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VANOS

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VANOS

Model: All

Production: All

OBJECTIVES

After completion of this module you will be able to:

- Using the Status requests (cam sensors) identify whether or not the VANOS Solenoids are adjusting the Cam Timing.
- Explain why it is necessary to check engine timing when the VANOS system is faulted.
- Explain how oil condition, level and pressure affect VANOS operation.
- Using an ISID, IMIB and ETM properly check the VANOS circuit electrically.
- Locate and identify the components used for VANOS operation.

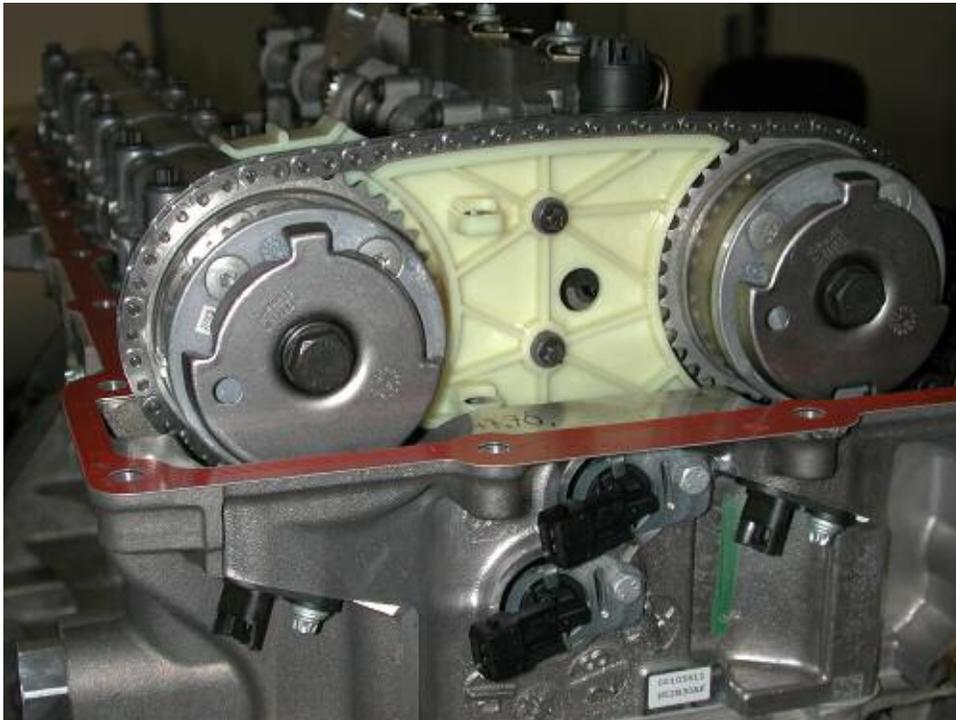
VANOS

Introduction

Performance, torque, idle characteristics and exhaust emissions reduction are improved by Variable Camshaft Timing. The VANOS system is currently used in all BMW engines.

The Vanos units are mounted directly on the front of the camshafts and adjusts the timing of the Intake and Exhaust camshafts throughout the entire spread range from retarded to advanced. The ECM controls the operation of the VANOS solenoids which regulates the oil pressure required to move the VANOS units. Engine rpm, load and temperature are used to determine VANOS activation.

N52 VANOS units



The VANOS mechanical operation is dependent on engine oil pressure applied to position the VANOS units. When oil pressure is applied to the units (via ports in the camshafts regulated by the solenoids), the camshaft hubs are rotated in the drive sprockets changing the position which advances/retards the intake/exhaust camshafts timing. The VANOS system is “fully variable”. When the ECM detects that the camshafts are in the optimum positions, the solenoids maintain oil pressure on the units to hold the camshaft timing.

The operation of the VANOS solenoids are monitored in accordance with the OBD II requirements for emission control. The ECM monitors the final stage output control and the signals from the Camshaft Position Sensors for VANOS operation.

Solenoid Valves

The VANOS solenoid valves are mounted through the front of the cylinder head. There are two solenoids, one for the intake VANOS and one for the exhaust. The solenoids control the oil flow to the camshaft ports for the intake and exhaust VANOS units.

The 4/3 way proportional solenoid valve is activated by the ECM to direct oil flow. The solenoid valve is sealed to the head by a radial seal and secured by a retaining plate.



The variable camshaft control serves the purpose of increasing torque in the lower and medium engine speed ranges. The VANOS solenoid valve activates the VANOS adjustment unit on the intake side. The VANOS solenoid valves are driven by the ECM control unit.

