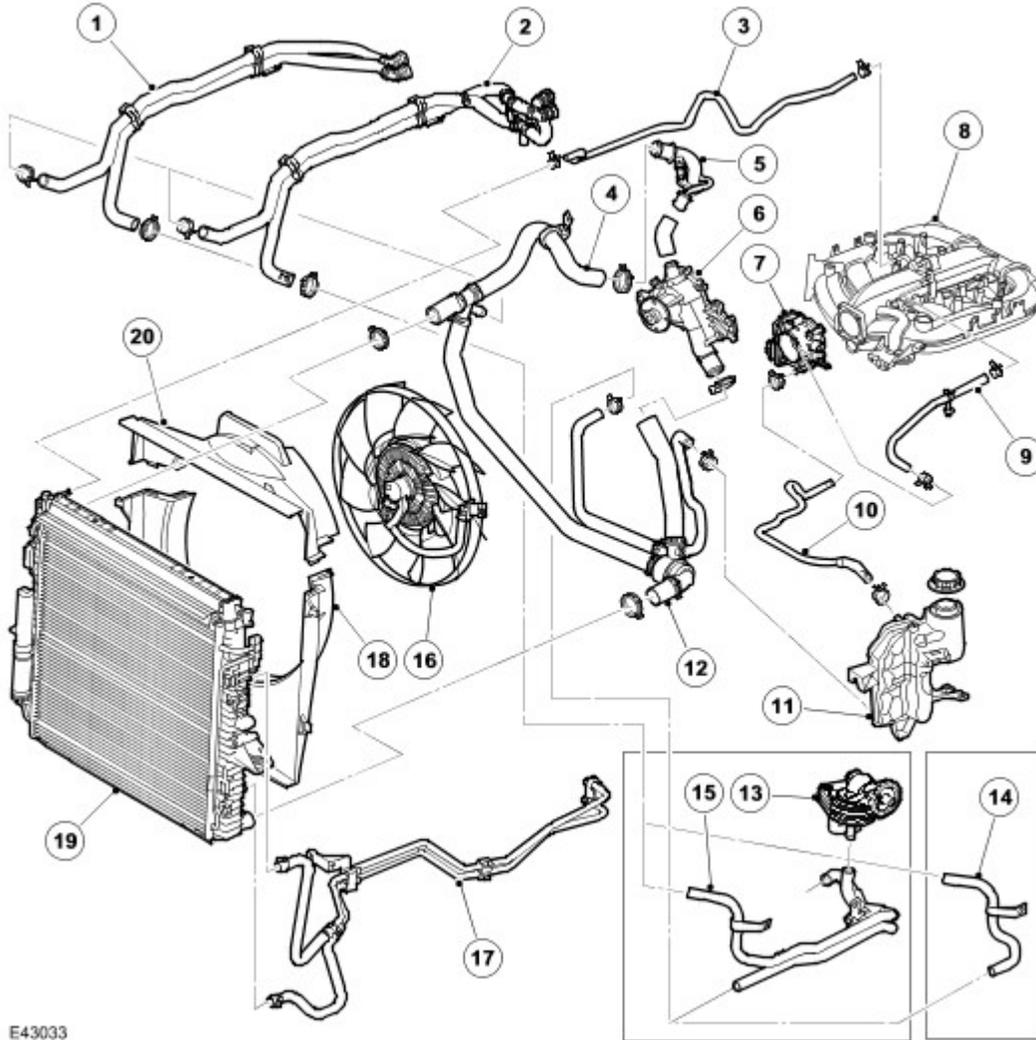




Engine Cooling

Cooling System Component Layout



E43033

Item	Part Number	Description
1	-	Heater hose, inlet and outlet
2	-	Heater hose, inlet and outlet for vehicles with rear heater (optional)
3	-	Hose, radiator to intake manifold
4	-	Radiator top hose
5	-	Engine Coolant Temperature (ECT) sensor
6	-	Water pump
7	-	Throttle body
8	-	Inlet manifold
9	-	Throttle body coolant hose
10	-	Hose, engine to expansion tank
11	-	Expansion tank

