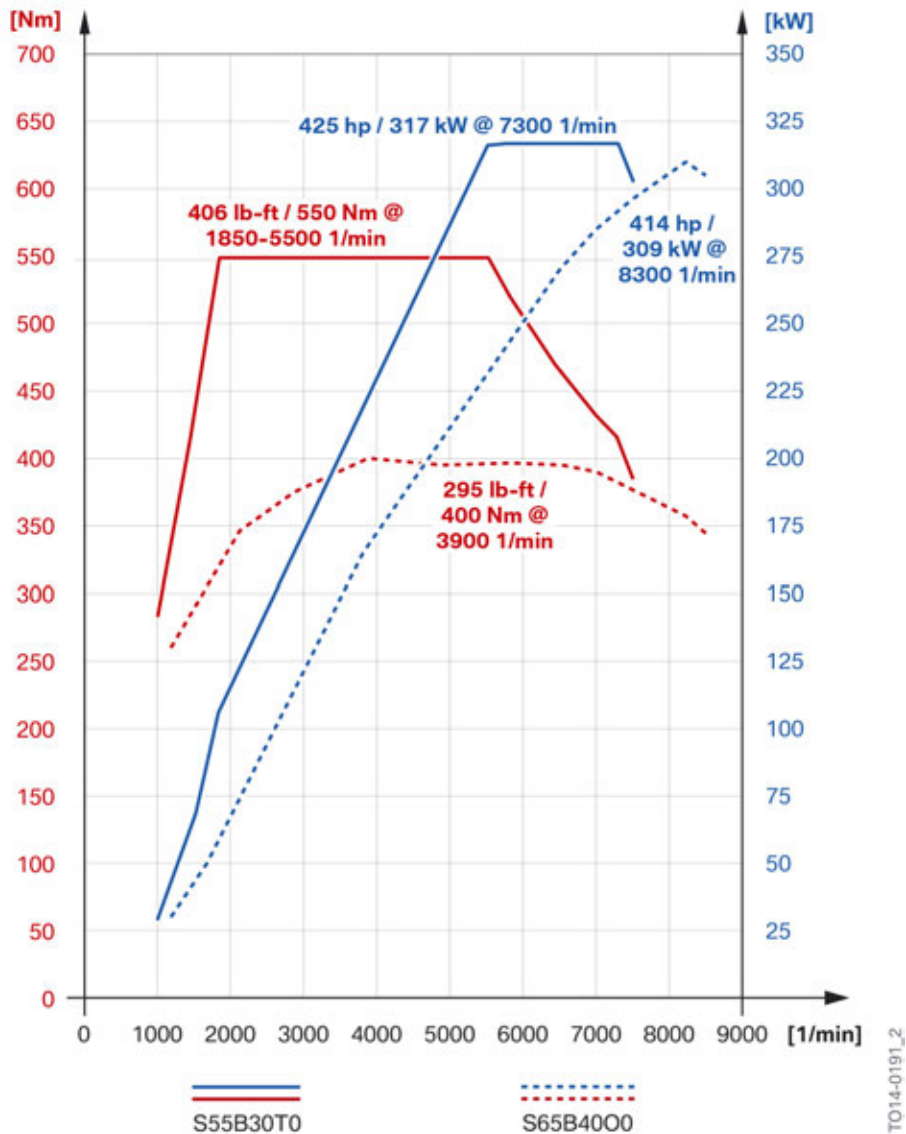
*** = with M Double-clutch Transmission with Drivelogic (SA 2MK)

S55 Engine

1. Introduction

1.1.2. Full load diagram

In comparison to the predecessor, the S55 engine features lower fuel consumption with higher power and torque output.



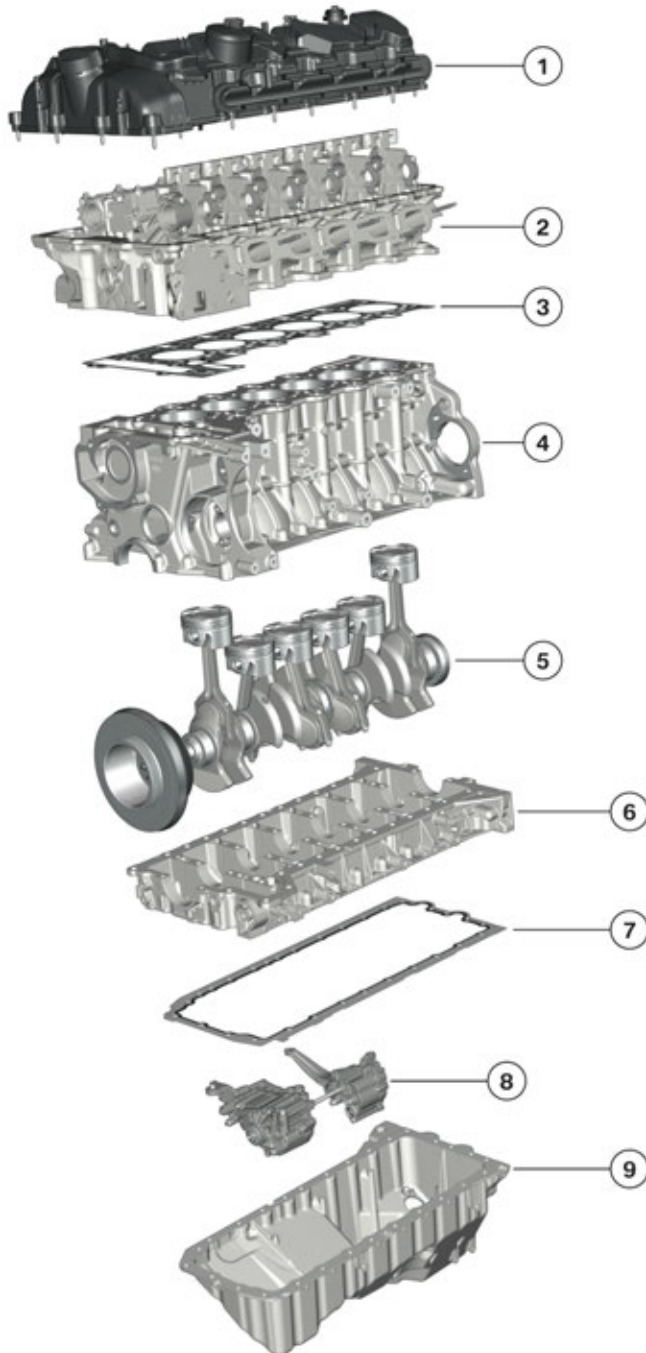
Full load diagram E9x M3 with S65B40 engine in comparison to the F80/F82 M3/M4 Coupé with S55B30T0 engine

S55 Engine

1. Introduction

1.2. S55/N55 new features/changes

1.2.1. Overview



S55 engine, overview

TO14-0246

S55 Engine

1. Introduction

Index	Explanation
1	Cylinder head cover
2	Cylinder head
3	Cylinder head gasket
4	Crankcase
5	Crankshaft drive
6	Bedplate
7	Engine oil sump gasket
8	Oil supply
9	Oil pan

1.2.2. Comparison of the N55 engine/S55 engine

Engine Mechanics

Component	New development	Identical in concept	Comment
Cylinder head cover		●	Deletion of vacuum reservoir Crankcase ventilation same as N55 engine
Cylinder head gasket		●	Revision of the cylinder head gasket, at water through-passages for higher coolant flow rate in the S55 engine
Crankcase	●		Modified for bi-turbo Closed Deck design Cylinder walls are LDS-coated Weight saving of approx. 5 lbs
Crankshaft with bearings	●		Weight saving of approx. 4 lbs in comparison to the N55B3000 (M235i) steel crankshaft Modification of main bearings and crankshaft to the high-speed concept
Connecting rod		●	Connecting rod bore hole in small connecting rod eye Lead-free connecting rod bearing shells Common part N20–N55 engine
Piston and wrist pin	●		Modifying of the piston and wrist pin to the high-speed concept

S55 Engine

1. Introduction

Valve Gear

Component	New development	Identical in concept	Comment
Intake valves and exhaust valves	●		Material change
VANOS		●	Solenoid valves with integrated non-return valve and 3 strainers Increased adjustment speed and reduced susceptibility to dirt
Fully variable valve lift adjustment		●	Integrated in the cylinder head and revised Brushless servomotor (3rd generation) Position sensor for eccentric shaft integrated in the servomotor Optimization of work curve for the valve opening, modified to the high-speed concept

Belt Drive and Auxiliary Components

Component	New development	Identical in concept	Comment
Belt drive		●	Vibration damper for adaptation to the high-speed concept Modified for the powertrain, mechanical coolant pump Additional belt tensioner between crankshaft and a/c compressor

Oil Supply

Component	New development	Identical in concept	Comment
Oil supply		●	Magnesium oil pan, weight saving of approx. 2.2 lbs Additional internal oil pan cover Oil pump with tandem output Additional oil extraction at front with 2nd oil pump Additional oil extraction, exhaust turbocharger Oil filter module

S55 Engine

1. Introduction

Air Intake and Exhaust Emission systems

Component	New development	Identical in concept	Comment
Exhaust turbocharger	●		Bi-exhaust turbocharger with electrical wastegate valve Mono-scroll concept Two exhaust manifolds and two exhaust turbochargers, each bank has its own unit (manifold/turbocharger).
Air intake duct	●		New air intake duct for use of indirect charge air cooling New clean air ducts Modified intake silencer
Exhaust system	●		Optimized for minimal exhaust gas pressure Electrical exhaust flaps Active Sound Design (ASD) in the passenger compartment
Heat shields Upstream catalytic converter	●		Heat shields made from AlMg3 Weight saving of approx. 3.3 lbs

Vacuum System

Component	New development	Identical in concept	Comment
Vacuum pump		●	Revised, similar to N55 engine Single-stage vacuum pump Fixture for high pressure pumps

Fuel System

Component	New development	Identical in concept	Comment
Injectors		●	Solenoid valve injectors adapted to ULEV2 Injectors for CVO support for ULEV2
High pressure pump	●		Double high pressure pump

S55 Engine

1. Introduction

Cooling System

Component	New development	Identical in concept	Comment
High-temperature circuit for engine cooling	●		Revised for high-performance operation without power restriction Mechanical coolant pump Additional electric coolant pump for exhaust turbochargers Map thermostat
Low-temperature circuit for charge air cooling	●		Indirect charge air cooling with 2 heat exchangers Separate cooling water circuit Electric coolant pump

Engine Electrical System

Component	New development	Identical in concept	Comment
Digital Engine Electronics (DME)		●	MEVD 17.2.G with CVO function Secured at the intake air system and cooled via the intake air Software adaptation to S55 engine
Hot film air mass meter		●	Hot film air mass meter 7
Oxygen sensor		●	Adopted from the N55 engine (LSU ADV) Monitoring sensor LSF XFOUR/ULEV2
Spark plugs	●		New spark plug for S55 engine

S55 Engine

2. Engine History

2.1. Variants of the BMW M3 engines

Engine	Version	Series	Displacement in cm ³	Stroke/ Bore hole in mm	Power in kW/HP at	Torque in Nm at
S14B23	US	E30	2,302	84.0 / 93.4	143 / 192 6,750	230 4,750
S50B30	US	E36	2,990	85.8 / 86.06	177 / 240 6,000	305 4,250
S52B32	US	E36	3,152	89.6 / 86.4	177 / 240 6,000	320 3,800
S54B32	US	E46	3,246	91.0 / 87.0	248 / 333 7,900	355 4,900
S65B40	US	E9x	3,999	75.2 / 92.0	309 / 414 8,300	400 3,900

S55 Engine

3. Engine Identification

3.1. Engine designation and engine identification

3.1.1. Engine designation

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

The technical documentation also contains the short form of the engine designation S55, which only indicates the engine type.

Position	Meaning	Index/Explanation
1	Engine developer	M, N = BMW Group P = BMW M Sport S = BMW M GmbH W = External developer
2	Engine type	1 = R4 (e.g. N12) 4 = R4 (e.g. N43) 5 = R6 (e.g. N53) 6 = V8 (e.g. N63) 7 = V12 (e.g. N73) 8 = V10 (e.g. S85)
3	Change to the basic engine concept	0 = Basic design 1 to 9 = Modifications, e.g. to 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 +
6	Displacement in 1/10 liter	8 = 0.8 liters = 1.8 liters
7	Performance class	K = Lowest U = Lower M = Medium O = Upper (standard) T = Top S = Super
8	Revision relevant to approval	0 = New design 1–9 = Revision

S55 Engine

3. Engine Identification

Breakdown of the S55 engine designation

Index	Explanation
S	BMW M GmbH development
5	6-cylinder in-line engine
5	Engine with direct fuel injection, Valvetronic and exhaust turbocharger
B	gasoline engine, longitudinal installation
30	3.0 liter displacement
T	TOP performance class
0	New development

S55 Engine

4. Engine Mechanical

4.1. Engine housing

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

4.1.1. Engine block

The engine block is made from die-cast aluminum alloy (AlSi 7Cu0.5Mg) and consists of a crankcase and bedplate.

Crankcase and bedplate

The crankcase of the S55 engine is designed as a **Closed Deck crankcase**, while the N55 is an open deck design. It does not have moulded cylinder liners made from cast iron like the N55 engine, but LDS-coated aluminium cylinder liners. For more information on electric arc wire spraying (LDS) please refer to the "ST1111 N20 Engine" Technical Reference Manual.

This material combination lightened the S55 engine block by 2.2kg/4.85lbs in comparison to the production engine (N55). This weight savings benefits the intelligent lightweight construction of the F80/F82-M3/M4 Coupé.

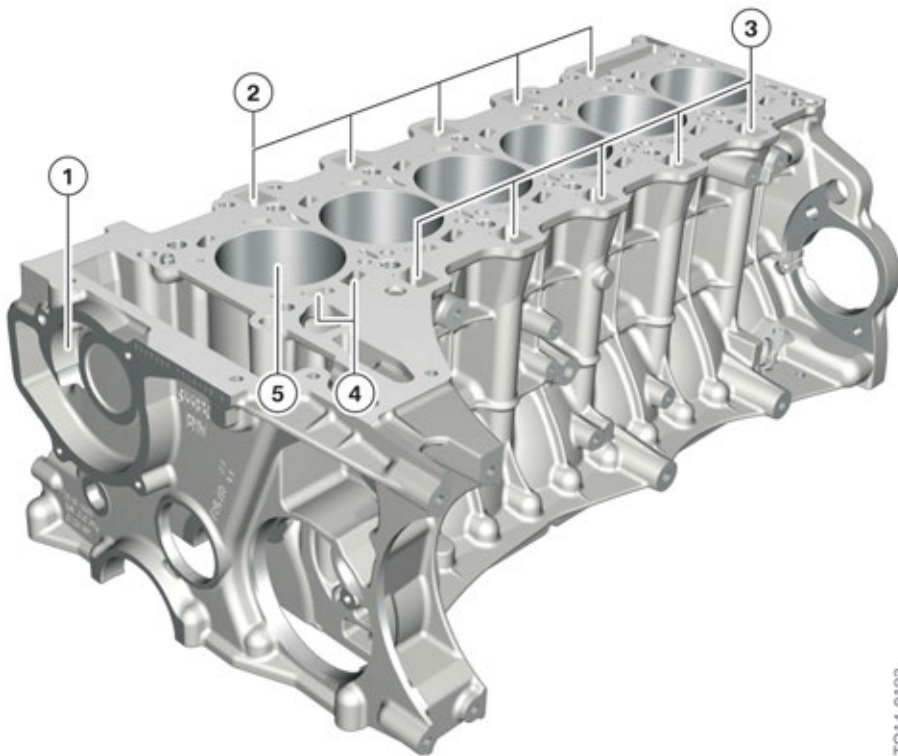
With a closed deck crankcase design, the openings for the crankcase cover plate are reduced and result in the increase of overall crankcase rigidity.

As a mechanical coolant pump is used in the S55 engine, the coolant ducts and the fixture for the coolant pump are inserted in the crankcase.

In addition, the mounting points for the S55 engine-specific auxiliary components have been adapted to the crankcase.

S55 Engine

4. Engine Mechanical



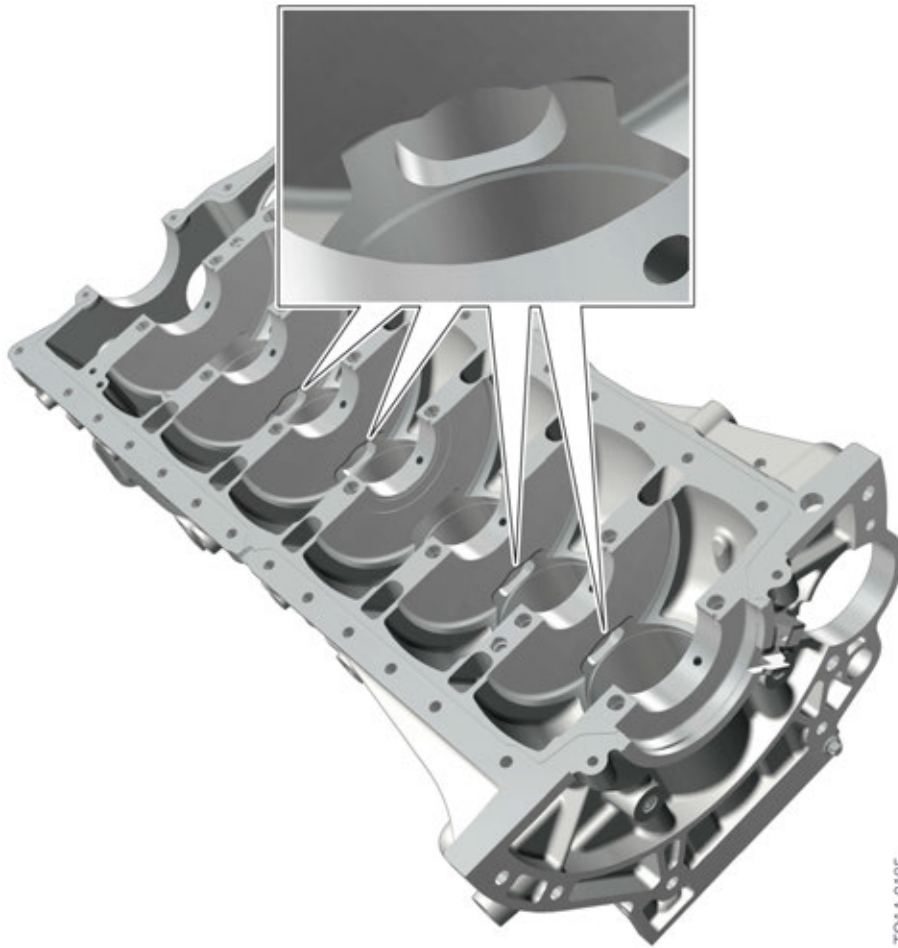
TO14-0193

S55 engine, Closed Deck crankcase

Index	Explanation
1	Fixture, engine coolant pump
2	Engine oil return, exhaust side
3	Engine oil return, intake side
4	Coolant ducts
5	Cylinder liners, LDS-coated

S55 Engine

4. Engine Mechanical

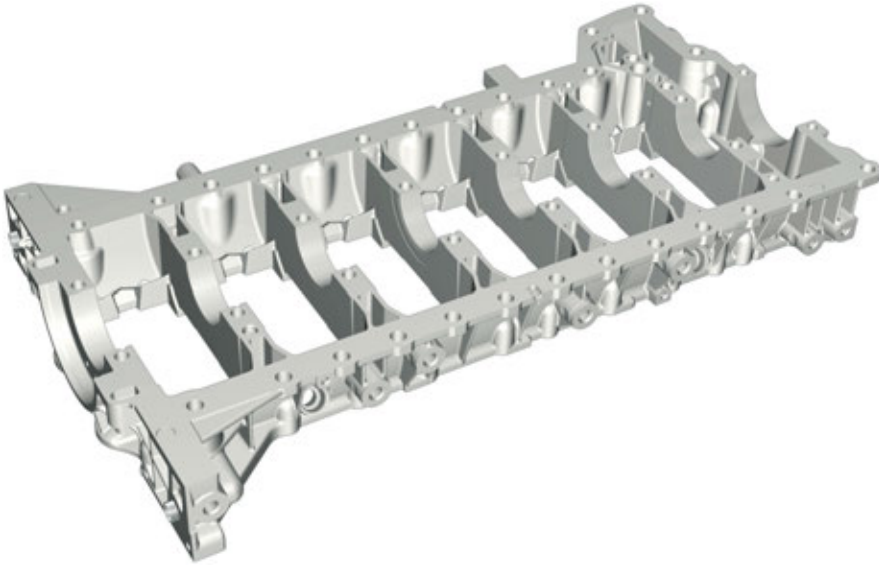


S55 engine, ventilation holes in the crankcase

The crankcase has longitudinal ventilation holes bored between the lower chambers of the cylinders. These ventilation holes improve the pressure equalization of the oscillating air columns created by the up and down strokes of the pistons.

S55 Engine

4. Engine Mechanical



TO14-0194

S55 engine, bedplate from above

The crankcase and bedplate also have the necessary connections for the two exhaust turbocharger coolant and oil supply/return lines.

S55 Engine

4. Engine Mechanical

4.1.2. Cylinder head

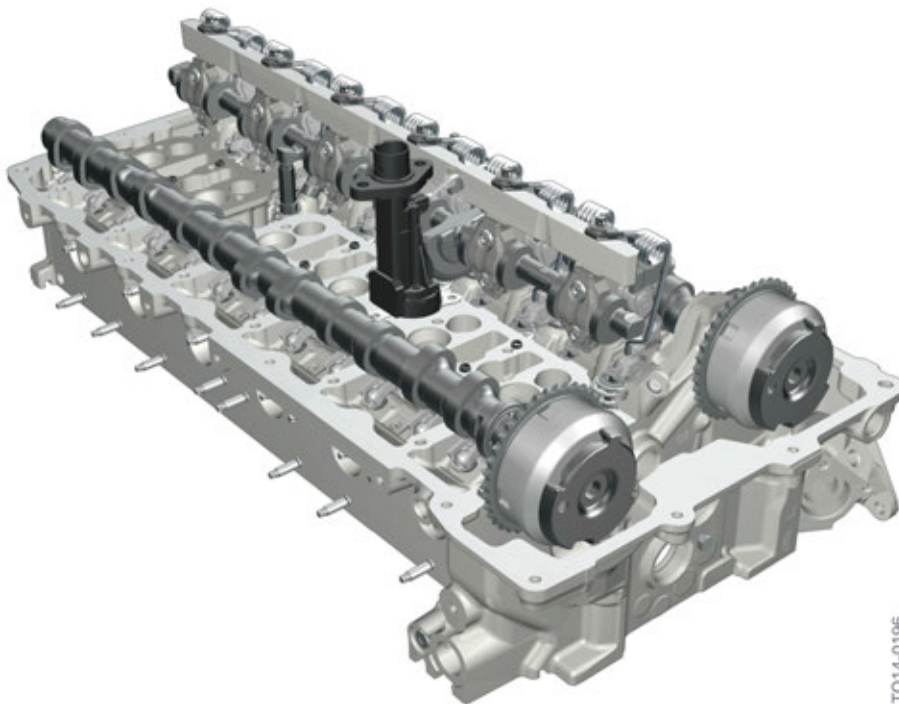
The cylinder head of the S55 engine has been modified to motor racing requirements. The basic structure of the cylinder head is similar to that of the N55 engine. The S55 6-cylinder engine also uses direct fuel injection with exhaust turbocharging and Valvetronic. The cylinder head is very compact and is equipped with the 3rd generation Valvetronic.



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

TVDI technology reduces CO₂ emission and fuel consumption by 3–6%.

The connections for the VANOS non-return valves were removed like in the N55 engine, as they have been integrated in the solenoid valves. The cylinder head also features coolant passages around the injectors for indirect cooling.



S55 engine, cylinder head

S55 Engine

4. Engine Mechanical

4.1.3. Cylinder head cover

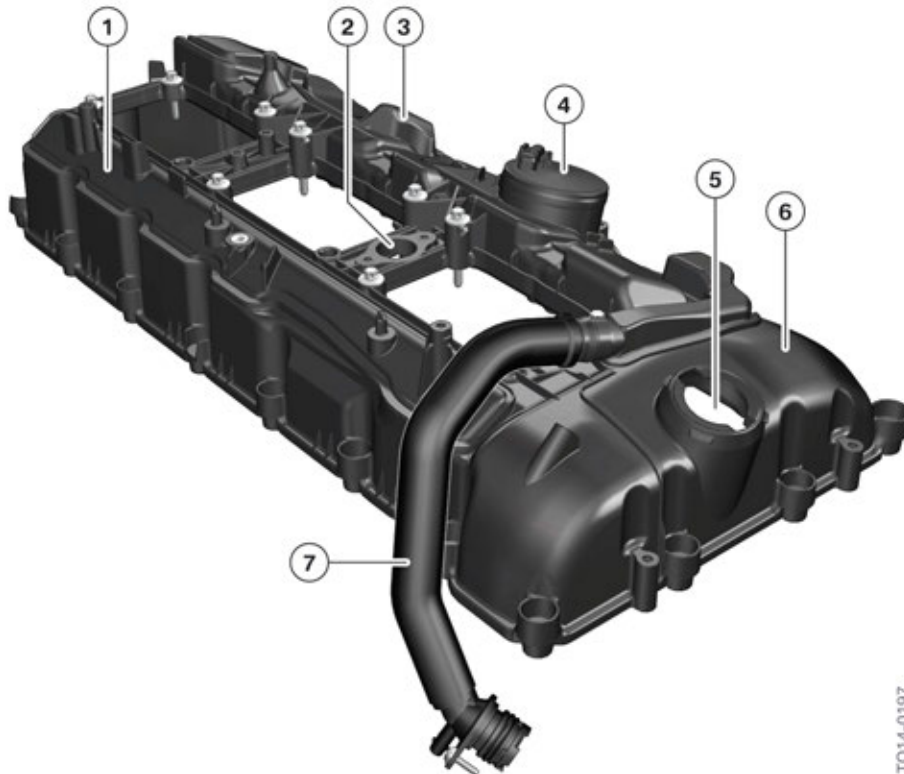
Design

The cylinder head cover is a modified part from the N55 engine. Unlike the N55 cylinder head cover, the S55 cylinder head cover no longer has a built in accumulator for the vacuum system.

The general operating principle of the crankcase ventilation in the cylinder head cover has not changed from a technical viewpoint.

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

The S55 engine is equipped with a vacuum-controlled crankcase ventilation system. A vacuum of approximately 38 mbar is regulated.



TO14-0197

S55 engine, cylinder head cover with crankcase ventilation

S55 Engine

4. Engine Mechanical

Index	Explanation
1	Housing without vacuum reservoir
2	Connection, Valvetronic servomotor
3	Blow-by gas duct with settling chamber, impact plate, pressure control valve and non-return valves
4	Pressure control valve
5	Oil filling lid opening
6	Housing, chain drive
7	Crankcase ventilation line



The crankcase ventilation line cannot be replaced individually, only together with the cylinder head cover.

The blow-by gases reach a settling chamber in the cylinder head cover through an opening in the rear of the cover. The blow-by gases are then directed through holes on an impact plate which the oil hits, at a high flow rate, and drains down. The blow-by gases, cleaned of oil, now flow via the pressure control valve through the non return valves (depending on the operating mode) to the charge air intake pipe before the exhaust turbocharger or to the intake manifold before the intake valves. The separated oil is directed via return duct to the oil sump.

Function

Naturally Aspirated Mode

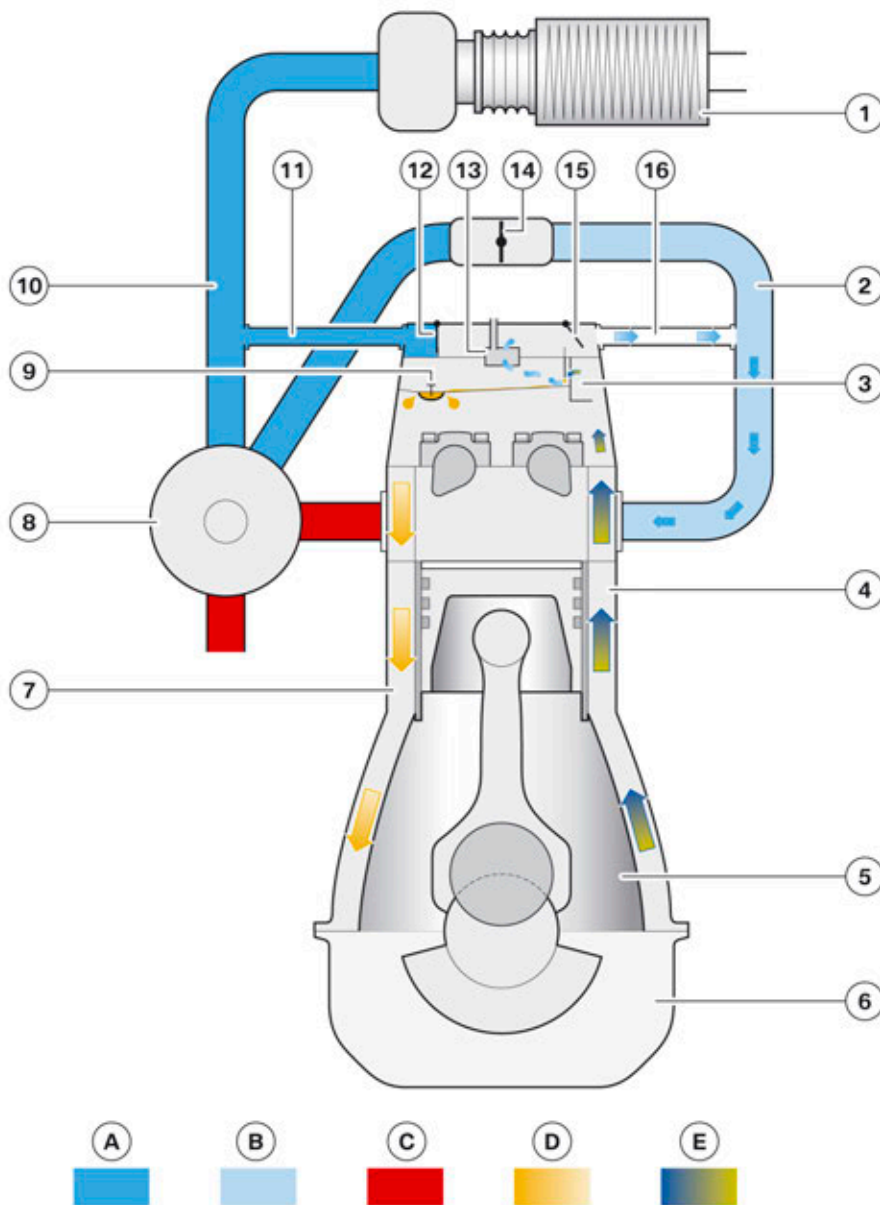
The standard function can only be utilized while there is a vacuum in the intake manifold, i.e. in naturally aspirated mode.

