Evans Tempcon, Inc.

Recreational Vehicle

FRONT OCCUPANTS’ HVAC
Service Manual

(All Electric Control Systems)

EVANS TEMPCON, INC.
701 ANN ST. NW
GRAND RAPIDS, MI 49504
(616) 361-2681
WWW.EVANSTEMPCON.COM

ISO 9001
REGISTERED

Table of Contents

Notes (Not applicable for hard copies):

1. Phrases in the color blue are **"Hyperlinks"** that allow you to jump directly to the section mentioned. **Press** the "**Ctrl**" key and **click your left mouse button** to activate. Example : **"Table Of Contents"**
2. The **Section Titles** are **"Hyperlinks"** that allow you **to** jump to the **"Table Of Contents".**

Table of Contents (Continued)

Service

Disclaimer:

WARNING!!

The technical information, provided in this service guide, is intended for use by properly trained HVAC service personnel, whom can ensure a safe and properly operating system. It is assumed that the user of this guide is trained and experienced in basic refrigeration principles, in addition to being familiar with Evans Tempcon HVAC hardware installed on Recreational Vehicles. The technician must also be certified in accordance with the Environmental Protection Agencies Clean Air Act.

Before any air conditioning service is started, it is the technician's responsibility to determine what type of refrigerant is contained in the system. Component marking and/or service port peculiarities are good places to start in an effort to identify the contents.

Evans Tempcon advises that the usual precautions associated, with servicing a motor vehicle, be exercised when servicing the HVAC system and assumes no liability with regard to vehicle damage or personal injury. Additionally, Federal and any Local regulations regarding the handling and use of refrigerants should be complied with at all times.

NOTES:

TECHNICAL SUPPORT IS PROVIDED TO CERTIFIED TECHNICIANS ONLY. EVANS DOESN'T SUPPLY TECHNICAL SUPPORT TO RV OWNERS.

THE AIR CONDITIONING SYSTEM CONTAINS REFRIGERANT R134A, UNDER HIGH PRESSURE, AND SHOULD BE SERVICED BY ONLY QUALIFIED PERSONNEL.

REPAIRS THAT ALTER THE DESIGN OF THE EVANS SYSTEM, INCLUDING USE OF NON-EVANS SUPPLIED PARTS, WILL VOID THE WARRANTY AND ANY EVANS LIABILITY FOR THE HVAC SYSTEM.

THE EVANS HVAC SYSTEM SHOULD BE SERVICED BY A FULLY TRAINED AND ENVIRONMENTALLY LICENSED TECHNICIAN. FAILURE TO AGREE TO ALL STATEMENTS COULD RESULT IN SERIOUS INJURIES, FINES AND POSSIBLE VOIDING OF ANY WARRANTIES.

Service

Contact Information

Address:

701 Ann Street NW
Grand Rapids, MI 49504
United States

Phone Numbers:

616-361-2681 - Phone
616-361-9646 - Fax

E-Mail Address: info@evanstempcon.com

Web Site: www.evanstempcon.com

REQUEST FOR TECHNICAL SUPPORT QUESTIONNAIRE

Open the front service door of the coach and verify if you are servicing an Evans HVAC system by checking the base unit mounted on the front firewall. Verify customer complaint by operating the vehicle. ***(Print this page for reference).***

DESCRIPTION OF COMPLAINT: ____

____

____

DEALER: ____

CONTACT/TECH: ______________________________ PHONE #: ______________________

CHASSIS: ______________________MODEL YR: _______ MODEL: ____________________

COACH MANUFACTURER: ____

CONDENSER TYPE & LOCATION ____

PRESSURE GAUGE READINGS:

LOW ___________ PSIG @ 1500 RPM, HIGH BLOWER SPEED

HIGH ___________ PSIG @ 1500 RPM, HIGH BLOWER SPEED

R134A REFRIGERANT CHARGE WEIGHT:_____________ POUNDS

AIR TEMPERATURE & HUMIDITY READINGS:

HUMIDITY LEVEL: _____ %RH

RECIRCULATION INLET AIR TEMPERATURE: ______________ ºF

DISCHARGE AIR TEMPERATURE (VENT CLOSEST TO BASE UNIT): ___________ ºF

SUBTRACT THE TWO AIR TEMPERATURES = ______________ ºF DIFFERENTIAL

NOTES: ____

____

____

____

Comments:

Electrical/Electronic System

Control Modules

Plastic Injection Molded Design

Evans' Part Number: RV012631

Front Side

Back Side

Metal Horizontal Design

Evans' Part Number: RV202036 & RV202040

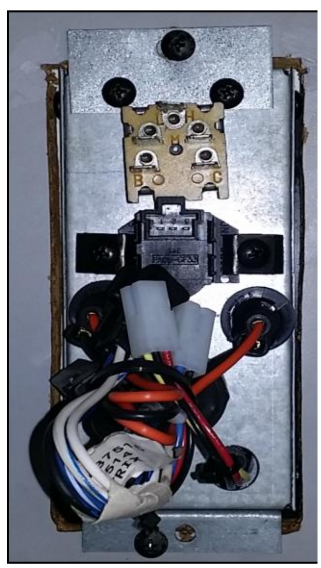
Front Side

Back Side

Metal Vertical Design

Evans' Part Number: RV202038

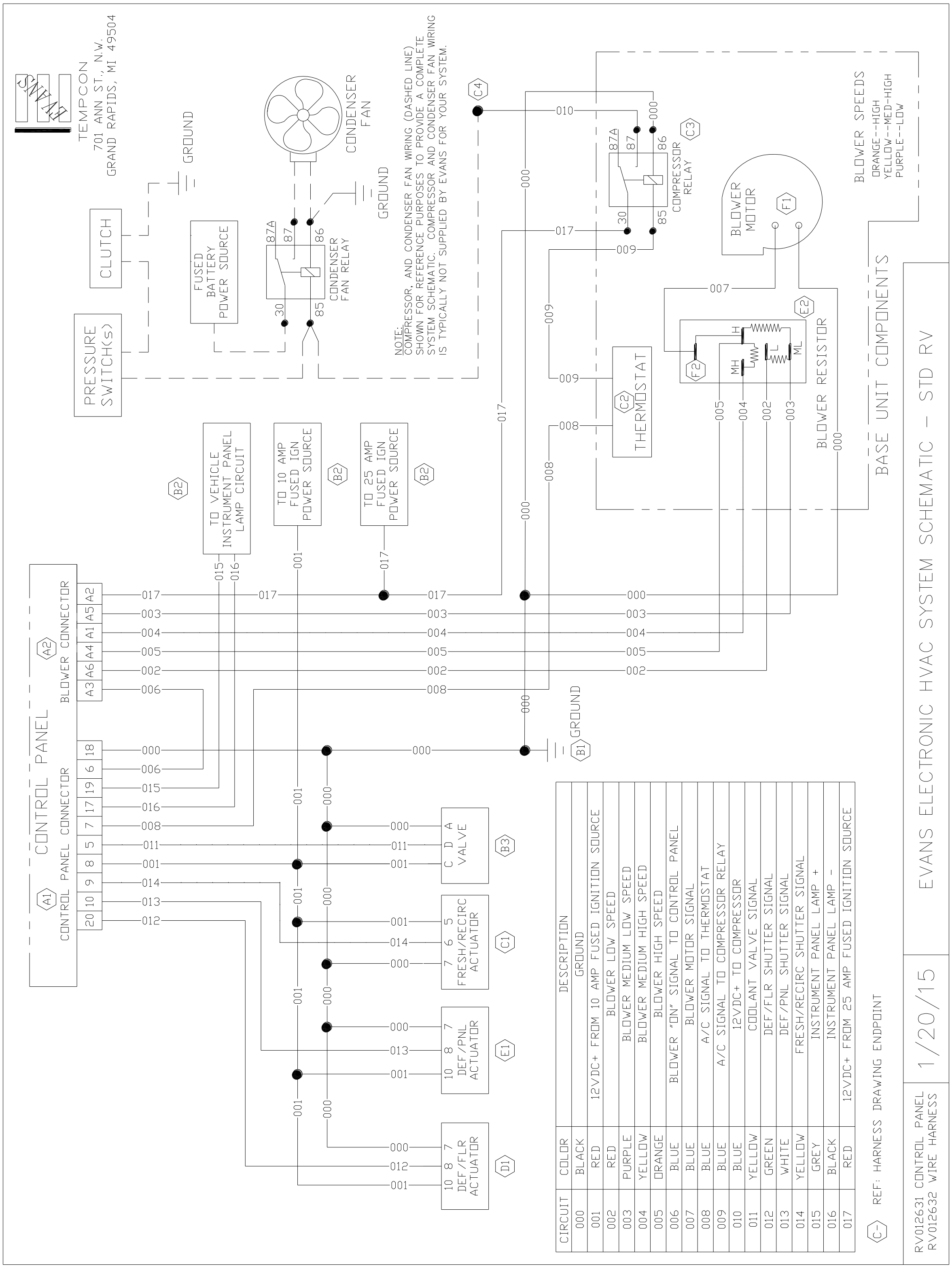
Front Side



Back Side

Electrical Schematics

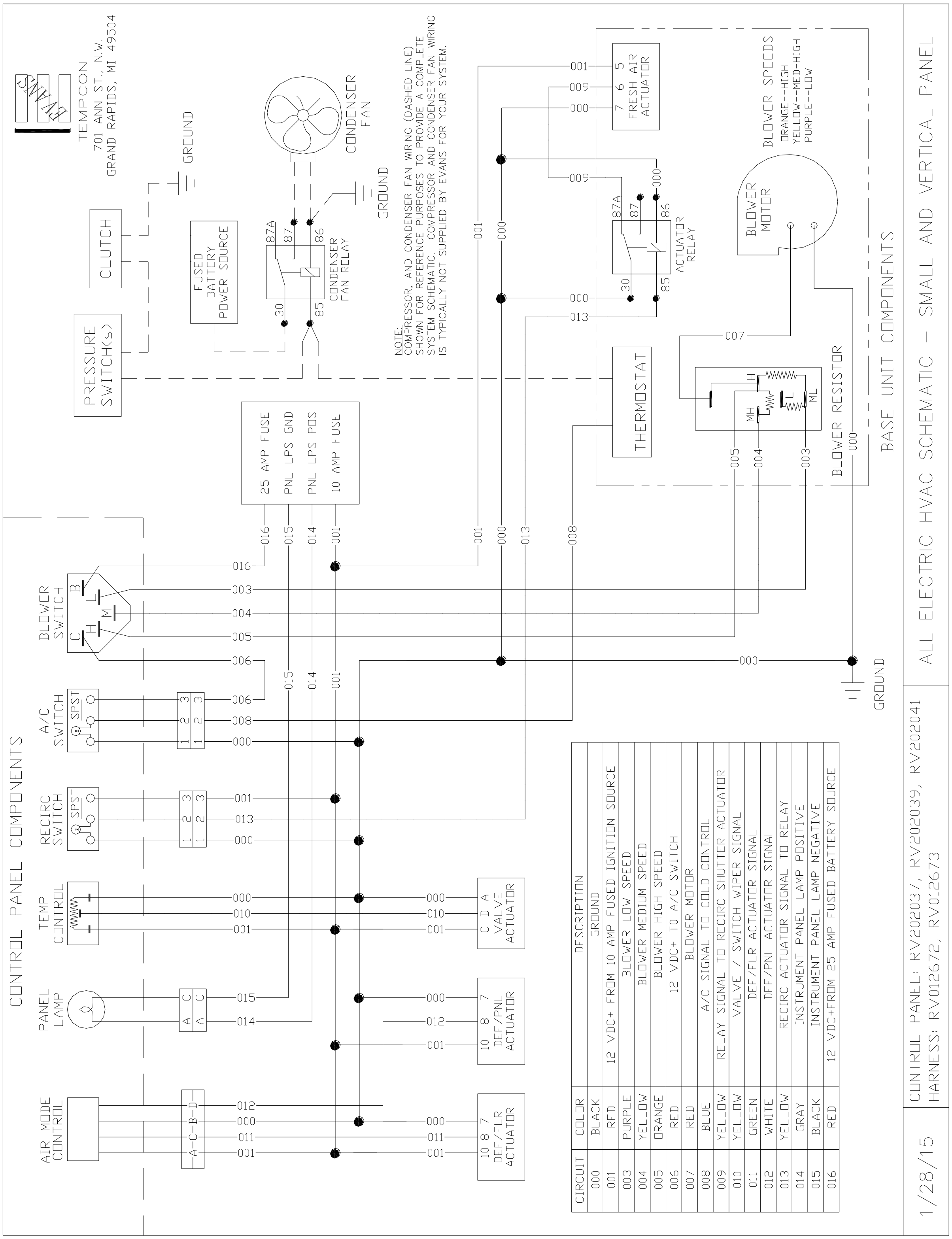
Plastic Control Panel - Harness PN: RV012632, RV012633, RV012634, and RV012703



Electrical/Electronic System

Electrical Schematics (Continued)

Metal Control Panel - Harness PN: RV012672 or RV012673



CIRCUIT	COLOR	DESCRIPTION
000	BLACK	GROUND
001	RED	12 VDC+ FROM 10 AMP FUSED IGNITION SOURCE
003	PURPLE	BLOWER LOW SPEED
004	YELLOW	BLOWER MEDIUM SPEED
005	ORANGE	BLOWER HIGH SPEED
006	RED	12 VDC+ TO A/C SWITCH
007	RED	BLOWER MOTOR
008	BLUE	A/C SIGNAL TO COLD CONTROL
009	YELLOW	RELAY SIGNAL TO RECIRC SHUTTER ACTUATOR
010	YELLOW	VALVE / SWITCH WIPER SIGNAL
011	GREEN	DEF/FLR ACTUATOR SIGNAL
012	WHITE	DEF/PNL ACTUATOR SIGNAL
013	YELLOW	RECIRC ACTUATOR SIGNAL TO RELAY
014	GRAY	INSTRUMENT PANEL LAMP POSITIVE
015	BLACK	INSTRUMENT PANEL LAMP NEGATIVE
016	RED	12 VDC+FROM 25 AMP FUSED BATTERY SOURCE

Electrical/Electronic System

Diagnostics Guide

(Reference the appropriate electrical schematic first and follow "POSSIBLE CAUSES" in sequence)

PROBLEM	POSSIBLE CAUSES	REMEDY
1. Control panel is not functional.	• Vehicle ignition switch isn't activated.	• Activate vehicle ignition switch.
	• Loss of power supply.	• Examine the chassis's HVAC circuit's protection device for failure (i.e. fuse or circuit breaker). Two power sources are required.
	• Open circuit between vehicle ignition and control panel. Open circuit between ground source and control panel.	• Check primary connections at power source, ground source and the control panel Verify vehicle voltage at each connection. Perform continuity test between each connection. Repair or replace harness if necessary.
	• Loose connection(s) at the control panel.	• Insure all connections are mated properly.
	• Failed control panel.	• Replace control panel.
2. Controller knob is rotating beyond its defined positions.	• Knob is damaged.	• Replace knob.
	• Control device is damaged.	• Internal stop has been broken. If control device can be rotated through more than designed positions, replace control device.
3. Discharge and/or inlet air systems aren't functioning properly. Blower is operating properly.	• Loss of power supply.	• Examine the chassis's HVAC circuit's protection device for failure (i.e. fuse or circuit breaker). Separate source from the blower motor circuit.
	• Open circuit between vehicle ignition and control panel. Open circuit between ground source and control panel.	• Verify vehicle voltage at each connection. Perform continuity test between the control panel and shutter actuator(s) connections. Repair or replace harness if necessary.
	• Incorrect circuit(s).	• Reference the **"Expected Voltages - Matrix"** section. Correct the circuit(s) if possible or replace harness.
	• Faulty shutter actuator.	• Replace the actuator if needed.
	• Faulty ventilation mode, or recirculated air push button switch.	• Replace the switch or control panel if needed.

Diagnostics Guide (Continued)

(Reference the appropriate electrical schematic first and follow "POSSIBLE CAUSES" in sequence)

PROBLEM	POSSIBLE CAUSES	REMEDY
4. Blower does not operate at any speeds.	• Loss of power source.	• Examine the chassis's HVAC circuit's protection device for failure (i.e. fuse or breaker).
	• Open circuit in harness between the circuit protection and control panel.	• Verify vehicle voltage at each blower switch connection. Perform continuity test between connections. Repair or replace harness if necessary.
	• Faulty blower switch.	• With vehicle ignition ON, rotate blower switch through all of its positions, check for voltage at all terminals. If no voltage is measured, replace switch or control panel if needed.
	• Open circuit in harness between the control panel and blower resistor.	• Rotate the blower switch to LOW speed. Verify vehicle voltage at LOW speed connection of the blower resistor. Perform continuity test between connections. Repair or replace harness if necessary.
	• Faulty blower resistor.	• Measure the voltage at the connection that feeds the motor lead. If no voltage is measured, replace blower resistor.
	• Faulty blower motor.	• Rotate the blower switch to HIGH speed. Check for voltage at the motor connection. If no voltage is measured, replace blower motor. Perform continuity test between connections if necessary.
5. Blower does not operate at all speeds.	• Faulty blower switch.	• With vehicle ignition ON, rotate blower switch to its inoperative speed position. Check for voltage at the controller's speed setting terminal. If no voltage is measured, replace switch or control panel if needed.
	• Open circuit in harness between the control panel and blower resistor.	• Verify vehicle voltage at each speed connection on the blower resistor. Perform continuity test between connections. Repair or replace harness if necessary.
	• Faulty blower resistor.	• Measure the voltage at the connection that feeds the motor lead. If no voltage is measured, replace blower resistor. Reference the **"Expected Voltages - Matrix"** section.

Diagnostics Guide (Continued)

(Reference the appropriate electrical schematic first and follow "POSSIBLE CAUSES" in sequence)

PROBLEM	POSSIBLE CAUSES	REMEDY
6. A/C Clutch does not operate.	• Blower switch isn't activated.	• AC switch receives its power source from the blower switch. Turn blower switch to any speed selection. Verify blower operation.
7. A/C Clutch does not operate. Blower is operating properly.	• AC switch isn't activated.	• Verify AC switch is depressed and operating correctly.
	• Faulty AC switch.	• Metal Control Panel's AC switch requires a "Compressor Activated" signal from the blower switch. Make sure the switch is receiving this signal from the blower switch. If not then replace the blower switch. Otherwise measure voltage at the control panel's "AC Signal" terminal. If no voltage is measured on the correct circuit, replace switch or control panel if needed.
	• Open circuit between A/C switch and A/C thermostat, or thermostat to clutch.	• Check primary connections at the control panel. Perform continuity test between AC switch connection and A/C thermostat. Repair or replace harness if necessary.
	• Defective A/C thermostat.	• Place a jumper across terminals of thermostat, if the clutch engages then replace thermostat.
	• Faulty A/C pressure switch (make certain adequate refrigerant is contained in system).	• Place a jumper across terminals of vehicle's harness mating connector, if the clutch engages then replace the switch.
	• Faulty A/C Clutch.	• With the engine OFF apply a separate 12V+ supply directly to clutch terminals and listen for clutch engagement. Replace clutch if there is no engagement.
	• Faulty chassis circuitry.	If voltage is read at pressure switch, and the clutch is working as noted above, the problem is originating in the chassis wiring. Refer to the chassis manufacturer service manual.

Electrical/Electronic System

Expected Voltages - Matrix

Plastic or Metal Control Panel Integrated To Plastic Tooled And Form Molded Air Distribution Assemblies.

Estimated Voltage Readings, Per Ventilation Mode, At The Control Panel Connection

Ventilation Mode	SHUTTER ACTUATORS								
	Fresh / Recirculation Inlet Air			*Defrost - Floor / Panel*			*Defrost / Floor*		
	BLK	*YEL*	*RED*	*BLK*	*WHT*	*RED*	*BLK*	*GRN*	*RED*
Fresh Air »	0	**Grd**	11-13	0	NA	11-13	0	NA	11-13
Recirculation Air »	0	No Signal	11-13	0	NA	11-13	0	NA	11-13
Panel »	0	NA	11-13	0	**0**	11-13	0	**11-13**	11-13
Panel / Floor »	0	NA	11-13	0	**5-7**	11-13	0	**11-13**	11-13
Floor »	0	NA	11-13	0	**11-13**	11-13	0	**11-13**	11-13
Defrost / Floor »	0	NA	11-13	0	**11-13**	11-13	0	**5-7**	11-13
Defrost »	0	NA	11-13	0	**11-13**	11-13	0	**0**	11-13

Metal Control Panels Integrated To Metal Air Distribution Assemblies.

Estimated Voltage Readings, Per Ventilation Mode, At The Control Panel Connection

Ventilation Mode	SHUTTER ACTUATORS								
	Fresh / Recirculation Inlet Air			*Defrost - Floor / Panel*			*Defrost / Floor*		
	BLK	*YEL*	*RED*	*BLK*	*WHT*	*RED*	*BLK*	*GRN*	*RED*
Fresh Air	0	**Grd**	11-13	0	NA	11-13	0	NA	11-13
Recirculation Air	0	No Signal	11-13	0	NA	11-13	0	NA	11-13
Panel	0	NA	11-13	0	**0**	11-13	0	**0**	11-13
Panel / Floor	0	NA	11-13	0	**5-7**	11-13	0	**0**	11-13
Floor	0	NA	11-13	0	**11-13**	11-13	0	**5-7**	11-13
Defrost / Floor	0	NA	11-13	0	**11-13**	11-13	0	**11-13**	11-13
Defrost	0	NA	11-13	0	**11-13**	11-13	0	**11-13**	11-13

Estimated Hot Water Valve Actuator Voltage Readings

Per Potentiometer Position

Potentiometer Position	*BLK*	*YEL*	*RED*
Full Cool (Far Left)	0	11-13	11-13
Full Heat (Far Right)	0	0	11-13

Estimated Blower Motor Voltage Readings Per Blower Speed

Plastic Control Panel

Blower Speed	*RED*	*BLK*
Off	0	0
Low	2-4	0
Medium / Low	5-7	0
Medium / High	8-10	0
High	11-13	0

Metal Control Panel

RED	*BLK*	*Blower Speed*
0	0	**Off**
2-5	0	**Low**
6-10	0	**Medium**
11-13	0	**High**

Notes:

1) Voltages per vehicle will vary depending on voltage regulation and voltage loss due to resistance of the wire.

