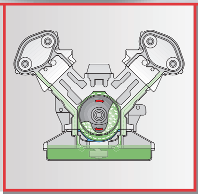
The 3.0-Liter V6 Engine

Audi Academy



Audi Academy

Self-Study Program
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Always check Technical Bulletins and the Audi Worldwide Repair Information System for information that may supersede any information included in this booklet.

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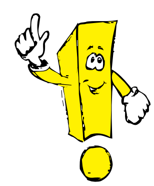
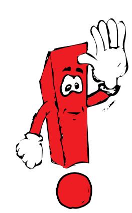
New !



Important/Note!



The Self-Study Program provides you with information regarding designs and functions.

The Self-Study Program is not a Repair Manual.

For maintenance and repair work, always refer to the current technical literature.

The New Audi 3.0-Liter V6 Engine

Audi introduces another top-of-the-line engine with the launch of the 3.0L V6. This new engine design offers high performance without sacrificing exhaust emissions quality or fuel economy.

3.0L V6 Features and Innovations

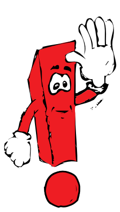
- **Aluminum cylinder block** manufactured using the patented Cosworth rollover casting process — a technique used for the manufacture of race car engines.
- **Light-weight smooth-skirt pistons** are designed to reduce oscillating mass.
- **Plastic two-position variable intake manifold** reduces engine mass and provides ample torque over a broad engine speed range with maximum power available at high rpm.
- **Dual overhead camshafts with continuously variable intake camshaft adjustment and two-position exhaust camshaft adjustment** boost power output and torque, and ensure compliance with exhaust emissions standards.
- **Five-valve-per-cylinder technology** ensures optimum flow of the fuel-air mixture and exhaust gases to keep fuel consumption and exhaust emissions low.
- **Balancer shaft** is integrated with the oil pump into a single module located underneath the engine block in the sump, and provides for exceptional running smoothness.
- **Motronic ME 7.1.1 engine management system with "drive by wire" electronic throttle control** for immediate response to driver input: accelerator pedal movement is transmitted to the engine management system instantly and without loss.
- **Mapped-characteristic ignition and solid-state high-tension distribution** are exceptionally reliable and improve fuel mixture combustion.
- **Tubular air-gap-insulated exhaust manifolds** lower weight, improve the noise pattern, quickly heat the catalytic converters to light-off temperature, and reduce heat transfer to the engine compartment.
- **Cylinder-bank-selective oxygen sensing, with two pre-converters close to the engine and two main catalytic converters farther back** ensure long-term stability in exhaust emissions values and optimum back pressure in the exhaust.
- **Ultra-low emissions vehicle (ULEV) certification** confirms the Audi commitment to the environment.

The new Audi 3.0L V6 is not only powerful and responsive, it is one of the most modern engines available in a production automobile.

SSP255/100

The Technical Data

- **Engine code**
  AVK
- **Type**
  90-degree V6 with dual overhead camshafts and five valves per cylinder
- **Displacement**
  182 cu in (2976 cm^3)
- **Bore**
  3.25 in (82.5 mm)
- **Stroke**
  3.65 in (92.8 mm)
- **Compression ratio**
  10.5 : 1
- **Maximum power output**
  220 bhp (162 kW) @ 6300 rpm
- **Maximum torque**
  221 lbs-ft (300 Nm) @ 3200 rpm
- **Weight**
  364 lbs (165 kg)
- **Engine management**
  Motronic ME 7.1.1
- **Firing sequence**
  1-4-3-6-2-5
- **Fuel type recommendation**
  Premium unleaded gasoline (91 AKI)



The specified power data is only possible if 91 AKI fuel is used. A reduction in power output must be expected if lower grade fuel is used.

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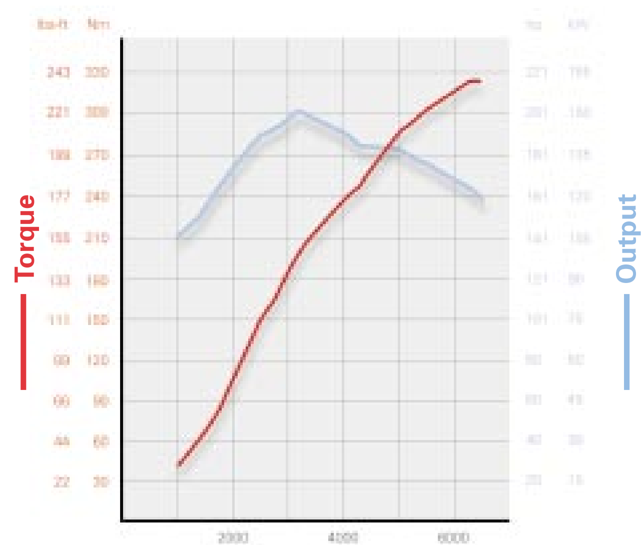

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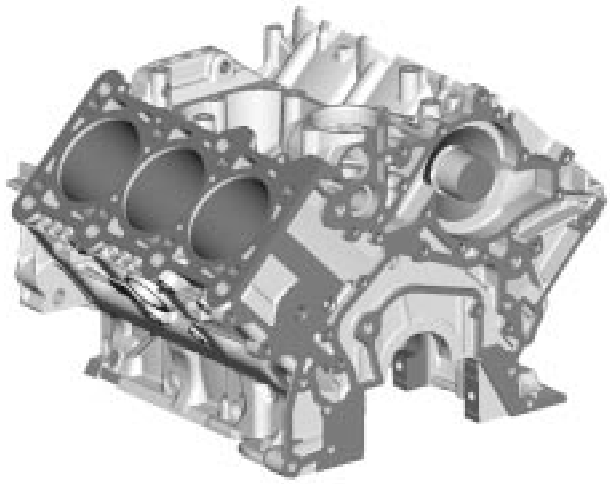

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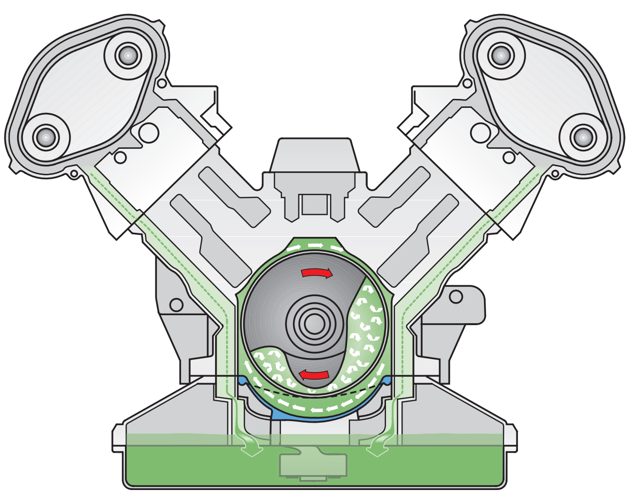
Crankcase

Experience with the development of an aluminum block for the Audi V8 lead to the development of an aluminum block for the 3.0L V6 application. These castings offer the best characteristics of rigidity, durability, and oil supply distribution. Using aluminum for the crankcase with cast iron cylinder liners, we have achieved a lower engine mass, more power output, and higher engine speeds.

The aluminum block is cast using the Cosworth rollover casting process. This patented process yields a fine-pore structure capable of withstanding severe loads and makes it suitable for use in race car engines.

This casting process has the following special features:

- The molten aluminum alloy is taken from the center of the foundry crucible without turbulence to minimize the introduction of impurities into the casting.
- A low-pressure feed pump that forces the molten metal into the core assembly controls mold filling and solidification of the metal.
- The entire core assembly is rotated during the casting process to prevent voids and cold flow, even within the thin land areas between the cast iron cylinder liners.



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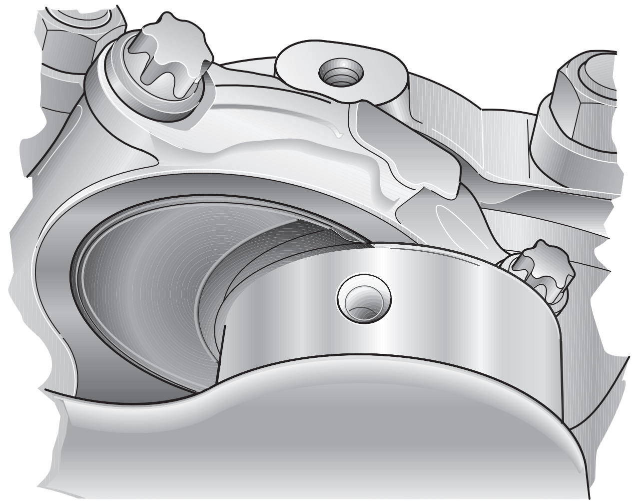
The return passages that carry the engine oil back from the cylinder heads to the sump are precast into the sides of the engine block. Together with the design of the sump and a special insert, the oil is routed to a point below the dynamic oil level. This prevents gases from entering the engine oil through the crank mechanism and significantly reduces the amount of air in the circulating oil.

Crankshaft

The crankshaft is mounted on four bearings with split cranks (30 degrees offset), allowing a uniform firing order of 120 degrees.

Lightweight smooth shaft pistons with a curved box form and closely spaced piston pin bearings have been adapted to the trapezoidal connecting rods.

The piston pins are short and have a small diameter, allowing a reduction in the weight of the oscillating masses.



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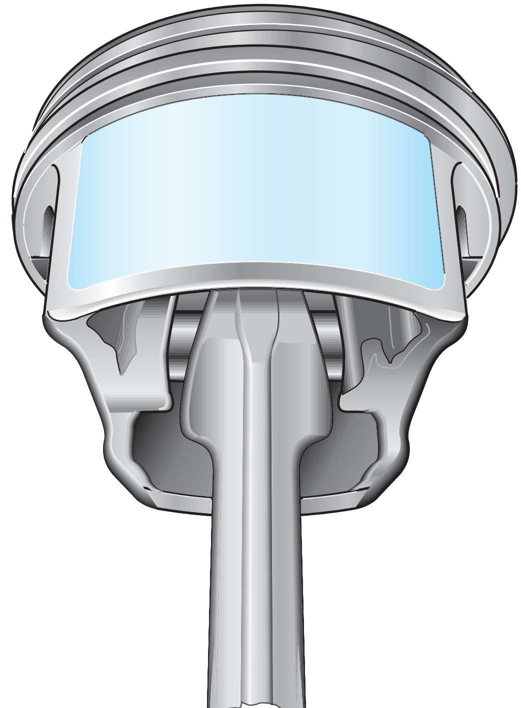
The pistons are cooled by oil spray nozzles in the crankcase. The piston skirts have a durable ferroprint running surface which is produced by a screen printing process.



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Balancer Shaft

Although it is possible to eliminate the free inertial forces in the V6 engines with a cylinder angle of 90 degrees, the first-degree free moments of inertia cannot be completely eliminated without additional measures.

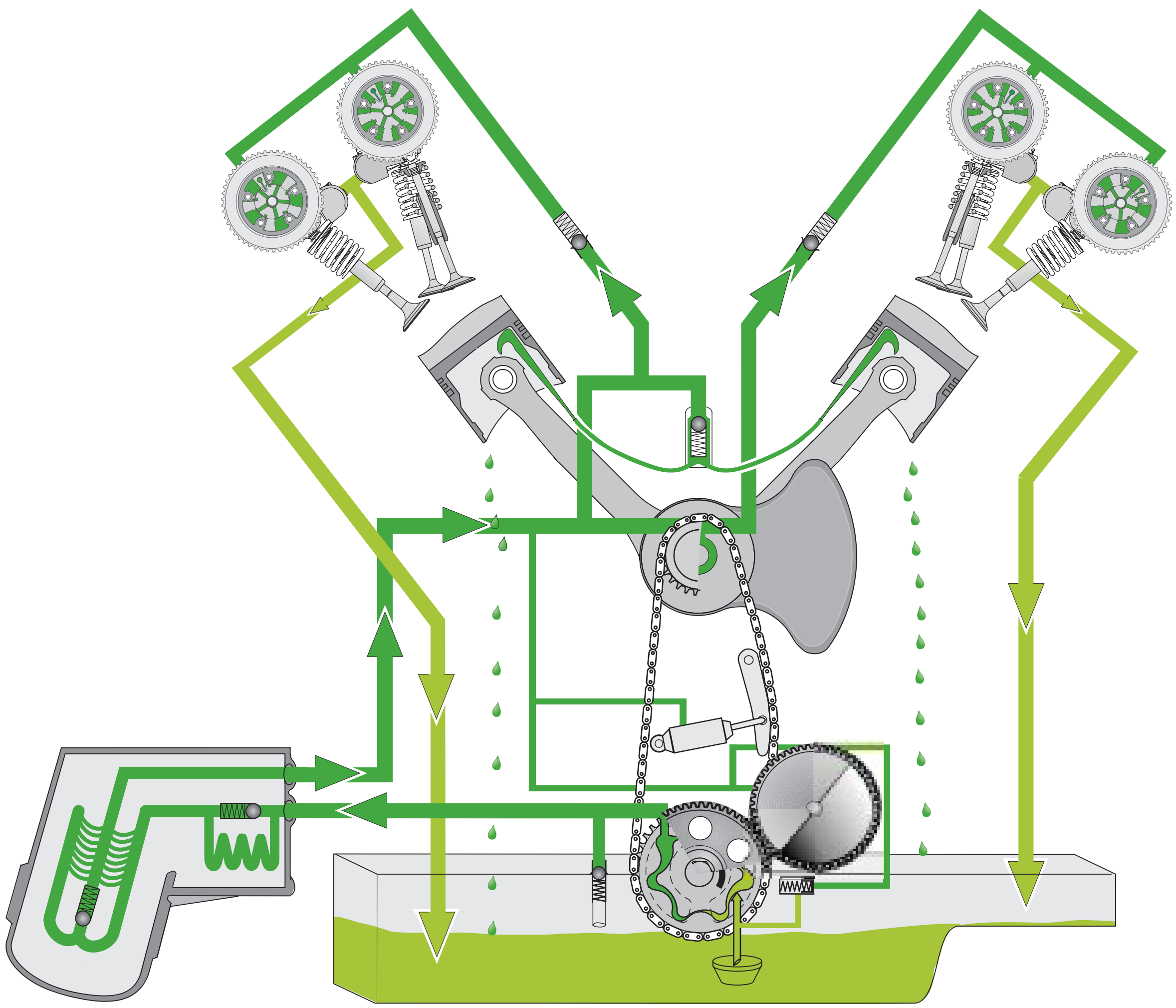
In order to further reduce vibration and keep up with growing comfort requirements, a balancer shaft has been installed below the crankcase.

