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TABLE

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GENERAL

This section covers general information on engines and engine components. See **Table a** for engine application information and specifications.

For specific repair procedures, refer to:

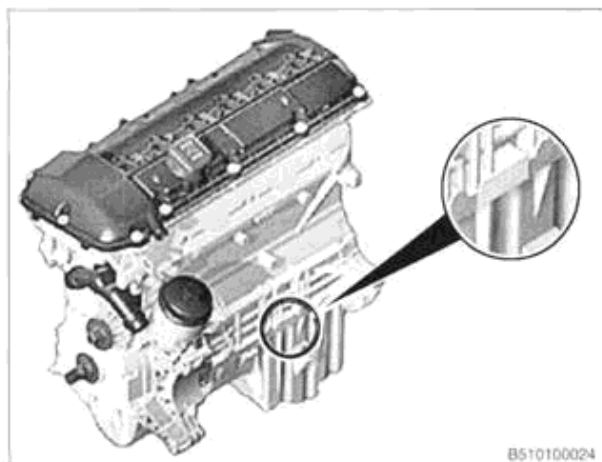
- **020 Maintenance** for engine compartment views and accessory belt service, oil change and air filter service
- **110 Engine Removal and Installation**
- **113 Cylinder Head Removal and Installation**
- **117 Camshaft Timing Chain**
- **119 Lubrication System** for lubrication system description and crankcase seal service
- **120 Ignition System** for ignition coil, camshaft sensor, crankshaft sensor and knock sensor service
- **130, 131, 132, 133 Fuel Injection** for engine management system description and component replacement (based on engine type)
- **170 Radiator and Cooling System** for radiator, coolant pump and coolant service
- **180 Exhaust System** for exhaust manifold, oxygen sensor and turbocharger service

100-2 Engine-General

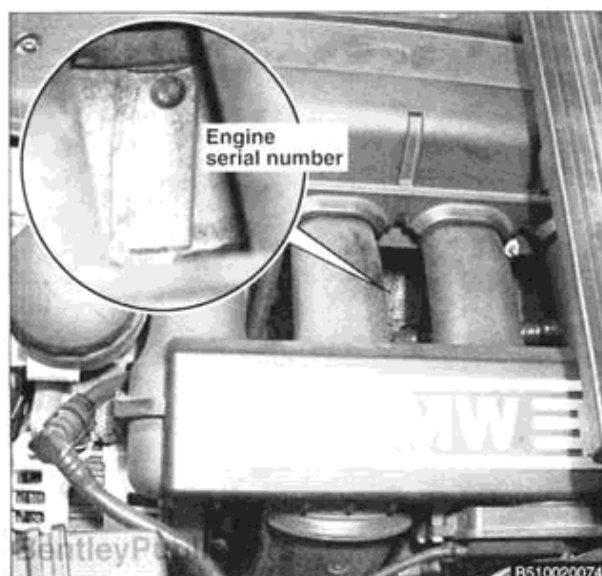
General

Engine ID tag

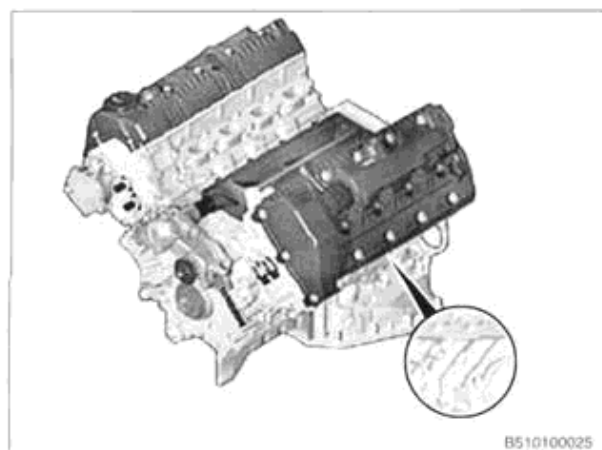
- M54 engine ID tag with engine serial number is on left side of engine block, above engine oil pan.



- N52 and N54 engine ID tag with engine serial number is on left side of engine block, underneath intake manifold.



- N62 engine ID tag with engine serial number is on left side of engine block, below cylinder head.



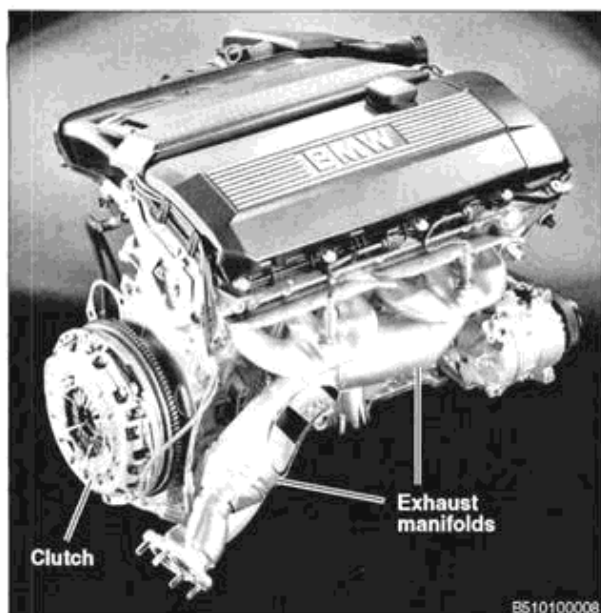
Engine applications

Table a. 5 Series engine applications and specifications

Year, model	Engine code, type	Displacement cc (cid)	Bore x stroke mm (in)	Comp. ratio	Torque lb-ft @ rpm	Horsepower hp @ rpm	Engine management
2.5 liter 6-cylinder							
2004 - 2005 525i	M54B25, double VANOS	2494 (152)	84 x 75 (3.31 x 2.95)	10.5 : 1	175 @ 3500	184 @ 5900	Siemens DME MS 45.1
3.0 liter 6-cylinder (normally aspirated)							
2004 - 2005 530i	M54B30, double VANOS	2979 (182)	84 x 89.6 (3.31 x 3.53)	10.2 : 1	214 @ 3500	225 @ 5800	Siemens DME MS 45.1
2006 - 2007 525i, 525xi Sports Wagon	N52B30, VANOS, Valvetronic	2996 (183)	85.0 x 88.0 (3.35 x 3.46)	10.7 : 1	185 @ 2750	215 @ 6250	Siemens MSV70
2006 - 2007 530i, 530xi, Sports Wagon	N52B30, VANOS, Valvetronic	2996 (183)	85.0 x 88.0 (3.35 x 3.46)	10.7 : 1	220 @ 2750	255 @ 6600	Siemens MSV70
2008 - 2010 528i, 528xi Sports Wagon	N52KB30, VANOS, Valvetronic	2996 (183)	85.0 x 88.0 (3.35 x 3.46)	10.7 : 1	200 @ 2750	230 @ 6500	Siemens MSV80
3.0 liter 6-cylinder (turbocharged)							
2008 - 2010 535i, 535xi 535xi Sports Wagon	N54B30 Turbo, VANOS	2979 (182)	84.0 x 89.6 (3.31 x 3.53)	10.2 : 1	300 @ 3500	300 @ 5800	Siemens MSD80 (up to 03/2008) MSD81 (from 03/2008)
4.4 liter V8							
2004 - 2005 545i	N62B44, VANOS, Valvetronic	4398 (268)	92 x 82.7 (3.62 x 3.26)	10.0 : 1	330 @ 3600	325 @ 6100	Bosch DME ME 9.2, with valvetronic control unit
4.8 liter V8							
2006 - 2010 550i	N62B48TU, Valvetronic, VANOS	4799 (293)	93 x 88.3 (3.66 x 3.48)	10.5 : 1	360 @ 3400	360 @ 6300	Bosch DME ME 9.2.2

