M62 TU ENGINE

OVERVIEW

As of 9/98 production the US market will equip the M62 TU B44 (4.4 liter) in the following models:

- 540i, 540i sport wagon
- 740i/iL

The M62 TU provides federal emission compliance for current and future model years. Additionally, the required new features, added systems and design changes also improve:

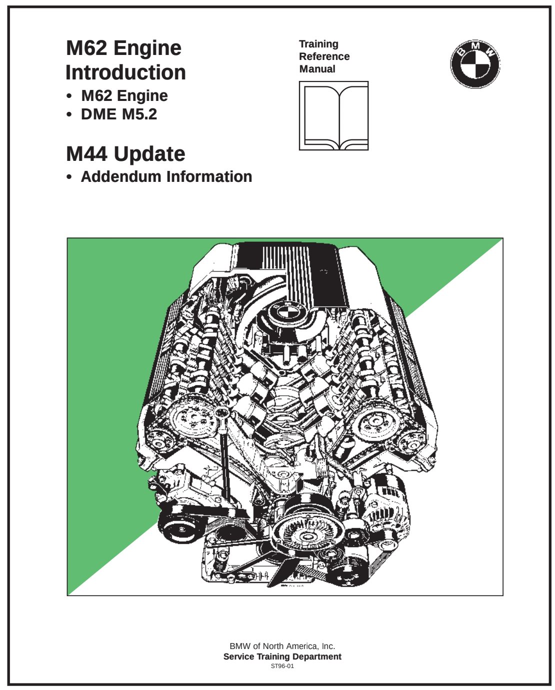
- Fuel efficiency
- Noise Reduction
- Idle quality

The fundamental mechanical design and function of the M62 TU is primarily carry over from the proven M62 engine.

Refer to M62 Engine Introduction handout (distributed 1-96) for background information on mechanical componentry and system descriptions.

The M62 TU is however a new, state of the art engine. It does contain new and unique parts.

The following engine components are new for M62 TU:

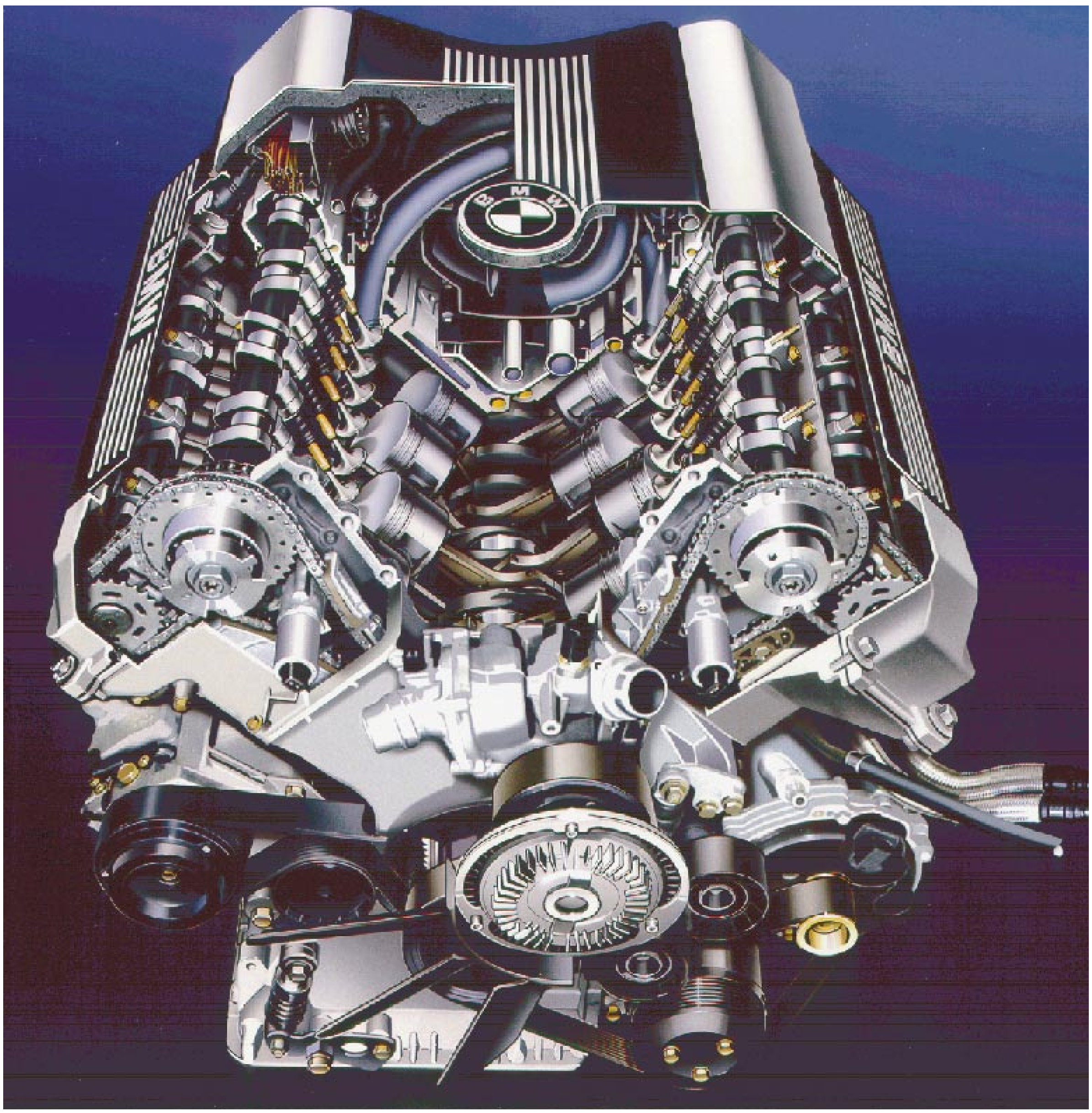


- Cylinder heads (VANOS oil ports, Secondary Air Injection Ports)
- Intake and exhaust camshafts (changes due to VANOS)
- Hydraulic Valve Actuators - HVA (modified internal design, improved oil retention after engine shut down to prevent noise on next start up)
- Head covers, gaskets, mounting hardware (Upgraded components due to VANOS)
- Timing chain cases (accommodation of VANOS and New Water Cooled Generator)
- Timing Chain Guide Rail (VANOS integration)
- Pistons/rings (improved ring land hardening process)
- Cyclone Separator, vent pipe, drain tube (modified for VANOS integration)
- Ribbed V belt, belt adjusting lever and pulley assembly

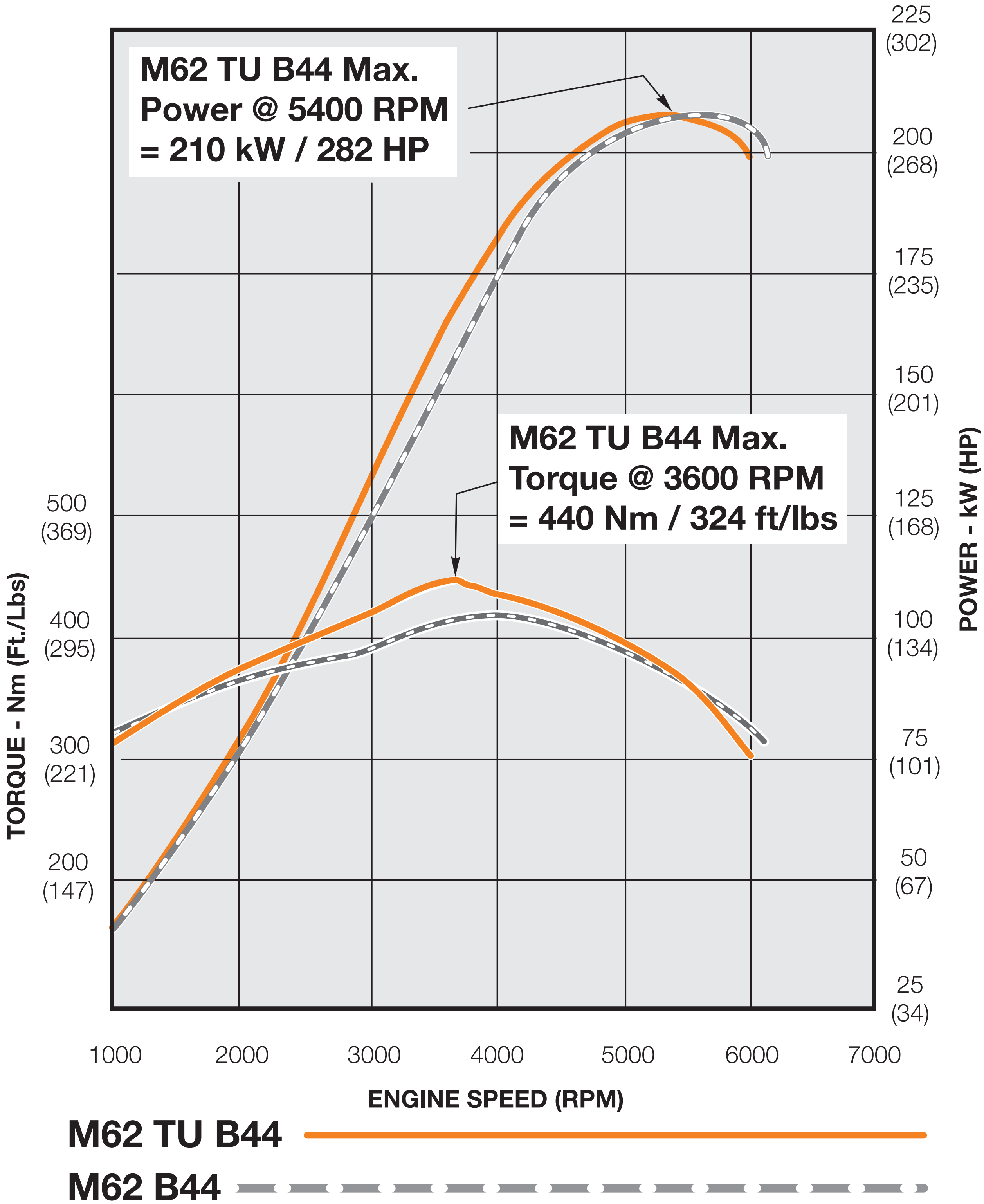
***Should engine mechanical repairs be necessary, always verify correct part numbers by checking the start of production indicator in the EPC*.**