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

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

S55 Engine

4. Engine Mechanical



S55 engine, 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

S55 Engine

4. Engine Mechanical

Index	Explanation
3	Perforated plates
4	Oil return duct
5	Crank chamber
6	Oil sump
7	Oil return duct
8	Exhaust turbocharger
9	Oil drainage valve
10	Charge-air intake line
11	Hose for charge-air intake line
12	Non-return valve
13	Pressure control valve
14	Throttle valve
15	Non-return valve
16	Duct in cylinder head and cylinder head cover

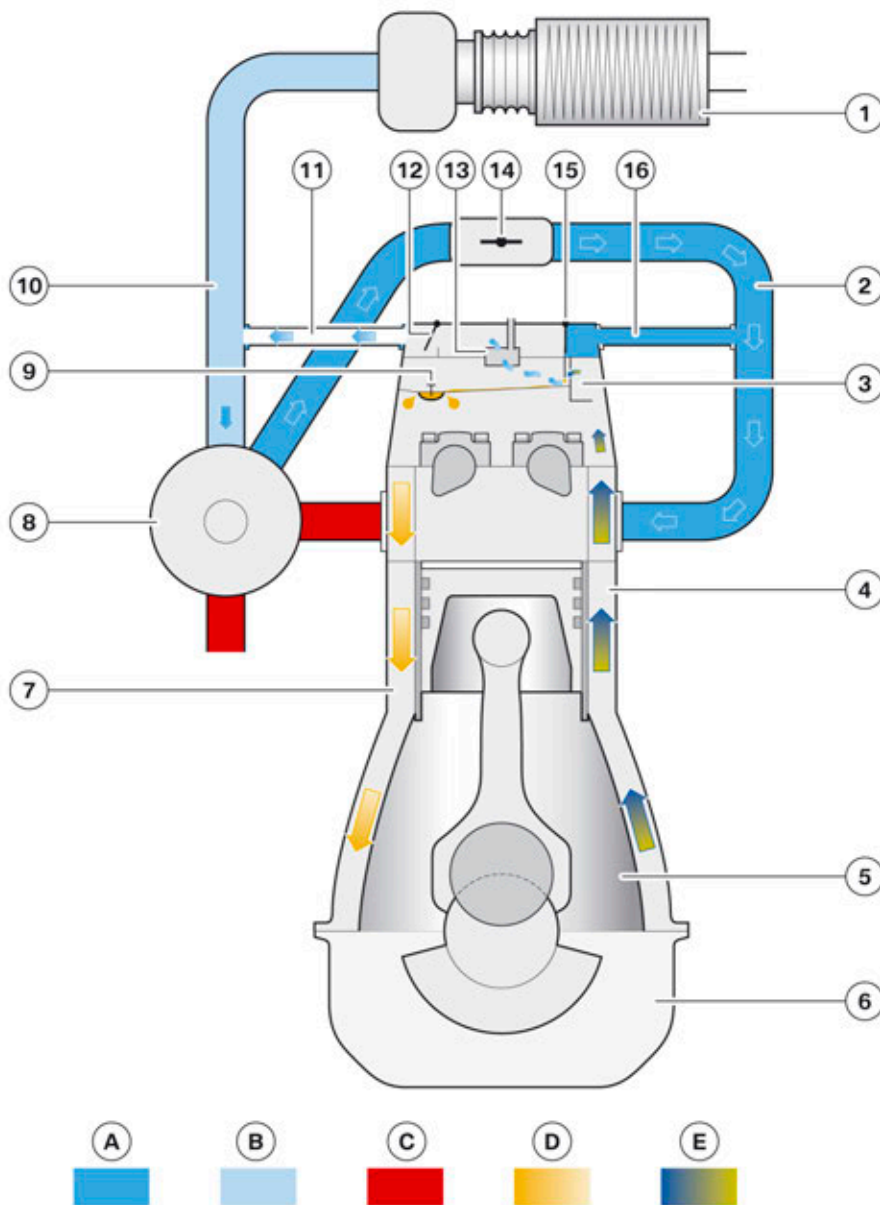
Boost Mode

Once the pressure in the intake manifold rises, it is no longer possible for the blow-by gases to be introduced via passages in the cylinder head. Otherwise, this would 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 increased demand for fresh air 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 to extract the blow-by gases via the pressure control valve.

S55 Engine

4. Engine Mechanical



S55 engine, crankcase ventilation, turbocharged mode

Index	Explanation
A	High pressure
B	Vacuum
C	Exhaust gas
D	Oil
E	Blow-by gas
1	Air cleaner
2	Intake manifold

S55 Engine

4. Engine Mechanical

Index	Explanation
3	Perforated plates
4	Oil return duct
5	Crank chamber
6	Oil sump
7	Oil return duct
8	Exhaust turbocharger
9	Oil drainage valve
10	Charge-air intake line
11	Hose for charge-air intake line
12	Non-return valve
13	Pressure control valve
14	Throttle valve
15	Non-return valve
16	Duct in cylinder head and cylinder head cover



If there is a complaint of high oil consumption and oil is found in the turbocharger, it should not be immediately concluded that the turbocharger is faulty. If oil is present in the fresh air pipe before the turbochargers, then the entire engine must be checked for leaks. The cause of an excessive blow-by gas flow rate may be faulty gaskets or crankshaft seals. Loose crankshaft seals may generate oil consumption of up to 3l/1000 km (3.2qt/621miles).

S55 Engine

4. Engine Mechanical

4.1.4. Engine cover

The engine cover was modified to the S55 engine. The engine cover consists of two independent components:

- the ignition coil cover
- the corrosion protection cover

With this design, the engine cover weighs 960 grams (2.1lbs) less than the N55 engine cover.



S55 engine, engine cover

Index	Explanation
1	Corrosion protection cover
2	Ignition coil cover

S55 Engine

4. Engine Mechanical

4.1.5. Oil pan

The oil pan of the S55 engine is made from magnesium and results in a weight savings of approximately 1000 grams (2.2lbs) in comparison to the aluminium oil pan in the N55 engine. An additional cover in the oil pan restricts the oil movements during longitudinal and lateral acceleration.



S55 engine, oil pan

Index	Explanation
A	Oil pan, inner
B	Oil pan from the outside
1	Additional oil pan lid
2	Oil separator

The sealing of the oil pan with the crankcase is done with a metal gasket with rubber inserts and aluminium screws. Due to the electrochemical corrosion between aluminium and magnesium the same operations and repair instructions must be observed as for other engines with these material combinations.

A cover plate is installed between the crankcase/oil pan and transmission to protect against corrosion.



Do not reuse aluminium screws. They must be replaced after single use.

S55 Engine

4. Engine Mechanical

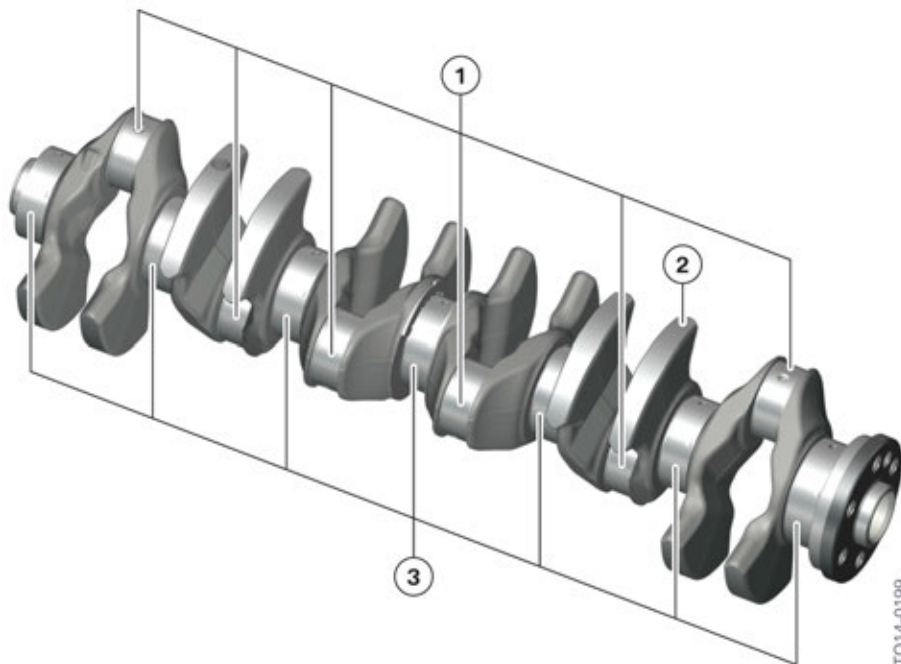
4.2. Crankshaft

4.2.1. Crankshaft with bearings

Crankshaft

While maintaining a lightweight construction, the forged steel crankshaft was adapted to the high-speed concept and increased power. At 21.1 kg (46.5 lbs), the crankshaft of the S55 engine is approximately 1.8 kg (4 lbs) lighter than the steel crankshaft of the N5530B0 (M235i) engine and 1 kg (2.2 lbs) heavier than the cast iron crankshaft of the N55B30M0 (standard) engine. The crankshaft is made from a steel alloy (42CrMoS4 Mod) and is then nitrocarburized (hardened). The counterweight arrangement is symmetrical, while the cast iron N55 engine crankshaft counterweight arrangement is asymmetrical.

There is no increment wheel installed on the crankshaft, similar to the N55 engine. The crankshaft speed is determined by a magnetic wheel and crankshaft speed sensor, based on the hall principle. The timing chains are connected by a M18 central bolt.



S55 engine, crankshaft

Index	Explanation
1	Connecting rod bearing
2	Counterweights
3	Main bearing

S55 Engine

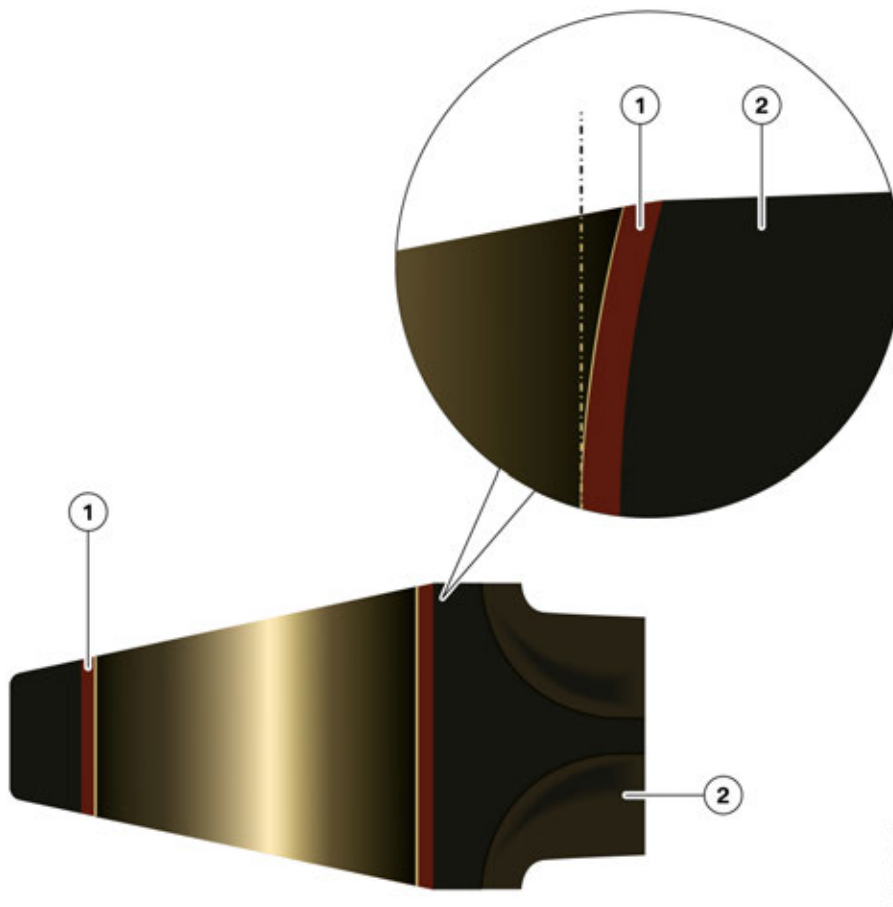
4. Engine Mechanical

Crankshaft main bearing

The crankshaft main bearings were modified, from the N55 engine, in order to satisfy the high-speed concept requirements. The bearings are lead-free. A three-material (Kolbenschmidt S703C) electroplated bearing is used for the lower bearing shells. For the upper bearing shells, a two-material bearing made from aluminium (Kolbenschmidt R25) is used. The thrust bearing is located at the fourth bearing position.

4.2.2. Connecting rod with bearing

The connecting rod of the S55 engine has an inside diameter of 144.35 mm. Like in the N20–N55 engines, the small end of the connecting rod has a specially shaped bore. It is machined wider on the lower edges. This design evenly distributes the force acting on the wrist pin over the entire surface of the rod bushing and reduces the load on the edges, as the piston moves downward, during the power stroke.



T008-2164

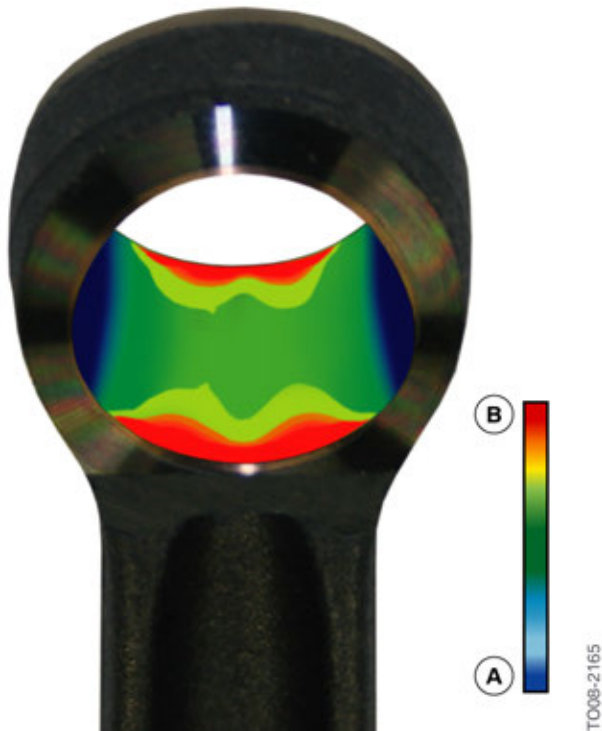
S55 engine, small connecting rod end

Index	Explanation
1	Bushing
2	Connecting rod

S55 Engine

4. Engine Mechanical

The following graphic shows surface load on a standard connecting rod without a shaped bore. Due to the pressure on the piston during combustion, most of the force is transferred by the wrist pin to the edges of the small connecting rod bushing.



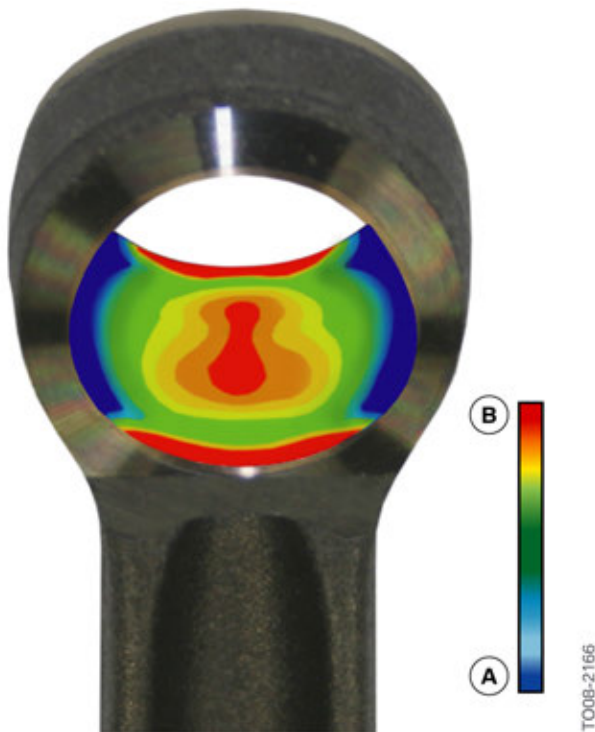
S55 engine, small connecting rod end without shaped bore

Index	Explanation
A	Low surface load
B	High surface load

The graphic below illustrates the small connecting rod end with the shaped bore. The force is distributed across a larger surface area and the load on the edge of the bushing is reduced considerably.

S55 Engine

4. Engine Mechanical



S55 engine, small connecting rod end with shaped bore

Index	Explanation
A	Low surface load
B	High surface load

Lead-free connecting rod bearing shells, like in the N20–N55 engine, are used for the large connecting rod ends. The rod side material G-488 is used and on the cap side the material G-444 is used.

The bolts for the S55, N55 and N54 engine connecting rods are the same (M9 x 47).

S55 Engine

4. Engine Mechanical



TO14-0248

S55 engine, connecting rod bearing

Index	Explanation
1	Piston
2	Connecting rod
3	Crankshaft
4	Connecting rod bearing

S55 Engine

4. Engine Mechanical

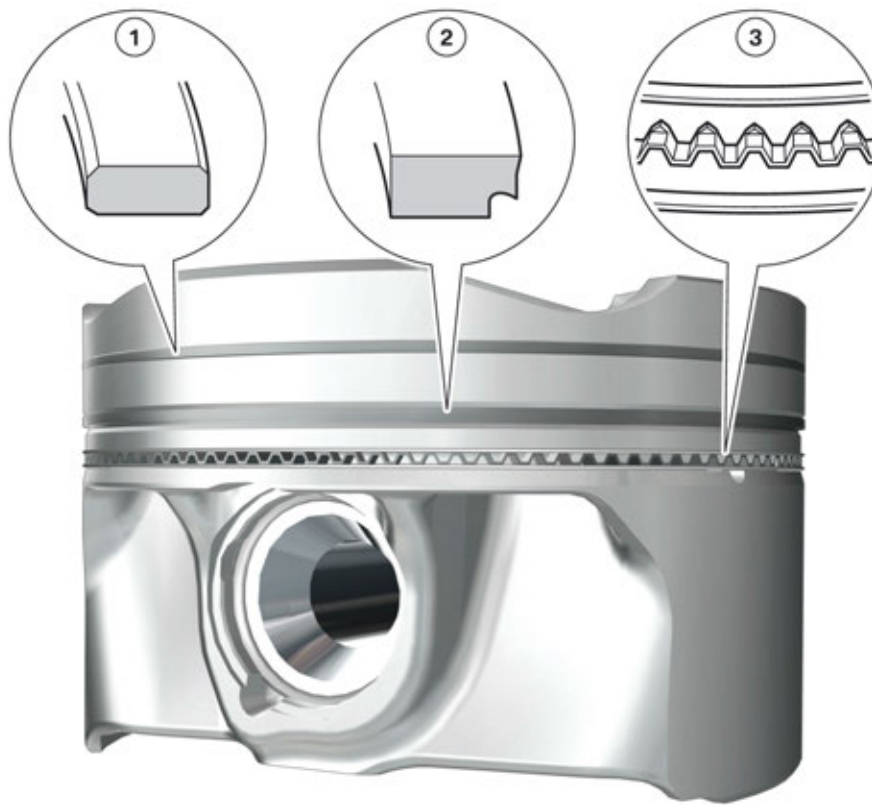
4.2.3. Piston and piston rings

The piston was modified in its styling and material properties to the higher requirements of the high-speed concept in the S55 engine.

A full slipper skirt piston manufactured by the Mahle company is used. The piston is made from an aluminium alloy (AlSi12Cu4Ni2Mg). This alloy is particularly suitable for high-performance gasoline engines.

The piston skirt is Grafal-coated. This is necessary due to the LDS-coated cylinder liners.

The piston diameter is 84 mm. The first piston ring is a nitride plain rectangular compression ring. The second piston ring is a taper-faced piston ring. The oil scraper ring is a nitride ES oil scraper ring.



S55 engine, piston with wrist pin and piston rings

Index	Explanation
1	Plain compression ring
2	Taper-faced piston ring
3	ES oil scraper ring

S55 Engine

4. Engine Mechanical

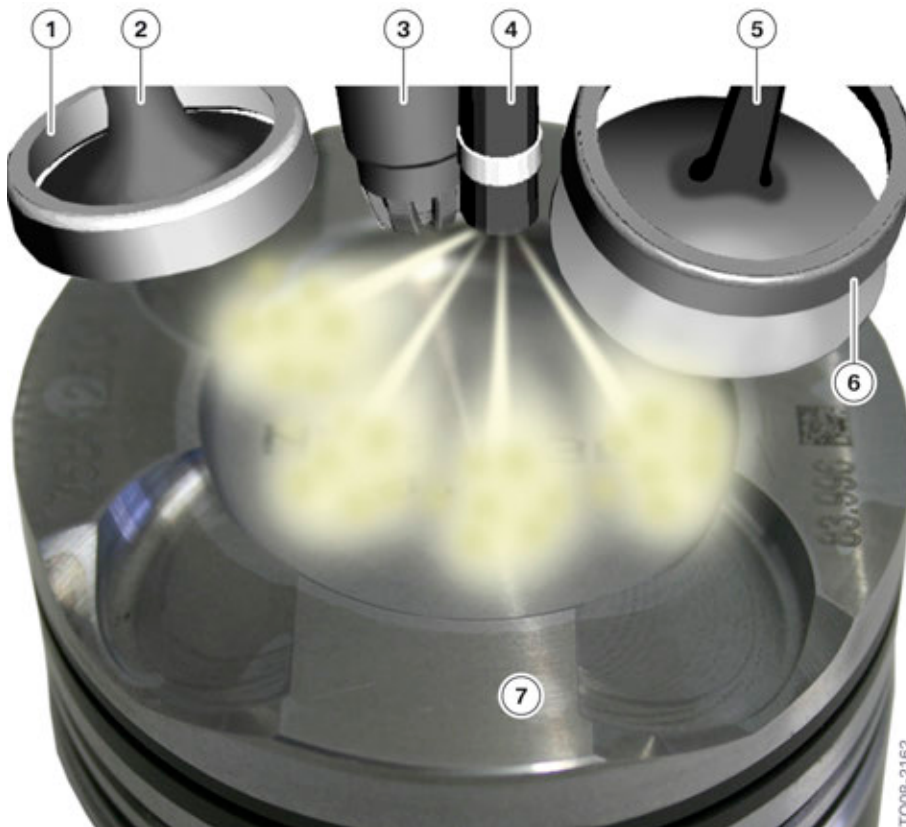
Wrist pin

The wrist pin was revised accordingly to the higher requirements in the S55 engine. The material and the strength was upgraded to satisfy the high-speed concept.

A wrist pin with restricted volume change and a 22 mm diameter is used. This wrist pin is made from a steel alloy (16MnCr5) and then case-hardened.

Combustion chamber geometry

The following graphic shows the arrangement of the individual components around the combustion chamber. From the graphic, one can see that the BMW high precision injection (HPI) is not used, but rather a Bosch solenoid valve fuel injector with a multi-hole nozzle. This fuel injector is specially adapted to the combination of turbocharging and Valvetronic III. For a clearer overview, a set of valves has been removed in the graphic.



S55 engine, combustion chamber with components

S55 Engine

4. Engine Mechanical

Index	Explanation
1	Valve seat, exhaust valve
2	Exhaust valve
3	Spark plug
4	Injector
5	Intake valve
6	Valve seat, intake valve
7	Piston

4.3. Camshaft drive

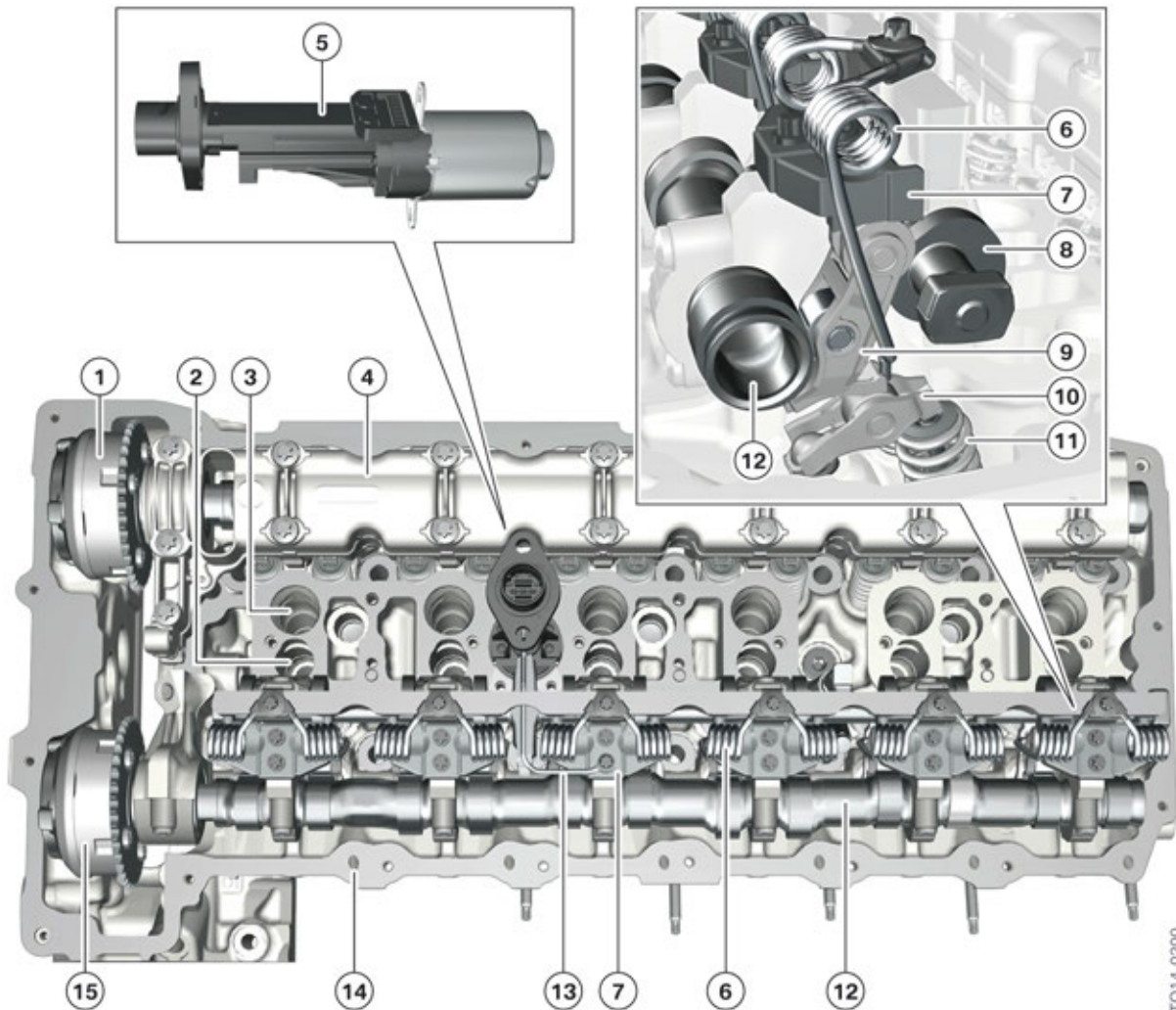
The camshaft drive corresponds to the camshaft drive of the N55 engine.

S55 Engine

5. Valvetrain

5.1. Design

The following graphic shows the design of the cylinder head on the S55 engine with Valvetronic III and direct fuel injection.



S55 engine, overview of valve gear

Index	Explanation
1	VANOS unit, exhaust camshaft
2	Injector shaft
3	Spark plug shaft
4	Exhaust-bearing strip
5	Valvetronic servomotor
6	Torsion spring
7	Gate

S55 Engine

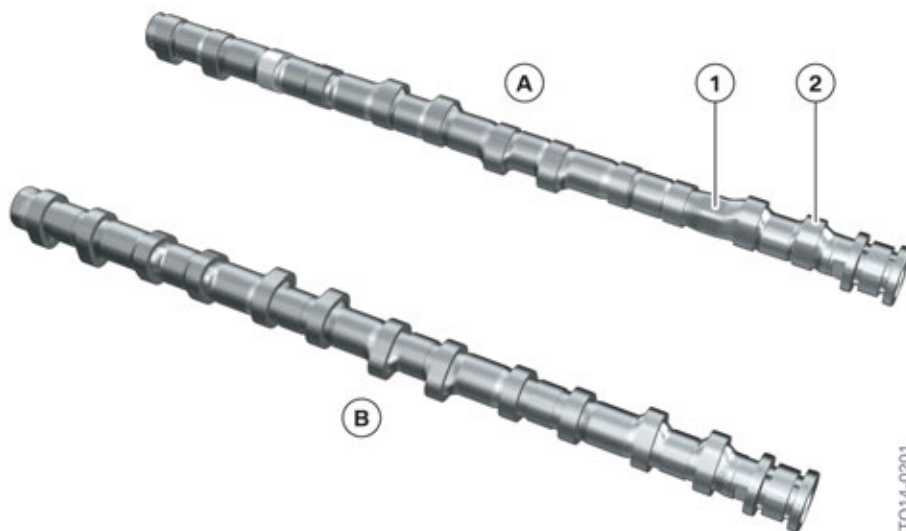
5. Valvetrain

Index	Explanation
8	Eccentric shaft
9	Intermediate lever
10	Roller cam follower
11	Valve spring
12	Intake camshaft
13	Oil spray nozzle
14	Passage for introduction of blow-by gas
15	VANOS unit, intake camshaft

5.1.1. Camshafts

In the N54 engine, cast or lightweight construction camshafts have been used simultaneously. In a N54 engine the use of lightweight construction camshafts and cast camshafts or a mixed installation is possible.

In the S55 engine, similar to the N55 engine, only lightweight construction camshafts are used. The lightweight construction camshafts for the S55 engine are manufactured by hydroforming. The exhaust camshaft has bearing races and is enclosed in a camshaft housing. Oil foaming during operation is reduced by the camshaft housing.



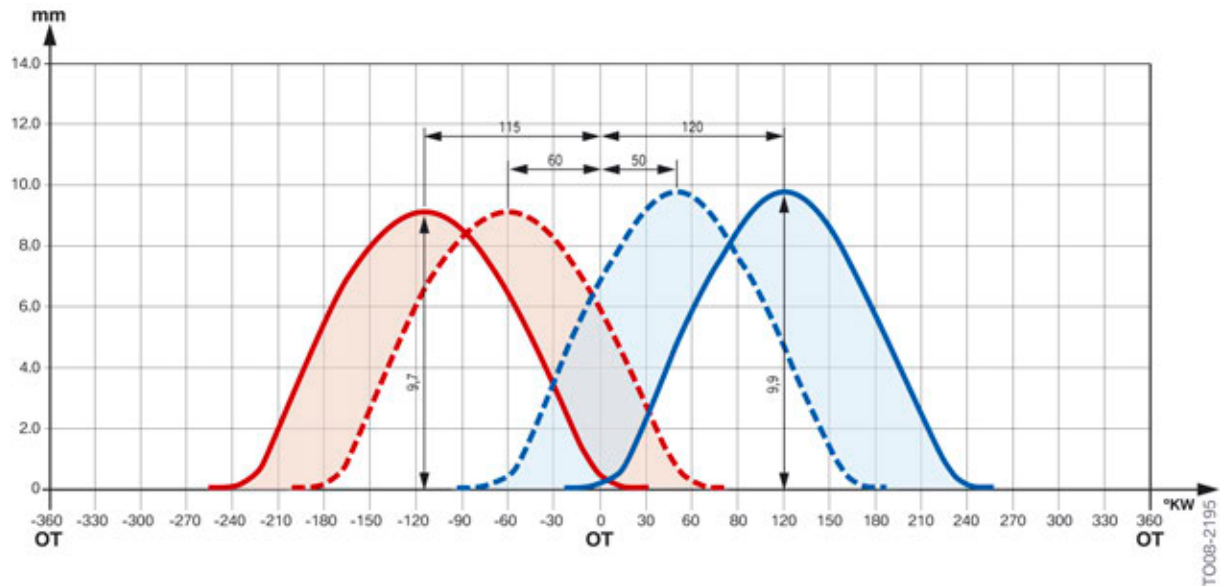
S55 engine, camshaft made from hydroforming

Index	Explanation
A	Intake camshaft
B	Exhaust camshaft
1	Corrugated tubing
2	Cam in shell shape

S55 Engine

5. Valvetrain

5.1.2. Timing



S55 engine, timing diagram

		N55B30M0	S55B30T0
Intake valve diameter	[mm]	32	32
Exhaust valve diameter	[mm]	28	28
Maximum valve lift, intake/exhaust valve	[mm]	9.9 / 9.7	9.9 / 9.7
Steering axis inclination, intake camshaft (VANOS adjustment range)	[crankshaft degrees]	70	70
Steering axis inclination, exhaust camshaft (VANOS adjustment range)	[crankshaft degrees]	55	55
Camshaft adjustment, intake	[crankshaft degrees]	120 - 50	120 - 50
Camshaft adjustment, exhaust	[crankshaft degrees]	115 - 60	115 - 60
Opening period Intake camshaft	[crankshaft degrees]	255	255
Opening period Exhaust camshaft	[crankshaft degrees]	261	261

S55 Engine

5. Valvetrain

5.1.3. Intake and exhaust valves

The valve stem of the intake valves has a diameter of 5 mm and the exhaust valves have a diameter of 6 mm. The reason for the larger diameter is that the exhaust valve is hollow and is filled with sodium, which improves heat transfer. In addition, the valve seat of the exhaust valve is reinforced.