100-4 Engine-General

M54 Engine Overview



M54 ENGINE OVERVIEW

Engine introduction

525i and 530i E60 and E61 (Sedan and Sports Wagon) models were introduced in 2004 in the North American market equipped with the 3-liter in-line 6-cylinder normally-aspirated M54 engine. Two levels of performance were available:

- Low output engine in 525i models
- High output engine in 530i models

Cylinder block and crankshaft

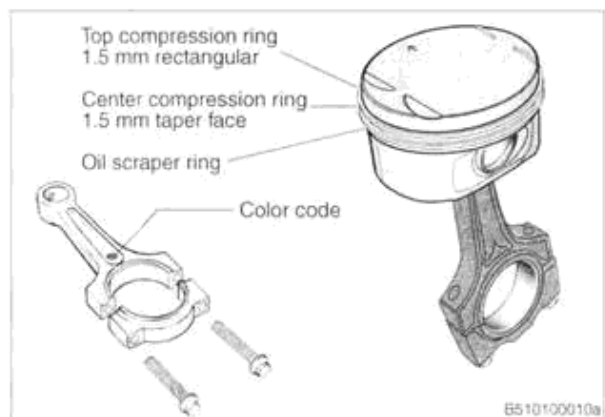
The cylinder block is cast aluminum alloy (AlSi₉Cu₃) with cast iron cylinder liners. The cylinders are exposed on all sides to circulating coolant.

Connecting rods and pistons

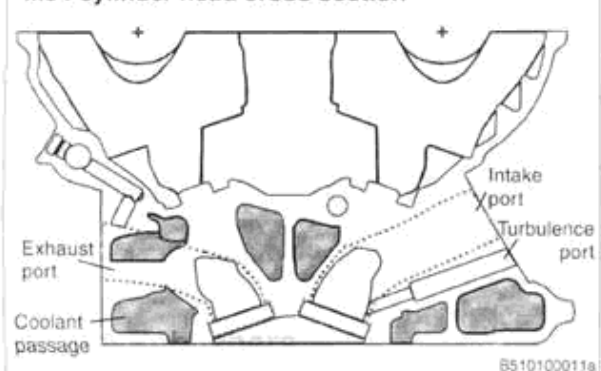
The forged steel connecting rods use replaceable split-shell bearings at the crankshaft end and solid bushings at the piston pin end. Connecting rods weight classes are indicated by a color code system.

The pistons are equipped with three rings with two upper compression rings and a lower one-piece oil scraper ring. Full floating piston pins are retained with circlips.

Graphite coating is used on piston skirts to reduce friction and noise.



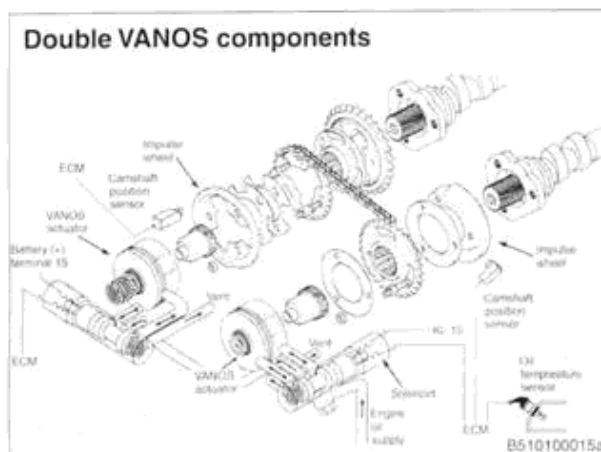
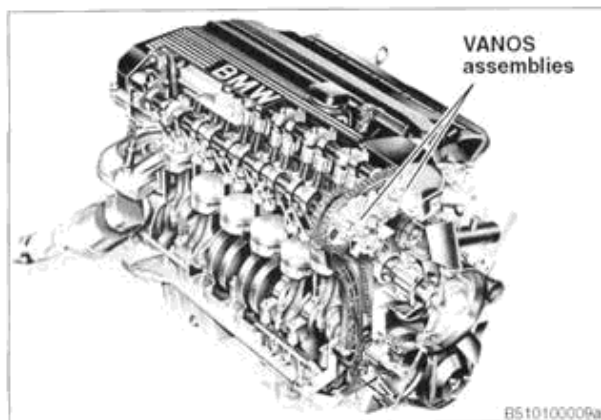
M54 cylinder head cross section



Cylinder head and valvetrain

Cooling passages in the M54 cylinder head are designed for optimum coolant circulation, allowing the head to operate at lower temperatures than the cylinder block.

The aluminum cylinder head uses chain-driven double overhead camshafts and four valves per cylinder. The cylinder head employs a crossflow design for greater power and efficiency. Intake air enters the combustion chamber from one side while exhaust gasses exit from the other. The spark plugs are centrally located down the middle of the cylinder head.



Double VANOS

- M54 engines are equipped with compact, infinitely variable vane-type VANOS units for both intake and exhaust camshafts. The VANOS system (from the German words *V*ARIABLE *N*Ockenwellen *S*teuerung) electrohydraulically adjusts valve timing for enhanced mid-range performance and improved emissions. VANOS is controlled by the engine control module (ECM), using engine speed, engine load and engine coolant temperature as the primary inputs. Engine oil pressure is used for powering camshaft adjustment.

- Engine oil pressure is used to position the VANOS actuators. Oil pressure is fed from the engine oil pump up to the VANOS solenoids; oil drains back to the sump as the camshafts are adjusted during engine operation.

With the engine off, the base setting of the camshafts is as follows:

- Intake camshaft: Retarded
- Exhaust camshaft: Advanced

This is also the fail-safe position in case of an electronic control failure. Both camshafts are held in these positions by oil pressure from the engine oil pump. The exhaust camshaft is held additionally by a spring in the VANOS actuator.

When the engine is started, the camshafts remain in these positions until the ECM detects the positions of the camshafts from the camshaft sensors (approximately 50 revolutions or 2 - 5 seconds). The engine is equipped with static Hall-effect camshaft sensors so that camshaft positions are recognized as soon as the ignition is switched ON, before the engine is started.

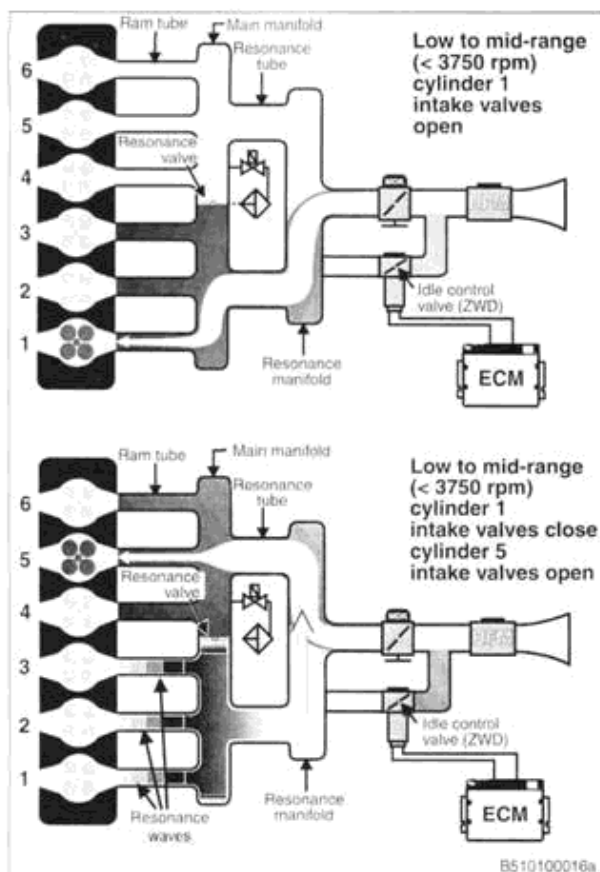
Once camshaft positions are recognized, the ECM makes an initial camshaft timing adjustment based on oil temperature, oil pressure and engine rpm. Following this initial setting, engine rpm, throttle position signal, intake air temperature and engine coolant temperature are used to adjust camshaft timing.

