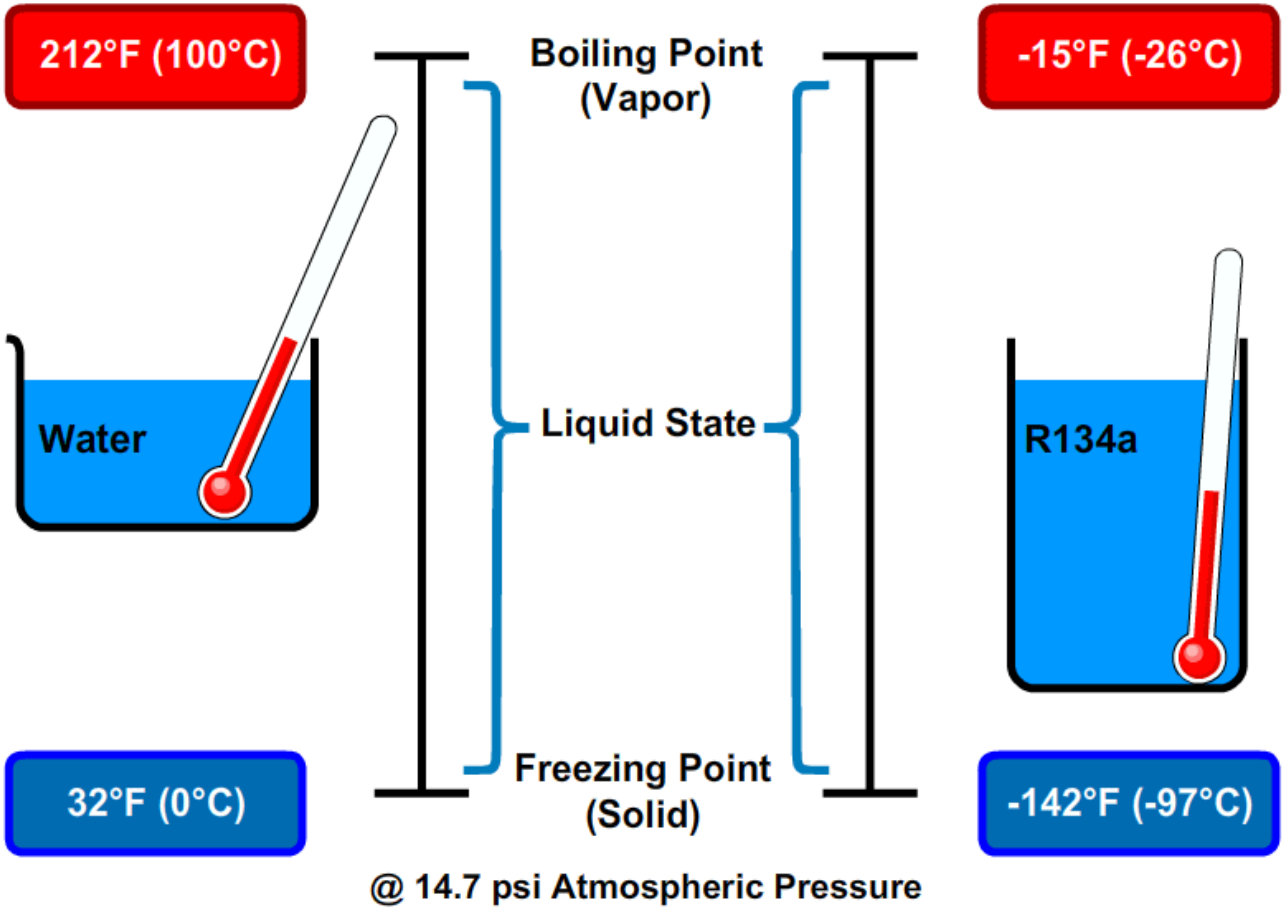
Motor Vehicle Air Conditioning (MVAC)

System operation and the refrigerant cycle

http://cf.linnbenton.edu/eit/auto/krolicp/upload/A-C_cycle.pdf (accessed 2019 05 14)



At Sea level - water boils at 212^{o} F - R-134a boils at -15^{o} F

At Sea level - - R-134a boils at -15^{o} F

At 30 psig - - R-134a boils at 35^{o} F

The Pressure of the evaporator will control it's Temperature

R134a Temperature-Pressure Chart

TEMPERATURE °F (°C)	PRESSURE PSI (kPa)	TEMPERATURE °F (°C)	PRESSURE PSI (kPa)
28 (-2)	24 (166)	112 (44)	152 (1045)
30 (-1)	26 (177)	114 (46)	157 (1079)

An R134a temperature-pressure chart shows what the refrigerant temperature should be at a specific pressure.

This can be helpful in A/C diagnosis.

MVAC systems that are low on refrigerant will have:

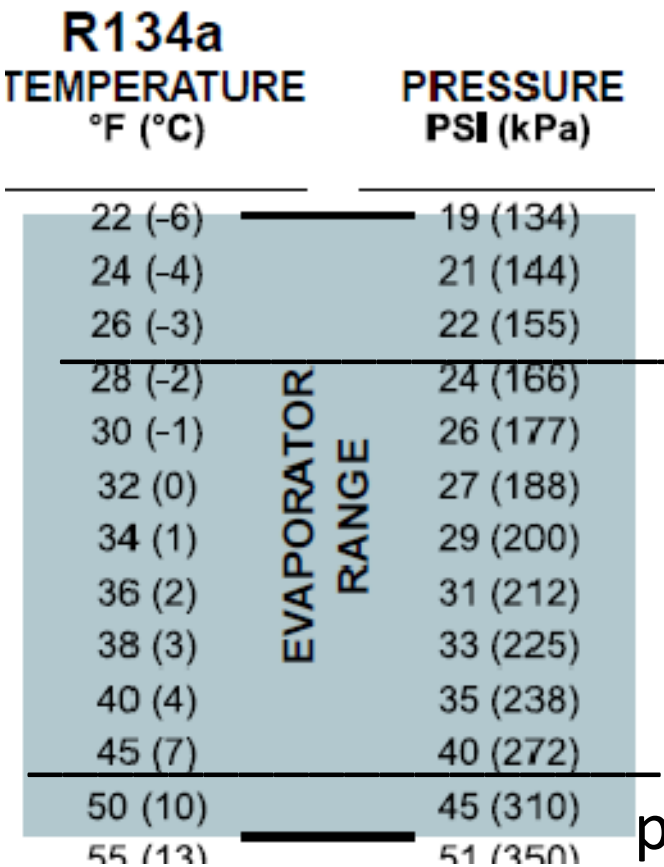
Low pressures in Evaporator (low side) and Condenser (high side)

45 (7)	40 (272)	126 (52)	188 (1298)
50 (10)	45 (310)	128 (53)	194 (1337)
55 (13)	51 (350)	130 (54)	200 (1377)

MVAC systems that are overcharges with refrigerant will have:

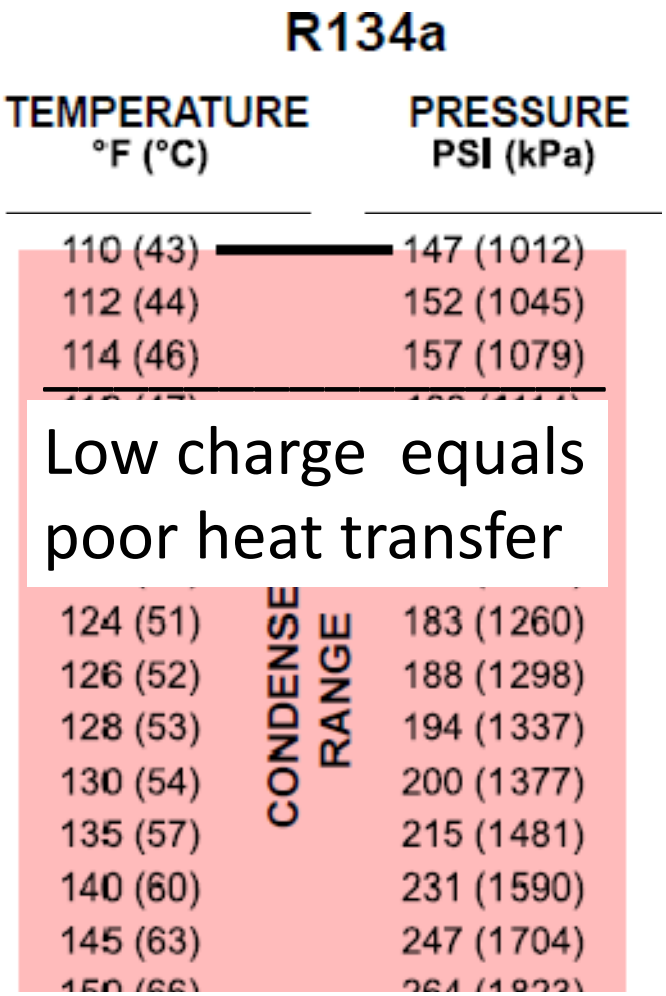
High pressures in Evaporator (low side) and Condenser (high side)

85 (30)	95 (655)	160 (71)	301 (2079)
90 (32)	104 (718)	165 (74)	321 (2215)
95 (35)	114 (786)	170 (77)	342 (2358)



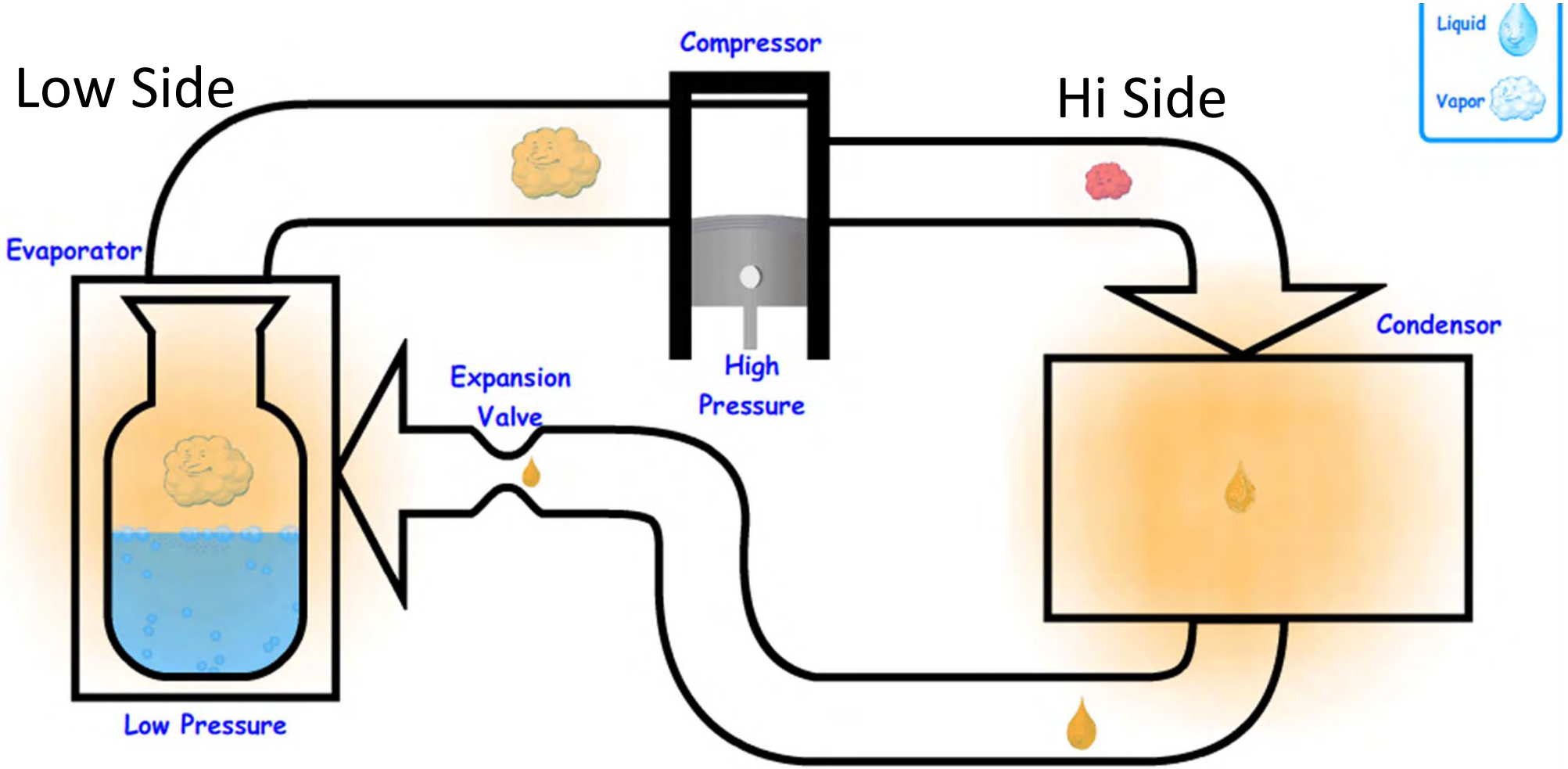
Low charge can freeze the evaporator

High charge gives poor heat transfer at the evaporator



Low charge equals poor heat transfer

The correct refrigerant charge ensures maximum heat transfer from the passenger compartment.



Absorbing latent heat
turns liquid to vapor

Releasing latent heat
turns vapor to liquid

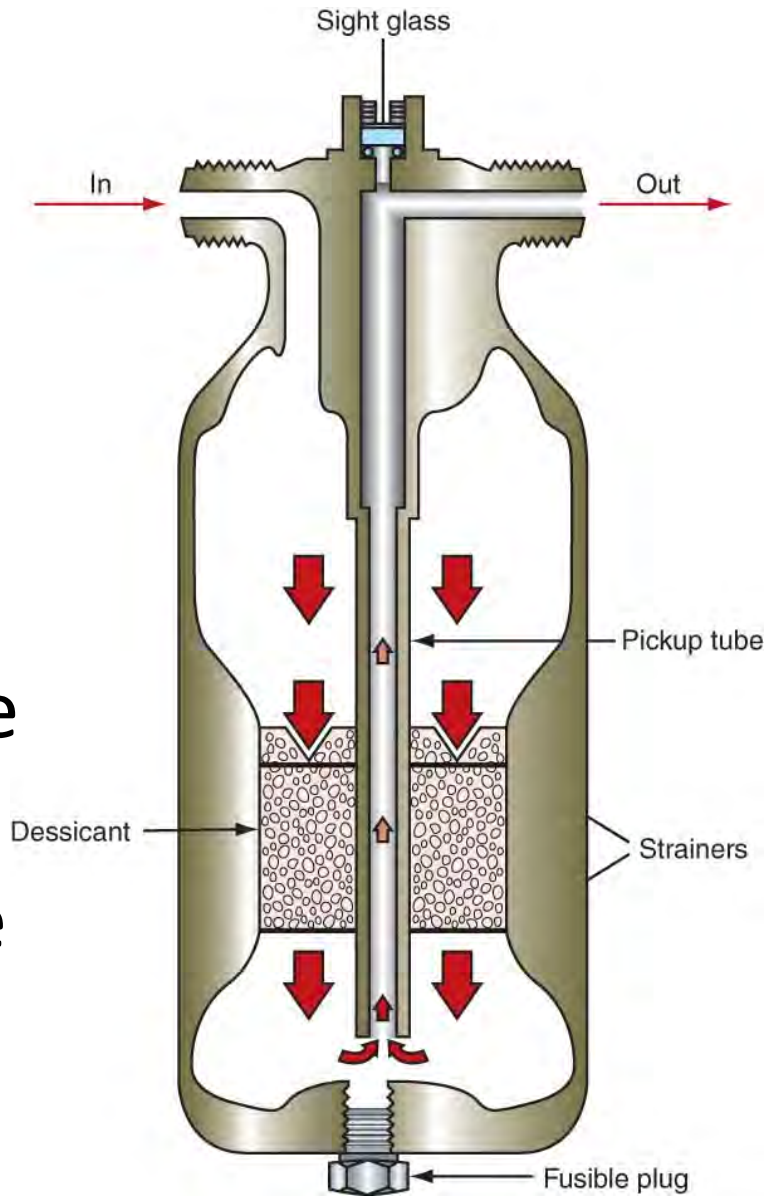
2 types of MVAC systems

All A/C systems use a compressor, condenser, evaporator

Some systems use the **Expansion Valve** with **Receiver/Drier**

Some systems use the **Fixed Orifice Tube** with **Accumulator**

Receiver-Drier



send high pressure liquid
to expansion valve

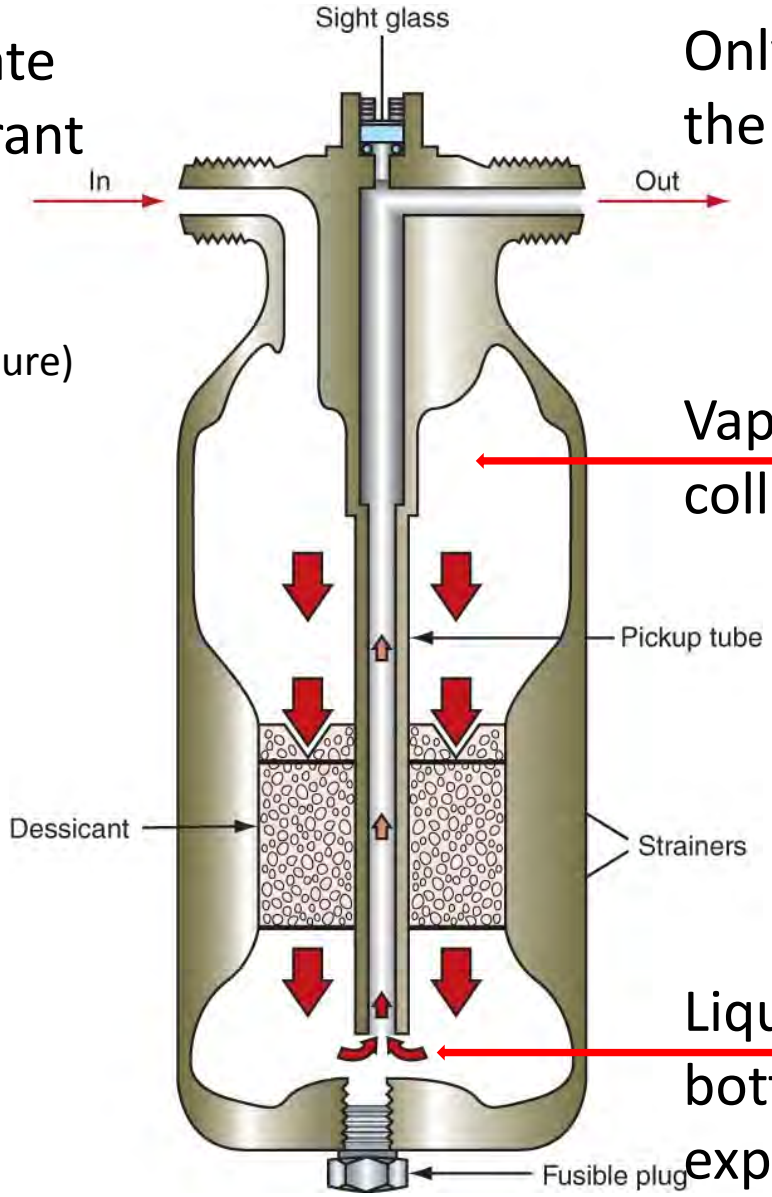
Receiver Drier will separate liquid from vapor refrigerant

Receiver Drier will send liquid refrigerant (high pressure) to the expansion valve

Receiver drier will have desiccant bag.