5.1.4. Valve springs

Due to the different shaft diameters between the intake and exhaust valves, the valve springs are different.

S55 Engine

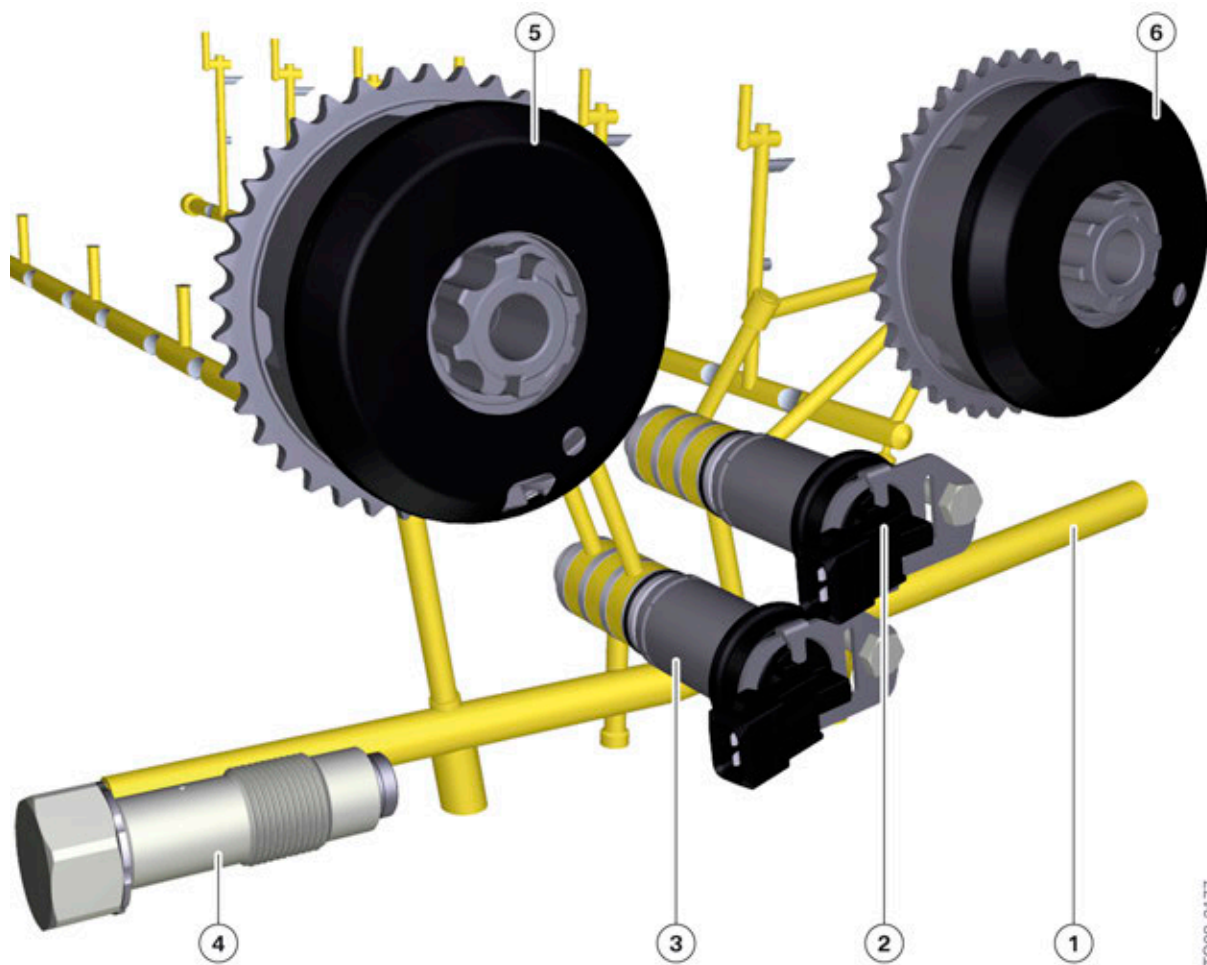
5. Valvetrain

5.2. Valvetronic

5.2.1. VANOS

Overview

The VANOS of the S55 engine corresponds in its design and function to that of the N55 engine. In the N55 engine the VANOS was optimized in comparison to the N54 engine. This optimization now provides for even faster VANOS unit adjustment speeds. The modification has also further reduced the system's susceptibility to fouling.



S55 engine, VANOS with oil supply

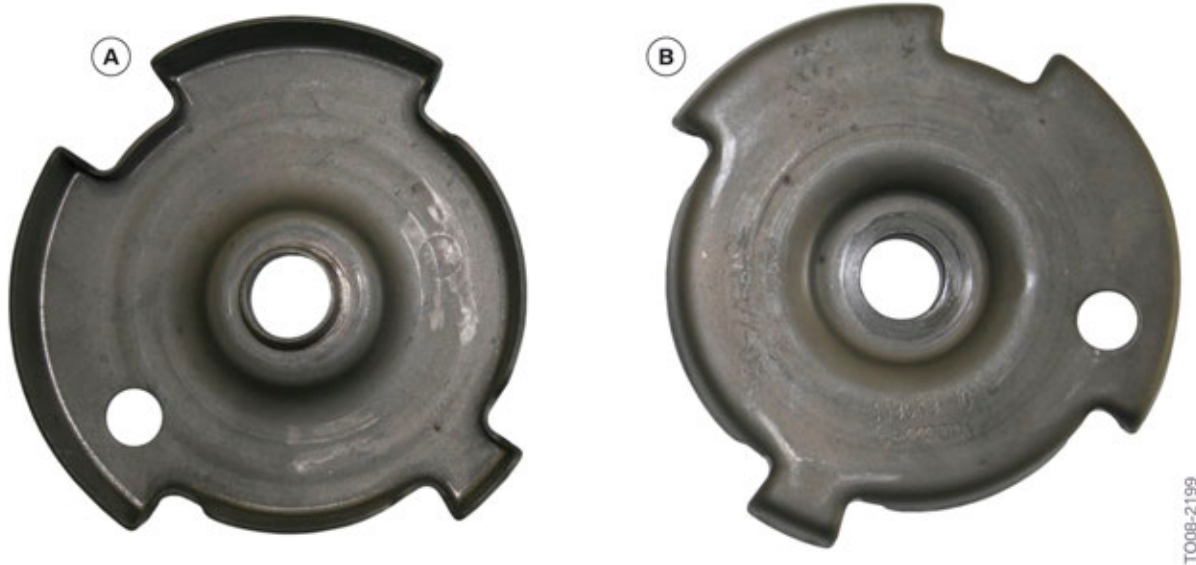
TO08-2177

S55 Engine

5. Valvetrain

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

The camshaft sensor wheels are now pure sheet metal “deep-drawn” parts and are no longer made from two parts. This measure increases the manufacturing accuracy and reduces the manufacturing costs.



S55 engine, camshaft sensor wheel

Index	Explanation
A	General view of rear side
B	General view of front

VANOS solenoid valves

The VANOS solenoid valves used in the N55 engine are identical to those in the S55 engine. Three strainers at each VANOS solenoid valve ensure trouble-free functioning and reliably prevent the VANOS solenoid valves from jamming due to dirt particles.

S55 Engine

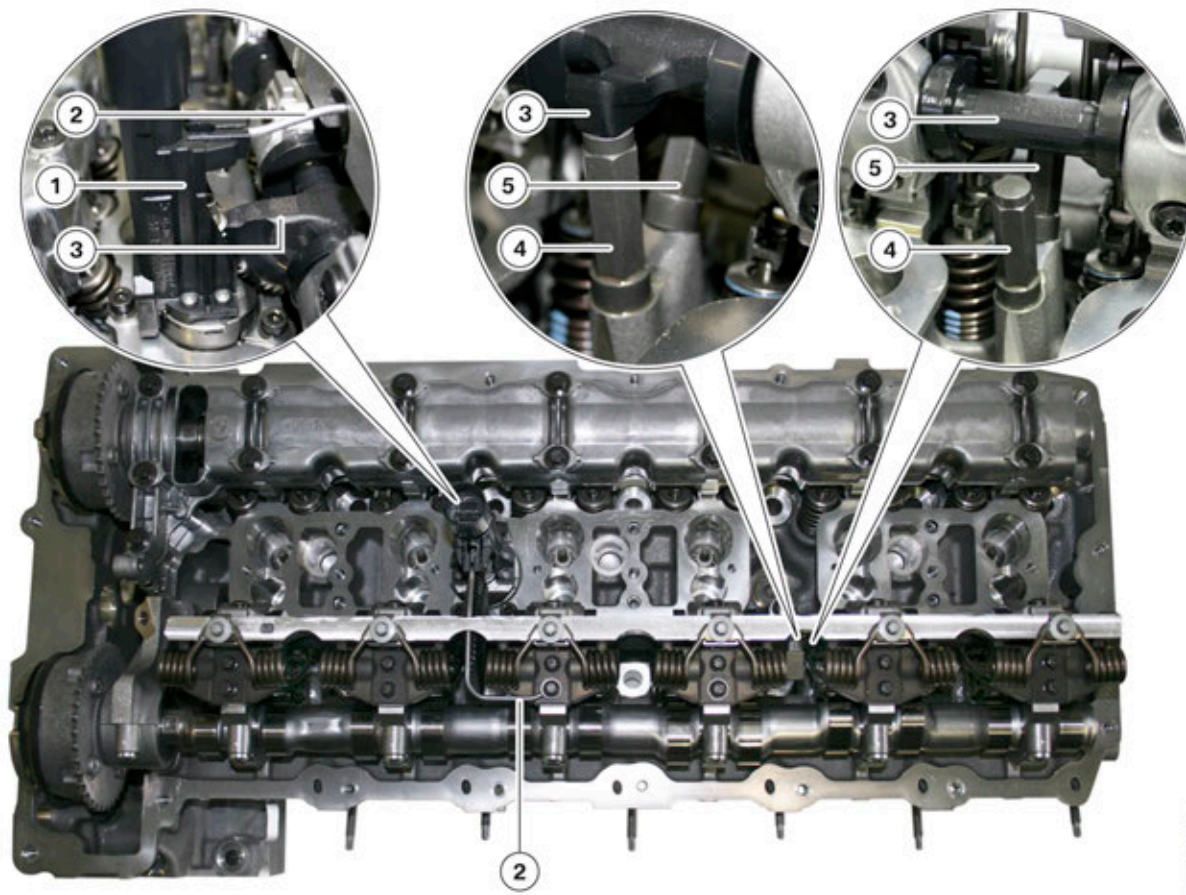
5. Valvetrain

5.2.2. Valve lift control

Overview

As can be seen from the following graphic, the installation location of the servomotor has not changed in comparison to the N55 engine. Another special feature is that the eccentric shaft sensor no longer sits at the eccentric shaft, but has been integrated in the servomotor.

Due to the higher engine speeds of up to 7,600 rpm, the work curve of the eccentric shaft has been modified.



S55 engine, valve lift control

Index	Explanation
1	Valvetronic servomotor
2	Oil spray nozzle
3	Eccentric shaft
4	Minimum limit position
5	Maximum limit position

S55 Engine

5. Valvetrain

Valvetronic III is used. The 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 the mixture formation.

Phasing

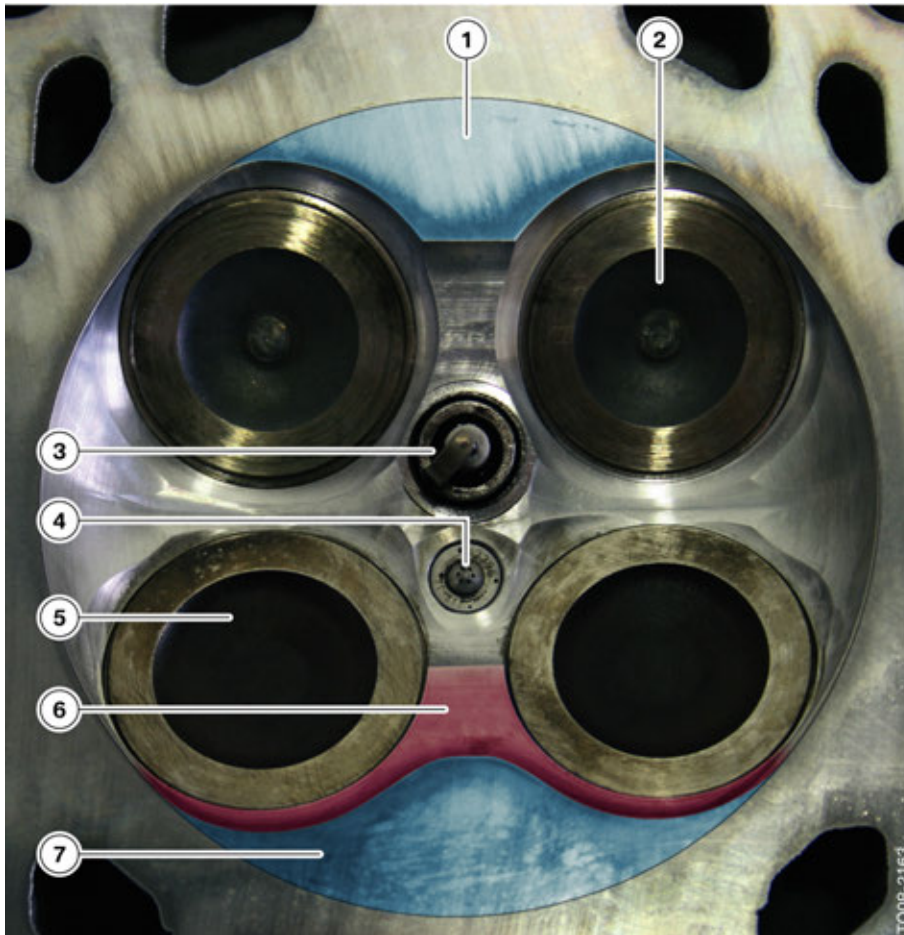
Phasing results in a lift difference between both intake valves of up to 1.8 mm in the lower partial load range. The fresh air drawn in is thus distributed unequally.

Masking

Masking refers to the styling of the valve seat area. This styling ensures that the incoming fresh air is aligned so that the desired cylinder charging movement is achieved. The advantage of these measures is that the combustion delay (retardation) is reduced by approximately 10° of crankshaft rotation. The combustion process is quicker and a larger valve overlap can be realized. The NO_x emissions can thus be reduced significantly.

S55 Engine

5. Valvetrain



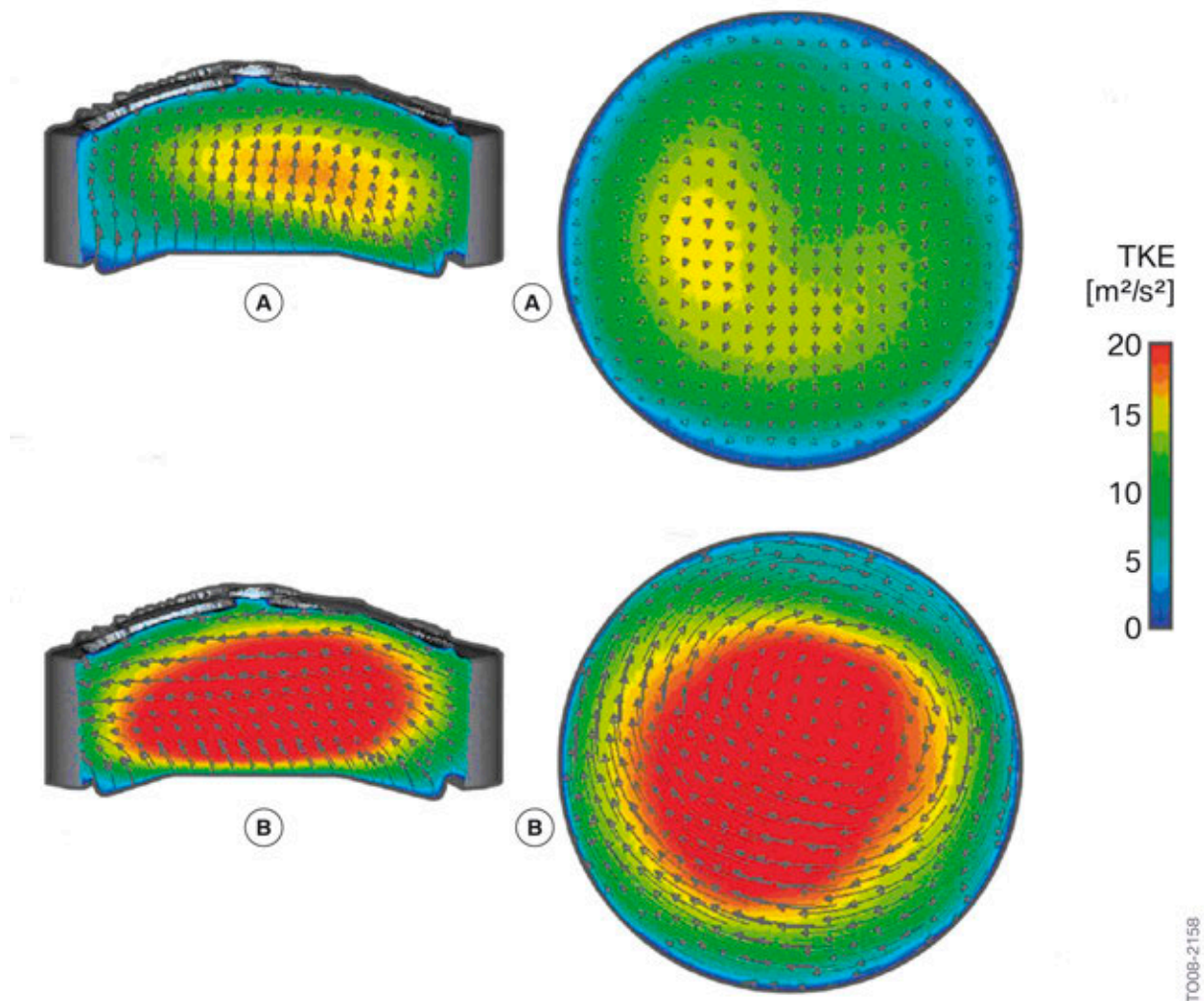
S55 engine, combustion chamber roof

Index	Explanation
1	Crushing area
2	Exhaust valve
3	Spark plug
4	Injector
5	Intake valve
6	Masking
7	Crushing area

The following graphic shows the effect of the previously described measures. An improved and quicker combustion process is enabled with these measures, in the red area. Technically, this is known as "turbulent kinetic energy".

S55 Engine

5. Valvetrain



Influence of phasing and masking on the flow in the combustion chamber

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

Engine response characteristics can be improved with the combination of Valvetronic III, direct fuel injection and turbocharging. The response characteristics up to the naturally aspirated engine full load are shortened, as with the naturally aspirated engine with Valvetronic, as the filling procedure of the intake manifold is deleted. The subsequent torque build-up as the turbocharger starts up can be accelerated at low engine speeds with a partial lift adjustment. The flushing of the residual gas leads to a quicker build-up of the torque.

S55 Engine

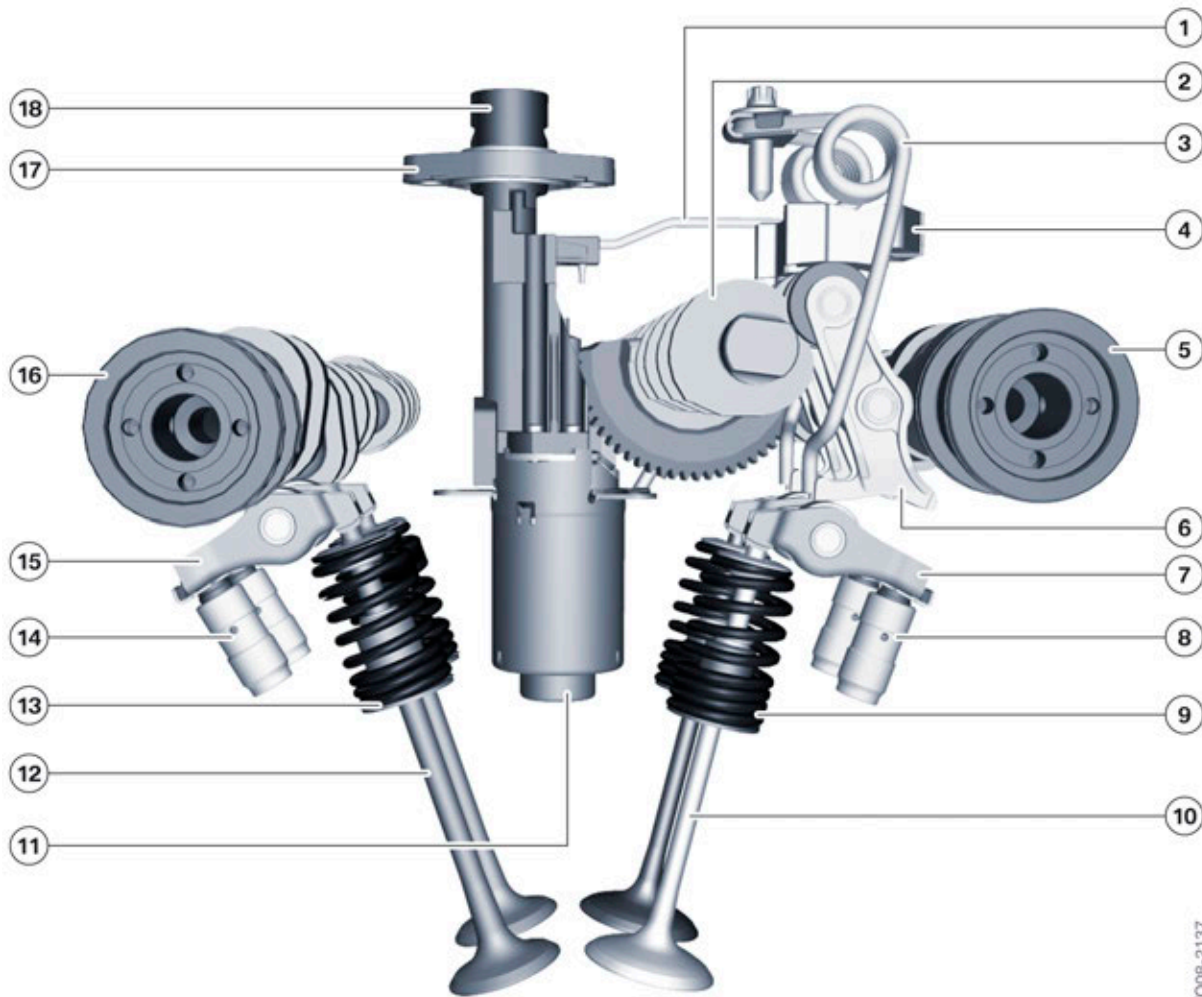
5. Valvetrain

Valvetronic

A brushless direct current motor is used, as in the N55 engine. The Valvetronic servomotor has the following special features:

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

The third generation of the Valvetronic servomotor also includes the sensor for identifying the position of the eccentric shaft. Another special feature is that engine oil flows through and around the Valvetronic servomotor. An oil spray nozzle ensures that the worm gear is lubricated for the eccentric shaft connection.



TO08-2137

S55 engine, structure of Valvetronic

S55 Engine

5. Valvetrain

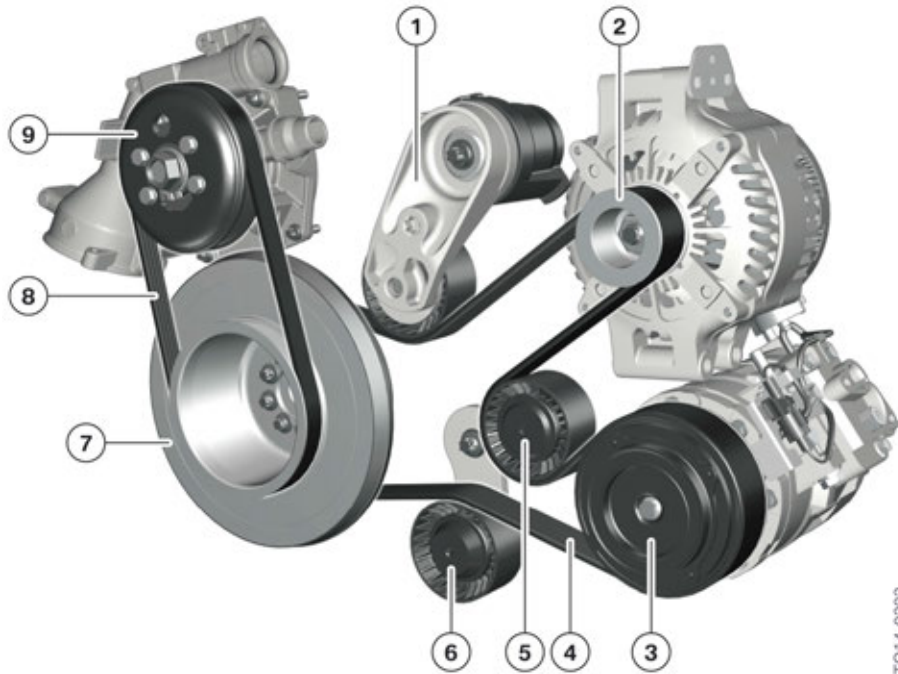
Index	Explanation
1	Oil spray nozzle
2	Eccentric shaft
3	Torsion spring
4	Gate
5	Intake camshaft
6	Intermediate lever
7	Roller cam follower
8	Hydraulic valve adjuster
9	Valve spring
10	Intake valve
11	Valvetronic servomotor
12	Exhaust valve
13	Valve spring
14	Hydraulic valve adjuster
15	Roller cam follower
16	Exhaust camshaft
17	Sealing cup
18	Socket

S55 Engine

6. Belt Drive & Auxiliary Components

6.1. Belt drive

The belt drive had to be modified due to the use of a mechanical coolant pump and deletion of the hydraulic power steering pump. An additional tensioning pulley is used between the vibration damper and the air conditioning compressor, which compensates for the deletion of the hydraulic power steering pump. The additional tensioning pulley suppresses possible oscillations of the drive belt between the vibration damper and air conditioning compressor.



S55 engine, belt drive

Index	Explanation
1	Mechanical belt tensioner
2	Belt pulley, alternator
3	Belt pulley, A/C compressor
4	Drive belt
5	Deflecting element
6	Additional tensioning pulley
7	Vibration damper with double belt pulley
8	Drive belt
9	Coolant pump belt pulley

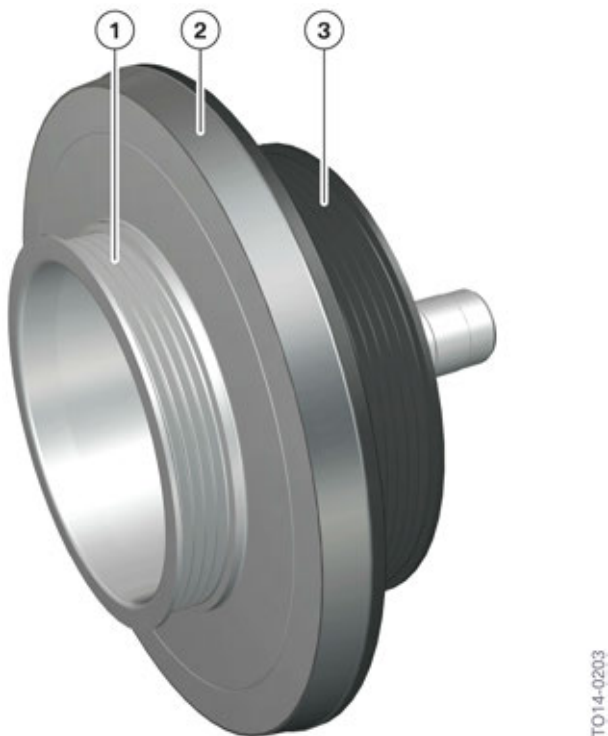
The diameter of the belt pulley for the alternator was increased in comparison to the one on the N55 engine. This was necessary as the alternator would generate excessive speeds due to the higher engine speeds of the S55 engine. With the addition of a mechanical coolant pump, a pulley and drive belt are added to the drive belt system, unlike the N55 which only has one drive belt.

S55 Engine

6. Belt Drive & Auxiliary Components

6.1.1. Vibration damper

The S55 engine uses a single-mass vibration damper. The belt pulley for the auxiliary components sits behind the damper. The drive pulley for the coolant pump sits on the front side of the vibration damper.



S55 engine, vibration damper

Index	Explanation
1	Coolant pump belt pulley
2	Vibration damper
3	Belt pulley, auxiliary components

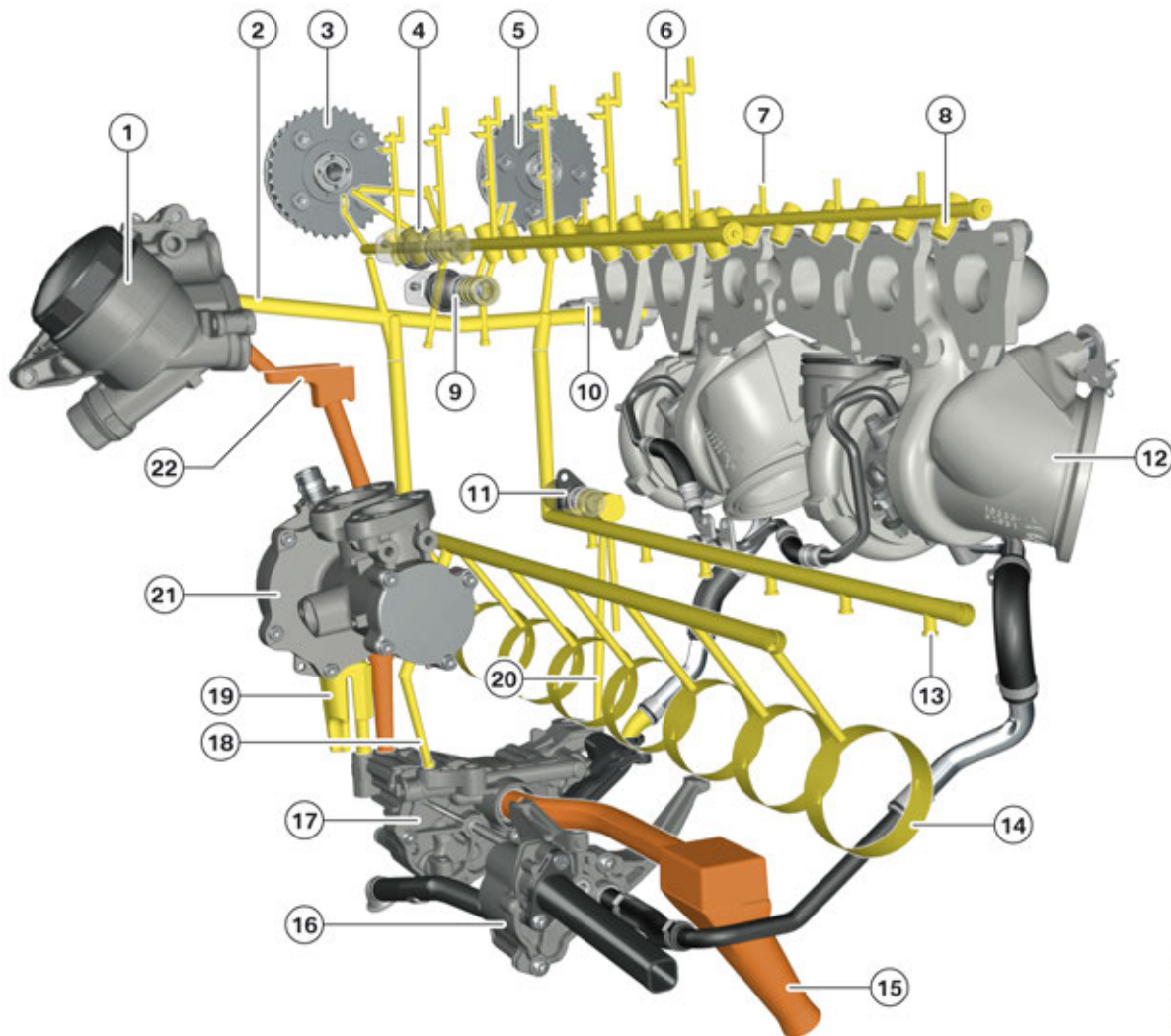
S55 Engine

7. Oil Supply

7.1. Oil circuit

7.1.1. Oil passages

The following graphic provides an overview of the oil circuit of the S55 engine.



