M.V.A.C
Service Guide

Aero Climate Control, Inc.

Welcome!!

Truck
Bus
Off-Road

At AC Parts you will find over 80 years of Auto Air Conditioning, AC Compressor and AC Parts experience on staff. We carry everything you need for any Domestic, Import, Heavy Duty Trucks, Bus, Farm Equipment or Off-Road Vehicle Auto, and Aviation Air Conditioning need.

Basic Theory

The basic principle at work in a climate control system is heat transfer. An A/C system takes heat inside the passenger compartment and transfers it outside.

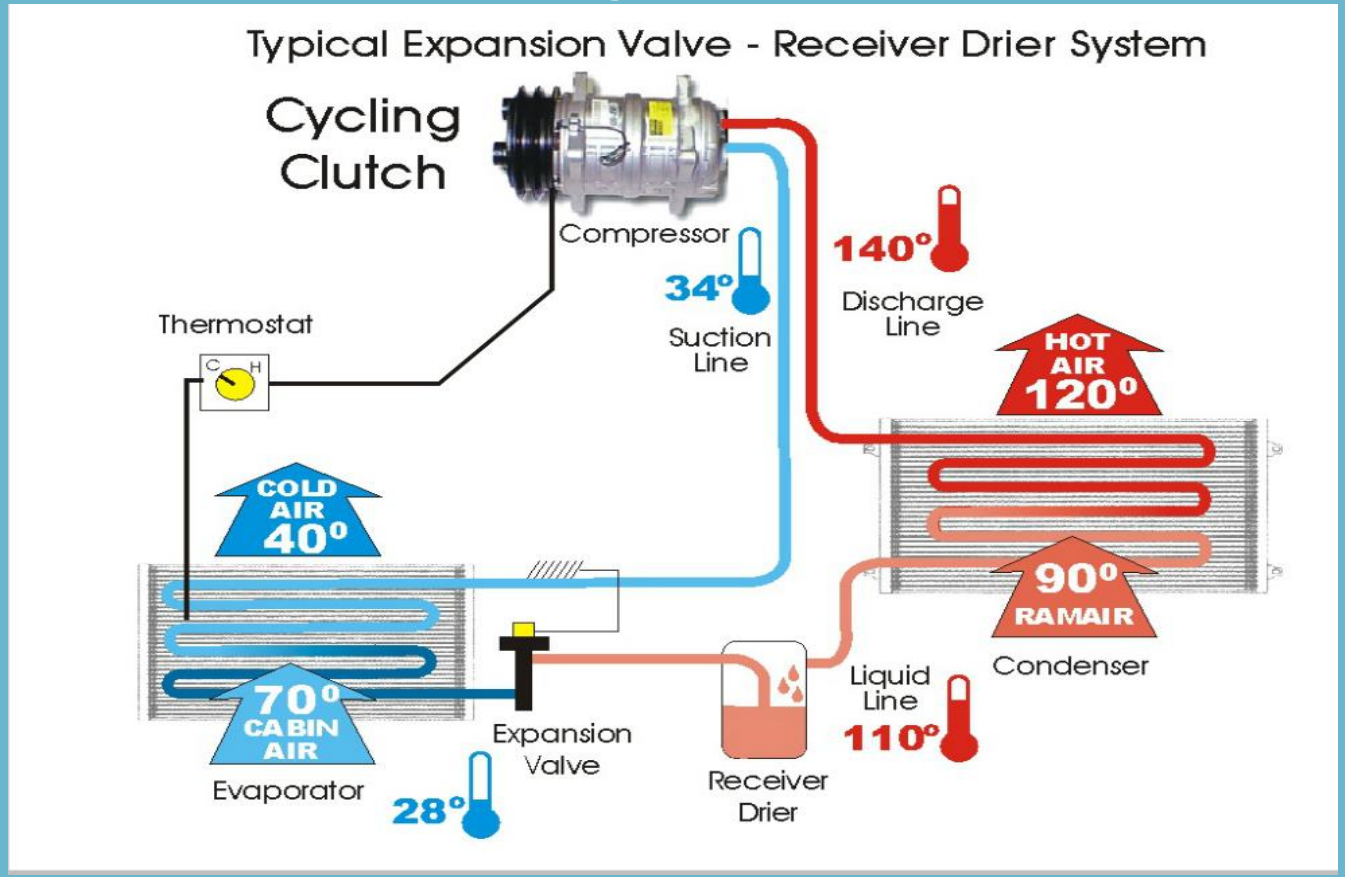
In an A/C system, heat is transferred using a refrigerant. The refrigerant absorbs heat from air entering the passenger compartment, carries the heat outside the compartment, releases the heat, and then re-enters the compartment to begin the cycle again.

An A/C system does not "add cold" to air, it removes some of the heat from it. Some heat is always present, but the less heat the air contains, the cooler it feels.

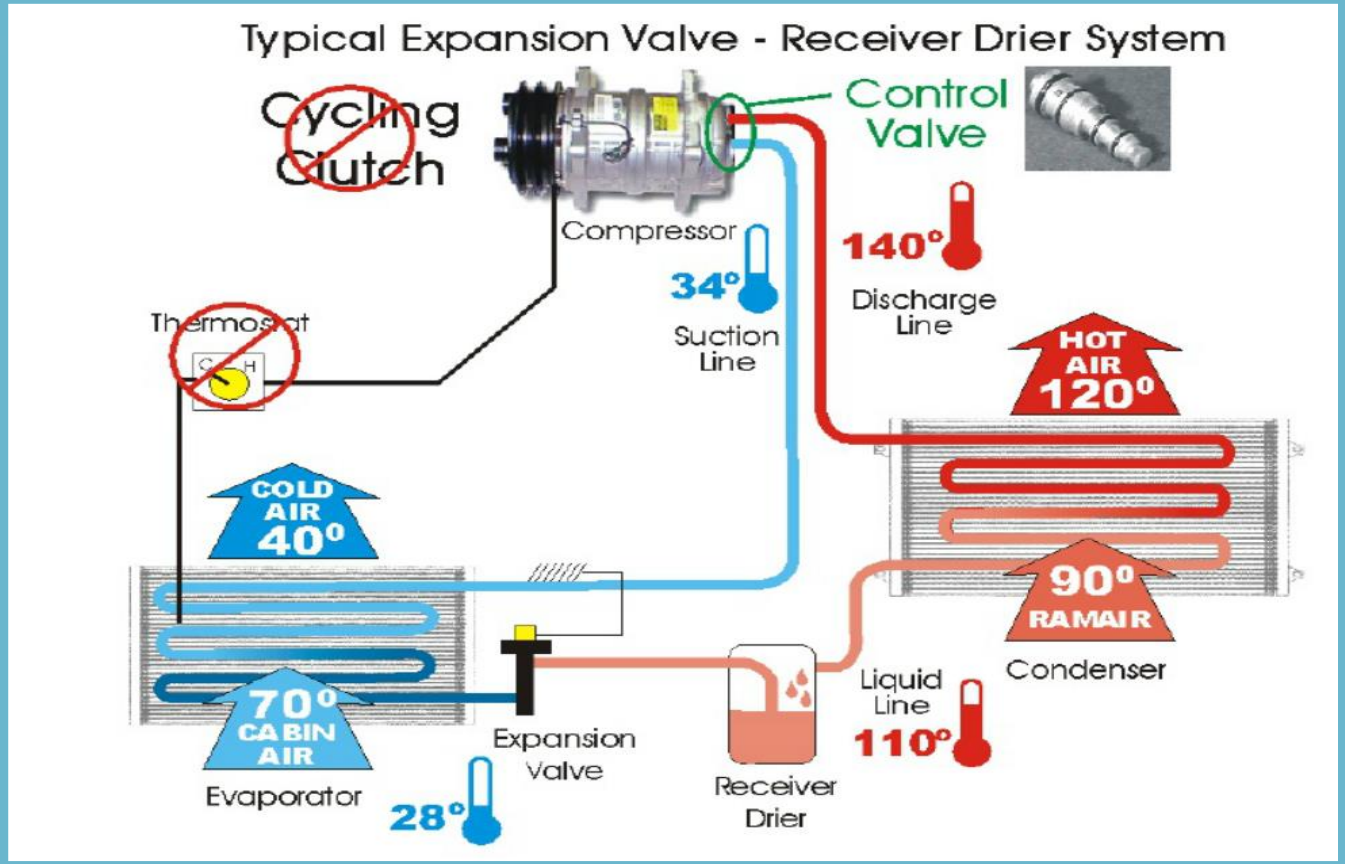
Refrigerants

Refrigerants are the most basic component of an A/C system. How these chemical compounds behave in a closed loop allows the HVAC system to transfer heat from one place to another. There are many types of refrigerants but R134a is primarily the one used in Mobile HVAC systems.

