



Service Manual

SPLIT-SYSTEM RESIDENTIAL AIR CONDITIONER AND HEAT PUMP

Cancels: SM01,02-3

SM01,02-4
3-1-94

NOTE: Read the entire instruction manual before starting the installation.

SAFETY CONSIDERATIONS

Service and repair of these units should be attempted only by trained service technicians familiar with BDP standard service instructions and training material.

All equipment should be installed in accordance with accepted practices and unit Installation Instructions, and in compliance with all national and local codes.

Power should be turned off when servicing or repairing electrical components. Extreme caution should be observed when troubleshooting electrical components with power on. Observe all warning notices posted on equipment.

Refrigeration system contains refrigerant under pressure. Extreme caution should be observed when handling refrigerants. Wear safety glasses and gloves to prevent personal injury. During normal system operation, some components are hot and can cause burns. Rotating fan blades can cause personal injury. Appropriate safety considerations are posted throughout this manual where potentially dangerous techniques are addressed.

⚠	<p>WARNING: Improper installation, adjustment, alteration, service, maintenance, or use can cause explosion, fire, electrical shock, or other conditions which may cause personal injury, death or property damage. Consult a qualified installer, service agency, or your distributor or branch for information or assistance. The qualified installer or agency must use factory-authorized kits or accessories when modifying this product.</p>
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INTRODUCTION

This service manual enables a service technician to service, repair, and maintain a family of similar air conditioners and heat pumps. It covers standard single-speed products and 2-speed products only. For variable-speed products, refer to the respective service manuals.

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UNIT IDENTIFICATION

I. PRODUCT NUMBER STAMPED ON UNIT RATING PLATE

The unit product number has 16 positions containing groups of numbers and letters that indicate specific information about the unit. Listed below is the breakdown of the 16 positions.

Positions 1, 2, and 3—Product Series

Example:

A 500 series number indicates a split-system condensing unit and a 600 series number indicates a split-system heat pump.

Position 4—Model Letter

New models are introduced with the letter A, and subsequent major model changes are identified by changing to the next letter, B then C, etc.

Position 5—Electrical Characteristics

Example:

J—208-230, 1 Phase, 60 Hertz

N—208/230, 208/240, 1 Phase, 60 Hertz

P—208/230, 208/240, 3 Phase, 60 Hertz

E—460, 3 Phase, 60 Hertz

Q—220, 3 Phase, 50 Hertz

S—220/240, 1 Phase, 50 Hertz

Z—380/415, 3 Phase, 50 Hertz

Position 6—Fuel and Controls

Not applicable on condensing units or heat pumps, so the letter X is used to signify none.

Positions 7, 8, and 9—Nominal Cooling Capacity (in thousands Btuh)

Example:

036 = 36,000 Btuh or 3-ton capacity.

Positions 10, 11, and 12—Heating Capacity

Not applicable on condensing units or heat pumps, so the number zero is used to signify none.

Position 13—Brand Name

Example:

A—Common unit (B, D or P logo)

M—BDP labeled

J—Common unit (50-cycle export products)

Position 14—Unit Series

New units are introduced with the letter A, and subsequent major component variations such as in compressor, fan motor, coil circulator size, etc., are identified by changing to the next letter, B then C, etc.

Positions 15 and 16—Product Variations

Example:

AA—Standard unit

Other letters—For product variations from standard

II. SERIAL NUMBER IDENTIFICATION

The unit serial number has 10 positions containing groups of numbers and a letter that indicate specific information about the unit. Listed below is the breakdown of the 10 positions.

Positions 1 and 2—Week of Manufacture

Example:

01—First week of a year

52—Last week of a year

Positions 3 and 4—Year of Manufacture

Example:

94—1994

Position 5—Manufacturing Site

Example:

A—Indianapolis

E—Collierville

Positions 6 through 10—Serial Number

CABINET

Certain maintenance routines and repairs require removal of cabinet panels. There are 4 basic cabinet designs for air conditioners and heat pumps. (See Fig. 1.)

I. REMOVE TOP COVER—RELIANT/ENDURA PRODUCTS PRIOR TO JANUARY 1992

1. Turn off all power to outdoor and indoor units.
2. Remove screws holding top cover to coil grille and corner posts.
3. Remove access panel.
4. Remove information plate.
5. Disconnect fan motor wires, cut wire ties, and remove wire ties from control box. Refer to unit wiring label.
6. Lift top cover from unit.
7. Reverse sequence for reassembly.