In addition to the basic mechanical changes, the M62 TU engine is equipped with:

- A new Digital Motor Electronics Control System; **ME 7.2** (described in detail further on).
- *Variably positioned* intake camshaft VANOS system.
- “EML” Electronic Throttle Control System identified as EDK.
- Compact water cooled generator (F-alternator).
- New exhaust system consisting of exhaust manifolds with integrated forward mounted warm up catalytic converters. Additional downstream main catalytic converters.
- Thermostat controlled transmission fluid/engine coolant heat exchanger system for automatic transmission equipped vehicles (similar to E46 system).
- Quick connect couplings for radiator/thermostat hoses and transmission fluid lines.
- New brake booster vacuum amplifier component and location.
- Non Return Fuel Rail (Running Loss Compliance)



COMPARATIVE POWER CURVES (M62 TU - M62)



COMPARATIVE SPECIFICATIONS (M62 TU - M62)

	M62 TU B44	M62 B44
Engine Design	90° V8	
Crankcase Material (Cylinder Bore Preparation)	Aluminum Alloy (Alusil) (silicone impregnated, cylinder bore etching)	
Displacement (cubic centimeters)	4398cc	
Bore/Stroke (mm)	92 x 82.7	
Max. Power Output (Kw/HP) @ Engine Speed	210/282 @ 5,400 RPM	210/282 @ 5,700 RPM
Torque Output (Nm / Ft/Lbs.) @ Engine Speed	440/324 @ 3600 RPM	420/310 @ 3900 RPM
Compression Ratio	10.0:1	
Idle Speed	550 RPM	550 RPM
Maximum Engine Speed (RPM)	6100	6100
Valve Stroke - Inlet/Exhaust (mm)	9.0/9.0	9.0/9.0
Inlet Valve Diameter	30.5mm	
Exhaust Valve Diameter	35mm	
Valve Timing - (Crankshaft °) • Opening Angle - Inlet/Exhaust • Spread - Inlet - Exhaust	 236° /228° 84° - 124° 104°	 238° /228° 112° 108°
Firing Order	1-5-4-8-6-3-7-2	
Fuel Rating	90 AKI/95RON	
Engine Management	Bosch ME 7.2	Bosch M 5.2.1
Generator	90-150 Amp Water Cooled	140 Amp

M62 TU VANOS

OVERVIEW

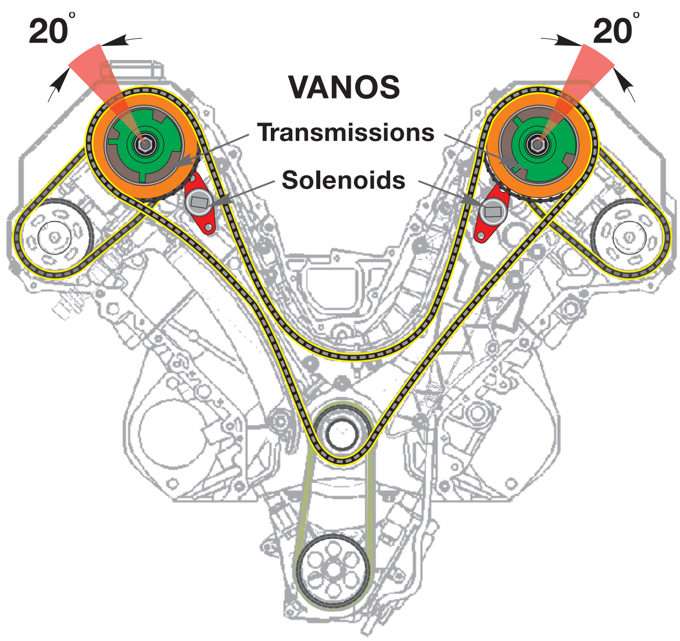
The variable intake valve timing system on the M62 TU continues to be identified as VANOS. This acronym comes from the German words; *VAriable NOckenwellen Steuerung,* which means Variable Camshaft Control.

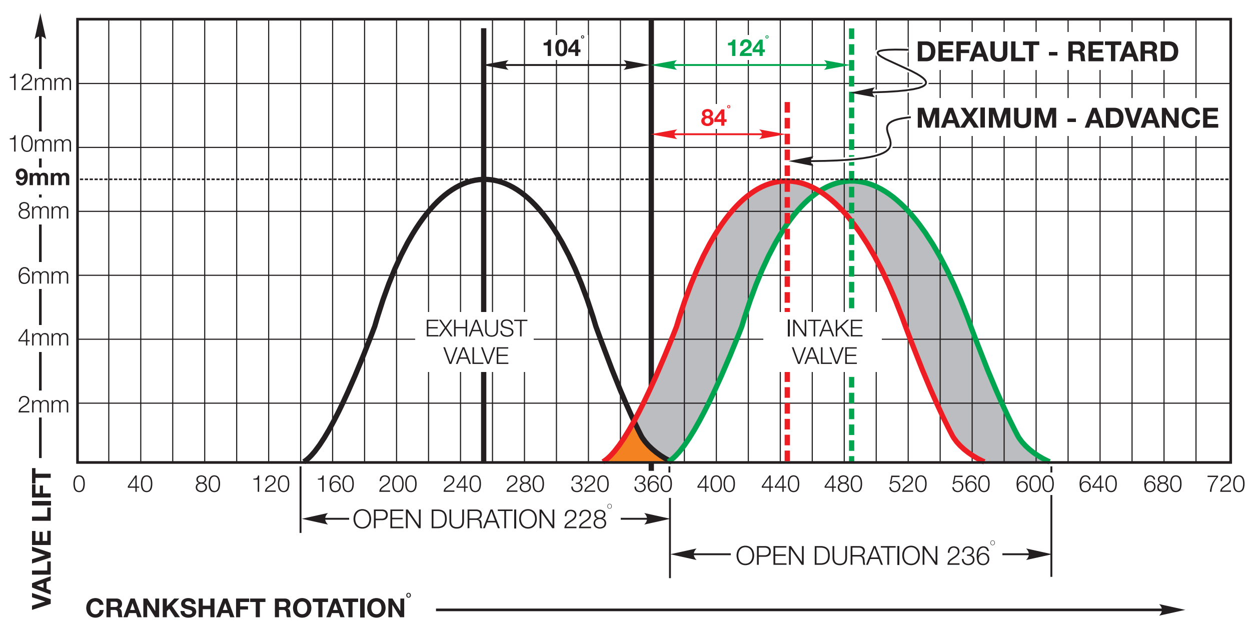
The M62 TU VANOS system is a new variant providing stepless VANOS functionality on each intake camshaft. The system is continuously variable within its range of adjustment providing optimized camshaft positioning for all engine operating conditions.

While the engine is running, both intake camshafts are continuously adjusted to their optimum positions. This enhances engine performance and reduces tailpipe emissions.

