



MPI Engine Management **for the** **Audi Coupe Quattro** **and** **Audi 90 Quattro 20-Valve**

Service Training
Self-Study Information

Service Training
Self-Study Information

Overview	2
Engine Components	7
Fuel Supply	8
Fuel Injectors	9
Fuel Injector Series Resistance	10
Ignition System	11
Idle Stabilization	14
Fuel Tank Ventilation	16
Crankcase Ventilation	17
Exhaust Gas Recirculation	18
Electrical System	20
Self-Diagnosis	22
Inputs And Outputs	24
 Components	
Control Unit	26
Air Mass Sensor	27
Coolant Temperature Sensor	28
Engine Speed And Reference Sender	29
Hall Sender	30
Diagram Of Control Signals	31
Throttle Body	32
Throttle Potentiometer And Idle Switch	33
Knock Sensor I And II	34
Oxygen Sensor	35
EGR Temperature Sensor	36
Fuel Injectors	37
Ignition Coil With Power Stage	38
Idle Stabilizer	39
Carbon Canister Frequency Valve	40
Carbon Canister Shut-off Valve	41
EGR Frequency Valve	42
Fuel Pump Relay	43
California OBD Warning Light	43
Control Unit Inputs And Outputs	44
 ECU Self-Diagnosis	
Self-Diagnosis With V.A.G 1551	48
V.A.G 1598	49
Wiring Diagram	55
Wiring Diagram	56

Table of contents

Components

Control Unit.....	26
Air Mass Sensor.....	27
Coolant Temperature Sensor	28
Engine Speed And Reference Sender	29
Hall Sender.....	30
Diagram Of Control Signals	31
Throttle Body.....	32
Throttle Potentiometer And Idle Switch.....	33
Knock Sensor I And II.....	34
Oxygen Sensor.....	35
EGR Temperature Sensor.....	36
Fuel Injectors.....	37
Ignition Coil with Power Stage.....	38
Idle Stabilizer.....	39
Carbon Canister Frequency Valve.....	40
Carbon Canister Shut-off Valve	41
EGR Frequency Valve	42
Fuel Pump Relay	43
California OBD Warning Light.....	43
Control Unit Inputs And Outputs.....	44
ECU Self-Diagnosis.....	48
Self-Diagnosis With V.A.G 1551.....	49
V.A.G 1598.....	55
Wiring Diagram.....	56

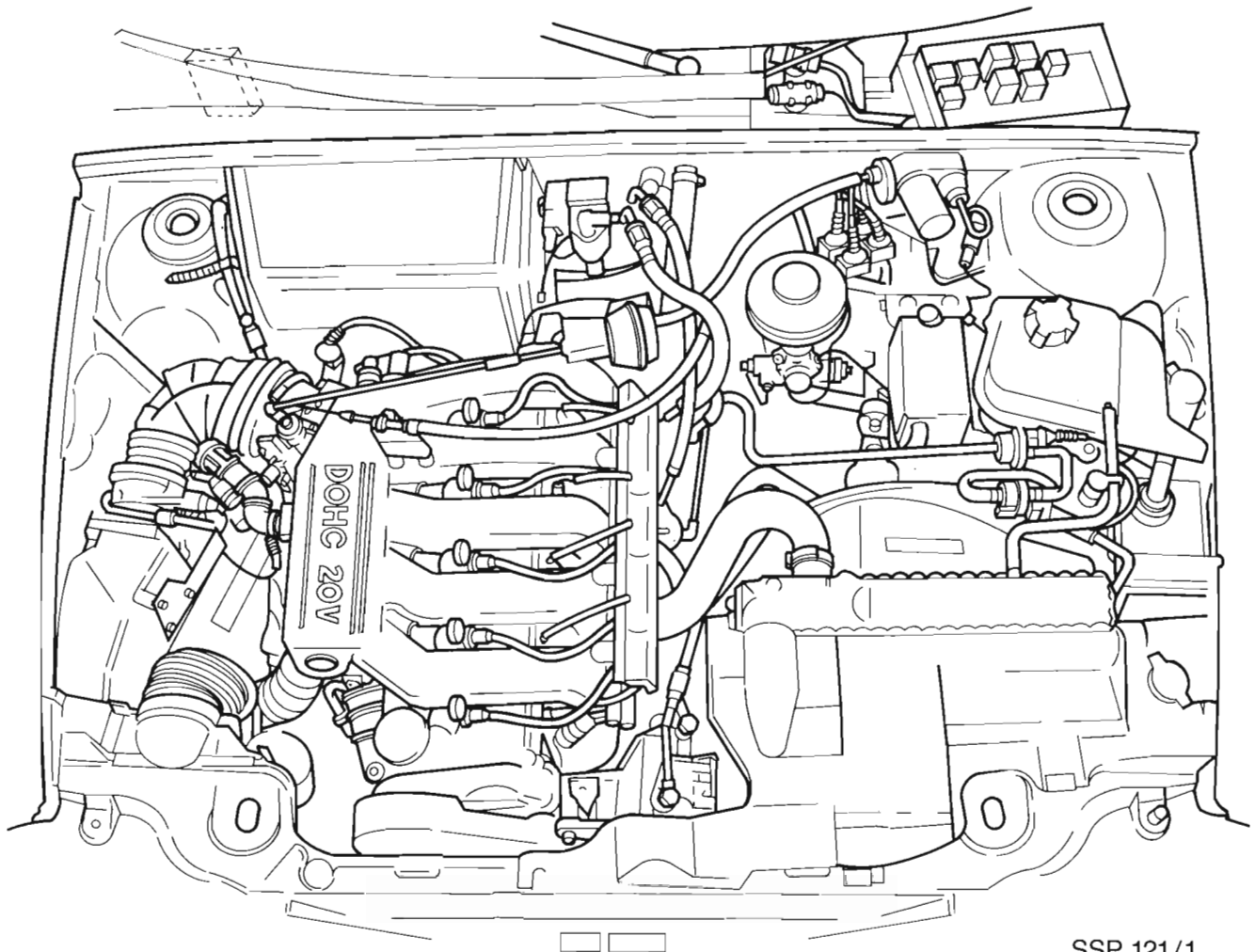
Overview

The 2.3 liter 20-valve engine that is installed in the Coupe Quattro and the Audi 90 Quattro has been updated during the 1990 model year. The MPI Engine Management System has been significantly revised and models sold in California now have Exhaust Gas Recirculation.

This revised engine can be identified by its new cast exhaust manifold and a new idle stabilizer valve.

Engine data

Construction:	5 cylinder in-line with 4 valves per cylinder
Displacement:	2309 cc
Bore:	82.5 mm
Stroke:	86.4 mm
Compression ratio:	10.3:1
Output:	164 HP @ 6000 RPM 158 ft.lb. @ 4500 RPM

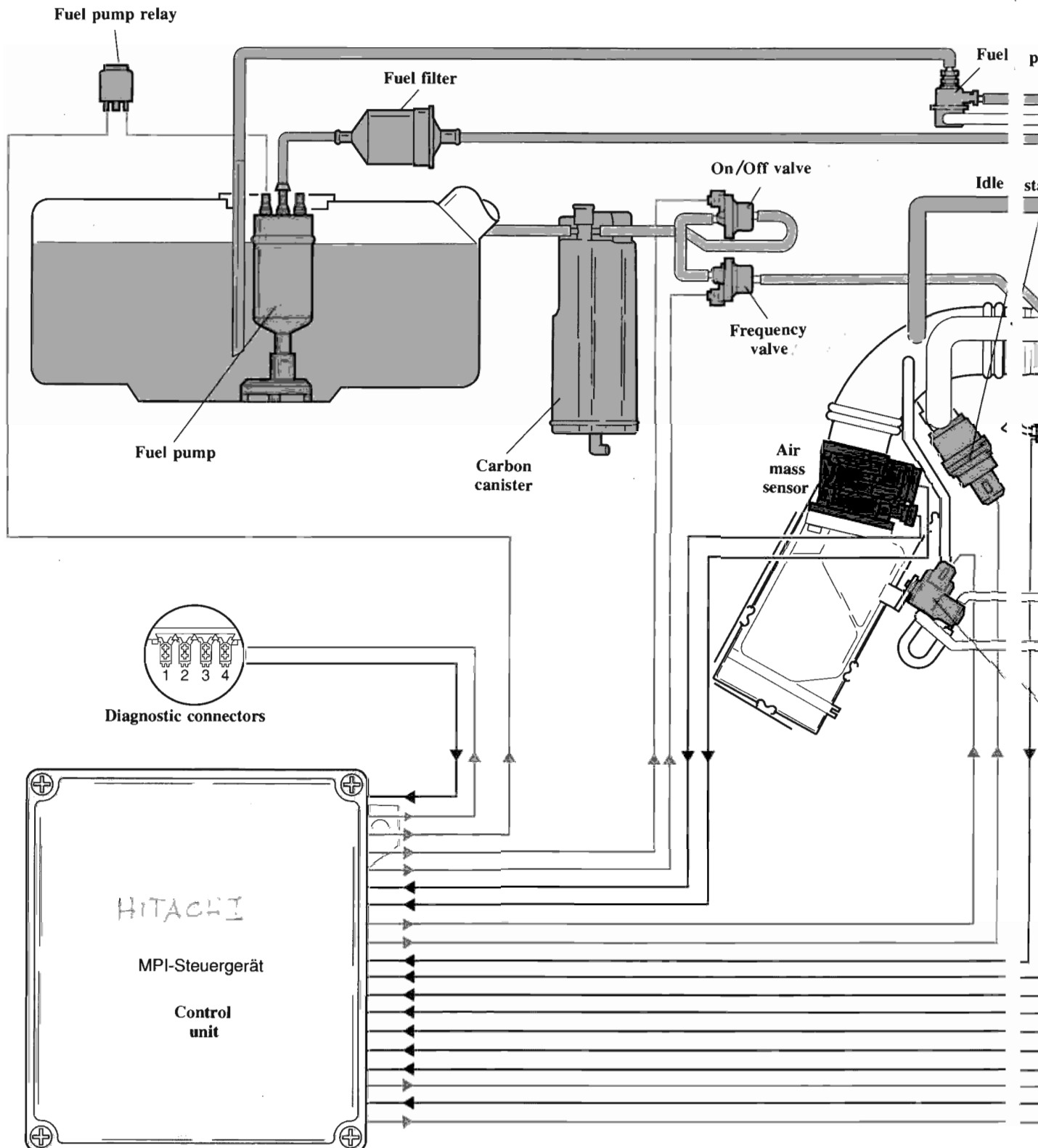


SSP 121/1

The revised 20-valve engine for the Audi Coupe Quattro and the Audi 90 Quattro has the following new features and changes:

- New cast iron exhaust manifold with a triple pipe “three-into-one” down pipe and new catalytic converter
- California models with Exhaust Gas Recirculation
- New MPI control unit now with 4 multi-pin connectors and gold-plated terminals
- New idle stabilizer valve
- Adaptive learning capability for idle speed control
- New throttle valve potentiometer with idle switch
- Separate frequency and shut-off valves for the fuel tank ventilation to carbon canister
- Expanded self-diagnosis capabilities with rapid data transmission

Overview



Fuel pressure regulator

stabilizer

EGR valve

Crankcase ventilation

Distributor

Ignition coil

Knock sensors I and II

Reference sensor

Engine speed sensor

Oxygen sensor

EGR frequency valve

SSP121/3

Overview

The MPI control unit performs the following functions:

Sequential fuel injection

- Basic fuel regulation via map in ECU memory
- Starting enrichment
- After-start enrichment
- Warm-up enrichment
- Acceleration enrichment
- Deceleration fuel shut-off
- Engine speed limitation
- Oxygen sensor control

Ignition timing control

- Basic timing control via map in ECU memory
- Dwell angle control
- Starting correction
- Warm-up correction
- Digital idle stabilization
- Cylinder selective knock correction

Idle stabilization

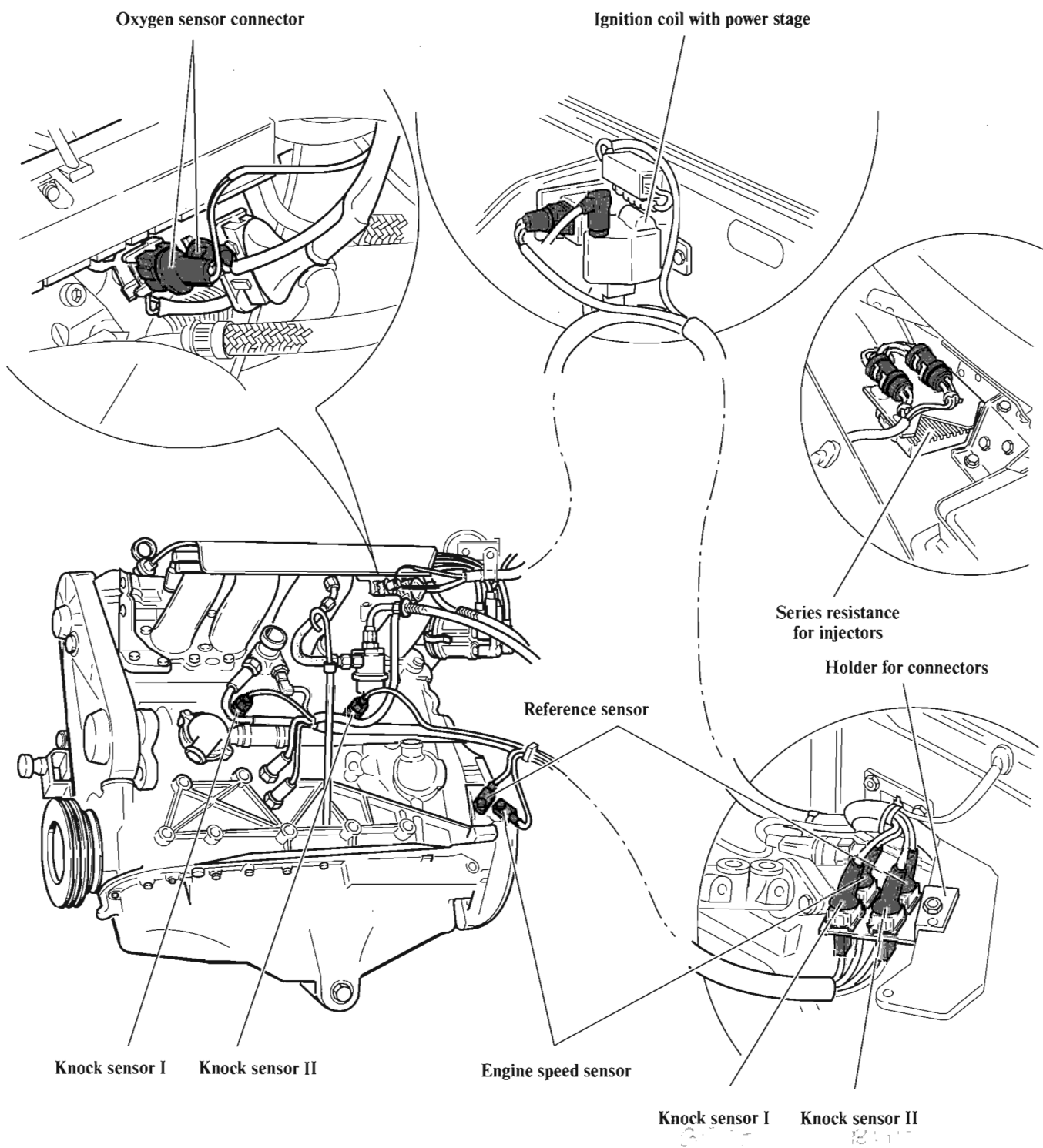
- Idle speed control with adaptive learning capability
- Starting correction
- Idle speed increase with A/C

Fuel tank ventilation

- Fuel tank vapor flow controlled via map in ECU memory
- Switched off during deceleration fuel shut-off

Self-diagnosis

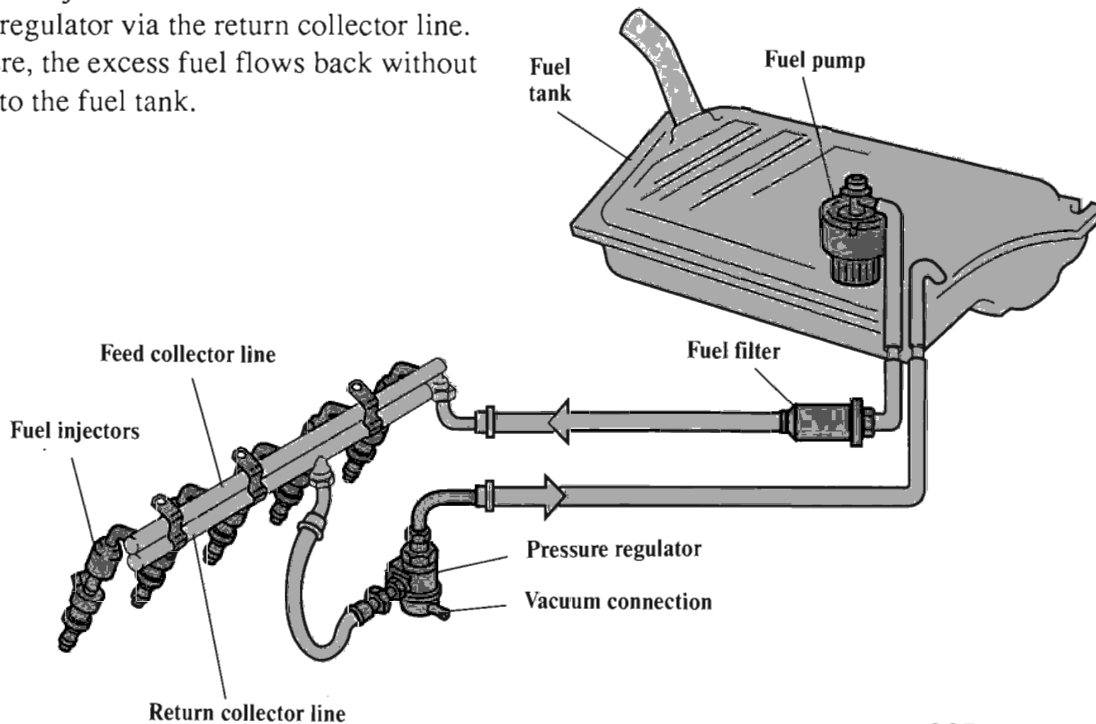
- Monitor sensor inputs
- Monitor outputs
- Fault output via V.A.G 1551
- Display individual values via V.A.G 1551
- Perform output checks
- Emergency mode operation



SSP121/4

Fuel Supply

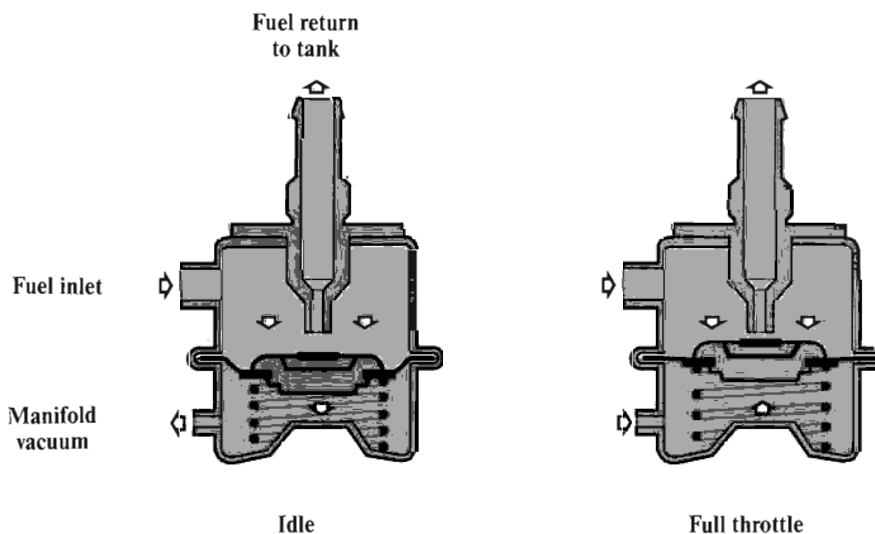
The fuel pump mounted in the fuel tank pumps the fuel through the fuel filter to the dual fuel collector line. From the feed collector line, the fuel flows through the injectors and is conducted to the pressure regulator via the return collector line. From there, the excess fuel flows back without pressure to the fuel tank.



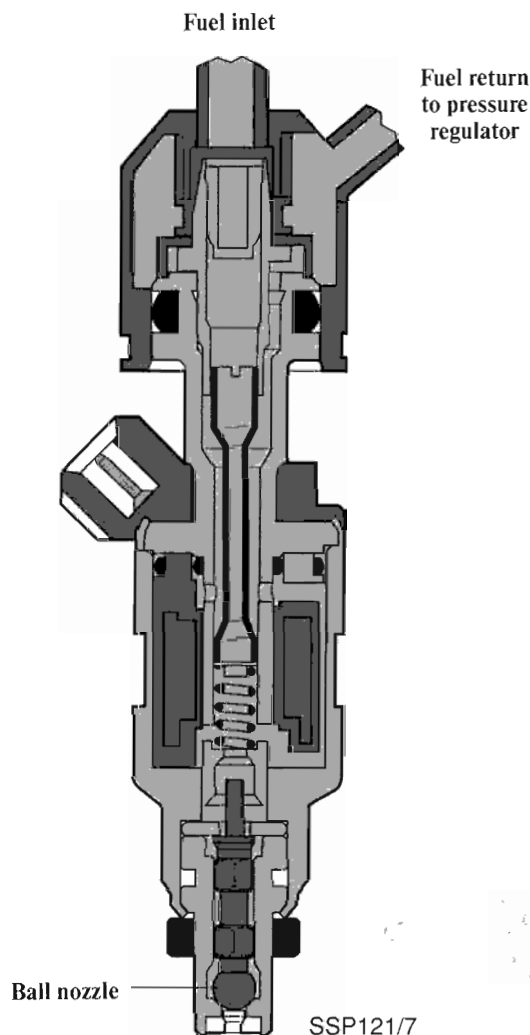
SSP121/5

Fuel pressure is regulated by a diaphragm-type pressure regulator between 3.8 to 4.2 bar (55 to 61 psi). The pressure regulator is connected to the intake manifold vacuum and regulates the amount of fuel returned to the fuel tank.

