Foreword

This service manual is the result of the dedication of The Dometic Corporation and its engineers in giving service people the necessary instruction for making accurate analyses of certain conditions. Provided is a diagnostic chart leading a qualified mechanic into the service manual pages to locate and solve symptoms which may occur. Dometic has continued its commitment in providing service people with this, the most up-to-date information about servicing Dometic RV accessories.

Form No. 3106924.008 2/96 (Replaces OS1400 1/94)

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This program will address the most common system problems associated with the Duo-Therm Air Conditioners supplied by The Dometic Corporation. Our intent is to provide you with a guideline of checks to make, should you encounter one of the following symptoms.

SYMPTOM	CAUSE	REFER TO	STEP
1. MECHANICAL CONTROL Unit does not run; no fan, no compressor.	Operating Instructions AC voltage Breaker Selector switch Wiring	**1.1** **2.1** **2.2** **4.1** **2.3**	
2. ELECTRONIC CONTROL Unit does not run; no fan, no compressor.	Operating Instructions AC voltage Breaker Wiring Control board Main board	**1.2** **2.1** **2.2** **2.3** **4.3** **4.4**	
3. BIMETAL RELAY CONTROL Unit does not run; no fan, no compressor.	Operating Instructions Voltage Breaker Thermostat Relay Board	**1.3** **2.1 & 3.1** **2.2** **4.2** **4.5**	**B**
4. MECHANICAL CONTROL Fan operates; compressor will not come on (does not hum).	Wiring Selector Switch Thermostat Overload Compressor	**2.3** **4.1** **4.2** **4.10** **4.11**	**A**
5. ELECTRONIC CONTROL Fan operates; compressor will not come on (does not hum).	Wiring Overload Compressor Control board Main Board	**2.3** **4.10** **4.11** **4.3** **4.4**	
6. BIMETAL RELAY CONTROL Fan operates; compressor will not come on (does not hum).	Wiring Thermostat Relay Board Overload Compressor	**2.3** **4.2** **4.5** **4.10** **4.11**	**B**
7. MECHANICAL, ELECTRONIC & BIMETAL RELAY CONTROL Fan operates; compressor tries to start, cycles OFF and hums again, or blows circuit breaker.	AC voltage PTCR or start relay Start or run capacitor Overload Compressor	**2.1** **4.6** **4.7 & 4.8** **4.10** **4.11**	
8. MECHANICAL, ELECTRONIC & BIMETAL RELAY CONTROL Fan operates; compressor runs for a short while, cycles off, cycles back on, but doesn't run.	Short cycle Air Flow obstruction Condenser fan Overload Compressor Refrigerant system	**5.1** **5.2** **6.5** **4.10** **4.11** **7.1**	

SYMPTOM	CAUSE	REFER TO	STEP
9. MECHANICAL CONTROL Compressor runs, no fan.	Wiring Switch Run Capacitor Motor	2.3 4.1 4.8 4.9	
10. ELECTRONIC CONTROL Compressor runs, no fan.	Wiring Run Capacitor Motor Control Board Main Board	2.3 4.8 4.9 4.3 4.4	
11. BIMETAL RELAY CONTROL Compressor runs, no fan	Wiring Thermostat Relay Board Run Capacitor Motor	2.3 4.2 4.5 4.8 4.9	B
12. MECHANICAL CONTROL Fan runs on one or two speeds only	Selector Switch Wiring Motor	4.1 2.3 4.9	
13. ELECTRONIC CONTROL Fan runs; but not on all speeds	Wiring Motor Control Board Main Board	2.3 4.9 4.3 4.4	
14. BIMETAL RELAY CONTROL Fan runs; but not on all speeds.	Thermostat Wiring Motor Relay Board	4.2 2.3 4.9 4.5	B
15. MECHANICAL, ELECTRONIC & BIMETAL RELAY CONTROL WITH AIR DISTRIBUTION BOX Evaporator freezes up.	Ambient Temperature Air Flow Obstruction Low Charge Capillary Tube Blockage Evaporator Blockage	6.1 5.2 7.1 7.2 7.2	
16. ELECTRONIC & BIMETAL RELAY CONTROL WITH DUCT IN CEILING Evaporator freezes up.	Ambient Temperature Air Distribution System Cold Control Low Charge Capillary Tube Blockage Evaporator Blockage	6.1 5.3 4.3 7.1 7.2 7.2	
17. MECHANICAL, ELECTRONIC & BIMETAL RELAY CONTROL WITH AIR DISTRIBUTION BOX Insufficient cooling; compressor runs constantly.	Air Flow Obstruction Heat Gain Refrigerant System Compressor	5.2 6.2 7.1 4.11	
18. ELECTRONIC & BIMETAL RELAY CONTROL WITH DUCT IN CEILING. Insufficient cooling; compressor runs constantly.	Air Distribution System Heat Gain Refrigerant System Compressor	5.3 6.2 7.1 4.11	

SYMPTOM	CAUSE	REFER TO	STEP
19. MECHANICAL, ELECTRONIC & BIMETAL RELAY CONTROL WITH AIR DISTRIBUTION BOX: Insufficient cooling; compressor cycles off occasionally.	Thermostat Overload Air Flow Obstruction	4.2 4.10 5.2	A, B
20. ELECTRONIC CONTROL WITH DUCT IN CEILING: Insufficient cooling; compressor cycles off occasionally.	Overload Air Distribution System Cold Control Control Board Main Board	4.10 5.3 4.13 4.3 4.4	
21. BIMETAL RELAY CONTROL WITH DUCT IN CEILING: Insufficient cooling; compressor cycles off occasionally	Overload Air Distribution System Cold Control Thermostat Relay Board	4.10 5.3 4.13 4.2 4.5	 B
22. MECHANICAL, ELECTRONIC & BIMETAL RELAY CONTROL WITH AIR DISTRIBUTION BOX Insufficient cooling; compressor often cycles off.	Short Cycle Overload	5.1 4.10	A
23. ELECTRONIC & BIMETAL RELAY CONTROL WITH DUCT IN CEILING Insufficient cooling; compressor often cycles off.	Short Cycle Overload Air Distribution System	5.1 4.10 5.3	B
24. MECHANICAL, ELECTRONIC & BIMETAL RELAY CONTROL WITH AIR DISTRIBUTION BOX Insufficient cooling with reduced air output.	Air Flow Obstruction Blower Wheel	5.2 6.5	
25. ELECTRONIC & BIMETAL RELAY CONTROL WITH DUCT IN CEILING Insufficient cooling with reduced air output.	Air Distribution System Blower Wheel	5.3 6.5	
26. MECHANICAL CONTROL Excessive cooling.	Thermostat	4.2	A
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SECTION 1

OPERATING INSTRUCTIONS

The operating instructions can change from one model to another.

Be sure you are familiar with the proper operating instructions for the specific model of air conditioner you are diagnosing. An installation and operating manual is packaged with each air conditioner system.

1.1 MECHANICAL CONTROLS

This type of air conditioner has an air distribution box that has a mechanical selector switch and thermostat installed in it.

CONTROLS:
The Selector Switch has eight positions including "OFF". This controls fan speed, heating mode and cooling modes.

The Thermostat controls the temperature range from 65°F on the coldest side to 90°F on the warmest side. In the cooling mode, the compressor ON/OFF is controlled by the thermostat setting.

COOLING OPERATION:
Set the thermostat at the desired temperature level. Select the fan speed that best satisfies your needs.

a. **HIGH COOL**: Selected when maximum cooling and dehumidification is required.
b. **MED. COOL**: Selected when normal or average cooling is required.
c. **LOW COOL**: Selected when room is at desired comfort level and needs to be maintained. Normally this speed is used for nighttime operation.

NOTE: The blower runs continuously to circulate air and maintain an even temperature. The compressor will come on as cooling is required to maintain the selected temperature level.

! CAUTION

AFTER SHUTTING THE AIR CONDITIONER DOWN WITH EITHER SELECTOR SWITCH OR THERMOSTAT, WAIT AT LEAST TWO (2) MINUTES BEFORE RESTARTING. THIS ALLOWS THE REFRIGERANT PRESSURE TO EQUALIZE AND COMPRESSOR TO RESTART EASILY.

FAN OPERATION:
This will circulate the air in your RV without cooling or heating. There are three positions: HIGH FAN, MED. FAN or LOW FAN to select from, depending upon personal choice.

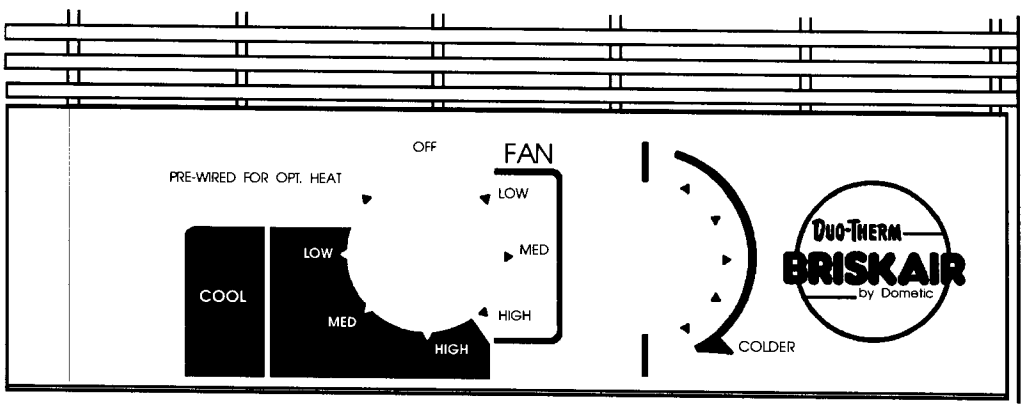
HEATING OPERATION:
(With Optional Heat Kit Installed)
NOTE: This electric heater will not replace a furnace for heating your RV in cold weather. The intent is to remove the chill on cool days or mornings.

1. Turn the selector switch to "OPT. HEAT".
2. The heater will come on and begin heating.
3. When desired temperature level in RV is reached, move the selector switch to off position or fan position. (NOTE: Thermostat does not control heater ON/OFF cycle.)

