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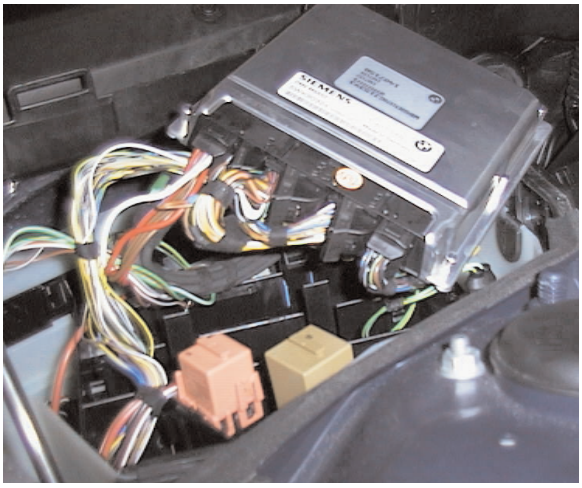
INTRODUCTION
DME - MS S52 ENGINE MANAGEMENT SYSTEM

The engine management system for the M5 is the BMW - MS S52 system. The hardware and software have been developed by BMW while the control module is supplied by Siemens. The control module is the SKE (Standard Shell Construction) 134 pin design. The MS S52 system conforms to TLEV emission standards.

The main features of the MS S52 include:



- Modular plug structure
- Engine Torque Calculation
- Electronic Throttle Control (EDR) single motor controlling 8 throttle valves
- Separate Idle Control Valve (ZWD 5)
- Integrated Cruise Control
- Double VANOS Control
- 2 - Hot-Film Air Mass Sensors
- Integrated Adaptive Knock Control
- Secondary Air Injection Control
- Mixture Adaption - Idle and Part load
- Fully Sequential Injection
- Engine Over-rev & Max Speed Limiting
- Oxygen Sensor Heating
- Catalytic Converter Temperature Monitoring
- Engine Torque Limiting through DSC Regulation

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- Two different throttle progression programs (sport switch)
- Two different servotronic characteristic programs (sport switch)
- Variable engine speed warning zone (Tachometer)
- Oil pump circuit changer over

Engine Torque Calculation

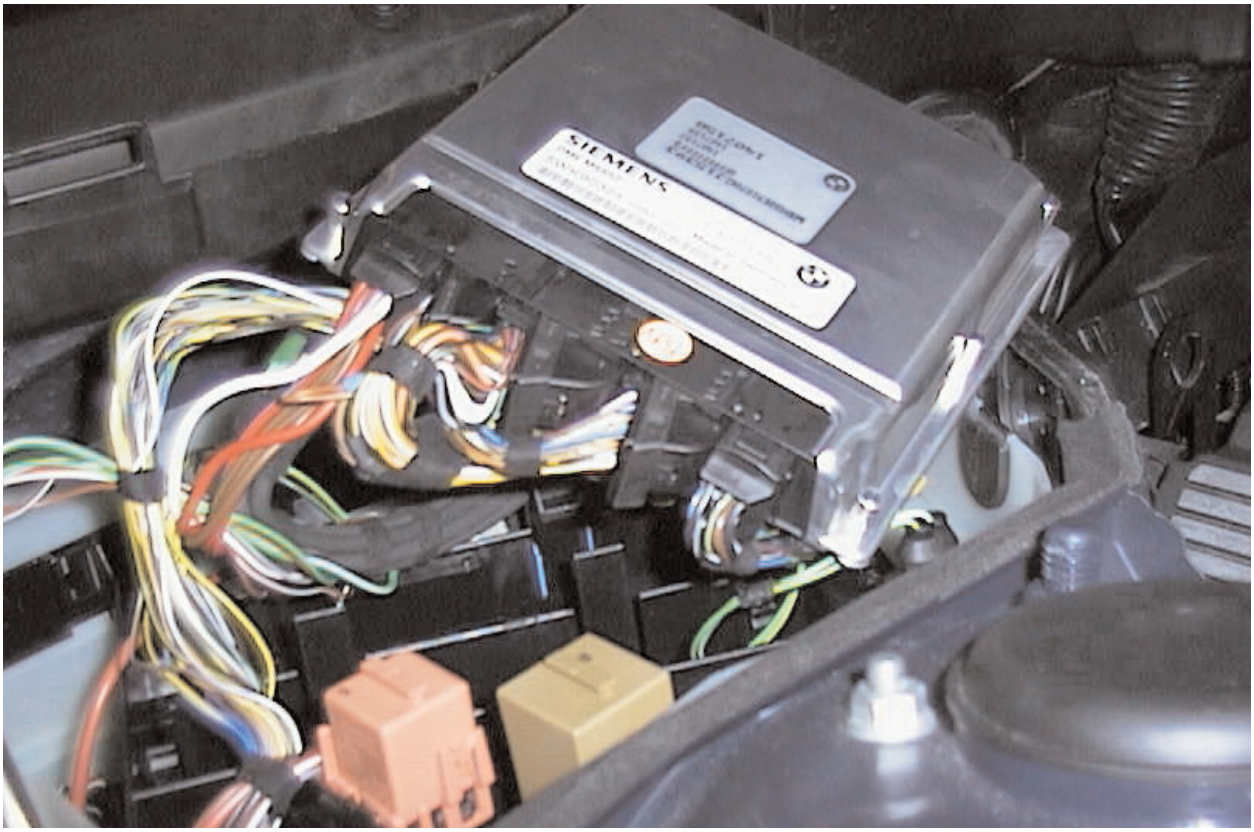
Design and Function

The MS S52 engine control system incorporates two separate, equivalent processors. However, the functions of the two processors are different. The functions of the first processor include:

- Load acquisition control
- Electronic throttle control (EDR)
- Idle actuator control
- Ignition and Knock control

The functions of the second processor include:

- Fuel injection control
- Engine speed limitation
- Misfire detection
- OBD II control
- DTML control (leak diagnosis)



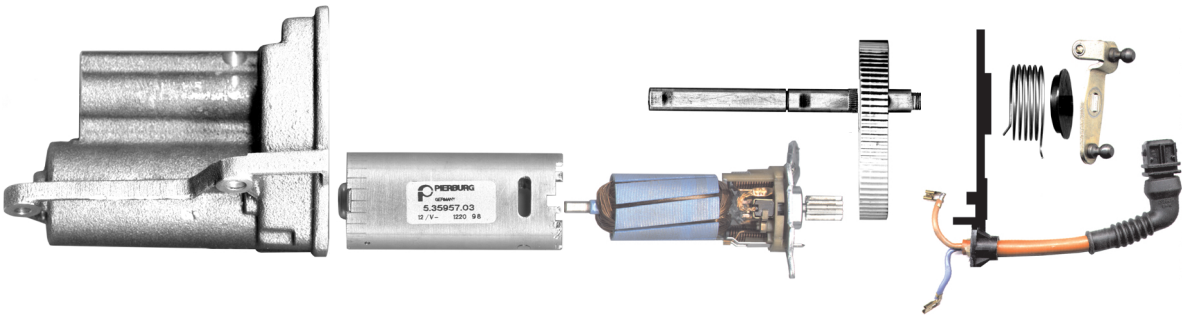
Electronic Throttle Control (EDR)

Function Description

The electronic throttle control system (EDR) was developed specifically for the S62 engine. The design criteria was to develop an EML system capable of actuating the eight throttles while ensuring that the power potential of the S62 engine was not compromised. The three main components of the system include:

- The pedal position sensor (PWG) - same component that is used on the M62 TU EML system.

- The EDR motor - new component designed with the ability to control the eight throttles.



* MS S52 engine control system - responsible for operation and monitoring of the throttle control system.

The pedal position sensor is the driver's wish for increased torque output of the engine. The PWG input is processed by the MS S52 control module. Plausibility checks are carried out and the EDR motor is operated to open the throttle valves. All eight throttle valves are opened simultaneously through the linkages connected to the EDR. The system requires approximately 120 ms to fully open the closed throttle valves.

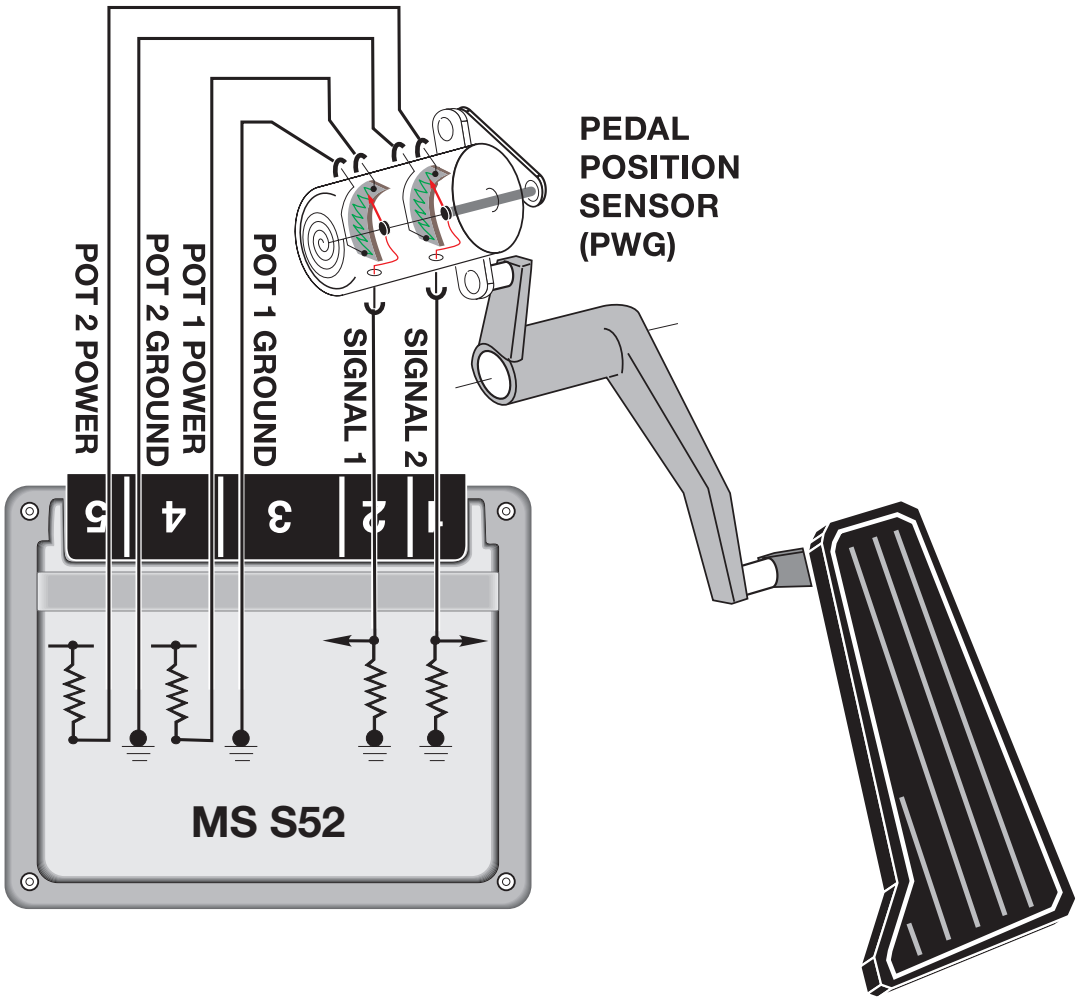
Feedback of the current throttle valve position is achieved through two throttle valve potentiometers located on the ends of the throttle valve shafts.

Throttle Position Sensor (PWG)

The PWG provides two separate variable voltage signals to the MS S52 control module for determining the request for EDR operation. The MS S52 monitors the changing signal ranges of both circuits as the pedal is pressed from idle to full throttle.

PWG Pot #1. = 0.5V to 4.5V.
PWG Pot #2. = 0.5V to 2.0V

PWG Pot signal #1. is the primary input for throttle opening request. The signal from Pot #2. is used primarily for plausibility checking. If the signal ranges are incorrect, The MS S52 will activate an emergency operating program based on the specific fault recognized.



Name of Signal or Function: _____

Vehicle: _____ **M.Y.:** _____ **DIS CD Version:** _____

What type of signal is this? ☐ Switched Power ☐ Switched Ground ☐ Pulse Width Modulated (PWM)

☐ Linear Voltage ☐ Linear Resistance ☐ Digital ☐ Other: _____

How will the control system react if this signal becomes impaired or lost ?

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Is there a substitute value for this signal? ☐ Yes ☐ No

Does the DIS software provide a Status Display for this signal? ☐ Yes ☐ No

Is "component activation" possible with this signal/function? ☐ Yes ☐ No

Does signal status display or the component activation functions help you with diagnosis? ☐ Yes ☐ No **Why?** _____

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☐ Voltage ☐ Resistance ☐ Capacitance ☐ Inductance ☐ Temperature ☐ Current ☐ Pressure ☐ Scope

Signal Range?: _____ **Nominal Value(s)?:** _____

Notes:

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EDR Throttle Position Feedback Signals

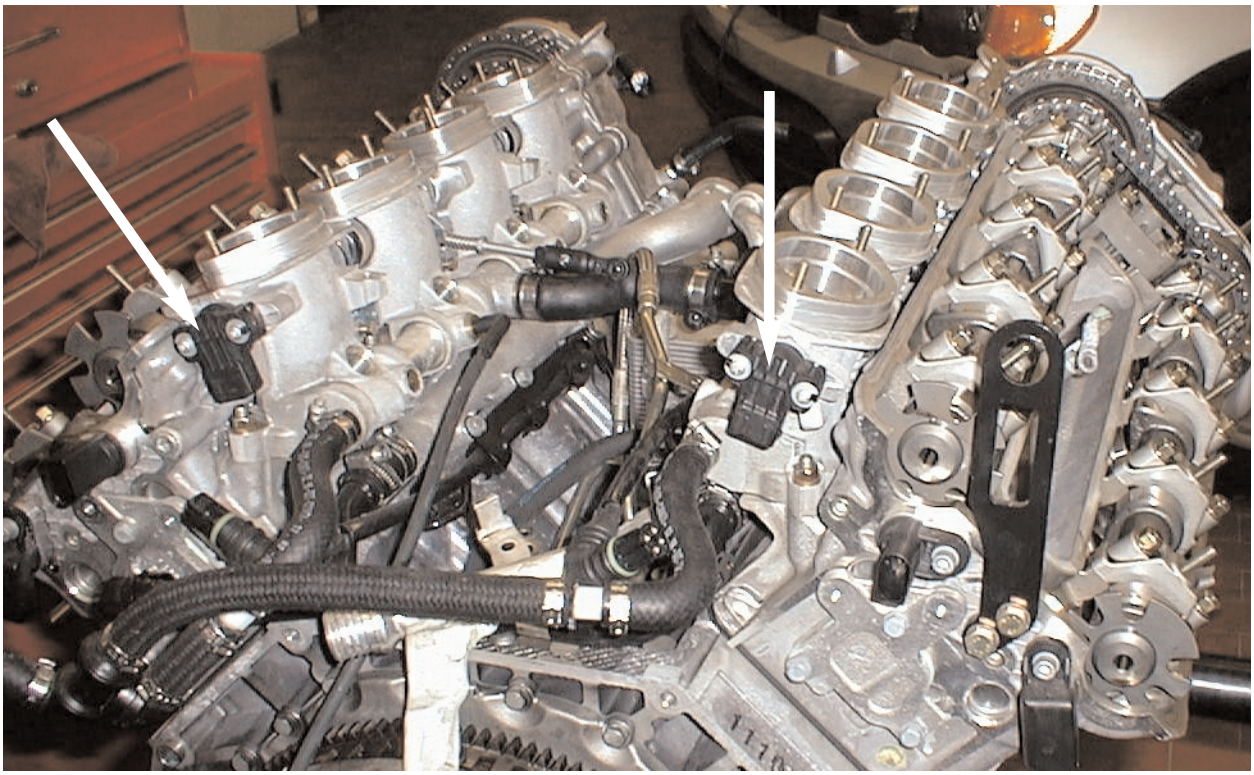
The throttle valve positions are monitored by two feedback potentiometers mounted on the ends of the throttle valve shafts. Each potentiometer has its own power (5 volt) and ground supply for safety reasons. The two signals are used for redundant monitoring of the throttle valve positions.

Due to their positioning on the engine, the signals from the potentiometers are inverse, however the MS S52 is monitoring the linear characteristics of the signal for determining throttle valve position.

Checking of the potentiometer signals is split into checking each signal individually and comparing the two signal values.

Different emergency operating programs are activated depending on what fault might occur with the feedback signal circuits as follows:

- Emergency program #1. - Error while checking signal comparison.
- Emergency program #1. - Fault with one potentiometer signal or sensor.
- Emergency program #2. - Fault with both potentiometer signals or sensors.



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Signal Range?: _____ **Nominal Value(s)?:** _____

Notes:

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EDR Safety Concept

A pre-drive check of the EDR system is carried out every time the ignition is switched On (KL 15). The MS S52 control module briefly opens the throttles and checks the following:

- The zero set point of the feedback potentiometers - throttle valve closed position.
- Free movement of the throttle valves.
- Operation of the EDR actuator motor.
- Operation of the return springs in the EDR actuator motor.