As the intake manifold pressure changes, the pressure regulator will increase or decrease the system fuel pressure. This maintains a constant difference between the intake manifold pressure and fuel pressure.



SSP121/6



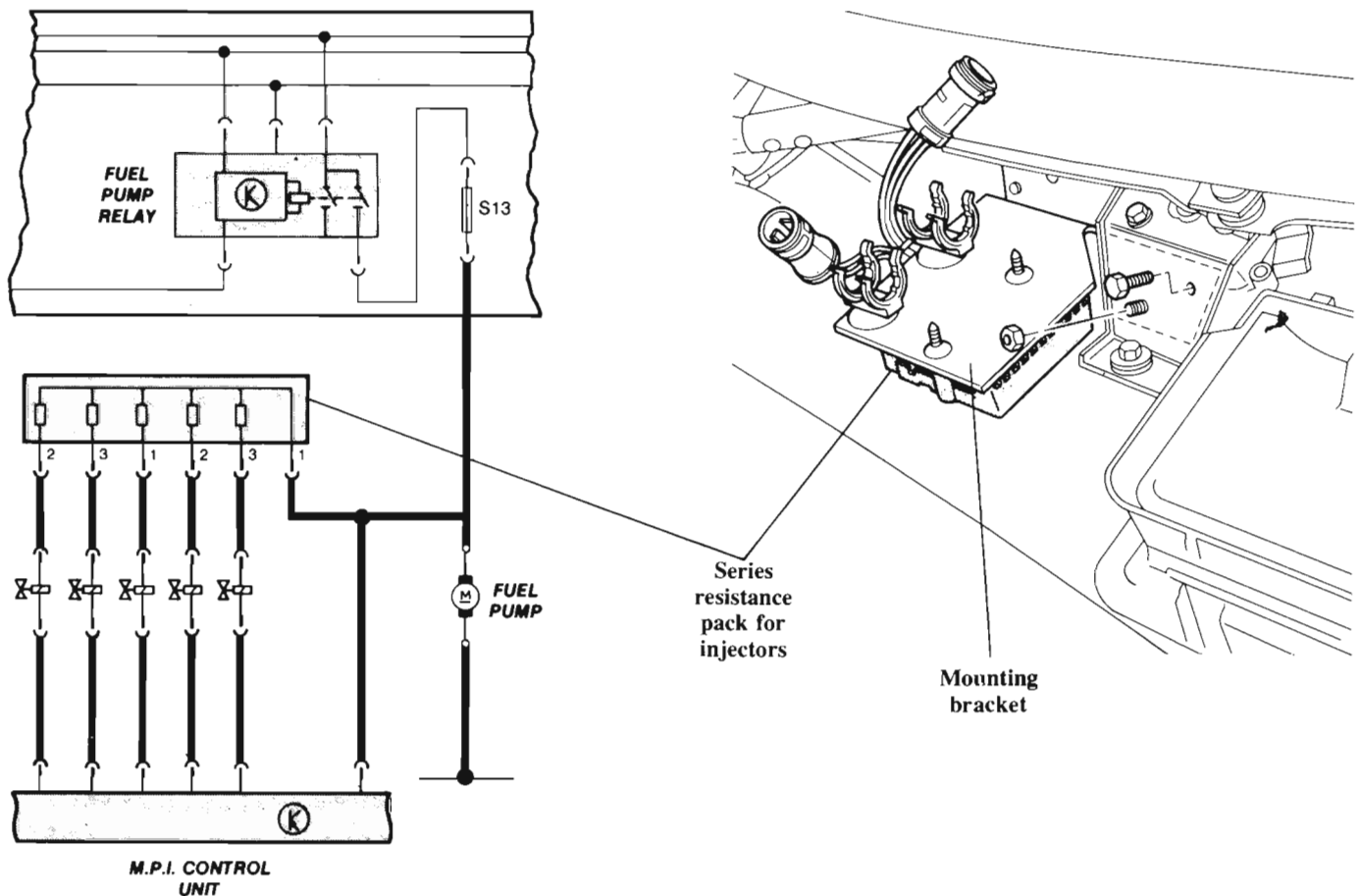
The fuel injectors for the MPI system are a new full flow design with ball-type nozzles. The injectors are designed so that a large amount of fresh fuel flows close to the nozzle of the injector. This tends to cool the injectors and reduce the tendency for the fuel to percolate at high engine temperatures. The results are good hot starting and running characteristics.

A ball-type nozzle is used to provide good fuel atomization. This design is affected less by deposit built-up from such things as carbon or varnish.

The MPI control unit triggers the fuel injectors sequentially in the firing order of the engine. Each injector is triggered 360° before the cylinder ignition point.

The control unit operates the injectors by completing a ground circuit. The fuel mixture is determined by the duration or length that the injectors are held open.

Series Resistance

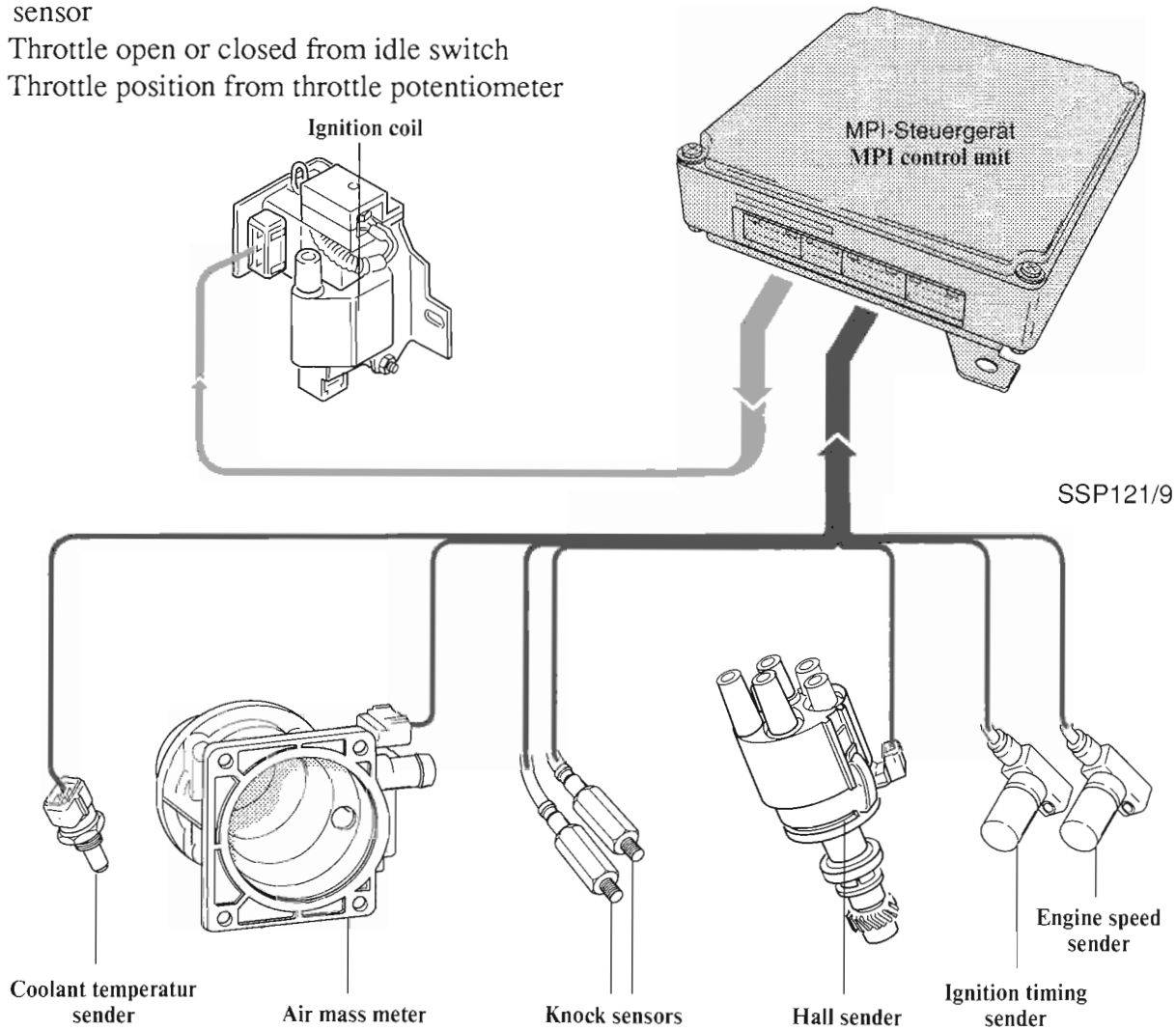


The fuel injectors are supplied with electrical power from the fuel pump relay. The electrical power passes first through a series resistor assembly. These resistors are 5 to 7 ohms each and limit the current supplied to the injectors. This allows the use of an injector with a lower internal resistance, which results in shorter response time. The lower operating current also helps to protect the power output stages in the MPI control unit.

The series resistor assembly is located on a mounting plate next to the wiper motor in the plenum chamber.

The ignition system uses the following inputs:

- Engine speed from engine speed sensor on bell housing
- Crankshaft position from reference sensor on bell housing
- Camshaft position from Hall sender in distributor
- Engine load from air mass sensor
- Engine temperature from coolant temperature sensor
- Throttle open or closed from idle switch
- Throttle position from throttle potentiometer



The functions of the ignition system are:

- Controlling the ignition timing according to the ignition map in the ECU
- Dwell angle control
- Digital idle stabilization
- Cylinder selective knock control

The ignition timing is calculated based on engine speed and load signals. Coolant temperature, throttle position and ignition knock signals are used as correcting factors.

The MPI control unit sends an output signal to the power stage on the ignition coil. This power stage switches the ignition coil's primary current and the ignition coil is fired.

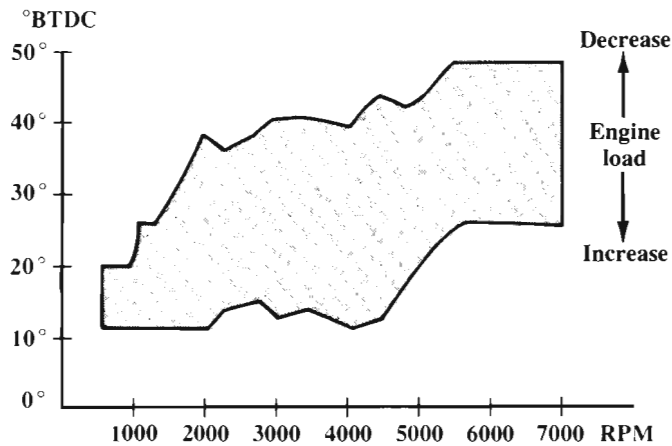
Ignition System

Ignition Maps

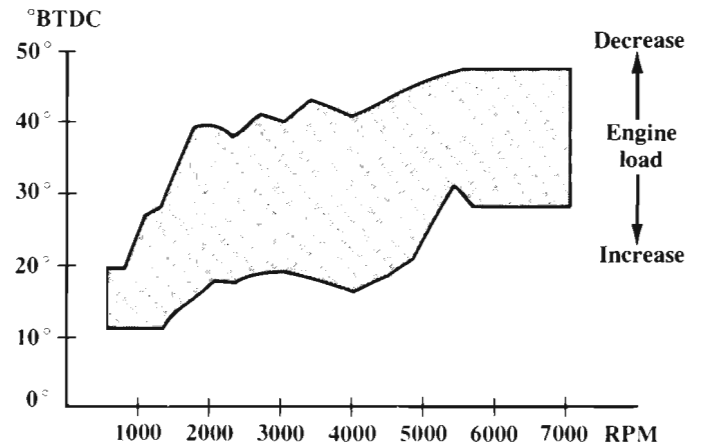
Two separate ignition maps are programmed into the control unit. One map is designed for operation with regular fuel and the other with premium fuel.

The MPI control unit automatically switches to the premium map when the car is started. If ignition knock occurs repeatedly, the control unit will switch to the map for lower octane regular fuel.

**Regular Fuel
Ignition Map**



**Premium Fuel
Ignition Map**



Dwell Angle Control

The ignition coil charging time is determined by the dwell angle. The MPI control unit changes the dwell angle as engine speed and load increase to assure adequate ignition voltage under all engine operating conditions.

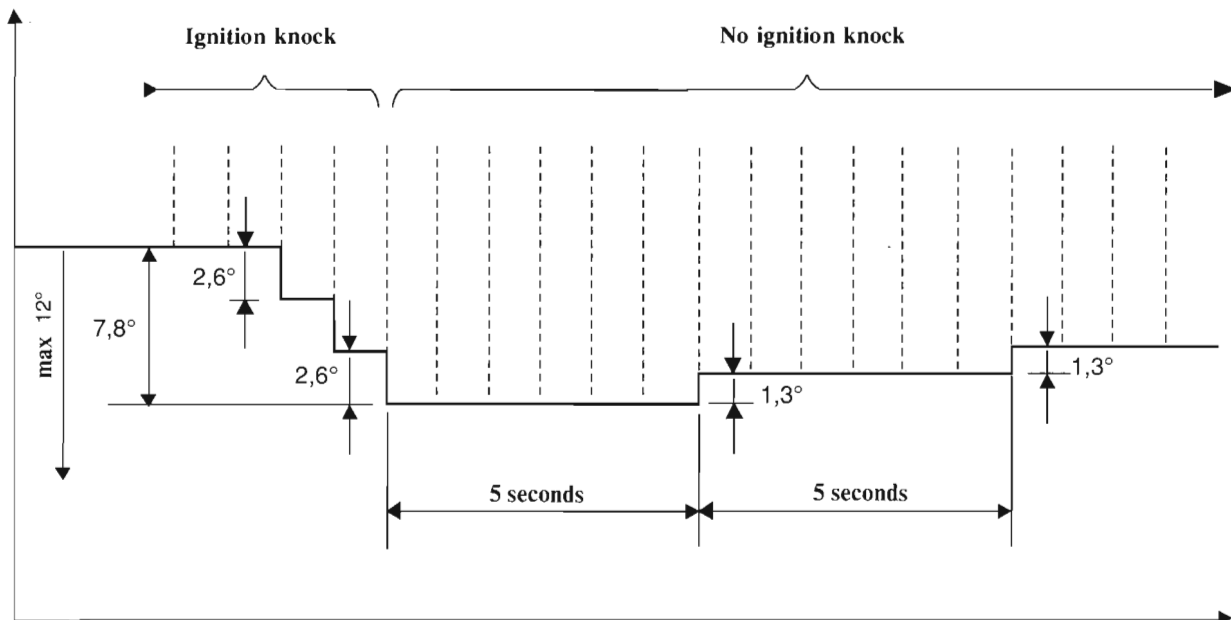
Digital Idle Stabilization

At engine idle, the MPI control unit varies the ignition timing to stabilize the engine speed. This function works together with the idle air stabilizer to control the idle speed.

The following inputs are needed for ignition knock regulation:

- Signals from knock sensors I and II
- Signal from Hall sender
- Engine coolant temperature
- Engine load
- Engine speed

Ignition Timing



SSP121/12

The knock control becomes active once the coolant temperature has reached at least 104° F (40°C). The knock control circuitry in the control unit evaluates the signals from the two knock sensors.

If a cylinder begins to develop ignition knock, the MPI control unit will retard the ignition timing for that cylinder. Different ignition timing points are possible for each cylinder when ignition knock occurs.

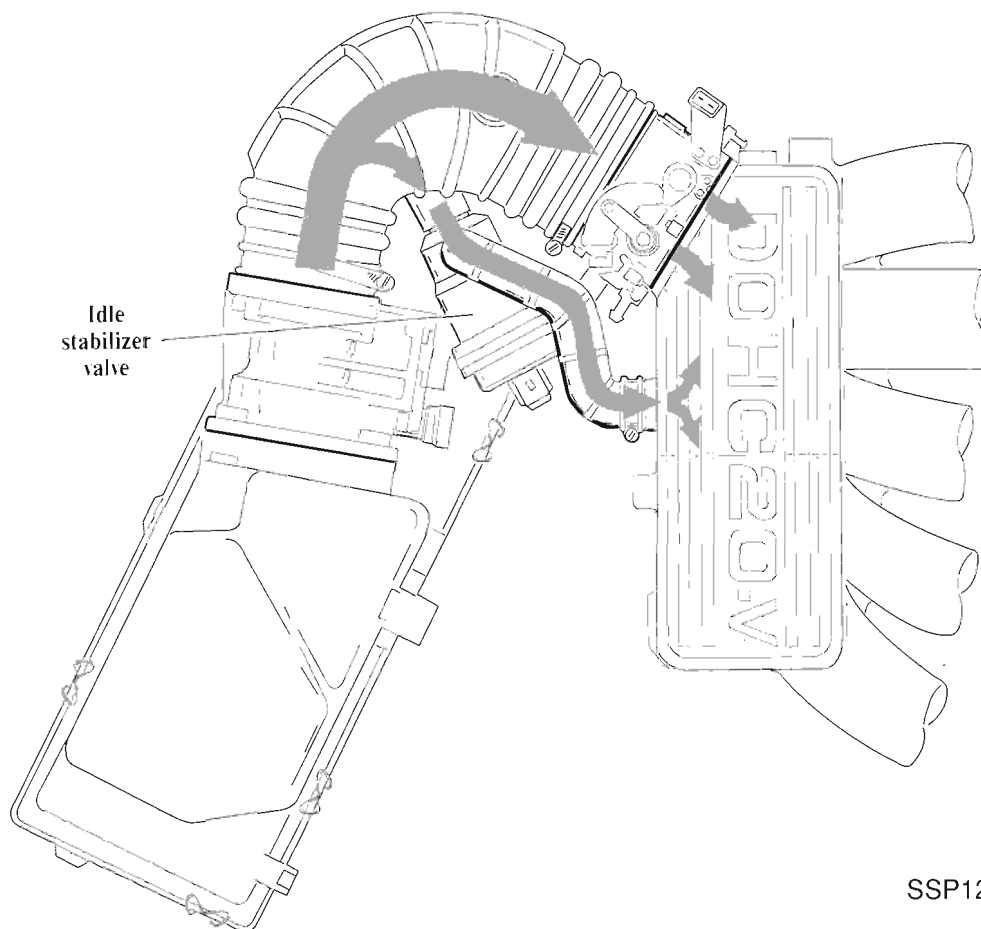
The maximum ignition retard angle is about 12°. The ignition timing is retarded in steps of 2.6° and advanced in steps of 1.3°.

Idle Stabilization

The following inputs are needed for idle speed regulation:

- Engine speed
- Coolant temperature
- Vehicle speed
- Signal from the idle switch
- Signal from the climate control system (A/C On/Off)
- Signal from the A/C compressor clutch

The basic idle air quantity is supplied through the adjustable bypass. The idle stabilizer valve regulates the amount of air that can bypass the throttle plates and thus regulate the idle speed.

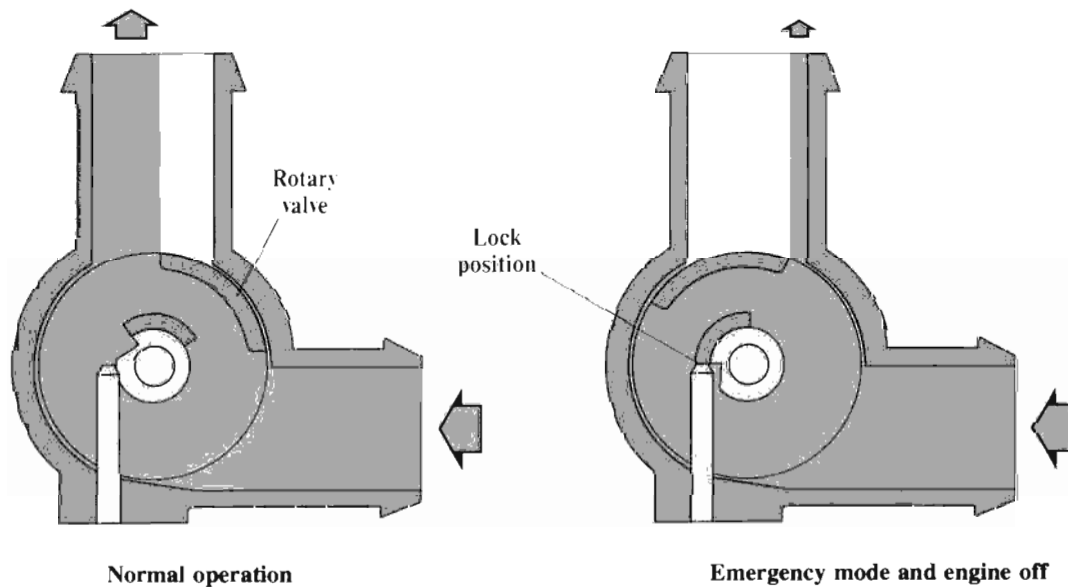


SSP121/13

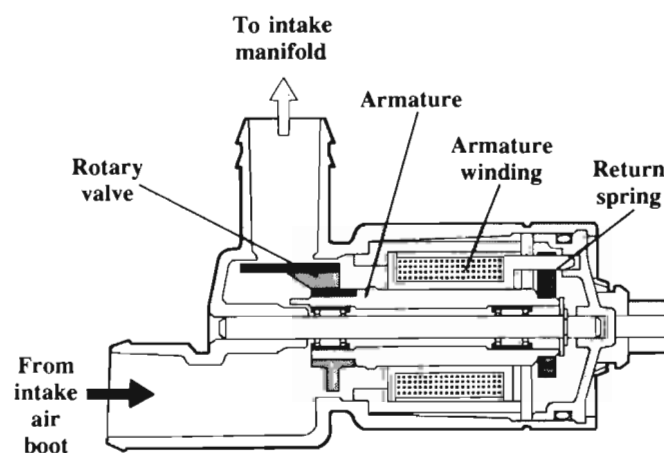
A small electrically operated valve is used to control the idle speed. The valve consists of a small single winding electric motor. A rotary valve and a return spring are attached to the motor's armature. This is a different design from previous versions.

The motor is operated by a cycled DC voltage (duty cycle) which will cause the armature to work against the return spring.