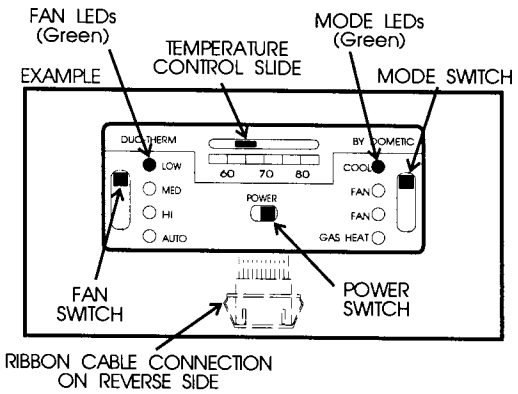
"OFF" POSITION: This is to turn Unit off.

1.2 ELECTRONIC CONTROLS

This type of air conditioner has a main board and a control board that replaces the mechanical switch and thermostat on the mechanical controlled air conditioner. The control board can be mounted in the air distribution box or on a wall. The control board that is mounted on a wall allows the air conditioner to utilize a ceiling duct to distribute the cool air throughout the structure. NOTE: Remember to check the installation and operating instructions for the specific model of air conditioner you are diagnosing.



CONTROL DESCRIPTION



POWER SWITCH

Located lower center of control.
Turns air conditioner or gas furnace ON to set condition.
Turns air conditioner or gas furnace OFF.
Green LED lights next to MODE switch light up to indicate power ON.
No LED lights on when control is OFF.

MODE SWITCH

Four position switch located on right side of control.
Used to select COOLING, FAN or GAS HEAT mode of operation.
Mode selected is indicated by green LED light when control is turned on.

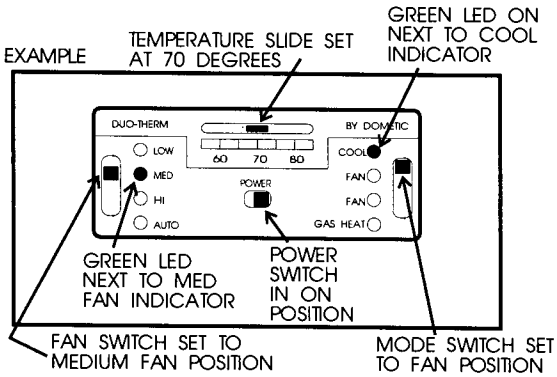
FAN SWITCH

Four position switch located on left side of control.
Used to select HIGH, MEDIUM, LOW or AUTOMATIC FAN operation of air conditioner
Fan speed selection is indicated by green LED light when control is turned on.

TEMPERATURE SLIDE

Located top center of control.
Movable arm on control selects temperature at which the compressor or gas heat is turned ON and OFF.
User sets to position to maintain temperature level desired.

COOLING MODE OPERATION

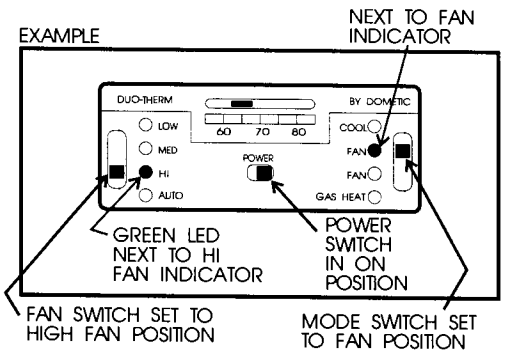


Turn POWER switch to ON position.
Place mode switch to COOL position.
Set temperature slide switch to your desired temperature level.
Select your desired fan speed. NOTE: See Special Features Section for AUTO Fan Operation.
The fan starts immediately and after a delay of approximately two minutes, the compressor will start.
The compressor will now cycle OFF per the thermostat set point. The fan will:

a. Continue to operate in the selected fan speed if AUTO FAN position is not selected.
b. Cycle OFF and ON with the compressor cycle if AUTO FAN position is selected.

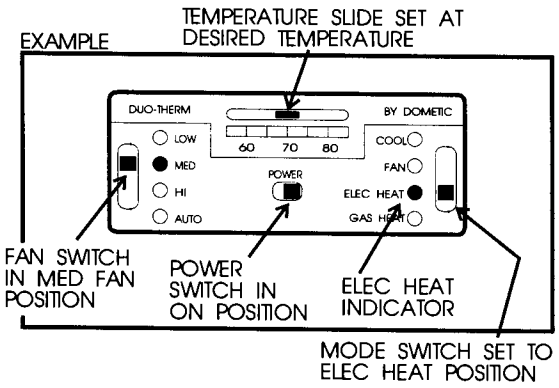
The compressor (and fan) will restart in approximately two minutes after the thermostat senses the need for cooling.

FAN MODE OPERATION



Turn POWER switch to ON position.
Place MODE switch in either FAN position.
Select the desired fan speed: HI-MED-LOW-AUTO.
NOTE: In AUTO position the fan operates only at low speed in the FAN mode of operation.

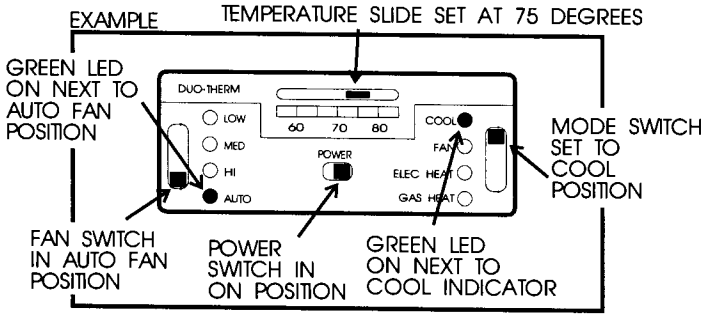
ELECTRIC HEAT MODE OPERATION (If So Equipped)



Turn POWER switch to ON position.
Place mode switch in ELEC HEAT position.
Set temperature slide switch to your desired temperature level.

Select your desired fan speed (HI-MED-LOW-AUTO).
NOTE: In AUTO position, the fan operates only at low speed in ELEC HEAT mode of operation.

SPECIAL CONTROL FEATURES



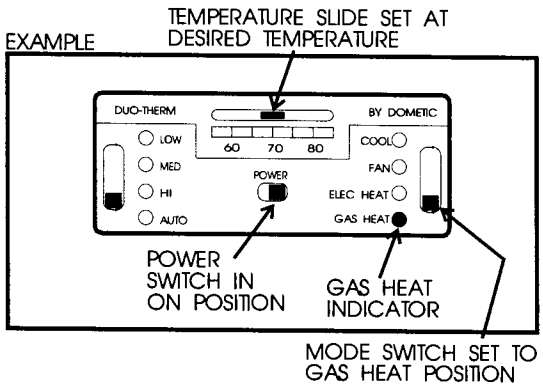
Auto Fan: When selected, FAN will:

a. Automatically select the fan speed depending on the difference between set temperature and room temperature.
   For temperature difference of:
   8° or more - Fan operates on HIGH
   4° to 8° - Fan operates on MEDIUM
   4° or Below - Fan operates on LOW
b. Cause the fan to cycle ON and OFF with the compressor and electric heat. Any change of any switch on the thermostat will cause the fan to come on.

Refrigerant Compressor Time Delay:
The compressor will always have a delay in starting of approximately two minutes any time it is required to begin the cooling cycle.

Power Interruption:
In the event power to the air conditioner is interrupted for any reason, the system will restart in the condition previously set by user.

GAS HEAT MODE OPERATION (If Installed)



Turn POWER switch to ON position.
Place mode switch to GAS HEAT position.
Notice that the fan indicators extinguish and the GAS HEAT indicator illuminates. (The Dometic A/C fan will not operate in the GAS HEAT mode.)
Set temperature slide switch to your desired temperature.
The gas furnace will cycle ON and OFF to provide the selected temperature.

1.3 BIMETAL RELAY CONTROLS

This type of air conditioner has a wall mounted bimetal thermostat and a relay board that replaces the mechanical switch and thermostat on the mechanical units and replaces the main board and control board on the electronic units.
NOTE: Remember to check the installation and operating instructions for the specific model of air conditioner you are diagnosing.

COOLING OPERATION

Place the **Temperature Set Lever** to desired temperature level (located at top of thermostat). Select fan speed that best satisfies your needs: (upper right switch at bottom of thermostat).

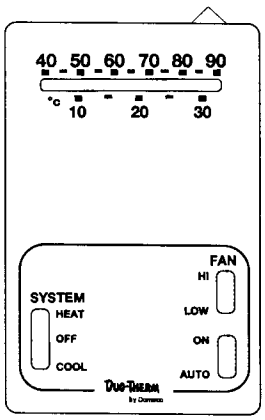
a. **High Speed**: Selected when maximum cooling and dehumidification are required.
b. **Low Speed**: Selected when RV reaches desired comfort level and needs to be maintained. Normally this speed is used for nighttime operation.

Select **Auto/ON Switch** operation as follows:
(Lower right switch at bottom of thermostat)

a. **Auto Position**: Air conditioner fan runs whenever cooling is required and stops whenever cooling is not required.
b. **On Position**: Air conditioner fan runs continuously to circulate air in RV.

Set the **Heat/Off/Cool Switch** to cool position
(Located at lower left side of thermostat)

The air conditioner will now come on when cooling is required and cycle off when the temperature level selected is reached.



! CAUTION

Wait at least two (2) minutes before restarting the air conditioner after shutting off with either the Heat/Off/Cooling Switch or the Temperature Set Lever. This allows the refrigerant pressure in the air conditioner to equalize and will allow the compressor to restart easily.

HEATING OPERATION
(If Furnace is connected to Thermostat)
Set Temperature Set Lever to desired temperature level (located at top of thermostat).
Set the Heat/Off/Cool Switch to heat position (located at lower left side of thermostat).

The furnace will now come on when heat is required and cycle off when temperature level selected is reached.

SPECIAL FEATURE:
When thermostat:
Heat/Off/Cool Switch is in the OFF or HEAT position and **Auto/On Switch** is in the ON position, the air conditioner fan will run continuously to circulate the air inside the RV.

SECTION 2

AC VOLTAGE REQUIREMENTS

2.1 AC VOLTAGE

The air conditioner is a 115 V AC, 60 Hz. appliance. The proper operation range is between 103 volts and 126.5 volts. The voltage reading should be taken at the air conditioner power supply leads. One test should be performed when the air conditioner is turned OFF and another with the air conditioner under a load. If the voltage is not within the proper operating range, it must be corrected before operating the air conditioner.

! WARNING

THIS IS AN ENERGIZED CIRCUIT. SHOCK CAN OCCUR IF NOT TESTED PROPERLY. TESTING TO BE DONE BY A QUALIFIED SERVICE TECHNICIAN.

