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S65B40 Engine

Initial Print Date: 1/08 Revision Date:

S65B40 Engine

Model: E90 M3, E92 M3

Production: 2/2008

OBJECTIVES

After completion of this module you will be able to:

- Identify the components of the S65B40 engine
- Identify the difference between the S85B50 and S65B40 engines
- Explain the oil supply system of the engine

Crankcase and Crankshaft Drive

Engine Block with Bedplate Construction

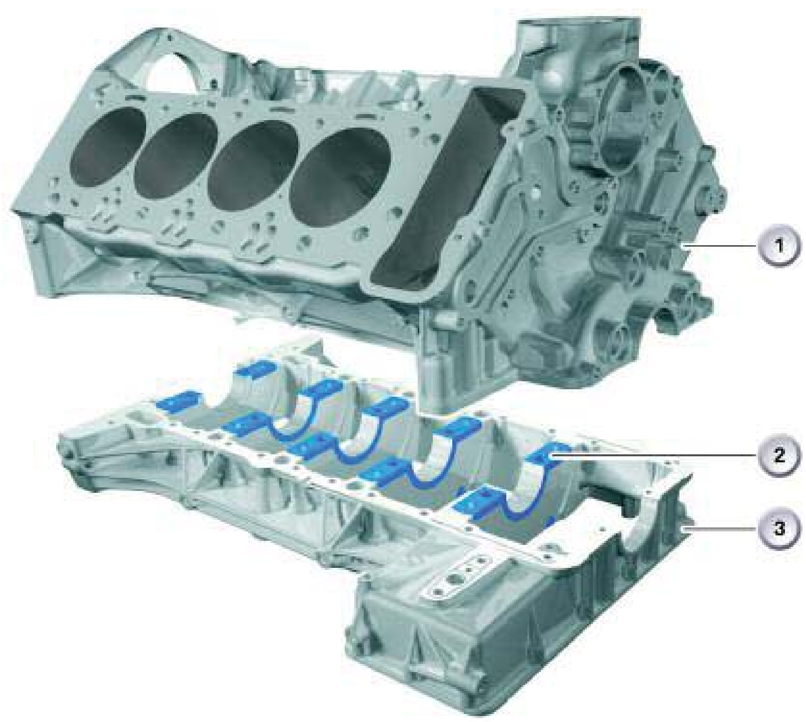
The construction and materials are identical to the S85; the upper low-pressure die-cast crankcase is made from an aluminum-silicon alloy.

The cylinder bores are formed using exposed hard silicon crystals, rendering the use of cylinder liners redundant.

The lower crankcase (bedplate) is also constructed using die-cast aluminum. Due to the extreme forces, grey cast iron inlays are used to reinforce the bedplate construction.

These also limit crankshaft bearing clearances over a greater temperature range and thus have a positive effect on the oil flow rate.

S65B40 Engine block with bedplate construction



Index	Explanation
1	Engine block (upper section)
2	Grey cast iron inlays
3	Bedplate construction (lower section)

Crankshaft

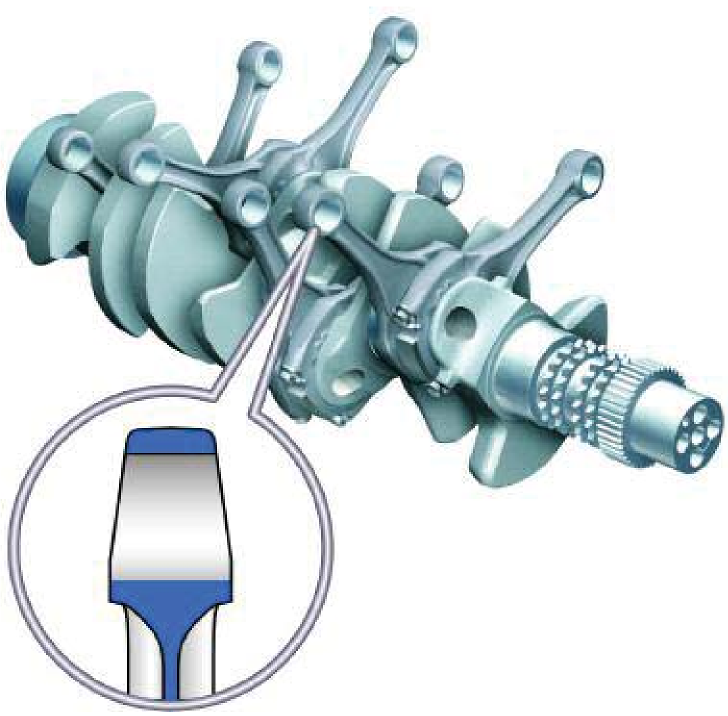
The five-bearing crankshaft is forged from a single piece, including the two double-chain wheels for driving the valve gear. The gear wheel for the oil pump drive is flange mounted.

The cylinder spacing is 98 mm. The crankshaft possesses a high level of bend resistance and high torsional strength at a relatively low weight. The crank pin offset is 90°. The diameter of the main bearing journal is 60 mm. The crankshaft end float is controlled by a thrust bearing located at the fifth main bearing.

For design reasons, the firing order 1-5-4-8-7-2-6-3 was chosen for the S65, instead of the firing order 1-5-4-8-6-3-7-2 more commonly employed in BMW V8 engines.

Connecting Rods

The weight-optimized, high tensile steel connecting rods split by fracture separation and the pistons are the same as those used in the S85 engine. For weight reduction, the upper section of the connecting rod has a trapezoidal shaped cross-section.

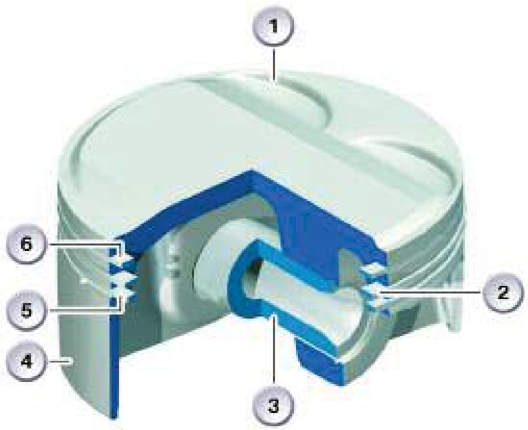


S65B40 crankshaft with magnification of the upper section of the connecting rod

Note: The large connecting rod eye is asymmetrically ground to reduce the length of the engine. This means that the installation is direction-specific. For the workshop, bearing shells are available in a repair stage (for more information, see the service documentation).
The identification marking of the bearing shells is engraved on the crankcase and on the first crank web.

