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VALVETRONIC

Initial Print Date: 03/11 Revision Date:

VALVETRONIC

Model: ALL

Production: ALL

OBJECTIVES

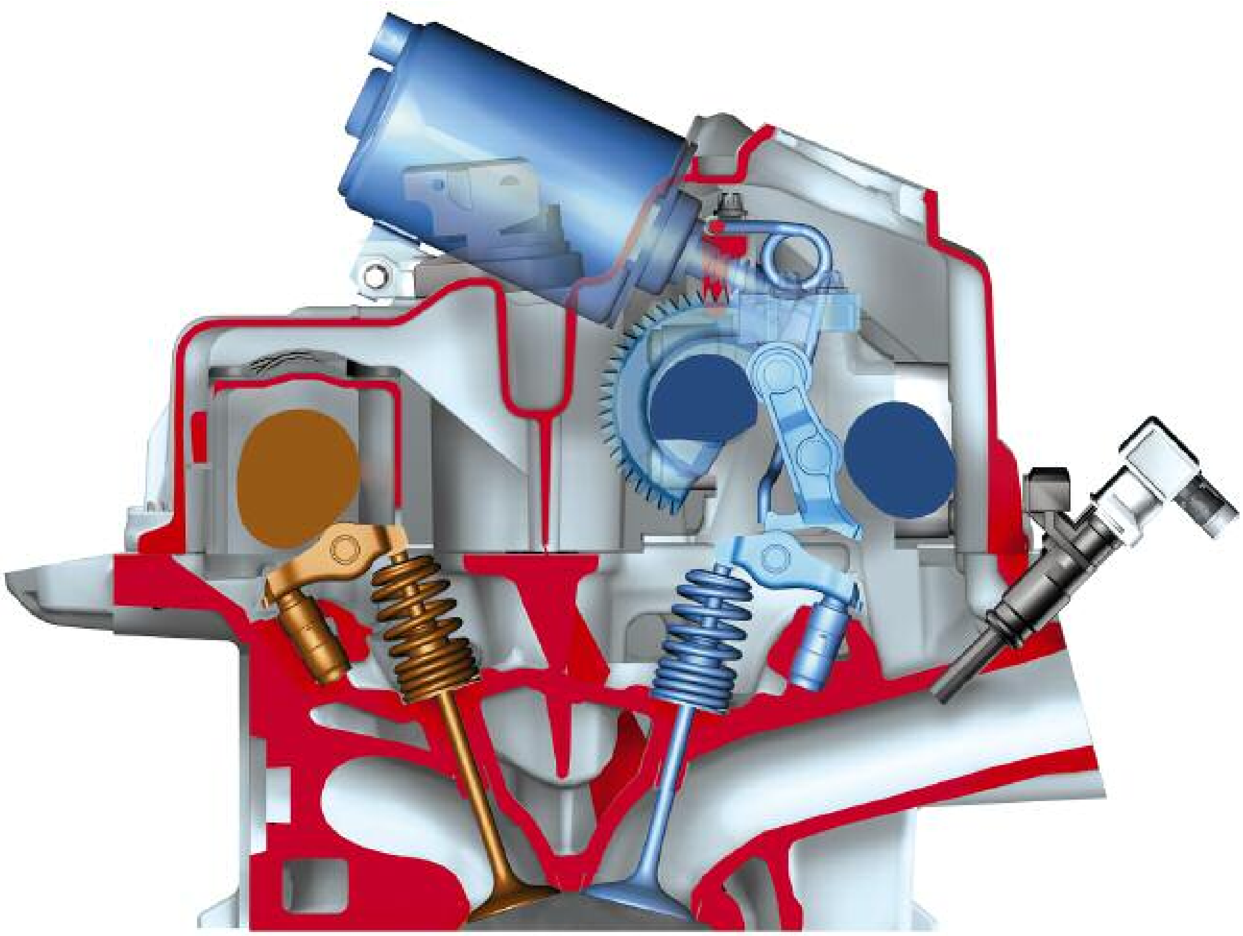
After completion of this module you will be able to:

- Name the service functions for VALVETRONIC .
- Explain how the VALVETRONIC system will function if faulted. Fail safe operation.
- Explain the relationship between the EDK and the VALVETRONIC system.
- Identify how the VALVETRONIC motor is powered using the appropriate SSP’s.
- Locate and identify the components used for VALVETRONIC operation.

VALVETRONIC

Introduction

With the introduction of the N52, the 6-cylinder engine incorporated the load control system based on the valve timing gear (VALVETRONIC II). The VALVETRONIC I system that was used on the 8 (N62) and 12 (N73) cylinder engines already achieved a substantial increase in efficiency.



BMW has further developed this concept with the VALVETRONIC II.