2.2 BREAKER

! WARNING

MAKE SURE THAT THE POWER SUPPLY TO THE UNIT IS DISCONNECTED BEFORE PERFORMING ANY WORK ON THE UNIT TO AVOID THE POSSIBILITY OF SHOCK INJURY OR DAMAGE TO THE EQUIPMENT.

The air conditioner circuit is to be protected by a 20 amp time delay fuse or HACR (heating, air conditioner, refrigerator) breaker. By taking an amp reading at the air conditioner's AC voltage supply line, you can determine if the breaker is tripping prematurely. Place a clamp-on type ammeter around the black wire from the breaker going to the air conditioner, turn the air conditioner on and record amp draw. If the breaker trips before the rated amperage, replace the breaker.

2.3 WIRING

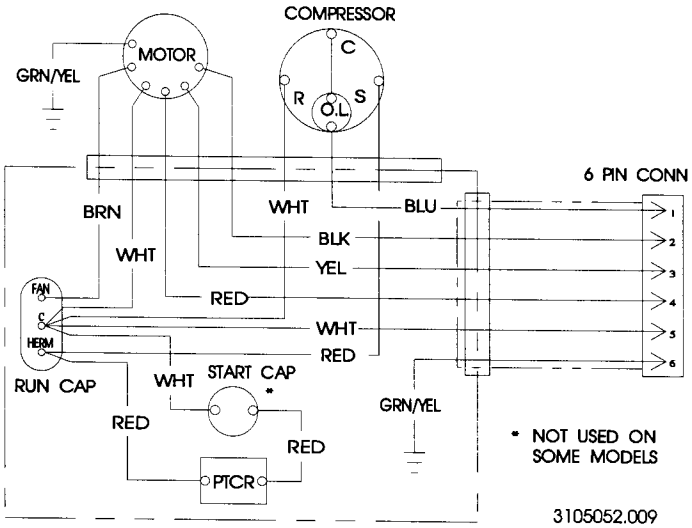
! WARNING

MAKE SURE THAT THE POWER SUPPLY TO THE UNIT IS DISCONNECTED BEFORE PERFORMING ANY WORK ON THE UNIT TO AVOID THE POSSIBILITY OF SHOCK INJURY OR DAMAGE TO THE EQUIPMENT.

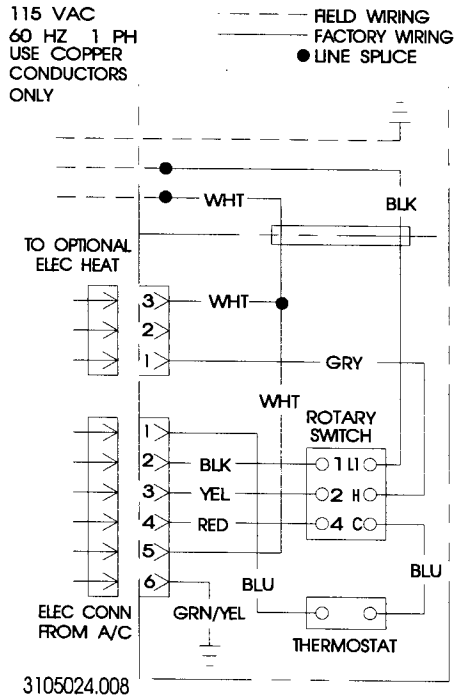
With the line circuit breaker turned OFF, check to see if the air conditioner is wired correctly. Each air conditioner is supplied with a wiring diagram. Check all wires for proper location. If you have difficulty in reading wiring diagrams or schematics, please enroll in an electricity course at your local school or college.
NOTE: Be sure to use the wiring diagram for the specific model of unit you are diagnosing

REFER TO THE SAMPLE OF TYPICAL WIRING DIAGRAMS & SCHEMATICS ON PAGE 8:

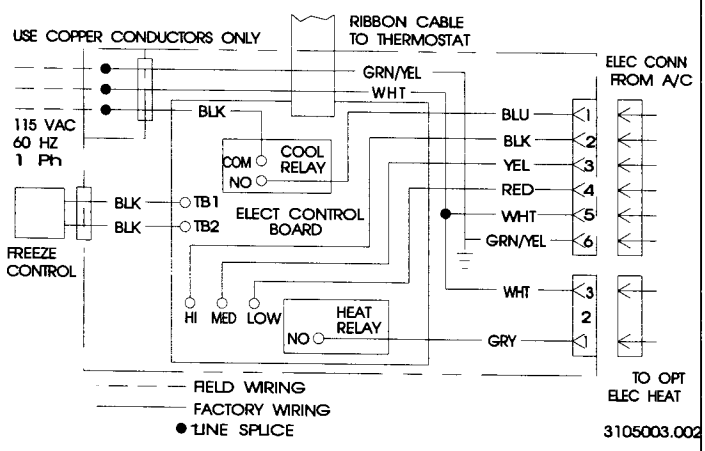
TYPICAL UNIT WIRING DIAGRAM



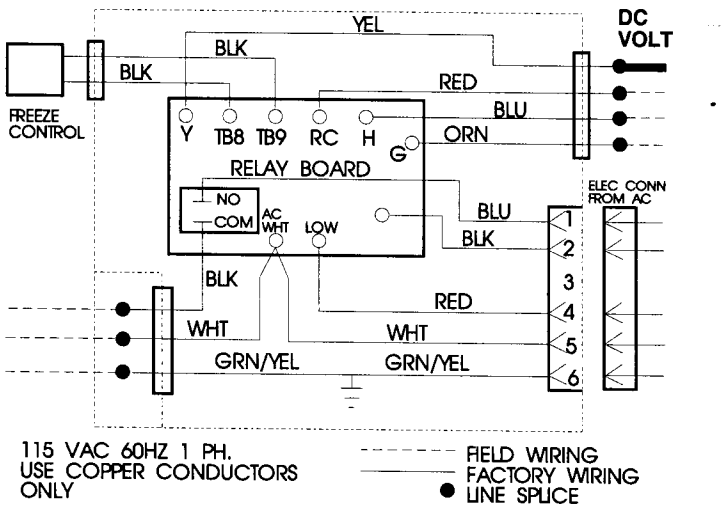
TYPICAL MECHANICAL CONTROL WIRING DIAGRAM



TYPICAL ELECTRONIC CONTROL WIRING DIAGRAM



TYPICAL BIMETAL RELAY CONTROL WIRING DIAGRAM



SECTION 3

DC VOLT REQUIREMENTS

3.1 DC VOLTS

On certain models of electronic control air conditioners, a DC volt supply is wired to the control board. The operating range is 10 to 16 volts. If voltage is below 10 volts, you could experience improper operation of the components within the main board.

SECTION 4

COMPONENTS

⚠ WARNING

MAKE SURE THAT THE POWER SUPPLY TO THE UNIT IS DISCONNECTED BEFORE PERFORMING ANY WORK ON THE UNIT TO AVOID THE POSSIBILITY OF SHOCK INJURY OR DAMAGE TO THE EQUIPMENT.

4.1 SELECTOR SWITCH

The selector switch in a mechanical air conditioner has several positions. The various switch positions can be tested for continuity with a volt/ohm meter set on the highest ohm scale.

First, turn the 20 amp air conditioner breaker to OFF and remove wires from the switch.

With the switch in the OFF position, you should not have continuity between terminal L1 and any other terminals.

In the HIGH FAN position, you should have continuity between L1 and terminal 1.

In the MEDIUM FAN position, you should have continuity between L1 and terminal 2.

In the LOW FAN position, you should have continuity between L1 and terminal 4.

In the HIGH COOLING mode, you should have continuity between L1 and C, and L1 and 1.

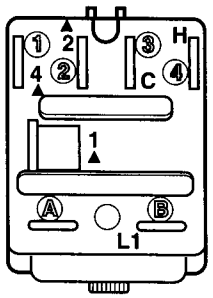
In the MEDIUM COOLING mode, you should have continuity between L1 and C, and L1 and 2.

In the LOW COOLING mode, you should have continuity between L1 and C, and L1 and 4.

In the HEATING mode, you should have continuity between L1 and H, and L1 and 4.

Be sure to check the switch in all positions and be sure you have continuity only on the terminals for the selected mode. Lack of continuity or continuity on incorrect terminals designates a defective switch, and it must be replaced.

POSITION	TERMINALS
OFF	
HI FAN	L1 and 1
MED FAN	L1 and 2
LOW FAN	L1 and 4
HI COOL	L1 and C; L1 and 1
MED COOL	L1 and C; L1 and 2
LOW COOL	L1 and C; L1 and 4
HEAT	L1 and H; L1 and 4



BACK VIEW OF TYPICAL SELECTOR SWITCH

4.2 THERMOSTAT

A. MECHANICAL CONTROL

The thermostat controls the ON/OFF cycling of the compressor. It has two terminals. The air temperature around the sensor tube should be between approximately 65 degrees and 90 degrees Fahrenheit. To check the thermostat for operation, turn the air conditioner circuit breaker off, and disconnect the wires to the thermostat. Turn the control knob to MAXIMUM. You should have continuity between the two terminals. Turn the thermostat to MINIMUM, and you should not have continuity between the two terminals. If you have incorrect readings, replace the thermostat.

B. BIMETAL RELAY CONTROL

This thermostat has a bimetal coil that makes or breaks a set of points to regulate the temperature.

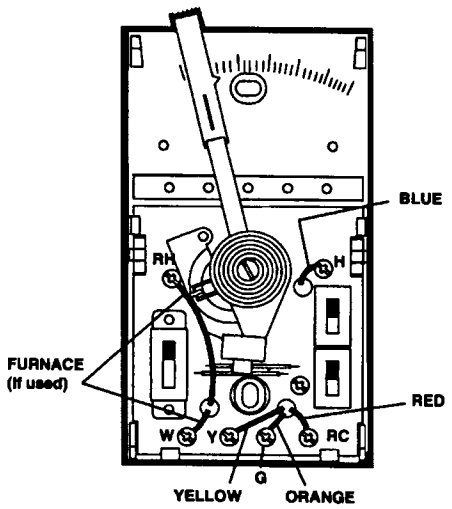
The thermostat is mounted on a wall of the RV and is connected to the relay board (mounted in the return air grille assembly) with red, orange, yellow and blue wires.

The thermostat is a "heat/cool thermostat". These instructions cover only the cooling connections required. If connection of furnace is required, follow the instructions provided with the furnace. Normally the furnace will connect to the **"RH"** and **"W"** terminals on the thermostat.