Pistons

A piston is manufactured from a cast aluminum alloy and weighs approximately 480 grams including gudgeon pin and piston rings. The piston design is the same as the S85 piston (piston shaft with galvanized iron coating [Ferrostan] and a running-in layer containing tin. The installation position is direction-specific.



Index	Explanation
1	Pistons
2	Taper-faced ring
3	Gudgeon pin
4	Piston skirt
5	Oil scraper ring (VF system)
6	Compression ring (plain compression ring with spherical contact face)

Oil Supply

Two oil pumps are installed in the S65 engine; the oil return pump, which is driven via a gearwheel by a crankshaft, and the volume flow-controlled main oil pump, driven via chain drive by the oil return pump.

In the S85, the VANOS high pressure pump is installed instead of the S65 oil return pump, and the S85 oil return pump is contained in a housing together with the main oil pump (tandem pump).

Since there is no space to install a tandem pump in the S65, the oil return pump has been moved from the main oil pump housing and installed instead of the VANOS high-pressure pump. This allows the pump drive principle (crankshaft => gearwheel => pump => chain => pump) to be maintained. As in the S85, the volume flow-controlled main oil pump is a hinged-valve oil pump with a feed capacity adjusted to suit the VANOS low-pressure system.

The duocentric design of the oil return pump ensures that oil is always available at the inlet pipe of the main oil pump in the rear area of the oil pan, even when braking sharply from high speeds.

The electrical oil return pumps installed in the S85 for scavenging the cylinder heads are no longer required, which results in a further weight saving.

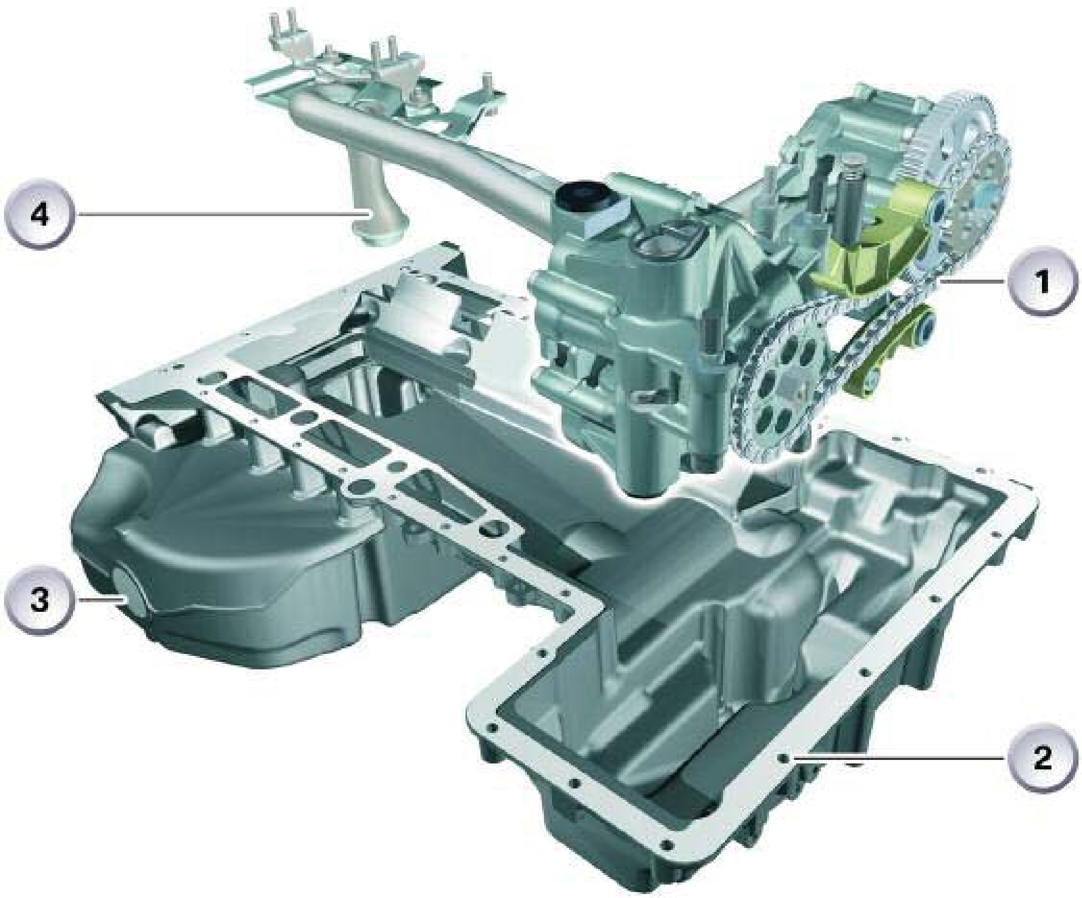
This is made possible by the lower number of cylinders, modification of the oil return routes, and the large capacity of the oil pan.

The oil pan has a capacity of 8.3 liters (S85 9.3 liters).

The oil supply is also guaranteed at extreme longitudinal and lateral accelerations of up to 1.4 times the normal gravitational acceleration.

