SIEMENS MS43 ENGINE MANAGEMENT SYSTEM

System Description

The KV6 engine is fitted with a Siemens MS43 Engine Management System (EMS), which is an adaptive system that maintains engine performance at the optimum level throughout the life of the engine.

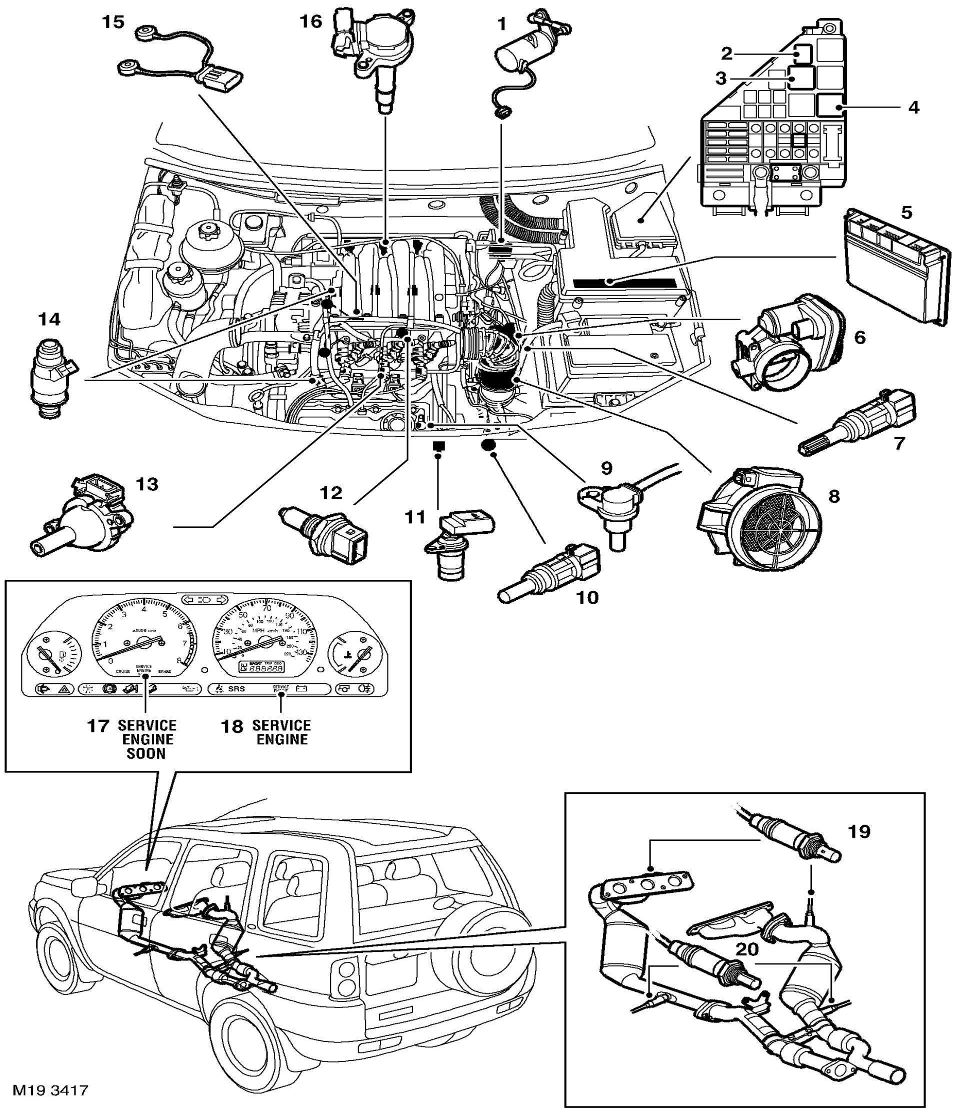
The EMS consists of an Engine Control Module (ECM) that uses inputs from engine sensors and from other vehicle systems to continuously monitor driver demand and the current status of the engine. From the inputs the ECM calculates the Air Fuel Ratio (AFR) and ignition timing required to match engine operation with driver demand, then outputs the necessary control signals to the electric throttle, fuel injectors and ignition coils. The ECM also outputs control signals to operate the:

- Air Conditioning (A/C) compressor.
- Engine cooling fans.
- Evaporative emissions (EVAP) purge valve and Diagnostic Module for Tank Leakage (DMTL).
- Fuel pump.
- Variable Intake System (VIS).

The ECM also interfaces with the:

- Immobilization ECU, for re-mobilization of the engine fuel supply.
- Cruise control interface ECU, to operate cruise control.
- Electronic Automatic Transmission (EAT) ECU, to assist with control of the gearbox.

Engine Management System Component Location



1	Accelerator Pedal Position sensor	11	Crankshaft Position sensor
2	A/C compressor clutch relay	12	Engine Coolant Temperature sensor
3	Main relay	13	LH bank ignition coil (x 3)
4	Fuel pump relay	14	Fuel injector (x 6)
5	ECM	15	Knock sensors
6	Electric throttle	16	RH bank ignition coil (x 3)
7	Intake Air Temperature sensor	17	Malfunction Indicator Lamp (emissions faults)
8	Mass Air Flow sensor	18	Service Engine lamp (non-emissions faults)
9	Camshaft Position sensor	19	Upstream HO2S (x 2)
10	Thermostat monitoring sensor	20	Downstream HO2S (x 2)

Sensor inputs and engine performance are monitored by the ECM, which illuminates the SERVICE ENGINE SOON (MIL) and/or the SERVICE ENGINE warning lamps in the instrument pack if a fault is detected.

As part of the security system's immobilization function, a vehicle specific security code is programmed into the ECM and the immobilization ECU during production. The ECM cannot function unless it is connected to an immobilization ECU with the same code. In service, replacement ECM are supplied uncoded and must be programmed using TestBook/T4 to learn the vehicle security code from the immobilization ECU.

A 'flash' Electronic Erasable Programmable Read Only Memory (EEPROM) allows the ECM to be externally configured, using TestBook/T4, with market specific or new information.

