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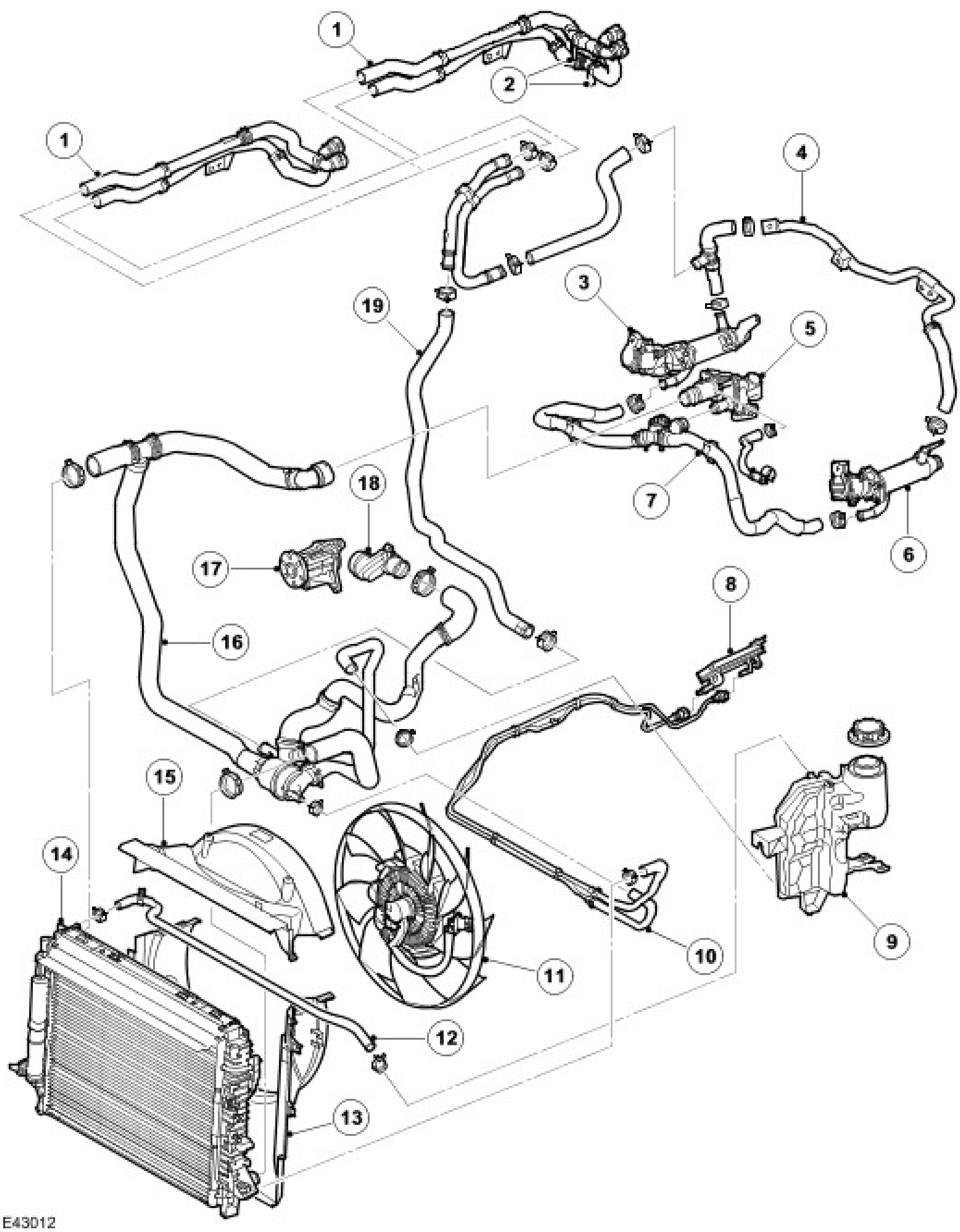
Engine Cooling