If the valve should fail for any reason, the return spring will force the armature against a stop. This will establish a fixed rotary valve opening.



SSP121/14



Fuel Tank Ventilation

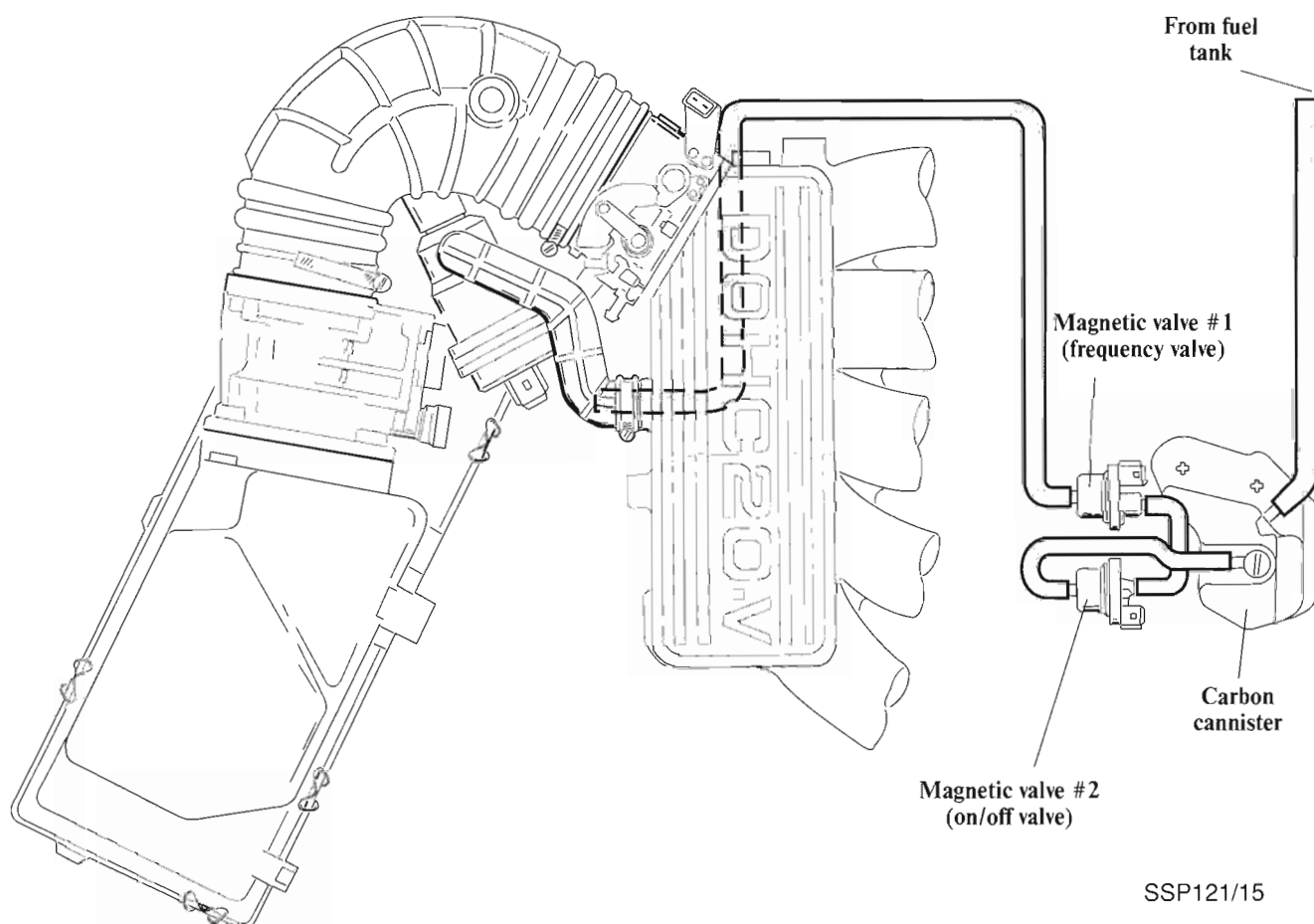
The following inputs are used to control the fuel tank ventilation:

- Engine speed
- Engine load
- Engine coolant temperature
- Signal from idle switch

Fuel vapors from the fuel tank are vented to the carbon canister. When the engine is warm and above idle speed, the carbon canister On/Off valve (magnetic valve #2) will open.

The fuel vapors will then be drawn into the intake air boot via the carbon canister frequency valve (magnetic valve #1). This frequency valve will regulate the flow amount of fuel vapors based on engine speed and load.

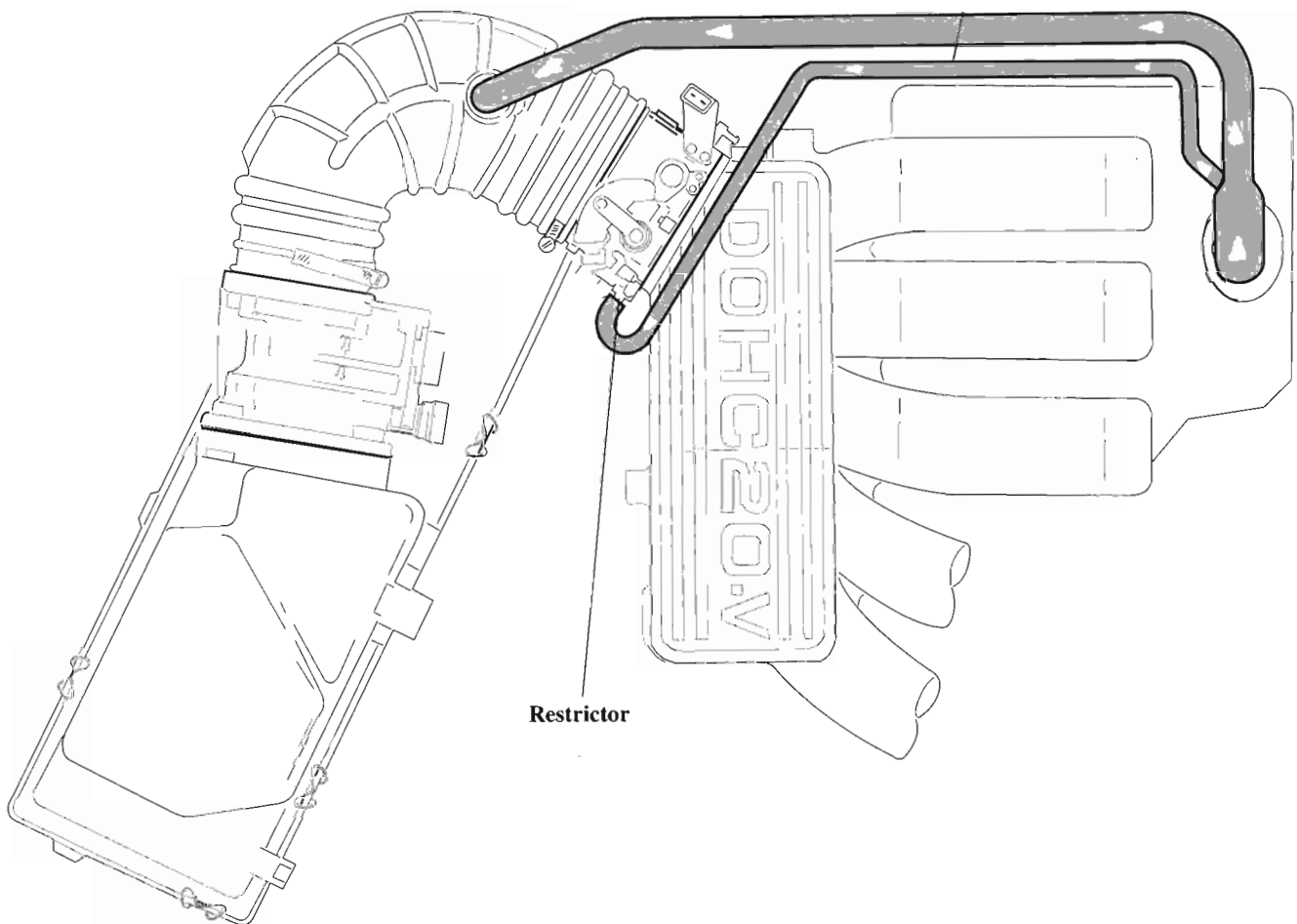
Both valves are operated by the MPI control unit.



Crankcase Ventilation

A single vent is used for the crankcase breather and is located on the lower left side of the cylinder block. From there, the crankcase is vented to the engine's intake through a connection at the intake manifold and a second connection at the intake air boot.

At idle or other periods of high manifold vacuum, most of the crankcase fumes are drawn into the intake through the connection at the manifold which has a 1 mm restrictor. When the throttle is opened, crankcase fumes will also be drawn in through the intake air boot.



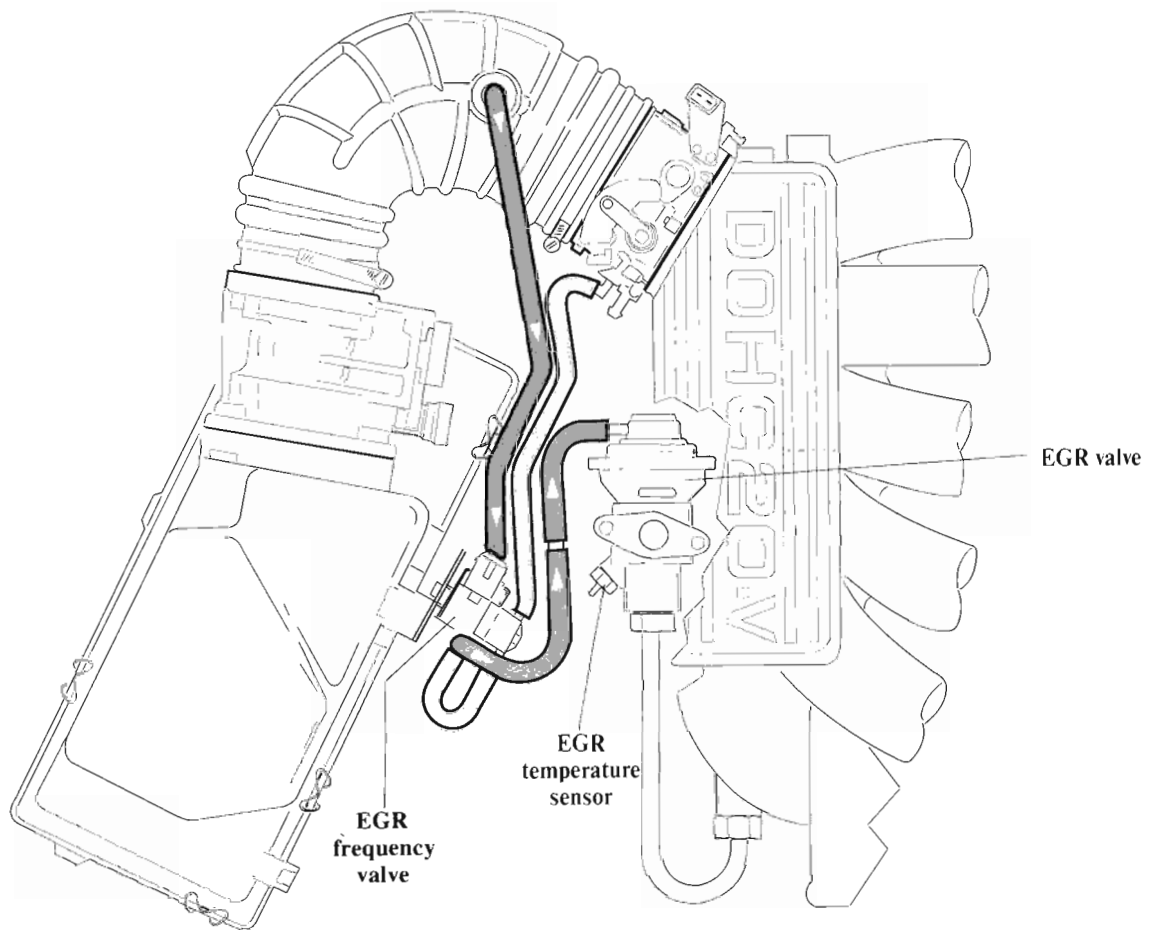
SSP121/16

Exhaust Gas Recirculation

Vehicles sold in California are equipped with EGR (Exhaust Gas Recirculation). The EGR system is used to reduce nitrous oxide emissions (NO_x). The system recirculates a small portion of exhaust gas into the intake mixture.

The EGR system does not operate at idle because NO_x emissions are low during this time.

This exhaust gas is non-combustible and takes up a small space in the intake charge. The result is lower combustion temperatures and reduced NO_x emissions.



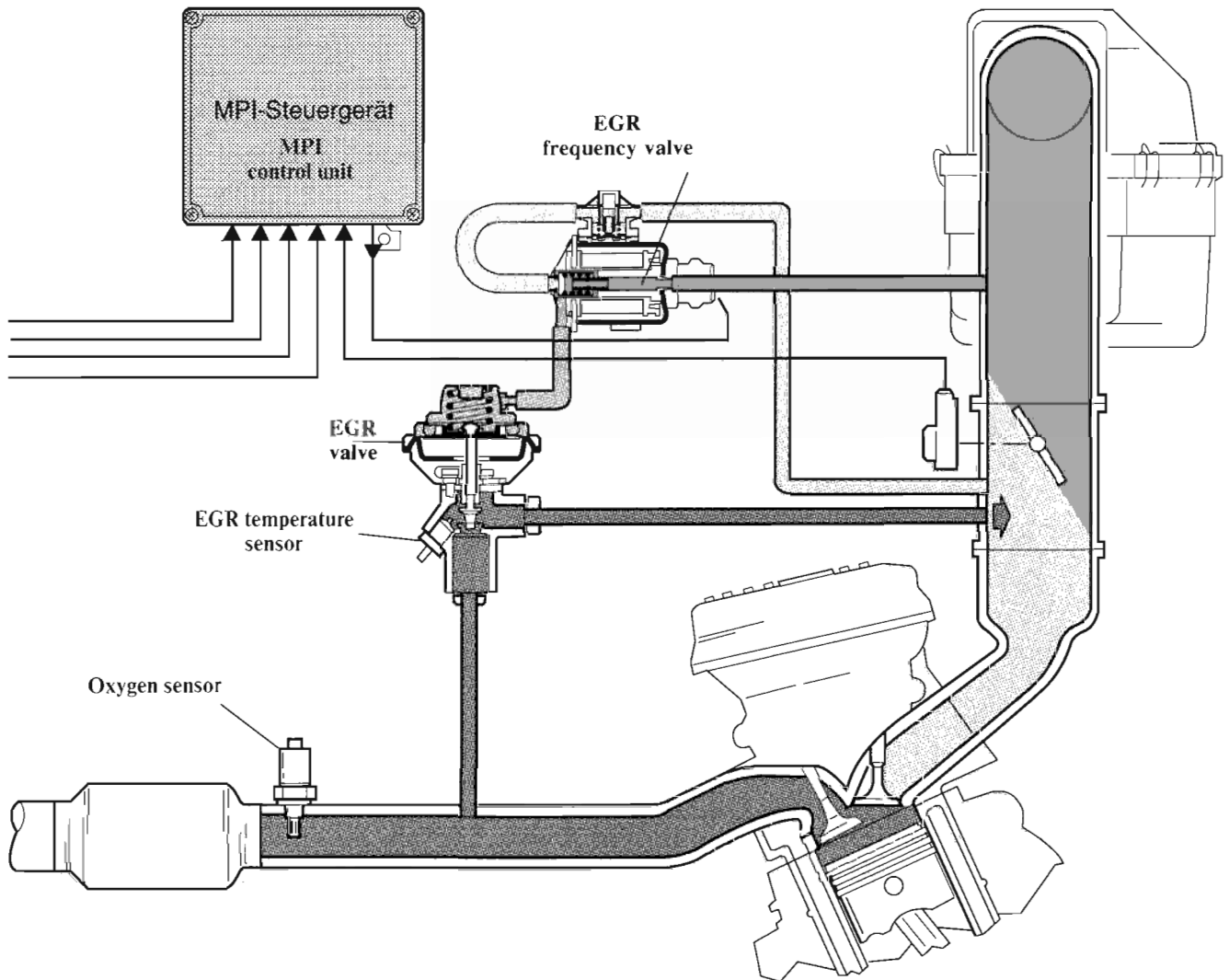
SSP121/17

Exhaust Gas Recirculation

The following inputs are used for Exhaust Gas Recirculation:

- Engine speed
- Engine load
- Engine coolant temperature
- Signal from idle switch

The Exhaust Gas Recirculation is controlled via a map in the MPI control unit. This allows very precise regulation of the exhaust gas recirculation flow.



SSP121/18

A frequency valve is connected to the intake manifold and operated by the MPI control unit. The frequency valve regulates the amount of vacuum supplied to the EGR valve.

By regulating the amount of vacuum to the EGR valve, its opening position and the amount of exhaust gas recirculated can be accurately controlled.

Electrical System

There are four fuses located in the fuse/relay panel that are important in the operation of the MPI Engine Management System:

Fuse S 13 - 15 amp (blue)

This fuse supplies power to the fuel pump (G 6) and the fuel injectors (N 30 to N 83).

Fuse S 21 - 10 amp (red)

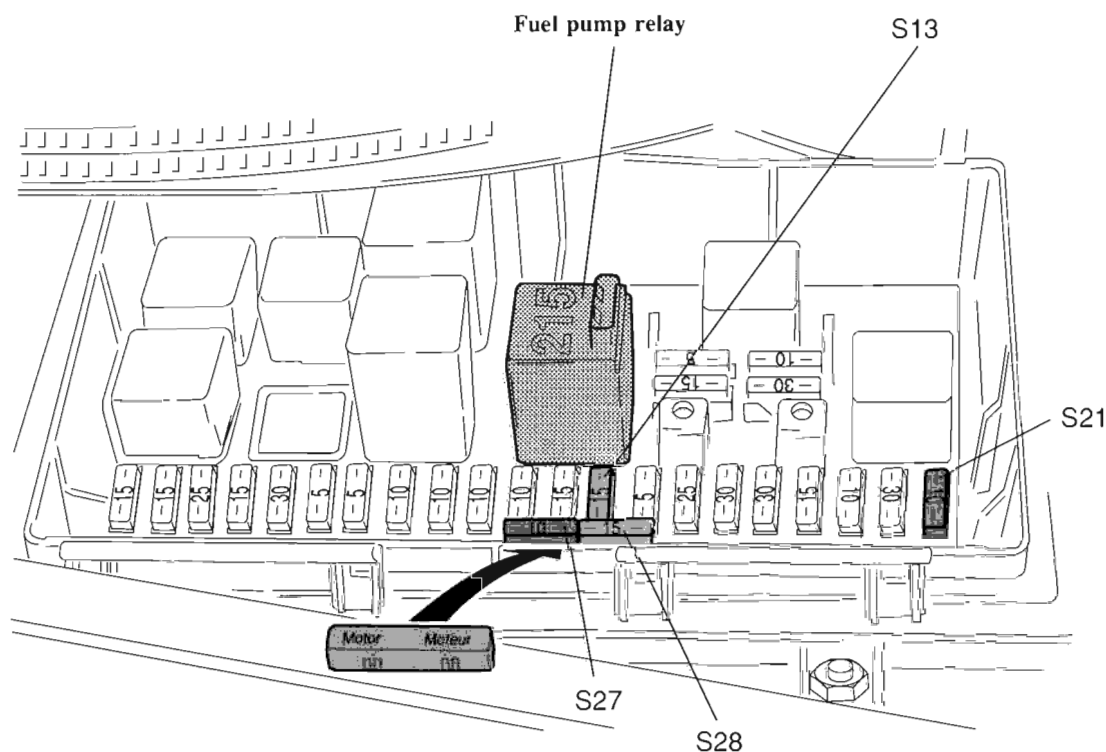
This fuse supplies the power to the black diagnosis connector for the V.A.G 1551.

Fuse S 27 - 10 amp (red)

This fuse supplies power to the air mass sensor (G 70) and the CO adjustment potentiometer (G 74). If this fuse is blown, the engine will run very poorly.

Fuse S 28 - 15 amp (blue)

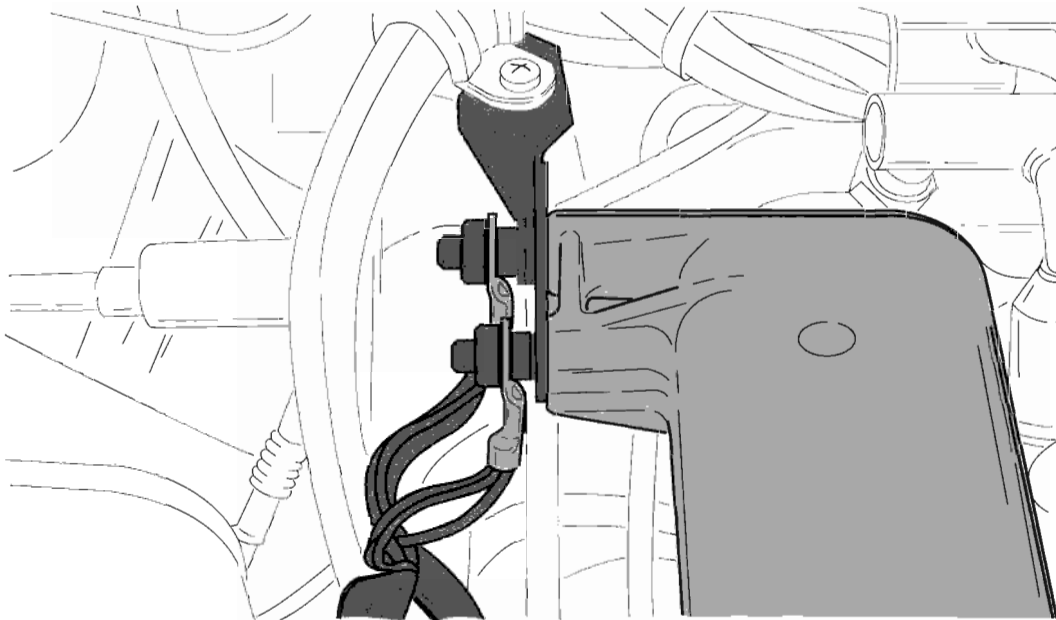
This fuse supplies power to the oxygen sensor (G 39), carbon canister frequency valve (N 80) and shut-off valve solenoid (N 115). This fuse also supplies the power for the EGR frequency valve (N 18) on California models.