The ECM memorizes the position of the crankshaft and the camshaft when the engine stops. During cranking on the subsequent start the ECM confirms their positions from sensor inputs before initiating fuel injection and ignition.

To achieve optimum performance the ECM is able to 'learn' the individual characteristics of an engine and adjust the fuelling calculations to suit. This capability is known as adaptive fuelling. Adaptive fuelling also allows the ECM to compensate for wear in engine components and to compensate for the tolerance variations of the engine sensors.

If the ECM suffers an internal failure, such as a breakdown of the processor or driver circuits, there is no back up system or limp home capability. If a sensor circuit fails to supply an input, where possible the ECM adopts a substitute or default value, which enables the engine to function, although with reduced performance in some cases.

Engine Starting

When the ignition switch is in position II a power feed is connected from the ignition switch to the ECM. The ECM then initiates 'wake up' routines and energizes the main and fuel pump relays.

When the engine cranks, provided a valid mobilization signal is received from the immobilization ECU, the ECM initiates throttle control, fuelling and ignition to start and maintain control of the engine as necessary to meet driver demand. If no mobilization code is received from the immobilization ECU, or the code is invalid, the ECM inhibits fuel injection and ignition to prevent the engine from starting.

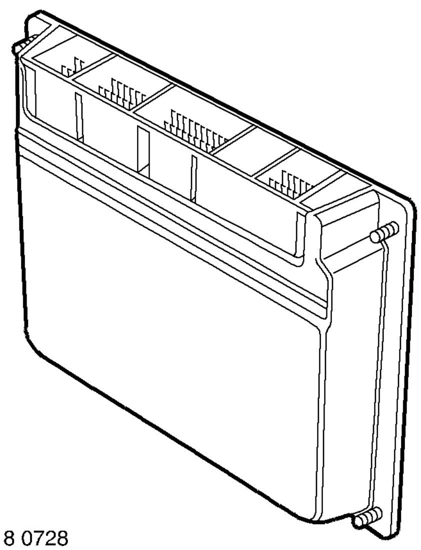
The electrical circuit from the fuel pump relay to the fuel pump is routed through the fuel cut-off inertia switch, located below the E-box in the engine compartment. In the event of a collision the switch breaks the circuit to prevent further fuel being delivered to the engine. The switch is reset by pressing down the centre of the rubber cover on the top of the switch.

During the start sequence, the ECM also illuminates the MIL, as a bulb check. While the ignition switch is in position II the MIL is continuously illuminated. The MIL is extinguished when the ignition switch turns to position III and the engine starts.

Engine Stopping
When the ignition switch is turned to position I, the ECM switches off the ignition coils, injectors and fuel pump to stop the engine. The ECM continues to energize the main relay until the power down functions are completed. Power down functions include the fuel tank leak check (6 minutes maximum), engine cooling (5 minutes maximum) and memorising data for the next start up. If neither a fuel tank lank check nor engine cooling are required, the power down process takes approximately 10 seconds.

When the power down process is completed, the ECM de-energizes the main relay and enters a low power mode. In the low power mode, maximum quiescent drain is 0.5 mA.

ECM



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The ECM is located in the engine compartment, in the E-box. Five connectors provide the interface between the ECM and the vehicle wiring.

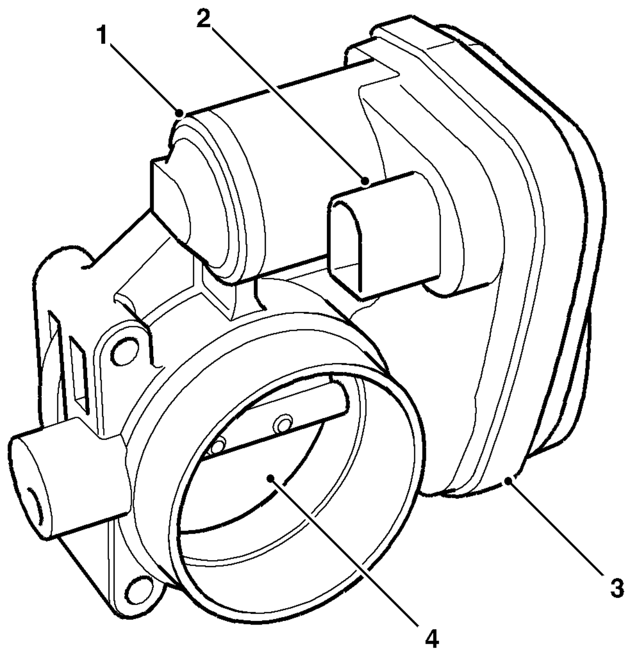
Controller Area Network (CAN) Bus
The ECM is connected to the Anti-lock Braking System (ABS) modulator, EAT ECU and the instrument pack by the CAN bus.

Electric Throttle
The electric throttle controls the air flow into the engine. In addition to the normal engine power control function, the electric throttle allows the cruise control, idle speed control and engine speed limiting functions to be performed without the need for additional hardware.

The electric throttle consists of a throttle body which incorporates a throttle plate driven by a DC motor via reduction gears. A return spring biases the throttle plate in the closed direction. Operation of the DC motor is controlled by the ECM, which outputs two Pulse Width Modulated (PWM) signals to a direction controlled H bridge drive in the motor. To enable closed loop control, the position of the throttle plate is supplied to the ECM by two feedback potentiometers in the throttle body.

The feedback potentiometers have a common 5 volt supply and a common ground connection from the ECM, and produce separate linear signal voltages to the ECM proportional to the position of the throttle plate. The ECM uses the signal from feedback potentiometer 1 as the primary signal of throttle plate position, and the signal from feedback potentiometer 2 for plausibility checks.