Both camshafts are adjusted simultaneously within 20° (maximum) of the camshafts rotational axis.

This equates to a maximum span of 40° crankshaft rotation. The camshaft spread angles for both banks are as follows.





VANOS BENEFITS

The design of a camshaft for a non adjustable valve timing system is limited to the required **overall** performance of the engine.

- An intake camshaft with an **advanced** (early) profile will provide a higher performing power curve at a lower engine speed. But at idle speed the the advanced position will create a large area of intake/exhaust overlap that causes a rough, unstable idle.

- On the other hand, an intake camshaft with a **retarded** (late) profile will provide a very smooth, stable idle but will lack the cylinder filling dynamics needed for performance characteristics at mid range engine speeds.

The ability to **adjust** the valve timing improves the engine's power dynamics and reduces tailpipe emissions by optimizing the camshaft angle for all ranges of engine operation. VANOS provides the following benefits:

- Increased torque at lower to mid range engine speeds without a loss of power in the upper range engine speeds.
- Increased fuel economy due to optimized valve timing angles.
- Reduction of exhaust emissions due to optimized valve overlap.
- Smoother idle quality due to optimized valve overlap.

BASIC FUNCTION OF BMW VANOS SYSTEMS

All BMW VANOS systems are operated through electric/hydraulic/mechanical control.

Electric Control: The engine control module is responsible for activating a VANOS solenoid valve based on DME program mapping. The activation parameters are influenced by the following input signals:

- Engine speed
- Load (intake air mass)
- Engine temperature
- Camshaft position
- Oil temperature (MS 42.0 only)

Depending on the specific VANOS system, the solenoid valve is one of two types:

- Basic black/white (on/off) solenoid valve. Found on M50 TU and M52 engines.
- Variable position solenoid valve. Found on the M52 TU and M62 TU engines.

Hydraulic Control: The position of the solenoid valve directs the hydraulic flow of engine oil. The controlled oil flow acts on the mechanical components of VANOS system to position the camshaft.

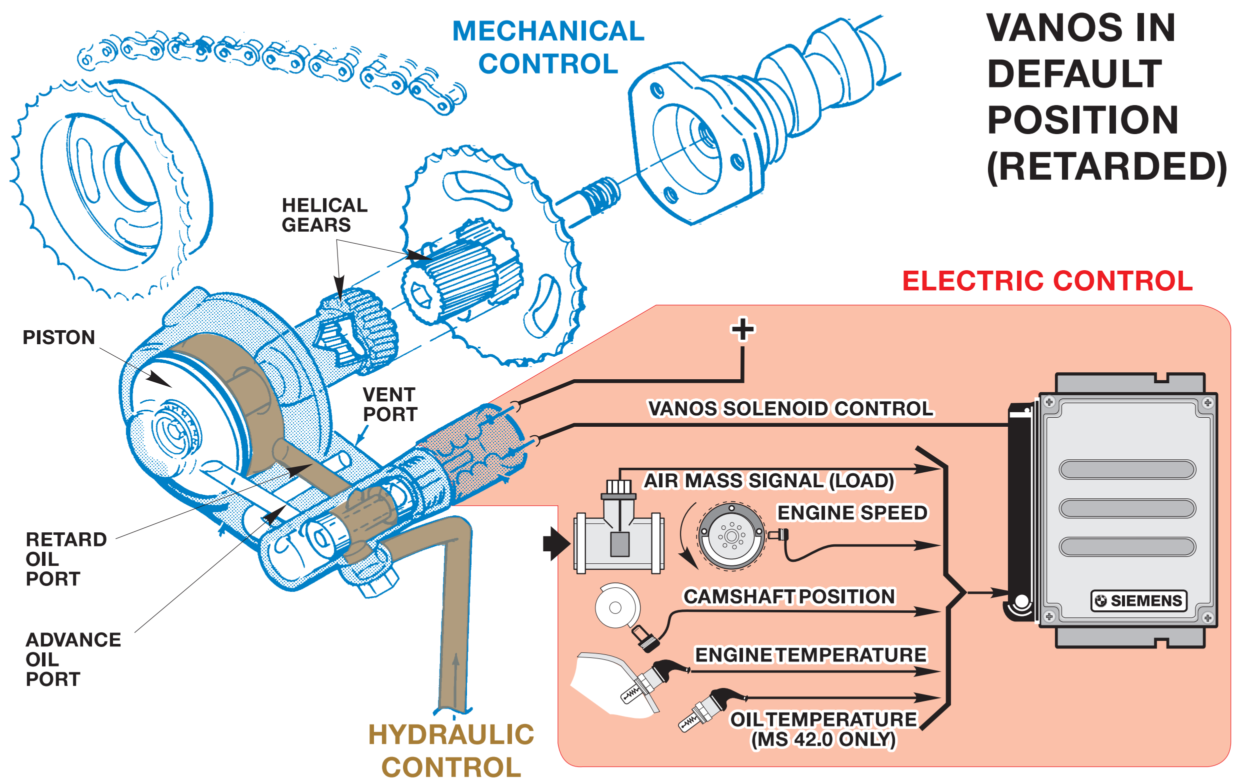
Mechanical Control: The mechanical components of all VANOS systems operate under the same principle. The controlled hydraulic engine oil flow is directed through advance or retard activation oil ports. Each port exits into a sealed chamber on the opposite sides of a control piston.

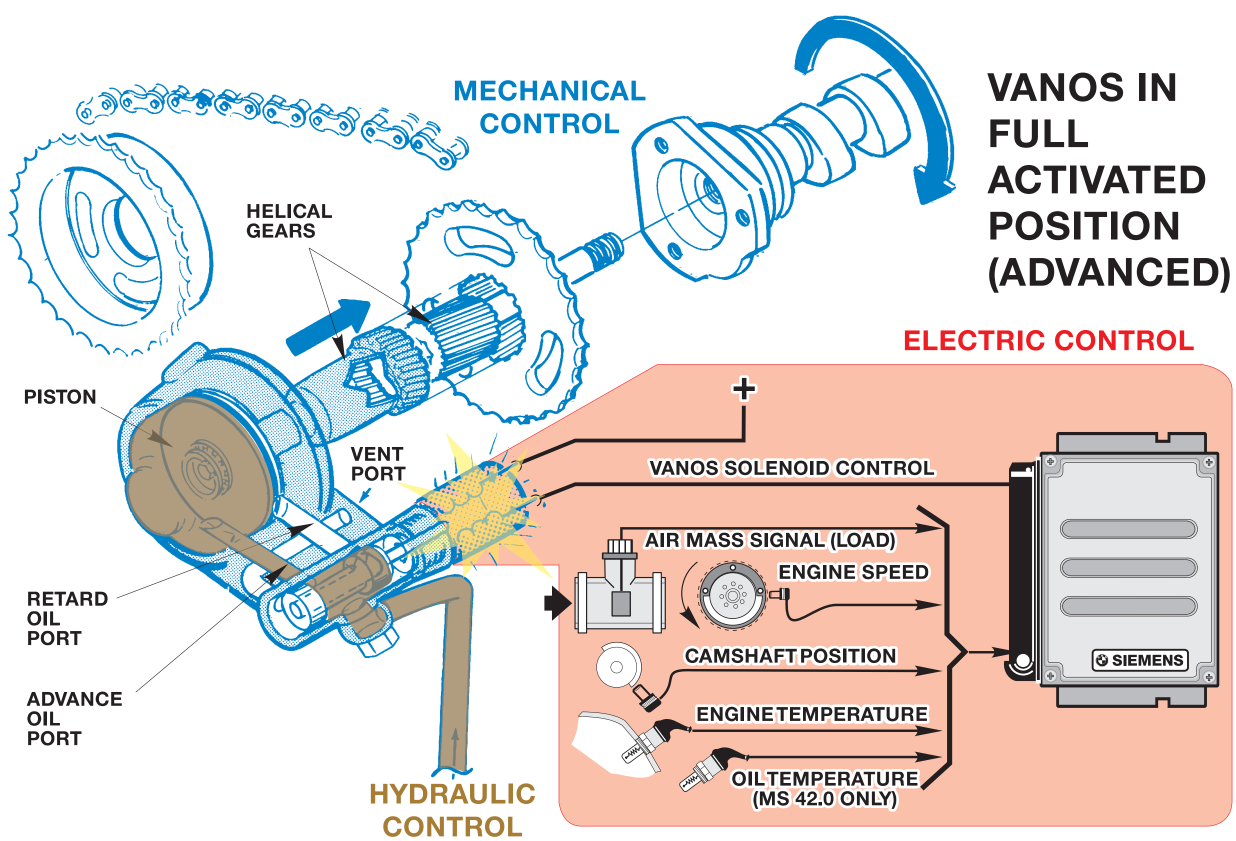
- The control piston on six cylinder engine systems (M50TU, M52 & M52TU) is connected to a separate helical gear cup.
- The control piston on the M62TU VANOS system incorporates the helical gear.