When the ECM detects that the camshafts are in the desired position, the solenoids are modulated at 100 - 220 Hz, maintaining oil pressure on both sides of the actuators to maintain camshaft timing.

In addition to increasing engine power output, double VANOS offers the following advantages:

- Increased torque at lower and medium rpm ranges
- More efficient combustion and improved idle quality
- Internal EGR in part-load range for lower NO_x emissions
- Quicker warm-up cycle for catalytic converter and faster reduction in emissions
- Overall improved fuel economy

See 117 **Camshaft timing chain** for Vanos system repairs.



Intake system

- The intake manifold, made of molded plastic, is configured as two sets of three runners. This design enhances low end torque by changing the intake air flow configuration for varying engine speeds. This helps achieve optimum torque throughout the entire rpm range.

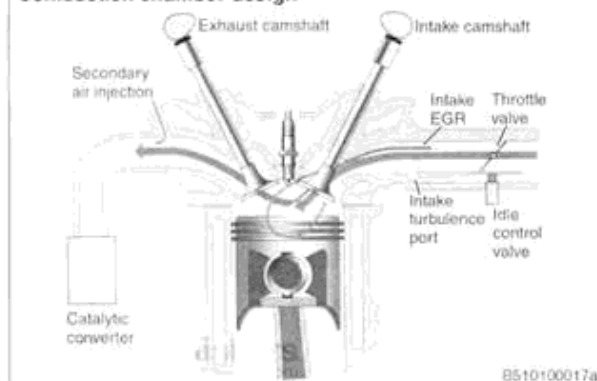
During engine operation, a closed resonance valve gives the intake air charge the dynamic effect of long intake runners at low to mid-range engine speeds (up to 3750 rpm). This helps increase torque.

During mid-range to high speed operation (above 4100 rpm), the solenoid is de-energized and the resonance valve is sprung open. This allows intake air to be drawn through both resonance tubes, providing the air volume necessary for additional power at the upper rpm range.

The rpm for resonance valve activation varies slightly depending on temperature.

In addition, when the valve is closed, a dynamic effect is produced. For example, as intake air is flowing into cylinder 1, intake valves close. This blocks onrushing air. Cylinder 1 air flow stops and expands backward (resonance back pulse) to fill cylinder 5. The resonance wave along with the intake velocity enhances cylinder filling.

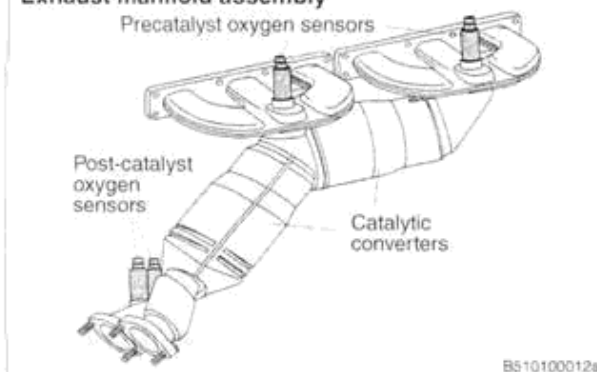
Combustion chamber design



- The intake manifold includes intake turbulence ports. The 5.5 mm (0.217 in.) turbulence ports channel idle and low speed air directly from the idle speed control valve to one intake valve of each cylinder.

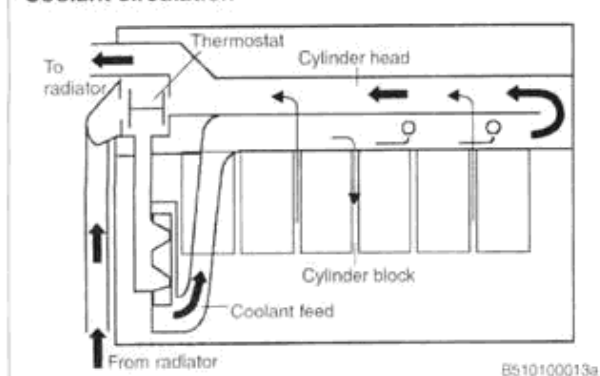
Routing intake air to one intake valve per cylinder causes the air charge to swirl in the cylinder. Together with the high flow rate of intake air across the small (5.5 mm) port, intake fluctuations are reduced for more stable combustion.

Exhaust manifold assembly



Exhaust manifolds

- Each exhaust manifold assembly incorporates a catalytic converter. The converters are mounted close to the engine for faster heat up and light off. Pre- and post-catalyst oxygen sensors are mounted in each exhaust manifold.

Coolant circulation**Cooling system**

- ▶ The cooling system is designed so that coolant flows directly from the coolant pump to the cylinder head. The coolant is fed from the coolant pump through a cast coolant feed passage to the rear of the cylinder head. From there it flows forward to the thermostat housing, radiator and heater valve.

525i and 530i models are equipped with a DME-controlled electric cooling fan. See **170 Radiator and Cooling System** for additional information

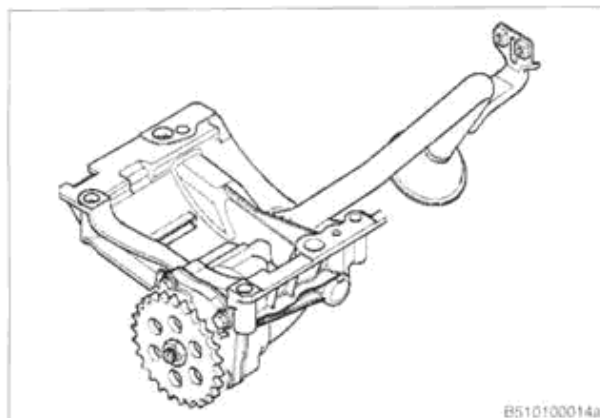
Lubrication system

The lubrication system is pressurized whenever the engine is running. The oil pump draws oil through a pickup in the bottom of the oil pan, then forces it through a replaceable oil filter and into the engine oil passages.

Oilways in the cylinder head provide lubrication for the camshafts and valvetrain.

- ▶ The chain-driven oil pump is bolted to the bottom of the cylinder block inside the oil pan. A pressure relief valve limits the maximum system pressure. A bypass valve prevents the oil filter from bursting and insures engine lubrication should the filter become plugged.

See **119 Lubrication System** for additional information.





N52 ENGINE OVERVIEW

Engine introduction

Beginning with 2006, 5 Series models were equipped with 3-liter in-line 6-cylinder normally-aspirated N52 engine. 2-wheel drive and 4-wheel drive models were offered:

- Low output engine in 525i or 525xi models
- High output engine in 530i or 530xi models

Beginning with 2008, 5 Series models were fitted with the N52KP engine. 2-wheel drive and 4-wheel drive (xDrive) models were offered:

- 528i or 528i xDrive models
- 530i or 530i xDrive models

The N52 engine family features the following:

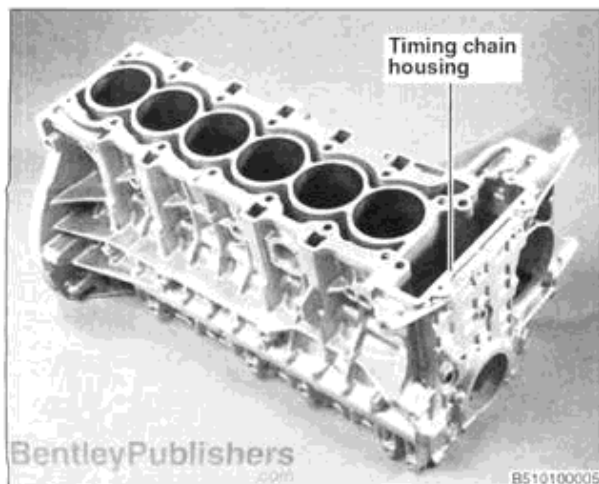
- 4-valves-per-cylinder friction-optimized components
- Two-piece crankcase
- Composite magnesium-aluminum engine block structure
- Trapezoidal weight-optimized connecting rods
- Aluminum silicon (AluSil) cylinder head
- Timing case integrated in crankcase and cylinder head
- Cylinder head gasket with silicon sealing lip
- Valvetronic system
- Weight-optimized double VANOS system
- Volumetric flow-controlled oil pump
- Electrically controlled coolant pump
- Crankcase ventilation with integrated heater
- 3-stage variable intake manifold or DISA

The weight reduction in these systems and components, as compared to the M54 engine, led to increased power-to-weight ratio, reduced emissions and decreased fuel consumption.

