

## Lubricants

### *Operation*

Automotive air conditioning lubricants are specially formulated because of how and where they operate. Air conditioning oils must be “dry” (having little or no water content) and mix with the system’s refrigerant so they can circulate. They must lubricate system components under temperatures ranging from -30°F to 200°F. Refrigerant oil is circulated throughout the system by the compressor.

Different oils are used in automotive A/C systems, based on the type of refrigerant. Polyalkylene Glycol (PAG) oil is used for R-134a refrigerant.

The three types of PAG oil are:

- PAG-R for rotary compressors
- PAG-S for swash plate compressors, and
- PAG-F for the FOT system on the Quest.

Refer to the service manual for the correct oil for the system you are servicing.

|       |   |
|-------|---|
| NOTE: | PAG oil is very hygroscopic (absorbs moisture from the air) and should be exposed to the atmosphere as little as possible while charging an R134a system. |
|-------|---|

### *Malfunctions*

Oil contamination, including moisture, can cause system failures. Improper lubrication can cause abnormal wear to the compressor as well as corrosion to other system components.

Different types of refrigerant oil (even PAG oils) are not interchangeable and should never be mixed. Because vehicles with R-12 systems continue coming in for service, it is important to remember that R-12 systems use mineral oil instead of PAG oil. Adding PAG oil to an R-12 system (or vice versa) can cause seal failure and refrigerant leakage.

In the old R-12 systems, lines and hoses relied on refrigerant oil to maintain seal integrity and prevent leakage at hose and line fittings. Newer R134a air conditioning systems use barrier-type hoses that are self-sealing and prevent refrigerant leakage with or without refrigerant oil.

Insufficient oil in the system will damage the compressor due to lack of lubrication, but excess oil will collect in the condenser and prevent proper cooling performance. When working with the ACR5 AC Service Center or replacing components, make sure to replace the exact amount of oil required. The best way to be certain is to drain all the oil, then refill with the amount specified in the service manual.

### *Diagnosis*

If the compressor sounds as though it needs lubricating, it probably does. Check the

system for debris, and replace the compressor if needed.

If cooling performance is poor despite several recent repairs, the system may contain excess lubricant, especially if oil was added to the system without draining and measuring all the oil.

## Climate Control Variations

There are two basic types of climate control: manual temperature control (MTC) and automatic temperature control (ATC). Manual controls are self-explanatory and will not be discussed in detail; however, many of the diagnostic exercises are designed specifically for vehicles with manual climate control systems.

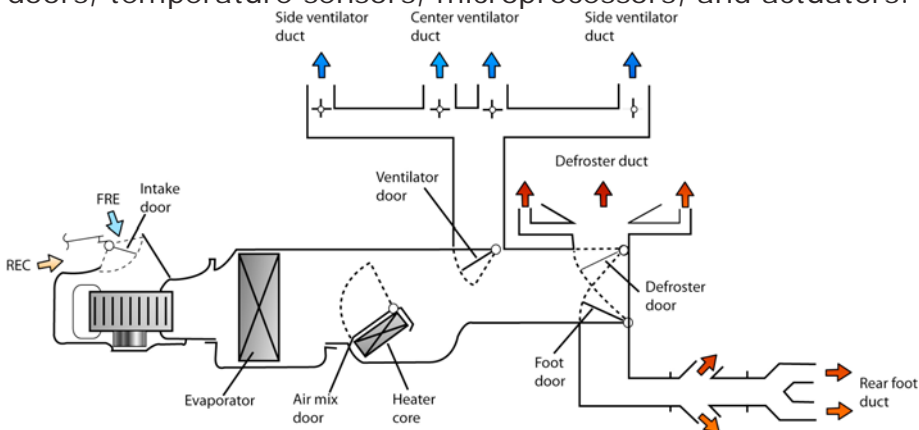
Over the past decade, ATC has progressed from being a luxury item offered only on high-end models to an option available on nearly all models. Understanding how ATC interacts with the other climate control systems is often the key to diagnosing problems. Understanding how HVAC functions also helps verify customer concerns, whether by clarifying the symptoms or demonstrating that the customer misunderstood the normal operation of the system.

## Automatic Temperature Control (ATC) Overview

The Automatic Temperature Control (ATC) system is designed to act much like a home thermostat for central heating. It keeps the interior of the vehicle at a set temperature without the customer monitoring the controls or changing the fan speed. In addition to keeping a constant temperature, the system tries to reach the set temperature in the most comfortable manner for the vehicle occupants.

While there are different ways to accomplish these goals, the basic operation of the ATC system is the same for all vehicles. Information on specific models can be found in the Auto Air Description section of the service manual (HA section). Briefly, the auto amplifier sends signals to the actuators to control the positions of the air distribution doors and the speed of the blowers, based on input from the temperature sensors.

The five major types of components of the ATC system are blowers, air distribution doors, temperature sensors, microprocessors, and actuators.



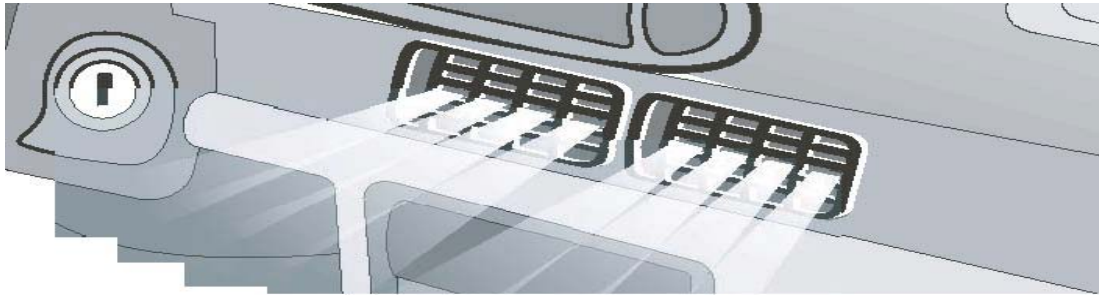
## Heating

The heating system is extremely simple. Hot engine coolant circulates through the heater core; air is blown across the heater core and into the passenger compartment. ATC systems control both the blower speed and the amount of directed through the heater core.