12	-	Radiator bottom hose
13	-	Engine oil cooler (if fitted)
14	-	Hose (for vehicles without engine oil cooler)
15	-	Hose, inlet and outlet (for vehicles with engine oil cooler)
16	-	Cooling fan
17	-	Transmission oil cooler pipes
18	-	Radiator cowl, lower
19	-	Radiator
20	-	Radiator cowl, upper

GENERAL

The cooling system employed is of the pressure relief by-pass type, which allows coolant to circulate around the engine and the heater circuit while the thermostat main valve is closed. The primary function of the cooling system is to maintain the engine within an optimum temperature range under changing ambient and engine operating conditions. Secondary functions are to provide heating for the passenger compartment and cooling for the transmission fluid and engine oil.

The cooling system comprises:

- A radiator
- A passenger compartment heater matrix
- An Engine Oil Cooler (EOC)
- A coolant pump
- A Pressure Relief Thermostat (PRT)
- An expansion tank
- A viscous fan
- Connecting hoses and pipes.

ENGINE COOLING SYSTEM

The coolant is circulated by a centrifugal pump mounted on the front of the engine and driven by an ancillary drive 'polyvee' belt. The coolant pump circulates coolant through the cylinder block and cylinder heads via a chamber located in the 'vee' of the engine. Having passed through the engine the coolant returns to the thermostat housing via the bypass pipe. Coolant also circulates through the top hose to the heater matrix. The coolant returns via the EOC to the engine side of the PRT.

The PRT housing contains a normal thermostat, which is positioned such that the wax's temperature is controlled by both the coolant from the radiator and the bypass. This results in the thermostat being able to vary its opening temperature dependant on ambient conditions. The PRT also contains a sprung loaded valve, which limits the amount flow using the bypass. This means that the engine can run without coolant flowing through the bypass temporarily, to improve heater performance.

The radiator is a cross flow type with an aluminium matrix and has a drain tap on the lower right-hand rear face. The lower radiator mountings are located part way up the end tanks. The mountings are fitted with rubber bushes, which sit on the upper chassis rails. The radiator upper is mounted by pins, which are pushed through rubber bushes mounted in the Front End Carrier (FEC) above the radiator. The radiator also incorporates two connections for the transmission oil cooler pipes.

The radiator top hose is connected to the PRT by the bypass hose and the bottom hose is directly connected to the outlet side of the thermostat housing.

The expansion tank is fitted forward of the LH suspension turret in the engine compartment. The expansion tank allows for the expansion of the coolant as the engine gets hot and also supplies the engine with coolant as the coolant in the engine contracts. The tank also allows any air trapped in the coolant to be removed.

The liquid cooled transmission fluid cooler is mounted in the cold side radiator end tank. It is positioned in the middle of the LH end tank.

For additional airflow through the radiator matrix, particularly when the vehicle is stationary, there is an engine driven Viscous fan unit fitted to the rear of the radiator. The fan is used for engine cooling and for Air Conditioning (A/C) system

cooling. The fan is mounted using a left hand thread.

