# The V8-5V Engine

## Construction Features and Functions

Self-Study Program
Course Number 921903

Audi

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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.

# The V8-5V Engine

AUDI has been producing advanced 8-cylinder engines since 1988. Their capacity has increased from 3.6 L to 4.2 L.

The V8 engine in combination with Aluminum Space Frame technology was the technical basis for Audi's breakthrough into the luxury class.

Steps to enhance the value of the Audi A8 have included the redesign of the V8 engine.

The new V8-5V engines are now also available for the Audi A6 model range.


SSP 217/048

# Contents



**New!**

**Important/Note!**

This Self-Study Program provides you with information concerning the engine's construction features and functions.

**The Self-Study Program is not a Repair Manual!**

When carrying out maintenance and repair work, it is essential to use the latest technical literature.

## The V8-5V Engine

Major modifications were made to the V8 engines during the course of further development.

Emphasis was placed on the following development objectives:

- compliance with future exhaust-emission regulations
- reduction of fuel consumption
- increase in torque and power
- improvement of comfort and convenience
- reduction of engine weight
- increased use of shared components for the AUDI engine series.

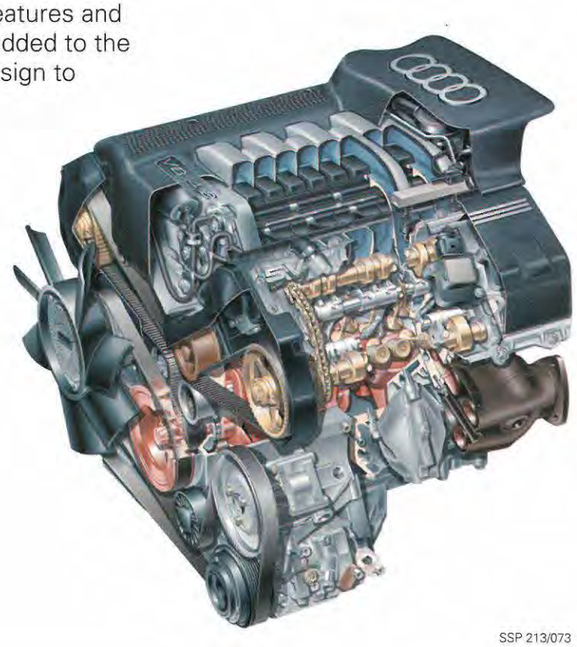
The following new features and modifications were added to the V8 4-valve engine design to develop the new V8-5V engine.

### New Features

- Five-valve cylinder head with roller rockers
- Camshaft adjustment
- Three-stage variable intake manifold
- Engine management system, Bosch ME 7.1
- Electro-hydraulic engine mounting

### Modifications

- to crankcase and crankgear
- to oil circuit
- to cooling circuit



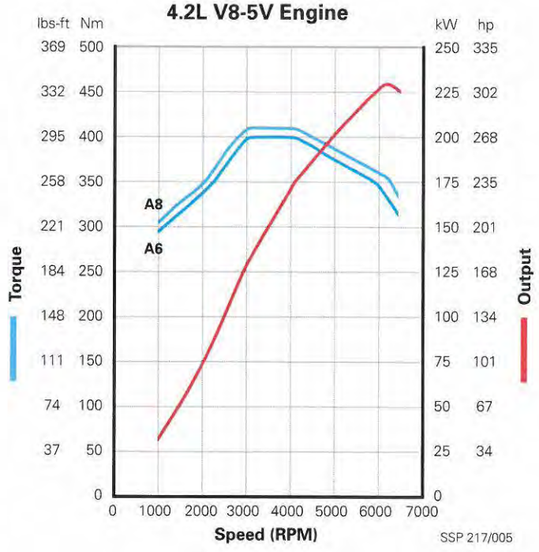
SSP 213/073





## The Technical Data

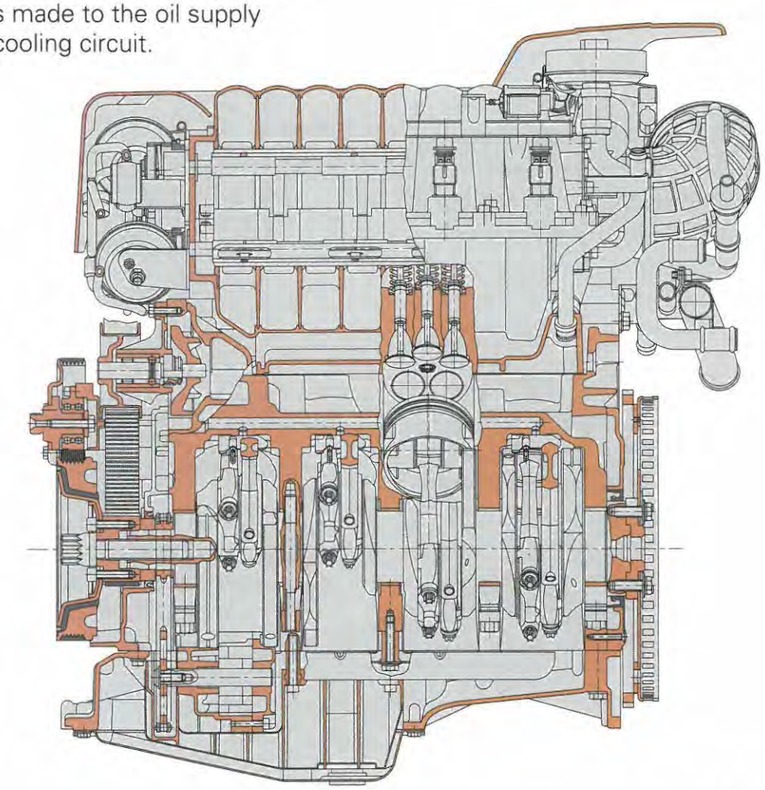
| | A6 4.2 L | A8 4.2 L |
|---|---|---|
| Engine code | ART | AKB |
| Design | V8 engine with 90° V angle | |
| Capacity | 255 cu in (4172 cm³) | 255 cu in (4172 cm³) |
| Power output | 300 hp (220 kW) at 6200 rpm | 310 hp (228 kW) at 6200 rpm |
| Torque | 295 lbs-ft (400 Nm) at 3000 rpm | 302 lbs-ft (410 Nm) at 3000 rpm |
| Bore | 3.32 in (84.5 mm) | 3.32 in (84.5 mm) |
| Stroke | 3.66 in (93.0 mm) | 3.66 in (93.0 mm) |
| Compression ratio | 10.8:1 | 10.8:1 |
| Weight | 441 lbs (200 kg) | 441 lbs (200 kg) |
| Engine management | Motronic ME 7.1 | Motronic ME 7.1 |
| Fuel | 91 AKI | 91 AKI |
| Firing sequence | 1 - 5 - 4 - 8 - 6 - 3 - 7 - 2 | |




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.

## Crankcase

The crankcase has been adapted to the modifications made to the oil supply system and cooling circuit.



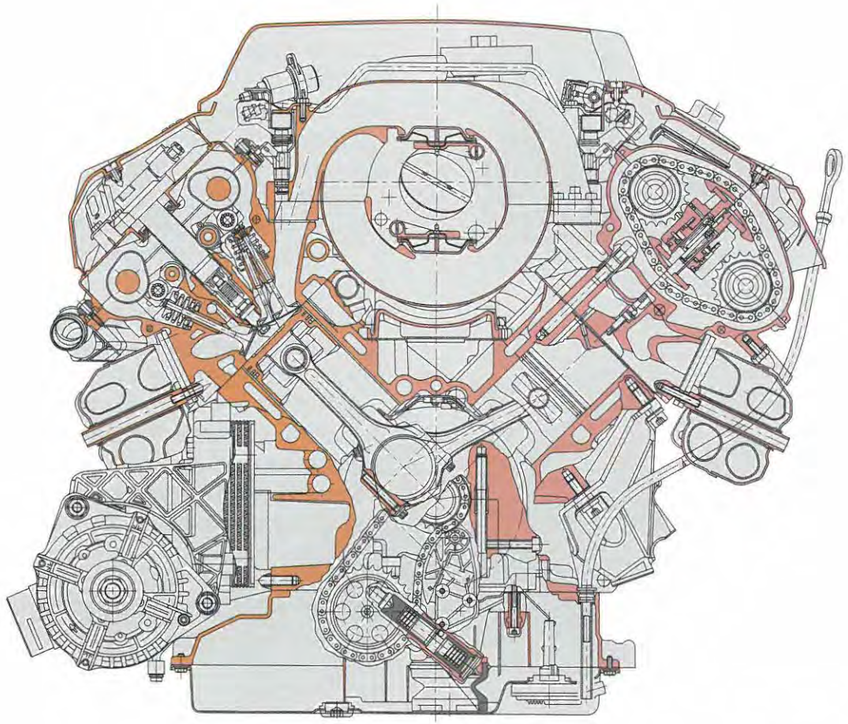
SSP 217/054

SSP 217/006

Cold-cracked connecting rods have been used for the 3.7 L engine since 1995 and are now also being used for the 4.2 L engine.



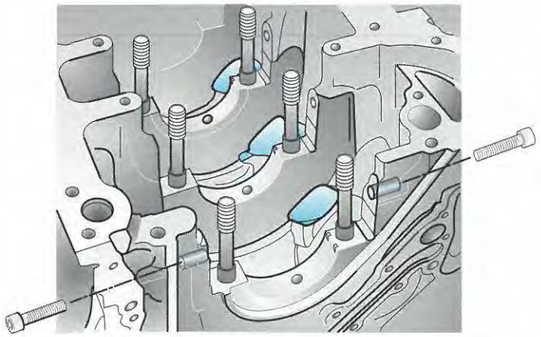




SSP 217/055

Recesses are designed into the tops of pistons to provide clearance for valves. Pistons are not interchangeable between cylinder banks.

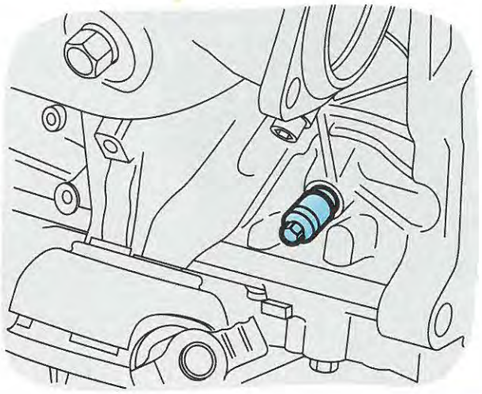
SSP 217/002



SSP 217/007

Wide, milled ventilation recesses above the thrust bearings reduce pumping losses.

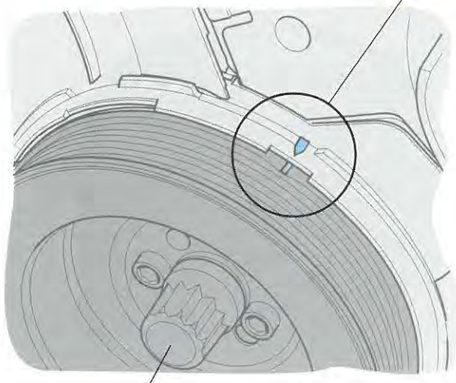
Bolts are also inserted at the sides of the two front crankshaft bearing caps to improve running smoothness.



SSP 217/009

The locking mandrel (V.A.G. 3242) used for the V6 engines is also used for locking the crankshaft on the V8-5V engines.
It is applied to the crank web of the fourth cylinder and is used for basic engine adjustment and also as a counterhold for loosening and tightening the central bolt of the crankshaft.

The fifth cylinder must be set to ignition TDC.




SSP 217/050

The central bolt does not have to be unscrewed for the vibration damper to be removed.

The marking indicates the ignition TDC of the fifth cylinder.





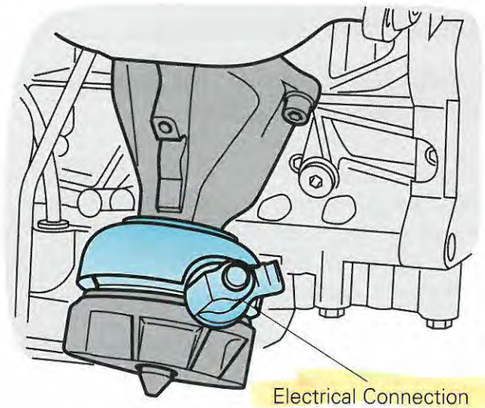
## Engine Mounting

To enhance driving comfort, hydraulic engine mounts with electrical activation are used for the eight-cylinder engines.

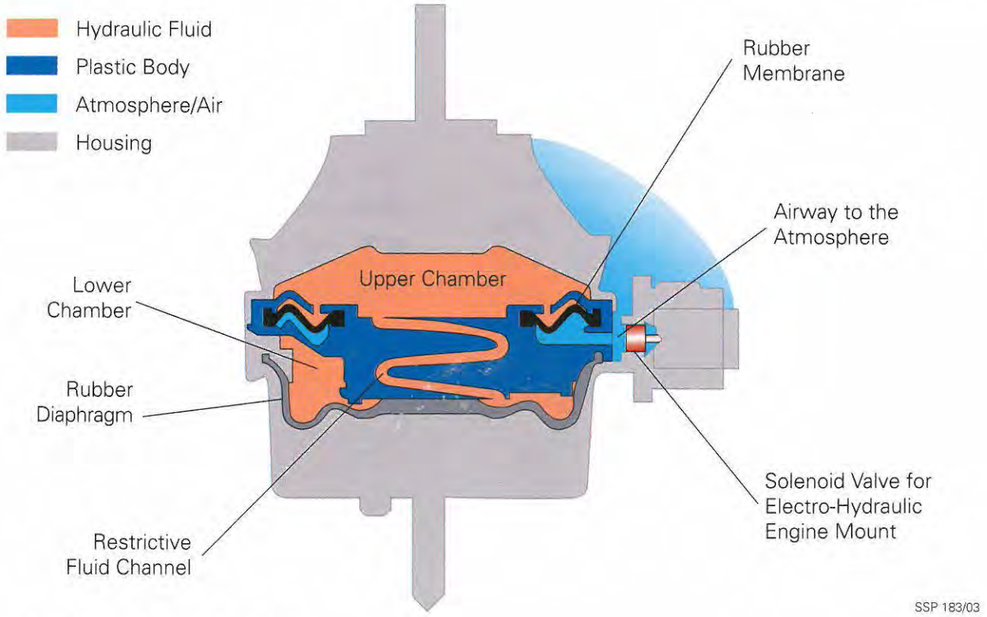
The mounts are activated by the engine control module according to engine speed.

Two hydraulically damped engine mounts reduce the transfer of engine vibrations to the body across the entire rpm range.

Damping is adjusted to compensate for two operating states, idling and driving.




SSP 217/039




SSP 183/03

**Each engine mount consists of:**

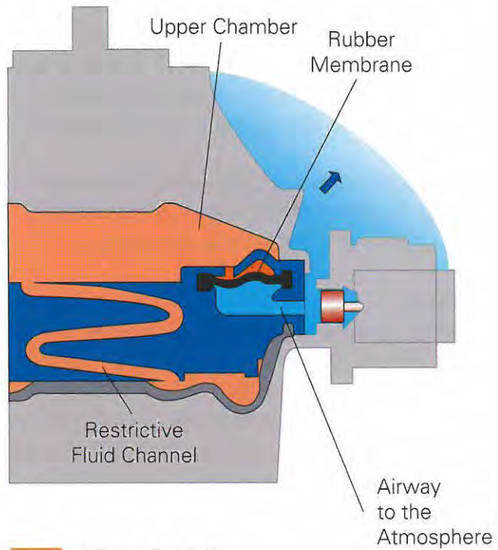
- a rubber and metal housing
- a plastic body with restrictive fluid channel
- an upper and a lower chamber filled with hydraulic fluid
- a rubber membrane
- a rubber diaphragm
- a solenoid valve

### Engine Mount Operation

**At idle speed (below 1100 rpm) the engine mount is soft.**

The hydraulic fluid in the upper chamber of each engine mount is pressurized by the movement created by engine vibrations. At idle speed, the high-frequency engine vibrational distances are small.

These high-frequency vibrations do not create enough pressure to push the hydraulic oil from the upper chamber through the restrictive fluid channel to the lower chamber. The airway in the plastic body is open to the atmosphere and the rubber membrane that separates the hydraulic fluid from the air creates a relatively soft cushion that absorbs the high-frequency vibrations transmitted through the hydraulic fluid.




SSP 183/98



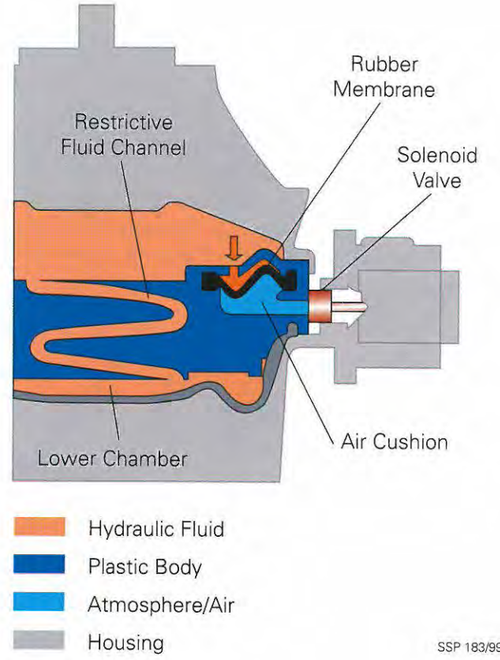


**At driving speeds (above 1100 rpm) the engine mount is hard.**

At driving speeds, a combination of engine-induced high-frequency vibrations with small vibrational distances and road-induced low-frequency vibrations with larger vibrational distances overlap each other.

At engine speeds above 1100 rpm, the engine mount solenoid valve is closed by the engine control module. This blocks the plastic body airway to the atmosphere and creates a relatively hard cushion of air under the rubber membrane that separates the hydraulic fluid from the air chamber. High-frequency vibrations continue to be absorbed by the rubber membrane at the air cushion.

The low-frequency vibrations induced by the roadway now create sufficient pressure in the hydraulic fluid to force it through the restrictive fluid channel in the plastic body that separates the upper and lower chambers. As the hydraulic fluid enters the lower chamber, the rubber diaphragm that lines the lower chamber distorts, reducing the effect of the low-frequency vibrations.




SSP 183/99

**Frequency:** This term is used to define vibration characteristics. Vibration frequency is measured as the number of vibration cycles per second and is expressed in hertz (Hz).

The low-frequency engine vibrations with large vibrational distances are actually induced by vehicle travel over the roadway. If the hydraulic engine mounts are defective, these vibrations are not damped properly and overall engine vibration increases

## Engine Lubrication

A duocentric oil pump driven by the crankshaft via a chain replaces the previously used external gear oil pump.

The duocentric oil pump extends deep into the oil sump. The low suction height means that the oil pressure can build up quickly, especially with cold starts.