II. REMOVE FAN MOTOR ASSEMBLY—RELIANT/ENDURA PRODUCTS PRIOR TO JANUARY 1992

1. Perform items 1 through 6 above.
2. Remove nuts holding fan motor top cover.
3. Remove motor and fan blade assembly.
4. Reverse sequence for reassembly.
5. Prior to applying power, check that fan rotates freely.

III. INFORMATION PLATE—RELIANT/ENDURA PRODUCTS

The information plate is secured to the front of the control box and provides a cover for it. (See Fig. 2.) This plate also provides a surface to attach the wiring schematic, superheat charging tables with instructions, and warning labels. The plate has 2 tabs on the top edge that are bent down at slightly more than 90°. When the information plate is removed, these tabs can be inserted into 2 mating slots in the bottom front edge of the control box and the plate will hang down forming a lower front panel. (See Fig. 3.) This is convenient where access to the controls is required while the unit is operating. The information plate on the small size casing completely covers the opening below the control box. On larger models, the information plate may not cover the entire opening. In this instance, the top cover can be removed and placed on its side to cover the additional space.

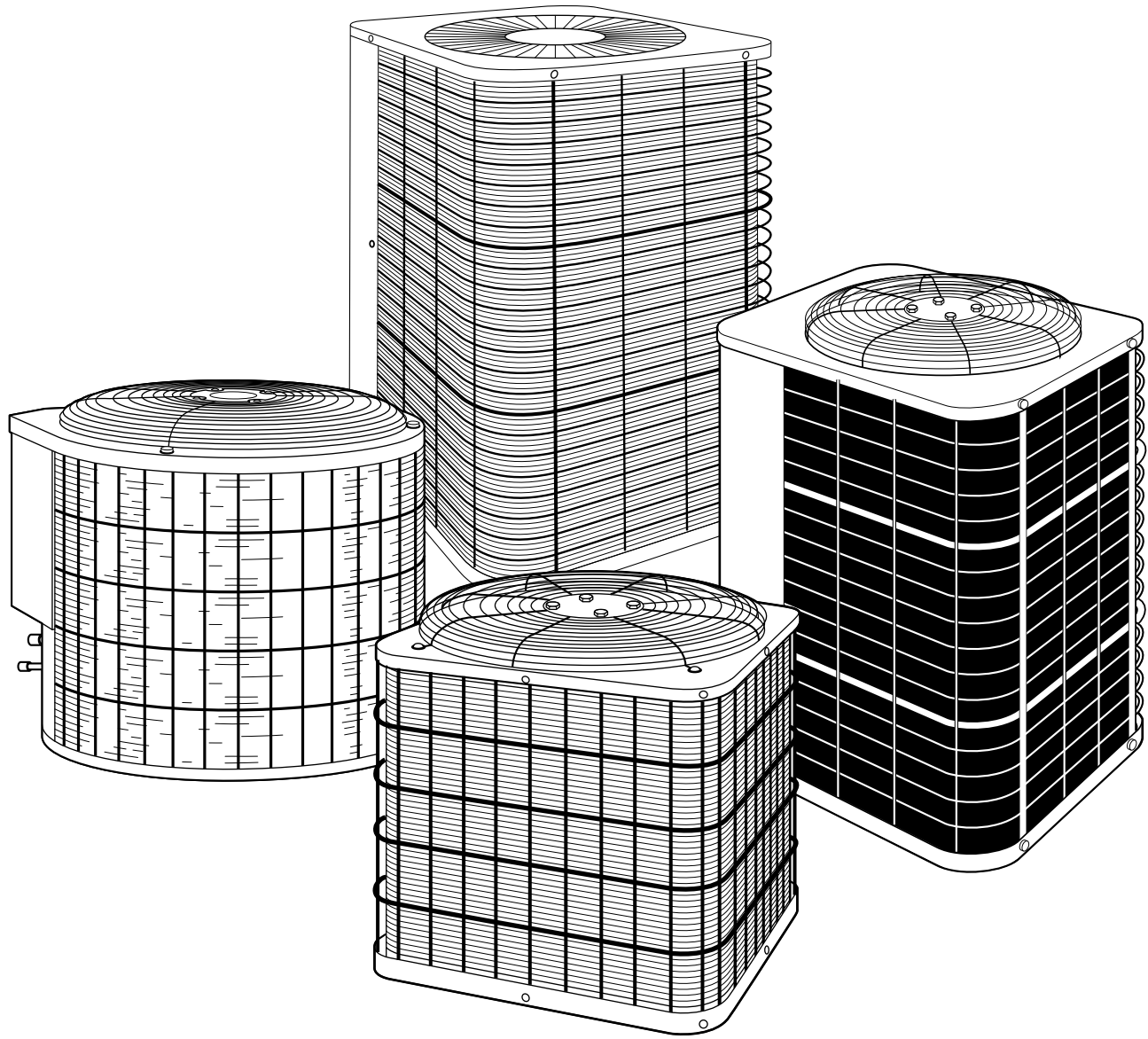


Fig. 1—Basic Cabinet Designs

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IV. CONTROL BOX COVER—CUBE/TEARDROP PRODUCTS

This panel contains much of the same information as the information plate mentioned previously, but is designed only to cover the control box.

V. REMOVE TOP COVER—ALL PRODUCTS AFTER JANUARY 1, 1992

1. Turn off all power to outdoor and indoor units.
2. Remove 5 screws holding top cover to coil grille and coil tube sheet.
3. Remove 2 screws holding control box cover.
4. Remove 2 screws holding information plate.
5. Disconnect fan motor wires, cut any wire ties, and move wires out of control box and through tube clamp on back of control box.
6. Lift top cover from unit.
7. Reverse sequence for reassembly.

VI. REMOVE FAN MOTOR ASSEMBLY—ALL PRODUCTS AFTER JANUARY 1, 1992

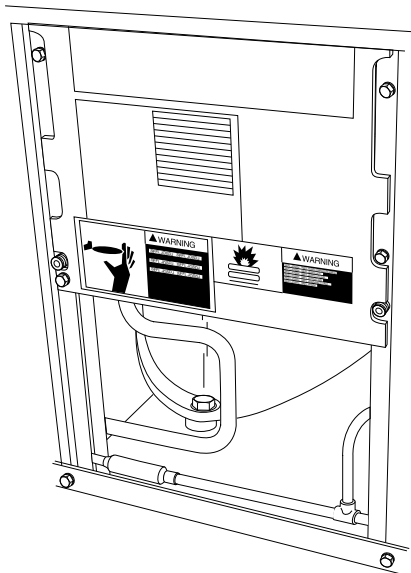
1. Perform items 1, 3, 4, and 5 above. (Note item 2 is not required.)
2. Remove 4 screws holding wire basket to top cover.

3. Lift wire basket from unit.
4. Remove nuts holding fan motor to wire basket.
5. Remove motor and fan blade assembly.
6. Pull wires through wire raceway to change motor.
