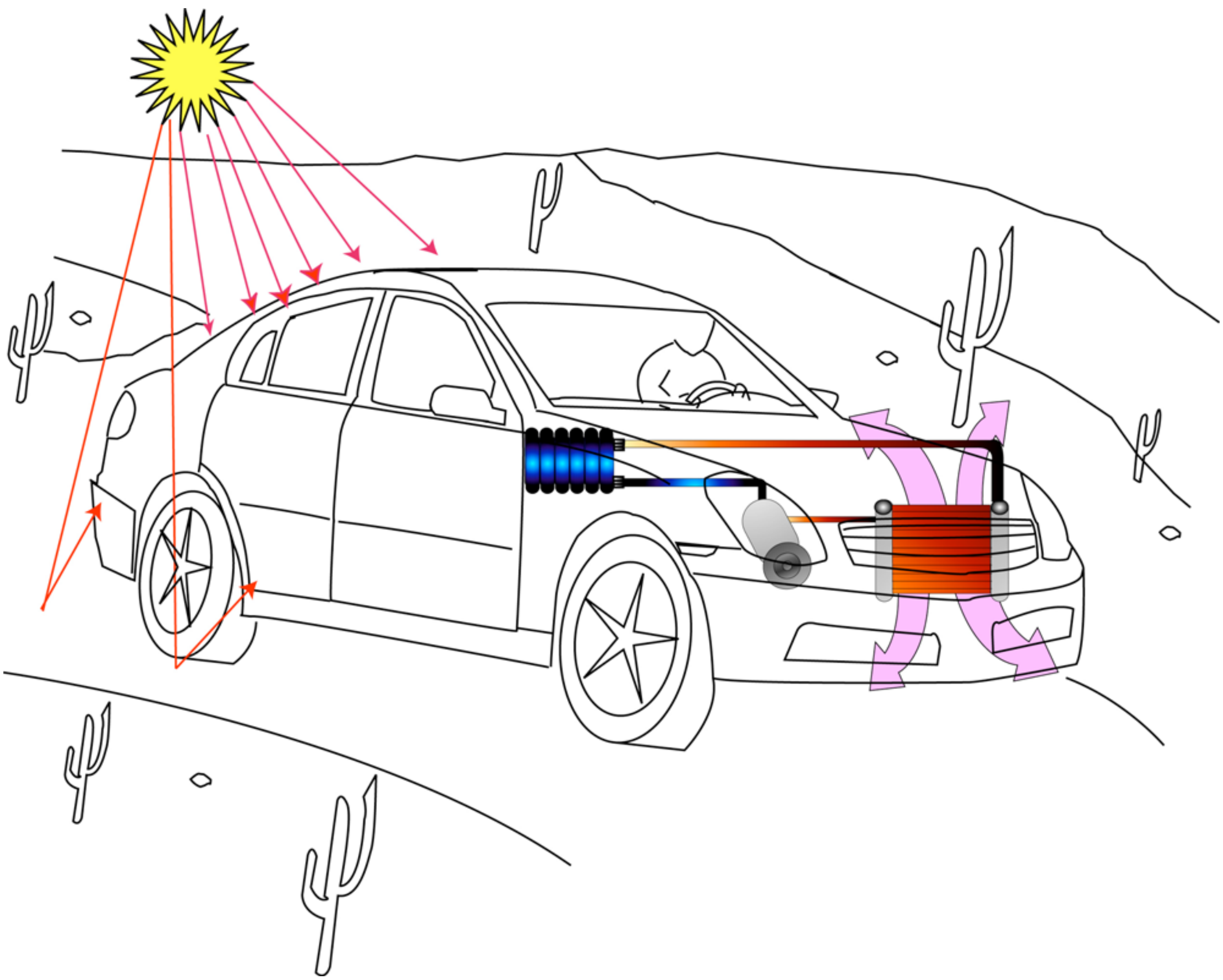
CLIMATE CONTROL SYSTEM OPERATION, DIAGNOSIS, AND REPAIR

Welcome to Climate Control System Operation, Diagnosis, and Repair, which is the final training course in the Electrical training sequence. When you have completed this course, you will know how to verify, diagnose, repair, and recheck problems related to the climate control systems (refrigerant loop, heater, controls, and automatic temperature control).

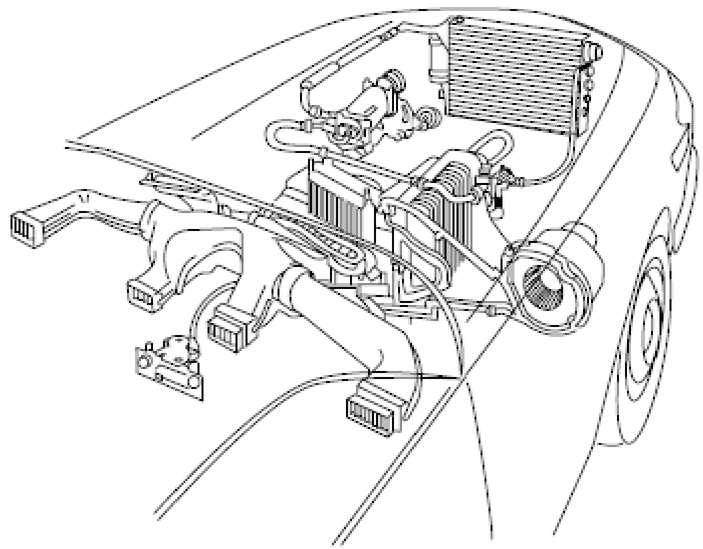
This course will teach you the diagnostic and repair skills you need to “fix it right the first time” so you have satisfied customers instead of unhappy ones. Just like any other automotive system, many Climate Control concerns are simple to solve, while others are tricky to diagnose or require repairs to multiple components when one component’s failure damages others.

Completing this course will also help prepare you for the ASE certification test for Air Conditioning. Because ASE exams use domestic car terminology, you may want to check out some ASE test preparation books from your local public library to finish studying for the exam. Besides the obvious benefit that ASE certification shows your expertise in auto repair, studying for the exams will improve your skills.



What is Climate Control?

Climate Control refers to the systems in a vehicle that allow customers to adjust air temperature, humidity, and direction. Although we usually think of climate control as just a comfort feature, the defroster is a safety feature. Air conditioning also improves the air quality, which may benefit people with certain health problems, by dehumidifying and cleaning the air as it cools it.