The oil-pressure control valve is located in the oil pump housing. The "diverted" oil is led off to the intake side of the oil pump. This helps optimize the level of efficiency.

There are five oil bores per triple roller rocker. Three oil bores each supply one hydraulic tappet. Two oil bores supply the oil-spray bores integrated in the roller rocker to lubricate the rollers. The oil-spray bores are only opened when the roller rockers are actuated. This results in a reduction of the amount of oil required in the cylinder head.

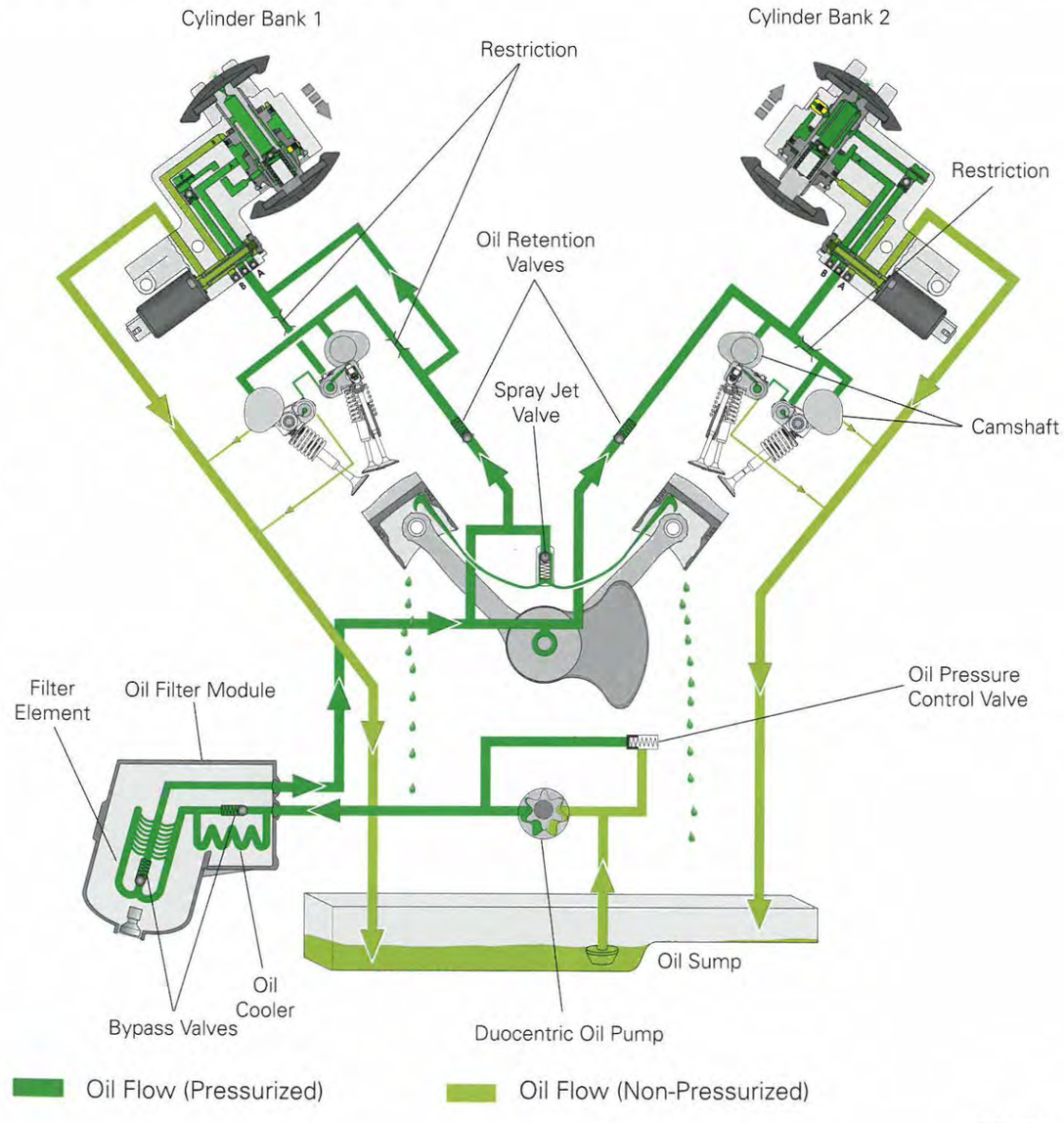
The roller rockers are described on pages 21 and 22.


SSP 217/010





Slight modifications have been made to the oil circuit in the cylinder heads.
The oil circuit for cylinder bank 2 shown in the illustration is the oil circuit that has been used since the introduction of the new model. Cylinder bank 1 shows the modified oil circuit.

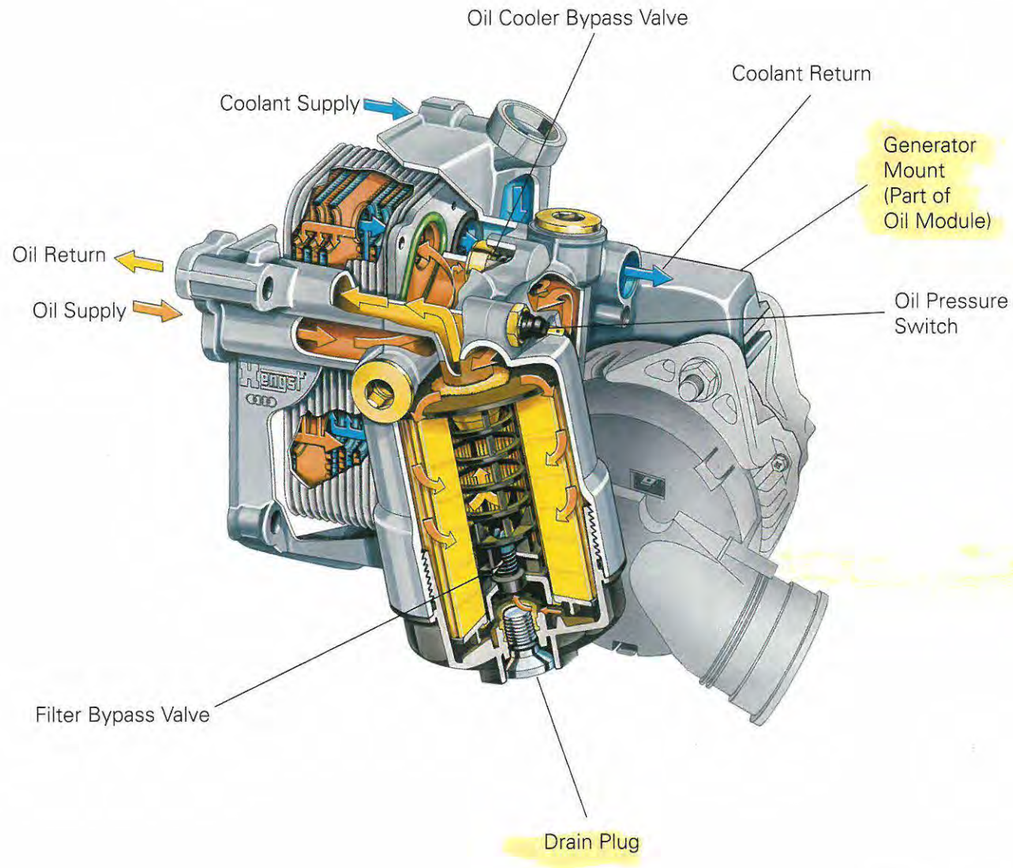



SSP 217/011

### Oil Filter Module (A8)

The oil filter module contains the oil filter and oil cooler. It is also used to hold the generator.

As in earlier engines, the oil cooler is designed as a coolant-to-oil heat exchanger. The "housing-less" oil cooler is bolted to the oil filter module using an O-ring seal to form a single unit.

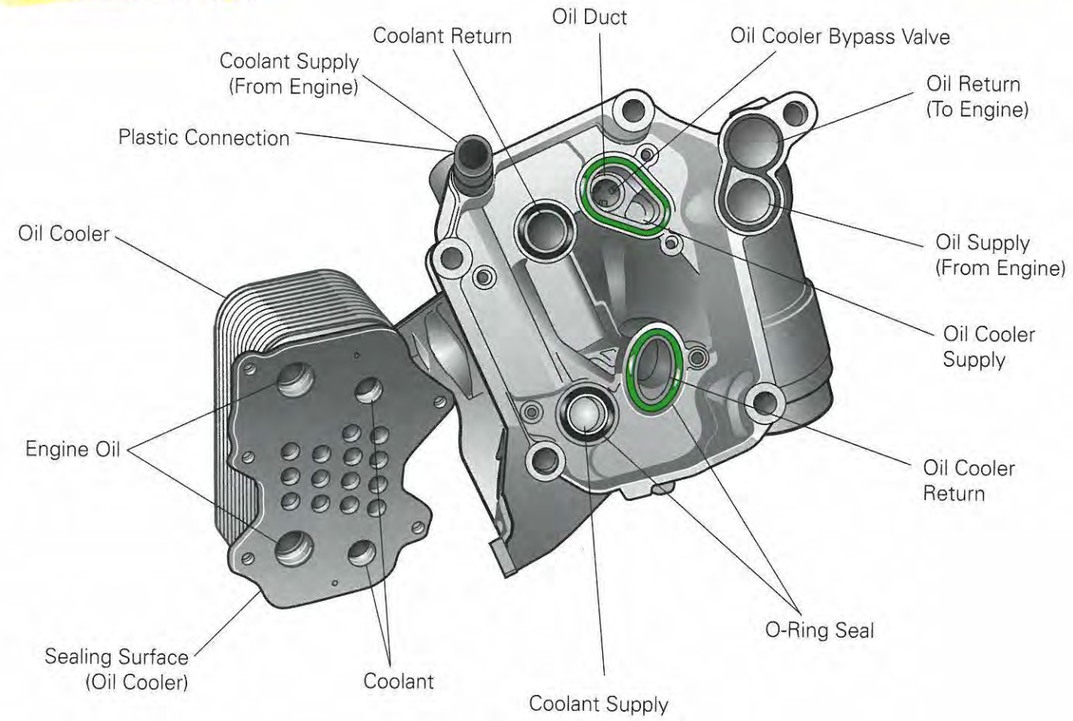



SSP 217/013





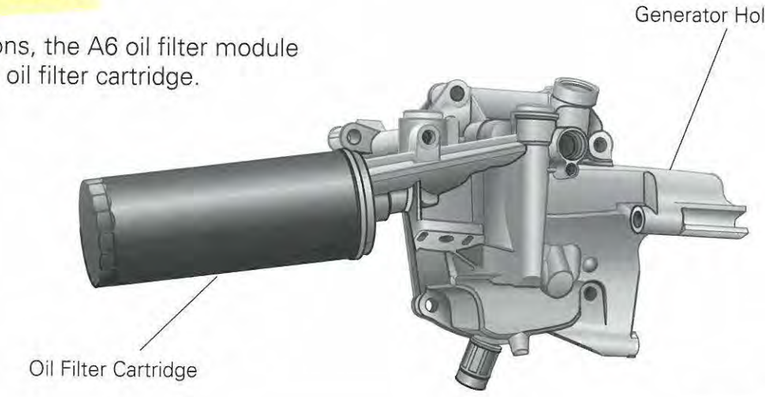
### Oil Filter Module (A8)




SSP 217/014

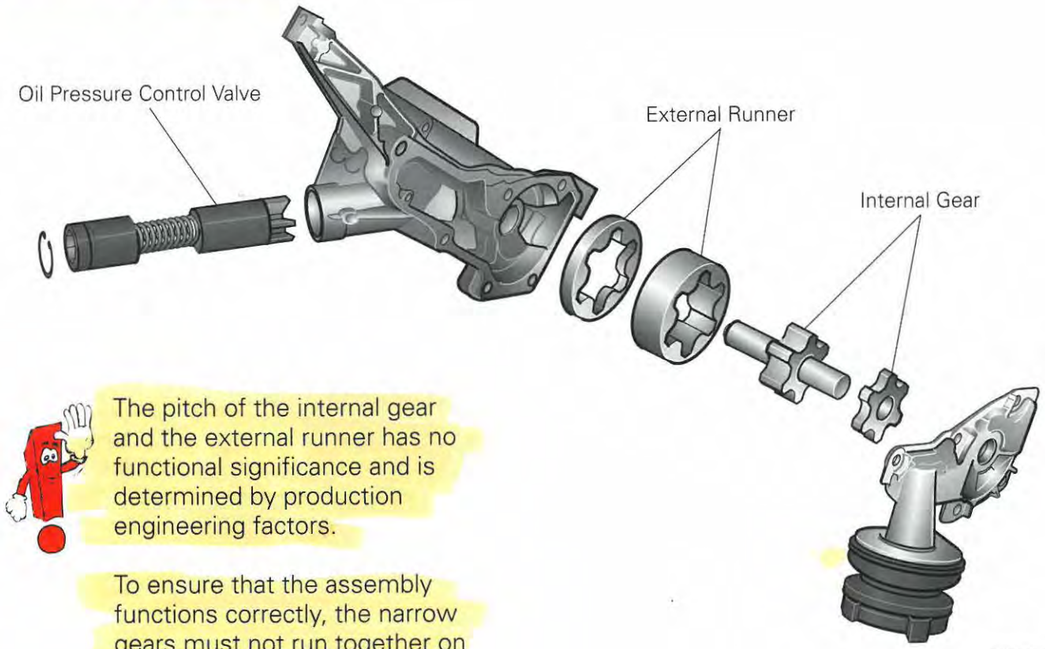
### Oil Filter Module (A6)

For space reasons, the A6 oil filter module is fitted with an oil filter cartridge.




SSP 217/003

## Duocentric Oil Pump




SSP 217/012

The pitch of the internal gear and the external runner has no functional significance and is determined by production engineering factors.

To ensure that the assembly functions correctly, the narrow gears must not run together on the same plane.


SSP 217/063

## Oil Level Sensor

The oil level sensor functions as an information sender which allows the flexible service interval to be calculated and the oil level warning to be displayed in the instrument cluster.

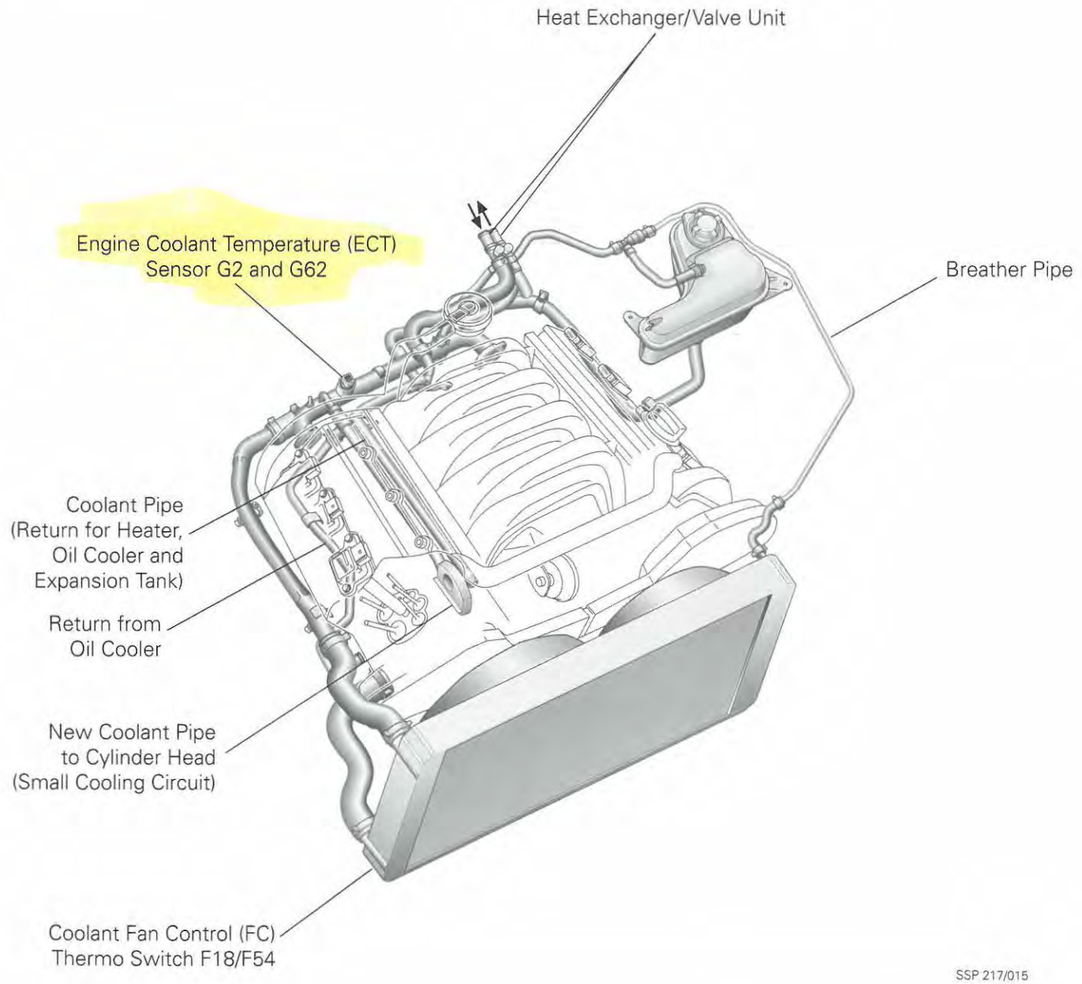
The Flexible Service Interval feature will be available on U.S. models at a later date.