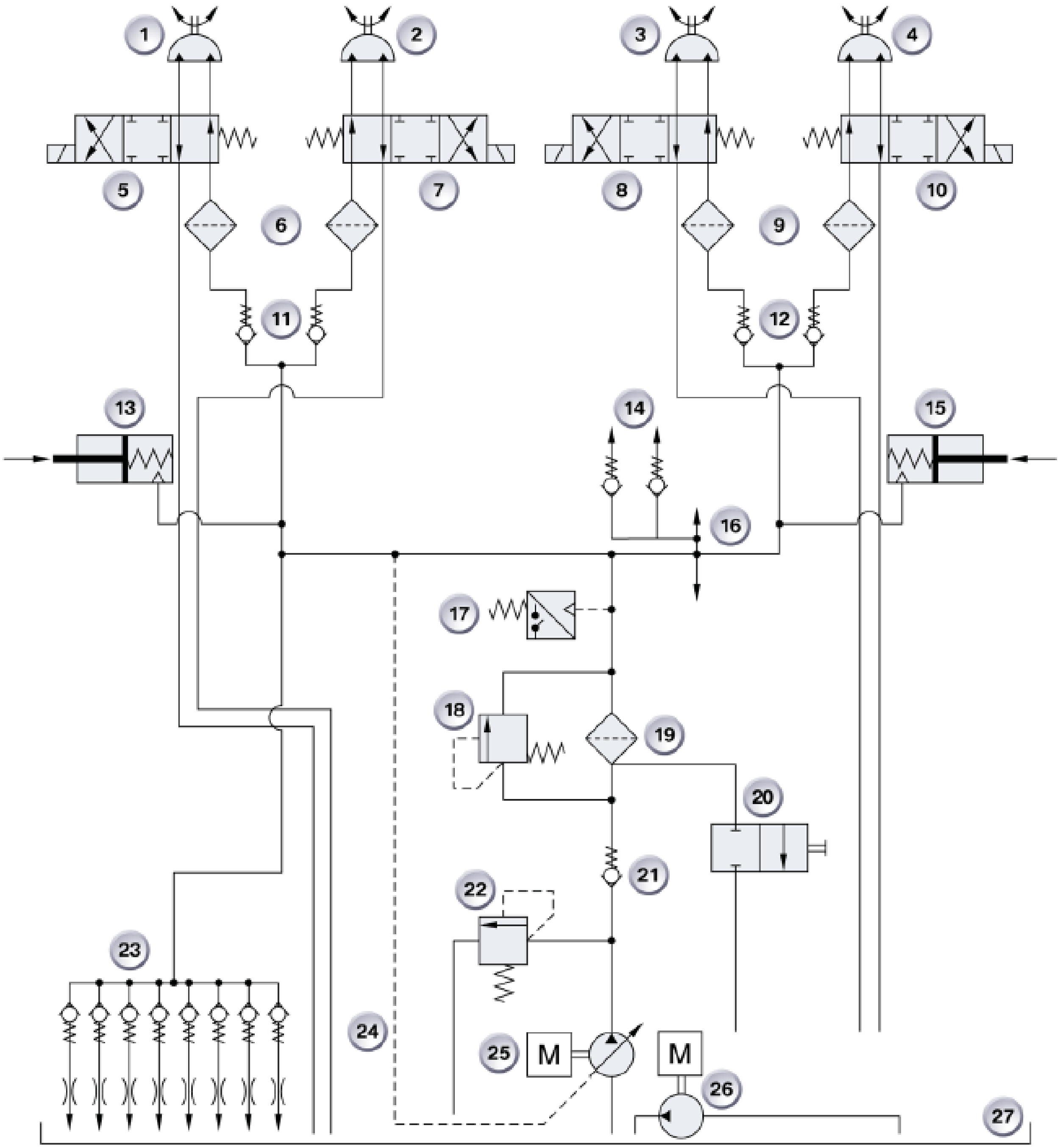
The oil filter housing is installed on the engine.

S65B40 Oil Pumps



Index	Explanation
1	Oil intake area of the oil return pump
2	Front, smaller section of the oil pan
3	Main oil pan
4	Oil intake area of the main oil pump

Oil Supply Hydraulic Circuit Diagram



Legend for Oil Supply Circuit Diagram

Index	Explanation
1	Cylinder bank 1 VANOS exhaust hydraulic motor
2	Cylinder bank 1 VANOS inlet hydraulic motor
3	Cylinder bank 2 VANOS inlet hydraulic motor
4	Cylinder bank 2 VANOS exhaust hydraulic motor
5	Cylinder bank 1 VANOS exhaust multi-way adjustment valve
6	Cylinder bank 1 VANOS sieve filter (max. 300 µm) before multi-way adjustment valve
7	Cylinder bank 1 VANOS inlet multi-way adjustment valve
8	Cylinder bank 2 VANOS inlet multi-way adjustment valve
9	Cylinder bank 2 VANOS sieve filter (max. 300 µm) before multi-way adjustment valve
10	Cylinder bank 2 VANOS exhaust multi-way adjustment valve
11	Cylinder bank 1 VANOS non-return valve
12	Cylinder bank 2 VANOS non-return valve
13	Cylinder bank 1 chain tensioner
14	Cylinder bank 1 and 2 non-return valve from chain lubrication
15	Cylinder bank 2 chain tensioner
16	Main oil channel (lubrication points engine block and cylinder head)
17	Oil pressure switch
18	Oil filter bypass valve
19	Oil filter
20	Oil filter outlet aperture
21	Non-return valve
22	Pressure limiting valve
23	Piston cooling nozzles
24	Oil pressure regulation line
25	Volume flow-controlled hinged valve main oil pump
26	Oil return pump
27	Sump

Valvetrain

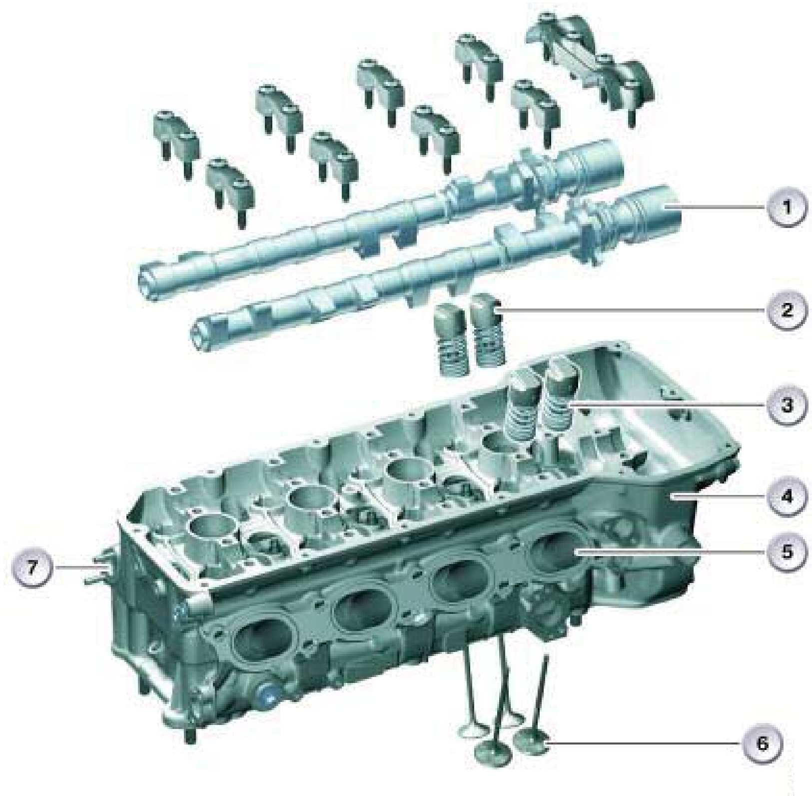
Cylinder Head

The cylinder head is constructed from a single piece of aluminum alloy. To reduce the number of sealing faces, the secondary air channel has been integrated back into the cylinder head.