The VANOS solenoid valve is connected by means of two lines to the ECM. The ECM control unit activates the VANOS solenoid valve as required.

Activation takes place **pulse-width modulated** with system voltage. PWM activation means that the actuator piston can be controlled in any position, making exact positioning of the VANOS unit possible.

Intake Solenoid Valve

The intake VANOS solenoid valve is responsible for controlling the timing of the intake camshaft.

Exhaust Solenoid Valve

The exhaust VANOS solenoid valve is responsible for controlling the timing of the exhaust camshaft.

Camshaft Sensors

There are two camshaft sensors, one for the intake camshaft and one for the exhaust. They are mounted at the front of the cylinder head and monitor the impulse wheels which are bolted to the front of the VANOS units.

The sensors are supplied power via the engine electronics fuses. Ground is supplied via the ECM. The sensors are **hall effect** and provide the ECM with a **5 volt** square wave signal.

The camshaft sensor operates in accordance with the Hall principle and it is used for detecting the camshaft position. A camshaft sensor wheel is mounted on the camshaft for this purpose.

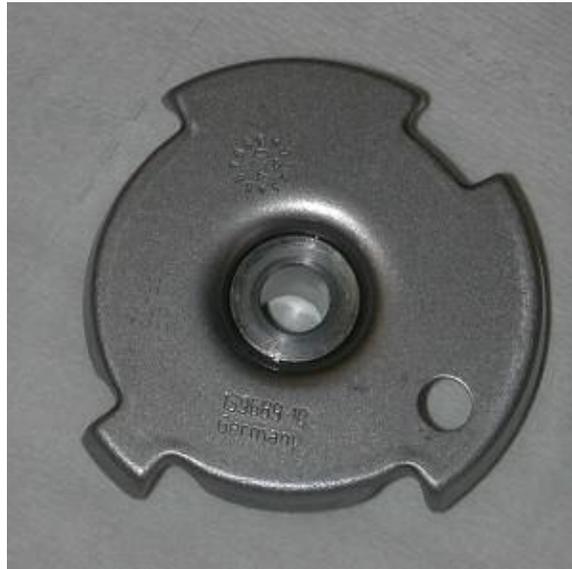
With the aid of the camshaft sensor, the ECM can determine whether the cylinder is in the compression cycle or in the charge cycle.

This deduction cannot be made from the crankshaft position. The corresponding assignment is necessary for the purpose of controlling the fuel injection and ignition accordingly.

Camshaft Sensor



Camshaft Sensor Wheel



A further task of the sensor is to provide feedback relating to the camshaft position for VANOS control. In this way, the ECM can regulate the camshaft position based on a characteristic map with the aid of a VANOS solenoid valve.

The ECM supplies the sensor with a 5V voltage and ground. The sensor sends a digital signal via the signal line to the ECM.

The camshaft sensor operates corresponding to the same principle as the crankshaft sensor. The camshaft sensor wheel however, is fundamentally different. A special aperture pattern facilitates emergency operation in the event of the crankshaft sensor failing. The resolution of the camshaft sensor signal, however, is too inaccurate to replace the crankshaft sensor during normal operation.

Intake Camshaft Sensor

The sensor for the intake camshaft has the following tasks:

- Detection of the camshaft allocation with respect to the crankshaft (cylinder compression cycle or cylinder charge cycle).
- Positioning the camshaft with respect to the crankshaft for VANOS adjustment.

With the aid of the sensor, the ECM can determine the position of the intake camshaft with respect to the crankshaft and adjust the camshaft with the aid of VANOS corresponding to ECM requirements.

Exhaust Camshaft Sensor

An exhaust camshaft sensor is also used. With the aid of the sensor, the ECM can determine the position of the exhaust camshaft with respect to the crankshaft and adjust the camshaft with the aid of VANOS corresponding to ECM requirements.

VANOS Units

The infinitely variable double VANOS system uses a hydraulic oscillating motor type VANOS units for the intake and the exhaust cams. Although they have identical function, the oscillating motor VANOS units are a further development of the variable vane type motor VANOS units used on previous systems. They are designed as an integrated component in the chain drive and are mounted with a central bolt on the respective camshaft. When de-pressurized, a coil spring holds the VANOS unit in the base position.

N52 Hydraulic oscillating motor/VANOS unit



Index	Explanation
1	Front plate
2	Locking pin
3	Oil channel
4	Casing with ring gear
5	Pressure chamber for advancing
6	Oscillating rotor
7	Pressure chamber for retarding
8	Oil channel

The VANOS units are controlled by oil pressure from the 4/3 proportional solenoid valves. The valves are located in the front of the cylinder head and are controlled by the ECM. The ECM regulates the VANOS based on factors such as engine RPM, load and coolant temperature.