Emergency Programs

There are a total of four emergency operation programs stored in the MS S52 control module. The MS S52 control module will activate one of these programs depending on which fault is present or what the failed component is. With any fault that is relevant to the EDR system, the engine's output torque will be reduced to provide limited driveability of the vehicle.

EMERGENCY PROGRAM #1. - Engine operation with PWG input. The engine's output torque is limited to 480 Nm. This program will set with faults in one PWG sensor input or one throttle valve feedback input.

EMERGENCY PROGRAM #2. - Engine operation through the idle valve actuator. The engine's output torque is limited to 300 Nm and the vehicle's speed to 70 MPH. With program #2, the throttle valves are shut down and only the idle valve is used for engine operation. This program will set with a fault in one air mass sensor input and one PWG sensor input.

EMERGENCY PROGRAM #3. - Engine operation with jammed throttle valves. The engine's output torque is limited to 300 Nm and the speed is limited to 35 MPH. This is carried out through ignition and injection intervention if the MS S52 senses that the throttle valves are jammed or stuck and cannot be closed by applying power through the EDR actuator.

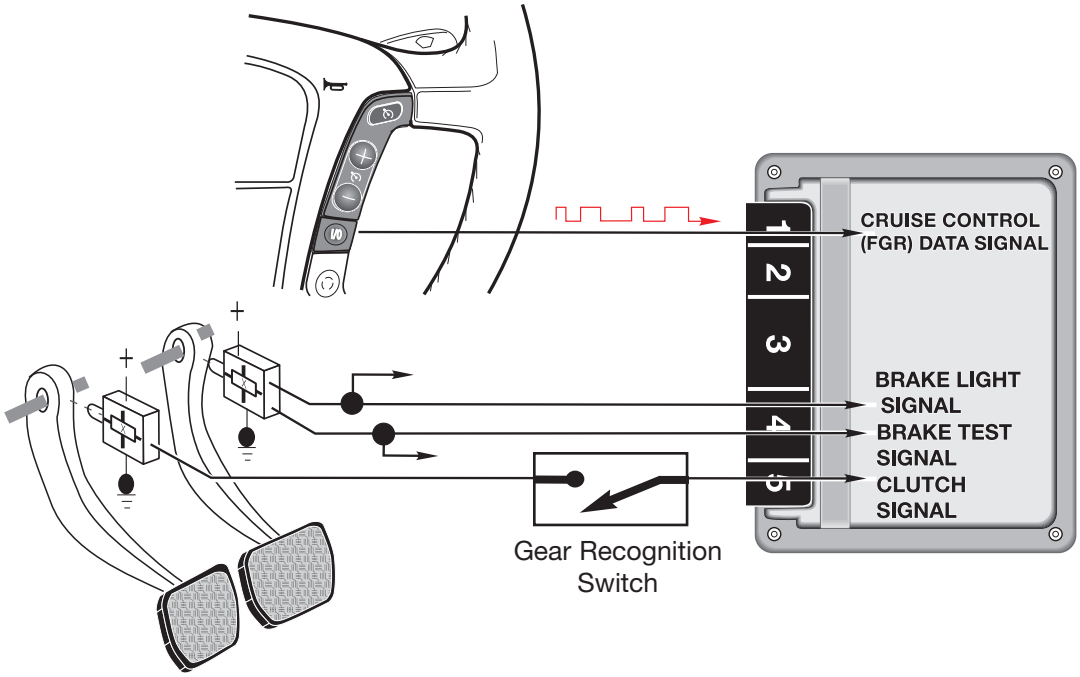
EMERGENCY PROGRAM #4. - Engine operation with a control module internal fault. The engine's output torque is limited to 250 NM and the speed is limited to 35 MPH. Depending on the degree of the fault, the control module with the dual processors will enable limited engine operation.

Cruise Control Operation

As with other EML systems, the MS S52 control module takes over the function of cruise control. Throttle activation is provided by the MS S52 automatic control of the EDR actuator and monitoring of the feedback potentiometers.

All driver requested cruise control function requests are provided to the MS S52 from the MFL control module in the steering wheel over a single FGR data lead.

Brake/Clutch Switch Inputs



The brake and clutch switch signals are input to the MS S52 control module for cruise control operation.

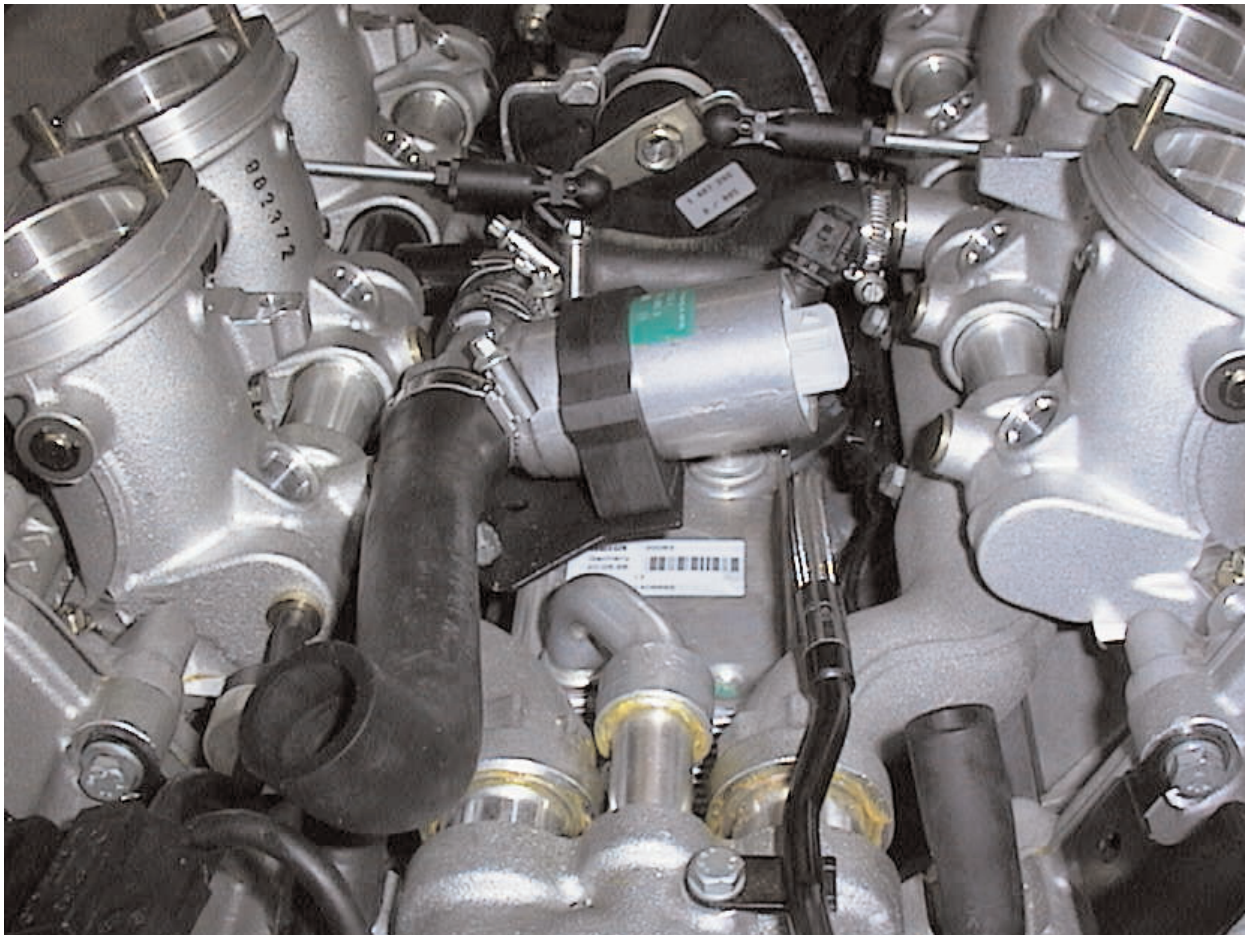
Idle Control System

ZWD 5

Idle control on the S62 engine is carried out using the ZWD 5 idle control valve. The valve features a second air supply system that functions independently from the throttle control system. The idle valve draws in metered air from the intake plenum and it is connected to both sets of throttle valves though an interconnected pipe.

The valve receives power from the main relay and the open and close windings are controlled by the MS S52 control module. Without power, the valve is open approximately 30%.

Under certain conditions, the idle control valve can be opened by the control module to provide air flow for emergency (limp home) operation.



INPUT SIGNALS/COMPONENTS

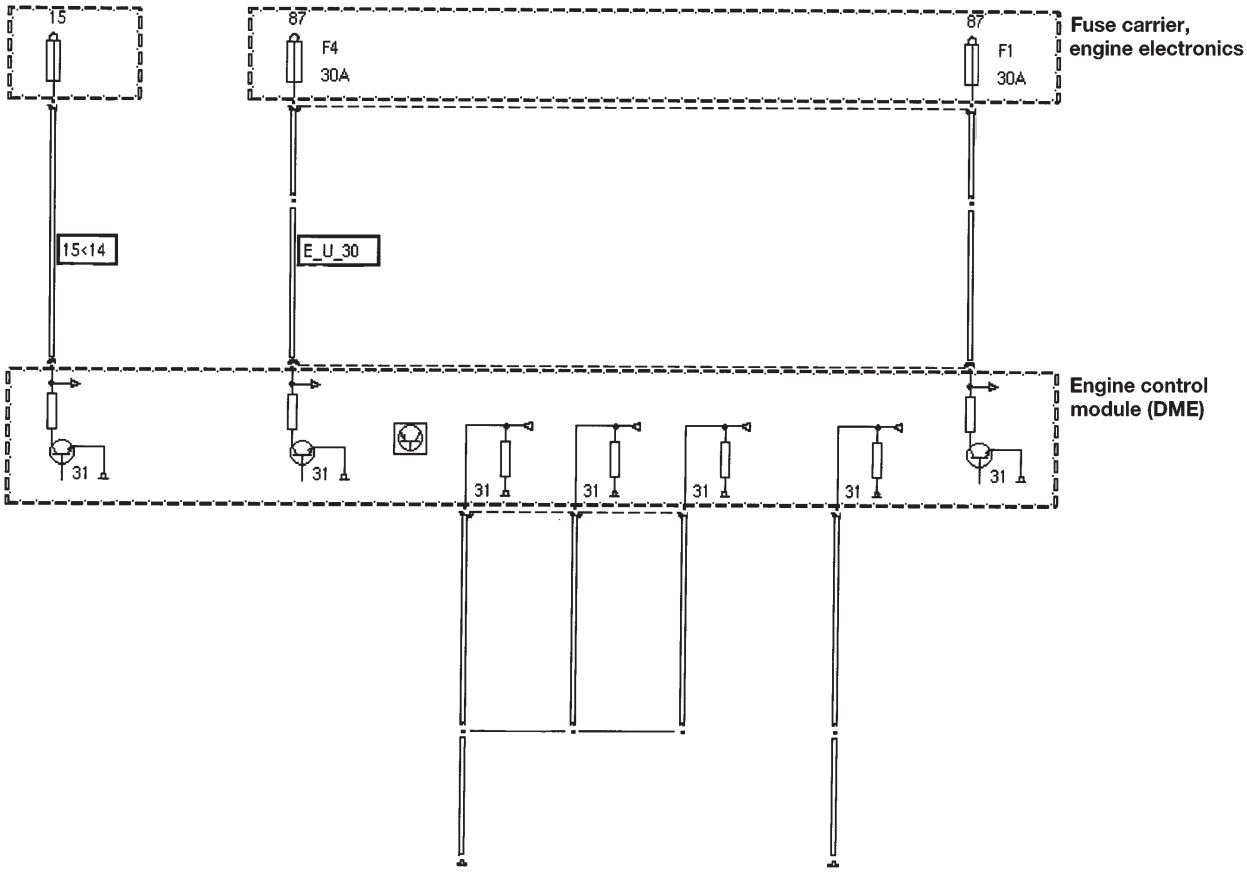
Power Supply and Grounds

The MS S52 control module receives the following power supply inputs:

- KL 30 - Constant Battery power. The ECM receives KL 30 from the battery to monitor the voltage level as an input and adjusts output functions if the battery voltage drops below a certain threshold.

- KL 15 - Ignition Key On. The MS S52 control module receives KL 15 for its wake up call and for activation of the engine control module relay.

- KL 15 - Main Relay (engine control relay) Power Supply. The ECM receives its operation from the main relay once the relay is energized by the ECM.

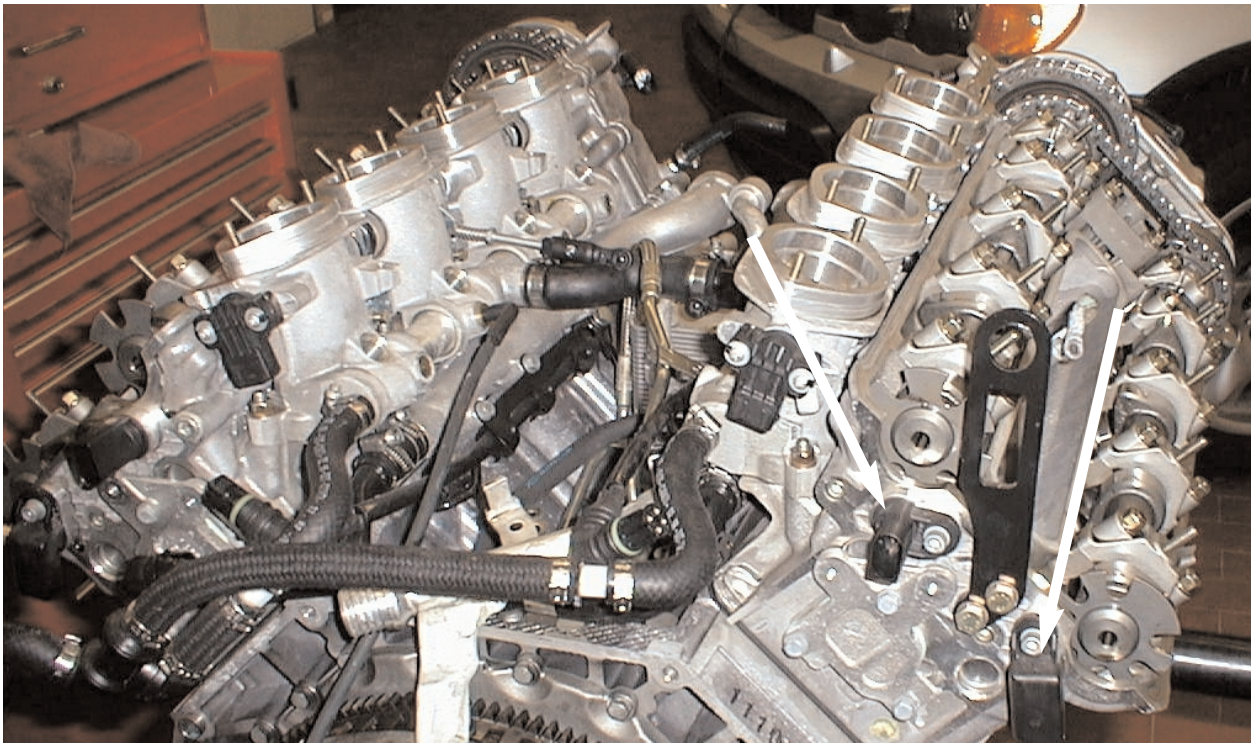


Crankshaft Position Sensor

Located on the rear of the cylinder head, the camshaft position sensors (Hall effect) monitor the position of the camshafts to establish start of ignition firing order, setup sequential fuel injection triggering and for accurate camshaft advance and retard (double VANOS) timing feedback.

With full variable VANOS control on both the intake and exhaust camshafts, four cam position sensors are required.

The sensors are provided with operating power from the ECM main relay and produce a square wave input signal to the ECM. The trigger wheels contain a wide tooth that is used to establish full sequential injection.



Name of Signal or Function: _____

Vehicle: _____ **M.Y.:** _____ **DIS CD Version:** _____

What type of signal is this? ☐ Switched Power ☐ Switched Ground ☐ Pulse Width Modulated (PWM)

☐ Linear Voltage ☐ Linear Resistance ☐ Digital ☐ Other: _____

How will the control system react if this signal becomes impaired or lost ?

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Is there a substitute value for this signal? ☐ Yes ☐ No

Does the DIS software provide a Status Display for this signal? ☐ Yes ☐ No

Is "component activation" possible with this signal/function? ☐ Yes ☐ No

Does signal status display or the component activation functions help you with diagnosis? ☐ Yes ☐ No **Why?** _____

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What is (are) the most suitable measurement(s) for this signal/component?

