

Description and Operation

System Operation

Engine Cooling System Operation



E290174

Item	Description
1	Bypass hose connection to coolant pump
2	Return from the oil cooler
3	Main connection to cylinder head
4	Hose connection to radiator (top hose)

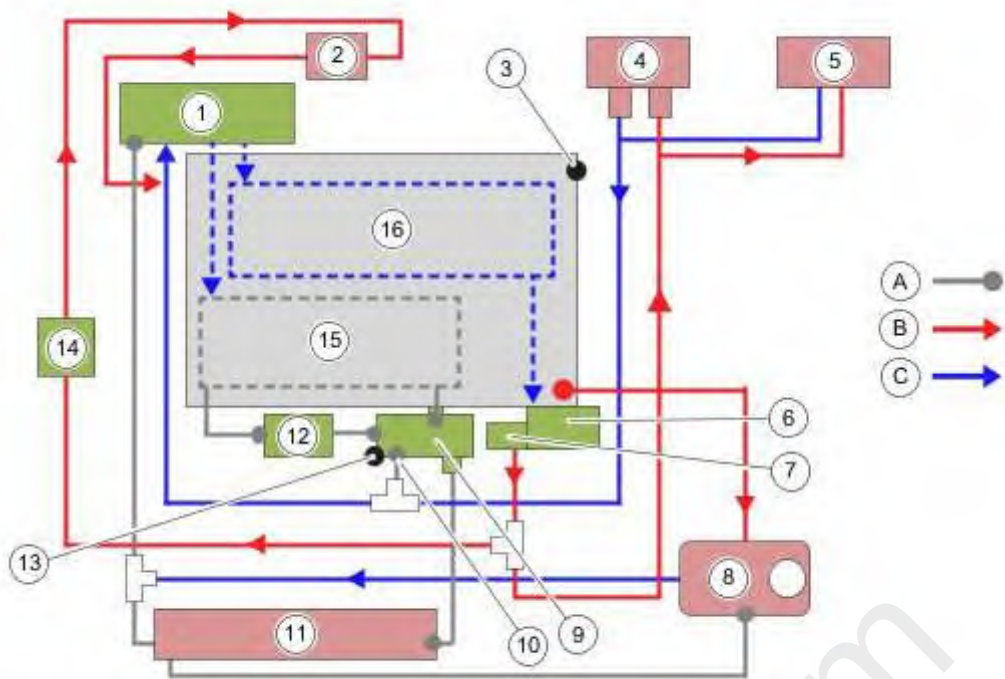
The engine enters the warm-up phase after a cold start. During this period the thermostat is closed and the coolant circulates through the inner upper cylinder circuit.

The thermostat bypass valve opens during normal operation and the coolant is routed through the inner upper and lower engine circuits in the cylinder head.

The bypass is closed during the hot phase and the entire volumetric coolant flow is passed through the radiator.