SSP121/19

The MPI system has two ground connections on the intake manifold. The MPI wire harness connects to the intake manifold at two points.

One connection is for the control unit. The second connection supplies the ground, via the MPI control unit, for the fuel injectors and other sensors for the system.



SSP121/20

The MPI control unit continuously monitors the system's inputs and outputs. If faults occur, they are stored in the control unit's permanent memory.

In addition, faults will also be stored if the knock regulation or oxygen sensor control reach their control limits. On California models, the control unit also monitors the operation of the EGR system and will record a fault if one occurs.

The expanded self-diagnosis of the MPI system can do the following:

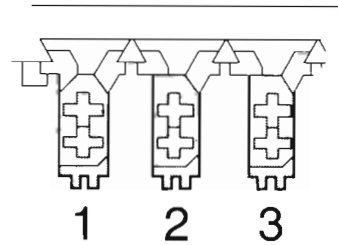
- Store and display faults from its permanent memory
- Transmit information via the V.A.G 1551 using rapid data transmission
- Generate output test signals of all actuators (fuel injectors, etc.)
- Use the following functions via the V.A.G 1551 for testing and troubleshooting:
 - "Introducing of basic setting"
 - "Read measured value block"
 - "Read individual measured values"

The MPI control unit has a permanent fault memory. Disconnecting the battery or removing the control unit will cause the fault memory to be erased.

Faults that occur sporadically or intermittently will be erased after 50 engine starts if the fault does not reoccur during this time.

Three diagnostic connectors are located above the driver's side footwell. The connectors are as follows:

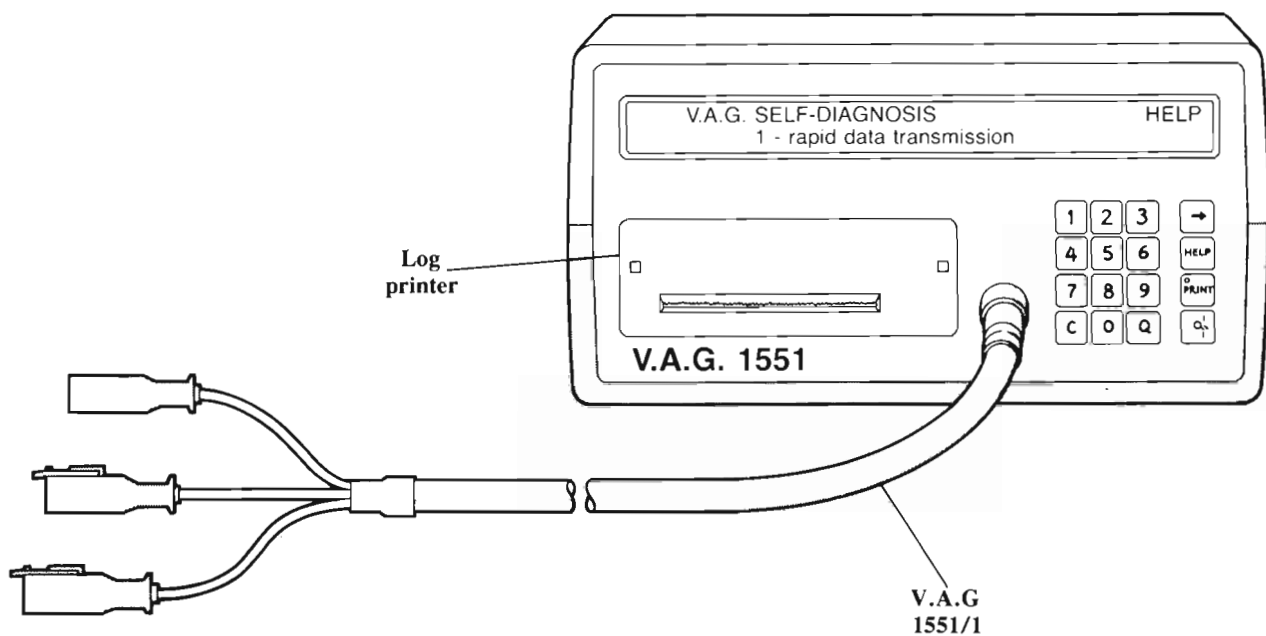
- 1 - power and ground for the V.A.G 1551
- 2 - rapid data transmission connector
- 3 - blink code connector



With the V.A.G 1551 connected to the rapid data transmission connector, the following functions can be performed in the rapid data mode:

- 01 - Check control unit version
- 02 - Check fault memory
- 03 - Output check diagnosis
- 04 - Introduction to basic setting
- 05 - Erase fault memory
- 06 - End output
- 08 - Read measuring block
- 09 - Read individual values from measuring block

Checking and erasing the fault memory and performing the output checks can also be done using the third connector with the blink code procedure.



The heart of the MPI system is the Electronic Control Unit. This receives the signals from the system's sensors and inputs and processes them in the control unit's microprocessor.

These signals, along with their inputs and the resulting outputs, are continuously checked and monitored by circuitry inside the ECU.

Sensors

Air mass sensor
with CO potentiometer

Coolant temperature sensor

Engine speed sensor

Engine reference sensor

Hall sender

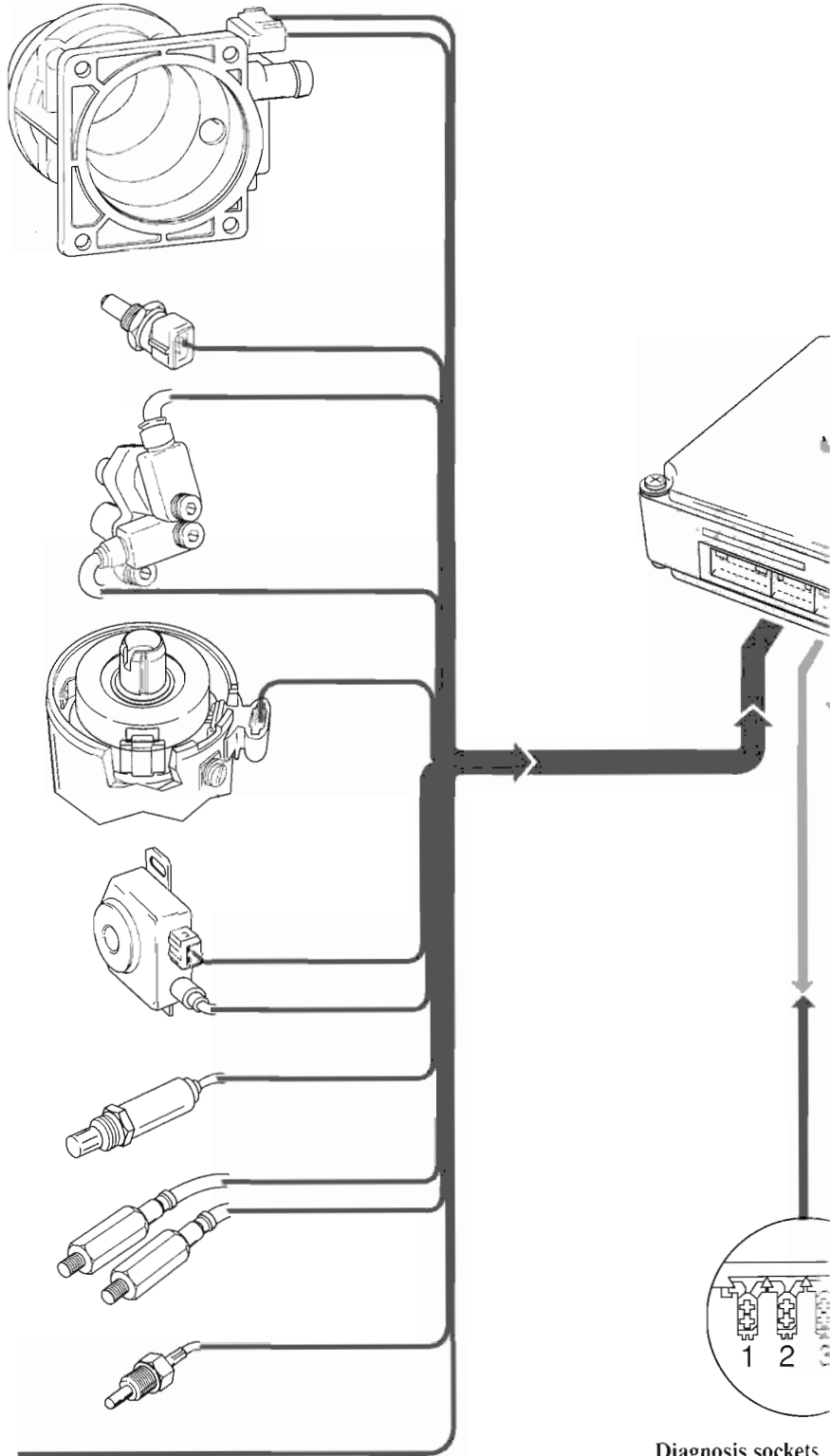
Throttle potentiometer and
idle switch

Oxygen sensor

Knock sensors I+II

EGR temperature sensor

Additional signals

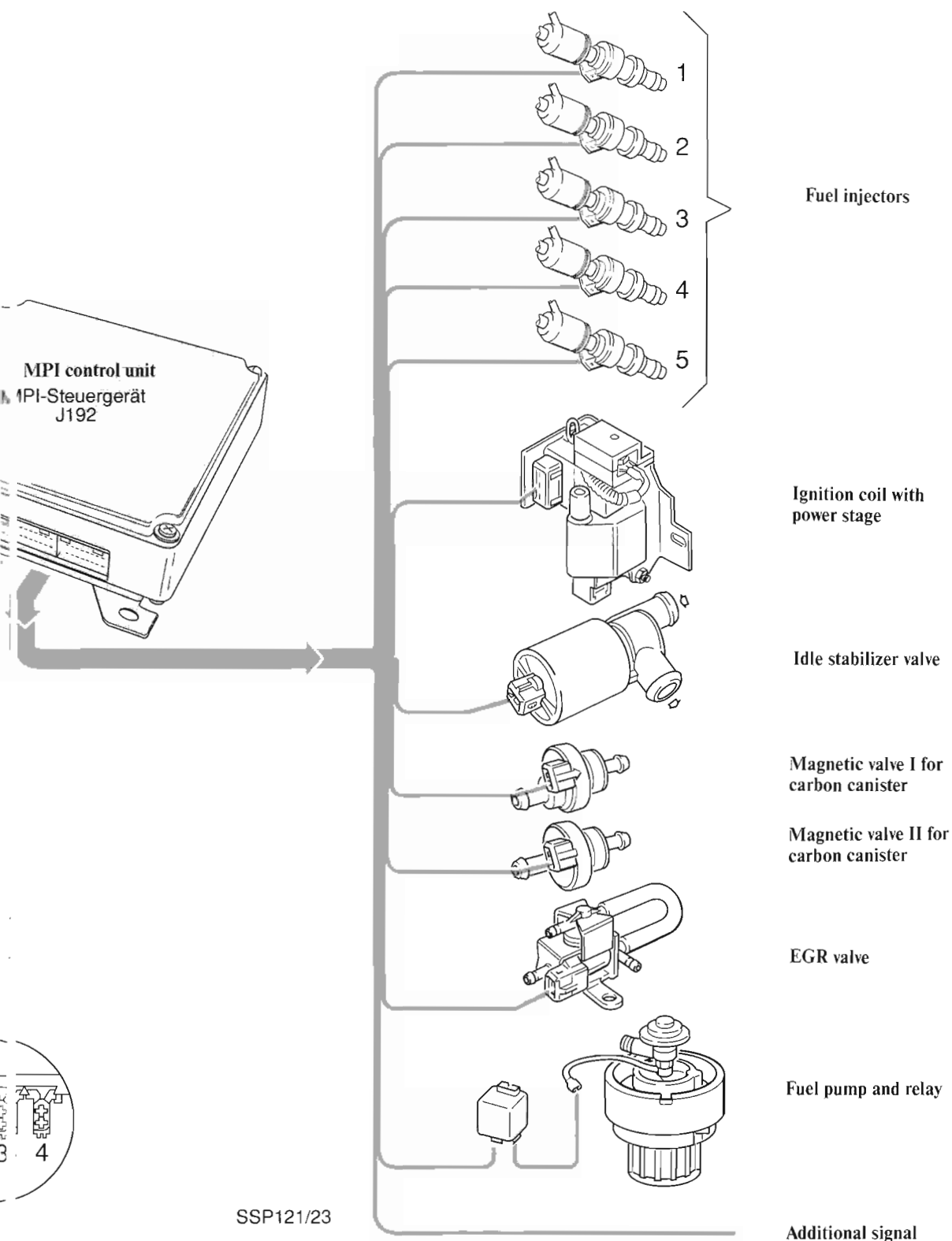


Diagnosis sockets

The control unit calculates the output signals based on various maps stored in the control unit's memories. The output signals are then generated and amplified by final power stages in the control unit.

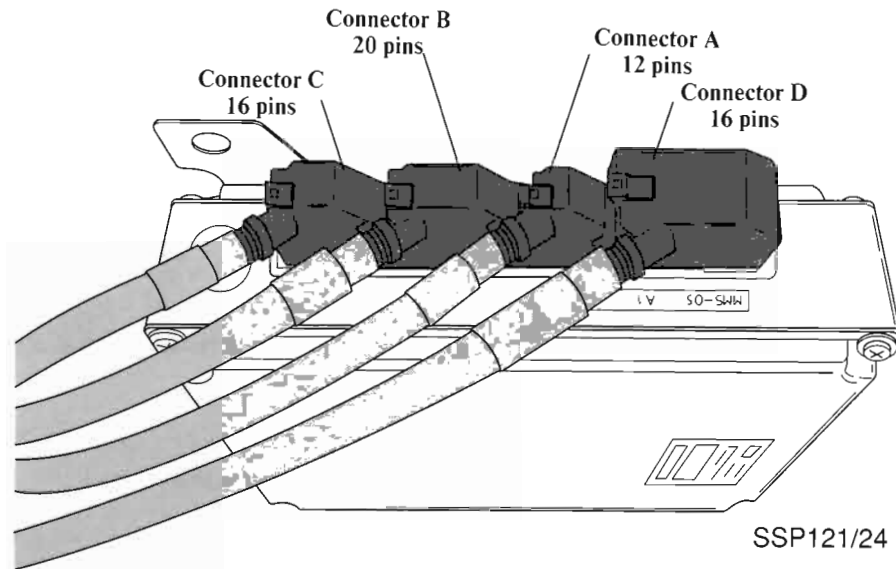
The MPI control unit generates the output signals for the various actuators such as the fuel injectors and ignition coil.

Actuators



Control Unit (J 142)

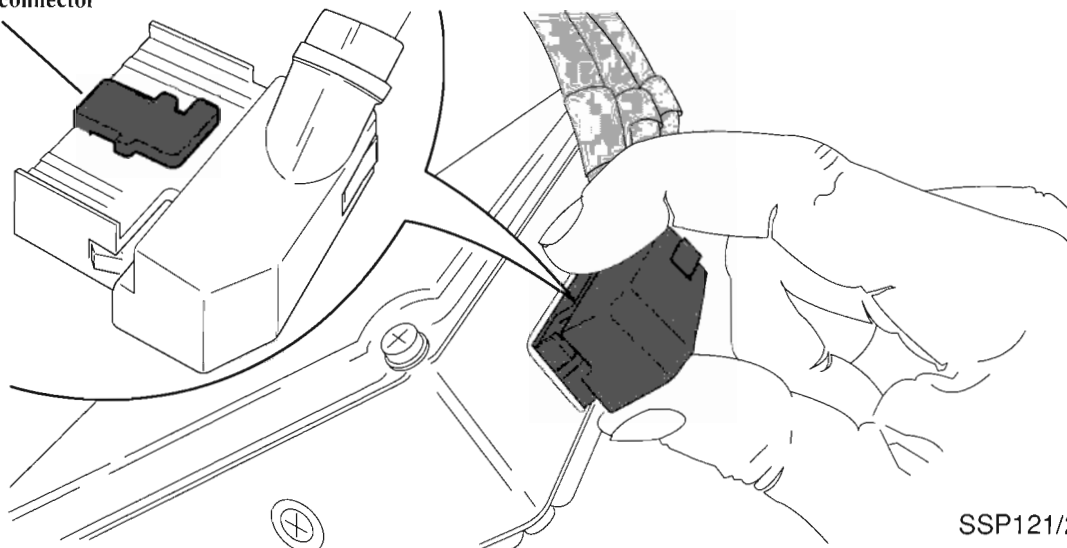
The MPI control unit has four connectors with a total of 64 pin terminals. The four connectors are identified as follows:



The individual connectors are attached to the control unit with a locking device. The locking device can be loosened by squeezing the connector shell while pulling it from the control unit.

Two new adapters are used to test the system using the V.A.G 1598 test box. See page 55.

Lock for connector



SSP121/25

Air Mass Sensor (G 70)

A hot wire air mass sensor is used to measure the air flow into the engine. The air mass sensor is attached to the air filter housing. The sensor housing includes a baffle grid which reduces air turbulence and pulses. The sensor has no moving parts.

The air measurement is done in a bypass duct. The flow conditions in the bypass duct are proportional to the main housing, however, the air speed is higher. Changes in the air flow are measured more accurately as a result and the sensor is less susceptible to dirt build-up.

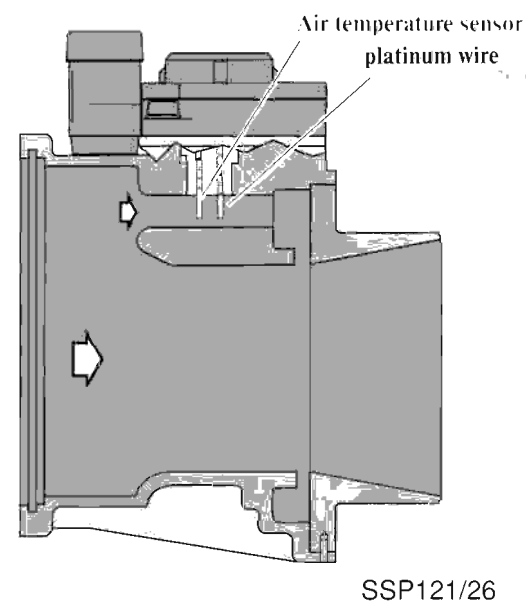
The measuring device consists of a platinum wire which is electrically heated. The air temperature sensor is used to determine the current required for heating the wire.

The heating current is regulated by the MPI control unit in such a way that the temperature difference between the platinum wire and the intake air remains constant. As more air passes the wire, more current is required to heat it.

The amount of current used to heat the wire is used by the MPI control unit to calculate the air mass. Calculating the measurement this way automatically compensates for changes in air pressure and air temperature.

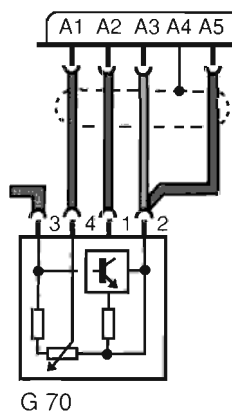
The signal from the air mass sensor is used to determine engine load. This value is then used for calculating the basic air/fuel ratio and ignition timing.

If a fault develops with the signal from the air mass sensor, the signal from the throttle potentiometer is used as a substitute in order for the car to remain driveable.



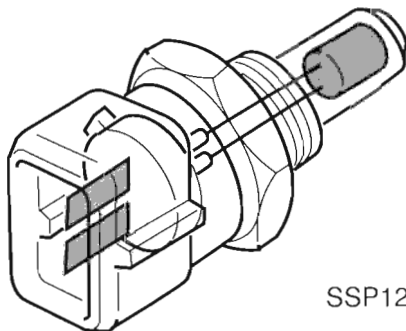
Electrical function

- A1 = CO potentiometer
- A2 = Load signal
- A3 = Ground
- A4 = Shielding
- A5 = Reference voltage signal



Coolant Temperature Sensor (G 62)

An NTC temperature sensor is threaded into the back of the cylinder head. The electrical resistance of the sender decreases when the engine temperature increases.



Signal use:

The engine coolant temperature is a correction factor for many system functions. The information is used for:

- Cold fuel enrichment
- Idle speed control
- Correction to ignition timing and injection timing for a cold engine
- Operating range for deceleration fuel shut-off

Substitute function:

If the control unit detects a fault in the coolant temperature sender (or wiring), it assumes a temperature of 68° F (20° C) when the engine is first started.

18° F (10° C) is added per minute of engine operation until the maximum temperature value of 185° F (85° C) is reached.

Electrical function

Self-diagnosis:

The ECU recognizes two fault conditions to the coolant temperature sensor:

- An open circuit
- A short circuit

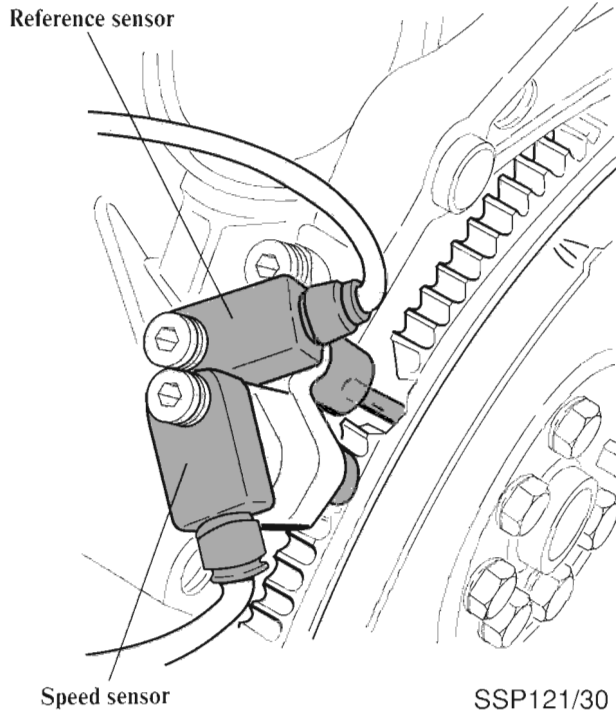


G 62

SSP121/29

Engine Reference Sender (G 4) And Engine Speed Sender (G 28)

The engine reference sender (G 4) and engine speed sender (G 28) are mounted in a common bracket on the left side of the engine block.