Some desiccant bags can be changed

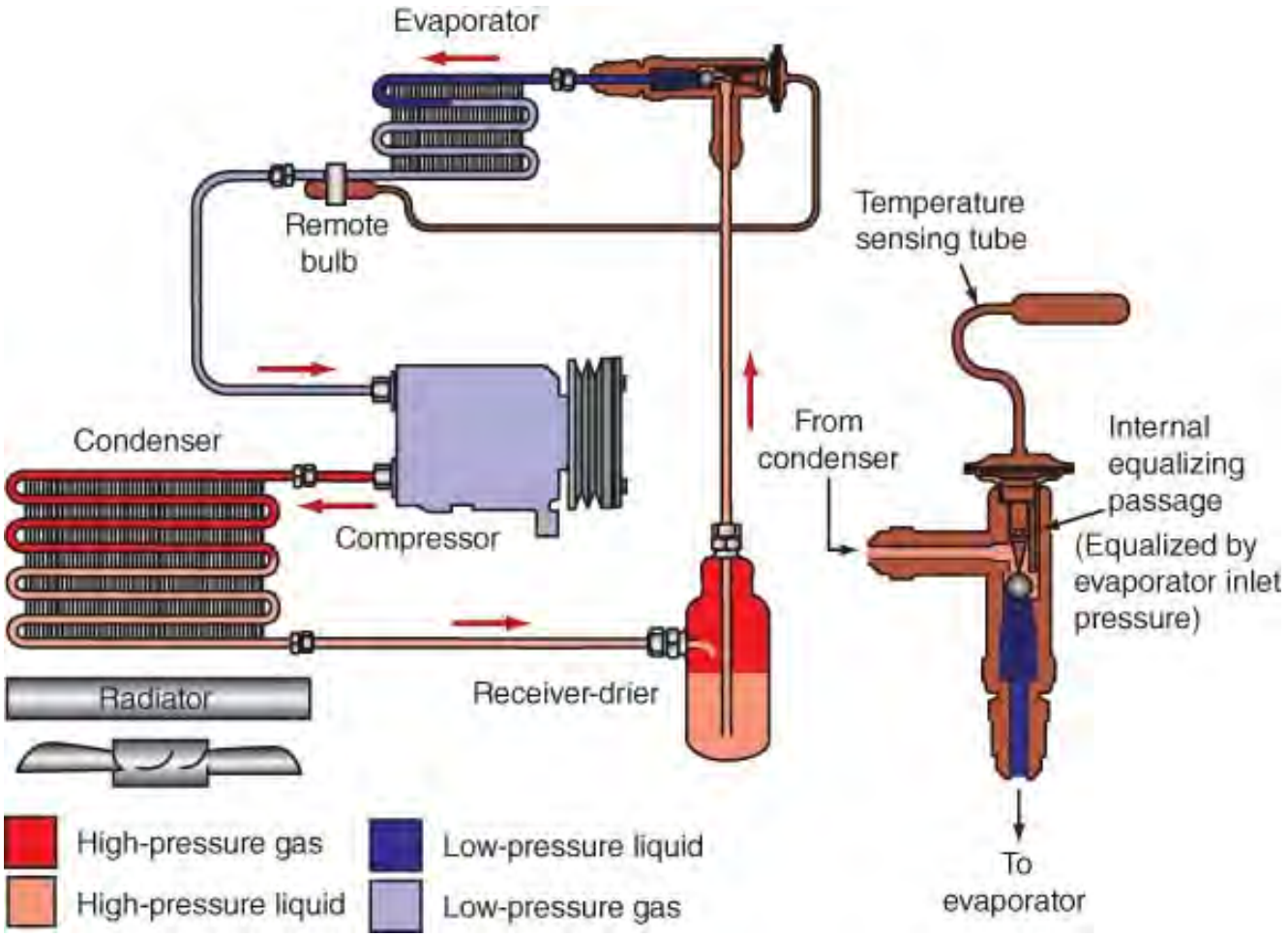
Other designs require component replacement



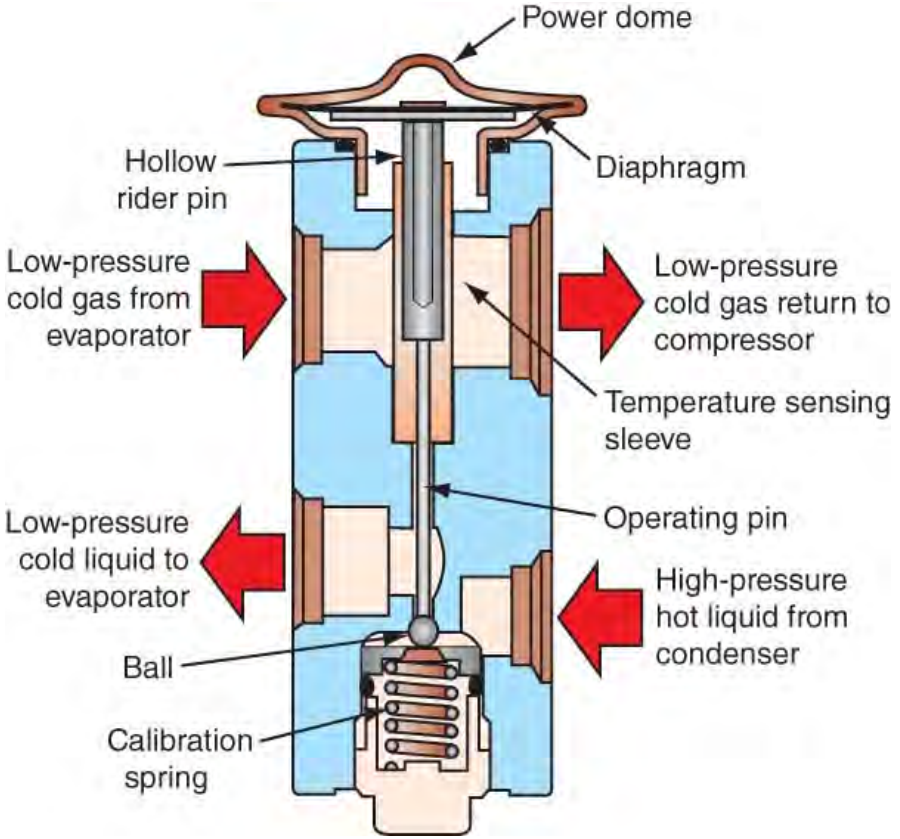
Only older R-12 systems use the sight glass

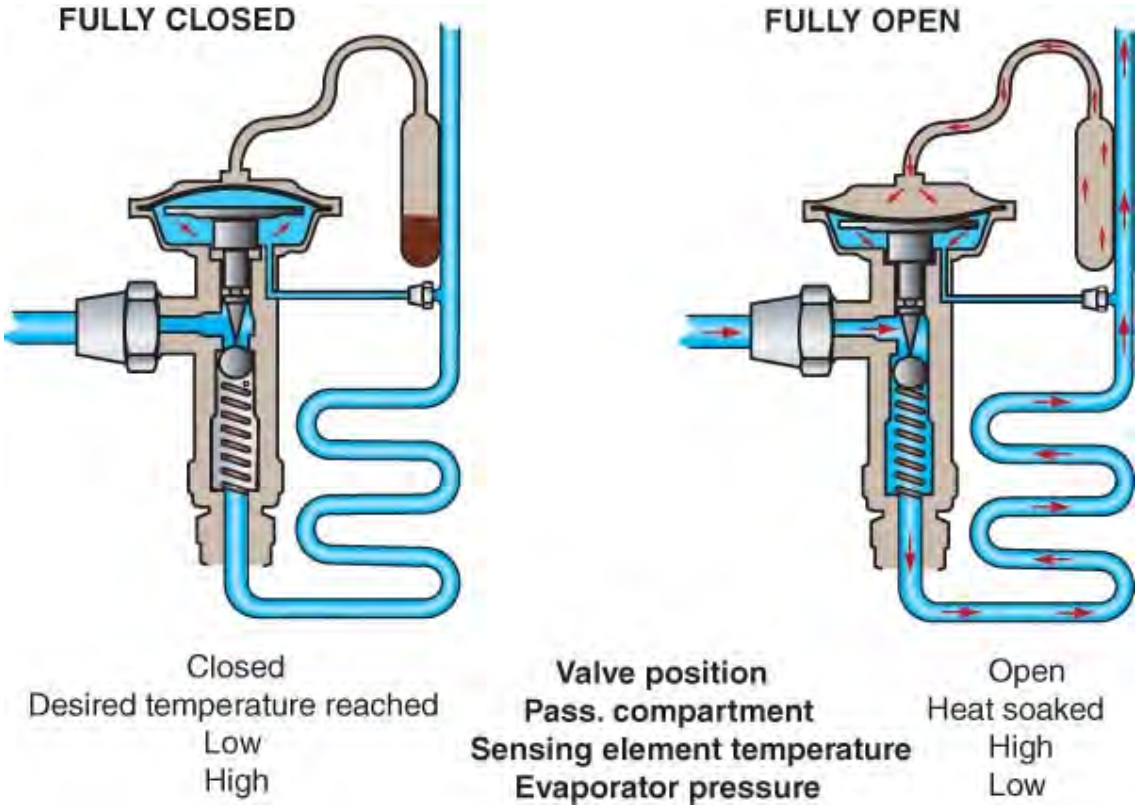
Vaporized refrigerant collects at top of receiver

Liquid refrigerant sinks to bottom and is sent to expansion valve

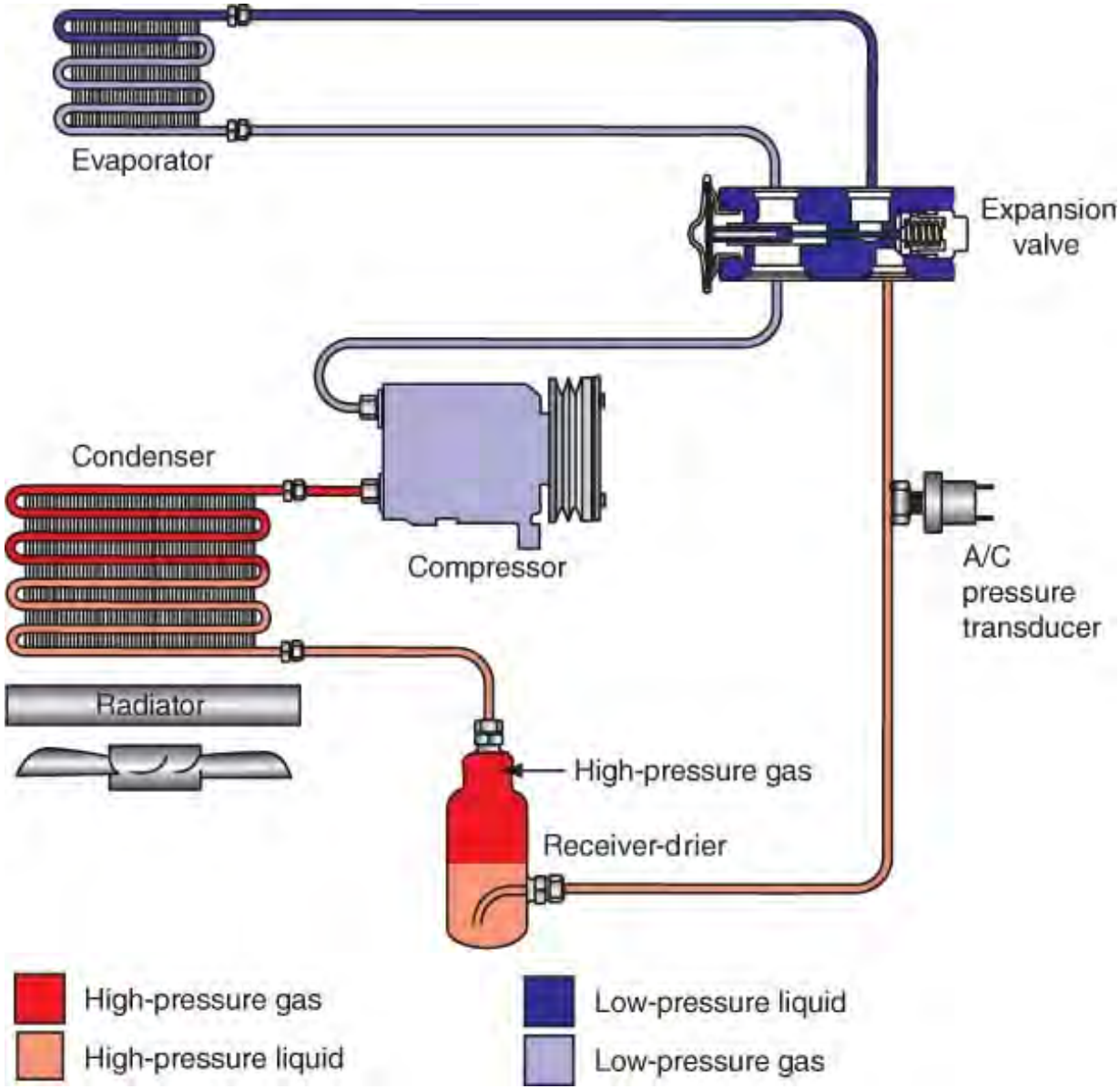

Evaporator
Remote bulb
Temperature sensing tube
From condenser
Internal equalizing passage
(Equalized by evaporator inlet pressure)
Condenser
Compressor
Radiator
Receiver-drier
To evaporator
High-pressure gas
High-pressure liquid
Low-pressure liquid
Low-pressure gas

Expansion valve CLOSES when evaporator is too COLD
Expansion valve OPENS then evaporator is too WARM