In its default position the oil flow is directed to the rear surface of the piston. This pulls the helical gear forward and maintains the retarded valve timing position.

When the oil flow is directed to the front surface of the piston, the oil **pushes** the helical gear in the opposite direction which rotates the matched helical gearing connected to the camshaft.

The angled teeth of the helical gears cause the **pushing** movement to be converted into a **rotational** movement. The rotational movement is added to the turning of the camshaft providing the variable camshaft positioning.

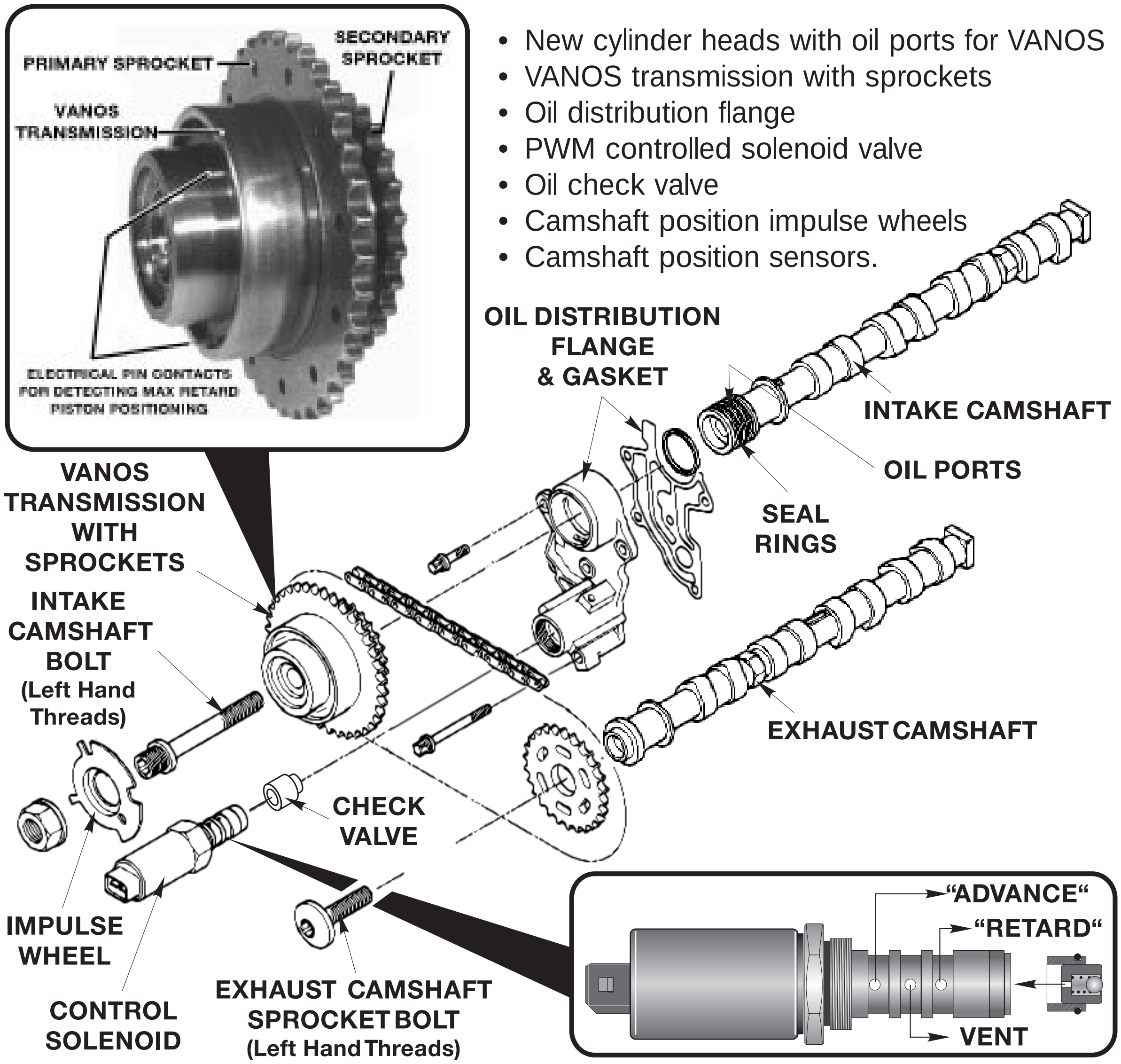

VANOS IN DEFAULT POSITION (RETARDED)
MECHANICAL CONTROL
HELICAL GEARS
PISTON
VENT PORT
RETARD OIL PORT
ADVANCE OIL PORT
HYDRAULIC CONTROL
ELECTRIC CONTROL
+
VANOS SOLENOID CONTROL
AIR MASS SIGNAL (LOAD)
ENGINE SPEED
CAMSHAFT POSITION
ENGINE TEMPERATURE
OIL TEMPERATURE (MS 42.0 ONLY)
SIEMENS


VANOS IN FULL ACTIVATED POSITION (ADVANCED)
MECHANICAL CONTROL
HELICAL GEARS
PISTON
VENT PORT
RETARD OIL PORT
ADVANCE OIL PORT
HYDRAULIC CONTROL
ELECTRIC CONTROL
+
VANOS SOLENOID CONTROL
AIR MASS SIGNAL (LOAD)
ENGINE SPEED
CAMSHAFT POSITION
ENGINE TEMPERATURE
OIL TEMPERATURE (MS 42.0 ONLY)
SIEMENS

M62 TU VANOS COMPONENTS

M62 TU VANOS components include the following for each cylinder bank:

- New cylinder heads with oil ports for VANOS
- VANOS transmission with sprockets
- Oil distribution flange
- PWM controlled solenoid valve
- Oil check valve
- Camshaft position impulse wheels
- Camshaft position sensors.



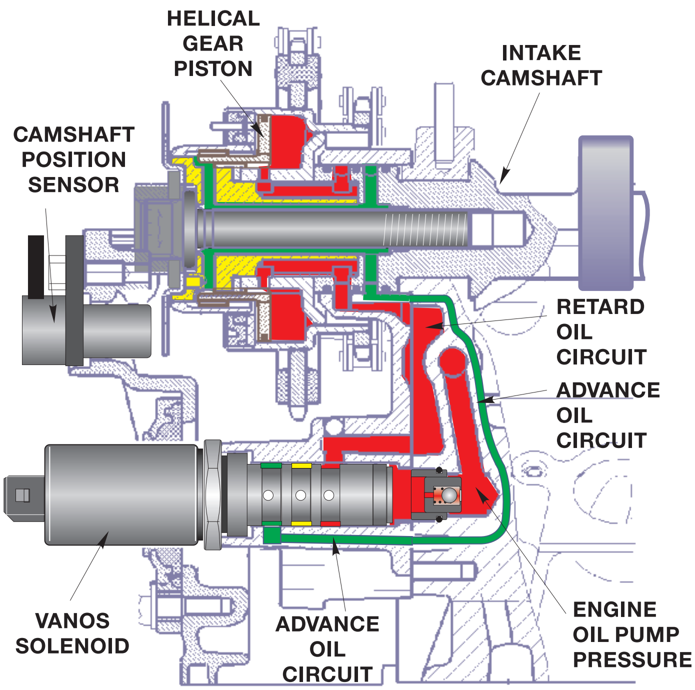
VANOS CONTROL SOLENOID & CHECK VALVE: The VANOS solenoid is a two wire, pulse width modulated, oil pressure control valve. The valve has four ports;

1. Input Supply Port - Engine Oil Pressure
2. Output Retard Port - To rear of piston/helical gear (retarded camshaft position)
3. Output Advance Port - To front of piston/helical gear (advanced camshaft position)
4. Vent - Released oil pressure

A check valve is positioned forward of the solenoid in the cylinder head oil gallery. The check valve maintains an oil supply in the VANOS transmission and oil circuits after the engine is turned off. This prevents the possibility of piston movement (noise) within the VANOS transmission system on the next engine start.

VANOS TRANSMISSION: The primary and secondary timing chain sprockets are integrated with the VANOS transmission. The transmission is a self-contained unit.

The controlled adjustment of the camshaft occurs inside the "transmission". Similar in principle to the six cylinder engine VANOS systems, controlled oil pressure moves the piston axially.