- The signal from feedback potentiometer 1 varies between 0.5 volt (0% throttle open) and 4.5 volts (100% throttle open)
- The signal from feedback potentiometer 2 varies between 4.5 volts (0% throttle open) and 0.5 volt (100% throttle open)



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1	DC motor	3	Reduction gear/ feedback potentiometer housing
2	Electrical connector	4	Throttle plate

While the ignition is on, the ECM continuously monitors the two feedback potentiometers for short and open circuits and checks the feedback potentiometer signals, against each other and the inputs from the Accelerator Pedal Position (APP) sensor, for plausibility. If a fault is detected in the feedback potentiometer signals or the DC motor, the ECM:

- Stores a related fault code in memory.
- Illuminates the SERVICE ENGINE warning lamp in the instrument pack.
- Adopts a throttle limp home mode or disables throttle control, depending on the nature of the fault.

In the throttle limp home mode the ECM uses the throttle plate to regulate engine speed at 1400 rev/min while the brake pedal is released and idle speed while the brake pedal is pressed. If the ECM disables throttle control, the DC motor is de-energized and the return spring holds the throttle valve closed; the ECM attempts to keep the engine running at idle speed using the ignition timing and fuelling, although the engine is likely to run rough or stall, depending on engine temperature and ambient conditions.

If a plausibility fault between the feedback potentiometer signals is detected, the ECM calculates a virtual throttle plate position from engine mass air flow and compares this to the feedback potentiometer signals:

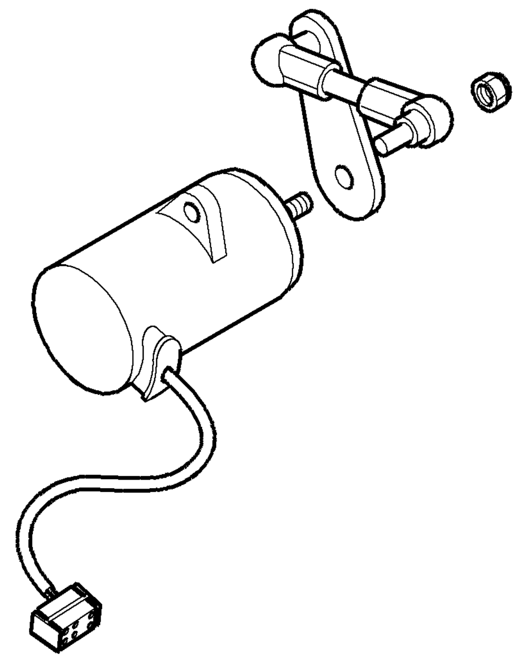
- If one of the feedback potentiometer signals matches the virtual throttle position, the ECM adopts the limp home mode and uses the valid signal to monitor throttle plate position. To ensure safe operation, the ECM continues to use the virtual throttle plate position for plausibility checks with the valid signal.
- If neither of the feedback potentiometer signals is plausible, the ECM disables throttle control.

Engine Sensors

The EMS incorporates the following engine sensors:

- An Accelerator Pedal Position (APP) sensor.
- A Crankshaft Position (CKP) sensor.
- A Camshaft Position (CMP) sensor.
- A Mass Air Flow (MAF) sensor.
- An Intake Air Temperature (IAT) sensor.
- An Engine Coolant Temperature (ECT) sensor.
- A thermostat monitoring sensor.
- Four Heated Oxygen Sensors (HO2S).
- Two knock sensors.

Accelerator Pedal Position (APP) Sensor



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The APP sensor enables the ECM to determine the throttle position requested by the driver on the accelerator pedal.

The APP sensor is installed on the pedal box and consists of a twin track potentiometer with wipers driven by a linkage connected to the accelerator pedal. Each potentiometer track has a 5 volt supply and ground connection from the ECM, and produces a linear signal voltage to the ECM proportional to the position of the accelerator pedal. The signal voltage from track 1 of the potentiometer is approximately double that of the signal voltage from track 2.

From the sensor signals, the ECM determines driver demand as a percentage of pedal travel, where 0% is with the pedal released and 100% is with the pedal fully depressed. Driver demand is then used to calculate throttle angle, fuel quantity and ignition timing. The ECM also outputs driver demand on the CAN system, for use by the brake and gearbox control systems.

The ECM stores the signal values that correspond with closed and wide open throttle, and adapts to new values to accommodate component wear or replacement.

The signals from the APP sensor are monitored by the ECM for short and open circuits and plausibility. If a fault is detected, the ECM:

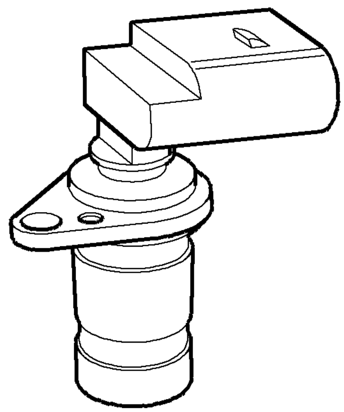
- Stores a related fault code in memory.
- Illuminates the SERVICE ENGINE warning lamp in the instrument pack.
- Inhibits the driver demand message on the CAN bus, which disables the Hill Descent Control (HDC) function of the ABS modulator and reduces the performance of the automatic gearbox (harsh gear changes and loss of kickdown).
- Adopts a sensor limp home mode or the throttle limp home mode (see Electric Throttle,

above), depending on the nature of the fault.

The ECM adopts the sensor limp home mode if a plausibility fault between the two sensor signals is detected. In the sensor limp home mode, the ECM:

- Uses the signal with the lowest throttle demand, which causes a slower throttle response and reduces the maximum throttle position.
- Sets the throttle plate and fuelling to idle when the brake pedal is pressed.