### Heater Core

#### *Operation*

The heater core is like a small secondary radiator that transfers heat from the engine cooling system into the passenger compartment when warm air is desired. Just like a radiator, it has tubes and fins to transfer heat to the air from the hot engine coolant flowing inside.



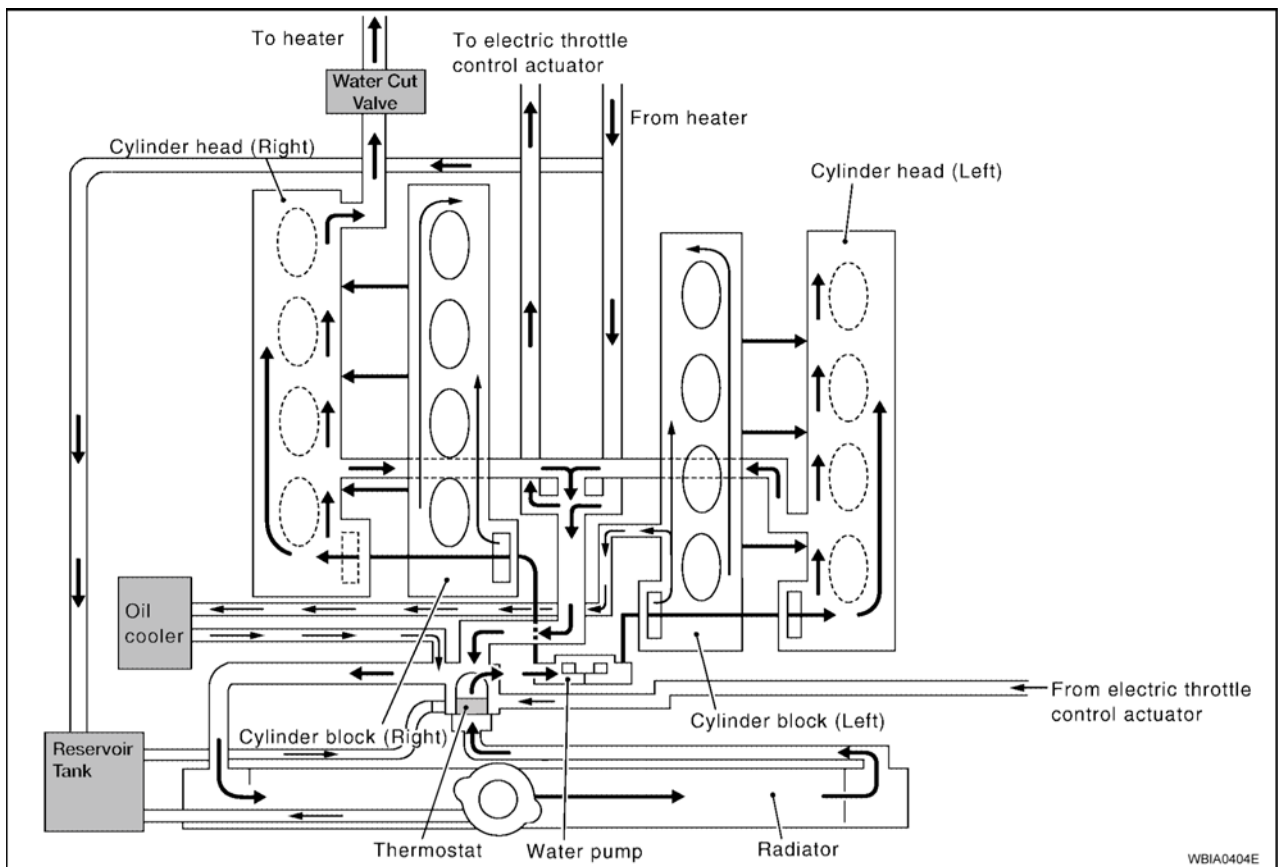
### Nissan and Infiniti Models with the VQ, QR, and VK engine

#### *Malfunctions*

Optimum heater performance depends on good cooling system performance. If any components of the cooling system are malfunctioning, the operation of the heating system will be affected as well.

#### *Diagnosis*

If the heater is slow to reach full temperature, the thermostat may be stuck open, causing the engine to warm up slowly. In addition to a thermostat, certain engines (such as the VQ30DE, VQ35DE, QR25DE, and the VK56DE) also have a water control valve, which prevents coolant flow into the heater core until the engine warms up. A slight delay in heating is normal for vehicles equipped with a water control valve.



QR25DE Cooling System

Poor heating performance can also be caused by air in the system. The air will rise to the highest point in the system, which is often the heater core. Using a coolant purging funnel or cooling system refill system is the easiest way to purge air bubbles. Otherwise, you will need to lift the vehicle's front end as much as 18" and suspend the overflow reservoir from the hood to make sure no air is trapped. Certain vehicles have air bleeding points in the cooling system, which simplify cooling system service.

### Thermal Transmitter (Water temperature)

#### *Operation*

The thermal transmitter or engine coolant temperature sensor (ECT) sends coolant temperature information from the coolant passages in the engine to the unified meter and auto amplifier. Until the ECT indicates the engine has reached operating temperature, the unified meter and auto amplifier will not send a signal for starting fan speed control. This prevents the heater from blowing cold air on the passengers, and helps the engine warm up somewhat faster. Refer to the service manual for each vehicle for the wiring diagram and physical location of the thermal transmitter.

#### *Malfunctions*

Since the thermal transmitter is an electrical component, either the part itself or the wires leading to it can be damaged or disconnected. If the thermal transmitter fails, the auto amplifier will be unable to determine the temperature of the heater core and will fail to turn on the heater.

### *Diagnosis*

If the heater fails to operate, the thermal transmitter is a possible cause.

Using self-diagnosis, follow the directions in the service manual to find malfunctioning components and rule out other control problems. If the vehicle is CONSULT-compatible, you should be able to detect a failed ECT using Data Monitor and/or self-diagnosis results.