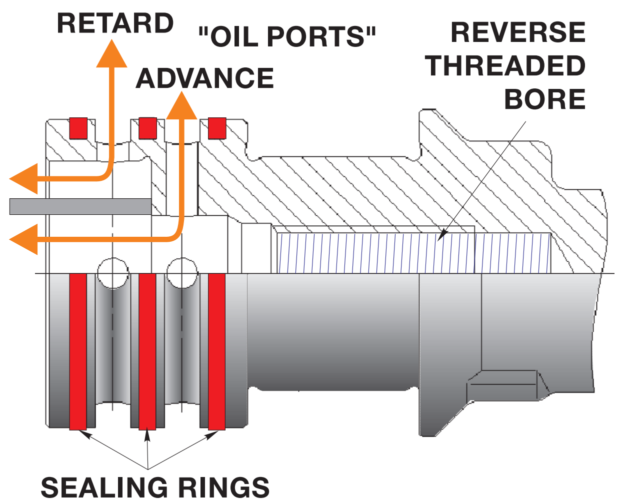


The helical gear cut of the piston acts on the helical gears on the inside surface of the transmission and rotates the camshaft to the specific advanced or retarded angle position.

Three electrical pin contacts are located on the front surface to verify the default maximum retard position using an ohmmeter. This is required during assembly and adjustment. (see service notes further on).

OIL DISTRIBUTION FLANGES: The oil distribution flanges are bolted to the front surface of each cylinder head. They provide a mounting location for the VANOS solenoids as well as the advance-retard oil ports from the solenoids to the intake camshafts.

CAMSHAFTS: Each intake camshaft has two oil ports separated by three sealing rings on their forward ends.



The ports direct pressurized oil from the oil distribution flange to the inner workings of the VANOS transmission.

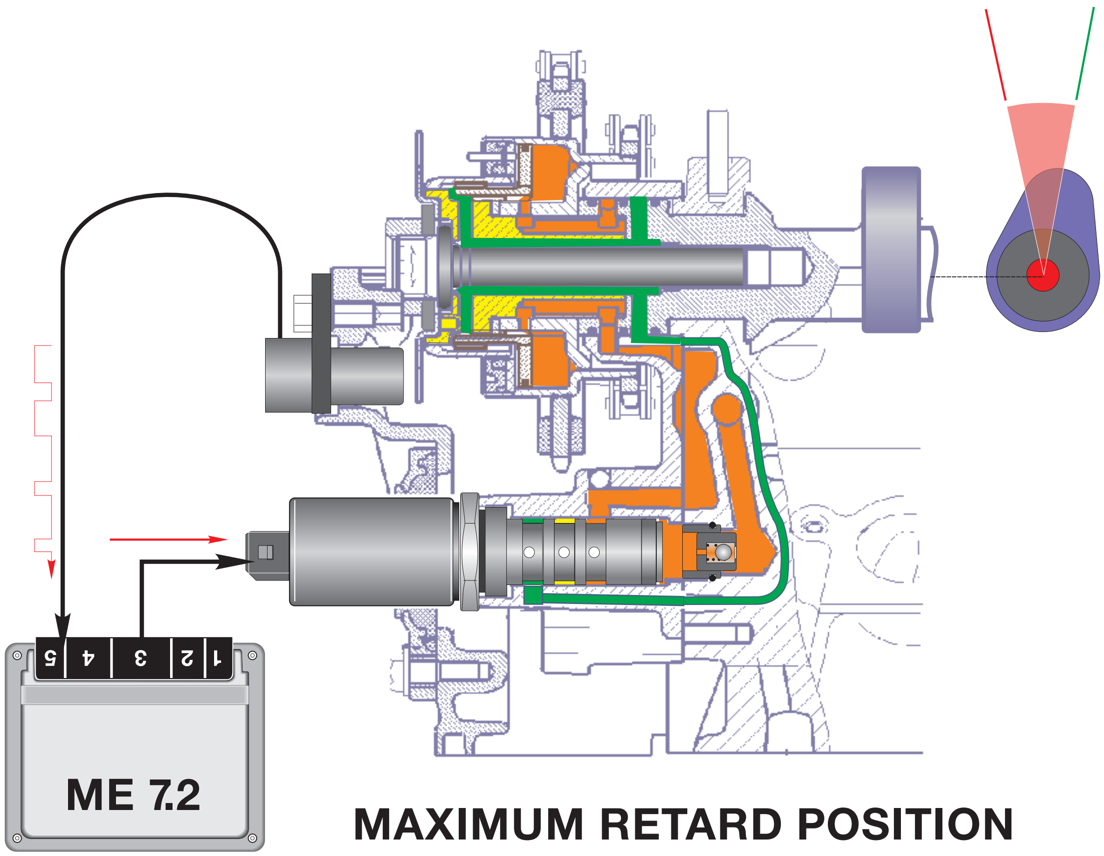
Each camshaft has ***REVERSE*** threaded bores in their centers for the attachment of the timing chain sprockets on the exhaust cams and the VANOS transmissions for each intake camshaft as shown.

CAMSHAFT POSITION IMPULSE WHEELS: The camshaft position impulse wheels provide camshaft position status to the engine control module via the camshaft position sensors. The asymmetrical placement of the sensor wheel pulse plates provides the engine control module with cylinder specific position ID in conjunction with crankshaft position.

M62 TU VANOS CONTROL

As the engine camshafts are rotated by the primary and secondary timing chains, the ME7.2 control module activates the VANOS solenoids via a PWM (pulse width modulated) ground signal based on a program map. The program is influenced by engine speed, load, and engine temperature.

- **Shown below:** In its inactive or default position, the valves direct 100% engine oil pressure flow to achieve max “retard” VANOS positioning



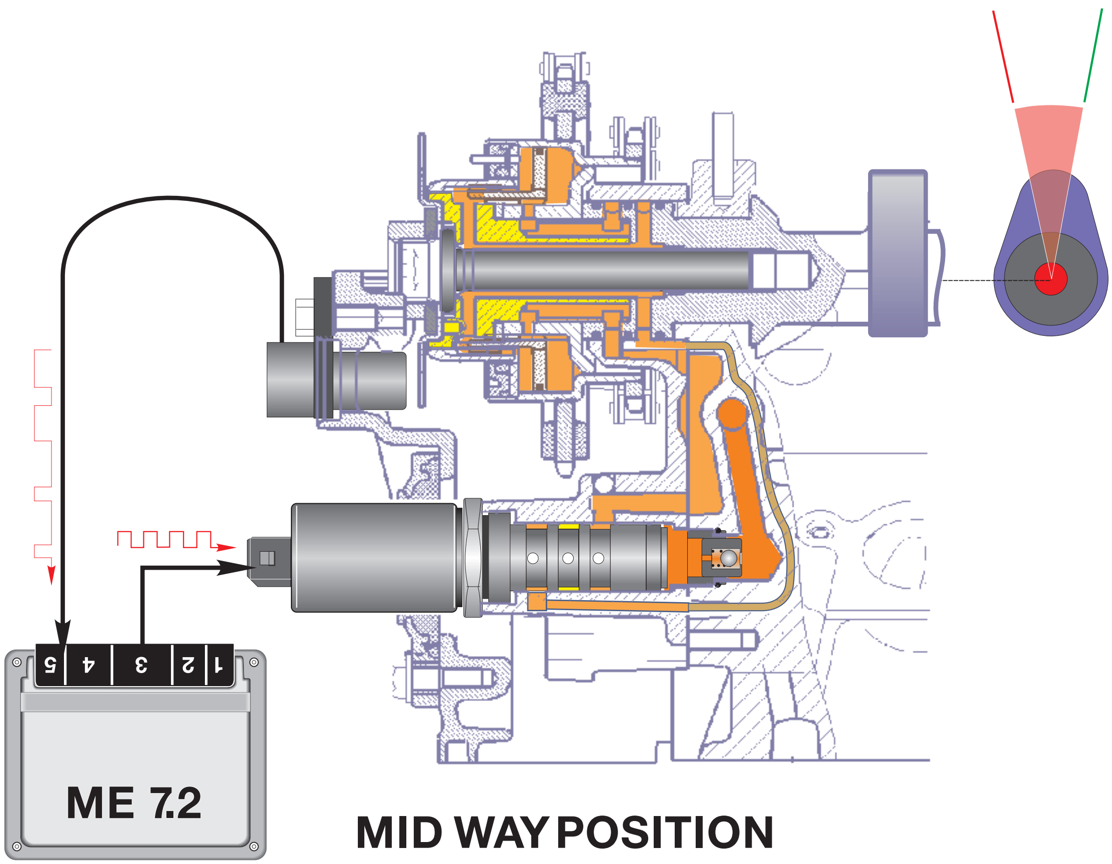
MAXIMUM RETARD POSITION

- **Top of next page**: As the Pulse Width Modulation (PWM) increases on the control signal, the valve progressively opens the advance oil port and proportionately closes the retarded oil port.