The oil pump and the balancer shaft are combined into one aluminum module. The shaft is positioned on plain bearing shells and is supplied with oil from the rear fixed bearing. The front free bearing is lubricated by a bore in the shaft.

SSP255/016

A roller chain from the crankshaft drives the oil pump shaft. The gear driving the balancer shaft is mounted in front of the sprocket, and meshes with the gear on the balancer shaft with a power transmission ratio of 1:1. This means that the balancer shaft runs counter to the direction in which the crankshaft rotates. The “first-degree” reversal of direction necessary to compensate for the moment of inertia is accomplished by the spur pinion.

Oil Circuit



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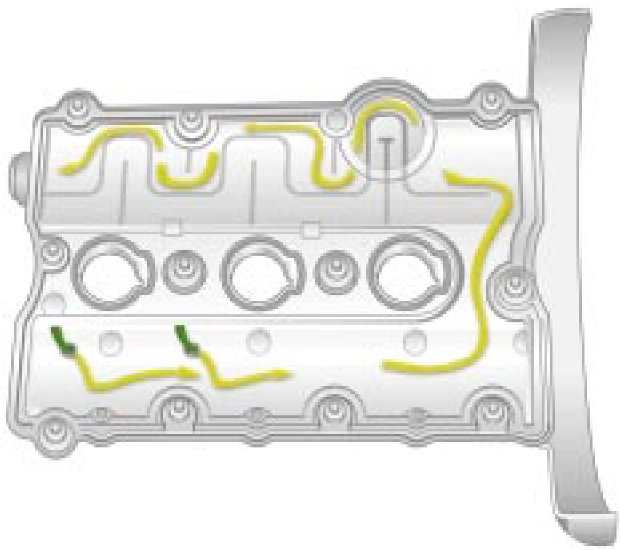
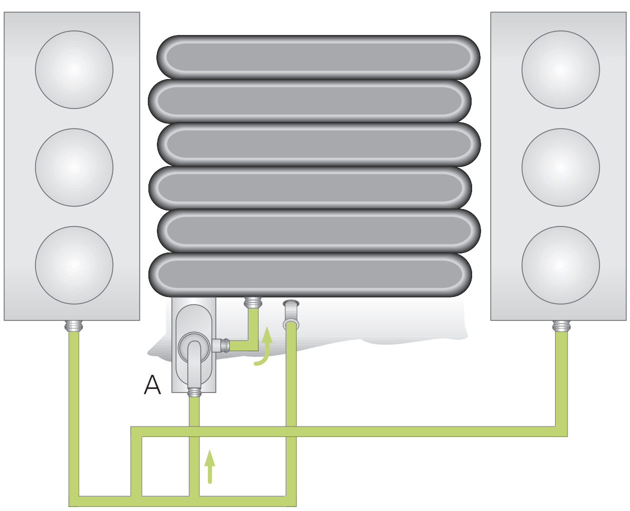


SSP254/027

Crankcase Breather

Similar to other current Audi V6 engines, the 3.0L V6 engine is ventilated from the V-chamber cover and the two cylinder head covers via the integrated labyrinth cut-off.

The blow-by gases are introduced directly into the intake manifold downstream of the throttle valve for combustion.



A Diaphragm Valve Controlled by Differential Pressure

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A diaphragm valve controlled by differential pressure regulates the required vacuum level for the crankcase.

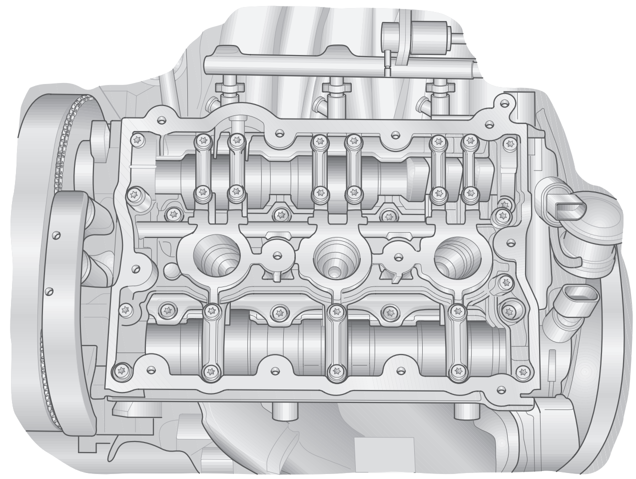
Cylinder Heads

The separate camshaft bearing caps used on previous V6 engine cylinder heads have been replaced by one-piece die-cast aluminum ladder bearing frames to reduce the number of components and to improve rigidity and acoustic characteristics. The ladder bearing frames are machined at the ends and in the bearing slots after their assembly with the cylinder heads. This results in flat axial sealing surfaces between the cylinder head covers, the ladder bearing frames, and their attached modular housings.

The cylinder heads have tumble intake ducts (bi-turbo) in order to achieve a high internal exhaust gas recirculation rate, even at low rpm and load ranges.

The cylinder head covers are rigid assemblies with welded partitions. These partitions cover the large breather chambers and include integrated labyrinth separators that act as oil separators for the crankcase breather blow-by gases. This reduces the amount of oil contained in the recirculated exhaust gases.

The pressurized oil supply needed by the continuous camshaft adjusters is routed through the ends of the ladder bearing frames to oil supply housings bolted to the front faces of the cylinder heads.



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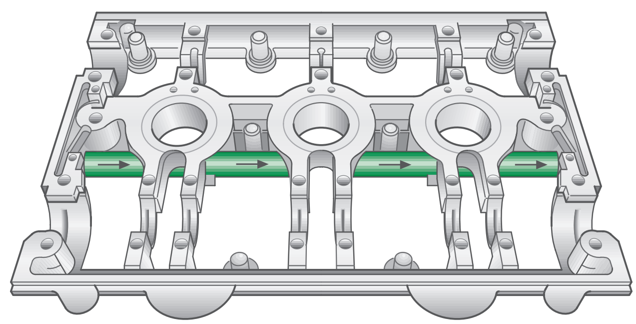

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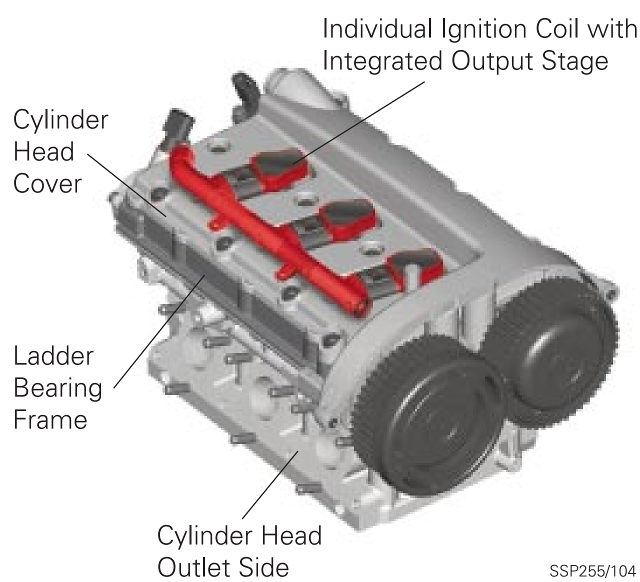

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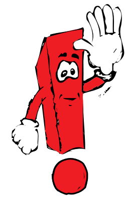
Camshaft Toothed Belt Drive

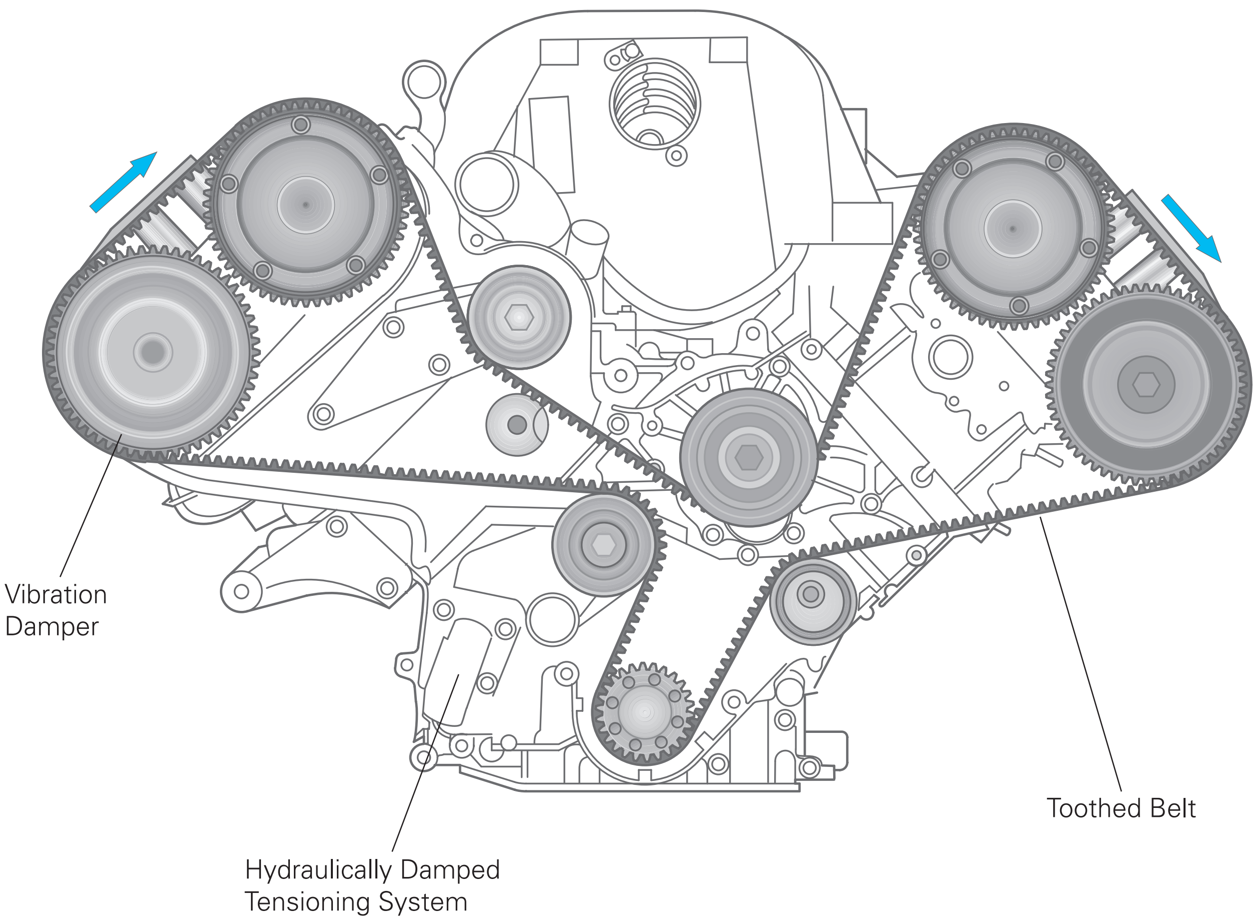
The drive of the intake and the exhaust camshafts with four camshaft adjusters required a hydraulically damped toothed belt tensioning system. This was developed together with a vibration damper on the exhaust camshaft of the right cylinder bank and a state-of-the-art toothed belt.

This design reduces wear and increases component service life.



The toothed belt is installed using several special tools.

- T40026 Crankshaft fixing screw
- 3299/1 Clawed clamping element (V-ribbed belt)
- T40030 Camshaft setting gauge
- T40028 Camshaft adjuster socket insert



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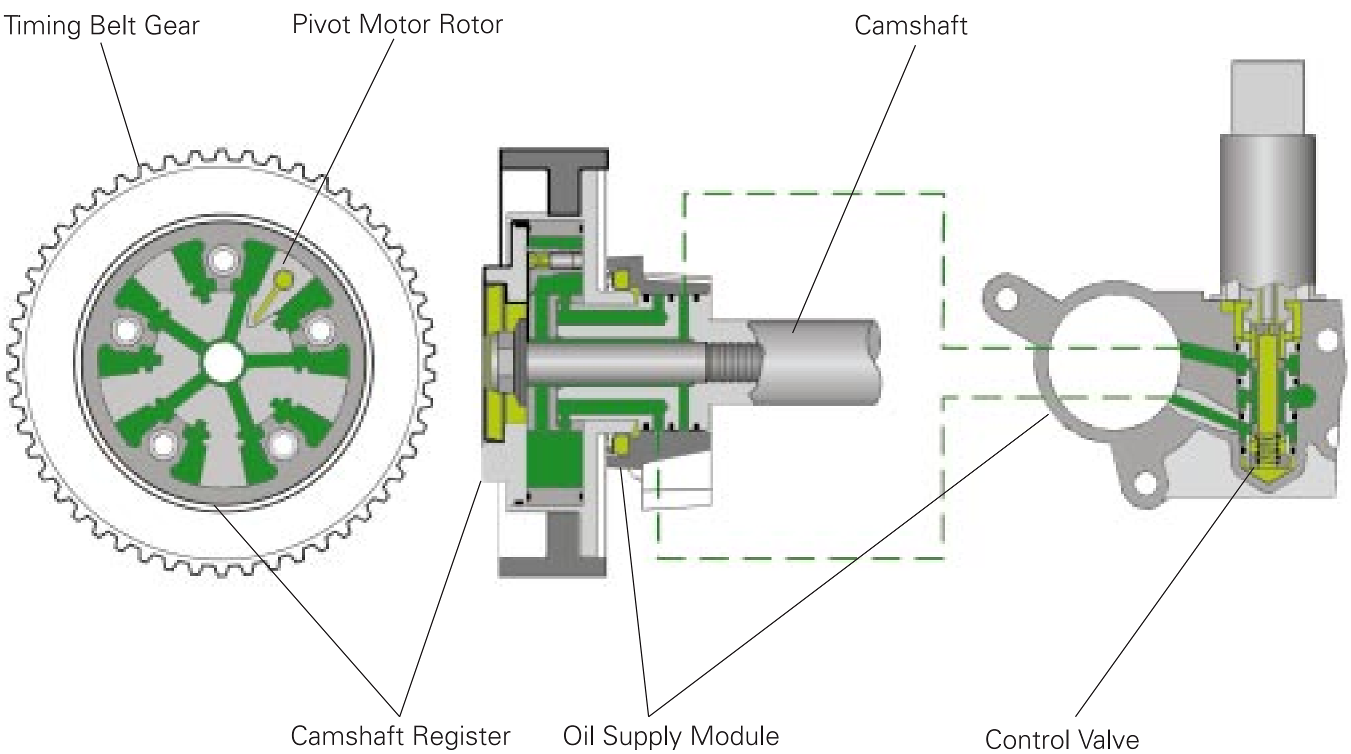
Continuous Camshaft Adjustment

The new ladder bearing frames in the cylinder heads provide a constant supply of pressurized oil to the oil supply modules at the front of the heads. This steady supply of oil is needed to operate the oil-actuated camshaft adjusters. All four camshafts are driven by the hydraulically-damped toothed belt.