## Heater Pump

The 2004 Quest and 2005 Pathfinder now utilize a heater pump for ATC vehicles. The heater pump is located in the engine compartment near the bulkhead. The heater pump only operates when the heater is set to full hot (90° F) and the fan speed is set to high. The pump provides quicker heating to the larger cabin area of the Quest and Pathfinder.



### *Malfunctions*

Anytime a customer has a concern of poor heating performance inspect the heater pump operation.

### *Diagnosis*

Inspect heater pump operation with the controls set to 90° F. Battery voltage is supplied to the pump through the heater pump relay.

## Heater Water Valve

The Armada and QX56 utilize a Heater Water Valve for improving maximum cooling when using the MAX AC setting. The water valve cuts the flow of engine coolant to the front and rear heater cores. This valve is controlled by the front air control unit through the water valve relay. The relay and valve are energized cutting coolant flow anytime MAX A/C is selected.

### *Malfunctions*

Insufficient cooling with all AC system pressures correct.

### *Diagnosis*

Inspect for a stuck open Heater Water Valve or a faulty heater valve relay.

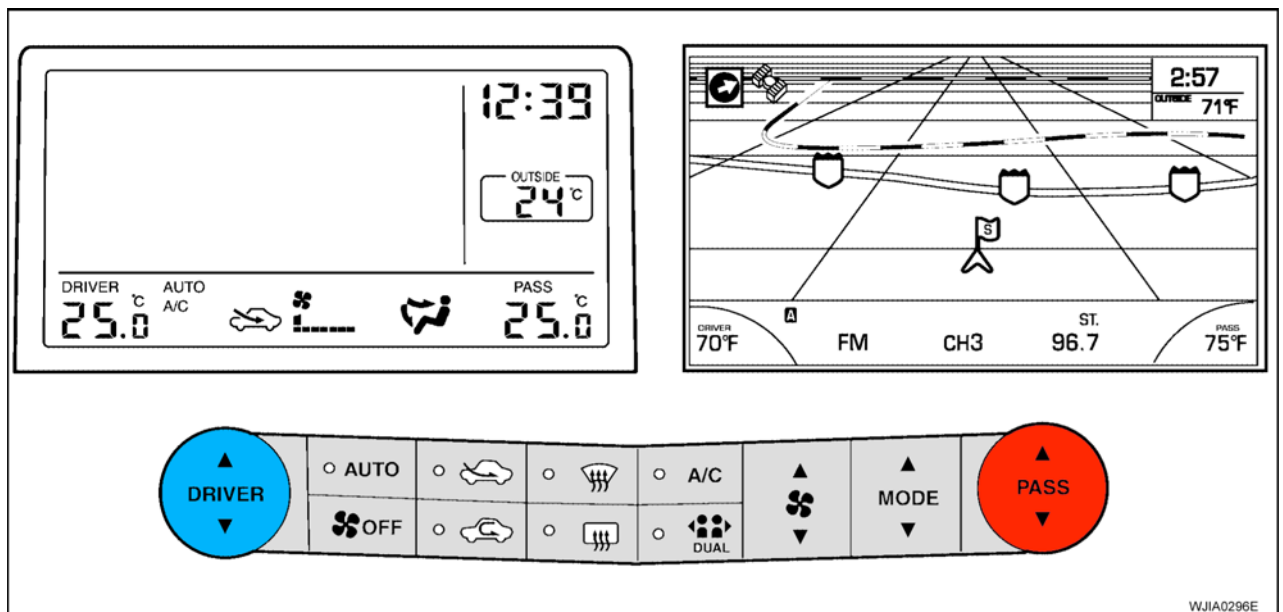
## Automatic Temperature Control

The Automatic Temperature Control (ATC) system is designed to keep the interior of the vehicle at a set temperature without the customer having to monitor the controls. In addition to keeping the set temperature constant, the system tries to reach the set temperature in the most comfortable manner for the vehicle occupants.

Because the ATC system controls the heating and air conditioning functions, it is important to verify customer complaints to make sure the customer understands how to use ATC most effectively. It is also possible for a malfunctioning ATC system to prevent the system from operating correctly, even though the refrigerant loop is in good working order. You can use self-diagnosis routines and CONSULT to help identify ATC problems.

While there are different ways to monitor the system and maintain a set temperature, the basic operation of the ATC system is the same for all vehicles. Information on specific models can be found in the Auto Air Description section of the service manual (HA section). Regardless of the vehicle, ATC systems use certain components for automatic temperature control.

All ATC systems currently installed in Nissan and Infiniti vehicles use "Dual Zone Automatic Temperature Control".