Cooling System During the Warm-up Phase

Coolant Temperature Below 70 °C



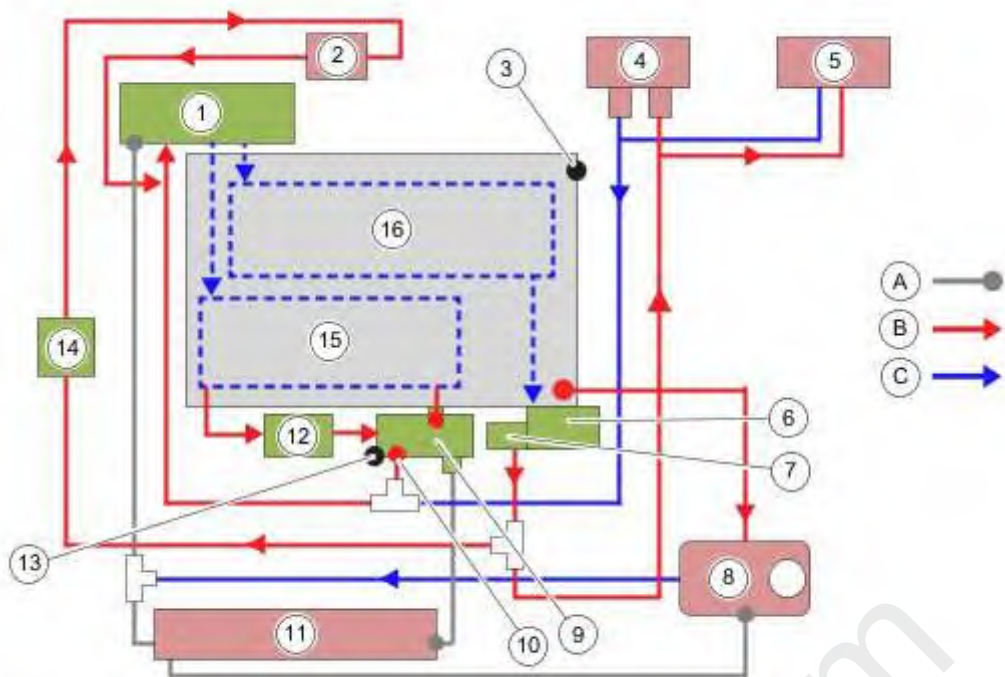
E244590

Item	Description
A	No flow
B	Hot flow
C	Cold flow
1	Coolant pump
2	AdBlue® injector
3	CHT (cylinder head temperature) sensor
4	Heater
5	Rear heater (if equipped)
6	EGR (exhaust gas recirculation)
7	EGR cooler
8	Degas bottle
9	Thermostat
10	Bypass to coolant pump
11	Radiator
12	Oil cooler
13	ECT (engine coolant temperature) sensor
14	AdBlue® injector electric pump
15	Cylinder head lower deck
16	Cylinder head top deck

The coolant temperature is below 70 °C when the engine is in the warm-up phase. The thermostat is closed and the coolant circulates through the inner upper engine circuit.

Cooling System During Normal Operation

Coolant temperature between 70 °C and 88 °C



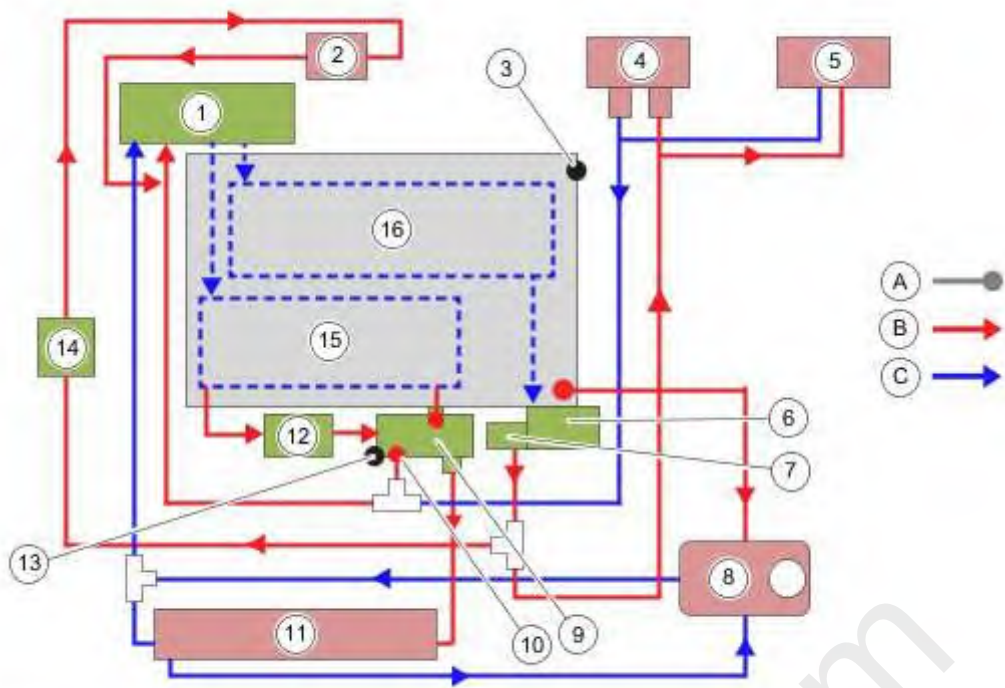
E244591

Item	Description
A	No flow
B	Hot flow
C	Cold flow
1	Coolant pump
2	AdBlue® injector
3	CHT sensor
4	Heater
5	Rear heater (if equipped)
6	EGR
7	EGR cooler
8	Degas bottle
9	Thermostat
10	Bypass to coolant pump
11	Radiator
12	Oil cooler
13	ECT sensor
14	AdBlue® injector electric pump
15	Cylinder head lower deck
16	Cylinder head top deck

The coolant temperature reaches the thermostat opening temperature of 70 °C. The thermostat bypass valve opens during normal operation (between 70 °C and 88 °C) and the coolant is routed through the inner-upper and lower engine circuits in the cylinder head.