Crankcase components

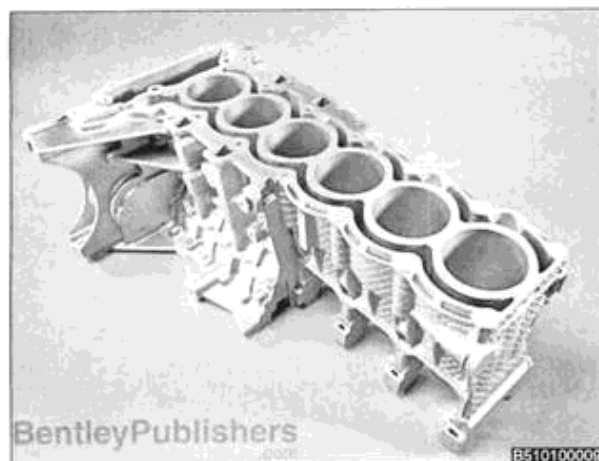
Crankcase

The upper section of the crankcase consists of an aluminum / silicon (AluSil) insert cast in a magnesium alloy. The timing cover is cast as an integral part of the engine block.





- ✦ The AluSil cylinder bores are not equipped with iron cylinder liners. Therefore, the cylinder bores cannot be machined, but the deck surface may be planed.



- ✦ The AluSil insert has threaded bores for transmission, cylinder head and crankshaft main bearing bolts.

The insert provides coolant passages as well. This is to prevent coolant contact with the magnesium portion of the engine block.



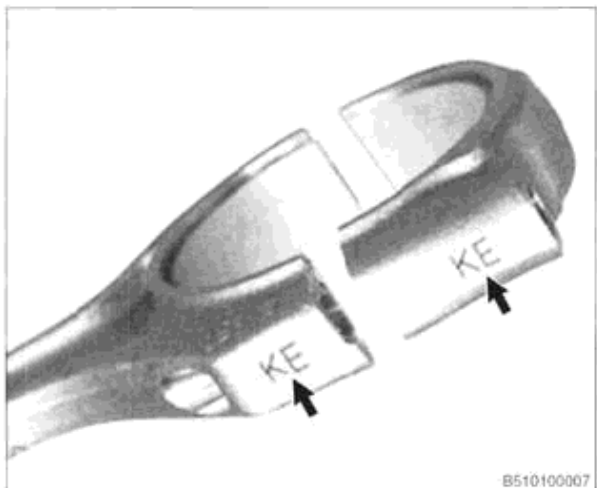
- ✦ The lower section of the crankcase is a bedplate structure made of magnesium with sintered steel inlays (**arrow**) for main bearing support. The magnesium structure is used to increase crankcase rigidity and the steel inlays take up forces which are not suitable for magnesium alone.

A liquid sealant is injected under high pressure into a machined groove between upper and lower crankcase sections. This detail is critical to understand in service applications. As an example, when the crankcase main seals are replaced, a special sealant is injected into the seal grooves and crankcase seams.



Crankshaft

- The crankshaft is cast iron with 7 main bearing journals. The trigger wheel for the crankshaft sensor is between cylinders 5 and 6. Due to the design of the timing chain housing (one piece with the crankcase), the crankshaft snout is modified to facilitate timing chain module removal and installation during service.



Connecting rods

- The big end of each connecting rod is cracked to allow centering of the bearing cap without the use of dowel pins. This contributes to the overall weight reduction.

Pairing codes (**arrows**) are stamped on each connecting rod to match the correct rod cap to the connecting rod.

The small end of the rod is tapered, reducing weight without affecting strength.

The connecting rods are separated into weight categories and can only be replaced as a set.

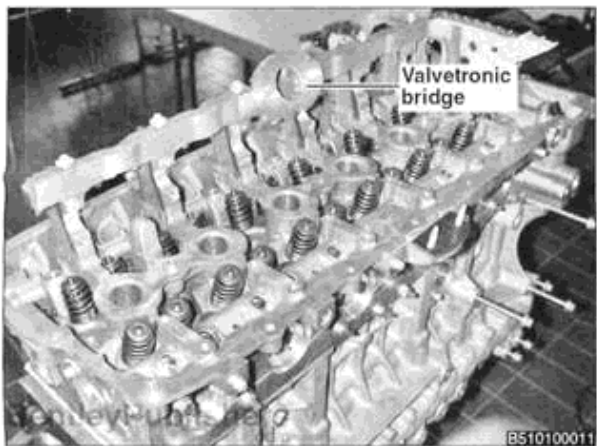
Pistons

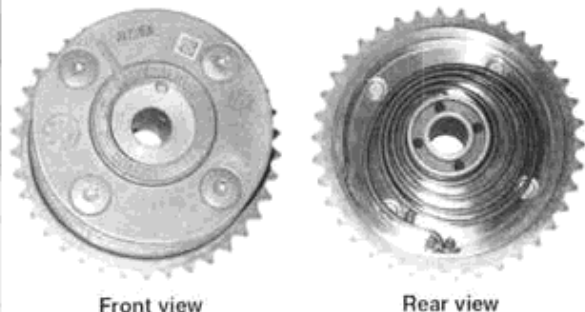
The pistons are manufactured from aluminum and have 4 valve reliefs. The undersides of the pistons are cooled with oil spray jets.

Cylinder head and valvetrain

Cylinder head

- The N52 engine uses an AluSil cylinder head with a cast bridge to mount the Valvetronic actuator motor.

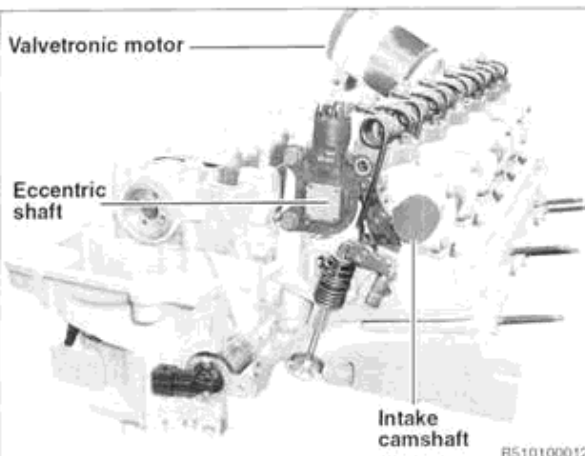


VANOS unit

B510100004

Variable camshaft timing (VANOS)

- N52 engines are equipped with compact, infinitely variable vane-type VANOS units for both intake and exhaust camshafts. The VANOS system (from the German words *V*ariable *N*ockenwellen *S*teuerung) electrohydraulically adjusts valve timing for enhanced mid-range performance and improved emissions. VANOS is controlled by the engine control module (ECM), using engine speed, engine load and engine coolant temperature as the primary inputs. Engine oil pressure is used for powering camshaft adjustment.