## ATC Components

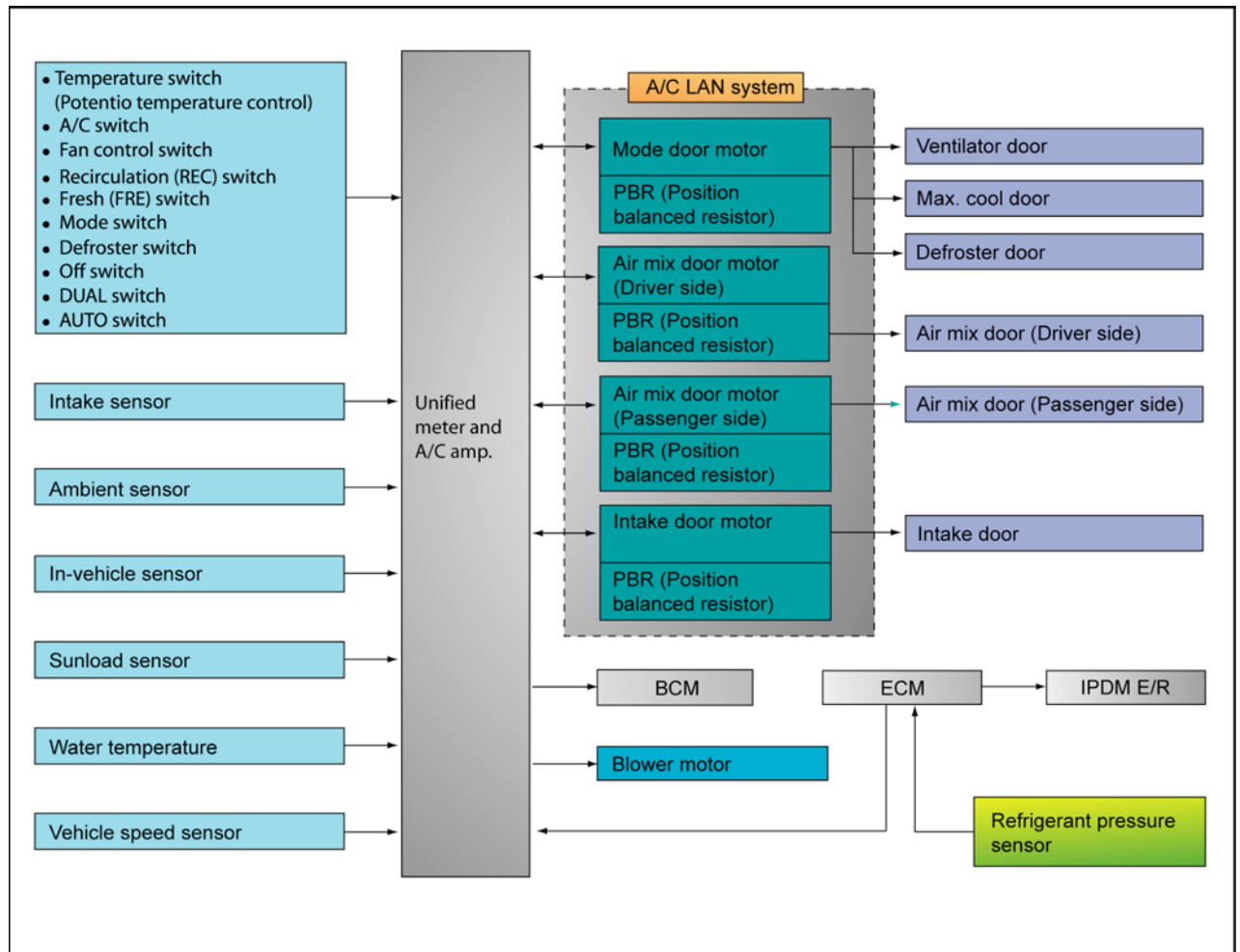
An ATC system needs to monitor the temperature outdoors (ambient sensor), the temperature inside the vehicle (in-vehicle sensor), the temperature of the heater core (thermal transmitter), and the heat from sunlight shining on the vehicle (sunload sensor). Some ATC systems also monitor the temperature of the air at the evaporator (intake sensor) and the vents (duct sensors). The auto amplifier translates this input into commands to the motors for the air mix door, mode door, intake door, and the blower in the HVAC module. It also controls the operation of the compressor in fixed-displacement systems and the amount of coolant flowing through the heater core.



## Unified Meter and A/C Amplifier

### Operation

The unified meter and A/C amplifier regulates air temperature, direction, and volume using inputs from various sensors and controlling the operation of components. This is similar to how the ECM monitors engine conditions and controls the fuel and exhaust systems. Consult the service manual for each vehicle for the wiring diagram and location of the unified meter and A/C amplifier.



### Malfunctions

Since the unified meter and A/C amplifier is a microprocessor, either the component itself or the wires leading to it can be damaged or disconnected. If the unified meter and A/C amplifier fails, the A/C system will not function properly.

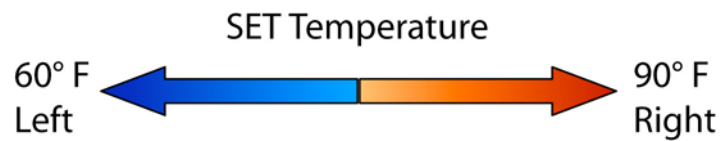
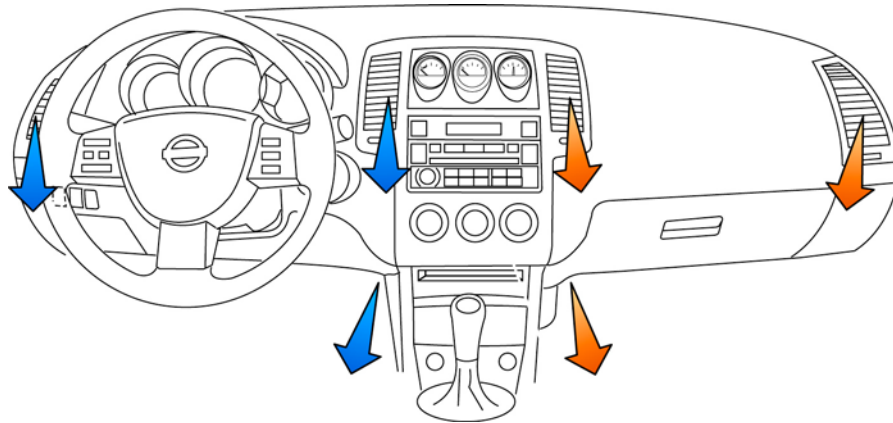
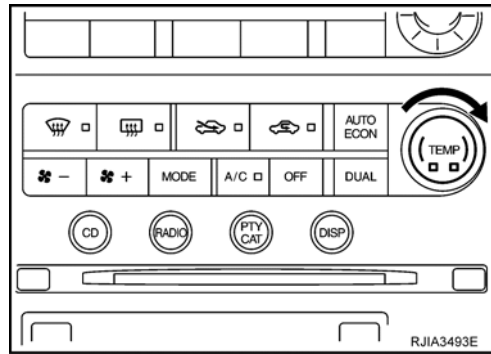
### Diagnosis

If the system appears to be stuck on defrost, fresh air, and heating, there is a problem with the **unified meter and A/C amplifier** and/or mode door motor. These are the default settings for safety reasons.

Follow the directions in the service manual for self-diagnosis to find malfunctioning components and rule out other control problems.

## Dual Zone Automatic Temperature Control

Certain vehicles contain the optional Dual Zone ATC. This allows the driver and passenger to establish individual temperature settings.



### *Malfunctions*

The driver or passenger temperature settings remain fixed in only one position.