1. Remove the cover of the provided thermostat.
2. Connect the **"RED"** wire from the air conditioner to the **"RC"** terminal on the thermostat.
3. Connect the **"YELLOW"** wire from the air conditioner to the "**Y**" terminal on the thermostat.
4. Connect the **"BLUE"** wire from the air conditioner to the **"H"** terminal on the thermostat.

5. Connect the **"ORANGE"** wire from the air conditioner to the **"G"** terminal on the thermostat.
6. Push the thermostat wires into hole in wall and fill excess hole with insulation.
7. Mount thermostat base to the wall with screws provided.
8. Check all thermostat wires on base to ensure they are completely clear of the bimetal coil of the thermostat. Adjust if necessary.
9. Replace thermostat cover.

THERMOSTAT BASE



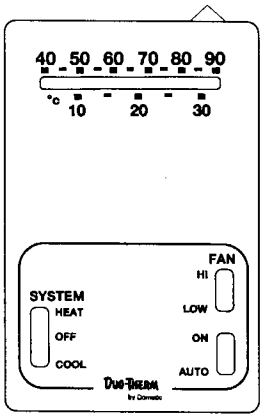
If nothing operates on the air conditioner, remove the return air grille assembly and verify the red, orange, yellow and blue wires are properly connected (red to red, orange to orange, etc.). Next disconnect the red wires and check for 12 volt D.C. between red wire from roof section and the orange or blue wire from roof section. If no voltage is received, refer to section 4.5. If voltage is received, the problem lies with the thermostat or thermostat wires.

Next disconnect all four wires (red, orange, yellow and blue) from the thermostat. With the thermostat set on COOL mode, the FAN mode set on AUTO and HIGH, and the temperature selector set lower than room temperature, check for continuity between:

terminal RC (red wire) and terminal Y (yellow wire),
and RC (red wire) and terminal G (orange wire)
and RC (red wire) and terminal H (blue wire).

If continuity is achieved on each, next set FAN switch to LOW. Continuity should NOT be present between terminal RC and terminal H, but present between the other terminals (Y and G) and terminal RC.

If all the previous checks are good, the thermostat is good. Do not replace it. If any one of these checks are not correct, replace the thermostat.



4.3 CONTROL BOARD

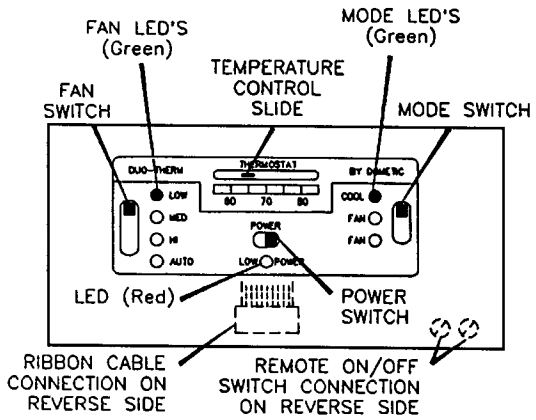
On electronic units two types of control boards have been used. They are 115 AC volt and DC volt controlled.

A. 115 AC VOLT CONTROLLED

NOTE: The PAL tester with the air conditioning module attached, will allow for proper testing of communication integrity between the control board and main board. The PAL and the AIR CONDITIONER MODULE are available from your Dometic parts distributor.

This control board is a signal receiver and completer. All power is supplied by the 115 AC volt main board. With the power switch ON, the FAN and MODE LED's will illuminate. To check the control board, first verify the power switch is on. Next, move the fan switch to all positions. The LED for each position should light. Next, move the mode switch to all positions. The LED for each position should light. If all the LED's light when switches are changed, the control board is good. If a LED does not light when switch is at that position, check the cable connections for a bent pin or improper connection. Also, check for any discolored or burnt areas on the board. If a discolored or burnt area is found correct the short in the cable before installing a new control board. If all lights illuminate and no discoloration or burnt area is found, the control board does NOT need to be replaced.

115 VOLT AC CONTROLLED



B. DC VOLT CONTROLLED

NOTE: The PAL tester with the air conditioning module attached, will allow for proper testing of communication integrity between the control board and main board. The PAL and the AIR CONDITIONER MODULE are available from your Dometic parts distributor.

This control board is wired to a DC volt supply and is capable of operating a DC volt furnace as well as operating the air conditioner. Only one of these will operate at a time. When the mode selection switch is at GAS HEAT, no lights for the air conditioner will illuminate.

DC volts is wired to the control board by attaching positive (+) DC to the red wire and negative (–) to the black wire. POLARITY has to be correct for operation. With the Center Slide (Power) switch to ON, all the way to the right, the control board sends DC volts to the main board and the main board sends signals to control board. It then completes the signals according to fan selection and mode selection to the appropriate appliance.

The DC volt operation range is 10 to 16 volts. To verify DC volts, check between the black wire and the red wire. If no volts are detected or voltage is outside of the operation range, correct the DC volt supply. If voltage is within the operating range, next check between Pin 1 and 10 on the cable. The voltage should be the same. If none is detected, the control pad is defective. Before replacing the part, verify where the shorted wire is and correct the problem. The most likely problem area would be in the cable that connects the main board and control board.

To check the gas heat mode, verify the control board is turned on, temperature control slide is all the way to the right, mode switch is to gas heat position and green LED is on. Next, remove furnace wiring from the two blue wires. Then check for continuity on the blue wires. Continuity means the thermostat is good.

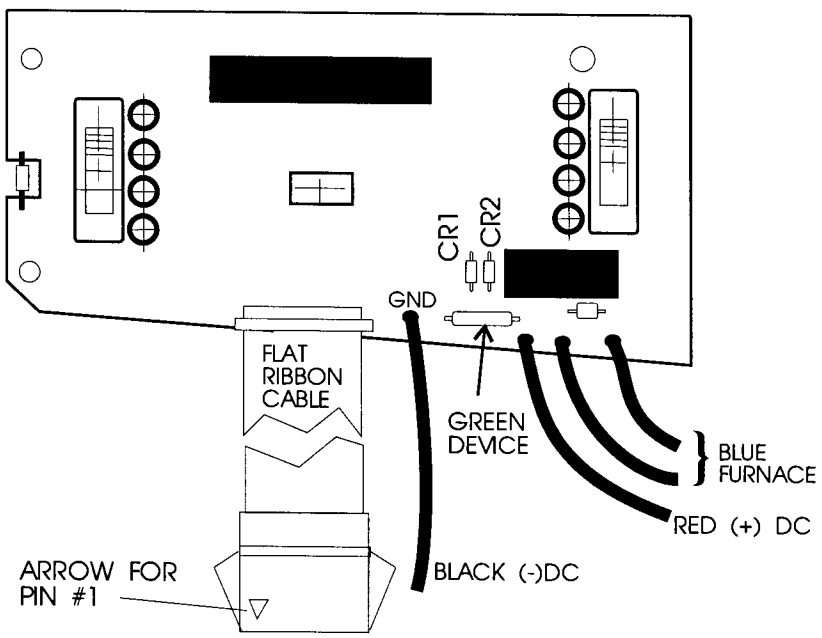
! CAUTION

BE SURE THE FOLLOWING CHECK IS DONE PROPERLY. AN INCORRECT TEST WILL DAMAGE THE CONTROL BOARD.

If your results are no continuity, then check for DC volts between black wire and bottom of **CR2 Anode** (side closest to green device). If DC volts are not present, check cable and main board. If DC volts are present (10 to 16), place a jumper wire between black wire and bottom of CR2 Anode. Next check continuity on the blue wires. Lack of continuity designates a defective control board. A continuity reading indicates a problem with the cable or main board.

If the furnace continues to operate when the control board is turned "OFF", check continuity on blue wires. Lack of continuity designates the control board is good. Continuity on the blue wires designates a defective control board.

DC VOLT CONTROLLED



4.4 MAIN BOARD

On electronic units, two types of main boards have been used: 115 volt AC and DC volt controlled.

A. 115 VOLT AC CONTROLLED

NOTE: The PAL tester with the air conditioning module attached, will allow for proper testing of communication integrity between the control board and main board. The PAL and the AIR CONDITIONER MODULE are available from your Dometic parts distributor.

To check this main board, disconnect all power to the air conditioner. Remove the fan speed wires and the compressor wire from the main board. Set the control board to COOL and HIGH FAN positions. Connect power to the air conditioner. Verify the lights on the control board are on. If no lights are lit, remove control board and attach directly into main board ribbon cable. If lights do not come on, replace main board. With lights on control board, use a 115 AC volt incandescent bulb with one lead to the AC WHITE terminal and the other lead on HIGH and then to compressor terminal to verify the circuit is being completed through the main board. Switch the control pad to other settings and verify all circuits are being completed. If not, replace the main board.

B. DC VOLT CONTROLLED

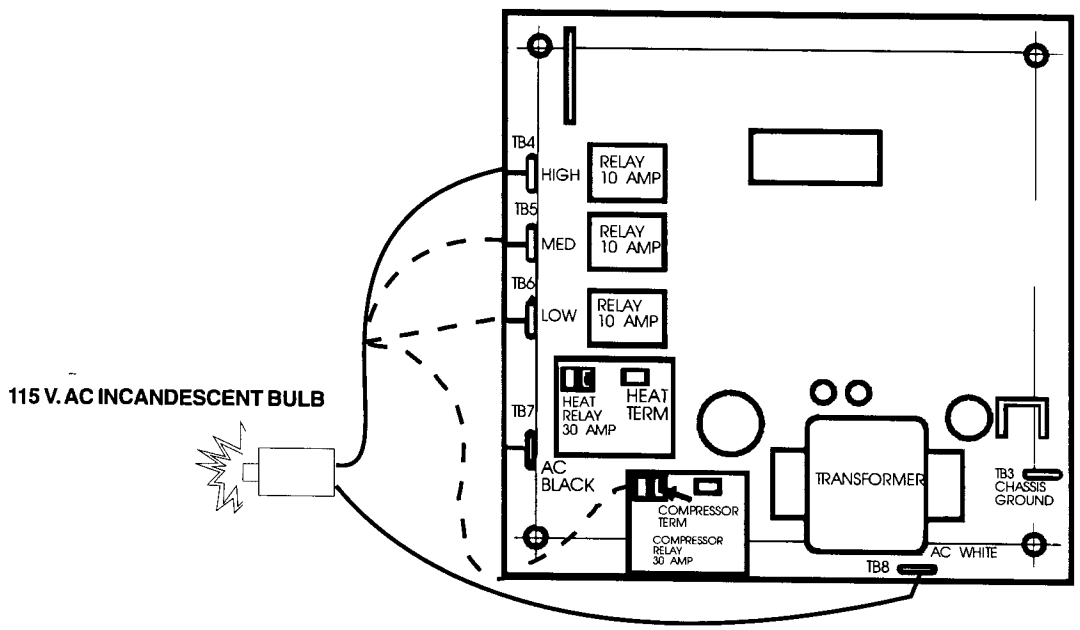
NOTE: The PAL tester with the air conditioning module attached, will allow for proper testing of communication integrity between the control board and main board. The PAL and the AIR CONDITIONER MODULE are available from your Dometic parts distributor.