Both senders are inductive pulse senders that supply an output signal to the control unit when a timing reference passes the sender.

The engine reference sender (G 4) generates one signal per crankshaft revolution through a reference pin that is inserted in the front of the flywheel. This signal is generated at 60° before TDC for the #1 cylinder.

The engine speed sender (G 28) scans the 135 teeth of the flywheel ring gear. It generates one output pulse per tooth.

Signal usage:

The signal from the reference sender is used along with the signal from the Hall sender (G 40) during engine starting to recognize TDC of cylinder #1.

The signal from the engine speed sender (G 28) is used to record engine speed and calculate crankshaft angle. Crankshaft angle is used to determine ignition and injection timing.

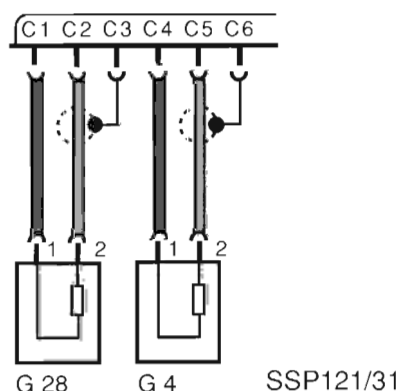
Substitute function:

There are no substitute functions for reference sender (G4) or engine speed sender (G28).

Electrical function

Self-diagnosis:

The ECU recognizes a missing signal from both the reference sender and engine speed sender after cranking the engine for five seconds.

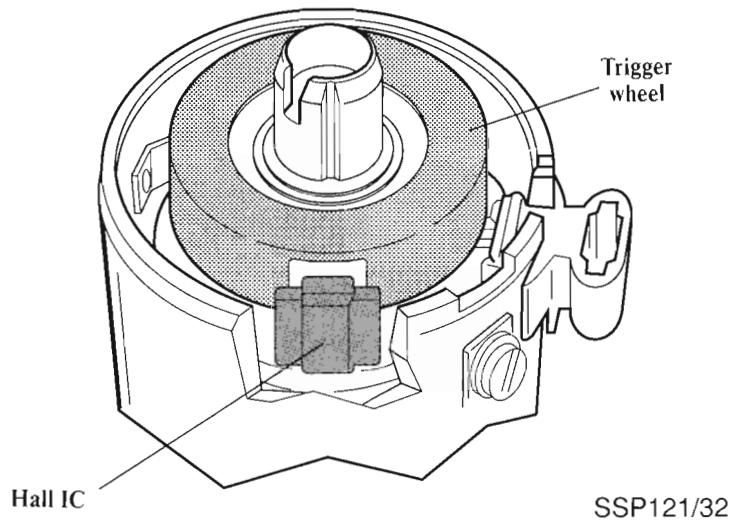


Hall Sender (G 40)

The Hall sender is mounted in the ignition distributor. It is an electronic control switch based on the Hall effect.

The Hall sender consists of a magnetic enclosure and integrated semiconductor circuit (the Hall IC). The IC is made of plastic to protect it from dampness, soiling and mechanical damage.

A voltage signal is generated when the trigger wheel interrupts the magnetic field created by the Hall IC. The trigger wheel turns at camshaft speed. This means that the Hall sender generates one voltage signal for every two crankshaft revolutions.



Signal usage:

The Hall sender (G 40) signal and the engine reference sender (G 4) signal are used to identify cylinder #1 in the firing order for the beginning of the ignition timing process and also the beginning of the sequential fuel injection.

Self-diagnosis:

The ECU will recognize a break in wiring or a continuously applied signal voltage (during start attempts as well).

Substitute function:

There is no substitute function for Hall sender G 40.

Electrical function

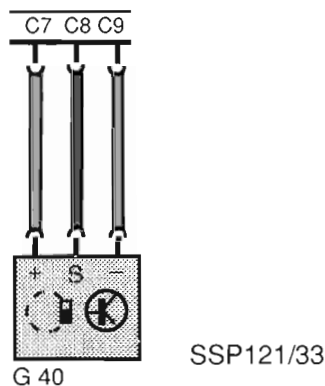
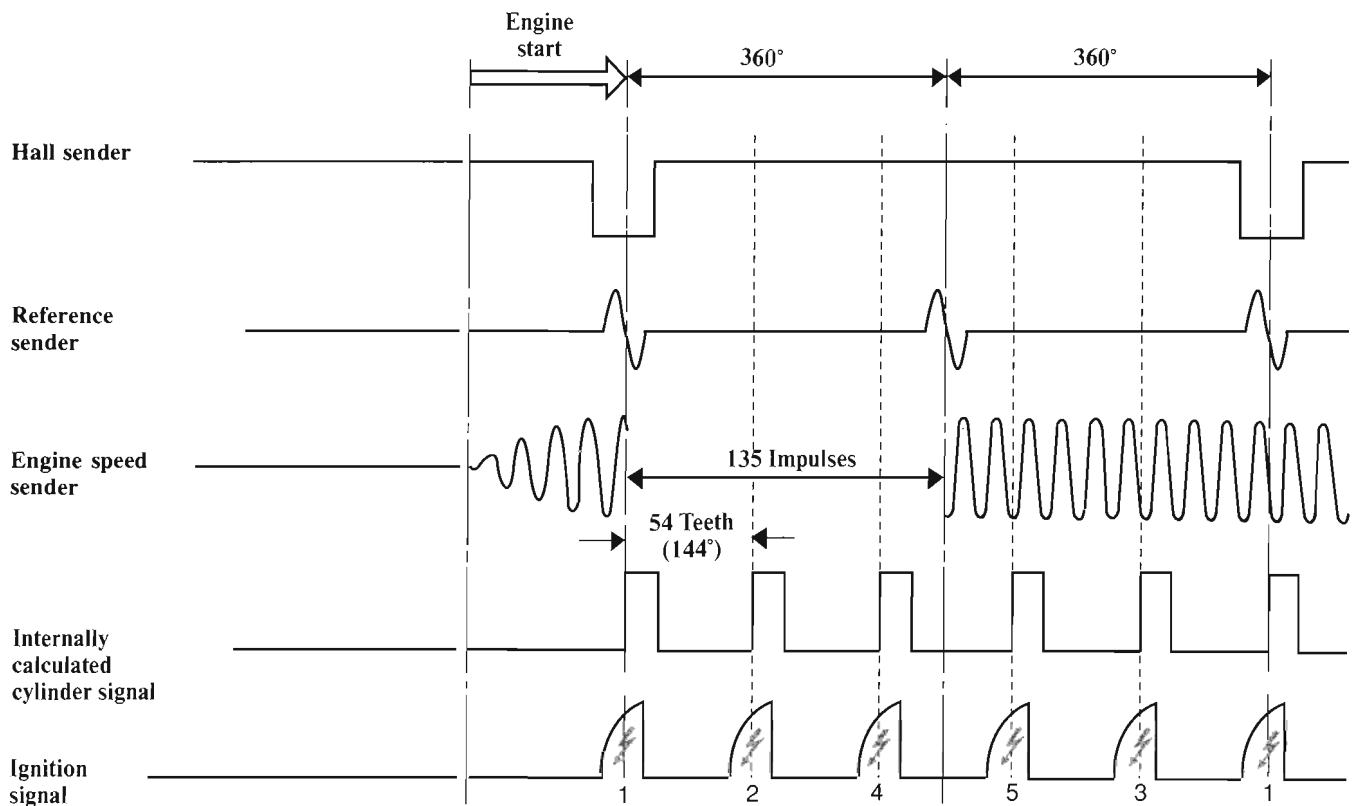


Diagram Of Control Signals

Signals from three senders are needed before the engine will start.



SSP121/34

During engine starting, the Hall sender signal and the reference sender signal work together to tell the ECU the location of TDC of cylinder #1. The ignition is then triggered and the sequential fuel injection is begun.

After the engine is started, the engine reference sender signal is no longer needed.

If the engine speed sender fails, the engine will stop running.

From this point, the engine speed sender will count 54 teeth (144° crankshaft revolution) of the flywheel ring gear and the next ignition point will be triggered by an internally calculated cylinder signal.

Throttle Body

The throttle body is mounted directly on the intake manifold. The throttle pedal position is transmitted mechanically to the throttle body via a cable.

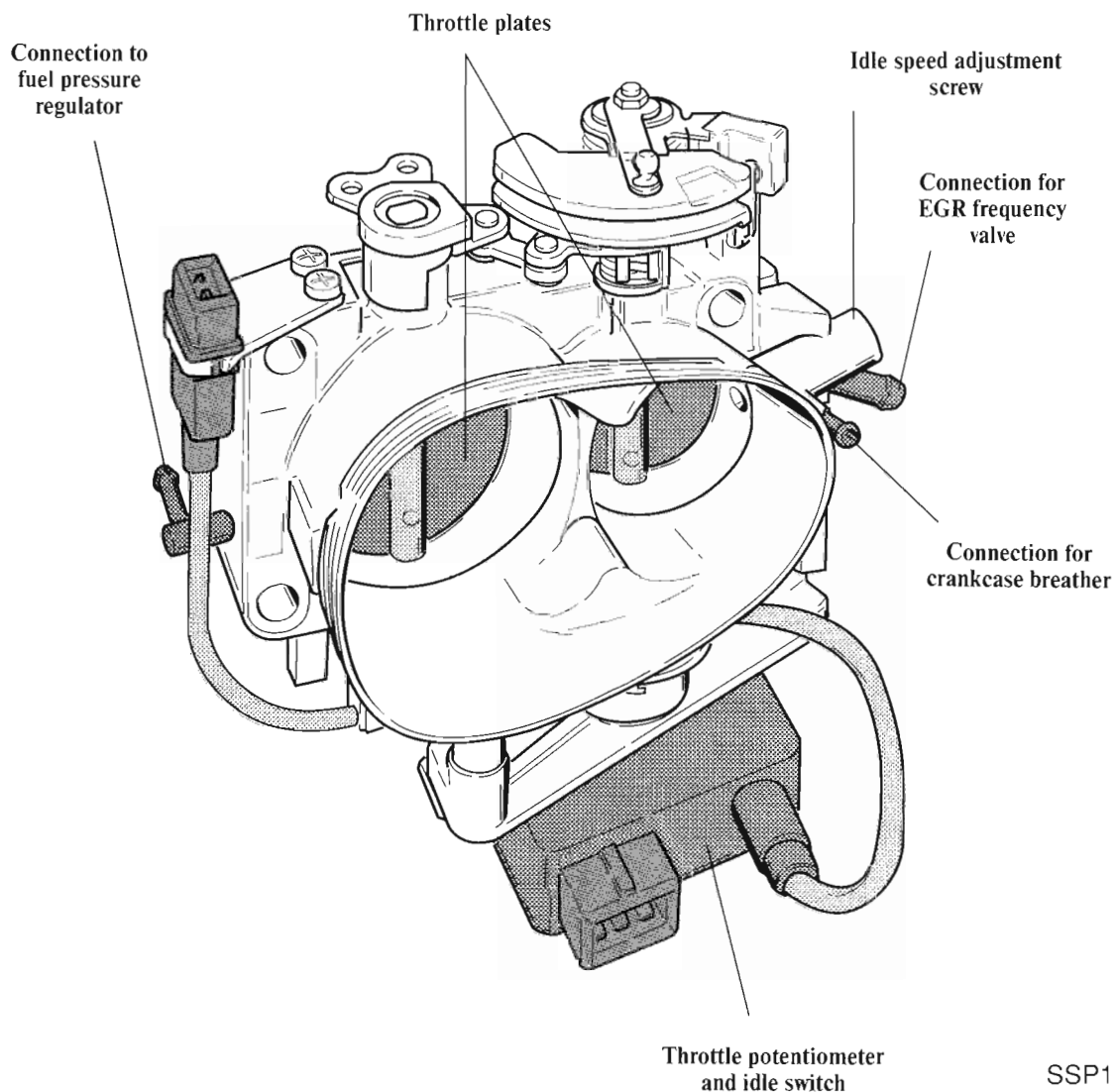
The throttle potentiometer/idle switch is a new component and is located on the throttle body.

The idle speed adjusting screw is located on the throttle body. This screw should only be adjusted when using the V.A.G 1551 in Function 04 or 08.

Vacuum ports on the throttle body are used to control the following components:

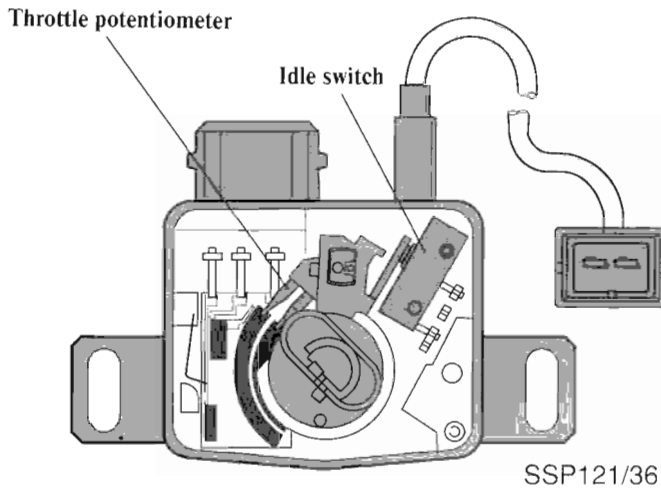
- Fuel system pressure regulator
- EGR frequency valve (California only)

In addition, crankcase emissions are vented at the throttle body.



SSP121/35

Throttle Potentiometer (G 69)/Idle Switch (F 60)



The throttle pedal position is transmitted mechanically to the throttle body via a cable. The throttle potentiometer and the idle switch are located in a common housing, mounted on the throttle body. Throttle potentiometer (G 69) and idle switch (F 60) are actuated by the throttle shaft.

The control unit recognizes the throttle setting using the position of the potentiometer and the idle switch.

The idle switch is adjustable. The ECU learns the adjustment of the throttle potentiometer.

Signal usage:

Throttle potentiometer (G 69)

This voltage signal is used by the ECU for recognition of the throttle position, for triggering acceleration enrichment (opening speed of the throttle) and as a substitute signal if the air mass sensor fails.

Idle switch (F 60)

This voltage signal is used by the ECU for idle speed control, deceleration fuel shut-off and for controlling deceleration air and deceleration ignition angle.

Substitute function:

There are no substitute functions for the throttle potentiometer (G 69) or idle switch (F 60).

Self-diagnosis:

Throttle potentiometer (G 69)

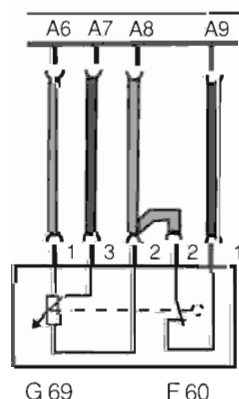
The ECU recognizes an open circuit or short circuit. During driving, the ECU also checks the plausibility of the signal by comparing it with the signal of the air mass sensor.

Idle switch (F 60)

The ECU checks the plausibility of the signal. It recognizes if the idle switch remains closed during a changing signal from the throttle potentiometer.

It also recognizes if, at speeds over the idle speed within 10 minutes after engine start, the idle switch has not closed at least once.

Electrical function



SSP121/37

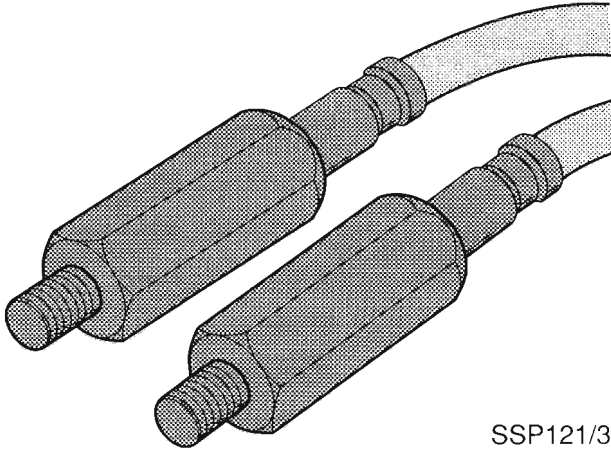
Knock Sensor I (G 61) And Knock Sensor II (G 66)

Two knock sensors are used. A knock sensor works like a microphone to "listen" for spark knock or detonation.

The use of two sensors makes it possible for the system to "hear" better and be more sensitive.

Engine knock can be caused by various operating conditions such as fuel quality or engine condition.

When knocking occurs, the ignition timing is retarded until the knocking is eliminated. Since the knock limit differs from cylinder to cylinder and changes within the operating range, knock regulation is done cylinder-selectively.



SSP121/38

Signal usage:

Knock regulation does not occur until the engine coolant temperature of 104° F (40° C) is reached.

Knock sensor I (G 61) monitors cylinders 1 and 2.
Knock sensor II monitors 3, 4, and 5.

With the aid of the Hall sender signal, the ECU can determine which cylinder is knocking. The ignition angle of the knocking cylinder is retarded in steps until the knocking stops up to maximum of 12°.

If the cylinder continues to knock, the ECU will switch to an ignition map for regular fuel, and further ignition timing retarding will occur.

If spark knock is still detected, the ECU will retard the ignition timing 16° for all cylinders and record a fault.

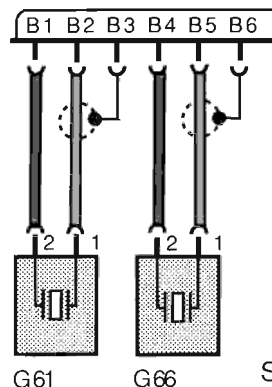
Substitute function:

If a knock sensor fails, the ignition timing angle of its assigned cylinders is retarded by a maximum of 16°.

Self-diagnosis:

The ECU recognizes an open circuit if no signal from knock sensor I (G 61) or knock sensor II (G 66) is received by the ECU at an engine coolant temperature above 104° F (40° C).

Electrical function



SSP121/39

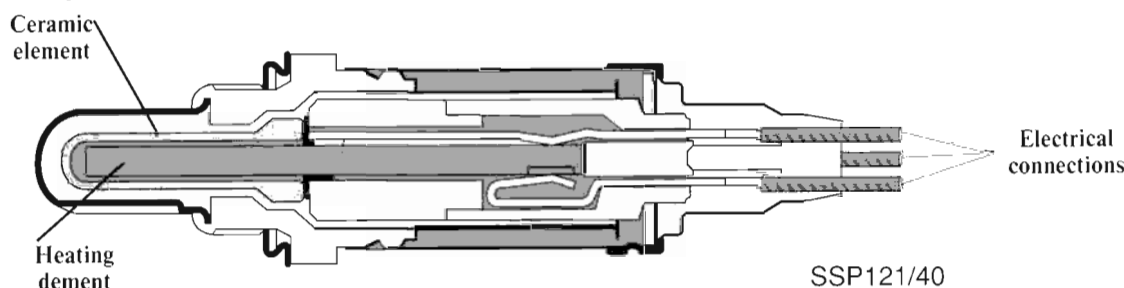
Oxygen Sensor (G 39)

The oxygen sensor (G 39) is made of a ceramic material called zirconium dioxide. The inner and outer surfaces of the ceramic material are coated with platinum. The outer platinum surface is exposed to the exhaust gas, while the inner surface is exposed to the outside air.

The difference in the amount of oxygen contacting the inner and outer surfaces of the oxygen sensor creates a pressure differential which results in a small voltage signal in the range of 100 to 1000 mV. The amount of voltage that is produced is determined by the fuel mixture.

The oxygen sensor (G 39) is heated electrically to keep it at a constant operating temperature. The heater also ensures that the sensor comes to operating temperature quickly.

The sensor has three wires, two for the heating element (ground and power) and a signal wire for the oxygen sensor. Power is supplied to the heating element whenever the engine is running.



Signal usage:

The base injection time is corrected according to the voltage signal from the oxygen sensor to maintain a fuel/air ratio of approximately 14.7 : 1. This allows the three-way catalytic converter to operate at its maximum efficiency.

If the fuel mixture is lean (excess oxygen), the oxygen sensor will send a low voltage signal (about 100 mV) to the ECU.

If the fuel mixture is rich (lack of oxygen), the oxygen sensor will send a high voltage signal (about 900 mV) to the ECU.

Electrical function

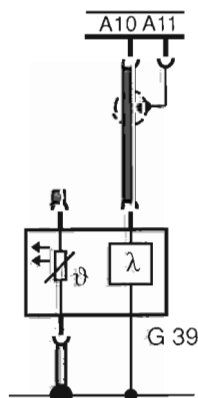
Substitute function:

There is no substitute function for oxygen sensor (G 39). If the signal fails, no oxygen sensor regulation takes place.

Self-diagnosis:

The ECU recognizes a fault if no reasonable signal voltage range is attained within five minutes after engine start with an engine coolant temperature over 104°F (40°C).

The ECU also recognizes an open circuit in the wiring or a short circuit to ground and short circuit to positive (sensor heating).

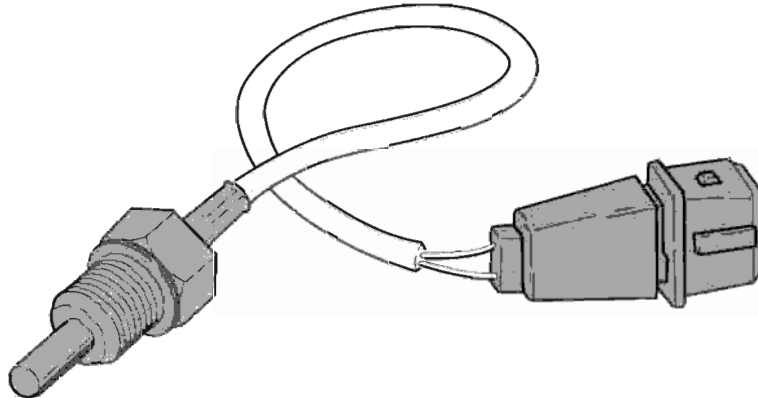


SSP121/41

EGR Temperature Sensor (G 98) (California Only)

The EGR temperature sensor (G 98) is located in the EGR valve exhaust gas channel. It measures the temperature of the exhaust gas.