2) Always test with voltage meter referencing vehicle ground and not wire harness ground.

3) A limiting resistor is wired in series with the shutter actuator's control signal wire in order to reduce the rotation of the air flow shutter to desired position. **Voltage readings at the shutter actuator will be less but follows the same voltage logic as the control panel voltage readings.**

Air Flow Systems

Blower Motor Assemblies

One of the most basic controls for maintaining a comfortable passenger compartment is the blower motor assembly. This is a fan that forces air through the evaporator and the heater core and into the passenger compartment.

In most cases, the blower motor speed is adjustable. By changing the switch position on the control panel, the operator can adjust the speed of the blower motor from low to high, in three or four steps.

The slower the fan speed, the longer the air sits along the evaporator and heater coils. This removes more heat, and reduces the temperature of the air being discharged from the vents, in A/C cooling mode. Conversely, in the heat mode, slow fan speeds increase the discharge air temperature.

In addition, cooler air holds less moisture than warm air. The longer the air stays near the evaporator fins, the more moisture will condense on the fins and the drier the air coming into the passenger compartment. As more condensation builds up on the evaporator fins, it begins to run off, and drains out of the HVAC module through the evaporator condensate drain tube.

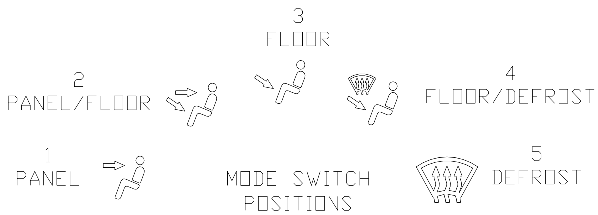
This also helps to purify the air to some degree. Dust and pollen particles that come in contact with the wet evaporator are pulled out of the air stream and wash out through the condensate drain.

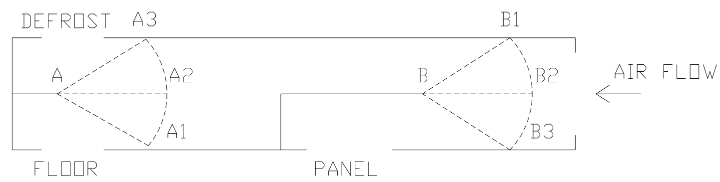
Plastic and Metal Blower Motor Assemblies

Air Flow System

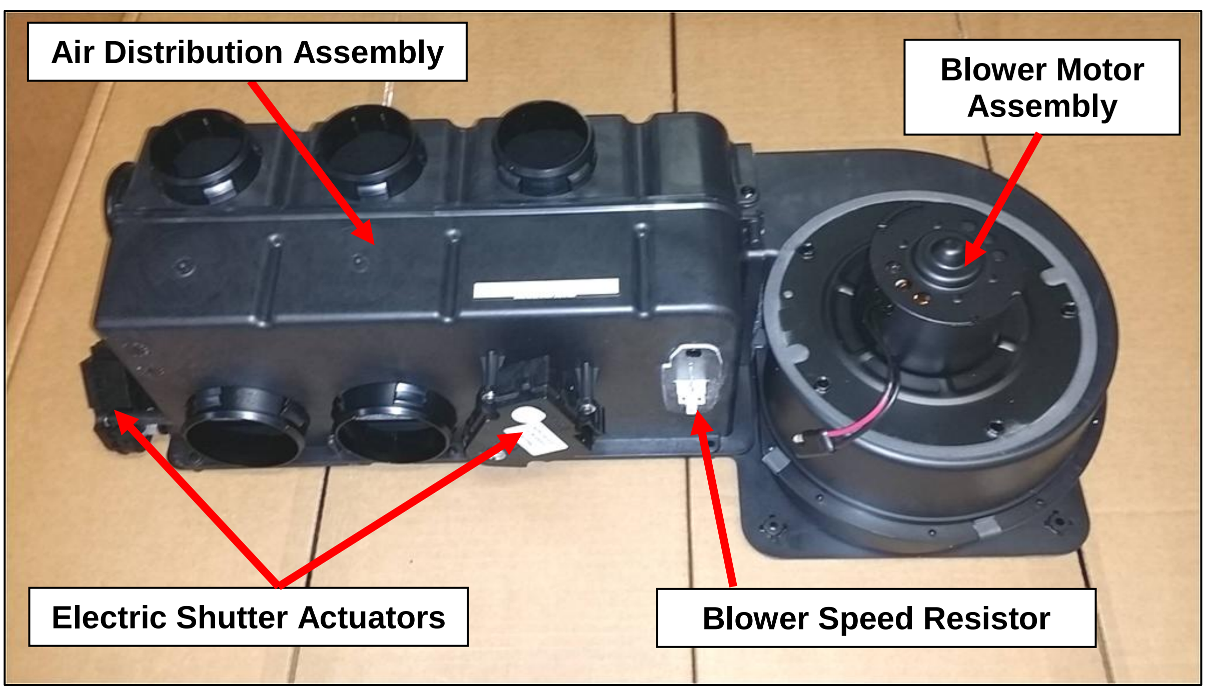
Air Distribution Systems

Plastic Injection Molded Air Distribution Assembly - Air Flow Logic





MODE	SHUTTER POSITION	SHUTTER POSITION	KNOB POSITION
PANEL	A @ A1	B @ B1	1
PAN/FLR	A @ A1	B @ B2	2
FLOOR	A @ A1	B @ B3	3
FLR/DEF	A @ A2	B @ B3	4
DEFROST	A @ A3	B @ B3	5



Plastic Injection Molded Air Distribution Assembly

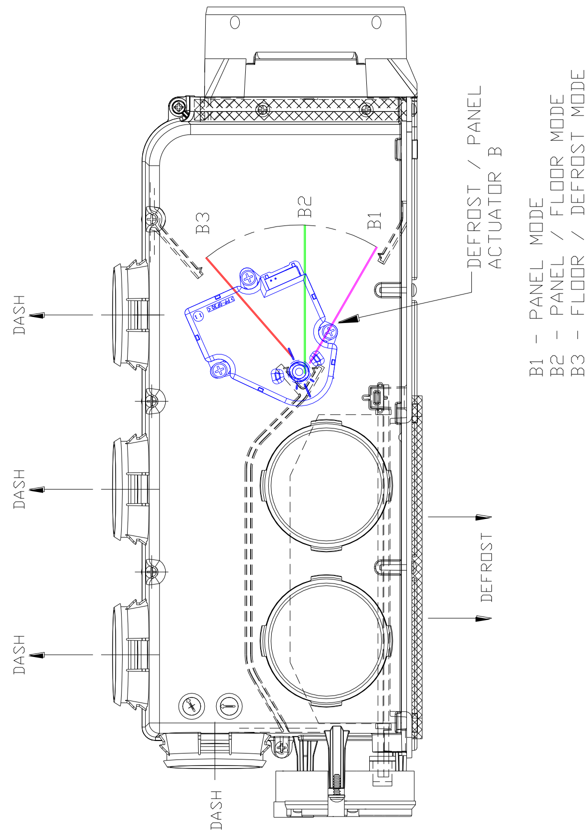
Air Flow System

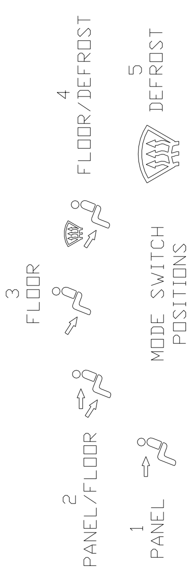
Air Distribution Systems (Continued)

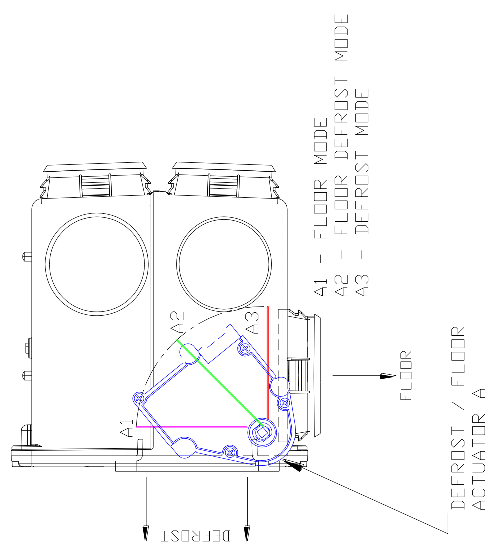
Plastic Injection Molded Air Distribution Assembly – Shutter Logic

Air Flow System

MODE	SHUTTER POSITION	SHUTTER POSITION	KNOB POSITION
PANEL	A @ A1	B @ B1	1
PAN/FLR	A @ A1	B @ B2	2
FLOOR	A @ A1	B @ B3	3
FLR/DEF	A @ A2	B @ B3	4
DEFROST	A @ A3	B @ B3	5

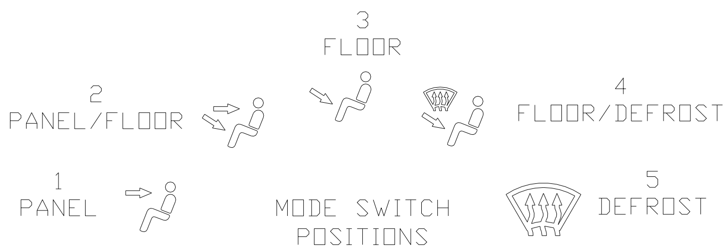


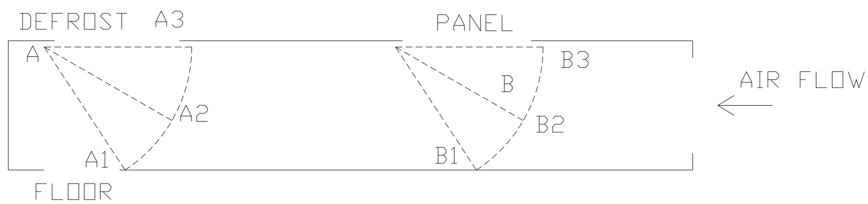




Air Distribution Systems **(Continued)**

Metal Air Distribution Assembly – Air Flow Logic





Note: A1 & A3 SHUTTER POSITIONS PROVIDE BLEED AIR TO DEFROST AND FLOOR OUTLETS RESPECTIVELY.

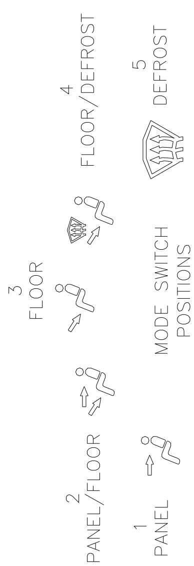
MODE	SHUTTER POSITION	SHUTTER POSITION	KNOB POSITION
PANEL	A @ A1	B @ B1	1
PAN/FLR	A @ A1	B @ B2	2
FLOOR	A @ A1	B @ B3	3
FLR/DEF	A @ A2	B @ B3	4
DEFROST	A @ A3	B @ B3	5

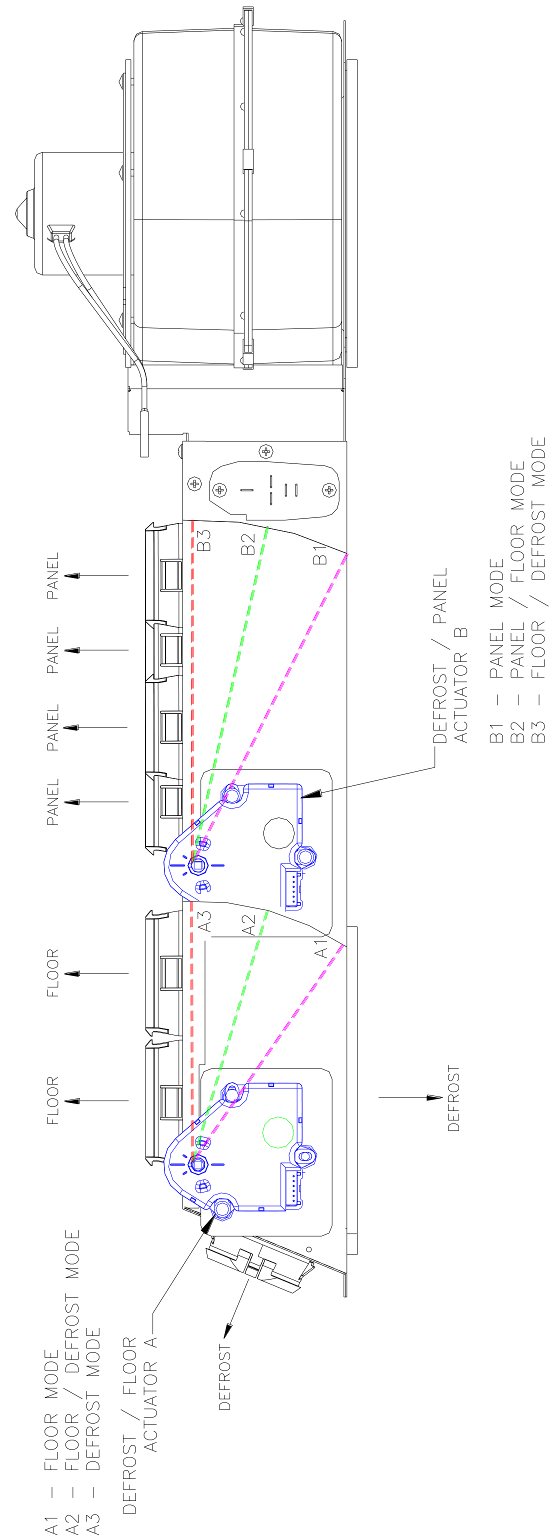
Air Flow System

Air Distribution Systems (Continued)

Metal Air Distribution Assembly – Shutter Logic

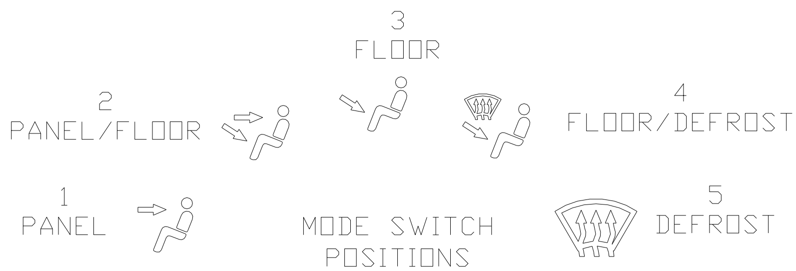
MODE	SHUTTER POSITION	SHUTTER POSITION	KNOB POSITION
PANEL	A @ A1	B @ B1	1
PAN/FLR	A @ A1	B @ B2	2
FLOOR	A @ A1	B @ B3	3
FLR/DEF	A @ A2	B @ B3	4
DEFROST	A @ A3	B @ B3	5

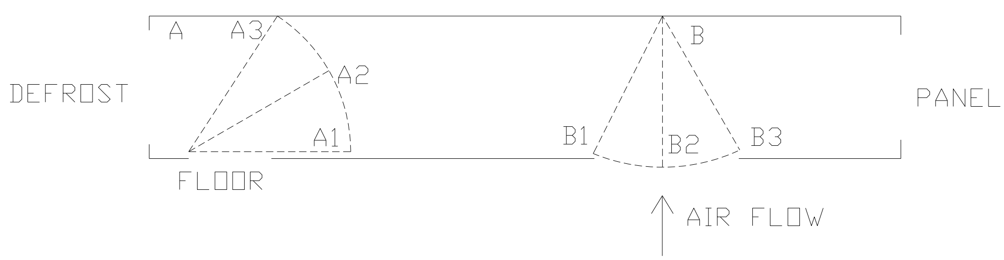




Air Distribution Systems (Continued)

Plastic Form Molded Discharge Air Assembly - Air Flow Logic





Note: A1 & A3 SHUTTER POSITIONS PROVIDE BLEED AIR TO DEFROST AND FLOOR OUTLETS RESPECTIVELY.

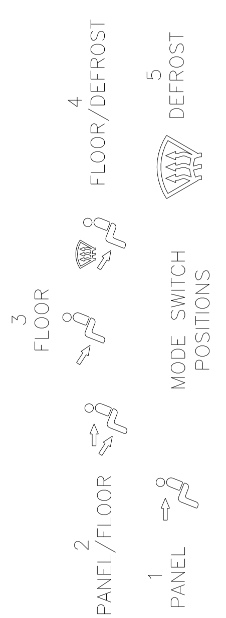
MODE	SHUTTER POSITION	SHUTTER POSITION	KNOB POSITION
PANEL	A @ A3	B @ B1	1
PAN/FLR	A @ A3	B @ B2	2
FLOOR	A @ A3	B @ B3	3
FLR/DEF	A @ A2	B @ B3	4
DEFROST	A @ A1	B @ B3	5

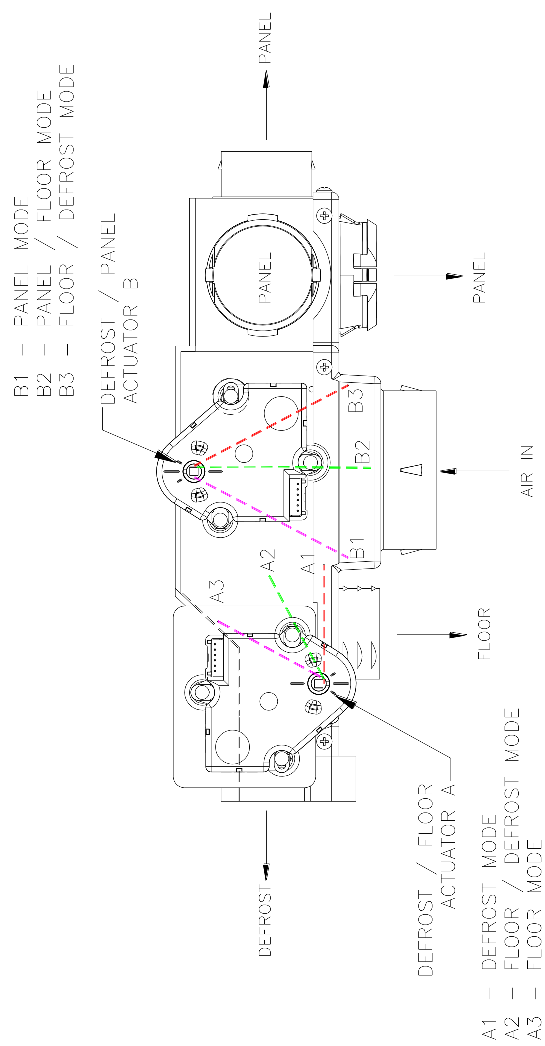
Air Flow System

Air Distribution Systems **(Continued)**

Plastic Vacuum Form Molded/Metal Air Distribution Assembly – Shutter Logic

MODE	SHUTTER POSITION	SHUTTER POSITION	KNOB POSITION
PANEL	A @ A3	B @ B1	1
PAN/FLR	A @ A3	B @ B2	2
FLOOR	A @ A3	B @ B3	3
FLR/DEF	A @ A2	B @ B3	4
DEFROST	A @ A1	B @ B3	5

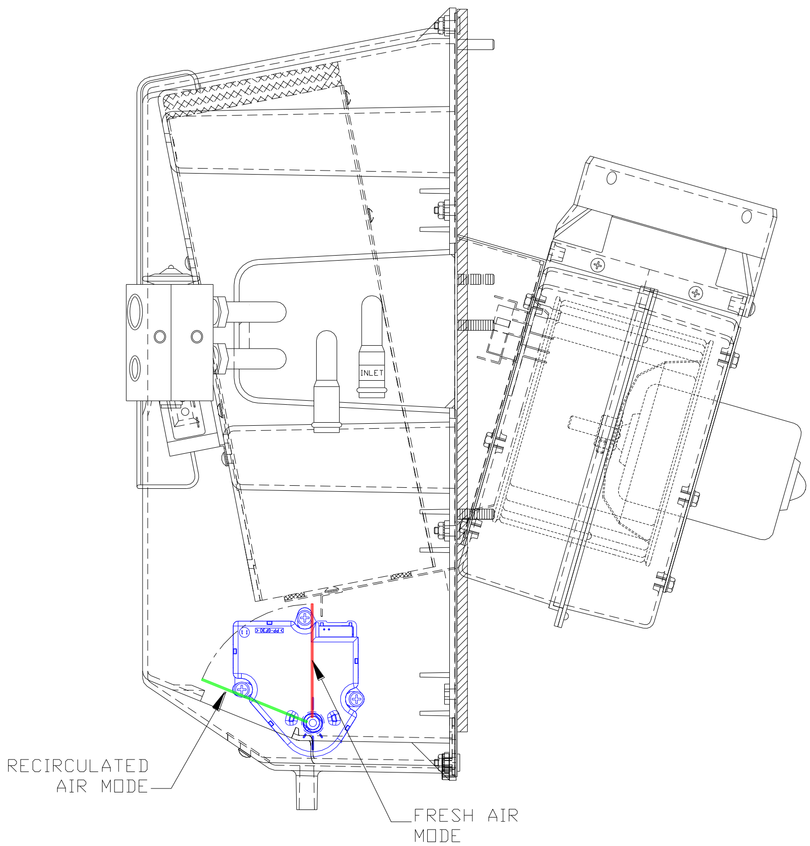


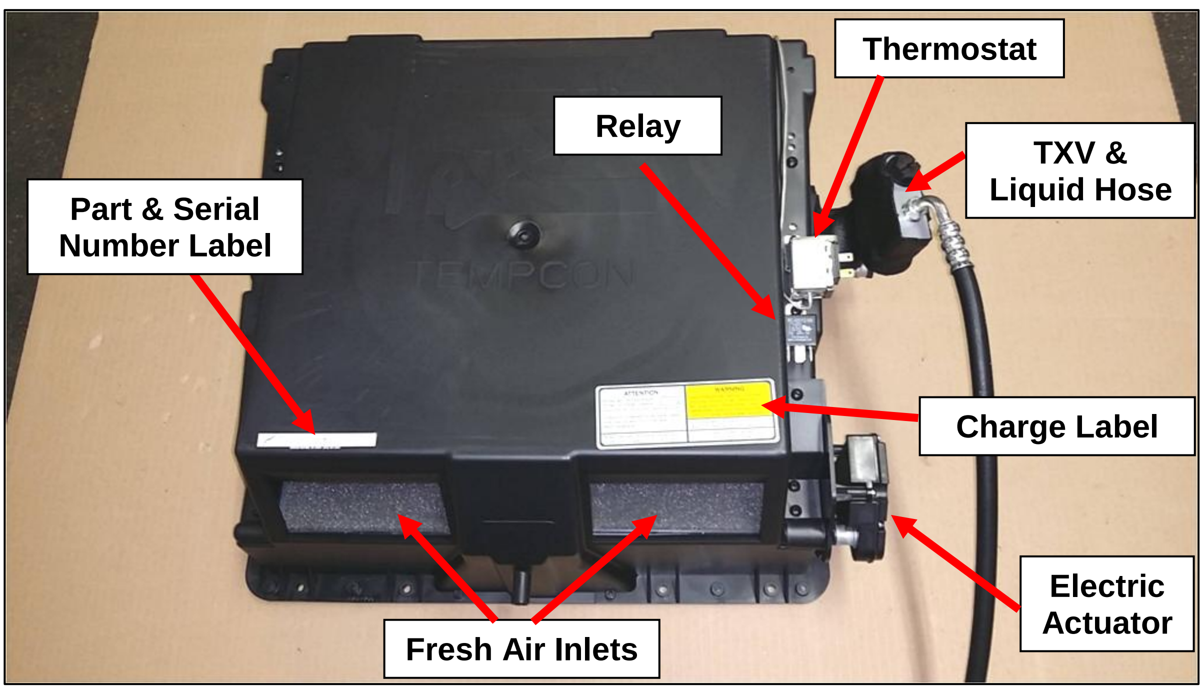


Air Flow System

Air Distribution Systems (Continued)

HVAC Base Unit – Shutter Logic





HVAC Base Unit

Heating System

Safety Precautions & Warnings

SERVICING ENGINE COOLANT SYSTEMS:

1. Always wear the proper protective eyewear and clothing before working on any engine coolant system. Remember, engine coolant systems can reach temperatures over 180ºF. If coolant gets in your eye, **IMMEDIATELY** flush eyes with running water for at least 15 minutes, keeping eyelids open. Seek medical attention.