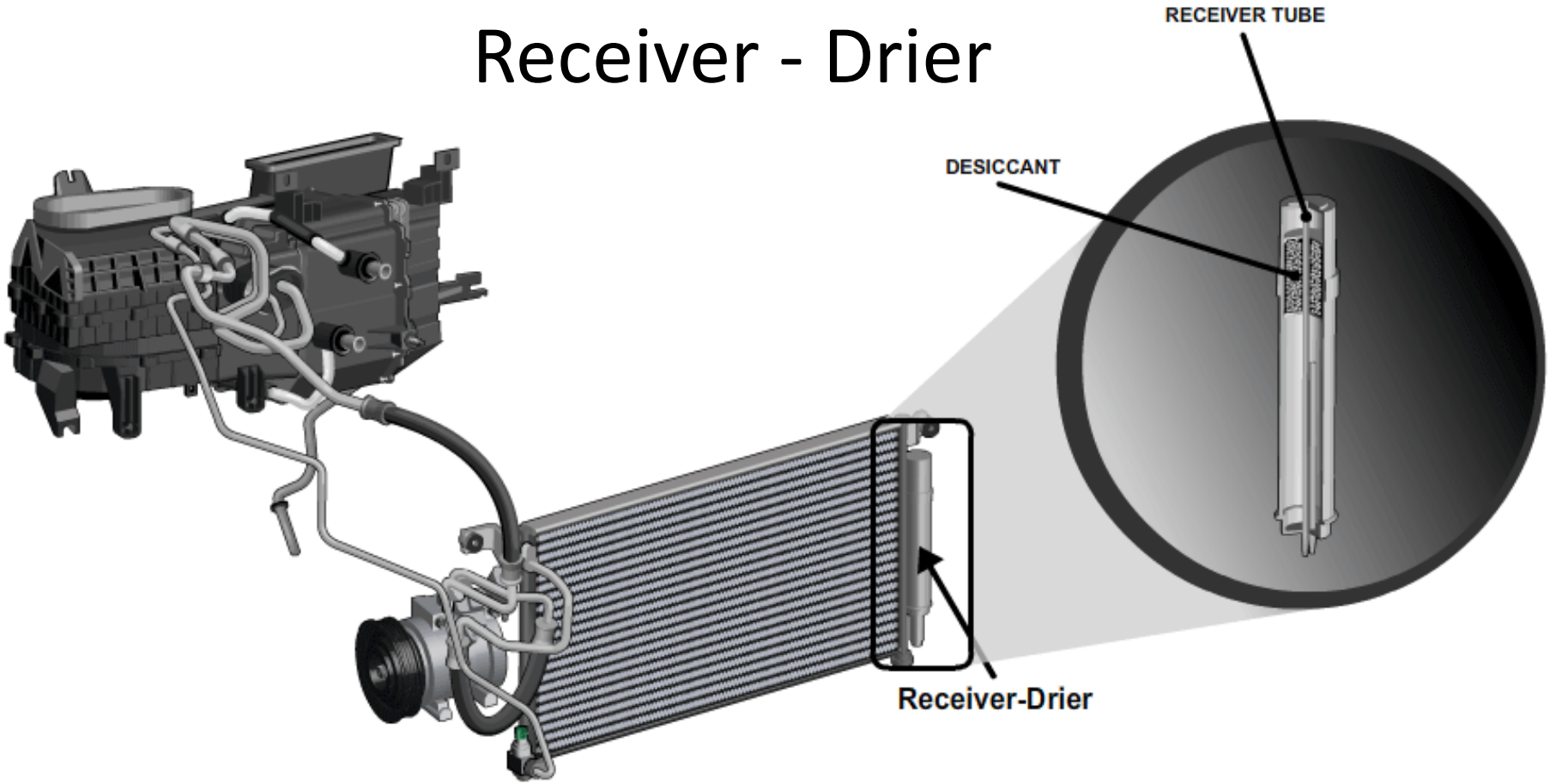




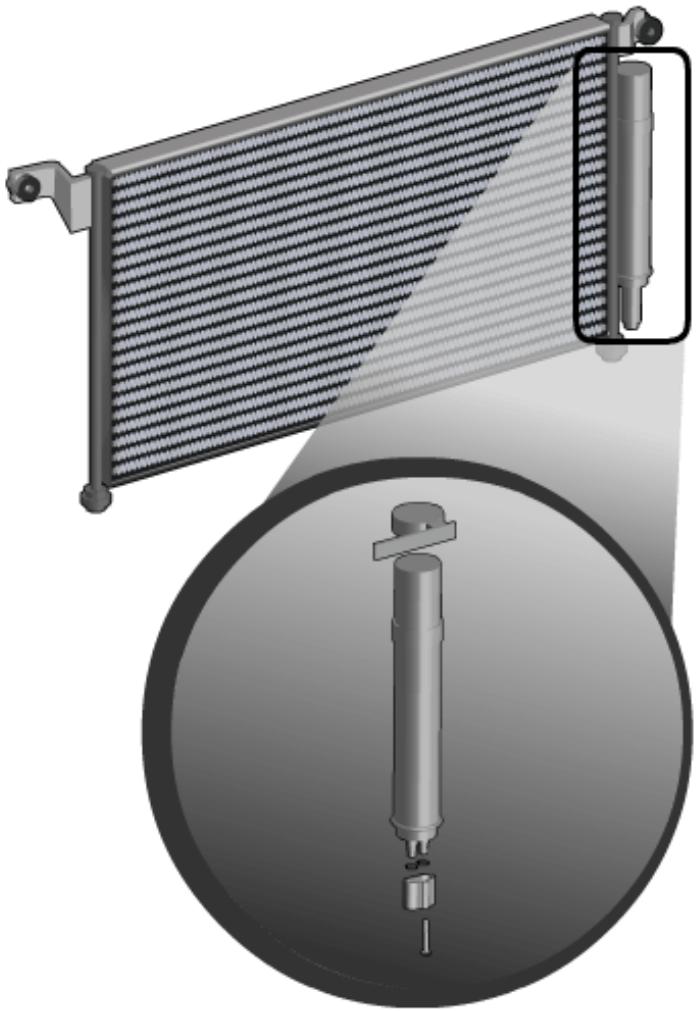
Expansion Valves sense evaporator pressure and will open or close to maintain ideal pressure/temperature



Receiver - Drier

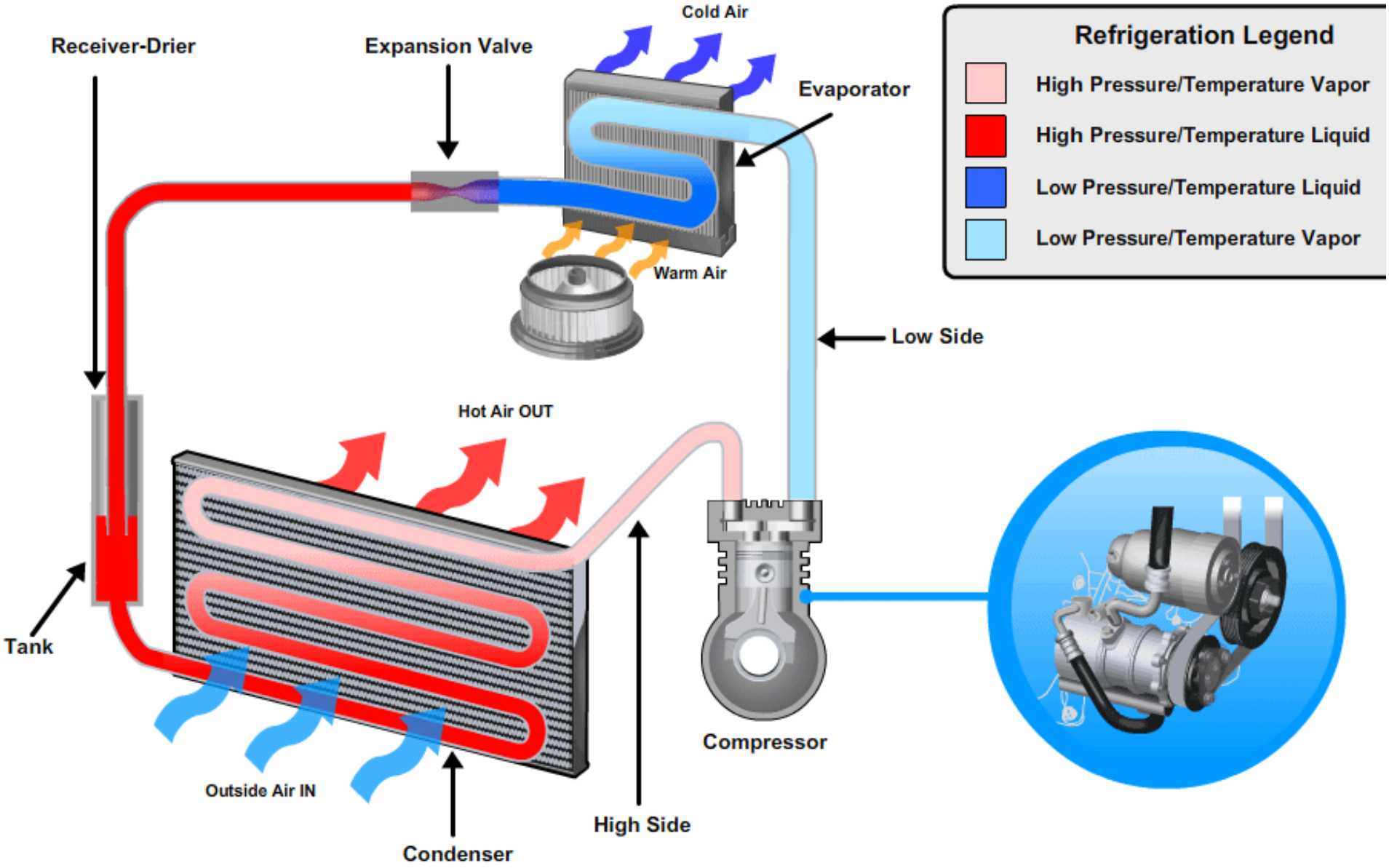


- Stores liquid refrigerant to supply the expansion valve
- Filters dirt and debris from the system to prevent its circulation.
- Desiccant removes moisture left in system due to improper service.

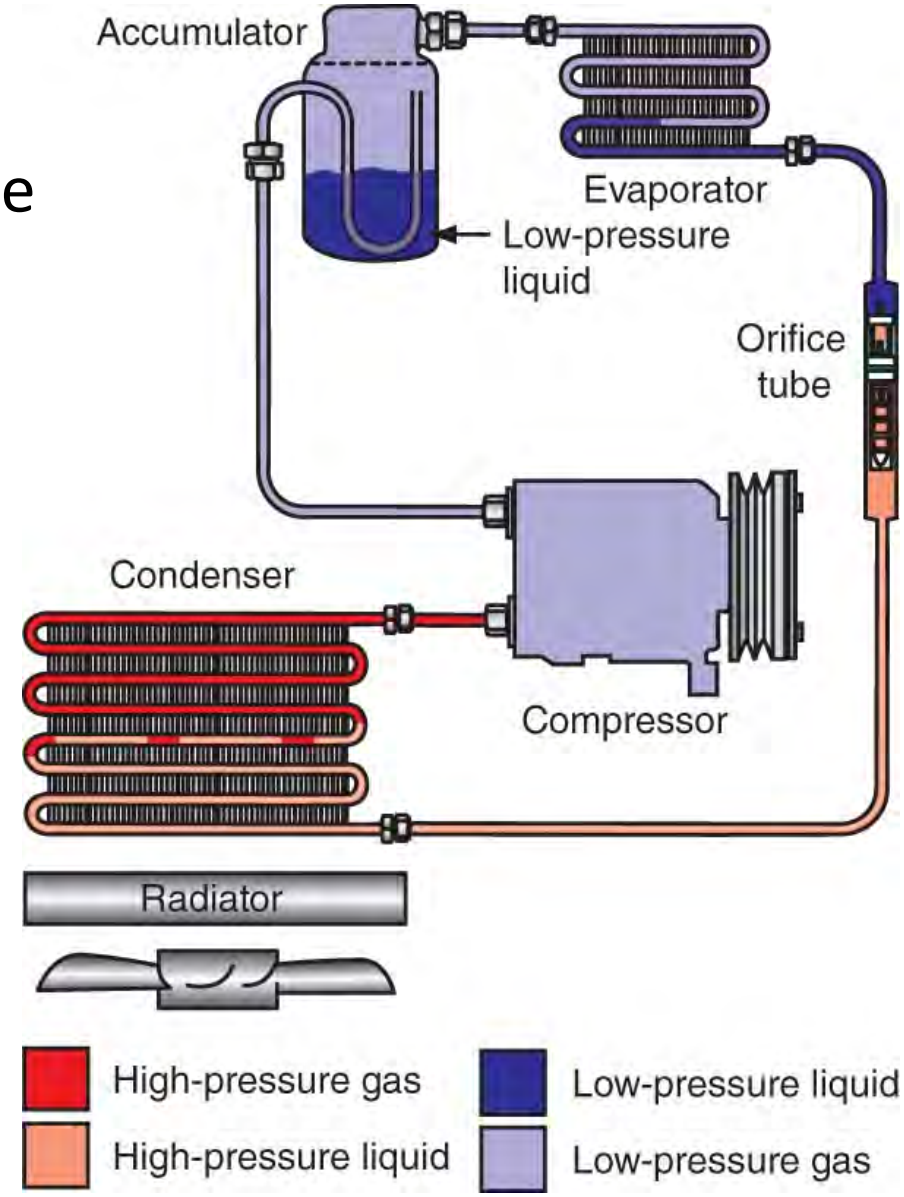


Integrated Receiver-Drier

Separate Receiver-Drier (Older Vehicles)


Receiver-Drier
Expansion Valve
Cold Air
Evaporator
Warm Air
Low Side
Refrigeration Legend
High Pressure/Temperature Vapor
High Pressure/Temperature Liquid
Low Pressure/Temperature Liquid
Low Pressure/Temperature Vapor
Hot Air OUT
Tank
Outside Air IN
Condenser
High Side
Compressor

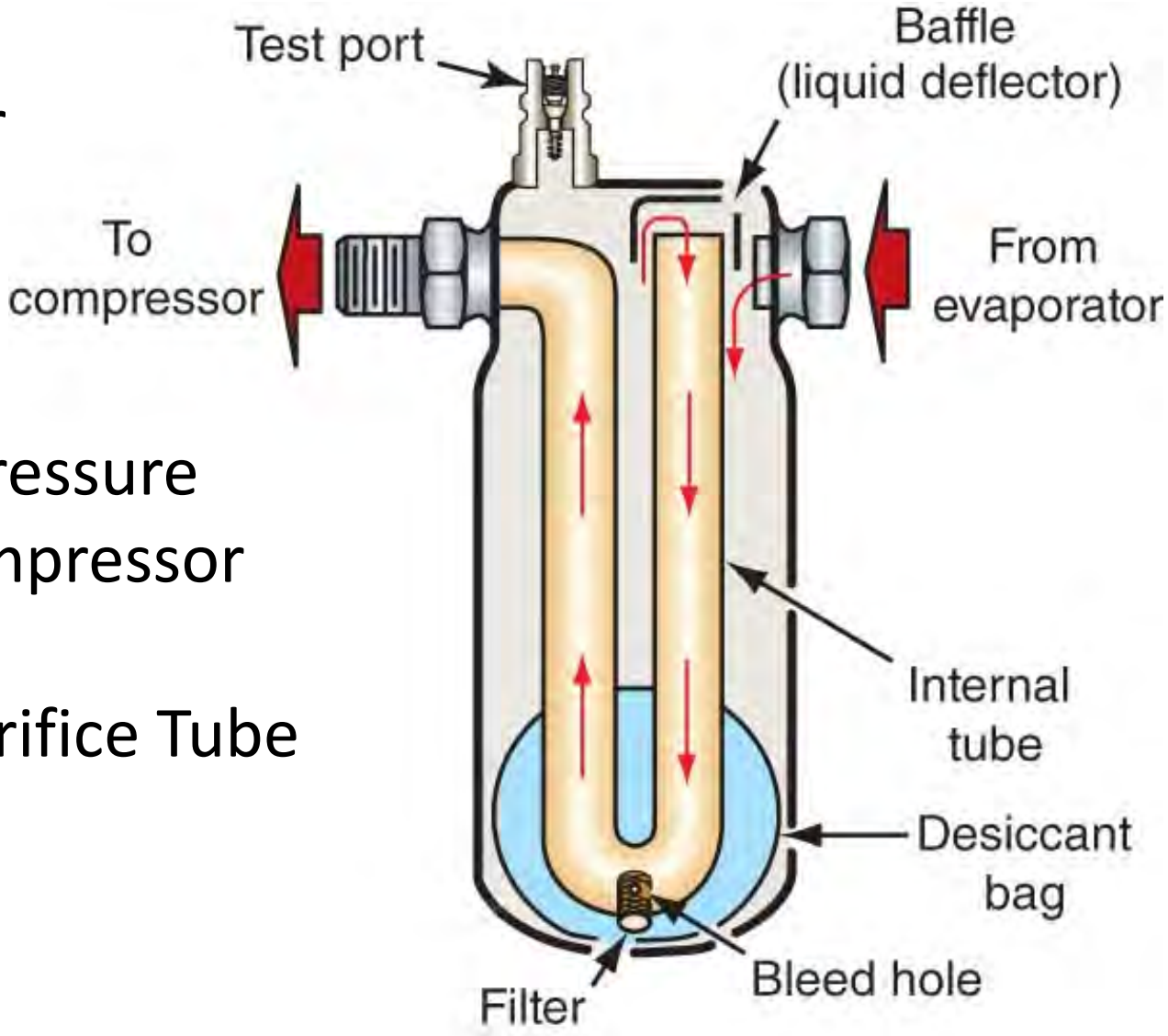
Some systems use a fixed orifice tube and Accumulator