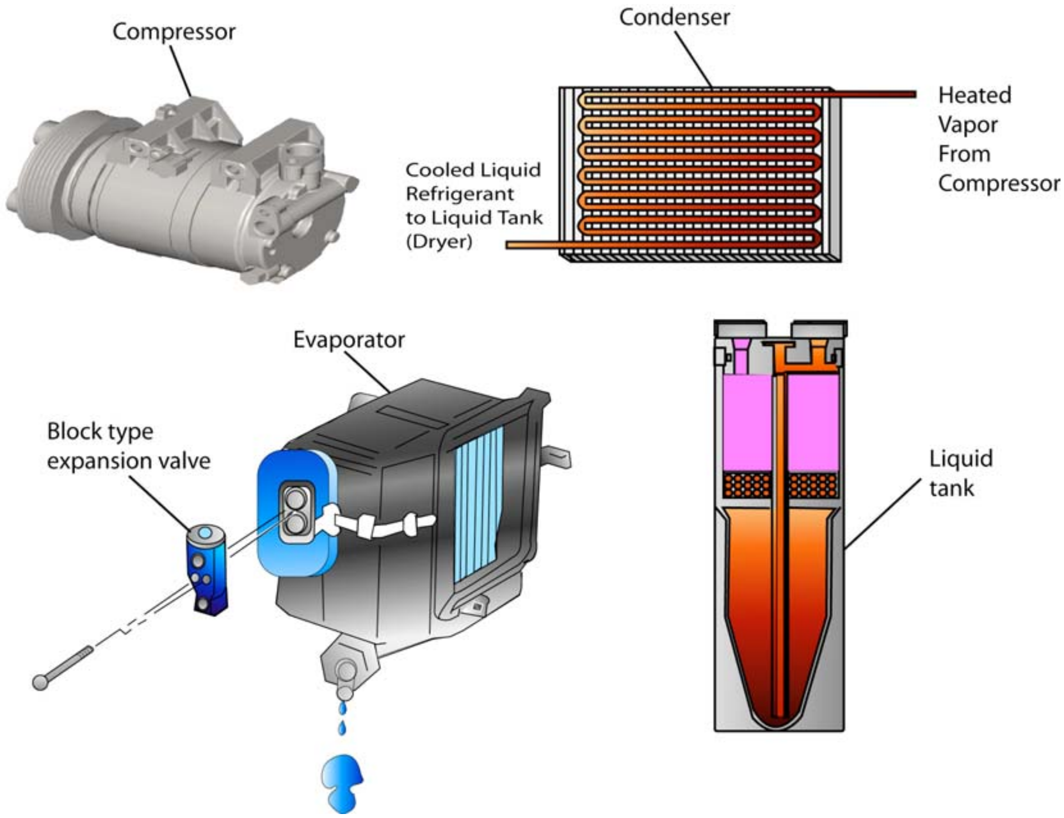


All the components of the Climate Control system work together as a complete system. Understanding the relationship between these components will help you accurately verify and diagnose complaints. For example, when a customer selects Defrost, the system opens the fresh air intake door, activates the heater core and refrigerant loop, directs air over the evaporator and the heater core, and blows this warm, dry air through the defroster ducts on the dashboard. If any one of these components isn't working properly, the customer will have concerns about poor defroster performance. Similarly, a customer may have concerns with poor air conditioner performance if the Sunload sensor has failed and the ATC is no longer accounting for the heating caused by sunlight on the vehicle.

System Overview

All Nissan and Infiniti vehicles, except the first and second generation Nissan Quests, have the same basic refrigerant loop components, and all models except the Frontier, Xterra, and Sentra are available with ATC. Once you've learned how the basic systems work, you can apply this knowledge to any vehicle. Although there are a few variations in the design of each component, you've probably noticed that Nissan and Infiniti systems are simpler than those of other makes.

The five major components of the refrigerant loop are the evaporator, compressor, condenser, liquid tank (receiver/drier) and the expansion valve.



Note: The receiver/drier is referred to as the "liquid tank" in the service manuals.

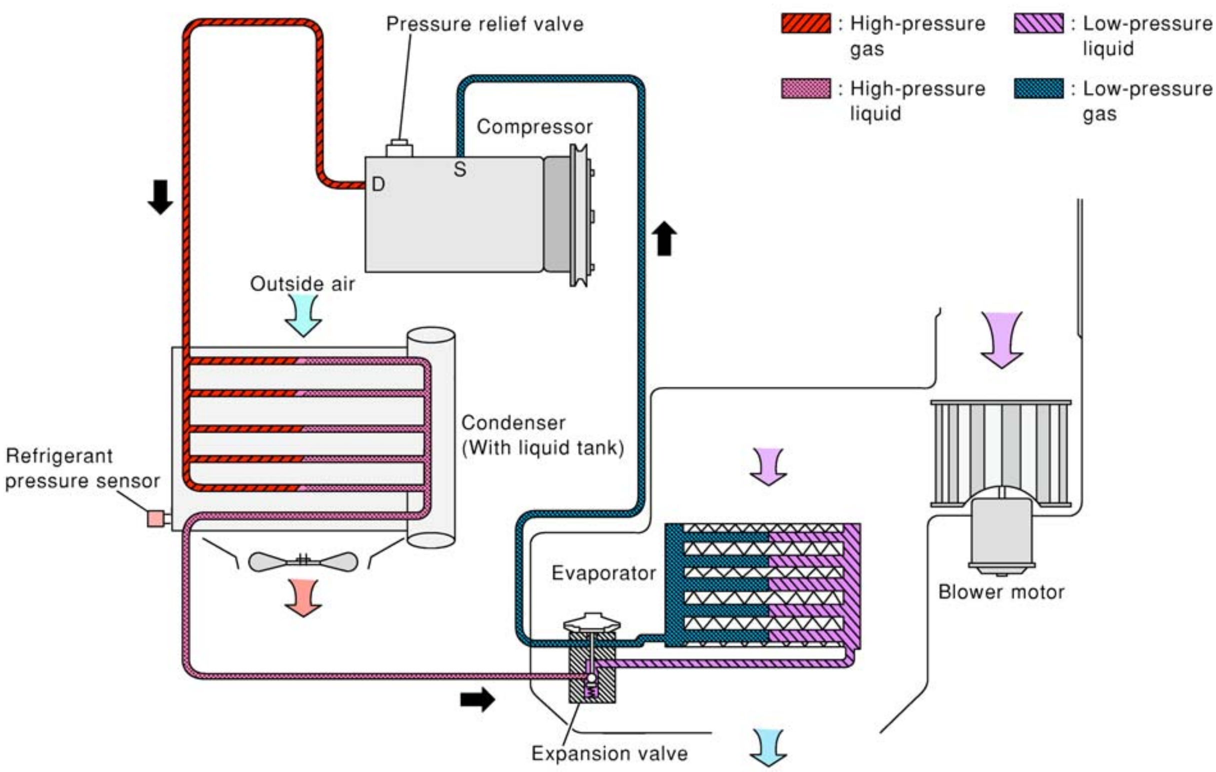
The basic operation of the refrigerant loop is quite simple: it moves heat from the interior of the vehicle to the outside air.

- The compressor concentrates the heat in the refrigerant and propels it through the system.
- The condenser transfers heat to the outside air.
- The receiver/drier filters the refrigerant and stores any excess liquid.
- The thermal expansion valve (TXV) sprays a mist of refrigerant into the evaporator to start the loop again.
- Finally, the evaporator absorbs heat from inside the passenger compartment.

All these components are connected by rigid metal tubes and flexible hoses, and are sealed with various seals and O-rings.

A variation of this basic system layout is found in the first and second generation Nissan Quest, which has a fixed orifice tube (FOT) and an accumulator in the basic system and a thermal expansion valve (TXV) in the optional rear air conditioner.

The engine compartment is a harsh environment due to vibration and heat, so it’s no surprise the most common A/C problem is low refrigerant charge due to gradual leakage.



Safety

Automotive air conditioners operate under high pressures and use refrigerants that can be dangerous if improperly handled. Service and repairs should be performed only by properly trained persons who understand refrigeration systems and their operation. They must have access to specialized service tools and equipment, and follow approved safety precautions. Additionally, any HVAC system refrigerant recovery repairs require special licensing.

- Always wear eye protection when working on the refrigerant loop. If refrigerant contacts your eye it may freeze, possibly causing an injury.

- Refrigerant can quickly cause frostbite. Avoid skin contact with refrigerant. Always wear gloves when working with refrigerant.
- Work in a well ventilated area. Since refrigerant evaporates quickly, breathing may become difficult due to lack of oxygen in poorly ventilated areas.
- Keep refrigerant away from open flame. Poisonous gas is produced when R-12 refrigerant burns.
- Never heat liquid refrigerant above 104°F as this may cause the container to explode. Never apply direct flame to a refrigerant container.
- Keep refrigerant containers stored below 104°F
- Never release refrigerant directly into the atmosphere. It's a federal law with fines and imprisonment for anyone releasing refrigerant into the atmosphere. Always use approved recovery, recycling and charging equipment.
- Never mix R-134a and R-12 or their refrigerant oils. Results will range from poor A/C system performance to expensive component and equipment damage.
- There are many different Federal, state, and local ordinances to control the use of refrigerants and their release into the atmosphere. Make sure you comply with these ordinances, including training and certification.

Refrigerant

Operation

The refrigerant in an air conditioning system absorbs, transports, and then releases heat via the condenser. A good refrigerant must have a number of specific characteristics. It must be:

- Compatible with a wide variety of materials such as brass, aluminum, copper, steel, rubber and neoprene.
- Oil soluble, which allows it to circulate through the system with the oil.
- Non-poisonous and non-flammable.

Unfortunately, no single substance found in nature has all these characteristics. Automotive refrigerants are man-made compounds developed especially for automotive air conditioning systems.

Automotive refrigerant has changed over the years from ammonia gas, to R12 (Freon), to R134a. The characteristics of each gas and the purpose in the refrigerant system have remained the same. The primary automotive refrigerant in general use today is R134a. Although the name “Freon” is sometimes used to refer to any automotive refrigerant, “Freon” is a registered trademark of DuPont.