S55 engine, oil passages (rear view)

Index	Explanation
1	Oil filter
2	Main oil passage (filtered oil)
3	VANOS unit, intake side
4	VANOS solenoid valve, intake side
5	VANOS unit, exhaust side

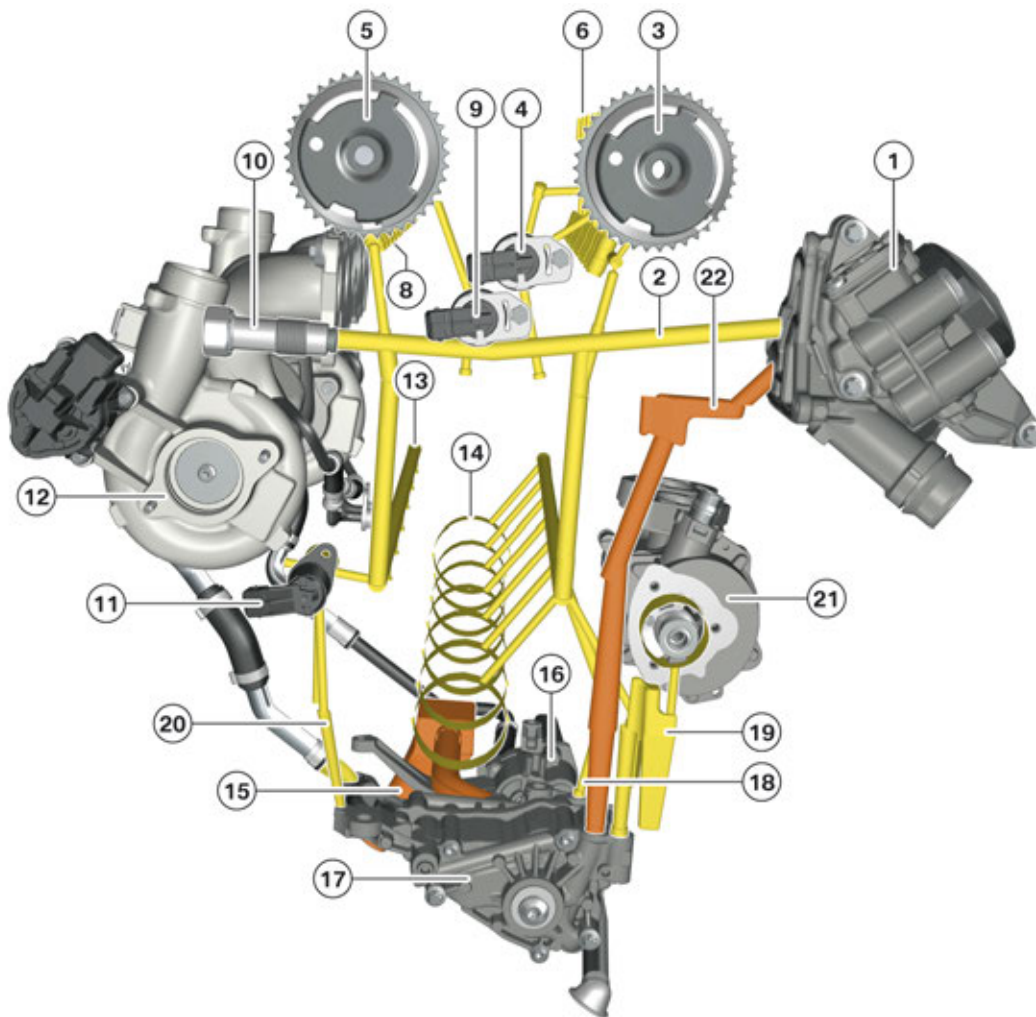
S55 Engine

7. Oil Supply

Index	Explanation
6	Oil passage for the intake camshaft lubrication and eccentric shaft lubrication
7	Oil passage for the exhaust camshaft lubrication
8	Hydraulic valve clearance compensation
9	VANOS solenoid valve, exhaust side
10	Chain tensioner
11	Oil pressure control valve
12	Exhaust turbocharger
13	Connection for the oil spray nozzles and connection for the exhaust turbocharger lubrication
14	Crankshaft bearings
15	Intake pipe
16	Suction pump
17	Oil pump
18	Oil passage for the oil-pressure control
19	Oil passage for the vacuum pump lubrication
20	Oil passage for the oil-pressure control
21	Vacuum pump
22	Unfiltered oil passage

S55 Engine

7. Oil Supply



TO14-0205

S55 engine, oil passages (front view)

Index	Explanation
1	Oil filter
2	Main oil passage (clean oil)
3	VANOS unit, intake side
4	VANOS solenoid valve, intake side
5	VANOS unit, exhaust side
6	Oil passage for the intake camshaft lubrication and eccentric shaft lubrication
8	Hydraulic valve clearance compensation
9	VANOS solenoid valve, exhaust side
10	Chain tensioner
11	Oil pressure control valve
12	Exhaust turbocharger

S55 Engine

7. Oil Supply

Index	Explanation
13	Connection for the oil spray nozzles and connection for the exhaust turbocharger lubrication
14	Crankshaft bearings
15	Intake pipe
16	Suction pump
17	Oil pump
18	Oil passage for the oil-pressure control
19	Oil passage for the vacuum pump lubrication
20	Oil passage for the oil-pressure control
21	Vacuum pump
22	Raw oil passage

S55 Engine

7. Oil Supply

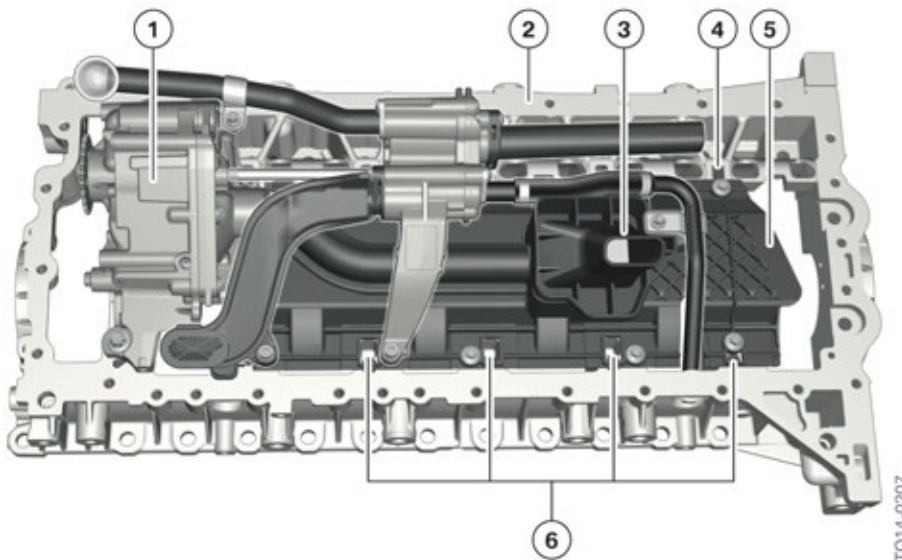
7.1.2. Oil return

The following graphic shows the integrated oil deflector. The following components have been combined:

- Oil deflector (5)
- Intake snorkel (3)

The integrated oil deflector gives rise to the largest possible cavity sealing between the oil pan and crankshaft drive. Additional oil scraper edges are fitted at the bedplate which direct oil spray from the crankshaft.

The oil flowing back from the cylinder head is directed under the oil deflector. This way, even at high lateral acceleration, no returning oil can reach the crankshaft and cause churning losses.

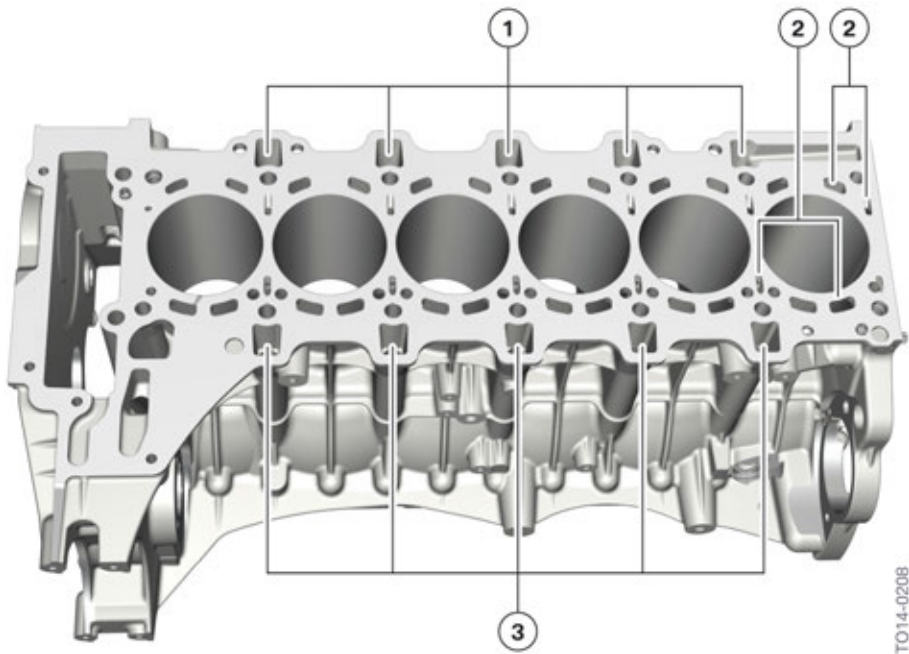


S55 engine, bedplate with oil pump, suction pump and oil deflector

Index	Explanation
1	Oil pump
2	Bedplate
3	Intake pipe with oil strainer
4	Oil return passages, intake side
5	Oil deflector
6	Oil return passages, exhaust side

S55 Engine

7. Oil Supply



S55 engine, oil return passages

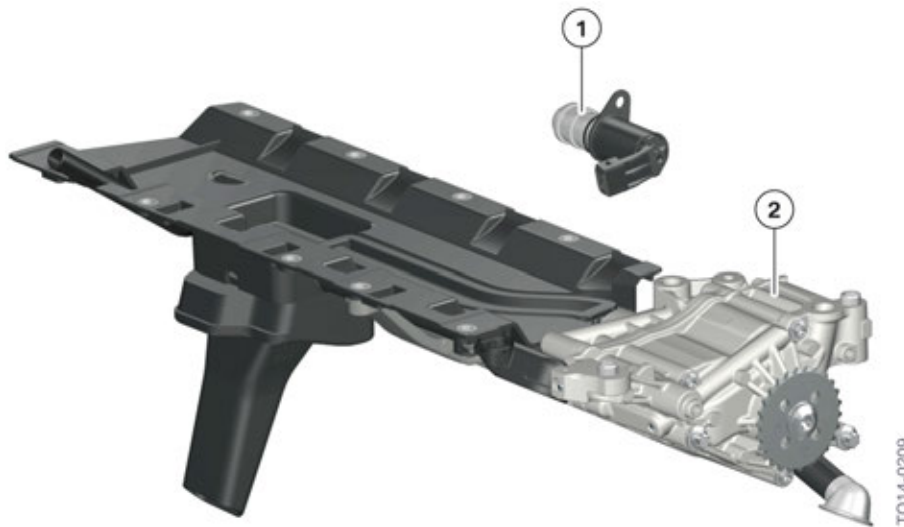
Index	Explanation
1	Engine oil return, exhaust side
2	Cooling passage
5	Engine oil return, intake side

S55 Engine

7. Oil Supply

7.1.3. Oil pump and pressure control

Passages were integrated for the oil supply of the vacuum pump, it is lubricated by filtered oil like in the N55 engine. Also, the oil pressure control valve was retained for the map-controlled oil pump, like the N55 engine.



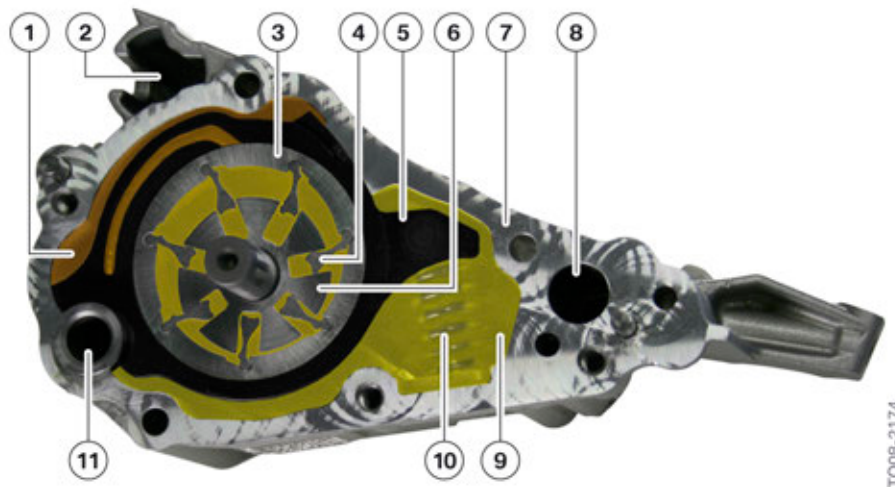
S55 engine, oil-pressure control

Index	Explanation
1	Oil pressure control valve
2	Oil pump

A modified version of the pendulum slide oil pump, known from the N55 engine, is used. The flow cross-sections within the oil pump have been optimized in the S55 engine for less loss; as a result, the delivery rate of the pump has improved by 18%. The shaft of the oil pump has an additional hexagon socket for the drive of the suction pump. The function of the oil pump can be found in the Technical Reference Manual "ST1209 N63TU Engine". The function of the pressure regulation is described in the Training Reference Manual "ST916 N55 Engine".

S55 Engine

7. Oil Supply



S55 engine, oil pump

Index	Explanation
1	Control oil chamber
2	Pressure-limiting valve
3	Rotor
4	Vane
5	Pendulum slide
6	Inner rotor
7	Housing
8	Bore hole for pressure control valve
9	Damping oil chamber
10	Compression spring (2x)
11	Rotational axis

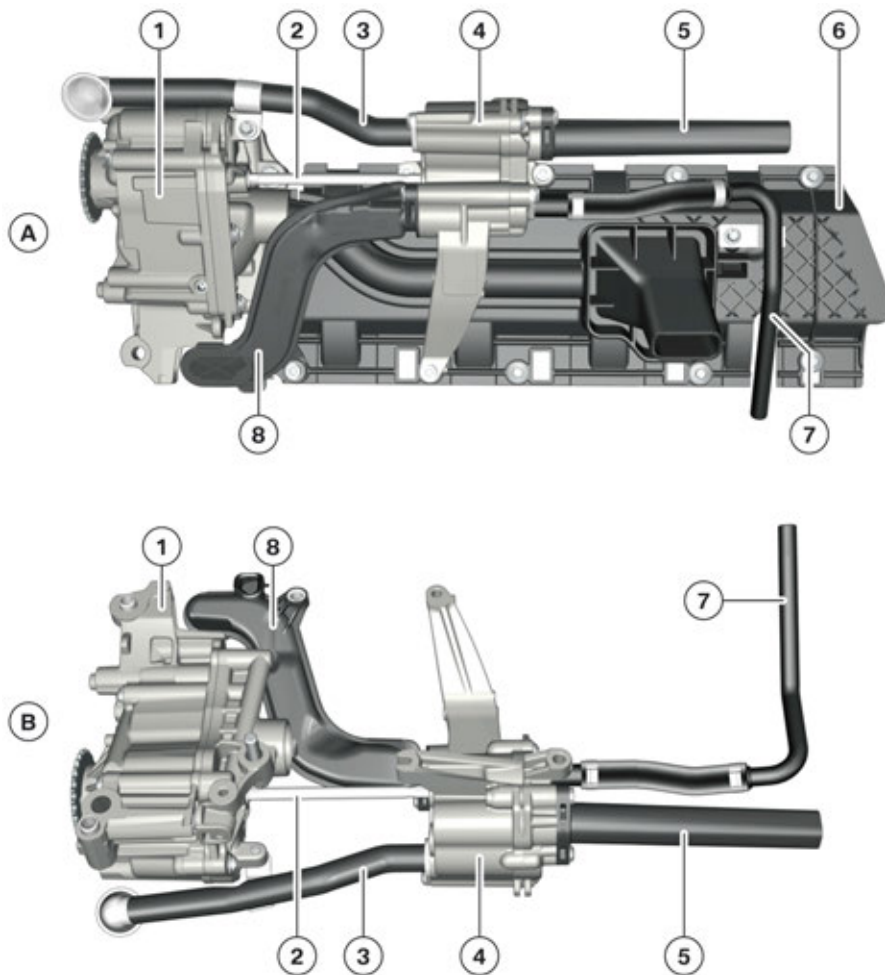
The structure of the oil pump was revised in order to guarantee the function and durability of the pendulum slide made from thermosetting plastics.

7.1.4. Suction pump

In order to adapt the oil supply to motor racing requirements, a second oil pump was installed as a backup. The second oil pump, also called a suction pump, supports the return flow of oil from the exhaust turbochargers and the front areas of the oil pan back to the rear of the oil pan.

S55 Engine

7. Oil Supply



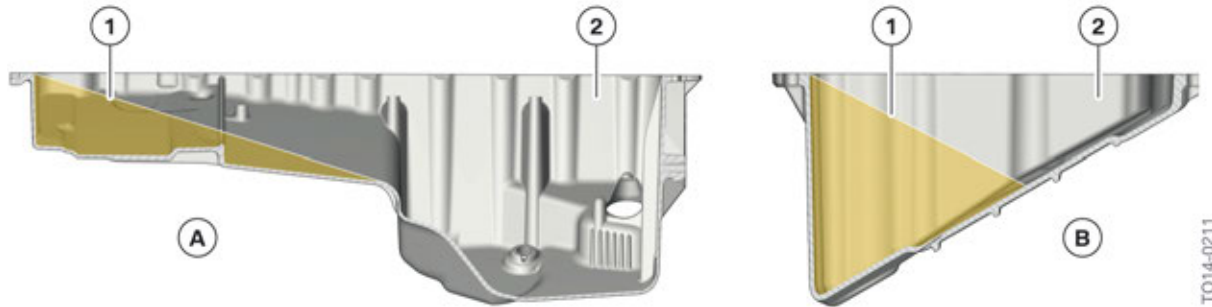
S55 engine, oil pump connected to suction pump

Index	Explanation
A	Oil pump unit with oil deflector and intake snorkel from below
B	Oil pump unit without oil deflector and intake snorkel from above
1	Oil pump
2	Link
3	Intake pipe, left, oil sump, front
4	Suction pump
5	Return flow
6	Oil deflector with intake pipe
7	Intake pipe, exhaust turbocharger, cylinders 4-6
8	Twin-flow intake pipe, oil sump, front right and exhaust turbocharger, cylinders 1-3

S55 Engine

7. Oil Supply

With these changes the oil supply can be guaranteed up to a longitudinal acceleration of 0.61 g and down to -1.2 g in the case of deceleration. Also with lateral acceleration, for example during cornering, this oil supply system enables a secure oil supply up to a constant 1.2 g.



S55 engine, engine oil level

Index	Explanation
A	Negative longitudinal acceleration (braking)
B	Lateral acceleration (dynamic cornering)
1	Engine oil level during braking and cornering
2	Oil pan

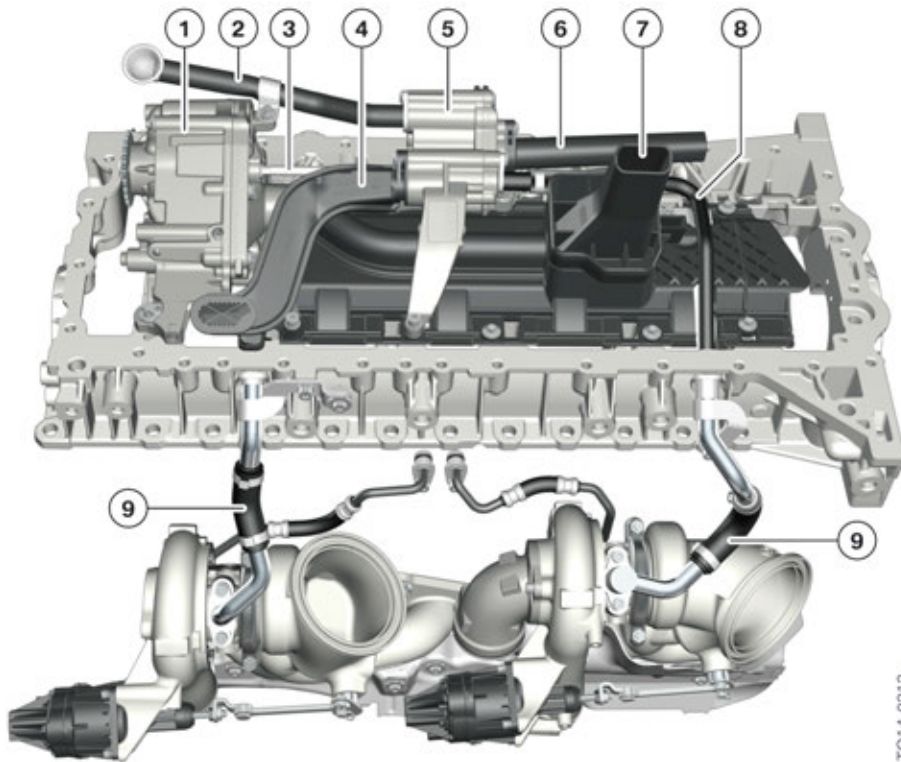
With the intake pipes (2,4,8), the suction pump draws oil from the front of the oil pan during longitudinal acceleration and from the sides of the oil pan during lateral acceleration. The oil drawn in is delivered by the return flow (6) back to the rear part of the oil pan. There the oil pump can re-absorb the oil via the oil deflector with intake pipe (7) and deliver it to the engine lubrication points.

The bearings of the exhaust turbochargers may collect engine oil due to the centrifugal force during lateral acceleration conditions. This prevents a normal backflow to the oil pan and thus a supply of fresh cool engine oil to the bearings.

To counteract this effect, the bearings of the exhaust turbochargers have engine oil continuously drawn in by the suction pump and delivered to the oil pan.

S55 Engine

7. Oil Supply



S55, oil suction, exhaust turbocharger

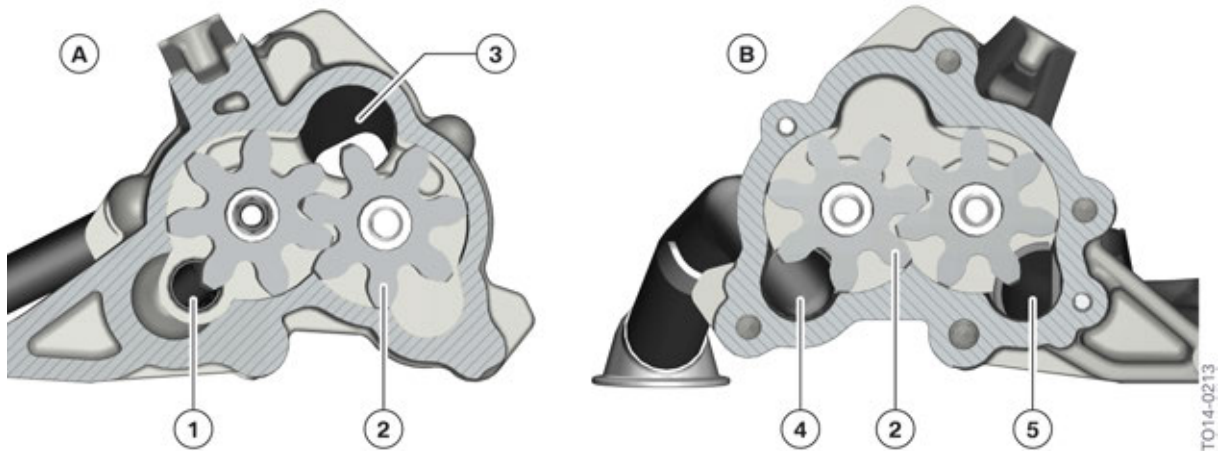
Index	Explanation
1	Oil pump
2	Intake pipe, left, oil sump, front
3	Link
4	Twin-flow intake pipe, oil sump, front right and exhaust turbocharger, cylinders 1–3
5	Suction pump
6	Return flow
7	Oil deflector with intake pipe
8	Intake pipe, exhaust turbocharger, cylinders 4–6
9	Oil return lines, exhaust turbocharger

The suction pump is a twin-flow gear pump. The outer chambers of the gear pump serve as suction chambers. At the suction chambers the intake pipes are connected which consist of the oil return lines from the exhaust turbochargers and the intake pipes at the front oil pan.

The inner chamber is a pressure chamber. The pressure chamber delivers the engine oil back to the rear of the oil pan via the return flow. Engine oil in the rear of the oil pan is thus available again to the oil pump via the intake pipe.

S55 Engine

7. Oil Supply



S55 engine, suction pump

Index	Explanation
A	Suction pump, rear part
B	Suction pump, front part
1	Intake pipe, exhaust turbocharger, cylinders 4–6
2	Gear pump
3	Return flow
4	Intake pipe, left, oil sump, front
5	Twin-flow intake pipe, oil sump, front right and exhaust turbocharger, cylinders 1–3

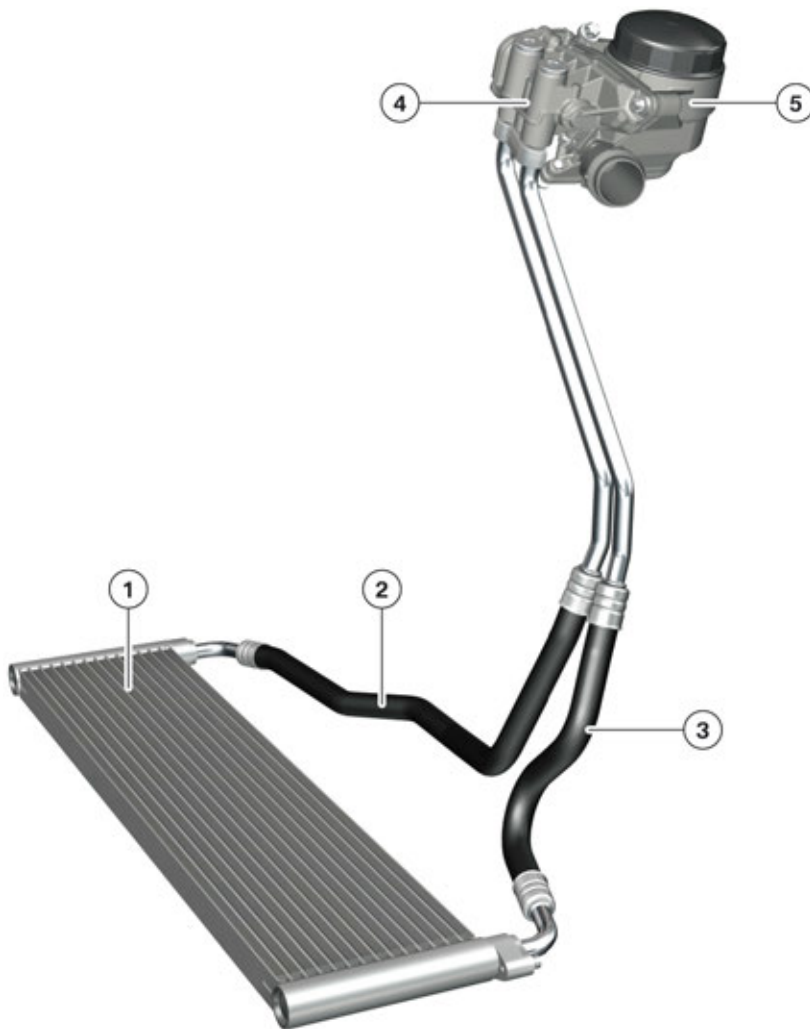
S55 Engine

7. Oil Supply

7.1.5. Oil filter and engine oil cooling

The oil filter housing is made from aluminium. For the engine oil cooling an upstream engine oil cooler is used which is installed in a horizontal position in front of the radiator package. Depending on the engine oil temperature, a thermostat at the oil filter housing enables the oil flow to the engine oil cooler.

Due to the higher engine performance, a large heat quantity must be dissipated by the engine oil cooler. The opening range of the thermostat is therefore earlier than in the N55 engine.



TO14-0214

S55, engine oil cooling

Index	Explanation
1	Engine oil cooler
2	Engine oil pipe, return
3	Engine oil pipe, supply
4	Thermostat
5	Oil filter

S55 Engine

7. Oil Supply

7.1.6. Oil spray nozzles

The S55 engine has oil spray nozzles for the piston crown cooling. They are common parts to the N55 engine. A special tool is required for the positioning of the oil spray nozzles.

7.1.7. Engine oil pressure monitoring

Oil pressure

Since the S55 engine has a electronic volume controlled oil pump, it is necessary to record the oil pressure precisely. This is why a new sensor (Puls2) is used.

The advantages of the new sensor are:

- Measurement of the absolute pressure (previous sensor measured relative pressure)
- Characteristic map control possible at every engine speed.

Oil level

The familiar oil-level sensor is used for the oil level measurement.