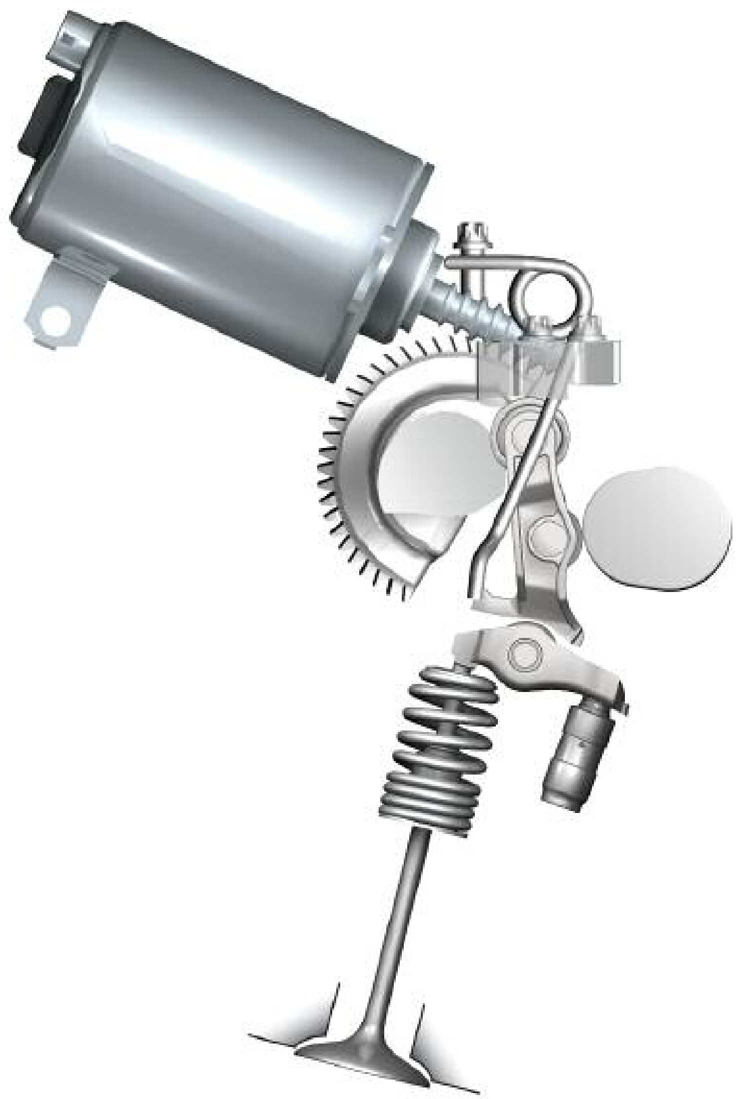
The results of this further development are:

- Increased engine dynamics
- Increased efficiency
- Improved emission values

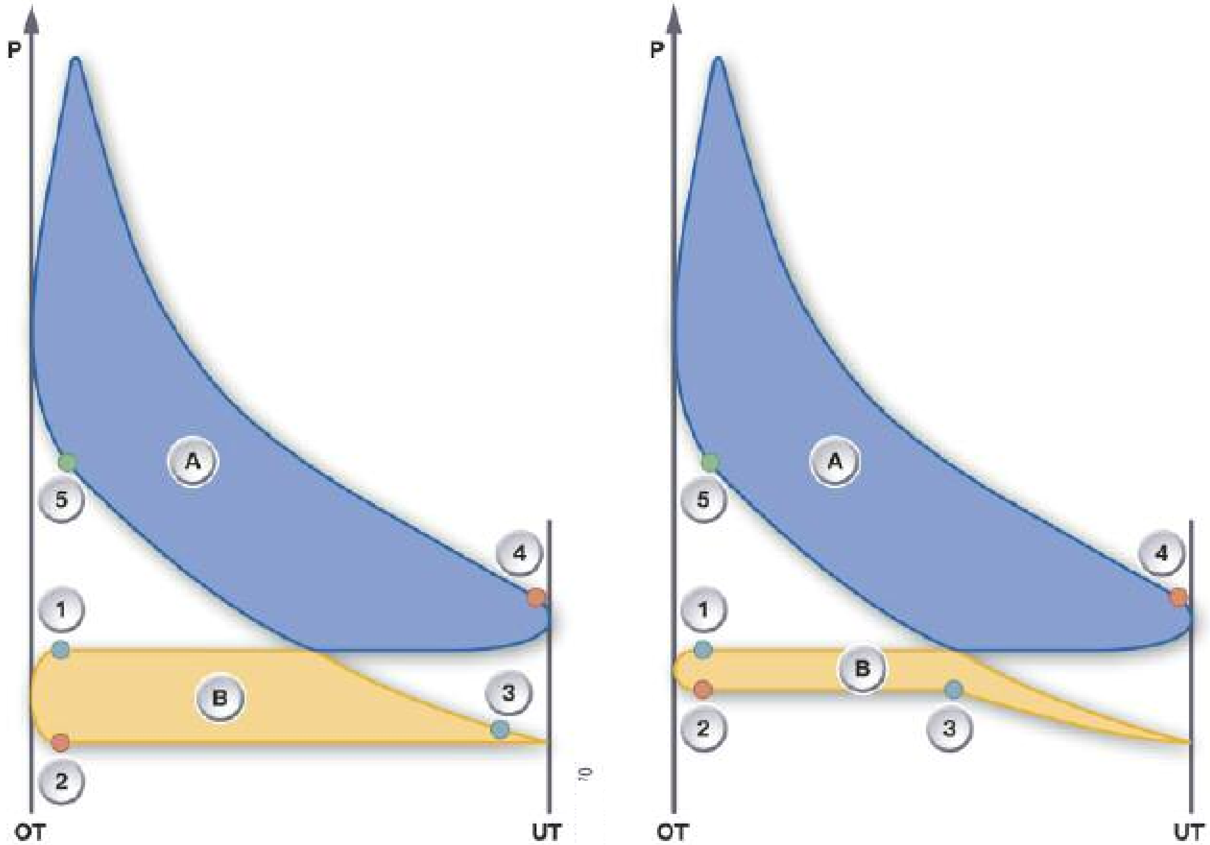
These results underscore BMW specific standards. As an example of VALVETRONIC II, the N52 engine features the following optimizations which further enhances the Ultimate Driving Machine:

- The top engine speed has been increased to 7,000 rpm.
- The specific power output has been increased to 63.4 kW/l.
- The specific engine torque is 100 Nm/l over a broad engine speed range.
- Distinctly increased valve acceleration values and friction-optimized transmission elements result in an even more responsive engine.
- CO emissions reduced.
- The world's most stringent exhaust emission regulations are complied with.

Valvetronic II - used on N52, N52KP and N51



Load Control



Index	Explanation	Index	Explanation
OT	Top dead center	4	Exhaust valve opens
UT	Bottom dead center	5	Firing point
1	Intake valve opens	A	Gain
2	Exhaust valve closes	B	Loss
3	Intake valve closes	P	Pressure

The illustration on the left shows the conventional method with the slightly higher loss. The reduced loss can be clearly seen in the illustration on the right. The upper area represents the power gained from the combustion process in the petrol engine. The lower area illustrates the loss in this process.

The loss area can be equated to the charge cycle, relating to the amount of energy that must be applied in order to expel the combusted exhaust gasses from the cylinder and then to draw the fresh gasses again into the cylinder.

Apart from the full load setting, the intake of fresh gasses in a throttle valve controlled engine always takes place against the resistance offered by the throttle valve to the inflowing gasses. The throttle valve is virtually always fully opened during intake on the VALVETRONIC controlled engine. The load is controlled by the closing timing of the valve.

Compared to the conventional engine where the load is controlled by the throttle valve, no vacuum occurs in the intake manifold. This means no energy is expended for the purpose of producing the vacuum. The improved efficiency is achieved by the lower power loss during the intake process.

A minimum vacuum in the intake system is required for the crankcase ventilation and evaporative purge systems. The throttle valve is slightly adjusted for this purpose.

Function

The VALVETRONIC II consists of the fully variable valve lift control combined with the variable camshaft control (double VANOS). The valve lift is controlled only on the intake side while the camshaft (VANOS) is adjusted also on the exhaust side.

The throttle-free load control is implemented by:

- variable valve lift of the intake valve,
- variable valve opening timing of the intake valve and
- variable camshaft spread of the intake and exhaust camshaft.