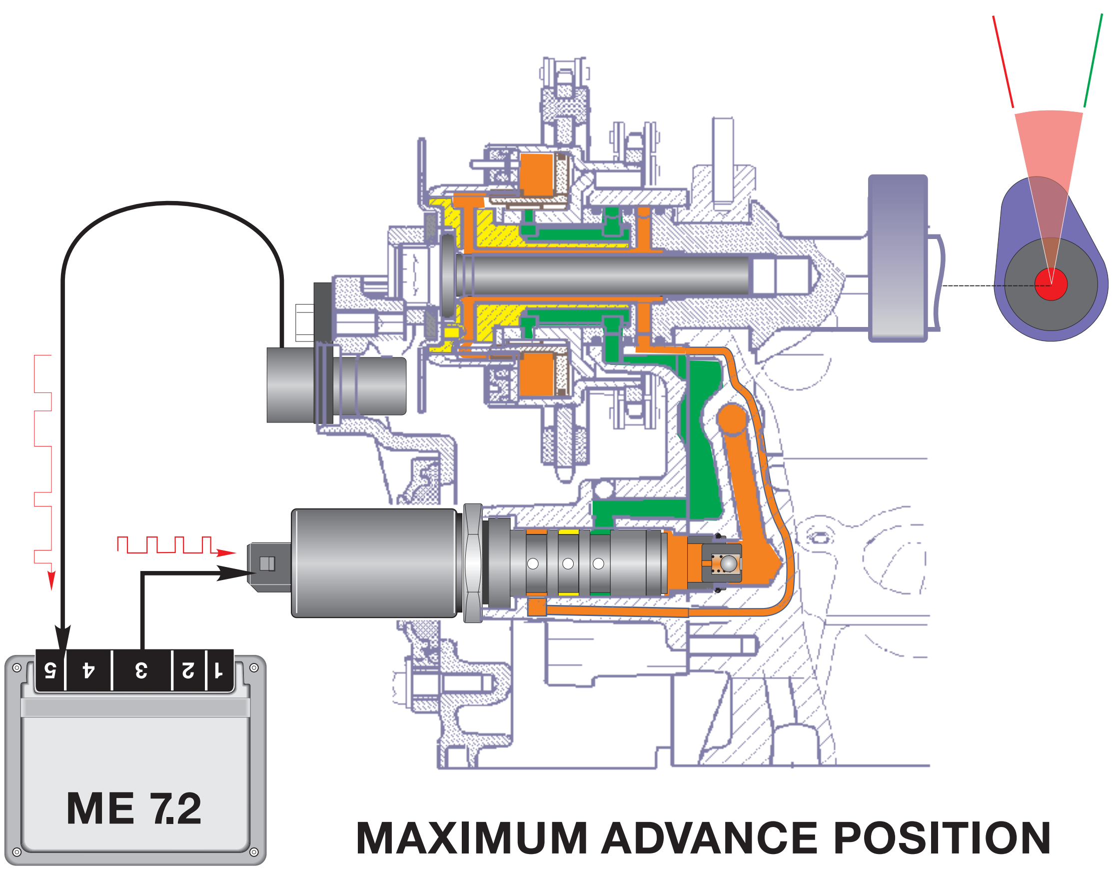
  Oil pressure pushes the piston toward the advance position. Simultaneously the oil pressure on the retarded side (rear) of the piston is decreased and directed to the vent port in the solenoid valve and drains into the cylinder head.

- **Bottom of next page:** At maximum PWM control, 100% oil flow is directed to the front surface of the piston pushing it rearward to maximum advance.

Varying the pulse width (on time) of the solenoids control signals proportionately regulates the oil pressures on each side of the pistons to achieve the desired VANOS advance angle.



MID WAY POSITION



MAXIMUM ADVANCE POSITION

VANOS SERVICE NOTES

VALVE TIMING PROCEDURES

Refer to TIS for complete Valve Timing Procedures. M62 TU valve timing adjustment is similar to the previous non-VANOS M62 engine ***with the exception*** of setting the VANOS transmissions to their max retard positions with an ohmmeter and attaching the camshaft gears to each camshaft with single reverse threaded bolts.

- After locking the crankshaft at TDC, the camshaft alignment tools (P/N 90 88 6 112 440) are placed on the square blocks on the rear of the camshafts locking them in place.

- The exhaust camshaft sprockets and VANOS transmission units with timing chains are placed onto their respective camshafts.

- The exhaust camshaft sprockets and VANOS transmissions are secured to the camshafts with their respective single, reverse threaded bolt. Finger tighten only at this point. Install the chain tensioner into the timing chain case and tension the chain.

- Connect an ohmmeter across two of the three pin contacts on the front edge of one of the VANOS transmissions. Twist the inner hub of transmission to the left (counter clockwise). Make sure the ohmmeter indicates closed circuit. This verifies that the transmission in the default max retard position.

- Using an open end wrench on the camshaft to hold it in place, torque the VANOS transmission center bolt to specification.

CAMSHAFT IMPULSE WHEEL POSITION TOOLS

The camshaft impulse wheels require a special tool set to position them correctly prior to torquing the retaining nuts.

The impulse wheels are identical for each cylinder bank. The alignment hole in each wheel must align with the tool's alignment pin. Therefore the tools are different and must be used specifically for their bank.

The tool rests on the upper edge of the cylinder head and is held in place by the timing case bolts.

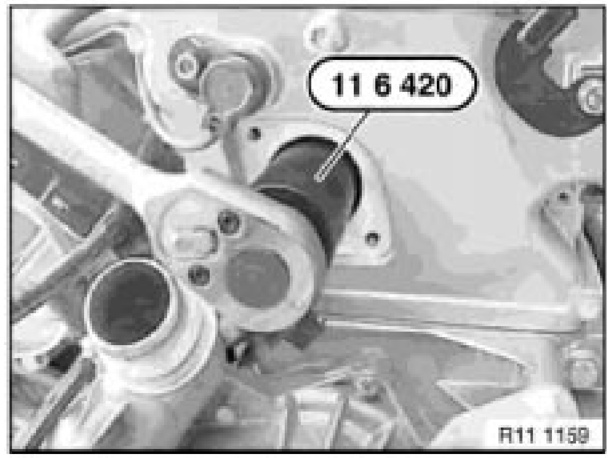
Refer to the TIS repair manual section for complete information.

VANOS SOLENOID REPLACEMENT

Refer to TIS repair manual section for complete solenoid replacement procedures.

The solenoids are threaded into the oil distribution flanges through a small opening in the upper timing case covers.

Special Tool 11 6 420 is required.

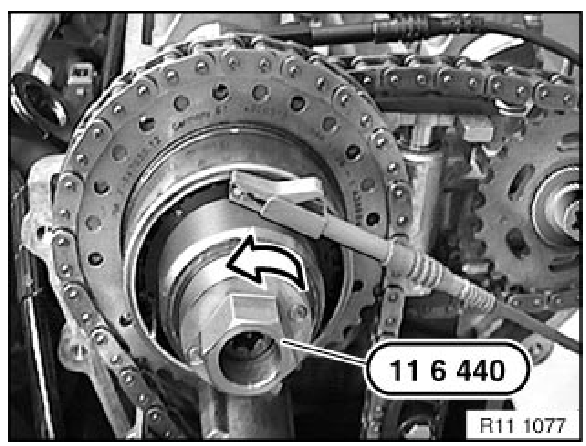


VANOS TRANSMISSION RETARD POSITION SET UP TOOLS

Special Tool 11 6 440 is used to rotate the transmission to the full retard position when checking the piston position with an ohmmeter.

This tool engages the inner hub of the transmission provides an easy method of twisting it to the left for the ohmmeter test.

Refer to SI Bulletin 04 12 98 for additional special tool information.