S55 Engine

8. Air Intake & Exhaust Emission Systems

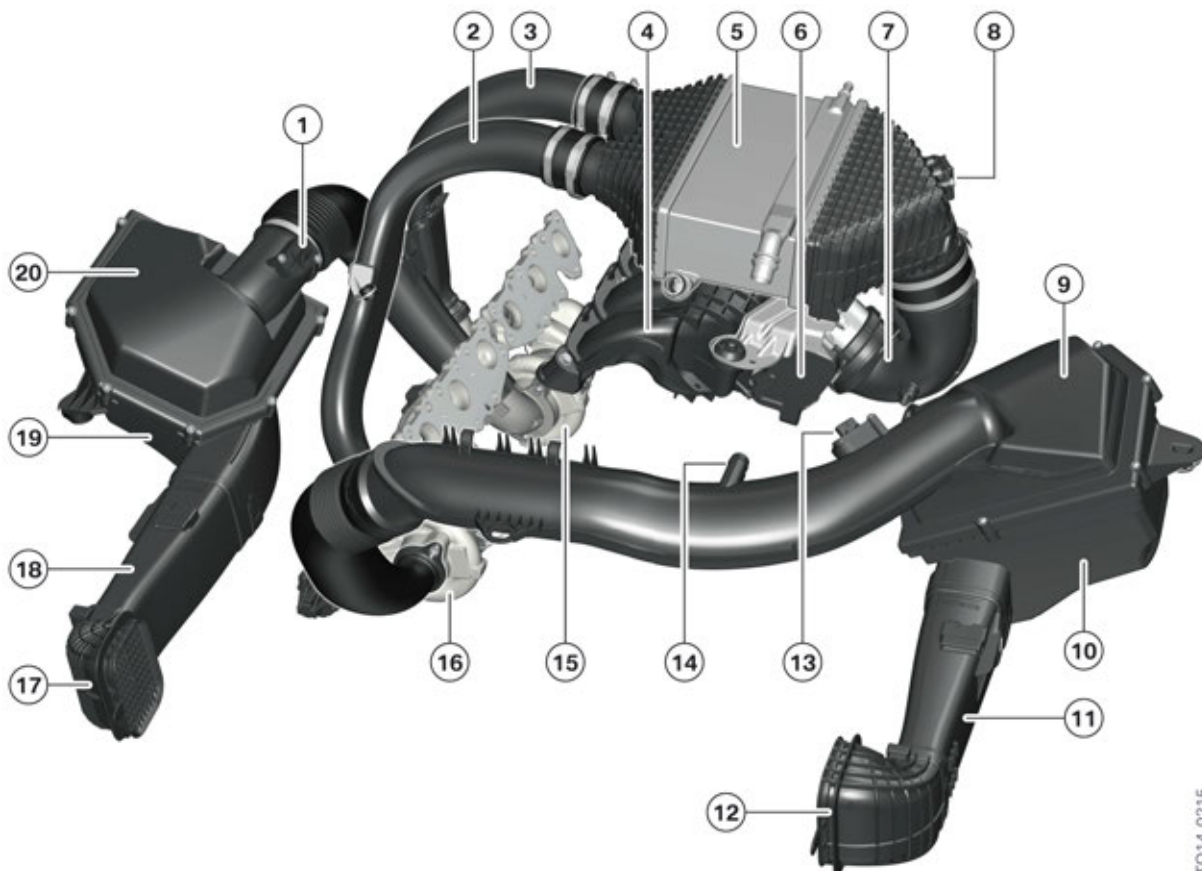
8.1. Air intake system

8.1.1. Overview

For the S55 engine, the air intake system had to be completely revamped. The following are the components that were revamped:

- Air intake duct up to the intake silencer
- Clean air duct, due to new exhaust turbochargers, completely new
- Crankcase venting components
- Indirect charge air cooling
- Recirculation air system deleted
- Tank ventilation system adapted

As can be seen from the graphic, the structure of the intake air system is more comprehensive, as two exhaust turbochargers are installed and indirect charge air cooling is used.



TO14-0215

S55 engine, intake air system

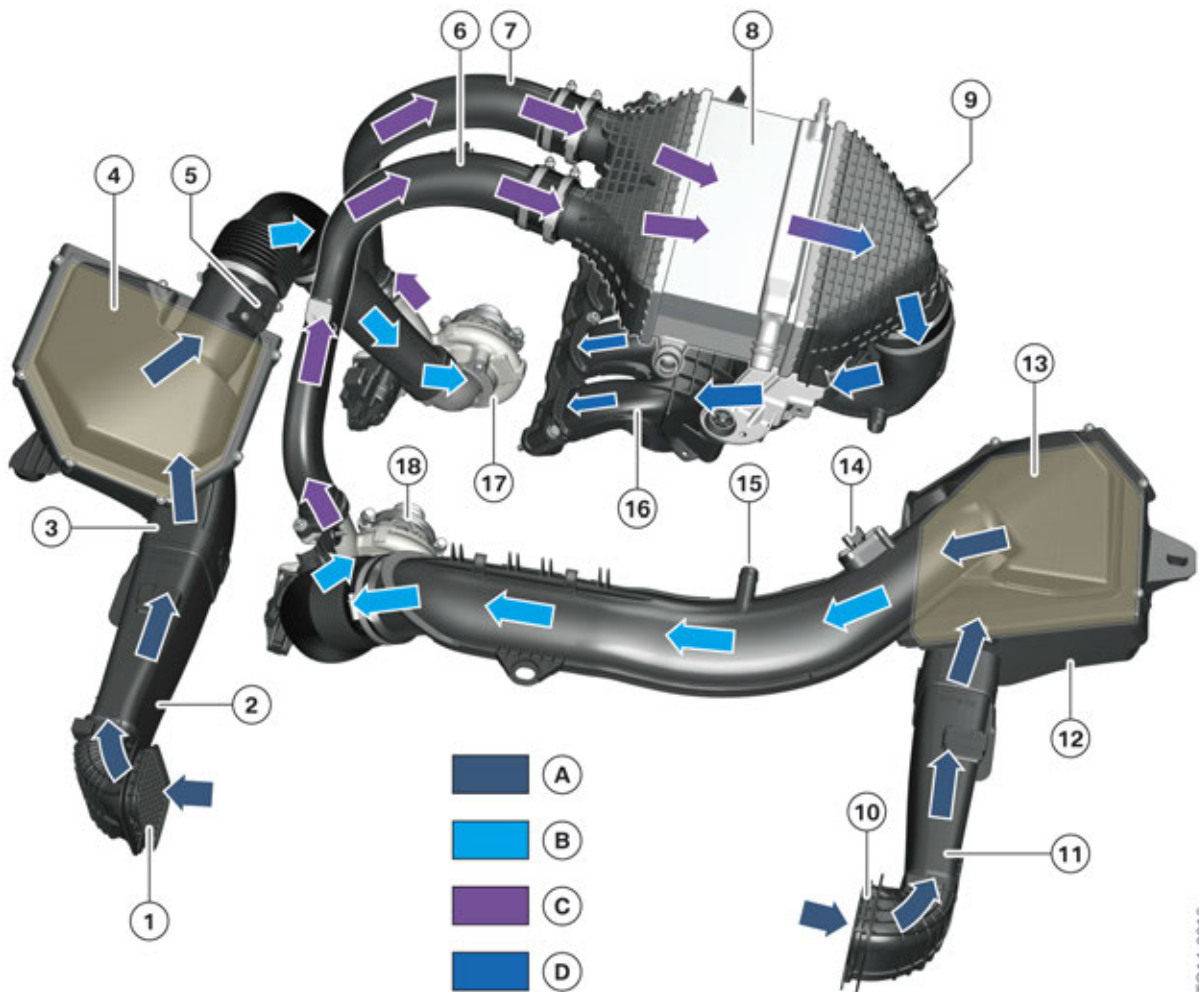
S55 Engine

8. Air Intake & Exhaust Emission Systems

Index	Explanation
1	Hot film air mass meter, cylinders 4–6
2	Charge air pipe, cylinders 1–3
3	Charge air pipe, cylinders 4–6
4	Intake plenum
5	Indirect charge air cooler
6	Throttle valve
7	Charge air pipe
8	Charge air pressure-temperature sensor
9	Lid, intake silencer, cylinders 1–3
10	Intake silencer, cylinders 1–3
11	Unfiltered air line, cylinders 1–3
12	Intake snorkel, cylinders 1–3
13	Hot film air mass meter, cylinders 1–3
14	Connection, crankcase ventilation
15	Exhaust turbocharger, cylinders 4–6
16	Exhaust turbocharger, cylinders 1–3
17	Intake snorkel, cylinders 4–6
18	Unfiltered air line, cylinders 4–6
19	Intake silencer, cylinders 4–6
20	Lid, intake silencer, cylinders 4–6

S55 Engine

8. Air Intake & Exhaust Emission Systems



S55 engine, intake air system from above

Index	Explanation
A	Fresh air
B	Clean air
C	Heated charge air
D	Cooled charge air
1	Intake snorkel, cylinders 4–6
2	Unfiltered air line, cylinders 4–6
3	Intake silencer, cylinders 4–6
4	Lid, intake silencer, cylinders 4–6
5	Hot film air mass meter, cylinders 4–6
6	Charge air pipe, cylinders 1–3
7	Charge air pipe, cylinders 4–6
8	Indirect charge air cooler

S55 Engine

8. Air Intake & Exhaust Emission Systems

Index	Explanation
9	Charge air pressure-temperature sensor
10	Intake snorkel, cylinders 1–3
11	Unfiltered air line, cylinders 1–3
12	Intake silencer, cylinders 1–3
13	Lid, intake silencer, cylinders 1–3
14	Hot film air mass meter, cylinders 1–3
15	Connection, crankcase ventilation
16	Intake plenum
17	Exhaust turbocharger, cylinders 4–6
18	Exhaust turbocharger, cylinders 1–3

A blow-off valve is no longer required due to the modified engine control.

Similar to the S63 top (S63TU) engine, the undesired spikes in charging pressure, which may arise in the event of quick throttle valve closure, are reduced. The electrical wastegate valves also play an important role in terms of the engine acoustics and contribute to the component protection of the turbochargers.

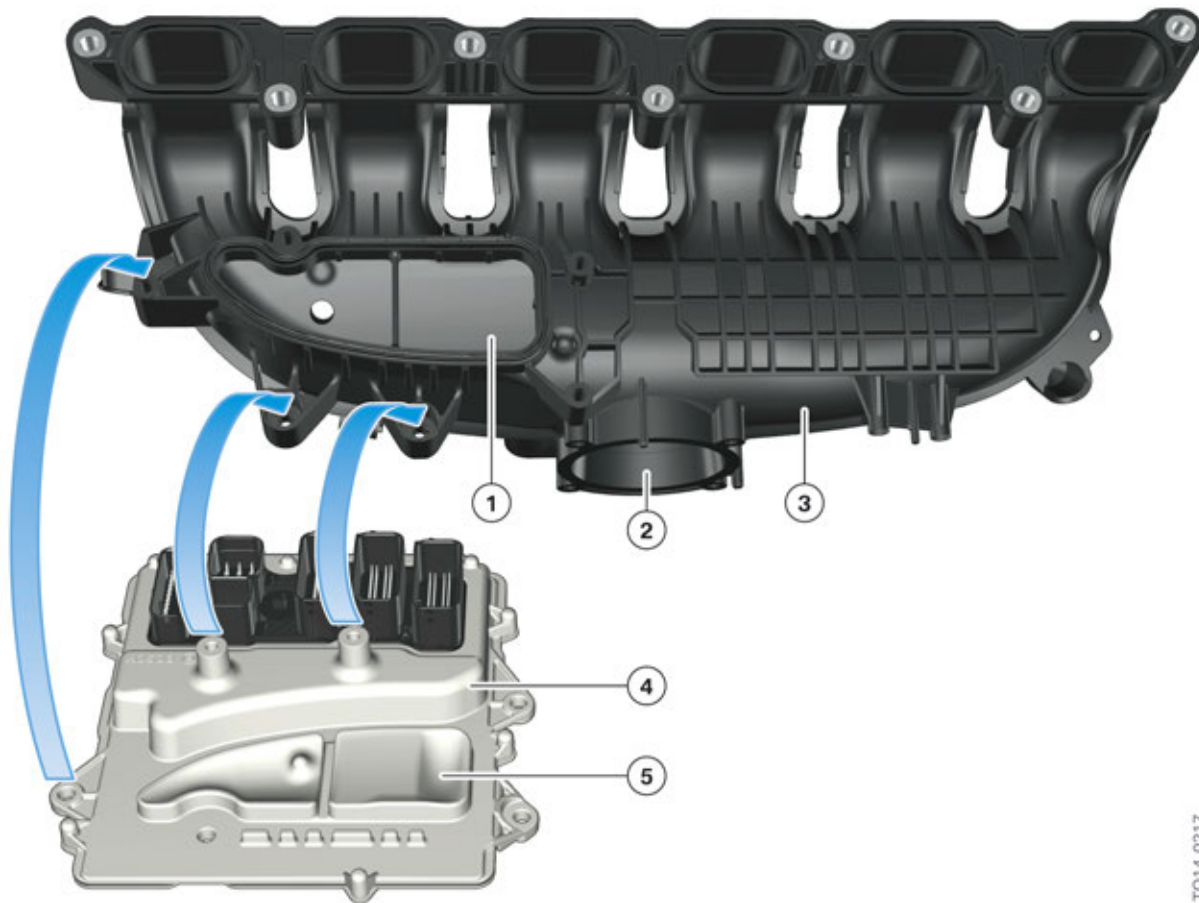
S55 Engine

8. Air Intake & Exhaust Emission Systems

8.1.2. Intake manifold

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

With this arrangement, the engine comes down the production line completely assembled with the control unit, sensors, and actuators already connected.



TO14-0217

S55 engine, intake air system with DME control unit

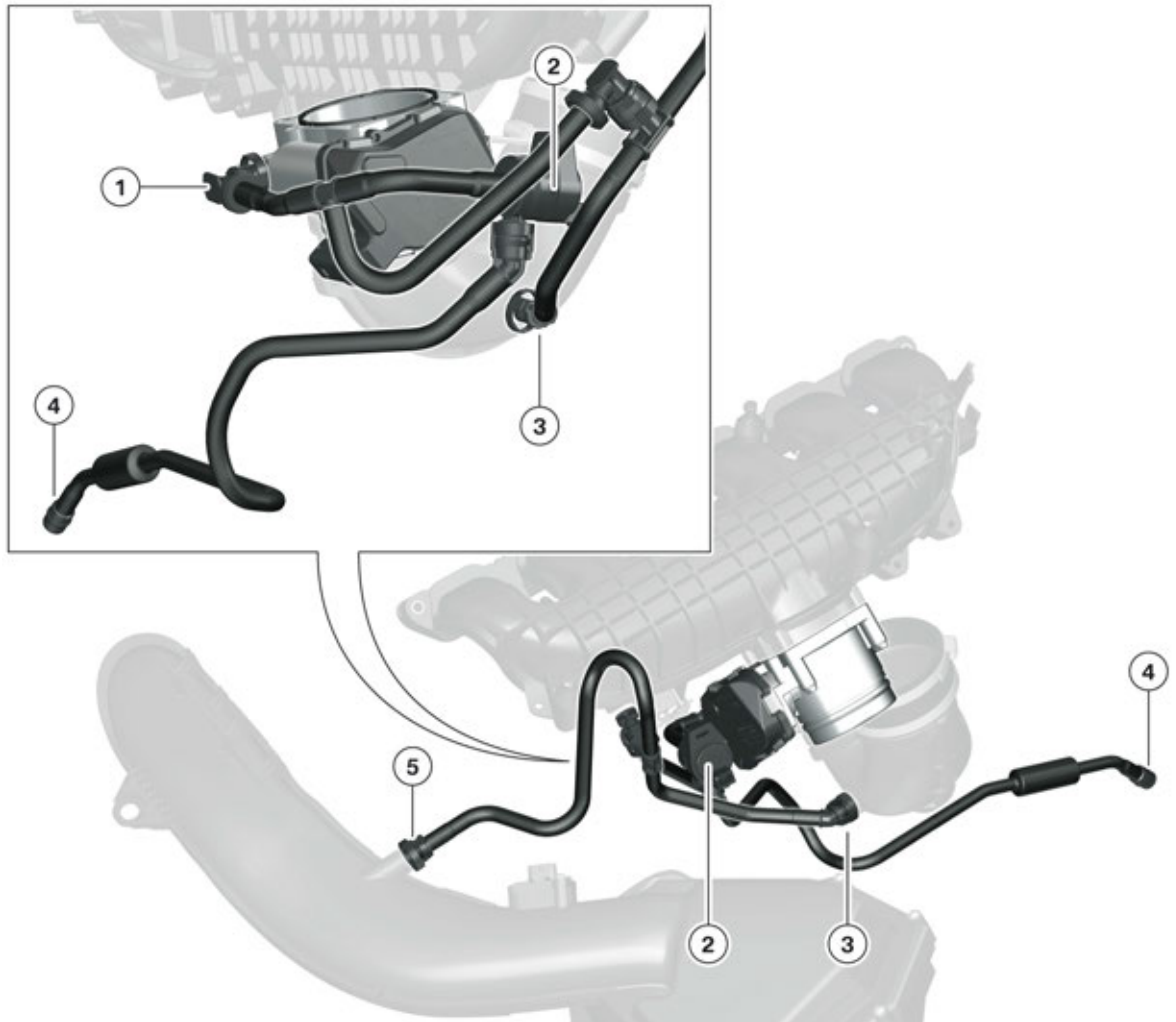
Index	Explanation
1	Connecting flange for cooling the engine control unit
2	Connecting flange for the throttle valve
3	Intake manifold
4	Engine control unit
5	Cooling fins

S55 Engine

8. Air Intake & Exhaust Emission Systems

8.1.3. Tank ventilation system

The S55 engine has a tank ventilation system that is similar to that of the N55 engine. Fuel vapors are stored in the charcoal canister and then fed via the tank vent valve to the combustion process.



S55 engine, tank ventilation system

Index	Explanation
1	Connection after throttle valve
2	Tank vent valve
3	Connection before throttle valve
4	Connection to the tank ventilation line from the carbon canister
5	Connection before turbocharger

S55 Engine

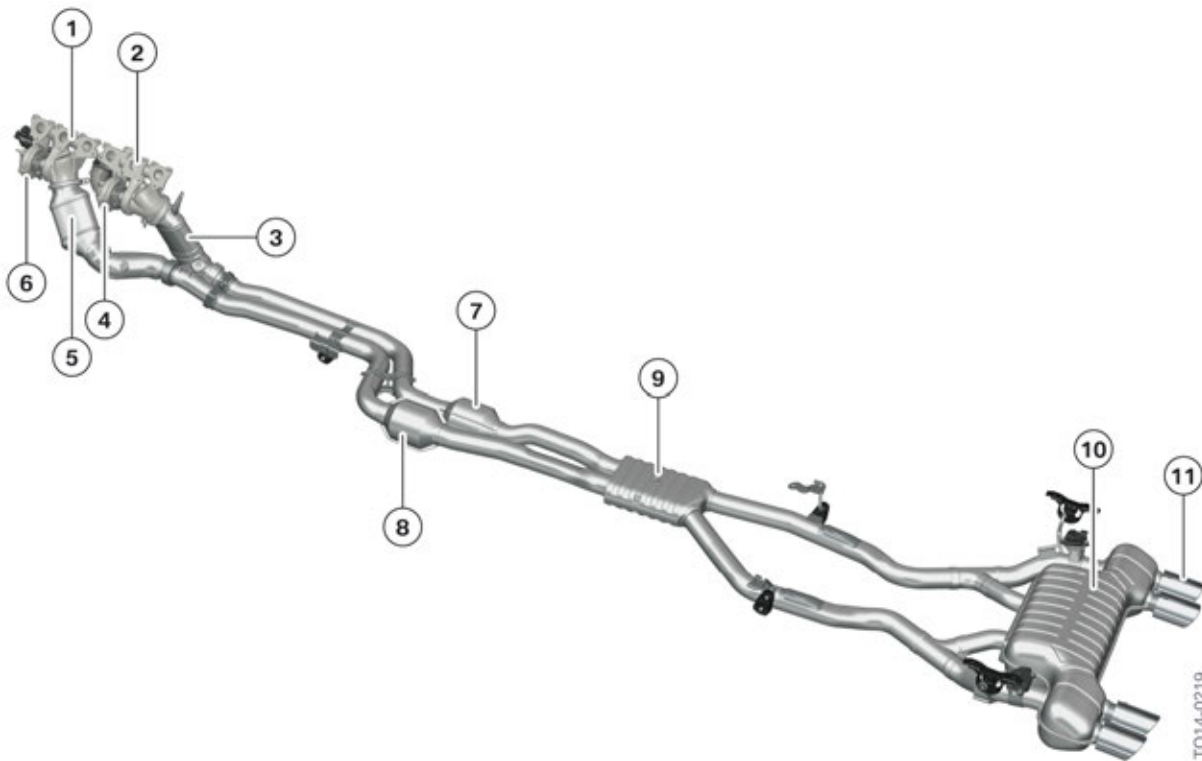
8. Air Intake & Exhaust Emission Systems

8.2. Exhaust emission system

8.2.1. Overview

The S55 engine has a different exhaust system structure than in the N55 engine. It uses two mono-scroll turbochargers instead of the single twin-scroll turbocharger of the N55. The exhaust system is a twin-pipe system in relation to the cylinder banks 1 and 2. In addition to the two catalytic converters (3/5) located close to the engine, two underbody catalytic converters (7/8) with a twin-pipe center silencer (9) and a rear silencer (10) are also installed.

The exhaust system was designed for minimum exhaust back pressure. The gas exchange efficiency was further optimized by sport tuning and intelligent lightweight construction. The weight was able to be reduced through selective wall thickness reduction.



S55 engine, exhaust system

Index	Explanation
1	Exhaust manifold, cylinders 1–3
2	Exhaust manifold, cylinders 4–6
3	Catalytic converter, cylinders 4–6
4	Exhaust turbocharger, cylinders 4–6
5	Catalytic converter, cylinders 1–3
6	Exhaust turbocharger, cylinders 1–3
7	Underbody catalytic converters, cylinders 4–6

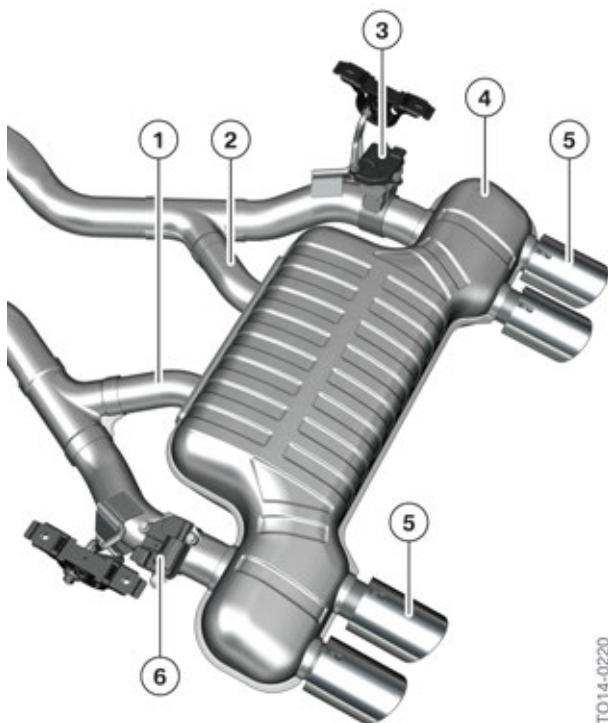
S55 Engine

8. Air Intake & Exhaust Emission Systems

Index	Explanation
8	Underbody catalytic converters, cylinders 1-3
9	Center silencer
10	Rear silencer
11	Exhaust tailpipes

The rear silencer has the typical M chrome-plated 4 exhaust tailpipes.

The pneumatic exhaust flaps were replaced, in the S55 engine, with electrical exhaust flaps. This simplifies the vacuum system and the vacuum reservoir in the cylinder head cover could therefore be deleted. The electrical exhaust flaps are activated directly by the DME by a pulse-width modulated signal.



S55, electrical exhaust flaps

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

S55 Engine

8. Air Intake & Exhaust Emission Systems

The exhaust flap can be opened by a pulse-width modulated (PWM) signal of 10% and closed with a signal of 90% . The end positions are the mechanical limit positions of the exhaust flap. Intermediate settings are not intended. The exhaust flap can be moved to the service position for installation by a PWM signal of 50%. To guarantee the desired position, in the case of extended non-operation of the electrical exhaust flap actuator, every 320 s (+/- 10%) a current is applied, which works in the direction of the limit position (duration of current feed: 50 ms +/- 5 ms).

Functional input variables for the calculation of the exhaust flap setting are:

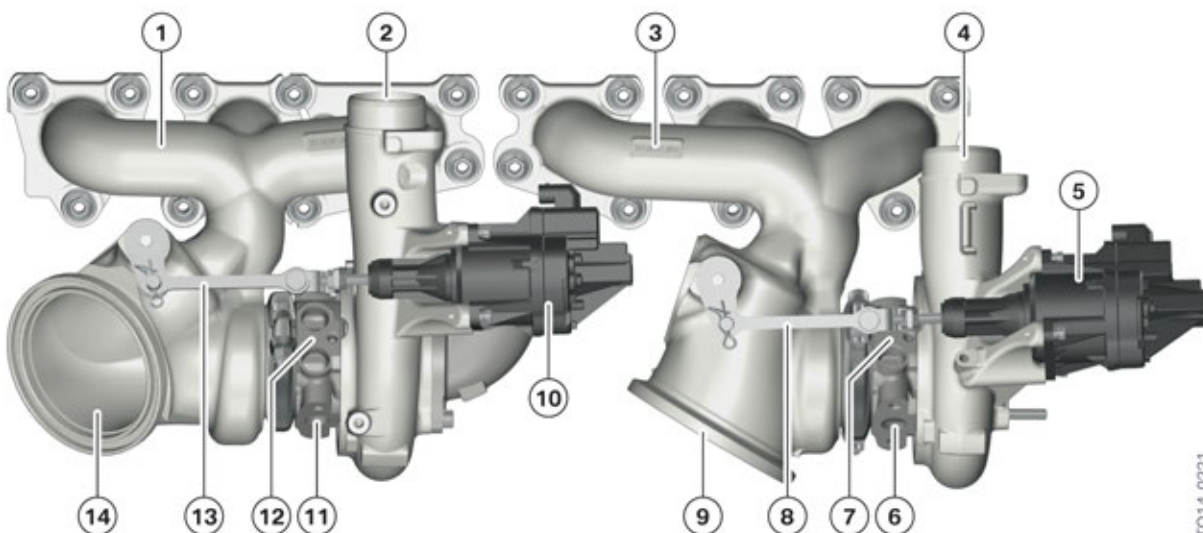
- Vehicle speed
- Accelerator pedal angle
- Engine temperature
- Transmission version
- Gear mode

There is always a flow through the two tailpipe pairs by the bypass pipe (1+2) regardless of the flap position. Therefore, no varying blackening of the two tailpipe pairs occurs, which is typical of vehicles with exhaust flaps. Furthermore, the exhaust flaps are not visible at the tailpipes.

Together with the Active Sound Design (ASD) and the electrical exhaust flaps, an optimal sound setting can be generated in every operating condition of the S55 engine, in the new M3/M4 Coupé. This results in a dominant, recognizable sound typical of BMW M vehicles. The character of the sound can vary depending on what mode the driver selects via the engine dynamics button. The three modes of the engine dynamics are Normal, Sport, and Sport+.

8.2.2. Exhaust manifold

The exhaust manifold is made from high-alloyed cast steel. One exhaust manifold is used for each bank, similar to the N54 engine. The condensing of the three exhaust ducts into a single exhaust duct results in an optimal flow to the turbine of the turbocharger. The exhaust manifold and turbine housing of the turbocharger are cast together, forming one component/unit.



S55 engine, connection of exhaust turbochargers at the engine housing

S55 Engine

8. Air Intake & Exhaust Emission Systems

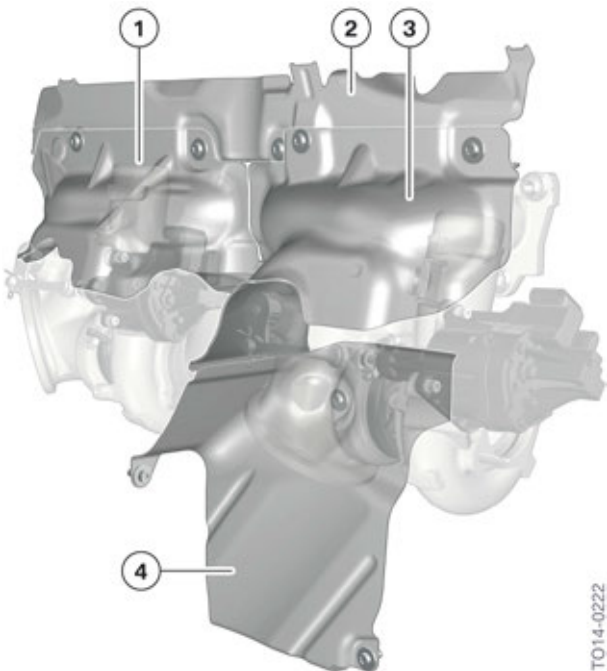
Index	Explanation
1	Exhaust manifold, cylinders 4–6
2	Connection for the charge air cooler, cylinders 4–6
3	Exhaust manifold, cylinders 1–3
4	Connection for the charge air cooler, cylinders 1–3
5	Electrical wastegate valve actuator, cylinders 1–3
6	Oil return
7	Coolant connections
8	Wastegate valve, control rod, cylinders 1–3
9	Connection for the exhaust system
10	Electrical wastegate valve actuator, cylinders 4–6
11	Oil return
12	Coolant connections
13	Wastegate valve, control rod, cylinders 4–6
14	Connection for the exhaust system

S55 Engine

8. Air Intake & Exhaust Emission Systems

8.2.3. Lightweight construction of heat shields for exhaust manifold

New weight-optimized heat shields are used in order to guarantee heat insulation, of the new cast steel manifold, and to support the intelligent lightweight construction concept of the S55 engine.



S55, lightweight construction heat shields

Index	Explanation
1	Heat shield, exhaust turbocharger, cylinders 4–6
2	Heat shield, support
3	Heat shield, exhaust turbocharger, cylinders 1–3
4	Heat shield, engine oil pipe

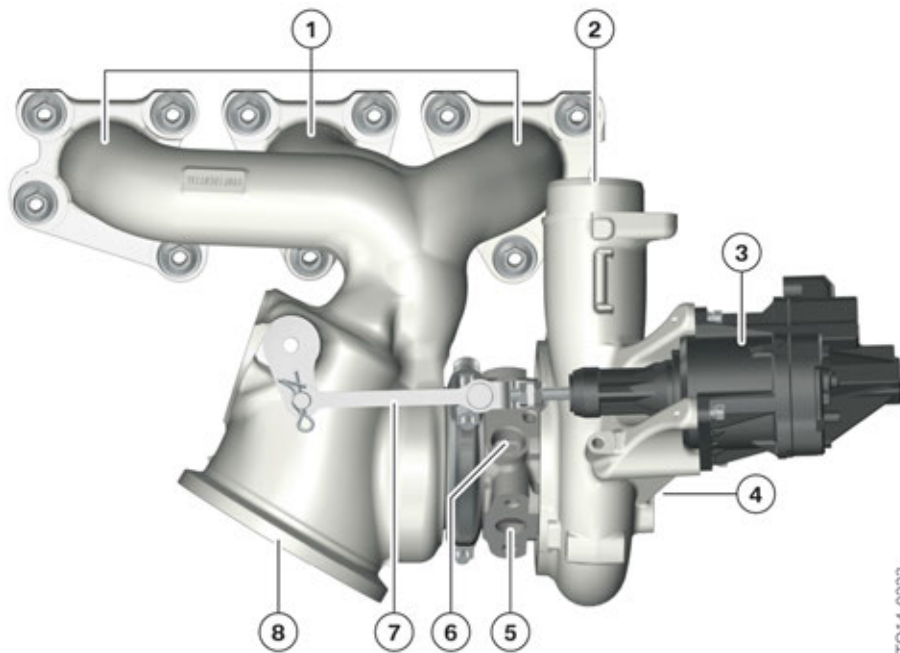
The heat shields are made from aluminum (AlMg3). A weight savings of 1,450 grams (3.2lbs) is achieved compared to the same heat shields made from sheet steel, which is used on standard engines.