The sensor is an NTC resistor. The electrical resistance of the sensor decreases as the temperature of the exhaust gas increases.



SSP121/42

Signal usage:

The signal from the EGR temperature sensor (G 98) is used only for the diagnosis of the EGR system and has no influence on the control.

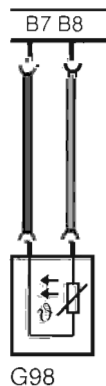
Substitute function:

There is no substitute function.

Self-diagnosis:

The EGR system is switched on when the engine coolant temperature reaches 122°F (50°C). If an exhaust gas temperature below this temperature is measured in the EGR valve, the ECU will store a fault.

Electrical function



G98

SSP121/43

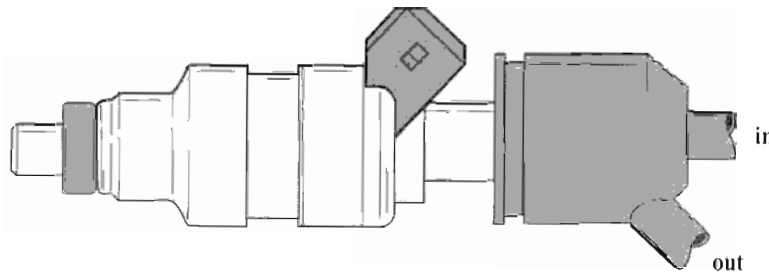
Fuel Injectors (N 30, 31, 32, 33, 83)

The fuel injectors are a full flow design with ball-type nozzles. The injectors are designed so that a large amount of fresh fuel flows close to the nozzle of the injector. This tends to cool the injectors and reduce the tendency for the fuel to percolate at high engine temperatures.

A ball-type nozzle is used to provide good fuel atomization. This design is affected less by deposit build-up from carbon or varnish.

The fuel injectors are supplied with electrical power from the fuel pump relay via a series resistor assembly.

These resistors are 5 to 7 ohms each and limit the current supplied to the injectors. This allows the use of an injector with a lower internal resistance. This results in shorter response time. The lower operating current also helps to protect the power output stages in the ECU.



Signal usage:

The ECU triggers the fuel injectors sequentially in the engine's firing order. Each injector is triggered 360° before the cylinder ignition point.

The ECU operates the injectors by completing a ground circuit. The fuel quantity is determined by the length of time the injectors are held open.

Substitute function:

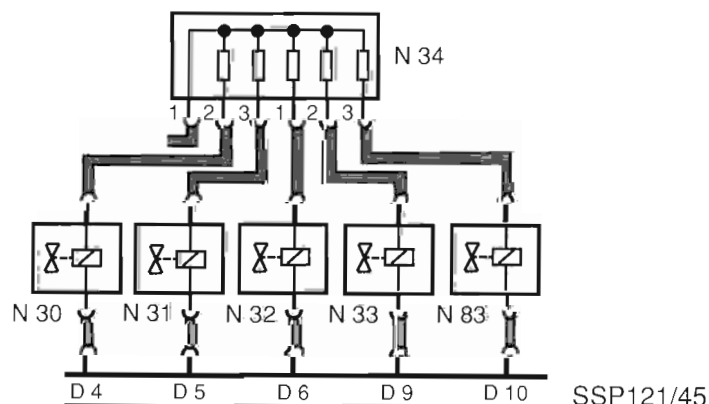
There is no substitute function.

Electrical function

Self-diagnosis:

The ECU recognizes short circuits in the component to ground cylinder selectively.

The ECU recognizes if there is an open circuit in the wiring to one injector. However, when checked with the V.A.G 1551, the injectors for all cylinders are displayed. To find the injector, you need to check the outputs using Function 03 of the V.A.G 1551.



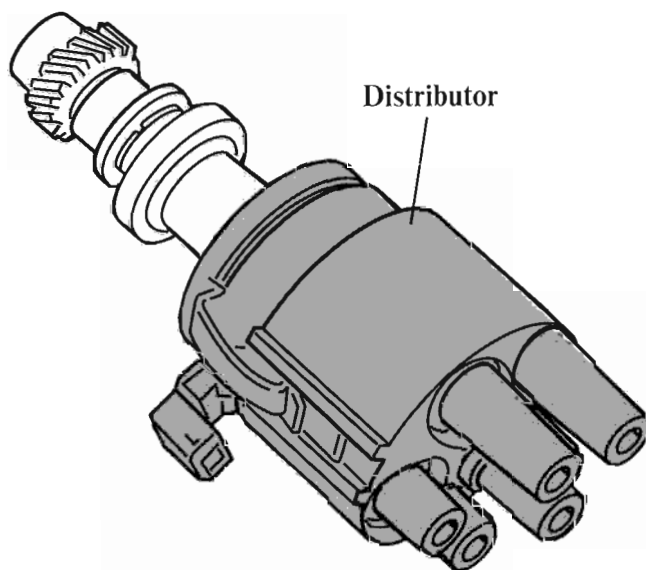
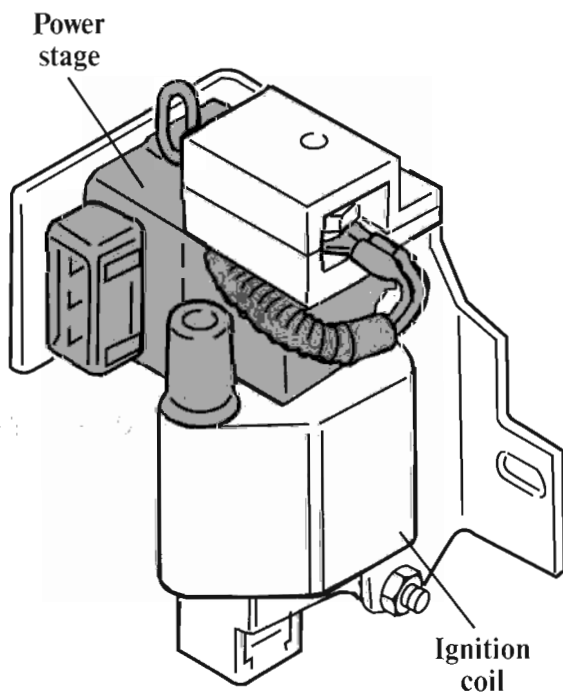
Ignition Coil (N) With Power Stage (N 70) And Ignition Distributor (O)

The ignition coil (N) consists of two copper windings lying on top of each other, wound around an iron core. It provides the secondary voltage needed to fire the spark plugs.

The power stage (N 70) has current amplifying tasks. The power stage is a Darlington-type transistor that switches the primary current for the ignition coil on and off. It is located directly on the ignition coil (N) (not in the ECU) in order to decrease voltage losses.

The power stage has a control to limit the maximum primary current through the ignition coil (N).

The ignition distributor (O) is mounted on the cylinder head and is driven by the camshaft. Since the ignition process is executed by the ECU, the ignition distributor is used only to distribute the secondary voltage to the spark plugs.



SSP121/46

Signal usage:

Ignition signal for all cylinders.

Substitute function:

There is no substitute function.

Self-diagnosis:

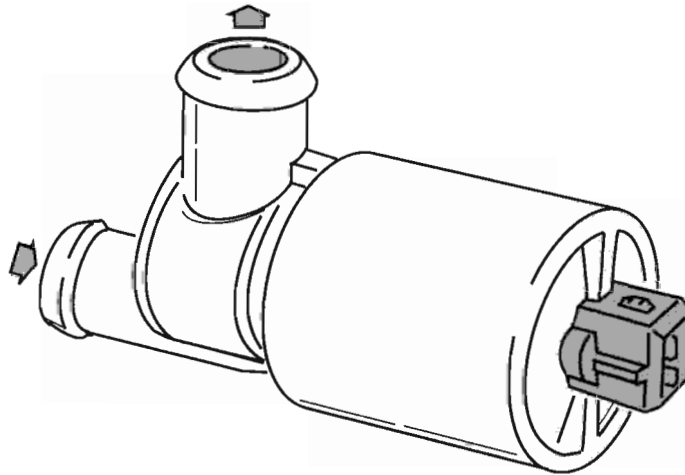
There is no self-diagnosis.

Idle Stabilizer Valve (N 71)

An idle stabilizer valve is used to control engine idle speed. It regulates the flow of air to the engine when the throttle plates and idle switch are closed.

By regulating the voltage, the opening cross-section of the valve is varied to allow more or less air to bypass the throttle plates.

The idle stabilizer valve (N 71) is controlled by the ECU. It is operated by a cycled voltage signal.



SSP121/47

Triggering:

The idle stabilizer valve (N 71) is actuated on the ground side by the ECU.

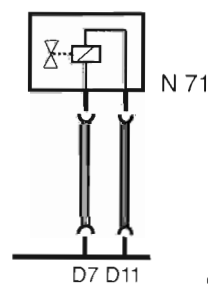
Self-diagnosis:

The ECU recognizes open and shorted circuits in the component.

Substitute function:

When a defect in the circuit is recognized, both output stages are shut off and the valve rotates to a fixed opening cross-section. This allows the engine to keep idling.

Electrical function



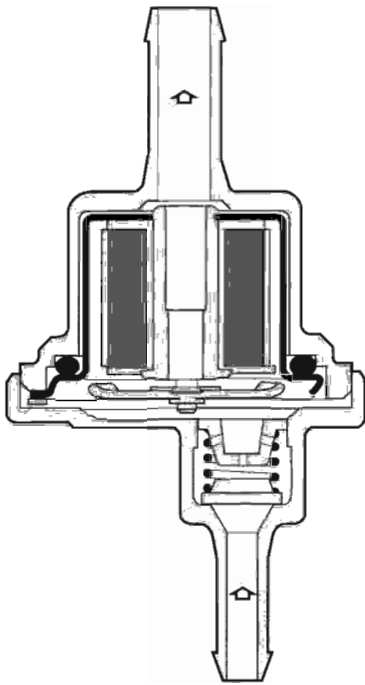
SSP121/48

Carbon Canister Frequency Valve (N 80)

The carbon canister frequency valve (N 80) is mounted together with carbon canister shut-off valve (N 115) on a bracket on the carbon canister.

The ECU determines the duty cycle of the valve to regulate the flow of fuel vapors from the carbon canister to the engine.

When no current is supplied to the valve, it remains in the open position. The valve is closed (duty cycle 100%) when the cold engine is started.



SSP121/49

Triggering:

The carbon canister frequency valve (N 80) begins to operate after oxygen sensor operation has begun.

Valve operation is load and speed dependent during driving operation. The valve is completely open at full throttle and completely closed during deceleration fuel shut-off.

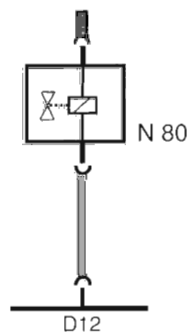
Substitute function:

If power to the valve is interrupted, the valve remains completely open. This could lead to rough running at idle speed and during partial load acceleration.

Self-diagnosis:

The ECU recognizes open circuits and short circuits in the component.

Electrical function

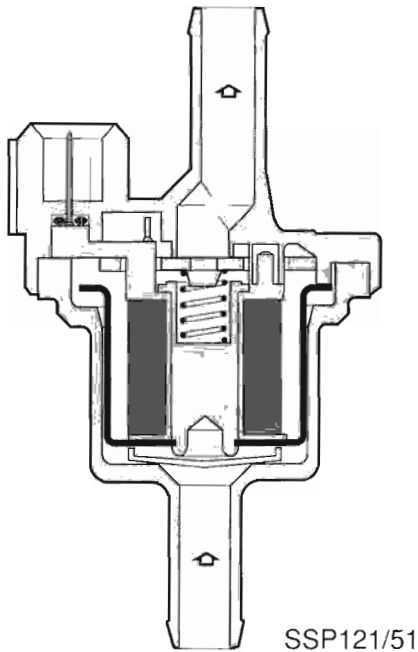


SSP121/50

Carbon Canister Shut-Off Valve (N 115)

The carbon canister shut-off valve (N 115) is mounted together with carbon canister frequency valve (N 80) on a bracket on the carbon canister.

The ECU controls the switching current to the valve. The valve is closed when it is not supplied with current. It closes off the carbon canister from the intake manifold so that no fuel vapor can flow into the intake manifold. The valve opens five seconds after the engine has started.



Triggering:

The carbon canister shut-off valve (N 115) is activated by the ECU 5 seconds after the engine is started and opens the connection from the carbon canister to the carbon canister frequency valve (N 80).

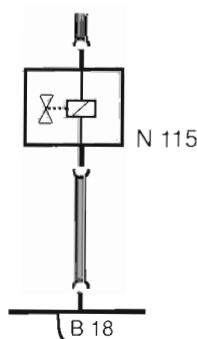
Substitute function:

There is no substitute function. If current to the valve remains closed, there is no purging of the carbon canister.

Self-diagnosis:

The ECU recognizes an open circuit or a short circuit to positive or ground.

Electrical function



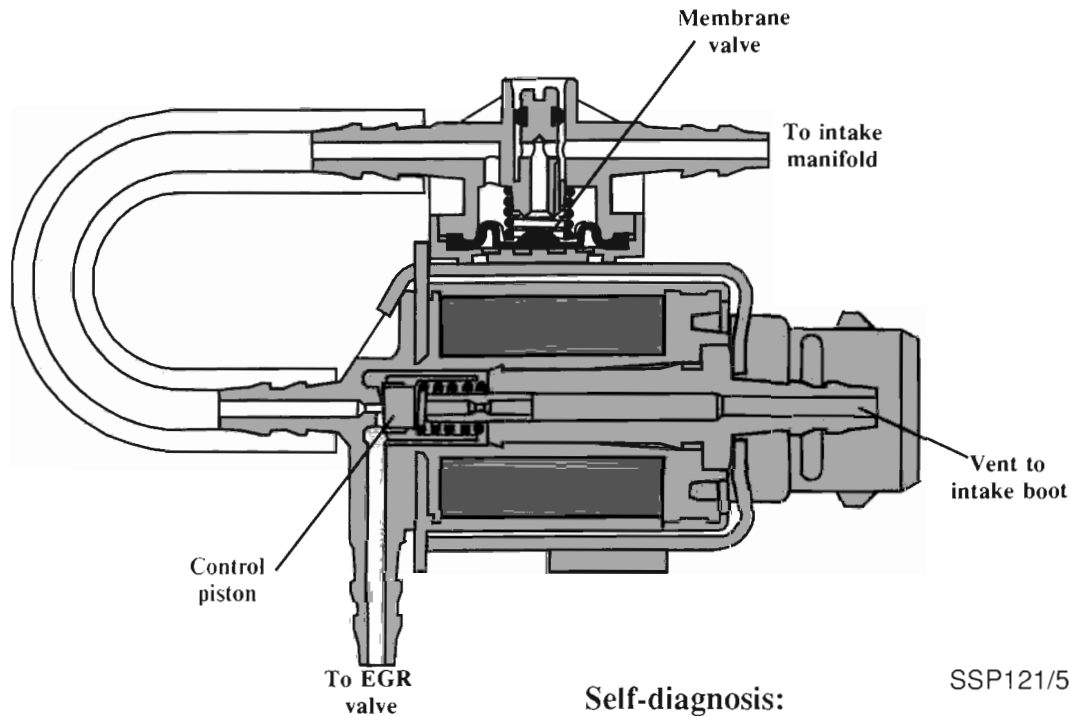
SSP121/52

EGR Frequency Valve (N 18) (California Only)

The EGR frequency valve (N 18) is mounted on the air filter housing. It is controlled by the ECU.

A control pressure (vacuum) is formed in the frequency valve from the intake manifold pressure

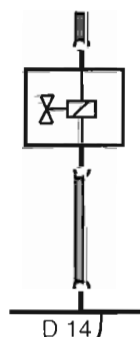
and atmospheric pressure (from the intake air elbow). This control pressure is applied to the EGR valve via the EGR frequency valve (N 18).



The frequency valve controls the amount of vacuum supplied to the EGR valve by switching between the connection to the EGR valve and intake air boot.

Thus, the actual amount of recirculated exhaust gas can be determined by the ECU, depending on engine speed and load conditions. A membrane valve limits the vacuum supplied to the frequency valve at 200 mbar.

Electrical function



Self-diagnosis:

SSP121/53

The ECU will recognize an open circuit or short circuit in the EGR frequency valve. If the EGR valve remains continuously open or closed because of a mechanical failure, the EGR temperature sensor (G 98) will signal this to the control unit.

Triggering:

The frequency valve (N 18) ground circuit is controlled by the ECU depending on engine load and speed.

Substitute function:

There is no substitute function. If current to the frequency valve (N 18) is interrupted, the EGR valve will remain closed.

SSP121/54

Fuel Pump Relay (J 17)

The fuel pump relay is mounted on the fuse/relay panel in the plenum.

Signal usage:

The fuel pump relay is triggered by the ECU as soon as the speed signal from the engine speed sender (G 28) is generated during engine starting.

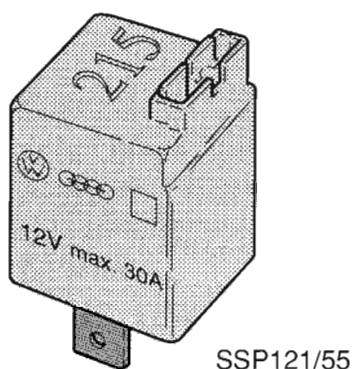
Note: The fuel pump will operate for one second when the ignition is first turned on.

Substitute function:

There is no substitute function. If the speed signal fails, the engine will not start.

Self-diagnosis:

There is no self-diagnosis.



OBD Warning Light (K 66) (California Only)

The warning light (K 66) is mounted in the instrument cluster on California vehicles.

Triggering:

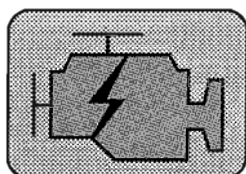
The light is triggered via pin C 14 to warn the driver of malfunctions in the fuel injection system.

Substitute function:

There is no substitute function.

Self-diagnosis:

There is no self-diagnosis.



Additional Input/Output Signals Engine Management System ECU

A/C Compressor Clutch Signal



Signal usage:

The signal at pin C 10 of the Engine Management ECU is bi-directional. It can be used as both an input and output signal.

Input signal:

The A/C compressor clutch relay (J 153) supplies voltage to pin C 10 via terminal 87A 140 milliseconds before the A/C clutch is engaged. The ECU increases the idle stabilizer valve opening to prevent an RPM drop when the compressor clutch engages.

Output signal:

During acceleration in 1st gear, the ECU sends a signal via pin C 10 to the A/C compressor clutch relay (J 153) to disengage the A/C compressor clutch.

Substitute function:

There is no substitute function.

Self-diagnosis:

A quick check of this operation is possible using V.A.G 1551 via Function 08, channel 7, in Rapid Data Transfer.

A/C On/Off Signal



Signal usage:

An input signal is received at terminal C 11 from the A/C switch (E 30) of manual A/C systems or the A/C control head (E 87) of Digital Climate Control systems.

Manual A/C systems:

Idle speed is increased when the A/C is switched on.

Digital Climate Control systems:

Idle speed is increased when the A/C is switched on in **Auto**, **Bilev** or **Defrost**.

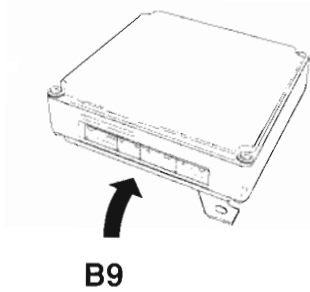
Substitute function:

There is no substitute function.

Self-diagnosis:

A quick check of this operation is possible using V.A.G 1551 via Function 08, channel 7, in Rapid Data Transfer.

Vehicle Speed Signal



Signal usage:

The ECU receives a vehicle speed signal at pin B 9 from the speedometer sender (G 68). The signal is used for:

- Deceleration air control (opening of idle stabilizer valve during deceleration)
- A/C compressor cut-out (first gear)

Substitute function:

There is no substitute function.

Self-diagnosis:

The ECU recognizes a missing signal. An operation check is possible using V.A.G 1551 via Function 09, channel 15, in Rapid Data Transfer.

Engine Speed Signal



The speed signal is supplied to the tachometer and Digimat ECU via pin B 10. The output signal is used to trigger various ECUs.

There is no substitute function or self-diagnosis.

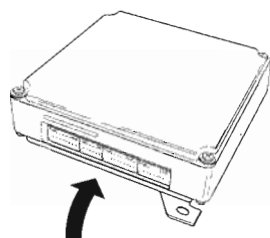
Fuel Consumption Signal



The consumption signal is supplied to the Trip Computer via pin B 11. It supplies information to the Trip Computer about instantaneous fuel consumption. Fuel consumption is calculated from the injection timing.

There is no substitute function or self-diagnosis.

Driving Mode Signal (Auto Trans Only)



B12

Signal usage:

The ECU receives a signal at pin B 12 from the Digimat ECU (pin 20). It identifies the selector lever position of the transmission. Idle speed is lowered in driving ranges to prevent "idle crawl."

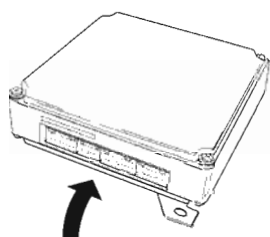
Substitute function:

There is no substitute function.

Self-diagnosis:

The signal can be checked with V.A.G 1551 via Function 08, channel 7, in Rapid Data Transfer.

Shift Timing Signal (Auto Trans Only)



B13

Signal usage:

The ECU receives a shift timing signal at pin B 13 from the Digimat ECU (pin 28). The Engine Management ECU then retards the ignition timing to increase shifting smoothness.

Substitute function:

There is no substitute function.