Accumulator

Sends low pressure Vapor to compressor

Used with Orifice Tube

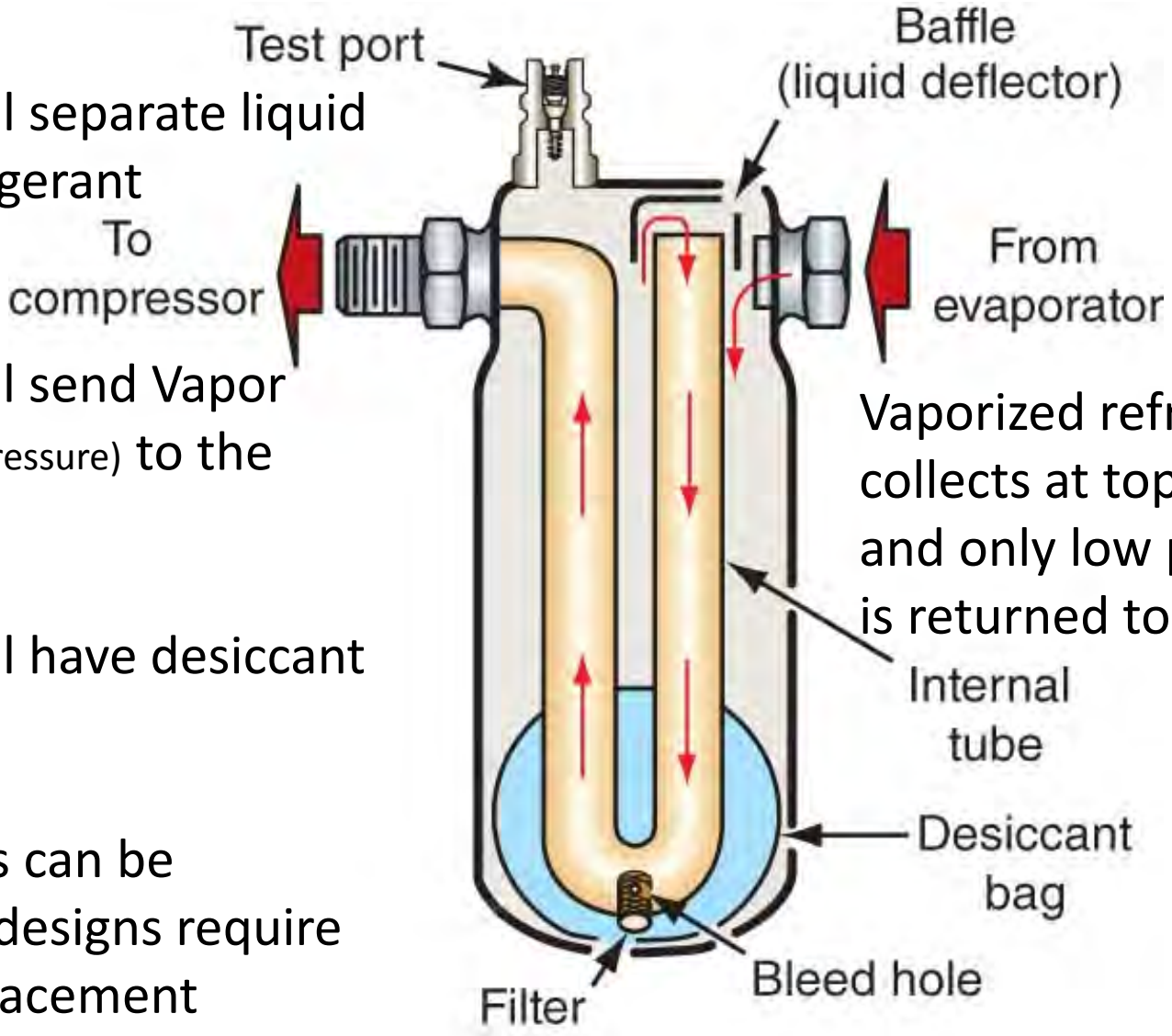


Accumulator will separate liquid from vapor refrigerant

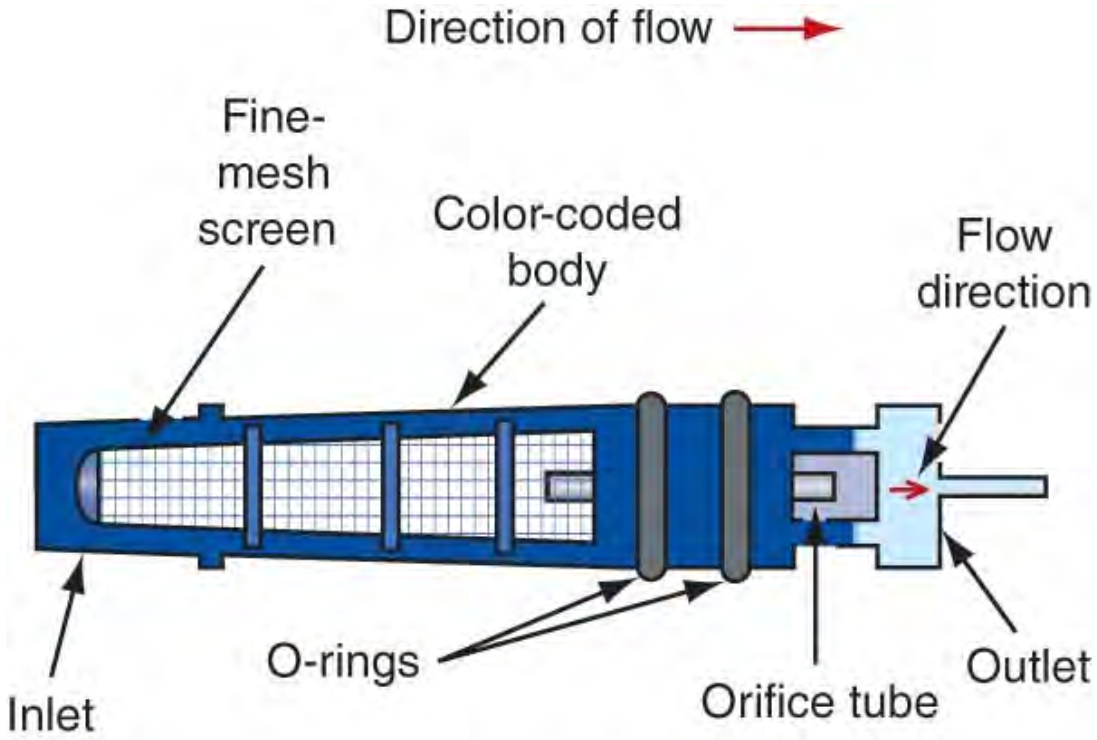
Accumulator will send Vapor refrigerant (low pressure) to the compressor

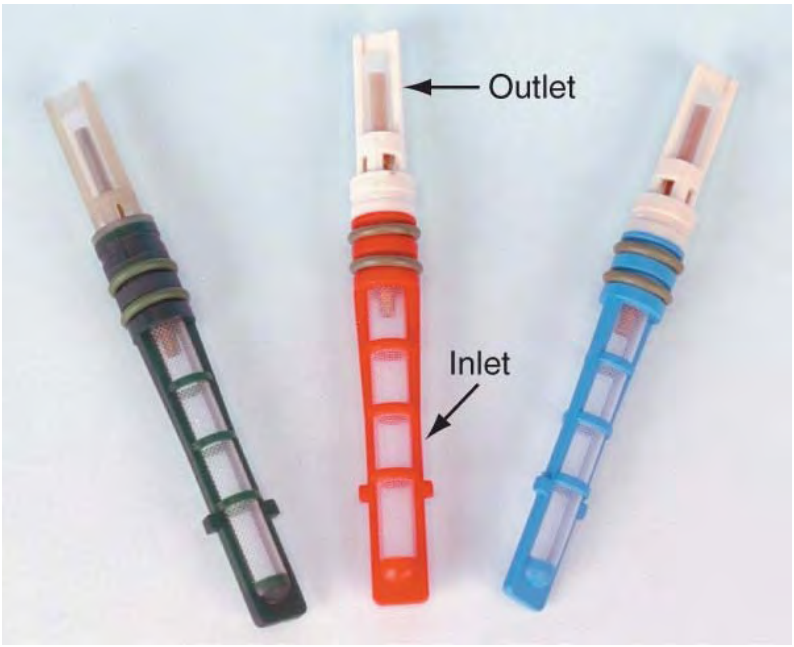
Accumulator will have desiccant bag.

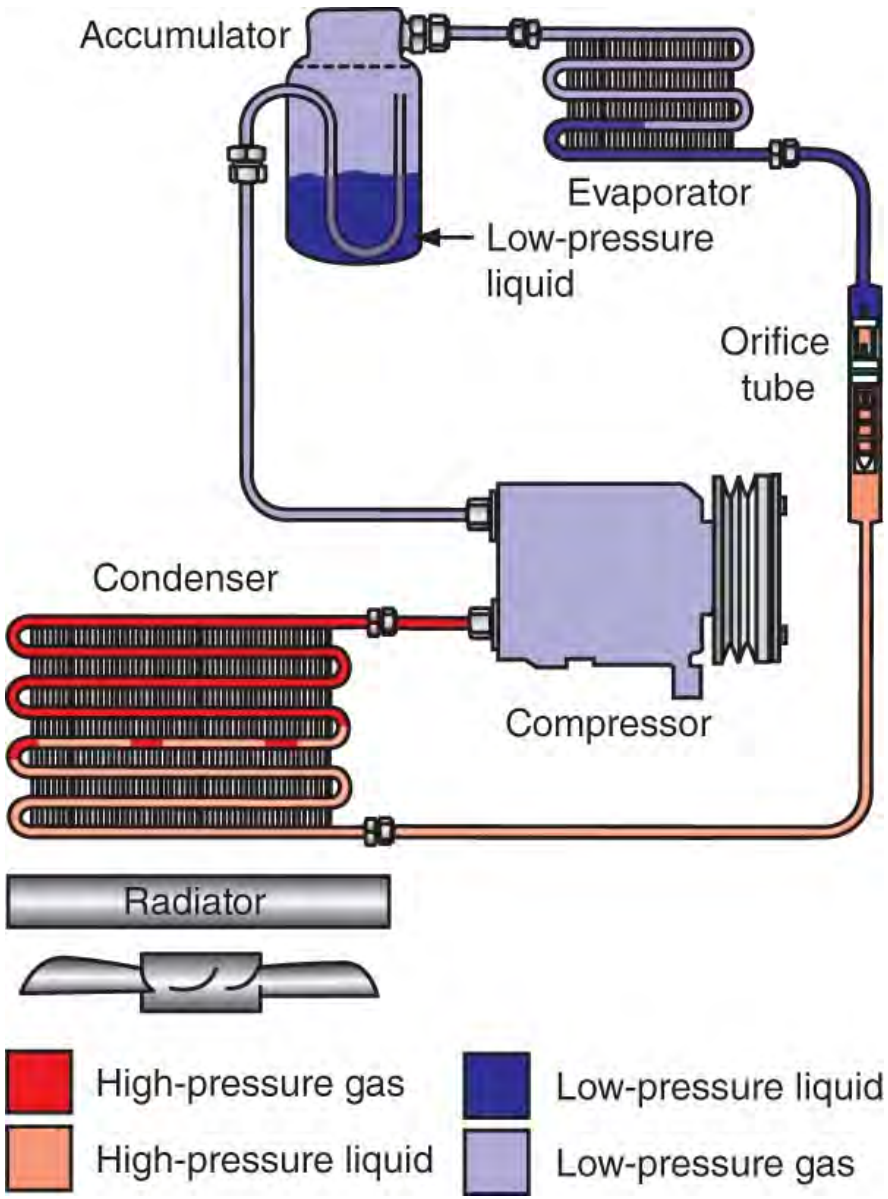
Some desiccants can be changed, other designs require component replacement



Fixed Orifice Tube

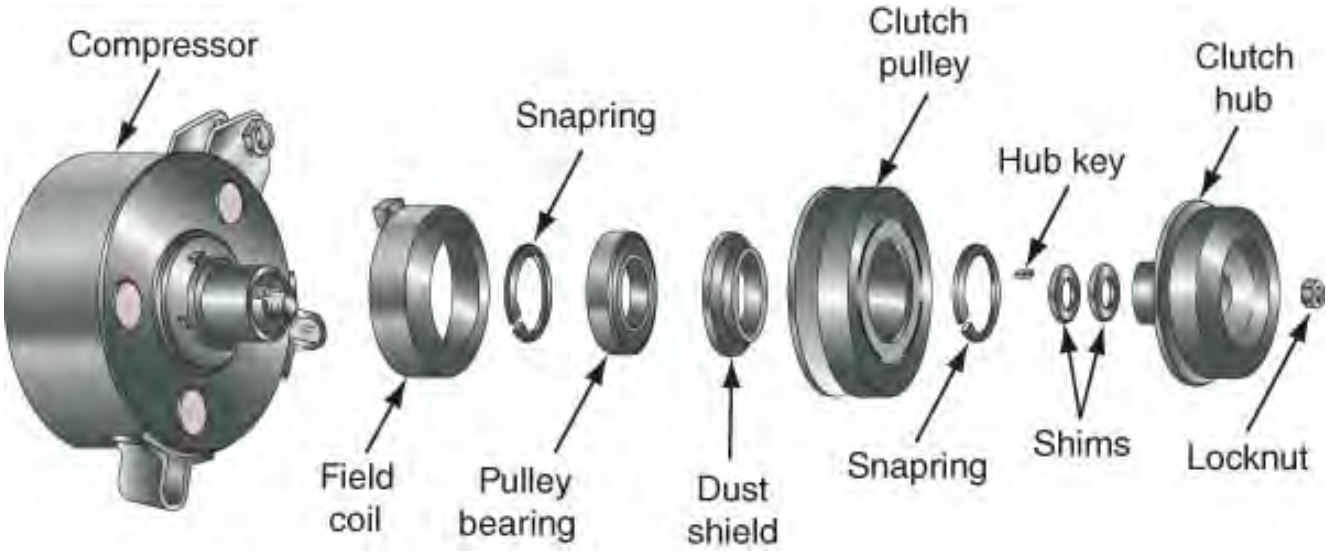




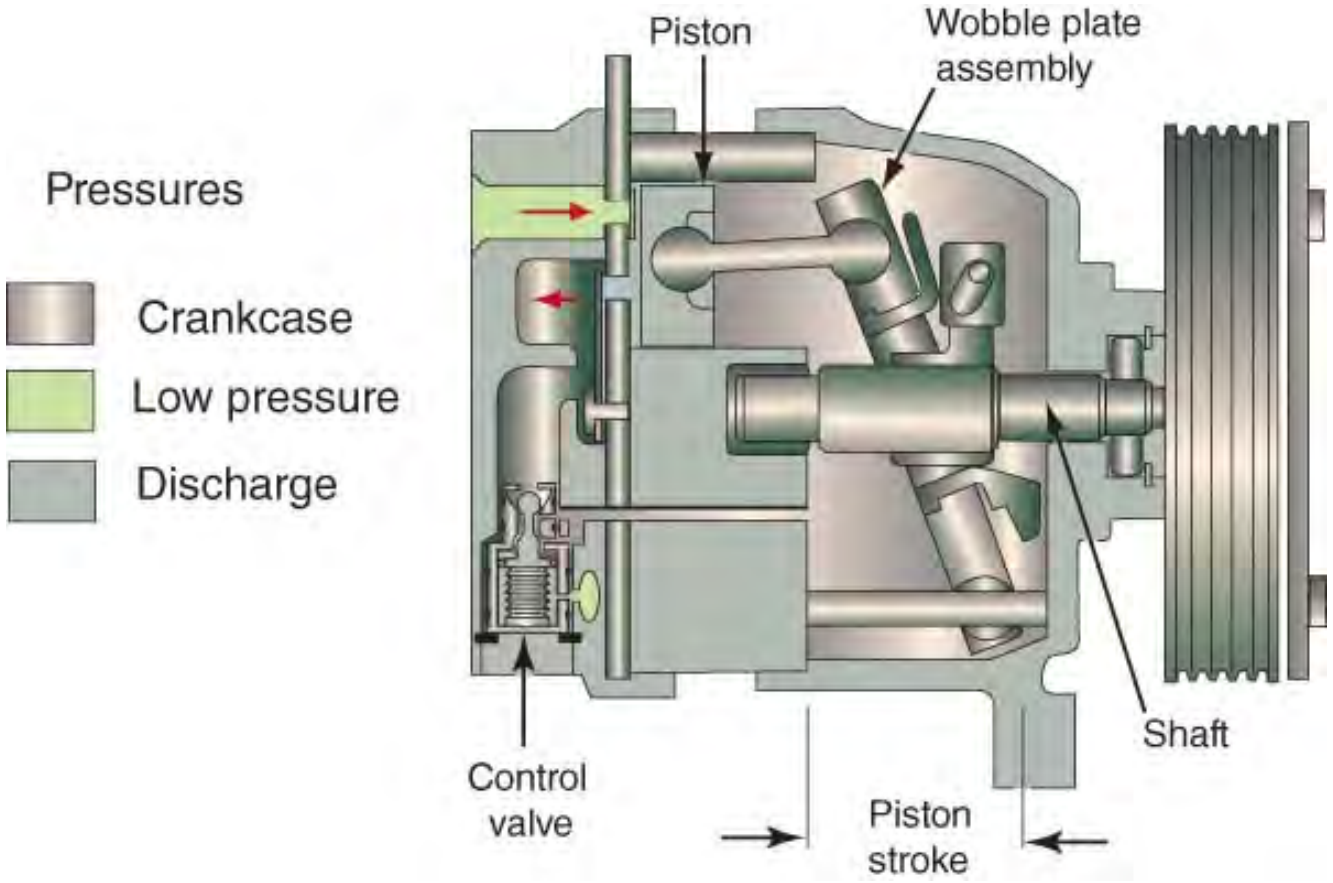

Accumulator
Evaporator
Low-pressure
liquid
Orifice
tube
Condenser
Compressor
Radiator
High-pressure gas
High-pressure liquid
Low-pressure liquid
Low-pressure gas