☐ Voltage ☐ Resistance ☐ Capacitance ☐ Inductance ☐ Temperature ☐ Current ☐ Pressure ☐ Scope

Signal Range?: _____ **Nominal Value(s)?:** _____

Notes:

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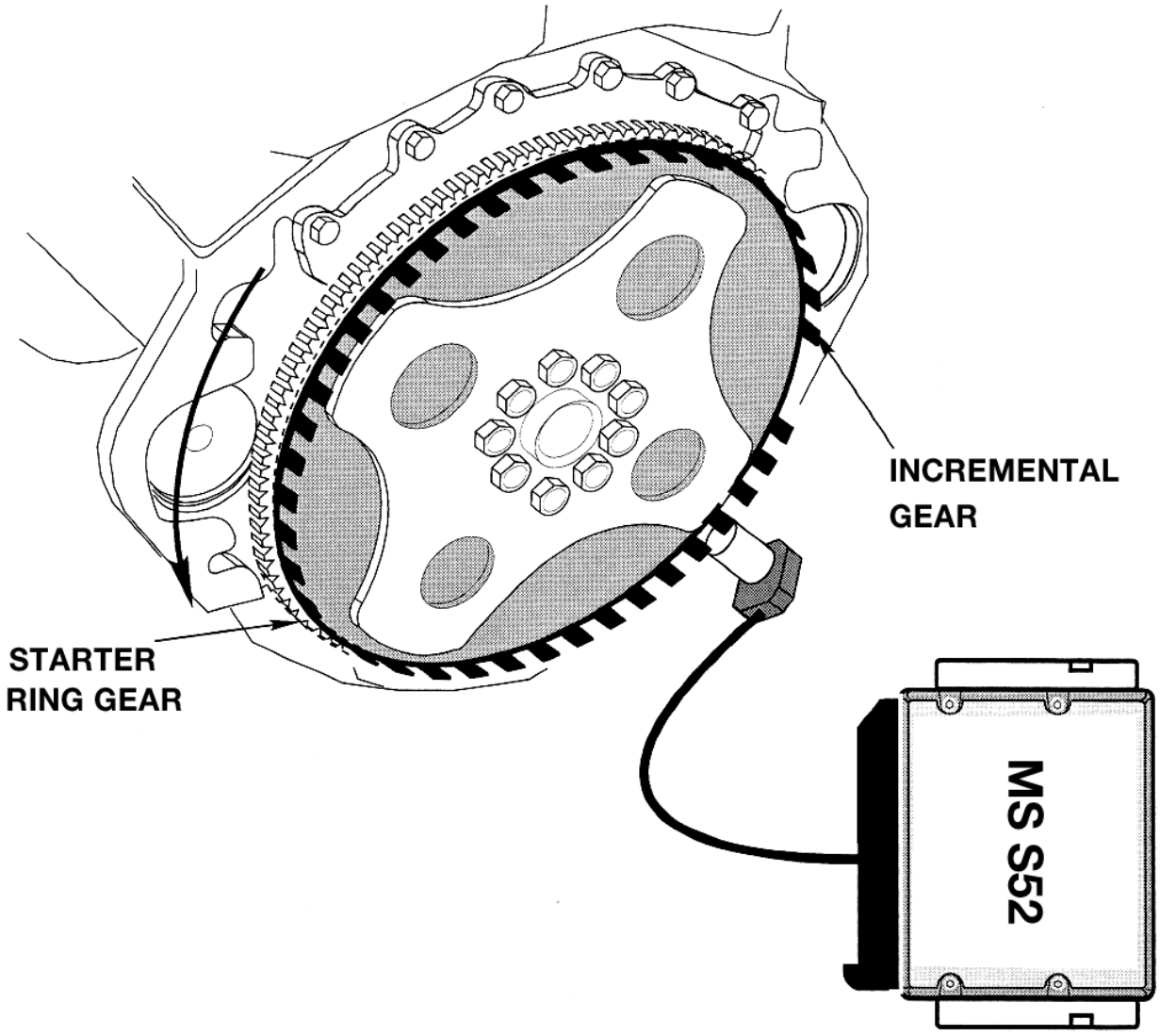
Crankshaft Position Sensor

The engine speed (RPM) and crankshaft position input signals are provided by the inductive pulse sensor that scans the incremental gear wheel mounted on the flywheel of the engine. The rotation of the gear wheel generates an A/C voltage signal in the sensor whereby each tooth of the wheel produces one pulse. The engine control module counts these pulses and determines engine speed and crankshaft position.

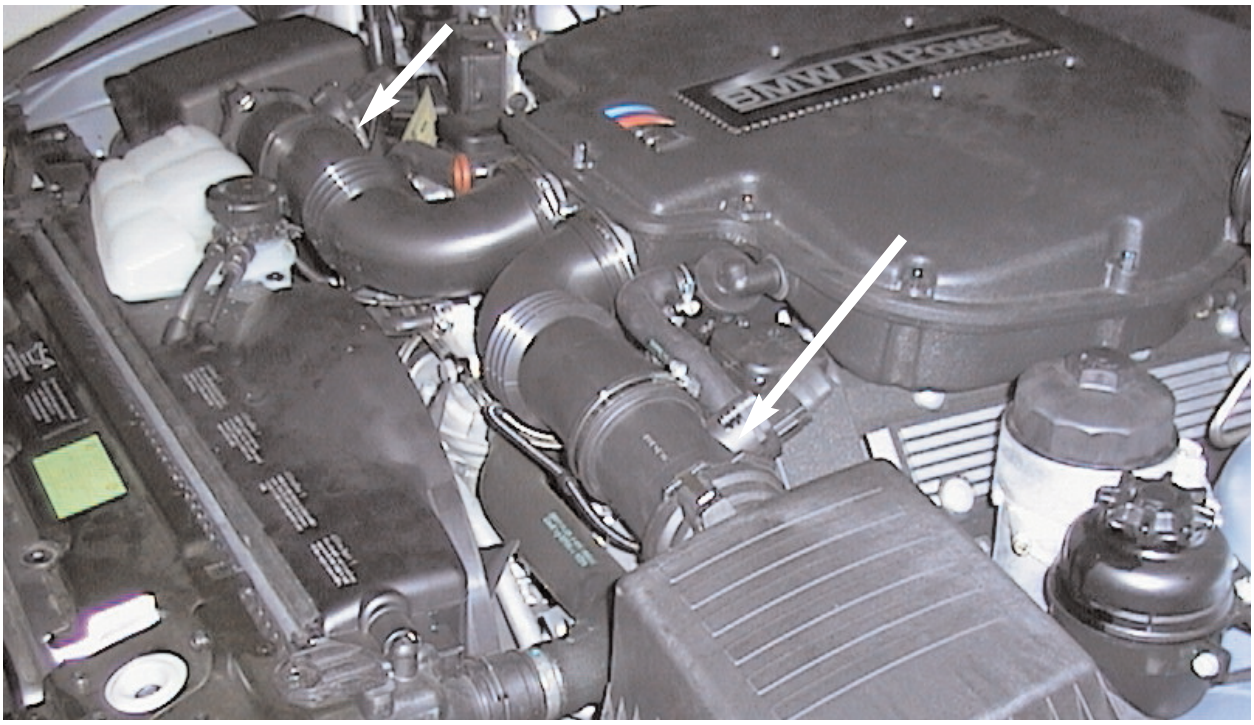
The signal from the crankshaft sensor is also used for OBD II monitoring for misfire detection.



Hot Film Air Mass Sensor

The MS S52 system uses the hot film air mass sensor for measuring the air intake volume. Two air mass sensors are used with the M5 engine to ensure that an sufficient volume of air can enter the engine under full load operating conditions.

The operation of the hot film air mass sensor remains the same as previous systems. The sensor receives operating power from the ECM relay.



Intake Air Temperature

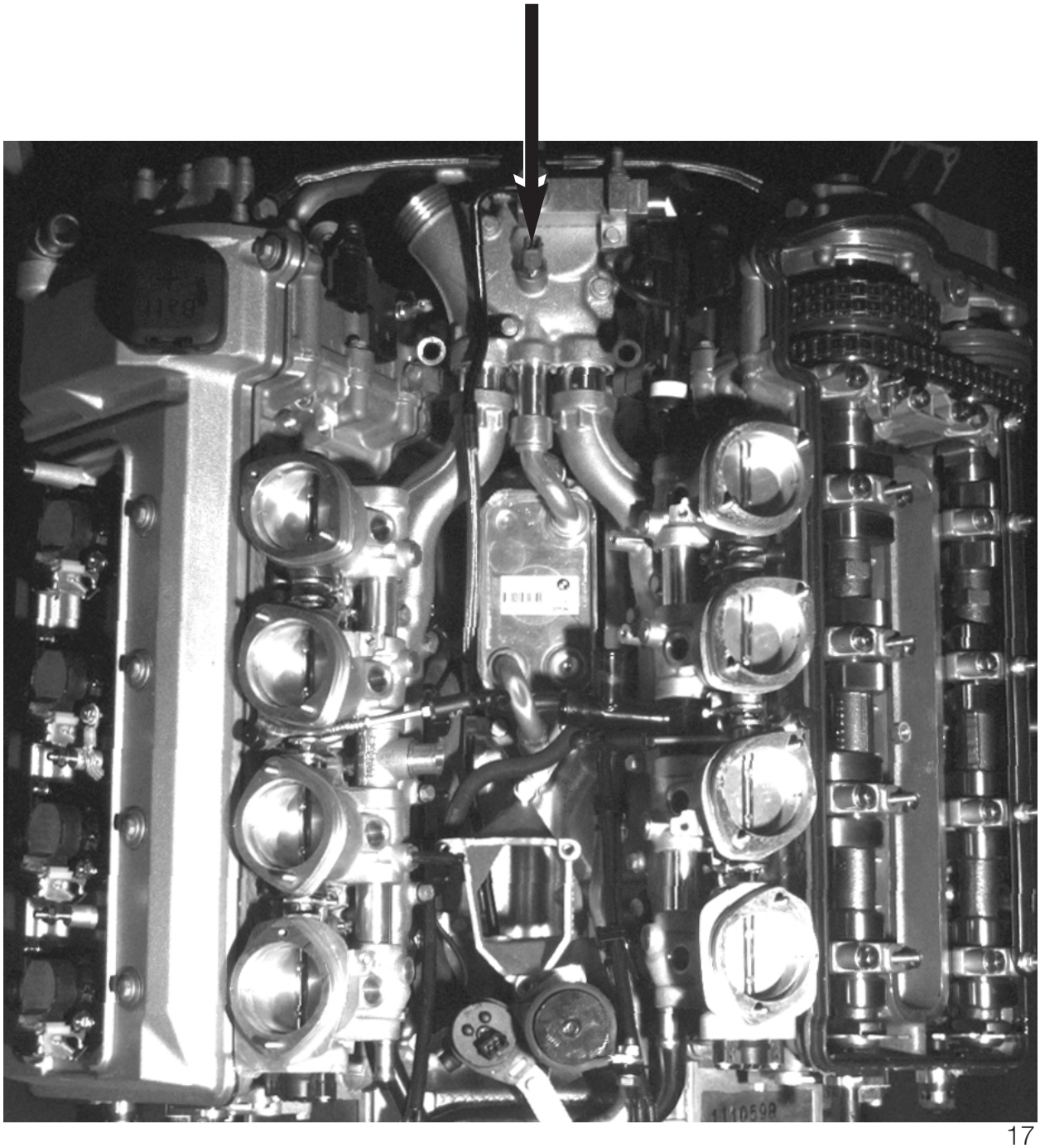
Intake air density (temperature) for injection is automatically compensated for by the air mass sensors.

However, an additional air temperature (NTC) function is required for ignition timing.The sensing function is integrated into the driver's side air mass meter and provides a signal dependent on air temperature.

Engine Coolant Temperature Sensor

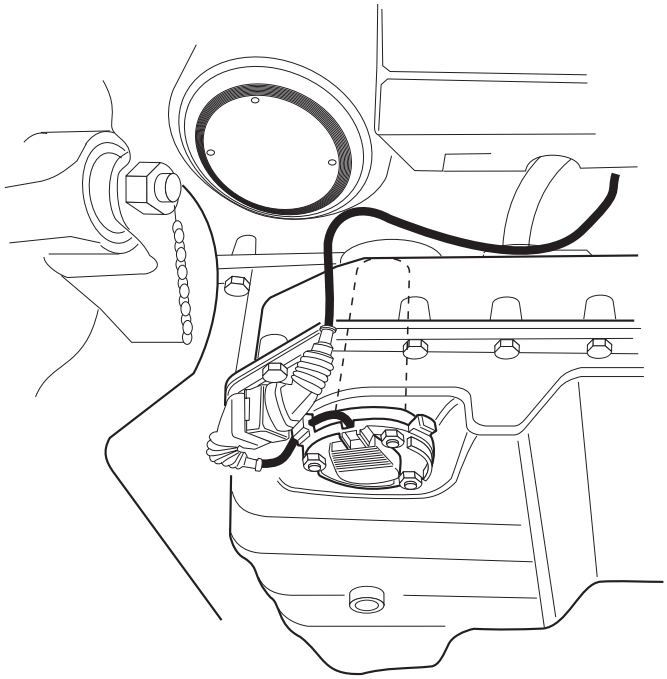
The engine coolant temperature (NTC) input to the control module is used to provide enrichment for cold starts and cold engine running conditions. The sensor is located near the thermostat housing.

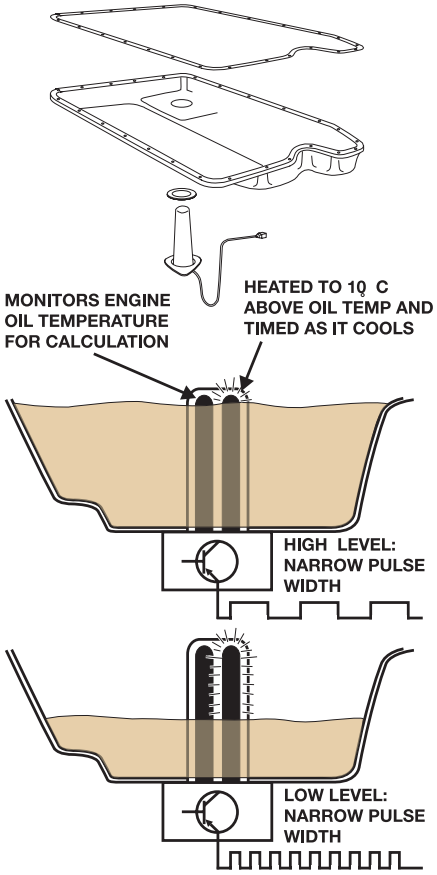
The oil temperature sensor input is used as a replacement value in the event of a failure with the coolant temperature sensor input.



Oil Temperature/Level Sensor

The electronic level sensor is located in the engine sump mounted to the engine oil pan.





The probe of the level sensor contains two temperature sensing elements.

- One senses the engine oil temperature.
- The other is heated to 10° C above the temperature of the engine and then is allowed to cool.

The length of time it takes to cool the heated element is how the sensor determines the engine oil level. When the oil level is high it covers a larger portion of the probe submersed in the oil sump. The engine oil around the probe absorbs the heat of the heated element quicker than if the level is low.

The microprocessor in the base of the sensor produces a pulse width modulated signal proportional to the oil level. The pulse width decreases with a decreased level of oil.

The MS S52 control module uses the oil temperature input signal to protect the engine during cold engine the warm-up phase. Based on the oil temperature, the visual warning LEDs in the tachometer will illuminate at cold engine start up and slowly be extinguished as the oil temperature increases.

The oil temp sensor also serves as a vital input for VANOS operation, varying the solenoid control based on oil temperature (reaction time of camshaft movement).

In the event of a fault the engine coolant temperature is used as a substitute value.

Name of Signal or Function:

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How will the control system react if this signal becomes impaired or lost ?

Is there a substitute value for this signal? ☐ Yes ☐ No

Does the DIS software provide a Status Display for this signal? ☐ Yes ☐ No

Is "component activation" possible with this signal/function? ☐ Yes ☐ No

Does signal status display or the component activation functions help you with diagnosis? ☐ Yes ☐ No **Why?** _____

What is (are) the most suitable measurement(s) for this signal/component?

☐ Voltage ☐ Resistance ☐ Capacitance ☐ Inductance ☐ Temperature ☐ Current ☐ Pressure ☐ Scope

Signal Range?: _____ **Nominal Value(s)?:** _____

Notes:

Throttle Progression Switch

The MS S52 control system contains two different throttle progression program curves (Sport and Normal). The sport program is selected by pressing the sport switch located in the center console switch panel.

The switch provides a ground signal as an input when pressed. The MS S52 activates the sport characteristics for the EDR throttle control. This provides an increase in throttle opening over the non-sport position.

At the same time the ZKE control module is signaled over the CAN and K-Bus to activate the sport servotronic (increased road feel) steering characteristic program.