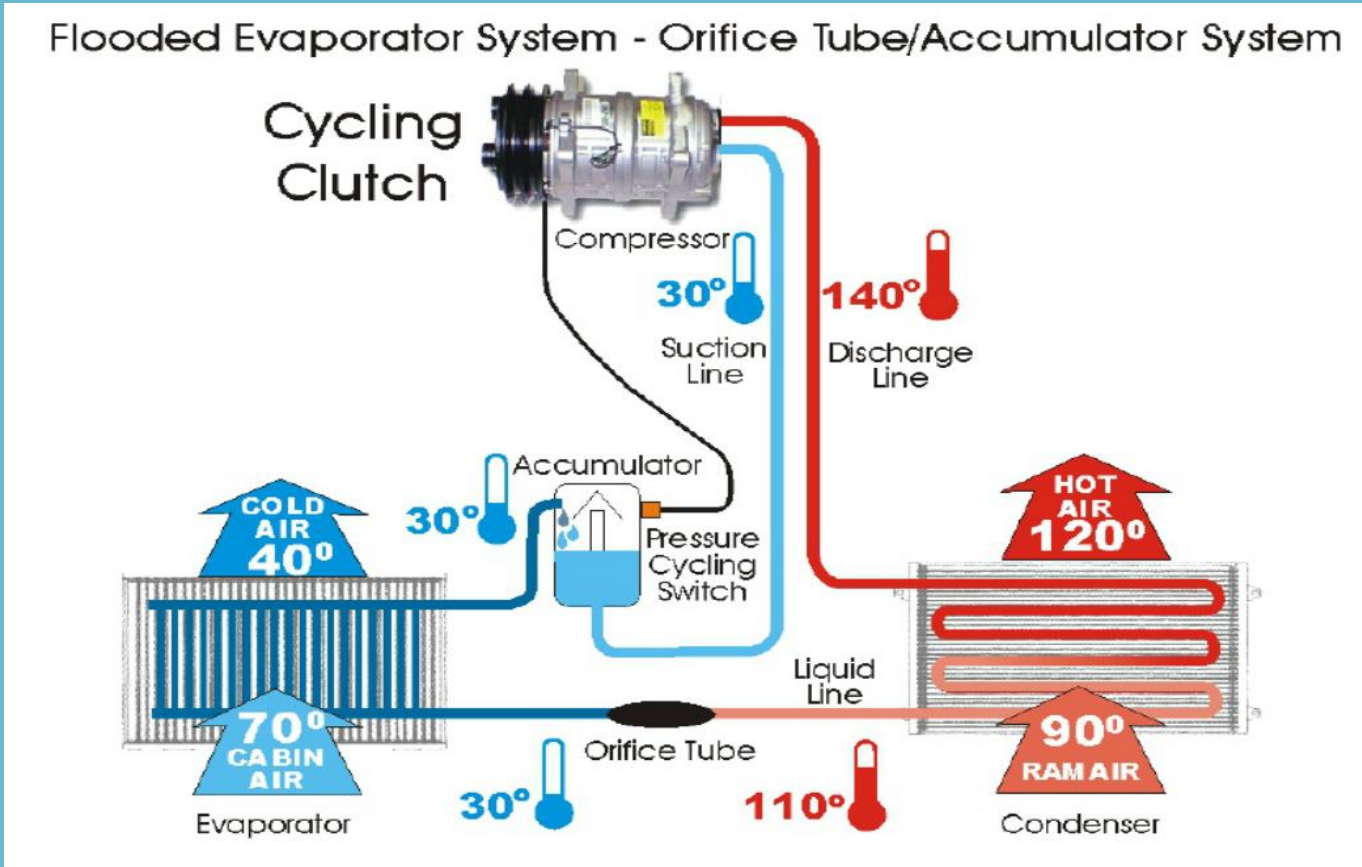
Basic System Flow
TXV System



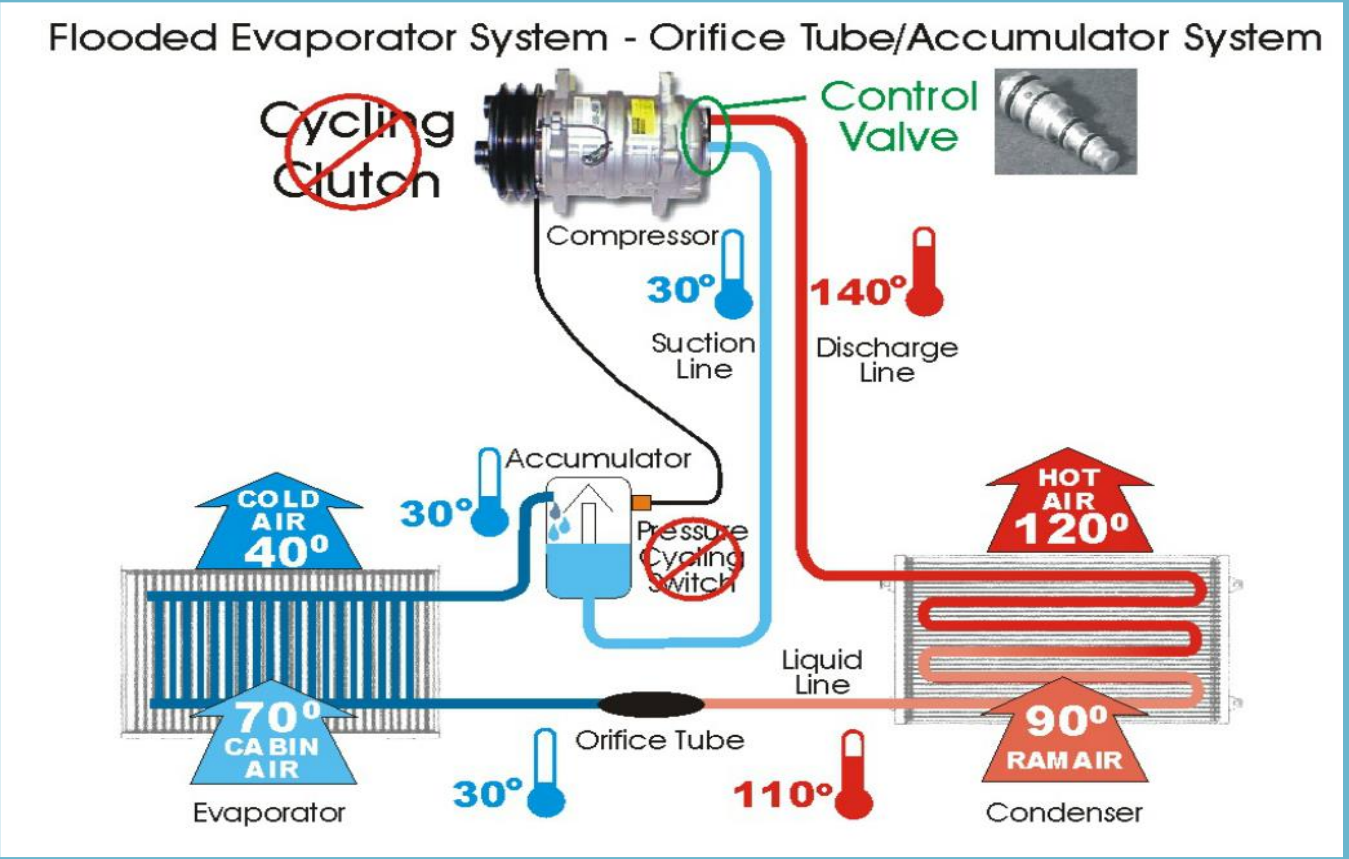
Basic System Flow
TXV System



Basic System Flow
CCOT System



Basic System Flow
CCOT System



Compressors

The heart of the A/C system is the compressor. Compressor designs vary in size and shape depending on the type of system and manufacturer specifications. The compressor is one of the dividing lines of the high and low pressure sides of the A/C system.

Compressors contain many small parts that move against each other and it is not uncommon for a heavy truck compressor to have well over 500,000 miles and thousands of runtime hours on them. This means that Teflon, aluminum, brass, and many other fine particles of material can be distributed through out the system. This is why compressor manufacturers require the system be flushed, a new drier, expansion valve(s), and sometimes even a new condenser to be installed. Proper service procedures will ensure that the new compressor lasts as long as the original.

The main function of the compressor is to pump the vaporized refrigerant and oil throughout the system. This process causes the refrigerant pressure and temperature to increase. When low-pressure refrigerant is drawn into the suction port of the compressor the scroll, pistons, or vanes will compress the vaporized refrigerant. The compressed refrigerant will then travel out of the discharge port toward the condenser taking a small amount of oil with it.

Compressors

There are many different types of compressors.

Fixed Displacement - Displacement of these compressors typically is dependent upon engine RPM. A cycling switch or other thermostatic device must be used to prevent evaporator freeze up. (Most common in Heavy-Duty applications)

- Piston
- Swashplale
- Wobbleplate
- Rotary Vane/Thru Vane
- Scroll

Variable Displacement - Displacement of the compressor is controlled by an internal control valve. Evaporator freeze up is prevented by the control valve changing the compressor displacement. This causes a change in suction pressure which prevents the evaporator from freezing up. Variable displacement compressors do not cycle while the A/C is on. (Not common on Heavy-Duty applications)

Common Compressor Model

Sanden SD5/SD7/TR

Direct Mount

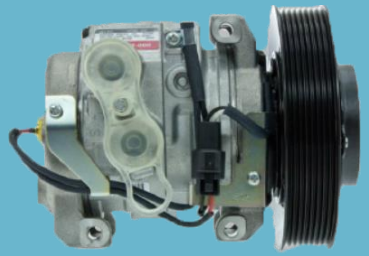
EAR Mount

Saltec/Valeo(TM Series)

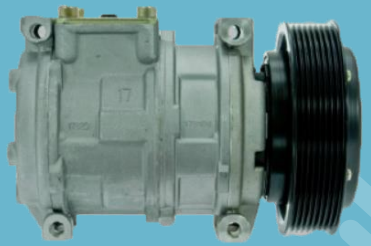
TM-08,15,16,21

TM-31

Denso



IDS - Series

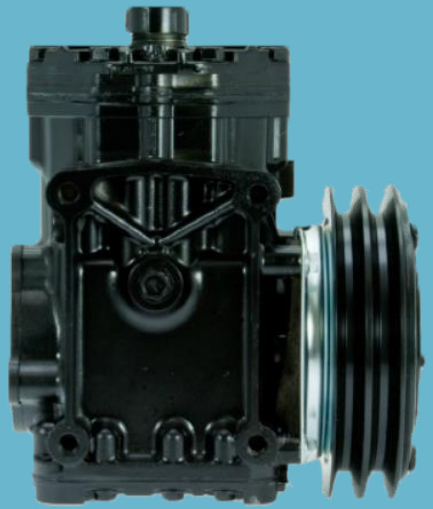


ICPA - Series

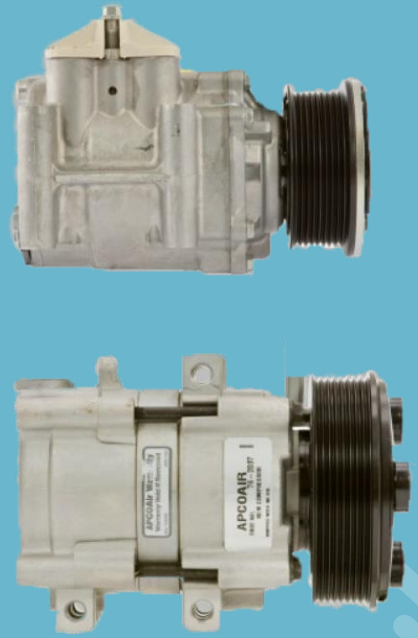
Common Compressor Model

GM A6/H Series

York/TCC/I



Ford FS/FX Series



Common Compressor Problems

- **Lock up caused by -**
  - Insufficient oil charge
  - Excessive discharge pressures
  - Insufficient or excessive refrigerant charge
  - Liquid slugging
  - Internal moving parts failure. (Ex. Bent piston rod)
  - Use of stop leak
  - Not properly flushing the system.
  - Operating environment (Excessive Dust, Grass, Sand)
  - Low Voltage

- **Clutch Failure** – Compressor clutches should not be replaced!!!