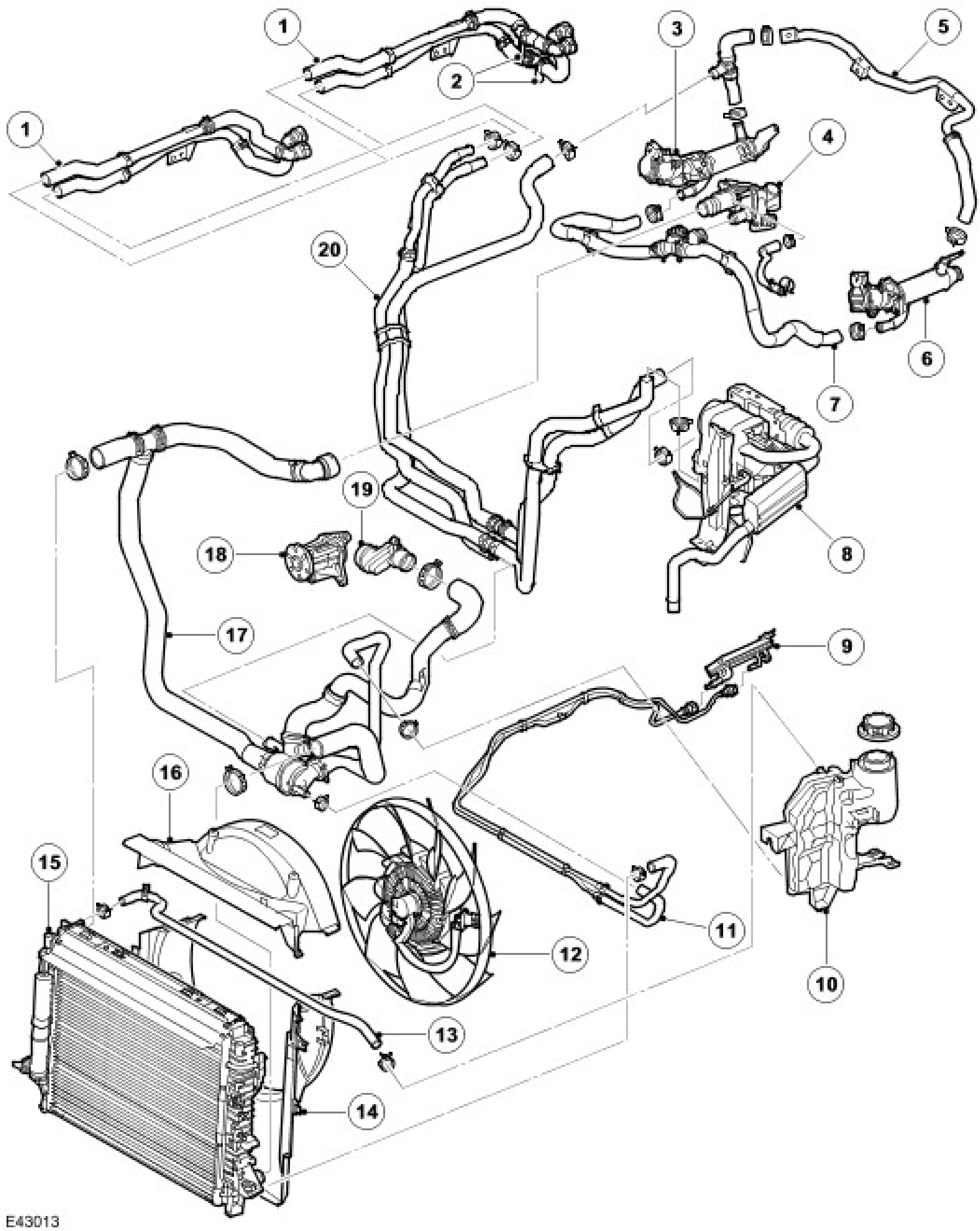
Cooling System Component Layout – Manual Gearbox Without Fuel Burning Heater (FBH)