2. Always wear work gloves whenever you're working with heating coils and hoses. The aluminum edges are sharp, and can cause serious cuts.

3. Always stay clear of the belts and fan blade, and be careful revving the engine on a vehicle with a flex fan – damaged blades have been known to come flying off without a moment's warning.

Warning:

NEVER remove the radiator cap on a vehicle while the engine is still hot or warm. Severe scalding could occur.

Heating System

Engine Coolant System

ANTIFREEZE / COOLANT:

The main function of the Cooling System is to carry heat away from the engine and maintain the desired operating temperature. This is accomplished by circulating antifreeze/coolant through the engine, where heat is generated, and carrying it to the radiator to be cooled.

Modern recreational vehicles operate in a wide variety of ambient temperatures, from well below freezing to well over 100 F. The fluid used to cool the engine must have a very low freezing point, a high boiling point, and it must have the ability to transfer heat.

An adequate amount of an antifreeze/coolant and water mixture is necessary to reduce the possibility of engine overheating and freezing, and contain additives to prevent rust and corrosion in the cooling system.

Water is one of the most effective fluids for holding heat, but water freezes at too high a temperature to be used in automobile engines alone.

The fluid used in most recreational vehicles is a mixture of water and ethylene glycol, also known as "antifreeze" or "coolant". By adding antifreeze / coolant to water, the boiling and freezing points are improved significantly.

The temperature of the coolant can sometimes reach 250 to 275 F (121 to 135 C). Even with antifreeze added, these temperatures would boil the coolant. To prevent this, the cooling system is pressurized, which further raises the boiling point of the coolant. Most systems have around 14 to 15 pounds per square inch (psi), which raises the boiling point approximately 45ºF so the coolant can endure the high temperatures produced in the engine.

ENGINE COOLANT HOSES:

The radiator hoses and heater hoses are easily accessed by opening the hood, at the engine location, and inspecting. You want to be sure that the hoses show no visible signs of cracking or splitting and that there is no bulging or swelling at the ends.

If there are any signs of problems, the hose should be replaced with the correct part number for the year, make, model and engine of the vehicle.

Never use a universal hose unless it is an emergency and a proper molded hose is not available.

For either the radiator hoses or the heater hoses, make sure that you route the replacement hose in the same way that the original hose was running. Position the hose away from any obstruction that can possibly damage it and always use new hose clamps.

After the cooling system is refilled with the proper coolant mixture, a pressure test should be performed to ensure that there are no leaks.

Engine Coolant System (Continued)

BELTS:

On most older recreational vehicles, the water pump is driven by either a “V” belt or serpentine belt on the front of the engine that is also responsible for driving the alternator, power steering pump and air conditioner compressor. These types of belts are easy to inspect and replace if they are worn. Check for dry cracking on the inside surface of the belt.

On newer vehicles, the water pump is often driven by the timing belt. This belt usually has a specific life expectancy at which time it must be replaced to insure that it does not fail. Since the timing belt is inside the engine and will require partial engine disassembly to inspect, it is very important to replace the timing belt at the scheduled interval.

ITEMS OF CONCERN:

- Check antifreeze/coolant level monthly. Only use a 50/50 solution of anti-freeze/coolant and water.
- Water quality plays an important role in protecting the cooling system. A high mineral content may cause scaling or corrosion. De-ionized or distilled water should be used in 50/50 solution.
- **CAUTION:** Do not remove the radiator pressure cap when the engine is HOT.
- Inspect belts monthly. Replace belts that are worn, frayed or glazed. Adjust belts when more than 1/2 inch can be depressed between the pulleys.
- Belts with spring-loaded tensioners do not require manual adjustments.
- Replace bulging, rotten, or brittle hoses and tighten hose clamps. If a hose looks bad or feels too soft or too hard, it should be replaced.

Heating System

Diagnostics Guide

(Reference the appropriate electrical schematic first and follow "POSSIBLE CAUSES" in sequence)

PROBLEM	POSSIBLE CAUSES	REMEDY
1. Inadequate or No Heat. (Discharge air only slightly warm, or neutral).	• Engine coolant system's fluid is low.	Check engine coolant level per Chassis Manufacturer's recommendation. Add Coolant as required.
	• Excessive air leaks around the HVAC base unit connection to the fire wall or the interior blower motor assembly.	• Locate and seal leaks as required.
	• Pinched heater hose(s) or other restrictions in the engine coolant system.	• Examine heater hoses from the engine cooling system to the heater Core for pinches and kinks.
	• Engine running cold. Thermostat is stuck open.	• Check engine coolant temperature specifications according to the chassis manufacturer's recommendations.
	• Hot water valve isn't operating properly.	• Reference the **"Hot Water Valve Diagnostic Guide".**

Heating System

Hot Water Valve Diagnostic Guide

SYSTEMS CHECK:

Before attempting to troubleshoot, verify that the HVAC system (other than temperature control) is operating correctly. With the vehicle running, test-operate the system and check the following:

- Blower Motor is operating at all speeds.
- Ventilation Modes are all operating correctly.
- A/C system is operating correctly (engine-driven compressor, refrigeration system, etc.).

1. Attach refrigerant manifold gauge set to the Service Ports. Clamp the heater inlet and outlet hoses to eliminate coolant flow through the heating valve.

2. Start the vehicle, set blower speed to high, depress the AC switch, rotate the temperature dial to full cool (far left) and rotate the ventilation mode dial to Dash / Floor position.

3. Test the A/C performance according to the **"A/C Systems Operation Check"** and **"Expected A/C Performance Guidelines"** located in the **"Air Conditioning System Guidelines"** section**.**

4. If the AC System isn't operating correctly then reference the **"Diagnostic Guide"** in the **"Air Conditioning System Guidelines"** section**.**

5. If the AC System is operating correctly then remove the heater hose clamps from the coolant hoses. If a significant loss in cooling capacity in the A/C system occurs with noticeable rise in discharge air temperature, after the clamps have been removed, then turn the vehicle's ignition switch off. This confirms flow of high temperature coolant through the water valve.

6. Carefully follow the step-by-step directions listed below for troubleshooting the coolant flow control system. If a problem is found, repair and correct the fault before proceeding to the next step.

7. When troubleshooting electric and/or electronic components, care must be taken to prevent component damage while inspecting, using a test meter, light, etc. If questions or concerns arise, during the troubleshooting process, then contact Evans Tempcon for telephone assistance before proceeding any further. Refer to **"Service"** section for contact information.

Heating System

Hot Water Valve Diagnostic Guide (Continued)

COMPONENT TESTING:

1. The temperature controller is located in the center of the HVAC system control panel. Rotate the potentiometer knob to verify smooth operation. The knob should rotate freely from the cool stop (blue), to the warm stop (red). Do not force the knob to rotate past the cool or warm stops. Doing so will cause irreparable damage to the potentiometer control. If the knob can be rotated past the internal stop at the full cool and full heat positions, the potentiometer must be replaced before any further valve diagnostics are done.

Locate the electronic coolant valve assembly near the Evans' Heater-Evaporator base unit (mounted on the dash sheet/bulkhead). The electrical connector is located on the top of the actuator housing.

2. Verify that the port on the outlet side of the valve is connected to the inlet tube on the heater coil. A flow direction indicator is located on the side of the valve to help distinguish inlet and outlet ports. Also, the inlet side of the valve is always on the same side as the harness connector. New valves also have tape wrapped around the inlet port that clearly identifies the inlet port. The coolant supply hose from the engine connects to the inlet side of the valve.

NOTE:

The electronic coolant valve is a "directional" valve, and must be correctly installed, or it will not function properly. *Coolant valves installed with the coolant flow reversed will leak coolant past the valve cylinder resulting in poor A/C performance. Valves that have been installed backwards should be replaced because seal damage could have occurred if the coolant flow has been applied in the wrong direction.*

CAUTION:

Removal of the coolant valve should be performed when the engine is cold. Attempting to remove the valve when the engine is hot could result in burns and/or serious injury due to extremely hot coolant escaping under pressure. Do not start the engine while the coolant lines are disconnected as the engine will quickly pump the system dry, which could result in damage to the engine.

3. Verify that the heater supply hose (connected to the coolant valve) is actually the hose coming from the supply port on the engine. The supply port is usually on, or near the engine thermostat housing. To positively identify the supply line, remove the valve from the coolant lines and place both ends of the lines into a container to capture escaping fluid. Have an assistant "turn over" the engine while you observe the coolant lines. ***The line that discharges coolant when the engine is turned over is the supply line for the HVAC system.***

NOTE:

This procedure will not be useful for systems with a bypass or "H" fitting. Correct plumbing will have to be checked at "H" fitting in this case. Reference your chassis manual for systems with "H" bypass fittings in the coolant lines.

Heating System

Hot Water Valve Diagnostic Guide **(Continued)**

ELECTRICAL TESTING:

1. Verify positive electrical connections at the coolant valve.
2. Unplug the wire harness connector from the coolant valve connector. Check the socket terminals for damage. Inspect the pin terminals on the coolant valve connector for damage. If any pins in the valve connector are loose or broken, replace the valve. Refer to the **"Electrical Schematics"** for correct pin locations and wire colors.

TEMPERATURE CONTROL POTENTIOMETER:

1. Use a DC voltage test meter and find a good vehicle ground for the negative probe. Do not use the negative connection on the wire harness.
2. Insert the positive probe from the meter into the black wire terminal on the wire harness valve connector. The voltage value should always read 0 VDC because this is the ground connection for the hot water valve. Refer to the **"Expected Voltages – Matrix"** for correct pin locations and wire colors.

   NOTE:

   If voltage is detected on this circuit, then entire harness should be visually inspected for damage, incomplete or misaligned connections. Do not proceed with testing until this voltage bleed has been resolved.

3. Insert the positive probe from the meter into the red wire terminal of the wire harness valve connector. The voltage value should always read near the vehicle's regulated voltage. If not then you have an issue with the wire harness or fuse.

   NOTE:

   Low system voltage could be the result of numerous causes and will cause the valve to fail to operate. Do not proceed with testing until this voltage issue has been resolved.

4. Insert the positive probe, from the meter, into the yellow wire terminal of the wire harness valve connector. Rotate the temperature control knob to the far left (BLUE) position. The voltage value should always read near the vehicle's regulated voltage when the potentiometer is in the closed (BLUE) position.
5. Rotate the temperature control knob to the far right and measure the yellow wire connection. The voltage value should always read 0 VDC when the potentiometer is in the open (RED) position.
6. If the proper voltage readings are not measured at either valve position and all other electrical issues have been resolved, then replace the temperature control potentiometer or controller if needed.

Heating System

Hot Water Valve Diagnostic Guide (Continued)

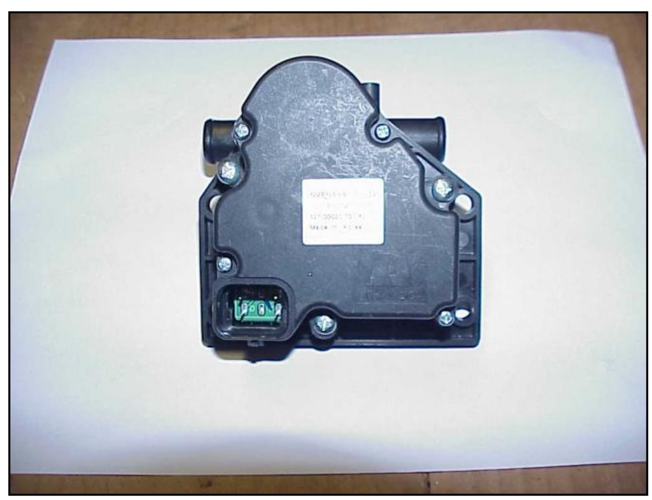
ELECTRONIC VALVE ;

1. If the voltages readings at the valve connector are normal then carefully plug the connector into the valve and then remove the HVAC control panel to access the temperature control potentiometer connector.
2. Remove the connector from the potentiometer and install a jumper wire on the connector from the red wire terminal to the yellow wire terminal. This will apply full vehicle voltage to the valve and force the valve to fully close. Look into the valve coolant inlet port to visually verify that the valve is completely closed.
3. Change the jumper from the red wire terminal to the black wire terminal so that the jumper connects the yellow wire terminal to the black wire terminal. This will ground the control wire of the actuator and the valve should be completely open. Visually verify again.

   NOTE:

   By nature of the design of the valve, when the coolant valve gate is fully open, half of the valve port opening appears to be blocked. At no time will the valve port appear to be empty.

4. If the valve does not visually open or close completely, then replace it, attach the coolant hoses and secure assembly for proper operation.
5. Proceed to **"SYSTEM VERIFICATION TEST"**, on the next page, to determine if repair is complete. Keep in mind that, if heated coolant has traveled through the heater core prior to these tests, then it will take several minutes before the core cools and proper valve operation can be verified. Operating the A/C system for a few minutes will speed up the process of cooling the heater core.



Hot Water Valve Assembly

Hot Water Valve Diagnostic Guide **(Continued)**

SYSTEM VERIFICATION TEST:

1. Attach both coolant hoses to the correct valve ports, reinstall the control panel, and secure the vehicle for operation.

2. Set the controller for high blower speed, and “Dash / Panel” ventilation mode.

3. Rotate the temperature control to full cool (BLUE - far left position).

4. Start the engine and set the engine speed to ~1500 rpm if possible. Remember to have the vehicle transmission in Park or neutral gear and the parking brake ON.

5. Measure the Fresh Air inlet temperature and the dash vent air temperature, nearest to the unit (passenger side dash louver), and record the values. Repeat these measurements at 5 minute increments until the engine has reached normal operating temperatures.

6. If the inlet and outlet air temperature difference does not vary significantly as the engine warms the coolant, then the valve can be considered completely closed. If the temperature difference increases significantly, then the valve is leaking coolant through the heater core. Replace the valve assembly.

7. Rotate the temperature control to full heat; an immediate and significant temperature change should occur between the inlet and outlet temperature readings.

8. Rotate the temperature control back to full cool and monitor the temperature differential. The change will be slower, but the outlet temperature should drop to where no significant difference is detected between inlet and outlet temperatures. If the temperature difference does not stabilize then the valve is leaking coolant through the heater core; replace the valve assembly.

9. Once the faulty component has been identified, the new replacement permanently installed, and everything is buttoned back up, then perform an actual function test for warm and cool air with the vehicle running. Test A/C performance using the **“A/C Systems Operational Check”** and **“Estimated A/C Performance Guidelines”.**

Air Conditioning System

Safety Precautions & Warnings

SERVICING REFRIGERANT SYSTEMS:

1. Always wear the proper protective eyewear and clothing before working on any refrigeration system. Remember, refrigerant in the air conditioning system can reach pressures of over 500 PSI – if one of those lines bursts while you're working on the system, it can cause serious injury. If refrigerant gets in your eye, it can freeze your eyeball, causing permanent damage or blindness.

2. Always wear work gloves whenever you're working with condensers or evaporators. The aluminum edges are sharp, and can cause serious cuts.

3. Always stay clear of the belts and fan blade, and be careful revving the engine on a vehicle with a flex fan – damaged blades have been known to come flying off without a moment's warning.

4. Always use a DOT-approved tank for storing used and recycled refrigerants. Look for the Department of Transportation stamp: DOT 4BW or DOT 4BA.

5. Always provide plenty of ventilation when using any electrical testing, recycling or recovery equipment. Avoid breathing any refrigerant vapor, lubricant vapor or mist. Exposure to these (particularly PAG oil mist) may irritate your eyes, nose and throat.

6. Always follow the instructions for your recycling equipment; failure to follow those directions could end up causing personal injury or damaging your equipment. Never perform any maintenance or service on your recycling equipment while the unit is plugged in (unless directed to do so) or without first consulting with authorized service personnel. Removing internal fittings and filters can release pressurized refrigerant. Use care and always wear appropriate safety wear.

7. Never use compressed air to leak test or pressure test an R-134a system or R-134a service equipment. Under certain conditions, pressurized mixtures of R-134a and air can be combustible. Always follow the proper procedures to prevent any safety hazards. In addition, shop air injects moisture into the system, and a pressure surge could damage the evaporator.

8. Microprocessors and computers are susceptible to damage from electrostatic discharge. Always use a static strap when working with these components, and always take the necessary precautions to prevent damage to electronic components.

Note:
To prevent cross contamination between refrigerants, verify that the A/C system has the correct label and unique service fittings designed for R134a refrigerant. If you're ever in doubt, check the system with a refrigerant identifier.

Air Conditioning System

Diagnostic Guide

(Reference the appropriate electrical schematic first and follow "POSSIBLE CAUSES" in sequence)

PROBLEM	POSSIBLE CAUSES	REMEDY
1. Inadequate Cooling (Discharge air from A/C vents is only slightly cool.	• Leaking valve (Cooling may be diminished at engine idle. Increased engine and compressor speed will improve A/C cooling).	• Refer to the **"Electronic Valve Troubleshooting guide".**
	• Condenser clogged with road debris or Condenser Fan inoperative.	• Examine fin region of the condenser for debris and bent fins. Clean and straighten as required. Repair and/or replace the condenser fan components as required.
	• Incorrect refrigerant charge in system. If charge is excessively low or high, the compressor clutch will not engage, or remain engaged.	Install a manifold gage set onto high side and low side service ports and operate A/C. Observe for low pressures. If low pressures are observed, check all A/C components for leaks as required. If excessive oil loss is suspected, check oil level in compressor, evacuate, and recharge. Refer to the **"Recommended R134a Refrigerant Charge Charts".**
	• Restriction in the TXV resulting in a starved evaporator.	• If low pressure readings are excessively low and/or the liquid line at the expansion valve is cool to the touch or showing signs of sweating or frosting, then recover the refrigerant. Evacuate and recharge the system with the proper refrigerant amount. Perform the **"TXV Function Test".** If symptoms repeat then replace the TXV following the same service procedure.

Air Conditioning System

Diagnostics Guide **(Continued)**

PROBLEM	POSSIBLE CAUSES	REMEDY
1. **Inadequate Cooling** (continued)	• Restriction in receiver/drier resulting in a starved evaporator.	• If low side readings are excessively low and/or the liquid line at the expansion valve is cool to the touch and showing signs of sweating or frosting, discharge then recover the refrigerant. Replace the receiver-drier. Add 2 ounces of recommended PAG oil, to replace oil removed from the old receiver/drier. Evacuate and recharge the system with the proper refrigerant amount.
	• Defective, worn or leaking compressor.	• Low side gauge reading too high and high side gauge reading too low. Recover refrigerant. Perform **"Compressor Function Test".** Remove and replace new or rebuilt compressor and replace receiver/drier. Add 2 ounces of oil, to replace oil removed with the old receiver/drier, evacuate and recharge. **(Check compressor for factory oil charge)**
2. **Inadequate cooling** during hot part of the day.	• Excessive moisture in system which can cause the expansion valve to frost and restrict refrigerant flow.	• Recover refrigerant. Replace receiver/drier, add 2 ounces of oil, to replace oil removed with the old receiver/drier, evacuate and recharge.
3. **Gradual loss of cooling and air flow**, over time, during A/C operation.	• Defective thermostat, causing continuous operation of the compressor and potentially freezing condensate within the evaporator core.	• Place a jumper across terminals of thermostat, if the clutch engages then replace thermostat.
4. **Compressor clutch cycles too rapidly** or discharge air temperature increases excessively during compressor clutch "OFF" cycle.	• Defective thermostat.	• Replace thermostat.