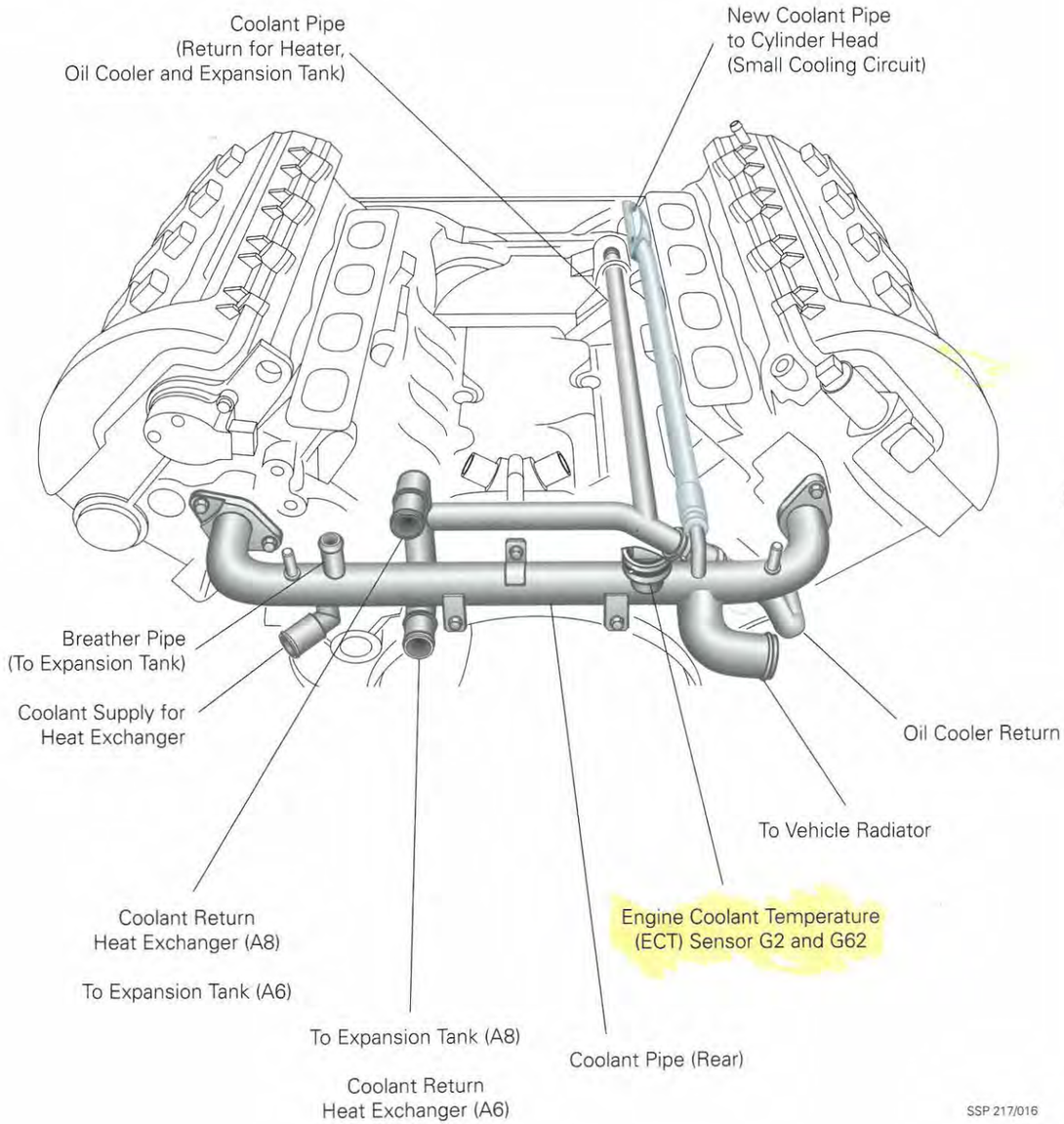
## Cooling Circuit

The flow direction of the coolant has been changed in the new V8 5-valve engines. As with the V6 engines, the coolant leaving the cylinder heads merges in the rear coolant pipe from where it is then led off to the cooler.




SSP 217/015

The new coolant pipe alters the coolant flow in the "small" cooling circuit.




SSP 217/016





**Previous Design:**

In the previous design the coolant thermostat was connected to the "small coolant circuit" via two holes in the cylinder crankcase (see Fig. 217/017).

The holes were directly connected to the cylinder-head water jacket (first cylinder) and the water jacket of the cylinder crankcase. The heated coolant flowed from the first cylinder to the coolant thermostat.

**New Design — Modified Components:**

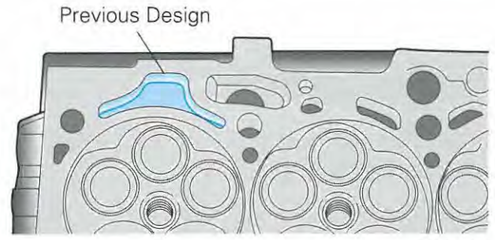
- Cylinder head in bank 1 modified
- Additional coolant pipe
- Rear coolant pipe modified

The connection in the cylinder head to the water jacket in the cylinder crankcase has been split (see Fig. 217/019).

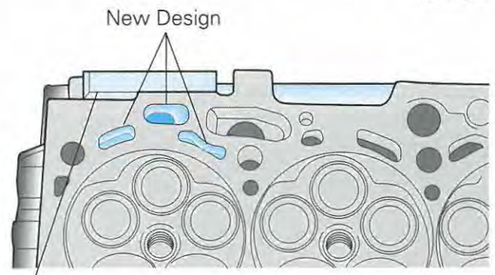
The coolant from the rear coolant pipe is divided by the new coolant pipe (mixture from all cylinders) and then passes through the cylinder head to the two holes which lead off to the coolant thermostat.

This ensures uniform temperature control.

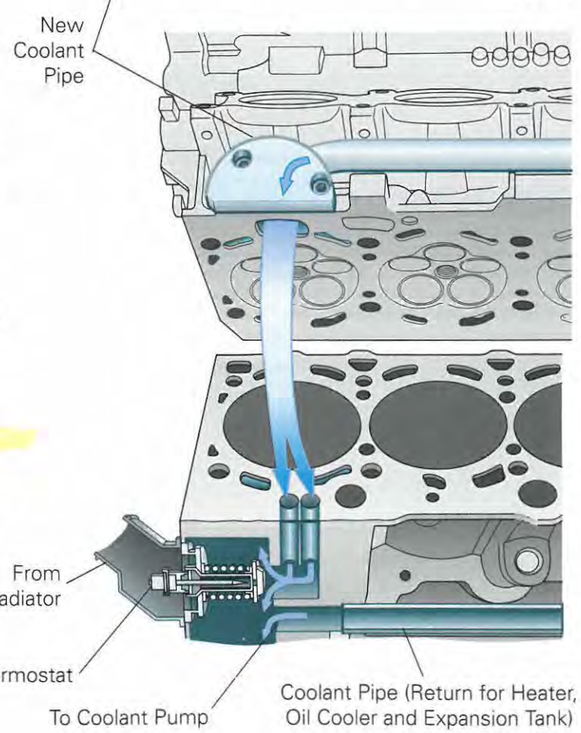
The function of the cylinder head is to connect the coolant pipe to the two holes leading off to the coolant thermostat.




SSP 217/018




SSP 217/019




SSP 217/017

## Cylinder Head

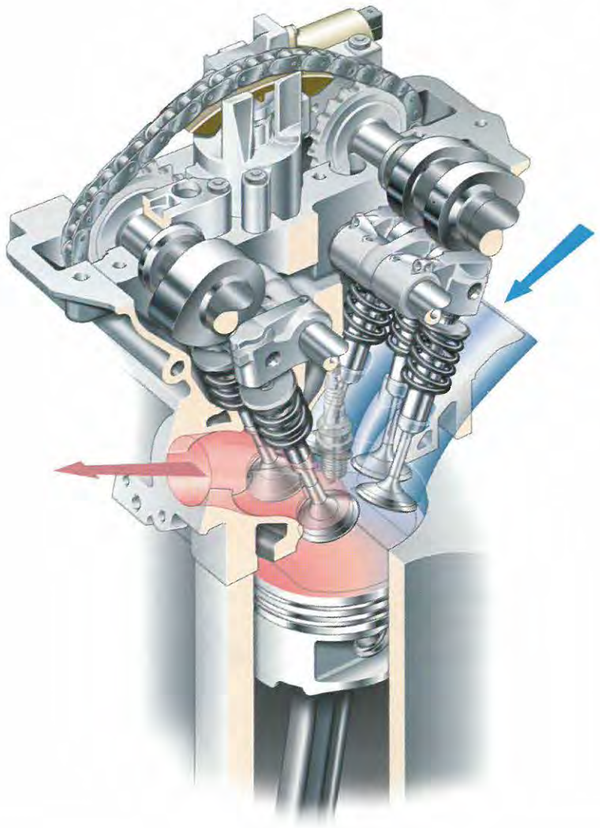
### Five-Valve Technology

Five-valve technology is now also being used in the V8 engines.

Roller rockers are being used for the first time in the enhanced five-valve cylinder head. This considerably reduces frictional losses in the valve train which, in turn, significantly improves efficiency.

The rockers are made of die-cast aluminum in order to keep inertia forces as low as possible. As a result, the valve train is able to function reliably at engine speeds of up to 7200 rpm.

The use of roller rockers has not only meant a considerable reduction in frictional losses in the valve train, but has also halved the oil delivery rate in the cylinder heads. This also has a positive effect on the degree of efficiency.



SSP 217/020





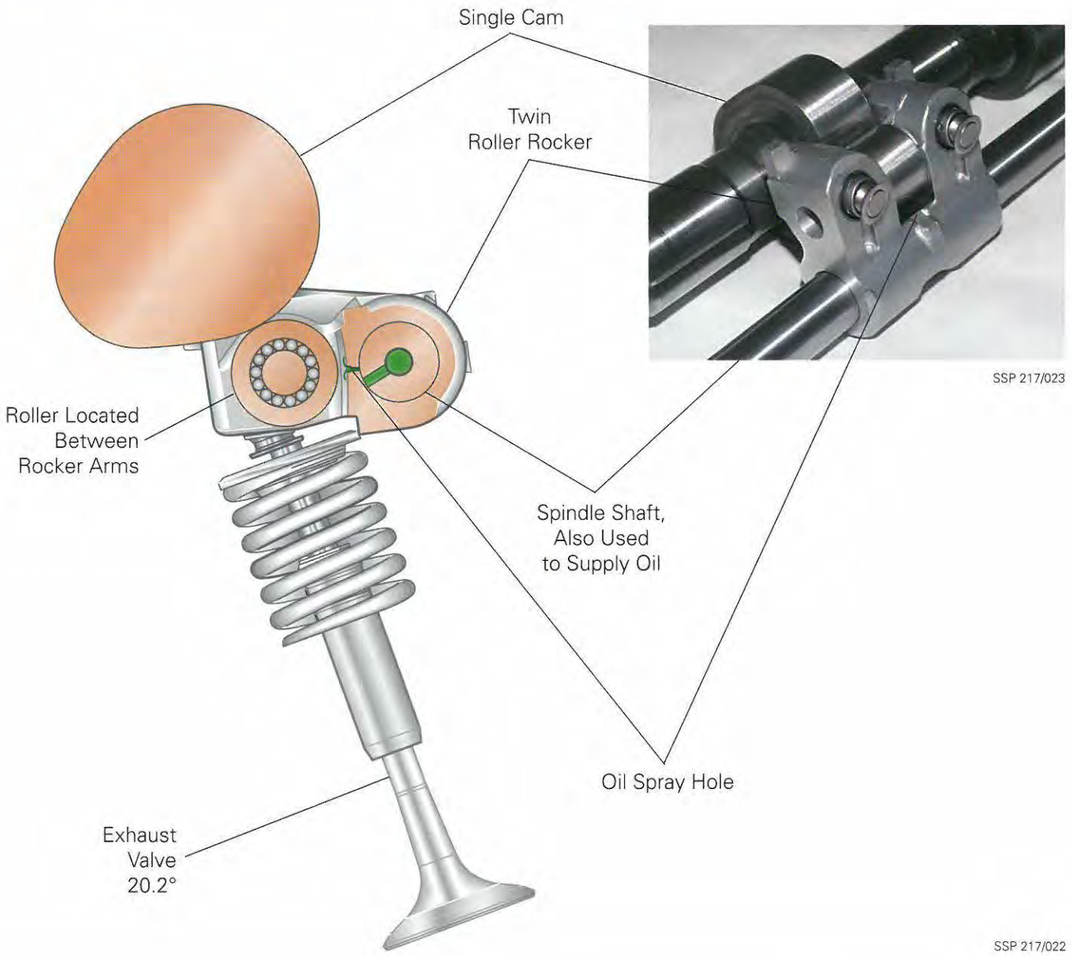
### Exhaust Valve Roller Rockers

Every valve has a hydraulic valve lifter which is integrated in the rocker. The rockers are supported by a spindle shaft which is also used to supply oil to the bearings and the hydraulic valve lifters.

The two exhaust valves are actuated by a twin roller rocker.

The single cam actuates the rocker by means of a roller located between the rocker arms.

The individual hydraulic valve lifters can be replaced without removing the rockers.



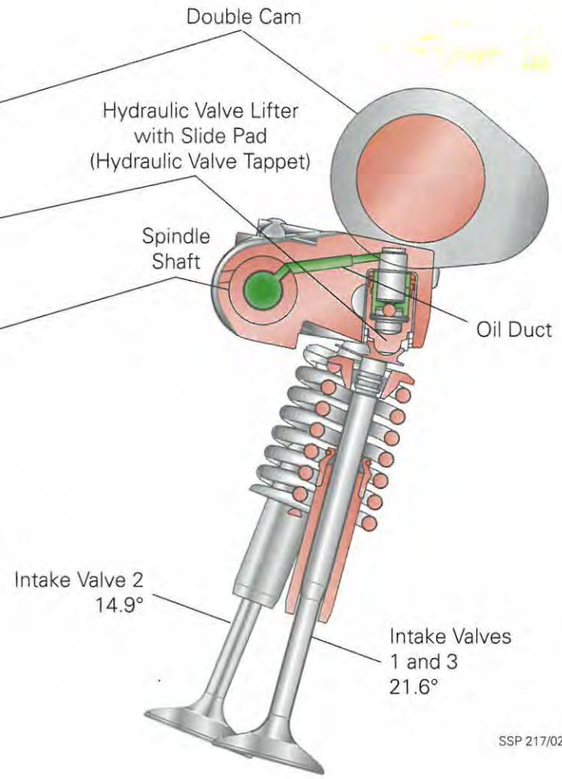

SSP 217/023

SSP 217/022

### Intake Valve Roller Rockers

SSP 217/025

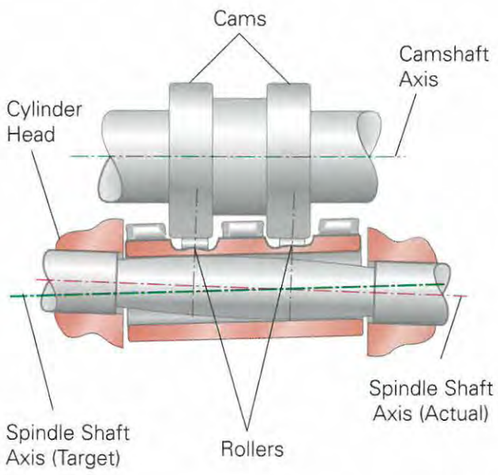
Triple Roller Rocker




SSP 217/024

The three intake valves are actuated via a triple roller rocker.

A double cam actuates the rocker by means of two rollers between the rocker arms.




SSP 217/021

### Tolerance Compensation for Intake Triple Roller Rocker

To ensure uniform compression between the two cams and rollers of the roller rockers, the spindle shaft of the intake roller rocker is convex in shape in order to compensate alignment and component tolerances. This prevents the roller rockers from "tilting."

For the sake of clarity, the tolerance of the spindle shaft relative to the camshaft has been greatly exaggerated in the illustration.





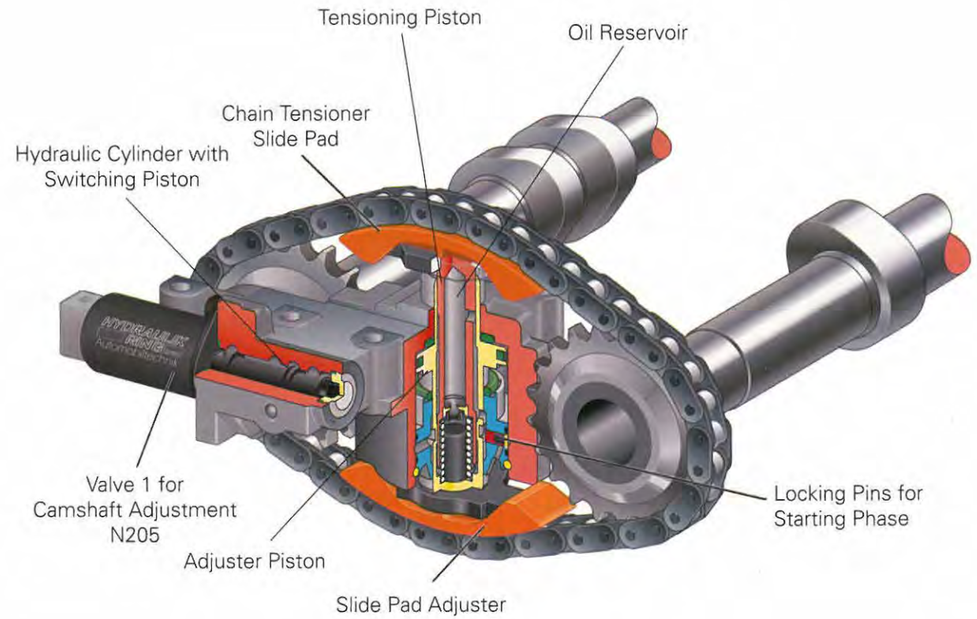
### Camshaft Adjuster (Cylinder Bank 1)

The camshaft adjustment system, a feature of many Audi engines, is also used in the new generation of V8-5V engines.

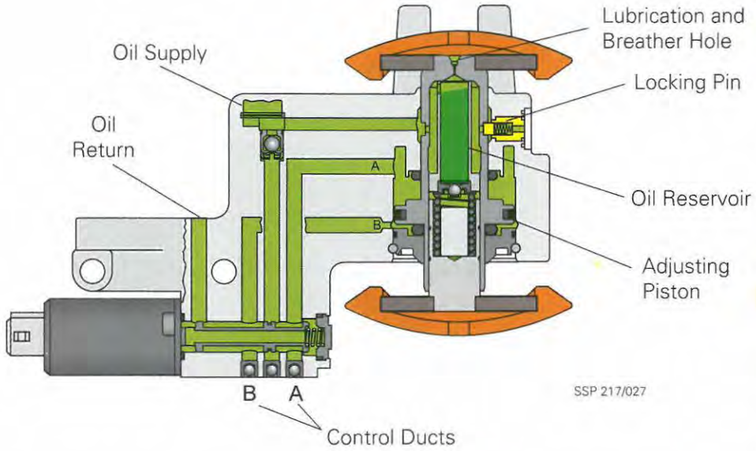
When the engine is switched off, no oil pressure is applied to the chain tensioner and camshaft adjuster.

On the new V8 engines, an interlock function and an oil reservoir have been added to the system.

These new features prevent vibrations in the chain drive that could cause noise during the start phase.

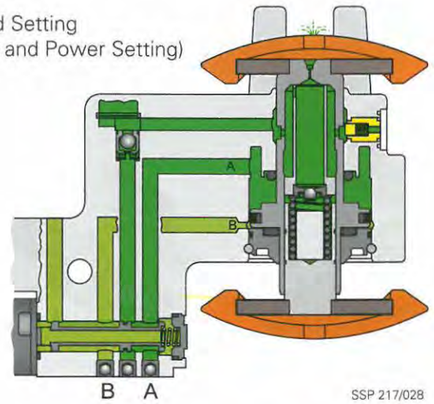



SSP 217/026



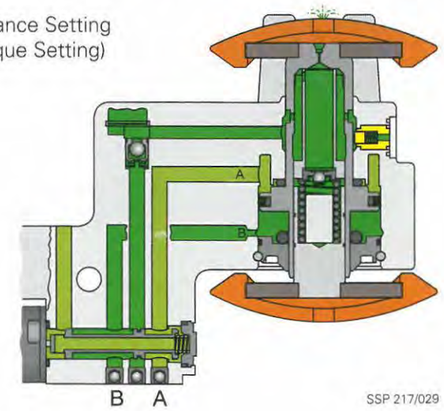

SSP 217/027

Retard Setting
(Basic and Power Setting)




SSP 217/028

Advance Setting
(Torque Setting)




SSP 217/029

**Engine Off:**

If there is no oil pressure, a spring-loaded locking pin is pushed into the detent slot of the adjusting piston. The adjusting piston is then locked.