N52 VANOS system



Index	Explanation
1	VANOS unit, Exhaust
2	VANOS unit, intake
3	Intake camshaft sensor
4	Exhaust camshaft sensor
5	VANOS solenoid valve
6	VANOS solenoid valve

The **infinitely variable double VANOS** system was first introduced on the M52B20TU engine. The design is similar to that of two-setting intake VANOS; the main difference is that in addition to the timing of the intake camshaft, the timing of the exhaust camshaft can also be varied. The system allows for infinite variation of timing of both camshafts according to the control commands from the engine management ECM.

The advantages of infinitely variable double VANOS are:

- Higher torque at low and medium engine speeds
- Smaller quantity of residual exhaust when idling due to smaller valve overlap resulting in improved idling
- Internal exhaust recirculation in the medium power band in order to reduce nitrogen oxide emissions
- Faster warm-up of catalytic converters and lower raw emission levels after a cold start
- Reduction of fuel consumption

The possible adjustment range of the double VANOS system is clearly identifiable by the blue/red shaded areas



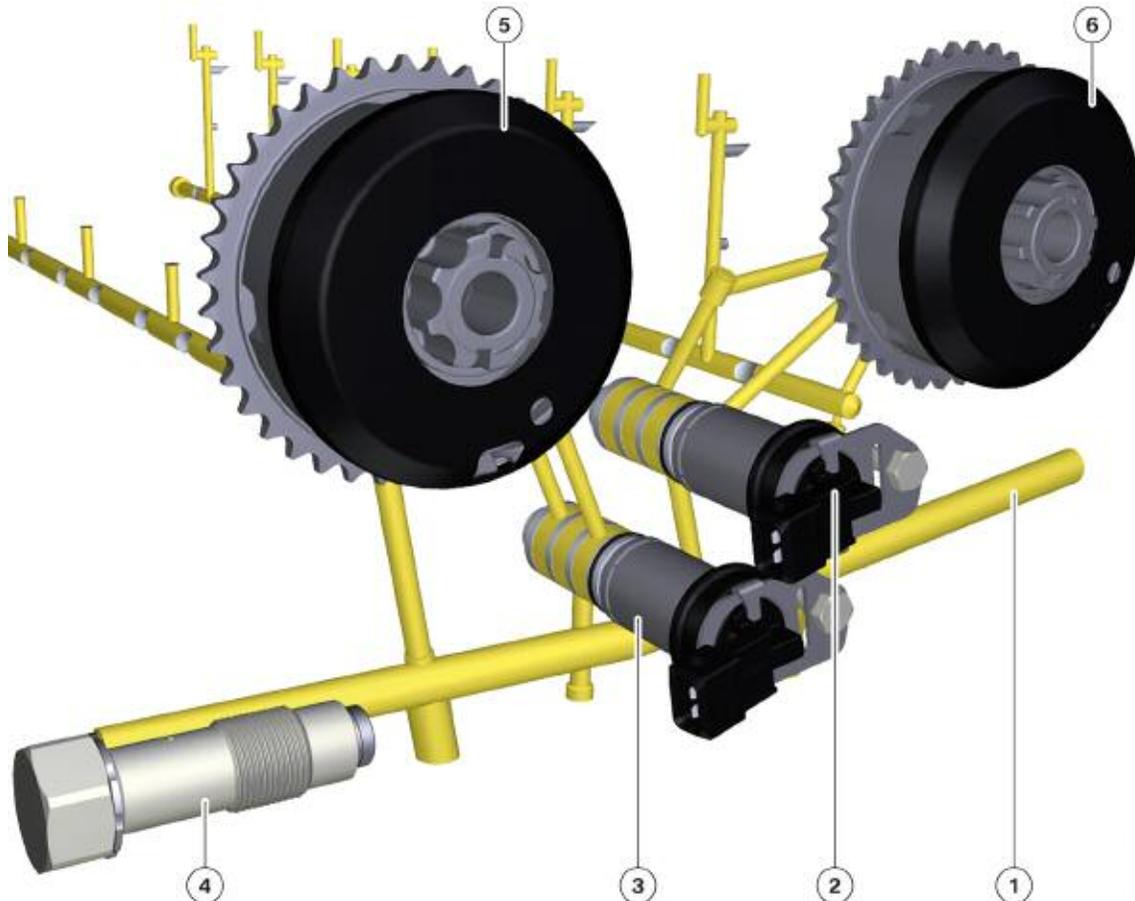
The infinitely variable double VANOS system is used on all current engines. The only change to the system is that each engine uses different spread ranges (check engine specifications for the individual cam spread).