The design of the cylinder head is based on the S85. Changes have been made in the front engine compartment to the VANOS and the timing chain.

The inlet and exhaust tracts have been further airflow-optimized. The integrated idle air channel has been discontinued and replaced by an idle air bar for each cylinder bank.

As in the S85, the camshafts are manufactured as a hollow-cast, one-piece construction with integrated sensor gears.



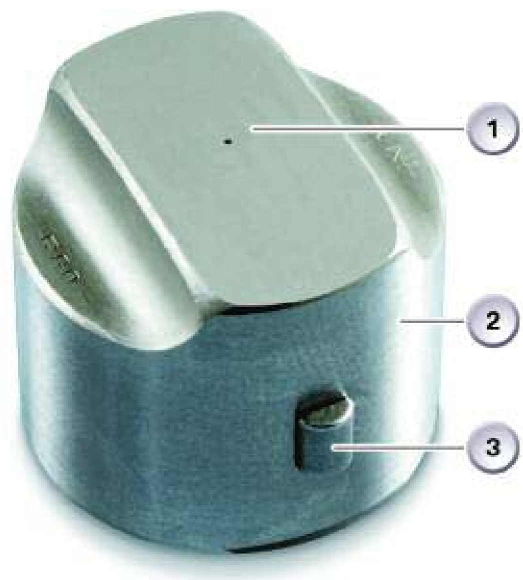
S65B40 Cylinder Head

Index	Explanation	Index	Explanation
1	Camshaft	5	Intake passage
2	Bucket tappet with hydraulic valve clearance adjustment	6	Valve
3	Beehive-shaped valve springs	7	Connection flange of the integrated secondary air channel
4	Cylinder head		

Hydraulic Bucket Tappet

The weight-optimized valves with a 5 mm shaft diameter and the spherical bucket tappets with hydraulic valve clearance adjustment are also used.

These bucket tappets with a cylindrical camshaft contact surface and rotational lock allow a high level of convexity. This results in effective valve lift characteristics with the smallest possible tappet diameter and hence tappet mass (ideal for high engine speeds).

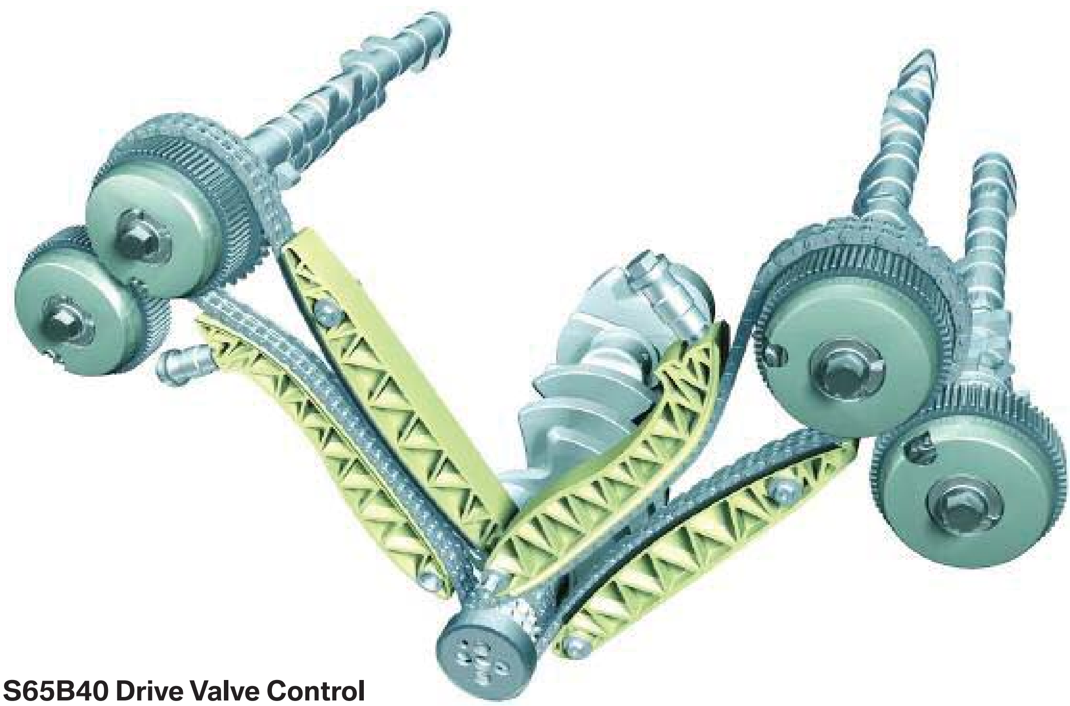


Index	Explanation
1	Spherical contact surface
2	Box tappet
3	Guide lug

Camshaft Drive

As in the S85, the inlet camshafts are driven by chain drive and the exhaust camshafts are driven by a gearwheel drive. This means that the inlet and exhaust camshafts always have an opposite direction of rotation. In contrast to the S85, which works with two single-roller chains between the crankshaft and the inlet crankshafts, in the S65, two double-roller chains are installed. This is because of the higher chain drive load in the V8 S65.

The VANOS adjustment units are an integral component of the valve control and are mounted on the relevant camshaft by a central bolt.



S65B40 Drive Valve Control

Technical Data	E92 M3	E46 M3	E6x M5/M6
Engine identifier	S65B40	S54B32	S85B50
Camshaft drive	2x double-roller chain	Double-roller chain	2x single-roller chain

Note: The central bolts of the inlet and exhaust side have a CCW thread, please refer to the repair instructions.

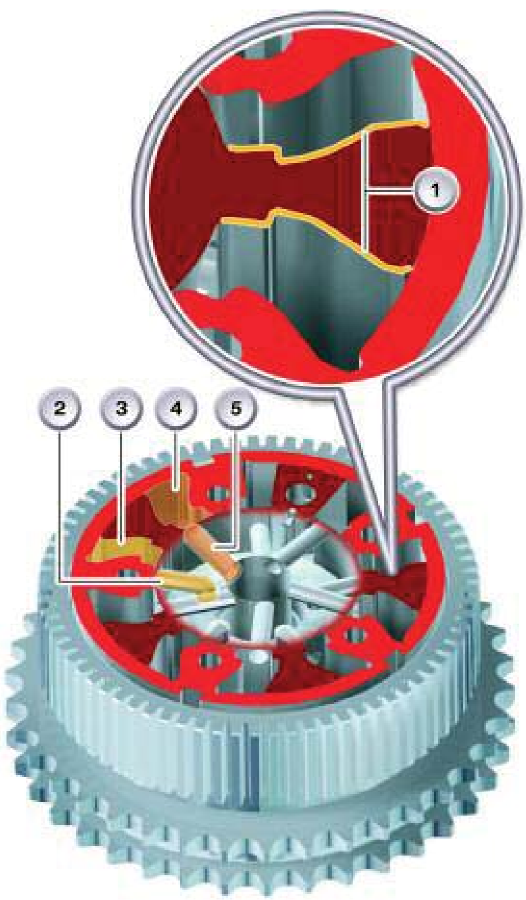
VANOS

The compact double VANOS system fitted to the S65 engine operates at normal oil pressure, unlike the S85 engine (which uses high oil pressure). The low-pressure system means that the high-pressure pump and additional pressure lines and reservoir are unnecessary. This results in a space saving as well as a weight reduction of approximately 8.4 kg.