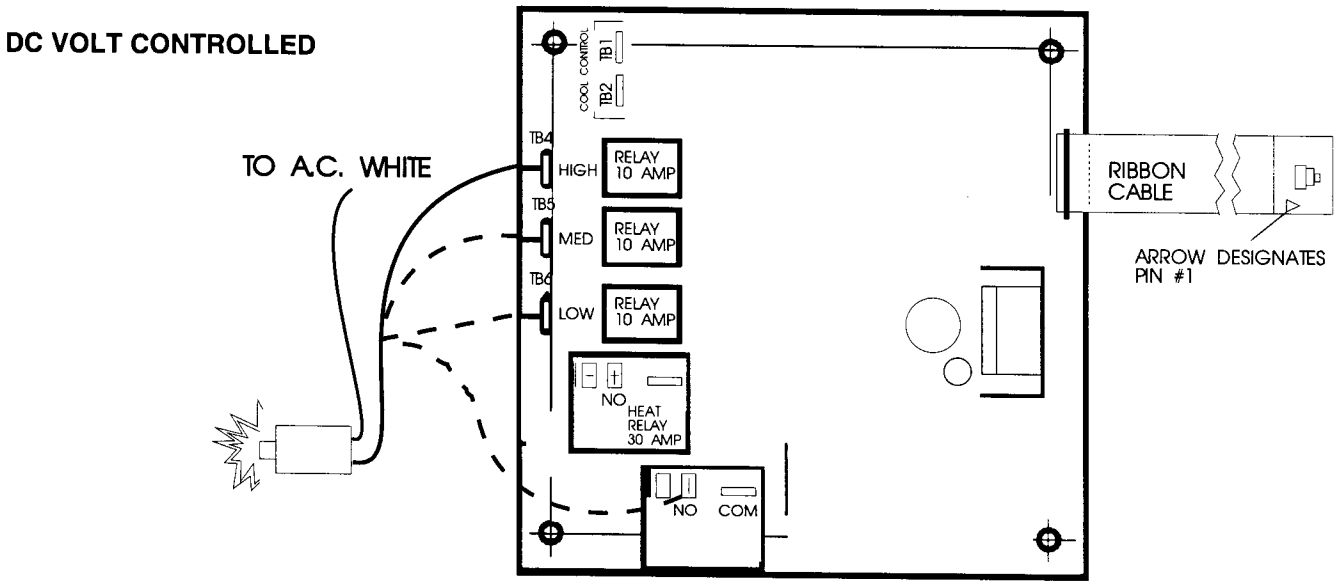
This main board is controlled by DC volts supplied from the control board. To check DC volts, be sure OFF/ON switch on control board is "ON". Measure the outside (#1 [+] and #10 [–]) terminals on the cable between the main board and the control board. The operating range is 10 to 16 volts DC. If DC volts are not within this range, correct the DC volt supply.

To check the circuit completing capabilities of the main board, first disconnect all power to the air conditioner. Then remove the fan speed wires and the compressor wire from the main board. Set the control board to COOL and HIGH FAN positions. Next, connect power to the air conditioner. Verify the lights on the control board are on. If no lights are on, remove control board and attach directly into the main board ribbon cable. If lights do not come on, replace the main board. With lights on control board, use a 115 AC volt incandescent bulb with one lead to the AC WHITE wire and the other lead on HIGH terminal and then to compressor terminal to verify the circuit is being completed through the main board. Switch the control board to other settings and verify all circuits are being completed according to the operation manual for the specific model you are diagnosing. If not, replace the main board. If the circuits are being completed, DO NOT replace the main board.

NOTE: When the control board fan setting is in the AUTO mode, the fan motor will cycle OFF and ON with the compressor cycle. There is a two minute delay on start after the control board senses cooling is needed.

115 VOLT AC CONTROLLED





4.5 RELAY BOARD

The relay board is controlled by the bimetal type thermostat. It consists of a transformer, compressor relay, two fan relays and other components. If any one of these are defective the complete relay board must be replaced.

The relay board completes circuits to the fan motor and compressor depending on what mode switch and temperature setting is on the thermostat.

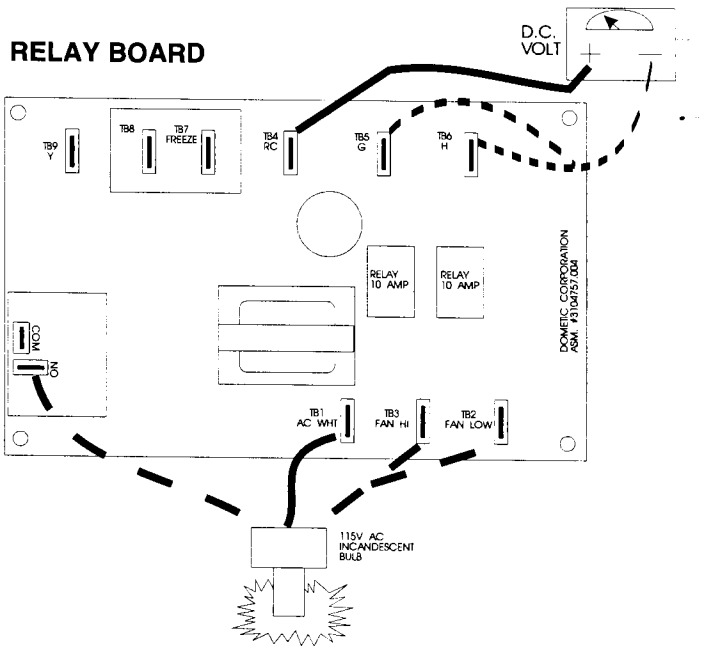
The first check would be to turn all power OFF to the air conditioner. Disconnect the four wires (red, yellow, orange and blue) from the thermostat wires and wire all four wires together. Turn power ON to the air conditioner. The compressor and high fan should operate. Next, remove the blue wire from the others. With the red, yellow and orange wires connected, the compressor and low fan should operate. If these checks are not correct, the problem is in the relay board or its wiring.

Remove the cover from the relay box housing and verify the red wire is on terminal RC, orange wire is on terminal G, blue wire is on terminal H and yellow wire is on terminal Y.

With AC power to the relay board, check between terminals RC and G or H. There should be 12 volts DC. If no voltage is detected, the transformer on the relay board is defective. Replace the relay board.

If 12 volts DC is available, disconnect power to the air conditioner and remove the HI FAN wire (black) and the LOW FAN wire (red) and the compressor wire (large blue) from the NO terminal on the compressor relay on the relay board.

Next, connect together all four low voltage wires (red, yellow, orange and blue) that go to the thermostat from the relay box. Provide power to the air conditioner. Using an incandescent bulb, check from AC WHITE terminal (one lead from bulb) to NO terminal and HI FAN terminal (other lead from bulb). The bulb should illuminate. Next, disconnect the blue wire from the other three. Check from AC WHITE to LO FAN and NO terminals. The light should illuminate. If these tests are correct, the relay board is good. Do NOT replace it. If any one of these tests are incorrect, replace the relay board.



4.6 PTCR DEVICE OR START RELAY

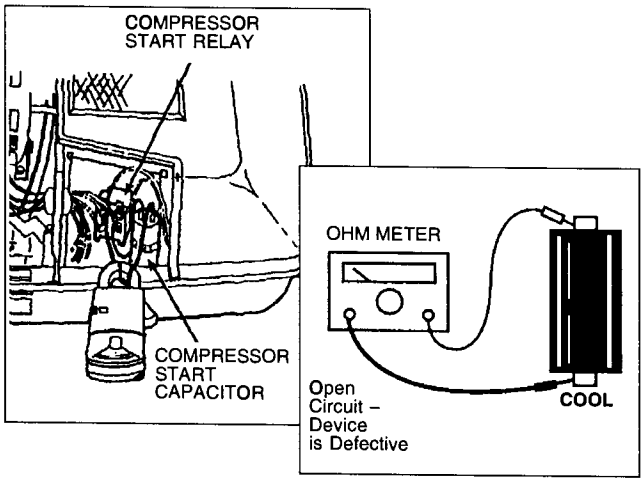
The positive temperature coefficient resistor, or PTCR, has replaced the compressor start relay and the start capacitor, on some models of air conditioners. It should be checked in two different ways:

The first check that should be made is continuity. Turn the air conditioner circuit breaker to OFF. Disconnect the PTCR from the circuit. Check for continuity. If there is no continuity, replace the PTCR, and connect it back into the circuit.

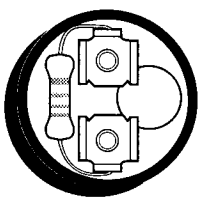
! WARNING

THIS IS AN ENERGIZED CIRCUIT. SHOCK CAN OCCUR IF NOT TESTED PROPERLY. TESTING TO BE DONE BY A QUALIFIED SERVICE TECHNICIAN.

The second check to take is an amperage reading. This check can also be used for the start relay. Clamp an ammeter around the wire from the PTCR to the run capacitor. Turn the air conditioner circuit breaker to ON and start the air conditioner. When the compressor starts, there will be an amperage reading for approximately one second or less. If there is no reading, or if there is a prolonged reading, the PTCR or start relay is faulty and must be replaced.



4.7 START CAPACITOR



The start capacitor should be checked with a capacitor tester. Follow the tester manufacturer's testing procedures. If one is not available, an ohm meter may be used. Turn the air conditioner circuit breaker to OFF. Disconnect the wires to the capacitor. The start capacitor does not need to be manually discharged since it has a built-in resistor. Use only an analog or dial type ohm meter. Set the ohm meter to the proper scale and connect the probes to the capacitor terminals. The reading should show continuity and slowly return to 15,000 ohms. You should then reverse the leads and check again. If there is no reading or a reading greater than 15,000 ohms, the start capacitor should be replaced.