R134a refrigerant is more environmentally friendly than R-12. Systems using R134a have slightly higher pressures than an R12 system. In addition, R134a systems use a different type of refrigerant oil which is specific to the type of compressor.

There is a distinct temperature-pressure relationship for R-134a refrigerant. As the pressure increases, the boiling point rises. Refer to the chart on the following page for these relationships.

REFRIGERANT R-134A: TEMPERATURE VS. PRESSURE RELATIONSHIP

Temp °F			Pressure psig	Temp °F			Pressure psig
16			15.3	100			124
18			16.7	102			129
20			18.0	104			133
22	E		19.4	106			137
24	V		21.9	108			142
26	A	R	22.4	110			147
28	P	A	24.0	112			152
30	O	N	25.6	114			156
32	R	G	27.3	116			162
34	A	E	29.0	118	C		167
36	T		30.8	120	O		172
38	O		32.6	122	N	R	178
40	R		34.5	124	D	A	182
45			39.5	126	E	N	188
50			44.9	128	N	G	194
55			50.7	130	S	E	200
60			56.9	135	E		215
65			63.6	140	R		230
70			70.7	145			247
75			78.3	150			264
80			88.4	155			283
85			95.0	160			301
90			104	165			321
95			114	170			342

R-134A BOILING POINT IS -15.1°F

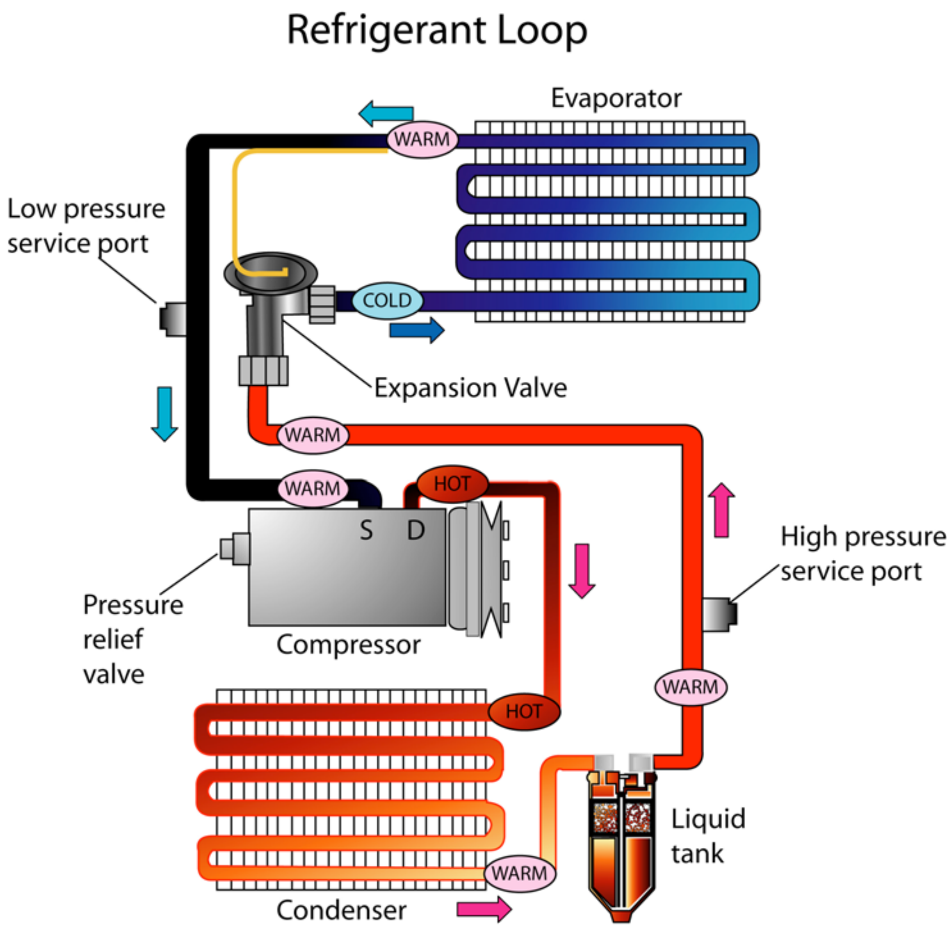
Malfunctions

All automotive A/C systems eventually require service. A typical A/C system needs recharging every three or four years, and contamination in the system (water, incorrect oil, dirt, metal fragments, acids) can cause a wide variety of problems. Much contamination can be prevented by keeping things clean while working on the HVAC system. Make sure all valves and fittings are free of grease and dirt, and keep the protective caps on components, lines, and hoses until you are ready to install them. Always flush the system after failure of the compressor, receiver/drier, or accumulator, as these components can introduce debris into the system when they fail. Always double-check to make sure you are using the right type of oil for the compressor.

Diagnosis

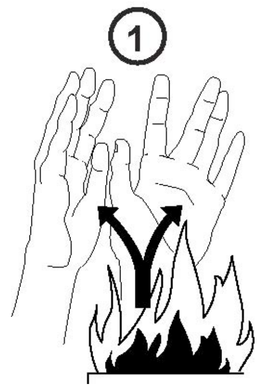
Cooling performance will be poor if the refrigerant is undercharged. To rule out other causes of poor cooling performance, perform touch and feel diagnosis. If the refrigerant charge is low, the thermal expansion valve and receiver/drier (or the fixed orifice tube) will be warm or slightly cool to the touch. Both high-pressure and low-pressure readings are low if refrigerant undercharge is the cause. Always check for leaks and make any required repairs before recharging the system.

The compressor may be noisy if the refrigerant is overcharged. If the A/C alternates between working well and not working, an excessive refrigerant charge may be causing icing. If both high-pressure and low-pressure readings are high, and particularly if splashing water on the condenser lowers the pressure, you will need to remove enough refrigerant to meet the specification in the service manual.

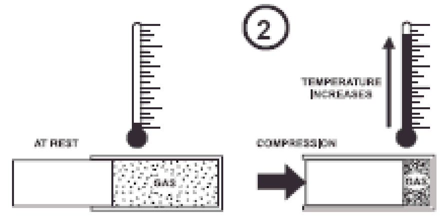


The better you understand the basic principles of refrigeration, the easier it will be to diagnose A/C problems. Refrigeration works by taking advantage of a few simple physical principles:

1. Heat travels from high temperature to low temperature areas.
2. Compressing a gas or vapor increases both its temperature and pressure.
3. Removing heat from a gas or vapor makes it condense into a liquid.
4. Raising the temperature of a liquid makes it evaporate into a gas or vapor.

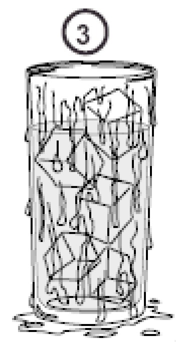


When refrigerant enters the evaporator as a mist, it vaporizes and absorbs heat from the passenger compartment until it leaves the evaporator as a slightly superheated vapor.

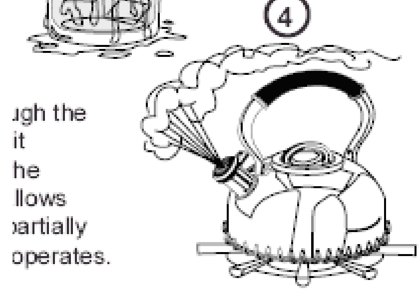


The vaporized refrigerant travels through the low-pressure vapor lines to the compressor. The pistons in the compressor pressurize the refrigerant and raise its temperature.

This hot, high-pressure refrigerant vapor goes through the high-pressure vapor lines to the condenser at the front of the car. Because it is much hotter than the outside air, air passing through the condenser absorbs heat from the refrigerant. As the refrigerant loses heat, it condenses to a liquid.



Next, the cool liquid refrigerant passes through the liquid line to the receiver/drier to absorb any moisture or impurities which could damage the system.



The refrigerant is still a warm liquid as it continues through the liquid line to the thermal expansion valve (TXV). When it reaches the TXV, the liquid refrigerant is evaporator. During normal system operation, the TXV allows enough liquid refrigerant into the evaporator to keep it partially filled with vaporizing liquid refrigerant while the system operates.