**Engine Start:**

The adjusting piston is locked until sufficient oil pressure has built up. This prevents vibrations in the chain drive and, therefore, noise generation.

The camshaft adjuster is locked in the "Retard position."

**Engine Running:**

Once a defined oil pressure has been reached, it acts on the surface of the locking pin, i.e. against the resistance of the spring.

The locking pin releases the adjusting piston so that the engine control module can adjust the timing in the "Advance" direction.

**Oil Reservoir**

The oil reservoir ensures that the pressure chamber of the tensioner piston is filled during the non-pressurized phase of the starting cycle. This also reduces noise when the engine is started.

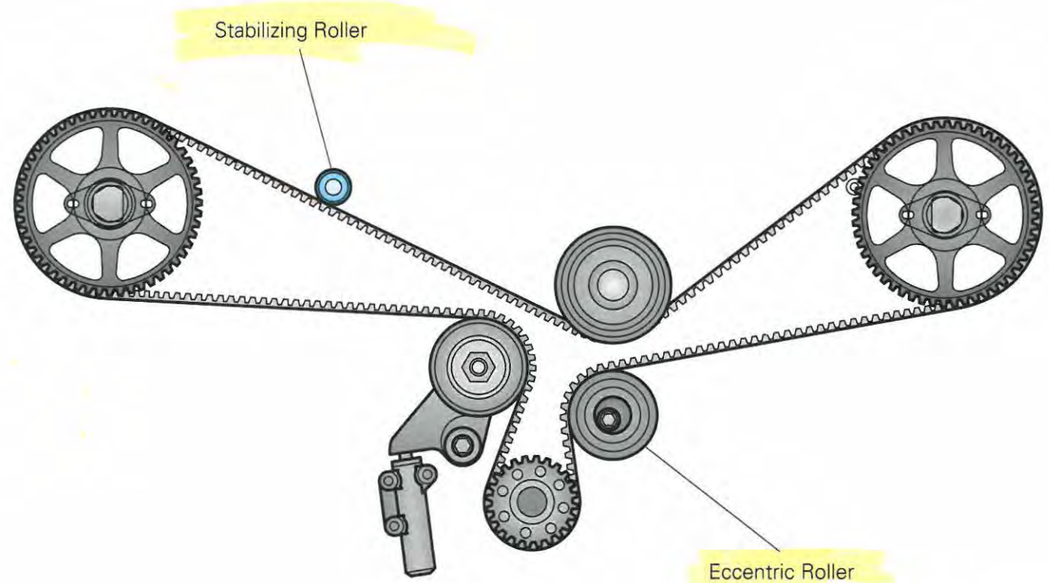
A hole in the top of the oil reservoir allows air to escape and supplies the chain with oil.





**Toothed-Belt Drive**

The V8-5V engine toothed-belt drive is nearly identical to that of the V6-5V engine. The V8-5V engine is also fitted with a stabilizing roller.




SSP 217/038

## Cylinder Head Gasket

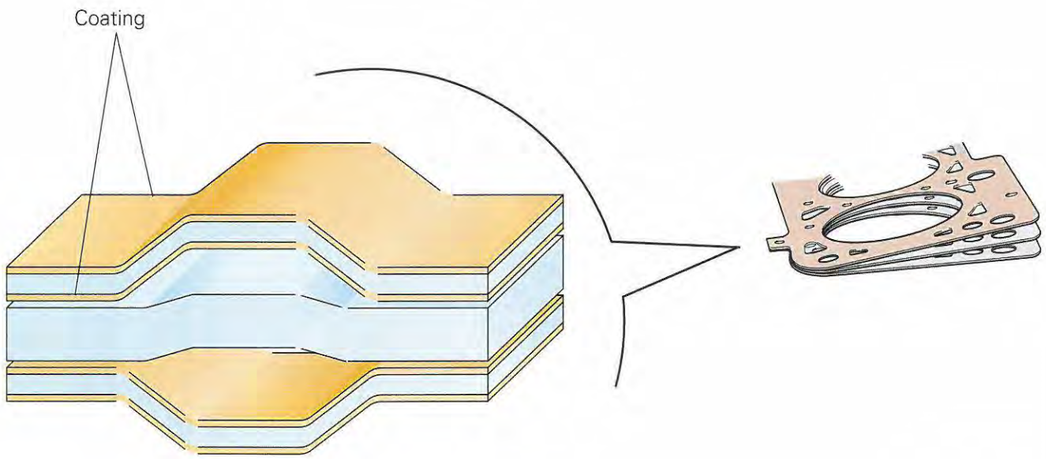
The new V8-5V engines have a multi-layer metallic cylinder head gasket like those already used in the 4- and 6-cylinder engines. This seal design replaces the soft seal design used in previous models.

The multi-layer gasket is comprised of three individual metallic layers.

The two outermost layers are treated with a special coating.

**Advantages:**

- Very good settling behavior
- Improved durability




SSP 217/056





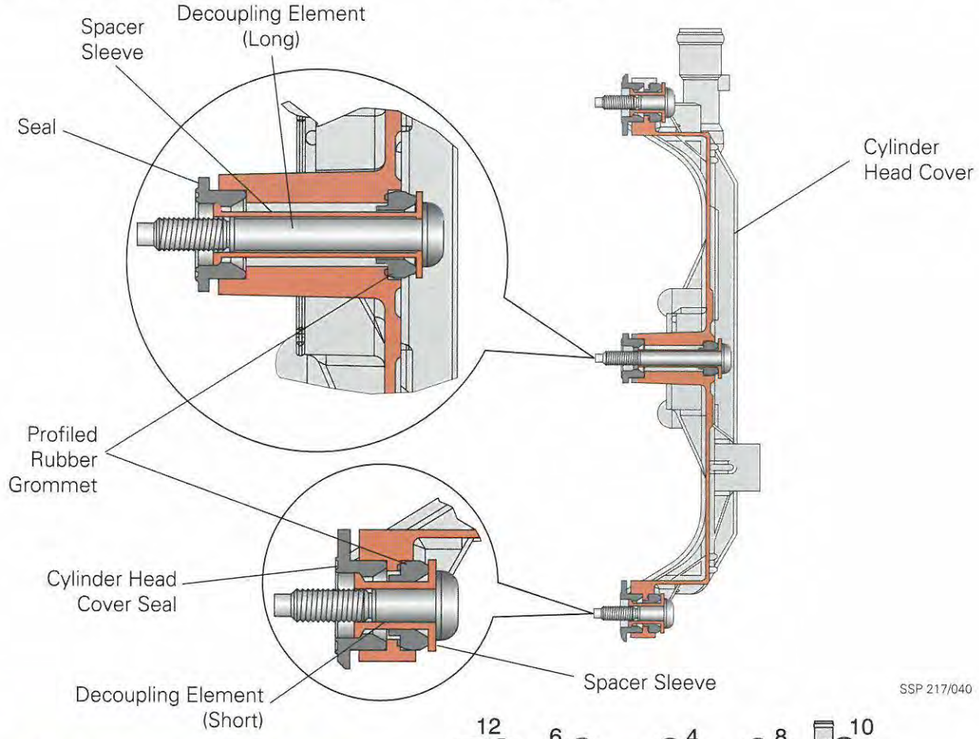
## Cylinder Head Cover Seal

The thin-wall cylinder head covers are made of a die-cast magnesium alloy. A seal system that isolates the cylinder head cover from the cylinder head reduces engine noise.

The bolted connections of the cylinder head cover have decoupling elements.

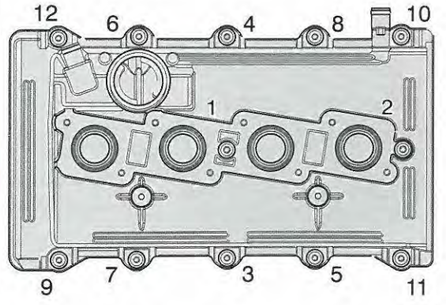
A seal, which is similar to a radial shaft oil seal, is used for the sparkplug shaft.

These techniques result in the cylinder head cover not being directly coupled with the cylinder head. It is, therefore, "insulated" against vibrations generated by the engine.




SSP 217/040

The securing bolts must be tightened uniformly in the specified order. This prevents distortion of the cylinder head cover and ensures that the seal is completely air tight. It also helps prevent oil leaks.



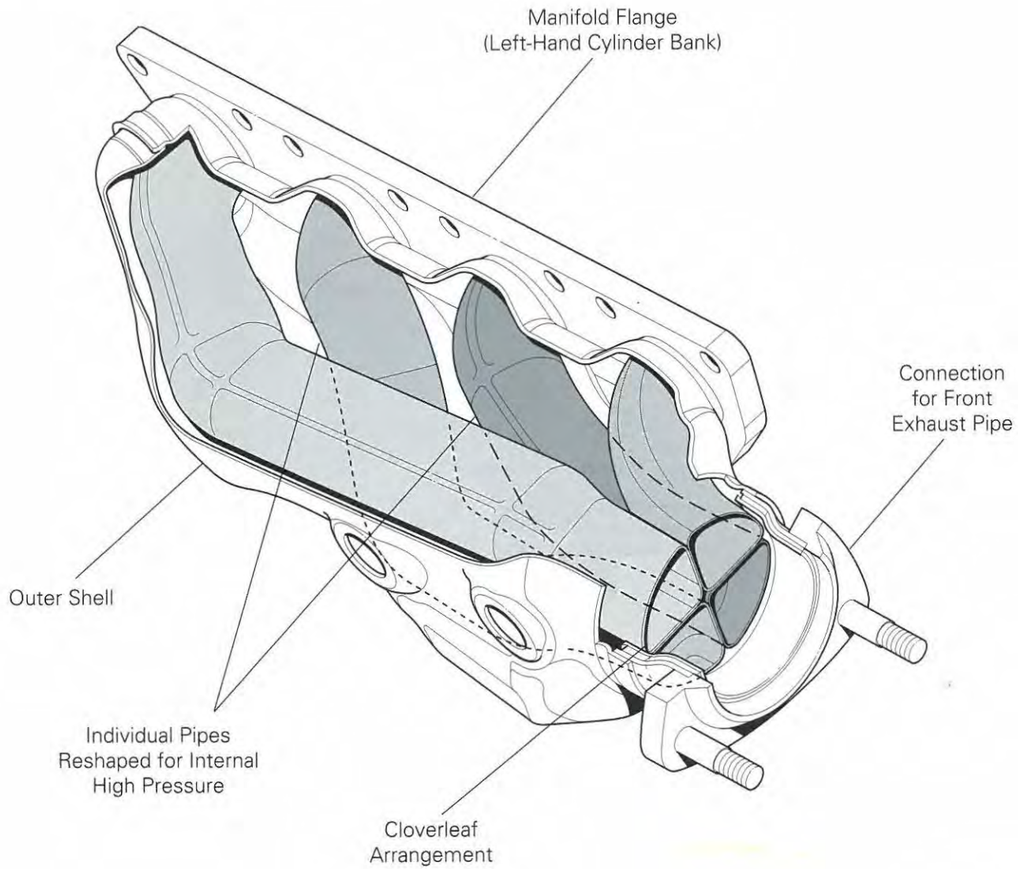

SSP 217/043

## Exhaust Manifold

The pipe sections and assembly of the air-gap-insulated exhaust manifold have been modified.

The exhaust pipes of the individual cylinders are assembled in a cloverleaf configuration for each cylinder bank (4 in 1 arrangement).

This effectively protects the individual cylinders against annoying exhaust vibrations which, in turn, has a positive effect on engine torque characteristics.

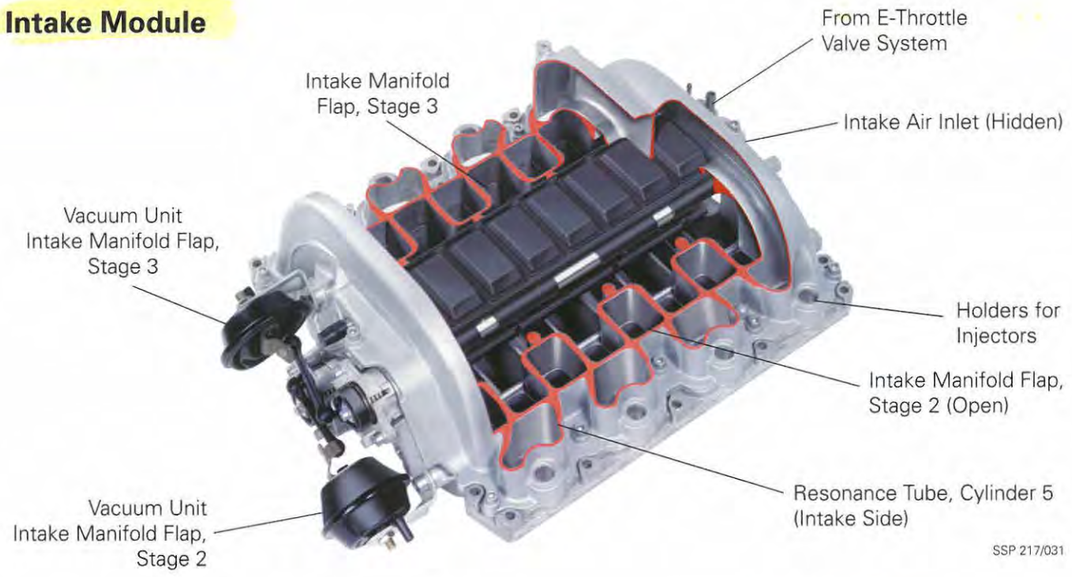



SSP 217/036





## Intake Module




SSP 217/031

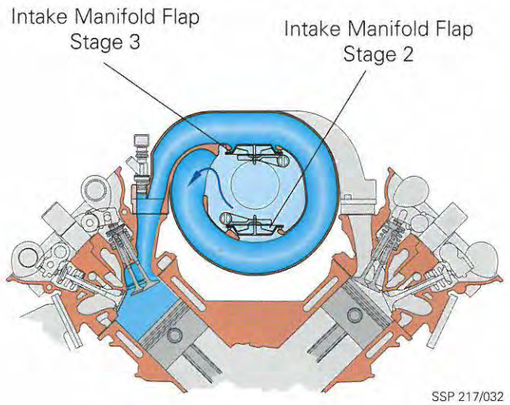
Increasing torque by means of variable intake manifolds is a tradition at Audi. A three-stage variable intake manifold made of a die-cast magnesium alloy, a further development of previous concepts, is being used for the first time.

The variable intake manifold consists of four principal housing components which are bonded and bolted together.

The concept uses two intake manifold flaps to produce three different intake manifold lengths ("resonance tube lengths"). To utilize the pulsations to optimum effect, the intake manifold flaps close the resonance tube openings by means of a molded-on sealing lip.

The variable intake manifold must not be dismantled. If necessary, the entire assembly must be replaced as a unit.

P 217/030



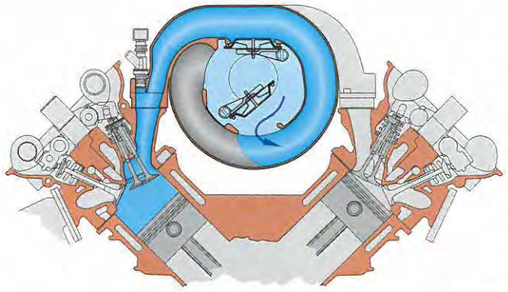

SSP 217/032

## Operating Stages

### Stage 1
### Lower Speed Range

When the engine is switched off, both flaps are open.

If the engine is idling, the two vacuum units are evacuated by the appropriate intake manifold changeover solenoid valves. The intake manifold flaps are, therefore, closed between the idling speed and the switching speed.

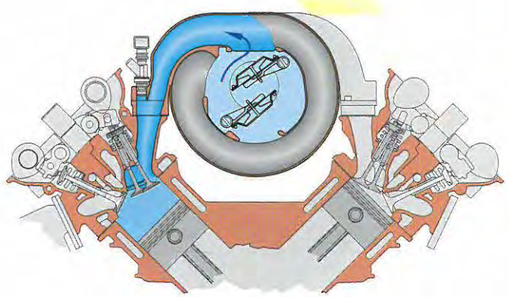


SSP 217/033

### Stage 2
### Middle Speed Range

In the middle speed range, the Intake Manifold Changeover Valve N156 allows atmospheric pressure into the vacuum unit of the stage 3 intake manifold flap.

The stage 2 intake manifold flap is opened and the intake path is shortened.



SSP 217/034

### Stage 3
### Upper Speed Range

In the upper speed range, the stage 3 intake manifold flap is also opened. The intake air takes the shortest path to the combustion chamber.



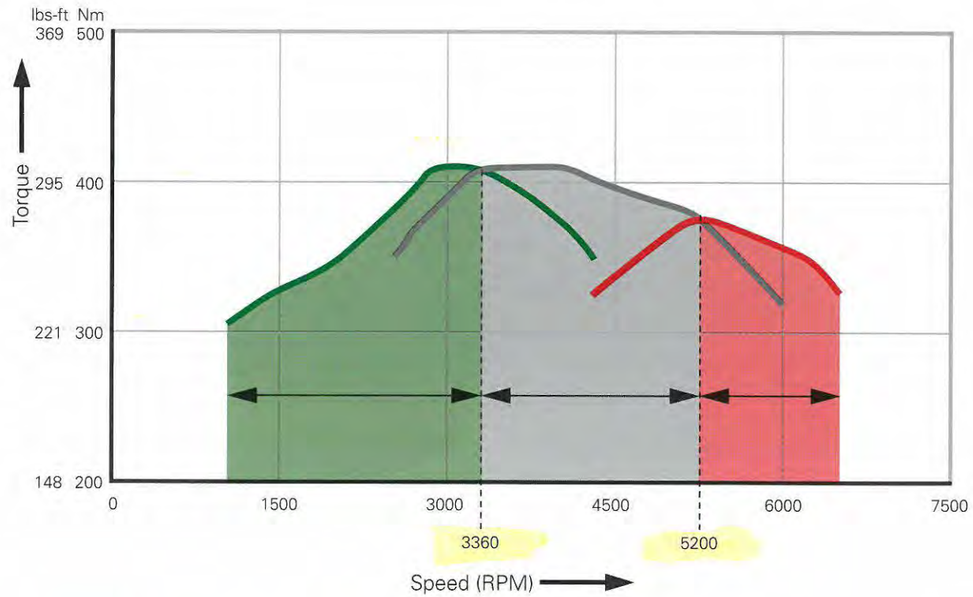


## Effect of Variable Intake Manifold on Torque

Since the maximum torque across the speed range depends primarily on the length and cross section of the intake manifold, the new three-stage variable intake manifold comes closest to producing the optimum characteristic torque curve across the speed range.