Name of Signal or Function:

Vehicle: _____ **M.Y.:** _____ **DIS CD Version:** _____

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Notes:

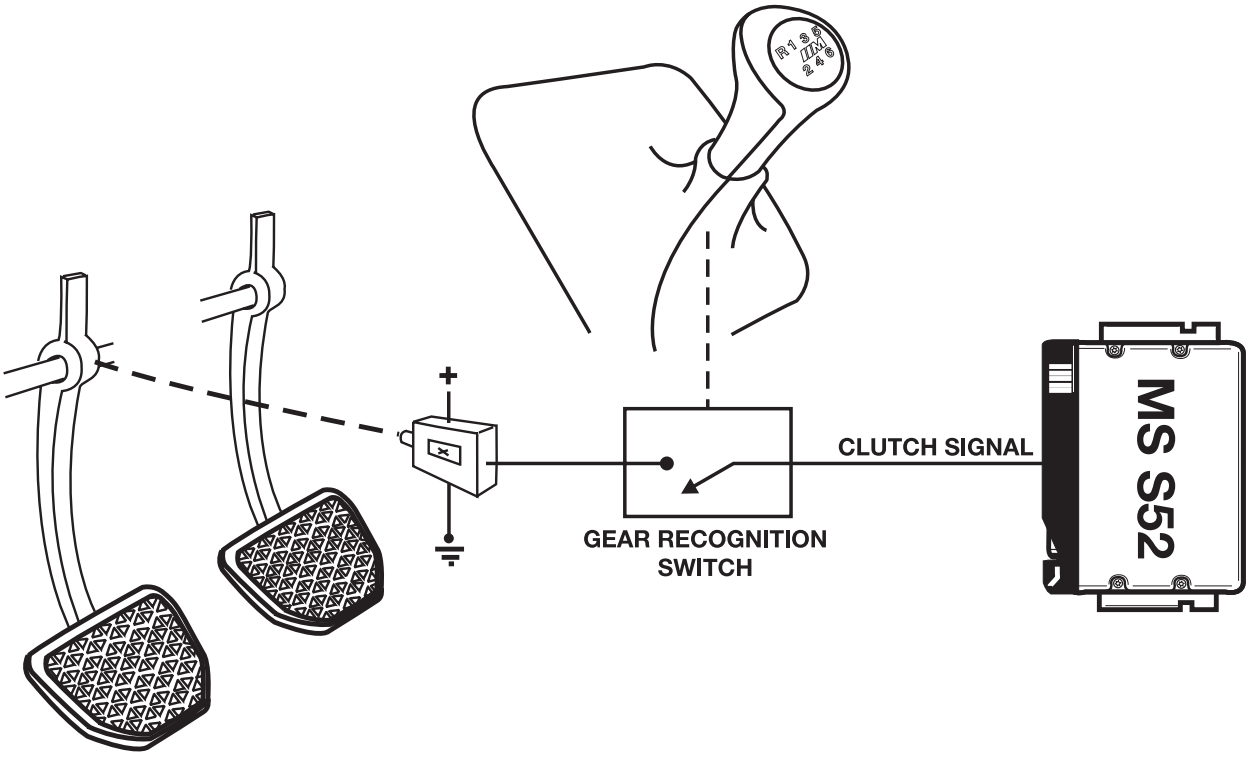
Power Transmission Switch

The power transmission switch (circuit) consists of two switches in series. The circuit includes a clutch switch and a gear selector switch on the transmission. The functions of the power transmission switch are as follows:

- Cutout for cruise control operation
- Enable condition for idle control

The switches provide a high signal for the MS S52 when the clutch is disengaged and the transmission is in gear.

If either the clutch is engaged or the transmission is in neutral, the cruise control will be disengaged.



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Signal Range?: _____ **Nominal Value(s)?:** _____

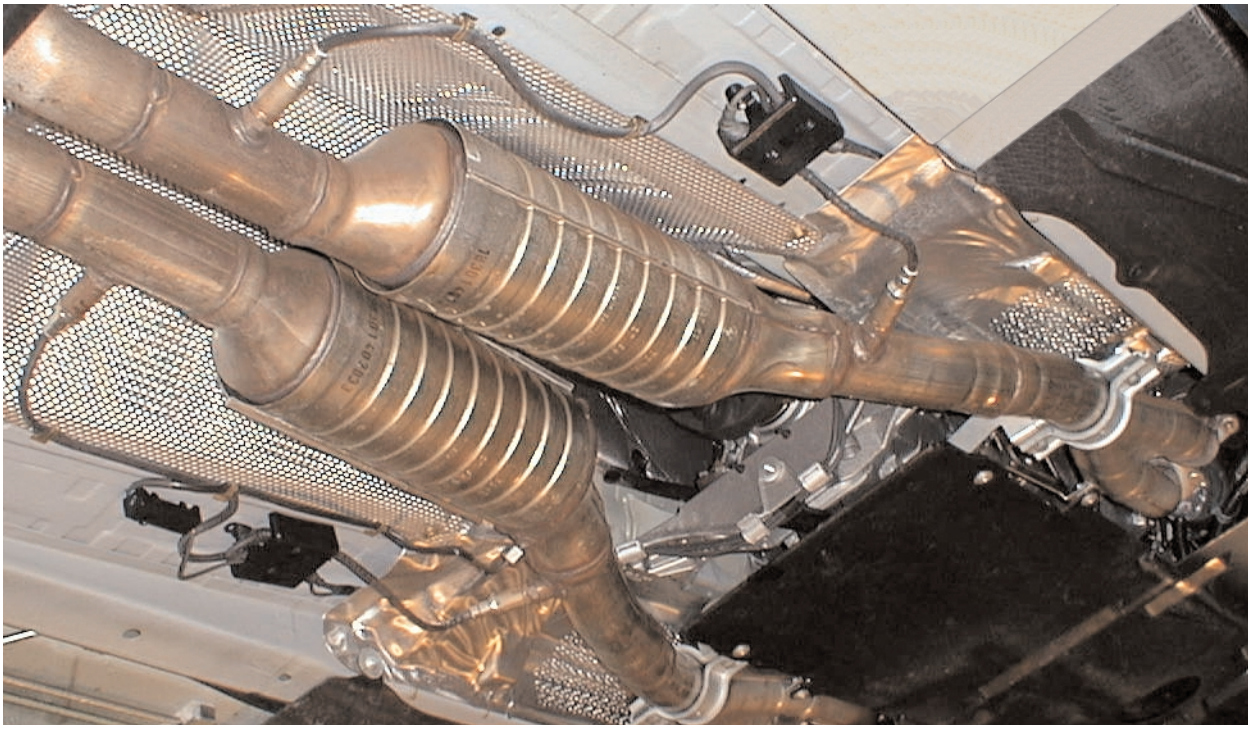
Notes:

Oxygen Sensors

Four oxygen sensors are used on the MS S52 as with other engine management systems. Two oxygen sensors, mounted in front of the catalytic converters and two sensors are mounted behind the converters to monitor the efficiency of the catalyst.

The two pre-converter oxygen sensors monitor the air fuel mixture and their inputs are used to adjust the mixture to achieve the ideal air/fuel ratio for all driving conditions. When heated, the oxygen sensor generates a voltage based on the oxygen content differential between the exhaust gas and the ambient air. The greater the oxygen differential, the higher the voltage generated will be. The oxygen sensor swing in voltage ranges from 0.15V (Lean) to 0.85V (Rich).

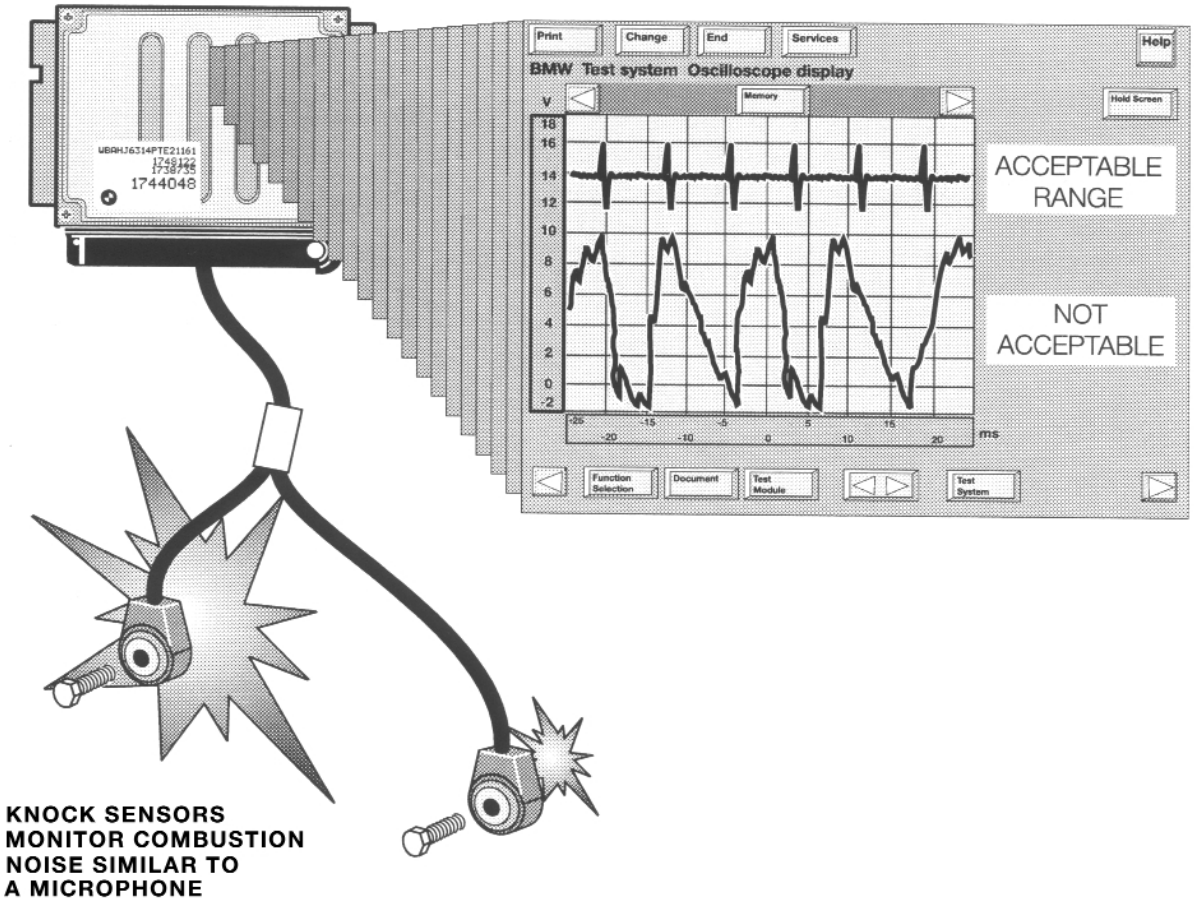
The two post-converter oxygen sensors monitor the oxygen level after the conversion by the catalyst. This signal is relatively steady at approximately 0.8V. The engine control module compares the signals of the pre and post oxygen sensors for conversion efficiency and if the values go outside of the programmed parameters, faults will be stored relating to catalytic converter operation.



Knock Sensors

The use of knock sensors allows the MS S52 control module to maintain the optimum ignition timing curve for all engine operating conditions. If detonation occurs, the signal from the knock sensors allows the engine control module to retard the timing to prevent engine damage.

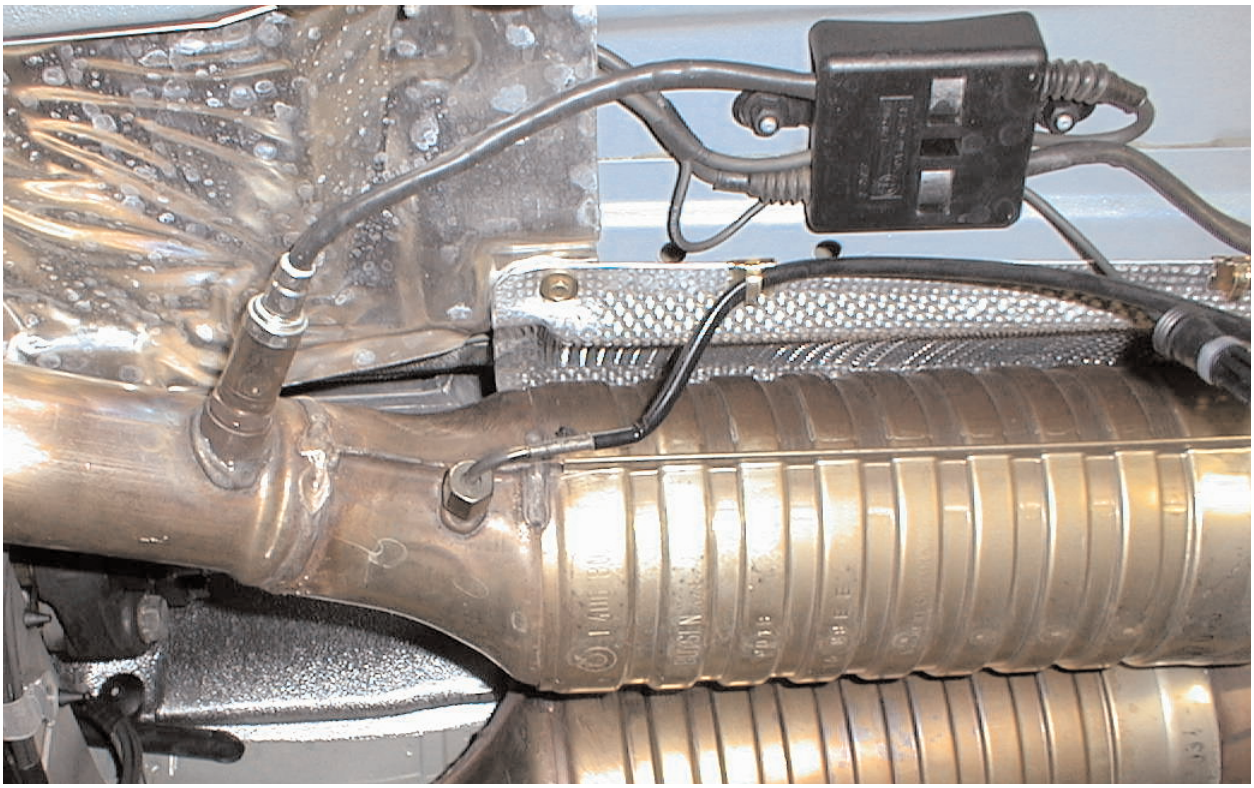
Each knock sensor produces a varying voltage signal that is dependent on the level of noise produced by the cylinders. This voltage signal input is processed by the control module and if the level exceeds the programmed parameters for knock, the timing is retarded until the knock is eliminated.



KNOCK SENSORS MONITOR COMBUSTION NOISE SIMILAR TO A MICROPHONE

Catalytic Converter Temperature Monitoring

The M5 is equipped with an exhaust temperature sensor at the catalyst for cylinder bank 5-8. The sensor is a PTC resistor which allows the MS S52 to monitor the catalyst temperature. This input is considered for mixture control by the MS S52 for catalyst efficiency. In the event of an overheat situation, the ECM will illuminate the Malfunction Indicator Light (MIL) and set a fault code. Under certain load conditions, the fuel mixture is enriched to aid in cooling down the catalytic converters.



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Signal Range?: _____ **Nominal Value(s)?:** _____

Notes:

Integrated Ambient Barometric Pressure Sensor

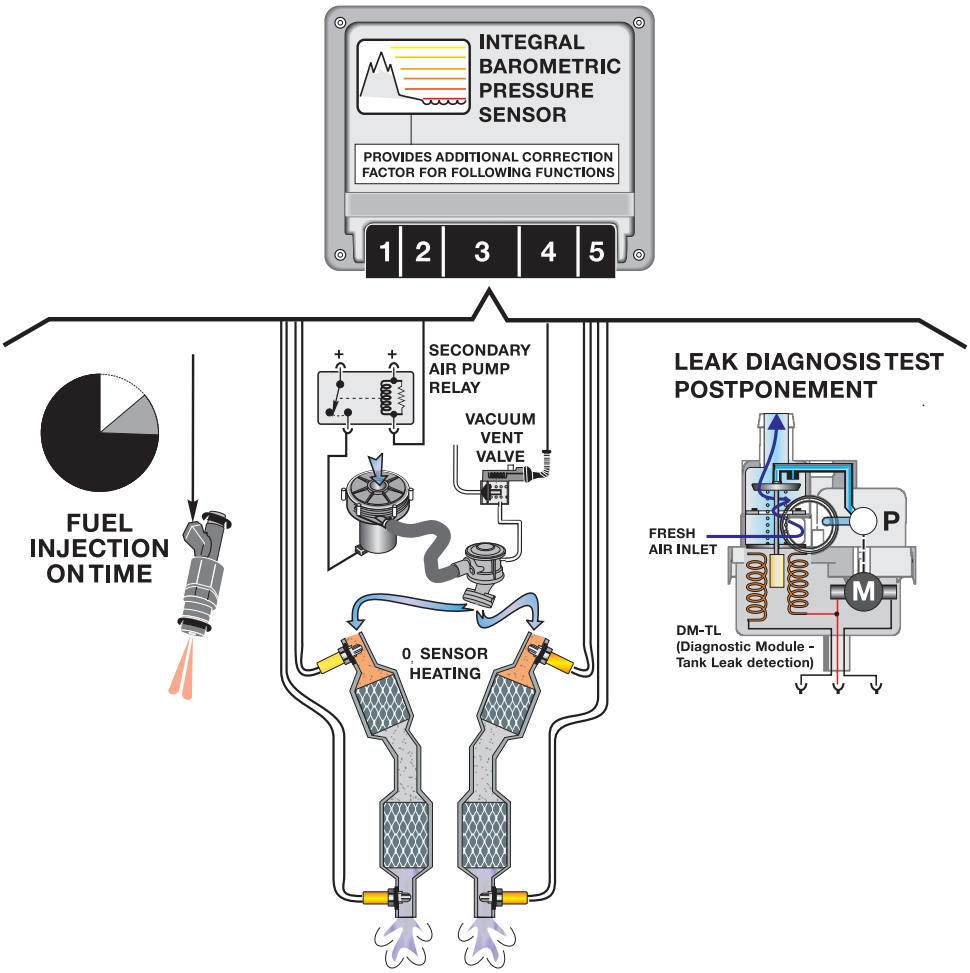
The MS S52 Control module contains an integral ambient barometric pressure sensor. The sensor is part of the SKE and is not serviceable. The internal sensor is supplied with 5 volts In return the sensor provides a linear voltage of approximately 2.4 to 4.5 volts representative of barometric pressure (altitude).