- **Compressor leakage** -
  - Shaft seals - Usually not a visible leak. Vacuum leak tests are the most efficient way to find this type.
  - Body - Easily identified by UV or Nitrogen leak tests. Oil and dust accumulation indicates a leak.

- **Faulty Reed Valves** - Caused by excessive pressure and/or contamination. This is identified by excessive manifold gauge flutter or a high low side in conjunction with a low high side. In extreme cases static pressure readings while compressor is in operation indicates faulty valves. (See Examples)

Common Compressor Problems

This York compressor was installed on a system that was not properly flushed. Total system runtime was less than five minutes. Notice y f the imbedded debris fused to the piston and head.

This example shows a Sanden compressor removed from a customers vehicle. A new compressor was installed without flushing by demand of the customer. Later inspection revealed a broker valve. Notice debris on top of the piston.

Compressor Clutches

Electromagnetic device that allows the compressor to engage and disengage as needed.

Voltage - Clutches come in 12 or 24 Volt. Proper voltage must be maintained within 1.5 volts of charging system voltage. Not enough voltage causes clutch to slip which leads to clutch overheating and failure. A voltage drop greater than 1.5 volts can indicate corrosion or faulty electrical components. The source of the voltage drop should be isolated and repaired.

Connectors - Typically have a one or two wire connector. Loose electrical connections can cause the clutch to engage & disengage rapidly causing overheating and failure. Certain clutches are sensitive to polarity. Improper installation can cause damage to the coil.

Diodes - Some clutches may contain diodes. (One way check for electrical current that prevents voltage spikes from damaging electrical components.)

Do not replace compressor clutches!!! Service the compressor as a unit!!!

Compressor Clutches

Air Gap - Proper air gap must be maintained between clutch hub and pulley to prevent unwanted compressor operation (continuous operation), slippage & overheating. Excessive air gap will cause the compressor to not engage at all

Computer Controls - In most modern HVAC systems the clutch is controlled by an ECM or other computerized device. These complex devices rely on multiple inputs to determine if the conditions are correct for clutch engagement. If every condition is not met, the clutch will not operate. Some of these inputs are listed below

- Engine coolant temperature
- Ambient air temperature
- Engine RPM
- Blower motor RPM
- Throttle position sensor
- A/C pressure switches
- Supply voltage
- Power steering cut-off
- MIL (Malfunction Indicator Light

Power Transmission System

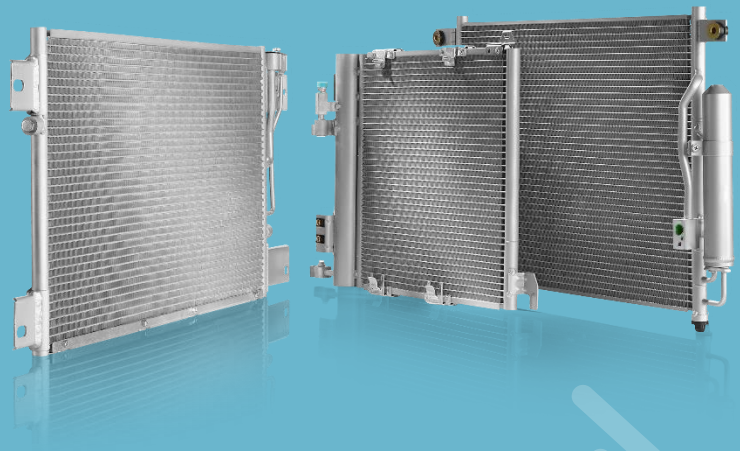
Drive belts - Condition and tension of all drive belts is crucial to proper compressor clutch operation.

Pulleys and Tensioners - All idler pulleys should be checked for wear and belt tensioners should be actuated to their full range to ensure smooth spring operation. Excessive tension can cause compressor clutch bearing noise and failure. Insufficient tension can cause slippage, resulting in noise and bearing failure.

Condensers

The condenser is one of the most critical yet overlooked components of an A/C system. The heat exchange process that happens inside is crucial to the operation and survival of the A/C system. A poorly performing condenser can cause excessive discharge pressures resulting in poor cooling, discharge hose leaks, and compressor failure. The capacity of the system is directly related to the efficiency of the condenser!!!

Condenser operation starts when refrigerant flows to the inlet of the condenser via the discharge line as a high pressure, high temperature gas. The vapor enters the top and flows down towards the outlet to the liquid line. Air flowing through the condenser causes the heat absorbed into the refrigerant to be released to the much cooler air passing through. As the heat is removed from the refrigerant it changes state from a vapor back to a liquid. This process is called condensation and is continuous while the system is in operation.

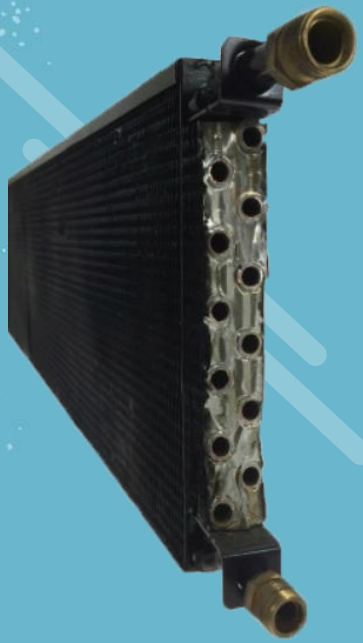


Condensers

OEM's recommend replacement of the condenser any time there is catastrophic compressor failure. Modern condenser designs have multiple small passages allowing flush to flow around a blockage, preventing effective flushing.

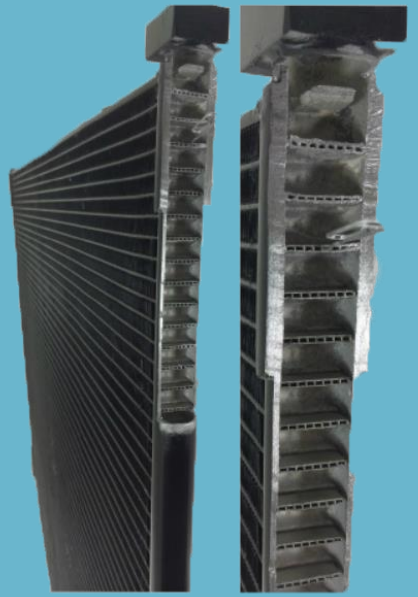
Ideal temperature change at the condenser is a 30-50' F drop inlet to outlet, this reflects the heat being absorbed by the evaporator. Temperature drops significantly larger can indicate an internal restriction. If this is the case replacement of the condenser is required.

Condensers



Round Tube & Fin

Oval/Flat Tube
Serpentine



Oval/Flat Tube
Parallel Flow

Oval/Flat Tube Parallel Flow Condensers are the latest and most efficient design.

Common Condenser Problem

- Leaks
- Air flow restrictions either through the condenser fins or a heat exchanger located on either side of the condenser. All heat exchanges must be clean to allow proper air flow!!!
- Internal restrictions
- Cooling fan issues
- Vehicle overheating
- Missing shrouds/air dams
- Condensers not manufactured to OEM specifications. (Ex. Tube and Fin
- used in place of a Parallel Flow.)

Cooling Fans

The A/C systems survival depends on the cooling fan(s) ability to provide air flow at low vehicle speeds and in extreme ambient temperatures. Cooling fans can be belt driven or powered by electric motors. Common belt driven fan types are air. viscous, and electronic viscous. Cooling fans and related components should be inspected for proper operation anytime the A/C system is serviced.

Cooling Fans

Air Fans- Currently these are the most widely used fans in heavy-duty truck applications. An electric solenoid sends pressurized brake air to the fan hub to engage or disengage as needed. In many systems a fan override pressure switch is installed on the high side of the system to signal the fan to engage. Common air fan problems include excessive friction disc wear causing slippage and cracked or blown engagement diaphragm. Most air fans are field serviceable. Audible air leaks or a fan that turns by hand while engaged should be repaired or replaced.

Electric Cooling Fans- Found on many light-duty applications. The electric circuits that provide power to these fans must be inspected. Perform a current draw test, check electrical connections, relays, and wire condition. A motor turning slow or drawing excessive current must be replaced. Fan relays must be replaced any time a new fan is installed. Scan tools can be useful when diagnosing these fans.