Notes: ____

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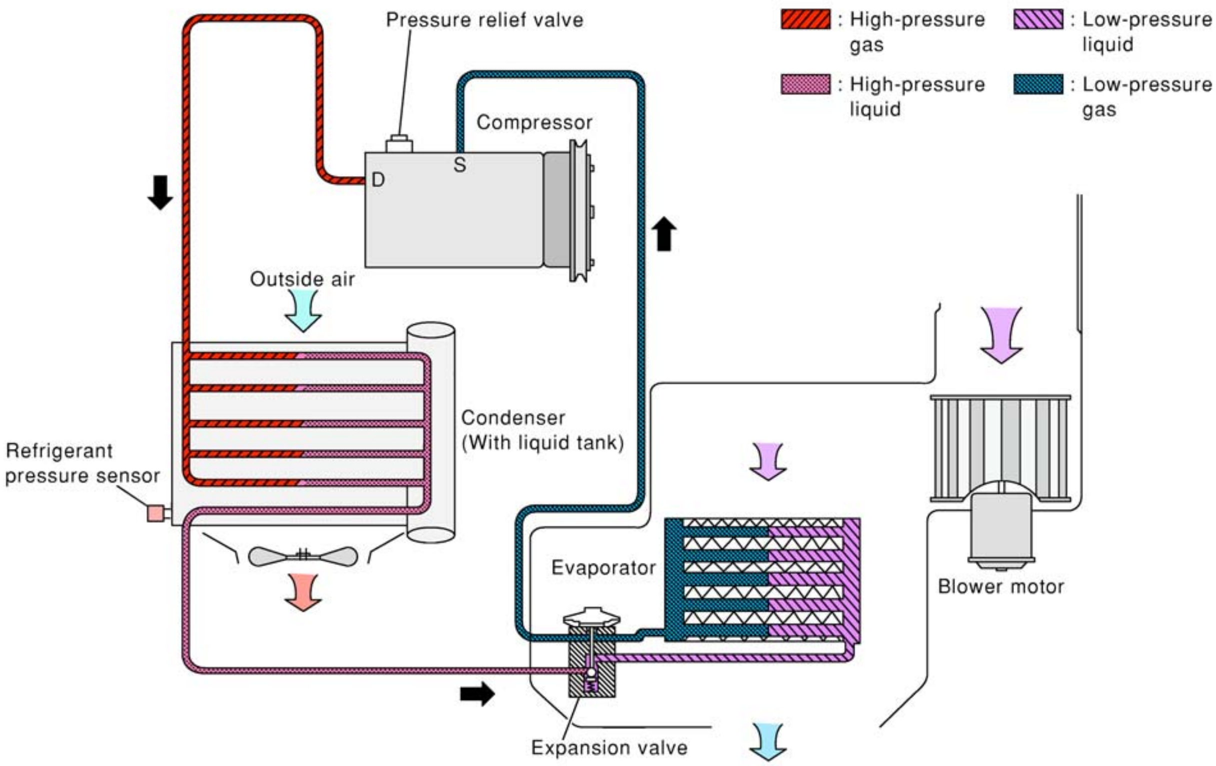
Refrigerant Loop Components

The refrigerant loop consists of a group of components which are connected by rigid lines and flexible hoses and sealed with seals and O-rings. There are also two service ports, one on the high pressure side and one on the low pressure side, to allow access to the refrigerant for diagnosis and repair.



THERMAL EXPANSION VALVE (TXV) SYSTEM

In the standard thermal expansion valve TXV system, the major components are the evaporator, compressor, compressor clutch, condenser, receiver/drier (liquid tank), and block type thermal expansion valve.

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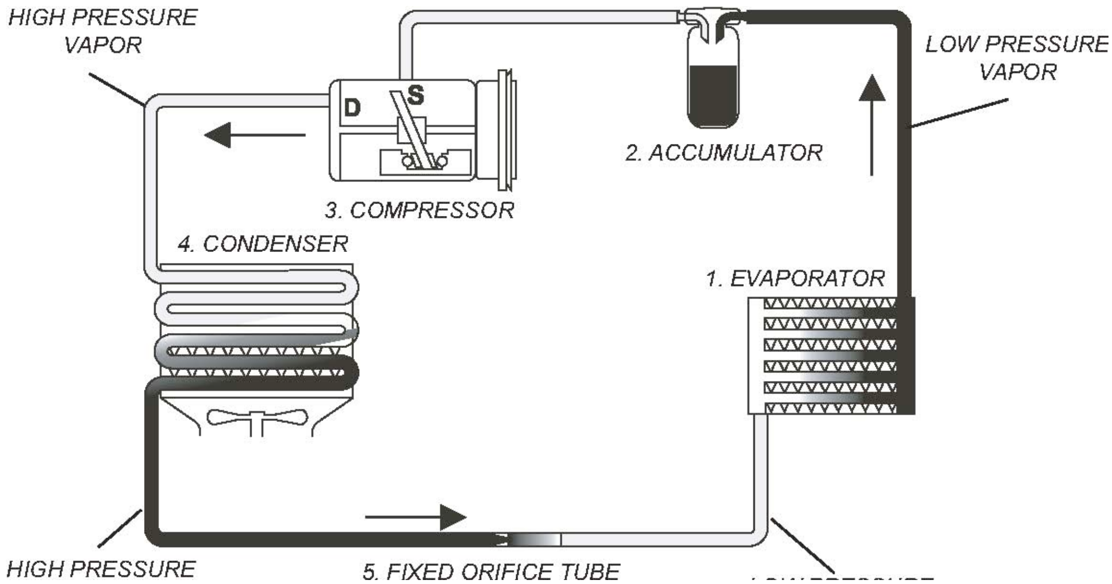
Fixed Orifice Tube Systems (Quest Only)

The front air conditioning system available on the first and second generation Quest is the only fixed orifice tube system used in a Nissan vehicle.



LOW PRESSURE LIQUID

FIXED ORIFICE TUBE SYSTEM

1. The compressor moves the refrigerant through the loop starting as a high pressure, high temperature vapor. Remember the temperature-pressure relationship.

2. Heat is released from the refrigerant to cooler air flowing over the condenser fins. This causes the refrigerant vapor to condense. The refrigerant leaves the condenser as a warm, high temperature liquid.

3. The fixed orifice tube (FOT) uses a preset opening to reduce the pressure of the refrigerant and limit the amount of refrigerant entering the evaporator. Unlike the TXV, there is no feedback and no adjustment of refrigerant flow to increase efficiency. The refrigerant enters the fixed orifice tube as a warm, high pressure liquid and leaves as a low pressure, low temperature liquid before entering the evaporator.

4. In the evaporator, the refrigerant absorbs heat from the air circulating in the passenger compartment. This heat transfer causes the refrigerant to finish evaporating and cools the air in the passenger compartment. The refrigerant leaves the evaporator under low pressure as a low temperature vapor.

5. The refrigerant enters and leaves the accumulator as a low temperature, low pressure vapor. The accumulator stores, filters and removes moisture from the refrigerant. It also stores refrigerant oil and prevents liquid refrigerant from entering the compressor. Notice that the accumulator is located on the low pressure side of the refrigerant loop, while the receiver/drier is located on the high pressure side.

FOT systems use an accumulator to dry, filter, and store refrigerant. It is placed between the evaporator and the compressor to collect any liquid refrigerant in the low pressure lines before it reaches the compressor.

Notes: ____

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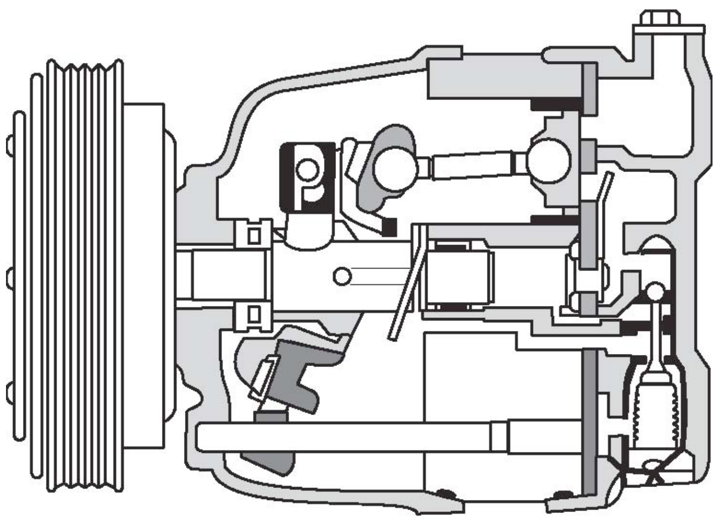
Compressor

Operation

The compressor moves the refrigerant through the refrigerant loop. It also pressurizes the refrigerant vapor until it becomes a high pressure, high temperature vapor, hot enough it can transfer heat to the outside air in the next component, the condenser.