The MS S52 monitors barometric pressure for the following reasons:

* The barometric pressure signal along with calculated air mass provides an additional correction factor to further refine injection “on” time.

* Provides a base value to calculate the air mass being injected into the exhaust system by the secondary air injection system. This correction factor alters the secondary air injection “on” time, optimizing the necessary air flow into the exhaust system.

* Recognition of altitude above the accepted criteria postponing DM-TL activation for evaporative emission leak diagnosis.



OUTPUTS

Main Relay Control

The MS S52 control module activates the main relay when KL 15 is switched ON. This provides operating power for the control module and in addition the following systems/circuits also receive operating power from the main relay:

- Traction control module
- Fuel pump relay
- Secondary air pump relay/air pump
- E-box cooling fan
- Auxiliary oil pump solenoids
- Purge valve
- Fuel injectors
- Vanos solenoids
- Oxygen sensor heaters
- Air mass sensors
- Idle control valve

The MS S52 maintains the ground for the main relay for a short duration after the ignition has been switched off. This allows the control module to store the adaption values and any fault codes.

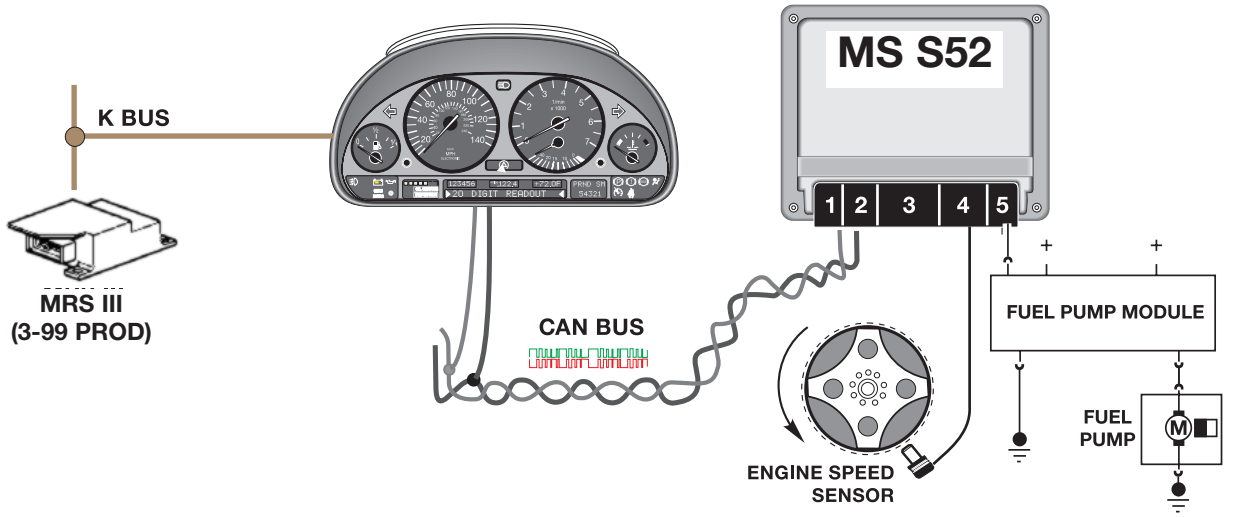
Fuel Pump Module

The MS S52 controls the activation of the fuel pump module. After the ignition is switched ON, the MS S52 provides a pulse width modulated ground for the fuel pump module and the ground is maintained with the presence of the engine speed signal.

A new fuel pump is utilized to match the fuel supply demands of the S 62 engine. While the pump delivers more volume and pressure, this creates more heat due to the increased power consumption. To lower the in-tank temperature, the fuel pump module will vary the pump speed (amperage). The MS S52 control module will vary the ground signal (PWM) to the fuel pump module.

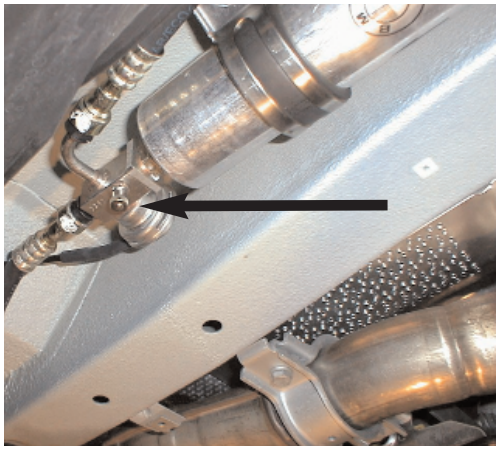
This variation is based on engine speed and load:
- Idle and part load = low pump speed
- Start-up (20 seconds) and full-load = full pump speed

The power to the fuel pump relay will be switched off in the event of an airbag activation. The MRS III control module will signal the Engine control module over K-bus and CAN bus for this purpose.



Non Return Fuel Rail System

The S62 engine utilizes the same method of meeting Running Loss Compliance as previously seen on the M62 TU. The regulated fuel supply is controlled by the fuel pressure regulator integrated in the fuel filter assembly (pressure testing tap at this point). A fuel return line is located on the filter/regulator assembly. The system provides even fuel distribution to all fuel injectors due to a “T” connection feeding both fuel rails. The new fuel rails do not contain a return line.



Name of Signal or Function: _____

Vehicle: _____ **M.Y.:** _____ **DIS CD Version:** _____

What type of signal is this? ☐ Switched Power ☐ Switched Ground ☐ Pulse Width Modulated (PWM)

☐ Linear Voltage ☐ Linear Resistance ☐ Digital ☐ Other: _____

How will the control system react if this signal becomes impaired or lost ?

_____

_____

_____

Is there a substitute value for this signal? ☐ Yes ☐ No

Does the DIS software provide a Status Display for this signal? ☐ Yes ☐ No

Is "component activation" possible with this signal/function? ☐ Yes ☐ No

Does signal status display or the component activation functions help you with diagnosis? ☐ Yes ☐ No **Why?** _____

_____

_____

_____

_____

What is (are) the most suitable measurement(s) for this signal/component?

☐ Voltage ☐ Resistance ☐ Capacitance ☐ Inductance ☐ Temperature ☐ Current ☐ Pressure ☐ Scope

Signal Range?: _____ **Nominal Value(s)?:** _____

Notes:

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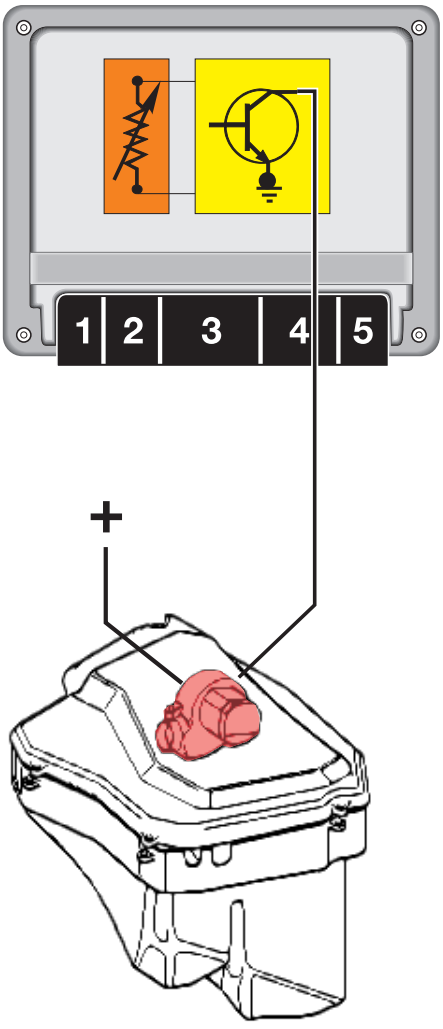
E Box Fan Control

The E Box fan is controlled by the MS S52. The control module contains an integral NTC temperature sensor for the purpose of monitoring the E Box temperature and activating the fan.

When the temperature of the E Box exceeds predetermined values, MS S52 provides a switched ground for the E Box fan to cool the E Box located control modules.

With every engine start-up, MS S52 briefly activates the fan ensuring continued fan motor operation for the service life of the vehicle. This feature is intended to prevent fan motor “lock up” from lack of use.



E-BOX FAN CONTROL

Secondary Air Injection

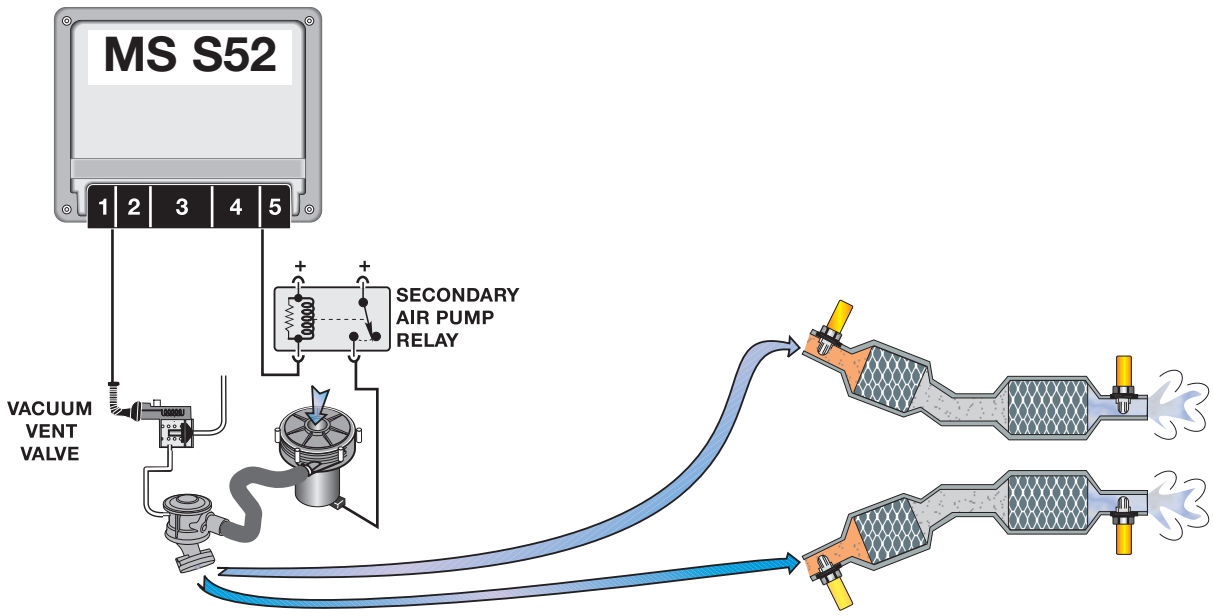
The secondary air injection system consists of the same components as previous systems with V8 specific locations.

The MS S52 control unit controls the vacuum vent valve and the secondary air injection pump relay separately but simultaneously.

The secondary air pump operates at a start temperature of between 10°C and 40°C. It continues to operate for a max. of 2 minutes at idle speed.

MS S52 contributes an additional correction factor for secondary air “on” time with the additional input from the integral ambient barometric pressure sensor.

This sensor provides a base value to calculate the air mass being injected into the exhaust system. This helps to “fine tune” the secondary air injection “on” time, optimizing the necessary air flow into the exhaust system which reduces the time to catalytic converter light-off.



Auxiliary Fan Control

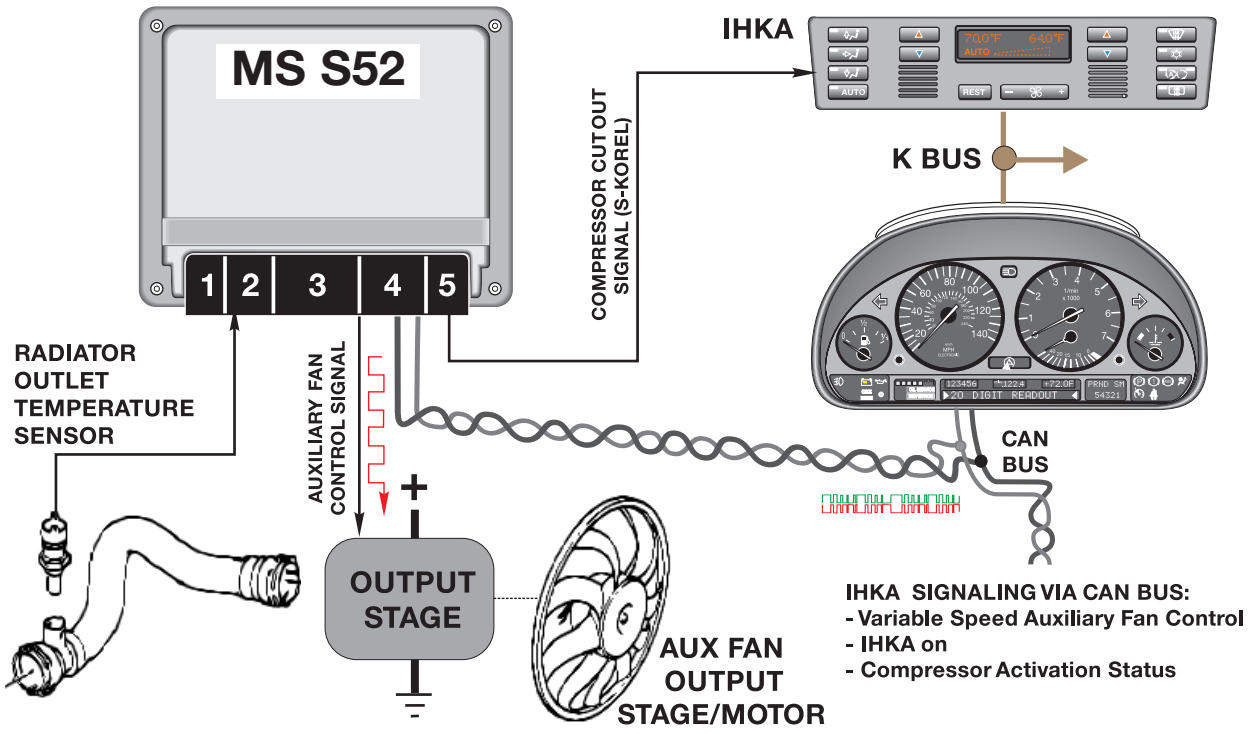
The Auxiliary Fan motor incorporates an output final stage that activates the fan motor at variable speeds.

The auxiliary fan is controlled by the MS S52. The motor output stage receives power and ground and activates the motor based on a PWM signal (10 - 100 Hz) received from the MS S52.

Similar to the aux fan in the E46 with MS 42.0 control, the fan is activated based on the following factors:

- Radiator outlet temperature sensor input exceeds a preset temperature.
- IHKA signalling via the K and CAN bus based on calculated refrigerant pressures.
- Vehicle speed.
- Battery voltage level.

When the over temperature light in the instrument cluster is on (120°C) the fan is run in the overrun function. This signal is provided to the ECM via the CAN bus. When this occurs the fan is run at a frequency of 10 Hz.



Vanos Solenoid Control

Control of the VANOS solenoids is an output function of the MS S52 control module. There is an inlet and exhaust solenoid for each camshaft. These solenoids are both installed on one side of the control piston. The engine control module regulates the solenoids through a pulse width modulated signal to apply or drain control oil pressure from the VANOS pistons.

Camshaft adjustment is based on several characteristic maps stored in the control module. The main control parameters for camshaft adjustment are derived from the the engine speed signal and the throttle valve position signal.

Name of Signal or Function:

Vehicle: _____ **M.Y.:** _____ **DIS CD Version:** _____

What type of signal is this? ☐ Switched Power ☐ Switched Ground ☐ Pulse Width Modulated (PWM)

☐ Linear Voltage ☐ Linear Resistance ☐ Digital ☐ Other: _____

How will the control system react if this signal becomes impaired or lost ?

Is there a substitute value for this signal? ☐ Yes ☐ No

Does the DIS software provide a Status Display for this signal? ☐ Yes ☐ No

Is "component activation" possible with this signal/function? ☐ Yes ☐ No

Does signal status display or the component activation functions help you with diagnosis? ☐ Yes ☐ No **Why?** _____

What is (are) the most suitable measurement(s) for this signal/component?