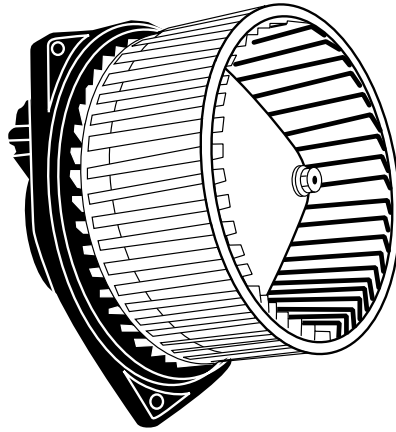
### *Diagnosis*

Inspect the air mix door operation for the faulty side. Use self-diagnosis to find malfunctioning components and rule out any other problems.

## Fans and Blowers

### *Operation*

Fans and blowers move fresh or recirculated air across the evaporator and heater cores to provide cooled or heated air for the climate control system. Without blowers, the refrigerant inside the evaporator would absorb very little of the heat from the passenger compartment. Similarly, the cold air in the passenger compartment would absorb very little of the heat from the hot coolant inside the heater core.



In a vehicle with ATC, the unified meter and auto amplifier sends signals to the fan speed control to determine the speed of the blower, according to the operating conditions. Refer to the service manual for each vehicle for the wiring diagram and physical location of the fans and blowers.

### *Malfunctions*

Fans and blowers rarely fail. However, there are still a few potential problems:

- Foreign objects may obstruct or damage the blades
- Wiring or controls may fail
- Bearings may wear and fail

### *Diagnosis*

A distinctive buzzing or rattling noise from the dashboard area when the fan is running usually indicates leaves, paper, or other debris have fallen inside the blower. Other noises may indicate something more substantial damaged the blades, or the bearings are worn.

If the fan will not operate at all, it is most likely a control or wiring problem. Since fan and blower operation depends on several different controls, failure of any of those components or their wiring will prevent the fan or blower from operating. The fan may also have been disconnected from its power supply or ground.

Using self-diagnosis, follow the directions in the service manual to find malfunctioning components and rule out other control problems.

## **Fan Speed Control**

### *Operation*

Fan speed is based on the difference between the set temperature selected by the customer and the actual temperature of the vehicle interior. If there is a big difference between set temperature and the actual interior temperature, the system switches to a high fan speed. As the interior temperature approaches set temperature the fan speed decreases.

Fan speed also varies to compensate for sunload. On some vehicles, fan speed also varies according to the ambient (outside) temperature. Fan speed can also be manually controlled.

The unified meter and auto amplifier uses the fan speed control to translate its signals into different voltage levels to control the speed of the blower motor. Refer to the service manual for each vehicle for the wiring diagram and physical location of the fan speed control.

### *Malfunctions*

Since the fan speed control is an electrical component, either the part itself or the wires leading to it can be damaged or disconnected. If the fan speed control fails, the blower motor will not turn on.

### *Diagnosis*

If the fan does not operate and the fan switch is good, the fan speed control is a possible cause.

Using self-diagnosis, follow the directions in the service manual to find malfunctioning components and rule out other control problems.

## **Starting Fan Speed Control**

### *Operation*

The "Starting fan speed" is the fan speed during vehicle start up. If the ambient temperature is low, fan operation is delayed briefly. This feature allows the engine to warm up to a specific temperature before the fan switches ON. Once the engine is warm, the fan operates under normal fan speed control conditions. Refer to the service manual for each vehicle for the wiring diagram and physical location of the starting fan speed control.

### *Malfunctions*

Since the starting fan speed control is an electrical component, either the part itself or the wires leading to it can be damaged or disconnected. If the starting fan speed control fails, the blower motor will not turn on.

### *Diagnosis*

If the fan will not operate and the fan switch is good, the starting fan speed control is a possible cause. Also check the auto amplifier.

Using self-diagnosis, follow the directions in the service manual to find malfunctioning components and rule out other control problems. If the vehicle is

CONSULT-compatible, you should be able to detect a failed starting fan speed control using Data Monitor.

## **Fan Control Amplifier**

### *Operation*

An ATC system typically runs the blower at a faster speed when the difference between the set temperature and the in-vehicle temperature is greater. In other words, the fan blows fastest when the ATC is trying to cool down a hot car or warm up a cold one. When the system is merely maintaining the set temperature, it slows down the blower, which also allows the system to operate more quietly. The fan control amplifier is the component that controls fan speed in response to signals from the auto amplifier. Refer to the service manual for each vehicle for the wiring diagram and physical location of the fan control amplifier.

### *Malfunctions*

Since the fan control amplifier is a microprocessor, either the component itself or the wires leading to it can be damaged or disconnected. Power surges or physical impacts can damage it. If the fan control amplifier fails, the ATC system will be unable to operate the blower and no air will flow from the ducts.

### *Diagnosis*

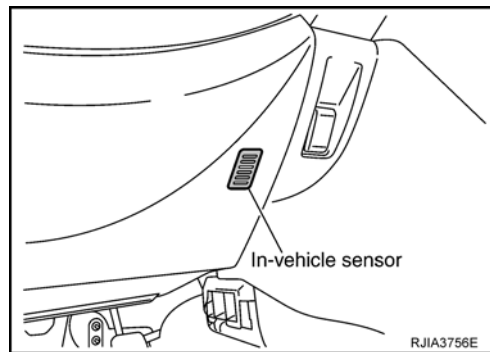
If the fan does not operate, a failed fan control amplifier is one of the possible causes. Using self-diagnosis, follow directions in the service manual to find malfunctioning components and rule out other control problems.

## In-vehicle Sensor

### *Operation*

The in-vehicle sensor sends passenger compartment temperature information to the auto amplifier. The sensor is located on the instrument panel near the drivers side. The sensor converts variations of in vehicle temperature into a resistance value which is input into the unified meter and A/C amplifier. The sensor utilizes an aspirator for drawing air across the thermistor by creating a low or negative pressure from the blower fan. The sensor is a negative coefficient thermistor (NCT) or sometimes referred to as a Non-Linear Thermistor (NLT). For these types of sensors, when the temperature increases the resistance decreases.

Refer to the service manual for each vehicle for the wiring diagram and physical location of the in-vehicle sensor.