Thermodynamic studies determined the optimum camshaft adjustment ranges to be up to 42 degrees of crankshaft angle on the intake side and 22 degrees of crankshaft angle on the exhaust side.

The adjustments are made by four pivot motors, one for each camshaft. Each pivot motor is actuated by an electrically controlled pulse-width-modulated control valve (housed in either Valve 1 for Camshaft Adjustment N205 for cylinder bank one, or Valve 2 for Camshaft Adjustment N208 for bank two). The adjustment on the intake camshafts is continuous over the entire 42 degree range. The adjustment on the exhaust camshafts is essentially "on" or "off" to advance exhaust camshaft timing the specified 22 degrees or return it to normal.

The maximum valve overlap is set at 1900 rpm, to keep engine torque as high as possible.



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Oil Supply Module

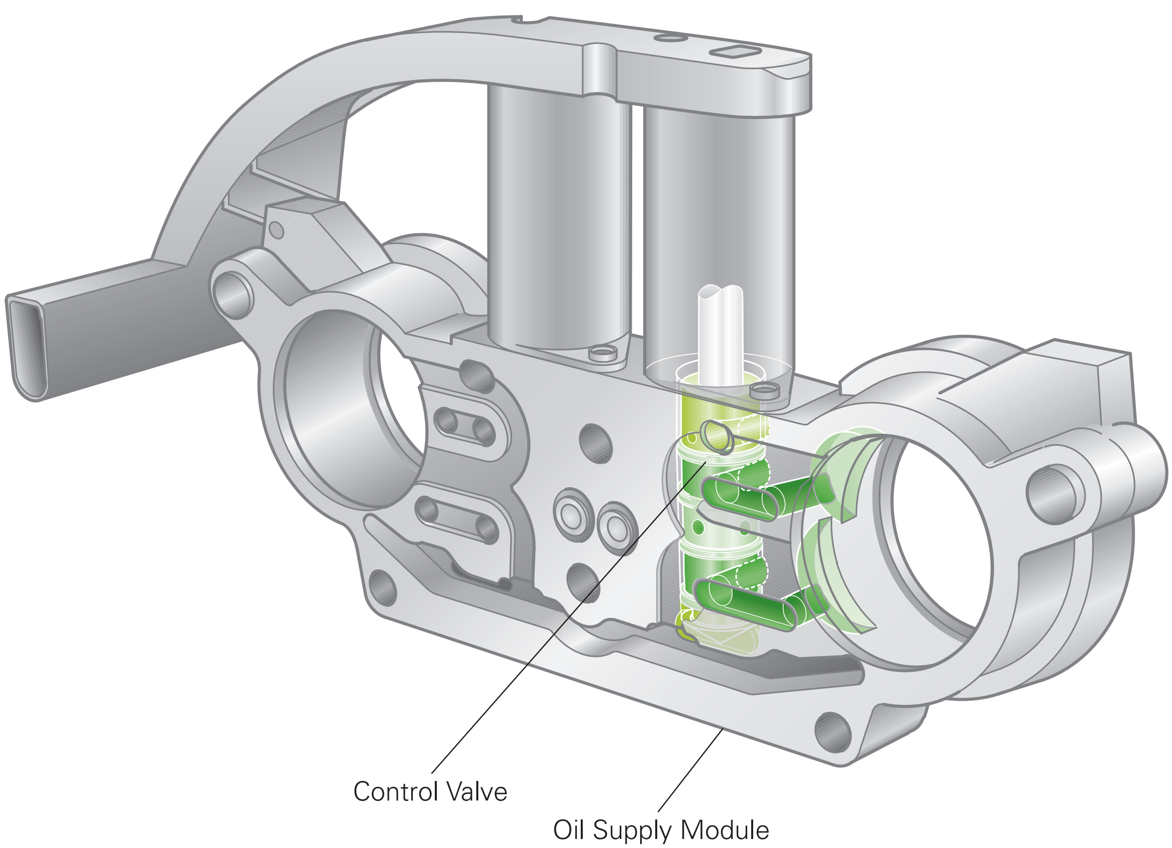
The oil supply modules are located at the front of the cylinder heads. They are fed pressurized oil through the new cylinder head ladder bearing frames. Using an oil circuit duct, the oil needed for hydraulic adjustment is fed through each camshaft to its adjuster.

The interior rotor of each pivot motor is connected to its camshaft. The stator of each pivot motor is connected to its timing belt gear.

The adjustment of the camshaft angles relative to the crankshaft angle is achieved by filling the chamber between the rotor and the stator of each pivot motor with oil.

Valve 1 for Camshaft Adjustment N205 for cylinder bank one and Valve 2 for Camshaft Adjustment N208 for bank two control the flow of oil to the pivot motors.

They are regulated by the Motronic Engine Control Module J220 to move the intake camshafts to each position from 0 to 42 degrees between stops and to move the exhaust camshafts from advanced to normal timing. Regulation is based on engine speed, load, and coolant temperature.



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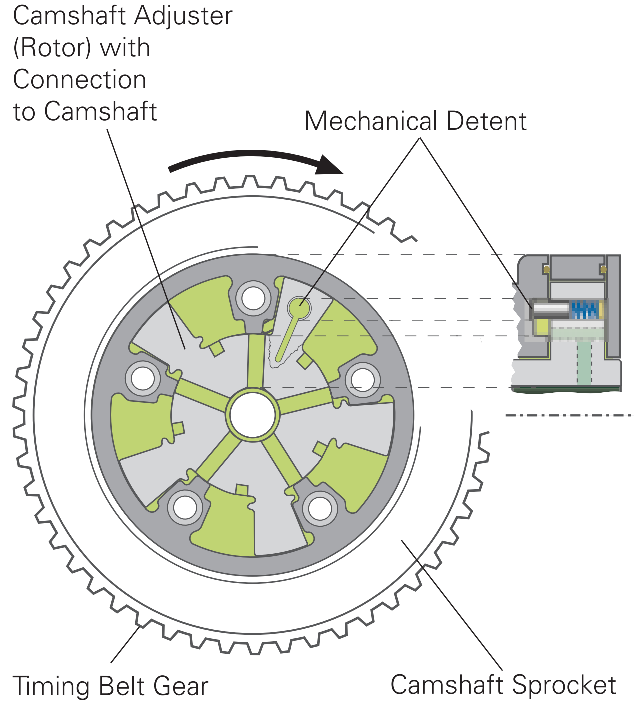
Intake Camshaft Adjustment at Engine Start (No Oil Pressure)

The adjusters are locked mechanically until the necessary engine oil pressure has built up. The control valve (part of either Valve 1 for Camshaft Adjustment N205 for cylinder bank one, or Valve 2 for Camshaft Adjustment N208 for bank two) has no control voltage applied to it by the Motronic Engine Control Module J220 at this time.

Using a mechanical detent device, a spring-loaded differential pressure pin prevents the camshaft from being adjusted during the engine start cycle.

The adjuster is designed to move to the retard position and remain locked there whenever the engine is turned off.



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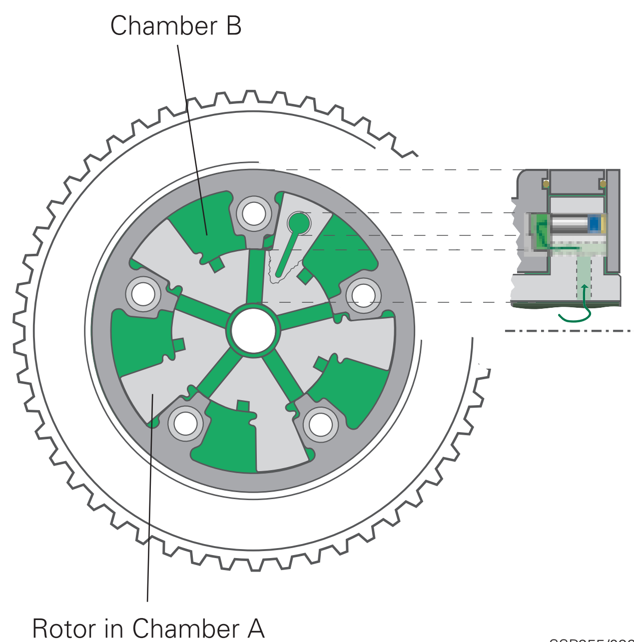
Intake Camshaft Adjustment in Retard Position (Engine Running at Idle)

The rising engine oil pressure unlocks the spring-loaded differential pressure pins.

The Motronic Engine Control Module J220 applies pulse-width-modulated control voltage minimum signals to the solenoid of the control valve (at Valve 1 for Camshaft Adjustment N205, or Valve 2 for Camshaft Adjustment N208), and the valve opens the access to chamber B and holds the rotor in chamber A.

The intake camshaft is in the retard position.

Because the exhaust camshafts are rotated to the advance position at engine idle speed, there is as little overlap as possible between intake and exhaust valve operation at this point. This results in a relatively low proportion of exhaust gases in the fuel-air mixture and a stable engine idle speed.



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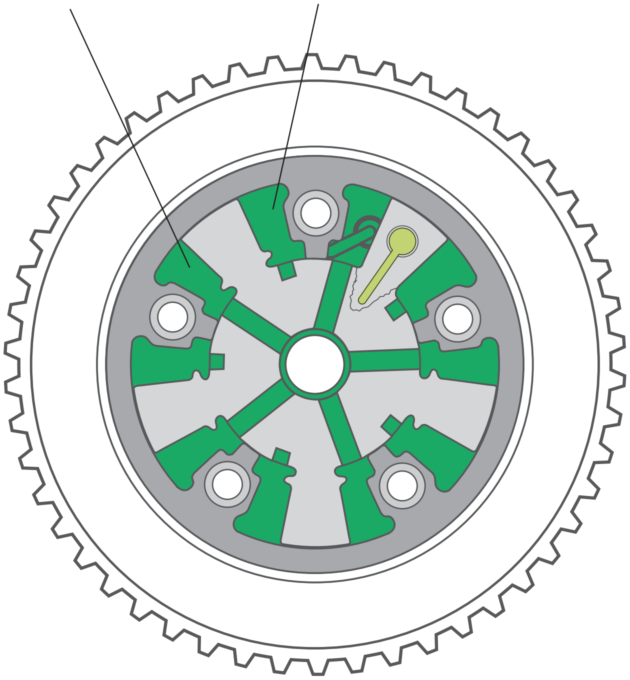

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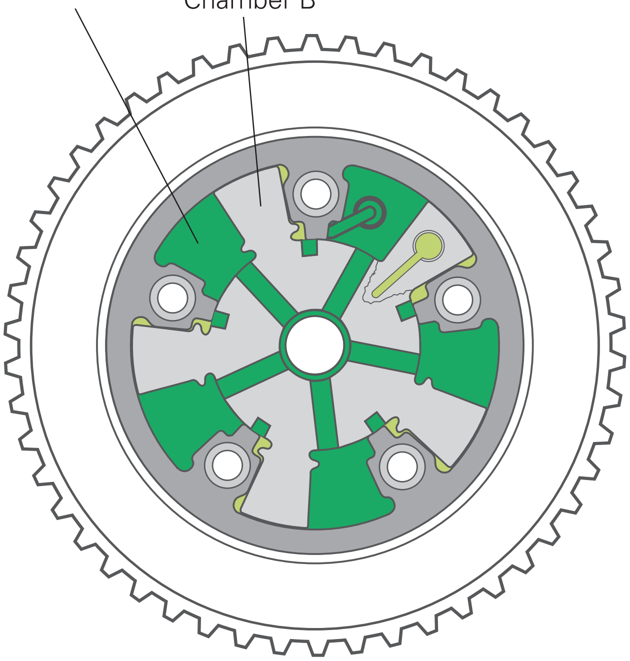

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Intake Camshaft in Control Position (Engine Speed Above Idle and Below 1900 rpm)

The Motronic Engine Control Module J220 controls the solenoid of the control valve (at Valve 1 for Camshaft Adjustment N205, or Valve 2 for Camshaft Adjustment N208) using a pulse-width-modulated signal.

The control valve piston is set so that both chamber A and chamber B are under oil pressure.

The pulse-width-modulated signal allows a continuously variable adjustment of the intake camshaft timing.

The valve opening timing for both intake and exhaust is adjusted depending on the engine speed, temperature, and working load.

Intake Camshaft in Advance Position (Engine Speed Above 1900 rpm)

At engine speeds above 1900 rpm, the Motronic Engine Control Module J220 sets the solenoid of the control valve (at Valve 1 for Camshaft Adjustment N205, or Valve 2 for Camshaft Adjustment N208) so that pressurized oil completely fills chamber A and moves the pivot motor rotors all the way into chamber B.

This places the intake camshafts in the maximum advance position.

With intake camshafts rotated to their maximum advance position and exhaust camshafts at their initial position, maximum valve timing overlap is achieved and more exhaust gases are recirculated for re-burn at the next ignition cycle.

Why Variable Valve Timing?

To achieve optimum volumetric efficiency throughout the engine's speed range, the valves must be opened and closed at precise points during the four-stroke Otto cycle. This is necessary to allow adequate time for the filling and scavenging of the cylinders. These points are not static, but change depending on engine speed and load.

The non-adjustable camshafts used in most passenger cars are designed to provide a compromise in valve opening and closing so that the engine can perform satisfactorily at all speeds. This generally results in an engine with a torque output that peaks early and declines gradually as engine speed (rpm) is increased.

Adjustable valve timing systems overcome the limitations of static valve timing by altering the points in the four-stroke cycle when the valves open and close. This allows the engine to produce higher torque throughout a wider rpm range.