This has been made possible by the considerably stronger switching moments at the camshaft compared to the 10-cylinder and 6-cylinder engine, particularly in the lower engine speed range. The low-pressure system uses these switching moments to adjust the overall gear ratio.

The oil is directed to the sealed oil chambers (3 and 4) of the VANOS adjustment unit.

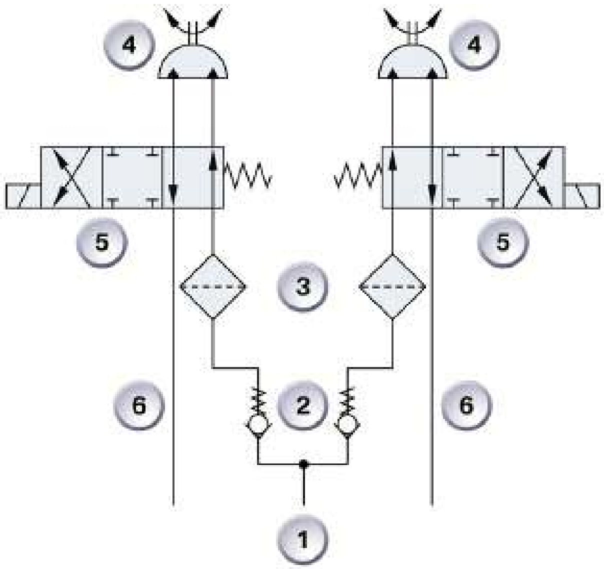
When the chambers are pressurized with oil pressure, one chamber allows the camshaft to advance whilst the other chamber allows the camshaft to retard.



Index	Explanation
1	Optimized hydraulic rotor pressure surfaces
2	Optimized inlet channel oil chamber 1
3	Oil chamber 1
4	Oil chamber 2
5	Optimized inlet channel oil chamber 2

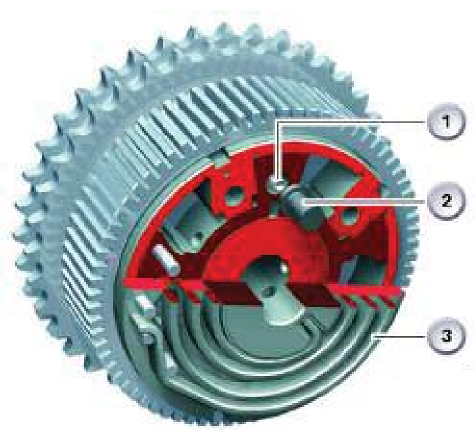
S65B40 VANOS hydraulic motor

S65B40 VANOS Hydraulic schematic of a cylinder bank



Index	Explanation
1	Oil supply from the main oil gallery
2	Non-return valves
3	Sieve filter upstream from control valves
4	Hydraulic motor at the inlet and exhaust camshaft
5	Multi-way adjustment valves inlet and exhaust side
6	Oil return flange to the oil sump

The VANOS oil pressure is supplied by the engine's main oil pump. The VANOS oil flow is controlled by one multi-way valve for each camshaft. These VANOS multi-way valves are controlled by the MSS60 and are directly installed in the cylinder head.



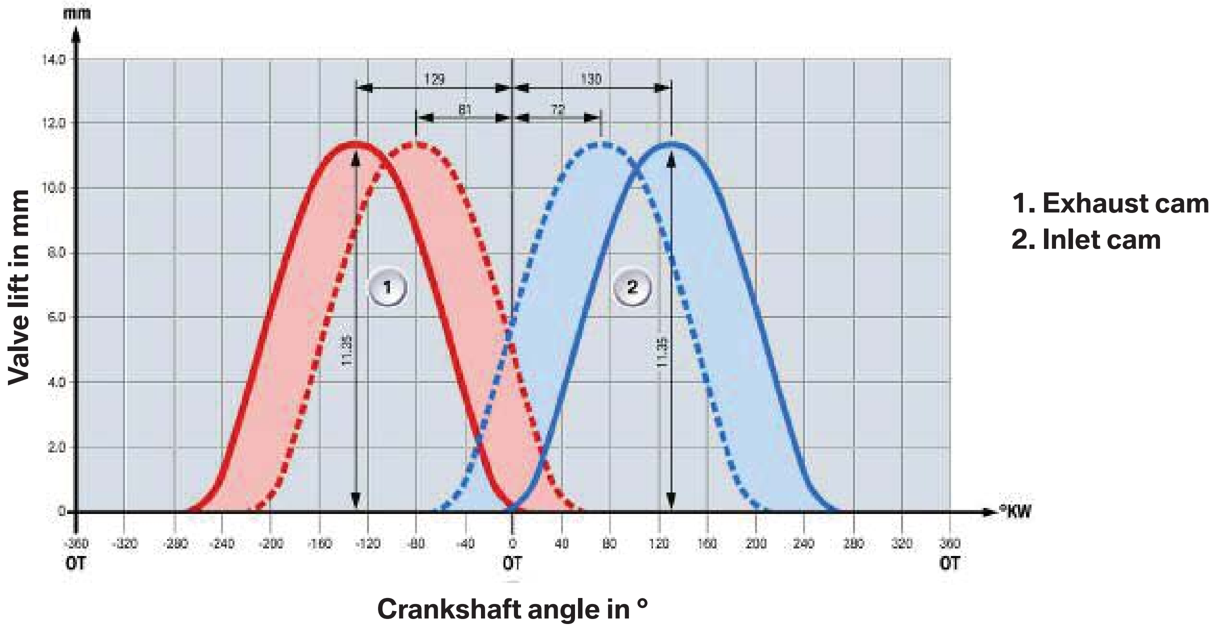
Index	Explanation
1	Locking pin spring
2	Locking pin
3	Spiral-wound spring

As with the S85, the VANOS adjustment unit of the inlet camshaft drives the VANOS adjustment unit of the exhaust camshaft by means of a constantly meshed gear.

