



303-03A Engine Cooling - 2.3L EcoBoost (199kW/270PS)

2025 Bronco

Description and Operation

Procedure revision date: 02/17/2023

Engine Cooling - System Operation and Component Description

System Operation

Engine coolant flows primarily from the engine to the radiator circuit and back to the coolant pump. Coolant is sent from the coolant pump through the engine block and cylinder head. A separate circuit from the engine also feeds the heater core with coolant. The coolant pump, operated by engine rotation through the accessory drive belt, circulates the coolant. The coolant thermostat is a control valve actuated by coolant temperature. When the thermostat is closed, coolant flow bypasses the radiator circuit and returns to the coolant pump. When the thermostat is opened, coolant flows through the radiator circuit to transfer engine-generated heat to the outside air.

The engine uses a cold side thermostat. This means the thermostat is located at the lower radiator hose connection to the engine, where coolant enters the engine after being cooled by the radiator. During initial warm-up, the cooler coolant from the radiator quickly closes the thermostat after the warm coolant in the engine opens the thermostat slightly. The thermostat opens and closes several times before the coolant coming from the radiator is warm enough to allow the thermostat to remain open. The engine must run much longer than a vehicle with a hot side thermostat before the thermostat remains fully opened.

The degas bottle holds surplus coolant and removes air from the cooling system. It also allows for coolant expansion and system pressurization, replenishes coolant to the cooling system and serves as the location for service fill.



signed to verify correct cycle and runs for a calibrated threshold. If a malfunction occurs, PTC PTC or PTC sets, and the MIL illuminates.

Fail Safe Cooling

A strategy called fail safe cooling is built into the PCM that controls the engine if it starts to overheat.

Fail safe cooling has two modes: A closed loop mode that relies on a CHT 2 sensor and an open loop mode that relies on an ECT sensor. When the engine starts to overheat, the decision to go into closed loop or open loop mode is made based on sensor availability and sensor failures. Closed loop mode takes priority over open loop. The reason is that a good CHT 2 sensor can reliably track engine temperature at all times, while the ECT sensor fails to do so.

Closed Loop Mode

Stage 1 of the strategy begins if the engine starts to overheat. The CHT 2 sensor transmits a signal to the PCM , which moves the temperature gauge pointer into the red zone.

If the engine is not switched off and the temperature continues to rise, the Powertrain Check Lamp is illuminated. This indicates to the driver that the engine is approaching critical limits and should be stopped. At this point DTC P1285 sets in the PCM and is retrieved using a scan tool.

Stage 2 of the strategy begins if the lamp and temperature gauge are ignored by the driver. The PCM starts to control the engine by cutting out 2 cylinders and restricting load. The RPM will be limited below 3,000 RPM initially then slowly ramped down with time to as low as 800 RPM . Simultaneously the MIL illuminates. This indicates that long term engine damage can occur and vehicle emissions will be affected. At this point DTC P1299 sets in the PCM and is retrieved using a scan tool.

Air is drawn into the deactivated cylinders to help control the temperature of the engine internal components. The deactivated cylinders alternate to allow even cooling of all the cylinders.

NOTE: *If the driver is using a high percentage of throttle travel, for example, passing another vehicle, when the PCM starts engine deactivation (Stage 2), the deactivation will be delayed for 10 seconds.*

NOTE: *After 2-cylinder operation has started, the engine will not revert to 4-cylinder operation, even if the temperature should fall, until the ignition is switched off and then on again.*

NOTE: *The MIL can only be extinguished by using a scan tool after the fault has been corrected and the DTC cleared.*

Stage 3 of the strategy begins if the engine temperature continues to rise. This results in the engine being totally disabled before major engine damage or seizure occurs. The Powertrain Check Lamp begins to flash, indicating to the driver that the engine will be switched off after 30 seconds. This allows the driver time to choose a suitable parking place.

Open Loop Mode

This mode is entered when the ECT sensor indicates a high engine temperature that is rising at a dangerously high rate, much faster than expected based on current engine running conditions. This mode can also be entered when all sensors used in fail safe cooling determination have failed.

When this mode is activated, the PCM restricts load and engine speed to below 3000 RPM , starts to slowly lower engine speed to as low as 800 RPM and holds the speed there.

At the same time, the PCM also moves the temperature gauge pointer into the red zone and sets DTC P1285.

If the engine is not switched off after a short period of time, the engine will be totally disabled before major engine damage or seizure occurs, the Powertrain Check Lamp begins to flash, indicating to the driver that the engine will be switched off and sets DTC P1299.

If the driver decides to restart the vehicle, it will be restarted but with DTC P1299 still set and the engine speed is limited to 800 RPM . This mode can only be reset by clearing the DTC using a diagnostic scan tool.

Thermostat Monitor

The thermostat monitor identifies a thermostat concern.