Crankshaft Position Sensor (CKP)



M18 0711

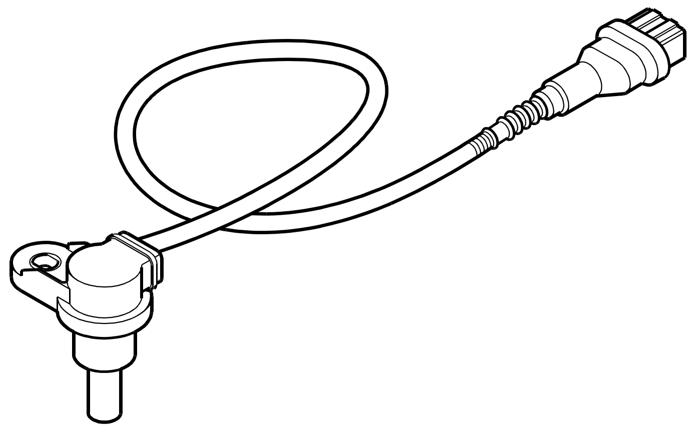
The CKP sensor provides the ECM with a digital signal of the rotational speed and angular position of the crankshaft, for use in ignition timing, fuel injection timing and fuel injection quantity calculations. To determine the exact position of the crankshaft in the engine cycle, the ECM must also use the input from the CMP sensor.

The CKP sensor is mounted on the front of the gearbox housing, in line with the outer circumference of the torque converter. The sensing tip of the CKP sensor is adjacent to a reluctor ring formed in the periphery of the torque converter. The reluctor ring has 58 teeth spaced at 6° intervals. A gap equivalent to two missing teeth, 36° After Top Dead Centre (ATDC) of No. 1 cylinder, provides the ECM with a reference point.

The CKP sensor operates using the Hall effect principle. A permanent magnet inside the sensor applies a magnetic flux to a semiconductor, which receives a power supply from the main relay. The output voltage from the semiconductor is fed to the ECM. As the gaps between the poles of the reluctor ring pass the sensor tip the magnetic flux is interrupted, causing a fluctuation of the output voltage and producing a digital signal.

If the CKP sensor fails the ECM immediately stops the engine.

Camshaft Position Sensor (CMP)



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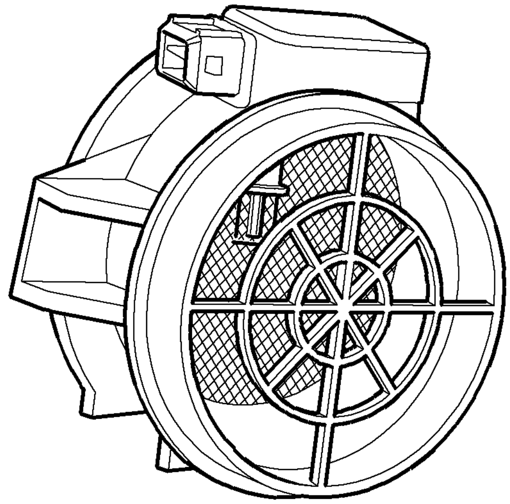
The CMP sensor provides a signal which enables the ECM to determine the position of the camshaft relative to the crankshaft. This allows the ECM to synchronize fuel injection for start and run conditions.

The CMP sensor is located on the camshaft cover of the LH (front) cylinder bank, at the opposite end to the camshaft drive, in line with a 'half moon' reluctor on the exhaust camshaft. The reluctor is a single tooth which extends around 180° of the camshaft circumference.

The CMP sensor operates using the Hall effect principle. A permanent magnet inside the sensor applies a magnetic flux to a semiconductor, which receives a power supply from the main relay. The output voltage from the semiconductor is fed to the ECM. As the gap in the reluctor passes the sensor tip, the magnetic flux is interrupted, causing a fluctuation of the output voltage and producing a digital signal.

If the CMP sensor fails during engine running, the engine will run normally until turned off, but will not restart until the CMP sensor input is restored.

Mass Air Flow Sensor (MAF)



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The MAF sensor provides a signal which the ECM uses for engine load calculations.

The MAF sensor is a hot film type, and is located in the intake system between the air filter housing and the throttle body.

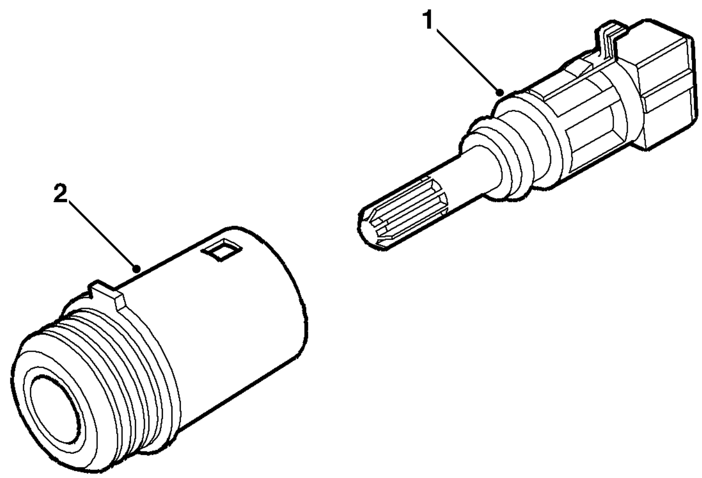
A closed-loop control circuit in the MAF sensor maintains a thick film resistor at a constant 200 °C (392 °F) above ambient temperature. The current required to maintain the temperature of the thick film resistor, against the cooling effect of the air flowing through the sensor, provides a precise, non-linear, measure of the air mass entering the engine.

The MAF sensor receives a battery voltage power supply and generates an output signal to the ECM, between 0 and 5 volts, which is proportional to the air mass drawn into the engine.

In the event of a MAF sensor signal failure, the following symptoms may be apparent:

- During driving engine speed may dip before recovering.
- Difficult starting.
- Engine stalls after starting.
- Delayed throttle response.
- Reduced engine performance.

Intake Air Temperature Sensor (IAT)



M18 0714

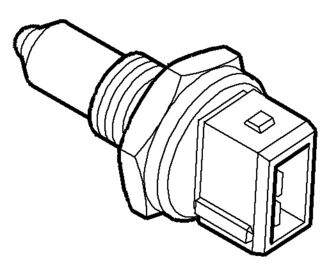
1 Sensor
2 Housing

The IAT sensor provides a signal that enables the ECM to adjust ignition timing and fuelling quantity according to the intake air temperature, thus ensuring optimum performance, driveability and emissions.

The IAT sensor is a Negative Temperature Coefficient (NTC) thermistor located in a plastic housing installed in the intake duct between the MAF sensor and the throttle body. The sensor is a push fit in the housing and sealed by an 'O' ring. A clip is integrated into the sensor to secure it in the housing.

If the input from the IAT sensor fails, the vehicle will continue to run. The ECM will substitute a default value using the information from the speed/load map to run the engine, but adaptive fuelling will be disabled.

Engine Coolant Temperature Sensor (ECT)



M18 0713

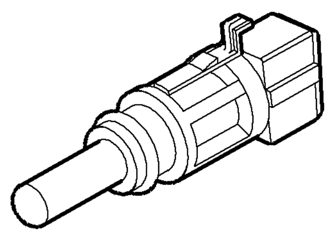
The ECT sensor provides the ECM with a signal voltage that varies with coolant temperature, to enable the ECM to adapt the fuelling quantity and ignition timing with changes of engine temperature.

The ECT sensor is located between the cylinder banks, between cylinders 3 and 6.

The ECT sensor consists of an encapsulated Negative Temperature Coefficient (NTC) thermistor which is in contact with the engine coolant. As the coolant temperature increases the resistance across the sensor decreases and as the coolant temperature decreases the sensor resistance increases. To determine the coolant temperature, the ECM supplies the sensor with a regulated 5 volts power supply and monitors the return signal voltage. The ECM also outputs the coolant temperature on the CAN system, to operate the coolant temperature gauge.

If the ECT signal is missing, or outside the acceptable range, the ECM assumes a default temperature reflecting a part warm engine condition. This enables the engine to function, but with reduced driveability when cold and increased emissions, resulting from an over rich mixture, when the engine reaches normal operating temperature. The ECM will also switch on the cooling fans to prevent the engine and gearbox from overheating.

Thermostat Monitoring Sensor

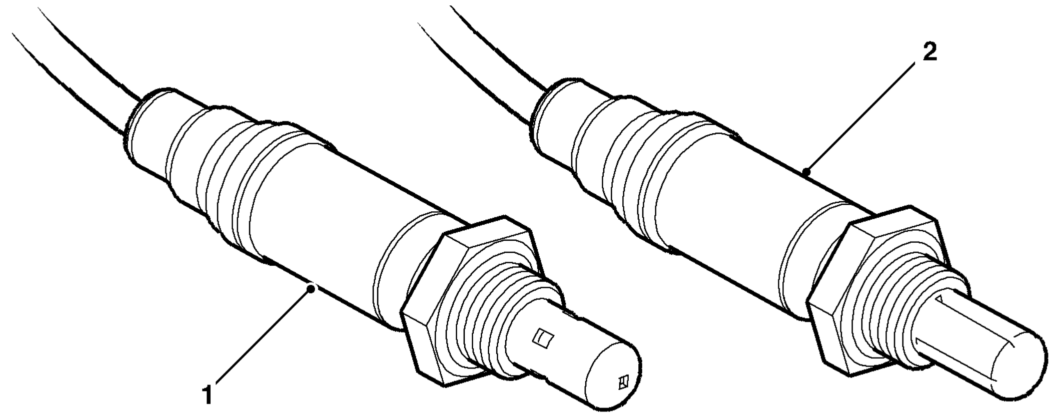


M18 0715

The input from the thermostat monitoring sensor is used by the ECM to monitor the operation of the cooling system thermostat and to control the operation of the engine cooling fans.

The thermostat monitoring sensor is a NTC thermistor installed in a plastic 'T' piece in the radiator bottom hose. The sensor is a push fit in the T piece and sealed by an 'O' ring. A clip is integrated into the sensor to secure it in the T piece.

Heated Oxygen Sensor (HO2S)



M18 0716

1 Downstream HO2S

2 Upstream HO2S

The EMS has four HO2S:

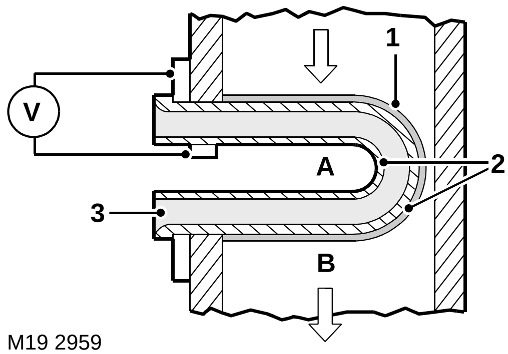
- One upstream of each catalytic converter, identified as LH and RH front HO2S.
- One downstream of each catalytic converter, identified as LH and RH rear HO2S.

The LH and RH front HO2S enable the ECM to determine the AFR of the mixture being burned in each cylinder bank of the engine. The LH and RH rear HO2S enable the ECM to monitor the performance of the catalytic converters and the upstream oxygen sensors, and trim fuel.

Each HO2S consists of a sensing element with a protective ceramic coating on the outer surface. The outer surface of the sensing element is exposed to the exhaust gas, and the inner surface is exposed to ambient air. The difference in the oxygen content of the two gases produces an electrical potential difference across the sensing element. With a rich mixture, the low oxygen content in the exhaust gas results in a higher sensor voltage. With a lean mixture, the high oxygen content in the exhaust gas results in a lower sensor voltage.

During closed loop control, the voltage of the two front HO2S switches from less than 0.3 volt to more than 0.5 volt. The voltage switches between limits every two to three seconds. This switching action indicates that the ECM is varying the AFR within the Lambda window tolerance, to maximize the efficiency of the catalytic converters.

Sectioned View of HO2S



M19 2959

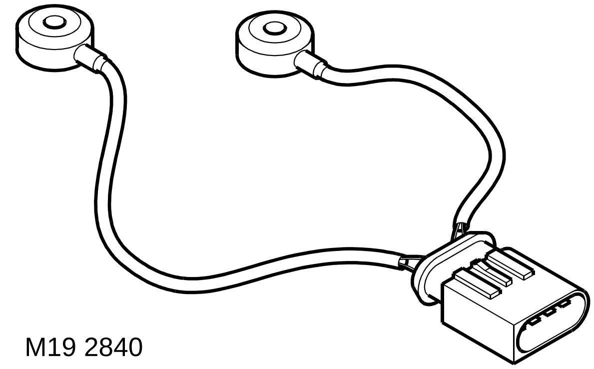
A Ambient air
B Exhaust gases
1 Protective ceramic coating
2 Electrodes
3 Zirconium oxide

The material of the sensing element only becomes active at a temperature of approximately 300 °C (570 °F). To shorten the warm up time and minimize the emissions from a cold start and low load conditions, each HO2S contains a heating element powered by a supply from the main relay. The earth paths for the heating elements are controlled by the ECM. On start up, the current supplied to the heating elements is increased gradually to prevent sudden heating from damaging the ceramic coating. After the initial warm up period the ECM modulates the earth of the heating elements, from a map of engine speed against mass air flow, to maintain the HO2S at the optimum operating temperature.

The nominal resistance of the heating elements is 6 Ω at 20 °C (68 °F).

If an HO2S fails, the ECM illuminates the MIL. If a front HO2S fails the ECM also adopts open loop fuelling and catalytic converter monitoring is disabled. If a rear HO2S fails, catalytic converter and upstream HO2S monitoring is disabled.

Knock Sensors



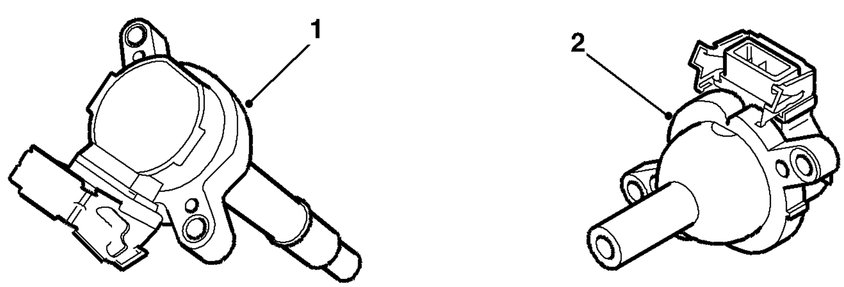
M19 2840

The knock sensors enable the ECM to operate the engine at the limits of ignition advance, for optimum efficiency, without combustion knock damaging the engine. The ECM uses two knock sensors, one for each cylinder bank, located between the cylinder banks on cylinders 3 and 4.

The knock sensors consist of piezo ceramic crystals that oscillate to create a voltage signal. During combustion knock, the frequency of crystal oscillation increases, which alters the signal output to the ECM. The ECM compares the signal to known signal profiles in its memory. If the onset of combustion knock is detected the ECM retards the ignition timing for a number of cycles. When the combustion knock stops, the ignition timing is gradually advanced to the original setting.

The knock sensor leads are of different lengths to prevent incorrect installation.

Ignition Coils



M19 3384

1 RH bank ignition coil
2 LH bank ignition coil

The ECM uses a separate ignition coil for each spark plug. The ignition coils for the LH bank spark plugs are positioned on the forward tracts of the Intake manifold and connected to the spark plugs with High Tension (HT) leads. The ignition coils for the RH bank spark plugs are of the plug top design, secured to the camshaft cover with 2 screws.

Each ignition coil has 3 connections in addition to the spark plug connection; an ignition feed from the main relay, an earth wire for the secondary winding and a primary winding negative (switch) terminal. The switch terminal of each ignition coil is connected to a separate pin on the ECM to allow independent switching. The ignition coils are charged whenever the ECM supplies an earth path to the primary winding negative terminal. The duration of the charge time is held relatively constant by the ECM for all engine speeds. Consequently, the dwell period increases with engine speed. This type of system, referred to as Constant Energy, allows the use of low impedance coils with faster charge times and higher outputs.

The ECM calculates the dwell period using inputs from the following:

- Battery voltage (main relay).
- CKP sensor.
- Ignition coil primary current (internal ECM connection).

The spark is produced when the ECM breaks the primary winding circuit. This causes the magnetic flux around the primary winding to collapse, inducing HT energy in the secondary coil, which can only pass to earth by bridging the air gap of the spark plug.

Ignition related faults are monitored indirectly by the misfire detection function.

Ignition Timing
The ECM calculates ignition timing using inputs from the following sensors:

- CKP sensor.
- MAF sensor.
- Knock sensors.
- TP sensor (idle only).
- ECT sensor.

At start up and idle the ECM sets ignition timing by referencing the ECT and CKP sensors. Once above idle the ignition timing is controlled according to maps stored in the ECM memory and modified according to additional sensor inputs and any adaptive value stored in memory. The maps keep the ignition timing within a narrow band that gives an acceptable compromize between power output and emission control. The ignition timing advance and retard is controlled by the ECM in order to avoid combustion knock.

Knock Control
The ECM uses active knock control to prevent combustion knock damaging the engine. If the knock sensor inputs indicate the onset of combustion knock, the ECM retards the ignition timing for that particular cylinder by 3°. If the combustion knock indication continues, the ECM further retards the ignition timing, in decrements of 3°, for a maximum of 15° from where the onset of combustion knock was first sensed. When the combustion knock indication stops, the ECM restores the original ignition timing in increments of 0.75°.

To reduce the risk of combustion knock at high intake air temperatures, the ECM retards the ignition timing if the intake air temperature exceeds 55 °C (169 °F). The amount of ignition retard increases with increasing air intake temperature.

Idle Speed Control
The ECM controls the engine idle speed using a combination of fuelling, ignition timing and the electric throttle.

When the engine idle speed fluctuates the ECM initially varies the ignition timing, which produces rapid changes of engine speed. If this fails to correct the idle speed, the ECM also adjusts the electric throttle and fuelling.

Misfire Detection
The ECM uses the CKP sensor input to monitor the engine for misfires. As the combustion charge in each cylinder is ignited the crankshaft accelerates, then subsequently decelerates. By monitoring the acceleration/ deceleration pulses of the crankshaft the ECM can detect misfires.