Item	Part Number	Description
1	-	Heater hose, in and out
2	-	Heater hose, in and out, for vehicles with rear heater (optional)
3	-	EGR valve

4	-	Hose, EGR
5	-	Water outlet assembly
6	-	EGR valve
7	-	Hose, EGR inlet
8	-	Fuel cooler
9	-	Expansion tank
10	-	Hose, fuel cooler
11	-	Cooling fan
12	-	Hose, radiator to expansion tank
13	-	Shroud, lower
14	-	Radiator
15	-	Shroud, upper
16	-	Hose and thermostat assembly
17	-	Water pump
18	-	Water inlet connector
19	-	Heater hose, thermostat

Cooling System Component Layout – Manual Gearbox, With FBH



Item	Part Number	Description
1	-	Heater hose, in and out
2	-	Connections for rear heater (optional)
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4	-	Water outlet assembly
5	-	Hose, EGR
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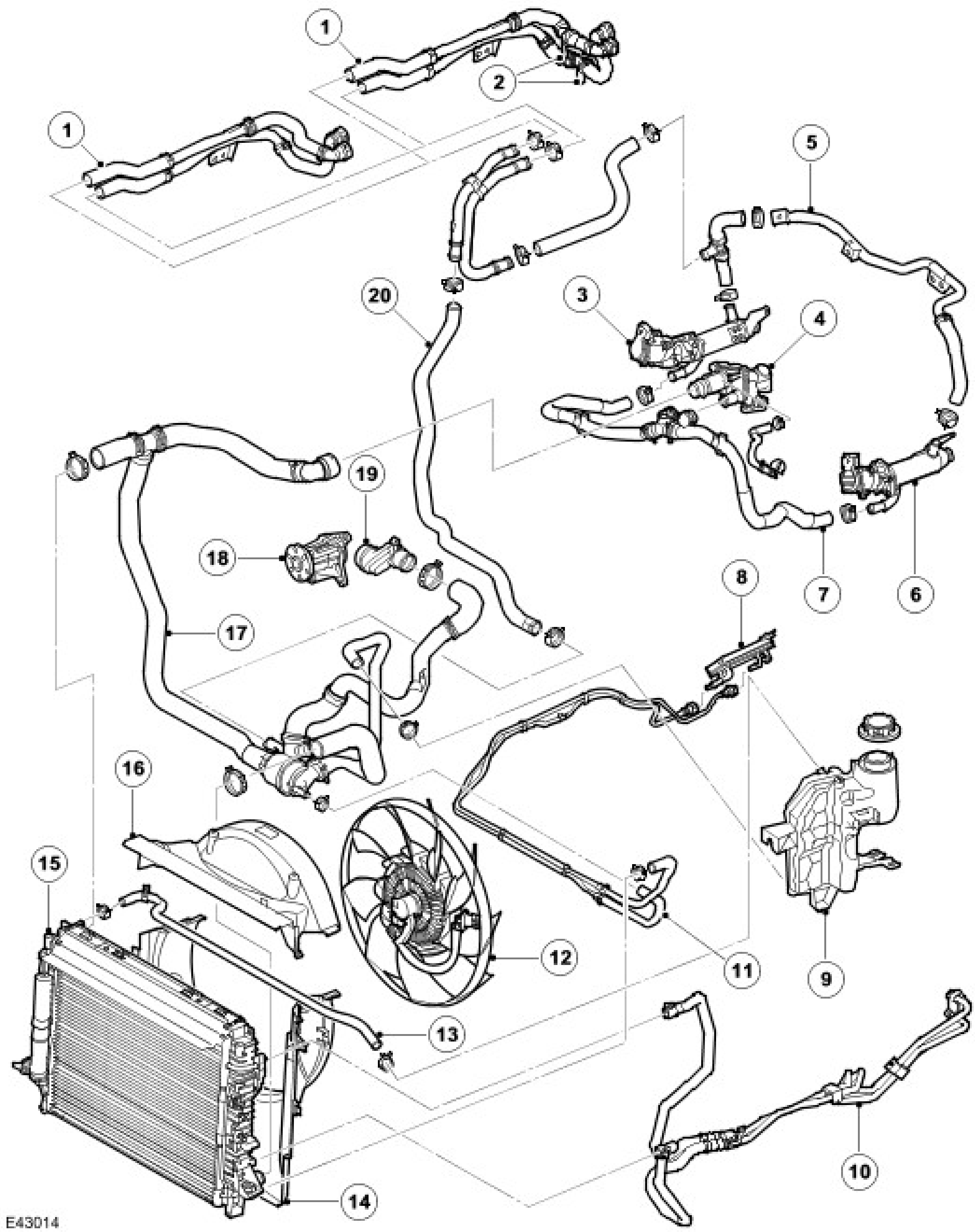
16	-	Shroud, upper
17	-	Hose and thermostat assembly
18	-	Water pump
19	-	Water inlet connector
20	-	FBH hose, in and out