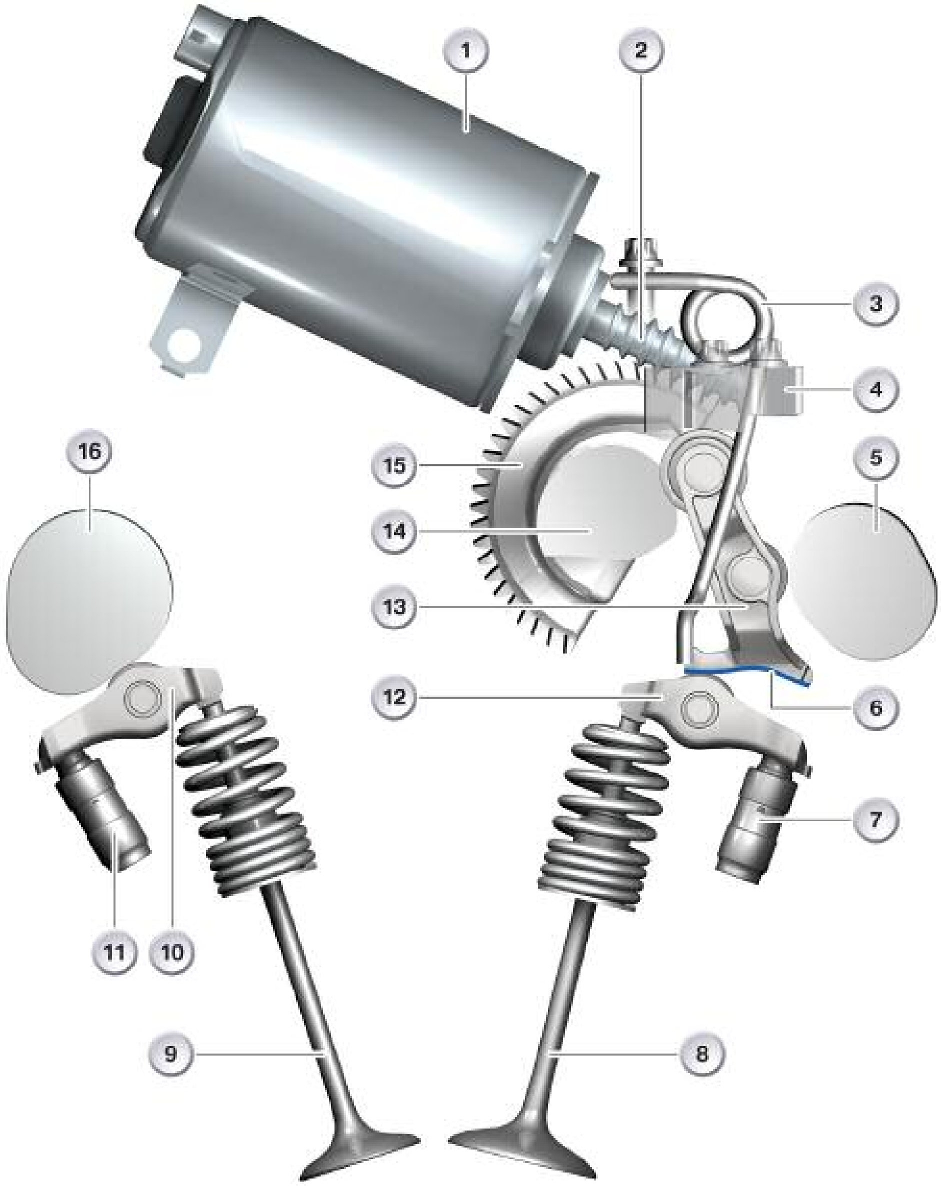
System optimization includes modification of the valve gear kinematics, a modified actuator motor and the adapted spread range of the VANOS units.

The main differences are:

- The plain bearing on the intermediate lever to the eccentric shaft has been replaced by a roller bearing, thus reducing the friction in the valve timing gear.
- Guidance of the intermediate lever is more precise. Only one spring is now required to guide and hold the intermediate lever.
- The moved mass of the valve timing gear has been reduced by 13%.
- The lift range of the intake valves has been improved. The maximum lift has been increased to 9.9 mm but more importantly the minimum lift has been further reduced to 0.18 mm.

The overall result is supported by further improvements in the intake manifold and exhaust dynamics.

Valvetronic II - used on N52, N52KP and N51



Index	Explanation	Index	Explanation
1	Actuator	9	Exhaust Valve
2	Worm Shaft	10	Roller Cam Follower
3	Return Spring	11	HVA, exhaust
4	Gate Block	12	Roller Cam Follower, Intake
5	Intake Camshaft	13	Intermediate Lever
6	Ramp	14	Eccentric Shaft
7	HVA, Intake	15	Worm Gear
8	Intake Valve	16	Exhaust Camshaft

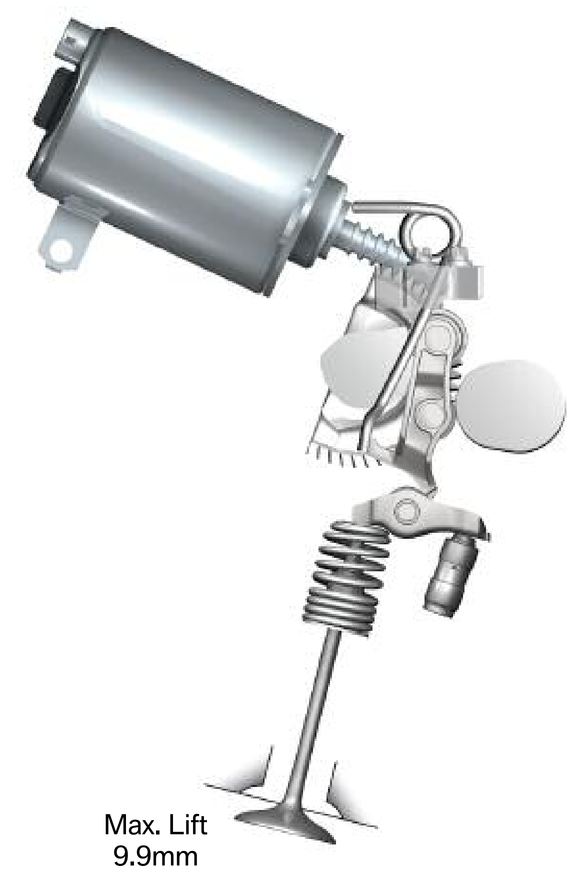
The fully variable valve lift control is activated with the aid of an actuator motor (1), an eccentric shaft (14), an intermediate lever (13), the return spring (3), the intake camshaft (5) and the roller cam follower (12). The actuator motor is installed in the cylinder head above the camshafts. It serves the purpose of adjusting the eccentric shaft. The worm shaft of the electric motor meshes with the worm gear mounted on the eccentric shaft. Following adjustment, the eccentric shaft does not have to be locked in position as the worm gear is sufficiently self-locking. The eccentric shaft adjusts the valve lift on the intake side.