During the four-stroke Otto cycle, there are four valve events. They are:

- Intake valve opens (IVO)
- Intake valve closes (IVC)
- Exhaust valve opens (EVO)
- Exhaust valve closes (EVC)

Of the four valve events, the intake valve closing (IVC) point is significant. It is this event that determines the distance into the compression stroke the piston travels before the intake valve closes. This effects the how much air/fuel mixture can enter the cylinder.

The exhaust valve opening (EVO) point is critical in determining how much of the air/fuel charge is burned during the power stroke, and the flow of exhaust from the cylinder. The longer the valve is closed, the longer the air/fuel mixture can burn. If the valve opens too late, energy is wasted pumping the exhaust from the cylinder.

The exhaust valve closing (EVC) point and intake valve opening (IVO) point are not as important as the other valve events when viewed separately. The importance of the EVC and IVO events is that together they determine the valve overlap period. This is the time that both the intake and exhaust valves are open simultaneously. This is a critical factor in scavenging exhaust gases from the cylinder and in controlling emissions.

By using adjustable intake and exhaust camshafts, it is possible to control the timing of the valve events at various engine speeds and loads. This results in strong performance and economical operation, while still meeting stringent emissions requirements.

Intake Camshaft Adjustment

When the engine is started or running at idle, the intake camshaft is adjusted to the retarded position. In this position the IVO occurs at 20° after top-dead-center (TDC). This allows no valve overlap, and results in low emissions and smooth engine running at idle.

At partial load, the intake camshaft is advanced to approximately 22° before TDC. When the intake valve timing is advanced, the IVO occurs earlier, and valve overlap is increased. With increased valve overlap time, the exhaust gases are not all scavenged from the combustion chamber.

This exhaust gas recirculation dilutes the incoming air/fuel charge, lowering combustion pressure and temperature without the need for an external EGR Valve.

Advancing the camshaft also means that the IVC occurs earlier. This is desirable at low engine speeds and partial loads to prevent the piston from pushing the air/fuel charge back into the intake manifold. This effect, known as "reversion," would severely limit low-end torque and raise emissions.

As engine load increases, the velocity of the intake air charge increases, and the IVC must occur later in order to allow the "ram effect" of the intake air to completely fill the cylinder. In addition, as engine speed (rpm) increases, the piston moves faster, and the time for the cylinder to become adequately filled becomes shorter.

Therefore, at high engine speeds and loads, the Motronic Engine Control Module J220 will vary the intake camshaft timing based on a map in the Motronic Engine Control Module J220 which takes into account load, rpm, and intake manifold change-over position.

If the camshaft adjustment fails, the intake camshaft is returned to the default position of 20° after TDC.

Exhaust Camshaft Adjustment

Unlike the intake camshaft, the exhaust valves are only adjusted to close at two points: 10° before TDC and 12° after TDC.

Early exhaust valve opening (EVO) may not allow all the power of the combustion process to be used. If the EVO occurs late, all the power of the combustion process is used, but power is wasted by pumping the exhaust gases from the cylinder. The optimum EVO varies with engine speed, and is closely related to the design of the exhaust system.

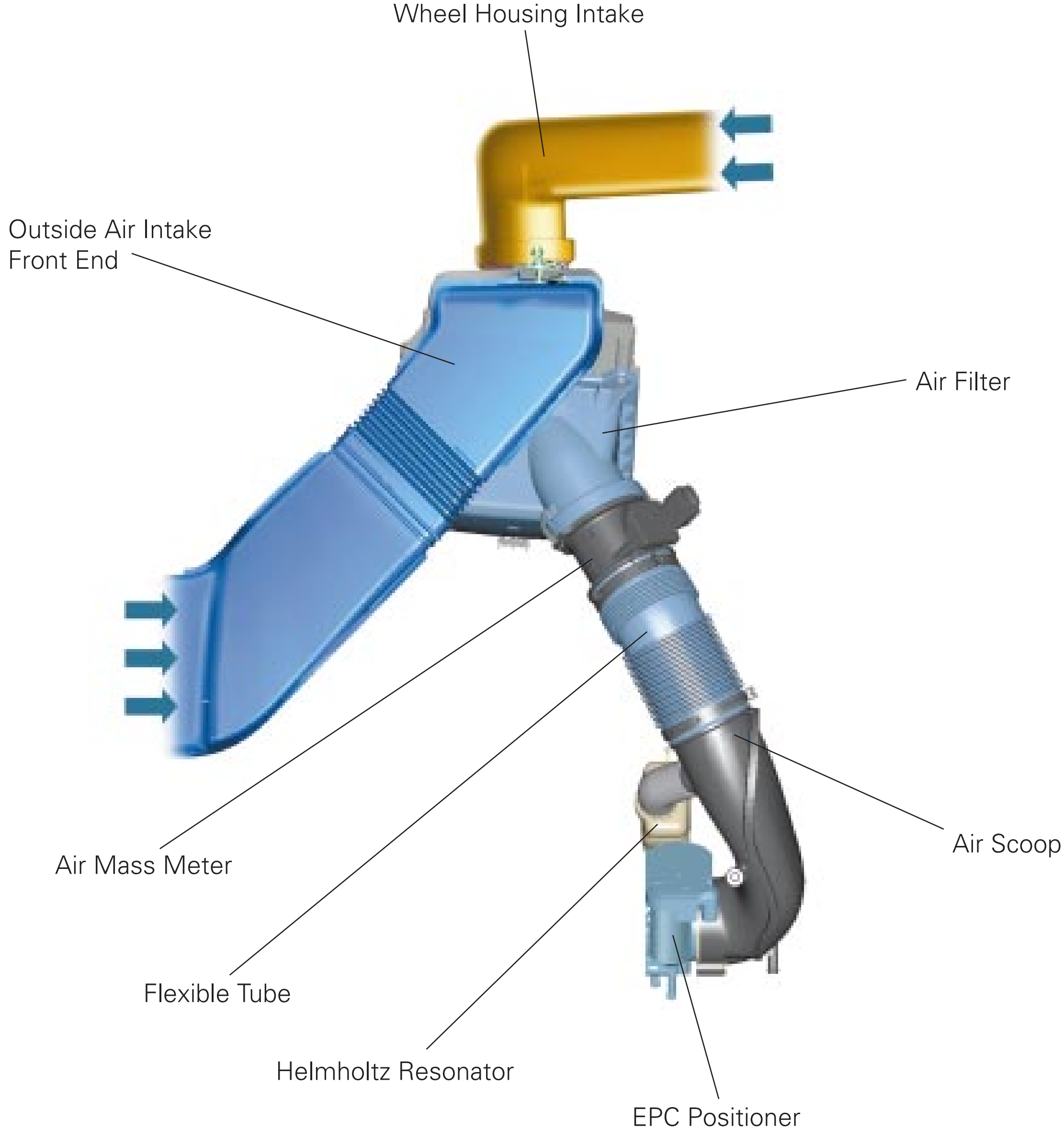
At engine speeds of less than 1900 rpm, EVC is set at the idling (advanced) position of 10° before TDC. For all other speeds, the EVC is set to 12° after TDC. This achieves good performance characteristics at full load, and a large valve overlap to reduce emissions at partial loading.

If the camshaft adjustment fails, the exhaust camshaft is returned to the default position of 12° after TDC.

Air Intake

The new 3.0L V6 air filter housing design provides a low profile to accommodate engine compartment packaging demands without sacrificing air volume. The filter area has been increased, resulting in longer intervals between changes.

To meet the increase in engine performance requirements, the primary air intake duct has been enlarged by about 50 percent. Third-order noise magnification at engine speeds between 4000 and 5000 rpm has been reduced by the addition of a Helmholtz resonator that opens directly into the most effective part of the air scoop. Modern three-dimensional flow calculation methods have resulted in the design of a low-loss air scoop shape that is virtually free of turbulence.



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Variable Intake Manifold

Increasing low-end torque using variable intake manifolds is not a new concept at Audi. A new two-stage variable intake manifold module was developed specifically for the new 3.0L V6. The one-piece plastic main body is produced by the lost-core process. The result is a compact intake manifold that meets the flow requirements of equal ram tube length and cross-section, and modern design requirements.

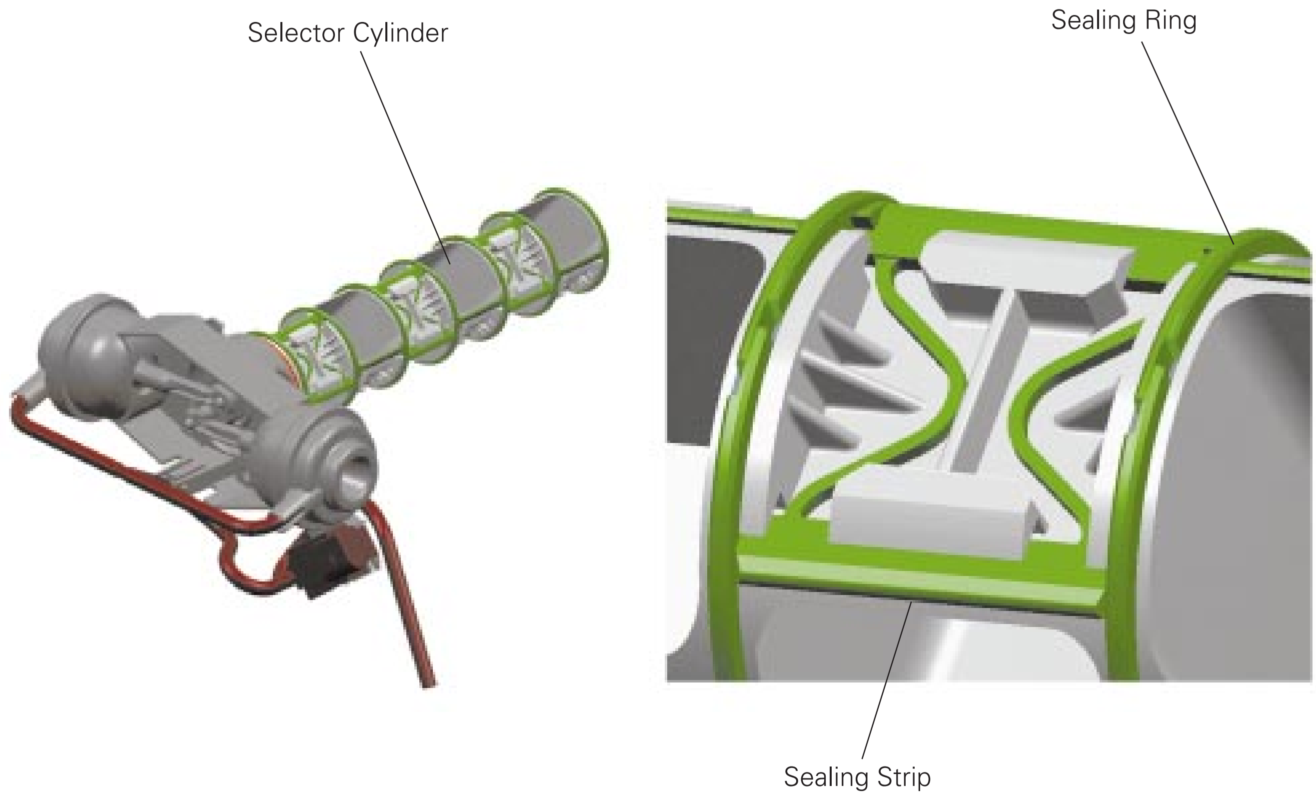
This design increases low rpm torque and high rpm power by taking advantage of the self-charging or “ram effect” that occurs at some engine speeds.

By “tuning” the intake manifold air duct length, engineers can produce this ram effect for a given rpm range. A manifold that has two different lengths of air ducts can produce the ram effect over a broader rpm range.

This design uses high velocity air flow in a long narrow manifold duct to ram more air into the engine at low rpm and then opens a short, large diameter duct for higher engine speeds.

Rotary Valve Selector Cylinder Design

The intake manifold change-over is achieved by a vacuum-operated plastic rotary valve selector cylinder with a spring return mechanism and two-point support. Leakage between the individual ram tube ducts is minimized by the use of pre-loaded sealing slip rings similar to piston rings. Spring-loaded dual sealing strips along the bore effectively seal between the short and long ducts.



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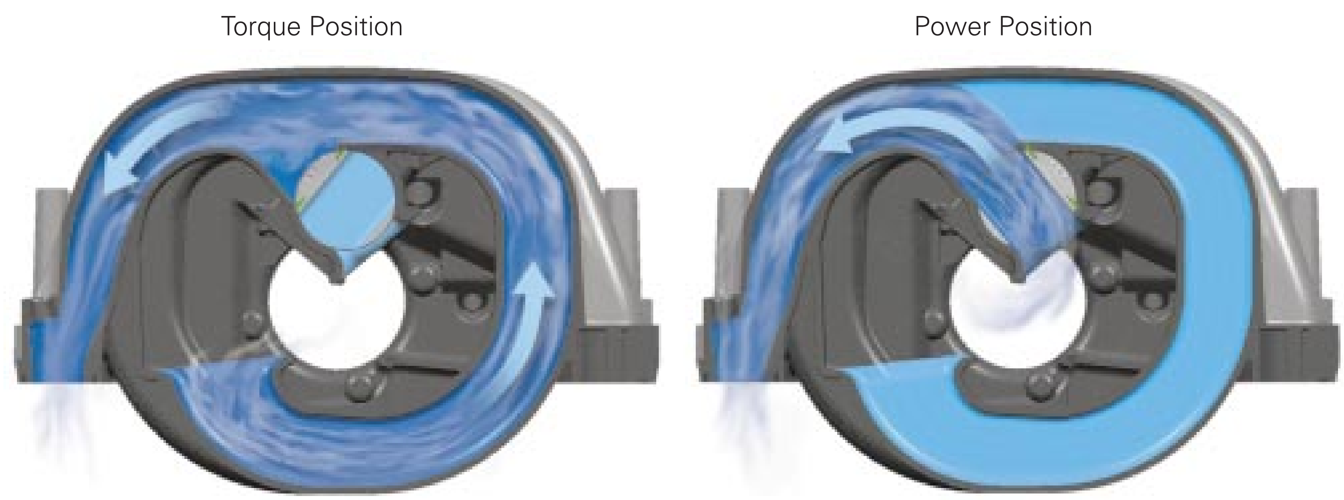
Rotary Valve Selector Cylinder Actuation

Intake manifold change-over is engine speed dependent. The Motronic Engine Control Module J220 activates the Change-Over Valve for Intake Manifold Flap N239, which in turn supplies vacuum to the two vacuum solenoids that rotate the selector cylinder.