4.8 RUN CAPACITOR

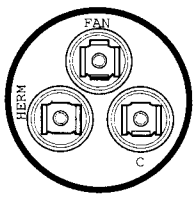
The run capacitor may be one of two different kinds: Either a single capacitor for the fan or compressor, or a combination capacitor for both the fan and the compressor.

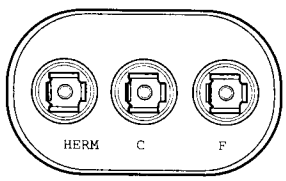
The run capacitor should be checked with a capacitor tester. Follow the tester manufacturer's testing procedures. If one is not available, an ohm meter may be used. Turn the air conditioner circuit breaker OFF. Disconnect the wires to the capacitor.

! WARNING

THERE MAY BE A CHARGE ON THE CAPACITOR UNTIL DISCHARGED.

The run capacitor must be manually discharged. Using an AC voltmeter set at the 500 volt scale or higher, connect meter leads to the terminals of the capacitor. After discharging the capacitor, set the VOM meter to the highest ohm scale and connect the probes to the capacitor terminals. The reading should rapidly move toward continuity and slowly return to infinity. You should reverse the leads and repeat the procedure. If there is no reading, or a prolonged reading, replace the run capacitor. The combination run capacitor has three terminals. The terminals are marked "F", "C" and "HERM". To check the combination run capacitor, follow the discharge procedures above. Again, make sure you test from "C" (common) to "F" (fan), and "C" (common) to "HERM" (compressor).

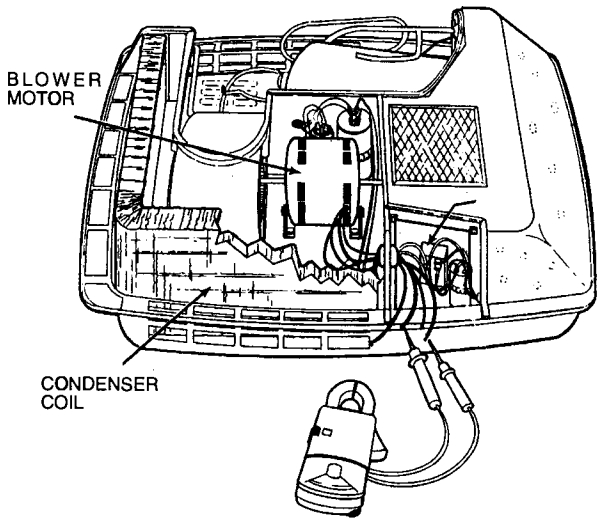


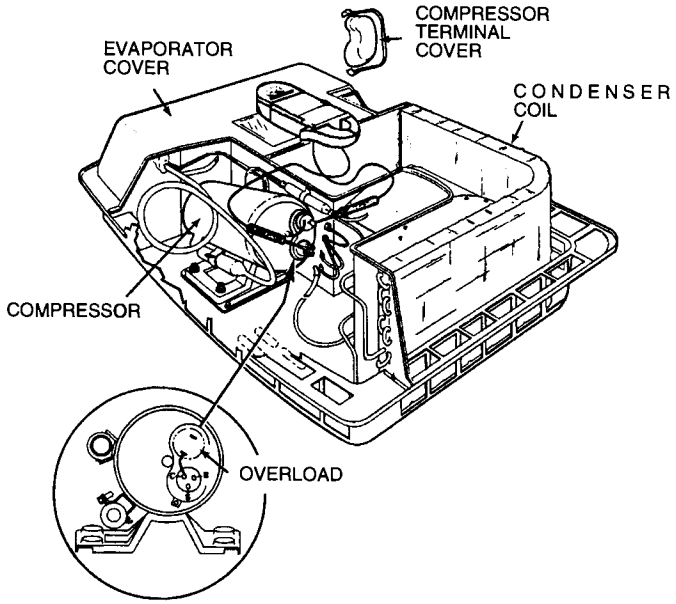


4.9 BLOWER MOTOR

To check the blower motor, turn the air conditioner circuit breaker to OFF, and disconnect the five wires. Set your ohm meter to its highest scale for these tests. Check for continuity between the white wire and each of the other wires.

Lack of continuity between the white wire and any of the other wires indicates an open circuit and requires that the motor be changed. Next, scrape some paint off the motor casing and check for continuity between each wire and the motor casing. If you get continuity between any of the wires and the motor casing, you have a grounded motor and it must be replaced.





4.10 OVERLOAD PROTECTOR

The overload protector will open the AC volt circuit to the compressor if the compressor overheats due to an electrical problem. To check the overload protector, turn the air conditioner circuit breaker OFF. Make sure that the overload is at ambient temperature and measure continuity across its terminals. If open, it should be replaced. A weak overload protector in the electrical system will cause the compressor to start and stop rapidly or short cycle. This situation would be difficult to test. An exact replacement overload protector should be used whenever a replacement is required.

4.11 COMPRESSOR

To check compressor, turn the air conditioner circuit breaker to OFF. Disconnect the wires from the COMMON, START and RUN terminals. With the ohm meter set on the lowest ohm scale, check for continuity between all three terminals. Lack of continuity between any of the terminals indicates faulty windings in the compressor, and the compressor should be replaced. Next, scrape some paint off the casing of the compressor and check for continuity between each terminal and the casing. If a reading is obtained, the windings are shorted to the casing and the compressor must be replaced.

4.12 HEATER

The heater is an optional component. To diagnose the heat strip, turn the air conditioner circuit breaker OFF. Unplug the heater and take an ohm reading across the two wiring terminals. You should have an ohm reading of 9.5 ohms ± 10 percent. If the ohm reading is outside of these parameters, replace the heater.

To check the heater limit switch, check for continuity across the limit switch terminals with the limit switch at ambient temperature. If you have an open limit switch, replace it. Also, make sure the heater plug is properly connected.

4.13 COLD CONTROL

(Low Temperature Protection Device)

On the roof mounted ducted (in ceiling duct) air conditioner, the cold control is used to prevent ice from forming on the evaporator coil. Restricted air entering or exiting the air conditioner is the most common cause of ice formation on the coil.

There are two types of cold controls: a normally closed and a normally open control.

If the cold control is wired in the power supply to the compressor, it is a normally closed type (continuity).

It will open the circuit at a temperature below freezing and will close when the temperature of the line reaches approximately 65° to 70°F. Do a continuity test through the control. Continuity means the control is completing the circuit. No continuity means the control is not completing the circuit. Verify the temperature of the line before changing.

If the cold control is wired other than in the power supply to the compressor, it is a normally open type (no continuity). When the refrigerant line the cold control is attached to reaches below freezing temperatures, it will close (continuity). When the temperature of the line reaches approximately 65° to 70°F., it will open (no continuity). Verify temperature of the refrigerant line before changing.

SECTION 5

AIR FLOW

5.1 SHORT CYCLE

A. AIR DISTRIBUTION BOX INSTALLATIONS

Short cycle is caused by cold air being drawn back into the intake side of the air conditioner before it is mixed with the warmer room air. The capillary tube of the thermostat senses this colder air and will make the compressor shut off. This may also cause the evaporator coil to freeze up.

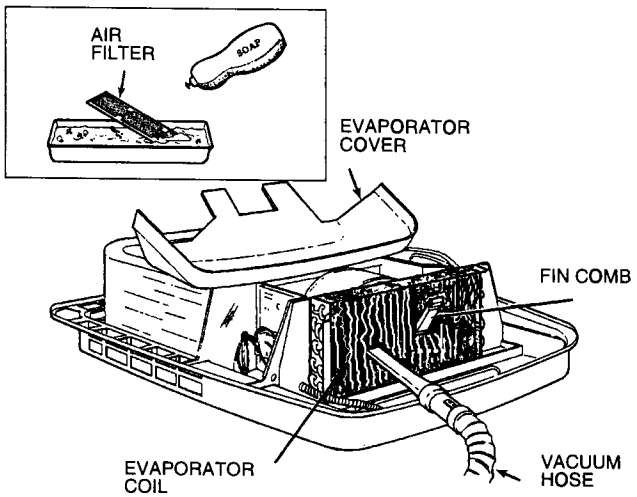
Two possible causes of this condition are the air box and the discharge duct. If the air box is not sealed tightly against the ceiling, it will allow cold air to cross over into the return air portion of the air box, and lower the temperature at the capillary sensor tube. Also, if the discharge duct is not installed properly, it can allow cold air to cross over into the return portion of the air conditioner. Make sure you have the correct discharge duct for the thickness of the roof. Seal all problem areas as necessary. You may need to use tape to seal the discharge duct. Also, make sure the discharge louvers are not restricted.

B. DUCT IN CEILING UNITS

Short cycle could be caused by cold air being circulated directly on the wall control unit (control board or thermostat). Make sure you do not have a ceiling register too close to the wall control. Verify the duct connection at the air conditioner is not leaking cold air into return air. Seal all problem areas.

5.2 AIR FLOW OBSTRUCTION

The coils and filters must be kept clean. Obstructions reduce the amount of air passing through the coils. Dirt acts as an insulator reducing the heat transfer across the fins. Turn the air conditioner circuit breaker to OFF. Brush the fins with a soft bristle brush, and vacuum up the residue. The filters should be cleaned in a soap solution and rinsed in clean water. Air-dry the filters before reinstalling; a wet filter can cause insufficient cooling or freeze-up.



5.3 AIR DISTRIBUTION SYSTEM

The below listed information is for the 579 series and 590 series air conditioners for specific information refer to the installation instructions for the specific model you are diagnosing.

The Installer of this Air Conditioner System must design the air distribution system for his particular application. Several requirements for this system **MUST** be met for the Air Conditioner to operate properly. These requirements are as follows:

A. Roof cavity thickness must be between 2.00" to 5.50". This distance is measured between roof and ceiling surface.

B. The total Cross-Sectional Discharge Area of outlet ducts from the Plenum Area under the Air Conditioner must be as follows:
   1. 579 & 600 Series; 17.5 sq. in.
   2. 590 Series; 21.0 sq. in.