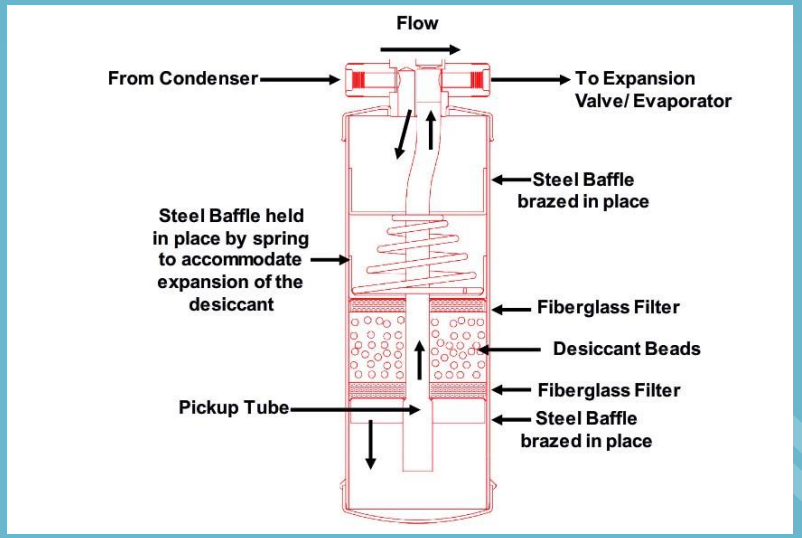
Cooling Fans

Viscous Cooling Fans- Found on light to heavy-duty applications. As airflow temperature increases a bimetal spring will release fluid to passageways increasing fan speed and cooling ability. These fans should be changed at any sign of fluid leakage. Vehicles should be at operating temperature before evaluating the fans performance.

Electronic Viscous Cooling Fans- Found on modern light to heavy-duty applications. These operate much like viscous cooling fans, the bimetal spring is replaced by a pulse width modulated solenoid. This solenoid is controlled by a control module using various inputs. These fans are becoming increasingly popular because they allow precise control of fan RPM. These fans can be checked with a scan tool or digital multimeter and should be changed at any sign of fluid leakage.

Receiver Driers

The receiver drier is a cylinder installed on the high side of TXV systems between the condenser and the expansion valve. Receiver driers store, filter, and remove moisture from refrigerant. When high pressure refrigerant from the condenser reaches the drier vapor will collect at the top of the drier and liquefied refrigerant and oil will filter through the desiccant. The liquefied refrigerant and oil will be pulled up the pickup tube to the outlet of the drier and sent to the expansion valve/ evaporator.



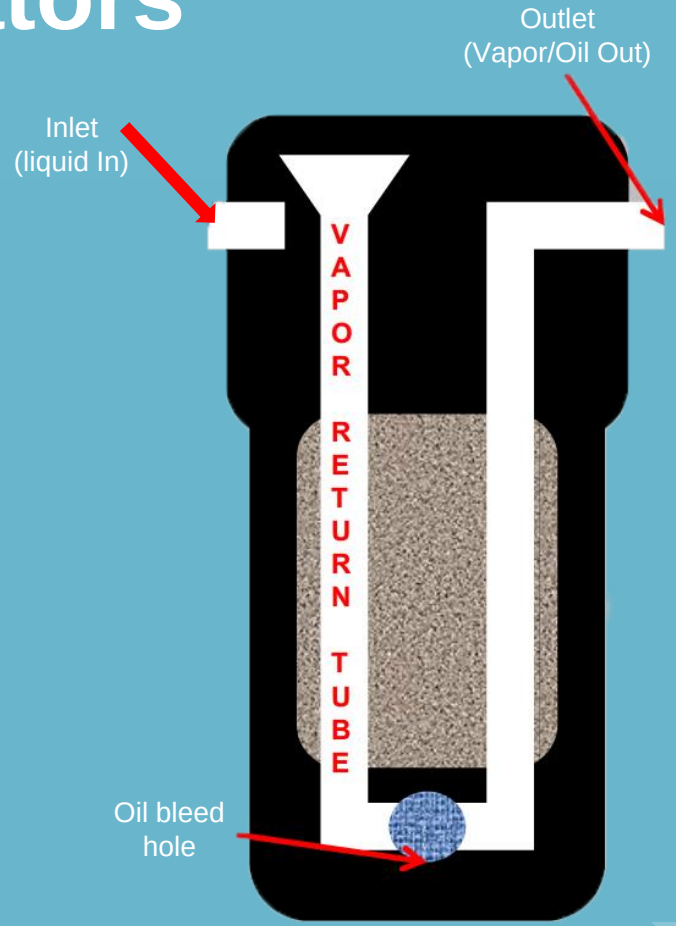
Common Receiver Drier Problems

- Leakage
- If the receiver drier is installed backwards, the A/C system will not function properly.
- In some cases you will have an integral receiver drier made onto the condenser. This type may or may not be serviceable and are not typically found in heavy-duty applications.
- Some receiver driers may have a sight glass. These should not be used to determine your refrigerant charge.
- Receiver driers should be replaced once a year or any time the A/C system opened. A dated receiver drier can become acidic and rupture releasing desiccant and acid into the system resulting in a clogged system and/or component failure.
- A clogged receiver drier can cause excessive high side/discharge pressure and increased strain on A/C compressor resulting in system damage.

Accumulators

The accumulator is a liquid-vapor separator designed to prevent liquefied refrigerant from reaching the A/C compressor. The accumulator will always be located between the evaporator outlet and the compressor inlet.

Liquefied refrigerant and oil upon entering the accumulator filter through the desiccant and fall to the bottom of the tank. The return tube will pull vaporized refrigerant from the top of the tank while drawing oil in through the bleed hole. The suction of the compressor will then pull vaporized refrigerant and oil through the accumulator outlet and into the compressor.



Accumulators

- Accumulators should be replaced any time the A/C system is opened.
- If accumulator is equipped with a heat sleeve/jacket you will need to reuse any time you replace.

Expansion Valves

Expansion Valves are a type of metering device used to ensure proper cooling and system operation. The valve is usually found at the inlet of the evaporator separating the high and low side of the system and is paired with a receiver drier. Proper expansion valve operation is essential to the A/C systems performance. Expansion valves should always be replaced when installing a new compressor.

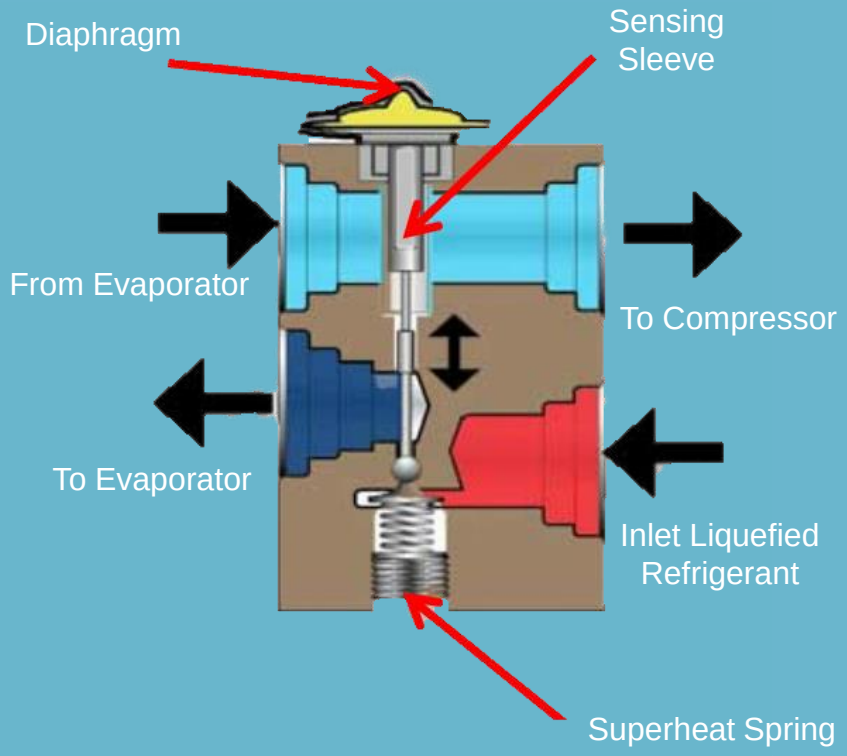
The expansion valve will regulate the amount of refrigerant that enters the evaporator core based on the temperature of the refrigerant exiting the evaporator core. The sensing element (bulb) varies by expansion valve design and is used to determine the heat load and adjust the refrigerant flow as needed. This regulating action prevents liquefied refrigerant from reaching the compressor. Most valves have a slotted seat which allows oil and refrigerant to
flow even if the diaphragm charge is lost.

Expansion Valves

Liquefied refrigerant enters the TXV passing through the orifice causing a pressure drop. As refrigerant exits the evaporator and flows across the sensing sleeve the diaphragm actuates a push pin. changing the orifice size. Tension from the superheat spring simultaneously pushes against the seat allowing smooth operation. This process regulates the amount of refrigerant entering the evaporator.

- Charge level in the diaphragm is critical to the valve's ability to control volume of liquid refrigerant into the evaporator.

- Expansion valve superheat settings are determined by A/C system design.