Many different types of compressors are used

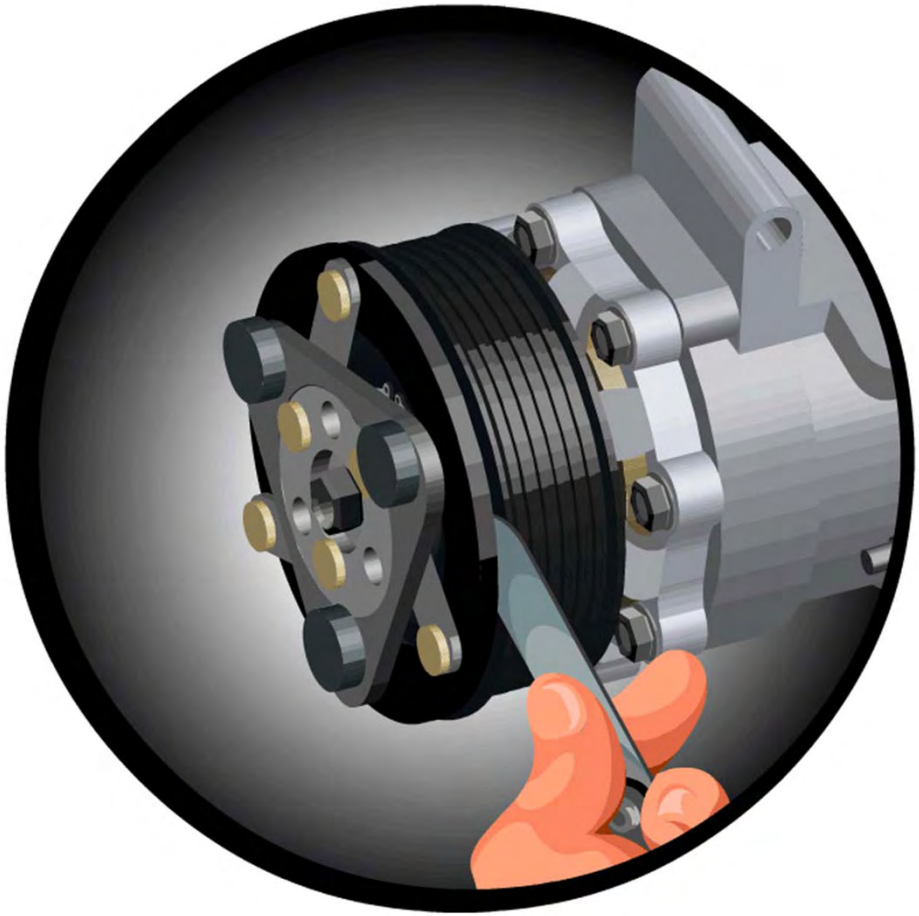
Most compressors use an electric clutch to cycle compressor ON and OFF to maintain proper evaporator pressure

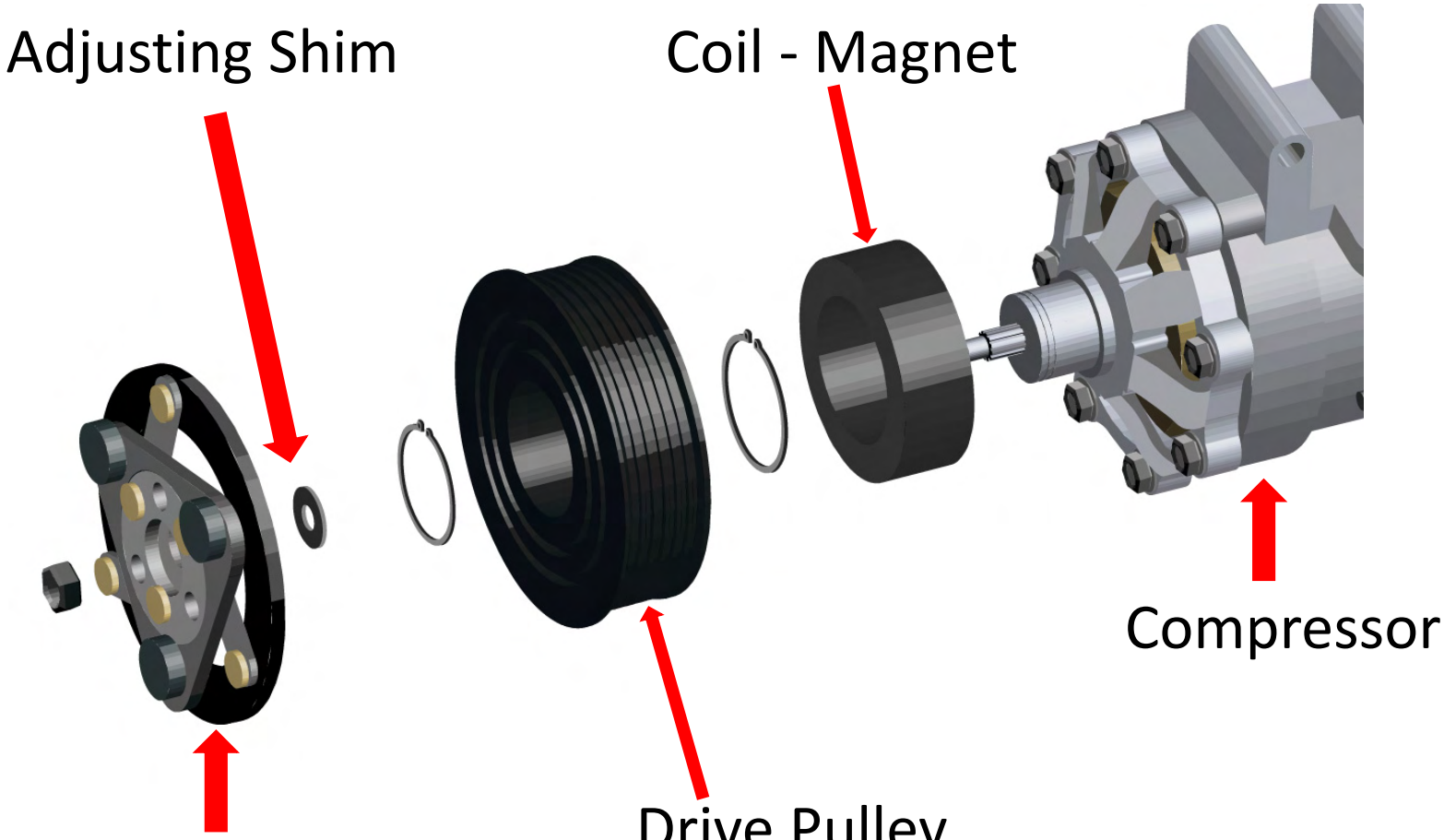


Some compressors will not cycle ON/OFF and will vary the piston stroke to maintain evaporator pressure



Most Clutches are checked using a feeler gauge.




Adjusting Shim
Coil - Magnet
Compressor
Drive Pulley
Spring loaded Clutch Plate

Any time you replace a compressor or clutch, the clearance must be checked.

Loose clearance will cause clutch to make noise, slip, and overheat.

Tight clearance can cause the clutch to stay mechanically engaged

This will raise pressure too high and may cause the pressure relief valve to open.

Most Clutches are checked using a feeler gauge.

Shims available in several thicknesses to adjust the clearance.

A/C Compressors require lubricating oil carried by the refrigerant

Refrigerant oil specifications vary between A/C compressor designs and manufacturers.

Always look up and use the correct oil for your system.

The oil type can be identified by a tag located on the compressor body or in the service manual.

Using the wrong type of compressor oil may cause excessive noise and shorten the A/C compressor's life.

Refrigerant oil can damage the vehicle's paint!

Wash off any spilled oil immediately. (wiping up spill will press oil into paint and NOT protect the vehicle)

An open oil can absorbs moisture. Keep any remaining oil tightly sealed.

Component Replacement

Completely discharge/recover ALL refrigerant BEFORE opening any line

Tightly plug any open line or component IMMEDIATELY
(Moisture will immediately begin to contaminate system when opened)

Use clean refrigerant oil (proper type) to lubricate any O-Rings

O-rings are not interchangeable with other types of O-Ring
(such as fuel injector O-Rings)

Component Replacement

The receiver drier's desiccant only holds a couple tablespoons of moisture.

The Accumulator desiccant only holds a couple tablespoons of moisture.

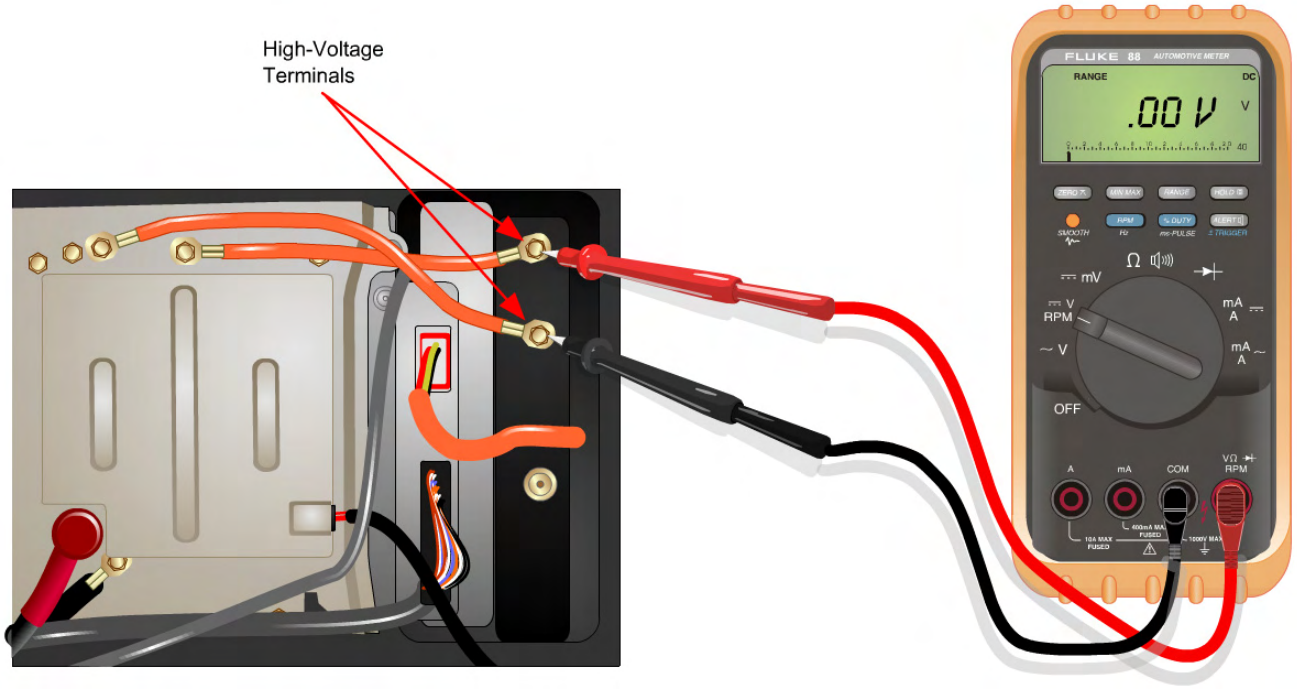
Replace the desiccant if the system was left open to the air for more than a few hours, such as after collision damage, or older systems that have leaked out all the refrigerant.

Check for contamination (use cotton swab) before deciding to make minor repairs on damaged or older systems.

Hybrid Vehicle A/C system precautions

- Many hybrid vehicles use high voltage to operate the compressor

- Do Not disconnect or work around Orange wiring until you have been properly trained.



Diagnose the HVAC air handling system

Poor Heating or Cooling can be caused by the Heater/Evaporator air handling box.

Often called the Evaporator Housing or Heater Core Housing

Air doors are operated by:

Cables - Vacuum Motors - Electric Motors

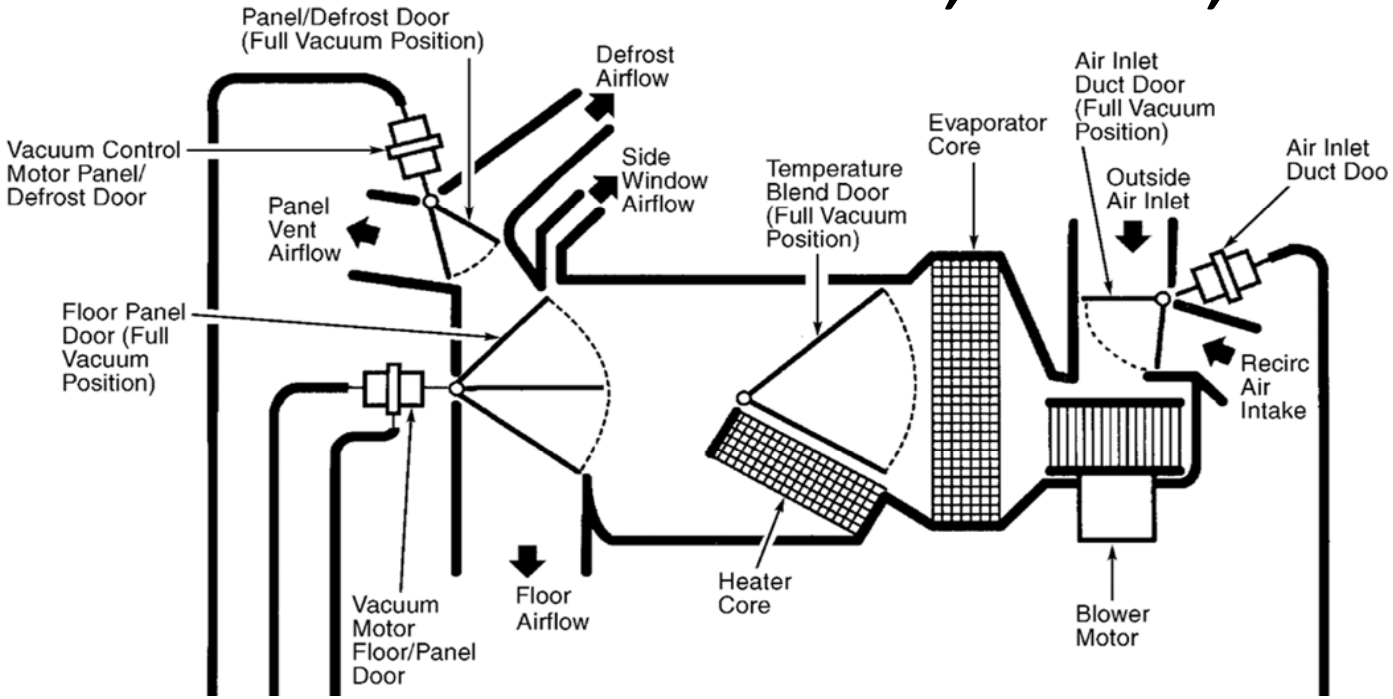
Look, listen, feel, for changes in air flow as doors are moved

Air doors control:

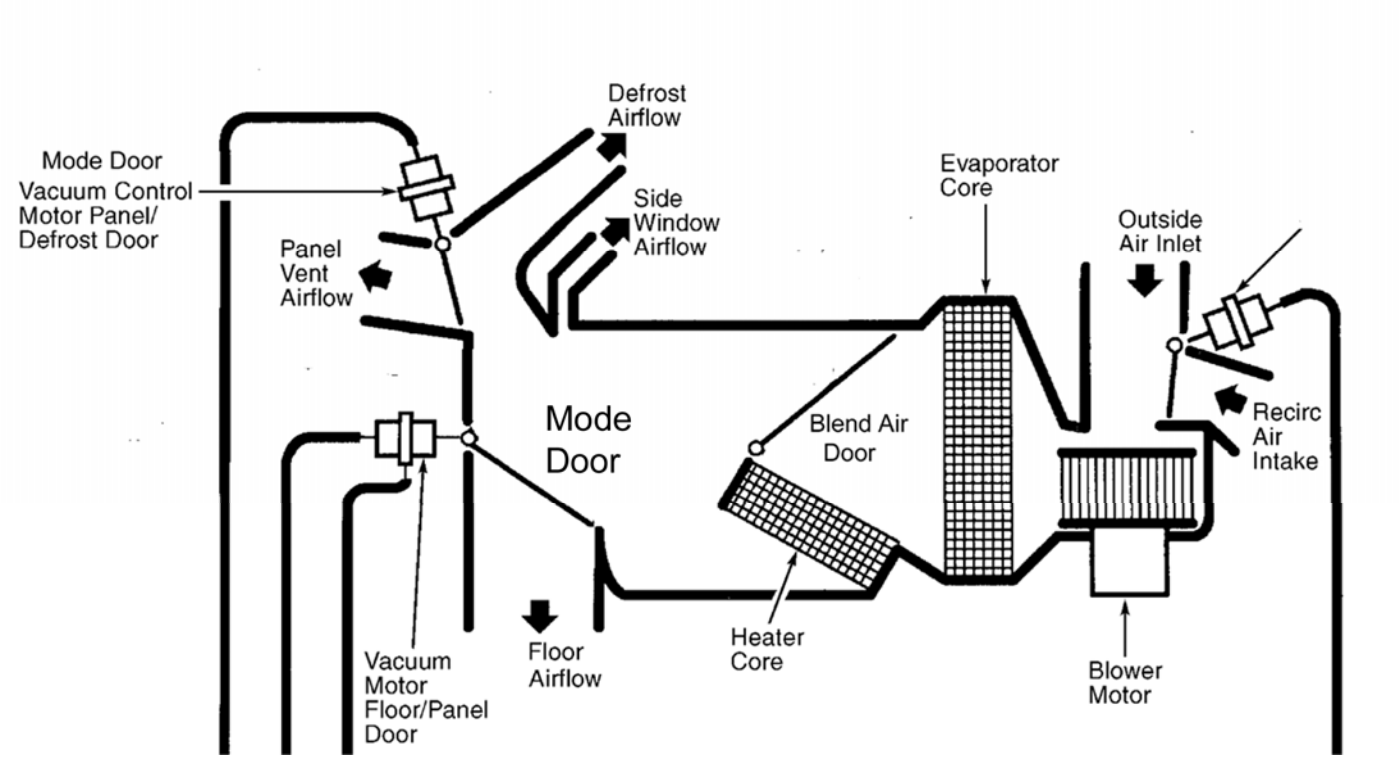
Temperature (**Blend Door**)

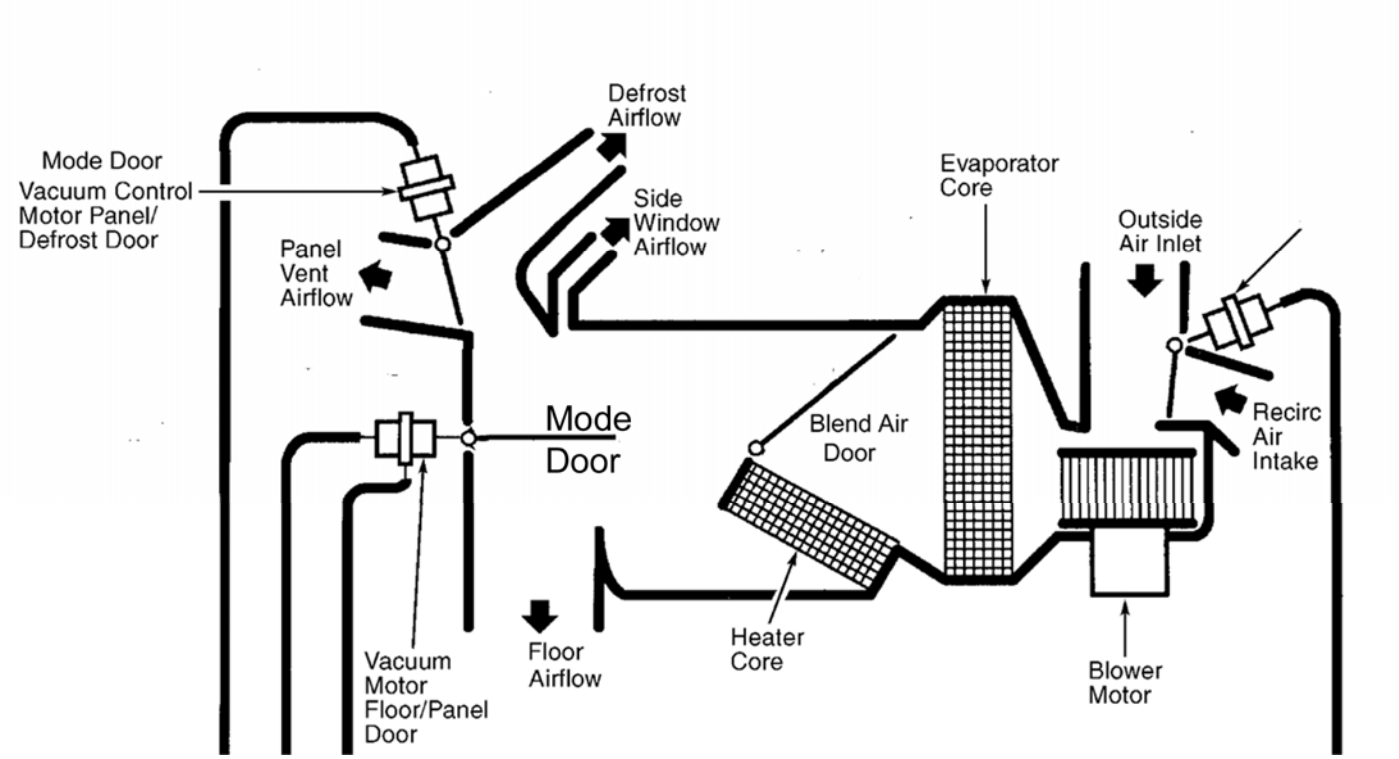
Fresh or Recirculate Air

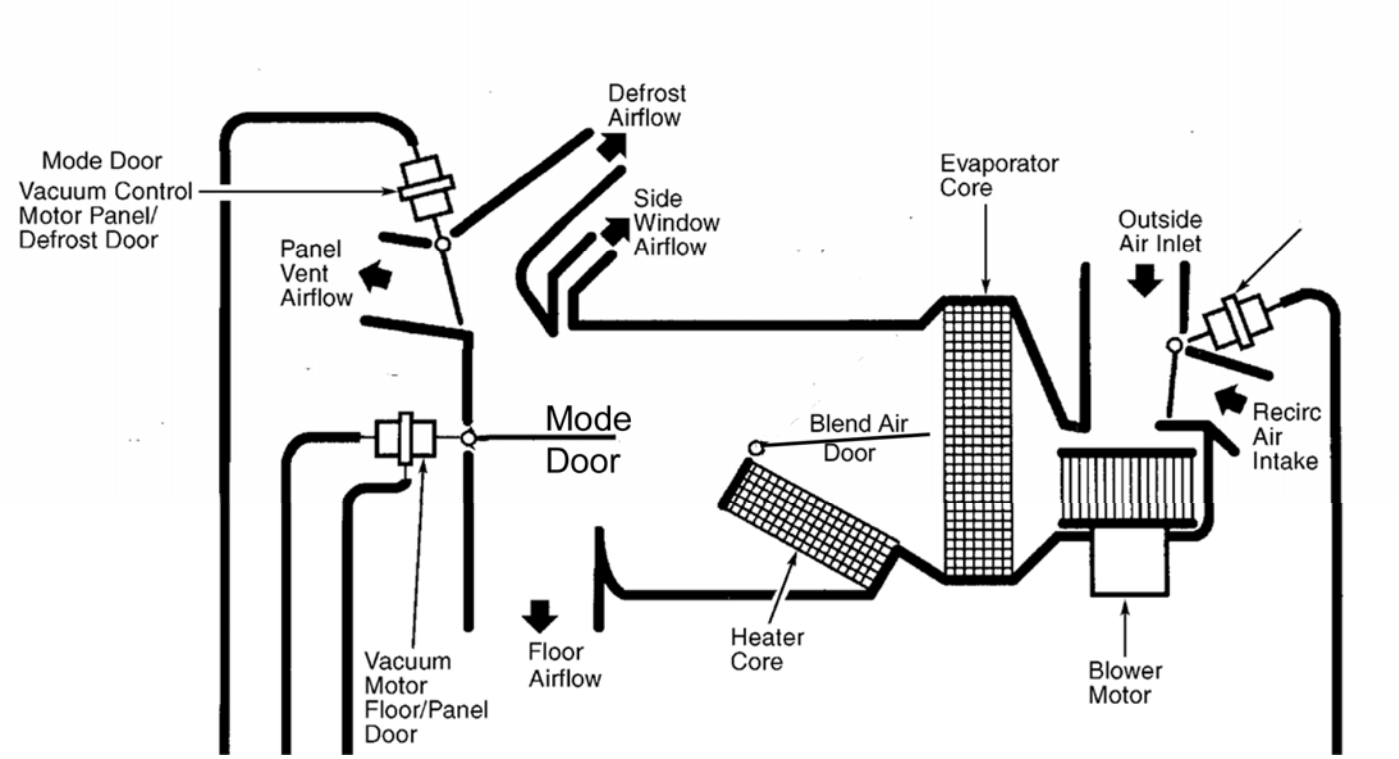
Mode Doors – Defrost, Floor, Panel

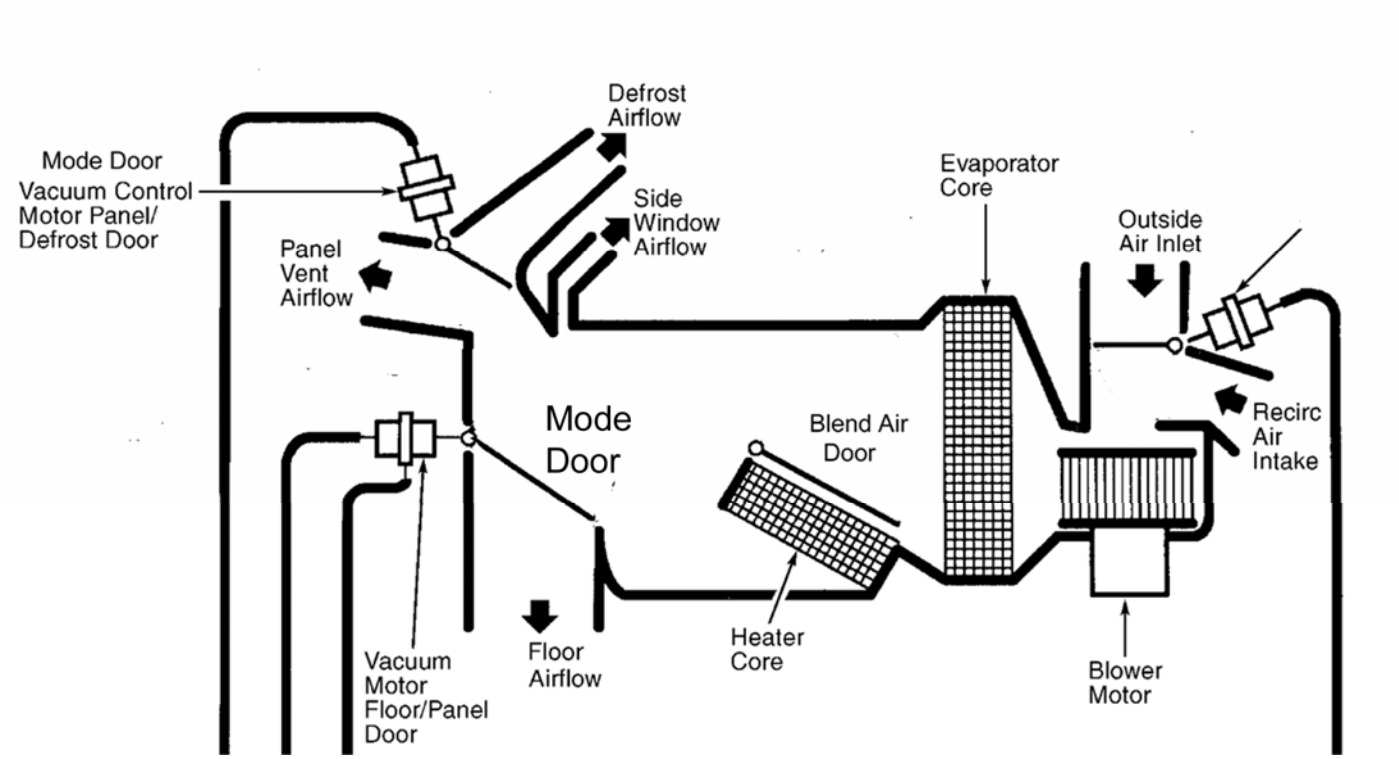


Air Door Quiz




Defrost
Airflow
Mode Door
Vacuum Control
Motor Panel/
Defrost Door
Side
Window
Airflow
Evaporator
Core
Outside
Air Inlet
Panel
Vent
Airflow
Mode
Door
Blend Air
Door
Recirc
Air
Intake
Vacuum
Motor
Floor/Panel
Door
Floor
Airflow
Heater
Core
Blower
Motor


Mode Door
Vacuum Control
Motor Panel/
Defrost Door
Panel
Vent
Airflow
Defrost
Airflow
Side
Window
Airflow
Evaporator
Core
Outside
Air Inlet
Recirc
Air
Intake
Mode
Door
Blend Air
Door
Vacuum
Motor
Floor/Panel
Door
Floor
Airflow
Heater
Core
Blower
Motor


Mode Door
Vacuum Control
Motor Panel/
Defrost Door
Defrost
Airflow
Side
Window
Airflow
Panel
Vent
Airflow
Evaporator
Core
Outside
Air Inlet
Recirc
Air
Intake
Mode
Door
Blend Air
Door
Vacuum
Motor
Floor/Panel
Door
Floor
Airflow
Heater
Core
Blower
Motor

Proper air flow through Evaporator and Condenser is critical for proper cooling.

EVAPORATOR air flow
Check to make sure the Blend Air door is operating

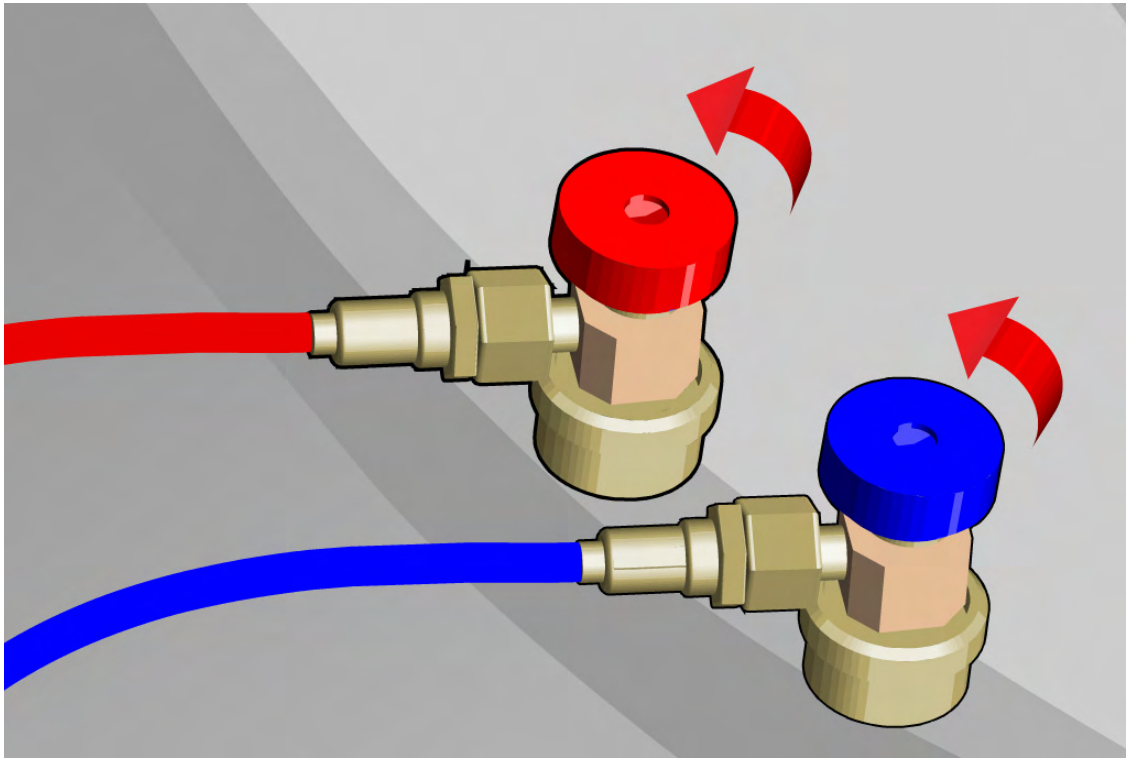
Check Cabin air filter and any intake air restriction
(usually leaves building up at base of windshield)

CONDENSER air flow
Check for bent fins or dirt, bugs leaves in front of evaporator