Valvetronic motor**Eccentric shaft**

Intake camshaft

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Valvetronic

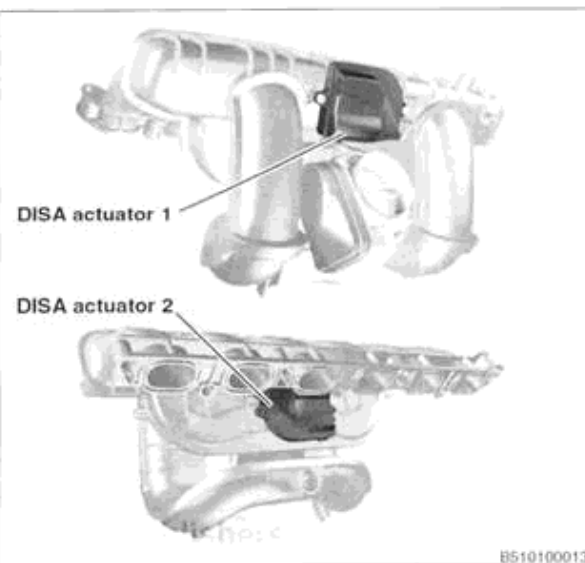
- N52 engine load is controlled via the valve timing gear. This system, called Valvetronic, varies valve lift rather than throttle valve opening to control engine power and torque. It offers the following:

- Increased engine efficiency.
- Improved emission values.
- Top engine speed to 7,000 rpm.
- Power output of 85 hp / liter displacement.
- Engine torque of 100 Nm / liter displacement over a broad engine speed range.
- Reduced CO₂ emissions.

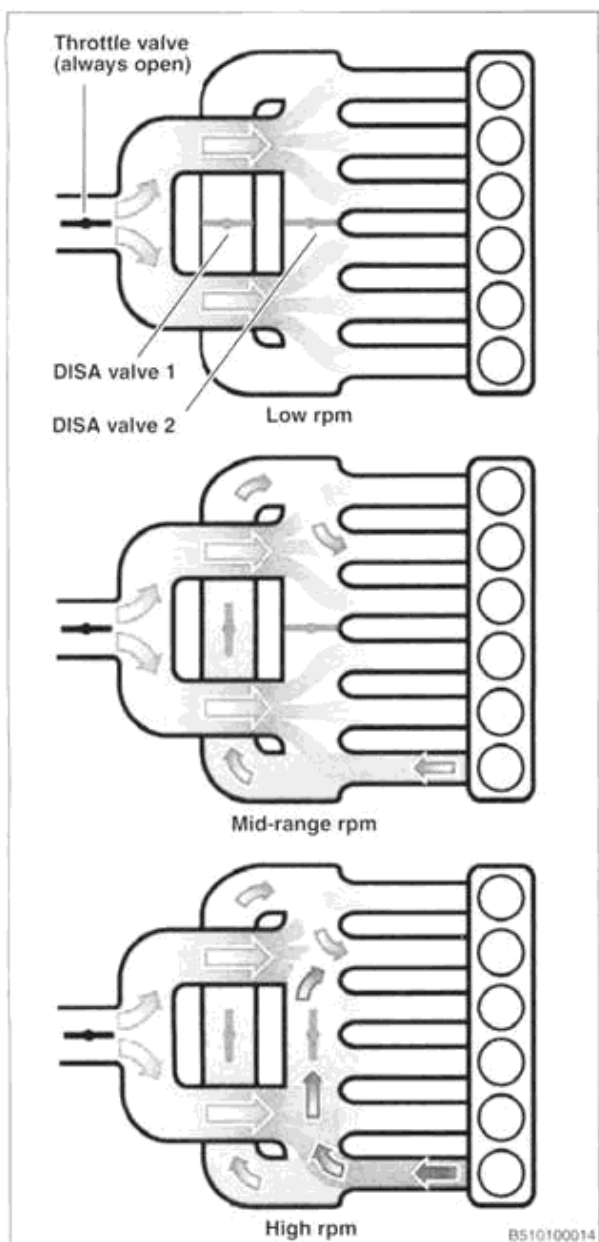
Intake manifold**Variable intake manifold (DISA)**

- 5 Series models with N52 engines are equipped with 3-stage variable intake runners in a system known as DISA.

Valves in the intake manifold are driven by DISA electric motors and gear mechanisms. DISA actuators are driven by pulse width-modulated signals from the engine control module (ECM). Each valve has only two possible positions: Open or closed.

DISA actuator 1**DISA actuator 2**

B510100013



Switched-length intake manifold runners help achieve a high torque over the entire engine speed range using two DISA valves and an overflow pipe in the intake.

- **Stage 1:** Idle and low engine speed range. Both DISA valves closed. Intake air flows past throttle valve into resonance pipe. Air flow is split in resonance pipe and is further routed via collector runner and intake resonating runners into individual cylinders. In this way, a relatively large air mass is made available to cylinders.
- **Stage 2:** Medium engine speed range. DISA valve 2 open. (In this example, cylinder 1 intake valves are just closing.) Air flow produces pressure peaks at closing intake valves. This resonates to next cylinder in firing order, thus improving charge of next cylinder.
- **Stage 3:** High engine speed range. Both DISA valves open. (Again, In this example, cylinder 1 intake valves are just closing.) Pressure peaks ahead of closing intake valves are also utilized in this case. Intake air mass is now routed via resonance, overflow and manifold runners.

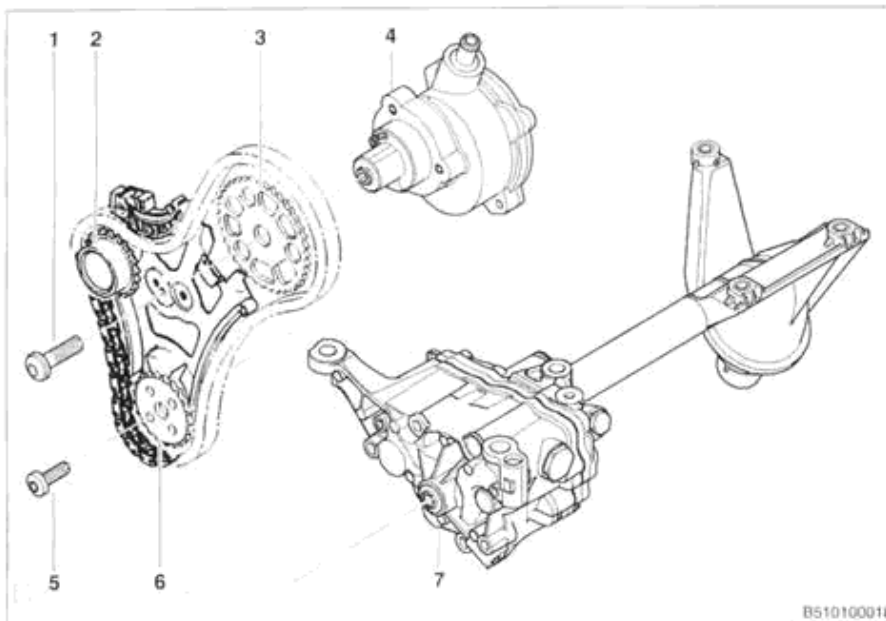
Lubrication, vacuum and cooling systems

Lubrication and vacuum systems

VANOS requires a large volume of oil, particularly at low engine speeds. To meet the oiling requirements of the engine, a high volume volumetric-flow controlled oil pump is utilized. The pump is designed to provide the high volume when needed, but drop back its flow at higher engine speeds when it is not needed. See **119 Engine Lubrication**.

Valvetronic engine load control requires a wide open throttle under most engine operating conditions, resulting in minimal intake manifold vacuum. In order to operate the brake vacuum booster, an auxiliary vacuum pump is fitted to the engine.

A chain assembly is used to drive the oil pump and brake booster auxiliary vacuum pump sprockets.