### *Malfunctions*

Since the in-vehicle sensor is an electrical component, either the part itself or the wires leading to it can be damaged or disconnected. If the in-vehicle sensor fails, the ATC system will be unable to determine whether the in-vehicle temperature has reached the set temperature, and it will keep heating or cooling.

### *Diagnosis*

If the ATC will not stop heating or cooling at the set temperature, the in-vehicle sensor is a possible cause.

Using self-diagnosis follow the directions in the service manual to find malfunctioning components and rule out other control problems.

## Compressor Clutch Control

### Operation

In vehicles without variable-displacement compressors, the compressor clutch is ON any time the ATC system is in the automatic or defrost modes unless the ambient temperature is too low (approximately 35° F). The compressor is OFF in the economy mode; however, the ATC will try to attain the set temperature without the compressor. Refer to the service manual for each vehicle for the wiring diagram and physical location of the compressor clutch control.

### Malfunctions

Since the compressor clutch control is an electrical component, either the part itself or the wires leading to it can be damaged or disconnected. If the compressor clutch control fails, the compressor will not cycle ON. This will also occur if either the auto amplifier or the ATC receives an improper signal.

### Diagnosis

If the compressor does not cycle ON the compressor clutch control is a possible cause.

Using self-diagnosis, follow the directions in the service manual to find malfunctioning components and rule out other control problems.

All Nissan and Infiniti vehicles are CONSULT-II compatible. This allows technicians to view signals which indicate AC compressor operation, fan operation, AC pressure sensor, and AC ON signal operation. Information is located in both BCM and engine for AC operation.

| DATA MONITOR |      |        |      |
|--------------|------|--------|------|
| MONITOR      |      |        |      |
| IGN ON SW    |      | ON     |      |
| FAN ON SIG   |      | ON     |      |
| COMP ON SIG  |      | ON     |      |
|              |      |        |      |
|              |      | RECORD |      |
| MODE         | BACK | LIGHT  | COPY |

AC SIGNALS in BCM

| DATA MONITOR |      |         |      |
|--------------|------|---------|------|
| MONITOR      |      | NO DTC  |      |
| ENG SPEED    |      | 700 rpm |      |
| AIR COND SIG |      | ON      |      |
| AC PRESS SEN |      | 1.815   |      |
| COOLING FAN  |      | OFF     |      |
| AIR COND RLY |      | OFF     |      |
|              |      |         |      |
|              |      | RECORD  |      |
| MODE         | BACK | LIGHT   | COPY |

AC SIGNALS in ECM

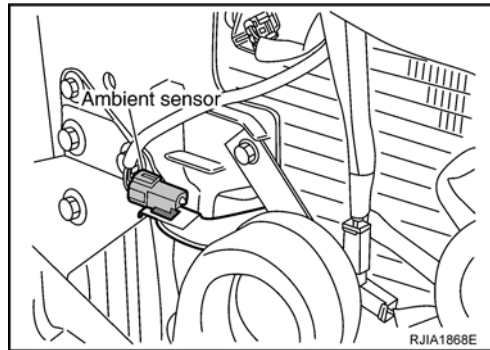
Using CONSULT-II in ENGINE rather than BCM enables you to quickly view the AC pressure sensor values. A low or high pressure sensor voltage value will disable the AC Compressor Magnet Clutch due to it being an input to the ECM and BCM. The ECM via a signal from the BCM activates or disables the AC Relay dependant upon input voltage signals.

## Ambient Sensor

### *Operation*

The ambient sensor sends outside air temperature information to the unified meter and A/C amplifier. It is located just inside the vehicle's grill, in front of the condenser. The sensor is a negative coefficient thermistor (NCT) or sometimes referred to as a Non-Linear Thermistor (NLT). For these types of sensors, when the temperature increases the resistance decreases.

Refer to the service manual for each vehicle for the wiring diagram and physical location of the ambient sensor.



### *Malfunctions*

Since the ambient sensor is an electrical component, either the component itself or the wires leading to it can be damaged or disconnected. Since it is located at the front of the engine compartment, it is subject to more severe conditions than the sensors located inside the passenger compartment. If the ambient sensor fails, the ATC system will be unable to determine the outside temperature and the air conditioner may not cycle on. If the circuit is open, this signal will be interpreted as a very low temperature. The unified meter and A/C amplifier will not send a signal to turn on the compressor.

### *Diagnosis*

If the air conditioner will not blow cold even though touch and feel diagnosis shows the refrigerant loop is functioning properly, the ambient sensor is a possible cause.

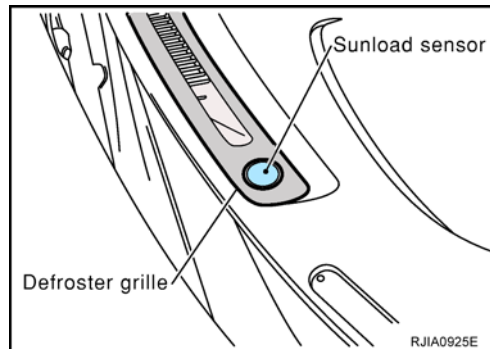
Using self-diagnosis, follow the directions in the service manual to find malfunctioning components and rule out other control problems.



## Sunload Sensor

### *Operation*

The Sunload sensor measures the amount of sunlight entering the vehicle and sends this information to the unified meter and A/C auto amplifier. The Sunload is detected by means of a UV Photo Diode or a Non-Linear Photo Resistor. The Sunload sensor converts the Sunload into a current value which is then input into the unified meter and A/C auto amplifier. The sensor is located on the dashboard near the windshield.



Refer to the service manual for each vehicle for the wiring diagram and physical location of the Sunload sensor.

### *Malfunctions*

Since the Sunload sensor is an electrical component, either the part itself or the wires leading to it can be damaged or disconnected. If the Sunload sensor fails, the ATC system will be unable to determine whether or not sunlight is warming the passenger compartment, and will not cool the car sufficiently on hot, sunny days.