Depending on the engine speed, appropriate "resonance tube lengths" are available for the lower, middle and upper speed range.

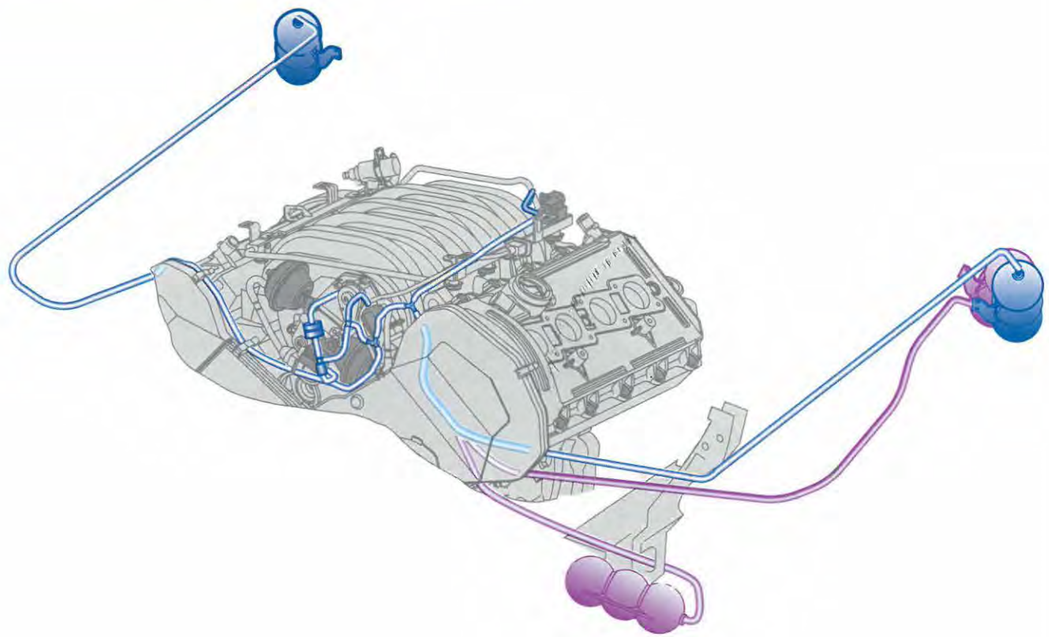
The illustration explains the correlation between the length/cross section of the intake manifold and engine speed and shows the characteristic torque curve produced by the three stages.




SSP 217/035

## Vacuum Reservoirs

The vacuum required to control the variable intake manifold and the secondary air system is provided by two vacuum reservoirs. If a vacuum exists in the intake manifold, the reservoirs are evacuated via a non-return valve.



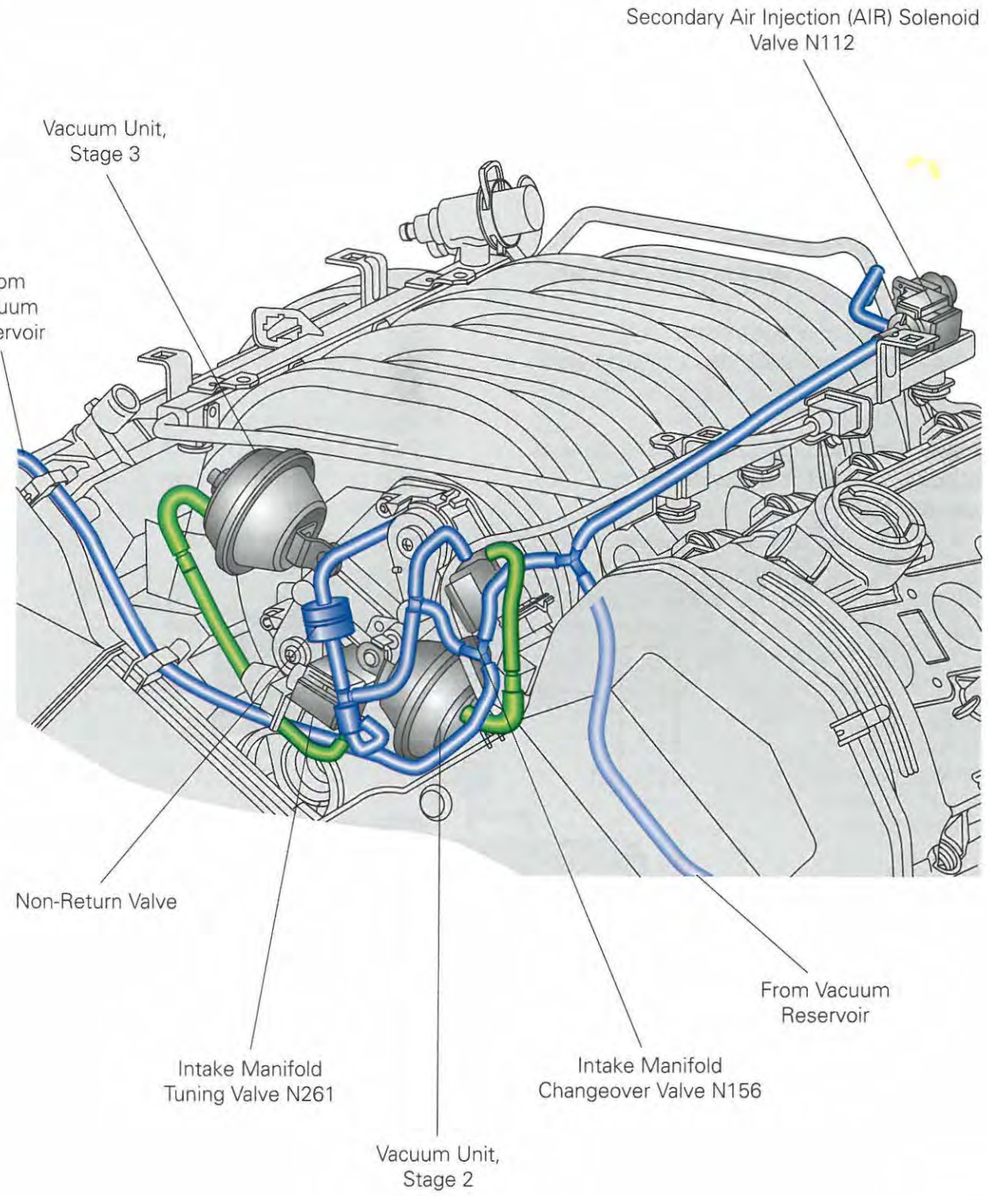
Location of Vacuum Reservoir, Audi A8

Location of Vacuum Reservoir, Audi A6

SSP 217/051








SSP 217/052

## Secondary Air System Overview

Because of high mixture enrichment during the cold-start and warm-up phase, an increased proportion of unburned hydrocarbons exists in the exhaust gas during this time.

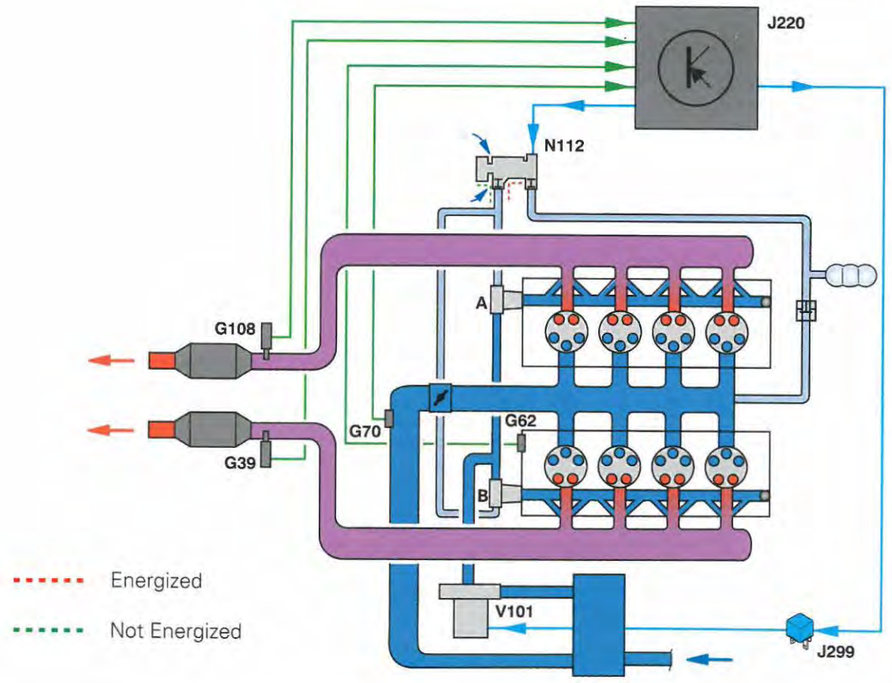
The catalytic converter cannot process this high proportion of hydrocarbons because:

1. the required operating temperature of the catalytic converter has not yet been reached and
2. a stoichiometric mixture (14.7 : 1 air-fuel ratio) must exist to allow complete conversion.

Air injection downstream of the outlet valves causes oxygen enrichment of the exhaust gases. As a result, the hydrocarbons and the carbon monoxide undergo post-oxidation (afterburning). The thermal energy released during this process also heats up the catalytic converter so that it reaches its operating temperature more quickly.

The secondary air system consists of

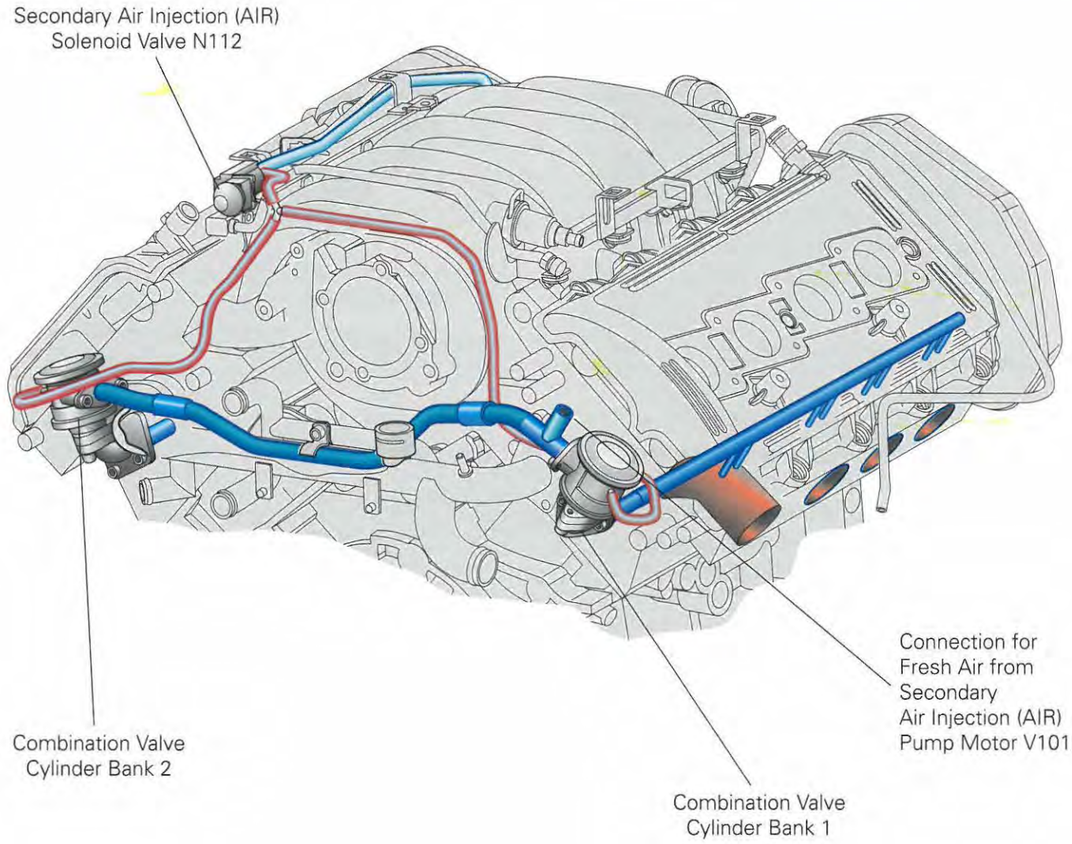
- the Secondary Air Injection (AIR) Pump Motor V101
- two combination valves A + B
- the Secondary Air Injection (AIR) Solenoid Valve N112




SSP 217/ 0042








SSP 217/001

Vacuum from Engine

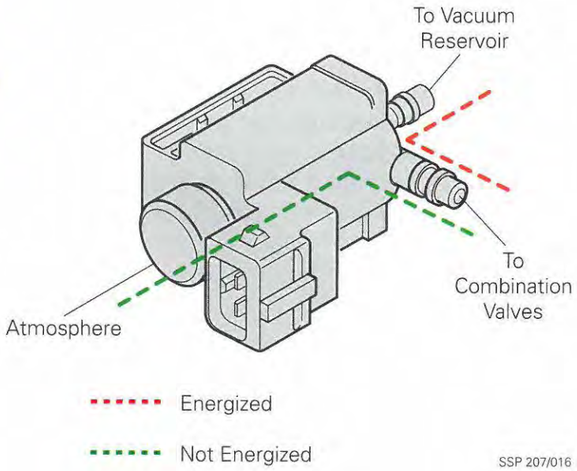
Control Line (Vacuum or Atmospheric Pressure from Secondary Air Injection (AIR) Solenoid Valve N112)

Fresh Air from Secondary Air Injection (AIR) Pump Motor V101

## Component Function

### Secondary Air Injection (AIR) Solenoid Valve N112

The secondary air injection (AIR) solenoid valve is an electro-pneumatic valve. It is activated by the Motronic engine control module and controls the combination valve. It releases the vacuum stored in the reservoir to open the combination valve. Atmospheric pressure is released to close the combination valve.

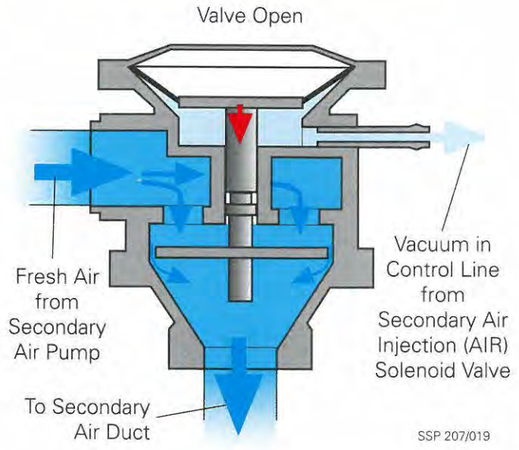



SSP 207/016

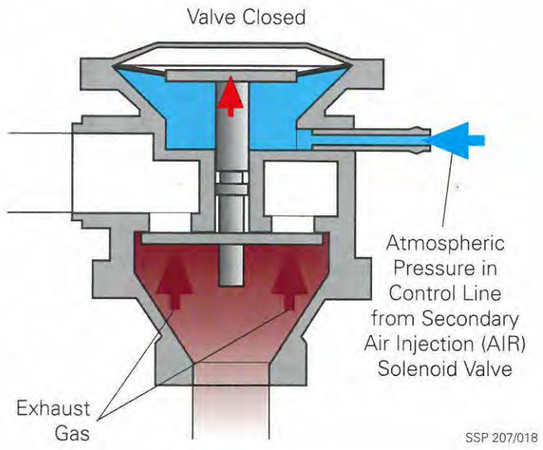
### Combination Valve

The combination valve is bolted to the secondary air duct of the cylinder head. The vacuum from the secondary air injection (AIR) solenoid valve causes the air channel between the secondary air pump and the secondary duct of the cylinder head to open.

At the same time, the valve prevents hot exhaust gases from entering and then damaging the secondary air pump.




SSP 207/019




SSP 207/018





### Secondary Air Injection (AIR) Pump Motor V101

The Secondary Air Injection (AIR) Pump Relay J299 activated by the Motronic engine control module connects the power supply for the Secondary Air Injection (AIR) Pump Motor V101. The fresh air is drawn from the air filter housing by the secondary air pump and released by the combination valve.

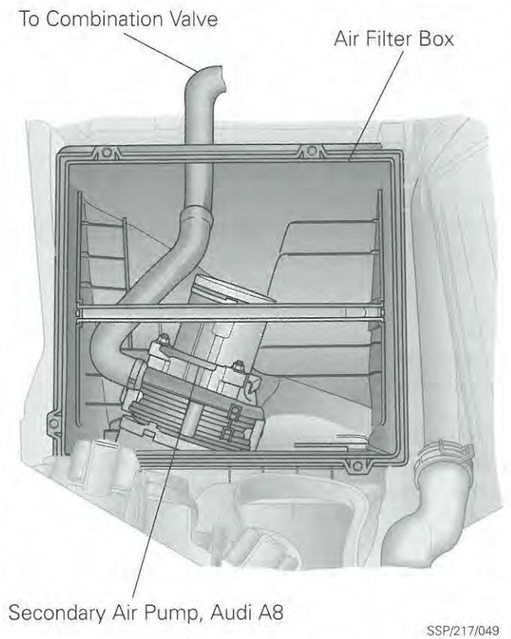
The secondary air pump in the Audi A8 has its own air filter. The pump is integrated in the air filter housing where it draws in unfiltered air.

The secondary air system is active at coolant temperatures between 32° and 131°F (0° and 55°C.)

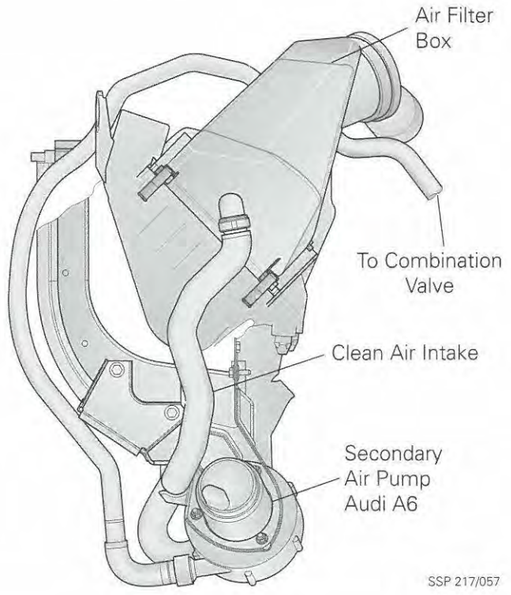
The Secondary Air Injection (AIR) Pump Relay J299 and the Secondary Air Injection (AIR) Solenoid Valve N112 are activated simultaneously.

The system is switched off after a defined air mass has been drawn in by the motor (information from the mass air flow (MAF) sensor). At idling speed, this occurs after approximately 60 - 90 seconds.

The secondary air pump in the Audi A6 does not have its own air filter. It is mounted to the longitudinal member and draws filtered air from the air filter box.