S55 Engine

8. Air Intake & Exhaust Emission Systems

8.2.4. Exhaust turbocharger

The S55 engine has two mono-scroll exhaust turbochargers, like the N54 engine. Even though there are two turbocharger units, this design still contributes to the intelligent lightweight construction of the S55 engine. The weight of the two mono-scroll turbochargers in the S55 engine was able to be retained at the weight of the one twin-scroll turbocharger in the N55 engine. For comparison: The twin-scroll turbocharger unit in the N55 weighs 14.1 kg (31.1 lbs), the mono-scroll turbocharger units in the S55 engine weigh 14.2 kg (31.3 lbs).

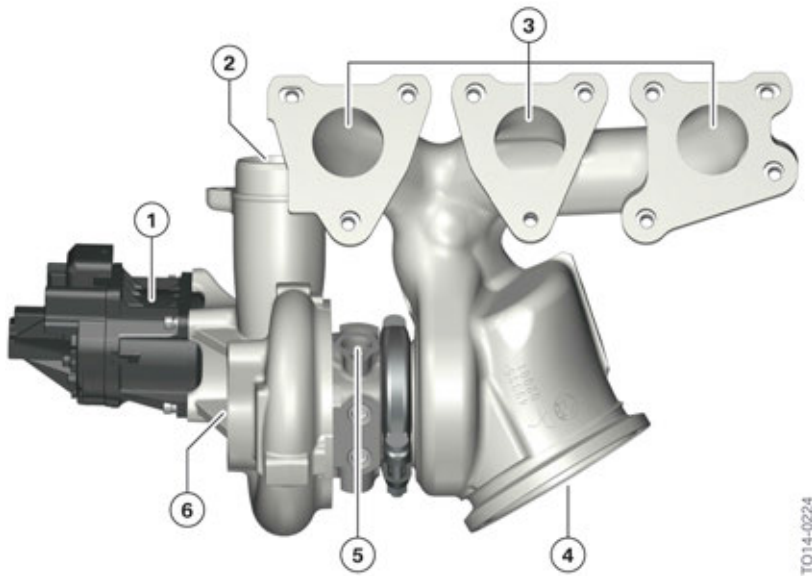


S55 engine, mono-scroll turbocharger unit, front view (bank 1/cyl 1-3)

Index	Explanation
1	Exhaust ports bank 1(cylinders 1-3)
2	Output for charge air cooler
3	Electrical wastegate valve actuator
4	Input, clean air
5	Oil return
6	Coolant connections
7	Wastegate valve control rod
8	Connection for the exhaust system

S55 Engine

8. Air Intake & Exhaust Emission Systems



S55 engine, mono-scroll turbocharger unit, rear view (bank 1/cyl 1–3)

Index	Explanation
1	Electrical wastegate valve actuator
2	Output for charge air cooler
3	Exhaust ports bank 1 (cylinders 1–3)
4	Connection for the exhaust system
5	Oil supply
6	Input, clean air

Electrical wastegate valve

The S55 engine is equipped with electrical wastegate valves, unlike the N54 which has the pneumatic design. The function of the electrical wastegate valves in the S55 engine is the same as in other BMW engines equipped with these valves. One important function is to satisfy ULEV2 emission standards.

The main advantages of the electrical wastegate valve compared to the pneumatic wastegate valve are:

- High adjustment speed
- Precise boost pressure control
- High closing force, thus less leakage and quicker build-up of boost pressure
- Complete opening of the wastegate valve possible (This supports quick heating of catalytic converter upon cold start)
- Lower exhaust emissions
- Fuel economy

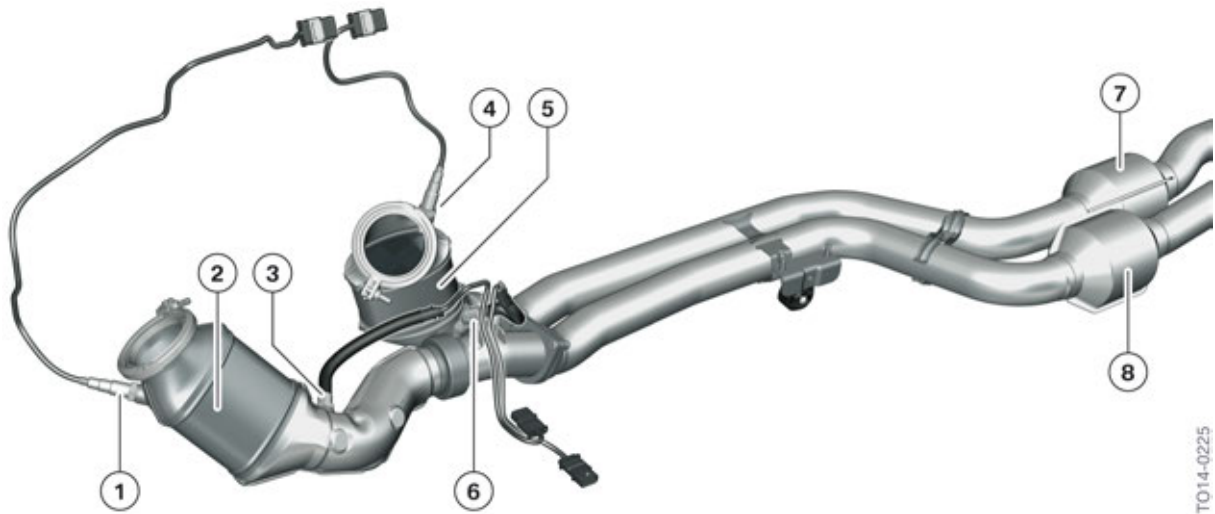
The electrical wastegate valve is activated directly via the DME by a pulse-width modulated signal.

S55 Engine

8. Air Intake & Exhaust Emission Systems

8.2.5. Catalytic converter

The S55 engine has two catalytic converters per bank. One main catalytic converter is installed close to the engine of each bank. The secondary catalytic converter is located in the underbody area after the transmission.



S55 engine, catalytic converters

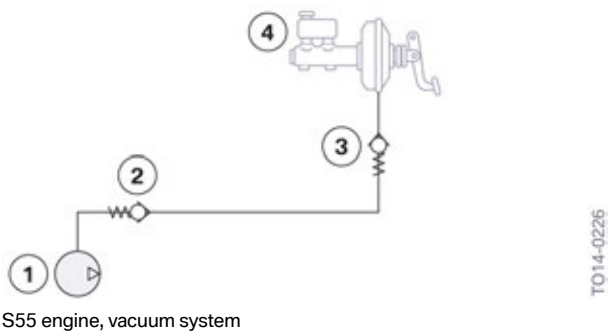
Index	Explanation
1	Oxygen sensor before the main catalytic converter, cylinders 1–3
2	Main catalytic converter, cylinders 1–3
3	Oxygen sensor after the main catalytic converter, cylinders 1–3
4	Oxygen sensor before the main catalytic converter, cylinders 4–6
5	Main catalytic converter, cylinders 4–6
6	Oxygen sensor after the main catalytic converter, cylinders 4–6
7	Secondary catalytic converter, cylinders 4–6
8	Secondary catalytic converter, cylinders 1–3

S55 Engine

9. Vacuum System

9.1. Design

The S55 engine is equipped with a vacuum pump for generating the vacuum required by the brake booster.



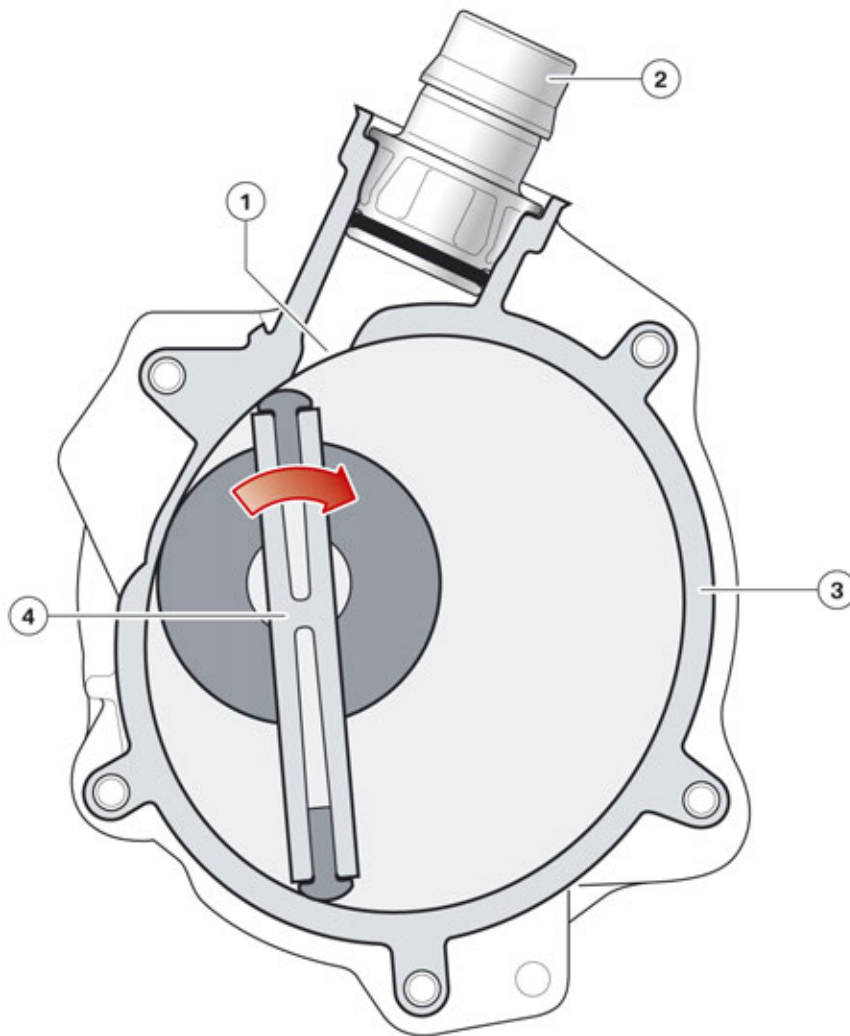
Index	Explanation
1	Vacuum pump
2	Non-return valve
3	Non-return valve
4	Brake booster

S55 Engine

9. Vacuum System

9.1.1. Vacuum pump

The vacuum pump is similar to the one used in the N55 engine. However, unlike the vacuum pump in the N55 engine, it is designed as a single-stage pump and only has one connection. The one connection is for the brake booster.



S55 engine, vacuum pump

Index	Explanation
1	Connection opening for the brake booster
2	Non-return valve for the brake booster
3	Housing of the vacuum pump
4	Vane

A vacuum reservoir was deleted as all pneumatic functions which were supplied via vacuum on the N55 engine have been electrified on the S55 engine. For example, the wastegate valves and exhaust flaps are now electrical on the S55 engine.

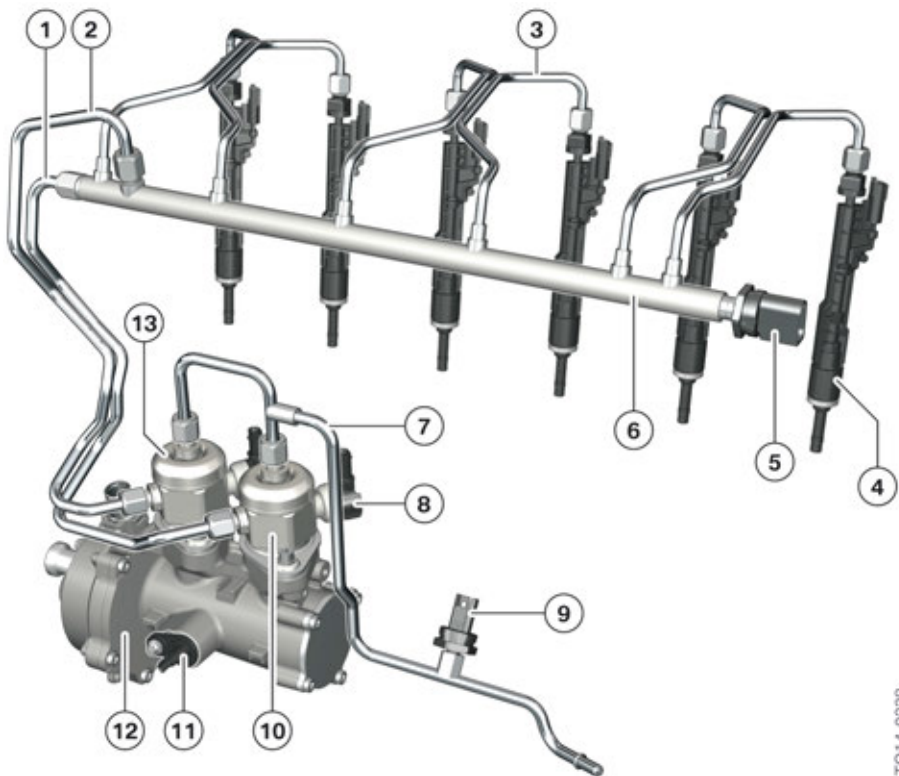
S55 Engine

10. Fuel System

10.1. Overview

The S55 engine uses the high-pressure fuel injection system (HDE), similar to the N55 engine. Instead of the high precision injectors (HPI) known from the N54 and N63 engines, solenoid valve fuel injectors with multi-hole nozzles are used in the S55 engine.

The following overview shows the entire fuel injection system. The fuel preparation of the S55 engine is closely related to the fuel preparation of the N55 engine. In the S55 engine, a new double-piston high pressure fuel pump is used, whereas the N55 engine has a single-piston high pressure pump. This is necessary in order to provide for the higher fuel demand needed with the increased performance and engine speeds of the S55 engine. The high pressure fuel injection valves meet the exhaust emission standards ULEV2. The S55 uses high pressure fuel injection valves from Bosch with the designation HDEV5.2, which also support the Controlled Valve Operation (CVO) function.



S55 engine, high-pressure fuel injection system

Index	Explanation
1	High pressure line, high pressure pump 2
2	High pressure line, high pressure pump 1
3	High pressure line for injectors
4	Solenoid valve fuel injector
5	Rail pressure sensor
6	Rail
7	Fuel feed line

S55 Engine

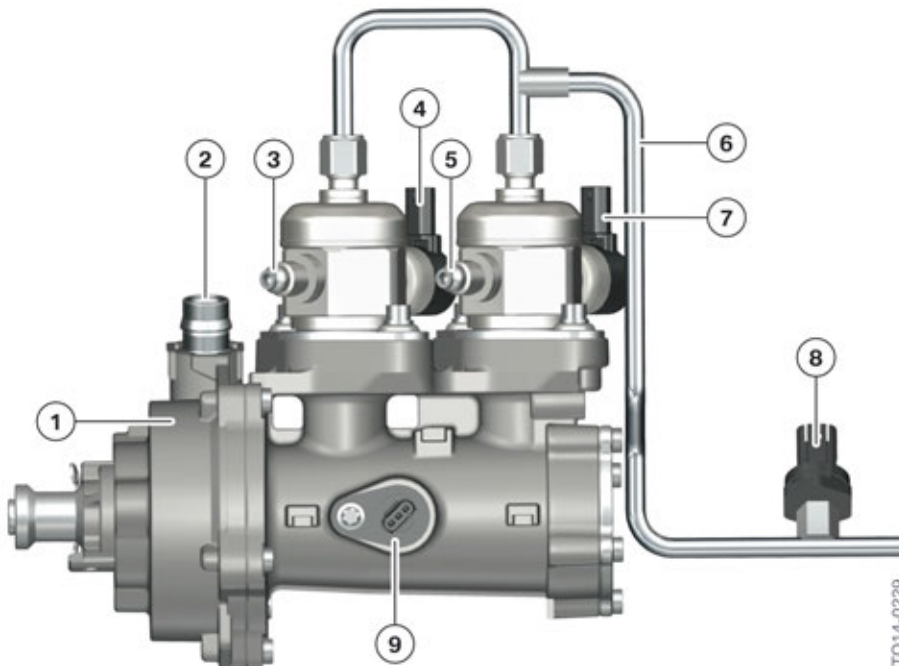
10. Fuel System

Index	Explanation
8	Quantity control valve, high pressure pump 2
9	Fuel pressure sensor
10	High pressure pump element 2
11	Position sensor
12	Vacuum pump
13	High pressure pump element 1

10.1.1. Low pressure fuel sensor

The fuel is supplied to the high pressure fuel pumps by the in tank electric fuel pump through a feed line at a primary pressure of 5 bar. The primary pressure is monitored via the low pressure fuel sensor. This low pressure fuel sensor is known from the N55, N54, and N63 engines.

In the event of a failed low pressure fuel sensor, the electric fuel pump continues to operate at 100% delivery rate with terminal 15 ON.



S55 engine, high pressure pump assembly

Index	Explanation
1	Vacuum pump
2	Non-return valve, brake servo
3	Connection for high pressure line, high pressure pump 1
4	Quantity control valve, high pressure pump 1
5	Connection for high pressure line, high pressure pump 2

S55 Engine

10. Fuel System

Index	Explanation
6	Fuel delivery line
7	Quantity control valve, high pressure pump 2
8	Low pressure fuel sensor
9	Position sensor

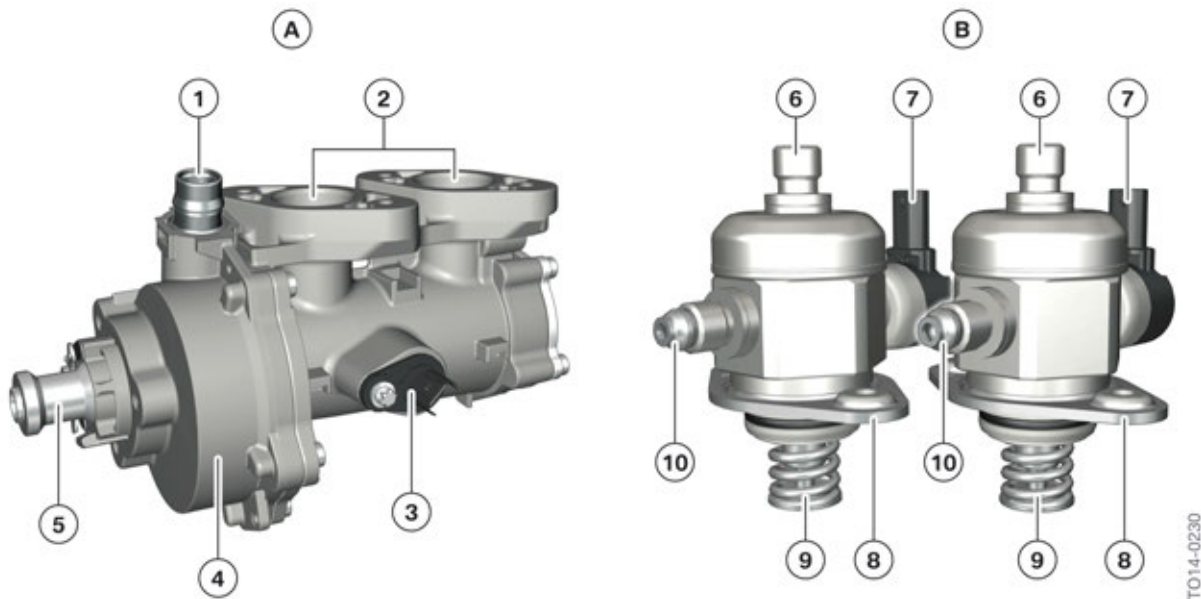
10.1.2. High pressure fuel pumps

The high pressure fuel pumps, known from the N20 and N63 engines, are bolted into the vacuum pump housing. The vacuum pump drive shaft runs the entire length of the vacuum pump housing and acts as a camshaft with two three-point lobes (triple lobes) to drive the high pressure fuel pumps.

Each point of the three-point lobes is offset by 120° degrees. The two three-point lobes, which drive the two high pressure pumps, are arranged so that there is a delivery every 60° degrees.

The high pressure fuel pump, HDP 5, is used and has the same function as the high pressure pump in the N55 engine.

However, for the S55 engine, two high pressure pumps are installed in parallel and the fuel lines are arranged differently. Below approx. 3,000 rpm only one high pressure pump is activated, at engine speeds above approx. 3,000 rpm both high pressure pumps are active. This was necessary in order to satisfy the higher volume of fuel needed at high engine speeds and loads. Regulation is carried out by the quantity control valve of the second high pressure pump. The quantity control valves, of the high pressure pumps, are controlled by a pulse-width-modulated signal from the DME.



S55 engine, vacuum pump with high pressure pump elements

S55 Engine

10. Fuel System

Index	Explanation
A	Vacuum pump with high pressure pump drive
B	Pump elements
1	Non-return valve for the brake servo
2	Connections, high pressure pump element
3	Position sensor
4	Vacuum pump with drive for high pressure pump element
5	Drive
6	Fuel feed
7	Fuel quantity control valve
8	Mounting plate
9	Pump tappet
10	Connection, high pressure line

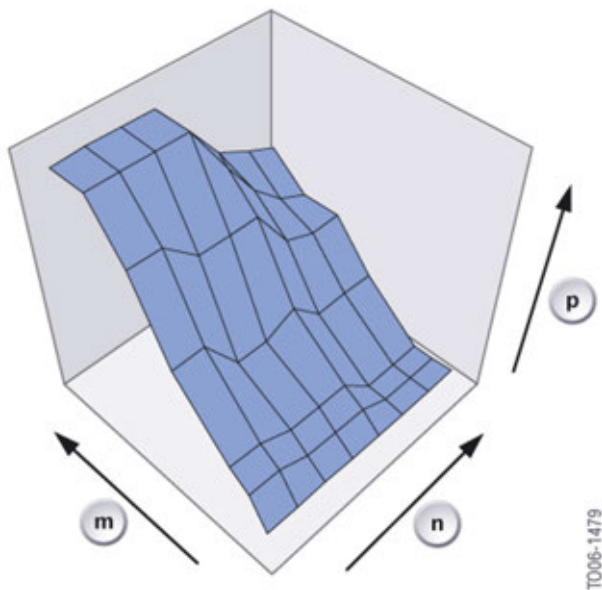
An additional sensor detects the position of the camshaft that drives the high pressure fuel pumps. The position of the camshaft in the high pressure pump is required in order to optimize the pump control by the quantity control valves.

The position sensor works according to the hall effect principle. It tracks the sensor gear electronically and sends the signal to the DME which in turn activates the quantity control valves for the fuel quantity control.

The double three-point lobe camshaft is permanently driven by the vacuum pump. The fuel is pressurized by the high pressure fuel pumps and delivered to the fuel rail via the two high pressure lines. 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 DME according to the engine load and speed. The fuel pressure is registered by the rail pressure sensor and sent to the DME. The fuel is regulated by the quantity control valve, on high pressure pump 2, based on a target/actual value comparison of the rail pressure. The fuel pressure is adjusted to achieve smooth running properties with the best possible fuel consumption. The maximum pressure of 200 bar is only required at a high load and low speed.

S55 Engine

10. Fuel System



S55 engine, fuel pressure diagram

Index	Explanation
m	Load
n	Engine speed
p	Pressure

ACHTUNG!	Öffnen des Kraftstoffsystems bei Kühlmitteltemperatur über 40 °C nicht zulässig. Gefahr von Körperverletzung. Reparaturanleitung beachten.
CAUTION!	Do not open the fuel system if the coolant temperature is above 40 °C/104 °F – risk of injury! Consult the repair manual.
ATTENTION !	Il est interdit d'ouvrir le système d'alimentation en carburant lorsque la température du liquide de refroidissement est supérieure à 40 °C. Risque de blessure. Respecter les instructions du Manuel de réparation.
¡ATENCIÓN!	Prohibido abrir el sistema de combustible cuando la temperatura del líquido refrigerante supere los 40 °C. Peligro de lesiones. Consultar el manual de reparaciones.
注意!	冷却液温度高于40摄氏度时禁止打开燃油系统。存在身体伤害的危险。注意维修说明。

Warning for working on the high-pressure fuel system

10.1.3. Fuel Injectors

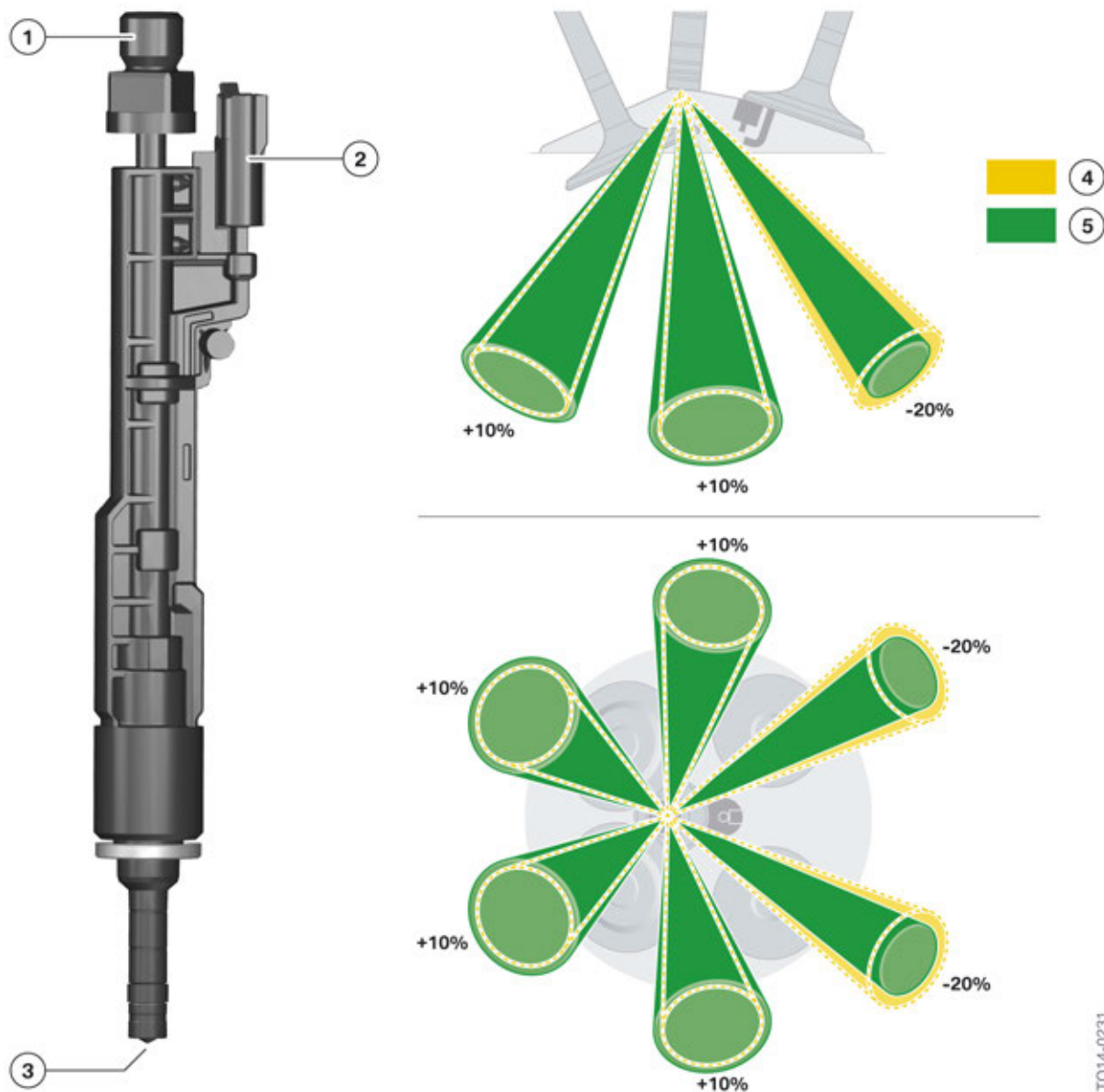
The Bosch HDEV5.2 solenoid valve fuel injectors are used in the S55, like in the N20 and N55 engines. The solenoid valve fuel injectors are designed as inward-opening multi-hole valves with highly variable spray angle and spray pattern. They are designed for system pressure of up to 200 bar.

The high-pressure fuel injection valves help satisfy ULEV2 emission standards.

The high-pressure fuel injection valves have different diameters of the laser-manufactured bore holes in the nozzles. The fuel quantity of the two spray jets in the exhaust direction is reduced by 20%, which increases the other spray jets by 10% respectively.

S55 Engine

10. Fuel System



S55 engine, high-pressure fuel injection valve HDEV5.2 injection pattern

Index	Explanation
1	High-pressure connection
2	Electrical connection
3	Six-hole nozzle
4	ULEV1, injection pattern
5	ULEV2, injection pattern

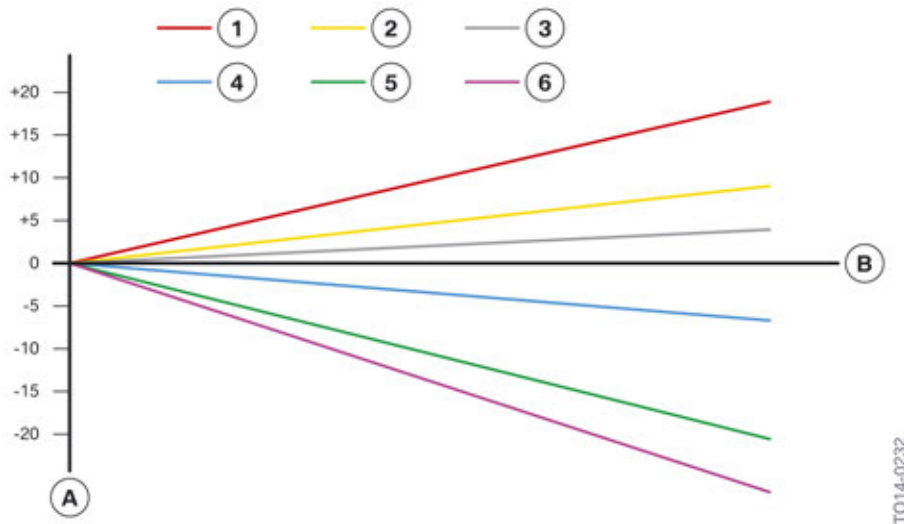
TO14-0231

S55 Engine

10. Fuel System

High-pressure fuel injection valves with solenoid coils do not have a linear behavior pattern across the entire service life, mainly in the area of minimal quantity fuel injection. This means over time the fuel injection rates vary from one injector to another injector. The high-pressure fuel injection valves are adapted during start-up by the injection quantity compensation in the DME, in order to compensate possible manufacturing tolerances and adjust all injectors to each other.

However, this only happens once during start-up (injection quantity compensation). The parameters for the activation of the injectors such as current and activation duration are the same for all injectors during the entire operating time and cannot be individually adapted. During the operating time, this would lead to transgressions from the strict exhaust gas emissions legislation such as ULEV2.



S55 engine, injector distribution without Controlled Valve Operation

Index	Explanation
A	Injector adaptation, start-up
B	Injector distribution during the operating time
1	Injector, cylinder 1
2	Injector, cylinder 2
3	Injector, cylinder 3
4	Injector, cylinder 4
5	Injector, cylinder 5
6	Injector, cylinder 6

The injectors are now therefore adjusted over the operating time with the help of a software function called "Controlled Valve Operation" (CVO) in the DME. The aim here is to limit the deviation of the individual injectors to each other to +/- 10%.

S55 Engine

10. Fuel System



S55 engine, injector, minimal quantity adjustment with CVO

Index	Explanation
A	Injector adaptation, start-up
B	Injector distribution during the operating time
1	Injector, cylinder 1
2	Injector, cylinder 2
3	Injector, cylinder 3
4	Injector, cylinder 4
5	Injector, cylinder 5
6	Injector, cylinder 6

The basic principle of the CVO function is to determine the precise opening period of the high pressure fuel injection valves. The DME can determine the precise opening period using the following parameters:

- Power consumption of the high-pressure fuel injection valve
- Voltage at the high-pressure fuel injection valve

These current and voltage values change in the event of a needle movement in the high-pressure fuel injection valve, for example:

- Armature mists up - when the needle valve is withdrawn from the valve seat
- Armature moves - needle valve moves in direction of open position
- Armature is stationary - attachment of needle valve at fully open position
- Reverse movement
- Armature moves - needle valve moves in direction of closed position
- Armature suffers impact and is braked hydraulically - needle valve closed

S55 Engine

10. Fuel System

With these values, the DME can determine the actual opening period of the high-pressure fuel injection valve. If the precise opening periods are known, the DME can also determine the exact fuel injection rate.

