Air Temperature Description and Operation

The air temperature controls are divided into 4 areas:

- HVAC control components
- Heating and A/C operation
- Engine coolant
- A/C cycle

HVAC CONTROL COMPONENTS

HVAC Control Module

The HVAC control module is a non-class 2 device that interfaces between the operator and the HVAC system to maintain air temperature and distribution settings. The battery positive and ignition 3 voltage circuits provide power to the control module. The temperature door is controlled by cable. The control module supports the following features:

Feature	Availability
After Blow	No
Purge	No
Personalization	No
Actuator Calibration	Yes

A/C Refrigerant Pressure Sensor

The A/C refrigerant pressure sensor is a 3-wire piezoelectric pressure transducer. A 5-volt reference, low reference, and signal circuits enable the sensor to operate. The A/C pressure signal can be between 0-5 volts. When the A/C refrigerant pressure is low, the signal value is near 0 volts. When the A/C refrigerant pressure is high, the signal value is near 5 volts.

The A/C refrigerant pressure sensor protects the A/C system from operating when an excessively high or low pressure condition exists. The powertrain control module (PCM) disables the compressor clutch under the following conditions:

- The A/C high side pressure is more than 2 929 kPa (425 psi).
- The clutch will be enabled after the high side pressure decreases to less than 1 376 kPa (200 psi).
- A/C low side pressure is less than 269 kPa (39 psi).
- The clutch will be enabled or will allow engagement again after the low side pressure increases to more than 296 kPa (43 psi).

Evaporator Low Ambient Protection

The refrigerant temperature at the temperature sensor in the thermal expansion valve (TXV) controls cycling of the compressor clutch to prevent freezing of the evaporator core. The compressor is disabled when the temperature goes below 3°C (37°F) and vehicle speed is greater than 8 km/h (5 mph). The compressor is enabled when the temperature exceeds 4°C (40°F). The minimum cycling time off is 4 seconds. For purposes of converting a voltage to a temperature value in the diagnosis of the temperature sensor located within the TXV at the inlet outlet of the evaporator the following conversion chart has been inputted. The evaporator temperature sensor is an input to the body control module (BCM).

TEMP (°C/°F)	MIN/MAX (BCM) Voltage
-2/28	2.80/2.90
-1/30	2.73/2.83
0/32	2.66/2.76
1/34	2.59/2.69
2/36	2.52/2.62
3/38	2.45/2.55
4/40	2.38/2.48
6/42	2.31/2.41
7/44	2.25/2.35
24/75	1.34/1.37
SET POINT	
-40/-40	OPEN (4.85)

81/178	SHORT (0.122)

Heating and A/C Operation

The purpose of the heating and A/C system is to provide heated and cooled air to the interior of the vehicle. The A/C system will also remove humidity from the interior and reduce windshield fogging. The vehicle operator can determine the passenger compartment temperature by adjusting the air temperature control. Regardless of the temperature setting, the following can effect the rate that the HVAC system can achieve the desired temperature:

- Recirculation
- Difference between inside and desired temperature
- Difference between ambient and desired temperature
- Blower motor speed setting
- Mode setting

The vehicle operator can activate the A/C system by pressing the A/C switch. The A/C system can operate regardless of the temperature setting.

The powertrain control module (PCM) will operate the A/C system automatically in FRONT DEFROST mode to help reduce moisture inside the vehicle. The A/C LED will not illuminate unless the driver presses the A/C request switch on the HVAC control module. The A/C system maybe running without the A/C LED indicator illuminated when in FRONT DEFROST mode. The HVAC system uses a compressor that incorporates a thermal switch that opens once the compressor temperature exceeds 211-217°C (380-454°F) creating an open circuit. The following conditions must be met in order for the PCM to turn on the compressor clutch:

- BCM
  - Battery voltage between 11-16 volts
  - A/C request from the HVAC control module
- PCM
  - Engine coolant temperature (ECT) is greater than 117°C (243°F).
  - Engine speed is less than 4,760 RPM.
  - A/C pressure is between 2,929-2,706 kPa (425-39 psi).

Once engaged, the compressor clutch will be disengaged for the following conditions:

- Throttle position is 100 percent
- A/C pressure is more than 2,929 kPa (425 psi).
- A/C pressure is less than 269 kPa (39 psi).
- ECT is more than 120°C (248°F).
- Engine speed is more than 6240 RPM.
- Transmission shift
- PCM detects excessive torque load.
- PCM detects insufficient idle quality.
- PCM detects a hard launch condition.

When the compressor clutch disengages, the compressor clutch diode protects the electrical system from a voltage spike.

Engine Coolant

Engine coolant is the key element of the heating system. The thermostat controls engine operating coolant temperature. The thermostat also creates a restriction for the cooling system that promotes a positive coolant flow and helps prevent cavitation. Coolant enters the heater core through the inlet heater hose, in a pressurized state.

The heater core is located inside the HVAC module. The heat of the coolant flowing through the heater core is absorbed by the ambient air drawn through the HVAC module. Heated air is distributed to the passenger compartment, through the HVAC module, for passenger comfort.

The amount of heat delivered to the passenger compartment is controlled by opening or closing the HVAC module air temperature door. The coolant exits the heater core through the return heater hose and recirculated back through the engine cooling system.

A/C Cycle

Refrigerant is the key element in an air conditioning system. R-134a is presently the only EPA approved refrigerant for automotive use. R-134a is a very low temperature gas that can transfer the undesirable heat and moisture from the passenger compartment to the outside air.

The A/C compressor is belt driven and operates when the magnetic clutch is engaged. The compressor builds pressure on the vapor refrigerant, which adds heat to the refrigerant. The

refrigerant is discharged from the compressor, through the discharge hose, and forced to flow to the condenser and then through the balance of the A/C system. The A/C system is mechanically protected with the use of a high pressure relief valve. If the high pressure switch were to fail or if the refrigerant system becomes restricted, and the refrigerant pressure continues to rise, the high pressure relief valve will pop open and release refrigerant from the system.

Compressed refrigerant enters the condenser in a high temperature, high pressure vapor state. As the refrigerant flows through the condenser, the heat of the refrigerant is transferred to the ambient air passing through the condenser. Cooling the refrigerant causes the refrigerant to condense and change from a vapor to a liquid state.

The condenser is located in front of the radiator for maximum heat transfer. The condenser is made of aluminum tubing and aluminum cooling fins, which allows rapid heat transfer for the refrigerant. The semi-cooled liquid refrigerant exits the condenser and flows through the liquid line, to the thermal expansion valve (TXV).

The TXV is located at the evaporator inlet and outlet pipes. The TXV is the dividing point for the high and the low pressure sides of the A/C system. As the refrigerant passes through the TXV, the pressure on the refrigerant is lowered. Due to the pressure differential on the liquid refrigerant, the refrigerant will begin to boil at the TXV. The TXV also meters the amount of liquid refrigerant that can flow into the evaporator.

Refrigerant exiting the TXV flows into the evaporator core in a low pressure, liquid state. Ambient air is drawn through the HVAC module and passes through the evaporator core. Warm and moist air cause the liquid refrigerant to boil inside of the evaporator core. The boiling refrigerant absorbs heat from the ambient air and draws moisture onto the evaporator. The refrigerant exits the evaporator through the suction line and back to the compressor, in a vapor state, and completing the A/C cycle of heat removal. At the compressor, the refrigerant is compressed again and the cycle of heat removal is repeated.

The conditioned air is distributed through the HVAC module for passenger comfort. The heat and moisture removed from the passenger compartment condense, and is discharged from the HVAC module as water.