Self-diagnosis:

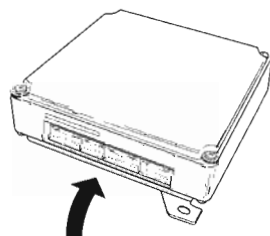
The signal can be checked with V.A.G 1551 via Function 08, channel 7, in Rapid Data Transfer.

Signal usage:

The coding connector supplies (through external wiring) a ground signal to the ECU.

Pin 14 open	= manual transmission
Pin 14 connected	= automatic transmission

Coding Signal



B14

Substitute function:

There is no substitute function.

Self-diagnosis:

The coding can be read using V.A.G 1551 via Function 01.

00	= Auto Trans
10	= Manual Trans

Coding Signal



Signal usage:

The coding connector supplies (through external wiring) a signal to terminal B 16 of the ECU.

Pin 16 B connected = California

Pin 16 B open = rest of world

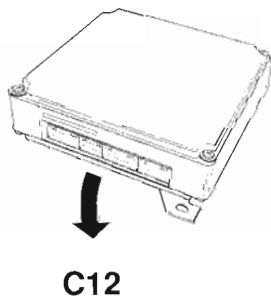
Substitute function:

There is no substitute function.

Self-diagnosis:

The coding can be read using V.A.G 1551 via Function 01.

Diagnosis Signal



Signal usage:

The ECU supplies an output signal via C 12 to the brown diagnosis plug connector (K circuit). It is used to transmit data to V.A.G 1551 in the Rapid Data Transfer mode.

Substitute function:

The Blink Code Output can be used via the OBD warning light (K 66) or diode test light to read the faults.

Self-diagnosis:

If the circuit is interrupted, V.A.G 1551 will respond with the display:

“Control unit does not answer”

Stimulus Circuit Signal



Signal usage:

The ECU receives a signal via pin C 13 from the brown diagnosis plug connector (L circuit).

It is used to activate the Rapid Data Transfer mode with V.A.G 1551 and, if necessary, the Blink Code Output via the OBD warning light (K 66) or diode test light.

Substitute function:

There is no substitute function.

Self-diagnosis:

If the circuit is interrupted, V.A.G 1551 will respond with the display:

“Control Unit does not answer”

Engine Management System ECU Self-Diagnosis

Self-diagnosis functions:

- EGR system
- Knock control and oxygen sensor control
- Senders and sender circuits
- Signal plausibility
- Actuator circuits

The ECU also provides substitute functions for failed operations and stores faults that have occurred.

Plausibility checks:

The ECU compares signals of some senders with signals from other senders to see if they “make sense.” For example, the idle switch signal cannot be checked for open circuits or short circuits since the signal from the idle switch is either on or off. Therefore, the signal from the idle switch is compared by the ECU with the signal from the throttle potentiometer to see if it is logical.

The following signals are checked for plausibility:

- Idle switch (F 60)
- Air mass sensor (G 70)
- Throttle potentiometer (G 69)

Substitute functions:

If a circuit is interrupted or short circuited, signals at the border limits of the operating range of the particular sender are supplied to the ECU. However, this could lead to poor driving behavior and an increase in emissions.

Therefore, substitute values are supplied by the ECU when a fault is recognized. This permits driving performance that is acceptable.

Fault memory:

The fault memory in the ECU recognizes faults and stores them until:

- The fault memory is erased after the fault is corrected
- A sporadic fault does not occur for the next 50 engine starts
- The battery is disconnected
- The ECU is disconnected

V.A.G 1551 Rapid Data Transfer

After connecting the V.A.G 1551 and selecting Address Word 01, Engine Electronics, the following Function Words can be selected:

- 01 - Check control unit versions
- 02 - Check fault memory
- 03 - Output check diagnosis
- 04 - Introduction of basic settings
- 05 - Erase fault memory
- 06 - End output
- 07 - Code control unit
- 08 - Read measuring block value
- 09 - Read individual measuring value

Function 02 - Check Fault Memory

Display example:

00520	2232
Air mass/quantity sensor -	G 70 / G 19
Short circuit to positive	SP/

00520 = Fault identification number
2232 = Fault code (Blink Code)
Air mass/quantity sensor G 70 / G 19 = affected components
Short circuit to positive = fault type
SP/ = sporadically occurring fault

The fault identification number is a new feature of V.A.G 1551. Each fault has an assigned fault identification number.

Note:

Fault identification numbers will be used with the introduction of program card version #2 for V.A.G 1551.

Fault identification numbers will be listed by number order in the Repair Manual making it easier to locate the fault.

Function 03 - Output Check Diagnosis

The output check diagnosis provides a means to quickly check the actuators for correct wiring and proper mechanical operation. This also checks the final stages in the control unit.

The function of the actuators is tested acoustically, with the exception of the fuel injectors. It is necessary to use a diode test light to test the fuel injectors because the switching sound is not very loud.

Note:

A switching sound is no guarantee that an actuator is working properly. Additional tests may be necessary.

The actuators are activated in the following sequence:

- 4443 - Fuel pump relay (J 17)
- 4411 - Injector, cylinder #1 (N 30)
- 4412 - Injector, cylinder #2 (N 31)
- 4413 - Injector, cylinder #3 (N 32)
- 4414 - Injector, cylinder #4 (N 33)
- 4421 - Injector, cylinder #5 (N 83)
- 4431 - Idle stabilizer valve (N 71)
- 4343 - Carbon canister frequency valve (N 80)
- 4331 - Carbon canister shut-off valve (N 115)
- 4312 - EGR frequency valve (N 18)

Function 04 - Introduction Of Basic Setting

Function 08 - Read Measuring Value Block

The measured value block is output on V.A.G 1551 as soon as Function 04 or 08 are selected.

Ten displays appear in the measured value block. These display values are required for engine adjustment and fault diagnosis.

Display example:

Read measured value block										
Display value	151	75	29	8	4	123	16	109	0	9
Channel	1	2	3	4	5	6	7	8	9	10

Measured Value Block - Functions 04 And 08 Explanation Of Channels 1 Through 10

Channel 1 - Engine coolant temperature

The display value minus 50 corresponds to the engine coolant temperature.

Channel 2 - Engine load

Display range from 1 to 255. 255 equals the theoretically possible full load.

Channel 3 - Engine speed

The display value multiplied by 25 corresponds to the engine speed.

Channel 4 - Idle stabilizer learning value

The display value corresponds to the deviation from the base setting of the idle stabilizer valve. Display **0 to 7** means that the control value is greater than the base setting.

Display values of **249 to 255** mean that the control value is less than the base setting.

Channel 5 - Idle stabilizer learning value with automatic transmission in a drive mode

The display value corresponds to the deviation from the base setting of the idle stabilizer valve.

In the base setting, the display value is 0. With manual transmission vehicles, the display value is always 0.

The display value corresponds to the deviation from the base setting of the idle stabilizer valve. Display **0 to 7** means that the control value is greater than the base setting.

Display values of **249 to 255** mean that the control value is less than the base setting.

Channel 6 - Setting idle speed control

When the valve is operating, the display varies around an average value of 128.

Channel 7 - Switch inputs

Please see next page.

Channel 8 - Oxygen sensor setting

When the sensor is operating, the display varies around an average value of 128.

A display value over 128 means the mixture is too lean. A display under 128 means that the mixture is too rich.

Channel 9 - Ignition distributor

A display value of 254, 255, 0, 1, 2 means the ignition distributor setting is correct.

Channel 10 - Ignition timing

The display value multiplied by 1.33 corresponds to the ignition timing calculated by the ECU.

Measured Value Block - Functions 04 and 08

Explanation of Channel 7

The display value in Channel 7 provides information about some of the input signals arriving at the ECU.

Each input signal is assigned a specific numerical value. The display value in Channel 7 results from the addition of the input signal numerical values.

Numerical value 2 = Transmission in gear signal
from Digimat ECU (pin 13)

Numerical value 4 = Automatic transmission in
"P" or "N" (pin B 12)

Numerical value 8 = Manual transmission
coding

Numerical value 16 = Idle switch closed
(pin A 9)

Numerical value 32 = A/C compressor on
(pin C 10)

Numerical value 64 = A/C system on
(pin C 11)

Display Example #1

Vehicle with manual transmission at idle.

Numerical values:

8 = manual transmission coding

16 = idle switch closed

24 = display value in channel 7

If the idle switch is open, the display value would be 8.

Display Example #2

Vehicle with transmission at idle (driving mode "N") with A/C system and A/C compressor engaged.

Numerical values:

4 = selector lever position "N"

16 = idle switch closed

32 = A/C compressor engaged

64 = A/C system on

116 = display value in Channel 7

If the A/C compressor is switched off, the display value would be 84.

Function 04 - Introduction Of Basic Setting

When Function 04 is selected, the following occurs:

- Ignition timing is fixed at 12°
- Idle stabilizer current is fixed at 540 + 50 mA
- Oxygen sensor control shut-off (system is in open loop)
- The learned (adapted) values of the idle stabilizer are erased and set to the base value 0
- The carbon canister shut-off valve (N 115) is closed so no tank ventilation occurs
- Engine coolant temperature value is fixed at 176°F (80°C)

This function can be used when checking or adjusting the basic engine settings using a CO meter and the VW 1367 or its equivalent.

Display example:

	System in base setting									
Display value	148	59	29	0	0	128	20	128	0	9
Channel	1	2	3	4	5	6	7	8	9	10

Channel 1 - display value 148

The display value minus 50 corresponds to the engine coolant temperature

Channel 4 and 5 - display value 0

The self-learning value of the idle stabilizer is set to the base value

Channel 6 - display value 128

The idle stabilizer is fixed at an average value

Channel 8 - display value 128

Oxygen sensor system is fixed at an average value

Channel 10 - display value 9

Ignition timing angle is fixed at 12°

Function 08 - Read Measuring Block Value

Function 08 is used to check the engine idle speed adjustment and adjust CO% using the V.A.G 1551.

When Function 08 is selected, the following operations are evaluated:

- Correct adjustment of the idle stabilizer
- Correct adjustment of the CO%

Before making adjustments, it is necessary to do the following:

- Vent the crankcase breather
- Disconnect carbon canister frequency valve (N 115)
- Switch off all electrical consumers

V.A.G 1551

Display example:

148 59 29 0 0 128 20 128 0 9

Idle speed

Oxygen sensor

Note:

The idle stabilization and oxygen sensor systems are **active** and not fixed in function 08.

Function 09 - Read Individual Measuring Values

In Function 09, Channels 00 to 15 can be selected. Currently, only 2 channels are being used.

Channel 08 - ECU supply voltage

The display value multiplied by 0.08 corresponds to the voltage supply at the ECU.

Example: 170×0.08 corresponds to 13.6 volts

Channel 15 - Vehicle speed

The display value corresponds to the vehicle speed.

Example: 100 corresponds to 100 km/h

Note:

Testing with the V.A.G 1551 during driving operation must be done by a passenger.

All the information in "Self-Diagnosis Functions" of this book describes many of the diagnostic possibilities for the V.A.G 1551. Check the Repair Manual Microfiche for exact instructions.

Adapter Cable V.A.G 1598/11 and 1598/12

After using V.A.G 1551, it may be necessary to do further testing. For this, adapter cables 1598/11 and 1598/12 can be connected to the ECU wiring harness.

These cables are included in test box V.A.G 1598.

Notes:

Adapter cable V.A.G 1598/11

The contact assignment of connectors A and B **is not identical** to the assignment of the sockets on the test box.

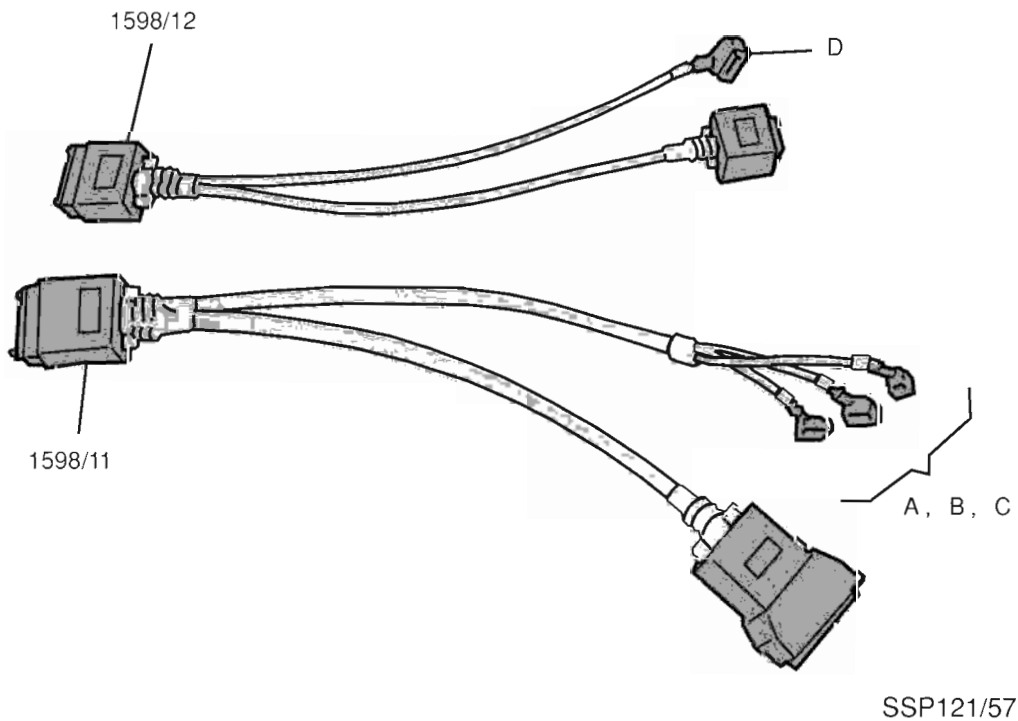
The contact assignment of connector C **is identical** to the assignment of the sockets on the test box.

Check the Repair Manual Microfiche for the latest information.

Adapter cable V.A.G 1598/12

The contact assignment of connector D **is identical** to the assignment of the sockets on the test box.

Check the Repair Manual Microfiche for the latest information.



Wiring Diagram

Functional Wiring Diagram

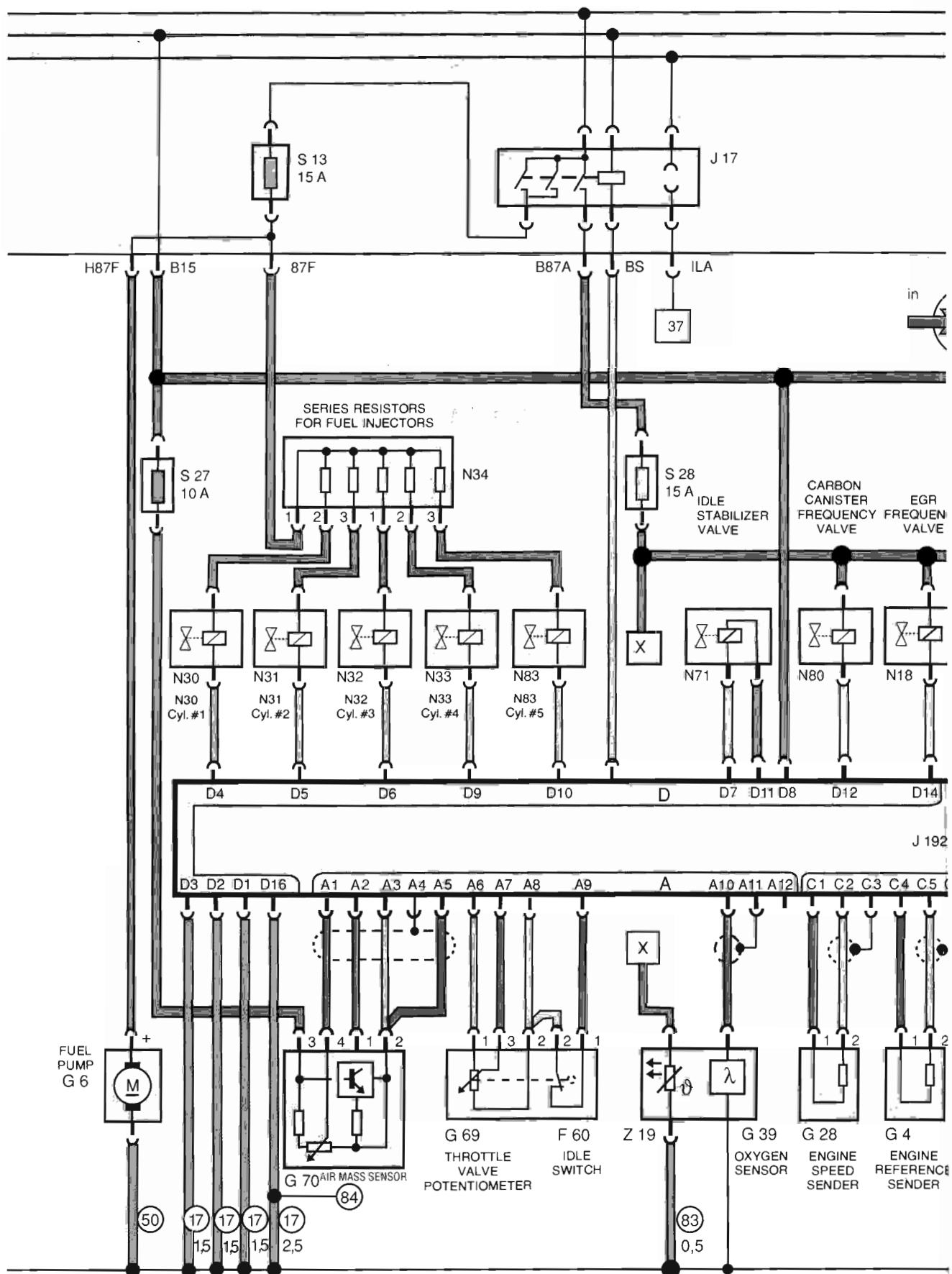
Color Coding

Green = input signal
Blue = output signal
Red = positive
Brown = ground

Components

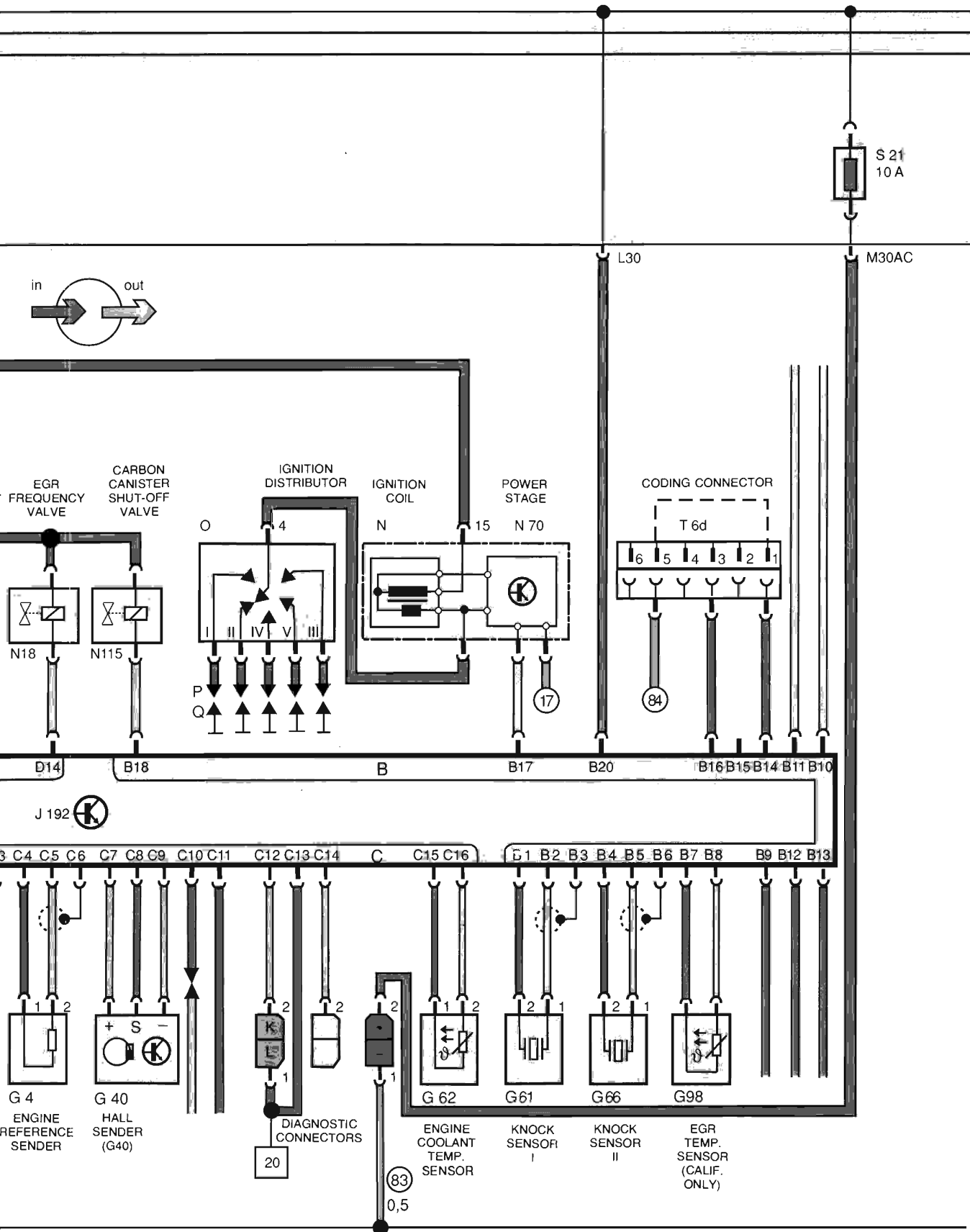
F 60 = Idle switch
G 4 = Engine reference sender
G 6 = Fuel pump
G 28 = Engine speed sender
G 39 = Oxygen sensor heater
G 40 = Hall sender
G 61 = Knock sensor I
G 62 = Engine coolant temperature sensor
G 66 = Knock sensor II
G 70 = Air mass sensor
G 98 = EGR temperature sensor (California)
J 17 = Fuel pump relay
J 192 = MPI control unit
N = Ignition coil
N 18 = EGR frequency valve (California)
N 30 = Injector, cylinder #1
N 31 = Injector, cylinder #2
N 32 = Injector, cylinder #3
N 33 = Injector, cylinder #4
N 34 = Series resistors
N 70 = Power stage (ignition coil)
N 80 = Carbon canister frequency valve
N 83 = Injector, cylinder #5
N 115 = Carbon canister shut-off valve
O = Ignition distributor
P = Spark plug connector
Q = Spark plugs
S 13 = Fuse, fuel pump and fuel injectors
S 21 = Fuse, diagnostic connector
S 27 = Fuse, engine control I
S 28 = Fuse, engine control II
T 6d = Coding connector
Z 19 = Oxygen sensor heater
17 = ground connection, intake manifold
50 = ground connection, luggage compartment
83 = ground connection, right front wiring harness
84 = engine ground connection, right front wiring

30
15
31



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 26 27 28 29

Wiring Diagram



Pin list

Note: When working with a V.A.G. 1598 test box it must be taken into account that pin connections of connectors A through D on adapter cables 1598/11 or 1598/12 are not always identical with connections of sockets on the test box. Consequently the **box** number specifies the socket of the test box corresponding with a pertinent pin number.