1. Auxiliary vacuum pump sprocket bolt
2. Crankshaft sprocket
3. Auxiliary vacuum pump drive sprocket
4. Auxiliary vacuum pump
5. Oil pump sprocket bolt
6. Oil pump drive sprocket
7. Oil pump

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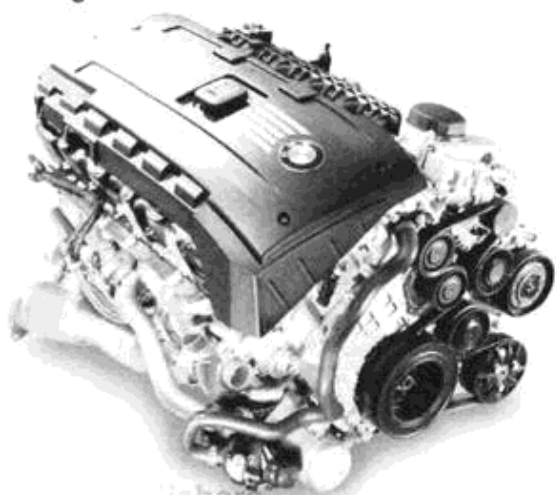
Cooling system

The cooling system utilizes a DME-controlled electric coolant pump which minimizes engine power losses and allows for increased fuel economy by a more efficient method of engine heat management.

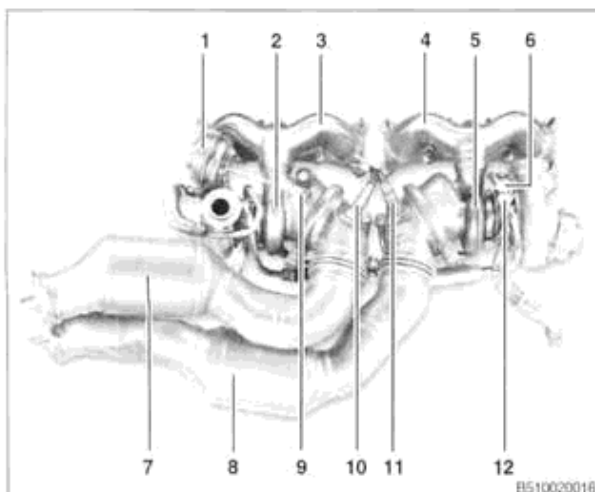
100-14 Engine-General

N54 Engine Overview

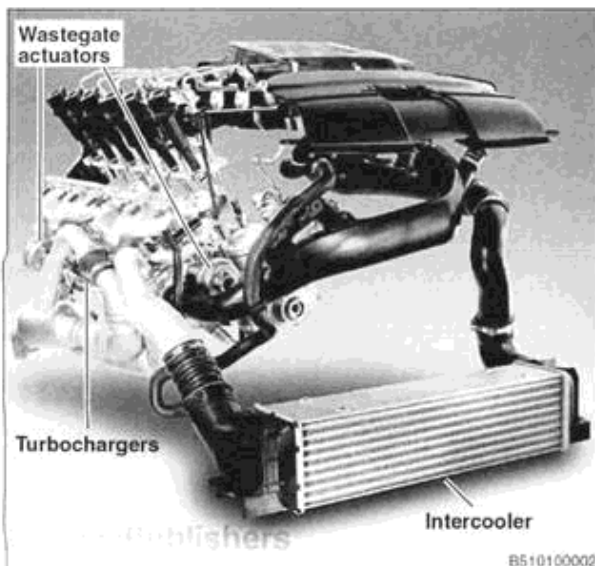
N54 engine



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N54 ENGINE OVERVIEW

Engine introduction

Beginning in 2008 the 535i Sedan and Sports Wagon models were equipped with the turbocharged in-line 6-cylinder N54 engine. Available as a 3.0 liter engine, it shares the following features with the N52 engine:

- Double VANOS
- Aluminum cylinder head with plastic cylinder head cover
- Steel crankshaft

The following features are specific to the N54 engine:

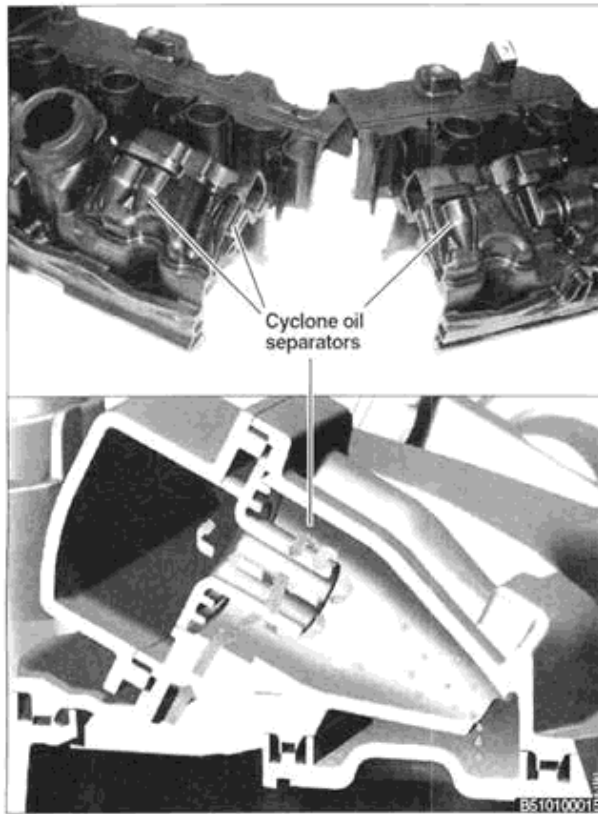
- Exhaust driven twin turbochargers (bi-turbo)
- Air to air intercooler
- High output (400 W) electric coolant pump
- Direct injection (high pressure injection or HPI) with piezo injectors
- Bosch MSD81 engine management
- External oil cooler
- All aluminum crankcase with iron cylinder liners

Turbochargers

1. Wastegate actuator, bank 2
2. Turbocharger, bank 2
3. Exhaust manifold, bank 2
4. Exhaust manifold, bank 1
5. Turbocharger, bank 1
6. Coolant return
7. Catalytic converter, bank 2
8. Catalytic converter, bank 1
9. Wastegate actuating lever
10. Planar broad-band oxygen sensor, bank 2
11. Planar broad-band oxygen sensor, bank 1
12. Coolant supply

Intercooler

The charge air is greatly heated when it is compressed in the turbochargers, making it necessary for the air to be cooled again in an intercooler.

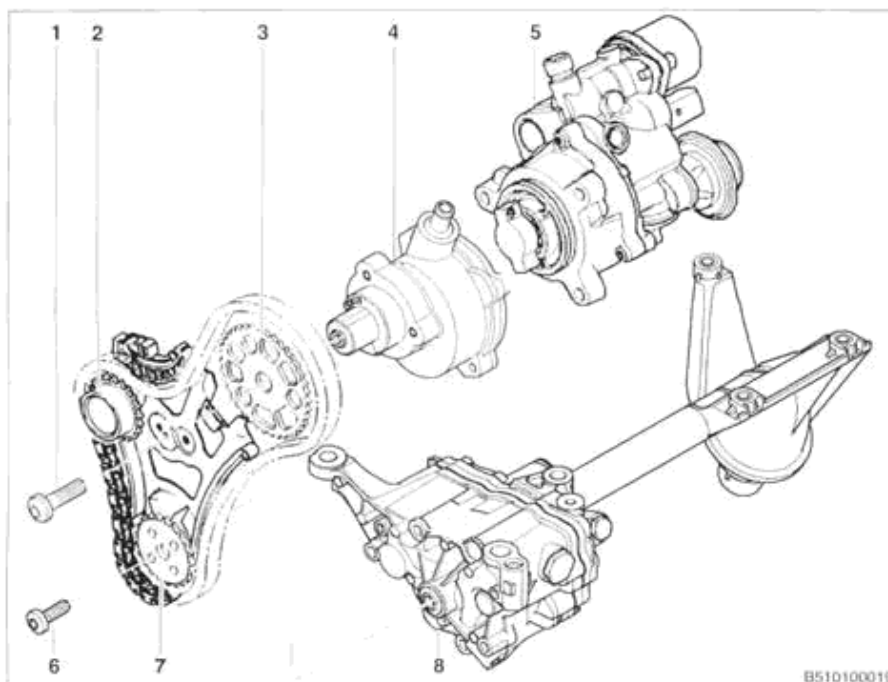


Crankcase breathing

- ◀ The turbocharged engine crankcase breather valve system is designed so that when the engine is in turbocharged mode, increased manifold pressure does not adversely affect crankcase venting. Instead of a crankcase ventilation valve, the engine breathing system consists of small cyclone separators integrated into the plastic cylinder head cover. The flow of crankcase gases is metered through a series of restrictions which control crankcase pressure.