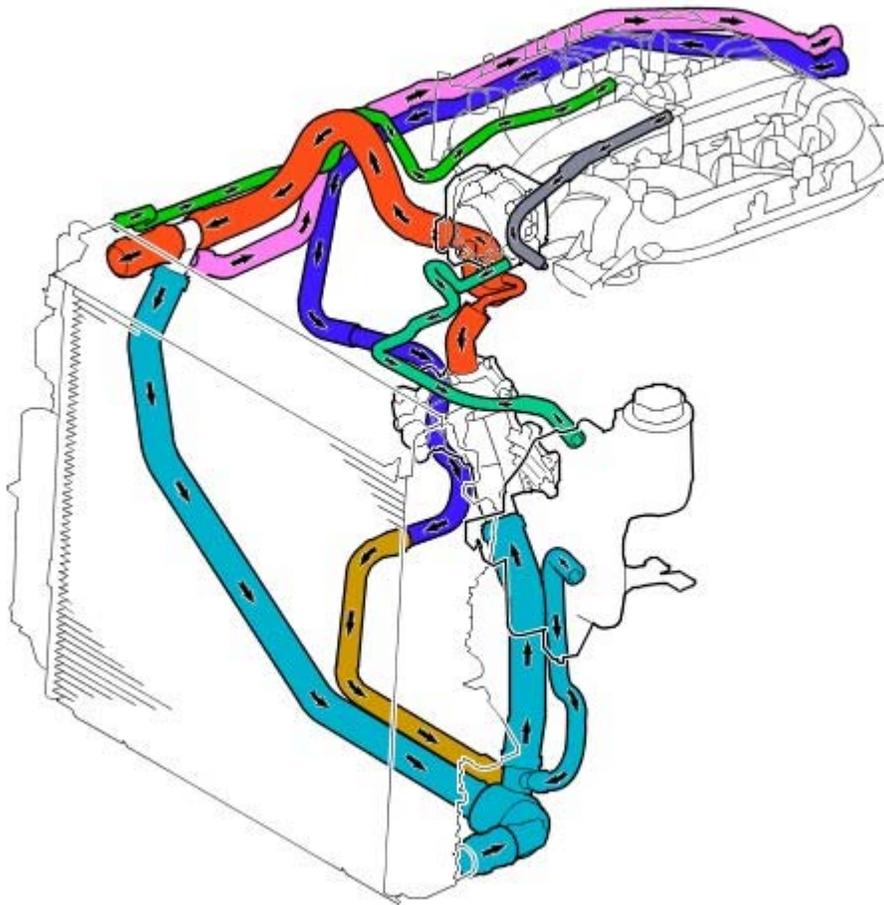
The viscous fan unit is electronically controlled by the ECM to optimise fan speed for all operating conditions.

NOTE :

If the electrical connections to the viscous fan are disconnected the fan will 'idle' and overheating may result. The ECM stores the appropriate fault codes in this case.