Cooling System During Hot Operation

Coolant temperature above 88 °C



E244592

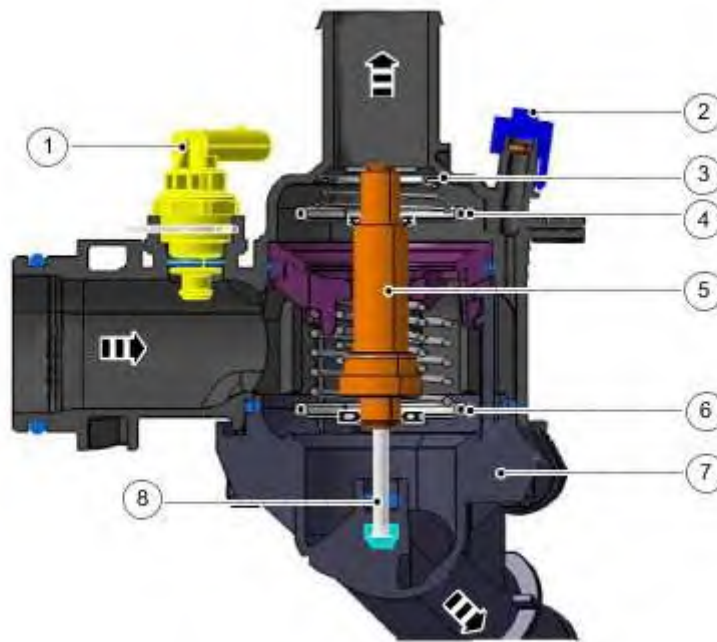
Item	Description
A	No flow
B	Hot flow
C	Cold flow
1	Coolant pump
2	AdBlue® injector
3	CHT sensor
4	Heater
5	Rear heater (if equipped)
6	EGR
7	EGR cooler
8	Degas bottle
9	Thermostat
10	Bypass to coolant pump
11	Radiator
12	Oil cooler
13	ECT sensor
14	AdBlue® injector electric pump
15	Cylinder head lower deck
16	Cylinder head top deck

NOTE: The 'Overheating' warning lamp comes on at an ECT of 112 °C and the engine switches off above an ECT of 118 °C.

When the coolant temperature reaches above 88 °C the thermostat bypass is closed. The thermostat opens fully, enabling coolant to flow to the top radiator hose. The entire volumetric flow is passed through the radiator.

Component Description

Three-Plate Thermostat



E230394

Item	Description
1	ECT (engine coolant temperature) sensor
2	Vent assembly
3	Bypass plate
4	Closing plate
5	Housing with wax element
6	Main valve plate
7	Heating element
8	Pin

This is an electrically assisted thermostat which functions in the same way as a conventional thermostat, but at a higher engine temperature. Coolant flows around the thermostat and as the temperature rises, the wax material in the thermostat melts, increasing in volume, moving a piston which opens the thermostat allowing coolant to flow to the radiator.

Under some heavy load conditions as determined by the PCM, the thermostat heating element (integrated in the thermostat) is actuated by the PCM. This additional heat source allows the wax material to expand quickly, opening the thermostat regardless of the coolant temperature. The PCM is able to increase coolant flow when it needs to, enabling the engine to operate within its optimum temperature range without the danger of overheating.

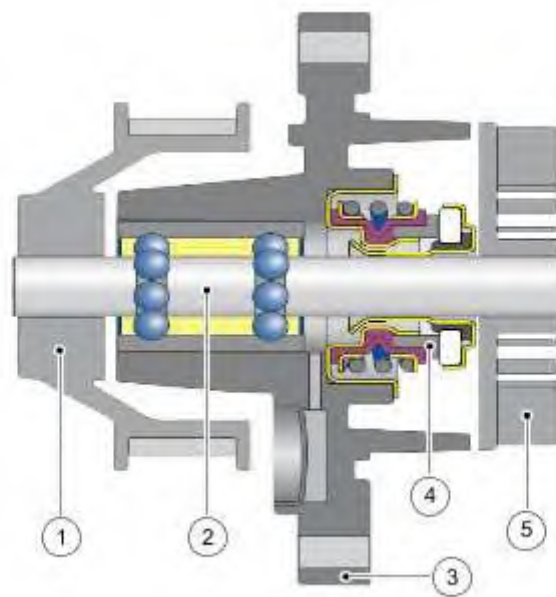
The heating element is controlled via a PWM (pulse width modulation) signal from the PCM (powertrain control module).

The [ECT](#) sensor is mounted to the thermostat housing. The voltage value supplied by the ECT sensor is assigned to a corresponding temperature value by the PCM.

The engine coolant temperature is required for the following calculations:

- Idle speed
- Injection timing
- Injected fuel quantity
- EGR quantity
- Glow plug control
- Actuation of the temperature gauge and glow plug warning indicator
- Fan control

Coolant Pump



E230377

Item	Description
1	Drive pulley
2	Bearing with pump shaft
3	Pump housing
4	Mechanical seal package
5	Impeller

The mechanical coolant pump is flange-mounted directly to the engine case and is driven by the crankshaft pulley using a dedicated toothed drive belt.

The coolant pump bearing shaft is an integral part of the bearing. This means that the balls roll directly on the pump shaft.

NOTE: The coolant pump must not be operated when the mechanical seal is dry.

The mechanical seal package contains two slide rings used to seal around the rotating pump shaft. The coolant in the cooling system lubricates and cools the slide rings. The pressure in the cooling system and the rotation of the pump shaft pushes coolant between the slide rings for low-wear fluid friction.