Air Conditioning System

A/C System Operation Check

The following is an A/C system **"Field Test" and Evaluation Procedure** to be used by service personnel. This procedure can be used to determine if an Evans A/C system is performing properly, and contains the correct refrigerant charge. The performance guidelines shown are approximate, and subject to many operational variables. Ambient temperature must be 50 deg F or above to accurately test for A/C performance.

1. Park the vehicle and set the engine speed at 1500 RPM.

2. Set the HVAC controls to AC on, recirculation inlet air, blower at HIGH speed, and the temperature control dial to the coldest setting.

3. Visually verify that the A/C compressor clutch is engaged, and the compressor is operating. Verify that the heater coolant valve is closed, and the heater coil tubes are neutral or cool to the touch.

4. The suction hose fitting (at the evaporator outlet) should be cold to the touch. This fitting may sweat or even frost slightly. The liquid hose fitting (at the evaporator inlet) should be warm to the touch.

5. Chilled air should be discharged from the supply louvers in the dash. After 3-5 minutes of A/C operation the system should begin to cool.

6. Air inlet / outlet temperature differentials are greatly affected by ambient temperature and relative humidity. In cool ambient conditions, differentials smaller than 30 degrees may be seen. Air can only be chilled to a certain level, and then the A/C compressor will cycle off to prevent evaporator freeze-up. High humidity may also result in smaller differentials; a large amount of cooling capacity is required to dehumidify the air, as well as cool it.

7. Measure and record the inlet air to the HVAC unit (near front passenger foot area) and vent discharge air temperature closest to the unit (usually center vent on the front passenger side) and calculate the differential of the two values. Record the humidity value for the day.

8. Measure and record the suction and discharge refrigerant pressures.

9. Refer to the **"Expected AC Performance Guidelines"**.

10. If the values fall within the guidelines then the system is functioning properly. If the values don't meet the guidelines then troubleshooting will be required.

Expected A/C Performance

The following performance guidelines are based on test conditions outlined under **"A/C System Operation Check".** Variables such as engine speed, condenser airflow, sun load, blower motor speed, and chassis voltage will all affect A/C system performance.

Air Temperature (F) Entering A/C Unit	Inlet - Outlet Air Temperature Differential**	
FRESH OR RECIRCULATED	LOW HUMIDITY	HIGH HUMIDITY
50	5-10	5-10
60	10-20	10-15
70	20-25	15-20
80	25-30	20-25
90	25-35	20-30
100	30-35	25-30
110	35-40	30-35
** The outlet louver closest to the A/C unit usually discharges the coldest air. The warmest inlet air temperature (fresh or recirculated) should also be used for the Differential calculation.		

A/C System Operating Pressures		
Ambient Air Temp (F) Entering Condenser	Suction Pressure (PSIG) @ Evaporator Outlet	Discharge Pressure (PSIG) @ Compressor Outlet
50	5-15	75-125
60	5-15	100-150
70	10-20	125-175
80	10-20	150-225
90	15-25	175-250
100	15-25	200-275
110	15-30	225-325

Air Conditioning System

Recommended R134a Refrigerant Charge Charts

1. Need to know chassis make, model, year built and engine location.
2. Need to know condenser type and location.

FRONT ENGINE CHASSIS	CHARGE
GM (Chevy) P-30, L-19, L-29, L-65	2.75 Lbs.
GM (Chevy) P-12 w/Parallel-Flow Condenser	2.00 Lbs.
Workhorse before '05 model except W-24	2.75 Lbs. **(1)**
Workhorse - all models with black Behr condenser and two fans	2.00 Lbs.
Workhorse W22/W24 w/Multi-flow Condenser and no fans	1.50 Lbs.
Ford E-33 w/Serpentine Condenser	2.25 Lbs.
Ford F-53 w/Black Fin & Tube Condenser	2.75 Lbs.
Ford F-53 w/Silver Multi-flow Condenser(starting with MY2012)	2.13 Lbs
Ford F-53 w/Silver Multi-flow Condenser(starting with MY2016)	2.75 Lbs
Ford V-10 Super Duty w/6mm Condenser	2.75 Lbs.
FTL Front Engine Diesel w/Parallel-Flow Condenser	1.5 Lbs.
FTL Front Engine Diesel w/remote mounted condenser and fan	2.25 Lbs.

(1) For W22 without an auxiliary condenser, charge would be 1.75 lbs and performance would be reduced.

DIESEL ENGINE CHASSIS BUILT PRIOR TO 2015	CHARGE
Front-mounted Step well Parallel-Flow Condenser	2.00 Lbs.
Spartan (Fleetwood Heritage only)	5.25 Lbs.
Spartan Rear-Side Mounted Condenser (>500 HP)	4.50 Lbs.
Spartan Rear-Side Mounted Condenser (<500HP)	3.00 Lbs.
Spartan Rear-Side Mounted Condenser (Full cover -2011 or later)	5.50 Lbs
Spartan Rear Std Center Mounted Condenser	3.00 Lbs.
Spartan Front Mounted Evans Fin & Tube Condenser	3.50 Lbs.
Spartan Mid-Engine Chassis	2.50 Lbs.
Spartan Front Mounted Parallel Flow Condenser	2.50 Lbs.
FTL Rear Mounted Evans Fin & Tube Condenser	4.50 Lbs.
FTL Remote Mounted Parallel Flow Condenser w/12" Elec. Fan	2.75 Lbs.
FTL Rear Mtd Large Parallel Flow Cond. w/Side Radiator w/No Elec. Fan	4.00 Lbs.
FTL Front Mounted Evans Fin & Tube Condenser	3.50 Lbs.
Workhorse Pusher Front Mounted Fin & Tube Condenser	3.00 Lbs.
Road Master (Monaco/Holiday Rambler) Rear Condenser	4.00 Lbs

DIESEL ENGINE CHASSIS BUILT IN 2015, 2016 & 2017	CHARGE
FTL Remote Mounted Parallel Flow Condenser w/ 12" Electric Fan, <=450 Hp	2.25 Lbs.
FTL Rear Mounted Serpentine Condenser Below Side Radiator w/ No Elect. Fan, >=450 Hp	7 Lbs.
Spartan Rear Mounted Fin & Tube Condenser, Side Radiator w/ No Elect. Fan, 450 Hp, 40' Long Chassis	7 Lbs
Spartan Rear Mounted Fin & Tube Condenser, Side Radiator w/ No Elect. Fan, >=450 Hp, 43' or Longer Chassis	8 Lbs.
Spartan Rear Mounted Multi-flow, Side Radiator w/ No Elect. Fan, 600 Hp	4.5 Lbs

Air Conditioning System

Compressor Function Test

A/C COMPRESSOR OPERATION:

The A/C compressor is the heart of the system since it produces the refrigerant flow. Check to see if the compressor's clutch is engaged or rotating and the compressor is operating by producing low and high side pressure ratios listed in the **"Estimated A/C Performance Chart".** Compressor and engine fan belts should be in good condition and tightened to the correct tension. Check the belts when the engine is off and the belt is still warm. Do not replace the compressor unless its function has been properly tested.

These are general guidelines to check the compressor function as part of the AC system, consult the chassis manufacturer or the compressor supplier before any repair or replacements to the compressor. Evans does not supply the compressor for RV A/C systems.

A/C COMPRESSOR FUNCTION TEST:

1) Restrict inlet air flow to the condenser with a piece of cardboard to increase the high side refrigerant pressure.

2) Monitor high side pressure gauge to see if the pressure rises to ~ 300-350 Psig. If the pressure does rise to this level then remove the cardboard.

3) This is a quick and simple test to see if the compressor has the capacity to build pressure and pump refrigerant. If it does not achieve that high pressure range then check the items below:

   1) Low refrigerant charge.
   2) High side refrigerant blockage.
   3) Ambient temperature is below 50°F.
   4) Clutch slippage or low voltage.
   5) Inspect compressor front seal and pressure relief valve for leaks.
   6) Clutch voltage should be ±11.5 Vdc. Clutch coil resistance between 2.2 and 4.4 ohms.
   7) Check compressor rotation for smoothness.

Air Conditioning System

Thermostatic Expansion Valve (TXV) Function Test

TXV OPERATION:

The Thermostatic Expansion Valve or TXV is an interactive device that senses pressure and temperature then adjusts refrigerant flow to maintain a given superheat. Do not replace this device unless its function has been properly tested.

Perform the **"A/C System Operation Check"** first to ensure that there aren't any other possible restrictions to refrigerant flow. Look for frost, potentially caused by a restriction, on components such as the Evaporator, Receiver/Drier, Condenser and adjoining refrigerant hoses.

TXV FUNCTION TEST:

1) A/C system is fully charged.
2) Blower motor set for high speed.
3) Engage compressor and allow A/C system to stabilize.
4) After 5- 10 minutes observe low side refrigerant operating pressures and record.
5) Change the blower motor speed to low and continue to watch the low side pressure. The pressure should drop ~3 – 4 Psig depending on the heat load in ~1 – 2 minutes.
6) Repeat this procedure 2 – 3 more times.
7) If the low side pressure can be influenced by changing the blower motor fan speed then the TXV is responding in the changing of the evaporator's heat load as designed.

Air Conditioning System

Refrigerant Charge Information – R134a

A correct refrigerant charge is necessary to achieve optimum performance from an air conditioning system. This is very important with the vehicle A/C systems designed for R-134a refrigerant. When servicing the refrigerant system, ***the only way to be certain of an exact charge is to fill an empty system with the specified amount of R-134a.*** If the A/C system is operating and the amount (charge) of refrigerant within the system is not known, some simple checks can be performed to determine if the operating charge is adequate:

1. Compressor clutch engaged, and compressor operating.

2. Suction hose fitting (at evaporator outlet) cold to the touch. This fitting may sweat or even frost lightly.

3. Chilled discharge air at the dash louvers, when the temperature control is set at the coolest setting (water valve completely closed).

4. **CAUTION!!** Some systems may have a sight glass on the receiver drier. The sight glass is only useful when considered along with steps 1 thru 3 above. ***R-134a compressor oil circulating in the system can make a sight glass appear foamy even with a proper system charge!*** Disregard a milky or foamy sight glass if the A/C system passes steps 1 thru 3 above. If a clear sight glass can be seen, this simply confirms an adequate operating charge.

5. See **Recommended R134a Refrigerant Charge Charts** for recommended refrigerant charges and **Expected A/C Performance Guidelines** for acceptable ranges of performance.

Air Conditioning System

Service Tips

1. **USE ONLY VIRGIN OR NEW R134A REFRIGERANT.**

2. RECLAIMING REFRIGERANT, EVACUATING THE A/C SYSTEM AND CHARGING WITH PROPER AMOUNT OF REFRIGERANT RESOLVES MANY A/C COMPLAINTS.

3. SOME REFRIGERANT LOSS WILL OCCUR IN ONE YEAR'S TIME AND THIS IS RECOGNIZED AS NORMAL. VIBRATION, HOSE POROSITY AND GENERAL CONSTRUCTION OF THE SYSTEM MAKE A LEAK PROOF SYSTEM NEARLY IMPOSSIBLE.

4. **EVANS DOES NOT RECOMMEND OR ENDORSE THE USE OF "STOP LEAK" OR "LEAK SEALING" PRODUCTS**.

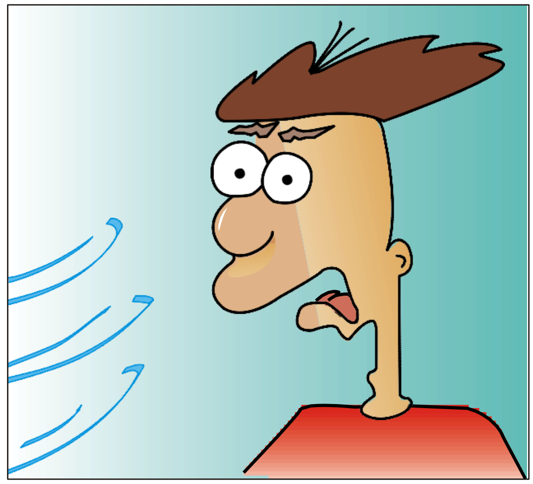
Air Conditioning Theory

The Four Major Functions Of An A/C system

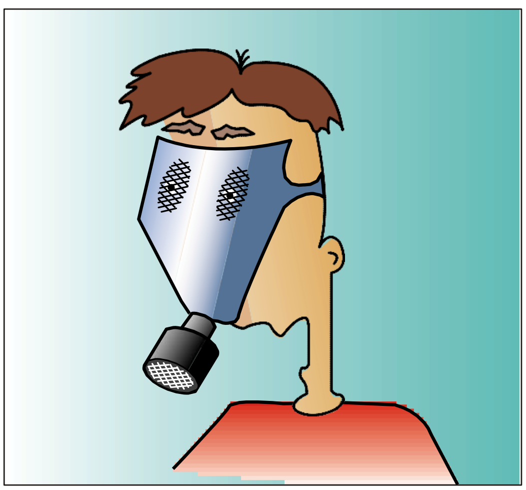
To be effective, the dash air conditioner must control four (4) conditions within the vehicle interior:

It must cool the air

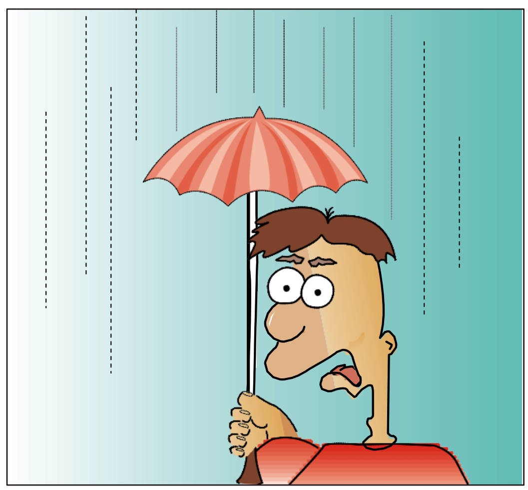
It must circulate the air



It must purify the air



It must dehumidify the air



These functions are essential if passenger comfort is to be maintained when the ambient temperature and humidity are high.

By performing these functions, the air conditioner maintains the body comfort of the driver and front passenger.

ASHRAE has developed a comfort range that is the standard in HVAC commercial, residential and automotive industries. In the summer, the comfort range is between 73ºF (22.5ºC) dry bulb (db) temperature and 79.5% relative humidity (rh) up to 81ºF (27ºC) db and 19.8% rh. In winter, it is between 67.1ºF (19.5ºC) db and 86.5% rh to 76ºF (24.5ºC) db and 23% rh.

Air Conditioning Theory

A/C System Basic Operation

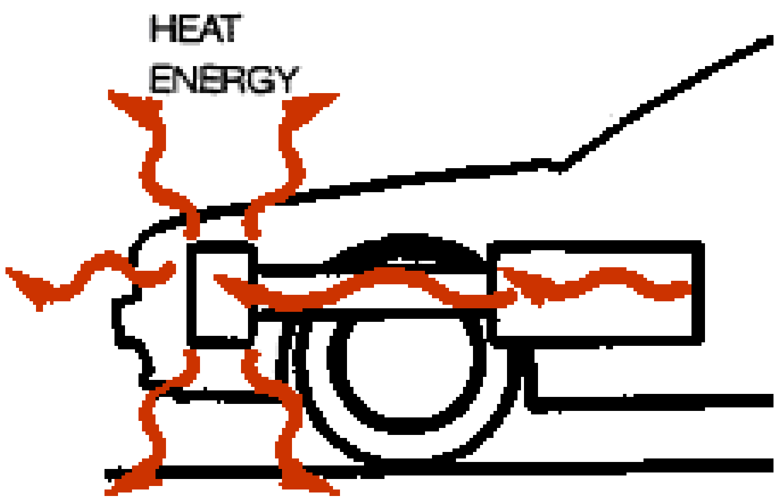
Air from either the interior of the vehicle (Recirculation Air Inlet Mode) or from the exterior of the vehicle (Fresh Air Inlet Mode) is sucked into the HVAC unit by an air flow moving device called a blower assembly.

The air flow passes through a heat absorbing coil called an evaporator located within the HVAC unit.

The evaporator then transfers the heat from the air to a cool fluid medium called R134a refrigerant which is encapsulated within a plumbing network.

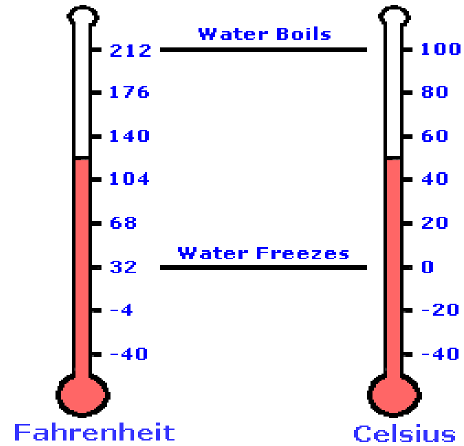
The heated refrigerant is transferred by a pump or compressor into the engine compartment where it then rejects this heat to exterior air flow traveling through a heat rejection coil called a condenser.

This is a continuous process that occurs whenever the compressor is operating.



Air Conditioning Theory

Heat Measurement



First we need to understand the fundamentals of Heat.

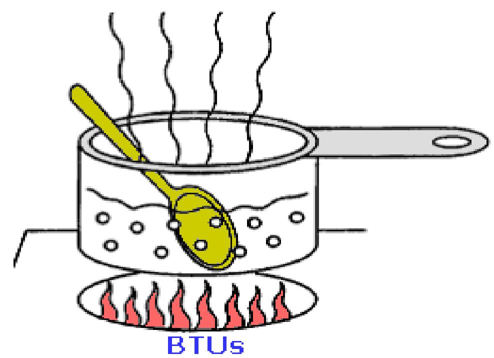
The amount of heat energy present in the air and refrigerant is measured as the temperature.

There are two different temperature scales most commonly used, Fahrenheit and Celsius.

Heat is measured in British Thermal Units (BTU's) and Calories.

BTU – amount of heat energy required to raise one pound of water one degree Fahrenheit.

Calorie – amount of heat energy required to raise one gram of water one degree Celsius.



Three Types Of Heat

Sensible Heat: When the heat that is applied to a substance merely raises its temperature, but does not change its physical state. It is the heat which, added to or subtracted from a substance, produces the **changes in temperature** indicated on a thermometer. (i.e. It is the heat that you feel or sense)

Latent Heat: The heat released or absorbed by a substance when it changes its physical state to another with **no change in temperature**. (i.e. ice to liquid and liquid to vapor)

There are two forms of latent heat:

latent heat of fusion in the conversion of a liquid to a solid, or vice versa (i.e. The Freezing Point – For water it is 32°F or 0°C).

latent heat of vaporization in the conversion of a liquid to a vapor, or vice versa. (i.e. The Boiling Point – For water it is 212°F or 100°C).

*The latent heat of vaporization phenomenon is the founding principle in refrigeration and air conditioning. It is known as **THE COOLING EFFECT**!*

Air Conditioning Theory

Understanding Heat Transfer

How does heat get inside a vehicle?

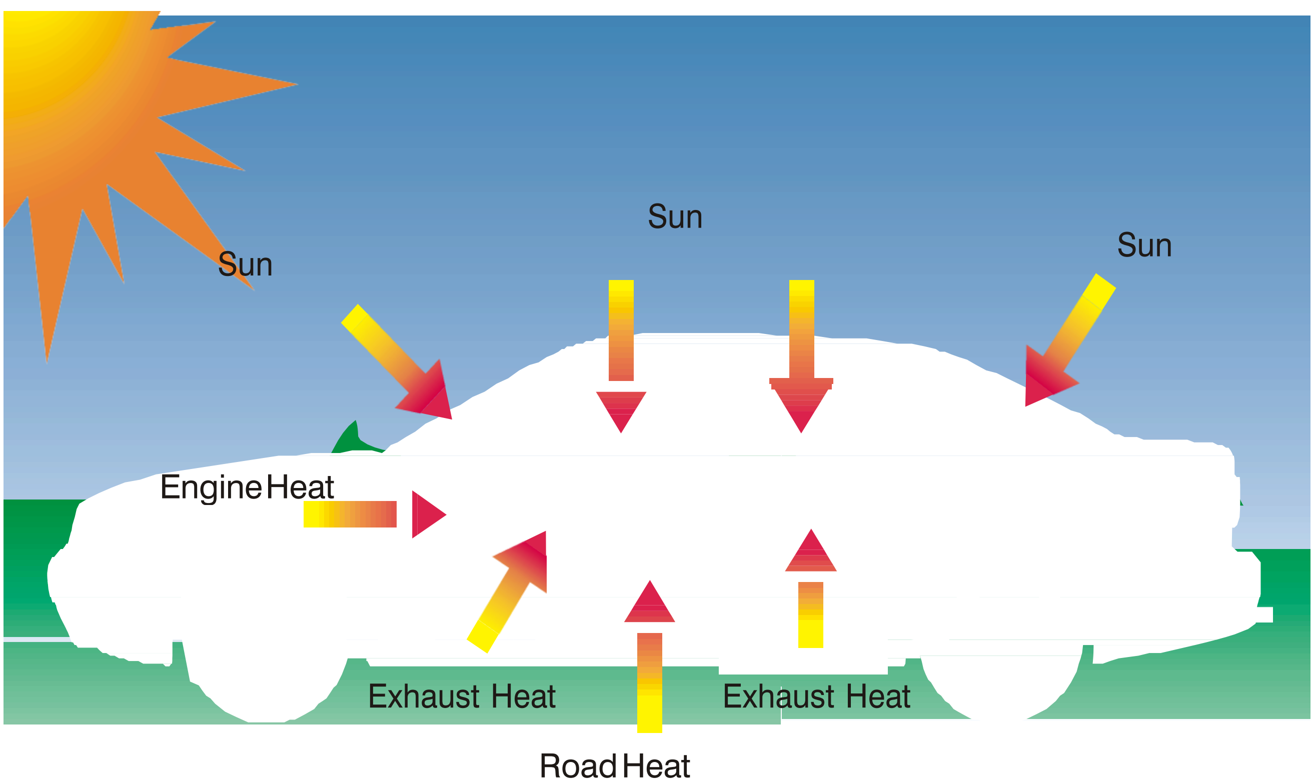
When a car is driven or parked in the sun, heat enters the vehicle from many sources.