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
A1 Box 41	in	CO potentiometer G 74 in air mass sensor G 70 Pin 4	Voltage signal from CO potentiometer. Adjustment of idling injection rate according to engine and ambient conditions.	None (engine runs without correction of mixture).	00521/2242 Recognizes breaks or shorts to positive	Adjustment of CO is not possible; poor transition from idling range
A2 Box 42	in	Air mass sensor G 70 Pin 1	Voltage signal proportional to air mass flow in intake manifold, designates engine load. Load information is a major input variable in MPI for all map value calculations depending on load and speed.	None (signals from the throttle valve potentiometer are used for calculation of the injection time and firing point)	00520/2242 Recognizes breaks and shorts to positive or ground	Disturbed operation in transition to acceleration; engine stops after starting or overrunning phase
A3 Box 43	out (ground)	Air mass sensor G 70 Pin 2	Earth for air mass sensor and CO potentiometer.	(see A1, A2 and A5)	00520, 00521/2242 Recognizes breaks and shorts to positive or ground	Single operation disturbances become stronger due to missing input signals (CO and load)
A4 Box 44	Screening of air mass sensor cable	--	Screening for protection against interfering pulses.	--	--	--

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
A5 Box 45	in	Air mass sensor G 70 Pin 2 (parallel to cable A3)	Voltage signal for recognition of voltage drop in earth cable of air mass meter	Replacement value of 0.1 V is assumed in case of a recognized fault	Recognizes breaks on Pin A3 as voltage above 1 V on Pin A5. Recognizes shorts to positive	Not to be expected
A6 Box 46	out	Throttle valve potentiometer G 69 Pin 1	Power supply voltage for throttle valve potentiometer	--	00518/2212 (see A7)	(see A7)
A7 Box 47	in	Throttle valve potentiometer G 69 Pin 3	Voltage signal, corresponding with throttle valve position, is used for: – recognition of throttle valve position, e.g. full load – releasing acceleration enrichment; how fast the throttle valve opens is evaluated (also refer to Pin C 10) – replacement signal in case of air mass meter failure	None (all functions controlled by the throttle valve potentiometer are no longer operated)	00518/2212 Recognizes breaks or shorts. Checks plausibility of signal by comparing it with idling switch signal and signal from air mass meter while driving.	Poor acceleration and power output
A8 Box 48	out (ground)	Throttle valve potentiometer G 69, Pin 2 Idling switch F 60, Pin 2	Ground for G 69 and F 60	(see A7 and A9)	(see A7 and A9)	--

Pin list

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
A9 Box 49	in	Idling switch F 60 Pin 1	Signal for idling stabilisation control, overrun cut-off, overrun air mass control and overrun ignition timing.	--	00516/2121 Checks plausibility of signal	Deviations from nominal idling speed, erratic idling, hesitation in overrun.
A10 Box 50	in	Oxygen sensor G 39	Voltage signal from oxygen sensor. Basic injection period is corrected on basis of this signal to keep the mixture at $\lambda = 1$.	--	00525/2342 Recognizes a fault if the practical signal voltage range is not reached. Recognizes a fault in case of short to positive (sensor heating). Recognizes a fault in case of break or short to ground.	Not noticeable as disturbance in driving. Possibly sulphur odor from warm engine, as with an unregulated catalyst.
A11 Box 51	Screening	Oxygen sensor G 39 (sensor housing)	Screening for protection against interfering voltage.	--	--	--
A12 B1 Box 21	Not used in	-- Knock sensor I G 61 Pin 2	Voltage signal from G 61 for recognition of knocking combustion in cylinders 1 and 2.	-- Ignition timing of cylinders 1 and 2 is retarded by the maximum of approx. 16°.	-- 00524/2142 Recognizes a break if no signals are put in with the coolant temperature above 40° C.	Power loss, poor acceleration, misfiring.

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
B2 Box 22	out (ground)	Knock sensor I G 61 Pin 1	Sensor ground of G 61.	(see B1)	(see B1)	(see B1)
B3 Box 23	Screening	Knock sensor I G 61	Screening for protection against interfering voltage.	--	--	--
B4 Box 24	in	Knock sensor II G 66 Pin 2	Voltage signal from G 66 for recognition of knocking combustion in cylinders 3, 4 and 5.	Ignition timing of cylinders 3, 4 and 5 retarded by maximum of approx. 16°.	00540/2144 Recognizes breaks if there are no signals with a coolant temperature above 40° C.	Power loss, poor acceleration, misfiring
B5 Box 25	out (ground)	Knock sensor II G 66 Pin 1	Sensor ground of G 66.	(see B4)	(see B4)	(see B4)
B6 Box 26	Screening	Knock sensor II G 66	Screening for protection against interfering voltage.	--	--	--
B7 Box 27	in	Exhaust gas recirculation temperature sensor G 98 Only California	Signal corresponding with exhaust gas temperature in EGR valve. Signal is used for diagnosis of exhaust gas recirculation; it has no influence on the control of exhaust gas recirculation.	--	00560/2411 Recognizes shorts to ground in sensor circuit and a continuously opened or closed EGR valve.	--

Pin list

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
B8 Box 28	out (ground)	Exhaust gas recirculation temperature sensor G 98 Only California	Ground for G 98	--	(see B7)	--
B9 Box 29	in	Road speed sender G 68	Road speed signal corresponding with road speed of car – for overrun air volume control – adaptation of idling stabilisation control works only on stopped car – air conditioner compressor cut-off works only in 1st gear (see Pin C10).	--	00218/1231 Recognizes when a signal is missing. Road speed can be read with Function 09, channel 15 (see self diagnosis).	Engine stops after overrun phase when declutching.
B10 Box 30	out	Tachometer, Pin 27 on Digimat control unit	Speed signal for activation of various electronic systems.	--	--	Specific faults of signal receiving systems.
B11 Box 31	out	On-board computer Pin 10	Consumption signal to on-board computer with information about instantaneous fuel consumption.	--	--	No display of instantaneous fuel consumption. Average consumption value drops continuously.
B12 Box 32	in	Digimat control unit Pin 20	Signal for recognition of selector lever position in cars with automatic transmission.	--	Signal can be checked with Function 08, display box 7 (see self diagnosis).	Stronger tendency of car creeping and possibly vibration in passenger compartment cell.

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
B13 Box 33	in	Digimat control unit Pin 28	Signal from Digimat control unit informs MPI control unit J 192 about shift point.	--	Signal can be checked with Function 08, display box 7 (see self diagnosis).	Harder shifts
B14 Box 34	in	Coding plug	Code for manual or automatic transmission version. B14 open = manual transmission B14 to earth = autom. transm.	--	Recognition with V.A.G. 1551, Function 01 Code 11 1 = Manual transm. 0 = Autom. transm.	--
B15	Not used	--	--	--	--	--
B16 Box 36	in	Coding plug	Code for California version. For releasing system functions of exhaust gas recirculation including self diagnosis (CARB)	--	Recognition with V.A.G. 1551, Function 01 Code 11 1 = Without EGR 0 = With EGR	--
B17 Box 37	out	Final output stage N 70 of ignition coil Pin 2	Ignition signal for all cylinders for activation of final output stage N 70.	--	--	No starting, engine stopped
B18 Box 38	out	Solenoid valve 2 for activated charcoal filter N 115 (cut-off valve)	Ground control of N 115 (closed when without current).	--	01241/4331 Recognizes breaks and shorts to positive or ground.	Possibly overfilled activated charcoal filter canister (fuel odor).
B19	--	--	--	--	--	--

Pin list

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
B20 Box 40	Power supply	Fuse/relay plate Pin L	Permanent positive (terminal 30). Power supply of fault memory.	--	--	--
C1 Box 1	in	Engine speed sender G 28 Pin 1	Sender senses 135 teeth of flywheel's starter gear ring. Control unit recognizes engine speed and calculates crankshaft angle.	--	00513/2111 Recognizes when a signal is missing with engine running and for engine starting	Misfiring, engine cannot be started
C2 Box 2	out (ground)	Engine speed sender G 28 Pin 2	Sender ground for G 28.	--	--	--
C3 Box 3	Screening	Engine speed sender G 28	Screening for protection against interfering voltage.	--	--	--
C4 Box 4	in	Firing point sender G 4 Pin 1	Senses steel pin pressed in on back of the flywheel (60° before TDC of cylinder no. 1).	--	00514/2111 Recognizes when a signal is missing 5 seconds after engine has been started.	Engine cannot be started
C5 Box 5	out	Firing point sender G 4 Pin 2	Sender ground for G 4.	--	(see C4)	(see C4)

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
C6 Box 6	Screening	Firing point sender G 4	Screening for protection against interfering voltage.	--	(see C4)	(see C4)
C7 Box 7	out (power supply)	Hall sender G 40 Pin +	Power supply for hall sender.	(see C8)	(see C8)	(see C8)
C8 Box 8	in	Hall sender G 40 Pin S	Hall sender signal. For recognition of ignition TDC for cylinder no. 1 to release first firing and injection after engine has been started.	--	00515/2113 Recognizes breaks or continuous signal voltage, even while attempting to start the engine.	Engine cannot be started
C9 Box 9	out (ground)	Hall sender G 40 Pin -	Ground for hall sender.	(see C8)	(see C8)	(see C8)
C10 Box 10	in + out (bidirectional)	Switch unit for solenoid coupling J 153 Pin 87A	in: Voltage is supplied to Pin C10 140 ms before switching on solenoid coupling for AC compressor. ISC compensates for the increased engine load. out: Air conditioner compressor is switched off via this pin when accelerating in 1st gear (recognized on engine speed and road speed).	--	Fast checking is possible with Function 08, display box 7 (see self diagnosis).	--

Pin list

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
C11 Box 11	in	Manual air conditioning: air conditioner switch E 30, Pin 1. Digital air conditioning: operating and indicating unit for air conditioner E 87	Engine speed boosted for operation of air conditioner. Manual air conditioning: Voltage signal is supplied to Pin C11 with air conditioner "ON"; idling speed is boosted. Digital air conditioning: Voltage signal is supplied to Pin C11 for maximum cooling or heating performance of air conditioner; idling speed is boosted.	--	Fast checking is possible with Function 08, display box 7 (see self diagnosis).	--
C12 Box 12	in / out (bidirectional)	Diagnosis socket (brown)	K-wire Output of rapid data transfer to V.A.G. 1551.	Output of flash code via fault lamp or diode test lamp.	Display on V.A.G. 1551: "control unit does not answer".	--
C13 Box 13	in	Diagnosis socket (brown)	L-wire Activation of rapid data transfer and flash code output.	--	--	--
C14 Box 14	out	Warning lamp K 66 for electronic ignition and diagnosis socket (blue)	Activation of warning lamp K 66 to warn driver of disturbance in MPI (only for California)	--	--	--

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
C15 Box 15	in	Coolant temperature sender G 62 Pin 1	Information about the coolant temperature is a factor of correction for many system functions, which in addition are started depending on the temperature.	20° C is assumed for starting the engine when this signal is missing; 10° C are added for each minute of engine operation until 85° C is reached.	00522/2312 Recognizes breaks and shorts to positive or ground.	Starting problems and poor driving behavior at low temperature in the warming-up phase.
C16 Box 16	out	Coolant temperature sender G 62 Pin 2	Sender ground for G 62.	(see C15)	(see C15)	(see C15)
D1 Box 1	in	Intake manifold ground point (17) Power ground point	Ground for injectors, switched through the final output stages. Control unit connected internally with D2.	Pin D2 and D3	--	Possibly misfiring at high load and speed, since the high flow of current cannot be taken care of in one ground cable.
D2 Box 2	in	Intake manifold ground point (17) Power ground point	(see D1)	Pin D1 and D3	--	(see D1)
D3 Box 3	in	Intake manifold ground point (17) Power ground point	Ground for final output stages of control elements, except for injectors.	Pin D1 and D2	--	(see D1)

Pin list

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
D4 Box 4	out	Injector, cylinder 1 N 30	Ground control for injector N 30.	--	01249/4411 Recognizes breaks and shorts to positive in component.	Erratic engine running, maximum power output is not reached.
D5 Box 5	out	Injector, cylinder 2 N 31	Ground control for injector N 31.	--	01250/4412 (see D4)	(see D4)
D6 Box 6	out	Injector, cylinder 3 N 32	Ground control for injector N 32.	--	01251/4413 (see D4)	(see D4)
D7 Box 7	out	Idling stabilisation control valve N 71	Ground control for N 71; regulates idling speed and controls starting air volume and overrun air volume.	Final output stages are switched off by Pin D7 and D11 when a fault is recognized (N 71 in emergency running cross section opening size).	01257/4431 Recognizes breaks and shorts to positive or ground.	Deviation from idling speed, "surging" with cold engine.
D8 Box 8	in	Fuse/relay plate Pin B15	Power supply of control unit (terminal 15).	--	--	No engine running.
D9 Box 9	out	Injector, cylinder 4 N 33	Ground control for injector N 33.	--	01252/4414 (see D4)	(see D4)
D10 Box 10	out	Injector, cylinder 5 N 83	Ground control for injector N 83.	--	01253/4421 (see D4)	(see D4)

Pin No.	Type of Signal	Component / Connection Pin	Function	Replacement Function	Self Diagnosis	Effects
D11 Box 11	out	Idling stabilisation control valve N 71	Positive control for N 71.	(see D7)	(see D7)	(see D7)
D12 Box 12	out	Solenoid valve 1 for activated charcoal filter N 80 (frequency valve)	Ground control for N 80. Controls delivery of fuel vapors into intake manifold with engine running.	Valve N 80 remains open when circuit is interrupted.	01247/4343 Recognizes breaks and shorts to positive or ground.	Possibly idling problems
D13	--	--	--	--	--	--
D14 Box 14	out	Frequency valve for exhaust gas recirculation N 18 Only California	Ground control for N 18.	None (exhaust gas recirculation remains closed when circuit is interrupted).	01265/4312 Recognizes breaks and shorts to positive or ground.	--
D15 Box 15	out	Fuse/relay plate Pin BS	Ground control of fuel pump relay J 17 (Pin T on J 17).	--	--	Engine cannot be started, engine off
D16 Box 16	in	Intake manifold ground point (17) Electronic ground	Ground for electronics, sensors and screenings.	--	--	Possibly misfiring with high load of ground cables



In order to bring training information to in-dealership personnel, Service Training develops and issues Self-Study booklets. The booklets describe and explain new product changes, and system and component operation. These booklets are produced on an as-needed basis as product changes and developments take place.

Five booklets are normally shipped to all Audi dealers participating in the Automatic Supply Program. In order to make it possible for extra copies to be obtained if needed, additional booklets may be ordered via normal ordering procedures. The booklets will then be shipped directly to the ordering dealer and the parts account billed accordingly.

The following booklets are available and can be ordered:

Book Title	Part #	Price
CIS-Electronic Fuel Injection	WSP-521-142-00	\$9.00
CIS-E III Engine Management System	WSP-521-146-00	\$7.50
Digital Climate Control (up to 1988 M.Y.)	WSP-521-137-00	\$6.50
Audi Coupe Electronic Instrument Display	WSP-521-138-00	\$6.50
The New Audi 80 and Audi 90	WSP-521-151-00	\$12.50
The New Audi 100 and Audi 200	WSP-521-170-00	\$10.00
1989 Model Change Information	WSP-521-180-00	\$10.00
Audi Coupe Quattro with 20-valve Engine	WSP-521-200-00	\$10.00
The New Audi V8 Quattro	WSP-521-201-00	\$12.00

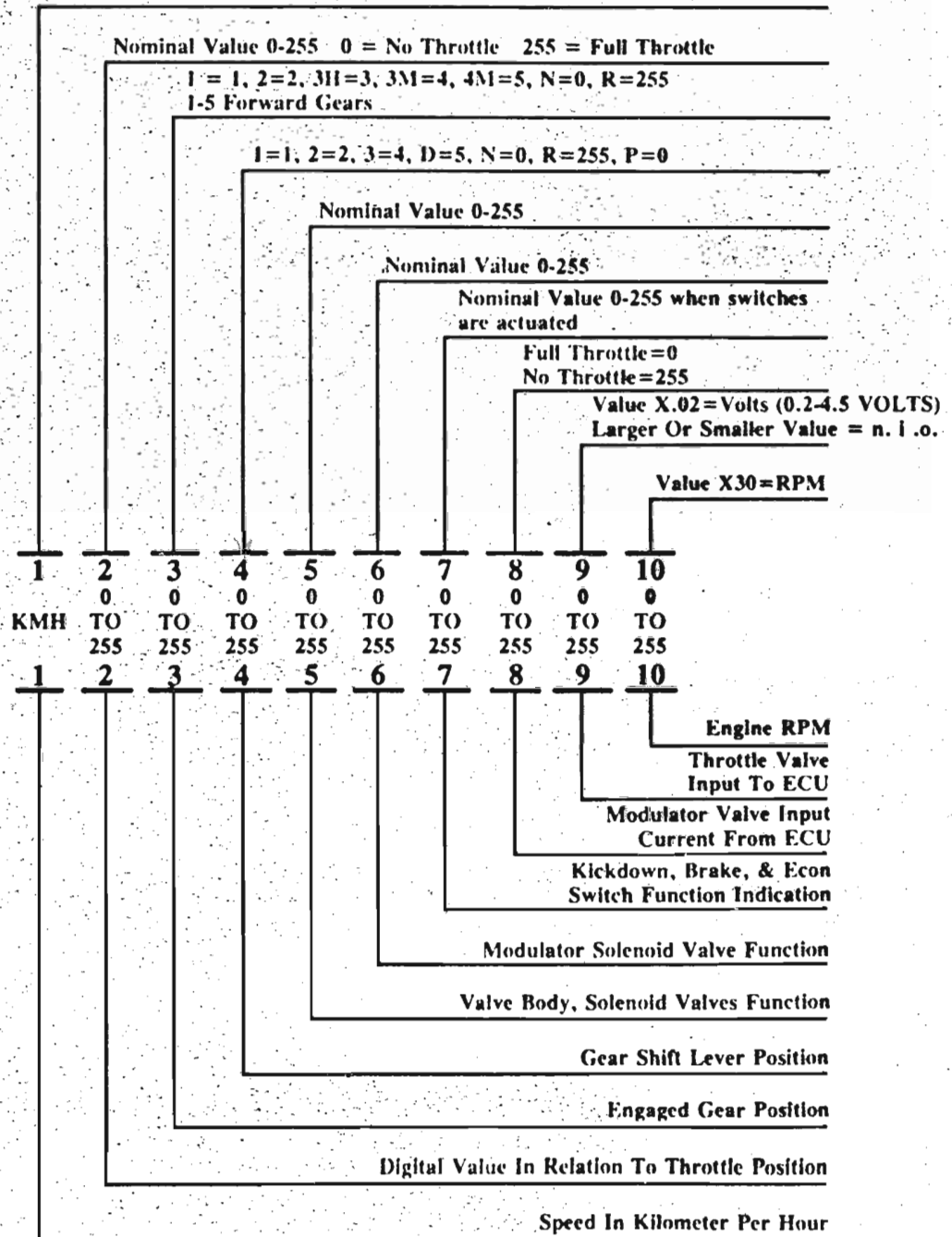


WE ENCOURAGE PROFESSIONALISM
THROUGH TECHNICIAN CERTIFICATION

Measurement Word Block Definition

For VW 1551 Function 8

In Kilometers Per Hour



FUNCTION 09 CH 3 FOR TRANS TEMP

2 = 20°C
 12 = 60°C
 24 = 80°C

FS

91 - Audi Coupe & V6 MPI system

Measuring Block Values

Function #9

- | | |
|------------|---|
| Channel 00 | Display value x 2.56 = air mass in kg/h
(example: 08 = 20,56 kg/h) |
| Channel 01 | Throttle potentiometer signal.
Display value x 20 mV = voltage from potentiometer |
| Channel 02 | EGR temperature sensor value in °C |
| Channel 03 | Display value x 10 mA = idle stabilizer control current |
| Channel 04 | Display value x 46.66 mV = voltage from CO adjustment potentiometer |
| Channel 05 | Display value x 0.5% = idle stabilizer valve duty cycle |
| Channel 06 | RC voltage for thermo/time switch function |
| Channel 07 | Display value x 10 mV = voltage drop measurement value from air mass sensor |
| Channel 08 | Display value x 80 mV = supply voltage to control unit
(example: 175 = 14V) |
| Channel 09 | Display value x 10 mV = signal from oxygen sensor
(example: 40 = 400 mV) |
| Channel 10 | Display value x 20 mV = voltage from knock integrators in ECU |
| Channel 11 | Ignition map selected
(example: less than 128 = premium octane ignition map;
greater than 128 = regular octane map) |
| Channel 12 | Display value x 0.39% = carbon canister frequency valve duty cycle
(example: 100 = duty cycle of 39%) |
| Channel 13 | Display value x 0.5% = EGR frequency valve duty cycle
(example: 100 = duty cycle of 50%) |
| Channel 14 | Display value times 0.128 mS = fuel injector opening duration
(example: 50 = opening time of 6.4 mS) |
| Channel 15 | Display value = vehicle speed signal in km/h |