SSP/217/049




SSP 217/057

## Motronic ME 7.1 System Overview

### Sensors

Mass Air Flow (MAF) Sensor G70

Engine Speed (RPM) Sensor G28

Camshaft Position (CMP) Sensors (Bank 2) G40 and (Bank 1) G163

Heated Oxygen Sensors (HO2S) G39 and G108; G130 and G131

Throttle Valve Control Module J338 with Angle Sensors (1) G187 and (2) G188 for Throttle Valve Drive (Power Accelerator Actuation) G186

Engine Coolant Temperature (ECT) Sensors G2 and G62

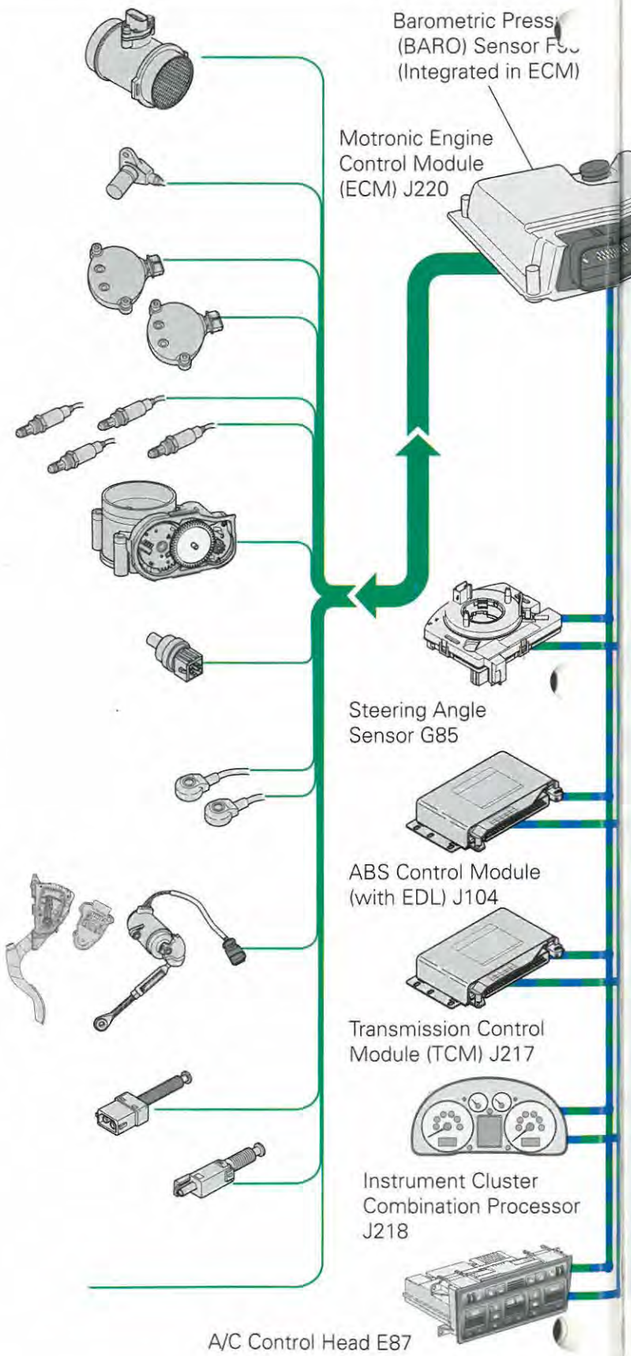
Knock Sensors (KS) (Bank 1) G61 and (Bank 2) G66

Sender -1- for Accelerator Pedal Position G79 and Sender -2- for Accelerator Pedal Position G185

Brake Light Switch F and Brake Pedal Switch F47

Clutch Vacuum Vent Valve Switch F36 (With Manual Transmission Only)

Additional Signals
- Air Conditioner Requirement Signal
- Air Conditioner Compressor, Bidirectional
- Crash Signal
- Cruise Control Switch E45
- LDP Vacuum Switch
- Vehicle Speed Sensor Signal








### Actuators

Fuel Pump (FP) Relay J17 and Fuel Pump (FP) G6

Fuel Injectors (Bank 1) N30, N31, N32, N33

Fuel Injectors (Bank 2) N83, N84, N85, N86

Ignition Coils N (Cyl. 1), N128 (Cyl. 2), N158 (Cyl. 3), N163 (Cyl. 4)

Ignition Coils N164 (Cyl. 5), N189 (Cyl. 6), N190 (Cyl. 7), N191 (Cyl. 8)

EVAP Cansiter Purge Regulator Valve N80

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

Secondary Air Injection (AIR) Solenoid Valve N112

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

Valves for Camshaft Adjustment (Bank 1) N205 and (Bank 2) N208

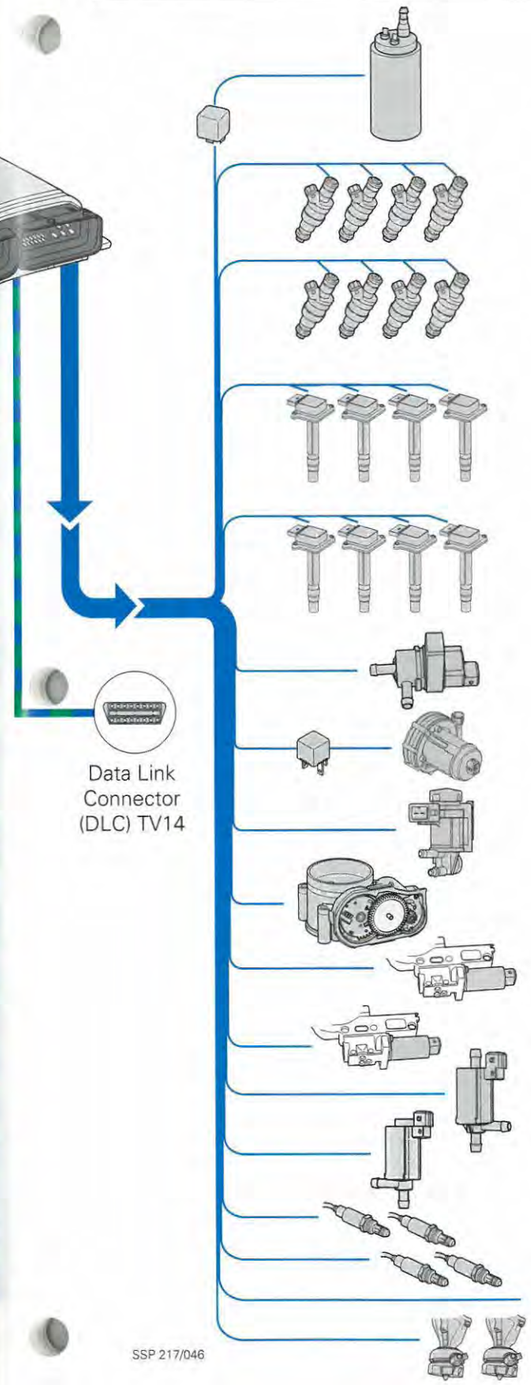
Intake Manifold Changeover Valve N156

Intake Manifold Tuning Valve N261

Oxygen Sensor (O2S) Heaters Z19 and Z28; Z29 and Z30

Additional Signals
- Air Conditioner Compressor (Out)
- LDP Reed Switch

Left Electro-Hydraulilc Engine Mount Solenoid Valve N144 and Right Electro-Hydraulic Engine Mount Solenoid Valve N145

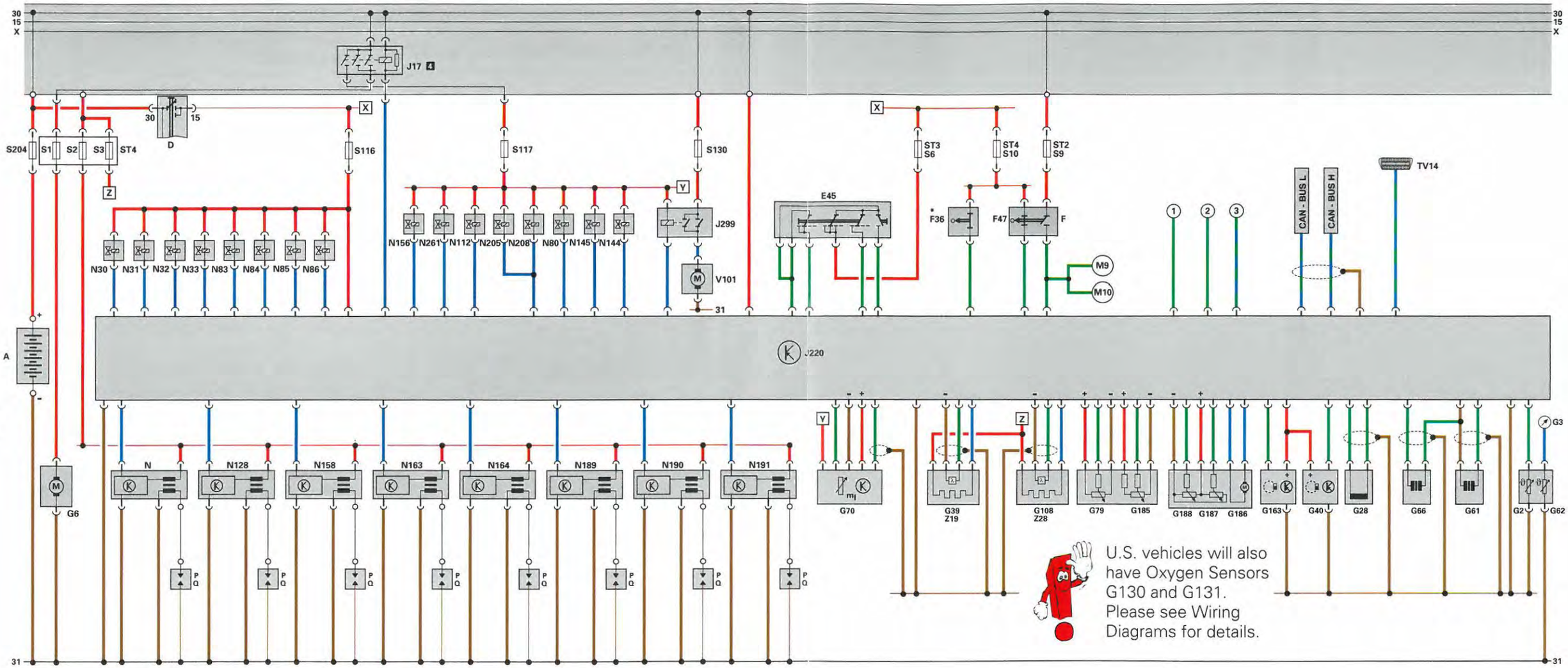


SSP 217/046

## Functional Diagram

### Components

| | |
|---|---|
| A | Battery |
| E45 | Cruise Control Switch |
| D | Ignition/Starter Switch |
| F | Brake Light Switch |
| F36 | Clutch Vacuum Vent Valve Switch (With Manual Transmission Only) |
| F47 | Brake Pedal Switch (For Cruise Control System) |
| G2 | Engine Coolant Temperature (ECT) Sensor |
| G3 | Engine Coolant Temperature (ECT) Gauge |
| G6 | Fuel Pump (FP) |
| 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 | Sender -1- for Accelerator Pedal Position |
| G108 | Heated Oxygen Sensor (HO2S) 2 |
| G130 | Oxygen Sensor, Behind Three Way Catalytic Converter |
| G131 | Oxygen Sensor, Behind Three Way Catalytic Converter |
| 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 (Power Acclerator Actuation) |
| G188 | Angle Sensor -2- for Throttle Drive (Power Acclerator Actuation) |
| J17 | Fuel Pump Relay |
| J220 | Motronic Engine Control Module (ECM) |
| J299 | Secondary Air Injection (AIR) Pump Relay |
| M9 | Left Brake Light |
| M10 | Right Brake Light |
| N | Ignition Coil |
| N30 | Cylinder 1 Fuel Injector |
| N31 | Cylinder 2 Fuel Injector |
| N32 | Cylinder 3 Fuel Injector |
| N33 | Cylinder 4 Fuel Injector |
| N80 | Evaporative Emissions (EVAP) Canister Purge Regulator Valve |
| N83 | Cylinder 5 Fuel Injector |
| N84 | Cylinder 6 Fuel Injector |
| N85 | Cylinder 7 Fuel Injector |
| N86 | Cylinder 8 Fuel Injector |
| N112 | Secondary Air Injection (AIR) Solenoid Valve |
| N128 | Ignition Coil 2 |
| N144 | Left Electro-Hydraulic Engine Mount Solenoid Valve |
| N145 | Right Electro-Hydraulic Engine Mount Solenoid Valve |
| N156 | Intake Manifold Change-over Valve |
| N158 | Ignition Coil 3 |
| N163 | Ignition Coil 4 |
| N164 | Ignition Coil 5 |
| N189 | Ignition Coil 6 |
| N190 | Ignition Coil 7 |
| N191 | Ignition Coil 8 |
| N205 | Valve 1 for Camshaft Adjustment |
| N208 | Valve 2 for Camshaft Adjustment |
| N261 | Intake Manifold Changeover Valve 2 |
| P | Spark Plug Connector |
| Q | Spark Plugs |
| S | Fuse |
| ST | Fuse Holder |
| V101 | Secondary Air Injection (AIR) Pump Motor |
| Z19 | Oxygen Sensor (O2S) Heater |
| Z28 | Oxygen Sensor (O2S) 2 Heater |
| Z29 | Oxygen Sensor (O2S) Heater |
| Z30 | Oxygen Sensor (O2S) 2 Heater |




S204 Fuse 1 (30)

Location in Audi A6: Plenum Chamber Next to Battery

Location in Audi A8: Top Right in Luggage Compartment

Additional Signals and Connections

- Data Link Connector (DLC) TV14
- (1) Crash Signal (In) from Airbag Control Module
- (2) Air Conditioner Requirement Signal (In)
- (3) Air Conditioner Compressor Signal (In-Out)

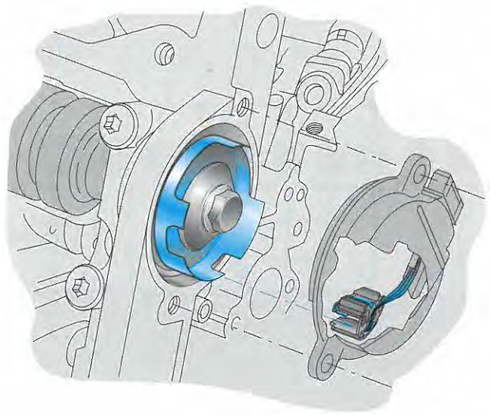
CAN-Bus L
CAN-Bus H
} Connection to Data Bus

X
Y
Z
} Connections in Functional Diagram

**Color Codes**

- Input Signal
- Output Signal
- Positive
- Ground
- Bidirectional

SSP 217/044



SSP 217/053

## Quick-Start Functions

### Camshaft Position (CMP) Sensors G40 and G163

As with the V6-5V engines, the new V8-5V engines also have two sensors for determining the position of the camshaft (G40 and G163).

The sender system with "quick-start rotor ring" already used in the 4-cylinder 5-valve engines is implemented.

The quick-start rotor ring is a shutter wheel with four alternating vanes and air gap openings — two wide and two narrow.

When an air gap is in the pickup range, the sensor is subjected to a greater magnetic field and the signal output is high. When a rotor vane is in the sensor pickup range, the signal output is low.

The alternating vanes and air gaps pass the Hall sensor in a sequence that produces a distinctive pulse width pattern for each 90° of camshaft rotation as the magnetic field is interrupted by the rotor vanes.

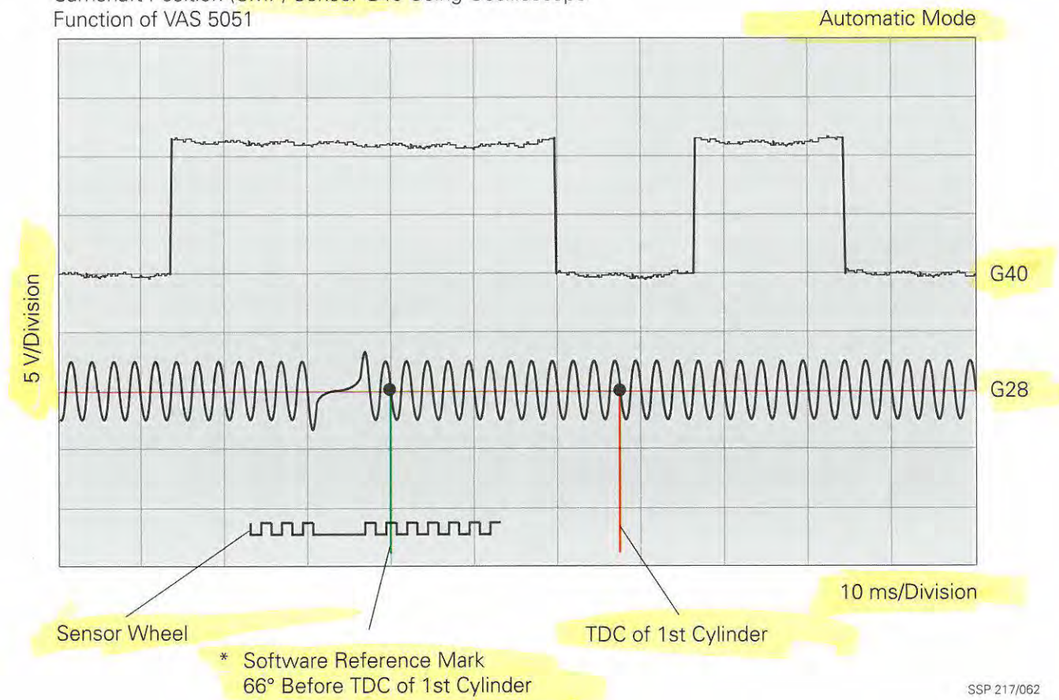
This distinctive signal pattern from Camshaft Position Sensor G40 is used together with input from Engine Speed (RPM) Sensor G28 by the Motronic Engine Control Module (ECM) J220 to determine the camshaft position relative to the crankshaft more quickly.





When the engine is started, the engine control module can thus determine the ignition TDC of the next cylinder more quickly so that the engine starts more quickly (synchronization with the first cylinder is no longer necessary). This is referred to as quick-start synchronization or the quick-start function.