### *Diagnosis*

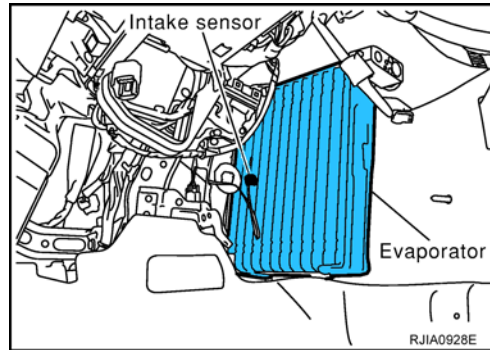
If the air conditioner is not cold enough on hot, sunny days, the Sunload sensor is a possible cause.

Using self-diagnosis, follow directions in the service manual to find malfunctioning components and rule out other control problems.

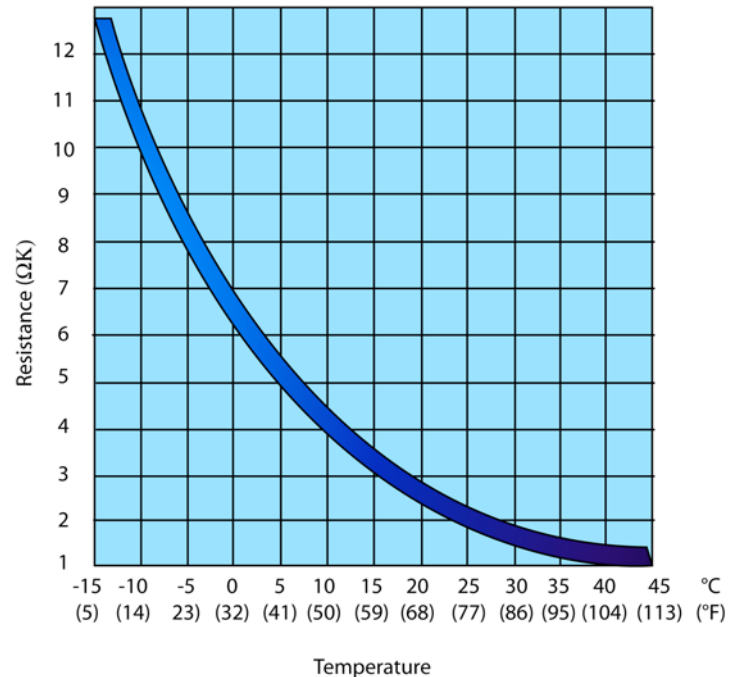
## Intake Sensor

### Operation

All current Nissan and Infiniti vehicles use an intake sensor to send evaporator air temperature information to the unified meter and A/C amplifier. It is located behind the dashboard near the evaporator. The sensor determines evaporator and intake air temperature. The sensor is a negative temperature coefficient thermistor which changes resistance value depending upon temperature.



Temperature vs. Resistance



Refer to the service manual for each vehicle for the wiring diagram and physical location of the intake sensor.

### Malfunctions

Since the intake sensor is an electrical component, either the part itself or the wires leading to it can be damaged or disconnected. If the intake sensor fails, the ATC system will be unable to determine the evaporator is working and the air conditioner will not cycle on or off as expected.

### *Diagnosis*

When the intake sensor fails, it appears to be an open circuit. This is interpreted by the system as a signal that the evaporator or intake air temperature is too cold, and the compressor is turned off.

Using self-diagnosis follow directions in the service manual to find malfunctioning components and rule out other control problems.

### **Refrigerant Pressure Sensor**

#### Operation

The refrigerant pressure sensor attaches to the condenser. The sensor protects against excessively high or low refrigerant pressures. If the pressure rises above or below specification, the refrigerant pressure sensor sends a voltage signal to the ECM indicating high or low pressure in the refrigerant system.

#### *Malfunctions*

The sensor could stay at a specific voltage or go above or below the specification causing the AC compressor magnet clutch to be inoperative.

#### Diagnosis

Voltage for the refrigerant pressure sensor can be viewed using CONSULT-II under ENGINE.

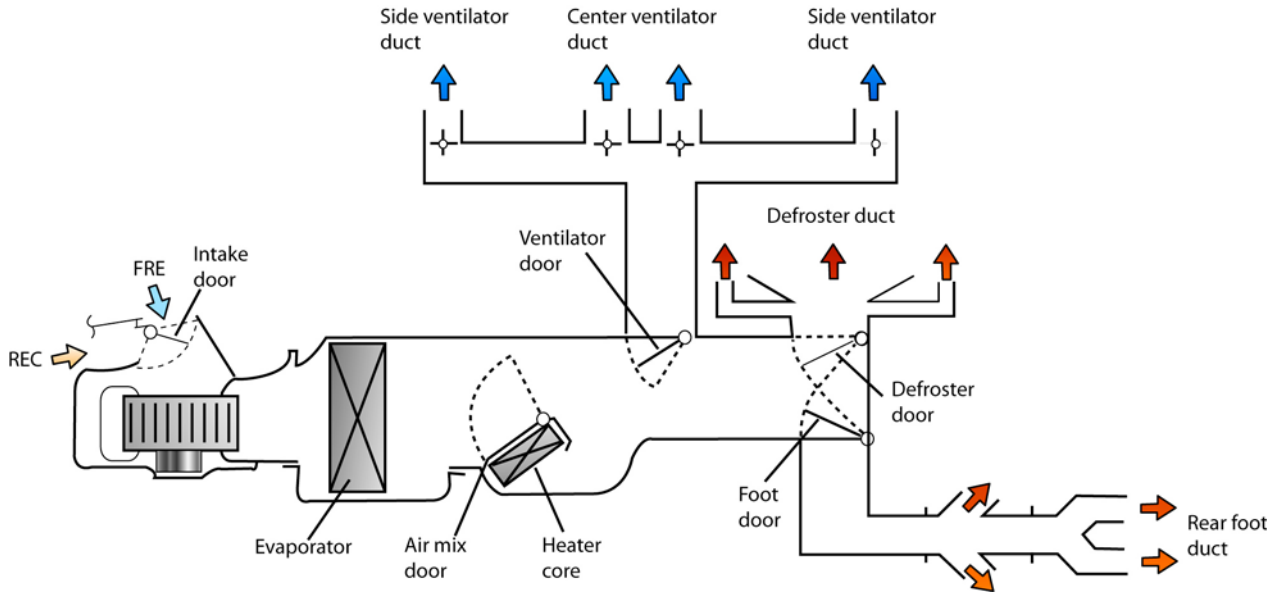


AC Pressure Sensor voltage value below specification causing an inoperative AC compressor.