During a cold start, when the thermostat should be closed, the thermostat monitor uses intake air temperature, engine speed, and engine load to predict the engine coolant temperature. Once the predicted temperature has exceeded a target temperature for a length of time, the actual engine coolant temperature is compared to its required threshold. This threshold is 11°C (20°F) below the thermostat regulating temperature. If the engine coolant temperature exceeds this threshold, the thermostat is functioning correctly. If the engine coolant temperature is too low, the thermostat may be stuck open and a DTC sets. This monitor is executed once per drive cycle during a cold start and run for a calibrated threshold.

During a cold start, when the thermostat should be closed, the heavy duty thermostat monitor uses intake air temperature, engine speed, and engine load to predict the engine coolant temperature. Once the predicted temperature has exceeded a target temperature for a length of time, the actual engine coolant temperature is compared to its required threshold. This threshold is 11°C (20°F) below the thermostat regulating temperature. If the engine coolant temperature exceeds this threshold, the thermostat is functioning correctly. If the engine coolant temperature is too low, the thermostat may be stuck open and a DTC sets. This monitor is executed during a cold start. After passing the cold start monitor

conditions the actual engine coolant temperature is continuously compared to the thermostat regulating temperature threshold. If measured engine coolant temperature drops below the thermostat regulating temperature threshold the cold start monitor is enabled again and the timer resets. If the engine coolant temperature is too low, the thermostat may be stuck open and a DTC sets.

Component Description

Cooling Fan

The PCM monitors certain parameters, such as engine coolant temperature, vehicle speed, A/C status and A/C pressure to determine engine cooling fan needs.

The PCM controls the fan speed and operation using a duty cycle output on the FCV circuit. The fan controller (located at or part of the engine cooling fan assembly) receives the FCV command and operates the cooling fan at the speed requested by varying the power applied to the fan motor.

The fan controller can detect certain failure modes within the fan motors. Under certain failure modes, such as a motor that is drawing excessive current, the fan controller shuts the fans off. Fan motor concerns may not set a specific DTC . With the fan motor disconnected from the fan controller, voltage may not be present at the fan controller.

CHT 2 Sensor

NOTE: *If the CHT 2 sensor is removed from the exhaust manifold for any reason it must be replaced with a new sensor.*

The CHT 2 sensor is a thermistor device in which resistance changes with the temperature. The resistance of a thermistor decreases as temperature increases, and the resistance increases as the temperature decreases. The varying resistance affects the voltage drop across the sensor pins and provides electrical signals to the PCM corresponding to temperature.

Thermistor type sensors are considered passive sensors. A passive sensor is connected to a voltage divider network so varying the resistance of the passive sensor causes a variation in total current flow. Voltage that is dropped across a fixed resistor (pull up resistor) in series with the sensor resistor determines the voltage signal at the PCM . This voltage signal is equal to the reference voltage minus the voltage drop across the fixed resistor.

The CHT 2 sensor is in the cylinder head. The CHT 2 sensor provides complete engine temperature information and is used to infer coolant temperature. If the CHT 2 sensor conveys an overheating condition to the PCM , the PCM initiates a fail safe cooling

strategy based on information from the CHT 2 sensor. A cooling system concern, such as low coolant or coolant loss, could cause an overheating condition. As a result, damage to major engine components could occur. Using both the CHT 2 sensor and fail safe cooling strategy, the PCM prevents damage by allowing air cooling of the engine and limp home capability. For additional information, refer to Powertrain Control Software for Fail-Safe Cooling Strategy in this section.

ECT Sensor

The ECT sensor is a thermistor device in which resistance changes with temperature. The resistance of a thermistor decreases as the temperature increases, and the resistance increases as the temperature decreases. The varying resistance changes the voltage drop across the sensor pins and provides electrical signals to the PCM corresponding to temperature.

Thermistor type sensors are considered passive sensors. A passive sensor is connected to a voltage divider network so varying the resistance of the passive sensor causes a variation in total current flow. Voltage that is dropped across a fixed resistor (pull up resistor) in series with the sensor resistor determines the voltage signal at the PCM . This voltage signal is equal to the reference voltage minus the voltage drop across the fixed resistor.

The ECT sensor is in an engine coolant passage and measures the engine coolant temperature. The PCM uses the engine coolant temperature input for fuel control and for cooling fan control. The ECT sensor can be a threaded or twist lock type.

Transmission Fluid Heater Coolant Control Valve (If Equipped)

The transmission fluid heater coolant control valve is an electrically controlled solenoid to allow or bypass the flow of engine coolant through the transmission fluid heat exchanger. This electrically controllable valve is normally open when not energized. The valve receives a fused 12V B+ (battery positive voltage) supply when the ignition is in the run or start position and is grounded by the PCM via a low side driver. The PCM monitors the solenoid and circuits for electrical faults and sets an appropriate DTC .