Signal trace for Engine Speed (RPM) Sensor G28 and Camshaft Position (CMP) Sensor G40 Using Oscilloscope Function of VAS 5051




SSP 217/062

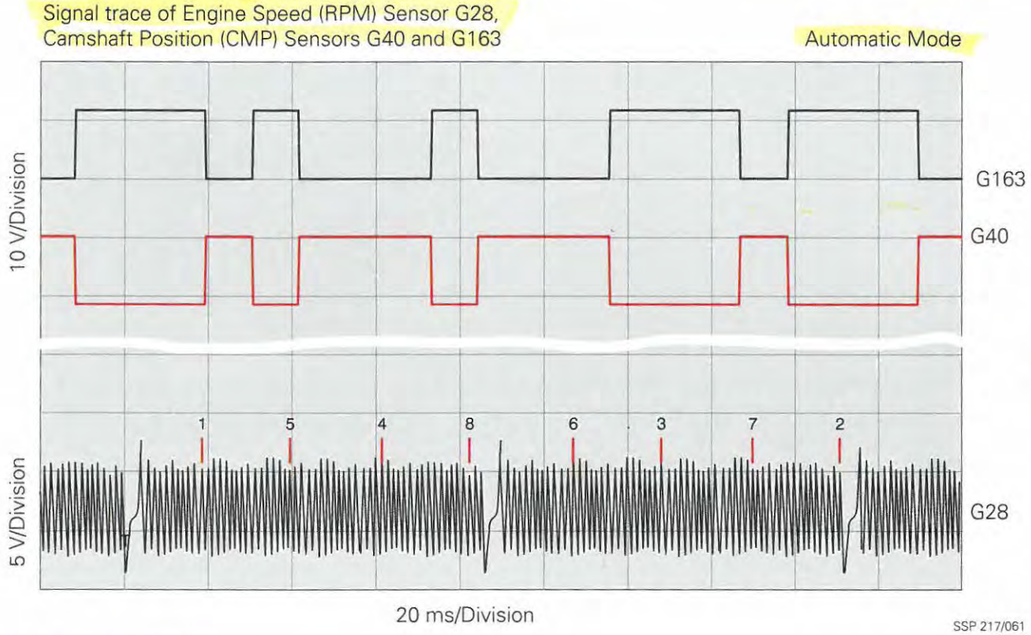
* The software reference mark is the point from which the engine control module begins its calculations to determine the ignition point. It is about one tooth after the hardware reference mark, which is approximately 66° - 67° of crankshaft rotation before ignition TDC of the first cylinder.

The Camshaft Position Sensor G163 is used to monitor camshaft adjustment and to generate a substitute signal if the G40 fails.

The Camshaft Position (CMP) Sensor G40 is mounted to cylinder bank 2.
The Camshaft Position (CMP) Sensor G163 is mounted to cylinder bank 1.

Signal trace of Engine Speed (RPM) Sensor G28, Camshaft Position (CMP) Sensors G40 and G163

Automatic Mode




SSP 217/061

## Engine Run-Down

The engine control module remains active for a defined time after the ignition has been switched off and, with the aid of the G28, "monitors" the engine as it slows to a standstill.

The position of the engine mechanical components (position of the next cylinder at ignition TDC) is stored and is available the next time the engine is started.
The ME 7.1 can immediately begin injection and has a fuel mixture ready, which results in faster starting.

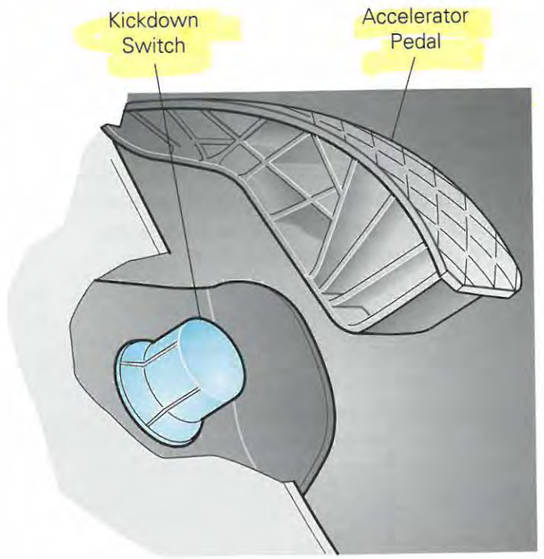




## Electronic Throttle Function

Apart from the following features, the electronic throttle functions are identical to those described in Self-Study Program, Course Number 992903, The 2.7 Liter V6 Biturbo.

The pedal sender is used in the Audi A8 and the accelerator pedal module in the Audi A6 to determine the requirements of the driver.




SSP 217/041

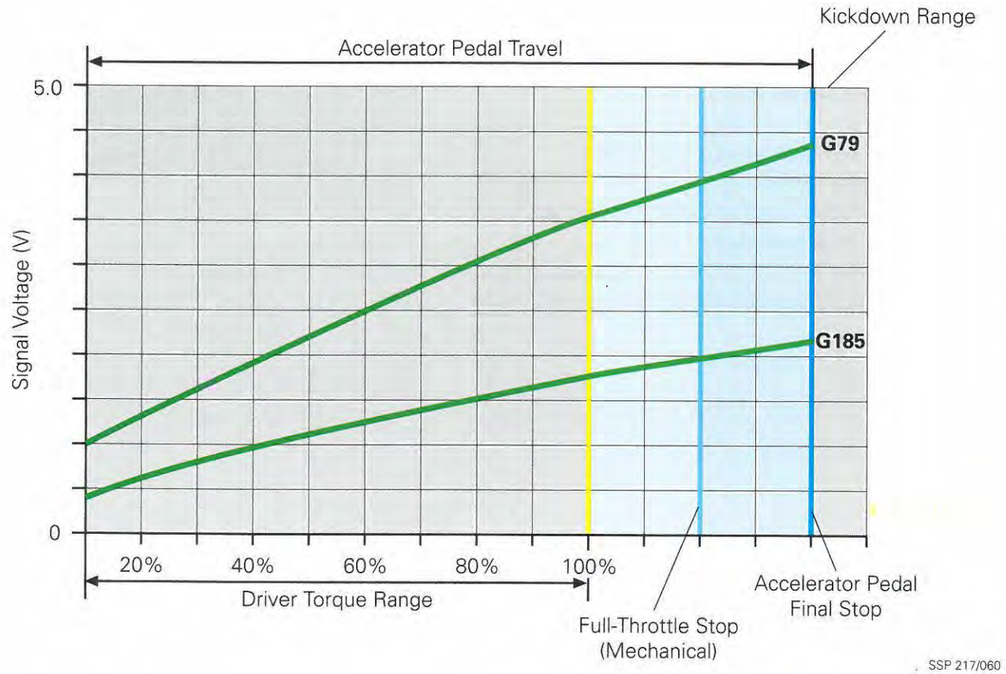
## Pedal Sender (Audi A8)

A separate switch is used to provide kickdown information.
It is located in the footwell and doubles as the accelerator pedal stop.
The full-throttle and kickdown positions must be calibrated accordingly.

### Accelerator Pedal Module (Audi A6)

No separate switch is used to provide kickdown information. In the case of automatic-transmission vehicles, the accelerator pedal stop is replaced by a pressure element. The pressure element generates a mechanical pressure point which gives the driver the "kickdown feeling."

If the driver activates the kickdown, the full-throttle voltage of the accelerator pedal position senders is exceeded. If a voltage defined in the engine control module is reached, this is interpreted as a kickdown and the information is sent to the automatic transmission via the CAN bus. The kickdown switching point can only be tested using diagnostic testers.




SSP 217/060

If the accelerator pedal module or the engine control module is changed, you will need to perform the adaptation function using the Scan Tool.

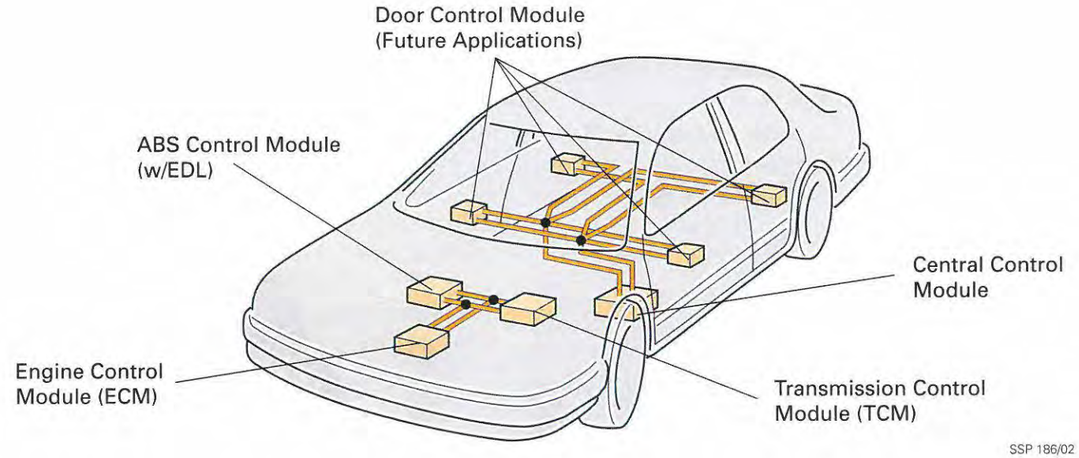




### The CAN Data Bus

is a type of data transfer between control modules. It links the individual control modules to form an integrated system.

The more information a control module has regarding the state of the overall system, the better it can coordinate the individual functions.




SSP 186/02

### Benefits of the Data Bus:

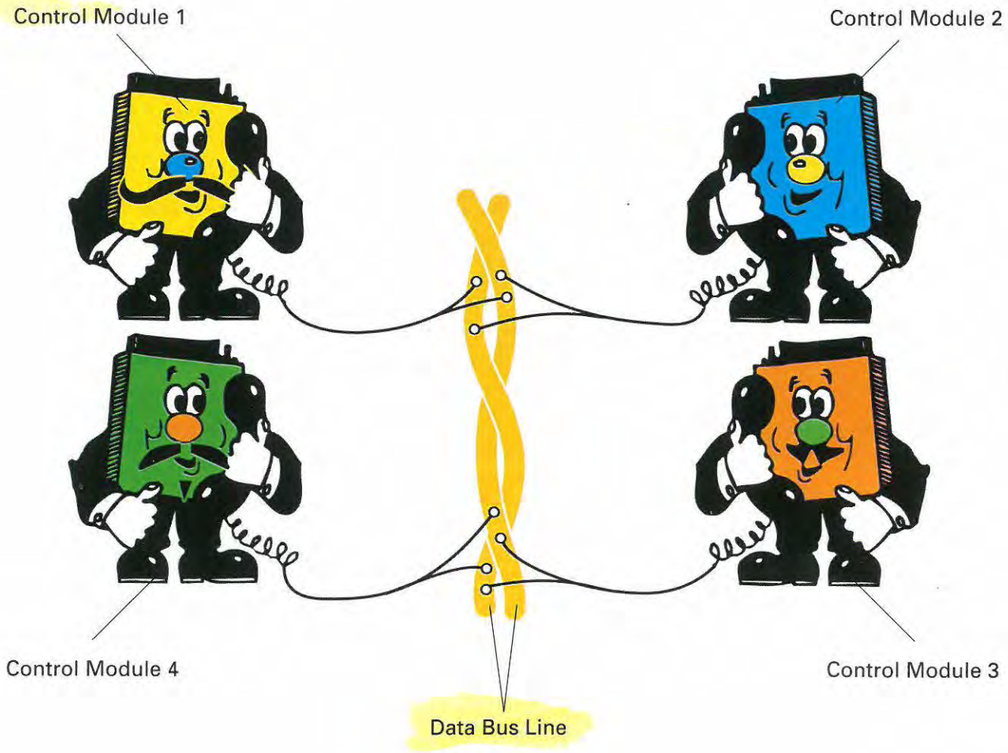
- If the data protocol is extended to include additional information, only software modifications are necessary.
- Low error rate through continuous verification of the transmitted information by the control modules as well as additional safeguards in the data protocols.
- Fewer sensors and signal lines through the multiple use of a sensor signal.
- High-speed data transfer is possible between control units.
- More space available through smaller control modules and smaller control module plugs.
- The CAN data bus conforms to international standards and therefore facilitates data interchange between different makes of control unit.

## The Principle of Data Transfer

Data transfer with the CAN data bus functions in much the same way as a telephone conference.

A subscriber (control module) "speaks" data into the line network while the other subscribers "listen in" to this data.

Some subscribers will be interested in this data and will utilize it. The other subscribers will choose to ignore this data.




SSP 186/06





## What Components Make Up a CAN Data Bus?

The CAN data bus comprises a controller, a transceiver, two data bus terminals and two data bus lines.

Apart from the data bus lines, the components are located in the control modules. The functions of the control modules are the same as before.

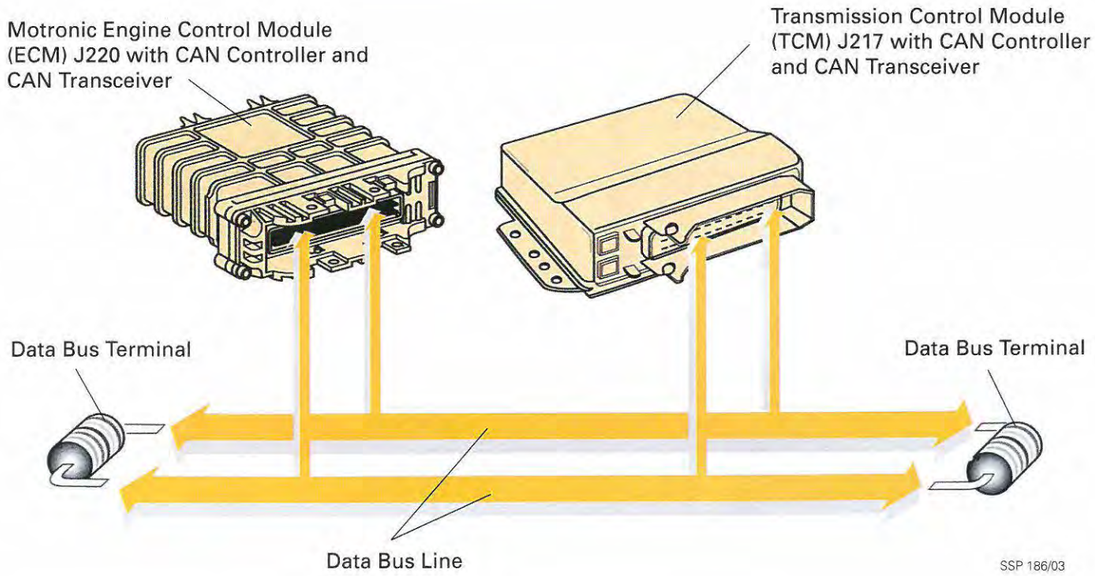
**They have the following tasks:**

**The CAN controller**
receives the transfer data from the microcomputer integrated in the control module. The CAN controller processes this data and relays it to the CAN transceiver. Likewise, the CAN controller receives data from the CAN transceiver, processes it and relays it to the microcomputer integrated in the control module.

**The CAN transceiver**
is a transmitter and receiver in one. It converts the data which the CAN controller supplies into electrical signals and sends this data over the data bus lines. Likewise, it receives data and converts this data for the CAN controller.

**The Data bus terminal**
is a resistor. It prevents data sent from being reflected at the ends and returning as an echo. This would corrupt the data.

**The Data bus lines**
are bidirectional and transfer the data. They are referred to as CAN High and CAN Low.

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The data bus does not have a designated receiver. Data is sent over the data bus and is generally received and evaluated by all subscribers.

**Data Transfer Process:**

**Supplying the data**

The control module provides data to the CAN controller for transfer.

**Sending data**

The CAN transceiver receives data from the CAN controller, converts it into electrical signals and sends them.

**Receiving data**

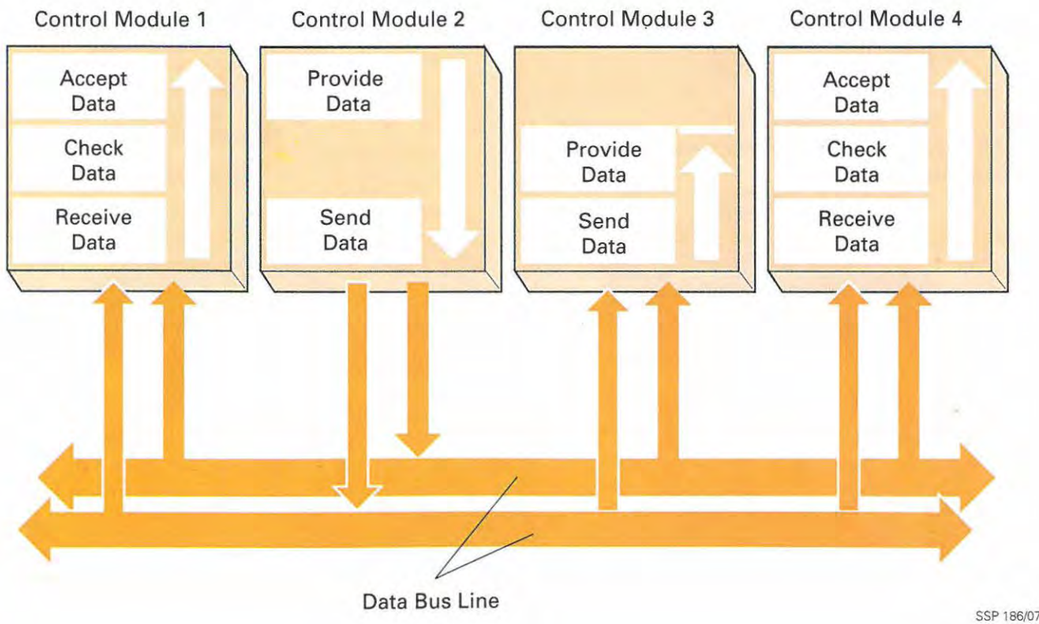
All other control modules networked with the CAN data bus become receivers.

**Checking data**

The control modules check whether they require the data they have received for their functions or not.

**Accepting data**

If the received data is important, it is accepted and processed. If not, it is ignored.