☐ Voltage ☐ Resistance ☐ Capacitance ☐ Inductance ☐ Temperature ☐ Current ☐ Pressure ☐ Scope

Signal Range?: _____ **Nominal Value(s)?:** _____

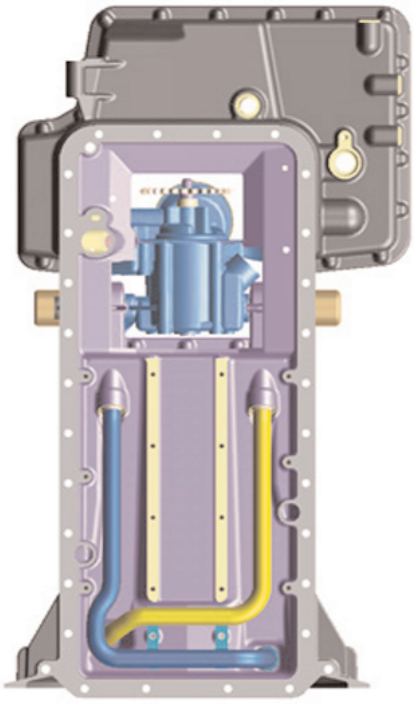
Notes:

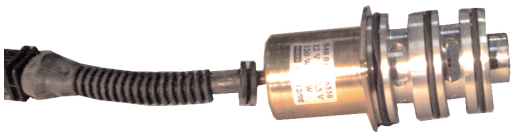
Oil Sump Changeover Valves

The oil supply system of the S62B50 engine is specifically designed for the M5, due to its ability for high speed cornering (transverse acceleration of up to1.2g) that could cause the engine oil to be forced (and trapped) into the outer edge of the cylinder head and the rear area of the oil sump. To prevent oil starvation from occurring during these driving situations, two additional scavenging oil pumps are installed within the main oil pump housing. The main oil pump's function is to supply the engine with the required volume of oil for all of its lubrication needs. The two additional pumps only supply the oil sump with the scavenged oil.

Each additional oil pump incorporates a solenoid changeover valve that is connected to two scavenging tubes that pickup from the rear section of the oil pan and the outer edge of the cylinder head. The scavenging tubes in the oil pan crossover so that the right side pump draws from the rear left side of the pan and the left pump from the right side of the pan.

When cornering at forces > 0.9g, the MS S52 will switch one solenoid to draw oil from the cylinder head while the second solenoid will continue to draw oil from the rear of the pan.The MS S52 control module receives the G-force signal from the DSC control module over the CAN line.





Name of Signal or Function

Vehicle: _____ **M.Y.:** _____ **DIS CD Version:** _____

What type of signal is this? ☐ Switched Power ☐ Switched Ground ☐ Pulse Width Modulated (PWM)

☐ Linear Voltage ☐ Linear Resistance ☐ Digital ☐ Other: _____

How will the control system react if this signal becomes impaired or lost ?

_____

_____

_____

Is there a substitute value for this signal? ☐ Yes ☐ No

Does the DIS software provide a Status Display for this signal? ☐ Yes ☐ No

Is "component activation" possible with this signal/function? ☐ Yes ☐ No

Does signal status display or the component activation functions help you with diagnosis? ☐ Yes ☐ No **Why?** _____

_____

_____

_____

_____

What is (are) the most suitable measurement(s) for this signal/component?

☐ Voltage ☐ Resistance ☐ Capacitance ☐ Inductance ☐ Temperature ☐ Current ☐ Pressure ☐ Scope

Signal Range?: _____ **Nominal Value(s)?:** _____

Notes:

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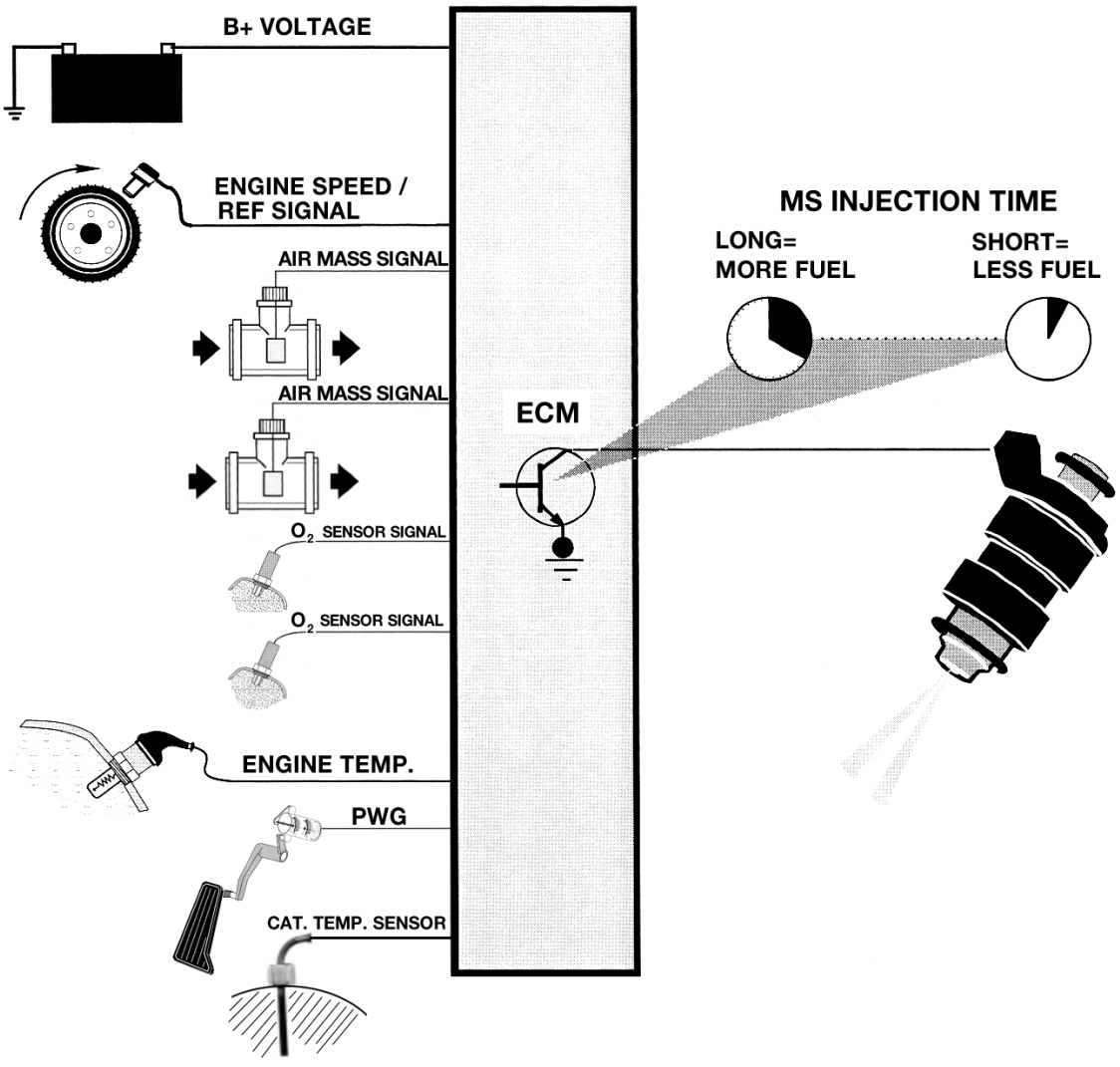
Injector Control

The MS S52 control module calculates the correct injection time based on the control parameters of:

- Engine speed
- Air mass
- Throttle position
- Oxygen Sensor feedback signal
- Engine coolant
- Barometric pressure
- Battery voltage
- Catalyst Temperature Sensor

The injectors receive operating power from the main relay and the control module provides the ground for the duration of the injection time (MS value).



Ignition Coil Triggering

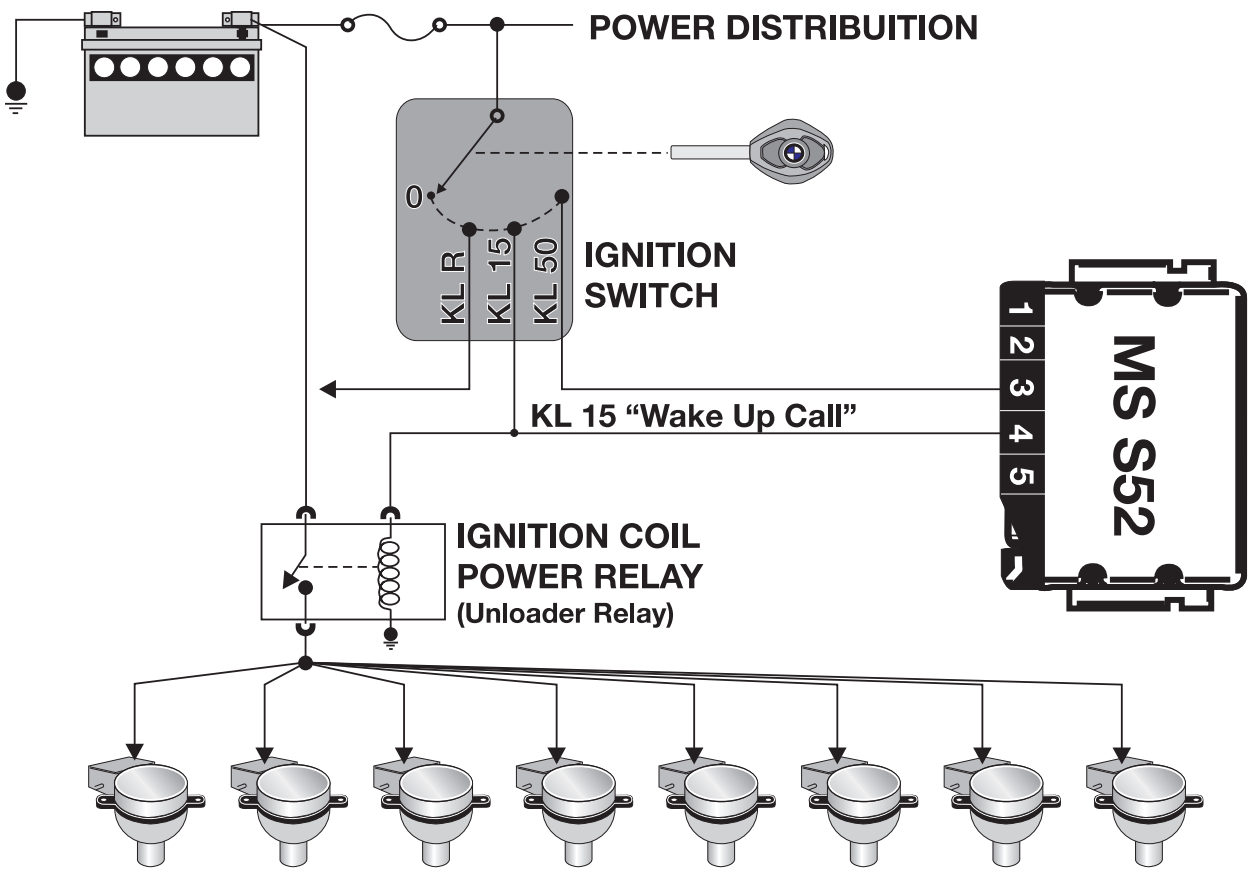
Control of the ignition coils is an output function of the MS S52 control module. The system is 100% solid state with no moving parts. The control module triggers each coil individually based on the parameters of engine speed and crankshaft position.

The ignition timing can be modified between each individual coil firing and can also be adjusted on a cylinder selective basis for knock control.

The power supply for the ignition coils is provided by a relay. This relay is identified as an **"unloader relay"** in the ETM and component listing displays.

The unloader relay was integrated into all vehicles starting with the 1997 model year. The purpose of this relay is to isolate the voltage supply as well as to relieve the ignition switch of the additional current draw needed by the ignition coils.

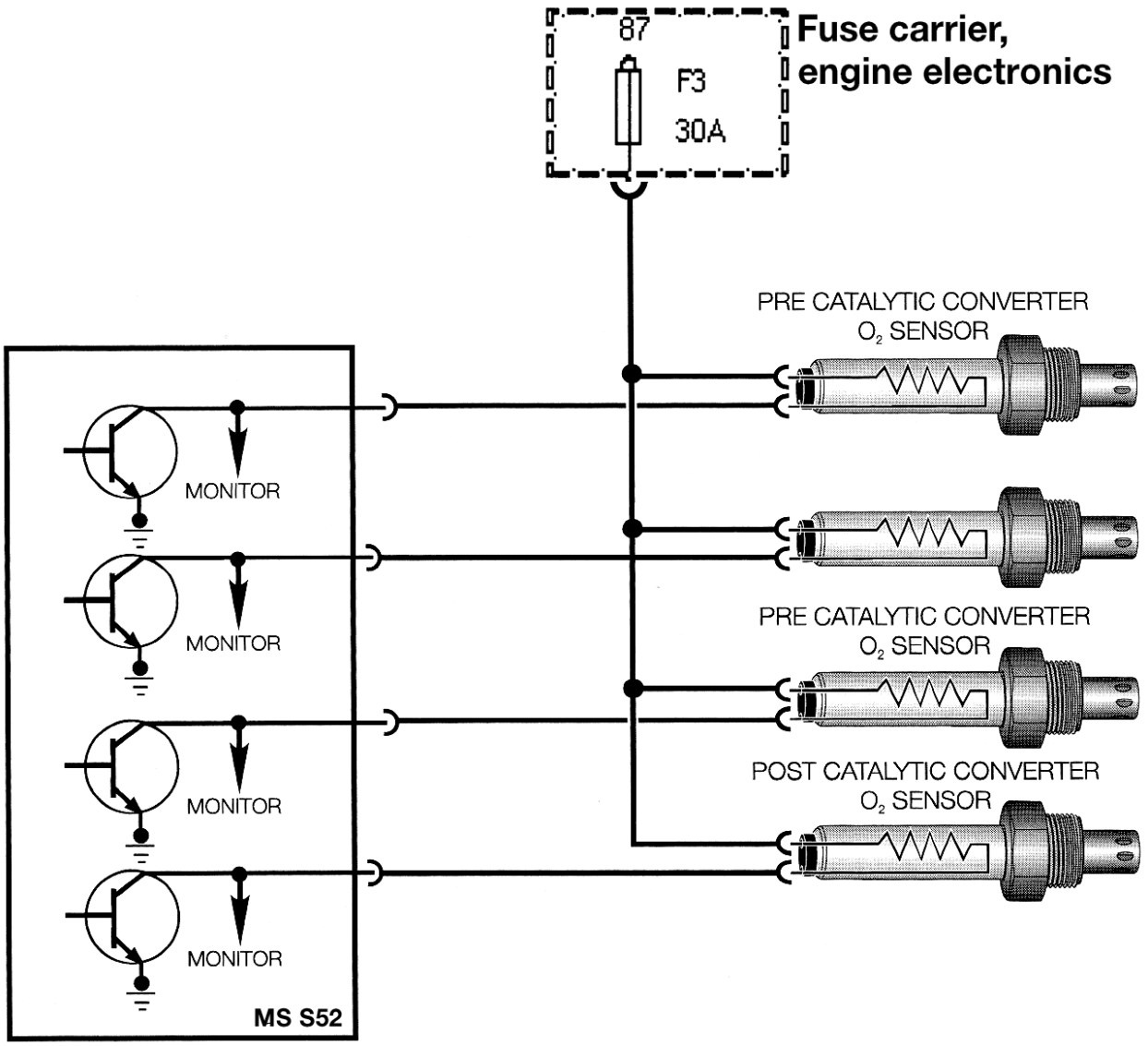
When KL 15 is switched on, the relay control circuit is provided power to close the relay providing operating voltage to ignition coils.



Oxygen Sensor Heating

Oxygen sensor heating is an output function of the MS S52 control module. The heating circuits receive operating power from the main relay when KL 15 is switched on. Each of the heaters is controlled through a separate final stage which is monitored by the control module for OBD II purposes.

The heaters are controlled with a pulsed square wave voltage during cold start which allows heating to occur without the result of thermo-shock. The duty cycle is then varied to maintain the heating of the sensors. On decel, the duty cycle will be increased to maintain the heating of the sensors during closed throttle operation with fuel cut.