At zero pressure, a locking pin (2) also holds the VANOS unit in the normal position or engine start position.

The spiral-wound spring (3) is also used for coordinating the adjustment time between the advance and retard adjustment. In contrast to AG petrol engines, the spiral wound spring for the inlet and exhaust sides is mounted in the opposite working direction, since the camshafts in the S65 rotate in the opposite direction.

The principle of action of the hydraulic motor in this M VANOS is based on the VANOS in current BMW petrol engines and is optimized for the S65 in terms of oil supply and drainage diameters, and in the rotor surface area.



The setting angle of the inlet camshaft is 58° in relation to the crankshaft. The exhaust camshaft has a setting angle of 48°. As in the S85 engine, this VANOS also reaches an adjustment rate of 360° camshaft per second.

Note: The service instructions should be followed exactly. The VANOS adjustment unit must not be disassembled.

Technical Data	E92 M3	E46 M3	E6x M5/M6
Engine identifier	S65B40	S54B32	S85B50
Variable camshaft control (VANOS)	2x double (engine oil pressure) oscillating rotor VANOS	Double high-pressure VANOS	2x double high-pressure VANOS
Adjustment range E/A [°KW]	72-130/81-129	70-130/83-128	79-145/91-128
Kingpin inclination E/A [°KW]	58/48	60/45	66/37
Response time E/A [°KW]	256/256	260/260	268/260

Belt Drive

The main belt drive drives the coolant pump and the generator, while the auxiliary belt drive drives the air conditioning compressor and the power-assisted steering pump.

The generator and the coolant pump are in the same position as in the S85.
The coolant pump is identical to the S85, but has a larger belt pulley.

S65B40 Belt Drive

Air Supply

Air Intake Guide/Oil Separator/Secondary Air System

Index	Explanation
1	Engine hood air inlet
2	Air inlet behind the ornamental grills of the BMW kidney
3	Air inlet in the bumper
4	Air filter element

The combustion air enters the engine via three flow-optimized air guides. An air inlet is located on the left side of the engine hood when viewed in the direction of travel. To maintain an optical balance in the appearance of the engine hood, another intake grill is located on the right-hand side, but this is blinded and does not perform any function.

The second air inlet guide is located behind the kidney grills of the BMW kidney.

The third air inlet guide is on the left below the front bumper.

The S65 has a large, single-piece air collector for the intake air to both cylinder banks.

A cylindrical air filter element (4) with an enlarged surface area is used.

The filtered air flows into the intake manifold, from where it flows through eight integrated individual inlet pipes and into the individual throttle valve assemblies.

To optimize air resistance, no air-mass sensor is installed in the intake area.

The air flow is determined using a model based calculation from the aperture of the throttle valve assemblies and the idle speed actuator, the VANOS adjustment position, the engine speed, the air temperature and the atmospheric pressure.

For safety reasons, an additional pressure sensor is mounted in the idle speed system (see idle speed control).

Oil Separators

The oil separators are bolted onto the cylinder head covers. The connection between the oil separator and the intake manifold is not screwed but plugged. This reduces the risk of incorrect assembly.

As is typical for the M series, no crankcase pressure control is mounted/integrated.

Oil separator connection point to the intake manifold

Secondary Air System

The secondary air pump is mounted on the rear side of the engine in the "V" of the cylinder banks. The secondary air is guided into the relevant exhaust channel via a check valve and an air channel integrated in the cylinder head.

An upstream secondary air pump hot-film air mass sensor measures the secondary air flow. The structure and function are the same as the system in the E60M5.

Individual Throttle Butterfly System

Single throttle valve system

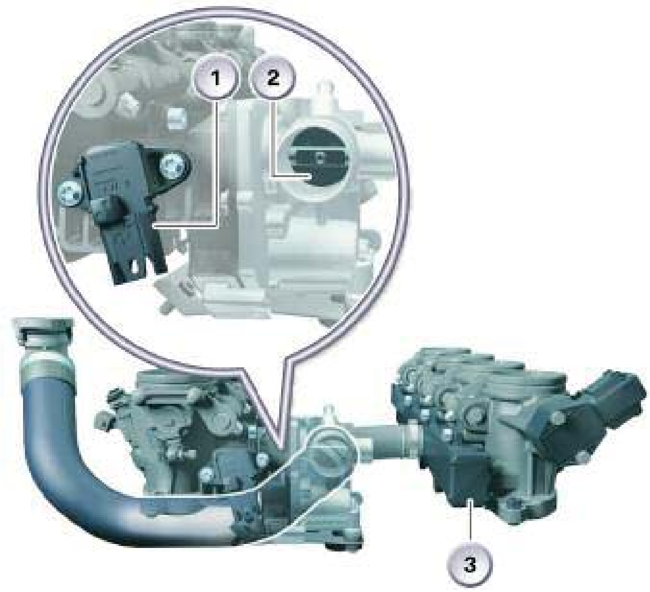
Index	Explanation
1	Double throttle valve sensor cylinder bank 1 and 2
2	Individual throttle valve assemblies
3	Electrical throttle-valve actuator

The design principle of the S65 individual throttle valve air intake system is the same as the S85 and consists of eight individual throttle valve assemblies and two electrical throttle valve actuators. One electric throttle valve positioner activates four individual throttle butterflies of one cylinder bank, which are mechanically coupled. The throttle valve position for each cylinder bank is recorded using a double throttle valve sensor on the shared throttle body shaft. A signal is sent directly to the throttle valve actuator responsible for this cylinder bank. The throttle valve actuator can therefore independently adjust the throttle valve position specified by the MSS60.

The second signal is sent to the MSS60 for checking purposes.

For communication with the MSS60, the two electrical throttle valve actuators use a shared DK-CAN bus (DK-CAN).