These sources include:

- Ambient air
- Sunlight
- Engine heat
- Road heat
- Transmission
- Exhaust heat

All of these and other miscellaneous heat sources, increase the air temperature within the vehicle.

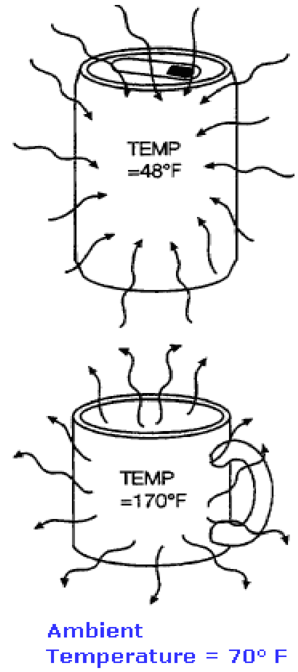
In a high ambient temperature situation, (e.g. on a 99 ºF or 37ºC day), the interior of a vehicle left standing in the sun with windows closed could reach 150 - 158 ºF or 65-70ºC!



Air Conditioning Theory

Understanding Heat Transfer (Continued)

How does heat transfer work in an A/C system?



Three processes of heat transfer:

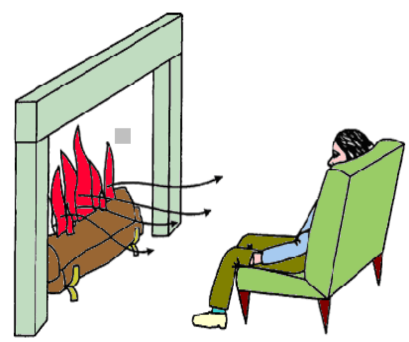
An air conditioning system's efficiency is based on how it moves heat.

Heat Transfer is the method by which heat flows.

Heat always travels from warm material to cold. The reverse is never true.

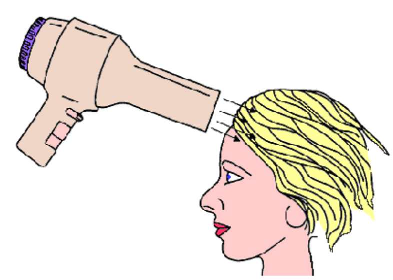
For example, if a hot cup of coffee is left standing. it will cool off, while a cold soda will get warm.

The heat from the warm coffee moves to the cooler surrounding air (i.e. condenser's heat rejection). The heat from the surrounding air moves to the cooler soda, until a balance is reached (i.e. evaporator's heat absorption).



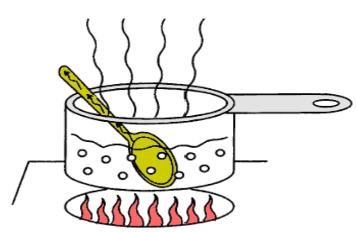
1. ***Radiation**:* Heat moves from a heat source to an object by means of heat rays.

   For example, you feel heat from a fireplace, even though air is traveling past you and going up the chimney. You are warmed by radiated heat. (i.e. Engine compartment heat, body of the vehicle exposed to the sun, etc.)



2. **Convection**: Heat flows in a stream of air or liquid that is hotter than what it flows over, around, or through.

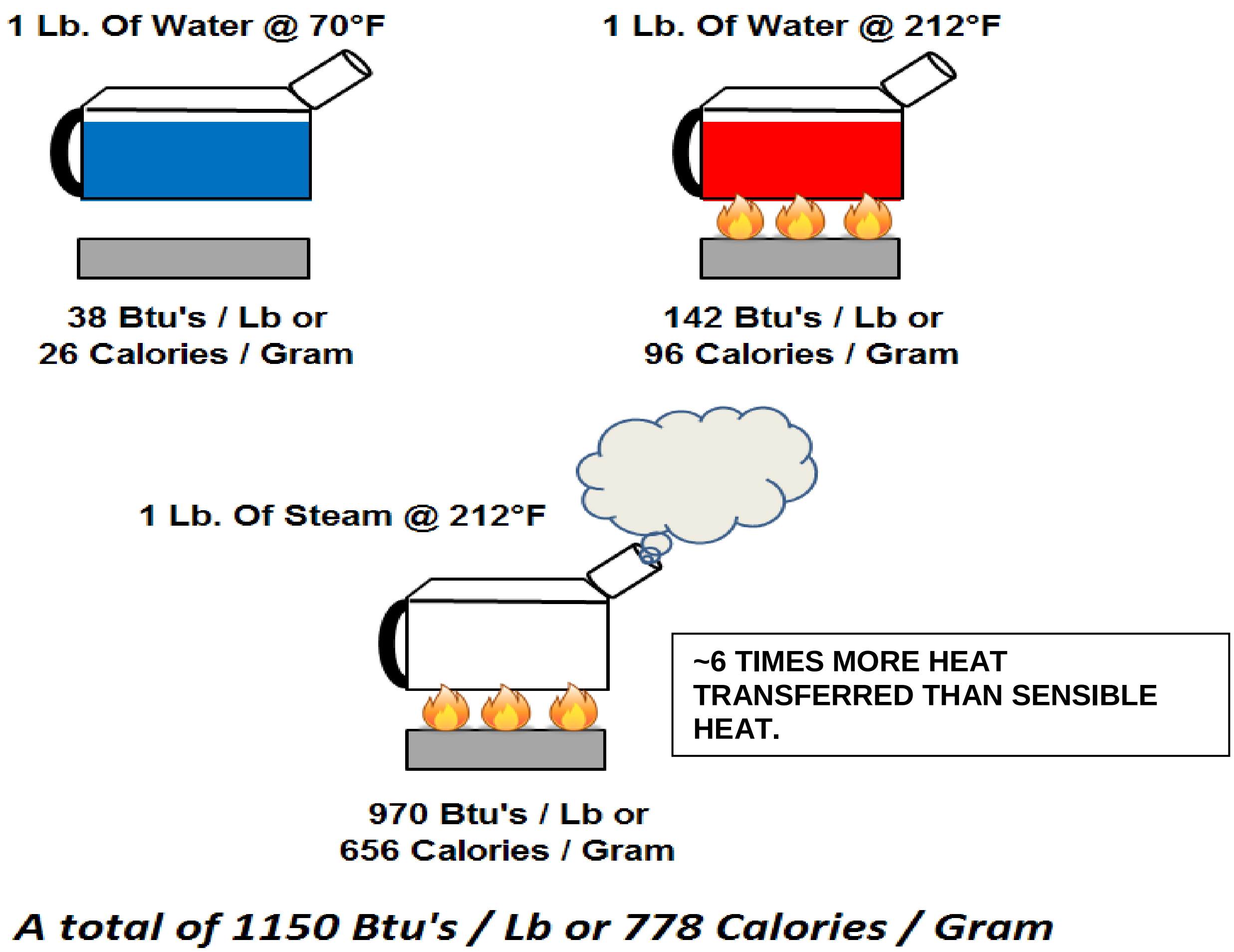
   For example, a blow dryer generates a stream of heated air to dry hair. The hair is heated by convection. (i.e. The inlet air of the HVAC unit scrubbing the aluminum fins of the evaporator or vice versa with the condenser)



3. **Conduction**: Heat travels along a material.
   For example, if a spoon is left in a pot of boiling water, the spoon handle will get hot, even though the handle is outside the pot. Heat is conducted along the spoon handle. (i.e. The heat in the coil's fins passing to the refrigerant passages & into the refrigerant)

Air Conditioning Theory

The Added Value Of Latent Heat Transfer



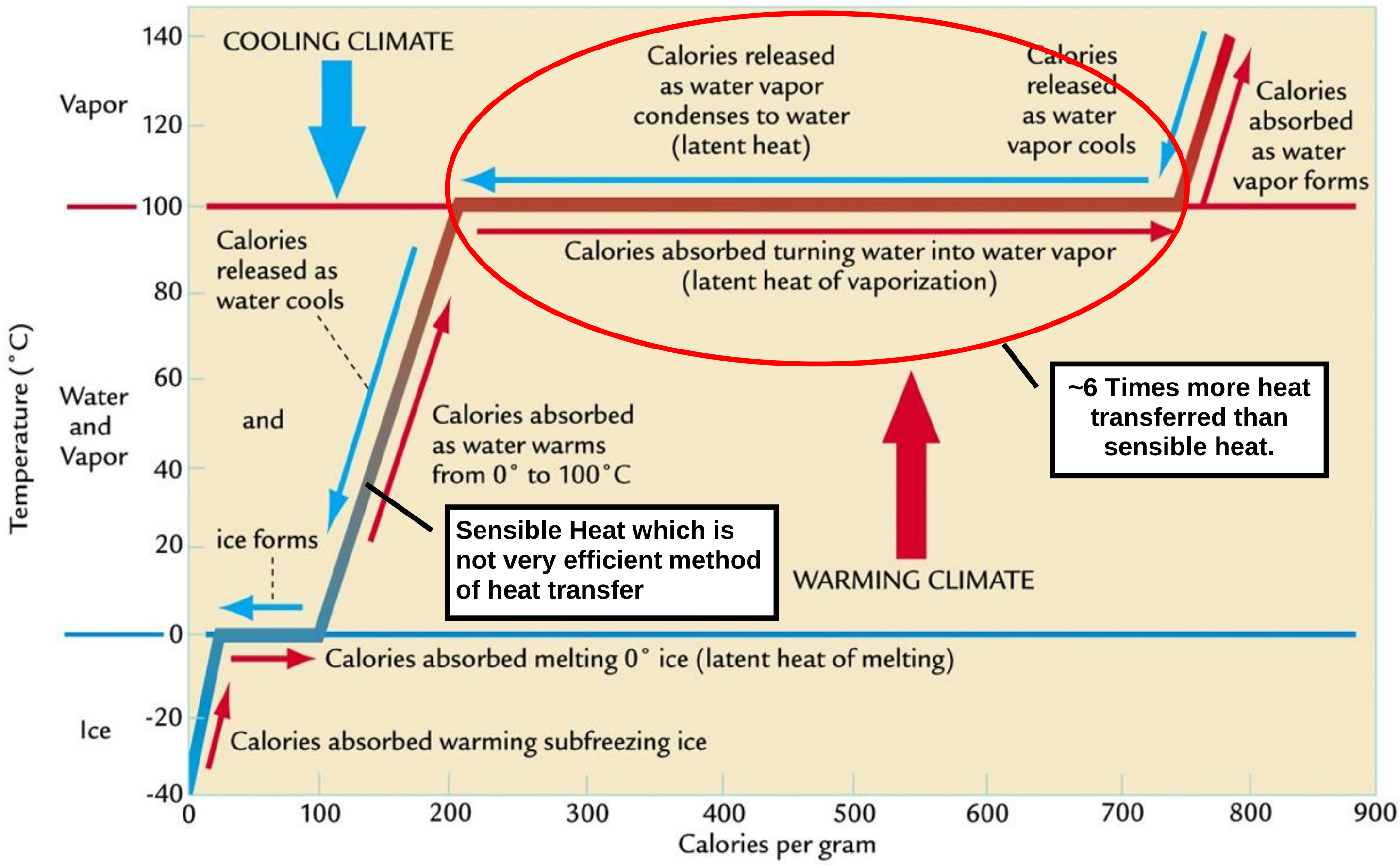
R134a refrigerant is about one tenth less in latent heat value but is used instead of water because it boils at temperatures below the freezing point of water and at a higher pressure than atmospheric pressure.

It has the needed characteristics to boil at a low temperature and is able to change its state readily from liquid to vapor, and vice versa.

The A/C system creates the situation were the refrigerant is either evaporating or condensing to provide the most efficient means of heat transfer.

Air Conditioning Theory

Heat Transfer Diagram

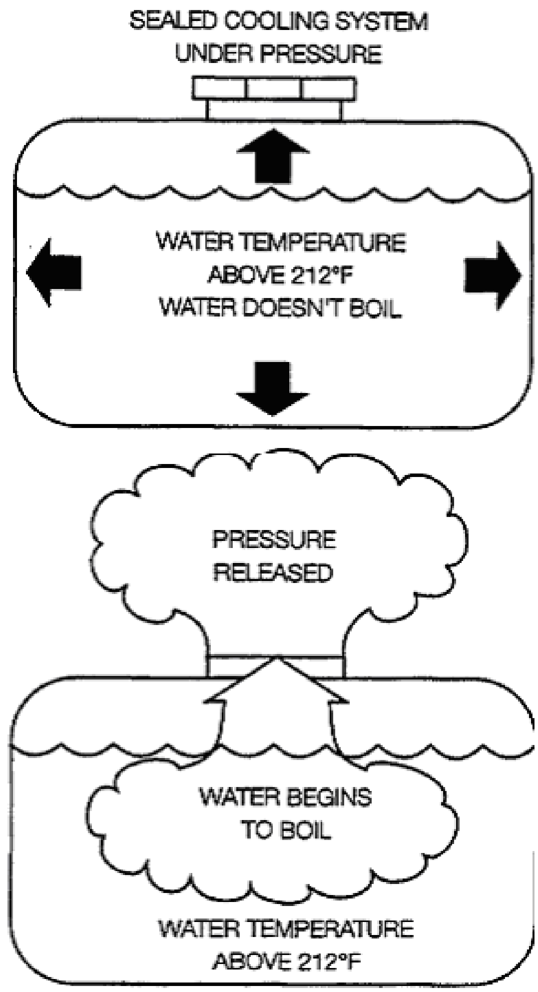


Air Conditioning Theory

Temperature/Pressure Relationship

How does the AC system create this phenomenon?

Pressure / temperature relationship: As the pressure on a liquid is increased, the boiling point rises. As the pressure on a liquid is decreased, the boiling point drops.



In an air conditioning system, the refrigerant is contained in a closed loop plumbing system that can be pressurized.

The pressure in the evaporator is low, so that all the refrigerant vaporizes. The pressure in the condenser is high, so the refrigerant readily changes state to a liquid.

In an air conditioning system, a compressor is used to increase the pressure of the refrigerant; this raises its temperature. The refrigerant vapor entering the condenser is hot.

In this air conditioning system, an expansion valve is used to lower the pressure of the refrigerant; the refrigerant in the evaporator is cold.

Automotive A/C Systems are designed to operate at pressures that keep the refrigerant at the optimum temperature for taking heat out of the passenger compartment.

Air Conditioning Theory

Typical A/C Operating Conditions

A/C system typically operates in a 50°F to 110°F environmental range.

In those given conditions the A/C operating pressures range from 5 to 30 psig on the evaporator side and 75 to 325 psig on the condenser side.

This correlates in refrigerant temperature to -2°F to 35°F on the evaporator side and 73°F to 166°F on the condenser side.

In 110°F environment, the air flowing through the evaporator is ~75°F hotter than the refrigerant and it boils and becomes a vapor.

In 110°F environment, the air flowing through the condenser is ~56°F cooler than the refrigerant and it condenses and becomes a liquid.

ESTIMATED A/C PERFORMANCE GUIDELINES

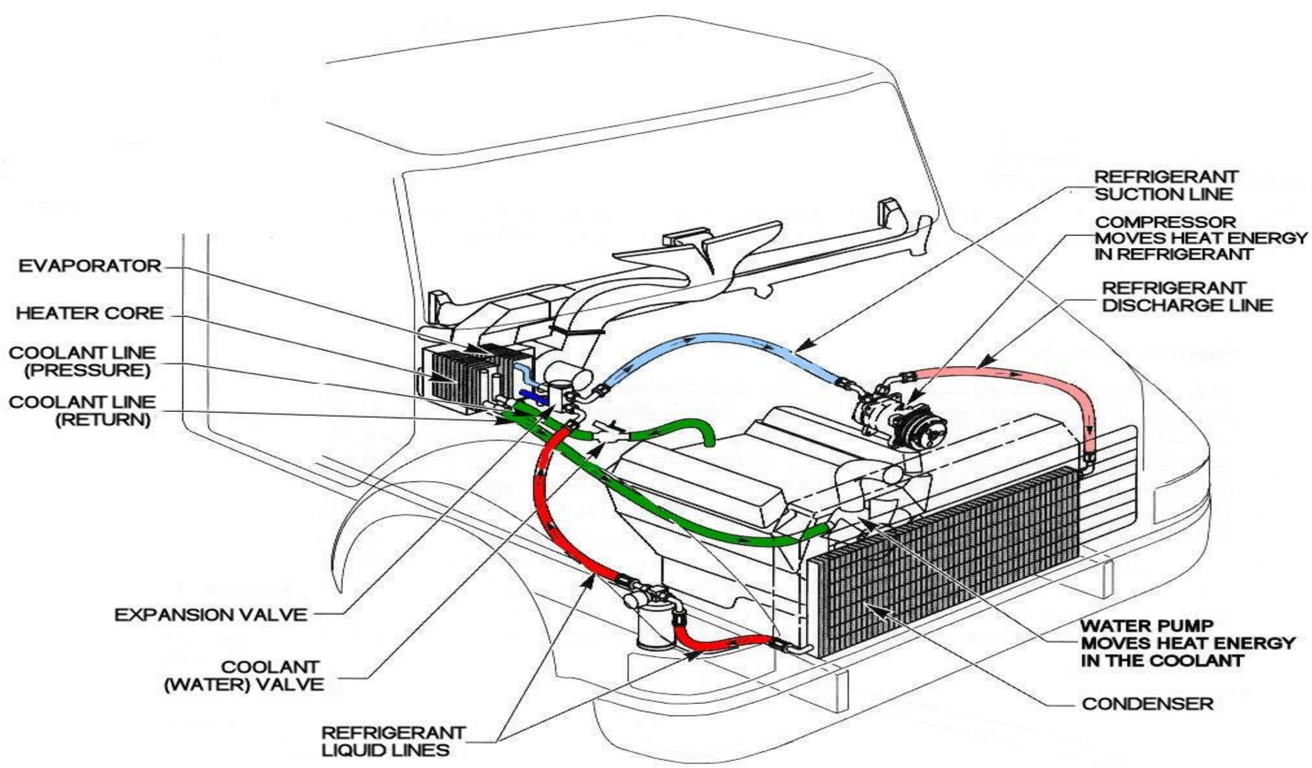
The following performance guidelines are based on test conditions outlined under A/C System Operational Check. Variables such as engine speed, condenser airflow, sun load, blower motor speed, and chassis voltage will all affect A/C system performance.

AIR TEMPERATURE (F) ENTERING A/C UNIT	INLET-OUTLET AIR TEMPERATURE DIFFERENTIAL**	
FRESH OR RECIRCULATED	LOW HUMIDITY	HIGH HUMIDITY
50	5 – 10	5 – 10
60	10 – 20	10 – 15
70	20 – 25	15 – 20
80	25 – 30	20 – 25
90	25 – 35	20 – 30
100	30 – 35	25 – 30
110	35 – 40	30 – 35

**The outlet louver closest to the A/C unit usually discharges the coldest air. The warmest inlet air temperature (fresh or recirculated) should also be used for the Differential calculation.

A/C SYSTEM OPERATING PRESSURES

AMBIENT AIR TEMPERATURE (F) ENTERING CONDENSER	SUCTION PRESSURE (PSIG @ EVAPORATOR OUTLET	DISCHARGE PRESSURE (PSIG) @ COMPRESSOR OUTLET
50	5 – 15	75 – 125
60	5 – 15	100 – 150
70	10 – 20	125 – 175
80	10 – 20	150 – 225
90	15 – 25	175 – 250
100	15 – 25	200 – 275
110	15 – 30	225 – 325



This picture shows the direction of refrigerant and engine coolant flow in the system. The air conditioner evaporator coil and condenser, and the heater core, are the main points of heat transfer.

Air Conditioning Theory

Air Conditioning System

1. The compressor sucks in & compresses the cool R134a refrigerant gas, causing it to become hot, high pressure gas.

2. This hot gas runs through the condenser & dissipates its heat into its cooling air flow and condenses into a liquid.

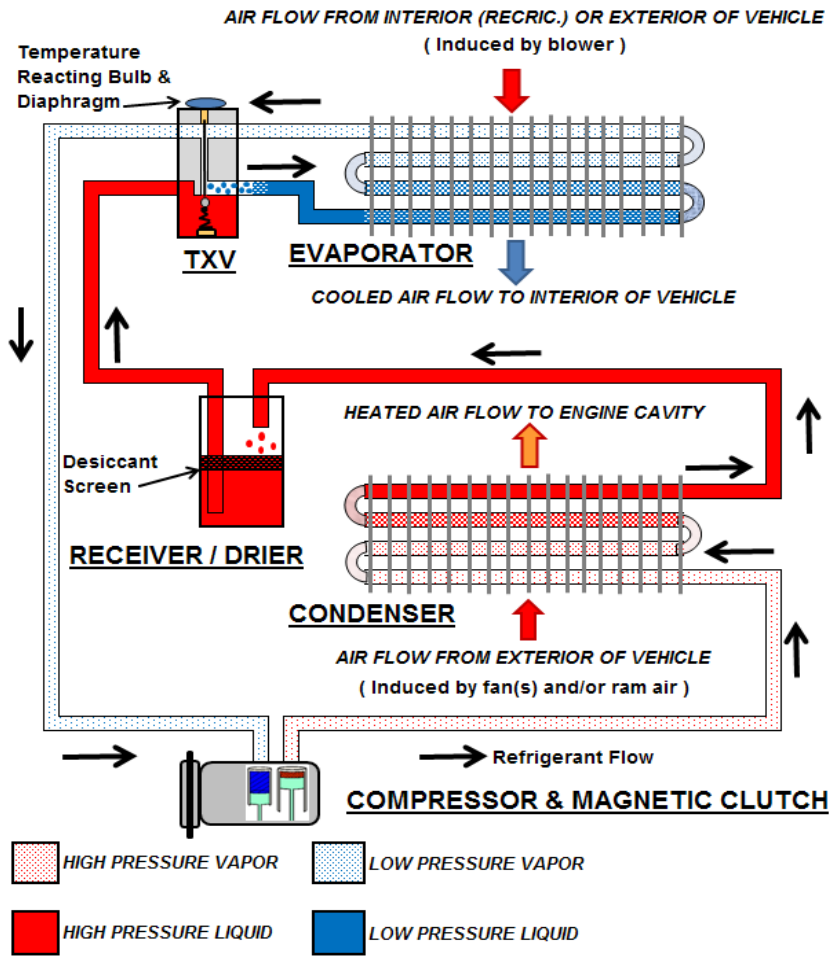
3. The high pressure liquid enters the receiver/drier for storage and moisture removal.