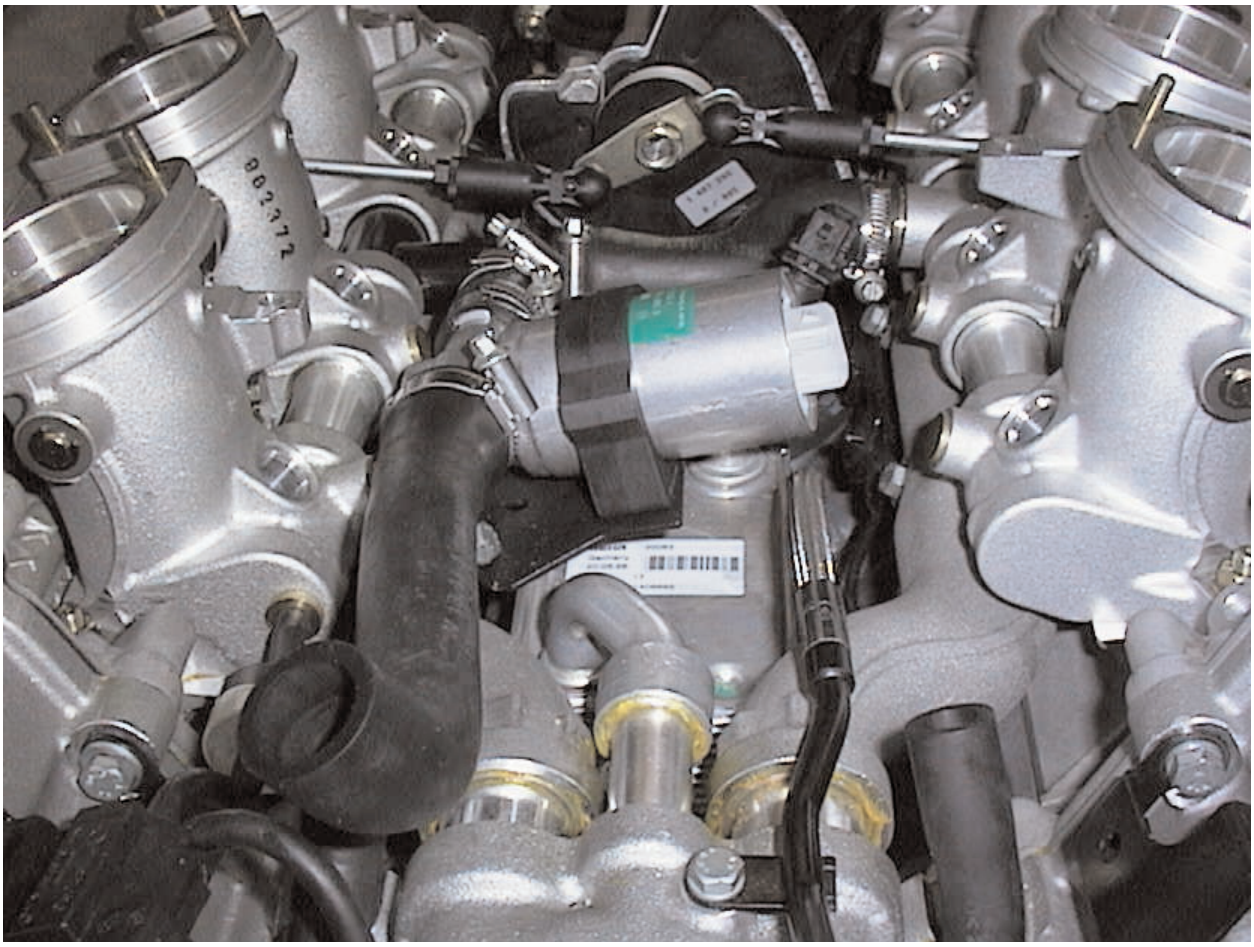


Idle Control Valve

The S62 engine uses an idle control valve for idle stabilization. During idle conditions, the throttle valves are closed and all idle air passes through the idle valve. The valve on the S62 engine is the three wire ZWD 5 system.

The valve has two windings that oppose each other. By varying the duty cycle applied to the windings, the valve can be progressively opened, closed or held steady to maintain the idle at a specified speed. The valve has a mechanical fail-safe opening (30%) which will allow the engine to idle in the event of a malfunction with the control of the valve.

The idle control valve also serves as a fail-safe in the event of certain faults with the throttle control system (EDR). The MS S52 control module can progressively open the valve to allow limited operation of the engine.



Purge Control Valve

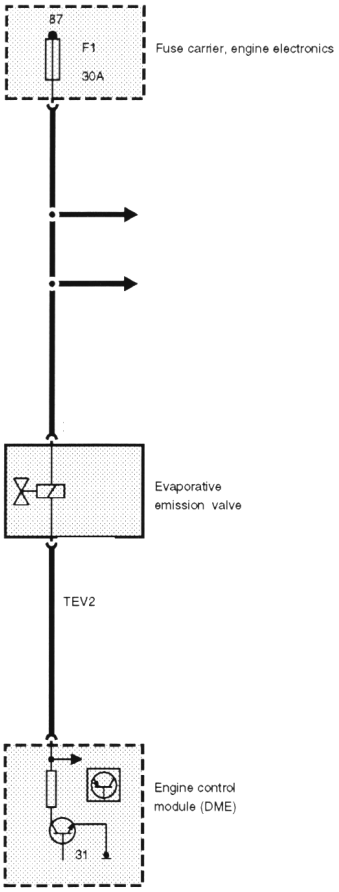
The MS S52 system uses a purge valve that is sprung closed and powered open. This type of purge valve is required for OBD II compliancy and evaporative system leak detection tests. This type of valve also prevents vapors escaping into the atmosphere when the vehicle is not in use. The valve will not open under fuel vapor over pressure.

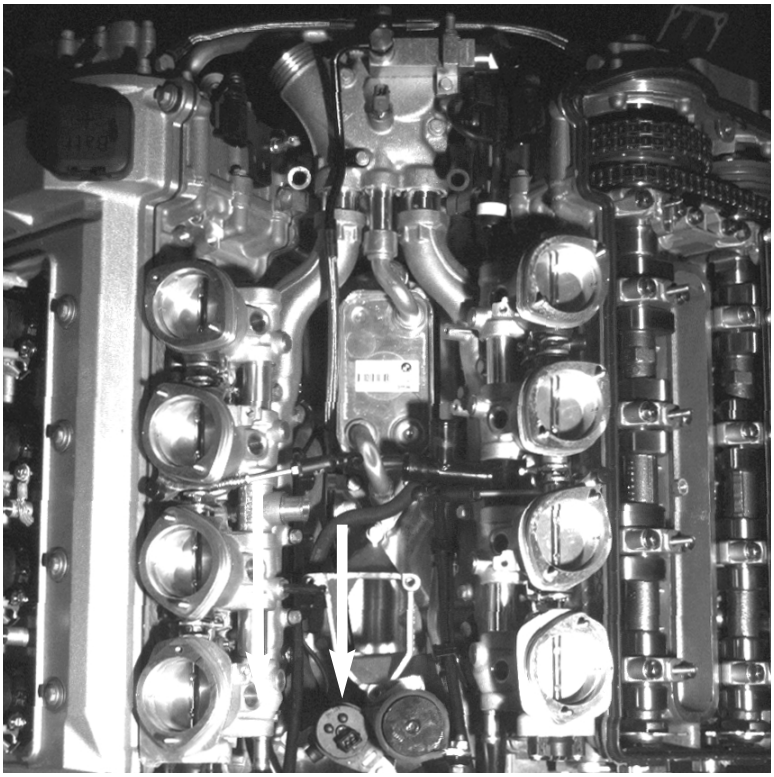
The valves are cycled periodically during engine operation. The duty cycle of the purge valve solenoid may vary between 0 and 100% depending on engine operating conditions.

The evaporative purge system is monitored for flow check after fuel system adaptation is complete and the ECM oxygen sensor feedback is in closed loop. The diagnosis starts during normal purge operation. After the system has completed a purge cycle, the valve is cycled abruptly several times. In addition to the rich/lean shift, the engine idle speed will vary. If the predetermined values are reached, the system is functioning properly.

The flow check will operate after the following conditions have been met:

- Vehicle speed = 0
- Oxygen sensors in closed loop
- Engine at idle speed
- Coolant temperature above set limit





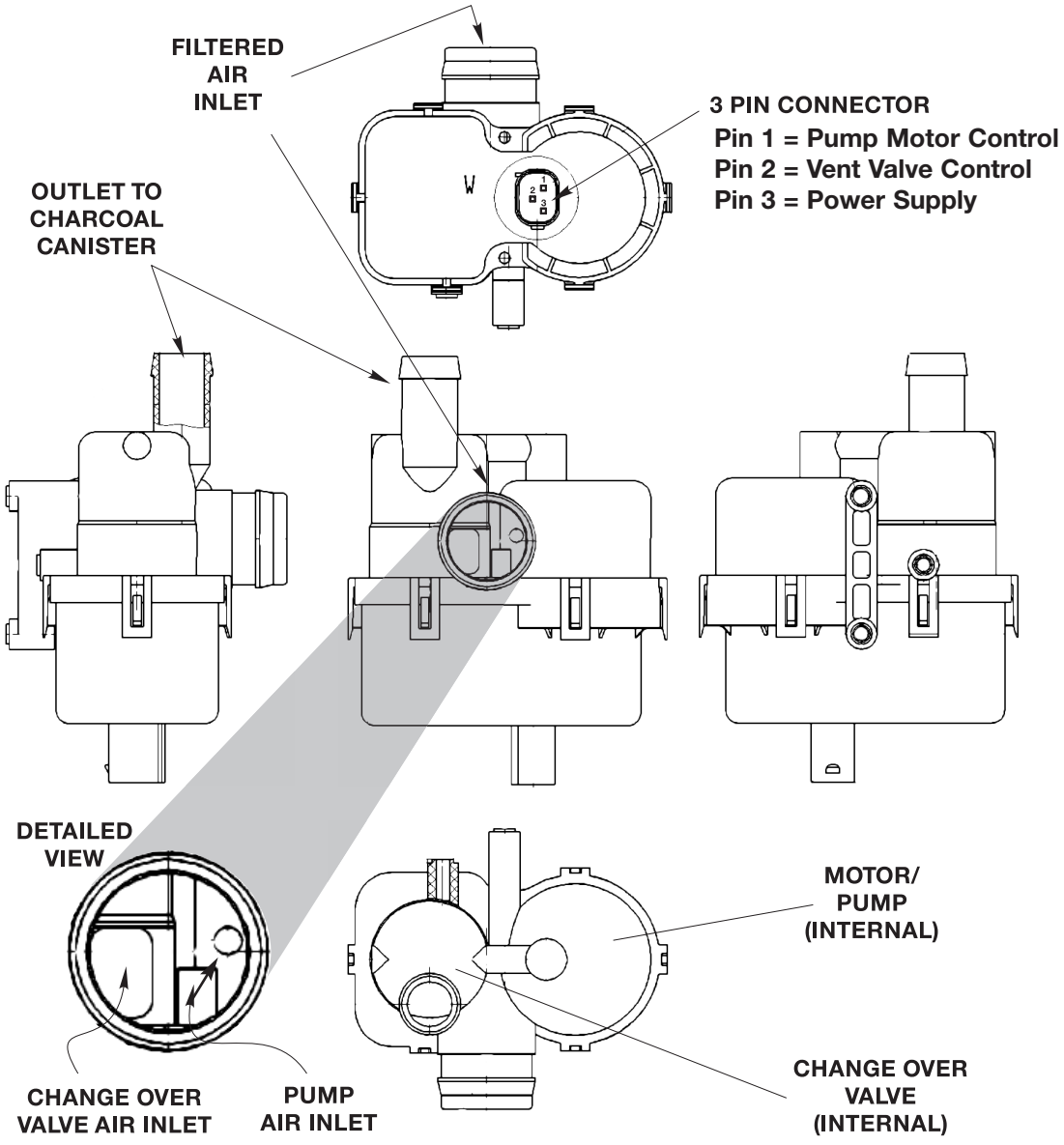
DM-TL (Diagnosis Module - Tank Leakage)

Introduction

A new Fuel System Leak Diagnosis Pump is equipped on the M5. The pump will eventually replace the current vacuum LDP on all vehicles.

The pump is manufactured by Bosch to BMW specifications.

- Bosch ECMs identify the electrical function of the pump as DM-TL.
- Siemens ECMs identify the electrical function as “LDP-M1”.



Functional Overview:

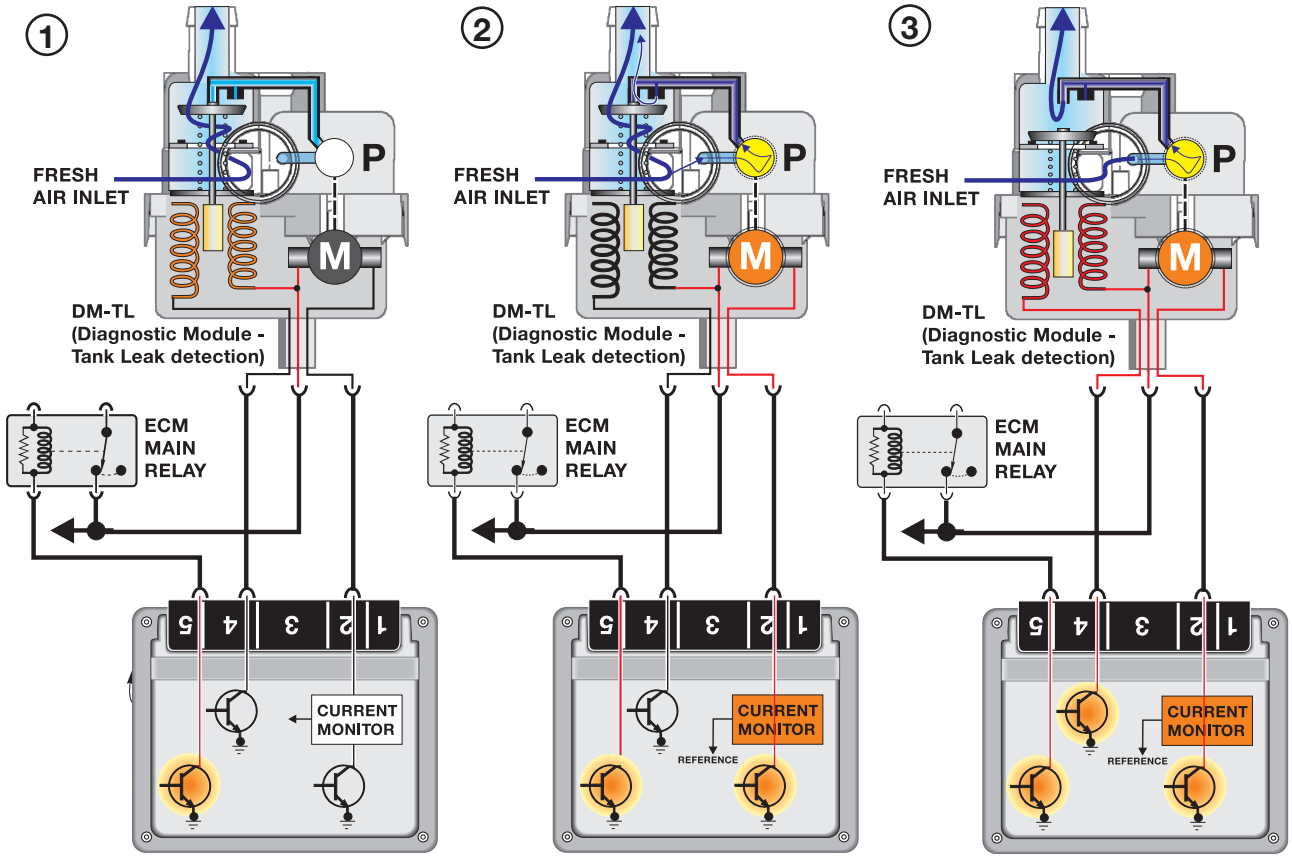
The DM-TL is located in the drivers side rear wheel well in the M5.

1. In it's inactive state, filtered fresh air enters the evaporative system through the sprung open valve of the DM-TL.

2. When the DME activates the DM-TL for leak testing, it first activates only the pump motor. This pumps air through a restricted orifice (1.0 or 0.5 mm) which causes the electric motor to draw a specific amperage value. This value is equivalent to the size of the restricted.

3. The solenoid valve is then energized which seals the evap system and directs the pump output to pressurize the evap system.