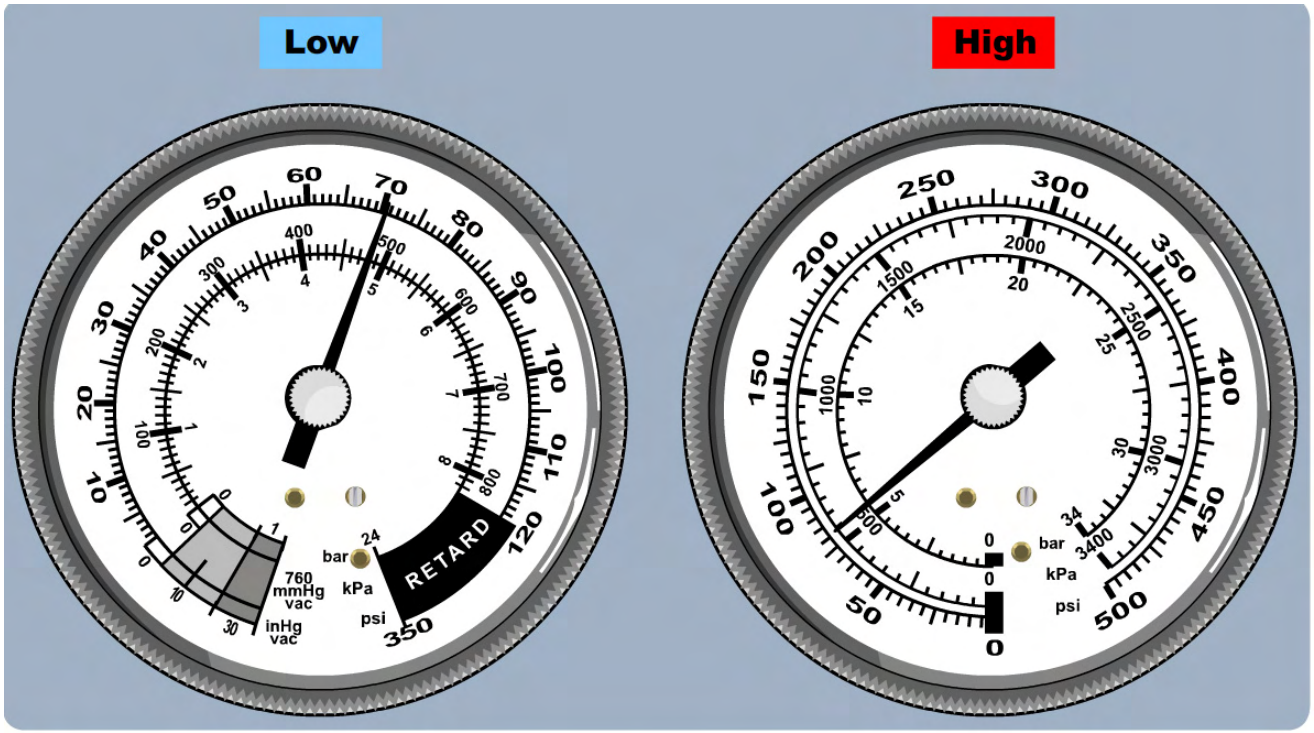
Check to make sure cooling fan is operating

Pressure Testing Refrigerant

Move gauge or recovery valves fully counter clockwise (OFF position)
to prevent refrigerant discharge when you connect or disconnect couplers



With proper charged\ and vehicle cold, the gauges should read close to 70 psi with a 70 degree ambient temperature.



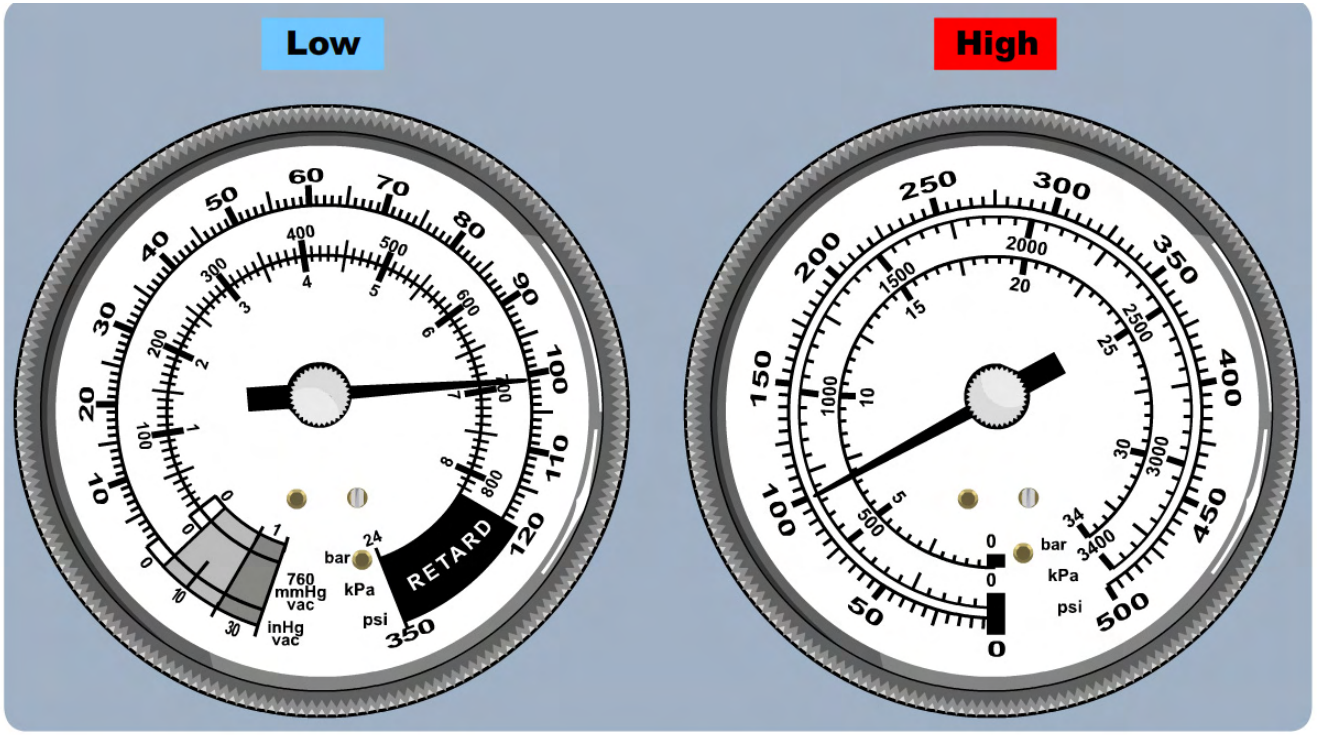
Normal Static Pressures with Vehicle Cold @70°F

Compare Ambient temperature to Static Charge pressure

R134a Temperature-Pressure

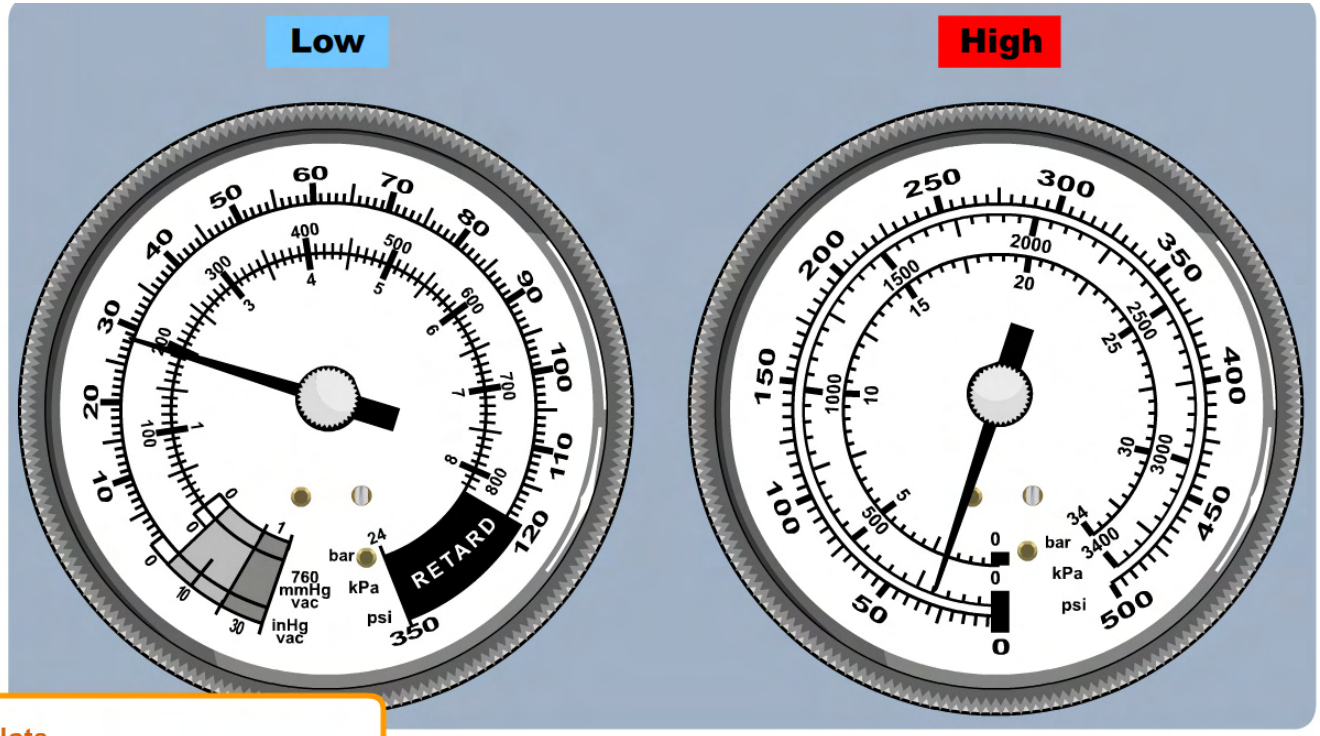
TEMPERATURE °F (°C)	PRESSURE PSI (kPa)
60 (16)	57 (392)
65 (18)	64 (438)
70 (21)	71 (487)
75 (24)	78 (540)
80 (27)	88 (609)
85 (30)	95 (655)

Static pressure significantly higher than the chart indicates contaminated refrigerant, too much refrigerant, or air in the system.



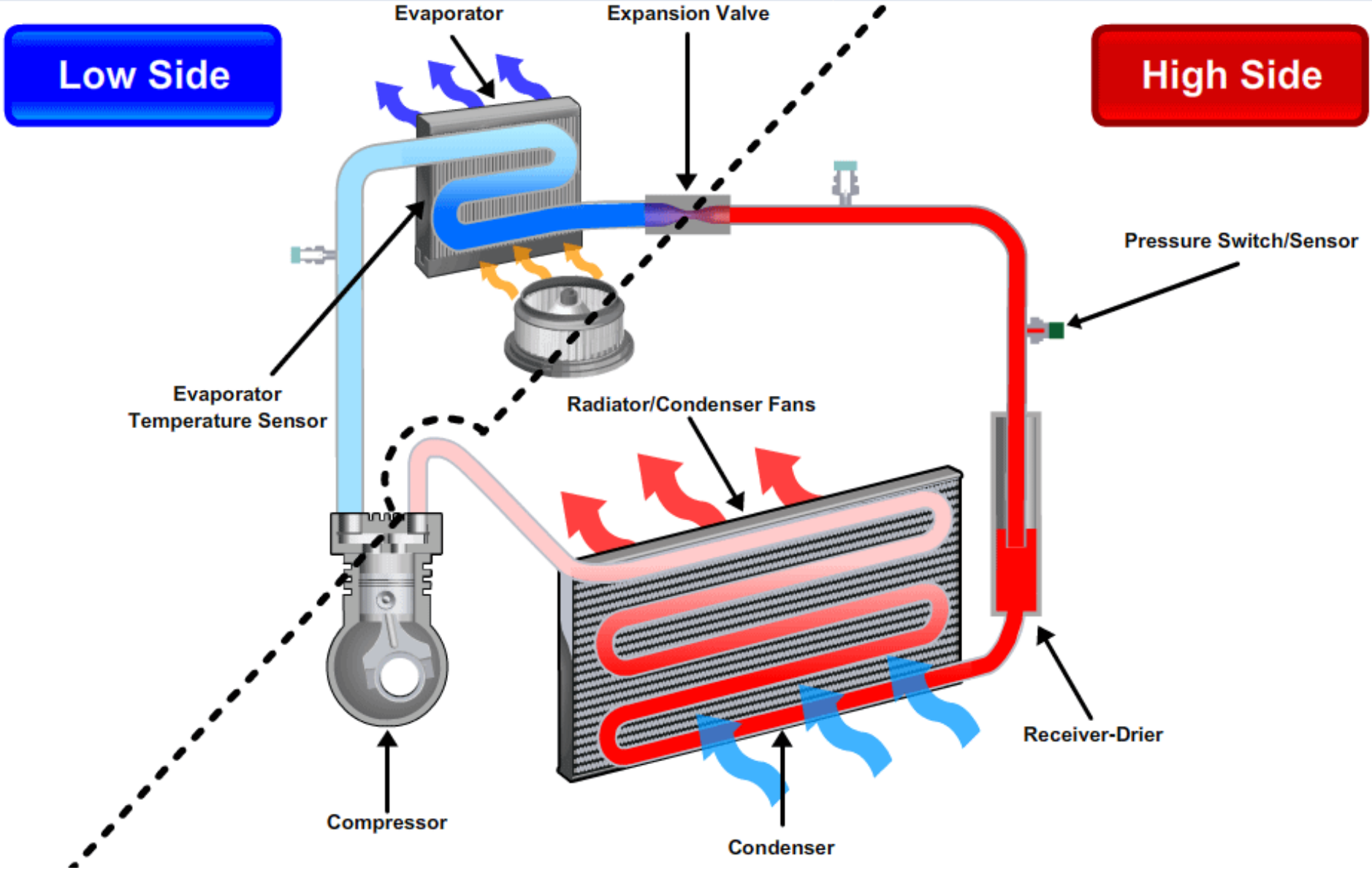
High Static Pressures with Vehicle Cold @70°F

If static pressure is below about 30 psi the A/C pressure switch or sensor will prevent A/C compressor operation. (check for leaks)