At engine speeds below 4200 rpm, the selector cylinder remains in the torque position with a long air passage length of 25.20 inches (640 mm).

At engine speeds of 4200 rpm and above, the selector cylinder is rotated to the power position with a short air passage length of 11.30 inches (287 mm).



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Motronic ME 7.1.1 Engine Management System

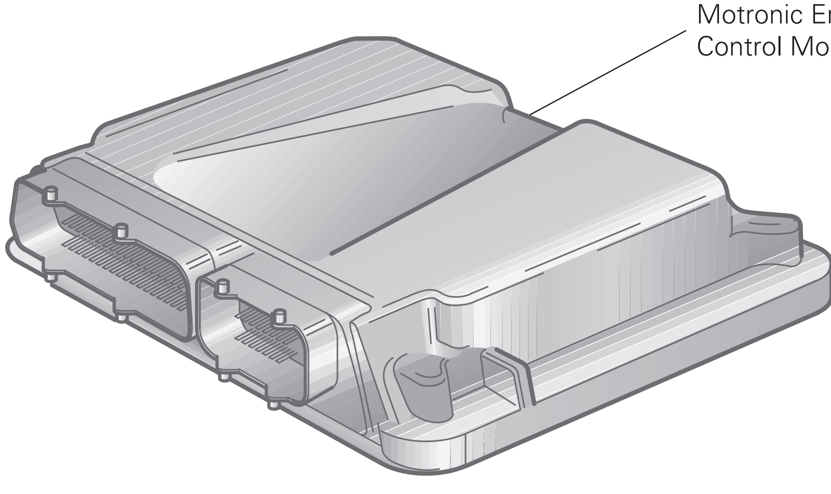
The engine management system for the new Audi 3.0L V6 is a torque-controlled electronic engine output system with continuous lambda closed-loop control.

Lambda refers to the ratio between the actual measured air-fuel ratio and the theoretically ideal air-fuel mixture of 14.7 to 1 (the stoichiometric ratio at which complete combustion takes place).

The ME 7.1.1 engine management system from Bosch has evolved from systems used on previous Audi engines. The computing demands of continuous intake camshaft adjustment and periodic exhaust camshaft adjustment require the power and speed of a 32 MHz microprocessor.

The two cylinder banks of the 3.0L V6 must be synchronized because component tolerances can allow the intake camshaft adjusters to change at different rates. This is especially likely when the engine oil temperature is low or extremely high. Without synchronization, this would result in incorrect fill data and associated operating errors. The Motronic Engine Control Module J220 developed for the ME 7.1.1 system compensates for such differences between cylinder banks by sensing the relative timing positions of the two intake camshafts and using the trailing (slower) camshaft signal as the master signal to set fuel fill rate and ignition timing for both banks.

This precise control ensures good driveability characteristics under all operating conditions.



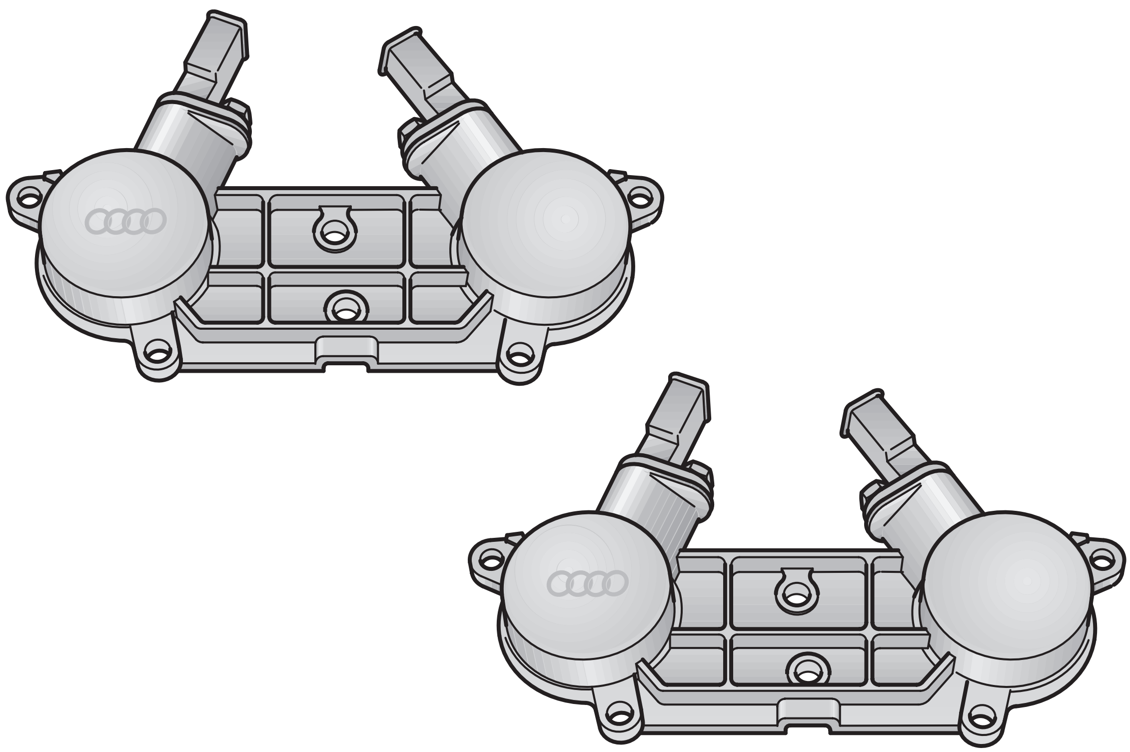
SSP254/028

Camshaft Position (CMP) Sensors G40, G163, G300, and G301

A separate Hall sensor is used to monitor the position of each of the four camshafts relative to the position of the crankshaft.

- Camshaft Position (CMP) Sensor G40
- Camshaft Position (CMP) Sensor 2 G163
- Camshaft Position (CMP) Sensor 3 G300
- Camshaft Position (CMP) Sensor 4 G301

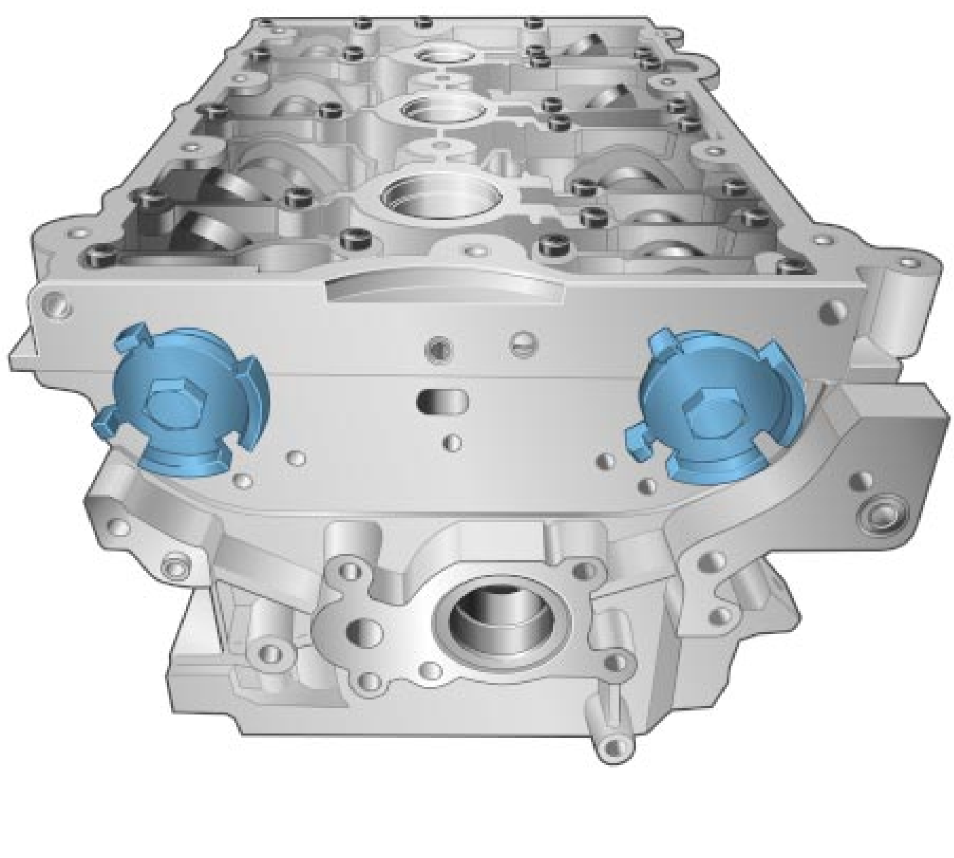
The two sensors required for each cylinder bank are ganged together in one housing and mounted at the front of the cylinder head.



SSP255/101

The sender system with "quick-start rotor ring" used on other Audi engines is used here as well. The quick-start rotor rings are shutter wheels at the ends of the camshafts that each have four alternating vanes and air gap openings — two wide and two narrow. The alternating vanes and air gaps pass each Hall sensor in a sequence that produces a distinctive pattern for each 90 degrees of crankshaft rotation as the magnetic field is interrupted by the rotor vanes.

If one of the sensors fails, the intake camshafts are mechanically locked in their default retard positions by spring-loaded differential pressure pins and the exhaust camshafts remain in their initial positions. The engine will start and run despite the signal failure.



SSP255/037

Engine — Multi-Port Fuel Injection

ME 7.1.1 System Overview

Sensors
Mass Air Flow (MAF) Sensor G70

Engine Speed (RPM) Sensor G28

Camshaft Position (CMP) Sensor G40
Camshaft Position (CMP) Sensor 2 G163

Camshaft Position (CMP) Sensor 3 G300
Camshaft Position (CMP) Sensor 4 G301

Heated Oxygen Sensor (HO2S) G39
Oxygen Sensor (O2S) Behind Three Way Catalytic Converter (TWC) G130

Heated Oxygen Sensor (HO2S) 2 G108
Oxygen Sensor (O2S) 2 Behind Three Way Catalytic Converter (TWC) G131

Throttle Valve Control Module J338 combined with Throttle Drive (Power Accelerator Actuation) G186
Angle Sensor 1 for Throttle Drive G187
Angel Sensor 2 for Throttle Drive G188

Engine Coolant Temperature (ECT) Sensor G2 combined with Engine Coolant Temperature (ECT) Sensor G62