Engine oil, vacuum and fuel pump drive

As with the N52 engine, the turbo engine oil pump and auxiliary vacuum pump are driven by a single chain powered by a sprocket at the front of the crankshaft. In addition, the high pressure fuel pump is tandem mounted to the rear of the vacuum pump.



1. Auxiliary vacuum pump sprocket bolt
2. Crankshaft sprocket
3. Auxiliary vacuum pump-high pressure fuel pump drive sprocket
4. Auxiliary vacuum pump
5. High pressure fuel pump
6. Oil pump sprocket bolt
7. Oil pump drive sprocket
8. Oil pump

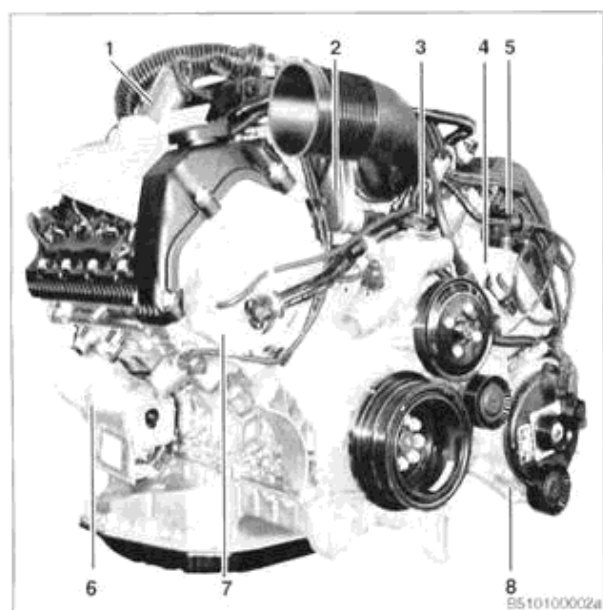
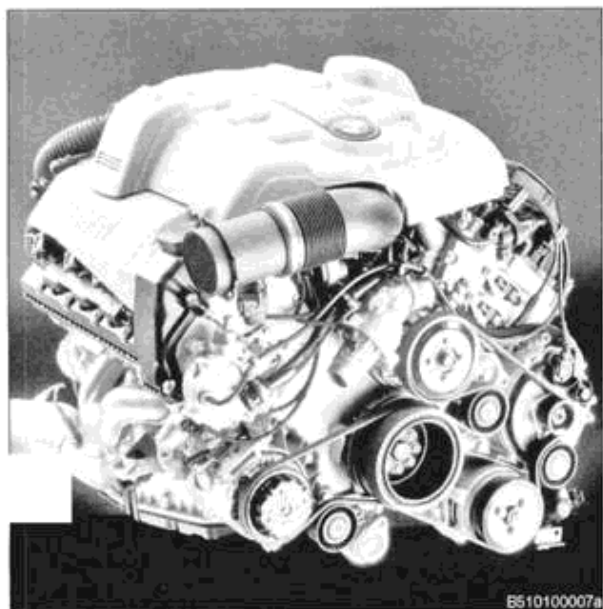
100-16 Engine-General

N62 Engine Overview

N62 ENGINE OVERVIEW

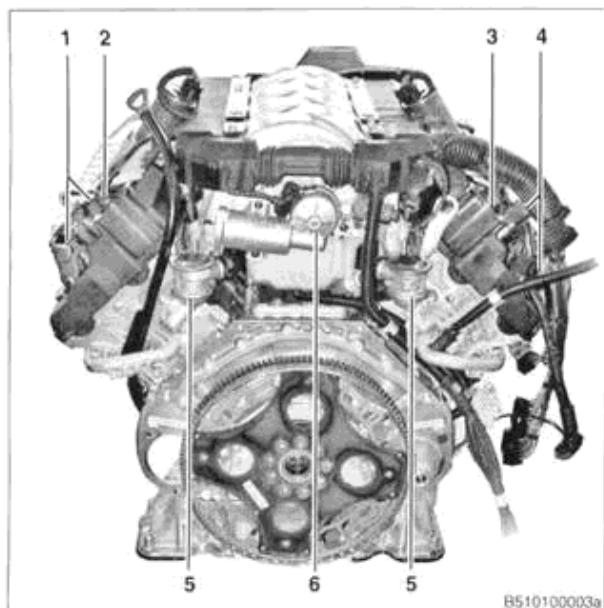
Engine introduction

- 545i and 550i models are equipped with the V8 N62 engine with Valvetronic.



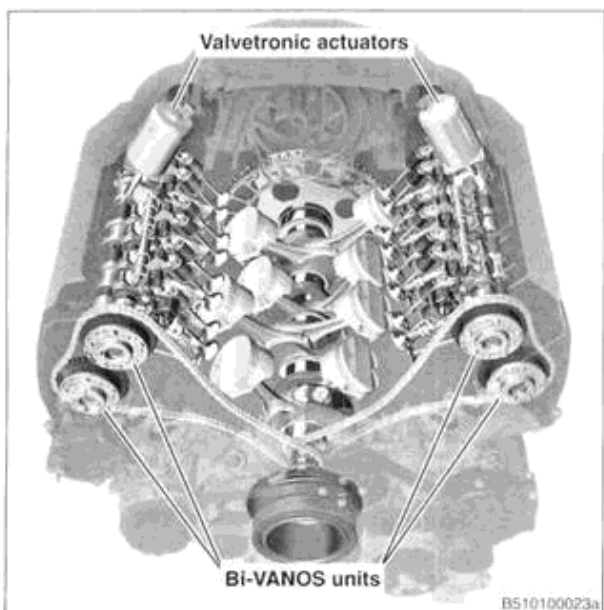
- N62 engine from the front:

1. Valvetronic actuator
2. Throttle unit
3. Thermostat housing
4. VANOS solenoid
5. Evaporative emissions valve
6. Starter with heat shield
7. Brake booster vacuum pump
8. Water-cooled alternator

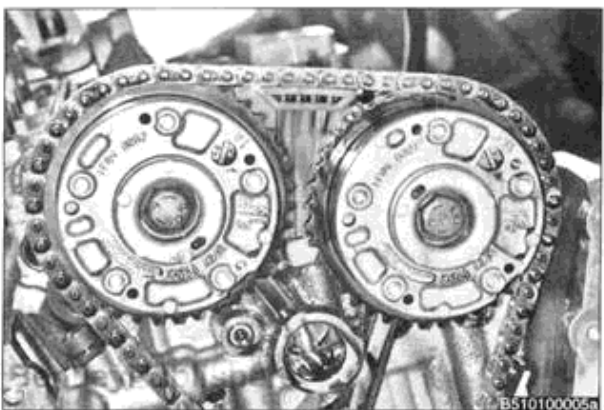


◀ N62 engine from the rear:

1. Camshaft sensors, left bank
2. Valvetronic eccentric shaft position sensor, left bank
3. Valvetronic eccentric shaft position sensor, right bank
4. Camshaft sensors, right bank
5. Secondary air injection valves
6. Variable intake manifold servomotor



◀ In addition to Valvetronic technology, the N62 engine is equipped with double VANOS.



