



Workshop Manual

System Description & Operation

Werkplaatshandboek

Systeem-beschrijving en werking

Manual d'Atelier

Description et fonctionnement du système

Werkstatthandbuch

Systembeschreibung und Funktionsweise

Manuale d'Officina

Descrizione e funzionamento del sistema

Manual de Taller

Descripción y funcionamiento del sistema

Manual de Oficina

Funcionamento do Sistema



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DESCRIPTION AND OPERATION

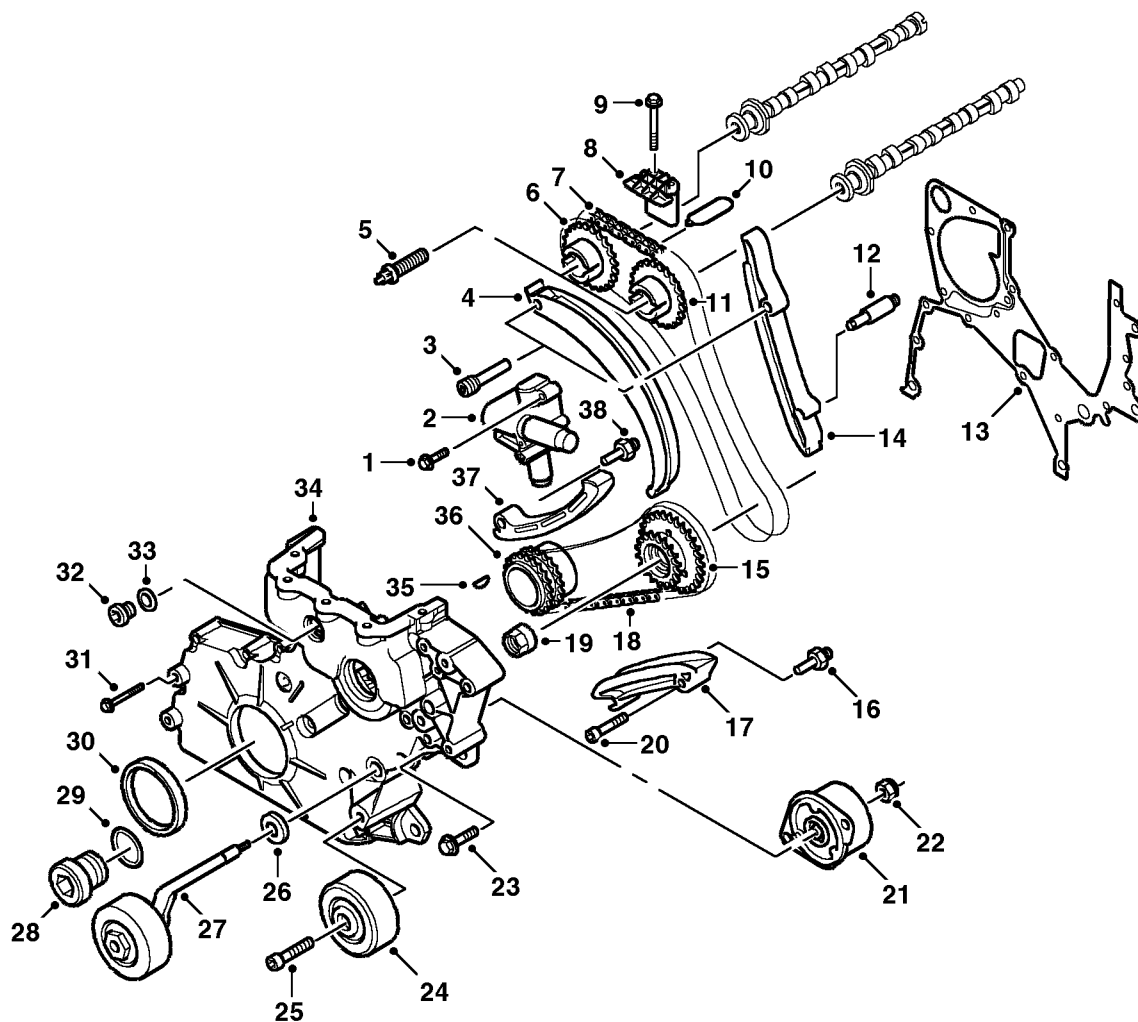
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Camshaft Timing Chain Components



M12 6911

ENGINE - TD4

The camshaft cover includes an integrated air filter housing which is de-coupled from the cylinder head to absorb and minimise the transmission of engine noise. The air cleaner is designed in the form of an oval cartridge. The camshaft cover also provides a mounting for the mass air-flow (MAF) sensor.

Camshaft Timing Train Components

The timing chain cover and timing chain components are described below:

Timing Chain Cover

The timing chain cover is cast and machined aluminium alloy and is attached to the cylinder block by 14 bolts. Five bolts are used to fix the upper flange of the timing cover to the cylinder head casting, and a further four bolts secure the front of the sump to the timing cover. The bottom of the timing cover is located to the front face of the cylinder block by two metal dowels.

The front of the crankshaft passes through a hole in the timing cover, and an oil seal is used to seal the interface between the front of the crankshaft and the timing cover.

Timing Chains

Two chain drives are utilised. The timing chain between the crankshaft sprocket and the fuel injection pump sprocket is a simplex type. The timing chain is contained between one fixed and one hydraulically adjustable tensioning rail.

The chain drive from the fuel injection pump sprocket to the two camshaft sprockets is also a simplex type. The chain between the camshaft and injection pump runs between one fixed guide rail and a hydraulically adjustable tensioning rail to minimise chain flutter. An additional plastic chain guide is located above the two camshaft sprockets.

The adjustable tensioning rails are of aluminium die casting construction with clip-fastened plastic slide linings. The fixed guide rails are moulded plastic. The tensioner rails are attached to the front of the cylinder blocks using pivot bolts which allow the tensioner rail to pivot about its axis.

The hydraulic tensioner for both chains is provided from a single unit which contains two hydraulically operated plungers that operate on the tensioning rails at the slack side of each of the timing chains. Pressurised oil for the adjuster is supplied through the back of the unit from an oil supply port in the front of the cylinder block. The lateral movement in the tensioner arm causes the timing chain to tension and consequently, compensation for chain flutter and timing chain wear is automatically controlled.

The timing chains are oil splash lubricated via the oil pump and chain tensioner. Oil spray is directed to the chain from several oil supply ports in the front of the cylinder block and cylinder head.

An additional chain from the crankshaft sprocket connects to the oil pump sprocket for oil pump operation.

Lubrication Circuit

Oil from the sump is drawn up through a fabricated metal pick-up pipe which contains a mesh to filter out any relatively large pieces of material which could cause damage to the oil pump. The head of the pick-up is centrally immersed in the sump oil and oil is delivered to the inlet side of the eccentric rotary pump.

The oil pump is driven from the crankshaft by a chain and sprocket system. Pressurised oil from the pump is passed through a port in the bottom of the cylinder block and is directed up to the oil inlet port of the oil filter housing via a port in the RH side of the cylinder block. The oil pump contains an oil pressure relief valve which opens to allow oil to be recirculated back around the pump if the oil pressure increases to a high enough level.

The inlet port of the oil filter housing has an integral non-return valve which allows flow into the filter, but prevents unfiltered oil draining back out of the filter housing when oil pressure is reduced.

The oil passes through the oil filter element and out to the oil cooler. The percentage of oil flow passed through to the oil cooler is dependent on a thermostatic by-pass valve which is integrated into the oil filter housing. An increase in oil temperature causes the by-pass valve to open and allow a greater percentage of oil flow to be directed through the oil cooler. The remainder of the oil flow from the outlet side of the filter element is directed to the outlet port of the oil filter housing where it combines with the oil flow being returned from the oil cooler before being passed back into the cylinder block.

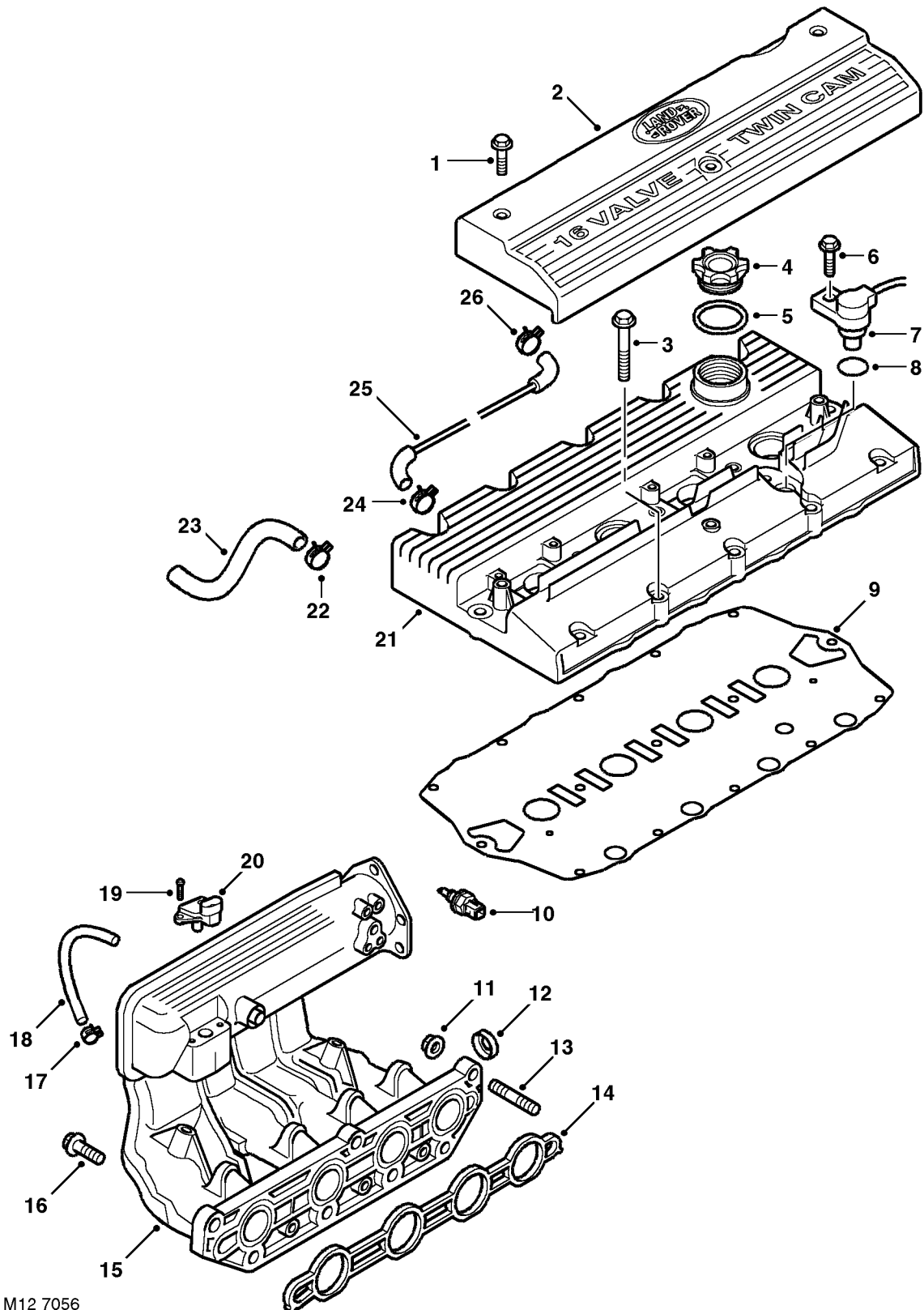
An oil pressure switch is included in the outlet port of the oil filter housing to sense the oil pressure level before the oil flow enters the main oil gallery in the engine block. A warning lamp in the instrument pack is switched on if the oil pressure is detected to be too low.



INSTRUMENTS, DESCRIPTION AND OPERATION, Description.

ENGINE - K SERIES 1.8

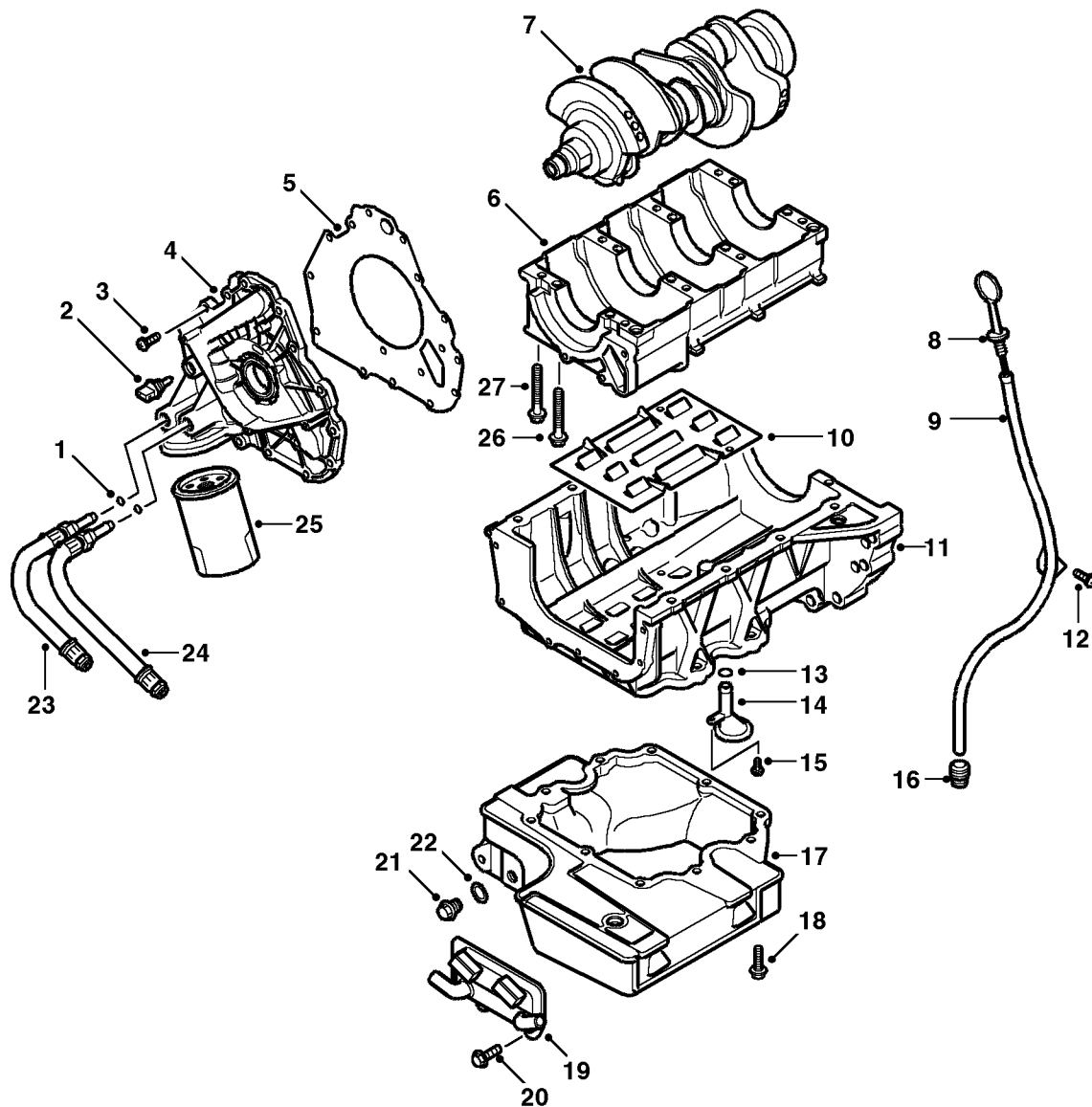
Camshaft Cover, Engine Cover and Inlet Manifold



M12 7056

ENGINE - K SERIES KV6

KV6 Engine – Crankshaft, Sump and Oil Pump Assembly



M12 6645

Operation

Lubrication Circuit

The lubrication system is of the full-flow filtration, force fed type.

Oil is drawn, via a strainer and pick-up pipe in the sump, through the bearing ladder and into a crankshaft driven oil pump which has an integral pressure relief valve. The strainer in the pick-up pipe prevents any ingress of foreign particles from passing through to the inlet side of the oil pump and damaging the oil pump and restricting oil drillings. The oil pressure relief valve in the oil pump opens if the oil pressure becomes excessive and diverts oil back around the pump.

Pressurised oil is pumped through a full-flow cartridge type oil filter, mounted on the oil pump housing. The lubrication system is designed so that a higher proportion of oil flow is directed to the cylinder block main oil gallery while a lower proportion of oil flow, (controlled by a restrictor in the oil filter housing), is directed to the engine oil cooler. The remainder of the oil flow from the outlet side of the oil filter is combined with the return flow from the oil cooler before being passed into the cylinder block main oil gallery.

The main oil gallery has drillings that direct the oil to the main bearings. Cross drillings in the crankshaft main bearings carry the oil to the connecting rod big-end bearings.

The oil pressure switch is located at the outlet side of the oil filter housing to sense the oil pressure level before the oil flow enters the main gallery in the engine block. A warning lamp in the instrument pack is illuminated if low oil pressure is detected.

Oil at reduced pressure is directed to each cylinder bank via two restrictors in the cylinder block/cylinder head locating dowels, one at the front on the LH bank and the other at the rear on the RH bank. Oil then passes through a drilling in the cylinder head to the camshaft carrier, where it is directed via separate galleries to the camshaft bearings and hydraulic tappet housings. Return oil from the cylinder head drains into the sump via the cylinder head bolt passages.

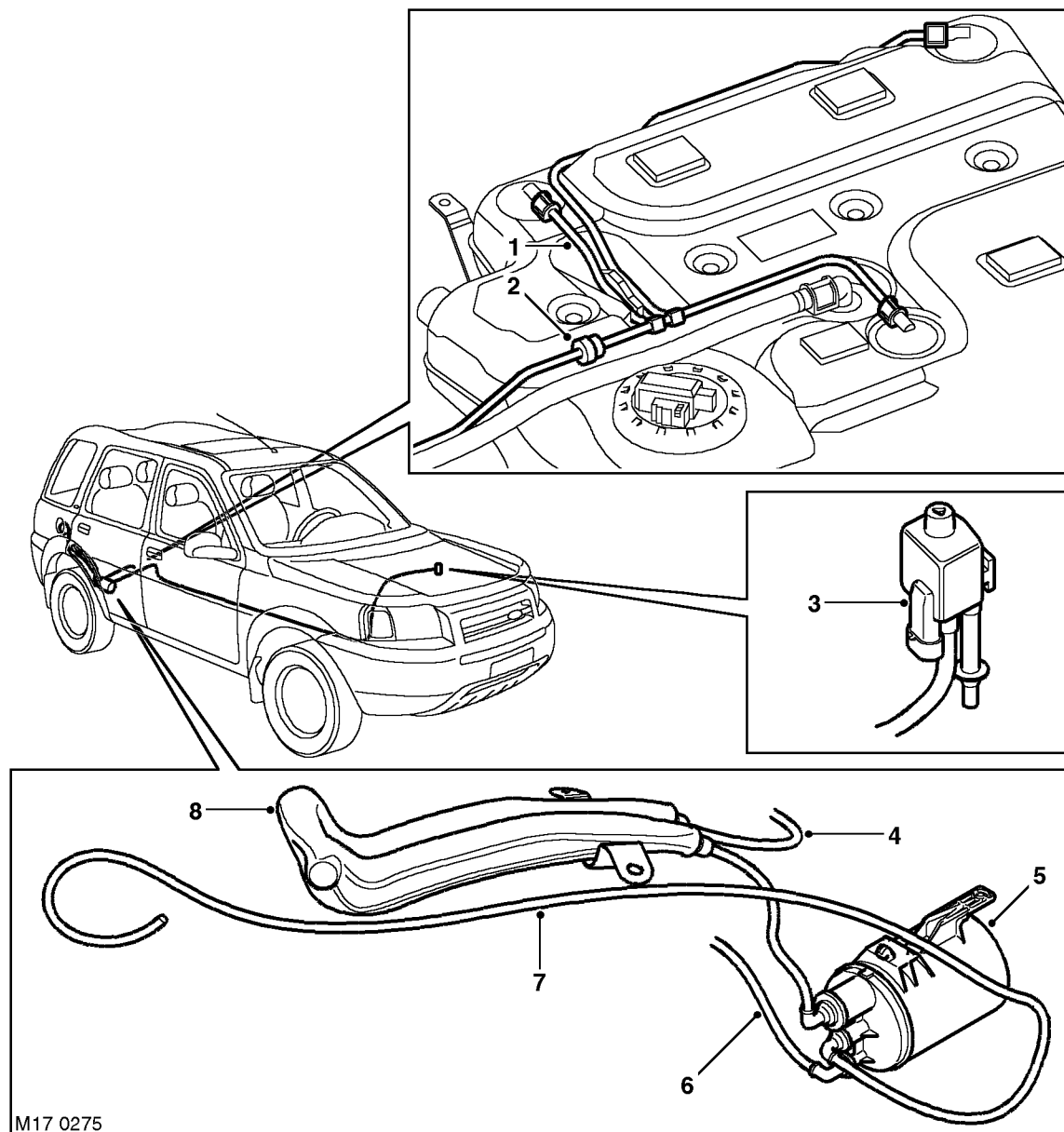
Crankcase Ventilation

A positive crankcase ventilation system is used to vent blow-by gas from the crankcase to the air intake system. The blow-by gas passes through a gauze oil separator in the camshaft cover, and then through hoses into the throttle housing and inlet manifold.

 **EMISSION CONTROL - K SERIES KV6, DESCRIPTION AND OPERATION, Description.**

EMISSION CONTROL - K SERIES 1.8

Emission Control Component Layout – EVAP



- 1 Fuel tank vent lines
- 2 Two-way valve
- 3 EVAP purge valve
- 4 Vent line from fuel tank

- 5 EVAP canister
- 6 Vent line to purge valve
- 7 Vent line to atmosphere
- 8 Vapour separator

ENGINE MANAGEMENT SYSTEM - EDC

ECM Harness Connector Pin Details (C0603)

Pin No.	Description	Input/Output
1	Battery voltage	Input
2 and 3	Not used	-
4	Earth	-
5	Earth	-
6	Earth	-
7	Ignition voltage	Input
8	Main relay supply	Input
9	Main relay earth	Output

ECM Harness Connector Pin Details (C0604)

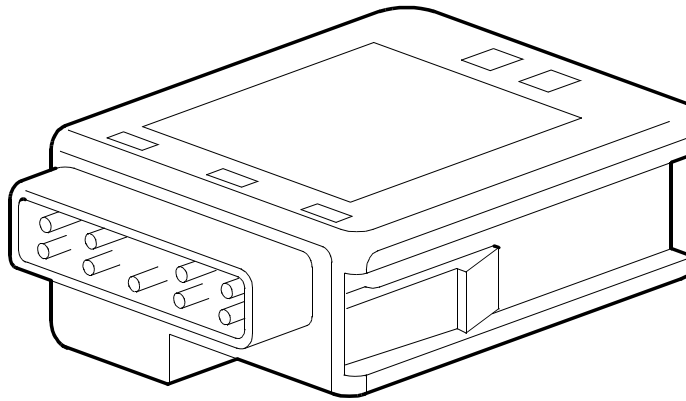
Pin No.	Description	Input/Output
1 to 8	Not used	-
9	Fuel pressure sensor supply	Output
10	Fuel pressure sensor earth	-
11 to 16	Not used	-
17	Fuel pressure sensor signal	Input
18 to 24	Not used	-

ECM Harness Connector Pin Details (C0606)

Pin No.	Description	Input/Output
1	MAF sensor supply	Output
2	MAF sensor signal	Input
3	MAF sensor earth	-
4	CMP signal	Input
5	Not used	-
6	CKP signal	Input
7 to 9	Not used	-
10	EGR	Output
11	Not used	-
12	Glow plug control	Output
13	Not used	-
14	Boost pressure sensor supply	Output
15	Boost pressure sensor signal	Input
16	Boost pressure sensor earth	-
17	CMP earth	-
18	Not used	-
19	Speed signal screen earth	-
20	Fuel rail pressure sensor earth	-
21 to 27	Not used	-
28	ECT signal	Input
29	IAT signal	Input
30	Not used	-
31	CKP earth	-
32	ECT earth	-
33	Fuel rail pressure sensor signal	Input
34	Not used	-
35	Fuel rail pressure sensor supply	Output

ENGINE MANAGEMENT SYSTEM - EDC

Glow Plug Relay and Glow Plugs



M19 2769

The glow plug relay is located next to the ECM in the E-box. The ECM controls all glow plug operations via the glow plug relay. The glow plug warning lamp is controlled by the ECM from information received from the glow plug relay.

The 4 glow plugs are located in the cylinder head on the inlet side. The glow plugs form a vital part of the engine starting strategy. The glow plugs heat the air inside the cylinder during cold starts to assist combustion. The use of glow plugs helps to reduce the amount of extra fuel required on start up, the main cause of black smoke. It also requires less injection advance, which reduces engine noise, particularly when idling with a cold engine.

The main part of the glow plug is a tubular heating element that protrudes into the combustion chamber of the engine. The heating element contains a spiral filament encased in magnesium oxide powder. At the tip of the tubular heating element is the heater coil. Behind the heater coil, and connected in series, is a control coil. The control coil regulates the heater coil to ensure that it does not overheat.

Pre-heat is the length of time the glow plugs operate prior to engine cranking. The ECM controls the pre-heat time of the glow plugs based on battery voltage and coolant temperature information.

Post-heat is the length of time the glow plugs operate after the engine starts. The ECM controls the post-heat time based on ECT information. If the ECT fails, the ECM will operate pre-heat and post-heat time strategies with default values from its memory. The engine will be difficult to start.

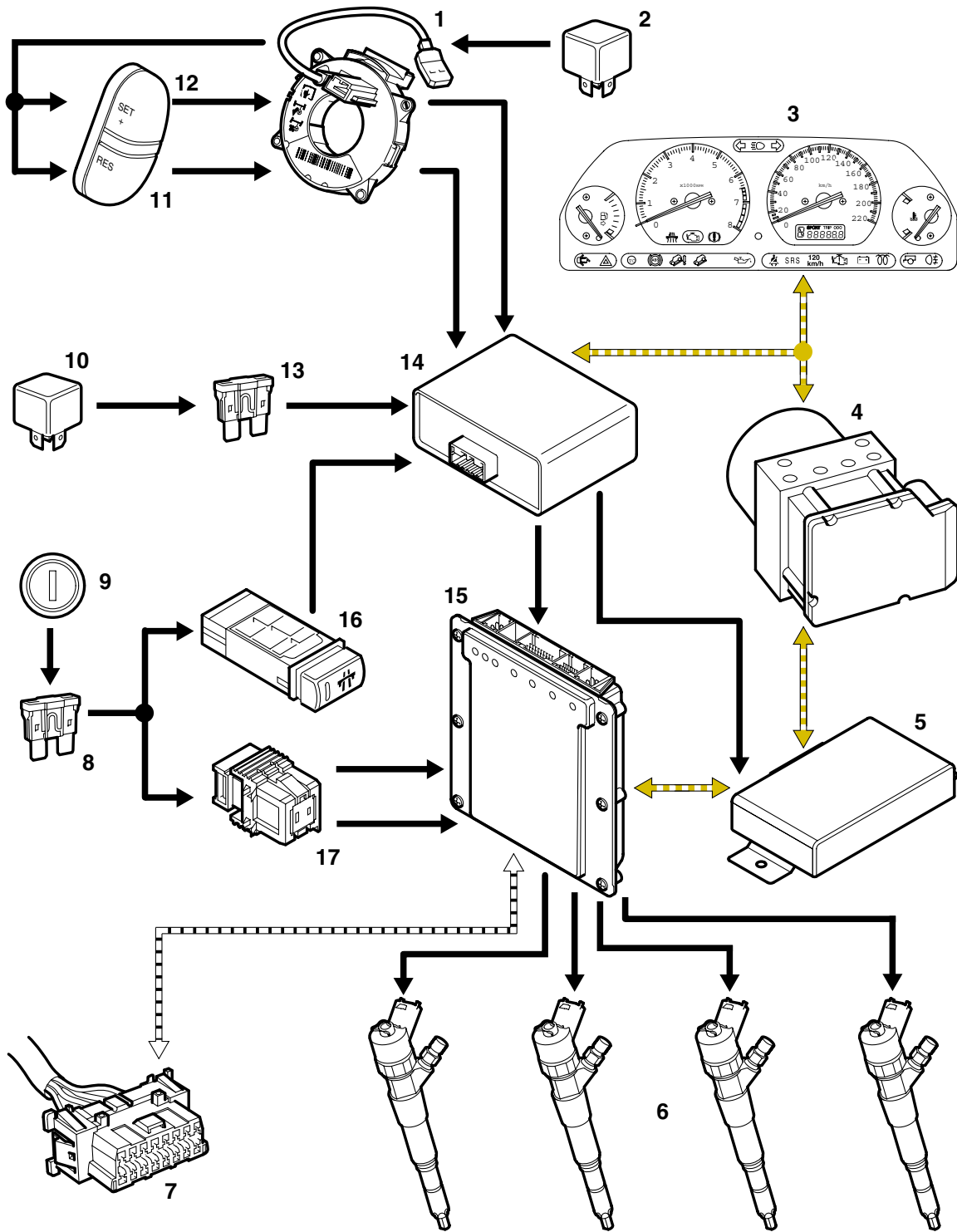
The glow plug relay is supplied with power directly from the vehicle battery, an earth connection directly to the vehicle body from the glow plug relay is used. The glow plug relay also receives a voltage signal from the main relay to indicate ignition switch operation. Input information relating to engine temperature and time base calculations comes from the ECM. The glow plug relay is able to process this information and then supply output control to the glow plugs in the engine.

In the event of a glow plug failure any of the following symptoms may be observed:

- Difficult starting.
- Excessive smoke emissions after engine start.

ENGINE MANAGEMENT SYSTEM - EDC

Cruise Control, Control Diagram



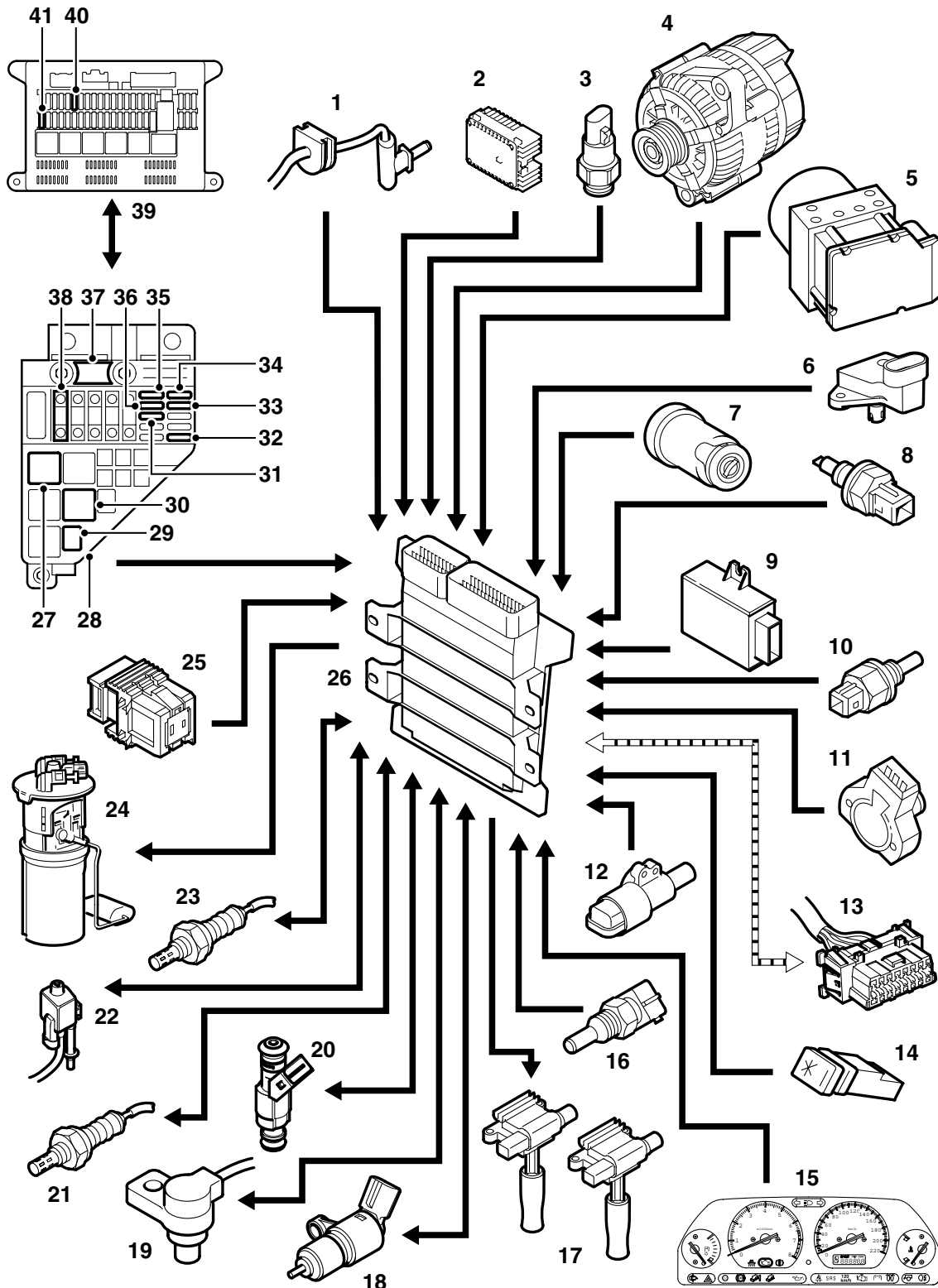
A ——— D ——— J ———

M18 0650

A = Hardwired connection; D = CAN bus; J = Diagnostic ISO 9141 K line bus

ENGINE MANAGEMENT SYSTEM - MEMS

MEMS3 Control Diagram



M18 0602

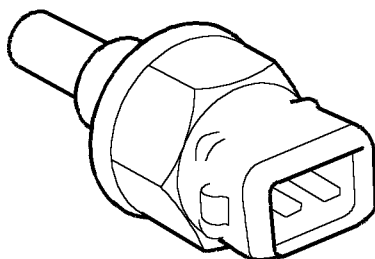
A ———

J ———

A = Hardwired; B = Serial link; J = Diagnostic ISO 9141 'K' Line

ENGINE MANAGEMENT SYSTEM - MEMS

Engine Oil Temperature Sensor



M18 0613

The engine oil temperature sensor is located in the oil filter housing. The oil temperature measured by the ECM is used to adjust fuelling values according to engine oil temperature.

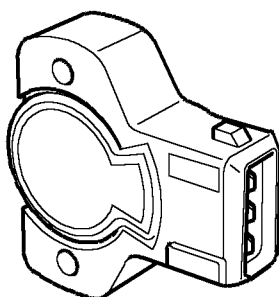
The use of an engine oil temperature sensor allows the ECM to provide optimum engine performance and minimum emissions during the engine warm up phase. The sensor provides a signal to pin 32 of ECM connector C0914. The ECM provides an earth for the sensor on pin 6 of ECM connector C0914.

The sensor consists of an encapsulated Negative Temperature Coefficient (NTC) thermistor which is in contact with the engine oil.

If the sensor fails, the ECM will substitute a default value which is ramped up 90°C (194°F). This condition will not be apparent to the driver.

The vehicle will run but may suffer from reduced engine performance and increased emissions as adaptive fuelling is disabled. The ECM will store fault codes which can be retrieved using TestBook.

Throttle Position (TP) Sensor



M18 0614

The TP sensor is mounted on the throttle body and is driven from the end of the throttle spindle. The TP sensor consists of a potentiometer which provides an analogue voltage that the ECM converts to throttle position information.

ENGINE MANAGEMENT SYSTEM - MEMS

Replacement ECM's are supplied blank and must learn the immobilisation ECU security code for the vehicle to which it is fitted. When the ECM is connected to the vehicle, TestBook is required to enable the ECM to learn the immobilisation ECU code. If a new immobilisation ECU is fitted, the ECM will need to learn the new security code using TestBook. A procedure must be followed when replacing the ECM or immobilisation ECU. This procedure is detailed in the Security Description and Operation section.

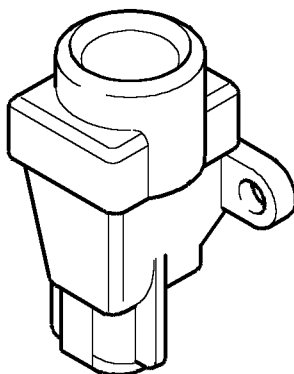
SECURITY, DESCRIPTION AND OPERATION, Description.

Rough Road Detection

MEMS 3 has a misfire detection facility which is part of the On-Board Diagnostics (OBD) system. Misfire detection is disabled when the ECM senses that the vehicle is on a 'rough road'. The system software receives rough road signal outputs from the ABS ECU and can disable misfire detection to prevent incorrect faults being logged by the ECM.

The 'rough road' signal is passed from the ABS ECU to ECM pins 65 and 79 on the CAN bus. The CAN message is a measure of the maximum wheel acceleration from any one of the four wheel sensors, which is updated by the ABS ECU every 20 ms.

Fuel Shut-off Switch



M18 0624

The fuel shut-off switch is located in the engine compartment to the rear of the LH suspension turret. In the event of a sudden deceleration the switch removes the power supply to the fuel pump relay, stopping the fuel pump.

The fuel shut-off switch, when tripped can be reset by depressing the rubber top of the switch. The switch receives a power supply from fuse 10 in the engine compartment fusebox. The supply is passed through the switch to the contacts of the fuel pump relay in the engine compartment fusebox. The supply from the switch is also passed to the Central Control Unit (CCU) to unlock the doors in the event of a collision causing the fuel shut-off switch to be tripped.

WARNING: Ensure there are no fuel leaks and confirm the integrity of the fuel system before resetting the fuel shut-off switch.

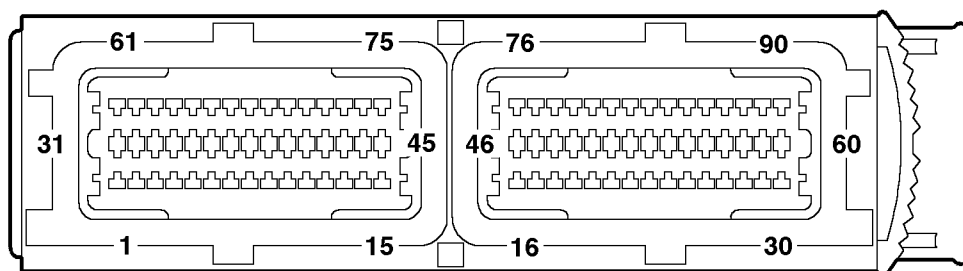
Throttle Pedal Switch

The throttle pedal switch is located at the top of the pedal box and secured in a cut-out hole in the fabrication. The switch is a proximity type Hall effect switch which senses a target located on the throttle pedal. The switch is connected on a single wire to pin 77 of ECM connector C0913.

The switch is normally open when the throttle pedal is at rest. When the throttle pedal is depressed, the target on the pedal moves away from the switch causing the switch to close and complete an earth path from the ECM. This is sensed by the ECM which uses the signal as a throttle status to detect for stuck throttle when using Hill Descent Control (HDC). The pedal status is compared with the inputs from the TP sensor to confirm that the throttle is being depressed.

ENGINE MANAGEMENT SYSTEM - SIEMENS

ECM Harness Connector (C0371)

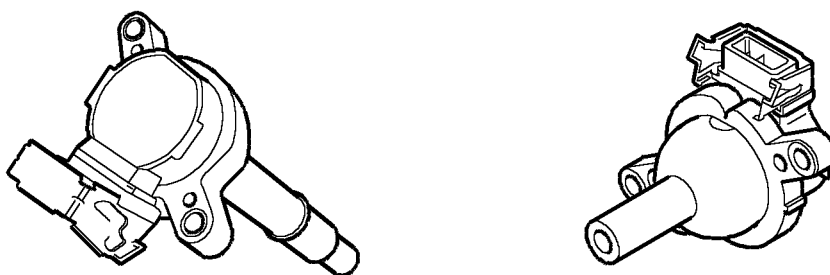


M19 3200

ECM Harness Connector Pin Details

Pin No.	Description	Input/Output
1	Ignition coil 4	Output
2	Ignition coil 3	Output
3	ECM earth	-
4	EVAP canister purge valve	Output
5 and 6	Not used	-
7	Main relay	Output
8	VIS balance valve motor supply	Output
9	Fuel pump relay	Output
10	Cruise control enable (where fitted)	Output
11	Not used	-
12	IAT/MAP sensor earth	-
13	LH front HO2S signal	Input
14	RH front HO2S signal	Input
15	ECT sensor earth	Input
16	Rear HO2S signal	Input
17	A/C pressure sensor signal	Input
18	CKP sensor earth	-
19	CMP sensor earth	-
20	LH knock sensor signal	Input
21 and 22	Not used	-
23	VIS power valve motor position feedback	Input
24 to 26	Not used	-
27	CAN bus high	Input/Output
28	ECM earth	-
29	Ignition power supply	Input
30	Permanent battery power supply	Input
31	Ignition coil 6	Output
32	Ignition coil 5	Output
33	ECM earth	-
34	RH front HO2S heater	Output
35	Rear HO2S heater	Output
36	LH front HO2S heater	Output
37	Not used	-
38	VIS power valve motor supply	Output
39 to 41	Not used	-
42	IAC valve stepper motor (step 3)	Output
43	Not used	-

Ignition Coils



M19 3211

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 inlet 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 dwell angle using inputs from the following:

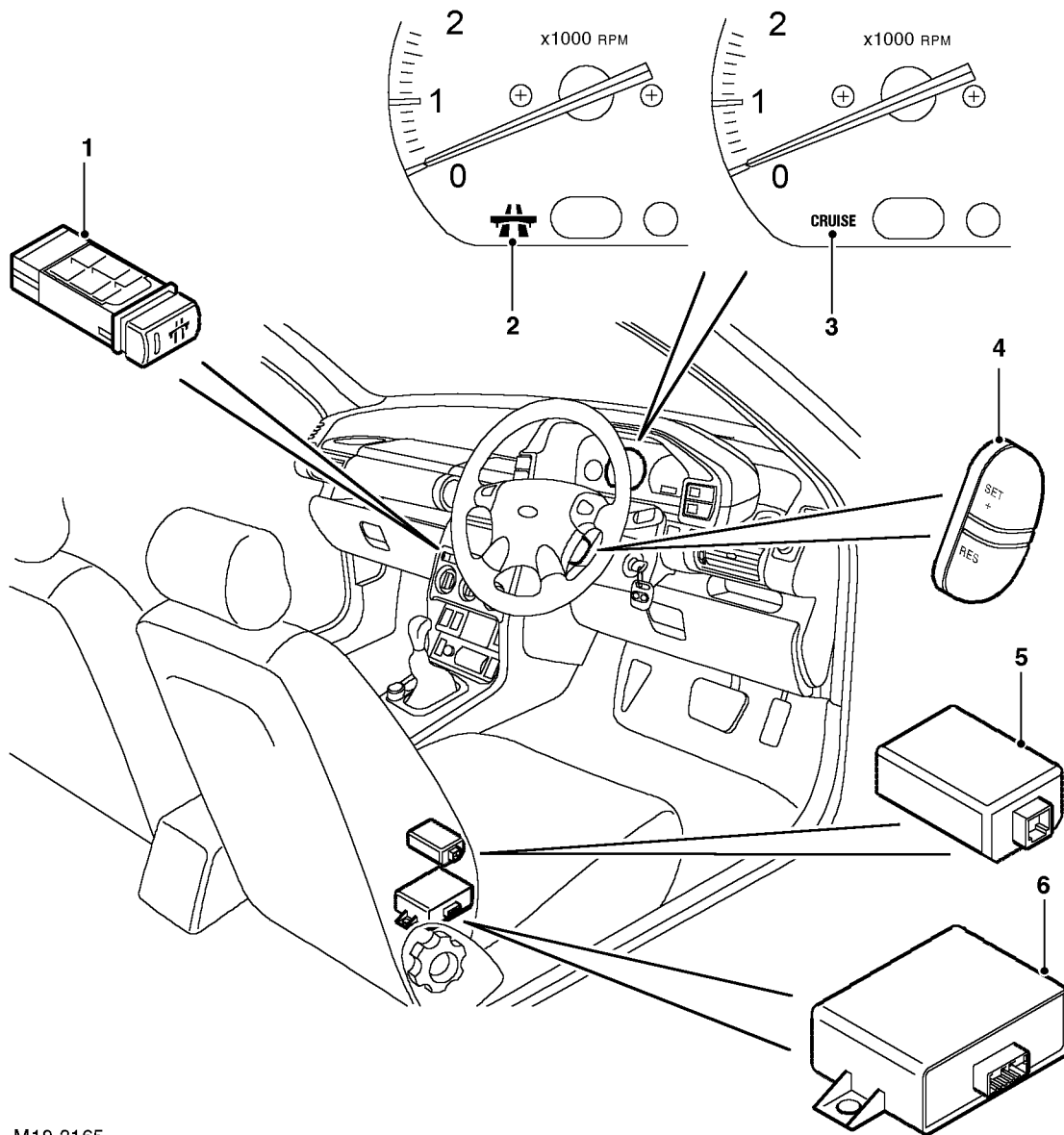
- Battery voltage (main relay).
- CKP sensor.
- Ignition coil primary current (internal ECM connection).

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.

ENGINE MANAGEMENT SYSTEM - SIEMENS

Cruise Control System Component Layout - Sheet 2 of 2



M19 3165

RHD shown, LHD similar

- | | |
|---------------------------------|---------------------------|
| 1 Master switch | 4 Steering wheel switches |
| 2 Warning lamp (all except NAS) | 5 Interface ECU |
| 3 Warning lamp (NAS only) | 6 Cruise control ECU |

ENGINE MANAGEMENT SYSTEM - SIEMENS

Operation

General

When the ignition is switched on, the interface ECU and the master switch receive a power feed from the passenger compartment fusebox. When the master switch is pressed, the LED in the master switch illuminates and further power feeds are connected to the interface ECU and the cruise control ECU to enable the system.

Cruise control is enabled provided the interface ECU is in receipt of a cruise enable signal from the ECM and the system inputs indicate that:

- The brakes are off.
- The vehicle is moving at a road speed between 22 and 125 mph (35 and 200 km/h).

The ECM outputs the cruise enable signal to the interface ECU, when:

- The engine is running and vehicle speed is above 3 mph (5 km/h).
- Engine speed does not exceed 6496 rpm.
- The gearbox is not in Park, Neutral or Reverse.
- Electronic Traction Control (ETC) is not active.

While the system is enabled, the interface ECU outputs the power supply to the cruise control ECU for operation of the vacuum pump assembly.

Engagement

When the system is enabled, cruise control is engaged by pressing the SET+ steering wheel switch. On receipt of the input from the SET+ switch, the cruise control ECU stores the current vehicle speed as the set speed and outputs the pump and valve power supply to the vacuum pump assembly. The cruise control ECU also outputs signals to operate the vacuum pump and control valves in the vacuum pump assembly. The vacuum pump and control valves regulate the vacuum sensed by the vacuum actuator, to adjust the throttle as necessary to maintain the vehicle at the set speed.

When cruise control is engaged, the pump and valve power supply is also connected to the EAT ECU and the instrument pack. On receipt of the power supply, the EAT ECU adopts the cruise control mode, which uses a gear change map less sensitive to changes of throttle opening to prevent unnecessary gear changes, which improves operating refinement for a minor loss of performance. In the instrument pack, the power supply illuminates the cruise control warning lamp.

Acceleration

While cruise control is engaged, the vehicle can be accelerated using either the SET+ switch or the accelerator pedal. A momentary press (less than 0.5 second) of the SET+ switch causes the cruise control ECU to increment the stored set speed by 1 mph (1.6 km/h) and operate the vacuum pump assembly to accelerate the vehicle to the new set speed. If the switch is held on, the cruise control ECU keeps incrementing the stored set speed and accelerating the vehicle until the switch is released. When the switch is released, the cruise control ECU adopts the increased vehicle speed as the new set speed.

If the accelerator pedal is used to accelerate the vehicle, the cable from the accelerator pedal overrides the vacuum actuator and increases the throttle opening to meet driver demand. Cruise control remains engaged and the set speed is resumed once the accelerator pedal is released. If the SET+ switch is pressed before the accelerator pedal is released, the cruise control ECU adopts the higher speed as the new set speed.

Suspend/Resume

Cruise control can be manually suspended and resumed (at the previous set speed) using the RES steering wheel switch. The interface ECU, the cruise control ECU and the ECM automatically suspend cruise control if one of the conditions required to enable the system is no longer present, e.g. the brakes are applied or ETC activates. Cruise control is also automatically suspended by the cruise control ECU if the vehicle speed decreases to less than 75% of the set speed, e.g. when travelling up a steep hill.

FUEL DELIVERY SYSTEM - TD4

The four injectors are located in the cylinder head, between the four valves in each cylinder. Each injector is sealed into the cylinder head with a copper washer. Two studs in the head locate a plate on the injector which is secured with two nuts on the studs. Each stud has an external Torx fitting on the end, which allows the stud to be wound from the head and simultaneously extract the injector from its bore.

Each injector has an electrical connector for power supply and connections to the ECM. The top of each injector is fitted with a fuel return pipe which allows fuel used in the operation of the injector to return to the tank. Each injector only uses approximately 50% of the fuel delivered to it. The remaining 50% is used to cool the injector and is passed to return via the fuel return pipe. The injectors are sensitive to fuel pressure and if pressure in the fuel rail falls to below 0.6 bar (8.7 lbf/in²) the injectors will not deliver the correct fuel requirements resulting in poor emissions and driveability.

Each electronic injector has a solenoid valve which, when energised, allows a ball valve to lift off its seat. This allows pressurised fuel to lift a needle valve in the injector nozzle and spray a finely atomised jet of fuel into the cylinder. Fuel which spills past the ball valve is directed into a return line which is connected to the fuel return from the HP injector pump.

Each injector has an electrical connector which provides a 12V direct supply from the main relay and connections to the ECM. If the battery voltage falls to between 6V and 9V, the operation of the injector solenoid will be impaired affecting, acceleration, maximum speed and idle. Battery voltage below 6V will result in the injectors not operating.

Each injector solenoid is controlled separately by the ECM which provides an earth path to open the injector nozzle at the correct time and for a calculated period to provide a metered injection of fuel into the cylinder. The ECM uses signals from other sensors and a programmed fuelling strategy to ensure that the precise amount of fuel is injected at the correct timing for maximum fuel efficiency and minimum emissions.

Fuel Rail

The metal fuel rail is a forged steel tube mounted on the cylinder head and secured with two cap screws. The rail has five threaded bosses with machined taper seats. The central threaded boss is for the HP fuel feed pipe from the injector pump. The four remaining bosses are for connection to each injector. Each pipe has a cone end which seals with the tapered seat in the rail and a similar seat on the injector.

A fuel rail pressure sensor is fitted into a threaded bore in the LH end of the rail. The sensor is connected to ECM connector C0606 via the engine harness which supplies a 5V power supply, earth and signal connections. The sensor is a diaphragm type sensor with a resistive element attached to the diaphragm. The diaphragm changes shape as the fuel pressure increases or decreases, causing the element to deflect, changing the resistive characteristics of the sensor. The sensor uses the 5V supply through the resistor to produce an analogue signal to the ECM which corresponds to the fuel pressure. The ECM compares this signal to values stored in its memory to calculate the actual fuel pressure present in the rail.

Bi-metallic Valve

The bi-metallic valve is located at the front of the engine compartment at the LH end of the fuel cooler. The valve has three connections and is connected via rubber hoses to the HP injector pump return pipe and the fuel cooler feed pipe and to the tank return line at the five-port valve.

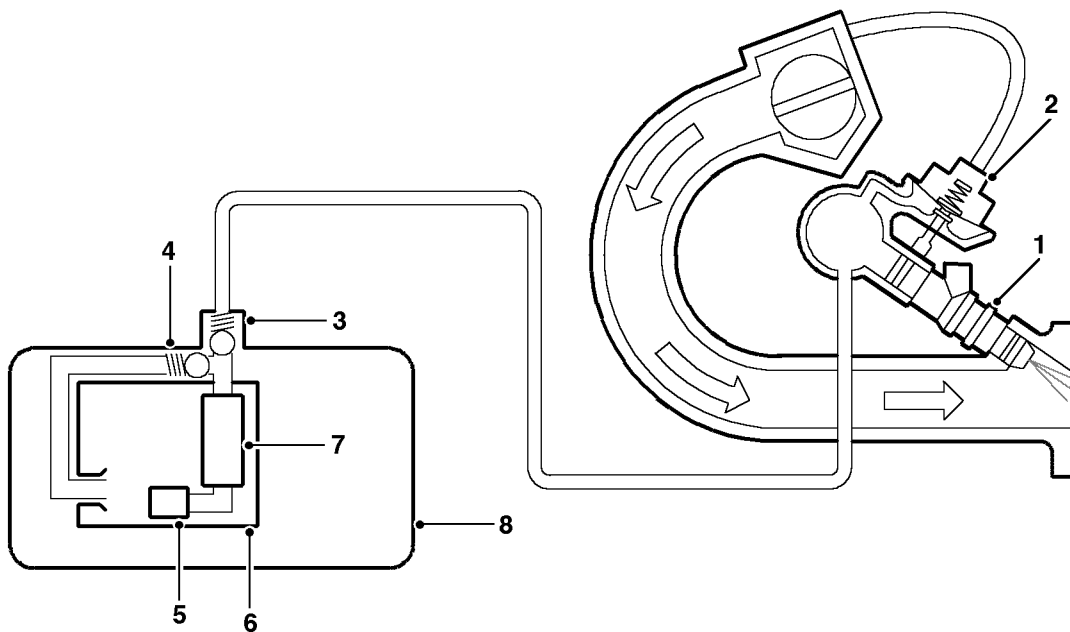
The valve contains a bi-metallic strip which moves in relation to the temperature of the fuel flowing over it. At fuel temperatures below 76°C (169°F), the valve is closed and fuel returning from the injector pump is directed into the tank return line to the five-port valve, where it is directed into the secondary LP pump feed line. At temperatures above 76°C (169°F), the bi-metallic valve closes the return line and fuel is directed through the fuel cooler.

Pressure Relief Valve

The pressure relief valve is located below the fuel filter. A tee connection in the outlet hose from the filter is connected back into a tee connection in the fuel feed hose, upstream of the secondary LP pump. The relief valve is located in this line and controls the pressure of fluid delivered to the fuel injection pump to between 2 and 2.4 bar (29 to 35 lbf/in²). At pressures above this, the relief valve opens allowing fuel to flow back to the fuel feed hose, decaying the pressure delivered to the injection pump. The primary reason for the relief valve is to protect the injection pump from high fuel input pressure from the secondary pump if a high voltage condition occurs.

FUEL DELIVERY SYSTEM - K SERIES KV6

Fuel Delivery System Schematic



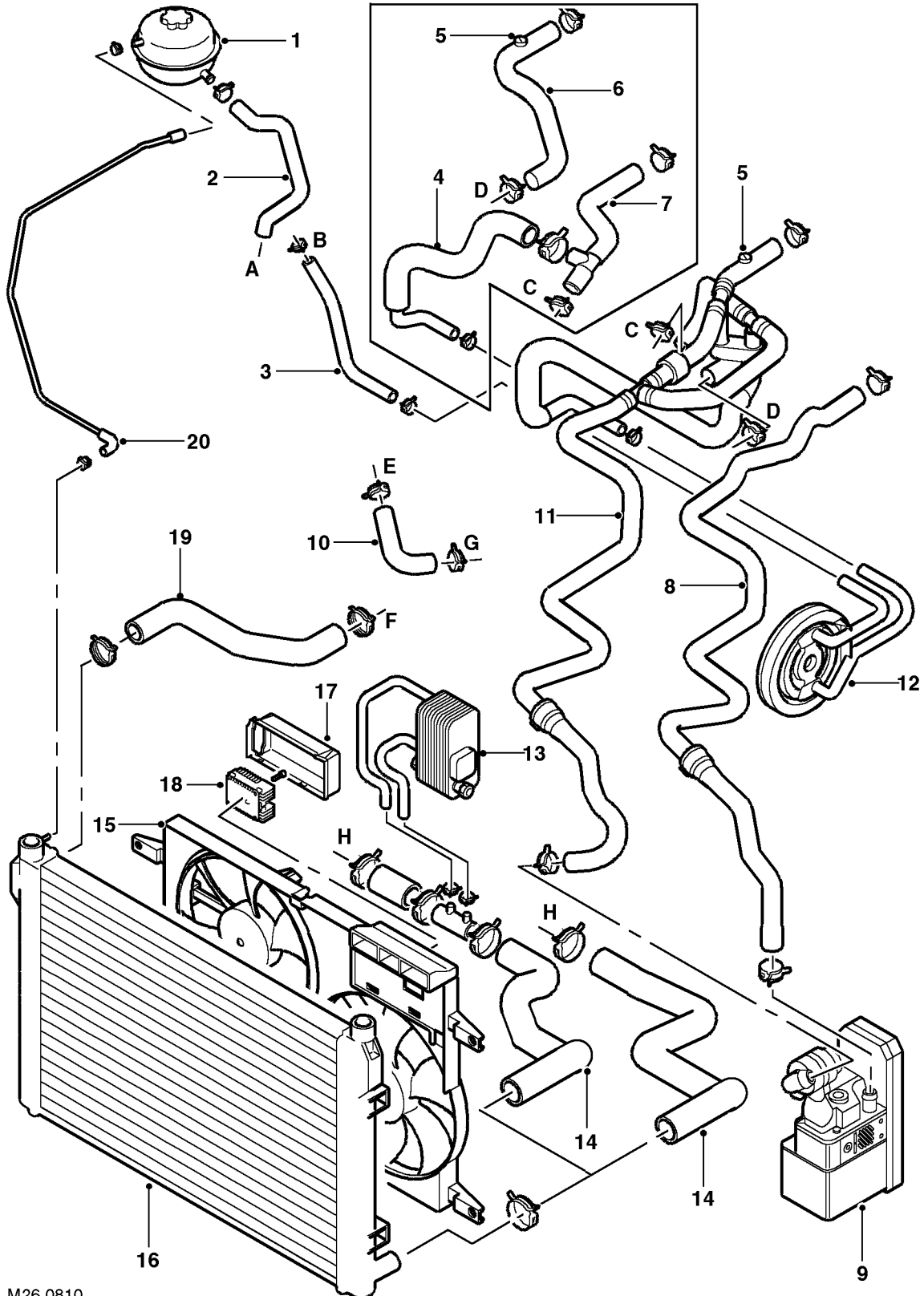
M19 3254

- 1 Injectors
- 2 Accumulator
- 3 Non return valve
- 4 Fuel pressure regulator

- 5 Fuel filter
- 6 Swirl pot
- 7 Fuel pump
- 8 Fuel tank

COOLING SYSTEM - TD4

Cooling System Component Layout – Automatic Gearbox, Sheet 1 of 2

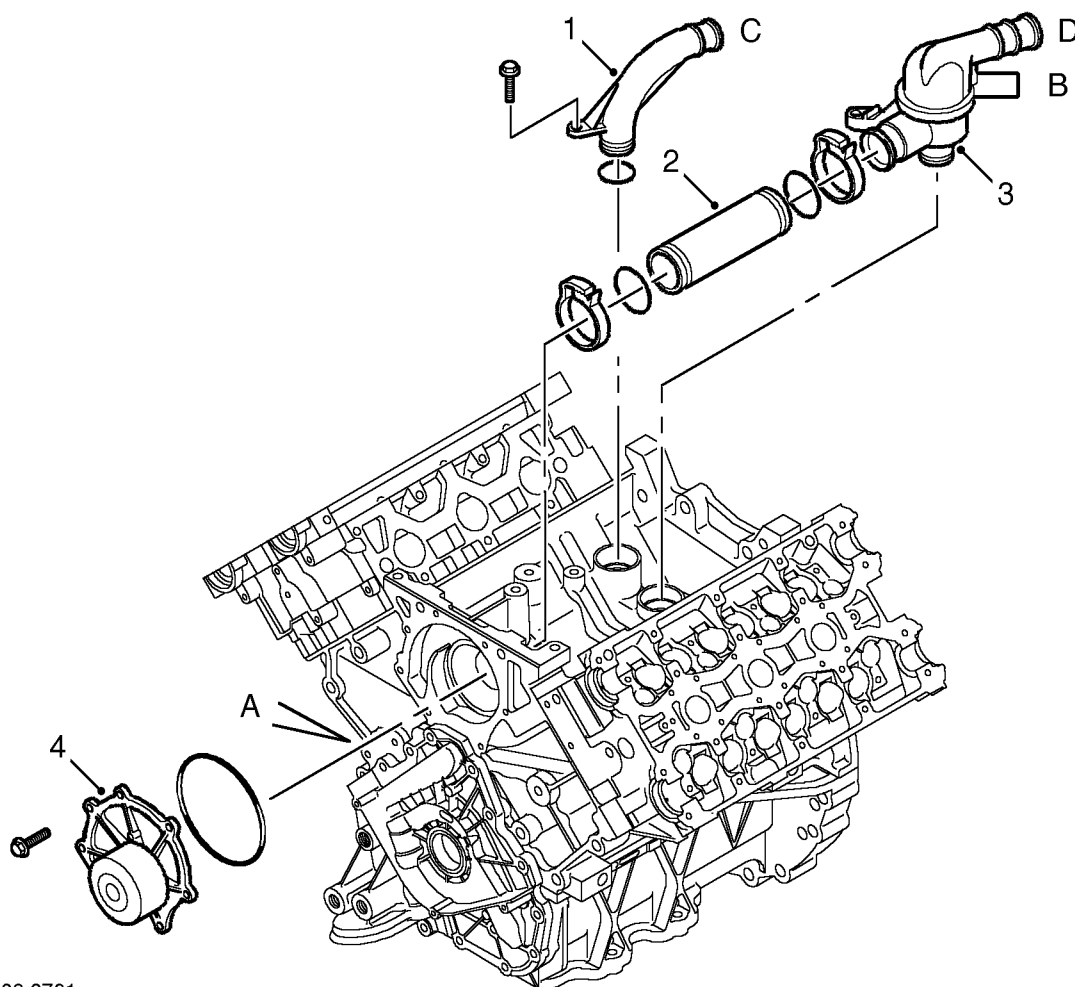


M26 0810

For connections A to H, see sheet 2

COOLING SYSTEM - K SERIES KV6

Cooling System Component Layout - Sheet 2 of 2



M26 0791

For connections A to D, see sheet 1

- 1 Outlet elbow
- 2 Pipe - thermostat to pump

- 3 Thermostat housing assembly
- 4 Coolant pump

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CLUTCH

Clutch Mechanism – Td4 Engines

The clutch mechanism comprises a dual mass flywheel, clutch driven plate, clutch cover assembly and a hydraulically operated release bearing. The clutch mechanism is fully enclosed at the end of the engine by a bell housing formed by the gearbox casing.

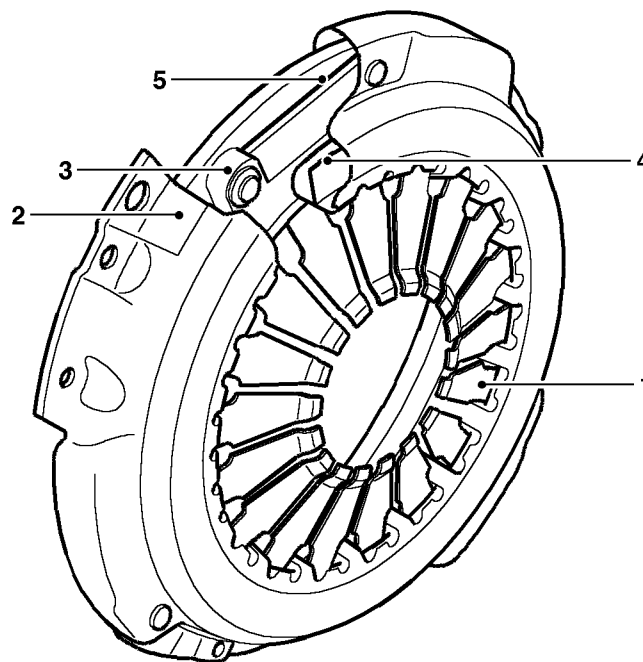
The release bearing is located on a tube which covers the gearbox input shaft and is connected by a pipe to the master cylinder. The release bearing is kept in contact with the pressure plate diaphragm by a spring which is located on the slave cylinder piston.

The dual mass flywheel comprises a primary mass and a secondary mass which, via the clutch driven plate, transmit drive to the gearbox. The secondary mass is located on a roller bearing in the primary mass. The primary mass is secured on the flanged end of the crankshaft with six bolts. The drive between the secondary and primary masses is achieved by a torsional spring damper. The flywheel insulates the gearbox from torsional and transient vibrations produced by the engine, giving an improved drive train refinement.

The operating face of the flywheel is machined to provide a smooth surface for the clutch driven plate to engage on. Three dowels in the secondary mass provide location for the clutch cover assembly which is secured with six bolts. The flywheel is balanced to ensure that it does not produce vibration when rotating.

A ring gear is located on the outer diameter of the flywheel. The ring gear is not serviceable and a new flywheel is necessary if the gear becomes worn or damaged.

Clutch Cover Assembly



M33 0402

- 1 Diaphragm spring
- 2 Cover
- 3 Pressure plate

- 4 Fulcrum rings
- 5 Drive straps

The clutch cover assembly comprises a diaphragm spring, pressure plate and cover. The clutch cover assembly is mounted on and rotates with the flywheel and is located with three dowels and secured with six bolts.

The pressure plate is forged from cast iron and machined to provide a smooth surface for the clutch driven plate to engage on. Three lugs on the outer diameter of the pressure plate connect it via drive straps to the cover. The drive straps have three tempered steel leaves and pull the pressure plate away from the clutch driven plate when the clutch pedal is depressed. The cover is made from pressed steel.

INTERMEDIATE REDUCTION DRIVE

There are also four internal oil seals in the IRD unit. Two smaller diameter oil seals are fitted internally at each end of the primary shaft. These prevent oil ingress along the intermediate shaft from the IRD unit at the differential end. At the opposite end, the seal prevents oil ingress from the gearbox along the intermediate shaft. Two larger oil seals are fitted in the main casing where the IRD unit enters the gearbox. The inner oil seal prevents oil ingress from the IRD primary shaft entering into the area between the two seals, and the outer oil seal prevents oil ingress from the gearbox entering the same area.

On the underside of the main casing is a 'tell-tale' drilling which is positioned between the inner and outer primary shaft oil seals. Oil leakage from the drilling will indicate either a faulty inner or outer primary shaft oil seal. An 'O' ring seal, fitted in a machined groove, seals the IRD main casing to the gearbox housing.

AUTOMATIC GEARBOX - JATCO

Duty Solenoid Valves

The duty solenoid valves are:

- Lock-up duty solenoid valve
- Line pressure duty solenoid valve
- 2-4 duty brake solenoid valve.

The lock-up duty solenoid valve is used by the EAT ECU to control the lock-up of the torque converter depending upon the vehicle speed and throttle position.

The EAT ECU will actuate the lock-up solenoid valve, which operates the lock-up control valve to direct fluid to either lock or unlock the torque converter.

The line pressure duty solenoid valve and 2-4 duty brake solenoid valve are used by the EAT ECU to control fluid line pressure in the gearbox.

The EAT ECU calculates the line pressure by using the engine speed, vehicle speed and throttle angle. The EAT ECU then actuates the solenoid valves accordingly to achieve the required line pressure.

The solenoid valves can fail in the following ways:

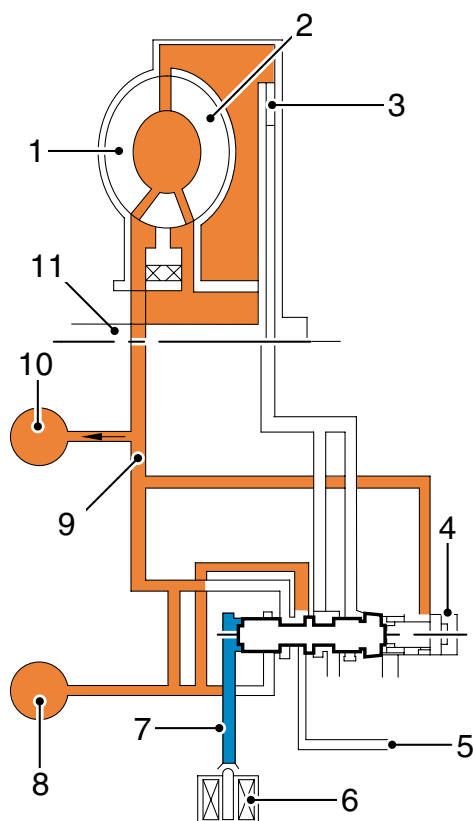
- Open circuit
- Short circuit to 12 or 5 volts
- Short circuit to earth.

In the event of a solenoid valve failure any of the following symptoms may be observed:

- Gearbox selects fourth gear only (shift solenoid valve failure)
- Gearbox will not upshift to fourth gear (timing solenoid valve failure)
- Increased fuel consumption and emissions (lock-up solenoid valve failure)
- Gear shifts will have no torque reduction therefore gear changes will be very harsh (line pressure duty solenoid valve failure)
- No pressure control will occur therefore gear changes from fifth gear will be very harsh (2-4 brake duty solenoid valve failure).

AUTOMATIC GEARBOX - JATCO

Lock-Up Condition



M44 1624

- | | |
|-----------------------------|-------------------------------------|
| 1 Impeller | 7 Pilot pressure |
| 2 Turbine | 8 Fluid cooler |
| 3 Lock-up clutch | 9 Torque converter applied pressure |
| 4 Lock-up control valve | 10 Lubrication |
| 5 Torque converter pressure | 11 Input shaft |
| 6 Lock-up solenoid | |

The EAT ECU operates the lock-up solenoid, which in turn supplies pilot pressure to the control valve. The control valve moves under the influence of the pilot pressure, blocking the release pressure feed to the lock-up clutch and re-directing it to the other side of the clutch mechanism.

With the release pressure removed, the lock-up clutch moves and engages with the torque converter, moving the lock-up mechanism into the locked condition.

Smooth Lock-Up

Smooth lock-up occurs as the mechanism moves from the unlock to the locked condition. Torque converter release pressure is lowered gradually preventing a sudden lock-up clutch engagement, reducing lock-up shock.

The lock-up solenoid is a driven duty solenoid operating at 50Hz. The lock-up control valve has a pressure regulation device which reacts to torque converter release pressure and solenoid pilot pressure.

As the solenoid is operated, the pilot pressure is gradually applied to the control valve. This moves the valve, partially exposing the release pressure to a drain port.

The control valve is moved against an opposing spring by the increasing pilot pressure. The release pressure is decayed proportionally in response to the increasing pilot pressure allowing the clutch to smoothly engage with the torque converter.

AUTOMATIC GEARBOX - JATCO


There are seven selector lever positions:

- **P (Park)** - prevents the vehicle from moving by locking the gearbox.
- **R (Reverse)** - select only when vehicle is stationary and the engine is at idle.
- **N (Neutral)** - no torque transmitted to the drive wheels.
- **D (Drive)** - this position uses all five forward gears. Normal position selected for conventional driving.
- **4** - this position uses 1st to 4th gears only.
- **2** - this position uses 1st and 2nd gears only.
- **1** - this position uses 1st gear only.
- **S/M (Sport/Manual - Steptronic)** - this position uses all five gears as in 'D', but will shift up at higher engine speeds, improving acceleration.
- **+ and -** - movement of the selector lever in the +/- positions, when the selector lever is in the 'S/M' position, will operate the gearbox in manual (Steptronic) mode, allowing the driver to manually select all five forward gears.

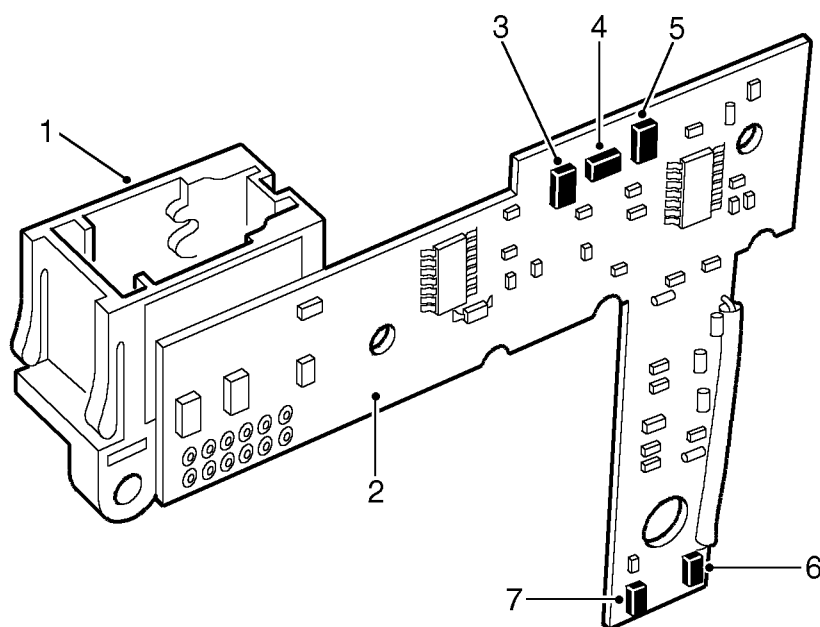
The selector lever position is displayed to the driver on the LED module in the centre console and in the instrument pack and corresponds with the position of the selector lever. The LED module illumination and instrument pack display is determined by the selector and inhibitor switch assembly on the gearbox, with the exception of the 'S/M' LED and the 'Sport' instrument pack display which are operated by a hall effect sensor located on the sport/manual switch.

All vehicles with an automatic gearbox incorporate an interlock solenoid at the bottom of the lever, which prevents the lever being moved from P (Park) unless the ignition switch is in position II and the foot brake is applied.

In selected markets, a key interlock mechanism, operated by a Bowden cable from the ignition switch barrel assembly, is also operated by the selector lever park position. The mechanism prevents the ignition key from being removed from the ignition barrel when the selector lever is not in the park position. The mechanism also prevents the selector lever from moving from the 'P' position until the ignition switch is in position II.

 **STEERING, DESCRIPTION AND OPERATION, Description.**

Sport/Manual Switch



M44 1637

- 1 Connector
- 2 PCB
- 3 '4' sensor
- 4 'D' sensor

- 5 'N' sensor
- 6 '+' (plus) sensor
- 7 '-' (minus) sensor

Operation

General

The EAT ECU controls the following functions:

- Gear shift scheduling
- Lock-up control
- Line pressure control
- Driving mode engagement
- Sport mode engagement
- Manual (Steptronic) mode engagement
- Reverse inhibit
- Hill mode strategy engagement
- Downhill recognition
- Cruise mode engagement
- Cooling strategy engagement
- Selector position display
- Driving mode display
- Fault status
- Fault code storage
- Emergency/Fail-safe program control.

Gear Shift Scheduling

The EAT ECU uses the relationship between the vehicle speed and the throttle position to carry out gear shift scheduling. Depending on these inputs, the EAT ECU controls gear selection using the three shift solenoid valves located in the valve block.

Lock-Up Control

The EAT ECU monitors the relationship between vehicle speed and throttle position to calculate when to lock-up the torque converter.

Lock-up control is possible in 4th and 5th gears. For example, lock-up is possible at high speed cruising with low throttle position. Torque converter lock-up is also provided in 2nd and 3rd gears when high fluid temperatures are detected by the ECU.

A refinement to the torque converter lock-up system is the reduction of harshness or shock during torque converter lock-up.

The EAT ECU controls the lock-up solenoid valve to provide a smooth lock-up function. The solenoid is operated slowly, and gradually varies the fluid pressure to the lock-up control valve. This causes the lock-up clutch to engage slowly, producing a smooth operation.

To promote engine warm-up at low temperatures, the EAT ECU will inhibit lock-up if the gearbox fluid temperature is below 40°C (104°F).

Line Pressure Control

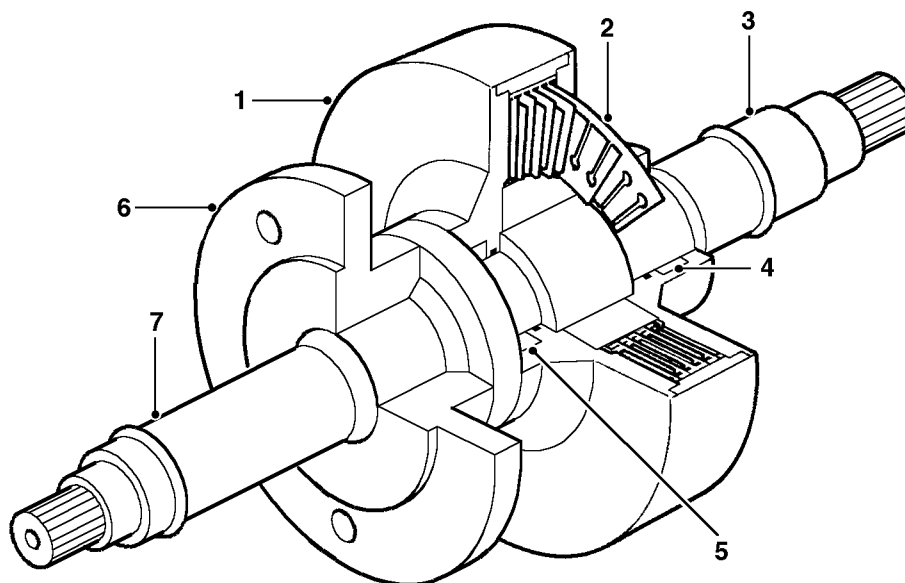
Line pressure refers to the operating fluid pressure that is supplied to the multi-plate clutches, multi-plate brakes and brake band within the gearbox.

Line pressure control provides smooth vehicle operation and gear shift action. The line pressure control is continuously responding to current driving conditions to regulate and deliver the optimum operating pressure at all times. For example, line pressure is lower under normal operating conditions than it would be under hard acceleration.

The EAT ECU controls line pressure by actuating the line pressure solenoid valve in the valve block. The ECU calculates the line pressure required by using engine speed, vehicle speed and throttle position.

High line pressures will cause very harsh gearshifts and gear engagement. Low line pressure will cause gearshifts to take an excessive amount of time to change, which will quickly burn out the clutches, brakes and brake band within the gearbox.

Section Through VCU



M47 0378

- | | |
|------------------|---------------------------|
| 1 Cylinder | 5 Ball bearing |
| 2 Slotted discs | 6 Torsional damper flange |
| 3 Input shaft | 7 Output shaft |
| 4 Roller bearing | |

The rear wheels are 0.8% under driven, so in most conditions the vehicle is effectively front wheel drive, with the rear wheels turning the rear propeller shaft slightly faster than the IRD drives the front propeller shaft. Since the speed differential is low, the increase in viscosity of the silicon jelly is marginal and there is little resistance to relative rotation of the slotted discs.

When there is a significant speed differential between the front and rear propeller shafts, e.g. the front wheels lose traction or traversing rough terrain, the viscosity and resistance to rotation of the silicon jelly increases to a level that slows or stops relative rotation of the slotted discs. With the front and rear propeller shafts locked together, drive is thus transferred from the IRD to the rear wheels.

Torsional Damper (1.8 K Series Models Only)

The torsional damper reduces vibration from the propeller shafts. The damper consists of a rubber membrane bonded between an outer ring and an inner hub. Three bolts secure the inner hub to the output shaft of the VCU.

Propeller Shaft Bearings

The two propeller shaft bearings are identical, and each consist of a roller bearing race mounted into a centre bearing housing. The bearing is sealed-for-life and is a press fit on the input/output shaft of the VCU. Bearing covers and flingers prevent the ingress of moisture.

Rear Propeller Shaft

The rear propeller shaft consists of a thin walled tube with a conventional universal joint welded to each end. The rear universal joint is bolted to the input flange of the final drive unit. The front universal joint is splined to the output shaft of the viscous coupling unit and secured by a bolt. Both universal joints incorporate serviceable, sealed needle bearings.

STEERING

Energy absorption is achieved by the following mechanism: When an axial load is applied to the steering column, the mounting bracket deforms or slides out of the 'U' clips and the curling plates deform. The 'U' clips remain captive on the studs. When the column mounting moves, the upper column tube slides on the lower column tube and allows approximately 63 mm (2.5 in.) maximum of axial movement. The nylon shear pins holding the upper and lower shafts together shear, allowing the central shaft to telescope the same amount as the column tubes.

In the event of a collision where the steering rack itself moves, the two universal joints in the column allow the intermediate shaft to articulate, minimizing movement of the column towards the driver. If movement continues after articulation of the intermediate shaft, the nylon shear pins retaining the two halves of the central shaft shear causing the shafts to 'telescope' together reducing further column intrusion.

The steering wheel comprises a cast centre and wire frame onto which the soft polyurethane foam is moulded. A horn switch is located at each side of the wheel. On models with a high specification ICE system and/or cruise control, additional switches are located on the steering wheel for control of one or both features. All switches are connected by wires to the rotary coupler connector.

Protection for the drivers face and upper torso is provided by an SRS airbag located in the centre of the steering wheel under a plastic cover.

RESTRAINT SYSTEMS, DESCRIPTION AND OPERATION, Description.

The column adjuster is located on the left hand side of the steering column and allows the steering column and wheel to be tilted up or down over a range of approximately 3.5° or 30 mm (1.2 in) of vertical movement of the steering wheel. The column adjuster comprises a bolt which passes through each side of the column upper mounting bracket. The column adjustment lever is attached to a two-start left hand threaded nut which screws onto the bolt.

When the lever is lowered the nut is slackened and allows the column to be moved up or down to the desired position. Lifting the lever upwards tightens the nut, clamping the mounting bracket to the column, retaining the steering column in the selected position. The nut tightening torque is 10.5 Nm (7.7 lbf.ft) which gives the correct 'feel' to the lever operation.

The steering lock houses the ignition switch, ignition illumination light ring, key lock barrel and the security system transponder coil.

The steering lock is attached to the upper column with a clamp plate and two shear bolts. The bolts are tightened to a torque which shears off the heads of the bolts preventing easy removal of the steering lock.

The steering lock operates by a bolt, which emerges when the ignition key is turned to position 0 and the ignition key removed. The bolt engages in a lock collar located on the upper shaft in the upper column tube. The lock collar is attached to the upper shaft by a 'wave form' interference ring, which allows the lock collar to slip on the upper shaft if a torque of 200 Nm (147.5 lbf.ft) or higher is applied. This prevents the bolt being sheared, by someone forcibly turning the steering wheel while the steering lock is engaged, yet still effectively locks the steering. The steering lock is also designed to be resistant to slide hammer and shock retraction.

STEERING

Left Steering (RHD Models; Right Steering on LHD Models)

Anti-clockwise (on RHD, clockwise on LHD) rotation of the steering wheel rotates the input shaft and the torsion bar in the same direction. The slots in the input shaft move out of their neutral alignment with the slots in the outer sleeve, as the torsion bar twists, and restricts the flow back to the reservoir. This restriction causes the supply pressure from the PAS pump to increase. The increased PAS pump pressure is directed to the annulus side of the hydraulic cylinder. Due to the relative displacement of the slots the increased PAS pump pressure is also applied to the full area side of the cylinder. The difference in effective areas on each side of the piston produces a linear output force along the rack which provides the power assistance to turn the road wheels in the appropriate direction.

Progressive Assistance

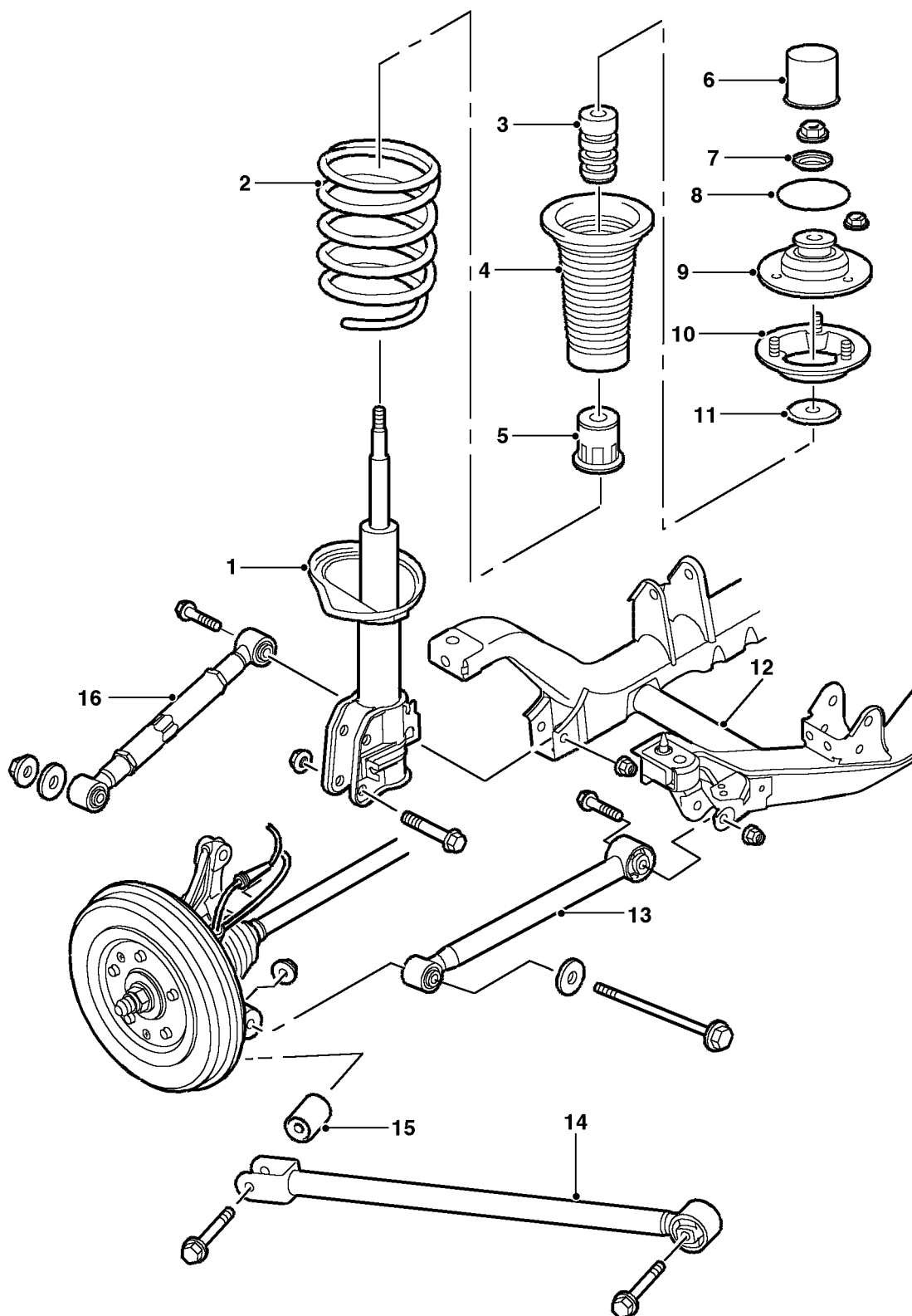
Progressive power assistance is dependent on the amount of road wheel resistance opposing the turning of the front wheels. When the steering wheel is turned to the left or right, the rotary movement is transferred through the steering column to the input shaft which rotates the same amount as the steering wheel. The rotary movement is also transferred from the input shaft to the torsion bar. If the road wheel resistance is high, e.g. when parking, the torsion bar will twist. The twisting of the torsion bar means that the rotary movement of the pinion and the outer sleeve is less than that of the input shaft.

The twisting of the torsion bar moves the slots in the input shaft and the torsion bar out of alignment. The greater the resistance of the road wheels to the steering rotary movement, the greater the misalignment of the slots in the input shaft and outer sleeve. As the misalignment becomes greater, the restriction in the return flow of fluid to the reservoir increases and therefore the fluid pressure applied to the hydraulic cylinder also increases. As the fluid pressure increases, so does the amount of assistance provided.

When the road wheel resistance reduces or less effort is applied to the steering wheel, the reduced torque applied to the input shaft allows the torsion bar to unwind. This reduces the misalignment between the slots in the input shaft and the outer sleeve, reducing the fluid pressure applied to the hydraulic cylinder and therefore the amount of assistance provided.

REAR SUSPENSION

Rear Suspension Component Detail



M64 0143

RH Rear suspension shown, LH is mirror image

BRAKES

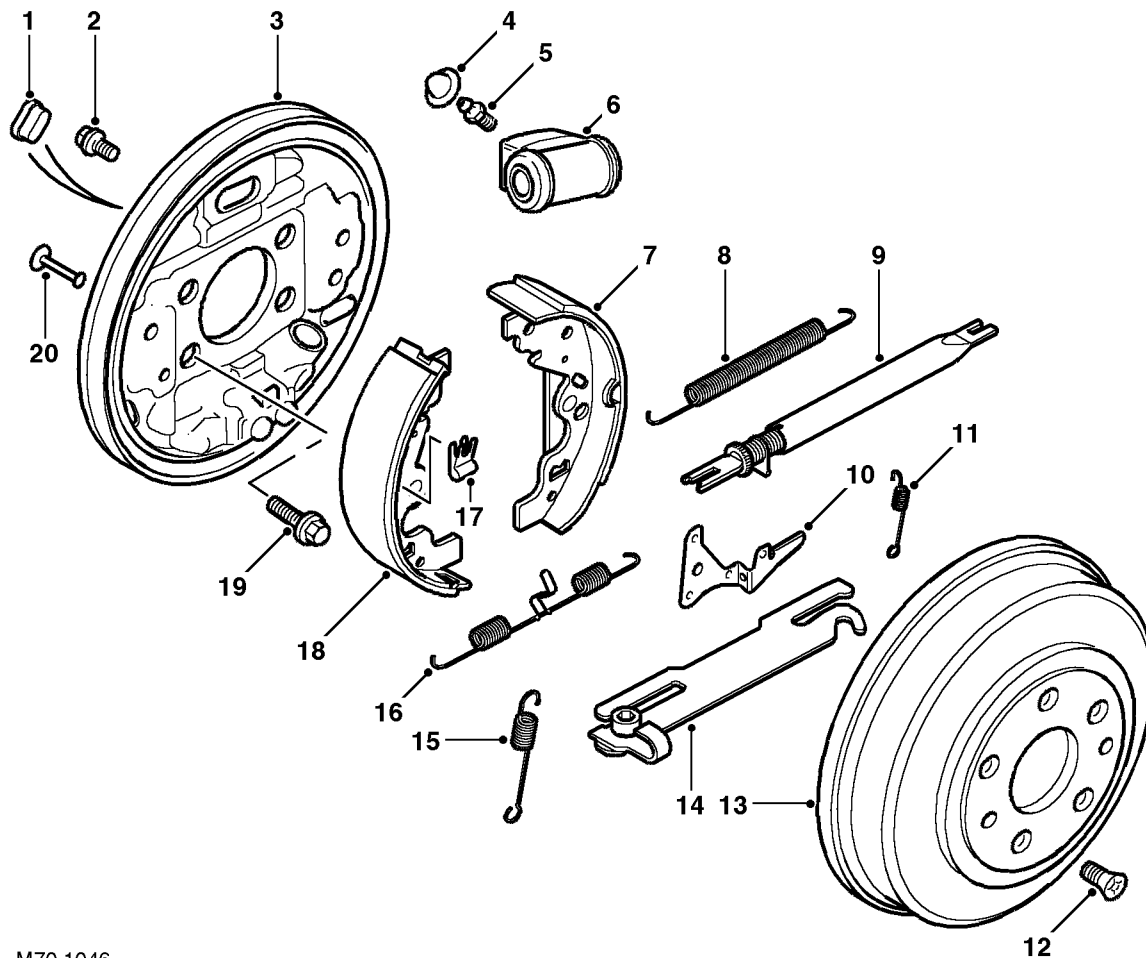
Rear Brakes

The rear brakes each comprise a hub mounted backplate and drum containing leading and trailing brake shoes when operated by the foot brake. An adjuster rod is incorporated to automatically adjust the brake shoes to compensate for wear of the brake linings. Adjustment occurs during operation of the foot brake.

When hydraulic pressure is supplied to the wheel cylinder, the cylinder extends and forces the brake shoes against the drum.

When a force is supplied to the shoes via the hand brake lever and cables, both brake shoes become leading.

Rear Brake Components



M70 1046

- | | | | |
|----|----------------------------|----|--------------------------------|
| 1 | Blanking plug | 11 | Anti rattle spring |
| 2 | Wheel cylinder fixing bolt | 12 | Drum fixing screw |
| 3 | Backplate | 13 | Brake drum |
| 4 | Bleed screw cap | 14 | Hand brake strut |
| 5 | Bleed screw | 15 | Adjuster lever spring |
| 6 | Wheel cylinder | 16 | Lower shoe return spring |
| 7 | Leading brake shoe | 17 | Shoe retaining pin spring clip |
| 8 | Upper shoe return spring | 18 | Trailing brake shoe |
| 9 | Adjuster rod | 19 | Backplate fixing bolt |
| 10 | Adjuster lever | 20 | Shoe retaining pin |

BRAKES

The ABS ECU incorporates a fade out strategy that, if a fault occurs or HDC is deselected during active braking, provides a safe transition from active braking to brakes off. The fade out strategy increases the target speed at a low constant acceleration rate, independent of actual throttle position. If active braking is in operation, this causes the braking effort to be gradually reduced and then discontinued. The HDC information warning lamp flashes while fade out is in progress.

If the clutch is disengaged during active braking, the HDC information warning lamp flashes after a delay of 3 seconds. After 60 seconds, if the clutch is still disengaged, the HDC fault warning lamp flashes and active braking operation fades out.

To prevent the brakes overheating, the ABS ECU monitors the amount of active braking employed and, from this, calculates brake temperature. If the ABS ECU determines brake temperature has exceeded a preset limit, it extinguishes the HDC information warning lamp and flashes the HDC fault warning lamp to indicate that HDC should be deselected. If active braking continues and the ABS ECU determines that brake temperature has increased a further 50 C, it fades out active braking and disables HDC. After fade out, the HDC fault warning lamp continues to flash, while HDC is selected, until the ABS ECU calculates brake temperature to be at an acceptable level. This calculation continues even if the ignition is turned off, so turning the ignition off and back on will not reduce the disabled time. When the ABS ECU calculates the brake temperature to be acceptable, it extinguishes the HDC fault warning lamp and illuminates the HDC information warning lamp to indicate HDC is available again. The disabled time is dependant on vehicle speed; typical times at constant vehicle speeds are as follows:

Diagnostics

While the ignition is on, the diagnostics function of the ABS ECU monitors the system for faults. In addition, the return pump is tested by pulsing it briefly immediately after the engine starts provided vehicle speed exceeded 4.4 mph (7 km/h) during the previous ignition cycle. If a fault is detected at any time, the ABS ECU stores a related fault code in memory and illuminates the appropriate warning lamps in the instrument pack. If a fault exists in a warning lamp circuit, the lamp will not illuminate during the lamp check at ignition on, but, provided there are no other faults, the related function will otherwise be fully operational.

RESTRAINT SYSTEMS

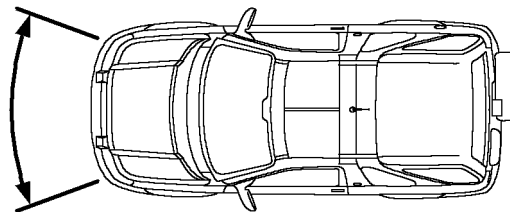
Description

General

The Supplementary Restraint System (SRS) provides additional protection for front seat occupants during a frontal collision above a preset severity. The SRS is an electronically controlled, single point sensing system. The system comprises:

- An airbag Diagnostic Control Unit (DCU).
- A driver's airbag module.
- A front passenger's airbag module (optional).
- Two front seat belt pretensioners.
- A warning lamp.

Impact Zone for SRS Activation (Approximate)



M76 4151

Interconnecting wiring for the system is contained in yellow sleeving and integrated into the vehicle harnesses. A rotary coupler connects the vehicle harness to the driver's airbag module. On vehicles with a passenger's airbag module, a link lead connects the module to the vehicle harness. An ISO 9141 K line (bi-directional) serial communication link connects the airbag DCU to the vehicle's diagnostic socket.

The system is operational only while the ignition is on. With the ignition on, any frontal collision is detected by the airbag DCU. If the impact is above the preset severity, the DCU sends out simultaneous fire signals to the airbag modules and the seat belt pretensioners. The airbag modules then deploy protective airbags in front of the driver and front seat passenger, and the seat belt pretensioners retract to tighten the front seat belts. Collision detection to full deployment of the airbags and pretensioners takes approximately 45 milliseconds.

RESTRAINT SYSTEMS

Description

General

Seat belts are provided as the primary restraint for all occupants. An inertia reel, three point seat belt is installed at each seat position. The inertia reels are of the Emergency Locking Retractor (ELR) type which incorporate a liftshaft locking system with webbing sensor and car sensor activating mechanisms. The webbing sensor activates the locking system if the webbing is subjected to a sharp pull. The car sensor activates the locking system if the vehicle is subjected to sudden deceleration or a severe tilt angle.

Front Seat Belts

The inertia reel of each front seat belt is attached to the related B/C post, behind the finishers. The webbing runs from the inertia reel, through an upper mounting attached to a height adjuster on the B/C post, to an anchor point either at the base of the B/C post (five door models), or on a bar attached to the inner sill (three door models).

The buckle assembly for each belt, consisting of a buckle attached to a flexible stalk and an integrated pretensioner, is secured to the inboard side of the related front seat frame.

Rear Seat Belts

Inertia reel seat belts are installed for all of the rear seats.

Three Door Models

The inertia reel of each rear seat belt is attached to a bracket on top of the related rear suspension turret, behind the loadspace rear quarter trim. The webbing runs from the inertia reel, through an upper mounting on the D post, to an anchor point in the rear wheel arch.

The buckle for each belt is directly attached to the inboard side of the related rear seat frame.

Five Door Models

The inertia reel of each outboard rear seat belt is attached to the related D post, behind the D/E post finisher. The webbing runs from the inertia reel, through an upper mounting on the D post, to an anchor point in the rear wheel arch.

The inertia reel for the centre rear seat belt is installed in a recess in the back of the rear seat. The webbing runs from the inertia reel, over the top of the seat, to an anchor point in the lower frame of the right rear seat.

The buckle assembly for each belt, consisting of a buckle attached to a length of webbing, is fixed to the lower frames of the rear seats. The buckle assembly for the right seat belt shares an anchor point with the webbing of the centre seat belt.

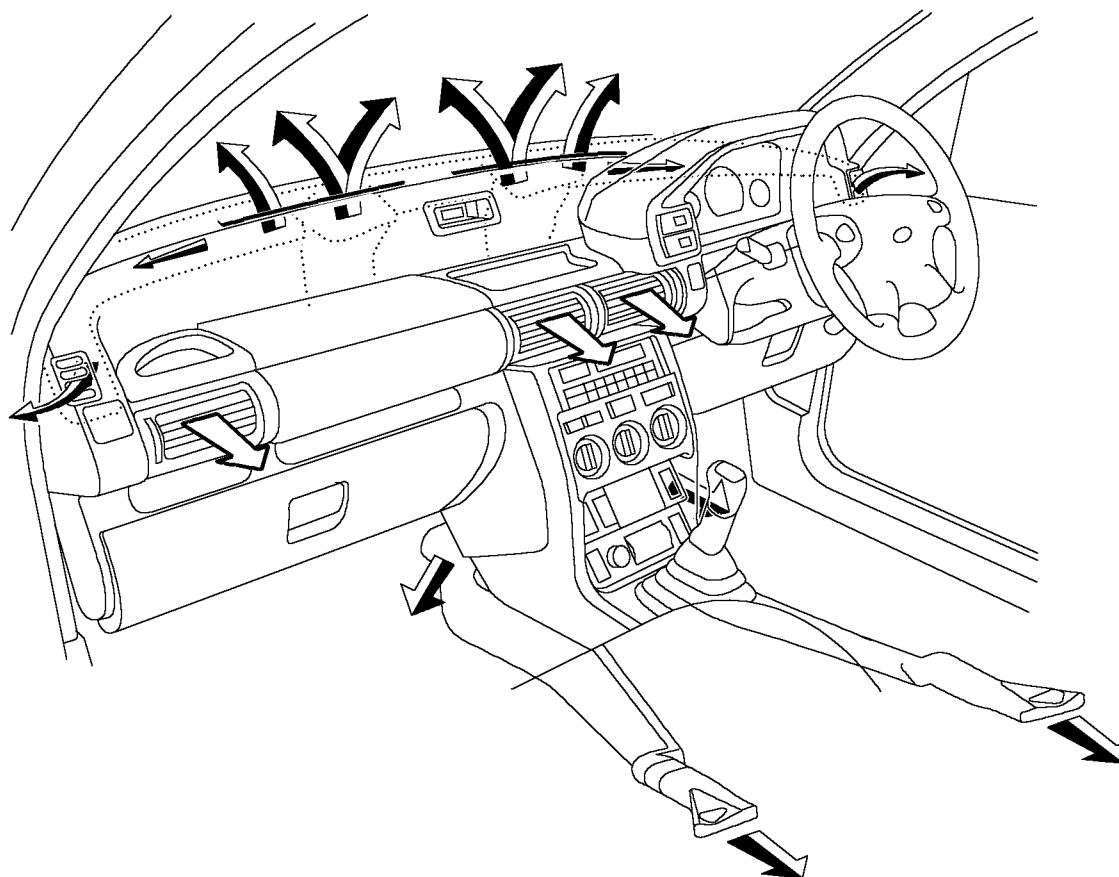
HEATING AND VENTILATION

Distribution

Air from the heater assembly is distributed around the vehicle interior through fascia and floor level outlets. Fascia outlets consist of fixed vents for the windscreen and side windows, and adjustable vent assemblies for face level air. Floor level outlets consist of fixed vents for the front and rear footwells.

The front footwell vents are integrated into the heater assembly. Two central vent assemblies for face level air are connected directly onto the related outlets of the heater assembly. Air for the rear footwell, outer face level vent assemblies and windscreen/side windows is distributed through ducts.

Fascia Outlets



M80 0468

Ducts

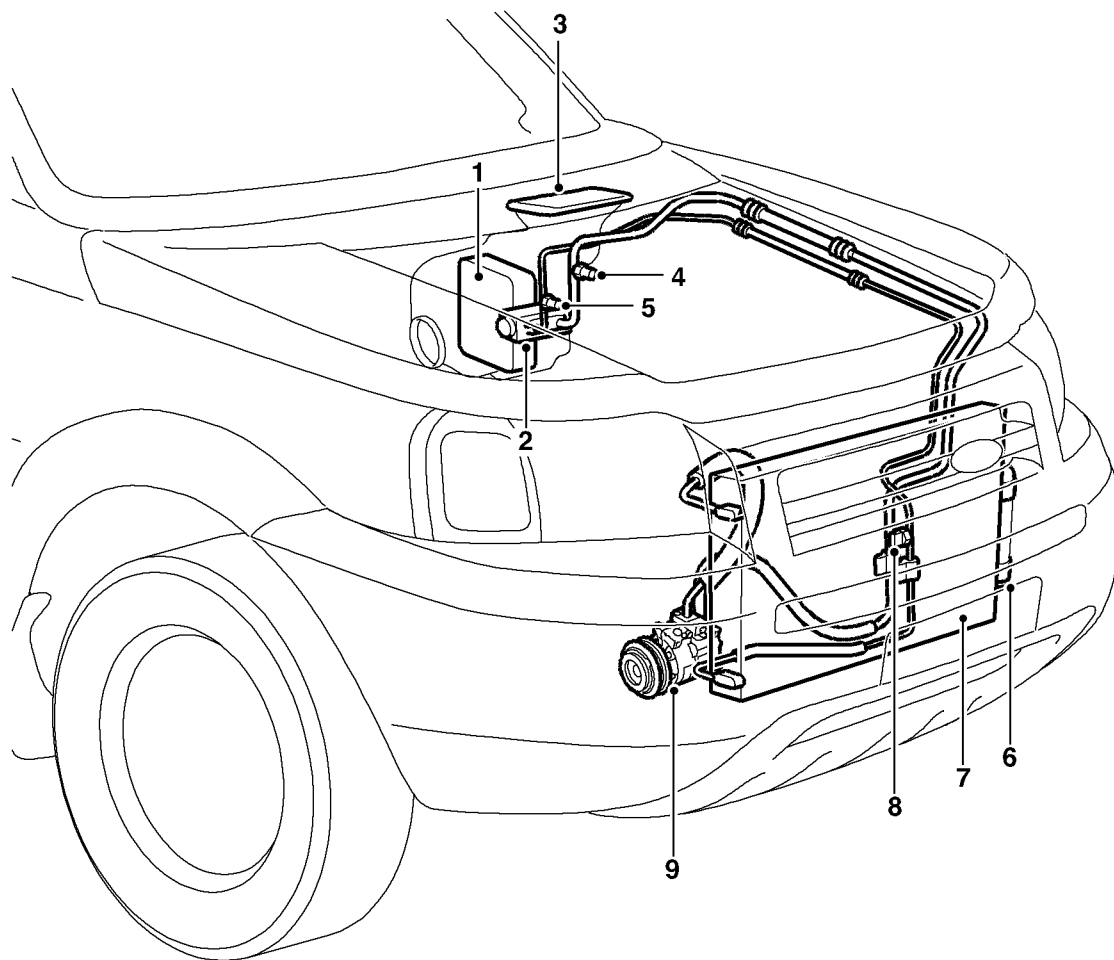
The rear footwell ducts extend along each side of the transmission tunnel and vent into the rear footwells from below the front seats. The outer face level ducts attach to the underside of the fascia and connect to the vent assembly at each end of the fascia. The windscreen/side window ducts connect to a duct integrated into the top of the fascia.

Vent Assemblies

The vent assemblies allow occupants to control the flow and direction of face level air. Each vent assembly incorporates a thumbwheel to regulate flow and moveable vanes to control direction.

AIR CONDITIONING

A/C Refrigerant System Component Layout – K1.8 Series Engines

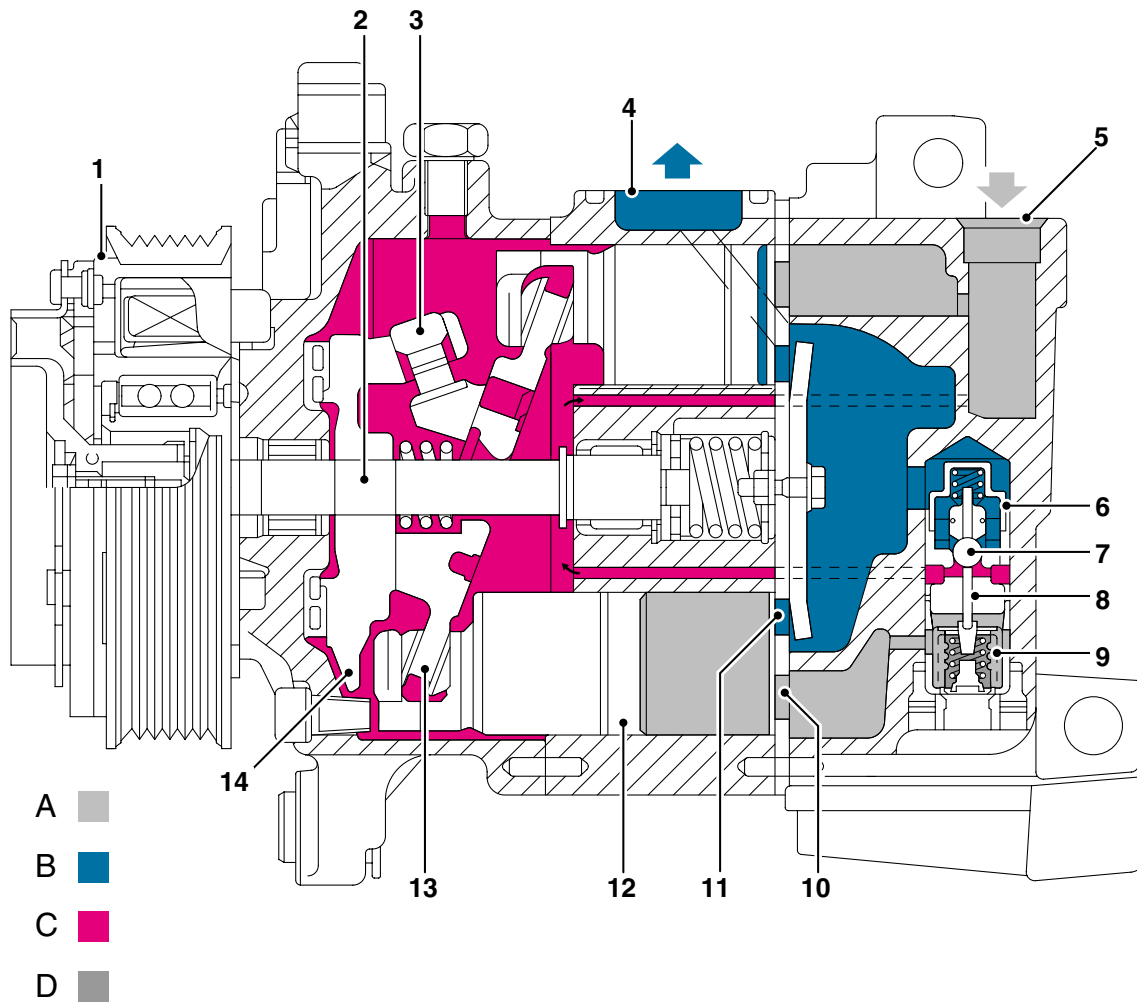


M82 0729

RHD shown, LHD similar

- | | |
|--------------------------------------|-------------------------------|
| 1 Evaporator | 6 Modulator |
| 2 Thermostatic expansion valve | 7 Condenser |
| 3 Air inlet duct | 8 Refrigerant pressure sensor |
| 4 Low pressure servicing connection | 9 Compressor |
| 5 High pressure servicing connection | |

Sectioned View of Compressor



M82 0713

A = Inlet pressure; B = Outlet pressure; C = Servo pressure; D = Ambient air pressure

- | | |
|------------------------------|--------------------|
| 1 Clutch and pulley assembly | 8 Push rod |
| 2 Shaft | 9 Diaphragm |
| 3 Guide pin | 10 Suction valve |
| 4 Outlet port | 11 Discharge valve |
| 5 Inlet port | 12 Piston |
| 6 Control valve assembly | 13 Swash plate |
| 7 Ball valve | 14 Lug plate |

The compressor consists of a housing which contains a shaft mounted in radial and thrust bearings. A lug plate is pressed onto the shaft and the clutch and pulley assembly is splined to the end of the shaft at the front of the housing. A swash plate is installed on the shaft and connected to the lug plate by two guide pins. The swash plate is a sliding fit on the shaft and biased away from the lug plate by a spring. The outer circumference of the swash plate is engaged in the ends of seven pistons, which are located in cylinders equally spaced around the housing interior. Two pressure chambers in the rear of the housing are connected to inlet and outlet ports in the housing wall. Suction and discharge valves, between each cylinder and the chambers, control the flow of vapour into and out of the cylinders. A control valve assembly regulates a servo (control) pressure supplied through drillings in the housing of the chamber containing the swash plate.

AIR CONDITIONING

Operation

General

Air conditioning operates only while the engine is running and the blower in the heater assembly is on (any speed). Fresh or recirculated air can be selected with or without the air conditioning being on, provided the ignition is on.

Air Conditioning

When the air conditioning switch is selected on, the indicator lamp in the switch illuminates and an air conditioning request signal is input to the ECM via the Instrument pack and CAN Bus. The air conditioning request signal consists of a positive voltage supply via the blower switch and A/C switch, hard wired to the instrument pack. The instrument pack interprets the A/C request signal and informs the ECM of the condition using a message on the CAN Bus. The ECM is also in receipt of signals from the refrigerant pressure sensor and the evaporator temperature sensor, which it uses to determine the necessary cooling fan speed and compressor clutch control.

On receipt of the air conditioning request signal, the ECM switches air conditioning on by signalling the compressor clutch relay module to engage the compressor clutch and the cooling fan controller to run the cooling fans at the appropriate speed using a PWM signal. The engine drives the compressor to circulate the refrigerant. The blower draws fresh or recirculated air through the evaporator. As the air flows through the evaporator, moisture condenses out from the relatively warm air onto the cold evaporator. The dehumidified air is then fed into the heater assembly, from where it is distributed to the vehicle interior.

When the air conditioning switch is selected off, or if the blower is selected off, the indicator lamp in the air conditioning switch extinguishes and the air conditioning request signal is removed from the ECM. The ECM then switches air conditioning off by signalling the relay module to disengage the compressor clutch and cooling fan controller to terminate the operation of the cooling fans.

Blower Control

The blower can be operated at any one of four speeds by rotating the blower switch to the required position. When the blower is switched off the air conditioning system will not operate.

The fresh air/recirculation flap has two positions and is operated by pressing the button in the centre console. In the recirculation position, air is drawn into the heater from the vehicle by closing the exterior air inlet and opening the interior inlet. In the fresh air position, air is drawn into the heater from outside the vehicle by opening the exterior air inlet and closing the interior inlet.

Heater Distribution and Blend Unit Control

Blower unit air flow, having passed through the evaporator passes into the heater blend unit to be heated, if required. It is then directed into the vehicle interior in accordance with the flap positions, which are designated by the air distribution control on the fascia panel. A heater flap controls the amount of air flowing through the heater matrix, this flap is moved in response to temperature selection using the knob on the control panel.

The distribution control moves the flaps which control the direction of the air flow into the interior of the vehicle.

Compressor and Cooling Fan Operating Conditions

The Engine Control Module (ECM) controls the compressor and cooling fan operation in response to signals received from the refrigerant pressure sensor, evaporator temperature sensor and engine coolant temperature sensor. The refrigerant pressure can be low, medium or high, the system operating characteristics applicable for each condition is shown in the following table:

WIPERS AND WASHERS

Continuous

When reverse gear is engaged while the rear screen wiper is on, the CCU changes the wiper to continuous operation until reverse gear is disengaged, then reverts to intermittent operation again. If reverse gear is engaged while the rear screen wiper is off, but the windscreen wipers are on, the CCU also operates the rear screen wiper continuously, until reverse gear is disengaged or the windscreen wipers are selected off.

Off-screen Park

When the rear screen wiper is selected off, the CCU waits for the next signal from the wiper vertical microswitch in the wiper motor, then de-energises the forward relay and energises the reverse relay. The reverse relay operates the motor in the opposite direction, which lengthens the stroke of the wiper arm. When the wiper arm reaches the off-screen position, the CCU receives a signal from the off-screen park microswitch in the wiper motor and de-energises the reverse relay to stop the wiper.

Off-screen Park Monitoring

In order to monitor the off-screen park function, the CCU invokes a 10 second timer each time intermittent or continuous operation of the rear screen wiper is deselected (by either the control switch on the instrument pack cowl or the CCU). If, within the 10 seconds, a signal is received from both the vertical and the off-screen park microswitches in the wiper motor, the CCU determines that the system is serviceable and continues operation as normal. If, within the 10 seconds, a signal is not received from both microswitches, the CCU determines there is a fault with one of the microswitches or the motor circuit and de-energises the forward and reverse wiper relays to prevent further operation. Since a faulty wiper could stop at any position on the tail door window, to prevent damage to the wiper or window after a fault is detected, the CCU also inhibits operation of the tail door window, with the following exceptions:

- Clear of seal/seal engagement window movement when the tail door is opened/closed.
- Automatic window retraction when the roof is removed/opened.
- Window calibration using the vehicle key in the tail door lock.

When the fault has been corrected, tail door window operation returns to normal after the CCU has detected the two microswitch inputs from the rear screen wiper motor again.

Windscreen Washers

The windscreen washers are operated by pulling on the wash/wipe stalk located on the RH side of the steering column. Operation of the windscreen washers can also operate the windscreen wipers in a programmed wash/wipe mode.

When the wash/wipe stalk is pulled, the washers operate immediately and stop immediately the stalk is released. When the stalk is held on for more than 0.6 second, the CCU enters the programmed wash/wipe mode and, if the windscreen wipers are selected to intermittent operation or off, operates them at slow speed. If the windscreen wipers are already selected to slow or fast speed, they remain at the selected speed. When the stalk is released with the CCU in the wash/wipe mode, if the windscreen wipers are selected to intermittent operation or off, the wipers operate at slow speed for a further 2 seconds (3 or 4 wipes) and then revert to intermittent operation or park, as applicable.

Rear Screen Washer

The rear washer is controlled by a non-latching push switch, located on the RH side of the instrument pack cowl, and the CCU. Pressing the rear washer switch operates the washer until the switch is released. When the washer switch is pressed, the CCU also operates the rear screen wiper in a programmed wash/wipe mode. While the switch is pressed, the CCU operates the wiper continuously. When the switch is released the CCU operates the wiper continuously for a further six seconds (3 or 4 wipes) and then parks the wiper or reverts to the previous operating mode.

COMMUNICATION DATA BUSES

Description

General

A number of different types of data bus can be incorporated into vehicle wiring harnesses for the transmission of commands and information between ECU's. Some of the buses are installed as a network connecting several ECU's together and some are installed as dedicated links between pairs of ECU's. The bus configuration installed on a particular vehicle depends on the model and equipment level.

Freelander 2001 incorporates the following data bus systems:

- Controller Area Network (CAN) bus. A network connected between the instrument pack, the ABS and powertrain related ECU's
- Diagnostic DS2 bus
- ISO 9141 K line

Serial interface circuits in the ECU's transmit and receive commands and information on the buses as digital messages. ECU's connected to the same bus use a common protocol (format) and baud rate (transmission speed) for the messages they transmit. The protocol and baud rate vary from bus to bus.

Not all system ECU's are connected to the CAN bus system but they may require information that is being transmitted on the CAN bus system. The IPK acts as a gateway translating CAN bus signals into a format compatible with non CAN ECU's. Some signals are also converted from their existing state into the CAN format and transmitted on the CAN bus system for use by CAN based ECU's, for example the air conditioning pressure sensor reading is converted by the IPK and sent via CAN to the respective engine management system.

A twisted pair of wires are used for the CAN bus and single wires are used for the diagnostic buses. Bus wires can be repaired using the recommended connectors and the recommended procedure. The unwound length of CAN bus wires must not exceed 40 mm (1.6 in). If a fault is suspected on the CAN bus system it must be diagnosed and rectified using TestBook.

Data Bus Types

Bus	Baud Rate (kbits/s)	Protocol
CAN	500	ISO 11898
ISO 9141 K line	10.4	ISO keyword 2000
Diagnostic DS2	9.6	BMW corporate for diagnostics

SECURITY

Description

General

This description covers all aspects of the vehicle locking and alarm system and the immobilisation system.

The vehicle locking and alarm system is controlled by the central control unit (27VT) located on the back of the passenger compartment fusebox below the fascia.

The immobilisation system (EWS-3D) is essentially a stand alone system with its own controlling ECU located centrally behind the fascia.

Locking and Alarm System

The locking and alarm system comprises:

- Central door locking master switch
- Door switches
- Roof switch (3 door only)
- Remote handset (RF transmitter)
- RF receiver
- Driver's door key barrel
- Door lock actuators
- Tail door switch
- Tail door release actuator
- Bonnet switch
- Inertia switch
- Horn or BBUS
- Alarm LED
- Immobilisation ECU
- ABS ECU Speed input
- Volumetric sensor

Central Locking

The vehicle can be locked and unlocked by three methods; CDL switch, vehicle key or remote handset.

CDL Switch

The CDL switch is located in the centre console. The CDL switch allows the occupants to CDL lock the vehicle from inside without arming the alarm. The CDL switch is inoperative if the inertia switch is tripped. The CDL locked state can be removed by operation of the CDL switch, remote handset or by a key unlock operation in the driver's door key barrel.

If the inertia switch is tripped while the doors are CDL locked and the ignition is on, all doors will automatically unlock.

Key Locking

The vehicle can be CDL locked using the vehicle key in the driver's door key barrel. Turning the top of the key to the rear of the vehicle will CDL lock all doors. Turning the key a second time, within one second of the first turn, will superlock all doors.

Key Unlocking

Single point entry is a programmable feature and its selection affects how the vehicle responds to key unlock requests:

- Turning the top of the key once towards the front of a vehicle which is in a CDL state, with the alarm disarmed, will unlock all the doors irrespective of their existing lock status
- Turning the top of the key once towards the front of a vehicle in a superlocked state without SPE selected and the alarm armed, will unlock all the doors irrespective of their existing lock status
- Turning the top of the key once towards the front of a vehicle in a superlocked state with SPE selected and the alarm armed, will unlock the driver's door. The remaining doors will unlock to the CDL state and can be unlocked with a further key unlock operation

SECURITY

Diagnostics

A diagnostic socket allows the exchange of information between the CCU and the immobilisation ECU and TestBook. The diagnostic socket is located in the driver's footwell and is constructed to ISO standard. A dedicated diagnostic bus is connected between the socket and the instrument pack and allows the retrieval of diagnostic information and programming of certain functions to be performed using TestBook.

The CCU and the immobilisation ECU monitor all inputs and outputs and if a fault is detected a code for that fault is stored in a fault log.

The CCU has two fault logs for internal and external faults. The CCU is capable of detecting short or open circuits. The CCU will disable certain functions when faults are detected and reinstate functions when faults are corrected and the function is again requested.

The immobilisation ECU also stores fault codes. The diagnostic interface is also used for matching a replacement ECM to the existing immobilisation ECU.

WINDOWS

Operation

Side Door Windows

Power for side door window operation is supplied from the window lift relay and, on 5 door models, the sunroof relay, both located in the passenger compartment fusebox. The CCU controls the relays, which are energised while the ignition switch is in position II and for 40 seconds after the ignition is turned off.

When an up or down selection is made on one of the side door window switches, the switch simultaneously connects a power supply and an earth to the related door window motor to drive the window in the required direction. When the opposite selection is made, the switch changes the polarity of the connections to drive the window in the opposite direction. The window stops moving immediately the switch is released, except when a momentary down selection is made on the driver's door switch.

The driver's door window switch is connected to the window motor via the window lift ECU. When the window lift ECU senses a momentary (0.2 second or less) down selection on the driver's door switch, it connects the driver's door window motor to a power supply direct from the window lift relay and to an ECU earth. The window lift ECU maintains these connections until the door window motor stalls, after driving the window fully down, or an up selection is made on the window switch.

On 5 door models, each rear window switch on the centre console is connected to the window motor via the related rear door mounted window switch. When the isolator switch is pressed, the earth path for the two rear door mounted window switches is disconnected. With the isolator switch pressed, only the rear window switches in the centre console will operate the rear door window motors.

Tail Door Window

The CCU controls the tail door window via the tail door window relay located above the RH rear suspension turret. The tail door window relay is a dual relay that incorporates separate 'up' and 'down' contacts. When the CCU wants to operate the window, it switches the appropriate contacts in the tail door window relay to connect a power supply and an earth to drive the window motor in the required direction. The contacts change the polarity of the motor to change the direction of drive.

The tail door window can be lowered using the console switch or the remote handset. On 3 door models, opening/removal of the roof will automatically lower the window. The window can be raised using the console switch or the vehicle key in the tail door key barrel. When the tail door is opened, the tail door window lowers to a 'clear of seal' position and, when the door is closed, the window automatically rises to its fully up position in the window seal.

Tail Door Window Lower

The rear screen wiper must be parked off-screen before the CCU will allow the tail door window to lower. If the rear screen wiper is operating when a window down request is made, the CCU will automatically park the wiper off-screen before lowering the window. If the Heated Rear Window (HRW) is operating, the CCU will turn off the HRW when the window is lowered.

Remote Handset Lower: With the ignition off and the tail door closed, if the unlock button on the remote handset is pressed for a minimum of 1 second the CCU will unlock the doors and energise the tail door window down relay to fully lower the window.

Console Switch Lower - Inch Down: With the ignition on, pressing the console switch in the down position will signal the CCU to lower the tail door window for as long as the switch is held. The window will stop at the chosen position when the switch is released. When the window is almost fully down, the CCU will continue to lower the window irrespective of whether the switch is pressed or not.

Console Switch Lower - One Shot: With the ignition on, pressing the console switch in the down position, for approximately 0.2 second or less, will signal the CCU to lower the tail door window until it is fully down or an up request is received. This feature is market programmable.

Roof Removal (3 Door Models Only): Opening/removal of the roof will trip the roof off switch. This signals the CCU which, if the alarm is not armed, automatically lowers the tail door window even if the tail door is open. If the roof is opened/removed while the alarm is armed, the roof off switch triggers the alarm and the CCU will not lower the tail door window.

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