The intermediate lever varies the transmission ratio between the camshaft and the roller cam follower. The valve lift (9.9 mm) and opening time are at a maximum in the full load position.

The valve lift (0.18 mm) and opening time are set to minimum in the idling position. The roller cam followers and the associated intermediate levers are divided into four classes. A corresponding code number is punched on the components. They always have the same class per pair. Assignment of the roller cam followers and the intermediate levers at the production plant ensures that the cylinders are uniformly charged even at the minimum valve lift of 0.18 mm.

Valvetronic II at minimum valve lift

Valvetronic II at maximum valve lift



Eccentric Shaft Sensor

The eccentric shaft sensor (3) signals the position of the shaft back to the ECM.

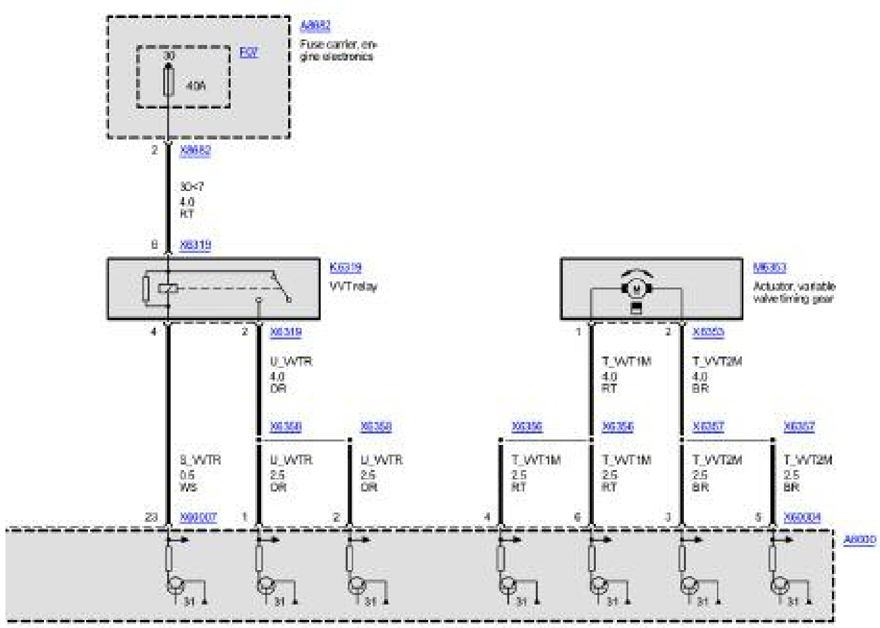
This sensor operates based on the magnetoresistive principle: A ferromagnetic conductor changes its resistance when the applied magnetic field changes its position.

For this purpose, a magnetic wheel (1) that contains a permanent magnet is mounted on the eccentric shaft. As the shaft rotates, the magnetic field lines of the magnet intersect the magnetically conductive material in the sensor. The resulting change in resistance is used as a correcting variable for the signal for the engine control unit.

The magnetic wheel must be secured on the eccentric shaft by means of a non-magnetic screw (2) otherwise the sensor will not function.

VVT Motor and Relay

The VVT motor is controlled directly by the ECM. The motor receives power from a relay located in the E-Box.



Phasing

The new VALVETRONIC II, is a very fast and exact engine control system. So-called phasing is implemented to assist adjustment in the lower valve lift range. The intake valves of a cylinder are opened synchronously up to a lift of 0.2 mm. Valve 1 then begins to lead (advance). Therefore, valve 2 opens with a slight delay behind valve 1 and catches up to valve 1 again at a lift of approximately 6 mm. From here on they open synchronously again.

This opening characteristic has a favorable effect on the inflow of gasses into the cylinder. By keeping the opening cross section of the intake valves small this results in a distinctly higher flow rate at a constant intake volume. In connection with the geometry in the upper area of the combustion chamber, this higher flow rate is used to mix the air/fuel mixture more effectively.

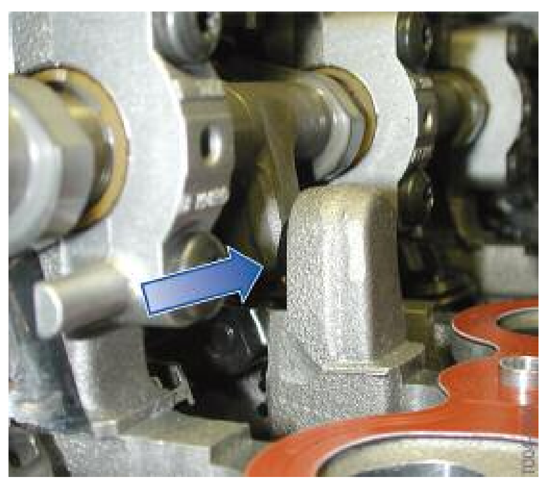
This phasing eliminates the need for the turbulence ports used on the previous generation six-cylinder engines. The phasing feature of the Valvetronic creates the necessary turbulence (swirl) in the combustion chamber.