Knock Sensor (KS) 1 G61
Knock Sensor (KS) 2 G66

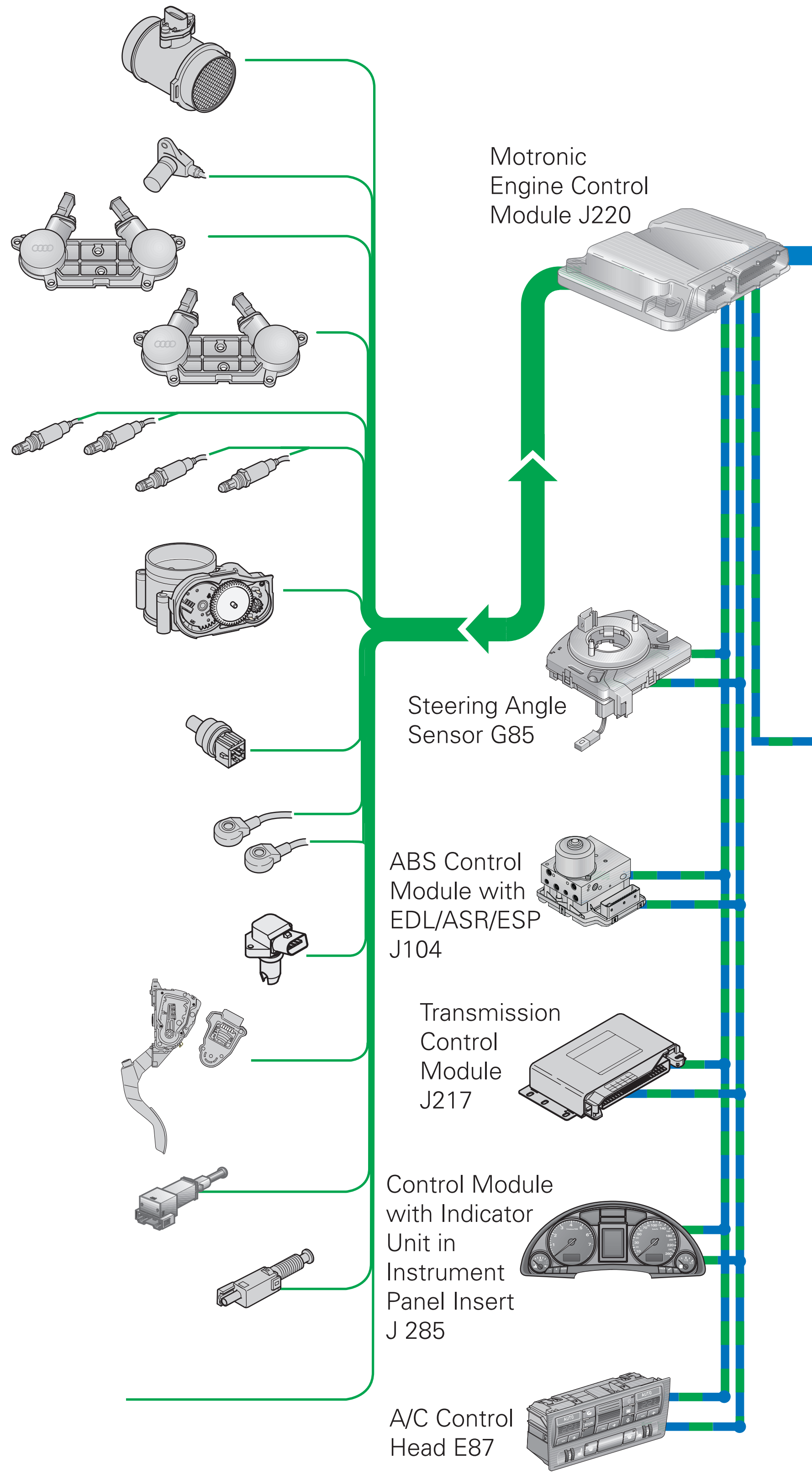
Brake Booster Pressure Sensor G294

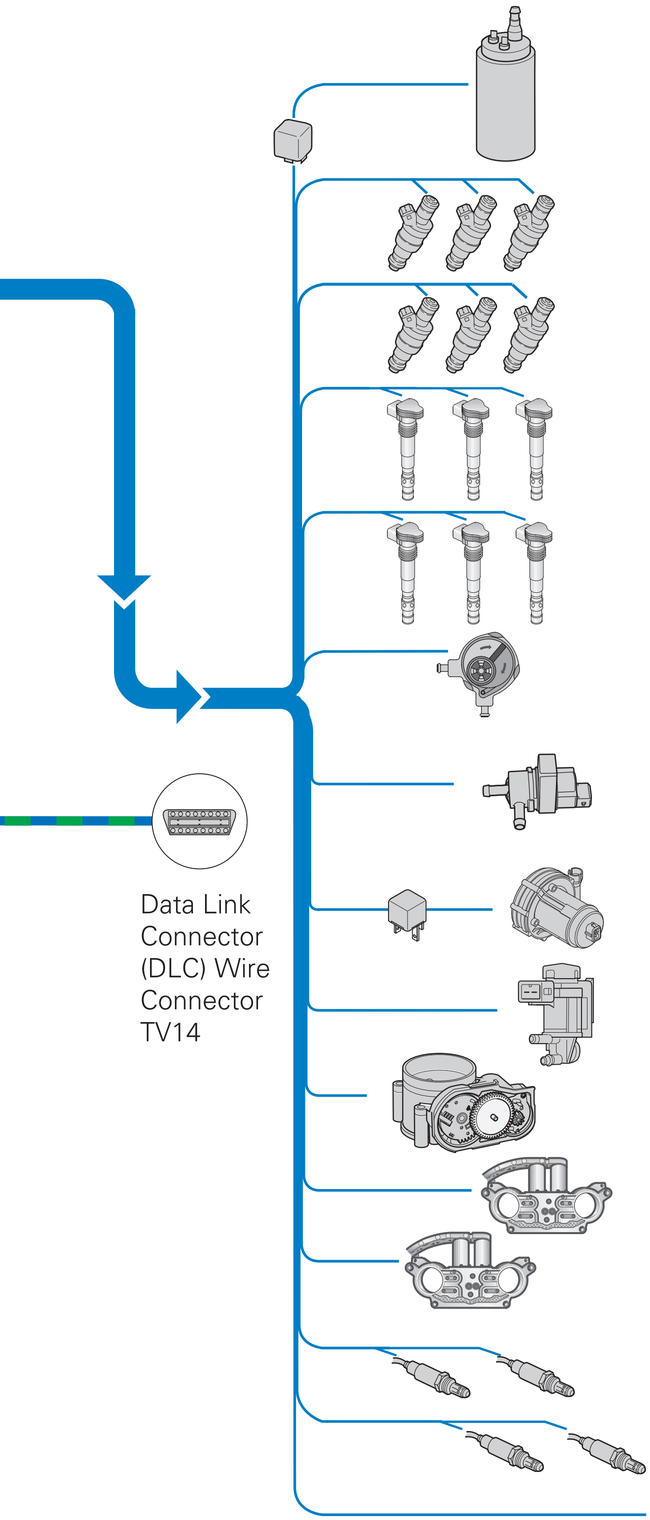
Throttle Position (TP) Sensor G79 combined with Sender 2 for Accelerator Pedal Position G185

Brake Light Switch F combined with Brake Pedal Switch F47

Clutch Vacuum Vent Valve Switch F36

Auxiliary Signals
— Air Conditioning Ready
— Air Conditioning Compressor (Bidirectional)
— Crash Signal
— Cruise Control System Switch





Actuators

Fuel Pump Relay J17
Fuel Pump G6

Cylinder 1 Fuel Injector N30
Cylinder 2 Fuel Injector N31
Cylinder 3 Fuel Injector N32
Cylinder 4 Fuel Injector N33
Cylinder 5 Fuel Injector N83
Cylinder 6 Fuel Injector N84

Ignition Coil N (Cylinder 1)
Ignition Coil 2 N128 (Cylinder 2)
Ignition Coil 3 N158 (Cylinder 3)
Ignition Coil 4 N163 (Cylinder 4)
Ignition Coil 5 N164 (Cylinder 5)
Ignition Coil N189 (Cylinder 6)

Brake System Vacuum Pump V192

Evaporative Emission (EVAP) Canister Purge Regulator Valve N80

Secondary Air Injection (AIR) Pump Relay J299
Secondary Air Injection (AIR) Pump Motor V101

Secondary Air Injection (AIR) Solenoid Valve N112

Throttle Valve Control Module J338 combined with Throttle Drive (Power Accelerator Actuation) G186

Valve 1 for Camshaft Adjustment (Bank 1) N205
Valve 2 for Camshaft Adjustment (Bank 2) N208

Heated Oxygen Sensor Control Module J208
Oxygen Sensor Heater Z19 (Bank 1)
Oxygen Sensor 2 Heater Z28 (Bank 2)
Heater for Lambda Probe 1 Z29 (Downstream from Catalytic Converter)
Heater for Lambda Probe 2 Z30 (Downstream from Catalytic Converter)

Auxiliary Signals
— Air Conditioning Compressor (Out)

SSP255/046

Engine — Multi-Port Fuel Injection

ME 7.1.1 Functional Diagram

Components

F	Brake Light Switch
F36	Clutch Vacuum Vent Valve Switch
F47	Brake Pedal Switch
G2	Engine Coolant Temperature (ECT) Sensor
G6	Fuel Pump
G28	Engine Speed (RPM) Sensor
G39	Heated Oxygen Sensor (HO2S)
G40	Camshaft Position (CMP) Sensor
G61	Knock Sensor (KS) 1
G62	Engine Coolant Temperature (ECT) Sensor
G66	Knock Sensor (KS) 2
G70	Mass Air Flow (MAF) Sensor
G79	Throttle Position (TP) Sensor
G82	Engine Coolant Temperature (ECT) Sensor (On Engine)
G108	Heated Oxygen Sensor (HO2S) 2
G130	Oxygen Sensor (O2S) Behind Three Way Catalytic Converter (TWC)
G131	Oxygen Sensor (O2S) 2 Behind Three Way Catalytic Converter (TWC)
G163	Camshaft Position (CMP) Sensor 2
G185	Sender 2 for Accelerator Pedal Position
G186	Throttle Drive (Power Accelerator Actuation)
G187	Angle Sensor 1 for Throttle Drive
G188	Angel Sensor 2 for Throttle Drive
G294	Brake Booster Pressure Sensor
G300	Camshaft Position (CMP) Sensor 3
G301	Camshaft Position (CMP) Sensor 4
J17	Fuel Pump Relay
J138	After-Run Coolant Fan Control Module
J220	Motronic Engine Control Module
J271	Motronic Engine Control Module Power Supply Relay
J 285	Control Module with Indicator Unit in Instrument Panel Insert
J299	Secondary Air Injection (AIR) Pump Relay
J496	Auxiliary Engine Coolant Pump Relay
J569	Relay for Brake Booster
M	Lamp
N	Ignition Coil (Cylinder 1)
N30	Cylinder 1 Fuel Injector
N31	Cylinder 2 Fuel Injector
N32	Cylinder 3 Fuel Injector
N33	Cylinder 4 Fuel Injector
N80	Evaporative Emission (EVAP) Canister Purge Regulator Valve
N83	Cylinder 5 Fuel Injector
N84	Cylinder 6 Fuel Injector
N112	Secondary Air Injection (AIR) Solenoid Valve
N128	Ignition Coil 2 (Cylinder 2)
N158	Ignition Coil 3 (Cylinder 3)
N163	Ignition Coil 4 (Cylinder 4)
N164	Ignition Coil 5 (Cylinder 5)
N189	Ignition Coil (Cylinder 6)
N205	Valve 1 for Camshaft Adjustment
N208	Valve 2 for Camshaft Adjustment
N239	Change-Over Valve for Intake Manifold Flap
S	Fuse
V51	After-Run Coolant Pump
V101	Secondary Air Injection (AIR) Pump Motor
V144	Leak Detection Pump (Fuel System)
V192	Brake System Vacuum Pump
Z19	Oxygen Sensor Heater
Z28	Oxygen Sensor 2 Heater
Z29	Heater for Lambda Probe 1
Z30	Heater for Lambda Probe 2