The compressor circulates refrigerant oil throughout the system to lubricate other moving parts such as the expansion valve.



COMPRESSOR

A system that uses a fixed displacement compressor, such as a fixed rotary vane type without a suction throttling valve or a swash plate type compressor will cycle the compressor ON and OFF to control evaporator (and interior) temperature.

Systems equipped with a variable displacement compressors such as the V-5 and V-6 do not cycle ON and OFF. Instead of cycling during operation, the V-5 and V-6 compressors change displacement or refrigerant output to control evaporator temperature by using a pressure feedback system which controls piston stroke length.

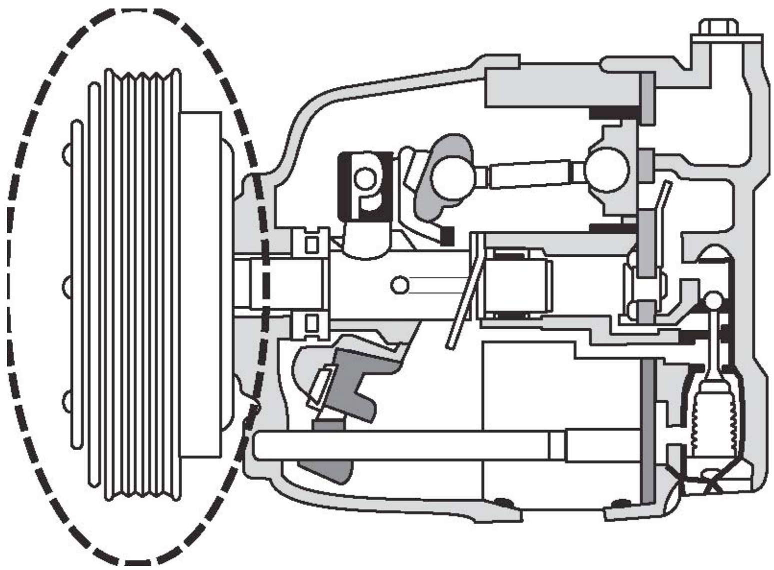
Since the compressor circulates refrigerant oil along with the refrigerant, it is necessary to know what type of oil to use. There are different refrigerant oils based on the type of refrigerant. Polyalkylene Glycol (PAG) oil is used for R-134a refrigerant.

Notes: ____

Compressor Clutch

Operation

The compressor clutch is an electro-mechanical assembly that transfers mechanical power from the engine to the compressor via a belt. The clutch engages the compressor using an electromagnet in response to various sensor input signals. In older fixed-displacement compressors, the clutch would stop and start the compressor to control refrigerant flow. For swash-plate and variable-displacement compressors, the clutch operates continuously.



COMPRESSOR CLUTCH

Malfunctions

Extreme operating conditions can cause the compressor clutch to fail. Compressor clutch problems are often mistaken for compressor failure, as mentioned in the discussion of the compressor.

Diagnosis

If the compressor is not operating, is operating poorly, or is operating noisily, check the compressor clutch and belt for slippage. Remove the belt and turn the compressor clutch by hand to check for noise and proper contact. (These parts may be hot, so be careful.) Idler pulley bearings, when worn, also create a grinding noise that could be misdiagnosed as a compressor clutch or compressor.

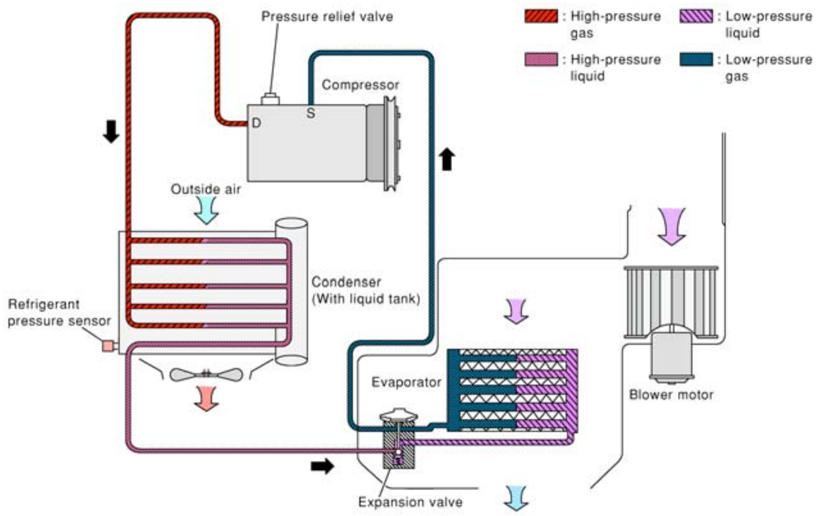
The clutch should always remain engaged for variable-displacement compressors, and should engage and disengage as the system cycles on and off for fixed-displacement and swash plate compressors. If the clutch does not engage, check the electrical circuit and also check the clutch to see if it engages when supplied with current.

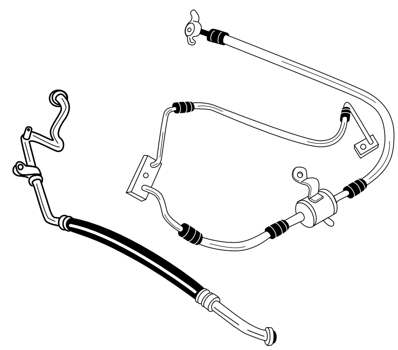
On vehicles with an IPDM E/R, A quick test for compressor circuitry inspection is done using the AUTO ACTIVE TEST. See the appropriate ESM PG section for information on this test.

Refrigerant Lines and Hoses

Operation

Air conditioning system lines and hoses are an integral part of the system. They direct refrigerant and oil between system components and they prevent leaks under conditions ranging from low temperature and pressure to high temperature and pressure. Hose diameter and type is determined by the application: rigid tubing (lines) between the evaporator and liquid refrigerant lines (low temperature and pressure), and flexible tubing (hoses) between the condenser and the compressor (high pressure and temperature).





An easy way to tell which lines and hoses are high pressure and low pressure lines and hoses is the high pressure lines and hoses are smaller diameter than those for low pressure side of the system.

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

Notes: ____

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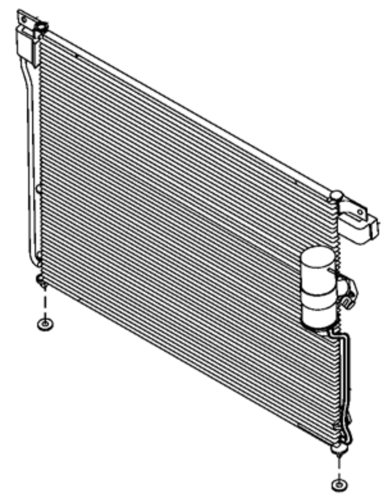
Condenser

Operation

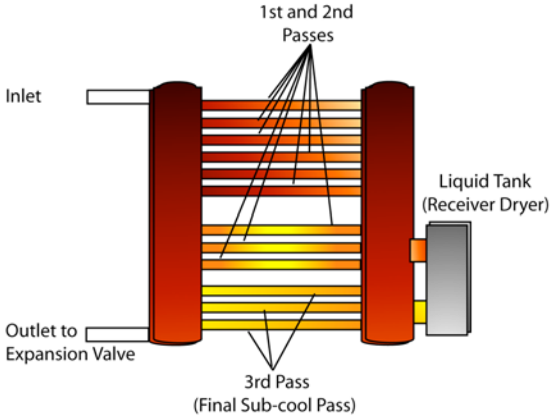
The condenser operates very much like the radiator in a car, transferring heat to the outside air by passing hot coolant through a collection of tubes and fins. Both the condenser and the radiator are placed at the front of the vehicle and have fans to ensure air flow even when the vehicle is stopped in traffic.