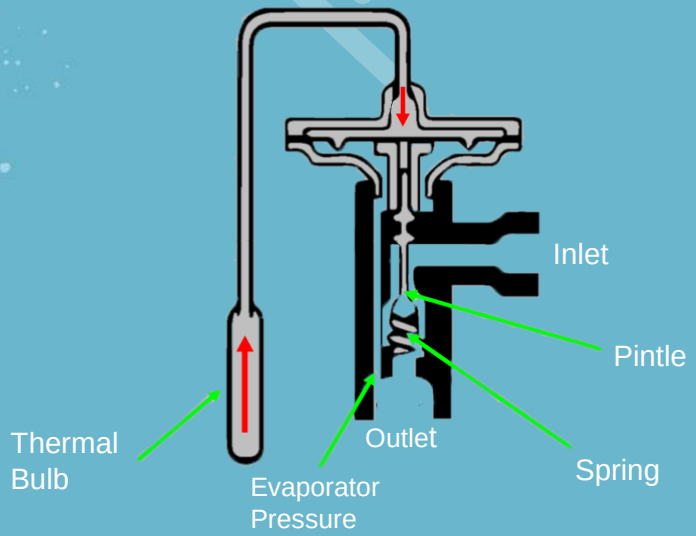
Note: The superheat spring is factory set. **DO NOT ADJUST!!!**

Expansion Valves

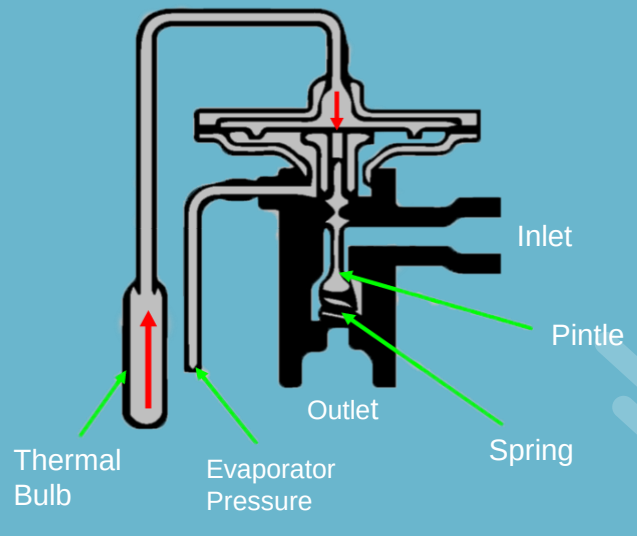
Sensing bulb must be attached to a clean surface and sufficiently insulated for proper temperature operation.

• Evaporator pressure is always applied to the underside of the diaphragm to allow smooth operation. Internally equalized valves use an internal passage and externally equalized valves use an external tube.

Internally Equalized



Externally Equalized



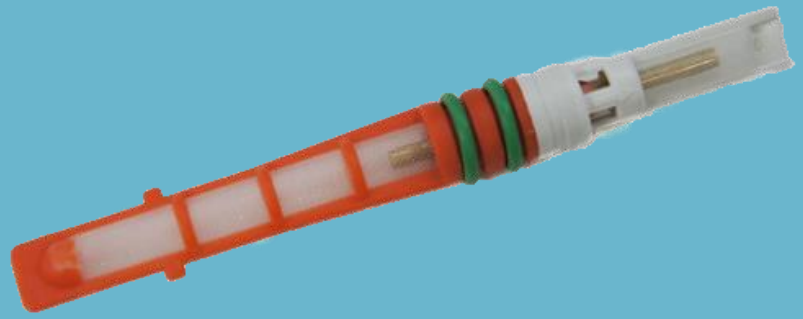
Common Expansion Valve Problem

- Sensing bulbs losing their refrigerant charge.
- Push pins can become corroded or stuck.
- Leakage
- The orifice/inlet screen can become clogged and restrict refrigerant flow.
- Improper valve installed - Tonnage and superheat settings must match OEM
- specifications to ensure proper system operation.

Orifice Tubes

Orifice tubes are a type of metering device used to ensure proper A/C system operation. Orifice tubes are always installed between the liquid outlet of the condenser and the inlet of the evaporator. These come in variable and fixed designs and are paired with accumulators. Many orifice tubes are stamped with an arrow indicating the flow direction. Common problems with orifice tubes include debris causing restriction; backwards installation, and incorrect size. Orifice Tubes should always be replaced when the A/C system is opened.

The orifice tube provides a restriction to the high pressure liquefied refrigerant, reducing its pressure. This pressure drop converts refrigerant into a low pressure liquid before it enters the evaporator. Orifice tube systems cycle on & off using pressure rather than temperature. This prevents oil starvation when the refrigerant charge is low.



Orifice Tubes

Evaporator Mounted
Fixed Orifice Tube

Condenser Mounted
Fixed Orifice Tube

Evaporator Mounted
Fixed Orifice Tube

Fixed Porous
Orifice Tube

Note: Some OEM's use a non-removable orifice tube crimped into the liquid line. In these systems you must replace the liquid line in order to replace the orifice tube.

Evaporators

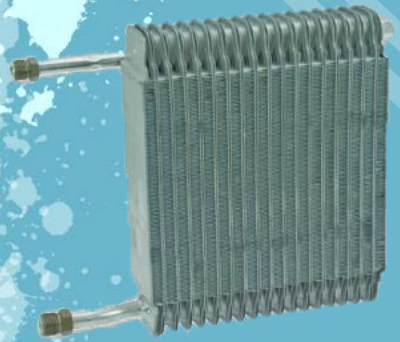
The evaporator is a heat exchanger usually located in the passenger compartment along with the air distribution plenum. Its function is to remove heat, dehumidify & clean the air entering the passenger compartment.

When the A/C system is on, the liquefied refrigerant will flow through the expansion valve/orifice tube, this will cause the pressure to drop. The refrigerant is now low-pressure liquefied gas when it enters the evaporator core. This process causes the evaporator to become cold. As the liquefied refrigerant passes through the evaporator it will change from a liquid to a gas and absorb heat from the cabin area.

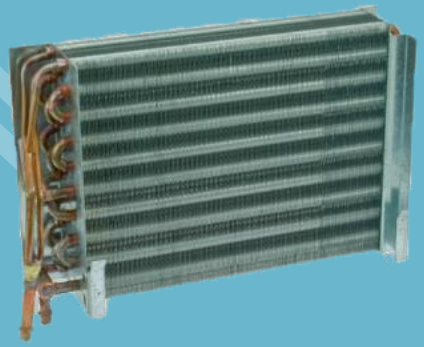
Cooler air cannot contain the same amount of moisture that warm air can. As a result, water droplets begin to form, flow down the fins, and exit through the drain tube at the bottom of the plenum.

Evaporator Types

Plate & Fin

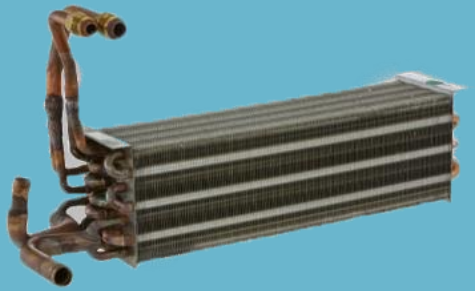


Tube & Fin



Serpentine

Combo



All these designs perform the same basic function. Design variations achieve this function by changing how refrigerant flows through the core.
Combo cores are designed as a heater and evaporator core made into one and must be serviced as a unit. Combo cores are found in many Ag applications and some light to heavy-duty truck applications in the rear/sleeper unit.

Common Evaporator Problems

- Poor Air Flow - Dirty cabin air filters and/or evaporators will result in poor A/C system performance and excessive clutch cycling leading to premature compressor failure. Always clean evaporator and replace cabin air filters!!!

- Leakage - Evaporator leaks can be especially difficult to locate. Electronic leak detectors and UV dye are the most effective methods used to locate this type of leak. Leak tests should be performed when evaporator pressure is at it highest (A/C system off).

- Sealing - Air bypassing the evaporator core can be caused by deteriorated seals, breaks in the evaporator housing, or improper installation.

- Oil - Excessive oil will displace the refrigerant causing poor cooling.

Hose Assemblies

Hose assemblies are made of aluminum or steel tubing with rubber in between to add flexibility. Their purpose is the carry refrigerant to the A/C system components.

- Discharge Line - Connects the discharge port of the compressor to the inlet on the condenser.
- Liquid Line - Connects the outlet of the condenser to the inlet of the metering device.
- Suction Line - Connects the accumulator or evaporator outlet to the suction port of the compressor.

The most common problems with hose assemblies are leakage and restrictions. Leakage can be caused by excessive discharge pressure, chaffing from improper mounting, or deterioration due to age. Restrictions can be caused by debris in the A/C system, or internal hose deterioration.

O-Rings & Seals

A/C systems use a wide variety of o-ring and seals, therefore it is very important to use the correct size and type. O-rings and seals should always be replaced when the connection is broken. O-rings should be lubricated with mineral oil. Sealing washers and gaskets should always be installed dry.

O-ring Fittings use -

- Standard O-rings
- Captive O-rings
- Dual O-rings

Flange Fittings use -

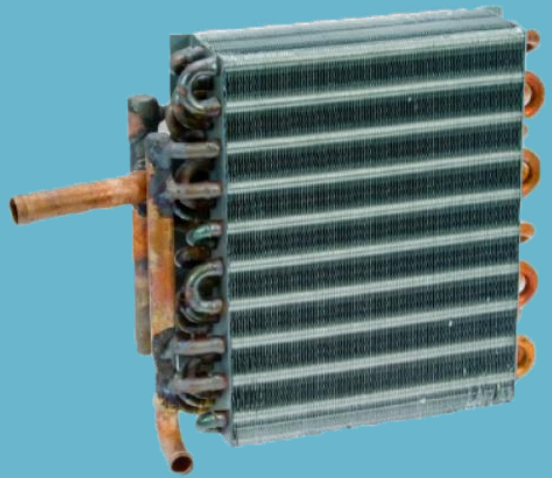
- Sealing Washers
- Stat Seals
- Slimline Sealing Washers
- Gaskets

Spring-lock fittings contain multiple o-rings and one garter spring. Replace o-rings and springs when connection is broken. Special tools are required.

Heater Cores

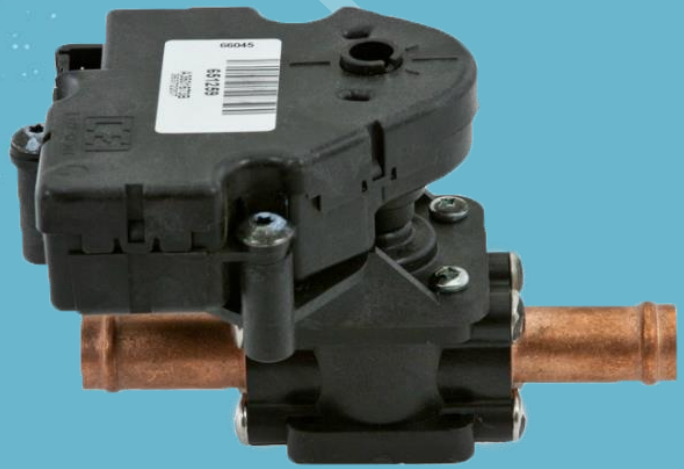
The heater core is a heat exchanger located in the passenger compartment along with the air distribution plenum. Heated coolant flows through the heater core to heat the cab or to blend with cooled air to maintain a desired temperature.