Color Coding

= Input Signal

= Output Signal

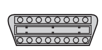
= Positive

= Ground

= CAN Bus

= Bidirectional

Auxiliary Signals


TV14 Data Link Connector (DLC) Wire Connector

1 TD Signal

2 Crash Signal

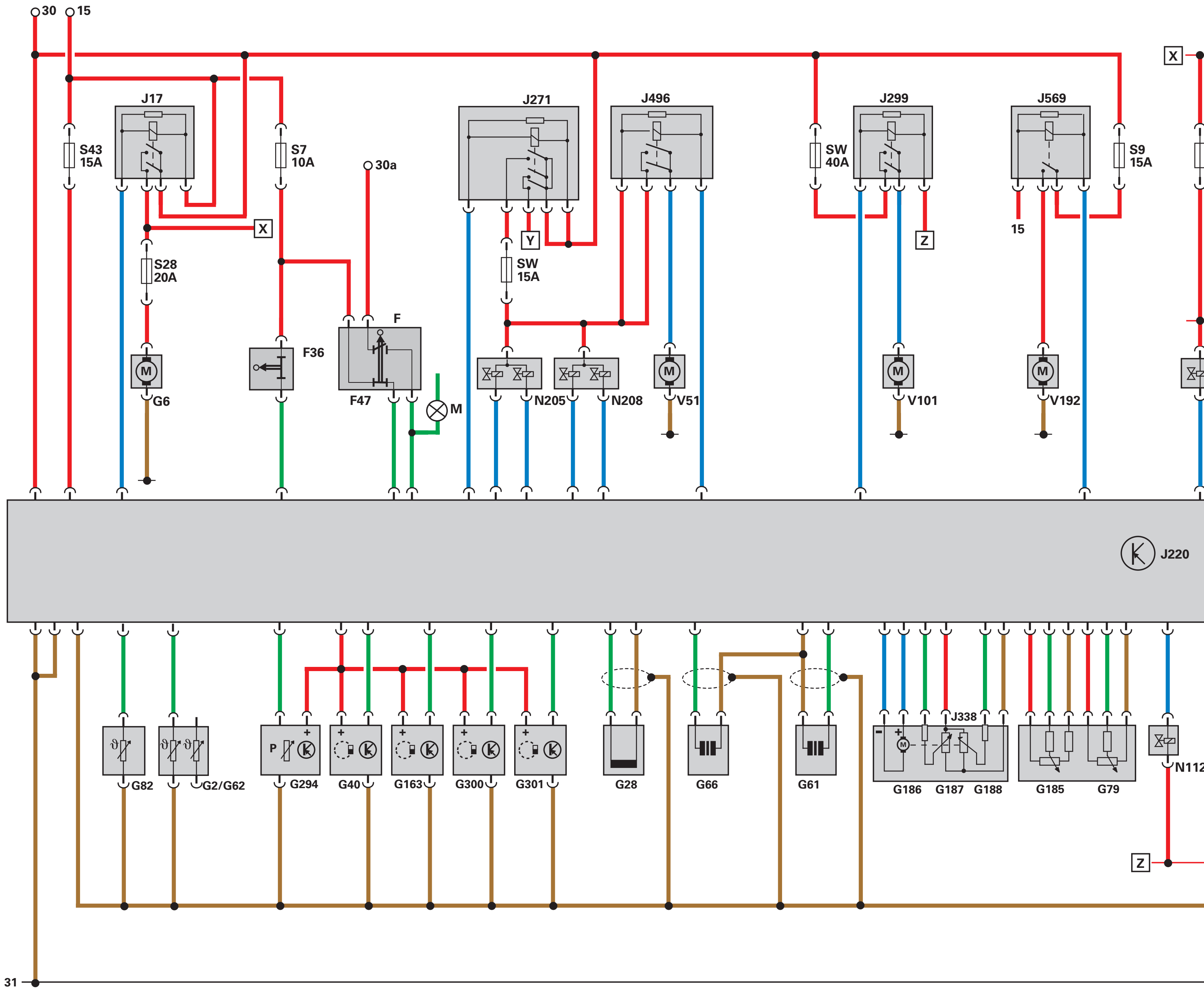
3 PWM Signal to Radiator Fan

4 TD Signal (V30 Automatic Transmission Only)

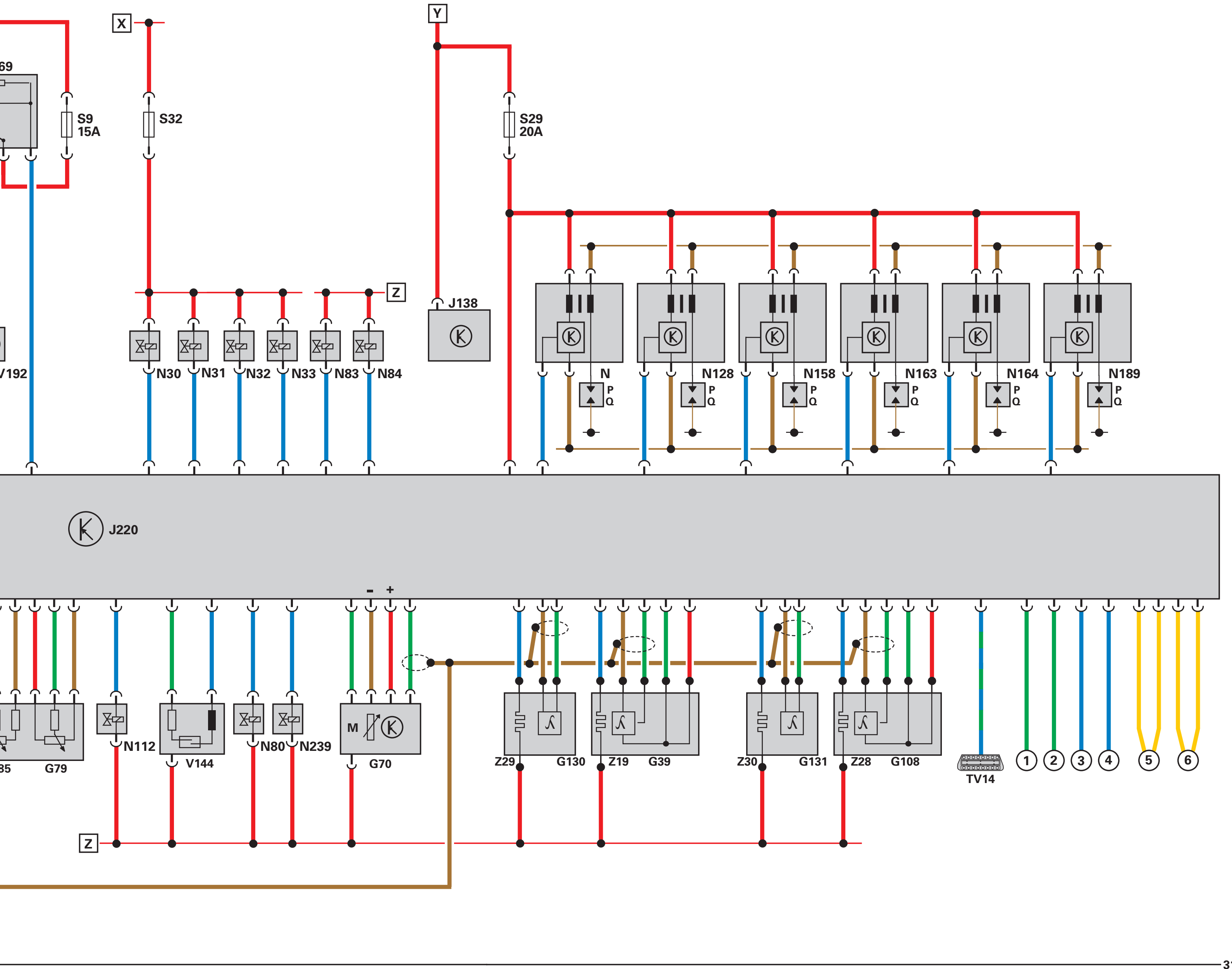
5 Data Bus Drive

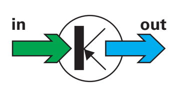
6 Data Bus Information System

X
Y
Z
} Connection within the Functional Diagram



30
15
J17
S43
15A
S7
10A
30a
J271
J496
SW
40A
J299
J569
S9
15A
X
S28
20A
Y
SW
15A
Z
15
F
F36
G6
F47
M
N205
N208
V51
V101
V192
J220
J338
G82
G2/G62
G294
G40
G163
G300
G301
G28
G66
G61
G186
G187
G188
G185
G79
N112
Z
31


X
Y
Z
69
S9
15A
S32
S29
20A
J138
N
N128
N158
N163
N164
N189
/192
N30
N31
N32
N33
N83
N84
P
Q
J220
-
+
N112
V144
N80
N239
M
G70
85
G79
Z29
G130
Z19
G39
Z30
G131
Z28
G108
TV14
1
2
3
4
5
6
31

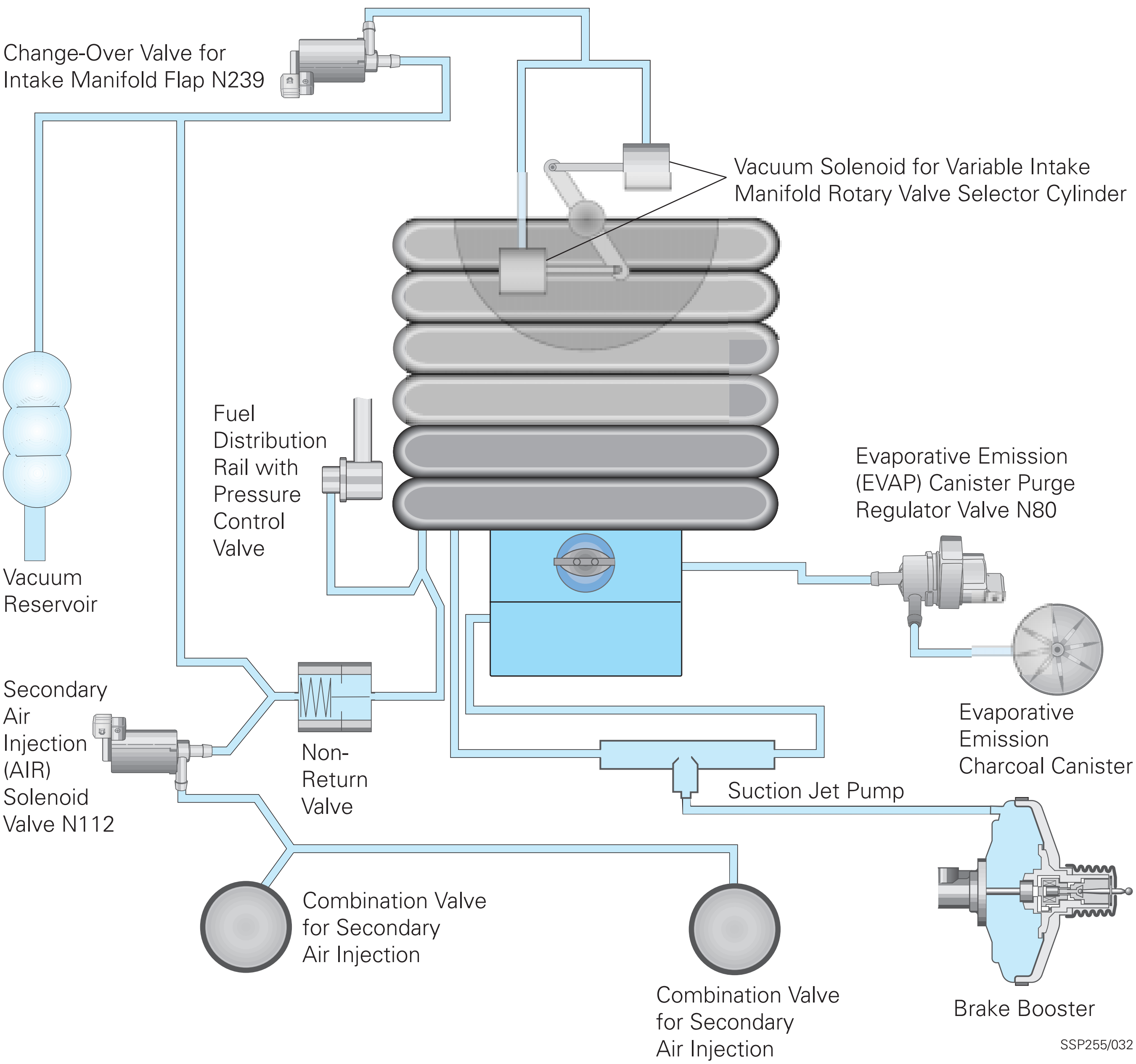

in
out

SSP 55/002

Vacuum Systems

A vacuum reservoir and non-return valve are used to store a vacuum supply for variable intake manifold rotary valve selector cylinder operation and other vacuum-operated systems. On vehicles with automatic transmissions, vacuum supply is further ensured by an electric vacuum pump. These measures are necessary because manifold vacuum may be insufficient to actuate the variable intake manifold vacuum solenoids and the power brake booster at high engine speeds.

Vacuum System Overview



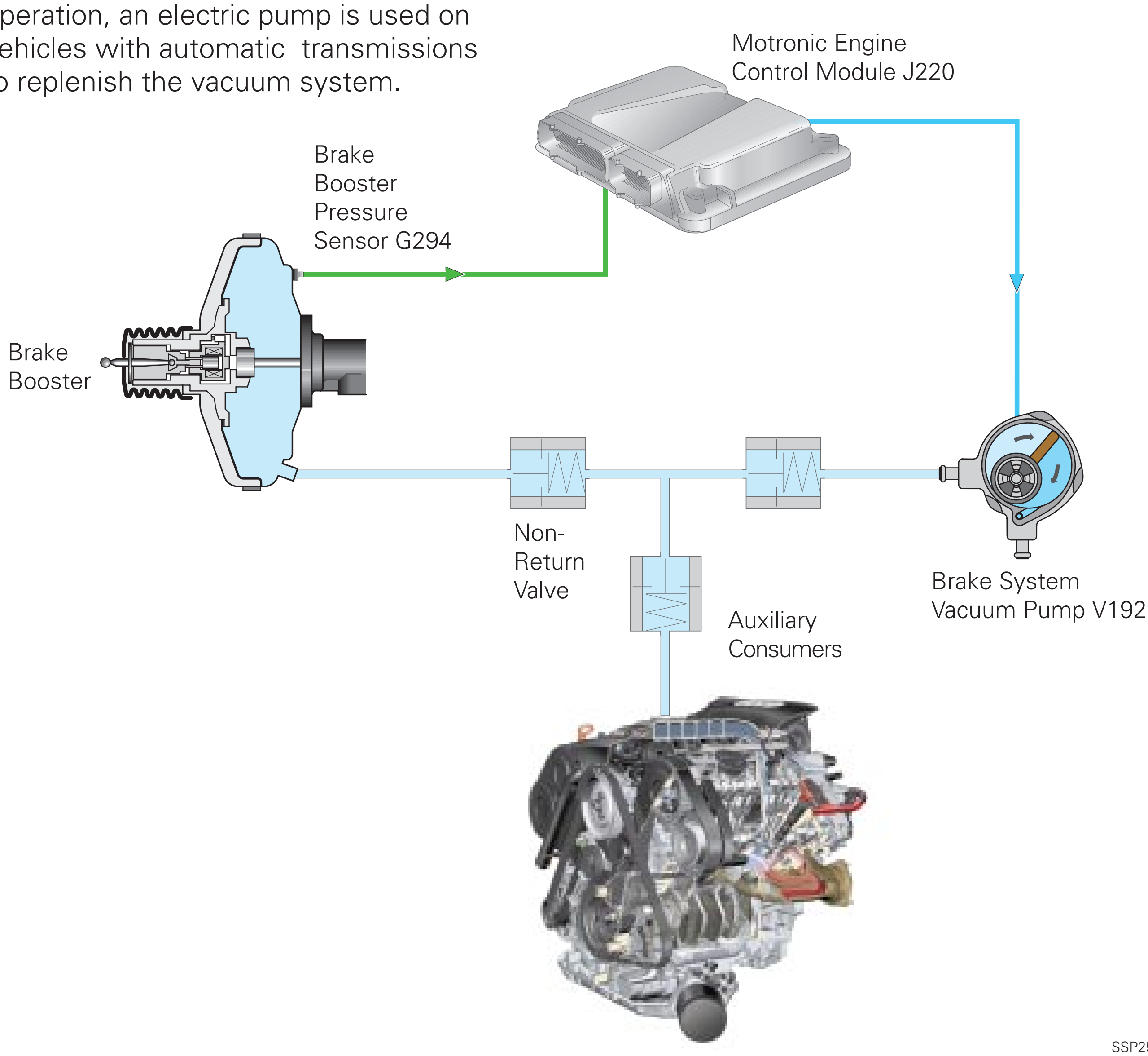
SSP255/032

Vacuum System for Vehicles with Automatic Transmission

Increased load requirements (throttle valve open wider) in some operating states result in a reduction of the vacuum provided by the engine, such as when the catalytic converter is warming up while the engine is idling after start.

To avoid an increase in brake pedal effort due to a shortage of engine vacuum supply and to ensure variable intake manifold vacuum solenoid operation, an electric pump is used on vehicles with automatic transmissions to replenish the vacuum system.

The vacuum value in the brake booster is detected by the Brake Booster Pressure Sensor G294, an absolute pressure sensor. When there is a detectable loss of vacuum in the brake booster, the Brake Booster Pressure Sensor G294 signal initiates a command from the Motronic Engine Control Module J220 to the Relay for Brake Booster J569 to activate the Brake System Vacuum Pump V192.



SSP255/033

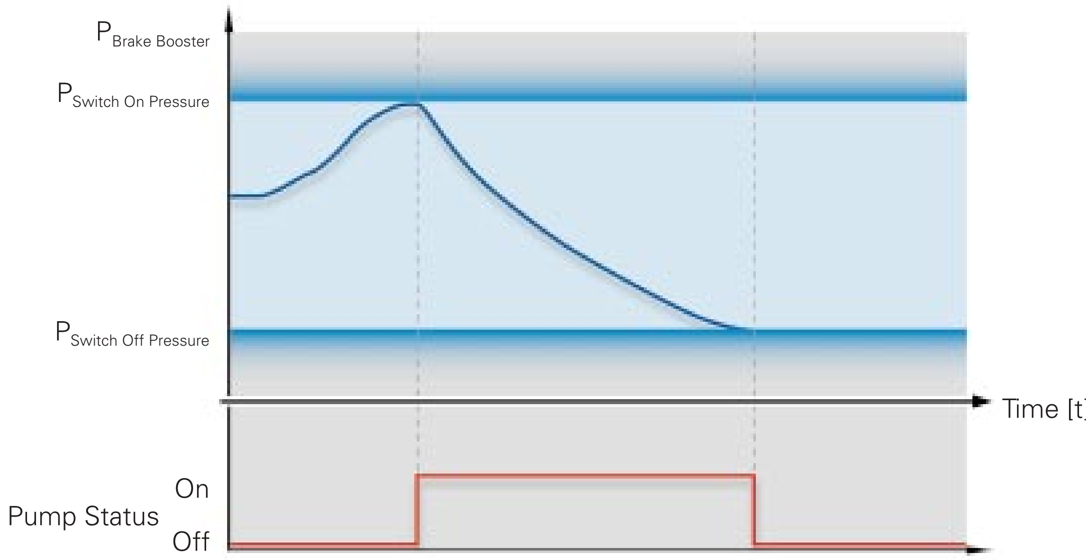
Activating the Brake System Vacuum Pump V192

The Brake System Vacuum Pump V192 is activated under the following circumstances:

- ▶ $P_{Brake\ Booster} > P_{Switch\ On\ Pressure}$ approximately 7.25 psi (50 kPa)

The Brake System Vacuum Pump V192 is deactivated under these conditions:

- ▶ $P_{Brake\ Booster} > P_{\ Switch\ Off\ Pressure}$ approximately 4.35 psi (30 kPa)



SSP255/034

Correction for Altitude

The Motronic Engine Control Module J220 corrects for altitude using an internal sensor and modifies the switching map for triggering the Brake System Vacuum Pump V192 accordingly.