If the fuel injection rates vary, then the DME can control the fuel injection rate by the opening period of each individual injector valve. The DME thus has the option to adjust all high-pressure fuel injection valves to the same nominal fuel injection rate.

This measure guarantees the same nominal fuel injection rate in all cylinders, primarily in the minimal quantity range, as well as at idle speed, so that the exhaust recirculation can always work efficiently. This is reflected in the emissions values and compliance with the existing exhaust emission standards ULEV2.



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

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

When working on the fuel system of the S55 engine, it is important to ensure that the ignition coils are not fouled with fuel. The resistance of the silicone material is greatly reduced by having contact with fuel. This may result in arching on the spark plug head and thus in misfires.

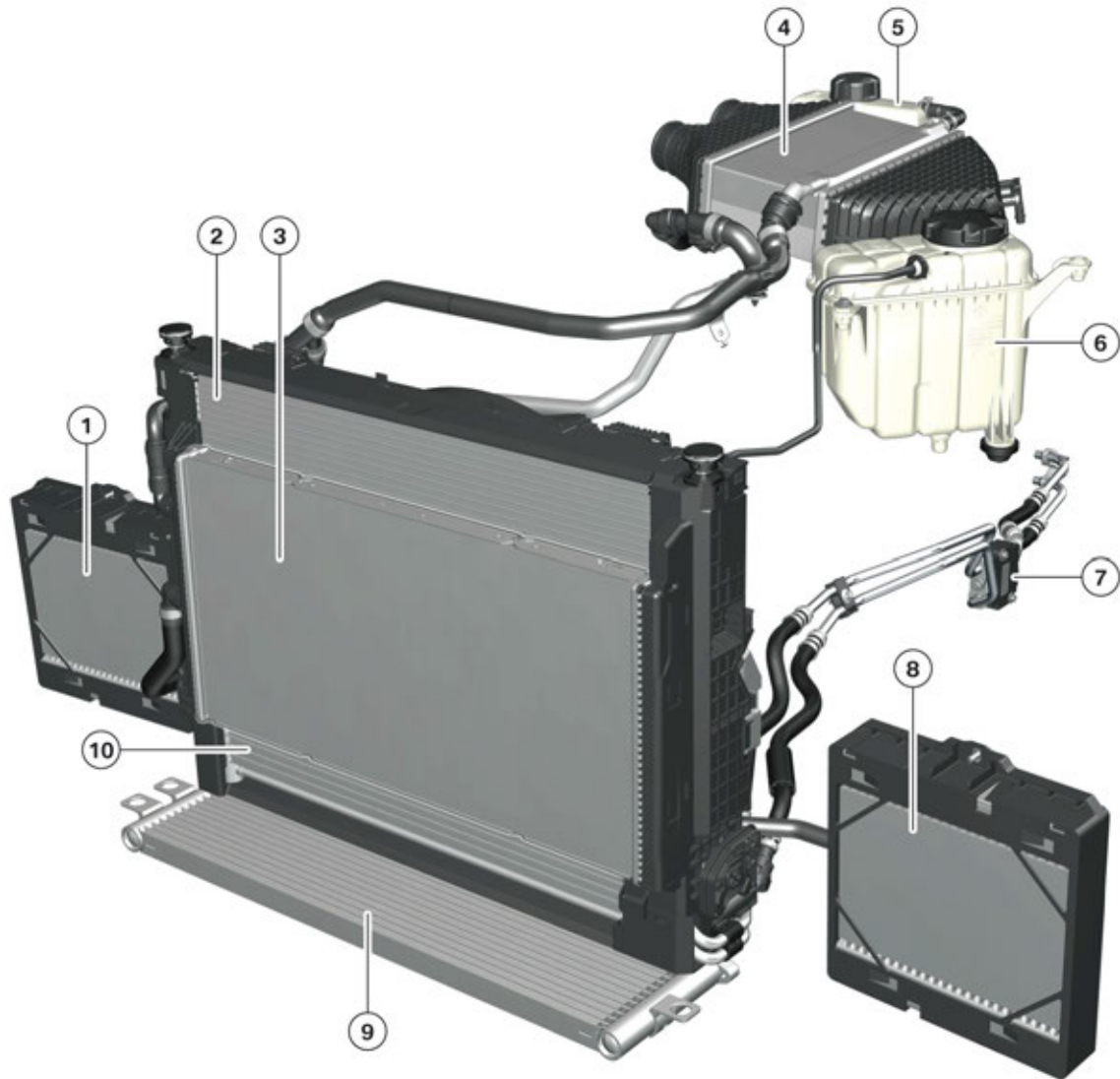
- Before making any modifications to the fuel system, make sure to remove the ignition coils and protect the spark plug holes against of fuel ingress by covering with them with a rag.
 - Before reinstalling the solenoid valve injectors, remove the ignition coils and ensure the best cleanliness conditions are maintained.
 - Ignition coils heavily fouled by fuel must be replaced.
 - The CVO function comprise the system components "Injector" and "Digital Engine Electronics" (DME). These components therefore have to be identified with the vehicle identification number in the EPC in the event of a replacement.
 - For injectors and a DME which supports the CVO function, the injection quantity compensation during the replacement of one of the components is deleted.
 - The information and repair instructions in the Integrated Service Technical Application (ISTA) must be observed.
-

S55 Engine

11. Cooling System

11.1. Overview

The S55 engine cooling system consists of engine and charge air cooling, as well as oil cooling for the engine oil and the M DCT.



TO14-0234

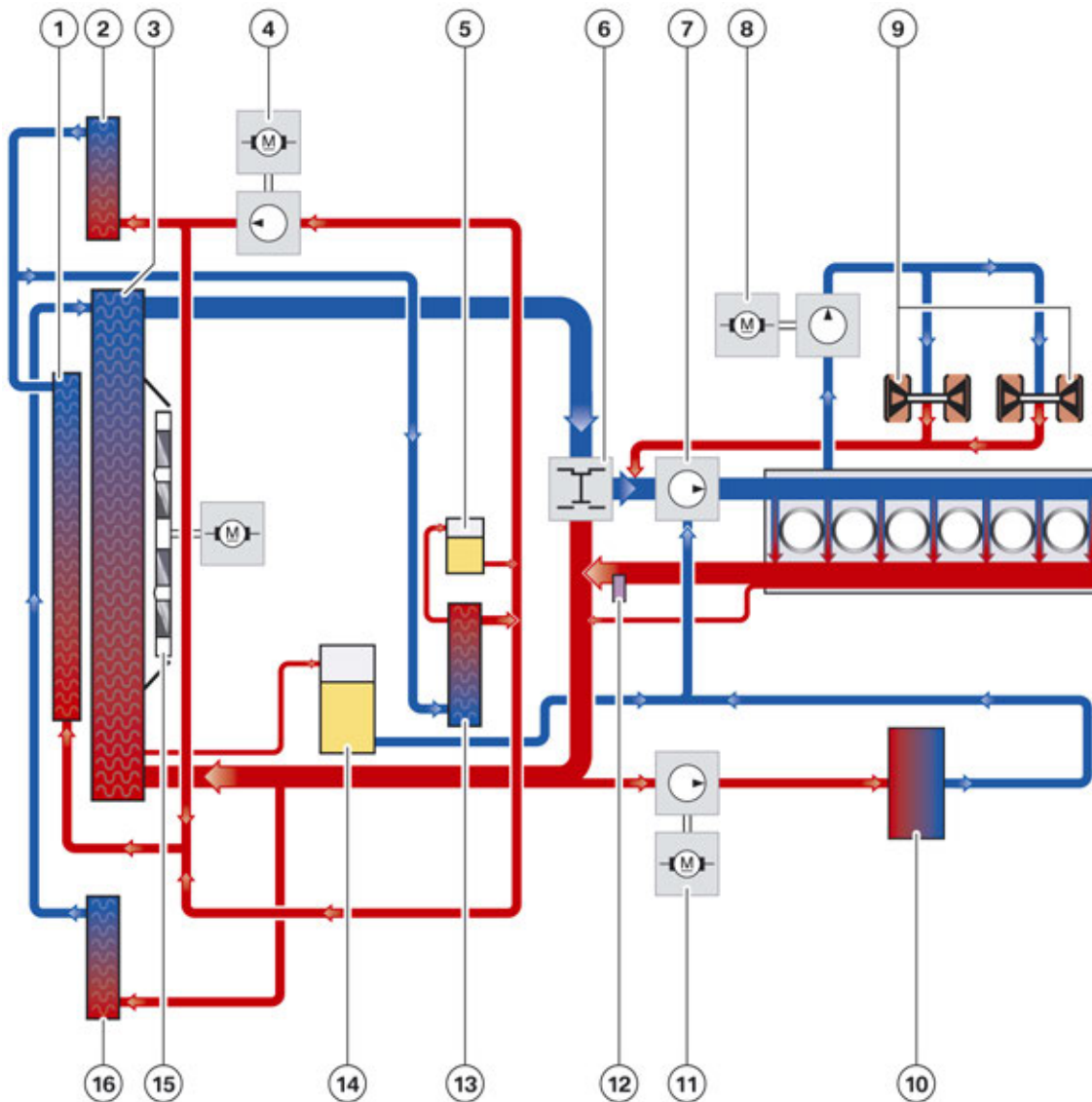
S55 engine, cooling system

Index	Explanation
1	Upstream low-temperature radiator, charge air
2	Radiator, engine
3	Low-temperature radiator, charge air
4	Indirect charge air cooler
5	Coolant expansion tank, charge air
6	Coolant expansion tank, engine

S55 Engine

11. Cooling System

Index	Explanation
7	Thermostat, transmission oil cooling, M DCT
8	Upstream radiator, engine
9	Engine oil cooler
10	M DCT transmission oil cooler



S55 engine, engine cooling with exhaust turbochargers and charge air cooling

TO14-0235

S55 Engine

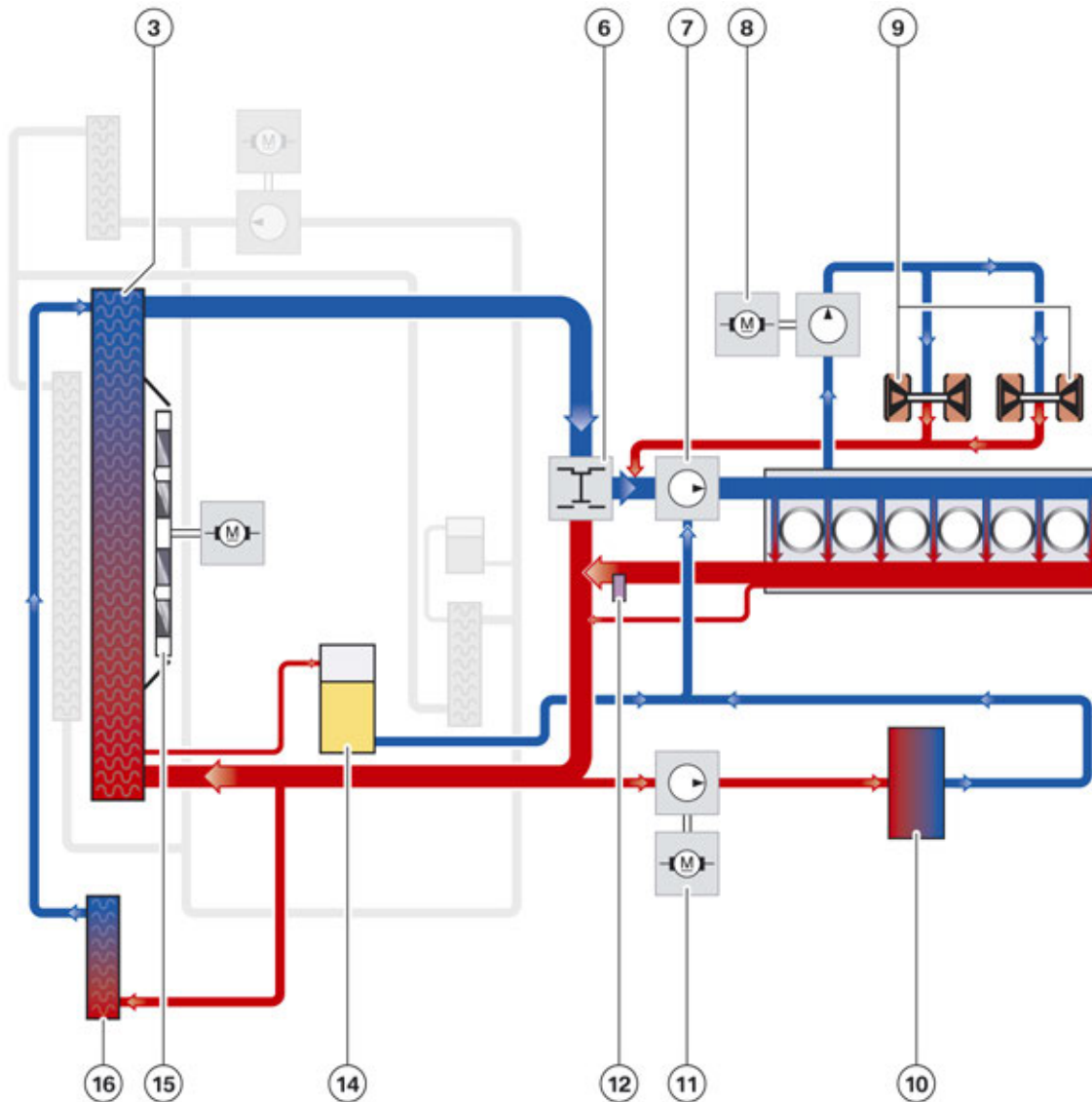
11. Cooling System

Index	Explanation
1	Low-temperature radiator, charge air
2	Upstream low-temperature radiator, charge air
3	Radiator, engine
4	Electric coolant pump, low-temperature circuit, charge air
5	Coolant expansion tank, charge air
6	Thermostat
7	Mechanical coolant pump, engine
8	Electric coolant pump for turbochargers
9	Turbochargers
10	Heat exchanger
11	Electric coolant pump, heating for passenger compartment
12	Coolant temperature sensor
13	Indirect charge air cooler
14	Coolant expansion tank, engine
15	Electric fan
16	Upstream radiator, engine

S55 Engine

11. Cooling System

11.2. Engine cooling



TO14-0236

S55 engine, cooling system

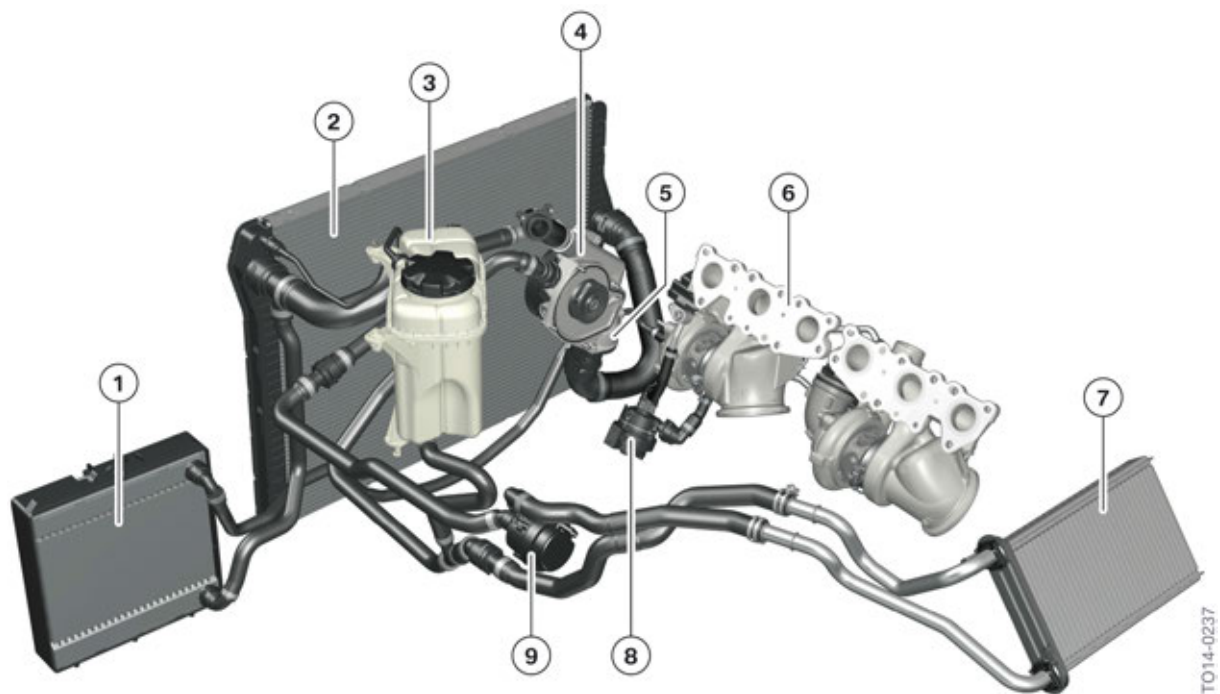
Index	Explanation
3	Radiator, engine
6	Thermostat
7	Mechanical coolant pump, engine
8	Electric coolant pump for turbochargers
9	Turbochargers
10	Heat exchanger
11	Electric coolant pump, heating for passenger compartment

S55 Engine

11. Cooling System

Index	Explanation
12	Coolant temperature sensor
14	Coolant expansion tank, engine
15	Electric fan
16	Upstream radiator, engine

The following graphic shows the connection of an auxiliary radiator to the cooling system. The auxiliary radiator is connected in parallel to the radiator with coolant lines, thus increasing the cooling surface area.



S55 engine, coolant circuit with exhaust turbochargers

Index	Explanation
1	Auxiliary radiator, engine
2	Radiator, engine
3	Coolant expansion tank, engine
4	Mechanical coolant pump, engine
5	Thermostat
6	Turbocharger unit
7	Heat exchanger
8	Electric coolant pump for turbochargers
9	Electric coolant pump, heating for passenger compartment

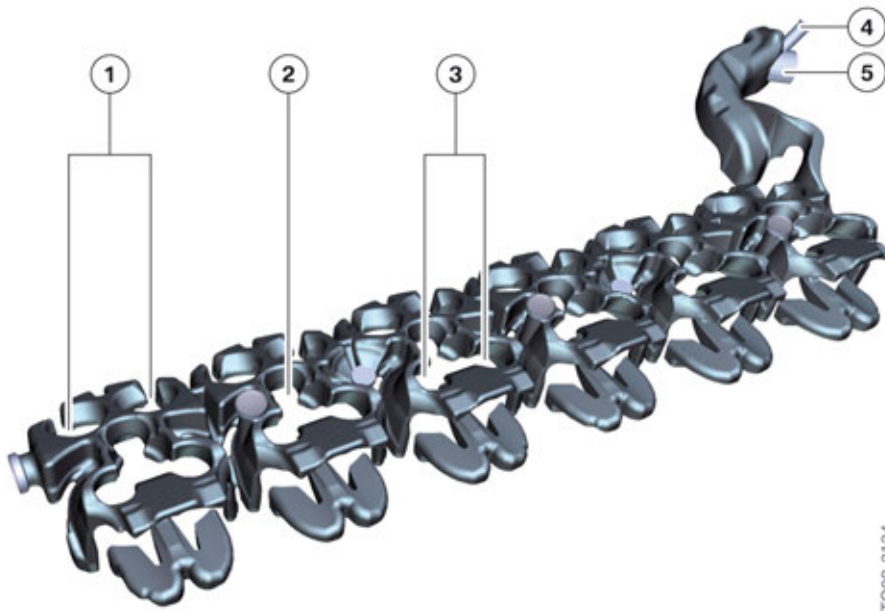
S55 Engine

11. Cooling System

The S55 engine uses a conventional belt driven coolant pump which replaces the electric coolant pump known from the N54 and N55 engines.

11.2.1. Coolant passages

The coolant passages in the cylinder head are also used for indirect cooling of the fuel injectors. The following graphic shows that the coolant flows around the valves and fuel injectors. The heat transfer to these components is therefore reduced to a minimum.



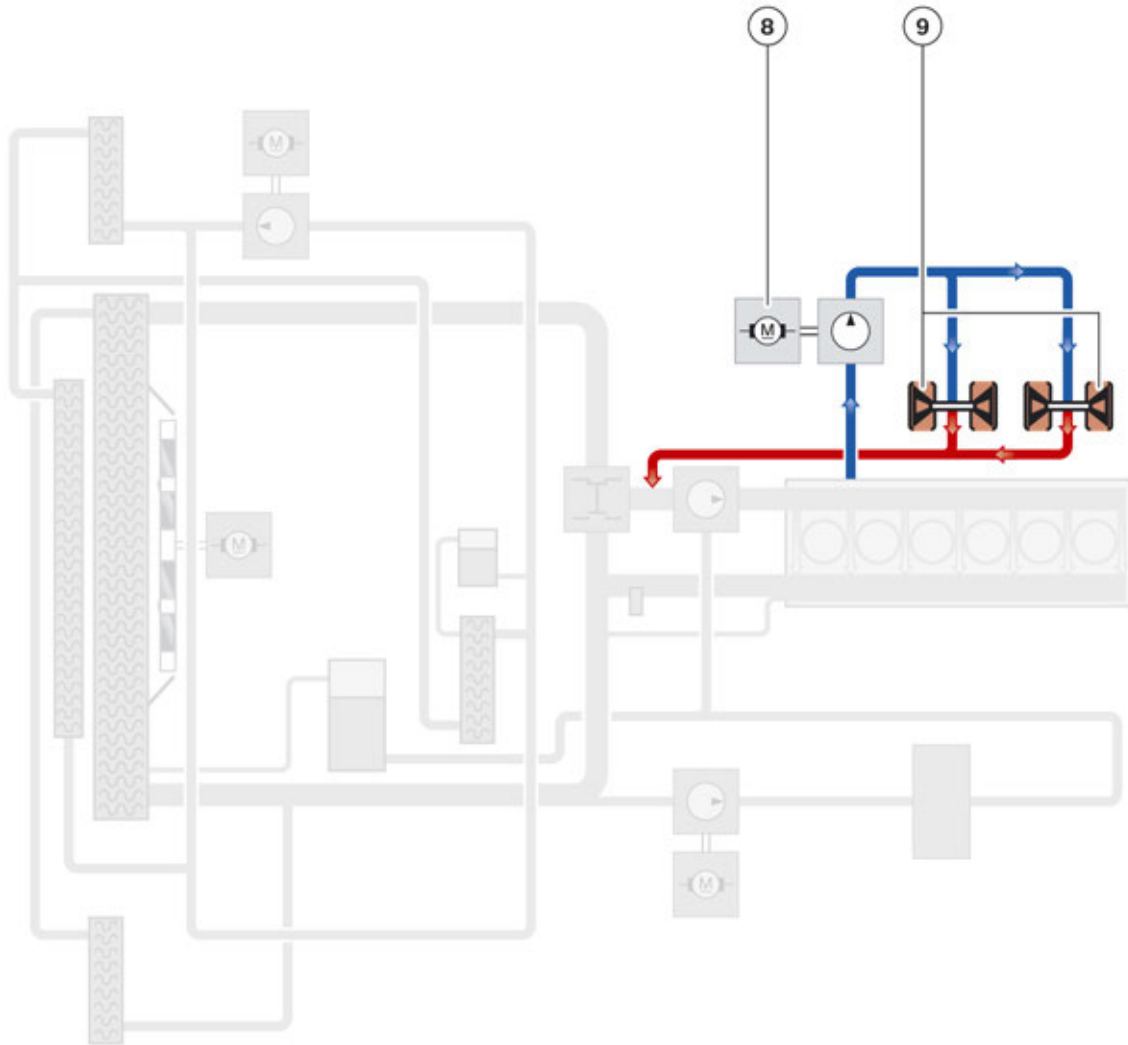
S55 engine, coolant passages in the cylinder head

Index	Explanation
1	Passage, intake valves
2	Passage, injector
3	Passage, exhaust valves
4	Connection of coolant hose and thermostat (small cooling circuit)
5	Connection of coolant hose and radiator (large cooling circuit)

S55 Engine

11. Cooling System

11.2.2. Cooling circuit, exhaust turbochargers



TO14-0238

S55 engine, cooling circuit of the turbochargers with electrical auxiliary coolant pump

Index	Explanation
8	Electric coolant pump for the turbochargers
9	Turbochargers

The conventional coolant pump is driven via the drive belt and cannot be used for cooling the turbochargers after the engine has shut down. This is why an auxiliary 20W electric coolant pump is used for the turbocharger coolant circuit.

S55 Engine

11. Cooling System

Not only does this additional coolant pump operate after engine shut down, but also during engine operation taking into account the following factors:

- Coolant temperature at the engine outlet
- Engine oil temperature
- Injected fuel quantity

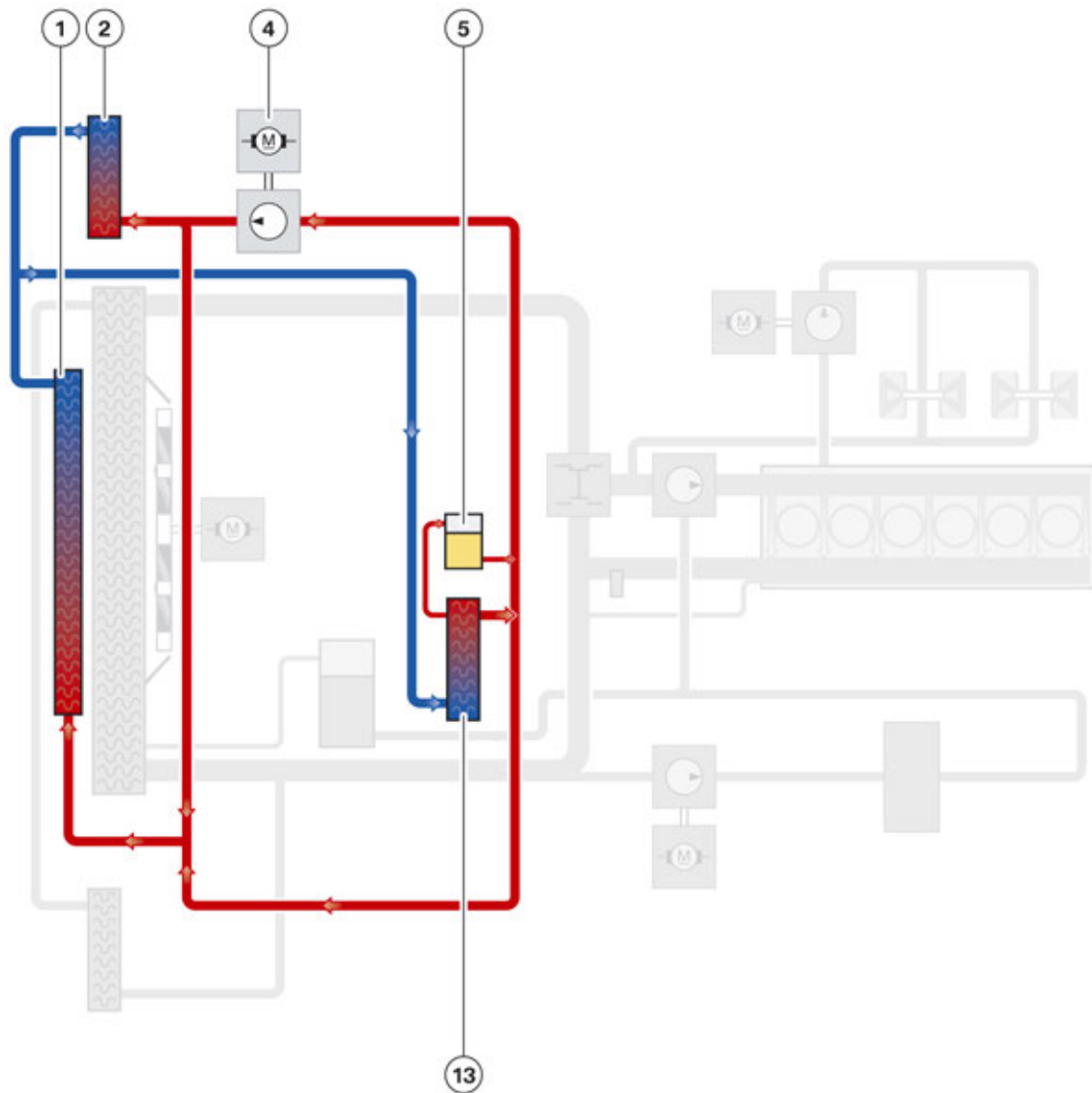
Using these values, the heat input to the engine is calculated. The after-run of the electric coolant pump can last up to 30 minutes. To improve the cooling effect, the electric fan is activated and can run for up to a maximum of 11 minutes after engine shut down.

S55 Engine

11. Cooling System

11.3. Charge air cooling

In the S55 engine, like in the S63 engine, indirect charge air cooling is used. During the indirect charge air cooling, the charge air is cooled by a low-temperature cooling circuit. The low-temperature cooling circuit is then cooled via two radiators by ambient air.



S55 Charge air cooling

TO14-0239

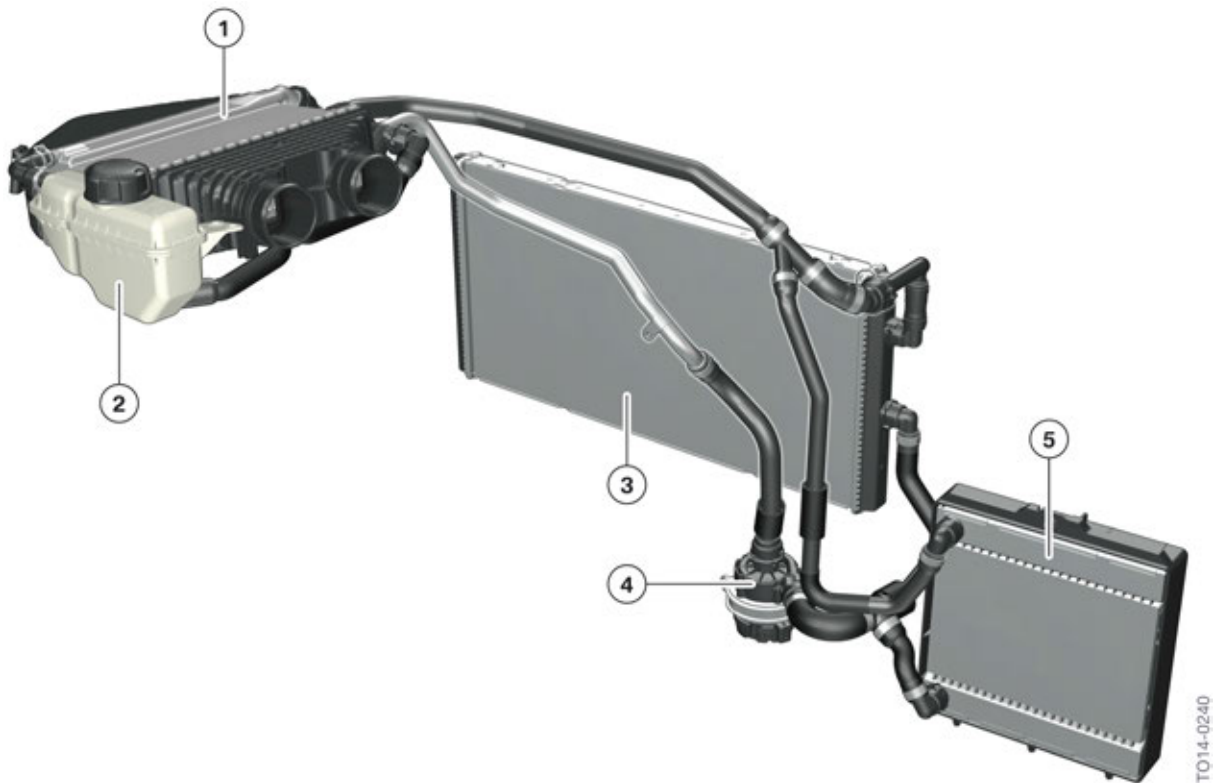
Index	Explanation
1	Low-temperature radiator, charge air
2	Upstream low-temperature radiator, charge air
4	Electric coolant pump, low-temperature circuit, charge air
5	Coolant expansion tank, charge air
13	Indirect charge air cooler

S55 Engine

11. Cooling System

Components

The capacity of the charge air cooling circuit is approximately 4 liters. The circulation of the coolant in the charge air cooling circuit is accomplished by an 80W electric coolant pump. The two radiators are connected in parallel and are supplied via an expansion tank secured at the charge air cooler. The indirect charge air cooler has a cooling power of 36 kW (10.3RT- refrigeration tons).