4. The liquid is drawn off the bottom of the receiver/drier and runs through a pressure dividing, fixed size orifice hole in the thermostatic expansion valve.

5. A bulb containing R134a liquid refrigerant controls the flow of refrigerant by using a diaphragm to push down or retract a pin. The pin pushes downward onto small, metal ball plugging the orifice allowing liquid refrigerant to enter the evaporator. The ball is cradled by an upward spring force to counter the pin's downward force. Together, these forces will modulate the refrigerant flow through the TXV.

6. The low pressure liquid refrigerant travels through the coil and evaporates thus becoming cold, low pressure gas which absorbs heat from the hot air flowing through the coil.

7. A small amount of lightweight oil is mixed in with the refrigerant to lubricate the compressor.



Super Heat

At a certain point in the evaporator the R134a refrigerant is completely vaporized, after that point any additional heat absorbed by the R134a vapor is described as SUPER HEAT.

The value of this SUPER HEAT is the temperature difference above the point at which R134a liquid changes to a vapor. A proper Super Heat value is the insurance that vaporized refrigerant will enter the vapor compressor instead of liquid (i.e. Slugging).

The thermal expansion valve (TXV) super heat setting is established at the factory for particular applications. Ensure when a valve is replaced that it is of the type suited to the R134a A/C system.

Saturation temperature = The temperature at which refrigerant in liquid form changes to a vapor at a given pressure. Saturation temperatures values can be derived from a R134a Temperature/Pressure Chart.

Actual temperature = The temperature of refrigerant at the evaporator outlet.

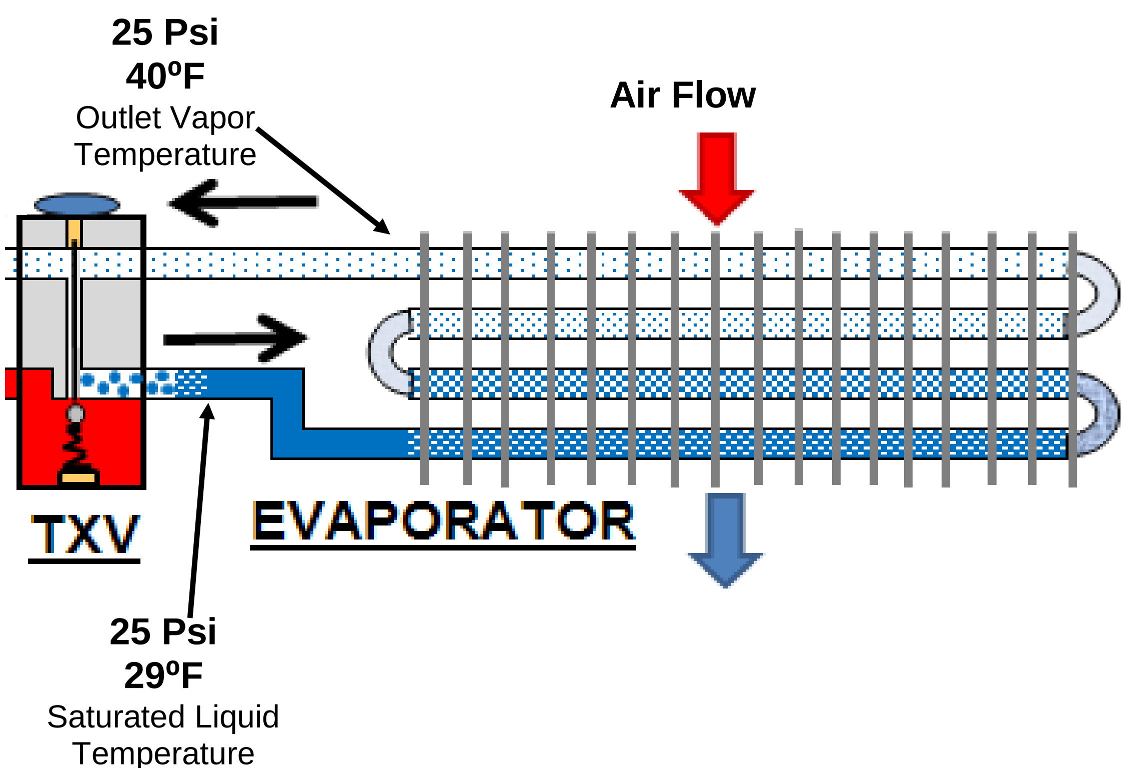
Example - Calculation for Super Heat

Actual Refrigerant Temperature = 40ºF

minus

Saturated Refrigerant Temperature = 29ºF

Super Heat = 11ºF



Air Conditioning Theory

R134a Temperature / Pressure Chart

Pressure	Temp	Pressure	Temp	Pressure	Temp	Pressure	Temp	Pressure	Temp	Pressure	Temp
psig/Hg"	Deg F	psig	Deg F	psig	Deg F	psig	Deg F	psig	Deg F	psig	Deg F
22	-62.38	13	11.77	37	42	61	62.75	145	109.4	265	150.6
20	-55.02	14	13.38	38	43	62	63.5	150	111.5	270	152
18	-48.85	15	14.94	39	43.98	63	64.24	155	113.6	275	153.4
16	-43.5	16	16.46	40	44.95	64	64.98	160	115.6	280	154.7
14	-38.76	17	17.95	41	45.91	65	65.71	165	117.6	285	156.1
12	-34.49	18	19.4	42	46.85	66	66.43	170	119.6	290	157.4
10	-30.6	19	20.81	43	47.78	67	67.14	175	121.5	295	158.7
8	-27.02	20	22.19	44	48.7	68	67.85	180	123.3	300	160
6	-23.7	21	23.55	45	49.61	69	68.55	185	125.2	305	161.3
4	-20.59	22	24.87	46	50.51	70	69.24	190	126.9	310	162.5
2	-17.67	23	26.16	47	51.39	75	72.62	195	128.7	315	163.8
0	-14.92	24	27.43	48	52.26	80	75.86	200	130.4	320	165
1	-12.31	25	28.68	49	53.13	85	78.98	205	132.1	325	166.2
2	-9.84	26	29.9	50	53.98	90	81.97	210	133.8	330	167.4
3	-7.47	27	31.1	51	54.82	95	84.87	215	135.5	335	168.6
4	-5.21	28	32.27	52	55.65	100	86.66	220	137.1	340	169.8
5	-3.04	29	33.43	53	56.48	105	90.37	225	138.7	345	171
6	-0.95	30	34.56	54	57.29	110	92.99	230	140.2	350	172.1
7	1.05	31	35.68	55	58.1	115	95.53	235	141.8	355	173.3
8	2.99	32	36.77	56	58.89	120	98	240	143.3	360	174.4
9	4.86	33	37.85	57	59.68	125	100.4	245	144.8	365	175.4
10	6.67	34	38.91	58	60.46	130	102.7	250	146.3	370	176.3
11	8.42	35	39.96	59	61.23	135	105	255	147.7	375	177.3
12	10.12	36	40.99	60	62	140	107.2	260	149.2	380	178.2

The numbers above represent the boiling points for R134a

Sub Cooling

At a certain point in the condenser the R134a refrigerant is completely condensed, after that point any additional heat released by the R134a liquid is described as SUB COOLING.

The value of this SUB COOLING is the temperature difference below the point at which R134a vapor changes to a liquid. A proper Sub Cooling value is the insurance that liquid refrigerant will enter the thermostatic expansion valve instead of vapor.

Saturation temperature = The temperature at which refrigerant in vapor form changes to a liquid at a given pressure. Saturation temperatures values can be derived from a R134a Temperature/Pressure Chart.

Actual temperature = The temperature of refrigerant at the condenser outlet.

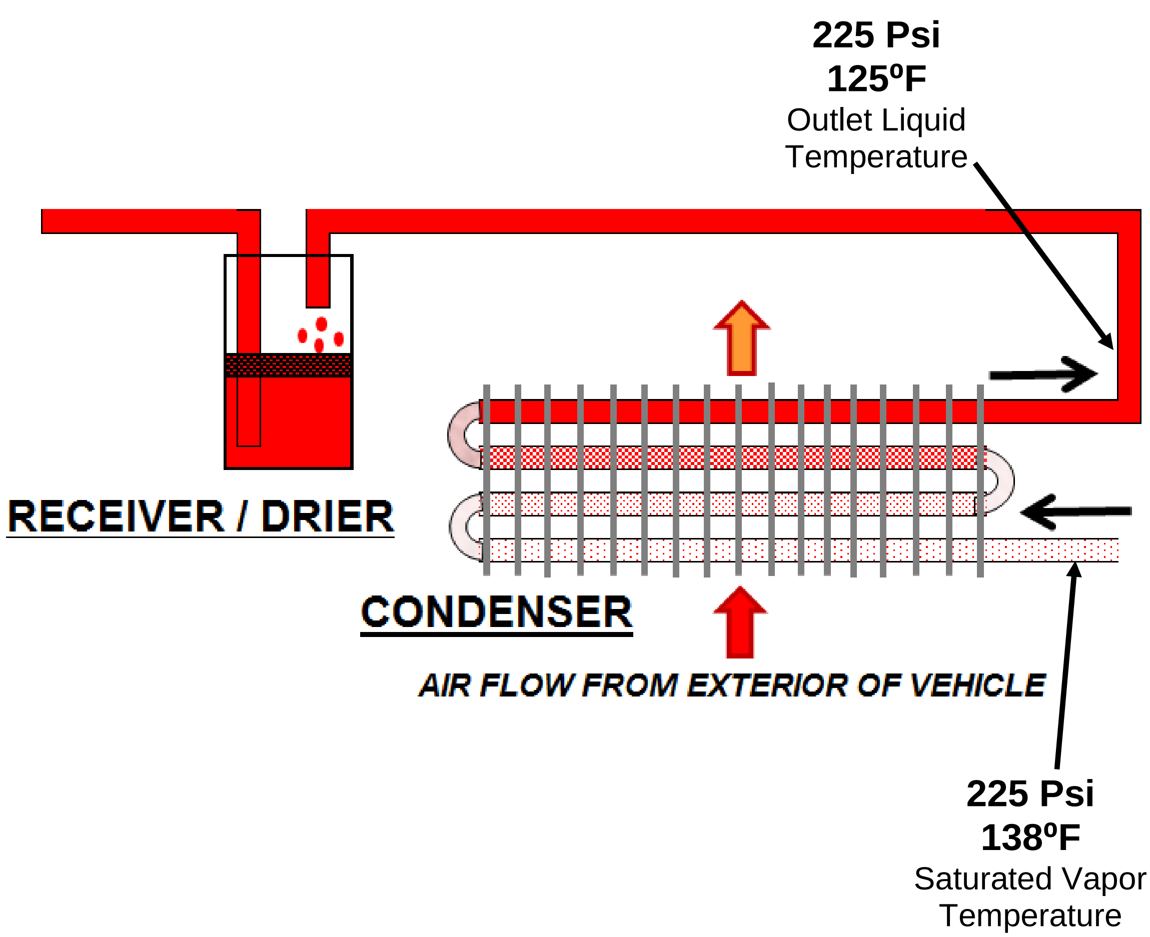
Example - Calculation for Sub Cooling

Saturated Refrigerant Temperature = 138°F

minus

Outlet Refrigerant Temperature = 125°F

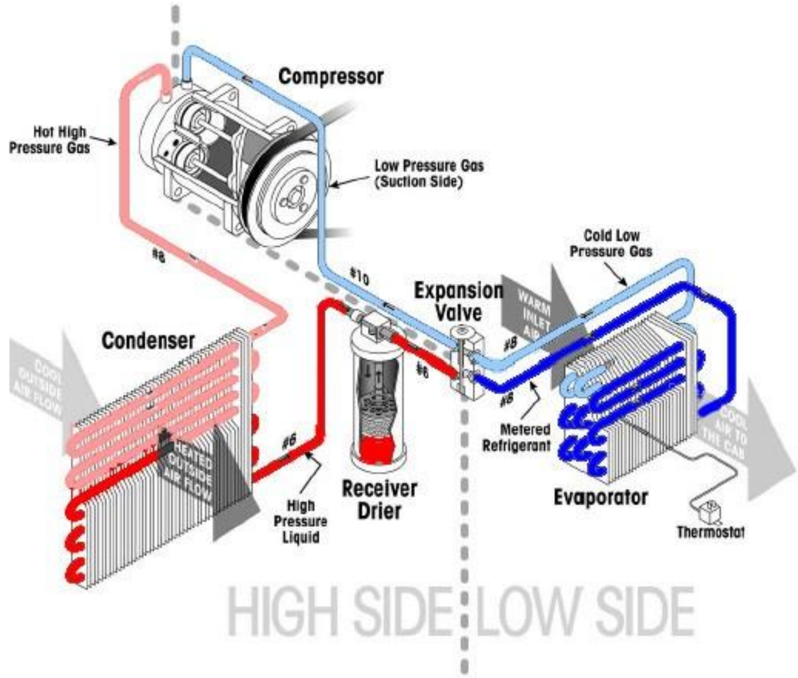
Sub Cooling = 13°F



Air Conditioning System Components

Refrigerant System Scheme

The system's refrigerant is divided into a high pressure side and a low pressure side – the dividing points are the compressor and the expansion valve.



In the expansion valve system, the high side begins at the compressor, continues through the condenser, on through the receiver/drier and ends at the expansion valve. The low side begins where the high side left off at the expansion valve. From there it continues through the evaporator and ends at the compressor.

.

Let's take a look at how each part in the system affects the refrigerant, to allow it to remove heat from the passenger compartment.

Compressor starts refrigerant flow

The compressor is nothing more than a pump (a gas pump, not a liquid pump); its job is to move the refrigerant and oil through the system. When restricted, that flow creates the pressure and temperature differential in the system. The compressor's mounted on the engine, and a drive belt from the engine turns the compressor driveshaft, working the compressor pistons back and forth. The back-and-forth movement of the pistons is what draws the refrigerant in on the low side and pumps it out on the high side.

The compressor pumps the refrigerant through the system to provide flow.

When the compressor runs, it pushes all of the refrigerant, in the system, toward the high side of the expansion valve. At the same time, it pulls all of the refrigerant it can from the evaporator side of the expansion valve.

Air Conditioning System Components

Compressors and Mount & Drive

Mount & Drive

Consists of a bracket,to mount the compressor to the engine, a belt idler pulley, compressor drive belt and possibly an extra drive pulley for the crankshaft.

Compressor Mount

Manufactured of either plate, cast iron, steel or aluminum, this bracket should exhibit excellent noise absorption qualities especially if using a piston type compressor.

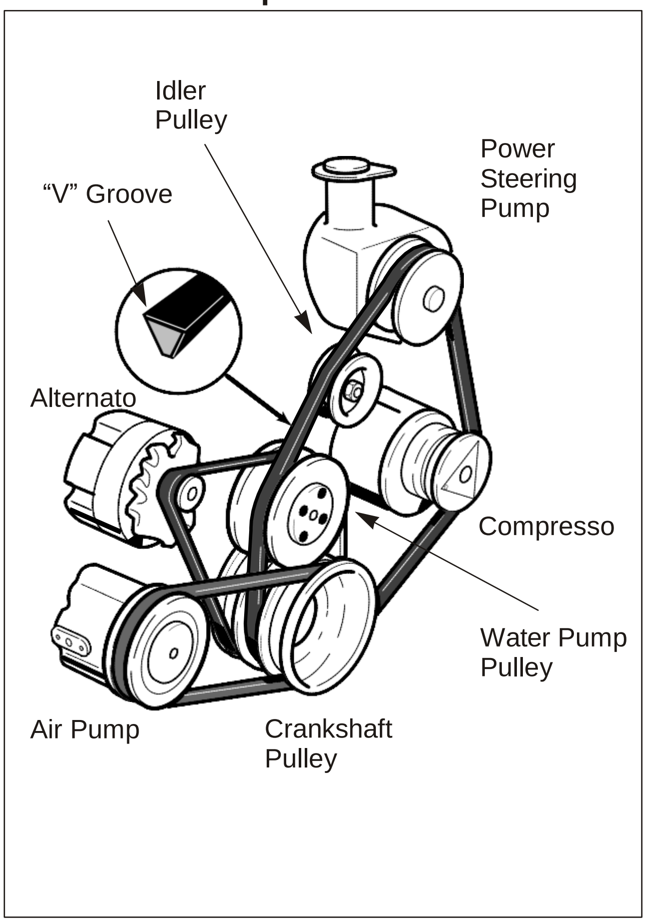
Idler Pulley

A small pulley normally used in conjunction with a belt adjusting mechanism, also used when a belt has a long distance between pulleys to absorb belt vibrations.

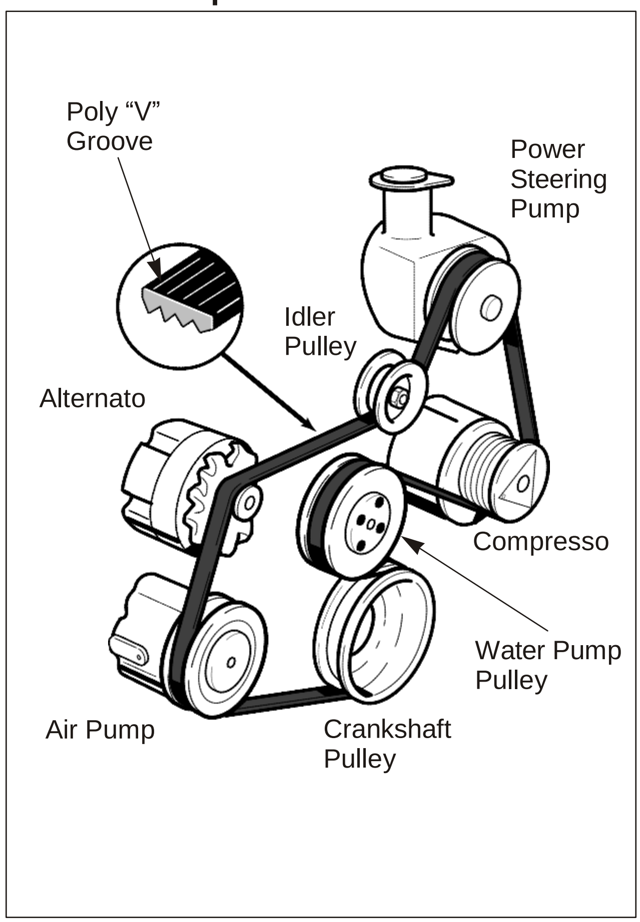
Drive Pulley

Some vehicles do not have an extra pulley to accommodate an A/C drive belt, in these cases an extra pulley is bolted onto the existing crankshaft pulley.

Multiple Belt Drive



Serpentine Belt Drive



Air Conditioning System Components

Compressor Clutches

The clutch is designed to connect the rotor pulley to the compressor input shaft when the field coil is energized. The clutch is used to transmit the power from the engine crankshaft to the compressor by means of a drive belt.

When the clutch is not engaged the compressor shaft does not rotate and refrigerant does not circulate the rotor pulley free wheels. The field coil is actually an electromagnet, once energized it draws the pressure plate towards it, locking the rotor pulley and the pressure plate together causing the compressor internals to turn, creating pressure and circulating refrigerant.

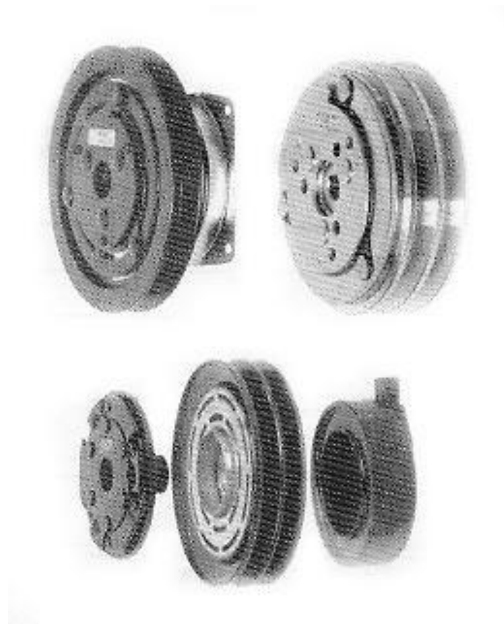
Basic Clutch Information

To assure you get the right part the first time, it is important to identify the compressor the clutch is to be used on, and the characteristics or specifications of the clutch. If possible, check for label or stamped numbers on the clutch body or the coil assembly to identify the clutch.

These are general guidelines to check and identify the compressor clutch as part of the AC system, consult the chassis manufacturer or the compressor clutch supplier before any repair or replacements to the compressor clutch. Evans does not supply the compressor and clutch for RV A/C systems.

Air Conditioning System Components

Compressor Clutches (Continued)



If the clutch marking or label is illegible, the following information will be needed:

1. Compressor Make and Model
2. Voltage – 12 or 24 Volt
3. Diameter of Clutch Pulley
4. Number of Grooves; Width of Drive Belt
5. A-B Distance or Gauge Line

A "How to Measure" guide is shown in each clutch section to help in identification.

IF PART NUMBER ON CLUTCH BEING REPLACED CANNOT BE READ, USE THE FOLLOWING PROCEDURE(S) TO DETERMINE REQUIRED CLUTCH.