Self-Diagnosis

Actuator diagnosis: The Brake Sysem Vacuum Pump V192 should run for approximately 10 seconds.

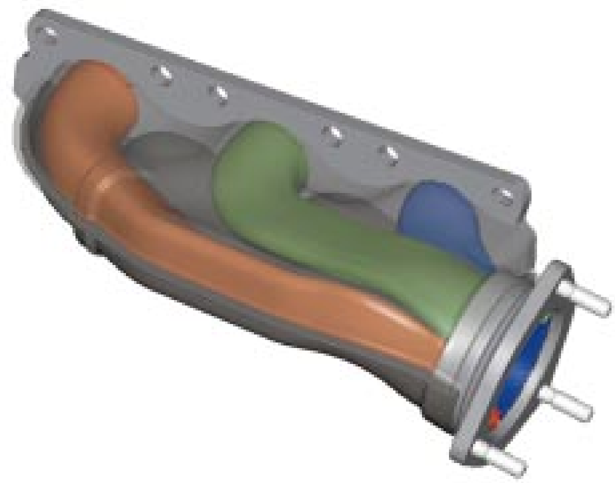
Measured value block: Channel 08

Byte 1	Byte 2	Byte 3	Byte 4
Brake Actuated/ Brake Not Actuated	Voltage Supply	Pump On/ Pump Off	Brake Booster Pressure (psi (kPa))

Exhaust Manifolds

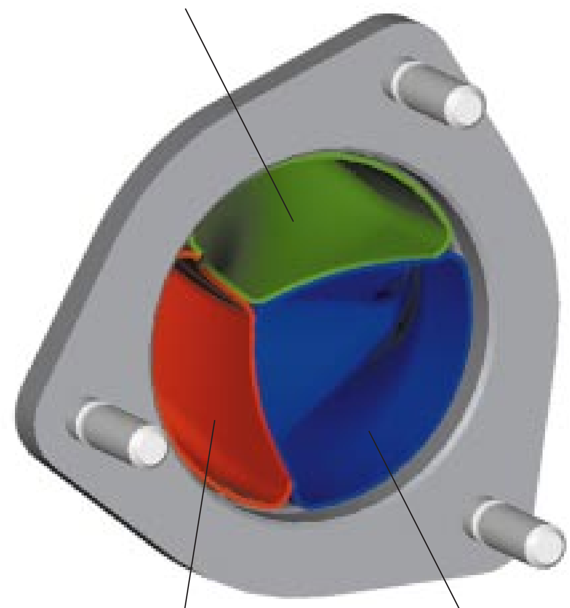
Tubular air-gap-insulated exhaust manifolds with monocoque construction have been developed for the 3.0L V6 engine. These manifolds each incorporate three separate internal tubes to conduct the exhaust gases and an external shell for thermal insulation. They reduce mass, improve the noise pattern, heat the pre-converter catalysts quickly to light-off temperature, and reduce heat transfer to the engine compartment.

Because of their compact geometry, the internal tubes are manufactured using an interior high-pressure molding process.



SSP255/035

The internal tubes merge from “three-into-one” at the exit flange. The geometry of the individual tubes has been designed to provide a uniform distribution of exhaust gases to the pre-converters. This helps to shorten the catalyst light-off time.



SSP255/036

Catalytic Converters

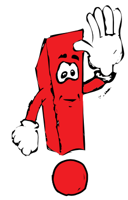
Catalytic converters used with the 3.0L V6 engine use noble metal catalysts to reduce exhaust emissions.

- Platinum
- Palladium
- Rhodium

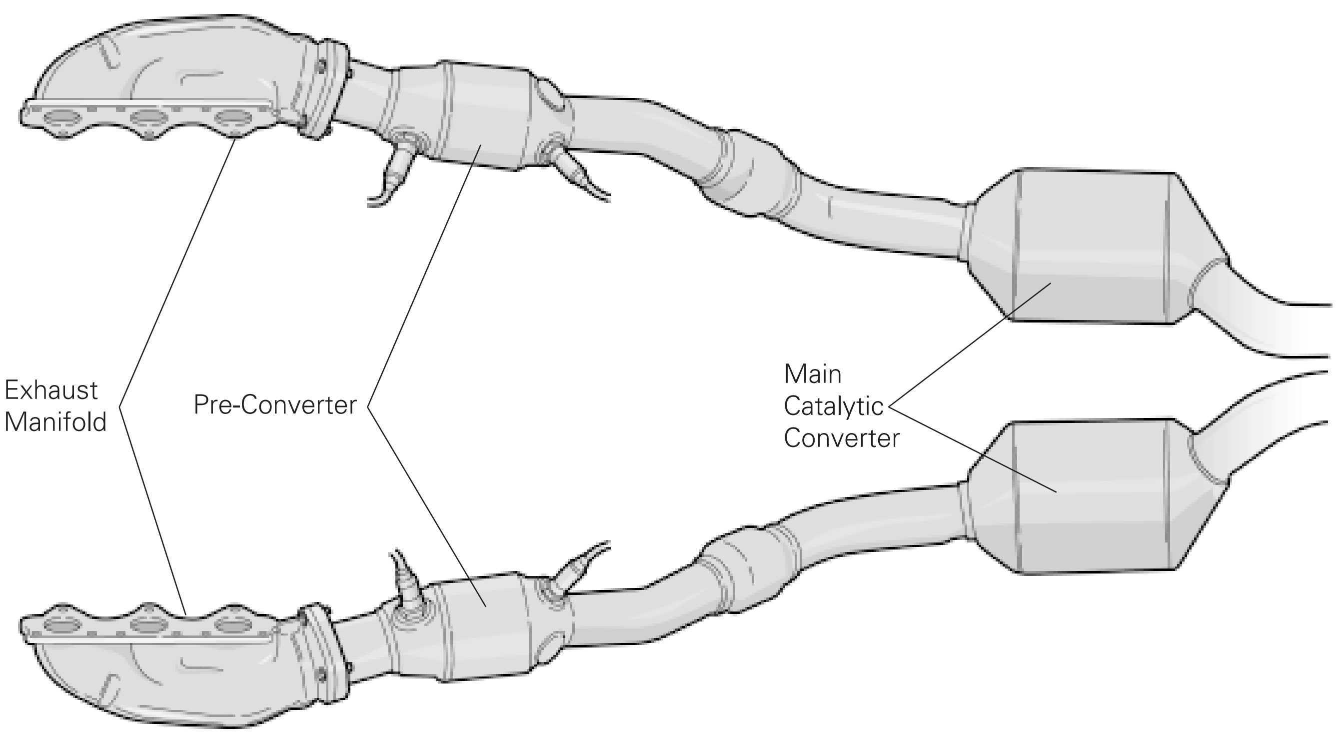
The two pre-converters close to the engine each have ceramic substrate with a coating of these three precious metals and a cell density of 600 cpsi.

This shortens their light-off time and makes the pre-converters begin to function quickly.

The two main catalytic converters are positioned further back to ensure long-term stability in emissions values and optimum back pressure in the exhaust system. Their substrates are coated with the same three noble metals as the pre-converters and they have a cell density of 400 cpsi.

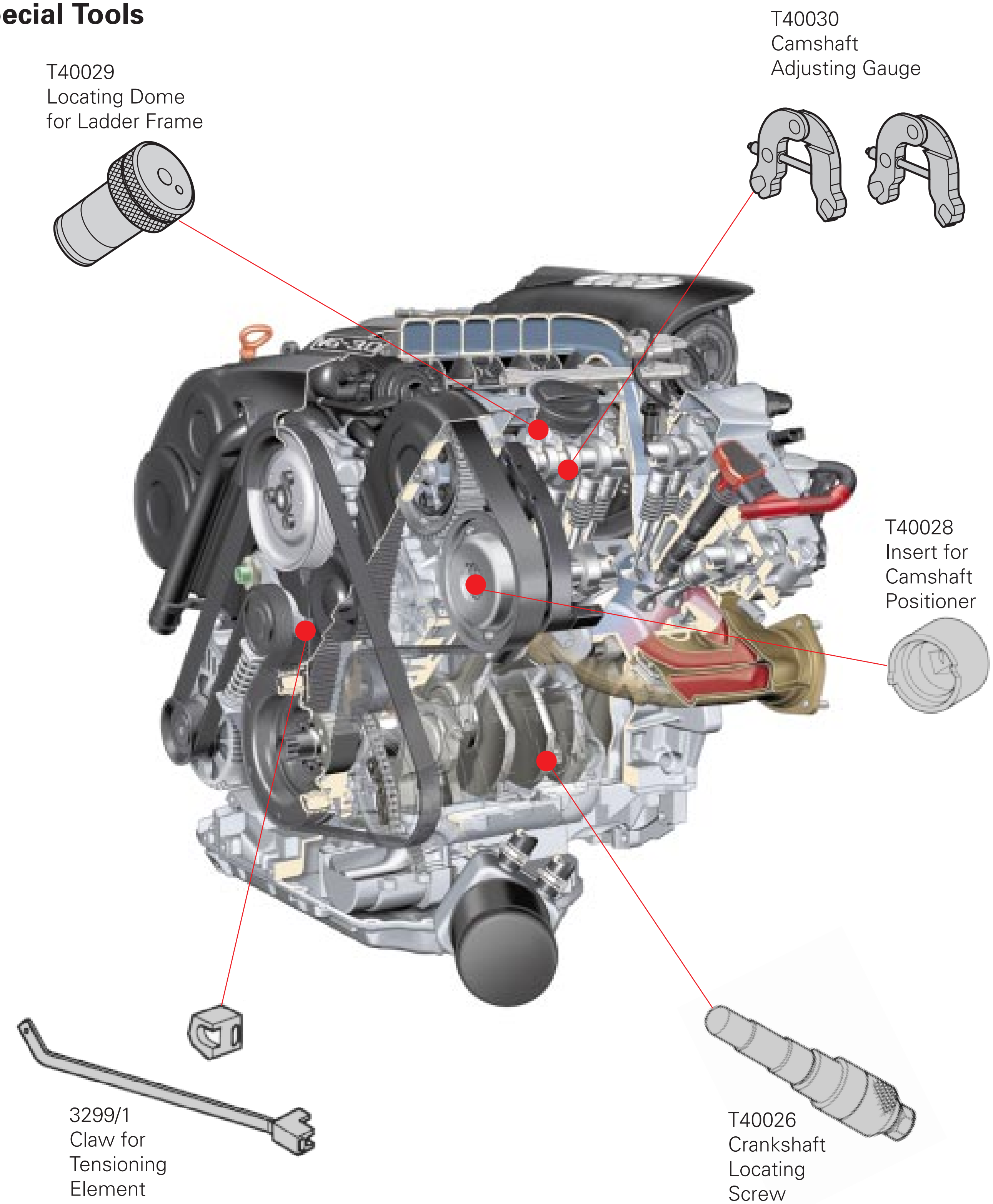


The abbreviation “cpsi” stands for “cells per square inch (per 6.452 cm^2).”



SSP255/102

Special Tools



Notes

Audi 3.0L V6 Engine Teletest

See page 37 for instructions.

1. Which of the following is NOT a characteristic of the Audi 3.0-liter V6 engine?

1. ULEV emission status.
2. Five-valve per cylinder technology.
3. Balancer shaft integrated with the oil pump.
4. Continuously adjustable exhaust camshaft timing.

2. True or False? The aluminum cylinder block of the Audi 3.0-liter V6 engine is manufactured using a patented Cosworth rollover casting process.

1. True.
2. False.

3. Technician A says the oil pump and balancer shaft of the Audi 3.0-liter V6 engine are combined into one aluminum module.

Technician B says a roller chain from the crankshaft drives the oil pump of the 3.0-liter V6 engine.

Who is right?

1. Technician A only.
2. Technician B only.
3. Both Technician A and Technician B.
4. Neither Technician A nor Technician B.

4. All of the following are characteristics of the 3.0-liter V6 engine cylinder heads EXCEPT:

1. Tumble intake duct design.
2. Separate camshaft bearing caps.
3. One-piece die-cast aluminum ladder bearing frame.
4. Five valves per cylinder.

5. True or False? A toothed belt driven by the crankshaft drives the intake and exhaust camshafts.

1. True.
2. False.

6. The intake camshaft adjustment is:

1. Controlled by a signal from the Motronic Engine Control Module J220.
2. Is actuated by a solenoid valve.
3. Is determined based on engine speed, load, and engine coolant temperature.
4. All of the above.

7. True or False? The signal to the intake camshaft adjuster is a pulse-width-modulated signal.

1. True.
2. False.

8. Technician A says the intake camshafts are continuously adjustable over a range of 42 degrees of crankshaft angle.

Technician B says the exhaust camshaft adjustment is essentially “on” or “off” to advance exhaust camshaft timing to the specified 22 degrees or return it to normal.

Who is right?

1. Technician A only.
2. Technician B only.
3. Both Technician A and Technician B.
4. Neither Technician A nor Technician B.

9. The intake manifold of the 3.0-liter V6 engine:

1. Is a two-stage variable intake manifold.
2. Is produced by the lost-core process.
3. Has a main body made of plastic.
4. All of the above.

10. True or False? Change-over between the long and short tubes of the two-stage variable intake manifold is accomplished by a vacuum operated rotary valve.

1. True.
2. False.

Notes

ANSWER WORKSHEET

AUTOMATED TELEPHONE TESTING INSTRUCTIONS

Testing Times: 24 hours a day

To take an Automated Telephone test:

- Record your responses to test questions in the boxes below.
- Dial **1-800-928-2834.**
- Enter your Social Security number or Social Insurance number, or Employee Identification Number.
- Enter the six digit Course Number. The Course Number for this test is **921103.**
- Enter your test answers by pressing the corresponding numbers on the phone key pad when prompted by the Audio Response system – enter answers in groups of five.
- If you want to change your previous answers, press 8. You may change your answers at this time only. Failure to change incorrect answers could result in incorrect score.
- You will be given your results at the completion of the test.
- If you did not achieve a score of 80% you must wait 24-hours before retaking the exam.

If you are using a rotary dial telephone, or have difficulty with the Audio Response system while taking your test, please call **1-888-565-7366**, Monday-Friday 7:00 a.m. to 7:00 p.m. (Central Time).

1	2	3	4	5
6	**7**	**8**	**9**	**10**

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