After refrigerant leaves the compressor, it enters the condenser as a high temperature, high pressure vapor. As the refrigerant travels through the condenser it is cooled by outside air flowing over the condenser fins. The refrigerant in the condenser coils changes from a vapor to a liquid and leaves the condenser as a warm, high pressure liquid. Because the refrigerant temperature is so high when it enters the condenser, it is always hotter than the outside air, and can lose heat to the air even on a hot day. However, just like the radiator, the condenser transfers heat least effectively when you need it the most—when it's very hot outside.

Three types of condenser are used in Nissan and Infiniti vehicles: serpentine flow, parallel flow, and subcooling. You can identify the parallel flow condenser by the refrigerant end tank and smaller, more closely spaced center section tubes, as illustrated above.

The subcooling condenser has an extra cooling pass between the receiver/drier and the lower third of the condenser for extra cooling power.



SUBCOOLING CONDENSER

Malfunctions

Condenser malfunctions are usually caused by internal restrictions, collision damage, or obstructed air flow through the cooling fins. Noise or a vibration may result from the condenser fins or lines touching the body due to deteriorating rubber mounts.

Diagnosis

If the condenser has internal restrictions, the air conditioner will be less efficient. Touch and feel diagnosis will show the high side is hot and the low side is warm. High side pressures will be high and low side pressures will be low. Collision damage can crimp tubes without breaking them, causing a restriction rather than a leak.

Another cause of poor cooling performance is obstructed air flow, which can be diagnosed by inspection. Leaves, plastic bags, dirt, and other trash can stick to the front of the condenser and block air flow. Also check between the condenser and radiator. Remember, at low speeds an inoperative condenser fan can cause the same symptoms as obstructed air flow, so make sure the fan is operating. If there is an air flow problem, touch and feel diagnosis will show that both inlet and outlet are hot, as no heat is transferred out of the refrigerant. If you check with gauges, both high and low side pressures will be higher than normal.

The condenser tubes are often overlooked as a source of refrigerant leakage and should be checked thoroughly during a leak check procedure.

If the condenser seems to be making noise, check the rubber mounts for deterioration and replace if needed.

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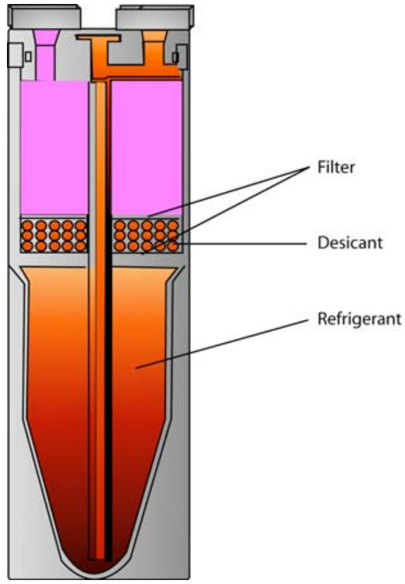
Liquid Tank (Receiver / Drier)

Operation

The receiver/drier, sometimes referred to as the liquid tank, is a container with an inlet and outlet at the top, and filters and a layer of desiccant inside. Older models were cylindrical, but the new pointed base design makes it easier to recover small amounts of refrigerant at the bottom.



RECEIVER/DRIER

The receiver/drier has three functions in the refrigerant loop:

- Stores refrigerant
- Removes moisture from the refrigerant using a desiccant
- Filters contaminants and debris from the refrigerant

Malfunctions

Receiver/drier malfunctions are often caused by contaminants clogging the filter. The desiccant can only absorb a certain amount of water before it becomes saturated. In either case, the receiver/drier will have to be replaced.

Notes: ____

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Diagnosis

If the receiver/dryer is restricted, discharge air will be warm. Touch and feel diagnosis will show the inlet is warm and the outlet is cold. Frost may even appear on the bottom of the receiver/drier. When a restriction is present, manifold gauge readings will show the high side to be high and the low side to be low or at a vacuum depending on the degree of restriction. This is because when refrigerant passes through the restriction, it expands suddenly and loses heat, as if it were in an thermal expansion valve.

If the receiver/drier is saturated with moisture, the outlet air will start out cold but warm up in 5 to 10 minutes. This is caused by excessive moisture freezing in the thermal expansion valve when the refrigerant temperature drops. If this happens, touch and feel results will show a warm inlet and a cold (even frosted) thermal expansion valve. Manifold gauge readings will be the same as those for a restricted receiver/drier.

<table>
<tr><td>NOTE:</td><td>At one time, it was standard practice to replace the receiver/drier whenever the system was opened. In recent years, however, tests have shown this is no longer necessary due to improved desiccant materials. You may have already seen the service bulletin directing technicians to reuse the receiver/drier in most circumstances.

The receiver/drier should only be replaced if:
• The compressor is seized
• Refrigerant oil contains metallic flakes
• Diagnosis indicates a major blockage

If you can’t document a specific reason to replace the receiver/drier, it will not be covered on warranty claims. If you encounter a car with a third-party extended warranty which requires receiver/drier replacement on all A/C work, discuss the situation with your Service Manager.</td></tr>
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<tr><td>NOTE:</td><td>This is sometimes a difficult problem to understand, when there is a restriction in the system like at the receiver/drier or at the expansion valve, the high side pressure is lower than normal. If there is less refrigerant going to the compressor from the restriction, the compressor has less to pump so the pressure is lower. If the restriction were close to the compressor then the refrigerant would hydro-lock and the pressure would be high. As long as there is room in the system to store the refrigerant between the compressor and the restriction, then the high side pressure is low.</td></tr>
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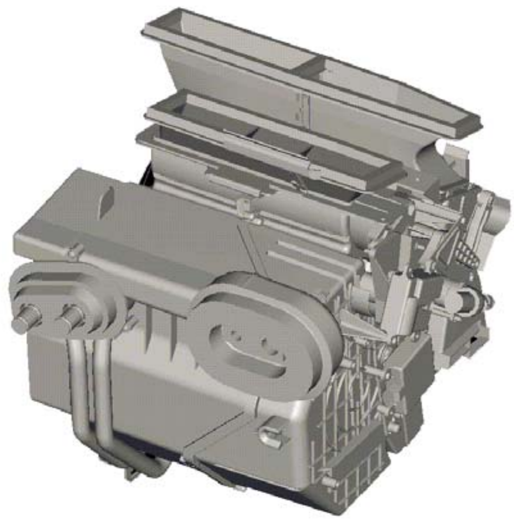
HVAC Module and Intake Assembly

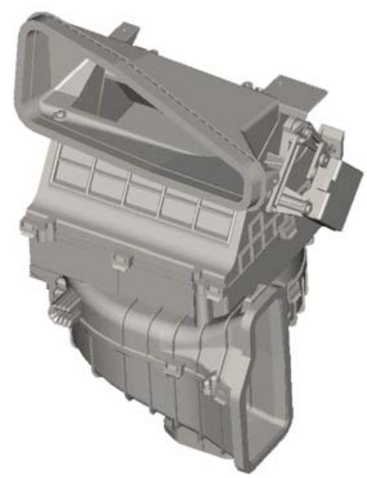
Operation

Most current HVAC systems consist of an HVAC module/unit assembly. The HVAC module assembly contains the heater core, the door system, and evaporator core. The blower housing is a separate unit. The cooling unit in the HVAC assembly contains the evaporator core, the block type thermal expansion valve, and the door system. The intake unit contains the intake door, thermo resistor or fan control amplifier, and a blower.

A control system (controlled manually or electronically) directs air over the heater core to raise the temperature, over the evaporator to lower the temperature and humidity, and through the desired vents. In vehicles with manual controls, the customer determines the airflow with a combination of settings, which directly control heating, air conditioning, vent position, and fresh air intake. With automatic temperature control (ATC), a central controller uses sensor input to control these components and determine which route air takes through the HVAC module. It also determines the most efficient fan speed.



HVAC UNIT



BLOWER UNIT

Malfunctions

Each of the A/C components is discussed separately, and the door system is discussed under ATC.