Idle Control System



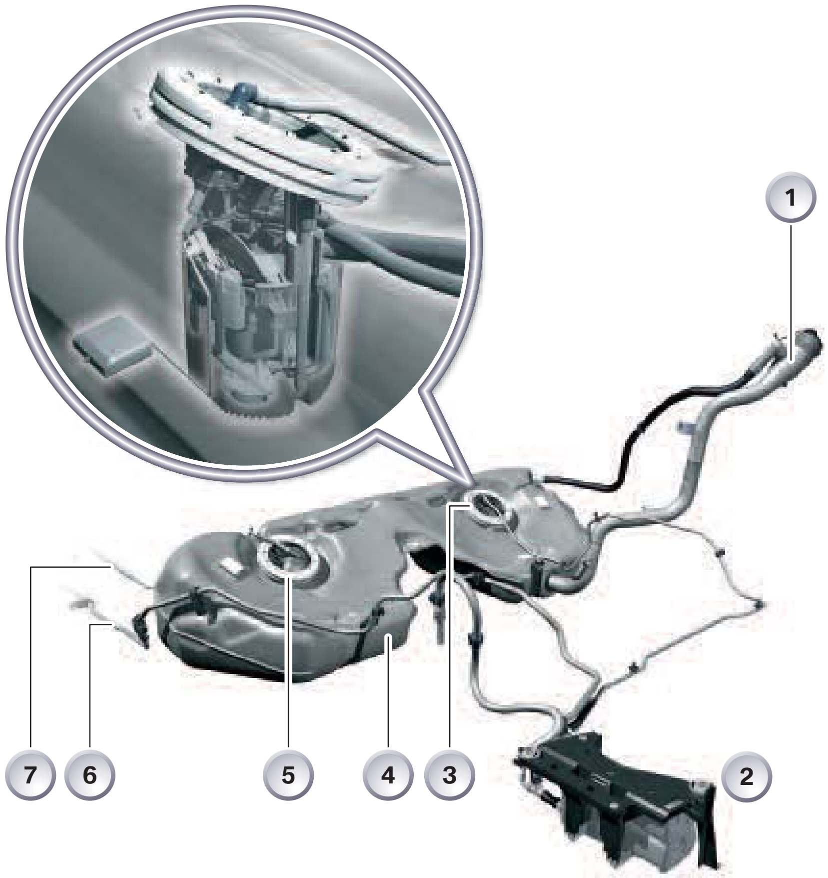
Index	Explanation
1	Pressure sensor on idle air bar, cylinders 5-8
2	Throttle valve
3	Idle air bar, cylinders 1-4

One common idle speed actuator for both cylinder banks controls the air supply at idle speed and at low engine loads. The idle speed actuator is located in the V formed by the two cylinder banks, and controls the idle air supply using a throttle valve. The air enters the shared bar for each cylinder bank via the relevant air ducts, and from there is guided into each throttle body below the throttle valve.

The idle speed actuator receives control instructions from the MSS60 via its own local CAN bus (LoCAN).

To ensure emergency operation in the event of the failure of one or both throttle valve sensors (even without the hot film air-mass sensor), an additional pressure sensor is integrated on the idle air bar (as in the S54B32HP (M3 CSL)). This allows evaluation of the pressure conditions behind the throttle valves. This pressure is also used for the plausibility check of filling and load in normal operation.

Fuel Supply



Index	Explanation	Index	Explanation
1	Tank filling supports	5	Left fuel supply unit
2	Tank leakage diagnosis unit	6	Tank vent valve
3	Right fuel supply unit	7	Engine fuel supply line
4	Fuel tank		

The fuel tank is based on the series E92 tank, although the shape has been changed to accommodate the exhaust system. Both in tank units are new. The fuel pump is installed in the right-hand unit, and the pressure regulator is installed in the left-hand unit in front of the fuel filter.

The ventilation lines have been adapted, while all other lines have been taken from the E92 335i. The US release is fitted with a tank leakage diagnosis unit.

The electrical controls are described in the MSS60 engine control system.

Cooling System

The mechanical coolant pump was taken from the S85.

The water pump belt pulley has been adapted due to the reduced water flow rate in the S65 compared with the S85. It has a larger diameter, which has allowed a reduction in pump speed.

A one-piece crossflow radiator is used to cool both banks, unlike the S85 engine which has a two-piece radiator, one part for each bank.

The following components have been adjusted for the M3: The expansion tank for the coolant, the crossflow radiator, the radiator hoses, the thermostat and the electric fan.

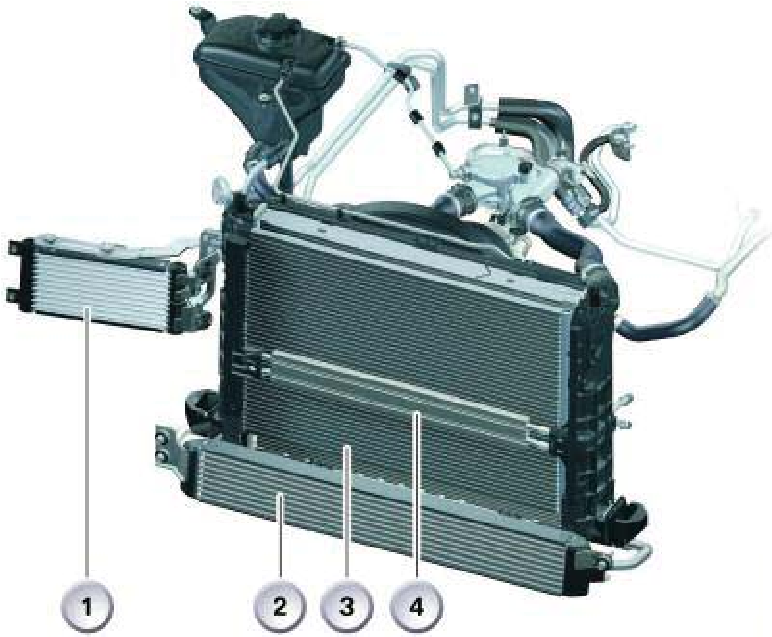
The gear oil and steering oil coolers are also installed in the series-model E92.

The control of the electric fan is described in the MSS60 engine control system.