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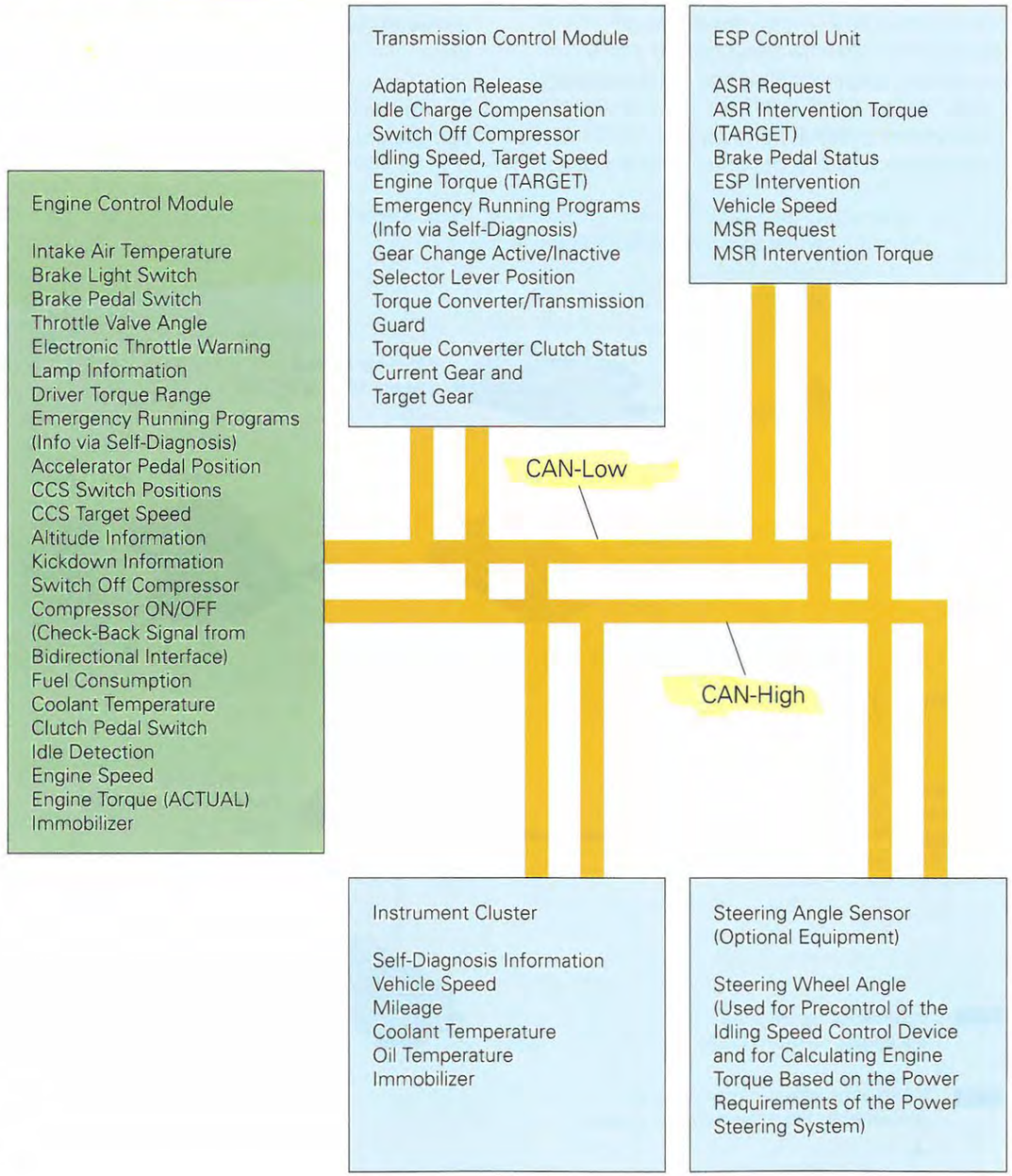
## CAN Bus Interfaces

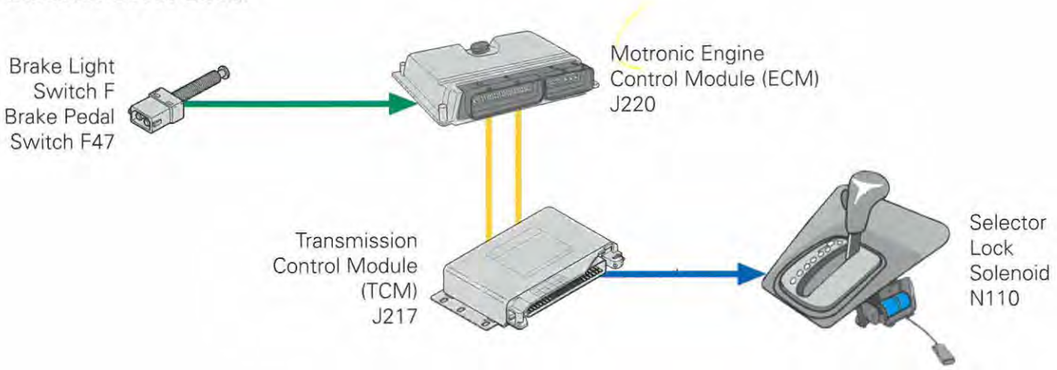


In the Audi A8, data between the engine control module and the other control modules is, with the exception of a few interfaces, exchanged via the CAN system.

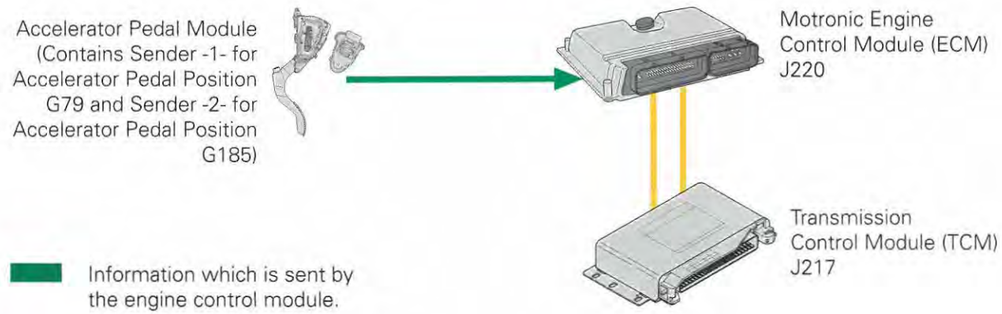
The system overview shows the information which is provided by the engine control module via the CAN bus, and received and used by the connected control units.

The following two examples simplify the complexity of the CAN bus network.

**Selector Lever Lock:**




**Kickdown (For Example, Audi A6):**




Information which is sent by the engine control module.

Information which is received and evaluated by the engine control module





### Additional Signals/Interfaces

In the Audi A8, the following interfaces also exist for data exchange via the CAN bus:

Pin 67 Crash Signal
Pin 43 K-Line/Diagnostic Connection
Pin 41 Compressor ON/OFF
Pin 40 Air Conditioner Requirement Signal

In the A6, there will be no CAN data exchange with the instrument cluster when production of the model begins. For this reason, the A6 has the following interfaces in addition to those of the A8:

Pin 43 Immobilizer/Self-Diagnosis
Pin 19 Coolant Temperature Signal
Pin 81 Fuel Consumption Signal
Pin 54 Vehicle Speed Signal
Pin 37 Engine Speed Signal
Pin 48 Warning Lamp for Electronic Throttle

## Crash Signal

In the event of a crash in which the belt tensioners/airbags are triggered, the engine control module deactivates the fuel pump relay. This prevents excessive quantities of fuel escaping if the fuel system is damaged.

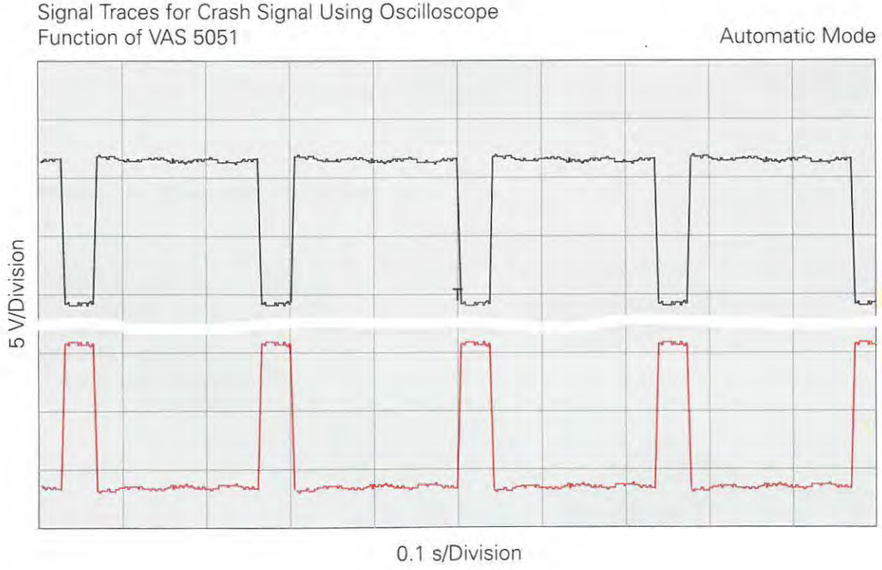
The crash signal is a square-wave signal with a specific signal ratio (high level to low level). The signal is transmitted continuously by the airbag control module.

In the event of a crash, the signal ratio is inverted for a defined period of time. During this period, the signal ratio is inverted relative to the standard signal so that the supply of fuel is shut off until the engine is restarted.

In addition, the "crash shut-off" fault is stored.

The fault entry can only be deleted using the diagnostic tester.

Signal Traces for Crash Signal Using Oscilloscope Function of VAS 5051

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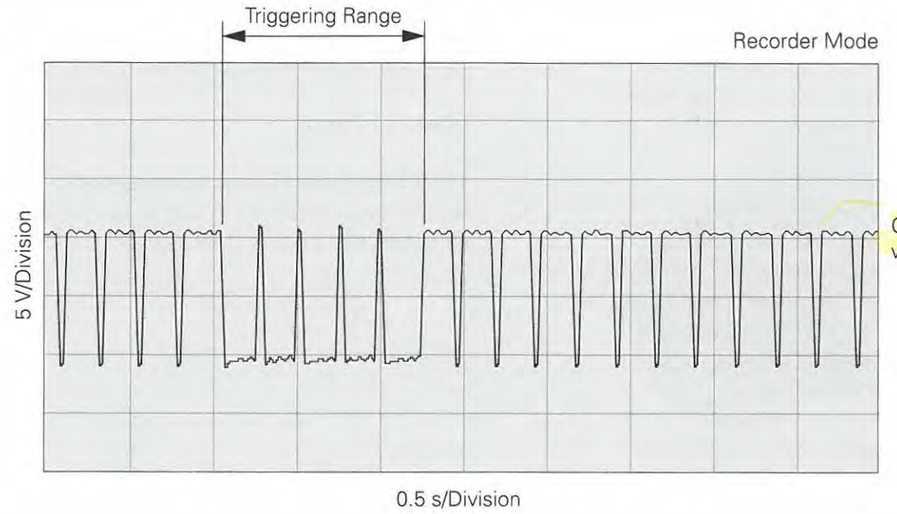


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## Self-Diagnosis

The crash signal is checked with respect to the plausibility of the crash signal and voltage.

## Effect of Fault

If the "crash shut-off" fault is stored in the engine control module and is not erased, the fuel pump is not primed with fuel when the ignition is switched on (no precompression is generated in the fuel system). This may result in delayed starting of the engine.

### The Air Conditioner Requirement

In the case of a high air conditioner output requirement, the idling speed of the engine is increased to increase the output of cool air from the air conditioning system.

In some cases, air conditioning requirements may be such that the "air conditioner requirement" interface is also switched to "high" at the A/C control head whereupon the engine control module is informed of the increased output requirement.

This can be tested using the "Read measured value block" function of the diagnosis tester (see repair manual).

It is important to note that the function for increasing the idling speed is not available for all engine options, even if the signal is sent to the engine control module.

### Self-Diagnosis

The air conditioner requirement interface is not monitored by the self-diagnosis system.

### Effect of Fault

The idling speed is not increased, which results in a reduction in the output of cool air when the engine is idling.



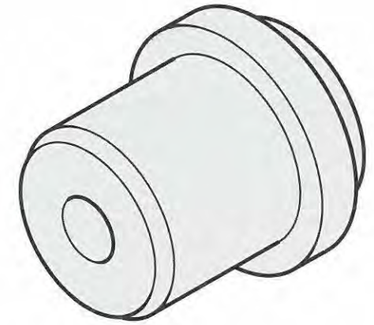


## Special Tools

A number of new special tools are required by the Service department for repairing the V8-5V engine.

### Thrust Pad for Crankshaft Oil Seal

Order No. T40007



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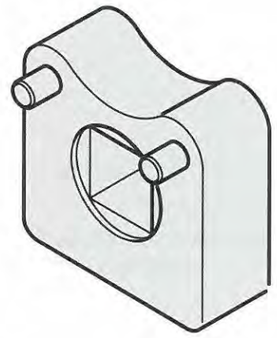
### Tensioning Roller Spanner

Order No. T40009



SSP 213/008

### Camshaft Retainer

Order No. T40005

SSP 213/009

# Notes





## Audi V8-5V Engine Teletest

See page 67 for instructions.

**1. New features of the V8-5V engine include:**

1. Five-valve cylinder heads with roller rockers and camshaft adjustment.
2. Electro-hydraulic engine mounting.
3. Three-stage variable intake manifold.
4. All of the above.

**2. The quick-start function enables the engine control module to more quickly determine ignition top-dead-center of the next cylinder. To help determine camshaft position relative to the crankshaft more quickly, the camshaft position sensor quick-start rotor rings have:**

1. One wide air gap and one narrow air gap.
2. One wide air gap and two narrow air gaps.
3. Two wide air gaps and two narrow air gaps.
4. Two wide air gaps and one narrow air gap.

**3. True or False. The variable intake manifold resonance tubes are altered to three different lengths by opening and closing three sets of manifold flaps.**

1. True
2. False

**4. The V8-5V engines have multi-layer cylinder head gaskets with:**

1. Five metallic layers.
2. Four metallic layers.
3. Three metallic layers.
4. Two metallic layers.

5. **Valve train roller rockers are made of what material to keep inertia forces low?**

   1. Titanium
   2. Magnesium
   3. Aluminum
   4. Iron

6. **Recesses are designed into the tops of the pistons to provide clearance for valves in the new V8-5V engine.**

   **Technician A says that all eight pistons in the new engine are the same.**

   **Technician B says that pistons are not interchangeable between cylinder banks.**

   **Who is correct?**

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

7. **True or False. The locking mandrel used at the crank web of the fourth cylinder on the new V8-5V engines is the same special tool that is used for locking the crankshaft on V6 engines.**

   1. True
   2. False

8. **The alignment of the engine and vibration damper timing marks indicates ignition top-dead-center of which cylinder on V8-5V engines?**

   1. First cylinder TDC
   2. Third cylinder TDC
   3. Fifth cylinder TDC
   4. Seventh cylinder TDC





9. **True or False. To enhance driving comfort, hydraulic engine mounts with electrical activation are used on eight-cylinder engines.**

   1. True
   2. False

10. **True or False: The CAN data bus is a type of data transfer between control modules.**

    1. True
    2. False

11. **The direction of coolant flow in the new V8-5V engines has been changed. As in the V6 engines, coolant leaving the cylinder heads merges at the rear coolant pipe. Which of the following is also true of the new design?**

    1. The cylinder head in bank one has been modified to route coolant with a uniform temperature through the cylinder block to the coolant thermostat.
    2. The new coolant pipe running from the rear coolant pipe to the cylinder head in bank one alters the coolant flow in the "small" cooling circuit with a mixture of coolant from all cylinders.
    3. Both are true.
    4. Neither is true.

12. **The changes to the camshaft adjustment system on the new generation of V8-5V engines:**

    1. Provide lubrication to the drive chain.
    2. Reduce noise during engine start.
    3. Lock the camshaft adjuster in the retard position during engine start.
    4. All of the above.

**13. On the new V8-5V engines, maximum torque across the entire engine speed range depends primarily upon:**

1. Length and cross section of the throttle body.
2. Length and cross section of the intake manifold runners.
3. Length and cross section of the exhaust manifold.
4. Length and cross section of the catalytic converter.

**14. In the event of a crash in which the belt tensioners/air bags are triggered and the ECM deactivates the fuel pump relay, the "crash shut-off" DTC is stored by the ECM until:**

1. The fuel supply is shut off.
2. The engine is restarted.
3. The crash shut-off switch is reset.
4. The DTC is deleted using the Scan Tool.

**15. The CAN data bus is comprised of the following:**

1. A controller.
2. A transceiver.
3. Two data bus terminals, two data bus lines.
4. All of the above.

**16. Hydraulic valve lifters for each valve are integrated in the:**

1. Spindle shaft
2. Camshaft
3. Rockers
4. Rollers





**17. The three inlet valves are actuated via a triple roller rocker and a double cam with how many rollers between the rocker arms?**

1. Four rollers
2. Three rollers
3. Two rollers
4. One roller

**18. To keep the roller rockers from tilting out of alignment and to compensate for component tolerances so that compression between cams and rollers will be uniform, the spindle shaft of the inlet roller rocker is ground to what shape?**

1. Flat
2. Convex
3. Concave
4. Straight

**19. The thin-wall cylinder head covers are made of a die-cast alloy of:**

1. Titanium
2. Magnesium
3. Aluminum
4. Steel

**20. The magnesium alloy variable intake manifold consists of four principal housing components that are bonded and bolted together.**

**Technician A says that the entire assembly must be replaced as a unit.**

**Technician B says that replacement parts are available, but you must be careful when disassembling the four part housing to avoid damaging the sealing surfaces.**

**Who is correct?**

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

**21. Vacuum to control the variable intake manifold and the secondary air system is provided by:**

1. One vacuum reservoir.
2. Two vacuum reservoirs.
3. Four vacuum reservoirs.
4. Eight vacuum reservoirs.

**22. The information necessary for the ECM to switch off the secondary air pump after a defined air mass has been achieved is sent by the:**

1. Heated oxygen sensor.
2. Throttle position sensor.
3. Throttle valve control module.
4. Mass air flow (MAF) sensor.





**23. The cylinder head cover fasteners must be tightened in a specified sequence to:**

1. Prevent distortion of the cover.
2. Ensure that the seal is air tight.
3. Prevent oil leaks.
4. All of the above.

**24. When the variable intake manifold stage 3 manifold flap is opened, the path of the intake air to the combustion chamber is:**

1. Widened
2. Lengthened
3. Narrowed
4. Shortened

**25. Which of the following is a benefit of a CAN data bus system?**

1. Low error rate.
2. Fewer sensors and signal lines.
3. High-speed data transfer.
4. All of the above.

# Notes





## ANSWER WORKSHEET

### AUTOMATED TELEPHONE TESTING INSTRUCTIONS

| | | |
|---|---|---|
| TESTING TIMES: | MONDAY-FRIDAY: | 7:00 A.M. - MIDNIGHT (CENTRAL TIME) |
| | SATURDAY: | 7:00 A.M. - 7:00 P.M. (CENTRAL TIME) |
| | SUNDAY: | 7:00 A.M. - 5:00 P.M. (CENTRAL TIME) |

**To take an Automated Telephone test:**

- Record your responses to test questions in the boxes below
- Dial **1-800-228-9500**
- Enter Transaction Code 113 followed by the pound sign (#)
- Enter your Social Security number or Social Insurance number followed by the pound sign (#)
- Enter the six digit course number followed by the pound sign (#). Course Number for this test is **921903**.
- 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 5, followed by the pound sign (#).
- If you want to change your previous answers, enter 9 followed by the pound sign (#). 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 **1-800-828-7682**, Monday-Friday 8:00 a.m. to 4:30 p.m. (Central Time).

| | | | | |
|---|---|---|---|---|
| **1** ☐ | **2** ☐ | **3** ☐ | **4** ☐ | **5** ☐ |
| **6** ☐ | **7** ☐ | **8** ☐ | **9** ☐ | **10** ☐ |
| **11** ☐ | **12** ☐ | **13** ☐ | **14** ☐ | **15** ☐ |
| **16** ☐ | **17** ☐ | **18** ☐ | **19** ☐ | **20** ☐ |
| **21** ☐ | **22** ☐ | **23** ☐ | **24** ☐ | **25** ☐ |

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