## Air Mix Door and Motor

### Operation

The air mix door position is controlled by the unified meter and auto amplifier and ATC, based on input from the various input sensors. The position of the air mix door directs cold air, hot air or a mixture of cold and hot air into the passenger compartment to arrive at the set temperature. Refer to the service manual for each vehicle for the wiring diagram and physical location of the air mix door motor.



### Malfunctions

The control rod to the air mix door can get dislodged or misadjusted, or the air mix door motor can fail. Also, the switch on the control panel or the connection to the auto amplifier can be damaged.

### Diagnosis

If the air mix door is stuck in the cold air position there will be no heating and possibly cold air blowing. If the air mix door is stuck in the hot air position, there would be no cooling and most likely hot or warm air blowing instead. If the door is stuck midway, the air will always be warm rather than hot or cold as appropriate.

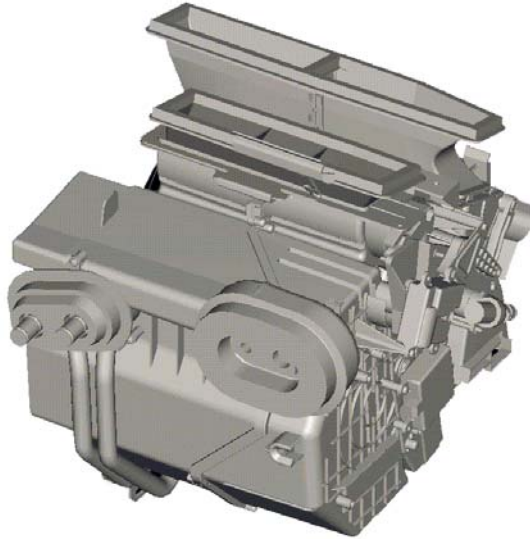
If the air mix is stuck on hot, the mode is stuck on defrost, and the intake is stuck on fresh air, check the unified meter and auto amplifier.

Using self-diagnosis, follow the directions in the service manual to find malfunctioning components and rule out other control problems.

## Mode Door

### *Operation*

The mode door controls the direction and distribution of discharge air according to the set temperature. If the discharge air is hot, the mode door directs air to the foot vents. If discharge air is cool, discharge air is generally directed to the face vents. Discharge air that is the same temperature as the set temperature is distributed in the bi-level (face and foot) mode. Refer to the service manual for each vehicle for the wiring diagram and physical location of the mode door motor.



HVAC Module with Mode Door and Air Mix Door Motors

### *Malfunctions*

The control rod to the mode door can get dislodged or misadjusted, or the mode door motor can fail. Also, the switch on the control panel or the connection to the auto amplifier can be damaged.

### *Diagnosis*

If air is coming out of the wrong vents, there is a problem with the mode door, its motor, the controls or any potential adjustments.

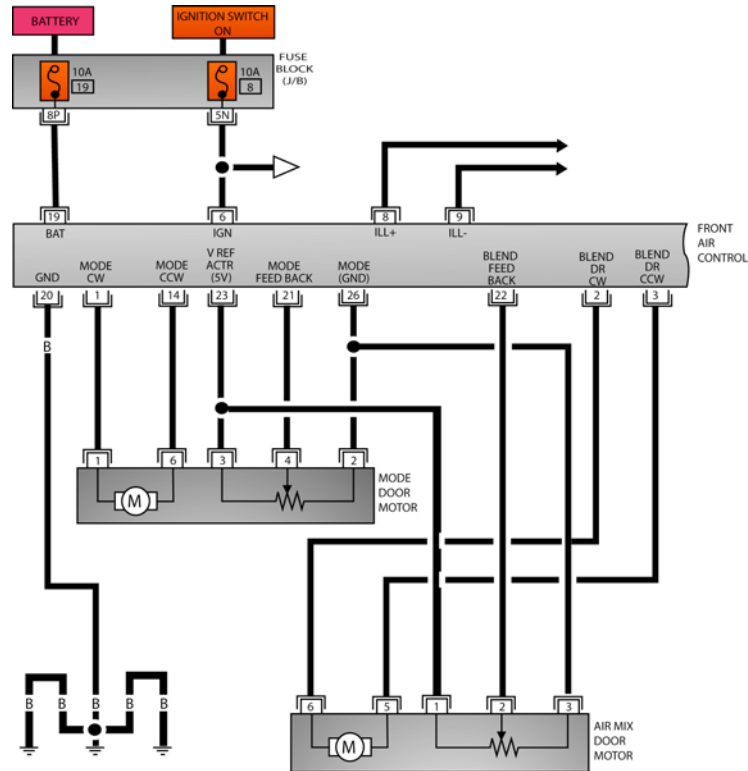
If the mode is stuck on defrost, the air mix is stuck on hot, and the intake is stuck on fresh air, check the unified meter and auto amplifier.

Using self-diagnosis, follow directions in the service manual to find malfunctioning components and rule out other control problems.

## Potential Balance Resistor (PBR)

### Operation

Potential Balance Resistors (PBR) send door position information to the unified meter and A/C amplifier. One PBR is located in the air mix door motor and another is located in the mode door motor. Refer to the service manual for each vehicle for the wiring diagram and physical location of each PBR.



### Malfunctions

Since the PBR is an electrical component, either the part itself or the wires leading to it can be damaged or disconnected. If the PBR fails, the ATC system will position the air mix doors incorrectly, and therefore the desired air mixture and temperature will be incorrect.

### Diagnosis

If the air temperature from the vents is not the expected temperature, the PBR is a possible cause.

If the vehicle has self-diagnosis, follow the directions in the service manual to find malfunctioning components and rule out other control problems. If the vehicle is CONSULT-compatible, you should be able to detect a failed PBR using Data Monitor.