As with previous systems, the VANOS units should not be mixed up as the spread ranges for the intake and exhaust are different and engine damage could result.

VANOS N55

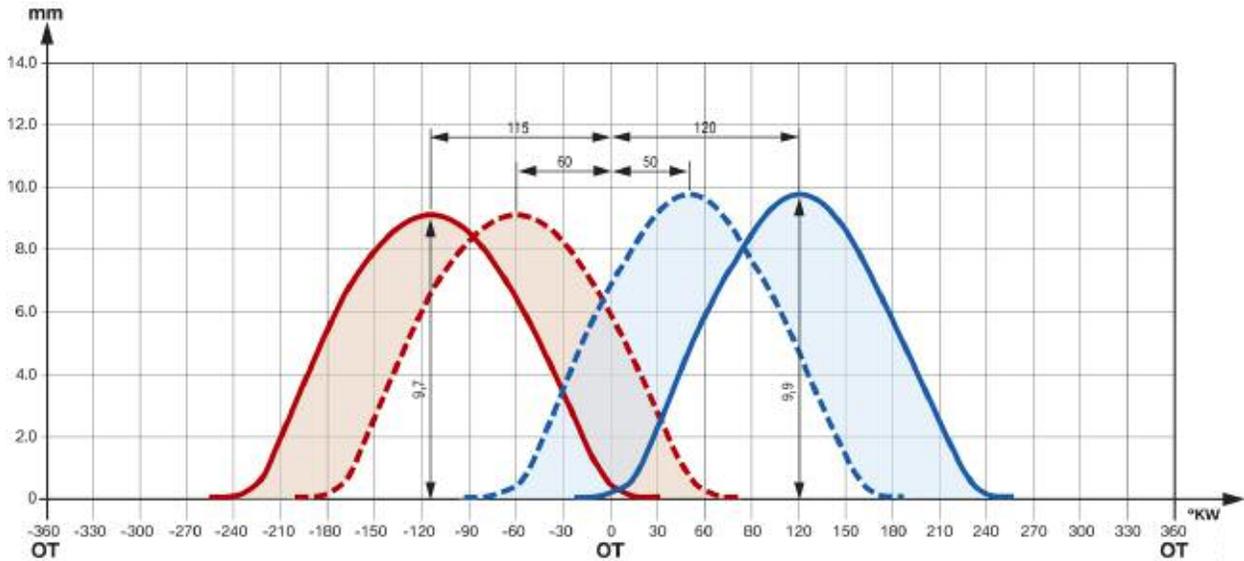
The VANOS system has been optimized to provide even faster adjustment speeds of the VANOS units. The aluminum VANOS units are much lighter and are also less susceptible to soiling. It can be seen by comparing the N54 VANOS system with the N55 VANOS that fewer oil passages are required and that the non-return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

N55, VANOS with oil supply



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

N55 valve timing diagram



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



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

VANOS Solenoid Valves (N55)

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

Cam Sensor Wheels (N55)

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

N55, camshaft sensor wheel



Index	Explanation
A	Rear View
B	Front view

VANOS N63

The charge cycle in the N63 engine is realized with four valves per cylinder, which are driven by two overhead camshafts.

The engine timing can be variably influenced by means of the two infinitely variable VANOS units.

The VANOS units used here have the following timing angles:

- Intake VANOS unit: 50° crankshaft angle
- Exhaust VANOS unit: 50° crankshaft angle



The VANOS units on the N63 engine differ from the VANOS units on the N62 engine. The function is identical but some components have been omitted and the VANOS unit has been optimized.

On the N63 engine, the individual vanes of the VANOS unit are no longer individual parts but rather they have been further developed to form an oscillating rotor (as on the N52 engine).

The torsion spring integrated in the N62 VANOS unit is now designed as a coil spring accommodated on the front of the N63 VANOS unit protected by a plastic cover.

VANOS N74

Like all current BMW gasoline engines, the N74 engine is also equipped with variable double VANOS. The VANOS units are common parts shared with the N63 engine, with the exception of the intake unit on cylinder bank though this is also designed to the same principle, it features a drive flange with a slot for the vacuum pump. The N74 uses two VANOS non-return valves, they are now integrated into the VANOS solenoid valves.

The VANOS units have the following adjustment angles:

- VANOS unit intake: 50° crank angle
- VANOS unit exhaust: 50° crank angle