HOW TO MEASURE:

1. DETERMINE IF 12 OR 24 VOLT (BLACK WIRE = 12V, GREEN WIRE = 24V)
2. DETERMINE IF CLUTCH IS SINGLE, DOUBLE OR POLY GROOVE
3. MEASURE OUTSIDE DIAMETER OF PULLEY
4. MEASURE WIDTH OF PULLEY GROOVE
    a. Single and Double Groove = measure the width of pulley groove
    b. Poly Groove = count the number of grooves
5. MEASURE ACCURATELY THE A-B DISTANCE
    a. Single and Double Groove = measure the distance from the compressor mounting hold on the side of the compressor to the middle of the first belt groove on the pulley
    b. Poly Groove = measure the distance from the compressor mounting hole on the side of the compressor to the middle of the first groove on the pulley
6. DETERMINE THE NUMBER OF WIRES

Air Conditioning System Components

Compressor Lubrication

R134a is part of the air conditioners lubrication system. ***Never*** operate an A/C system without refrigerant as there will be no lubrication for the compressor and internal damage will occur.

Refrigerant oil is circulated around the A/C system saturated in the refrigerant.

All Evans R-134a Air Conditioning systems currently supplied to the vehicle industry use PAG oil as the system lubricant. This oil is completely different than the mineral oil used in R-12 systems.

PAG oil must ***never*** be used in an R-12 system, and mineral oil must ***never*** be used in an R-134a system. Use of an incorrect oil can cause serious A/C system damage, and will void warranty coverage.

When an air conditioning system is serviced, it is important to maintain the original quantity and type of oil within the A/C system. Oil type and total system quantity will be listed on the compressor data label attached to the compressor body.

If additional oil is determined to be necessary, only use the exact oil type and viscosity shown on the compressor label. ***Do not mix oil brands or types.*** Ford, Spartan Freightliner, Workhorse , and other OEM's supply and warrant their own vehicle A/C compressors. They also supply their own specified compressor oil, which is available through the standard dealer network.

There are only three situations that justify adding oil to an A/C system:

1. Replacing oil that was removed in the refrigerant recovery process. Measure the oil quantity that settled in the oil-catch bottle of the recovery machine. Add an equal quantity of new oil back into the A/C system.

2. Replacing oil that was removed with a defective system component. Add an equal quantity of new oil back into the A/C system.

3. Replacing oil lost due to system damage or severe leakage. This lost oil will be visible on or around a damaged or leaking component. Only add new oil if more than 1-2 ounces is believed to have been lost.

Air Conditioning System Components

Compressor Lubrication **(Continued)**

The quantity of oil typically removed with a replaced component is shown below:

1. Compressor: Drain and measure oil from old compressor. Typically 2-4 ounces will be found. Drain and refill new compressor with new oil, using the same quantity found in the old compressor. Use a minimum of 2 ounces in the new compressor. Never add more than 8 ounces to a new compressor, to avoid compressor start-up damage.

2. Condenser: 2 ounces.

3. Receiver-Drier: 1 ounce.

4. Evaporator: 1 ounce.

5. System Hoses*: Typically none -- drain and measure.

*Systems with hoses 15 feet or longer, contact Evans for assistance.

Precautions when using PAG oil:

- Do not allow PAG oil to contact bare skin or vehicle paintwork.
- Flush skin immediately when using PAG oil.
- Avoid breathing PAG oil/R134a mixture.
- PAG oil is highly hygroscopic. Open containers only when ready to use. Cap container immediately after use.

Air Conditioning System Components

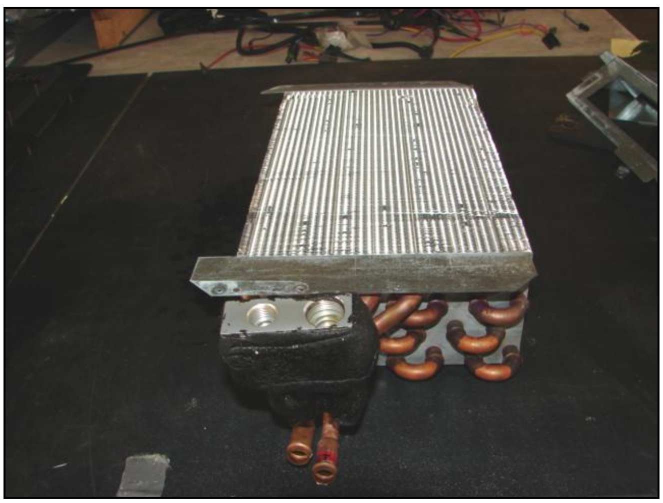
Evaporators

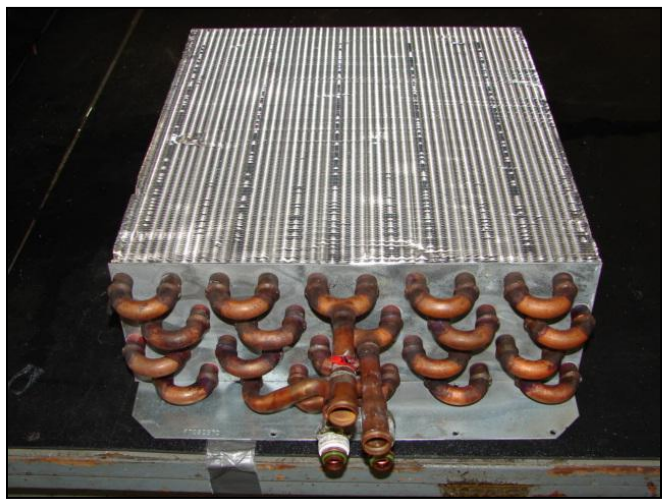
R134a enters the evaporator coil as a cold low-pressure liquid. As this liquid passes through the evaporator coil, heat moves from the warm air blowing across the evaporator fins into cooler refrigerant. This air that has now been cooled is then ducted into the cabin via the blower motor.

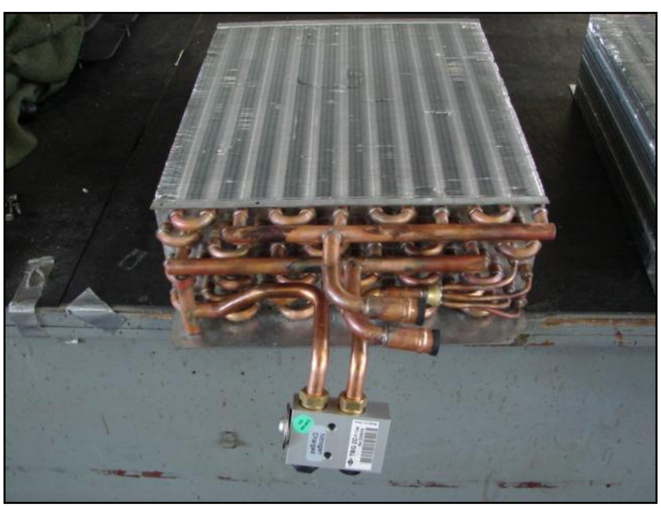
When there is enough heat to cause a change of state, a large amount of the heat moves from the air to the refrigerant. This causes the refrigerant to change from a low-pressure cold liquid into a cold vapor. **(Latent heat of vaporization).**

As the warmer air blows across the evaporator fins, moisture contained in that air (humidity) will condense on the cooler evaporator fins. Condensed moisture then runs off through the drain tubes located at the underside of the evaporator case.

Evans uses 4 different versions of combination heater core and evaporator, tube and fin heat exchangers in the RV industry:







Block Type Thermostatic Expansion Valve (TXV)

The **Thermostatic Expansion Valve** (also referred to as TXV) is located at the evaporator inlet; controlling the flow of refrigerant entering the evaporator, thus the cooling load or the evaporators temperature.

Sensing temperature changes via the diaphragm (11), the metering valve constantly opens or closes as it precisely meters the amount of refrigerant needed. The pathway internally, is smaller than the refrigerant line, causing the pressure to drop, changing it from a high pressure liquid to a low pressure liquid mist. The expansion valve, along with the compressor, are the dividing lines between the high and low pressure sections of the system.

As the refrigerant from the outlet side of the evaporator passes over the sensing element (12), expansion or contraction of the refrigerant takes place causing the activating pin (8) to move the ball valve (6) away or closer to the metering orifice. This allows more or less refrigerant to enter the evaporator coil inlet.

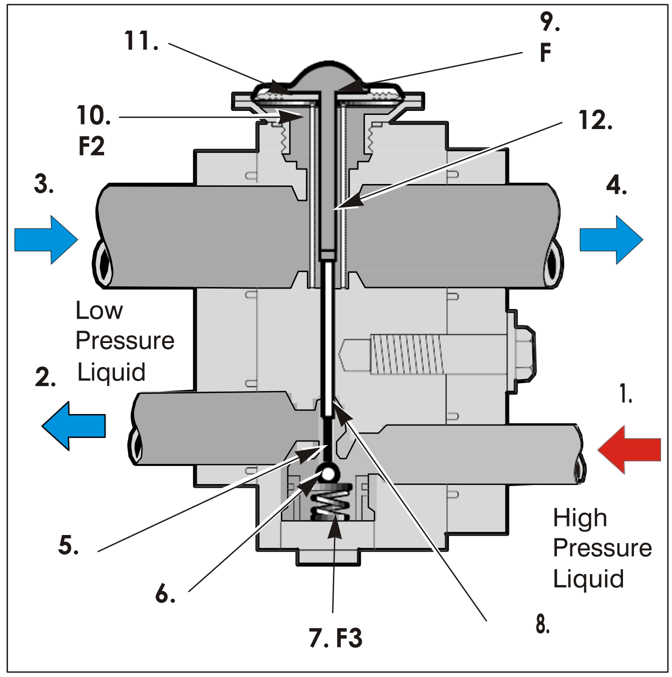
Pressures in control
As shown in the illustration, the block valve controls refrigerant flow by using a system of opposing pressures which we will call:

F1 - Temperature sensing
This is a sealed diaphragm and sensor containing refrigerant. As refrigerant leaving the evaporator coil outlet passes over sensing element (12) the refrigerant (9) above the diaphragm (11) expands moving pin (8) downwards pushing ball valve (6) away from the metering orifice (5).

F2 - Pressure compensation
This is a passage (10) in the block valve outlet side where refrigerant can build up under the diaphragm (11) to act as an opposing pressure to help regulate the amount of refrigerant into the evaporator coil inlet side.

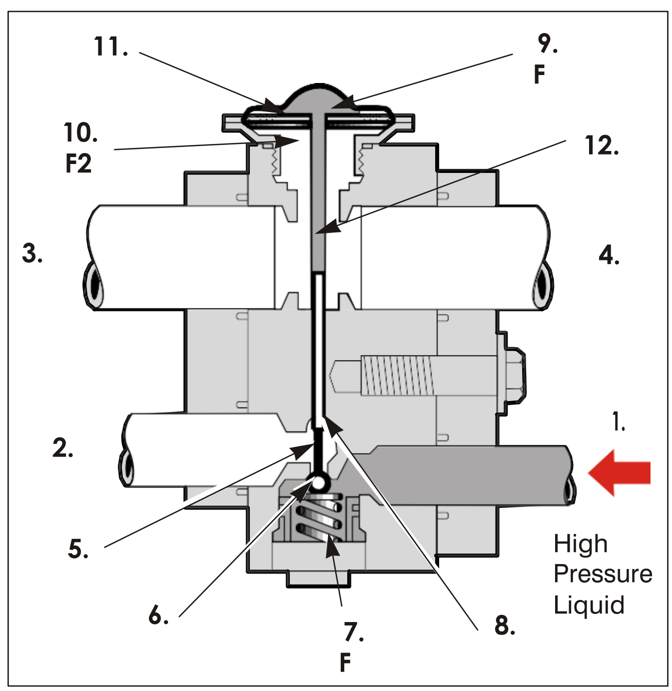
F3 - Pressure spring
This spring (7) is located under the ball valve (6) and acts as an opposing force trying to move the ball valve towards the metering orifice (12) and to reduce refrigerant flow to the evaporator coil inlet.

TXV - Open



1. **From Filter Drier**
2. **To Evaporator Inlet**
3. **From Evaporator**
4. **To Compressor**
5. **Metering Orifice**
6. **Ball**
7. **Spring**
8. **Activating Pin**
9. **Refrigerant**
10. **Pressure Compensation under Diaphragm**
11. **Metallic Diaphragm**
12. **Sensing Element**

TXV - Closed



Air Conditioning System Components

Thermostatic Switch

An evaporator normally removes the moisture or dehumidifies the air entering the HVAC unit and condensate develops on the surfaces of the cooling coil. This condensate runs down that surface to a collector pan, and is drained away.

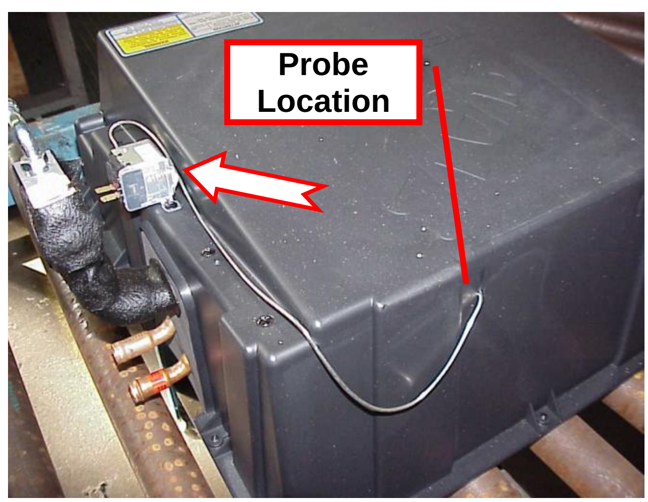
In some cases due to low ambient temperature, high humidity air entering the HVAC unit, low refrigerant charge or no air flow, the condensate can begin to freeze on the evaporator.

An air conditioning system will not operate properly and will lose cooling capacity if the evaporator coil becomes blocked with frost or ice. The cool air flowing out of the system will be reduced as the ice area continues to grow.

When liquid refrigerant enters the evaporator coil, temperatures may be as low as 10 ºF *at that point* - that is at the point of refrigerant entry to the evaporator. In normal operation of a refrigeration system, air movement across the evaporator coil provides enough warmth that frost or ice doesn't form on the coil.

The evaporator thermostat's function is too sense the coil's surface temperature and disengage the compressor's clutch should the temperature fall below the freezing point of moisture or 32ºF/0ºC.

Evaporator Thermostat



HVAC Base Unit Location

NOTES:

1. TEMPERATURE CALIBRATIONS °F °C (REF.)

		°F	°C (REF.)
SET ▲	CUT-OUT	31° ± 1.5°	-0.6° ± 0.8°
	CUT-IN	39.5° ± 1.5°	4.2° ± 0.8°

GAS FILL: R134, 1.3 DIAPHRAGM, .032 x .187 GROUND TERM.

Air Conditioning System Components

Condensers

The Condenser function is to act as a heat exchanger and allow heat to flow from the hot refrigerant to the cooler outside air.

R134a entering the condenser will be a high-pressure high temperature vapor. As the R134a vapor travels through the tubes of the condenser heat is given off to the cooler ambient air; the refrigerant vapor condenses and changes to a liquid state.

At this point a large amount of heat is given off by the R134a. The refrigerant will now be a hot, high pressure liquid.

Design types

Serpentine

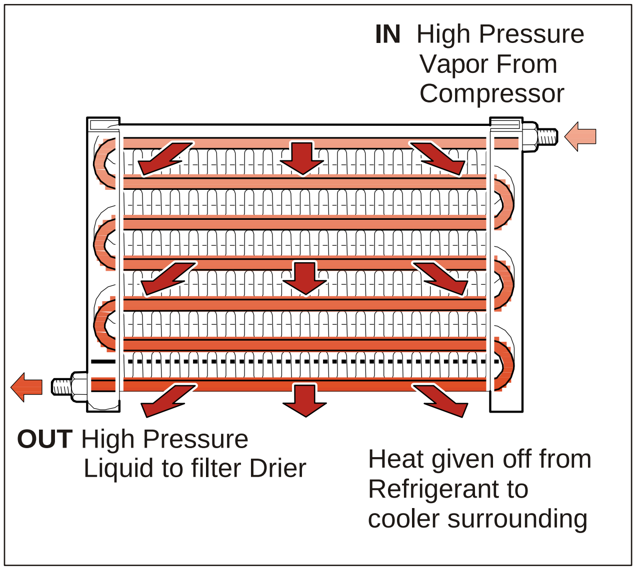
This type of condenser consists of one long tube which is coiled over and back on itself with cooling fins in between the tubes.

Parallel flow design

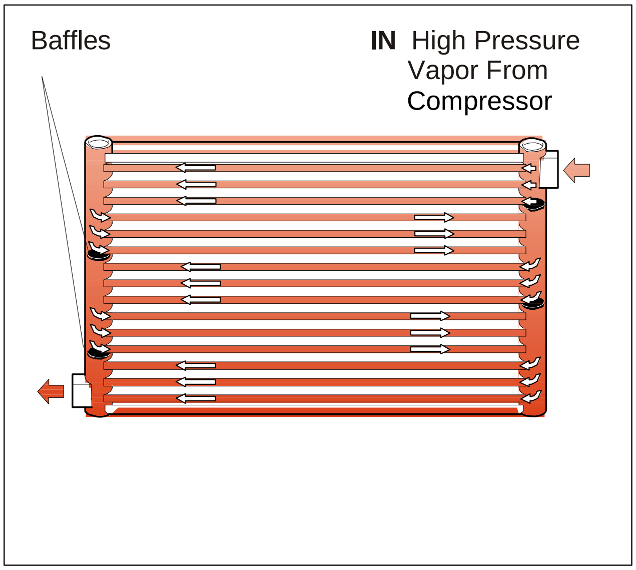
(Recommended for R134a)

This design is very similar to a cross flow radiator. Instead of refrigerant travelling through one passage (like serpentine type), it can now travel across numerous passages. This will give larger surface area for the cooler ambient air to contact.

Serpetintine Flow



Parallel Flow



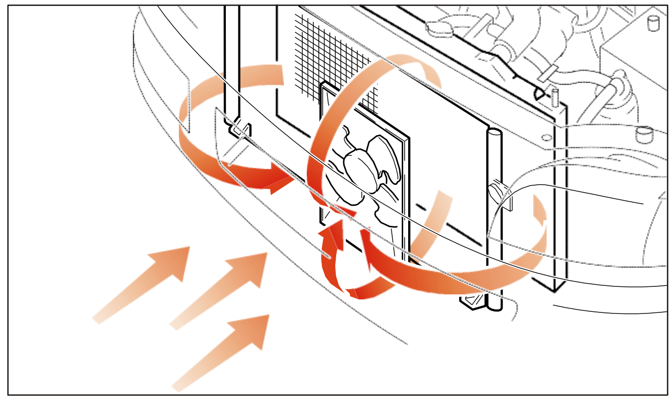
Air Conditioning System Components

Foam Seals

These seals are fitted in between the condenser and radiator to prevent the heated ambient air exiting above, below or to the sides of the space in between (normally 25mm) the radiator and condenser.

As ambient air is drawn through condenser by the condenser or radiator fan, its temperature increases. If gaps are present between the condenser and radiator this heated air can be circulated back through the condenser. This results in the increased condenser temperature and causes reduction in the performances of the A/C system.

Without Foam Seals



Condenser electric fan

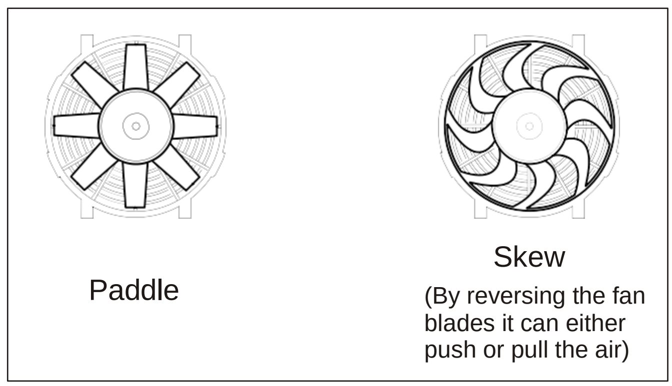
Most vehicles with air conditioning require an electric fan to assist air flow, either pushing or pulling the air through the condenser, depending on which side of the condenser the fan is placed.

The majority of vehicles using R134a require this additional condenser cooling due to the higher operating pressures of R134a. Also most modern vehicles now have smaller grilles or bumper bar openings. This causes poor air flow conditions especially by the amount of air flow over the condenser.

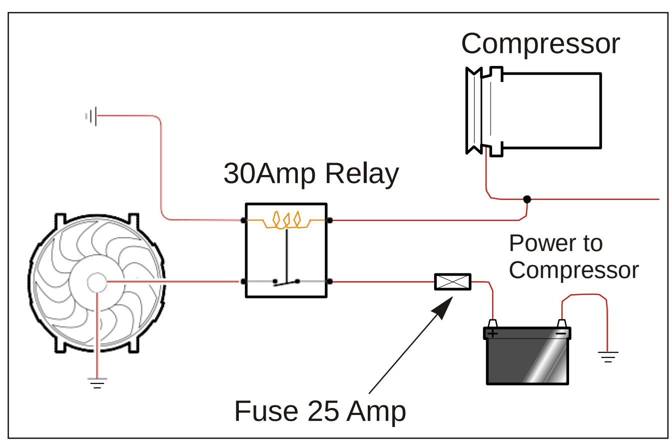
The condenser fan is operated with A/C engaged in various ways:

- Medium pressure switch;
- Indirect connection to the compressor clutch
- Via the Electronic Control Module (ECM);
- Signal from the A/C switch activation.