Lack of heat can be an indication of cooling system problems. Some heater cores will fail due to chemical erosion or corrosion causing blockage and/or leakage. Use of distilled water and proper amounts of coolant are key. The cooling system of a vehicle directly affects A/C and heating performance:. Cooling systems should be properly maintained to avoid problems.



Heater Control Valves

Many A/C systems are equipped with heater control valves which control coolant flow to the heater core. These valves can be variable or on/off. The variable design controls coolant flow into the heater core to maintain a desired temperature. The on/off design is used in conjunction with the blend door to completely cut off coolant flow to the heater core when max A/C is requested. These valves can be manual, cable, vacuum, or electronically controlled. A malfunctioning heater valve will cause higher than normal duct outlet temperatures. This is a common problem in mobile HVAC systems.



Blower Motors

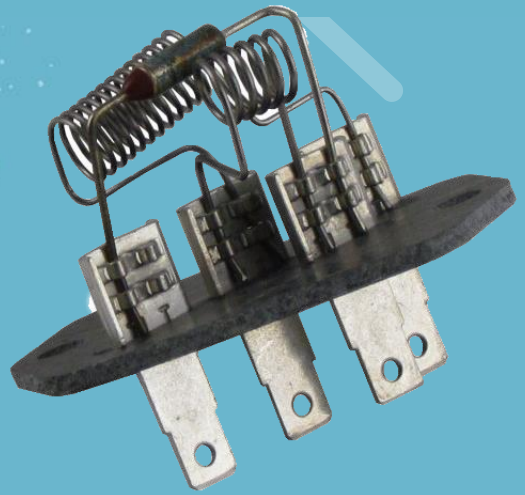
The blower motor can be found in the air distribution plenum. The main function of the blower motor is to pull or push air across the heater core/evaporator. Air will then flow through the duct outlets, circulating throughout the cab. Blower motor speeds are variable and selected at the controls. Common problems include noise, bearing/brush failure, excessive amp draw, and faulty electrical connections.

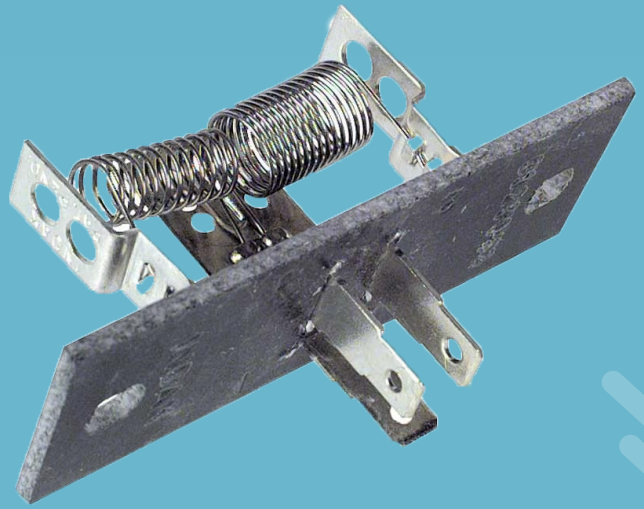
Brushless blower motors use a combination of magnets and
transistors that are pulsed in sequence. The opposing poles of the magnets will line up and repel each other causing the motor to turn (pulse width modulation). These motors have a feedback circuit that sends blower motor RPM to the controlling module. The module uses this information to adjust speed, eliminating the need for a resistor.

Resistors

Wire wound, circuit board, and ceramic design resistors reduce current flow to control the blower speed. Resistors are mounted in the air distribution plenum to keep them cool.

Modulator type resistors pulse the current that the motor receives at different intervals to control the blower speed. This is called pulse width modulation and gives more precise control over blower motor RPM. Modulator type resistors are used in modern electronically controlled A/C systems. Proper operation must be checked with a digital multi meter using factory service information.





Diverter Doors

Recirculation Doors - Determine whether air will be pulled from outside or inside the cab. Duct outlet temperatures will be affected when this door is set to fresh/outside air position. This type of door will be found in the air distribution plenum inlet.

Blend Doors - Position determines the temperature of the air corning into the passenger compartment. The blend door will direct air through the heater core controlling air temperature. Improperly sealed or inoperable blend doors will not control air temperature properly.

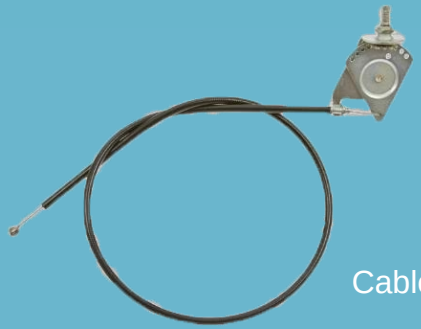
Mode Doors - Designed to determine where the air will enter the passenger compartment. Most systems contain two mode doors. One diverts air to dash vents or floor while the other opens and closes the defrost outlet. Some systems use gear sets or cams and utilize only one mode actuator.

Heater Isolator Doors - Prevent air flow through the heater core when Max A/C is requested.

Actuators

The diverter doors discussed in the previous section are controlled by actuators. Actuator types include electronic, cable, air. and vacuum.

Electronic



Cable

Air

Vacuum

Electronic Actuators

Recirculation Door Actuators - These are simply two position and may have only two or three pins.

Mode Door Actuators - May be required to stop in 3-5 positions and have a feed back circuit to communicate its position to the control head.

Blend Door Actuators - Normally fail first because they are in constant operation as interior temperature conditions change. They have infinite variation between hot and cold limits.

Before installation, do not run the actuator arm beyond its normal limits. This will disengage the feedback contacts resulting in no communication to the control head. Some vehicles require a calibration procedure be performed after actuator replacement. Detailed electrical diagrams, bidirectional scan tools, and digital multi meters are useful when checking actuator function or calibration.

Control Head Assemblies

A/C systems are equipped with a main component designed to control temperature, air distribution, and air speed. The control head assembly houses various types of control switches: knobs, and levers to properly interface with the A/C system. A combination of vacuum lines, air lines, mechanical cables, and electrical cables are attached to the control components. Different makes and models will vary by design. Most designs will have the following controls.

A/C on-off switch - Responsible for requesting compressor clutch engagement.

Temperature selector - Responsible for controlling outlet air temperature.

Blower motor switch - Responsible for controlling blower motor speed and air volume.

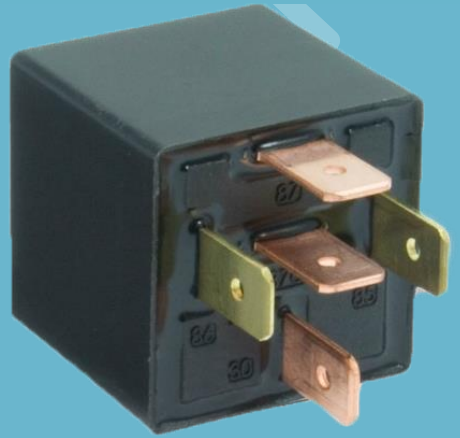
Mode selector - Responsible for routing airflow to various outlets. (Vents, floor, and defrost.)

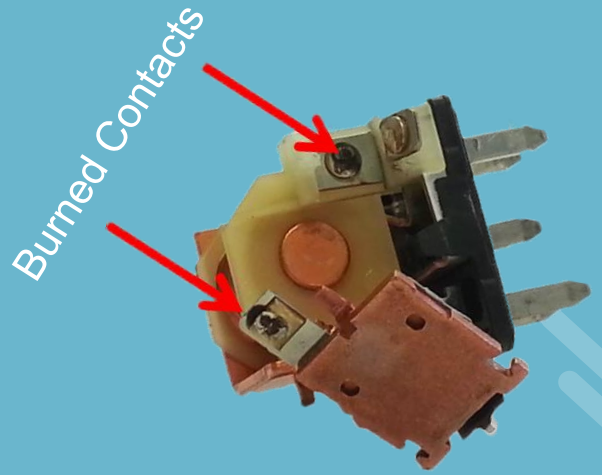
Recirculation switch - Closes the outside air inlet for Max A/C output.

Relays

A relay is an electro-mechanical device that allows a low current circuit to control a high current circuit without damaging components. Some relays have diodes to prevent damage to electronics. Relays control blowers, clutches, and cooling fans in A/C systems.

Relays have moving parts and are subject to mechanical failure. Contacts often burn and cause excessive voltage drop reducing available voltage in the circuit. Contacts can also stick together resulting in a component that operates continuously. Clutch relays must always be replaced when installing a new compressor.





Transistors

Transistors are semiconductor devices used to control current flow. They are often used in place of relays. These transistors have no moving parts, giving them an advantage over traditional relays. This electronic relay also switches faster than its mechanical counterpart which is an asset in faster operating computer circuits.

Thermistors

Thermistors vary resistance value according to the temperature they are exposed to. The resistance value is sent to a control module that makes decisions based on data input. In modern A/C systems thermistors have many applications.

Ambient Air Temperature Sensors - Mounted outside to relay temperature. These prevent clutch engagement in low ambient temperatures and are used in ATC systems to determine heat load.

Evaporator Temperature Sensors - Mounted in the evaporator housing and used to signal the compressor off. preventing evaporator freeze up.