Cooling System Component Layout – Automatic Gearbox Without FBH



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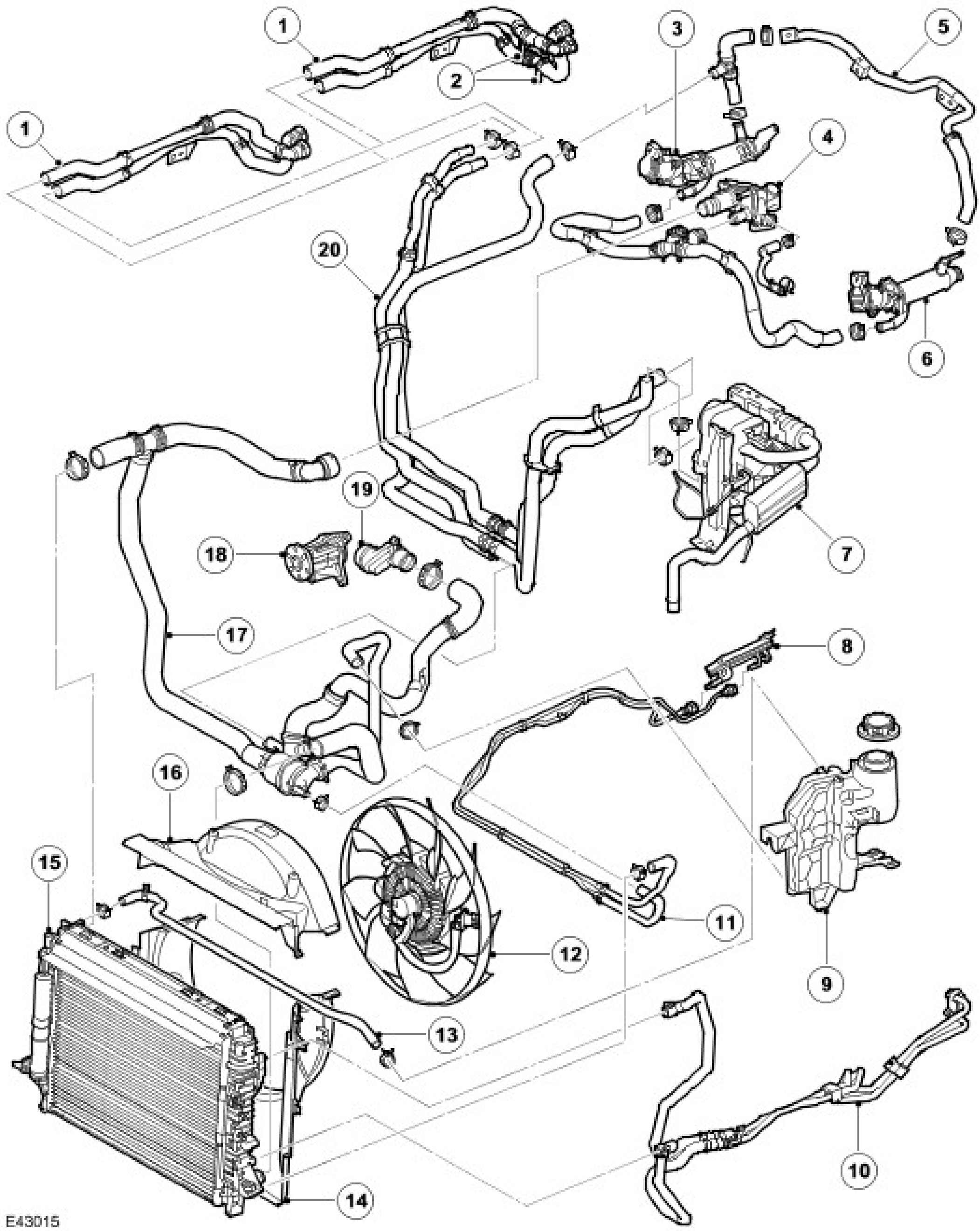