MIN/MAX Stops

A stop routine can be implemented between the mechanical stops in order to detect the positions of the mechanical stops. For this purpose, the eccentric shaft is adjusted from zero lift to full lift. The stop routine is executed only when the motor electronics determines implausible values during the engine start procedure. This routine can also be initiated by the diagnosis systems.

Eccentric Shaft - MIN Stop

Eccentric Shaft - MAX Stop

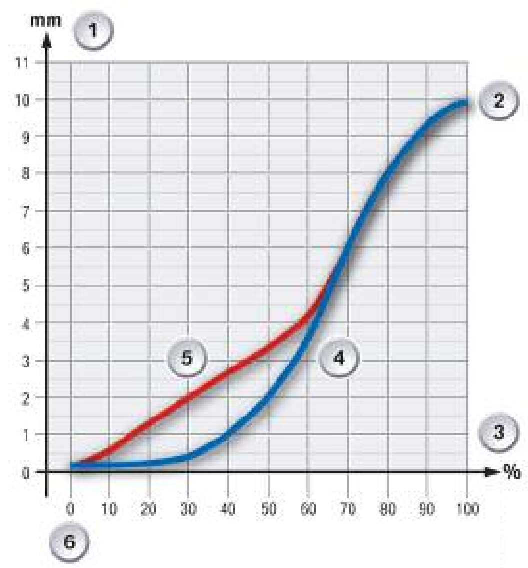


VALVETRONIC III

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

Phasing

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



Index	Explanation
1	Valve Opening (mm)
2	Maximum Valve Opening (mm)
3	Load (%)
4	Intake Valve 2
5	Intake Valve 1
6	Minimum Valve Opening (mm)