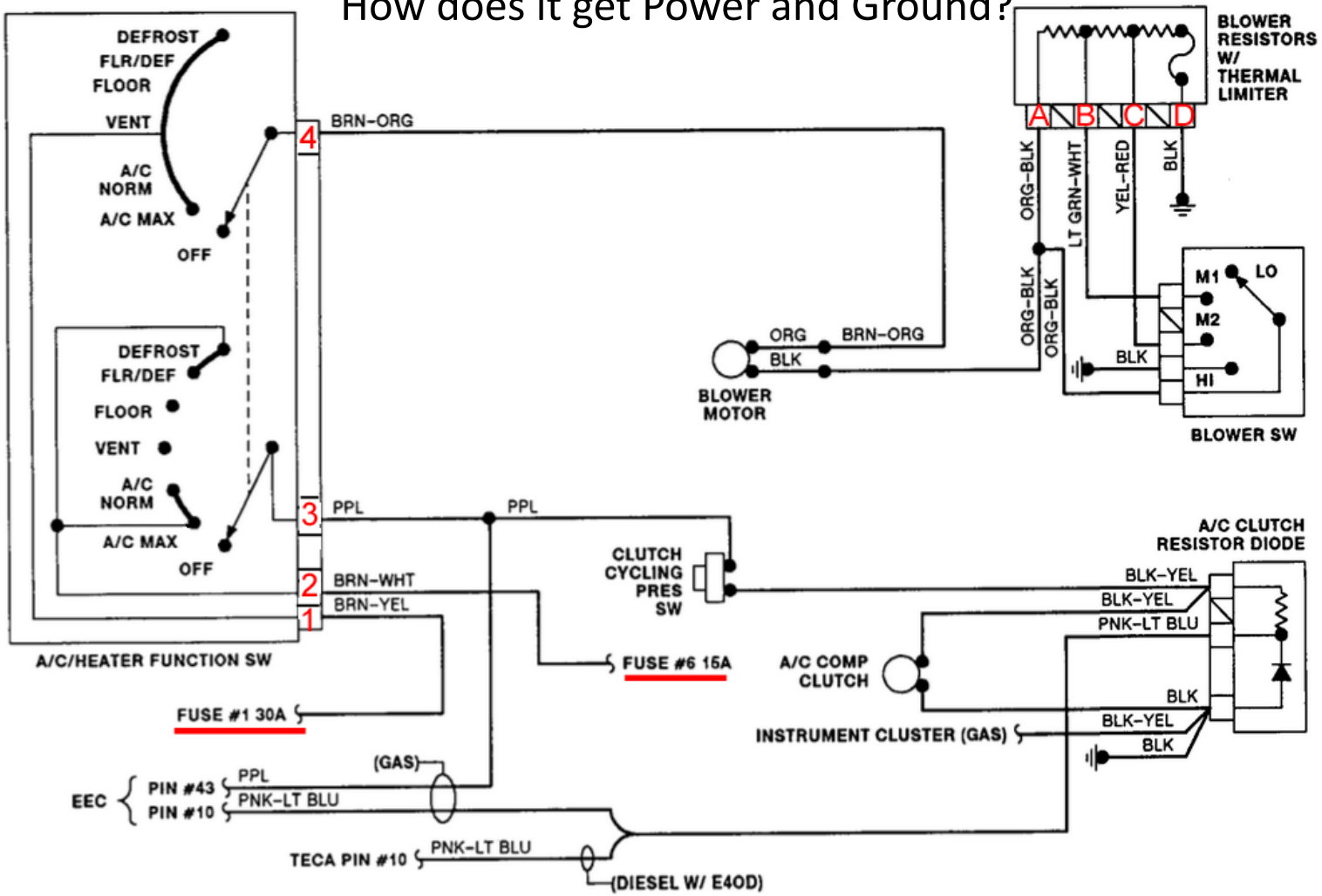


Tech Note

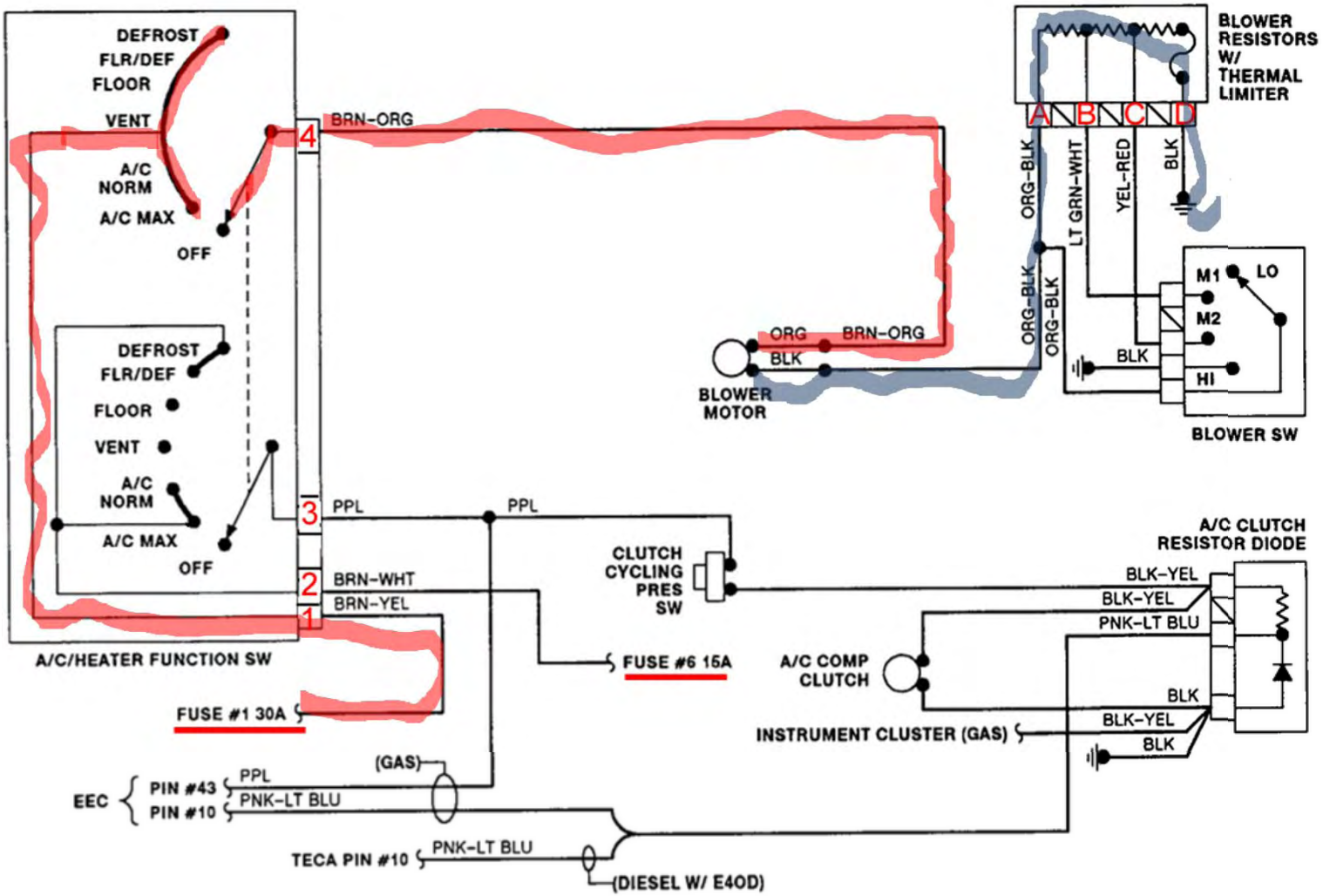
Never rely on static pressure readings as your only indication of the A/C system's state of charge.


Low Side
High Side
Evaporator
Expansion Valve
Pressure Switch/Sensor
Evaporator
Temperature Sensor
Radiator/Condenser Fans
Receiver-Drier
Compressor
Condenser

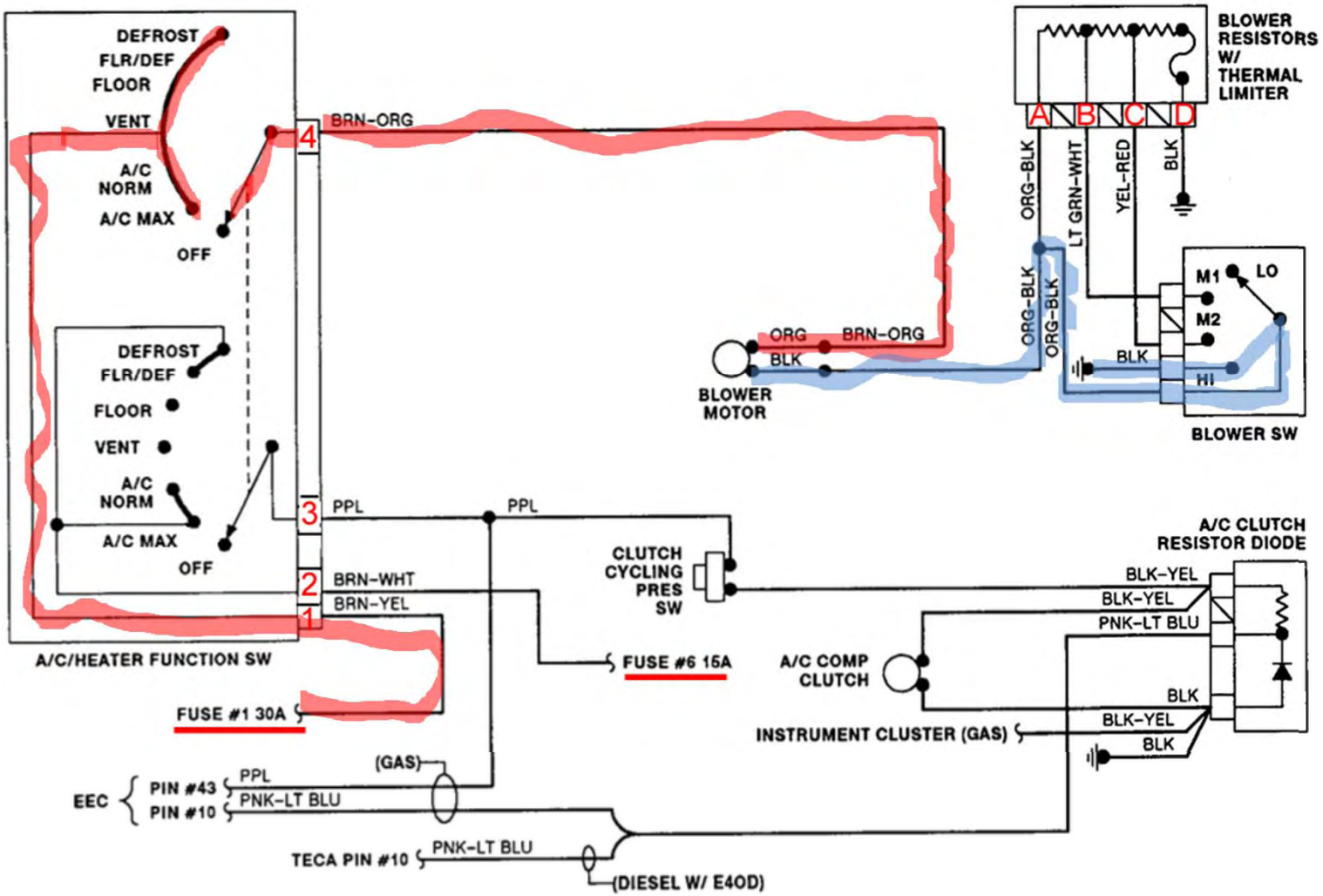
What does the Blower Motor do?
How does it get Power and Ground?



High resistance in the ground = low blower motor speed

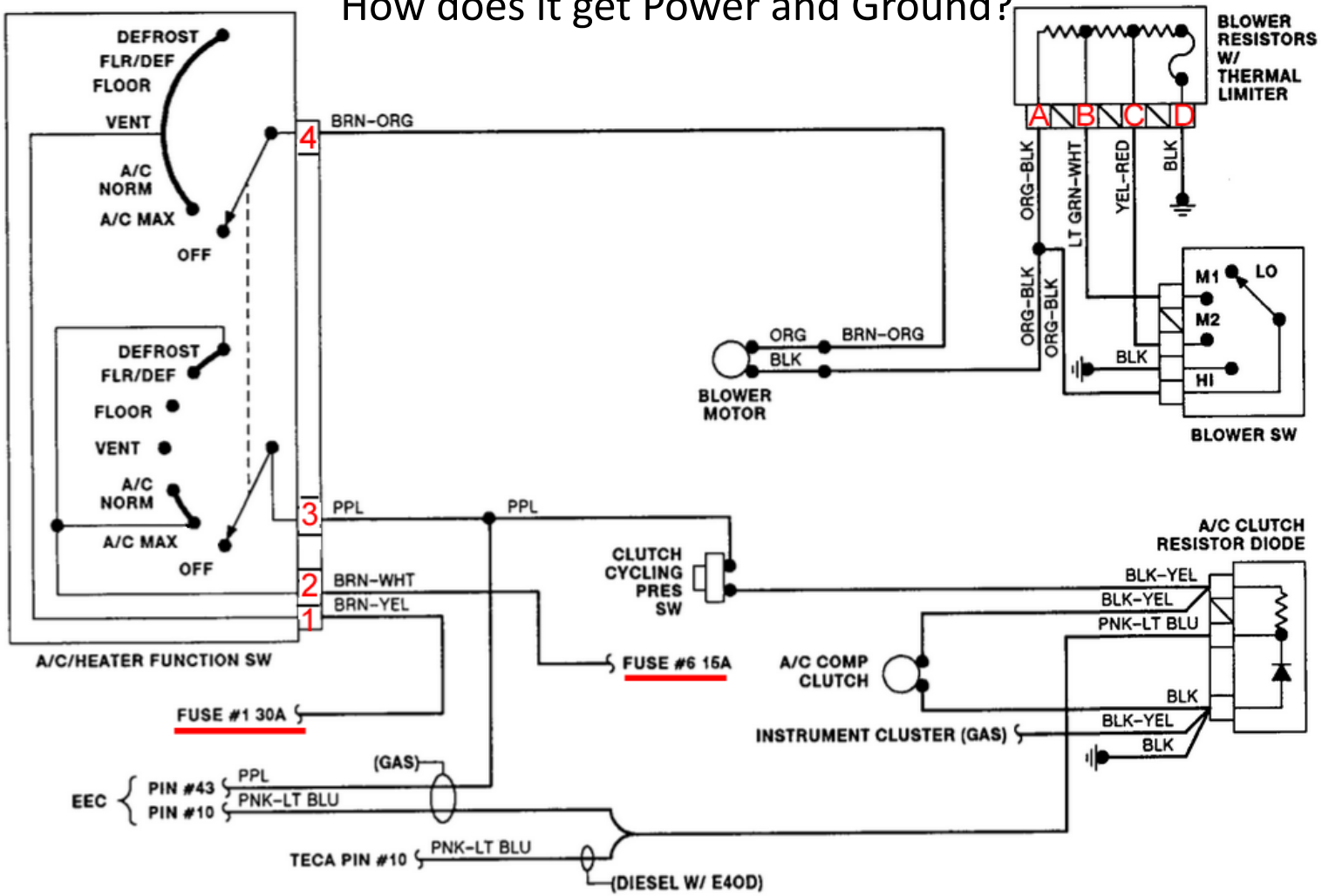


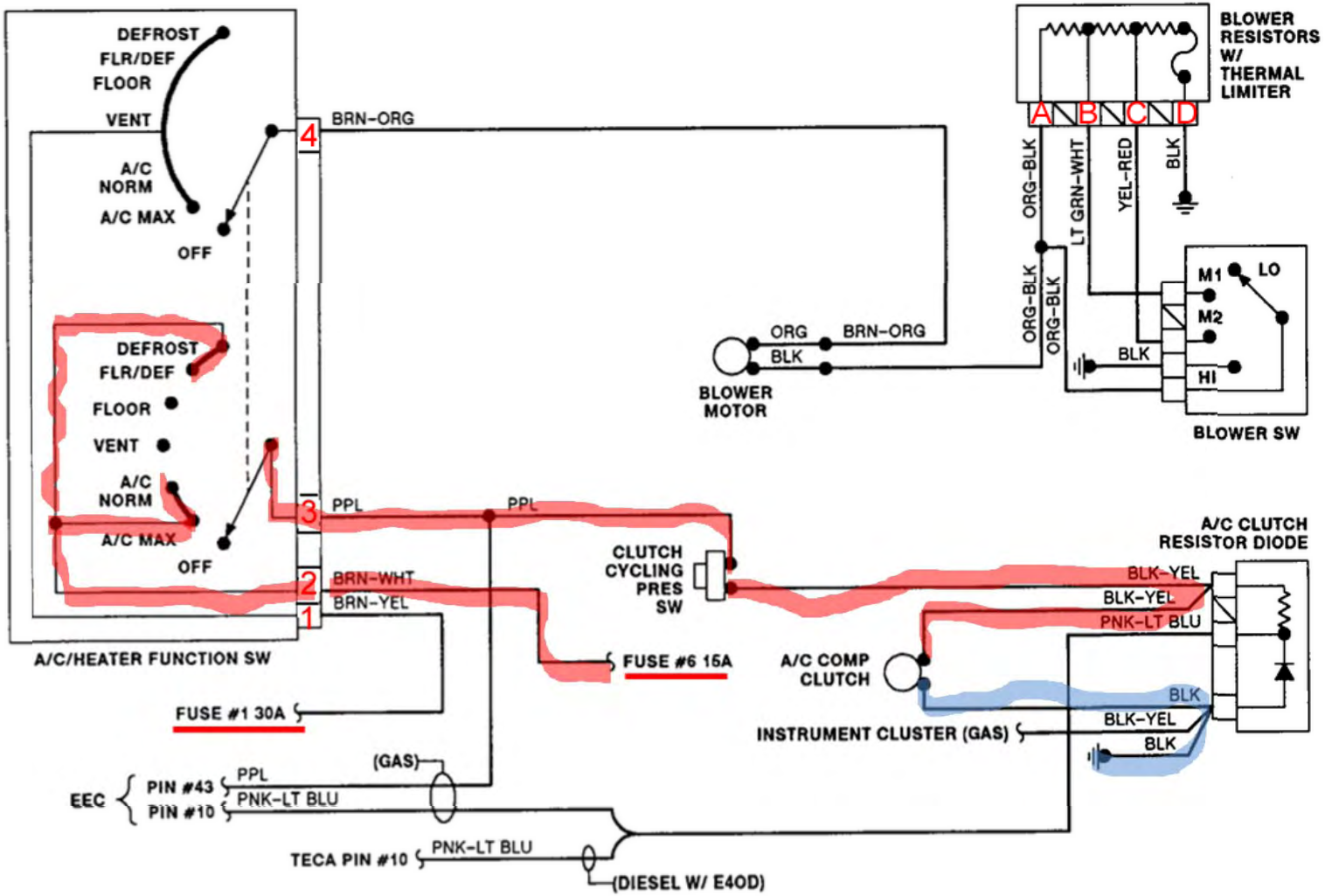
Low resistance in the ground = high blower motor speed



What does the Compressor Clutch do?

How does it get Power and Ground?




DEFROST
FLR/DEF
FLOOR
VENT
A/C NORM
A/C MAX
OFF
4
BRN-ORG
3
PPL
PPL
2
BRN-WHT
1
BRN-YEL
A/C/HEATER FUNCTION SW
FUSE #1 30A
FUSE #6 15A
BLOWER RESISTORS W/ THERMAL LIMITER
A
B
C
D
ORG-BLK
LT GRN-WHT
YEL-RED
BLK
ORG-BLK
ORG-BLK
M1
LO
M2
HI
BLK
BLOWER SW
ORG
BRN-ORG
BLK
BLOWER MOTOR
CLUTCH CYCLING PRES SW
A/C CLUTCH RESISTOR DIODE
BLK-YEL
BLK-YEL
PNK-LT BLU
A/C COMP CLUTCH
BLK
BLK-YEL
BLK
INSTRUMENT CLUSTER (GAS)
(GAS)
EEC
PIN #43
PIN #10
PPL
PNK-LT BLU
TECA PIN #10
PNK-LT BLU
(DIESEL W/ E4OD)