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20	-	FBH hose, in and out

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
- An intercooler
- A passenger compartment heater matrix
- Two fuel coolers
- Two Exhaust Gas Recirculation (EGR) coolers
- A Fuel Burning Heater (FBH) (Market dependant)
- A coolant pump
- A Pressure Relief Thermostat (PRT)
- An expansion tank
- An electro-viscous fan
- Connecting hoses and pipes.

ENGINE COOLING SYSTEM

The coolant is circulated by a centrifugal type pump mounted on the front of the engine and driven by the ancillary drive 'polyvee' belt. The coolant pump circulates coolant around the cylinder block and cylinder heads via a chamber located in the 'vee' of the engine. Some of the coolant flow is diverted through the integrated fuel and engine oil coolers. Having passed through the engine and oil coolers, the coolant returns to the thermostat housing via the by-pass pipe. Coolant also circulates through the EGR coolers to the heater matrix and returns to the engine side of the PRT.

On vehicles fitted with FBH, the coolant circulates through the EGR coolers to the FBH unit (whether active or not) and then on to the heater matrix. The coolant then returns 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 RH 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 intercooler is attached to the bottom of the radiator by two pins, which locate into fittings in the radiator end tanks.

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 (automatic models only) is mounted in the cold side radiator end tank. It is positioned in the middle of the LH end tank.

The 2nd fuel cooler is fed from the cold side end tank of the radiator from a sub cooled section and returns into the PRT housing on the radiator side.

On vehicles fitted with a FBH, the unit is located forward of the LH suspension turret. Coolant flows through the FBH whether it is active or not. The exhaust from the burner is vented into the front LH wheel arch. For additional information, refer to Auxiliary Heater (412-02B Auxiliary Heating)

For additional airflow through the radiator matrix, particularly when the vehicle is stationary, there is an engine driven electro-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. This unit functions as a normal viscous fan, but with electronic control over the level engagement of the clutch. The Engine Control Module (ECM), which determines the required fan speed, controls the level of clutch engagement. The ECM determines engagement based on the coolant, charge air, ambient and transmission oil temperatures and the A/C pressure. The fan is mounted using a left hand thread.