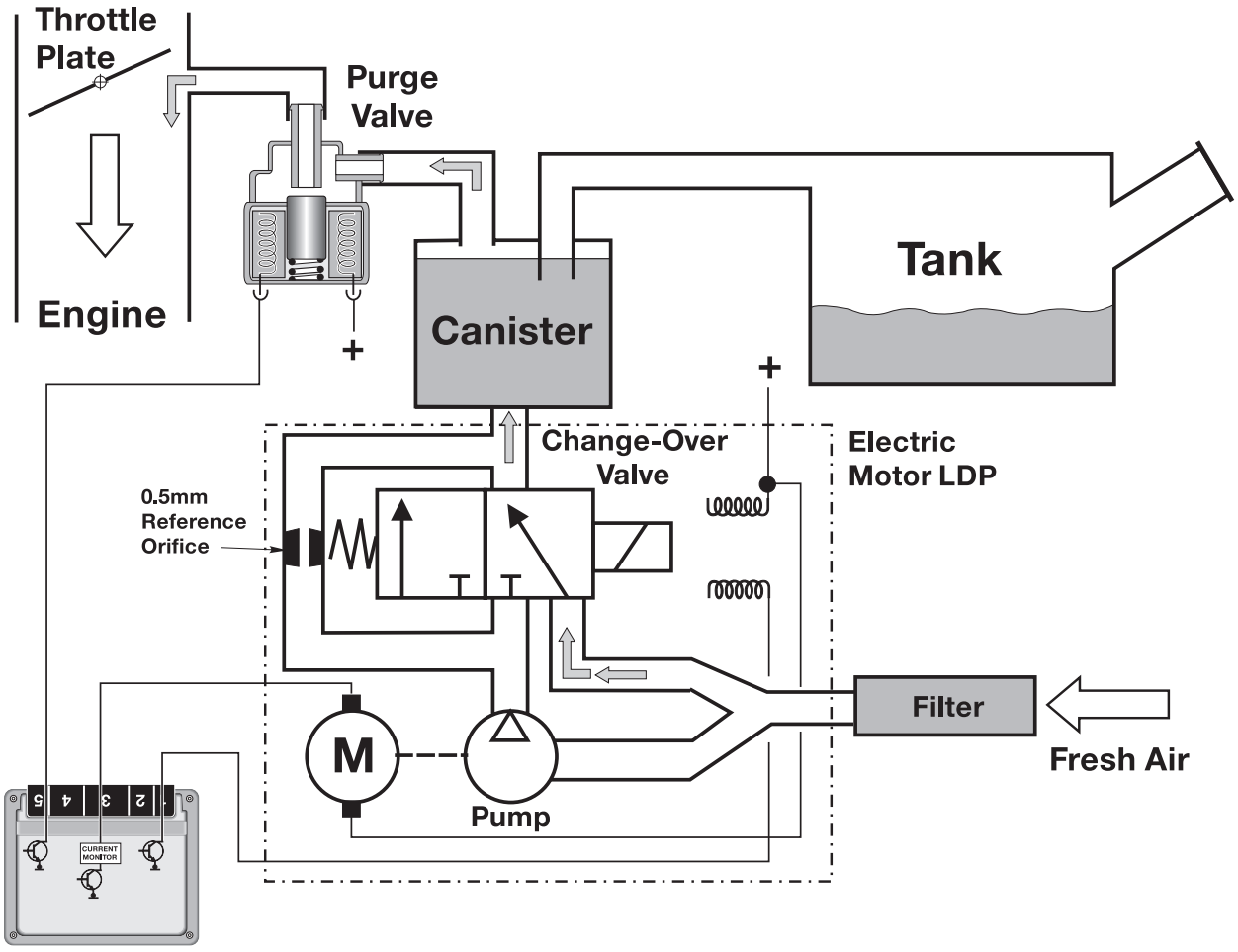
The evap system is detected as having a large leak if the amperage value is not realized, a small leak if the same reference amperage is realized or no leak if the amperage value is higher than the reference amperage.



Function

The DC Motor LDP ensures accurate fuel system leak detection for leaks as small as 1.0mm (.040”). The pump contains an integral DC motor which is activated directly by the engine control module. The ECM monitors the pump motor operating current as the measurement for detecting leaks.

The pump also contains an ECM controlled change over valve that is energized closed during a Leak Diagnosis test. The change over valve is open during all other periods of operation allowing the fuel system to “breath” through the inlet filter (similar to the full down stroke of the current vacuum operated LDP).



DC MOTOR LDP INACTIVE -- NORMAL PURGE VALVE OPERATION

In it’s inactive state the pump motor and the change over valve of the DC Motor LDP are not energized. When purge valve operation occurs filtered air enters the fuel system compensating for engine vacuum drawing on the hydrocarbon vapors stored in the charcoal canister.

Leak Diagnosis Test Preconditions

The ECM only initiates a leak diagnosis test every second time the criteria are met. The criteria is as follows:

- Engine **OFF** with ignition switched **OFF**.
- Engine Control Module still in active state or what is known as “follow up mode” (Main Relay energized, control module and ECM components online for extended period after key off).
- Prior to Engine/Ignition switch OFF condition, vehicle must have been driven for a minimum of 20 minutes.
- Prior to minimum 20 minute drive, the vehicle must have been OFF for a minimum of 5 hours.
- Fuel Tank Capacity must be between **15 and 85%** (safe approximation between 1/4 - 3/4 of a tank).
- Ambient Air Temperature between **-7°C & 35°C** (20°F & 95°F)
- Altitude **< 2500m** (8,202 feet).
- Battery Voltage between **11.5 and 14.5 Volts**

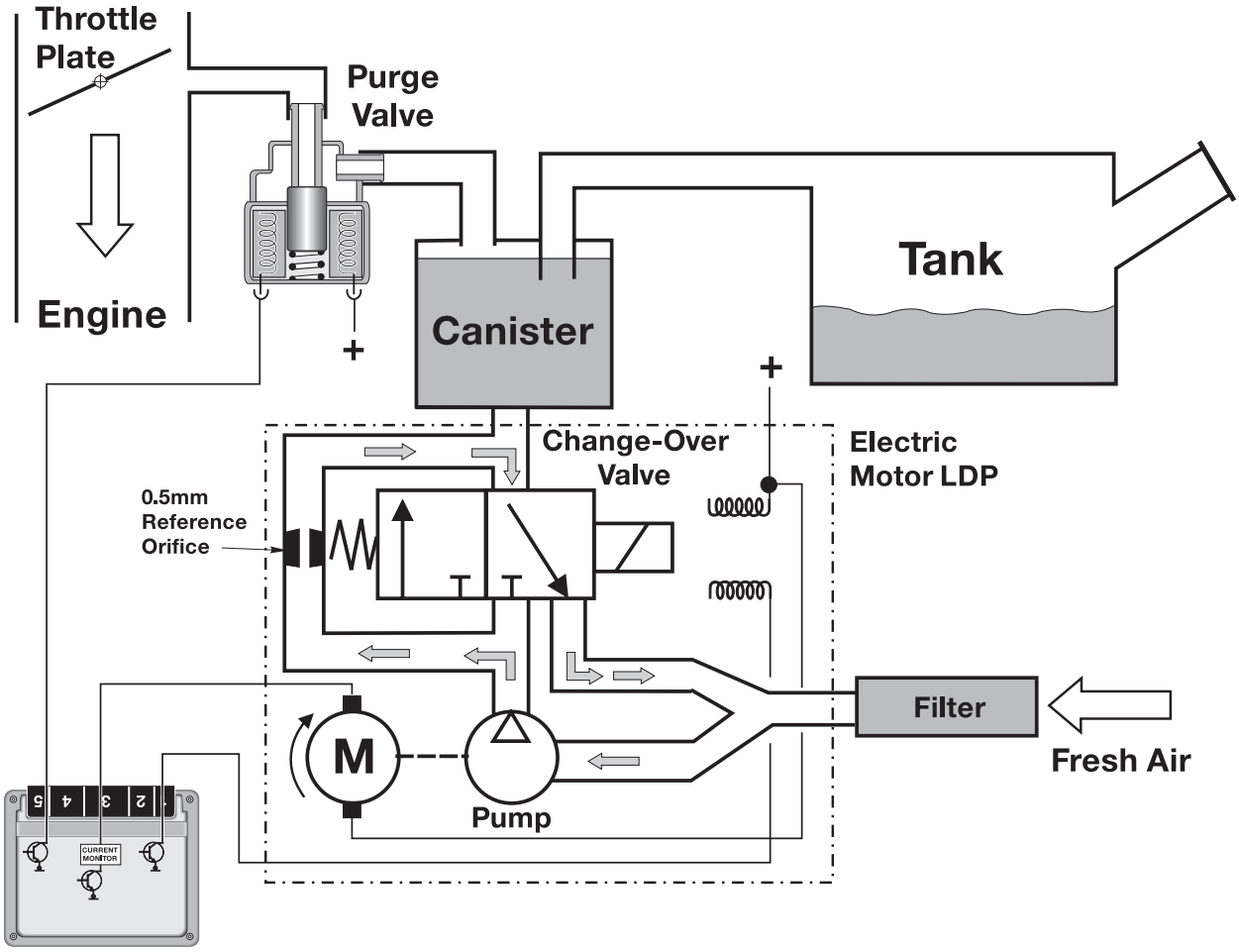
When these criteria are satisfied every second time, the ECM will start the Fuel System Leak Diagnosis Test. The test will typically be carried out once a day ie:, once after driving to work in the morning, when driving home in the evening, the criteria are once again met but the test is not initiated. The following morning, the test will run again.

Leak Diagnosis Test

Phase 1 - Reference Measurement

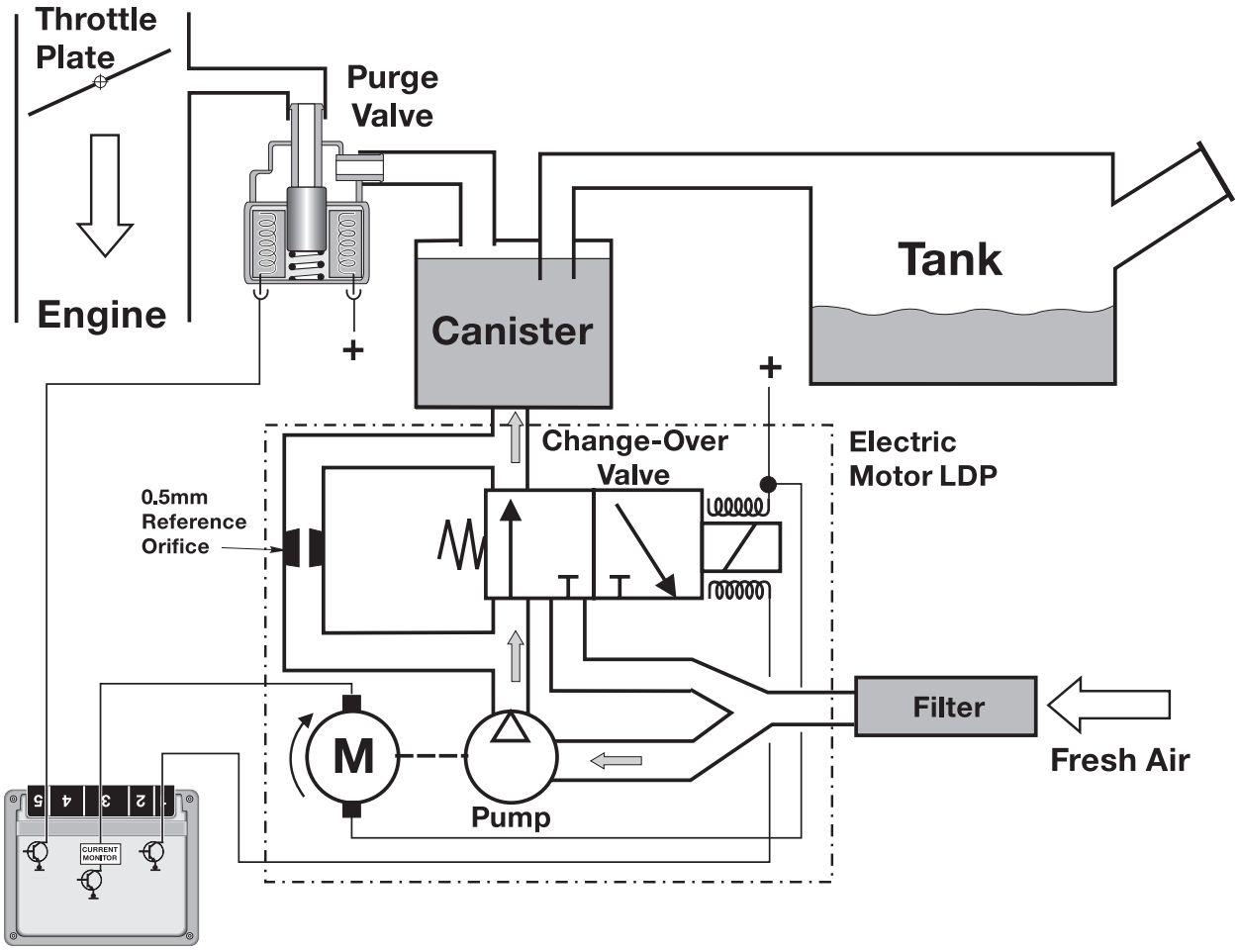
The ECM activates the pump motor. The pump pulls air from the filtered air inlet and passes it through a precise 0.5mm reference orifice in the pump assembly.

The ECM simultaneously monitors the pump motor current flow . The motor current raises quickly and levels off (stabilizes) due to the orifice restriction. The ECM stores the stabilized amperage value in memory. The stored amperage value is the electrical equivalent of a 0.5 mm (0.020") leak.



Phase 2 - Leak Detection

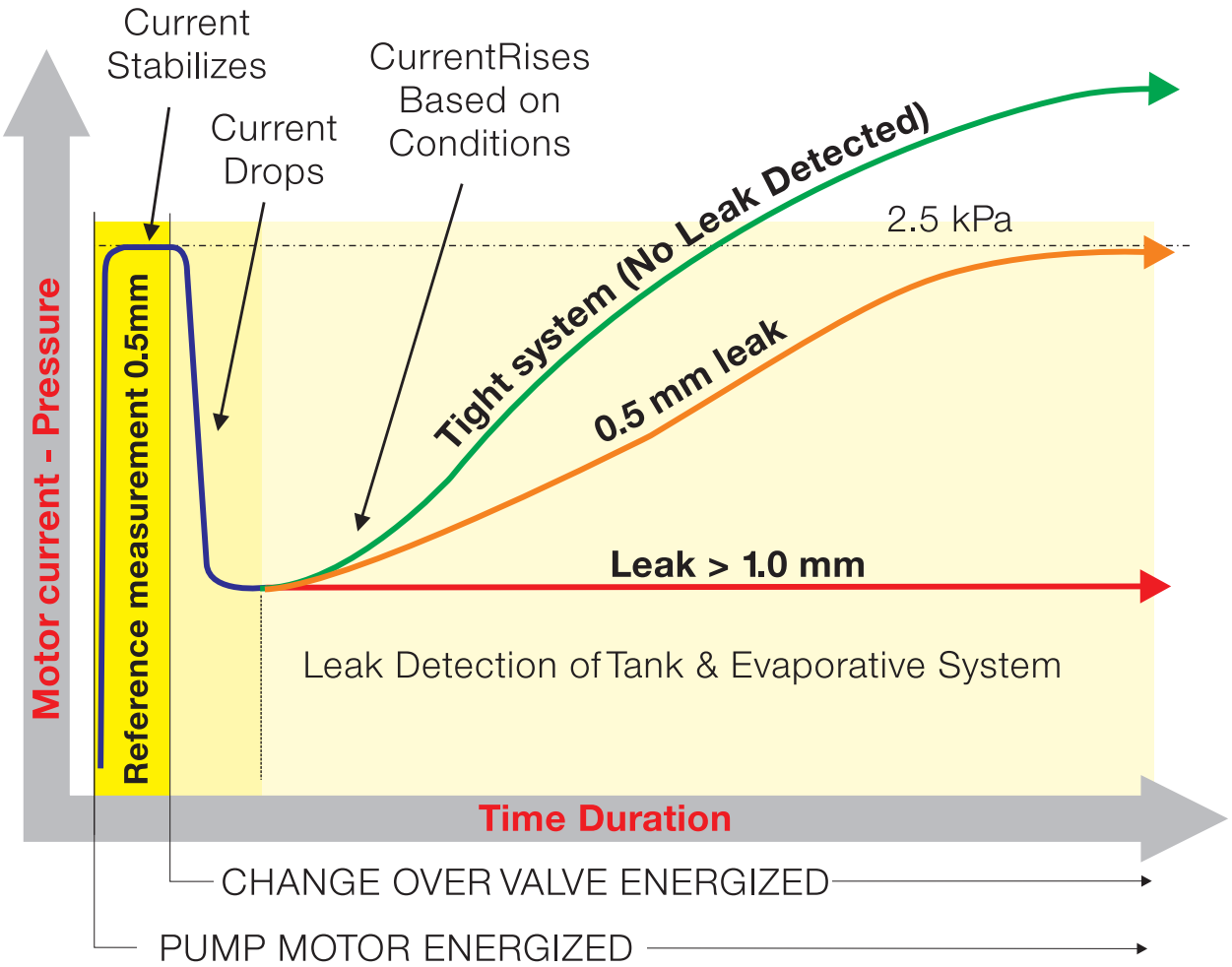
The ECM energizes the Change Over Valve allowing the pressurized air to enter the fuel system through the Charcoal Canister, The ECM monitors the current flow and compares it with the stored reference measurement over a duration of time.



Once the test is concluded, the ECM stops the pump motor and immediately de-energizes the change over valve. This allows the stored pressure to vent thorough the charcoal canister trapping hydrocarbon vapor and venting air to atmosphere through the filter.

Test Results

The time duration varies between 45 & 270 seconds depending on the resulting leak diagnosis test results (developed tank pressure “amperage” / within a specific time period). However the chart below depicts the logic used to determine fuel system leaks.



Name of Signal or Function:

Vehicle: _____ **M.Y.:** _____ **DIS CD Version:** _____

What type of signal is this? ☐ Switched Power ☐ Switched Ground ☐ Pulse Width Modulated (PWM)

☐ Linear Voltage ☐ Linear Resistance ☐ Digital ☐ Other: _____

How will the control system react if this signal becomes impaired or lost ?

Is there a substitute value for this signal? ☐ Yes ☐ No

Does the DIS software provide a Status Display for this signal? ☐ Yes ☐ No

Is "component activation" possible with this signal/function? ☐ Yes ☐ No

Does signal status display or the component activation functions help you with diagnosis? ☐ Yes ☐ No **Why?** _____

What is (are) the most suitable measurement(s) for this signal/component?

☐ Voltage ☐ Resistance ☐ Capacitance ☐ Inductance ☐ Temperature ☐ Current ☐ Pressure ☐ Scope

Signal Range?: _____ **Nominal Value(s)?:** _____

Notes:

Notes: