Diagnostics

The air suspension ECM can store fault codes which can be retrieved using TestBook/T4. The diagnostics information is obtained via the diagnostic socket which is located in the fascia, in the drivers stowage tray. The socket is secured in the fascia panel and protected by a hinged cover.

The diagnostic socket allows the exchange of information between the various ECU's on the bus systems and TestBook/T4 or a diagnostic tool. This allows the fast retrieval of diagnostic information and programming of certain functions using TestBook/T4 or a suitable diagnostic tool.

Fault Detection

The air suspension ECU performs fault detection and plausibility checks. Fault detection is limited to faults that the ECU can directly measure, as follows:

- Sensor hardware faults
- Valve hardware faults
- Sensor and actuator supply faults
- Bus failures
- ECU hardware errors.

Plausibility checks are checks on signal behaviour, as follows:

- Average height does not change correctly
  - Height changes too slowly
  - Suspension moves in the wrong direction.
- Reservoir pressure
  - Does not increase when reservoir filling requested
  - Does not decrease when reservoir used to lift vehicle
  - Does not decrease when reservoir is vented
  - Pressure varies too much when inactive.
- Compressor temperature
  - Increases when compressor inactive
  - Does not increase when compressor active.
- 'Energy' used to change height of corner
  - Too much 'energy' used – height change takes too long or long term filtered height does not reach target.
- Sensor activity
  - Signal floating
  - Inconsistent signal characteristics – signal on one side of axle is varying but other side remains static
  - Constant articulation when moving.

When a fault is detected, the ECU will attempt to maintain a comfortable ride quality with restricted functionality of the air suspension system.

The system functionality depends on the severity of the fault. The faults are defined as minor or major faults.

Minor faults are:

- Most sensor faults (hardware faults and plausibility faults)
- Cross link valve failure
- Reservoir valve failure.

For most minor faults, height changes are inhibited except for a return to standard height. If the suspension is not in standard height, the ECU will respond to a request for manual or automatic height change to return the vehicle to standard height. The ECU will continue to level the vehicle at the 'current' ride height.

Major faults are:

- Compressor faults
- Plausibility errors – for example:
  - Average height does not increase when lifting and the vehicle is moving. This could be caused by a compressor fault or a fault in the reservoir valve.
  - Reservoir pressure decreases when filling requested. This could be caused by a leak in the common gallery in the valve block or connecting pipe.

For major faults the ECU will not level the vehicle at the 'current' ride height. The ECU freezes height changes until it receives a manual or automatic request for height change. The ECU will return to standard height and freezes once standard height is achieved.

If the air suspension ECU loses information regarding vehicle speed, the ECU cannot determine if the current ride height is suitable for the vehicle speed. The ECU immediately returns to the 'default' height, which is 20 mm below the standard height. Once at the default height, the ECU will continue to level the vehicle at this height. A loss of the speed signal could be due to a fault in the CAN Bus or a fault in the ABS ECU. It is unlikely to be a fault in the air suspension ECU. It may, for example, be caused if the battery is disconnected and the steering sensor is not recalibrated immediately after reconnection. In this case a CAN Bus fault is recorded in the error memory. If this fault is seen, other ECU's using the CAN Bus should be also be checked for faults. When the fault is repaired, the air suspension ECU will resume full functionality but the CAN error remains in the memory.

If the suspension is above the standard height and the air suspension ECU cannot lower the suspension or cannot determine the vehicle height, all height changes will be frozen. The ECU will issue a message on the CAN Bus which is received by the instrument pack which displays a maximum advisable speed in the message centre of '35MPH'. an immediate 'freeze' of the vehicle height is caused by the following:

- Failure of more than one height sensor
- Implausible articulation symptoms detected
- Valve or solenoid failure (does not include reservoir valve)
- Stuck corner or whole vehicle (diagnosed using plausibility of the sensor inputs).

If the air suspension ECU has a hardware fault, the ECU will disable all air suspension functions. Detectable hardware errors include memory error, ECU failure, calibrations errors.

Fault Messages

The air suspension has two methods which it can use to inform the driver of a fault in the air suspension system; the air suspension control switch LED's and the instrument pack message centre.

When minor faults occur and the air suspension ECU is able to level the vehicle to the 'current' ride height, the control switch LED's will display the current ride height. When the vehicle returns to the standard ride height and further height changes are disabled, the 'HOLD' LED in the control switch will be permanently illuminated.

The air suspension ECU suffers a major failure and there is no air suspension control, all the control switch LED's will remain unlit.

If a fault occurs and the ECU can determine the ride height and the vehicle is not above standard ride height, the driver will be notified via a 'AIR SUSP. INACTIVE' message in the message centre. If the ECU cannot determine the height of the vehicle, or the vehicle is above standard ride height and cannot be lowered, the 'AIR SUSP. INACTIVE' message is accompanied with an alternating 'MAX 35MPH' message.

Operation

General

Under normal operating conditions, the air suspension ECU keeps the vehicle level at the 'current' ride height. The incoming height signals from the sensors are passed through filters to remove irregular signals produced by road noise or other irregularities. When the vehicle is stationary or a height change is in progress, the signals are passed through a 'fast' filter, which tracks the true rate of change of height. When the vehicle is moving, the signals are passed through a 'slow' filter. The 'slow' filtered signals remove almost all road noise from the signals and output a true long term average for each corner height. The 'slow' filtered signals cannot be used to respond quickly during height changes.

The air suspension ECU monitors each corner height signal using the fast filtered signals if the vehicle is stationary or the slow filtered signals if the vehicle is moving. If the height remains in a 'dead band' which is ±10 mm from the target height, the ECU does not implement any height adjustment changes. When the ECU detects that a corner has moved outside of the 'dead band', the ECU operates the compressor and/or the valves to raise or lower the corresponding corner(s) back into the target height.

When the engine is not running, the 'dead band' target height tolerance is increased to +20 mm and -25 mm. During 'wake-up', the tolerance band is ±20 mm. In all cases, the ECU will bring the corner height as close as possible to the target height. The ECU monitors the rate of change of height of the corner signals to predict when to close the valve so that the target height is not overshot.

Reservoir

The reservoir supplies pressurised air to the four air springs, via the valve block, to enable the air suspension system to carry out ride height changes.

If an upwards height change request is made when the engine is not running, air pressure within the reservoir is used to lift the vehicle. If the pressure within the reservoir has dropped below 9 bar (130 lbf/in^2) when an upwards height change request is made, the lift procedure is performed by the compressor. When the engine is started, the ECU runs the compressor to increase reservoir pressure to:

- 13.7 bar (199 lbf/in^2), in systems without an external pressure relief valve
- 12 bar (174 lbf/in^2), in systems with an external pressure relief valve