Notes: ____

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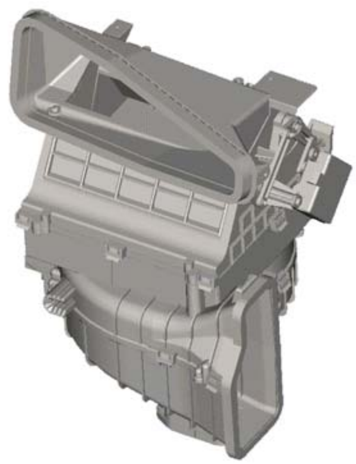
Intake Door

Operation

The intake door is automatically controlled by the unified meter and auto amplifier or the driver to help obtain the set temperature. The intake door motor positions the intake door to control either fresh outside air, recirculated air (air recirculated through the passenger compartment) or a mix of both into the passenger compartment. Refer to the service manual for each vehicle for the wiring diagram and physical location of the intake door motor.



BLOWER ASSEMBLY WITH INTAKE DOOR MOTOR

Exceptions to automatic control occur in defrost mode. In defrost mode, the intake door is set in the fresh air position. In manual recirculate mode, the intake door is set in the recirculate position.

Malfunctions

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

Diagnosis

If the intake door is stuck in the recirculate position, the defroster will be less effective and the air in the car may seem stuffy or musty. If the intake door is stuck in the fresh air position, this would be less noticeable except when trying to use the recirculate setting to avoid outside odors. If the door is stuck midway, the defroster may be somewhat less effective, but otherwise this fault would not be very noticeable.

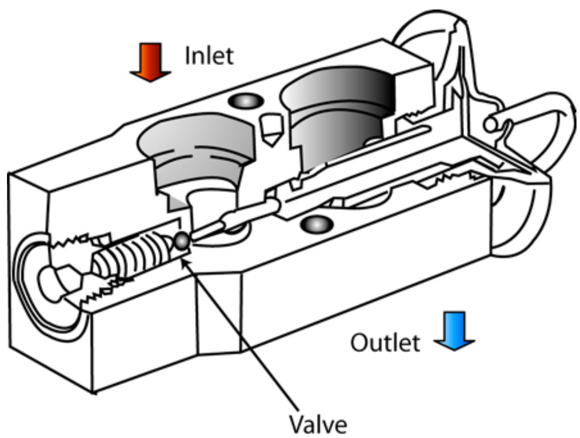
If the intake is stuck on fresh air, the air mix is stuck on hot, and the mode is stuck on defrost, check the unified meter and auto amplifier.

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

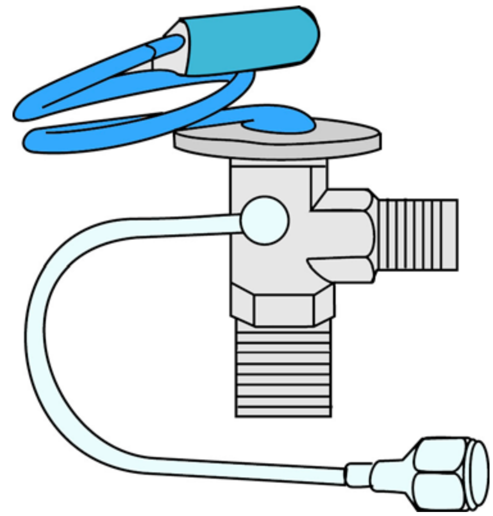
Thermal Expansion Valve

Operation

All Nissan and Infiniti vehicles (except the Quest's front air conditioner) use a thermal expansion valve (TXV) to control refrigerant flow into the evaporator. The TXV uses a controlled restriction to reduce refrigerant pressure and control the amount of refrigerant flowing into the evaporator. Refrigerant enters the TXV as a warm, high pressure liquid. When refrigerant leaves the TXV, it is a cold, low pressure liquid just beginning to vaporize.



Block Type Expansion Valve



Standard Expansion Valve

Refrigerant flow through the evaporator is moderated by feedback from a sensing bulb at the evaporator outlet tube. This sealed sensing bulb contains a gas that responds to the temperature of the refrigerant at the outlet of the evaporator and changes the pressure on the diaphragm in the TXV.

As the temperature of the evaporator rises, the valve opens to release more refrigerant. As the temperature falls, the valve closes to stop refrigerant flow and prevent evaporator icing.

On standard expansion valves the sensing bulb must have good thermal contact with the evaporator's outlet tube, so it is usually wrapped to it with insulating foam.

All current Nissan and Infiniti vehicles use a Block Type Expansion Valve. This valve functions exactly the same as the standard expansion valve with one exception, the sensing bulb is contained in the valve housing.

It could be said that TXVs use a variable valve controlled by a feedback mechanism, which allows them to change the refrigerant flow volume in response to varying temperature conditions which increase efficiency.

Malfunctions

The TXV can stick open, stick closed or become restricted. The sensing bulb can also malfunction, causing the TXV to stay closed. The opening of the valve is very small. If the valve opening becomes restricted with contaminants, the TXV should be replaced along with the receiver/drier.

Diagnosis

A TXV that is stuck closed or partially restricted will cause the discharge air to be cool to warm. Not enough refrigerant is entering the evaporator, and it is cooling inefficiently. The high side of the system will read high and the low side of the system will read very low.

NOTE:	When the TXV is closed all the way, refrigerant will still flow through the valve. If there is debris in the valve then it could stop the flow of refrigerant completely.

If the TXV is closed or completely restricted, you will not be able to hear the normal hissing or spraying sound. The discharge air will be warmer, the high side pressure will be higher than normal, and the low side may range from very low to a vacuum. Because no refrigerant is flowing into the evaporator, evaporator temperature remains high. A closed TXV may cause the compressor to run continually as it tries to cool the passenger compartment. Variable-displacement compressors will remain at maximum capacity. Fixed-displacement compressor systems will never cycle off. Contamination by particles typically restricts or closes the valve. Also, if the sensing bulb, its capillary tube, or the diaphragm has failed, the TXV will close. If examination of the failed TXV shows contamination, flush the system and replace the receiver/drier.

If the TXV is stuck open, outlet air will be slightly cool to warm. Touch and feel diagnosis will find the tubes leading from the TXV are quite cold, and frost or ice may be present. High side pressure will be slightly high and the low side will read high. A stuck open TXV may also cause the evaporator to freeze up. If the evaporator freezes, air flow from the outlet vents will be reduced. Ice formation can damage the evaporator, so this is a serious condition. Typically, water or wax contamination or mechanical failure will lock a TXV in the open position. If examination of the failed TXV shows contamination, flush the system and replace the TXV, tube, and receiver/drier (Liquid Tank).

NOTE:	The ACR5 AC Service Center has the capabilities of flushing an AC system. Refer to the owner's manual for the proper procedure and adapters.

Notes: ____

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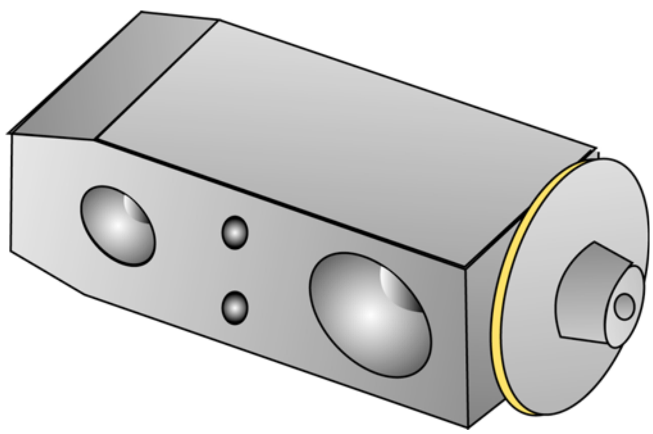
BLOCK TYPE THERMAL EXPANSION VALVE (TXV) SYSTEM

1. The compressor moves the refrigerant through the loop starting as a high pressure, high temperature vapor. Remember the temperature-pressure relationship.

2. Heat is released from the refrigerant to cooler air flowing over the condenser fins. This causes the refrigerant vapor to condense. The refrigerant leaves the condenser as a warm, high temperature liquid.

3. The refrigerant enters and leaves the receiver/drier as a warm, high pressure liquid. The receiver/drier stores, filters and removes moisture from the refrigerant. Its equivalent in the fixed orifice system is the accumulator.

4. The thermal expansion valve (TXV) uses a variable restriction to reduce the pressure of the refrigerant and control the volume of refrigerant entering the evaporator. If too much refrigerant enters the evaporator, it will not completely evaporate. If too little refrigerant enters the evaporator, it will evaporate too quickly. In either case, the system will not cool efficiently.