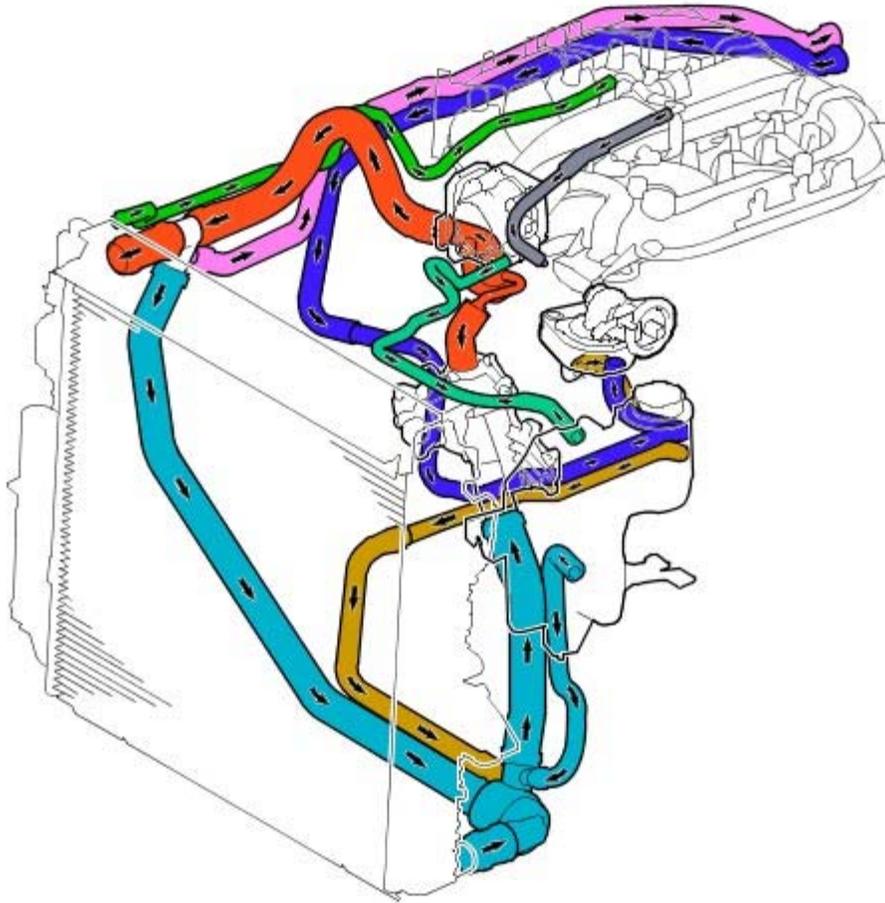
ENGINE COOLING SYSTEM OPERATION

Cooling System Coolant Flow, Without Engine Oil Cooler



E43034

Cooling System Coolant Flow, With Engine Oil Cooler



E43035

When the engine is running the coolant pump is driven by the ancillary drive belt. This forces coolant to circulate around the engine, heater and EOC, while the thermostat and bypass valve are shut. As the temperature and pressure increases the bypass valve is forced open allowing coolant to circulate through the bypass valve. When the temperature reaches 82°C (180°F) the main thermostat begins to open, allowing coolant to circulate through the main radiator. As the thermostat progressively opens (fully open at 95°C (203°F)), the bypass valve progressively closes forcing any coolant through the heater or radiator. Once coolant is allowed to circulate through the radiator, the transmission fluid cooler begins to receive coolant flow.

The increased coolant volume, created by heat expansion, is directed to the expansion tank through a bleed hose from the top of the radiator. The expansion tank has an outlet hose which is connected into the coolant circuit. This outlet hose returns the coolant to the system when the engine cools.

Coolant flows through the radiator from the top right hand tank to the bottom left hand tank and is cooled by air passing through the matrix. The temperature of the cooling system is monitored by the Engine Control Module (ECM) via the Engine Coolant temperature (ECT) sensor located in the cylinder head. The ECM uses signals from this sensor to adjust fuelling according to engine temperature. For additional information, refer to [Electronic Engine Controls](#) (303-14A Electronic Engine Controls - 4.0L)

To control the cooling fan, the ECM sends a Pulse Width Modulated (PWM) signal to the cooling fan module (integral to the ECM). The frequency of the PWM signal is used by the cooling fan module to determine the output voltage supplied to the fan motor.

The ECM varies the duty cycle of the PWM signal between 0 and 100% to vary the fan speed. If the PWM signal is outside the 0 to 100% range, the cooling fan module interprets the signal as an open or short circuit and runs the fans at maximum speed to ensure the engine and gearbox do not overheat.

The speed of the cooling fan is also influenced by vehicle road speed. The ECM adjusts the speed of the cooling fans, to compensate for the ram effect of vehicle speed, using the Controller Area Network (CAN) road speed signal received from the Anti-lock Braking System (ABS) module.

Pressure Relief Thermostat (PRT)

The thermostat is exposed to 85% hot coolant from the engine on one side and 15% cold coolant returning from the radiator bottom hose on the other side. This allows the thermostat to react to the ambient conditions and provide coolant control for both winter and summer use. Hot coolant from the engine passes via holes in the by-pass flow valve into a tube which surrounds 85% of the thermostat sensitive area. Cold coolant from the radiator conducts through the remaining 15% of the sensitive area. In cold ambient conditions, the engine temperature is raised by approximately 10°C (50°F) to compensate for the heat loss of 15% exposure to the cold coolant returning from the bottom hose. This improves heater performance and engine warm-up.

The by-pass flow valve is held closed by a light spring and operates to further assist engine and heater warm-up. When the main valve is closed and the engine speed is at idle, the coolant pump does not produce sufficient flow and pressure to overcome the spring and open the valve. In this condition the valve prevents coolant circulating through the by-pass circuit and directs coolant through the heater matrix only. This provides a higher flow of coolant through the heater matrix improving passenger comfort in cold conditions.

When the engine speed increases above idle, the coolant pump produces a greater flow and pressure than the heater circuit can accommodate. The build up of pressure acts on the flow valve, overcoming the spring pressure, opening the valve and relieving the pressure in the heater circuit. The valve then modulates to provide maximum coolant flow through the heater matrix and allowing excess coolant to flow into the by-pass circuit to provide the engine's cooling requirements at higher engine speeds. The thermostat then regulates the flow through the radiator to maintain the engine at the optimum temperature. Maximum opening of the thermostat, and therefore maximum flow through the radiator, occurs if the coolant temperature reaches 95°C (203°F).