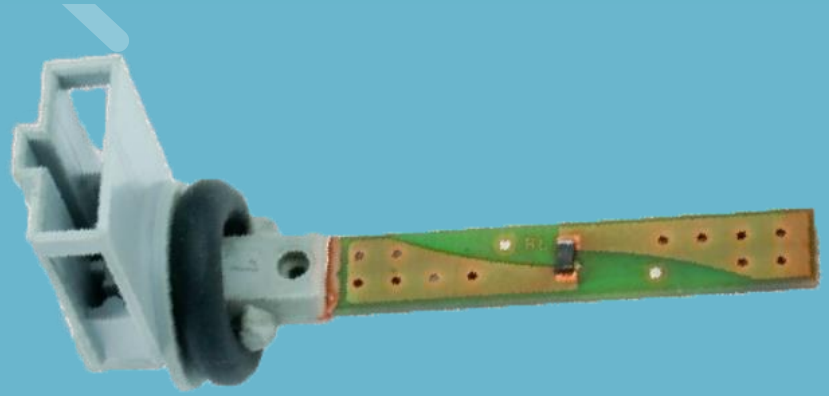
Refrigerant Temperature Sensors - Relay refrigerant temperature/pressure data to the control module for clutch cycling and refrigerant charge reference.

Thermistors

Discharge Air Temperature Sensors - Mounted in the duct work and relay outlet air temperature to the control module.

Cab Air Temperature Sensors - Mounted on the dash board and relay actual cab temperature to the control module. Usually found in ATC systems.

Thermistor specifications vary widely by application. Proper operation must be checked with a digital multi meter using factory service information or with a scan tool.



Thermostatic Switches

In expansion valve systems the thermostatic switch controls the compressor clutch cycling to prevent evaporator "freeze-up". There are two types or designs:

Electronic or Thermistor probe attached to evaporator coil

Thermostatic switch installed in evaporator coil

Location and depth of probe is critical for temperature accuracy!! Probe must be installed back to OEM location!!!

Pressure Switches

There are many different types of pressure sensing switches that have a wide range of functions within the A/C system. These switches can be normally open or normally closed.

- Normally Open - No current flow until closed PSI is achieved.
- Normally Closed - Constant current flow until open PSI is achieved.

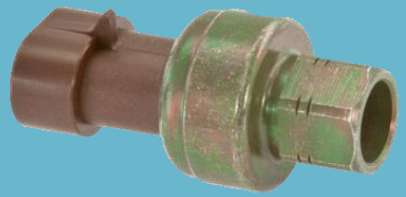
Cycling Switches- Used in CCOT systems, this type of switch is always found on the suction side. When pressure drops to a preset limit the switch signals the compressor clutch to disengage. This prevents evaporator freeze up and component damage when the refrigerant charge is low.
Low Pressure Switches- Manufactured in both normally open and normally closed. This type of switch signals the compressor off at extremely low pressure. This prevents A/C system damage due to low refrigerant charge.

Pressure Switches

High Pressure Switches- Manufactured in both normally open and normally closed. This type of switch is located on the high side of the system and signals the compressor to disengage at an unsafe discharge pressure.

Binary Switches- Dual function switches located on the high side of the system. This type of switch acts as a low and high pressure cut off.

Trinary Switches- Three function switches located on the high side of the system. This typo of switch has one circuit that acts as a low and high pressure cut off like a binary switch. The second circuit is used as a fan override to engage and disengage the cooling fans as needed. The fan override section comes in both normally open and normally closed configurations with varying pressure ranges.



Pressure Switches

Fan Override Switches- Engage and disengage the cooling fans as needed, based on system pressure. The fan override comes in both normally open and normally closed configurations with varying pressure ranges.

Pressure Transducers- Convert A/C system pressures to an analog voltage signal between 0 and 5 volts. The computer uses the feedback voltage to make decisions regarding compressor clutch and cooling fan engagement. Transducer specifications vary by application. Proper operation must be chocked with a scan tool or digital multi meter using factory service information.

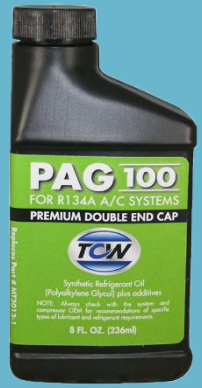
Lubricants, Dyes & Additives

Lubricants- There are two basic types of lubricants for R134a systems, PAG and Ester oils. Mobile applications predominantly use PAG oils which are very hygroscopic. This means that they easily absorb moisture and containers should be capped immediately after use. Correct type, viscosity, and amount of oil are critical to prevent A/C system damage. Always refer to OEM specifications for total system requirements. When components are individually replaced, drain and measure the oil from the removed components and replace with an equal amount. A rule of thumb guide is at the end of this section.

Lubricants, Dyes & Additives

Dyes- Late model A/C systems come factory charged with UV leak detection. When used in moderation this can be a very effective tool in locating hard to find leaks. It is important to use good quality dye meeting SAE J2297 standards. Excessive amounts of dye can cause internal corrosion and damage the A/C system.

Additives- Chemicals added to the A./C system must meet SAE J2670 standards. This does not guarantee the additive has any positive effect on A/C system performance. Compressor manufacturers will void warranty if these additives are used. Stop leak will severely damage the A/C system and void all warranties.



Component Oil Amounts

General Rule of Thumb

- Compressors-
  Flush complete A/C system and refill oil to OEM specifications.
- Evaporators-
  Plate & Fin- 3oz. Oil
  Tube & Fin- 2oz. Oil
- Condensers-
  1oz. Oil
- Receiver Driers-
  2 oz. Oil
- Accumulators-
  3 oz. Oil
- Lines & Hoses-
  0.5 oz. Oil per line

Always refer to OEM specifications when available!

Required Service Equipment

- Recovery & Recycle Machine
- Vacuum Pump
- Charging Scale
- Manifold Gauges
- Nitrogen Test Kit
- UV Dye Kit
- Electronic Leak Detector
- Micron Gauge
- Temperature Testing Devices
- Digital Multi Meter
- Flushing Kit

System Diagnosis

A/C system repairs should happen in stages.

1. A visual inspection should occur first which will find obvious problems and save time. Manifold gauge set should be installed at this time to verify that there is refrigerant in the system.

2. If after the visual inspection the system is able to be operated a performance evaluation should be conducted. The vehicle should be brought to operating temperature. The HVAC system should allowed to stabilize followed by vent temperature readings. Temperature drop checks should be conducted on the evaporator and condenser then compared to rules of thumb. (Condenser 30 to 50 degree drop inlet to outlet Evaporator 5 degree or less inlet to outlet.)

3. Gauge readings should be compared to the rule of thumb checklist. Any item that can be inspected on the system checklist should be at this time. Once this is completed if needed leak testing should be performed. When all issues have been diagnosed the necessary repairs should be performed followed by repair verification which means repeating the preceding steps.

System Pressure Rule of Thumb

Discharge Pressure:

Condenser Air Inlet Temperature

_____ F

Plus 35 F

Equals = _____ PSI

Suction Pressure:

Return Air Temperature Entering Evaporator

_____ F

Plus 30 F

Equals = _____ PSI

Note: The system head pressure rule of thumb serves as a guide to project system head pressures for comparison to actual gauge readings.

Use this in conjunction with the Pressure Vs. Temperature Chart

PRESSURE

TEMPERATURE

Table 5-1. R-134a Temperature - Pressure Chart

Temperature		Vacuum			
°F	°C	"/hg	cm/hg	kg/cm²	bar
-40	-40	14.6	49.4	37.08	0.49
.35	.37	12.3	41.6	31.25	0.42
-30	-34	9.7	32.8	24.64	0.33
-25	-32	6.7	22.7	17.00	0.23
-20	-29	3.5	11.9	8.89	0.12
-18	-28	2.1	7.1	5.33	0.07
-16	-27	0.6	2.0	1.52	0.02

Temperature		Pressure			
°F	°C	psig	kPa	kg/cm²	bar
-14	-26	0.4	1.1	0.03	0.03
-12	-24	1.2	8.3	0.08	0.08
-10	-23	2.0	13.8	0.14	0.14
-8	-22	2.9	20.0	0.20	0.20
-6	-21	3.7	25.5	0.26	0.26
-4	-20	4.6	31.7	0.32	0.32
-2	-19	5.6	36.6	0.39	0.39
0	-18	6.5	44.8	0.46	0.45
2	-17	7.6	52.4	0.53	0.52
4	-16	8.6	59.3	0.60	0.59
6	-14	9.7	66.9	0.68	0.67
8	-13	10.8	74.5	0.76	0.74
10	-12	12.0	82.7	0.84	0.83
12	-11	13.2	91.0	0.93	0.91
14	-10	14.5	100.0	1.02	1.00
16	-9	15.8	108.9	1.11	1.09
18	-8	17.1	117.9	1.20	1.18
20	-7	18.5	127.6	1.30	1.28
22	-6	19.9	137.2	1.40	1.37
24	-4	21.4	147.6	1.50	1.48
26	-3	22.9	157.9	1.61	1.58

Temperature		Pressure			
°F	°C	psig	kPa	kg/cm²	bar
28	-2	24.5	168.9	1.72	1.69
30	-1	26.1	180.0	1.84	1.80
32	0	27.8	191.7	1.95	1.92
34	1	29.6	204.1	2.08	2.04
36	2	31.3	215.8	2.20	2.16
38	3	33.2	228.9	2.33	2.29
40	4	35.1	242.0	2.47	2.42
45	7	40.1	276.5	2.82	2.76
50	10	45.5	313.7	3.20	3.14
55	13	51.2	353.0	3.60	3.53
60	16	57.4	395.8	4.04	3.96
65	18	64.1	441.0	4.51	4.42
70	21	71.1	490.2	5.00	4.90
75	24	78.7	542.6	5.53	5.43
80	27	86.7	597.8	6.10	5.98
85	29	95.3	657.1	6.70	6.57
90	32	104.3	719.1	7.33	7.19
95	35	114.0	786.0	8.01	7.86
100	38	124.2	856.4	8.73	8.56
105	41	135.0	930.8	9.49	9.31
110	43	146.4	1009	10.29	10.09
115	46	158.4	1092	11.14	10.92
120	49	171.2	1180	12.04	11.80
125	52	184.6	1273	12.98	12.73
130	54	198.7	1370	13.97	13.70
135	57	213.6	1473	15.02	14.73
140	60	229.2	1580	16.11	15.80
145	63	245.6	1693	17.27	16.93
150	66	262.9	1813	18.48	18.13
155	68	281.1	1938	19.76	19.37

Leak Detection

Missed leaks can cause numerous issues, so every effort should be made to diagnose and repair leaks the first time. Often the second time will be free!! There are many leak detection methods used in A/C system service. The most common are:

UV leak detectors - When used in moderation this can be a very effective tool in locating hard to find leaks. It is important to use good quality dye meeting SAE J2297 standards. Excessive amounts of dye can cause internal corrosion and damage to the A/C system. Trace dye is a colored liquid that circulates through the system and escapes with oil and refrigerant staining the area. UV glasses and a powerful ultraviolet light will cause stained areas to glow revealing the leak.