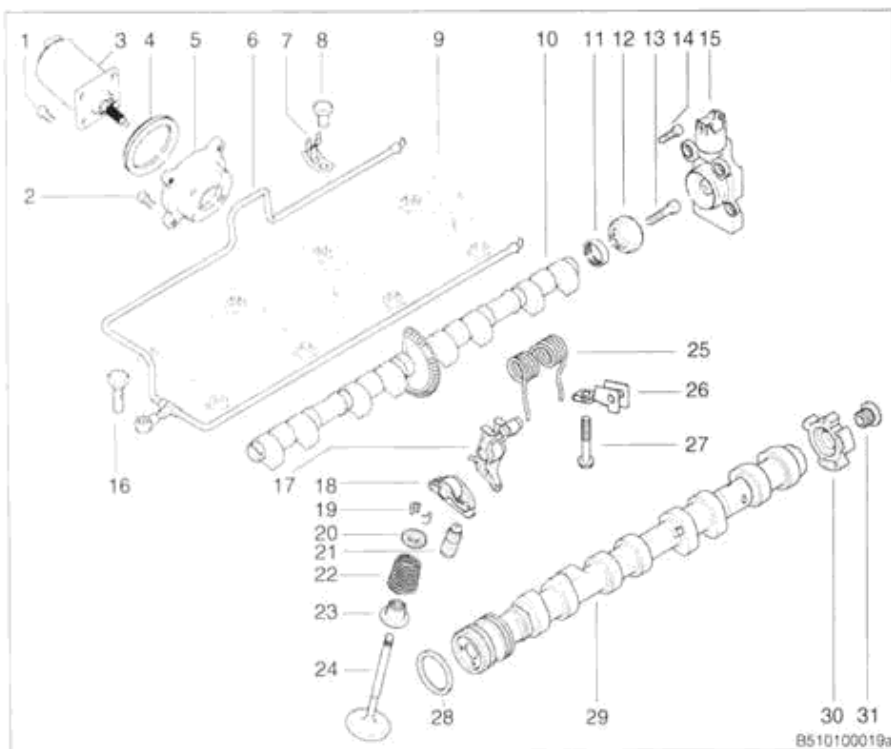
◀ Double VANOS allows for variable timing on both intake and exhaust camshafts. The VANOS unit is designed as an integral component of the chain drive and is secured to the respective camshaft with a central bolt.

Valvetronic principles

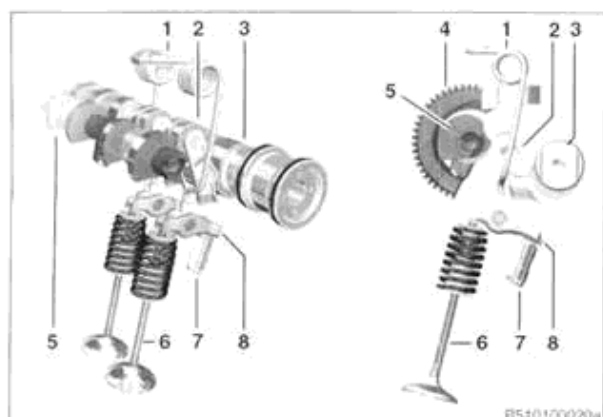
The Valvetronic system uses hardware and software to eliminate the conventional throttle mechanism. Instead of a throttle valve, intake air is regulated by adjusting valve lift. BMW claims that removing the throttle valve as an obstruction results in 10% fuel savings by minimizing pumping losses.

In order to diagnose and repair the Valvetronic system, be sure to have access to BMW scan tool.

Valvetronic components

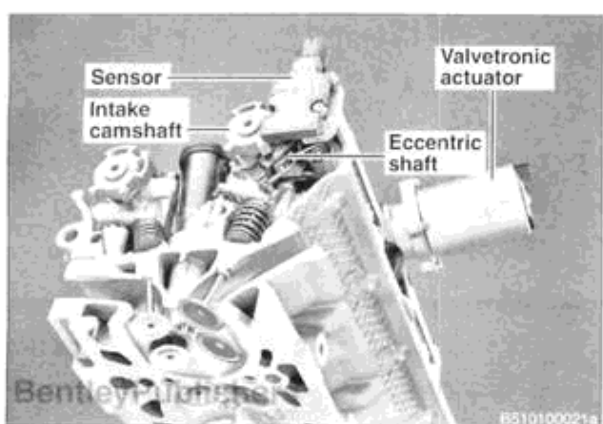


1. Bolt M5 x 12 mm
2. Bolt M5 x 30 mm
3. Valvetronic actuator
4. O-ring
5. Spacer
6. Oil spray tube
7. Locking clip
8. Bolt M7 x 8 mm
9. Bridge support
10. Eccentric shaft
11. Needle bearing
12. Eccentric shaft magnetic pulse generator
13. Bolt M6 x 20 mm
14. Bolt M5 x 16 mm
15. Eccentric shaft position sensor
16. Bolt M8 x 50 mm
17. Intermediate lever
18. Valve rocker (with roller)
19. Valve keeper
20. Upper valve spring seat
21. Hydraulic valve adjuster (HVA)
22. Valve spring
23. Valve stem seal
24. Intake valve
25. Retainer spring
26. Spring support
27. Torx bolt M7 x 44 mm
28. Sealing O-ring
29. Intake camshaft
30. Camshaft position pulse generator wheel
31. Allen bolt M14 x 19 mm



Valvetronic operation

1. Retainer spring
2. Intermediate lever
3. Intake camshaft
4. Cam gear operated by Valvetronic actuator
5. Eccentric shaft
6. Intake valve
7. Hydraulic valve adjuster (HVA)
8. Valve rocker (with roller)



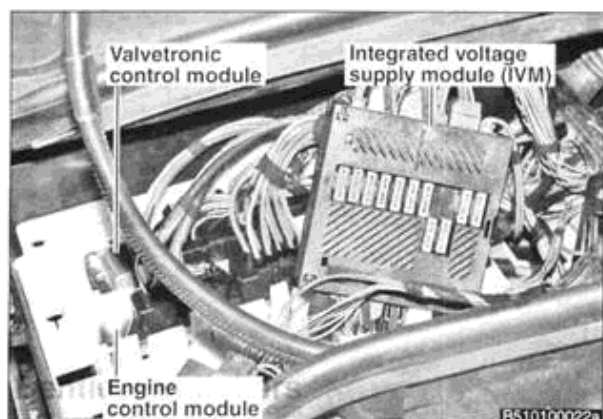
▶ The Valvetronic actuator in each cylinder bank operates an eccentric shaft. Lobes on shaft press on intermediate levers between intake camshaft lobes and each cylinder's pair of intake valve rockers.

Depending on position of eccentric shaft lobes, the size of intake valve opening ranges from about 0.3 to 9.85 mm.

Valvetronic electronic control

▶ Electrical and electronic controls for the Valvetronic system consist of:

- Valvetronic control module in E-box
- Engine control module (ECM) in E-box
- DME and valvetronic relays in integrated voltage supply module (IVM) in E-box
- Valvetronic actuators
- Eccentric shafts position sensors
- Eccentric shafts magnetic pulse generators



The Valvetronic DC motors (actuators) which adjust the eccentric shafts are operated at 16 kHz for exact control of valve lift. Once the target valve opening is attained, as determined by the ECM, polarity is briefly reversed to generate braking force and to position motors exactly. Adjustment time required to move motors from minimum to maximum valve lift is approximately 300 ms. Motor draw can peak at 100 amperes.

When the engine is stopped, self-stopping motors and worm gear drives prevents position changes. When restarted, if automatic valve opening adjustment is not detected, a fault is recorded and motors are moved back to the target positions.