Fan Types



Basic Circuit

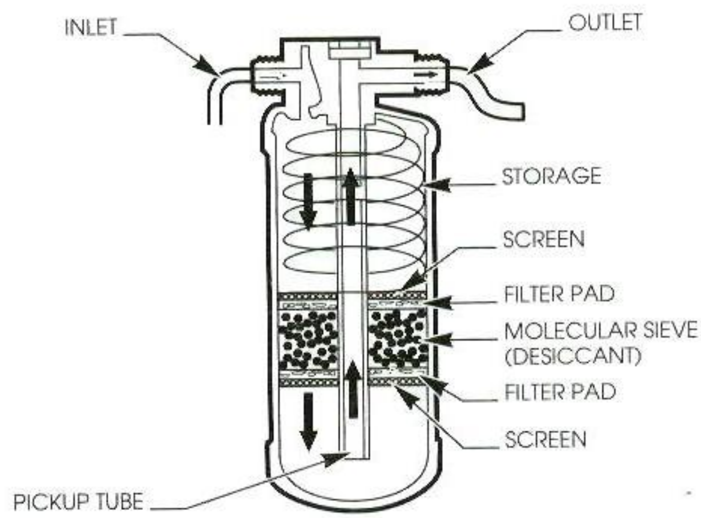


Air Conditioning System Components

Receiver/Driers

Receiver/Driers are usually located on the high side of the A/C system before the expansion valve. The receiver/drier "receives" liquid refrigerant from the condenser, stores it, filters out contaminants from the A/C system, and removes moisture. A/C systems using a receiver/drier use an expansion valve to control the refrigerant flow.

From the condenser, the refrigerant makes its way to the receiver/drier. The receiver/drier contains a desiccant to remove excess moisture away from the refrigerant.



RECEIVER-DRIER

The receiver/drier also stores additional refrigerant until it's needed later when the heat loads increase. The heat load is the amount of heat to be removed from the air. A number of variables affect heat load: ambient temperature, the number of passengers, hydraulic component heat, solar heat, and/or engine heat. As heat loads increase, the need for extra refrigerant increases with it. That extra refrigerant is stored in the receiver/drier.

From the receiver/drier, the high-pressure liquid refrigerant makes its way back to the expansion valve to begin its journey all over again.

Most R134a receiver/driers have NO sight glass. This is because the PAG oil will foam giving a false impression of low gas charge. If the receiver/drier does utilize a sight glass then ensure correct diagnosis when viewing.

Air Conditioning System Components

Refrigerant Pressure Switches

1. **Low refrigerant pressure switch –** prevents the suction or low side of the refrigerant circuit from going into a vacuum and potentially harming the compressor.

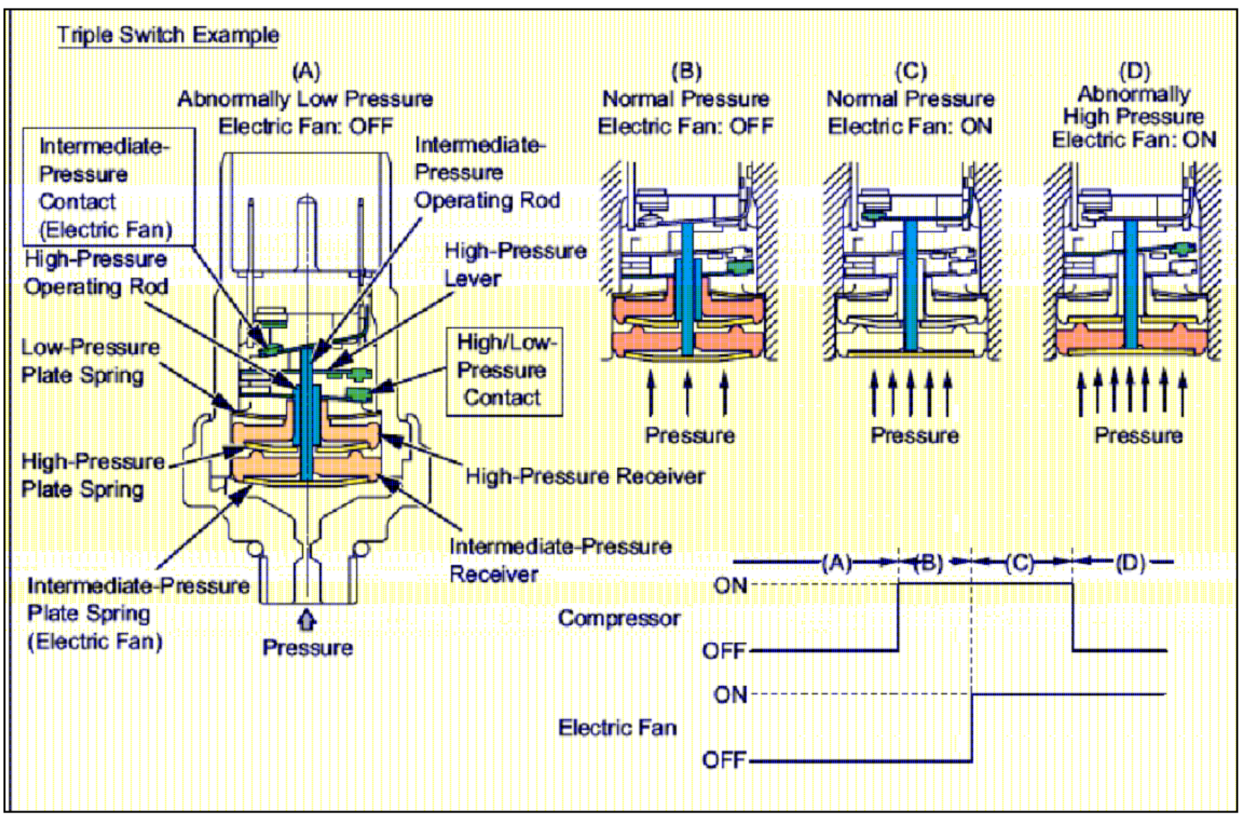
2. **High refrigerant pressure switch -** 3 typical types:

   A. Single – one fault setting.
   B. Binary – two fault settings.
   C. Trinary – three fault settings.

3. **High refrigerant pressure switch typical functions are:**

   A. Low refrigerant charge protection.
   B. Condenser fan control by energizing condenser fan relay at a predetermined high pressure setting.
   C. Compressor protection by de-energizing the compressor clutch at a very high pressure setting.

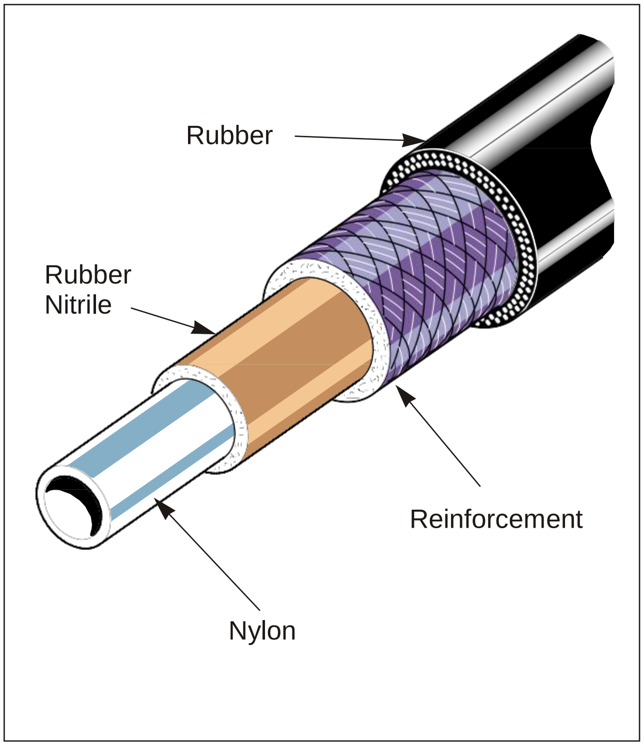
Trinary Switch Example



Air Conditioning System Components

Refrigerant Hoses

OWING TO THE SMALLER MOLECULAR SIZE AND HIGHER OPERATING PRESSURES OF R134a, the refrigerant hose now incorporates a nylon inner lining. This is to reduce the normal refrigerant leakage that would naturally occur through the porosity of rubber hoses, called permeation.
.



Most R134a hoses have a smaller outside diameter and thinner hose walls to improve flexibility and reduce noise levels within the A/C system.

O-Rings & Fittings

The "O" ring rubber compound used for R134a A/C system joints, fittings and components is a Hydrogenated Nitrile Butadiene Rubber (HNBR) and identified by the color green.

"O" ring lubrication can be carried out using mineral oil. Other manufacturers could use "O" rings of a different color and size. Ensure that only the approved "O" ring is used for the type of system being serviced or repaired.

Replace "O" ring on every fitting that has been disconnected. Use only HNBR "O" rings for replacement.

R134a - R12 Comparison

- R12 "O" rings' color is black
- **NEVER** use R12 "O" rings with R134a as the "O" ring will be damaged because of the lack of chlorine in R134a
- You can use R134a "O" rings in an R12 system
- **NEVER** use PAG oil to lubricate o-rings, as it is highly hygroscopic, retaining moisture that can contribute to fitting corrosion. Use Mineral Oil to lubricate o-rings.

Air Conditioning System Components

O-Rings & Fittings **(Continued)**

The following is a general list of recommended torque values for standard O-ring fittings for reference during service operations.

Always use specific torque values on installation instructions over these general values.

HOSE FITTING CONNECTIONS -- RECOMMENDED TORQUE VALUE

Fitting Size*	Thread Size	Torque Value (lb-ft)
# 6	5/8 – 18	11 to 13
# 8	3/4 - 16 or 18	15 to 18
#10	7/8 - 14 or 18	18 to 22
#12	11/16 - 14 or 16	24 to 28

*Do not judge fitting size by the size of the hose. Many times they will not be the same.

COMPRESSOR FITTINGS AND SERVICE VALUES

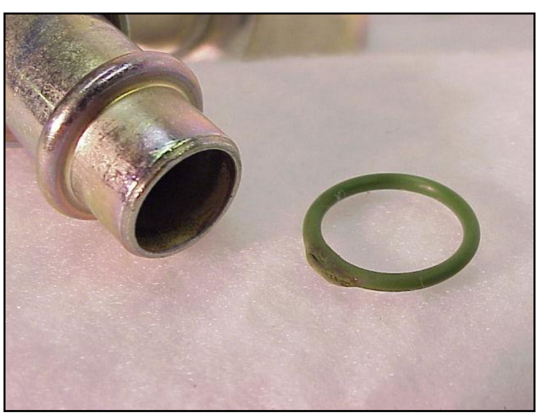
Type	Thread Size	Torque Value (lb-ft)
3-Way Service Valve to Compressor Fitting	1 -14	20 - 40
Compressor, Sanden Seltec (Zexel)	3/4 – 16	18 - 22
	7/8 – 14	18 - 22

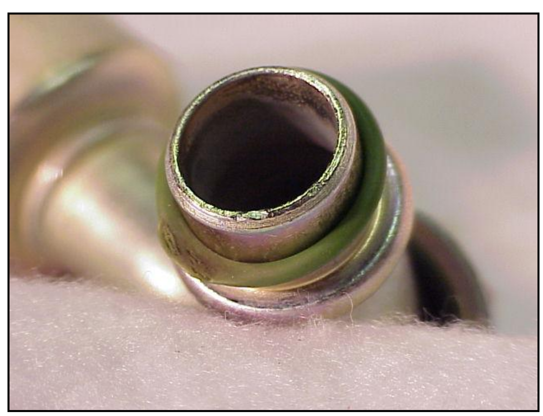
HOSE TO METAL COMPRESSION FITTING

See specific instructions for this type fitting.

- PAG oil is highly hygroscopic. Mineral oil is recommended for O-Ring Lubrication.

Example of an O-Ring that has experienced excessive torque





EVANS TEMPCON
DASH HEATER A/C
All Electric Control Systems

TEMPCON
ISO 9001
Registered

Owner's Manual
Operating Instructions

For additional owner and operator information visit us on the web at

www.evanstempcon.com

WARNING
This heater / air conditioner should be serviced by a fully trained and environmentally licensed technician. Failure to do the above could result in serious injuries, fines, and possible voiding of any warranties.

RV012682

LIMITED WARRANTY
MOTOR HOME DASH HEATER AND
AIR CONDITIONER SYSTEMS

EVANS Motor Home Dash Heater/Air Conditioners are warranted against defects in material and workmanship to the original end user. Please consult the Motor home manufacturer for warranty and service information. During the duration of the warranty, EVANS, will at its option, repair or replace any part which, upon examination by EVANS or an authorized service provider of EVANS, is found to be originally defective. A list of authorized service providers can be found at **www.evanstempcon.com.**

CALCULATION OF WARRANTY PERIOD

The warranty period for an EVANS product installed as original equipment shall begin on the date of the original purchase by the end user of the product in which it is installed. The end user may be required to provide proof of the original delivery.

EXCEPTIONS AND EXCLUSIONS

To the extent that any or all of the following exclusions are prohibited by the law of any state or municipality and cannot be pre-empted, they shall not be applicable.

1) There are no other express warranties, except as set out above, and any implied warranties are limited in duration to that of the express warranty.

2) **THERE IS NO WARRANTY COVERING CONSEQUENTIAL DAMAGES, INCIDENTAL DAMAGES OR INCIDENTAL EXPENSES, INCLUDING DAMAGE TO PROPERTY.**

3) There is no warranty covering damages caused by failure to perform normal and routine maintenance as set out in the operation and service instructions.

4) There is no warranty covering damages caused by mishandling, neglect, lightning, corrosive atmosphere, improper installation, or improper power supply.

5) The warranty shall be void if nameplate is removed or defaced.

701 Ann Street N.W.
Grand Rapids, MI. 49504
Telephone (616) 361-2681
Fax (616) 361-9646
www.evanstempcon.com

EVANS TEMPCON

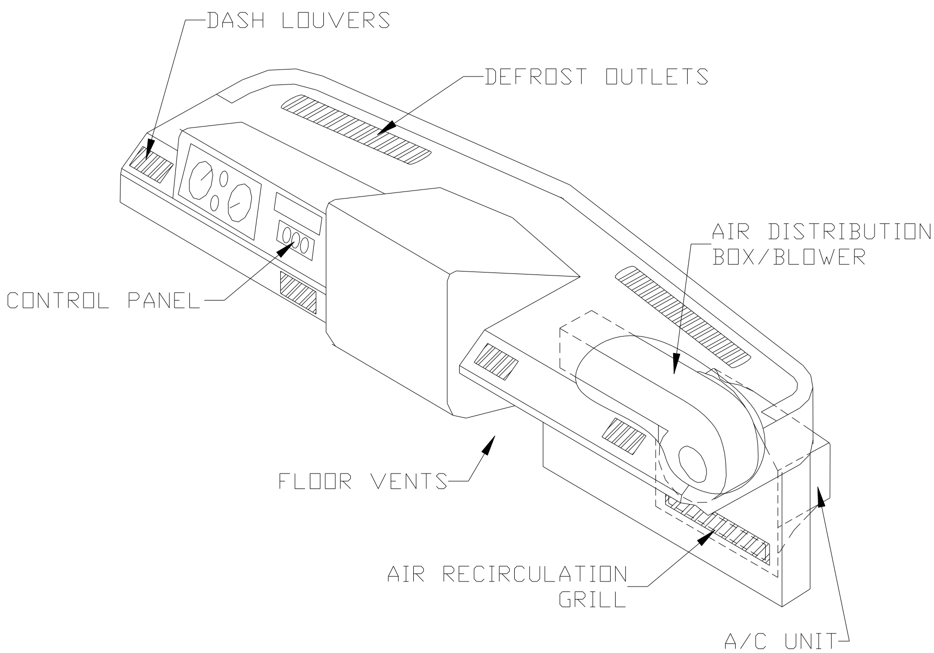
DASH HEATER / AIR CONDITIONER

Your new motor home has been equipped with the industry's highest performance integrated heating and air conditioning system. It is not designed to cool or heat the entire motor home.

This system is designed to provide windshield defrost, heating and cooling for the front seat occupants only. By following the operating instructions and tips, this heater / air conditioner will provide many years of comfort and dependable service.

System Layout

The heater / air conditioner unit is located beneath the dash of the vehicle with heating and cooling coils located on the outside of the firewall. In all modes of operation the unit takes fresh air from outside, and heats or cools it before discharging into the vehicle. Only when operated in the **RECIRC AIR** mode does the system take air from the inside of the vehicle.

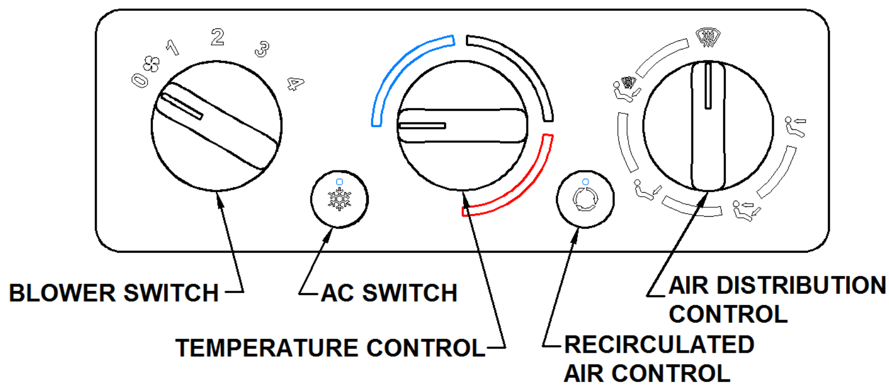


TYPICAL DASH A/C SYSTEM

The type and location of the air discharge outlets can be different in each model motor home. Consult your dealer on the location and operation of the air outlets on your motor home. Proper adjustment of air outlets will provide maximum comfort.

CONTROL PANEL OPERATION

The control panel enables the driver to control the temperature, volume, and direction of the air discharged from the heating/air conditioning system.



TYPICAL CONTROL PANEL

Blower Control

One of the best ways of controlling temperature is by changing the speed of the blower. The blower switch controls the system on/off and provides up to 4 speeds in any mode.

Temperature Control

The temperature control dial controls only the heat content of the discharge air. The temperature control dial will also control the overall temperature of the discharge air if the AC system is operating. Turn the knob to the right (red area) for warmer air, and to the left (blue area) for cooler air. Use of the temperature control will also moderate the discharge temperature when the cooling system is engaged.

AC Switch

Engages cooling system. The switch will be inactive unless the blower is set on any position other than off (0) to protect the system from forming ice on the core that would block air flow. AC will function in any discharge air mode.

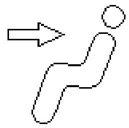
Recirculated Air Switch

Your driver/passenger heater and air conditioning system is designed to operate in fresh air mode by default. The recirculating air feature is primarily used for faster passenger area cool downs during the summer and warm ups during the winter by closing off the fresh air source and recirculating the passenger compartment air. Pressing this switch will place your system in the recirculated air mode.

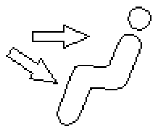
Note: Prolonged use of this feature can cause stale air quality and moisture to form on the windows.

AIR DISTRIBUTION - MODE CONTROL

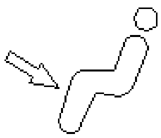
To achieve the maximum comfort in your motor home, the air must be directed where it is needed. The mode switch (right of center) gives the driver the ability to select where the air will flow.



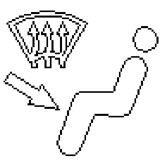
PANEL MODE – Air is drawn into the system and discharged though the dash louvers only.



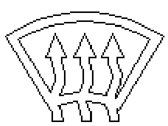
BI-LEVEL – Air is drawn into the system and discharged through the dash louvers and floor outlets.



FLOOR – Air is drawn into the system and discharged through the floor outlets.



MIX – Air is drawn into the system and discharged through the floor and defrost outlets.



DEFROST – Air is drawn into the system and discharged through the defrost outlets.

OPERATING FEATURES

The air conditioning system is designed to operate in all air distribution modes. This provides significant moisture, dust and pollen removal for enhanced passenger comfort.

The EVANS vehicle air conditioning system will not function if the outside air temperature is below approximately 40^{o} F. For cool air circulation during low temperatures, it is suggested the operator utilize FRESH AIR mode.

IMPORTANT OPERATING FEATURES AND TIPS

Window Fogging

In mild, but rainy or humid weather, windows may fog on the inside. To clear the fog of all driver area windows, turn on the air conditioning, set the system air intake to RECIRULATION AIR by engaging the RECIRC button, adjust the temperature and fan control to maintain comfort, position the mode control to DEFROST.

Winter Operation

- Remove snow and ice from windshields and system air intakes if applicable.
- The discharge air will heat up faster if the blower is operated on lower speeds until the engine is hot and the RECIRC switch engaged (illuminated)
- For windshield de-icing, use **DEFROST** mode.
- Insure the air intake is free of ice and slush.

Summer Operation

Air-conditioned vehicles must be protected with a high-quality antifreeze coolant during summer to provide corrosion protection and to raise the boiling point of the coolant for protection against overheating. A 50% concentration is recommended.

- Use Recirculated air control for a quick cool down.
- Close all windows and vents to hot humid outside air.
- Close all curtains which do not obstruct the driver's vision.

CARE AND SERVICE

- Keep the condenser and radiator free of bugs and debris.
- During periods of little use, operate the A/C system monthly to keep the compressor and seals lubricated.
- Periodically inspect the belts and hoses for wear and proper tension.
- Periodically check for proper coolant levels.

WARRANTY / SERVICE

WARNING:
THE AIR CONDITIONING SYSTEM CONTAINS REFRIGERANT 134a UNDER HIGH PRESSURE AND SHOULD BE SERVICED BY QUALIFIED PERSONNEL ONLY.

REPAIRS THAT ALTER THE DESIGN OF THE EVANS SYSTEM INCLUDING USE OF NON-EVANS SUPPLIED PARTS WILL VOID THE WARRANTY AND ANY EVANS LIABILITY FOR THE SYSTEM.

If repairs are required contact your dealer or motor home manufacturer for warranty period and details. If traveling and service is required, you can contact your motor home manufacturer for the nearest dealer, or contact Evans by phone or through our web site to find the nearest Evans Service Center.

EVANS ALL ELECTRIC CONTROL PANELS