Operation

Cooling System Operation
With the engine running, the coolant pump is driven via a pulley from the cam belt. When the engine is cold the thermostat is closed and coolant is prevented from circulating through the radiator. The coolant is directed around the by-pass, heater and IRD circuit.

As the engine temperature increases, the thermostat gradually opens allowing cool fluid from radiator bottom hose to flow through the pump and into the cylinder block. This cool fluid displaces the hot fluid in the cylinder block which flows to the radiator via the top hose. With the thermostat fully open the full coolant flow passes through the radiator, the IRD cooler and heater circuits.

Cooling Fan Operation - Vehicles Without Air Conditioning (A/C)
The ECM will energise the cooling fan relay in the E-box at a coolant temperature of 102°C (215°F) and will go off when the coolant temperature decreases to less than 96°C (204°F).

When the engine is switched off, the ECM maintains the cooling fan in an active condition for up to eight minutes. If the temperature does not reach a predetermined value within four minutes, the ECM will terminate the active period. If the fan is active and the temperature falls below a predetermined value, the ECM will terminate further fan operation.

Cooling Fan Operation - Vehicles With Air Conditioning (A/C)
The engine cooling fan and the condensor fan are operated in parallel by the ECM via a cooling fan ECU. The cooling fan ECU, which is located behind the radiator below the bonnet closing panel, receives a Pulse Width Modulated (PWM) signal from the ECM. The frequency of the PWM signal, which is varied by the ECM, is used by the ECU to determine the output voltage supplied to the fan motors.

The fan operation is also dependent on vehicle road speed. The ECM will calculate the required fan speed in relation to the road speed using CAN signals received from the ABS ECU.

The ECM varies the duty cycle of the PWM signal between 10% and 90%. At duty cycles of between 10% and 49% the cooling fan ECU will not supply any power to the fan motors. At a duty cycle of 50%, the ECU supplies 6 volts to the fan motors to operate them at a minimum speed of approximately 1300 rev/min. As the duty cycle increases above 50%, the ECU increases the voltage, non-linearly, to the fan motors up to 90%. At this point the fan motors are supplied with 12 volts and operate at a maximum speed of approximately 3000 rev/min.

When the main relay is energised, the cooling fan ECU requires a PWM signal from the ECM of between 10% and 90% duty cycle. If this condition is not detected, the ECU will assume a fault condition (open or short circuit) exists and operate the fans continuously at full speed when the main relay is energised to ensure that engine and A/C system do not overheat.

The ECM will operate the fans in response to inputs from the ECT sensor and the A/C switch and A/C pressure sensor. Refer to A/C system for details

☞ **AIR CONDITIONING, DESCRIPTION AND OPERATION, Description.**

When the engine is switched off, the ECM maintains the cooling fans in an active condition for up to 8 minutes. If the temperature does not reach a predetermined value within 4 minutes, the ECM will terminate the active period. If the fans are active and the temperature falls below a predetermined value, the ECM will terminate further fan operation.