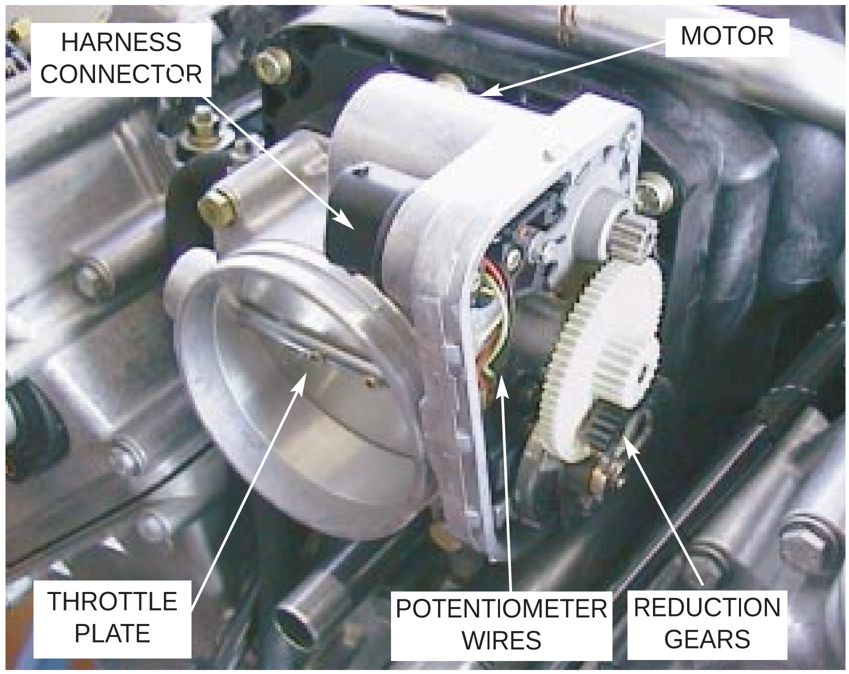
DIAGNOSIS

The VANOS is fully compatible with the diagnostic software providing specific fault codes and test modules. Additionally, diagnostic requests section provides status of the PWM of the VANOS solenoids and camshaft position feedback via the camshaft position sensors. The Service Functions section of the DIS/MoDiC also provides a VANOS system test.

ENGINE PERIPHERAL COMPONENTS/SYSTEMS

ELECTRIC THROTTLE VALVE ACTUATOR

The throttle valve assembly of the M62 TU is an electric throttle valve (EDK) controlled by an integral EML function of the ME 7.2. The throttle plate is positioned by a gear reduction DC motor drive.



Similar to the original Bosch EML 1.2 and 1.7 systems, the motor is controlled by pulse width modulated control signals providing precise plate positioning. The PWM signal is at a basic frequency of 2000 Hz.

The throttle plate position is monitored by two integrated potentiometers which provide DC voltage feedback signals to the ME 7.2.

Engine idle speed control is a function of the EDK. Therefore, the M62 TU does not require a separate idle control valve. This ME 7.2 controlled sub-system is described in the Electric Throttle System Functional Description (page 32) and in the ME 7.2 Input/Output signal sections further on.

HIGH PERFORMANCE PLATINUM SPARK PLUGS (NGK BKR6EQUP)

The high performance, quad electrode spark plugs introduced with the M52 TU are also used on the M62 TU and M73 TU engines. **Their replacement interval is 100,000 miles.**

The platinum plated center electrode with quad ground electrode design provides consistent operation throughout the entire service life of the plug. The plugs also improve cold start performance and improve idle quality.

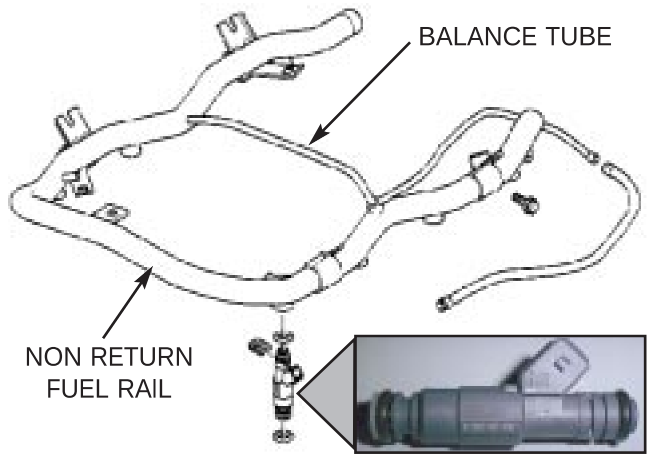
Additionally, the High performance platinum spark plugs are approved for use in M42, M44, M50, M52, M60, M62 and M70 engines. ***Refer to SI Bulletin 12 01 99*** for additional information and an updated spark plug application chart for all BMW vehicles.

FUEL INJECTORS

The M62 TU utilizes new fuel injectors manufactured by Bosch. The injector pintle consists of a two ball seat.

The ball seat design provides a tight seal when the injector is closed preventing HC formation in the intake.

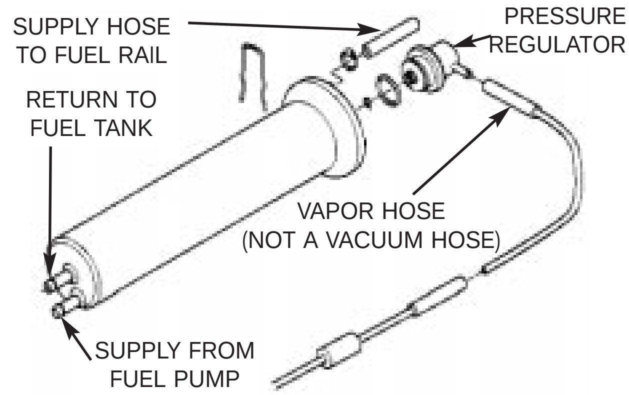
The injectors have an ohmic value of 15.5 ohms.



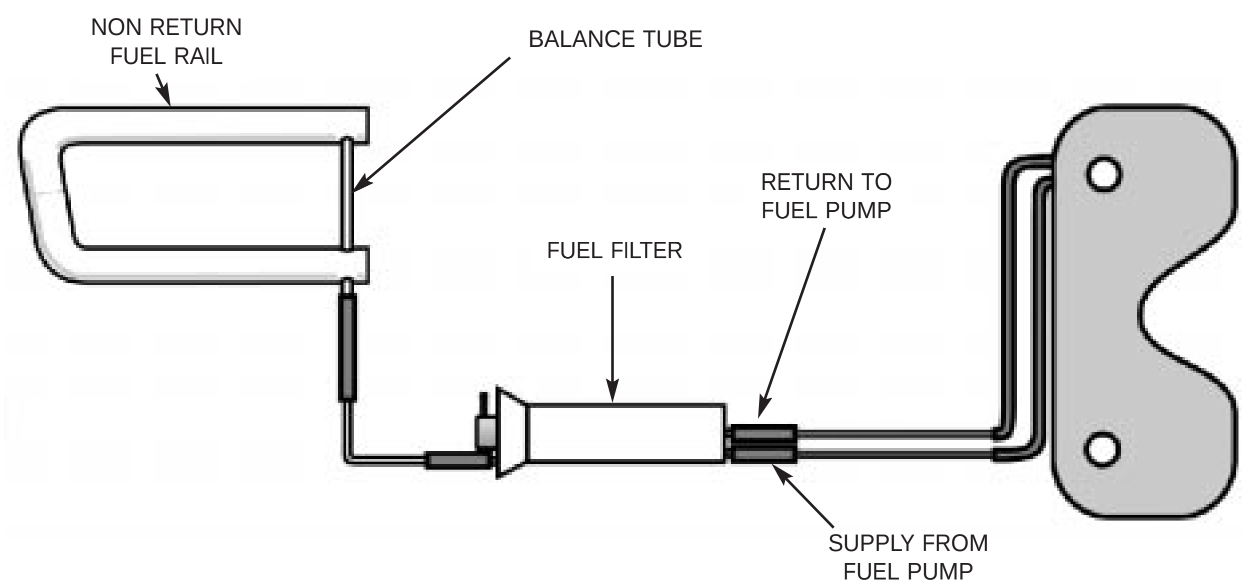
NON RETURN FUEL RAIL SYSTEM

The M62 TU introduces a new method of meeting Running Loss Compliance without the use of the familiar 3/2 way running loss valve.

The regulated fuel supply is controlled by the fuel pressure regulator integrated in the fuel filter. A fuel return line is located on the fuel filter.



The system provides even fuel distribution to all fuel injectors due to a balance tube connecting the feed with the end of the fuel rail. The new fuel rail does not have a fuel return line.