C. Duct Sizing Requirements as follows:

	Min.	Max.
1. Duct Depth (590 Series)	1-1/2"	2-1/4"
(579 & 600 Series)	1-1/4"	2-1/4"
2. Duct Width	7.00"	— — —
3. Total Duct Length	12 ft.	36 ft.
4. Duct Length (Short Run)	1/3 Total Length	

D. Register Requirements as follows:

	Min.	Max.
1. Distance from Duct End	5"	8"
2. Distance from End of Elbow	15"	
3. Distance between Registers	24"	—
4. Total Number Required/AC	4	8
5. Number required per Run/AC	2	- - -
6. Free Area per Register	14 sq. in.	- - -

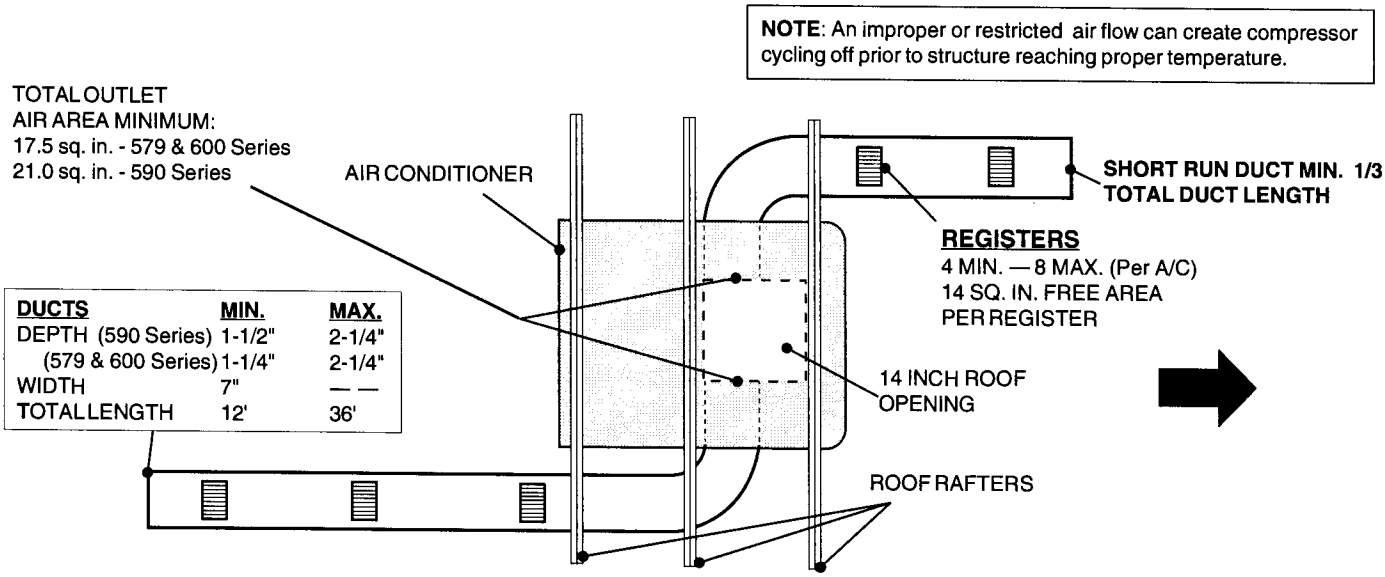
E. The Duct material must meet or exceed any agency or RVIA Standard that may be in existence at the time the RV is produced.

NOTE

IT IS THE RESPONSIBILITY OF THE INSTALLER OF THIS SYSTEM TO INSURE THE DUCT-WORK WILL NOT COLLAPSE OR BEND DURING OR AFTER THE INSTALLATION.

F. All Discharge Air Ducts must be properly insulated to prevent condensation from forming on their surfaces or adjacent surfaces during operation of the Air Conditioner. This insulation must be R-7 minimum.

G. Ducts and their joints must be sealed to prevent condensation from forming on adjacent surfaces during operation of the Air Conditioner.



NOTE

THE DOMETIC CORPORATION WILL NOT BE HELD LIABLE FOR ROOF STRUCTURAL OR CEILING DAMAGE DUE TO IMPROPERLY INSULATED OR SEALED DUCT-WORK.

H. Return Air Opening must have 40 sq. in. minimum free area including the filter.

I. Return Air to the Air Conditioner must be filtered to prevent dirt accumulation on Air Conditioner Cooling surface.

J. Total System Pressure must be between the following:
   1. 0.55 to 0.90 in. W.C. for 579 Series
   2. 0.40 to 1.10 in.W.C. for 590 Series
   3. 0.12 to 0.65 in W.C. for 600 Series

   This is determined with the Air Conditioner Blower operation on High Speed and Return Air Filter and Grille in place.

NOTE

IT IS THE RESPONSIBILITY OF THE INSTALLER OF THIS AIR CONDITIONER SYSTEM TO INSURE THE STRUCTURAL INTEGRITY OF THE RV ROOF.

K. The Thermostat must be located on an inside wall of the RV, 54" above the floor. The Thermostat must not be located near a heat source.

SECTION 6

OTHER

6.1 AMBIENT TEMPERATURE

Running the air conditioner at a temperature below 75 degrees Fahrenheit may cause the evaporator to freeze up. The most common time for this to occur is at night. Even after the ambient temperature has gone up, the coils will remain frozen. Therefore, to assist the defrosting of the evaporator coils, turn the air conditioner to HI FAN mode; set the temperature selector to a higher setting and let the air conditioner run until the coils are defrosted.

6.2 HEAT GAIN

Heat gain can be caused by several factors: A hot, humid and sunny day; a large number of people in the coach; frequent opening of the door; excessive showering and cooking, etc.

Other factors to be taken into consideration as possible heat gain causes are the size of the air conditioner relative to the size of the coach; the "R" factor of insulation; and the size and placement of widows. The manufacturer of the RV should be consulted for recommendations.

6.3 LOOSE PARTS

Loose parts can cause the air conditioner to operate noisily. Check for any loose bolts, any component rubbing against its housing, or any plastic parts which might be cracked. Repair or replace parts as necessary to correct any noise problems.

6.4 TUBING VIBRATION

If any of the copper tubing is rubbing against itself or any other part, verify that the proper tubing has been installed. Duo-Therm air conditioners are designed to avoid this problem if the correct tubing is used. Replace or position tubing as necessary.

6.5 CONDENSER OR BLOWER FAN

The blower motor will have either a squirrel-cage or blade-type fan attached to it. Turn the air conditioner circuit breaker to OFF. Adjust the component to make sure it is not rubbing against the bulkhead. If it is a blade-type fan, the blades should be half through the opening for proper operation. Replace the blade fan or squirrel-cage if necessary.

6.6 INSTALLATION

The installation must be according to manufacturer's instructions for the specific model.

The air conditioner must not be installed in a valley on the roof; water may pool around the drain holes and be drawn into the air conditioner.

Make sure the air conditioner is tightened to the specifications. Overtightening can cause the unit to leak. Use caution not to damage the mounting gasket when placing the air conditioner over the opening, as this can allow water to leak into the coach.

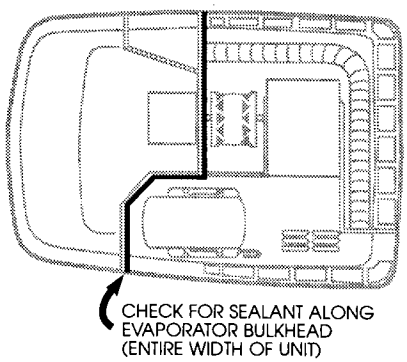
The air conditioner may be installed across a roof seam, but make sure this area is properly sealed to prevent leakage.

6.7 DRAIN HOLE PLUGGED

Some drain pan problems may be caused by a blockage or restriction of the drain holes. This could be a piece of styrofoam or dirt, etc., in or around a drain hole causing water to accumulate in the drain pan and be sucked up into the unit. Remove any blockage as necessary.

6.8 EVAPORATOR BULKHEAD LEAK

The rear section of the air conditioner which contains the compressor, blower motor and condenser coil is designed to dispose of any water which may enter. However, to ensure that no water enters the evaporator section, a watertight seal must exist along the entire evaporator bulkhead which separates the two compartments. Check for sealant along this entire section and add sealant at any area where none is visible. Note that the sealed portion extends up the sides of the unit.



SECTION 7

SEALED SYSTEM

7.1 RECHARGING

NOTE: The ***Clean Air Act*** of 1990 set guidelines in regard to recapturing or disposition of refrigerants. Check with local authorities for proper handling or evacuation of refrigerants.

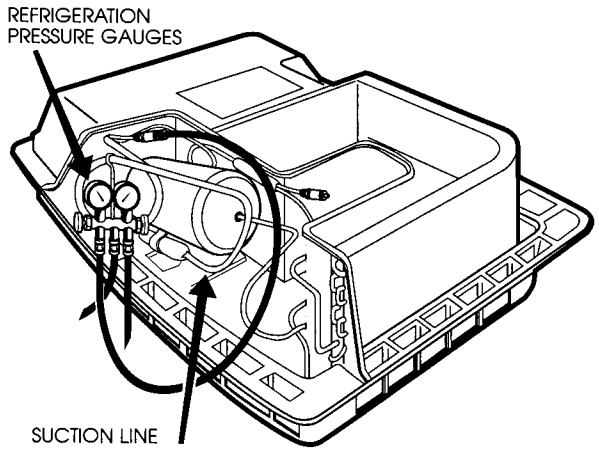
The equipment items needed to properly evacuate and recharge a sealed system are: a piercing type clamp-on saddle valve; a braze-on processing valve; a core removal tool; a process tube fitting; a set of compound gauges; a vacuum pump; equipment to weigh a precise amount of refrigerant; R-22 refrigerant; gas welding equipment; a R-22 refrigerant leak detector and recapturing or recycling equipment. **If you have not been properly trained in sealed system repairs, do not attempt this procedure.**

NOTE: This is not a thorough sealed system repair training program. For additional information or training, you may want to attend a basic air conditioning course at your local college.

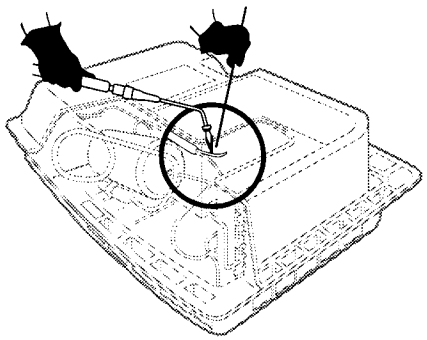
To drain the R-22 refrigerant, attach a clamp-on saddle valve on the low side process tube. If the air conditioner does not have a low side process tube, attach a saddle valve at the point where you will add a process tube.