BLOCK TYPE EXPANSION VALVE

5. In the evaporator, the refrigerant absorbs heat from the air circulating in the passenger compartment. This heat transfer causes the refrigerant to finish evaporating and cools the air in the passenger compartment. The refrigerant leaves the evaporator under low pressure as a low temperature vapor.

   The sealed, gas-filled sensing bulb on the TXV senses the temperature of the evaporator and adjusts the TXV accordingly. Refrigerant enters the TXV as a warm, high pressure liquid and leaves as a low pressure, low temperature liquid as it enters the evaporator.

   This feedback allows the thermal expansion valve system to operate more efficiently than a fixed orifice tube (FOT) system, which uses a preset opening to meter refrigerant.

Notes: ____

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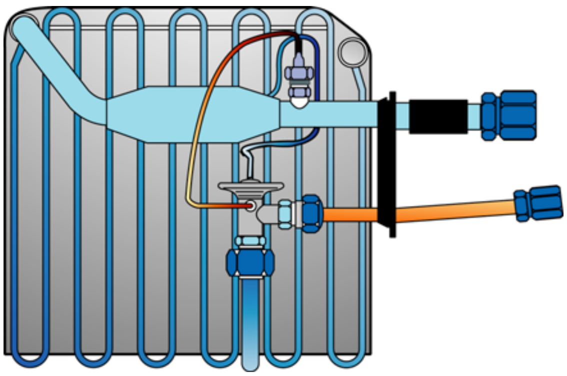
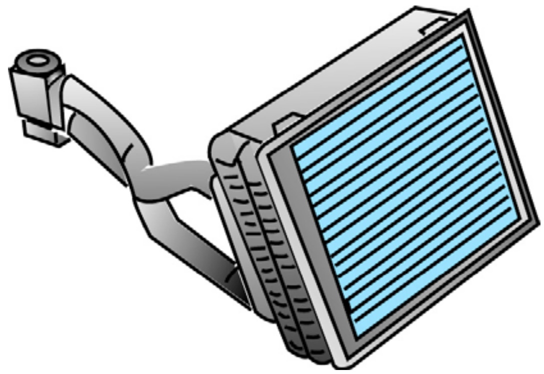
Evaporator

Operation

The refrigerant entering the evaporator from the thermal expansion valve is a cold, low pressure liquid just starting to vaporize. As air flows across the evaporator fins the refrigerant continues to vaporize as it absorbs the heat transferred from the air to the evaporator.



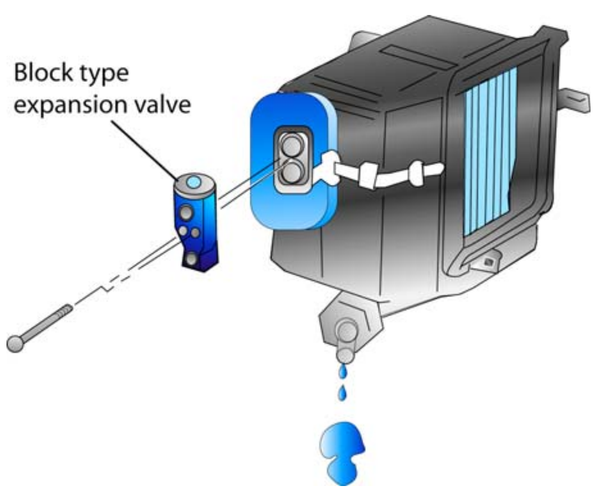
Previous Style Evaporator



Armada/QX56 Evaporator

The evaporator has a tube-and-vane construction similar to a radiator, and performs the same basic task: heat transfer. It is located in the HVAC module, along with a blower motor to circulate warm air past it to absorb the heat and send cooler air into the passenger compartment.

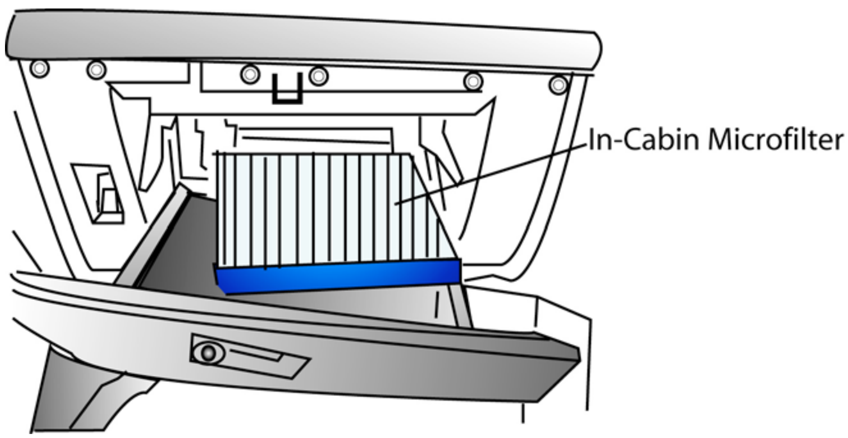
The evaporator also dehumidifies the air. As warm, humid air passes over the evaporator core, water in the air condenses on the cold evaporator, just like it does on a cold glass of your favorite beverage. Dry air feels cooler than its actual temperature and allows the body to cool itself more efficiently. Drying the air also relieves the sticky, clammy feeling of extremely humid air, and prevents humidity from building up on the inside of the vehicle. Air being sent to the defroster vents also passes over the evaporator to remove excess moisture, which helps it clear fog from the windshield more effectively.



Malfunctions

The evaporator is a very reliable component. Evaporator malfunctions are limited to obstructed air flow or internal restrictions.

Air flow can be blocked by air flow through the In-Cabin Microfilter (if equipped) leaves, paper, or other debris falling into the HVAC module through the air intake or interior vents and being held against the evaporator by the air from the blower. Ice forming on the outside of the evaporator fins (see "Diagnosis" below), may also block air flow and reduce air conditioning performance.



On vehicles with the In-Cabin Microfilter, the entry of airborne dust and pollen particles are filtered and restricted before they reach the evaporator coils.

If the Receiver/Drier fails, desiccant particles from the receiver/drier may lodge in the evaporator core, although they are more likely to clog the TXV. Replacing a damaged or failed receiver/drier or compressor without flushing the system may allow debris to reach the evaporator. This is why it's important to fix everything right the first time, and think ahead to the consequences of a component failure.

Moisture removed from the air collects in the condenser pan and flows out a drain tube. Occasionally, debris will clog the drain and water will accumulate in the HVAC module. Customers typically are concerned about a stagnant odor or even water dripping on their feet when it sloshes out of the condenser pan on sharp turns. Except for this situation, musty odors from the evaporator are much less common now due to water-repelling and mildew-resistant coatings on the condenser core and pan.

Note: To protect the mildew-resistant coating, never clean an evaporator with anything stronger than dishwashing detergent or other mild soap.

Diagnosis

- During touch and feel diagnosis (to be discussed later), the incoming line of a properly operating evaporator is cool, the evaporator is just above freezing, and the outgoing line is warm.

- Air flow through the discharge vents will decrease if air flow through the evaporator is obstructed. Check for leaves or other foreign objects inside the cooling unit.

- Evaporator icing can be a serious problem because the expansion of water as it freezes can crack the evaporator. When the humidity inside the vehicle is extremely high, water may condense on the evaporator and freeze if its surface temperature is cold enough.

- Ice buildup on the evaporator fins blocks air flow and causes symptoms noticed by the customer, such as poor or intermittent cooling. Except in conditions of excessive humidity, this is typically caused by a defective thermal expansion valve (TXV). Since it takes a while for ice to form, and it will often melt after the evaporator is blocked long enough for the temperature to rise above freezing, the customer may report that the air conditioner seems to work intermittently. However, if a variable compressor fails so it is always in its maximum stroke position, this will also cause the same symptoms.

- Any water in the refrigerant may freeze inside the evaporator. The symptoms would be similar to the above, and would be cured by recycling the refrigerant to remove the water and replacing the receiver/drier or accumulator (liquid tank), as applicable.

- A restriction in the evaporator will cause slightly cool air at the discharge vents. Touch and feel diagnosis will show the incoming line is cool, the evaporator is not as cold as it should be, and the outgoing line is also cool, due to poor heat transfer. High side pressures may be close to normal and low side pressures will be lower than normal. If the evaporator is completely restricted, you may get a vacuum reading on the low side manifold pressure gauge.

Notes: ____

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