Nitrogen leak tests - Nitrogen is an inert gas that absorbs moisture and is safe for use in A/C systems. The A/C system can be pressurized up to 200- 250 PSI with nitrogen using a manifold gauge set. While system is pressurized apply soapy water to all components and connections following system flow. Leaking areas will form bubbles where nitrogen is escaping.

Leak Detection

Vacuum leak tests - Once the desired micron reading is achieved the gauges should be closed and the system should maintain the vacuum reading fora minimum of 10 minutes. If this test is not passed further leak testing should be performed.

Electronic leak detectors - Portable devices designed to pinpoint refrigerant leaks as small as 0.15 - 0.5 ounce per year at a distance of 1/4 “ - 3/8” away from the leak point. These electronic leak detectors must be used with a minimum of 50 PSI in the A/C system. Refer to manufacturer instructions for proper usage.

Recovery & Recycling

A section 609 certification is required to service Mobile Air Conditioning Systems. Venting refrigerant is against the law and can result in fines up to $32,500 per day. You must have EPA approved equipment in your shop.

Recovery Machines- These machines are available in recovery & recycle only and recovery, recycle & recharge.

Recovery, recycle & recharge machines are the most practical on the market today because of their multi function design.

- Recovery & recycle machines must meet SAE J2210 standards.
- Recovery, recycle & recharge machines must meet J2788 standards.

Flushing

- DO NOT FLUSH
  - Compressors
  - Oval/Flat Tube Condensers
  - Receiver Drier/Accumulators
  - Expansion Valves/Orifice Tubes
- SYSTEM MUST BE FLUSHED
  - If orifice tube has debris on it
  - If the oil is contaminated
  - If the compressor is replaced
- Always flush opposite of system flow.

- Flush shortest lengths possible if not using closed loop flushing machine.
- All flush should be removed before charging the system. Chase flush with dry nitrogen. DO NOT USE SHOP AIR!!!! Follow proper evacuation procedures.

Use Solvent based flush ONLY!!!

Evacuating the A/C System

Proper evacuation of an A/C system is not measured in time but microns{500-1500 minimum of 10 minutes). OEM's highly recommend the use of a micron gauge for proper evacuation. In the absence of a micron gauge follow these guidelines. Vacuum for a minimum of 45 minutes, longer if the A/C system has been flushed or is in cooler ambient temperatures.

A proper evacuation is a must after **ANY** A/C system repair. This action removes air and lowers the pressure in the system allowing excess moisture to boil away at ambient temperatures. Moisture left in a system can freeze and cause blockage, dilute lubricants, and even promote the formation of acids. Air left in a system will cause excessive discharge pressures and reduced system performance.

A quality two stage vacuum pump (5 C.F.M or greater) with Fresh clean pump oil should be used to evacuate the system. Because the oil is hygroscopic, moisture removed from the system will become trapped in the oil. Regular pump service intervals ensure the moisture will not damage the pump and increase the pumps efficiency.

Once the desired micron reading is achieved the gauges should be closed and the system should maintain the vacuum reading for a minimum of 10 minutes to check for leaks.

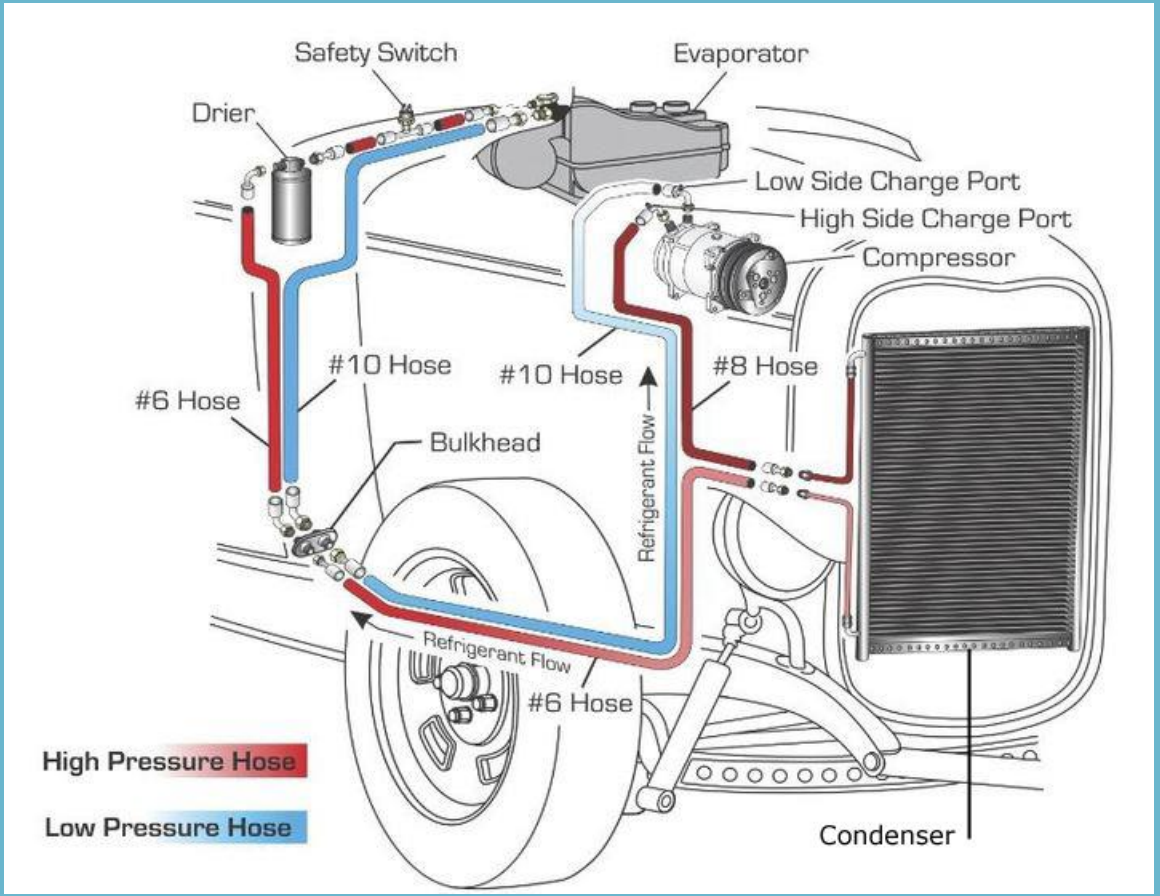
Charging the System

- Know the system lubricant and refrigerant specifications.
- Rotate compressor shaft by hand 20 full turns to distribute oil.
- Use charging equipment that has been calibrated regularly.
- Consider the charging hose length when programming scale. Every 6 ft. of hose holds 2 oz. of refrigerant.
- Verify pressure/temperature and performance using the PT Chart.
- Verify system cycling, cooling Fan operation, and vent temperature.

DO NOT charge by pressure readings!!!

COMPONENT	OK	Repair	Replace	Clean
1. Belts (check condition & tension)				
2. Belt Tensioner (Auto & Manual)				
3. Blower Motor-Main				
Electrical (breaker, relay, resistor)				
Switch (check speeds, knob)				
Wiring				
4. Blower Motor-Sleeper				
Electrical (breaker, relay, resistor)				
Switch (check speeds, knob)				
Wiring				
5. Blower Wheel-Main				
6. Blower Wheel-Sleeper				
7. Compressor (condition-leakage, lockup, etc.)				
Mounting Brackets/Alignment				
Service Valves, Adapters, Caps, Valve Cores				
8. Clutch (condition-air gap, burnt, etc.)				
Cycling Test				
Wiring				
9. Condenser (condition-dirty, leakage, bent fins, etc.)				
Mounting Brackets				
10. Condenser Fans				
Fan Blades				
Electrical (breaker, relay)				
Wiring				
11. Evaporator-Main (condition-dirty, leakage, bent fins, corrosion, etc.)				
Condensate Drain				
12. Evaporator-Sleeper (condition-dirty, leakage, bent fins, corrosion, etc.)				
Condensate Drain				
13. Expansion Valve/Orifice Tube-Main				
14. Expansion Valve-Sleeper				
15. Filters (Cabin Air)				
16. Heater Core-Main				
17. Heater Core-Sleeper				
18. Heater Parts				
Heater Hose				
Heater Valves				
Heater Valve Control Cables				
19. Hoses & Lines (condition-leakage, barrier damage, etc.)				
Mounting				
20. Louvers, Diffusers, Duct Hose, and Adapters				
21. O-rings				
22. Radiator (condition-dirty, leakage, bent fins, etc.)				
23. Radiator Fan Clutch (condition-air gap, fluid leakage, etc.)				
Operation				
Shroud & Seals				
24. Receiver Drier/Accumulator				
Mounting				
Quick Disconnects				
25. Switches				
Air (air control, air cylinder, air sensing)				
Mode (micro, push button, rocker, rotary, toggle, knob)				
Control (actuators, control head, potentiometer)				
Pressure (low pressure, high pressure, binary, trinary)				
Thermostatic/Thermistor (check for cycling)				
Wiring for Switches				

Aftermarket A/C System Components



Thank You