Slowly drain the R-22 refrigerant by using recapturing or recycling equipment. Do not leave the clamp-on saddle valve on the unit as it will cause leaks.

If you are going to use the braze-on processing valve, once the refrigerant has been drained, use a tubing cutter and cut the tube near the end. Do this on both the low and high side processing tubes.



Next weld the process tube in place. We recommend using a brazing material which melts between 950° and 1450° Fahrenheit, and contains a minimum of 2% silver, and 5% to 10% phosphorous. This type of brazing material does not require the use of a flux to join copper to copper. If you are using the weld on the process valve, be sure the valve core is removed before any heat is applied.



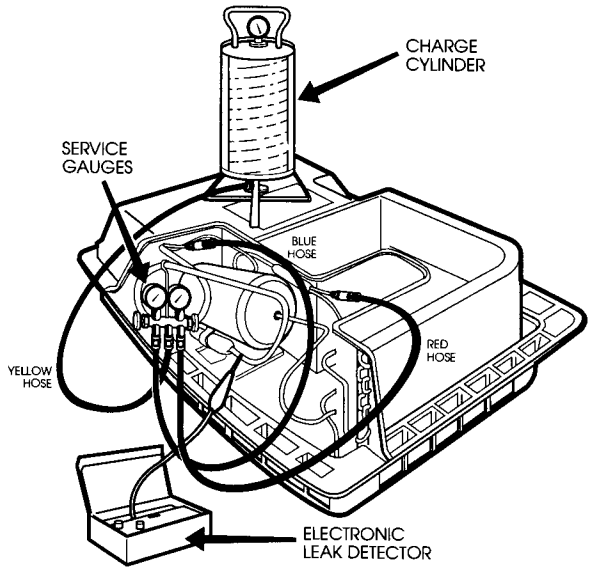
Connect the blue colored low pressure line of the compound gauges to the charging port on the low side pressure tubing. Next, connect the red colored high pressure line of the compound gauges to the charging port on the high side pressure tubing.
Next, connect the yellow colored line of the compound gauges to the charging cylinder and add 2 or more ounces of R-22 refrigerant to the sealed system and check all weld joints for leaks. Allow the refrigerant to stay in the system for at least 10 minutes. If a leak is detected, drain the system and repair the leak before you proceed.

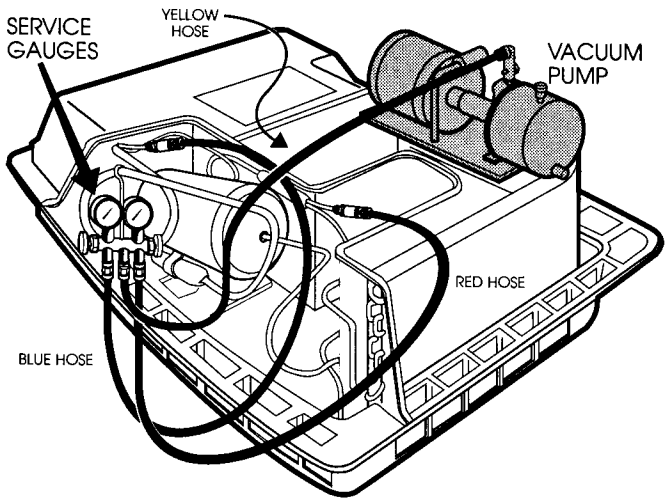
When you are certain the system is sealed, drain any refrigerant from the system and connect the yellow common line of the compound gauges to the vacuum pump.

Open the pressure relief valve on the vacuum pump. This allows the major contaminants from the sealed system to escape into the atmosphere rather than enter the oil in the vacuum pump.

Both the low and high side valves on the compound gauge set should be opened and the vacuum pump turned on.

After five minutes, close the pressure relief valve on the vacuum pump. Check the blue gauge after running the vacuum pump for 10 minutes. A vacuum reading of zero to 10 inches would indicate a leak in the system or the hose connections.





Check all hose connections for tightness. If the low side gauge does not change, there is a leak in the sealed system. Locate the leak and correct it before proceeding.

If the blue low side gauge is well below 10 inches of vacuum, continue the evacuation for at least 40 to 45 minutes or until **you have a dry system**.

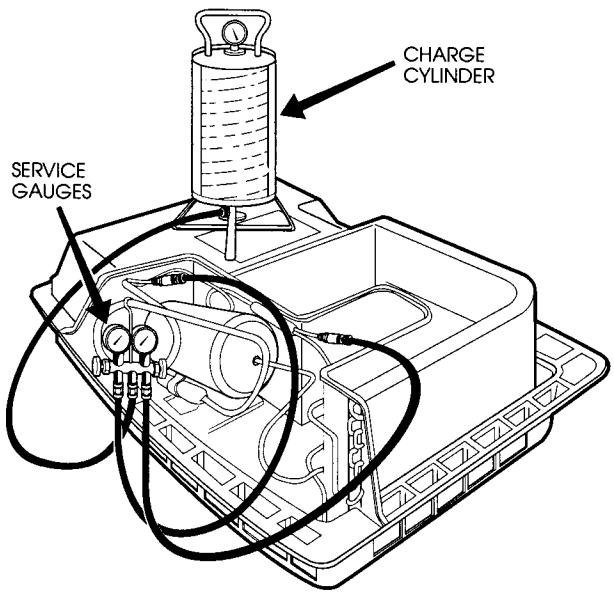
At this time there should be a good, deep evacuation, or dry atmosphere inside the sealed system. Close both the low and high side valves on the compound gauge set and turn off the vacuum pump.

Disconnect the yellow colored hose at the vacuum pump and connect it to the bottom port or connection on the charging cylinder. Open the valve on the cylinder.

For the correct amount of R-22 refrigerant charge, check the data plate of the air conditioner you are working on. To compensate for the red liquid line, on the gauge set (approx. 30—36 inches long), add one ounce to the data plate amount. You are now ready to do a weighted charge.

The air conditioner charge is critical and must be exact for proper cooling.

Allow the refrigerant charge to equalize by waiting 10 minutes before starting the system. After 10 minutes, do a cooling performance test to determine whether the problem was in the amount of charge or within the components of the system.



Now the blue low side and the red high side lines should be disconnected. Make sure that the air conditioner connection is sealed before removing the lines. The process tube can be pinched off in two places; the charging port cut off, and the end of the tube brazed for a hermetically sealed system.

7.2 SEALED SYSTEM PROBLEMS

One mechanical problem you may encounter is refrigerant flow restriction. There are two types of restrictions, high side and low side. The basics to use to determine a restriction are amp draw and pressure.

To determine the high side pressure, add 32 degrees to your ambient temperature. Find that temperature on the chart on Page 21. The pressure listed to the right of the temperature should be your correct high side pressure, plus or minus 7 PSIG. For the low side pressure, divide the high side pressure by four. This will be the low side pressure, plus or minus 3 PSIG.

High side restriction will cause higher than normal amp draw, drastically higher than normal high side pressures, and slightly higher than normal low side pressures.

Low side restriction will cause lower than normal amp draw, drastically lower than normal low side pressures and slightly lower than normal high side pressures.

A restriction that would not follow these basic conditions is a liquid line restriction, which is in the high side of the air conditioner. It will give the same results as a low side restriction.

The most common restriction is the capillary tube or tubes, and/or at the filter-drier. If there is a restriction in the liquid line, there will be a temperature drop from one side of the restriction to the other side.

In the case of a capillary tube restriction, one tube would be normal (warm to the touch) and the restricted tube would be cool or cold to the touch, and could even sweat if operated long enough.

A restriction in the filter-drier would cause a temperature drop at the point of the restriction. A buildup of frost or sweat could be evident if operated long enough.

Refrigerant leaks can occur from an improper weld, a broken line or other damage. Compressor oil will often be noticeable at the location of major leaks.

Replace any parts that are found to be bad. Whenever a component is replaced in the sealed system, or the system has been opened to the atmosphere, a new filter-drier and evacuation is required.

REFRIGERANT VAPOR PRESSURES (PSIG)

Temp. Deg. F.	Pressure PSIG R-22	Temp. Deg. F.	Pressure PSIG R-22	Temp. Deg. F.	Pressure PSIG R-22	Temp. Deg. F.	Pressure PSIG R-22
20	43.0	57	96.1	94	179.1	131	300.7
21	44.1	58	97.9	95	181.8	132	304.6
22	45.3	59	99.8	96	184.6	133	308.6
23	46.4	60	101.6	97	187.4	134	312.6
24	47.6	61	103.5	98	190.2	135	316.6
25	48.8	62	105.4	99	193.0	136	320.7
26	50.0	63	107.3	100	195.9	137	324.8
27	51.2	64	109.3	101	198.8	138	328.9
28	52.4	65	111.2	102	201.8	139	333.1
29	53.6	66	113.2	103	204.7	140	337.3
30	54.9	67	115.2	104	207.7	141	341.5
31	56.2	68	117.3	105	210.3	142	345.8
32	57.5	69	119.4	106	213.8	143	350.1
33	58.8	70	121.4	107	216.9	144	354.5
34	60.1	71	122.5	108	220.0	145	358.9
35	61.5	72	125.7	109	223.2	146	363.4
36	62.8	73	127.8	110	226.4	147	367.8
37	64.2	74	130.0	111	229.6	148	372.4
38	65.6	75	132.2	112	232.8	149	376.9
39	67.1	76	134.5	113	236.1	150	381.5
40	68.5	77	136.7	114	239.4	151	386.2
41	70.0	78	139.0	115	242.7	152	390.9
42	71.5	79	141.3	116	246.1	153	395.6
43	73.0	80	143.6	117	249.5	154	400.4
44	74.5	81	146.0	118	253.0	155	405.2
45	76.0	82	148.4	119	256.4	156	410.0
46	77.6	83	150.8	120	259.9	157	414.9
47	79.2	84	153.2	121	263.5	158	419.9
48	80.0	85	155.7	122	267.0	159	424.8
49	82.4	86	158.2	123	270.6	160	429.9
50	84.0	87	160.7	124	274.3	161	434.9
51	85.7	88	163.2	125	278.0	162	440.1
52	87.4	89	165.8	126	281.7	163	445.2
53	89.1	90	168.4	127	285.4	164	450.4
54	90.8	91	171.0	128	289.2	165	455.7
55	92.6	92	173.7	129	293.0		
56	94.3	93	176.4	130	296.8		