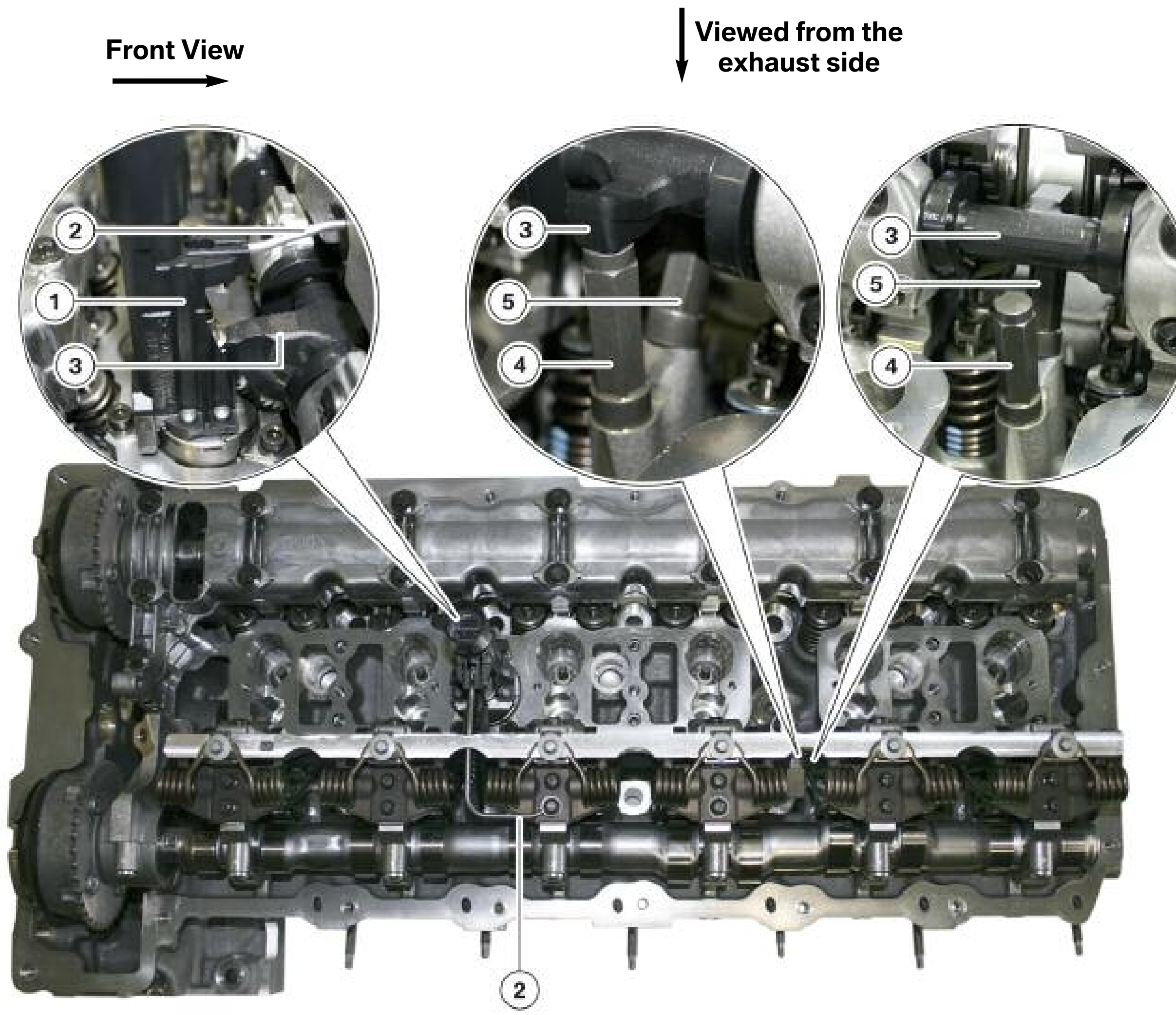
Masking

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

Valve Lift Adjustment Overview

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

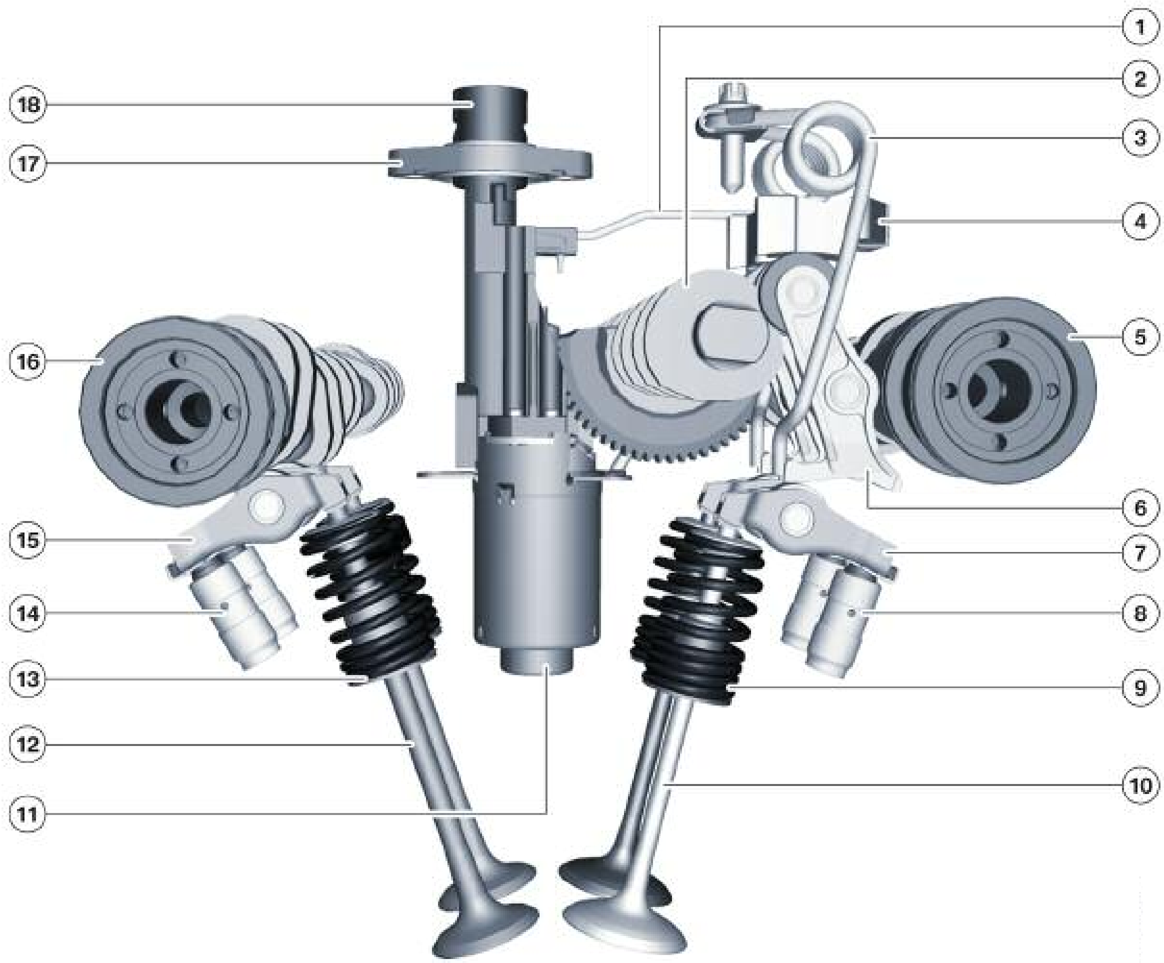
N55, valve lift adjustment



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

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

N55, design of valve lift adjustment



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

VALVETRONIC Servomotor

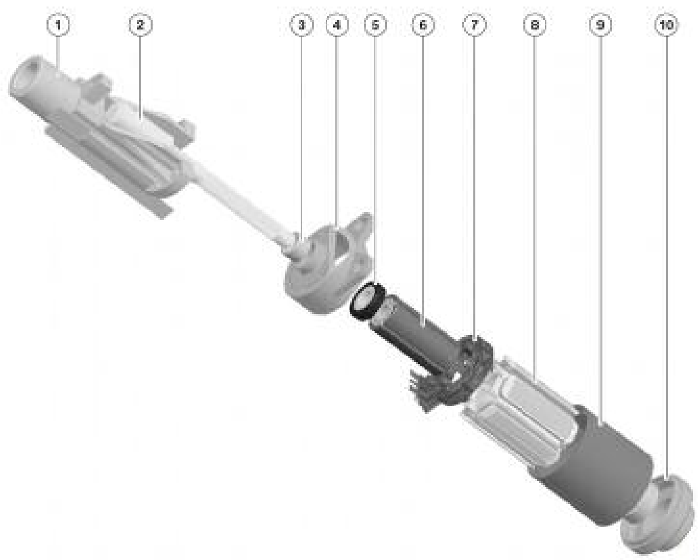
A brushless direct current motor (BLDC motor) is used. The BLCD motor is maintenance-free and very powerful, due to the contactless energy transfer system. The use of integrated electronic modules ensures precision control.