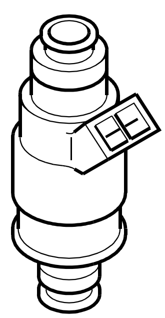
Low fuel level:

When the fuel tank is almost empty there is a risk that air may be drawn into the fuel system, due to fuel 'slosh', causing fuel starvation and misfires. To prevent false misfire faults being logged, the ECM disables misfire detection if it receives a low fuel level message on the CAN bus. Fuel tank content is monitored by the instrument pack, which transmits the low fuel level message if the fuel tank content decreases to less than 15% (8.85 litres; 2.34 US galls).

Rough road disable:

When the vehicle is travelling over a rough road surface the engine crankshaft is subjected to torsional vibrations caused by mechanical feedback from the road surface through the transmission. To prevent misinterpretation of these torsional vibrations as a misfire, the misfire monitor is disabled when a road surface exceeds a roughness limit programmed into the ECM. The roughness of the road is calculated by the ABS modulator, from the four ABS sensor inputs, and transmitted to the ECM on the CAN bus.

Fuel Injectors



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A split stream, air assisted fuel injector is installed for each cylinder. The injectors are located in the Intake manifolds and connected to a common fuel rail assembly.

Each injector contains a pintle type needle valve and a solenoid winding. The needle valve is held closed by a return spring. An integral nozzle shroud contains a ported disc, adjacent to the nozzles. 'O' rings seal the injector in the fuel rail and the Intake manifold.

The solenoid winding of each injector receives a 12 volt supply from the main relay. To inject fuel, the ECM supplies an earth path to the solenoid winding, which energizes and opens the needle valve. When the needle valve opens, the two nozzles direct a spray of atomized fuel onto the back of each Intake valve. Air drawn through the shroud and ported disc improves atomization and directional control of the fuel. The air is supplied from a dedicated port in the intake duct via a plastic tube and tracts formed in the gasket face of the intake manifolds.

Each injector delivers fuel once per engine cycle, during the Intake stroke. The ECM calculates the open time (duty cycle) of the injectors from:

- Engine speed.
- Mass air flow.
- Engine temperature.
- Accelerator pedal position (i.e. driver demand).

The fuel in the fuel rail is maintained at a pressure of 3.5 bar (51 lbf/in^2) by a pressure regulator incorporated into the pump unit in the fuel tank. An accumulator is attached to the fuel rail on the RH Intake manifold to damp out pressure pulses from the pump and ensure that the pressure in the fuel rail is constant (the same component functions as the pressure regulator on vehicles with a return fuel delivery system). The accumulator is connected by a pipe to the Intake manifold from which it receives a vacuum to aid the damping process. A Schraeder valve is installed in the 'fuel return' pipe of the accumulator to allow pressure to be released from the fuel rail and fuel feed pipe prior to maintenance.

The nominal resistance of the injector solenoid winding is 13 - 16 Ω at 20 °C (68 °F).

Evaporative Emissions (EVAP) Purge Valve
The ECM provides a PWM earth path to control the operation of the purge valve. When the ECM is in the open loop fuelling mode the purge valve is kept closed. When the vehicle is moving and in the closed loop fuelling mode the ECM opens the purge valve.

When the purge valve is open fuel vapour is drawn from the EVAP canister into the Intake manifold. The ECM detects the resultant enrichment of the AFR, from the inputs of the front HO2S, and compensates by reducing the duty cycle of the fuel injectors.

Variable Intake System (VIS) Valves
The ECM operates the two VIS valve motors to open and close the VIS valves in a predetermined sequence based on engine speed and throttle opening. Each VIS valve motor has a permanent power feed from the main relay, feedback and signal connections with the ECM, and a permanent earth connection. When the engine starts, the VIS valve motors are both in the valve open position. To close the VIS valves, the ECM applies a power feed to the signal line of the applicable VIS valve motor. To open the VIS valves, the ECM disconnects the power feed from the signal line and the VIS valve motor is closed by the power feed from the main relay.

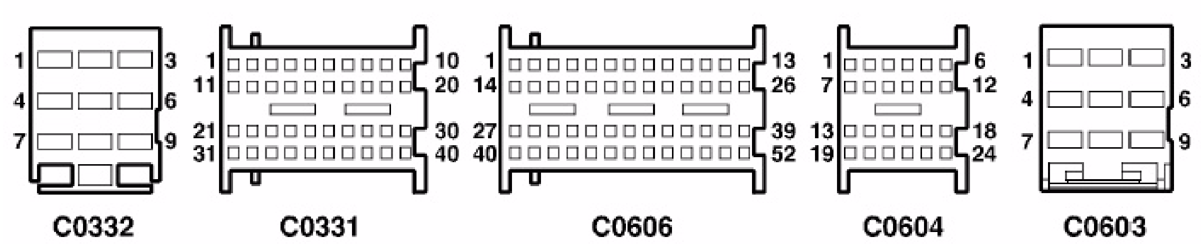
Warning Lamps

Two warning lamps in the instrument are used to indicate faults with the engine management system. The engine malfunction lamp consists of an amber SERVICE ENGINE legend and is illuminated to indicate the detection of a non emissions related fault. The Malfunction Indicator Lamp (MIL) consists of an amber SERVICE ENGINE SOON legend and is illuminated to indicate the detection of an emissions related fault. The ECM operates the warning lamps, by communicating with the instrument pack on the CAN bus. If a fault that can cause catalytic converter damage is detected, the warning lamps flash. For other faults the warning lamps are continuously illuminated.

Diagnostics

The ECM incorporates On Board Diagnostics (OBD) software that complies with market legislation current at the time of manufacture. During engine operation the ECM performs self test and diagnostic routines to monitor the performance of the engine and the EMS. If a fault is detected the ECM stores a related diagnostic trouble code (also known as a 'P' code) in a non volatile memory and, for most faults, illuminates the engine SERVICE ENGINE and/or the SERVICE ENGINE SOON warning lamps. Codes are retrieved using TestBook/T4, which communicates with the ECM via an ISO 9141 K line connection from the diagnostic socket.