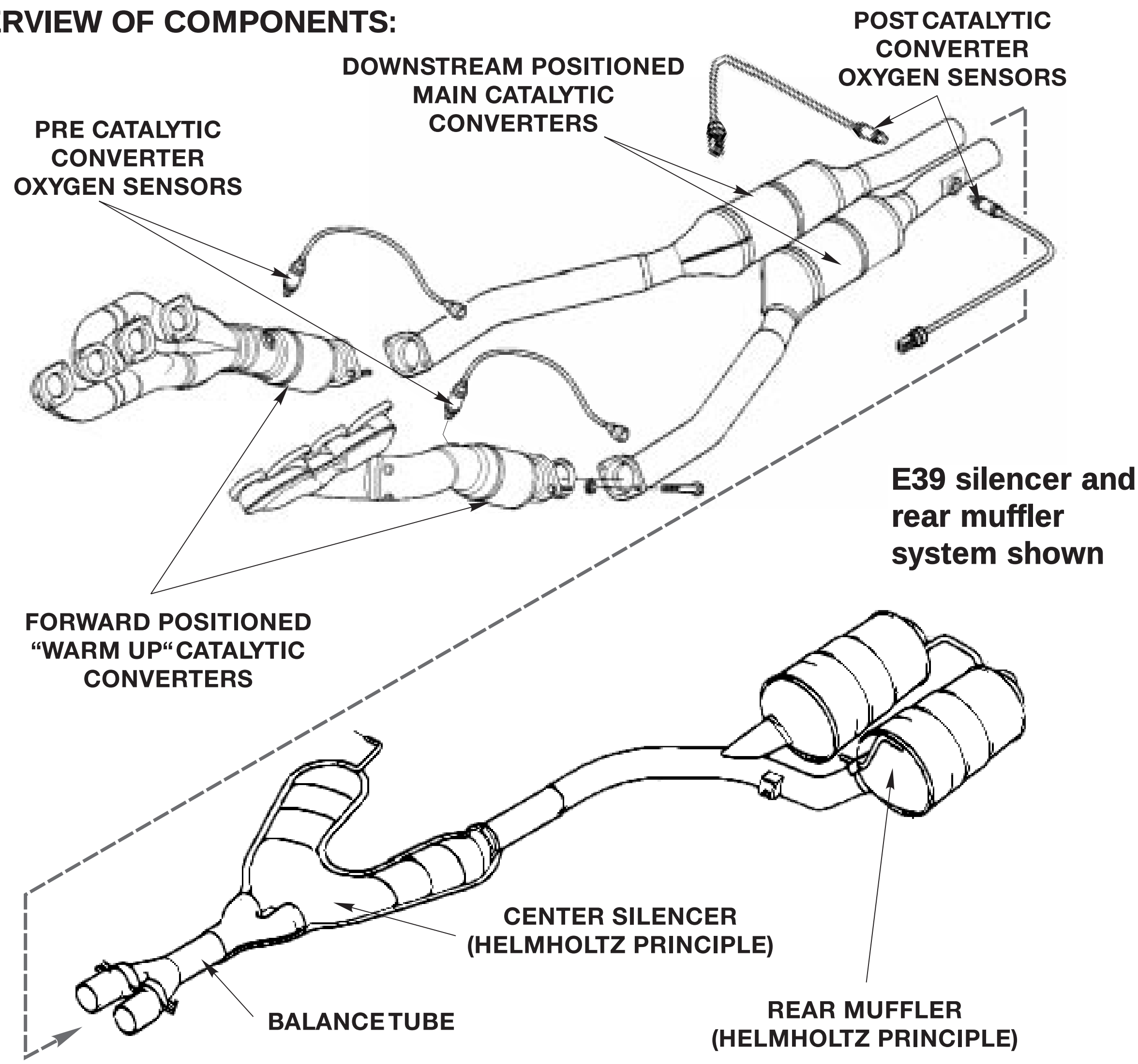


M62 TU EXHAUST SYSTEM

The M62 TU is equipped with two additional catalytic converters known as “warm-up converters”. This configuration positions the forward mounted warm-up catalytic converters closer to the hot exhaust gasses immediately exiting the combustion chambers. The closer location heats the catalytic converters to the point of light-off faster than previous systems. Earlier light-off reduces cold start emissions by allowing the gas conversion (HC to H_2O, CO to CO_2 and NOx by reduction to N_2 and O_2) to occur more rapidly just after cold start.

The system also contains two main catalytic converters. The main exhaust gas conversion process occurs further downstream in the main catalytic converters.

OVERVIEW OF COMPONENTS:

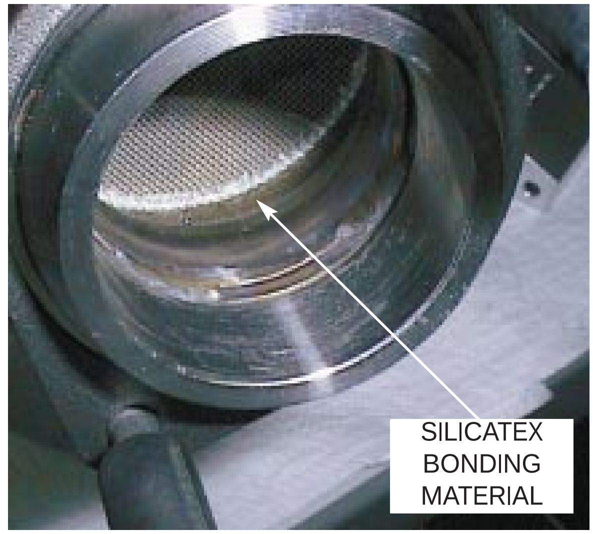


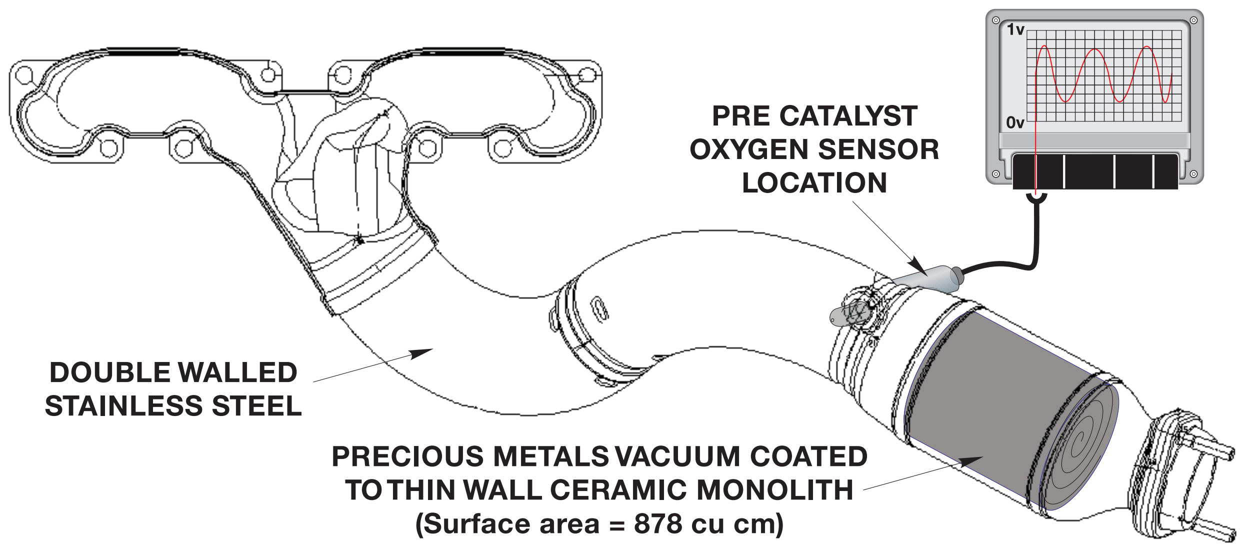
Hermann Ludwig Ferdinand von Helmholtz (died 1894). Professor of physics who studied the velocity of air in open tubes. The design of the twin chamber exhaust system mufflers and silencers used on BMW vehicles are the direct result of his studies.

The forward mounted warm-up catalytic converters are made of thin-wall ceramics. They are mounted in a pliable material called silicatex which isolates them from vibrations ensuring a long service life.

For their relatively small size, the catalyst volume of 878 cm^3 provides a large conversion surface area. Use of the thin-wall ceramic design also minimizes exhaust back pressure.

Both pre-catalytic converter oxygen sensors are positioned forward of each warm-up catalyst.





The Bosch LSH 25 oxygen sensors are carried over from the M62 engine and provide the familiar “swinging” voltage signal (0.2 - max lean to 0.8 - max rich) representing oxygen content in the exhaust gas.

The main catalytic converters are also made of thin-wall ceramics. The post catalytic converter oxygen sensors are positioned just behind the main catalytic converters to monitor the catalytic converter function.

The pipes of the exhaust system up to the rear main catalytic converters are made from dual wall stainless steel. This design insulates exhaust noise as well as insulating the thermal energy in the hot exhaust gasses to light-off the converters as quickly as possible.