S55 engine, cooling circuit, charge air

Index	Explanation
1	Indirect charge air cooler
2	Coolant expansion tank, charge air
3	Low-temperature radiator, charge air
4	Electric coolant pump, low-temperature circuit, charge air
5	Upstream low-temperature radiator, charge air

S55 Engine

12. Engine Electrical System

12.1. Electrical system connection

12.1.1. Overview

Like in the N55, the DME is bolted to the intake manifold and is cooled by the intake air. The advantages of the DME close to the engine are as follows:

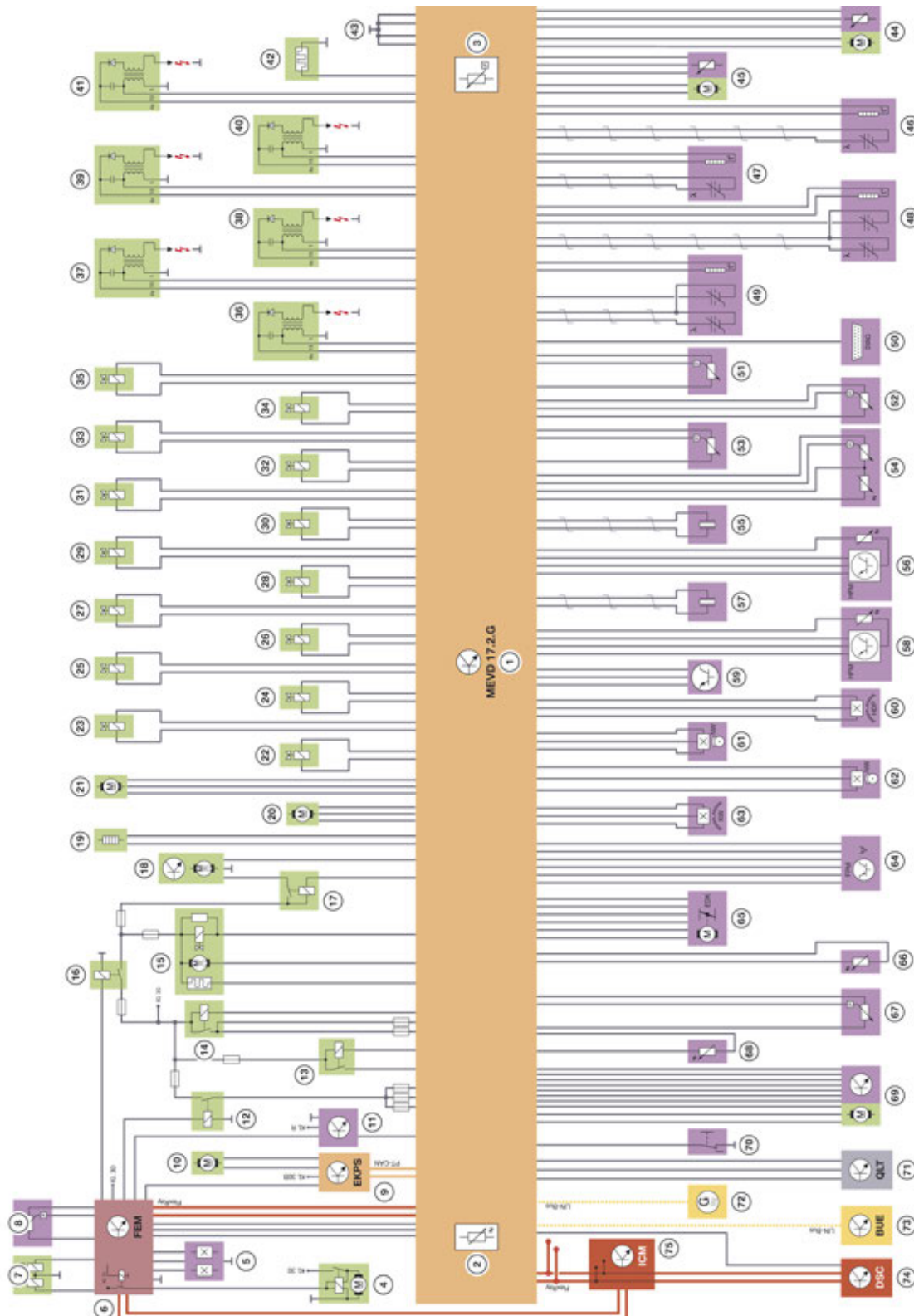
- The engine wiring harness is divided into six individual modules
- All electrical components on the engine are supplied directly by the DME
- E-box no longer needed
- 211 pins are available, the connections are waterproof when connected
- Shorter engine wiring harness
- Simplification of the production

S55 Engine

12. Engine Electrical System

12.1.2. System wiring diagrams

System wiring diagram for MEVD17.2.G



S55 Engine

12. Engine Electrical System

Index	Explanation
1	DME, Valvetronic, direct fuel injection MEVD17.2.G
2	Temperature sensor
3	Ambient pressure sensor
4	Starter motor
5	Brake light switch
6	Front Electronic Module (FEM)
7	Air conditioning compressor
8	Refrigerant pressure sensor
9	Electronic fuel pump control
10	Electric fuel pump
11	Clutch module
12	Relay, terminal 15N
13	Relay, Valvetronic
14	Relay, ignition and fuel injection
15	Diagnostic module for tank leaks (DMTL)
16	Relay, terminal 30B
17	Relay for electric fan
18	Electric fan
19	Map thermostat
20	Electric coolant pump, exhaust turbocharger
21	Electric coolant pump, charge air cooling
22	Tank vent valve
23	VANOS solenoid valve, intake camshaft
24	VANOS solenoid valve, exhaust camshaft
25	Oil pressure control valve
26	Quantity control valve, high pressure pump 1
27	Quantity control valve, high pressure pump 2
28	Electrical exhaust flap, cylinders 1–3
29	Electrical exhaust flap, cylinders 4–6
30 – 35	Fuel Injectors
36 – 41	Ignition coils
42	Engine ventilation heating
43	Ground connections
44	Electrical wastegate valve actuator, cylinders 1–3
45	Electrical wastegate valve actuator, cylinders 4-6

S55 Engine

12. Engine Electrical System

Index	Explanation
46	Oxygen sensor after catalytic converter, cylinders 1–3
47	Oxygen sensor after catalytic converter, cylinders 4–6
48	Oxygen sensor before catalytic converter, cylinders 1–3
49	Oxygen sensor before catalytic converter, cylinders 4–6
50	Diagnostic socket
51	Fuel low-pressure sensor
52	Intake-manifold pressure sensor after throttle valve
53	Rail pressure sensor
54	Charge air temperature and pressure sensor
55	Knock sensor, cylinders 1–3
56	Hot film air mass meter, cylinders 1–3
57	Knock sensor, cylinders 4–6
58	Hot film air mass meter, cylinders 4–6
59	Gear sensor
60	Position sensor, high pressure pump
61	Camshaft sensor, intake camshaft
62	Camshaft sensor, exhaust camshaft
63	Crankshaft sensor
64	Accelerator pedal module
65	Electromotive throttle controller
66	Coolant temperature sensor
67	Oil pressure sensor
68	Oil temperature sensor
69	Valvetronic servomotor
70	Engine dynamics button
71	Oil level sensor
72	Alternator
73	Battery supervision circuits (BUE)
74	Dynamic Stability Control (DSC)
75	Integrated Chassis Management (ICM)

S55 Engine

12. Engine Electrical System

12.1.3. Engine control unit

The S55 engine receives the engine control MEVD17.2.G from Bosch. The DME is integrated into the intake manifold and is cooled by the intake air. The MEVD17.2.G DME can operate on the FlexRay and supplies the sensors and actuators directly with voltage.

The top side of the DME housing is also the lower section of the intake manifold. The DME housing is contoured in order to ensure optimal flow in the intake manifold.

When connected, the plug connections between the wiring harness and DME are waterproof.

12.2. Functions

12.2.1. Fuel supply

A voltage signal is sent from the low pressure fuel sensor to the DME based on the system pressure applied between the electric fuel pump and the high pressure pump. The system pressure (fuel pressure) is determined using the low-pressure fuel sensor before the high pressure pump. In the DME, a constant comparison of the nominal pressure and the actual pressure is carried out.

In the event of a deviation of the nominal pressure from the actual pressure, the engine control unit increases or reduces the voltage for the electric fuel pump, which is sent as a message via the PT-CAN to the electric fuel pump control unit (EKP).

The electric fuel pump control unit transforms the message into output voltage for the electric fuel pump. The necessary delivery pressure for the engine (or the high pressure pumps) is adjusted. In the event of a signal failure (low pressure fuel sensor) the electric fuel pump is pre-controlled with terminal 15 ON. If the CAN bus fails, the electric fuel pump is operated via the electric fuel pump control unit with the system voltage. The high pressure pumps increase the fuel pressure between 50 to 200 bar. The fuel reaches the rail via the high pressure lines. The fuel is stored temporarily in the 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 inlets of the high pressure pumps when the quantity control valves are open. In the event of a failure of a high pressure pump, restricted driving is possible.

The quantity control valves control the fuel pressure in the rail. The quantity control valves are activated by the engine control 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. There is also an option to reduce the pressure in the rail.

12.2.2. Charging pressure control

The charging pressure is controlled by the engine control via the wastegate valves at each of the two turbochargers. In order to be able to infinitely adjust the wastegate valves, electrical wastegate valves are installed which implement the signals from the engine control to open or close the wastegate valve.

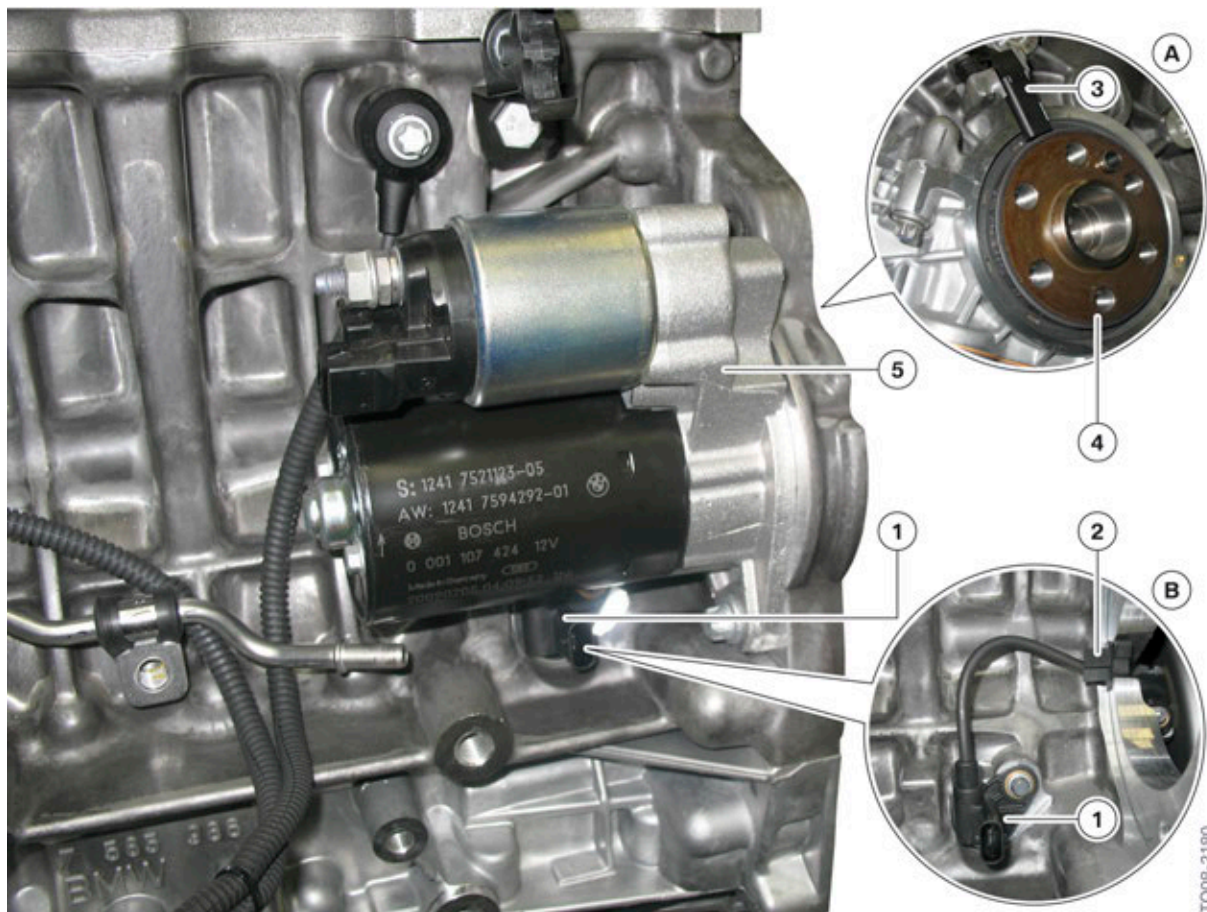
S55 Engine

12. Engine Electrical System

12.3. Sensors

12.3.1. Crankshaft sensor

The integrated crankshaft sensor has the same function as the crankshaft sensors used for the automatic engine start-stop function (MSA). The reverse detection of the engine is necessary for the MSA function. The sensor and the function are described in the Technical Reference Manual "ST1112 Automatic Start Stop (MSA)".



S55 engine, installation location of crankshaft sensor (using the example of the N55)

Index	Explanation
A	Line of vision on the crankshaft
B	Same line of vision without starter motor
1	Connector
2	Dust seal
3	Sensor
4	Multi-pole sensor gear
5	Starter

S55 Engine

12. Engine Electrical System



S55 engine, crankshaft sensor with multi-pole sensor gear

Index	Explanation
1	Connector
2	Dust seal
3	Sensor

12.3.2. Ignition coil and spark plug

Ignition coil

The S55 engine uses the same ignition coils that are installed in the N55 engine. Like in the N55 engine, the ignition coils offer higher ignition voltage, better electromagnetic compatibility and improved strength.

Spark plug

The spark plugs of the S55 engine are M-specific components.

S55 Engine

12. Engine Electrical System

12.3.3. Oil pressure sensor

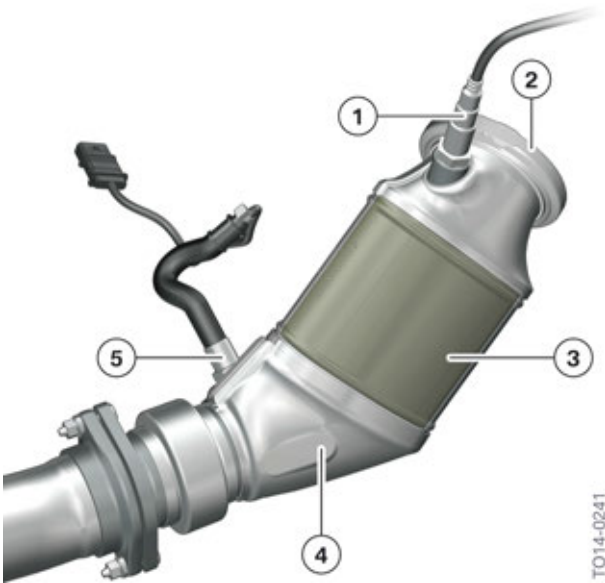
The oil pressure sensor can determine the absolute pressure, which is necessary for more precise oil-pressure control. The sensor is identical in its structure to the low pressure fuel sensor.

The oil pressure sensor is supplied with 5 V voltage by the DME.



S55 engine, oil pressure sensor

12.3.4. Oxygen sensors



S55 engine, catalytic converter

Index	Explanation
1	Oxygen sensor before catalytic converter
2	Connection at the exhaust turbocharger
3	Metal honeycomb structure
4	Catalytic converter housing
5	Oxygen sensor after catalytic converter

The same connectors are used for the oxygen sensors as in the N55 engine. This connector system offers significantly better contact properties and reduces the "ambient noise" due to contact problems. Another improvement is the oscillation- and vibration-free contact point.

S55 Engine

12. Engine Electrical System

Oxygen sensor before catalytic converter

The oxygen sensors (LSU ADV) from Bosch are used as control sensors before the catalytic converters. The function is comparable to the oxygen sensor (LSU 4.9) and therefore is not described in detail here. This oxygen sensor is already used in the N55 and N63 engine. The abbreviation LSU stands for universal oxygen sensor and ADV for "Advanced".

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

- High signal stability, especially in boost operation due to lower dynamic pressure dependence
- Increased durability thanks to reduced pump voltage
- Increased accuracy
- Quicker operating readiness (< 5 seconds)
- Greater temperature compatibility
- Improved connector with better contact properties

The LSU ADV has an extended measuring range, making it possible to measure precisely from lambda 0.65. The oxygen sensor is operational earlier, so after 5 seconds precise measurement values are available.

The higher measuring dynamics of the sensor makes it possible to more effectively determine and control the fuel-air ratio of each cylinder. As a result, a homogeneous exhaust flow can be adjusted, the emission levels lowered and the long-term emission behavior optimized.

Oxygen sensor after catalytic converter

The oxygen sensor after catalytic converter is also called a monitoring sensor. The monitoring sensor LSF XFOUR from Bosch is used.

The LSF XFOUR needs the MEVD17.2.G for the signal evaluation and is characterized by the following properties:

- Quicker response characteristics after engine start (a more controlled heater was integrated in the LSF XFOUR)
- Improved signal stability
- Small installation space
- High temperature resistance and optimal thermal shock protection
- Resistance against condensation in the exhaust duct after a cold start is improved

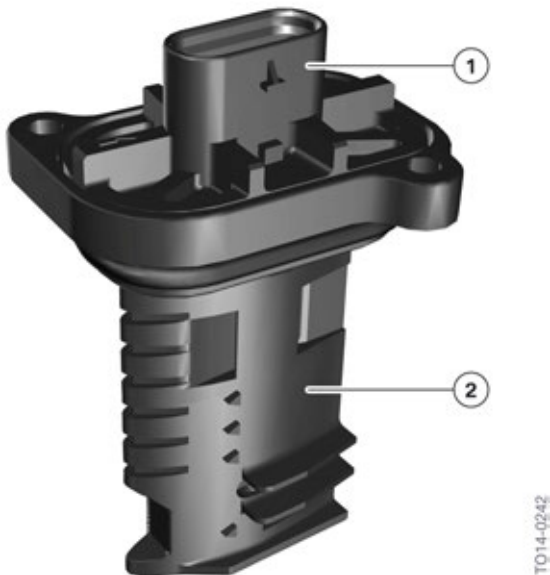
S55 Engine

12. Engine Electrical System

12.3.5. Hot film air mass meter

The hot film air mass meter 7 is used, like in the N55 engine. The S55 engine uses two hot film air mass meters, one for each bank.

The hot film air mass meter measures the flow of the filtered air which is drawn in by the engine. In conjunction with other sensors, the quantity of the fuel to be injected is controlled. The HFM signal is also used in other system diagnosis, like fuel tank ventilation. In contrast to the hot film air mass meter in the N20 and N26 engine, the hot film air mass meter in the N55 and S55 engine has an independent temperature sensor.



S55 engine, hot film air mass meter 7

Index	Explanation
1	Electrical connection
2	Sensor

12.4. Actuators

12.4.1. Valvetronic servomotor

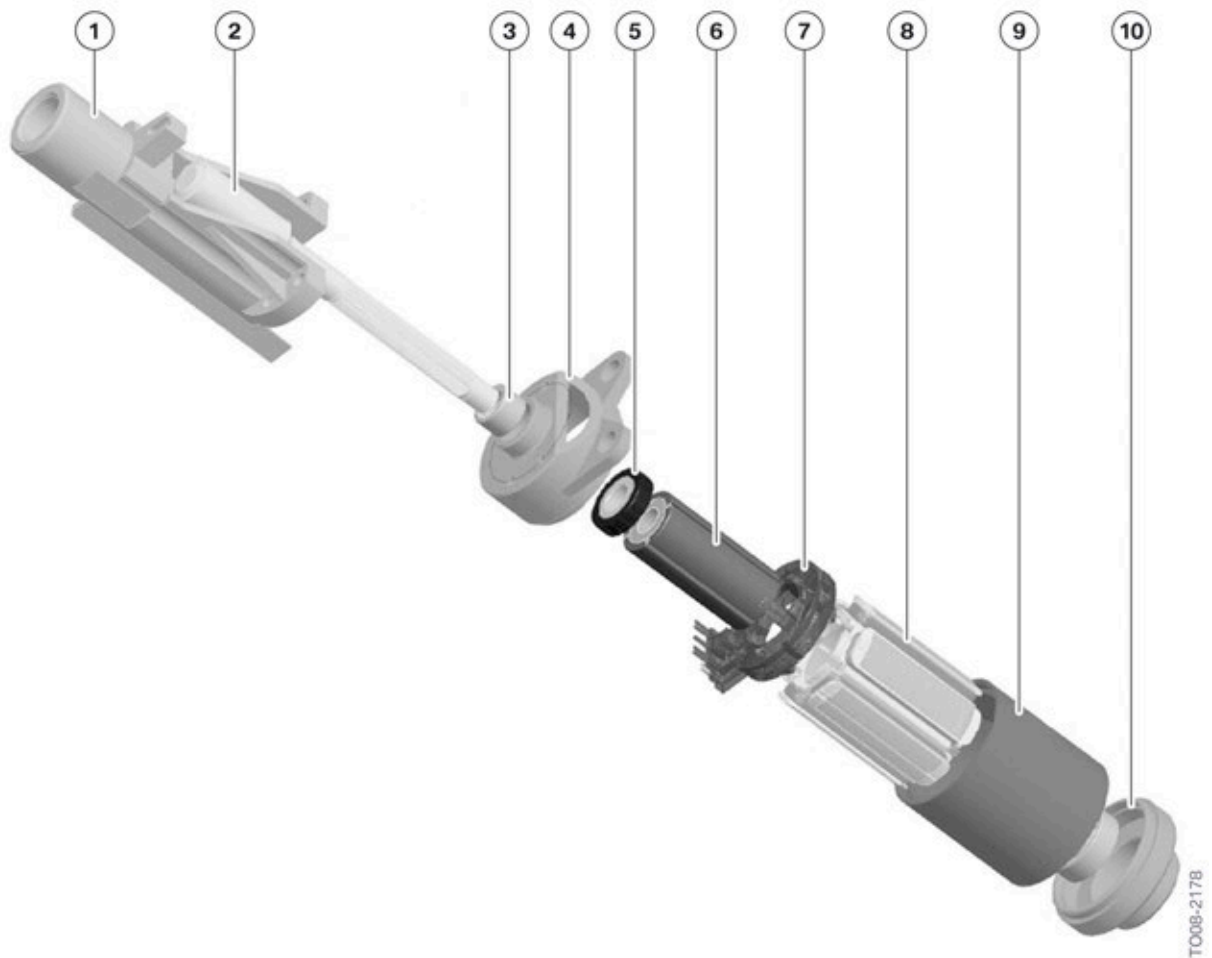
The brushless direct current motor, Valvetronic servomotor, is maintenance free and very powerful due to the contactless energy transfer. With the use of integrated electronic modules, it is controlled with precision.

Function

The activation of the Valvetronic servomotor is limited to a maximum of 40 A. Over a period of >200 milliseconds a maximum of 20 A is available. The Valvetronic servomotor is activated by a pulse-width-modulated signal. The duty cycle is between 5% and 98%.

S55 Engine

12. Engine Electrical System



S55 engine, Valvetronic servomotor

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

S55 Engine

12. Engine Electrical System

The sensor is supplied with 5 V voltage by the DME. The DME receives signals via five hall effect elements and evaluates them. Of the five hall effect sensors three are for rough classification and two are for precise classification. The angle of rotation of the servomotor can be determined at $<7.5^\circ$. With the ratio of the worm drive, a very precise and quick lift adjustment of the valves is possible.

12.4.2. High-pressure fuel injection valve

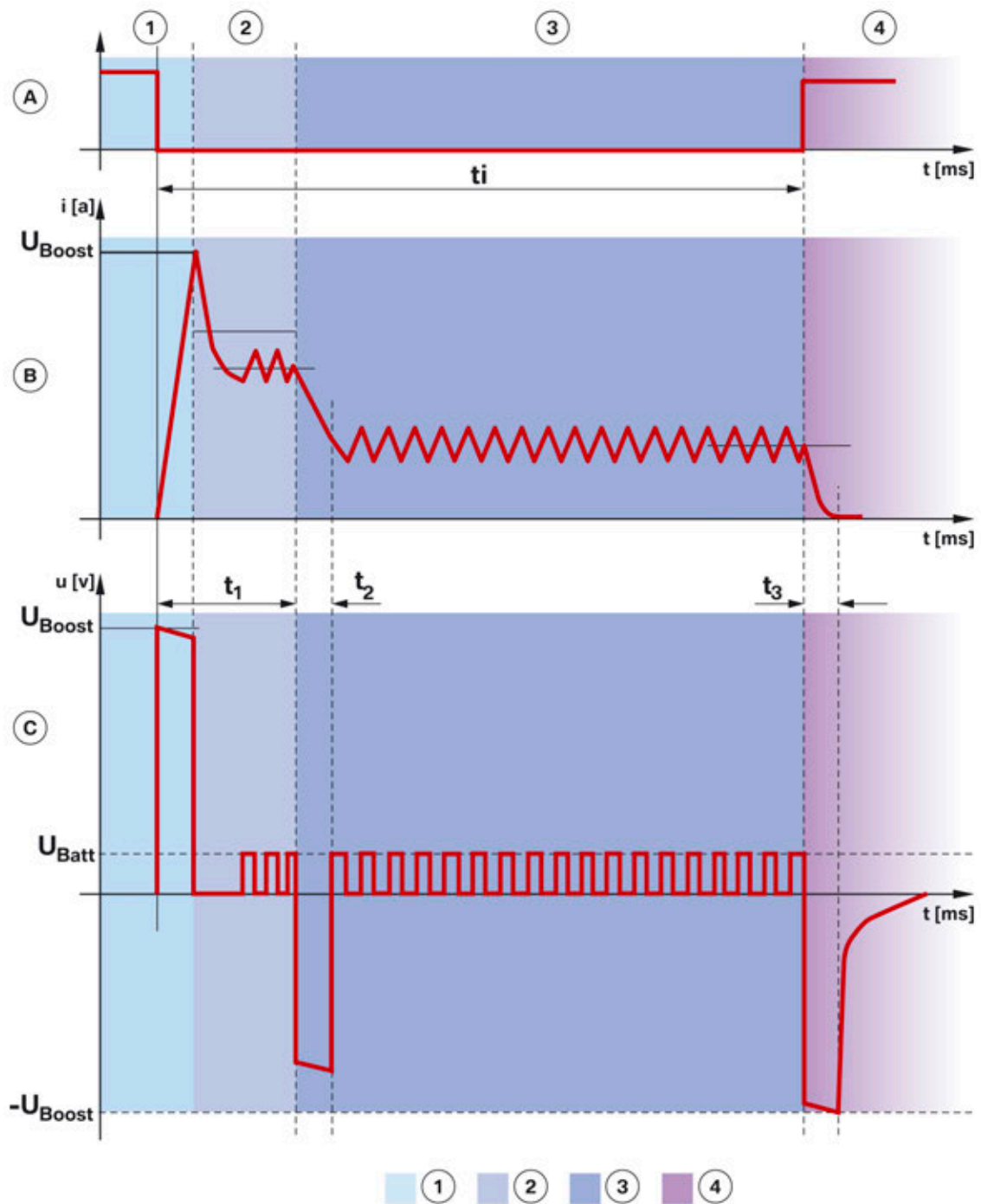
In the S55 engine the HDEV5.2 is based on the high-pressure fuel injection valve used in the N55 engine (HDEV5.2). The function is the same.

Function

The activation of the HDEV5.2 is effected in four phases, as shown in the following graphic:

S55 Engine

12. Engine Electrical System



S55 engine, activation phases of the HDEV5.2

TO08-2216

S55 Engine

12. Engine Electrical System

Index	Explanation
A	Activation signal, DME
B	Current flow HDEV5.2
C	Voltage at HDEV5.2
1	Booster phase
2	Activation phase
3	Holding phase
4	Shutdown phase

- 1 **Booster phase:** In the Booster phase the opening of the HDEV5.2 is introduced by the DME with a high booster voltage. The Booster phase is completed when approx. 10 A is reached. The high current is achieved with a voltage of up to approx. 65 V.
- 2 **Activation phase:** In the activation phase the HDEV5.2 is opened fully after the booster phase by current control of around 6.2 A. At the end of the activation phase the current is reduced from the activation to the holding current level of approx. 2.5 A.
- 3 **Holding phase:** In the holding phase the applied HDEV5.2 is held open by current control of around 2.5 A.
- 4 **Shutdown phase:** The current is shut down in the shutdown phase after the end of the injection period. At least 2 milliseconds pass between two injection processes.

S55 Engine

13. Service Information

13.1. Engine mechanics

13.1.1. Engine housing

Cylinder head



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

Cylinder head cover



If there is a complaint about higher oil consumption and at the same time an exhaust turbocharger fouled with oil is diagnosed, then it cannot be immediately concluded that the exhaust turbocharger is faulty. If the fouling is already present after the introduction of the blow-by gases, then the entire engine must be checked for leaks. The cause of an excessive blow-by gas flow rate may be faulty gaskets or crankshaft seals. Untight crankshaft seals may generate oil consumption of up to 3 l/1000 km.

S55 Engine

13. Service Information

13.2. Fuel preparation

13.2.1. Overview

Injectors



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

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

When working on the fuel system of the S55 engine, it is important to ensure that the ignition coils are not fouled with fuel. The resistance of the silicone material is greatly reduced by having contact with fuel. This may result in arching on the spark plug head and thus in misfires.

- Before making any modifications to the fuel system, make sure to remove the ignition coils and protect the spark plug holes against of fuel ingress by covering with them with a rag.
 - Before reinstalling the solenoid valve injectors, remove the ignition coils and ensure the best cleanliness conditions are maintained.
 - Ignition coils heavily fouled by fuel must be replaced.
 - The CVO function comprise the system components "Injector" and "Digital Engine Electronics" (DME). These components therefore have to be identified with the vehicle identification number in the EPC in the event of a replacement.
 - For injectors and a DME which supports the CVO function, the injection quantity compensation during the replacement of one of the components is deleted.
 - The information and repair instructions in the Integrated Service Technical Application (ISTA) must be observed.
-



Bayerische Motorenwerke Aktiengesellschaft
Qualifizierung und Training
Röntgenstraße 7
85716 Unterschleißheim, Germany