Siemens MS43 ECU Pin Out Tables



Connector C0603

Pin Number	Wire Color	Circuit Description	Circuit Status
1-01	W	Ignition sense	
1-02			
1-03			
1-04	B	Electronic earth	
1-05	B	Injector earth	
1-06	B	Power stage earth	
1-07	NG	Permanent battery supply	
1-08	NK	Main relay power	
1-09	NK	Main relay power	

Connector C0604

Pin Number	Wire Color	Circuit Description	Circuit Status
2-01	UY	LH bank front HO2S heater drive	12 – 0V Switching
2-02			
2-03			
2-04			
2-05			
2-06			
2-07	GY	LH bank rear HO2S heater drive	12 – 0V Switching
2-08			
2-09			
2-10			
2-11			

Pin Number	Wire Color	Circuit Description	Circuit Status
2-12			
2-13	GY	RH bank front HO2S heater drive	12 – 0V Switching
2-14	UN	LH bank front HO2S signal	.2 - .8V Switching *
2-15	GN	RH bank front HO2S signal	.2 - .8V Switching *
2-16	UN	LH bank rear HO2S signal	.2 - .8V Switching *
2-17			
2-18	GN	RH bank rear HO2S signal	.2 - .8V Switching*
2-19	UY	RH bank rear HO2S heater drive	12 – 0V Switching
2-20	BG	LH bank front HO2S earth	
2-21	BG	RH bank front HO2S earth	
2-22	BG	LH bank rear HO2S earth	
2-23	NG	Main relay drive	Active low
2-24	BG	RH bank rear HO2S earth	

* Note: The signal circuits are held at .5V by ECM when the HO2S's are not switching.

Connector C0606

Pin Number	Wire Color	Circuit Description	Circuit Status
3-01	GW	MAF sensor signal	0 – 5V
3-02			
3-03	BS	Brake vacuum enhancer solenoid valve	Batt + in Gear
3-04			
3-05	UG	CMP sensor signal	0 – 5V Square wave
3-06			
3-07	NW	Throttle feedback potentiometer supply	5V
3-08	WU	CKP sensor signal	0 – 5V Square wave
3-09			
3-10	NU	Throttle feedback potentiometer 2 signal	5V @ Closed Throttle
3-11	SB	VIS balance motor drive	Active low

Pin Number	Wire Color	Circuit Description	Circuit Status
3-12			
3-13			
3-14			
3-15			
3-16			
3-17	YW	MAF sensor earth	
3-18	BS	CMP sensor earth	
3-19	NP	Throttle feedback potentiometer 1 signal	0V 2 Closed Throttle
3-20	NG	Throttle feedback potentiometer earth	
3-21	BS	CKP sensor earth	
3-22	OG	IAT sensor signal	
3-23	OS	IAT sensor earth	
3-24	KB	ECT sensor signal	
3-25	KG	ECT sensor earth	
3-26			
3-27			
3-28			
3-29	BO	LH bank knock sensor	
3-30	BK	LH bank knock sensor	
3-31	LGS	RH bank knock sensor	
3-32	BK	RH bank knock sensor	
3-33	Y	Fuel injector 1	
3-34	YU	Fuel injector 3	
3-35	YP	Fuel injector 5	
3-36	YN	Fuel injector 2	
3-37	YG	Fuel injector 6	
3-38	YR	Fuel injector 4	
3-39			
3-40			

Pin Number	Wire Color	Circuit Description	Circuit Status
3-41			
3-42	BO	EVAP purge valve drive	0 –12V PWM
3-43	NB	Throttle motor open drive	0 – 12V PWM
3-44	GW	Throttle motor closed drive	0 – 12V PWM
3-45			
3-46			
3-47			
3-48	B	Knock sensors screen	
3-49	BG	VIS power valves motor drive	Active low
3-50			
3-51	BG	DMTL heater drive	
3-52			

Connector C0331

Pin Number	Wire Color	Circuit Description	Circuit Status
4-01			
4-02			
4-03			
4-04	UW	Engine cooling fan control	0 – 12V PWM
4-05			
4-06			
4-07	RU	APP sensor earth 2	
4-08	YR	APP sensor signal 2	.7 – 3.7V Closed – Open throttle
4-09	RN	APP sensor supply 2	
4-10	BP	Fuel pump relay control	
4-11			
4-12	UR	APP sensor earth 1	
4-13	RY	APP sensor signal 1	.35 – 1.85V Closed – Open throttle
4-14	NR	APP sensor supply 1	

Pin Number	Wire Color	Circuit Description	Circuit Status
4-15			
4-16			
4-17			
4-18			
4-19			
4-20	GR	DMTL pump motor	
4-21	GK	Alternator load sensing	0 – 12V PWM
4-22	WO	Vehicle speed	
4-23	OB	VIS balance valve position feedback	Active high
4-24	PG	Brake pedal sensor input	12V with pedal pressed
4-25			
4-26			
4-27	RG	Cruise control interface MFL signal	
4-28	GR	Brake pedal sensor input	12V with pedal pressed
4-29	UB	Air con compressor clutch relay	
4-30	U	DMTL solenoid valve drive	
4-31			
4-32	K	Diagnostic ISO 9141 K Line	
4-33	YR	Immobilisation signal	0 – 12V Data
4-34	UK	VIS power valves position feedback	Active high
4-35			
4-36	YB	CAN bus ‘high’ signal	
4-37	YN	CAN bus ‘low’ signal	
4-38	GU	Thermostat monitoring sensor earth	
4-39	UG	Thermostat monitoring sensor signal	
4-40			

Connector C0332

Pin Number	Wire Color	Circuit Description	Circuit Status
5-01	BP	Ignition coil 5	
5-02	BW	Ignition coil 3	
5-03	BR	Ignition coil 1	
5-04			
5-05	B	Ignition earth	
5-06	B	Ignition coil earth	
5-07	BY	Ignition coil 4	
5-08	BU	Ignition coil 6	
5-09	BG	Ignition coil 2	