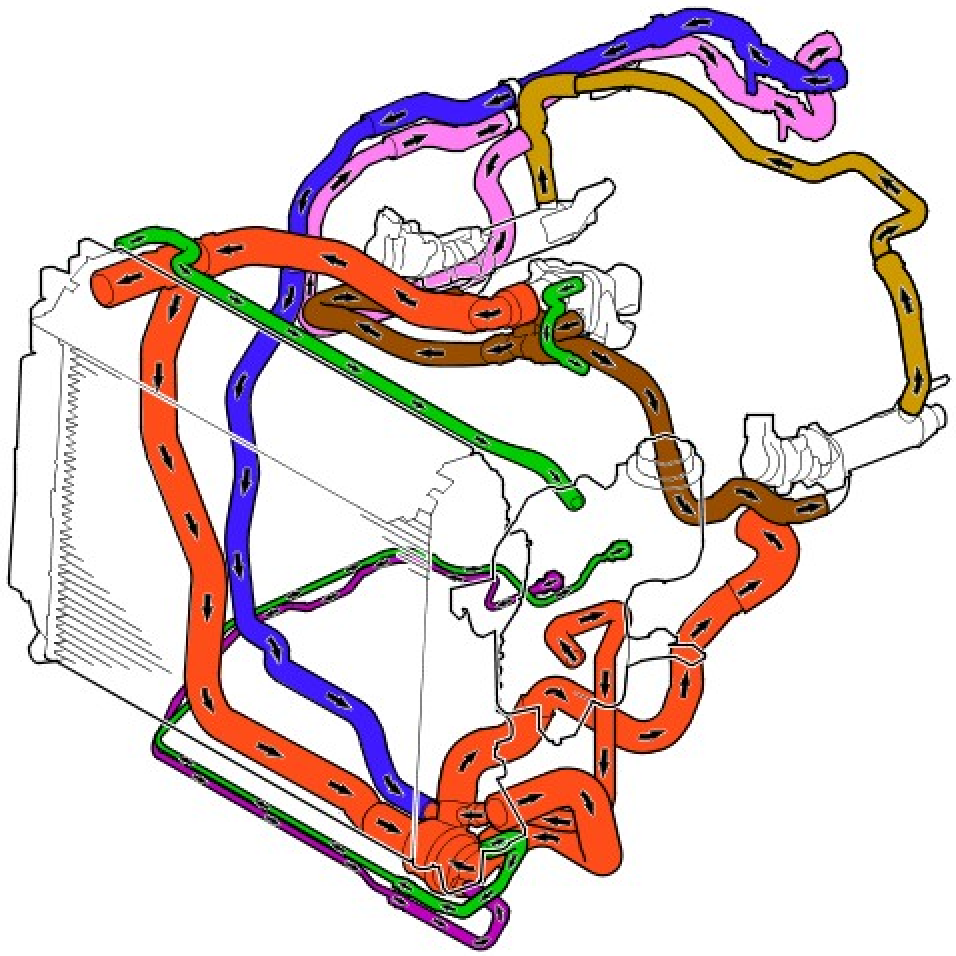
The viscous fan unit is electronically controlled by the ECM to optimise fan speed for all operating conditions.

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.