The Valvetronic servomotor has the following special features:

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

Function

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



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

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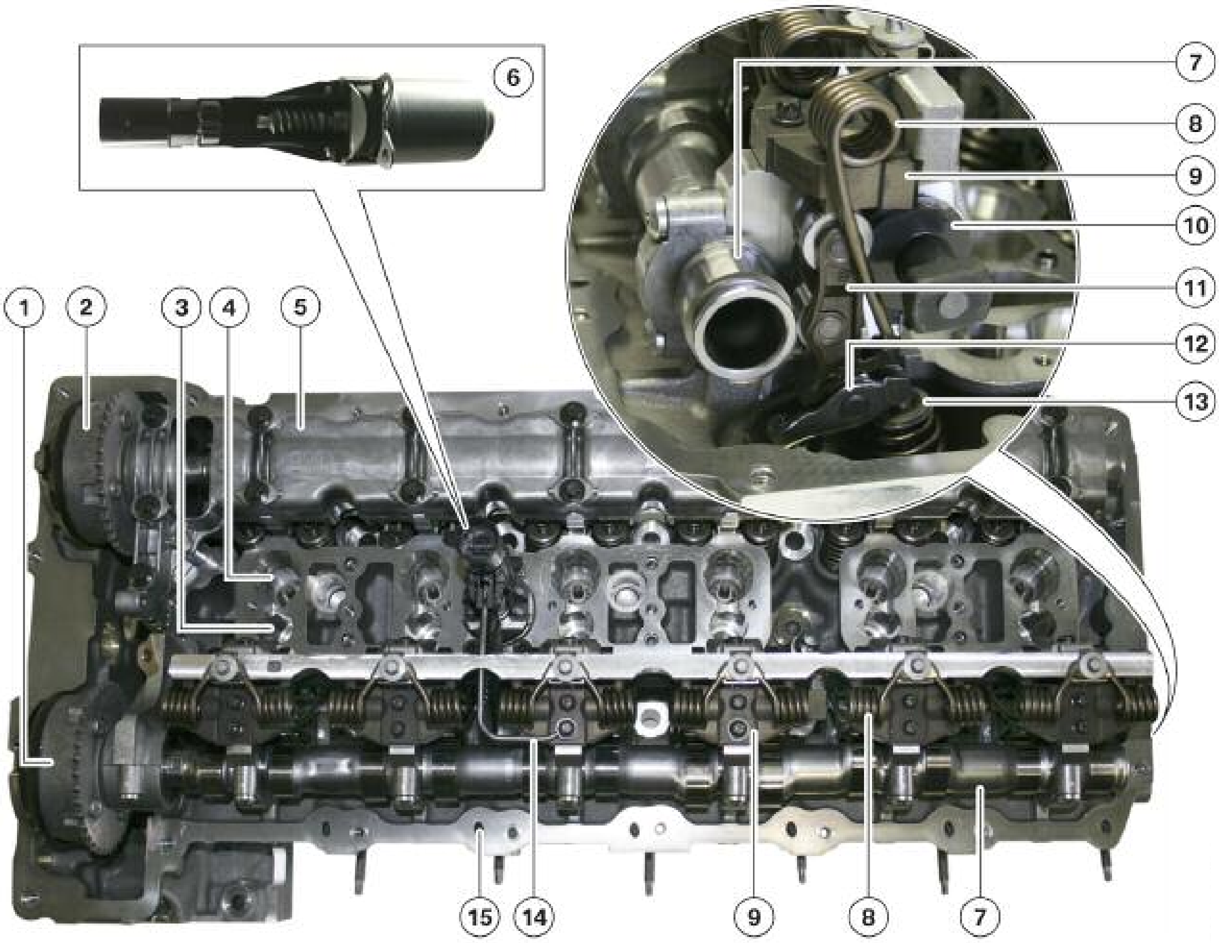
The following graphic shows the design of the cylinder head on the N55 engine with Valvetronic III and direct fuel injection.

N55, overview of valvetrain



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

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

NOTES PAGE