Oil cooler

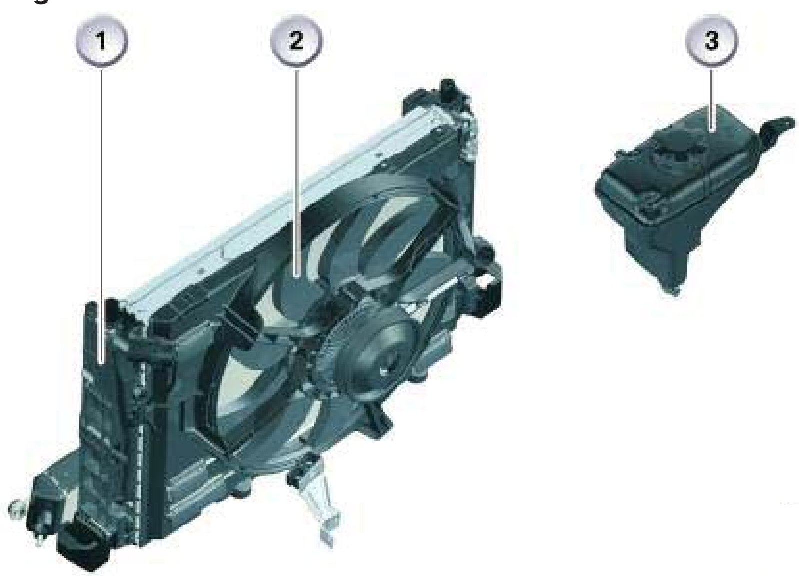
Index	Explanation
1	Gearbox oil cooler
2	Engine oil cooler

Complete cooler package



Index	Explanation	Index	Explanation
0	Gearbox oil cooler	3	Engine coolant cooler
1	Engine oil cooler	4	Steering oil cooler

Engine radiator



Index	Explanation	Index	Explanation
1	Engine cooler package	3	Expansion tank
2	Cooler fan		

Exhaust System

The exhaust pipes of the M vehicles are manufactured using the innovative internal high pressure forming technology (IHU). The "IHU" technology was used for the first time in the world in 1992 in the BMW M3, since when it has undergone continual refinement.

Using the IHU technology, the seamless stainless steel exhaust pipes are formed under a pressure of up to 800 bar. This results in extremely thin wall thicknesses of between 0.65 and 1.0 millimeters, which means both the weight of the exhaust system and the response characteristics of the catalytic converters can be optimized. At the same time, the IHU technology enables unprecedented styling and even more efficient geometric tolerances.

The largest possible pipe cross-sections are used, thus minimizing flow resistance. The complete exhaust system is manufactured in stainless steel and has a dual flow.

The 4-in-1 exhaust manifold in each cylinder bank, as used in motor sport, has a length and cross-section designed to enable optimal use of dynamics in the exhaust flow and to avoid unnecessary exhaust backpressure.

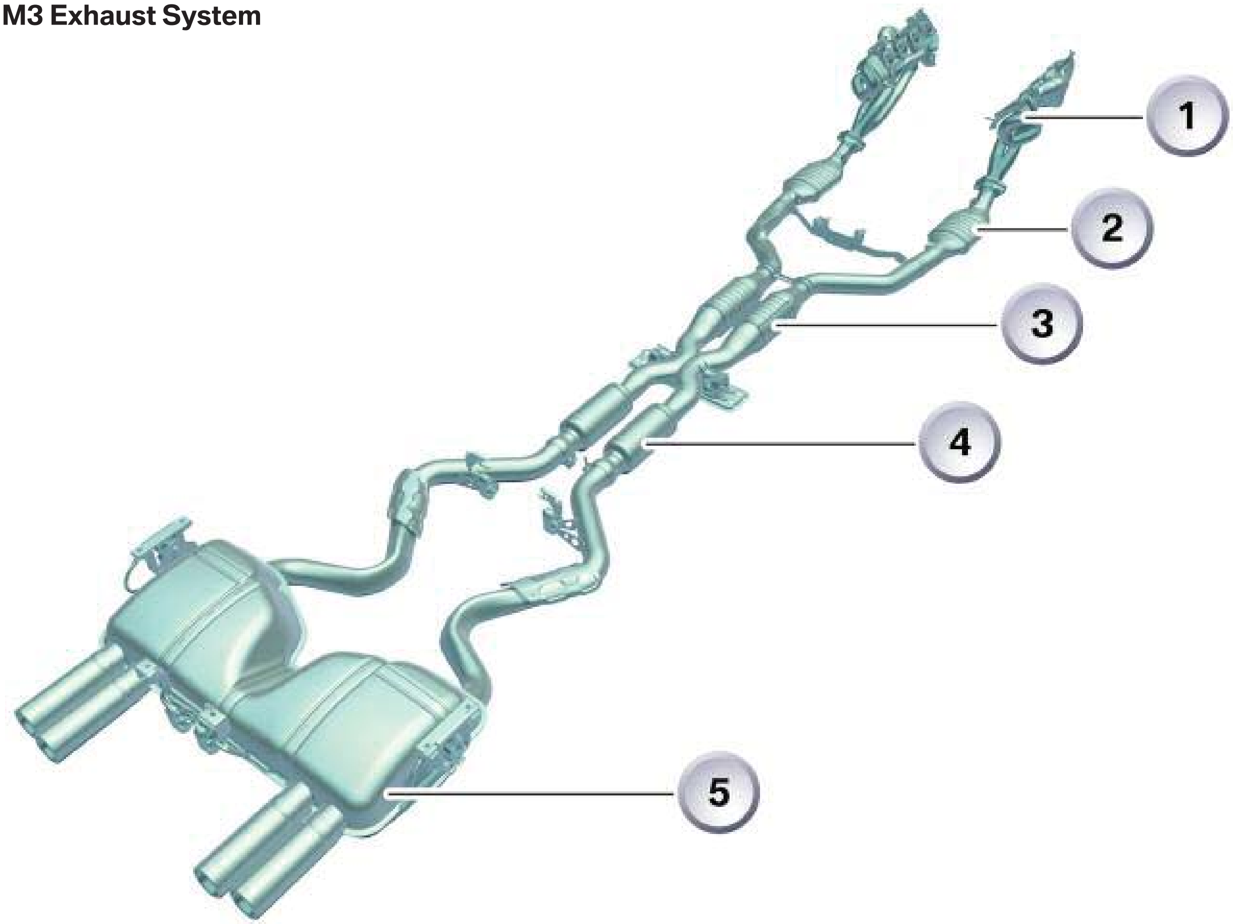
The exhaust system has one quick responding metal catalytic converter close to the engine per exhaust line, (approx. 20 cm behind the exhaust manifold), followed by the metal main catalytic converter. The front silencer and the final muffler shared by both exhaust lines with a volume of 35 liters are constructed in an absorption design.

The lambda oxygen sensors are located before and after both engine-side catalytic converters. The exhaust temperature sensor installed in previous M models is no longer required and is replaced by an internal calculation model in the control device.

The S65 fulfills the requirements of the LEV 2 classification.

Note: At maximum operating temperatures, the entire exhaust system can expand in length by 35 mm.

M3 Exhaust System



Index	Explanation
1	Manifold
2	Catalytic converter close to the engine
3	Main catalytic converter
4	Front exhaust silencer
5	Final muffler