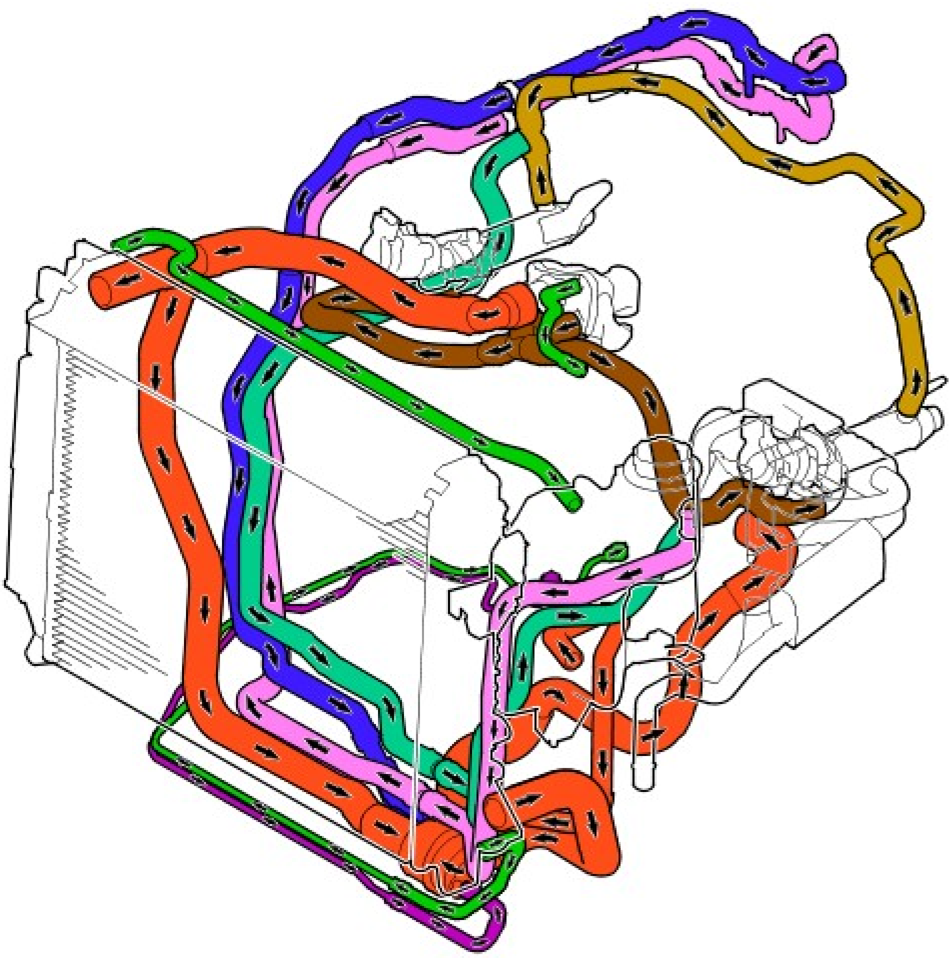
ENGINE COOLING SYSTEM OPERATION

Cooling System Coolant Flow – Manual Gearbox Without FBH



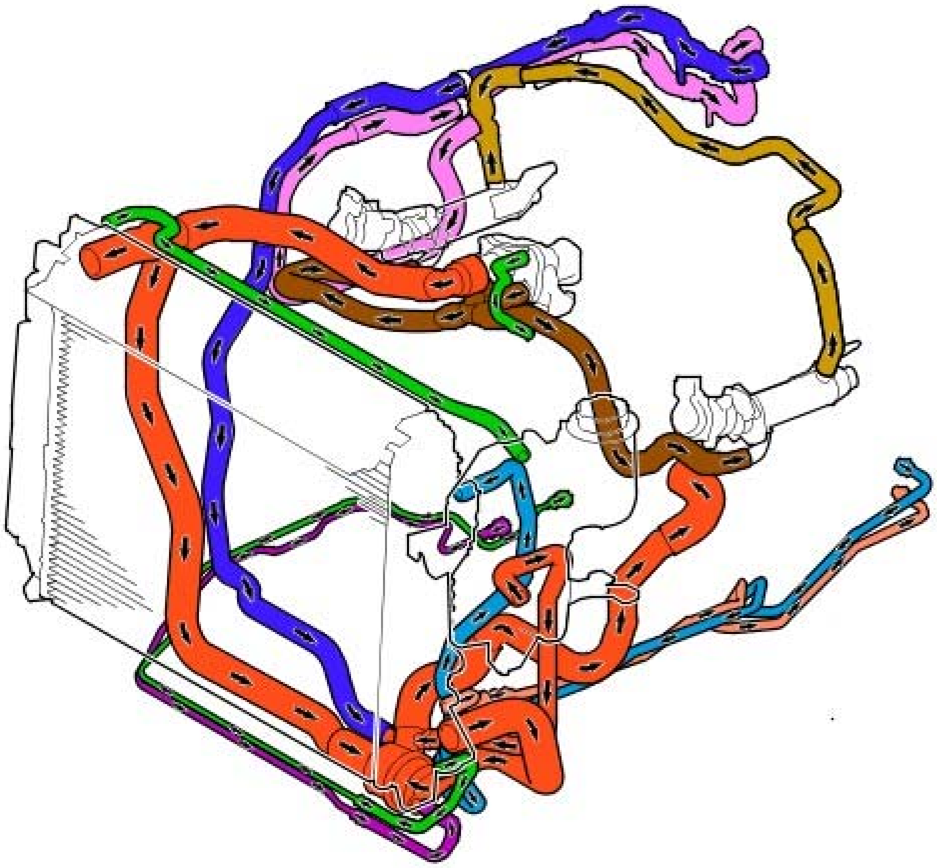
E43016

Cooling System Coolant Flow – Manual Gearbox With FBH



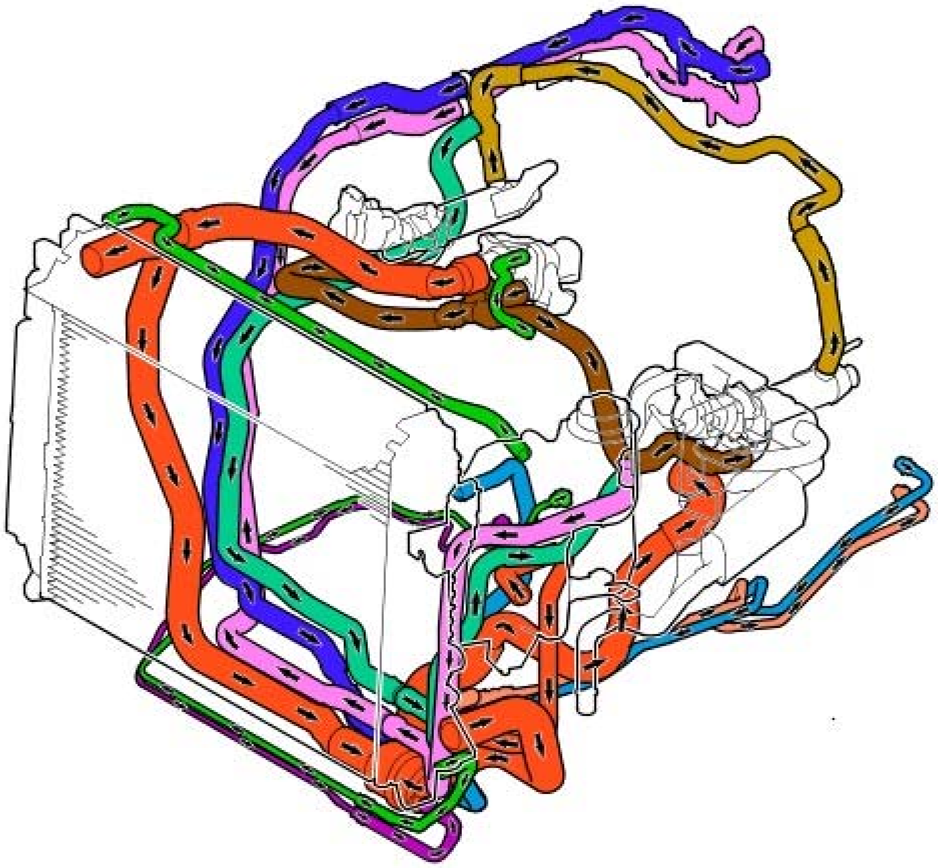
E43017

Cooling System Coolant Flow – Automatic Gearbox Without FBH



E43018

Cooling System Coolant Flow – Automatic Gearbox With FBH



E43019

When the engine is running the coolant pump is driven by the ancillary drive belt. This forces coolant to circulate around the engine and heater, 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 (automatic models only) and fuel coolers begin 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 ECM via the Engine Coolant temperature (ECT) sensor located in the cylinder head. The ECM uses signals from this sensor to control the cooling fan operation and adjust fuelling according to engine temperature. For additional information, refer to Electronic Engine Controls (303-14C Electronic Engine Controls - 2.7L Diesel)

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 ECM operates the fan in response to inputs from the ECT sensor, the transmission oil temperature sensor, the charge air temperature sensor, the A/C switch and the A/C pressure sensor. For additional information, refer to Air Conditioning (412-03A Air Conditioning - 4.0L)

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 assists 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).