7. Reverse sequence for reassembly.
8. Prior to applying power, check that fan rotates freely.

ELECTRICAL

⚠	<p>WARNING: Exercise extreme caution when working on any electrical components. Shut off all power to system prior to troubleshooting. Some troubleshooting techniques require power to remain on. In these instances, exercise extreme caution to avoid danger of electrical shock. ONLY TRAINED SERVICE PERSONNEL SHOULD PERFORM ELECTRICAL TROUBLESHOOTING.</p>
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Troubleshooting charts for air conditioning and heat pump units are provided in the back of this manual. They enable the service technician to use a systematic approach to locating the cause of a problem and correcting system malfunctions.



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Fig. 2—Information Plate

I. ALUMINUM WIRE

⚠	<p>CAUTION: Aluminum wire may be used in the branch circuit (such as the circuit between the main and unit disconnect), but only copper wire may be used between the unit disconnect and the unit on BDP systems.</p>
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Whenever aluminum wire is used in the branch circuit wiring with this unit, adhere to the following recommendations.

Connections must be made in accordance with the National Electrical Code (NEC), using connectors approved for aluminum wire. The connectors must be UL approved (marked Al/Cu with the UL symbol) for the application and wire size. The wire size selected must have a current capacity not less than that of the copper wire specified, and must not create a voltage drop between the service panel and the unit in excess of 2 percent of the unit rated voltage. To prepare the wire before installing the connector, all aluminum wire must be "brush-scratched" and coated with a corrosion inhibitor such as Pentrox A. When it is suspected that the connection will be exposed to moisture, it is very important to cover the entire connection completely to prevent an electrochemical action that will cause the connection to fail very quickly. Do not reduce the effective size of wire, such as cutting off strands so that the wire will fit a connector. Proper size connectors should be used. Check all factory and field electrical connections for tightness. This should also be done after the unit has reached operating temperatures, especially if aluminum conductors are used.

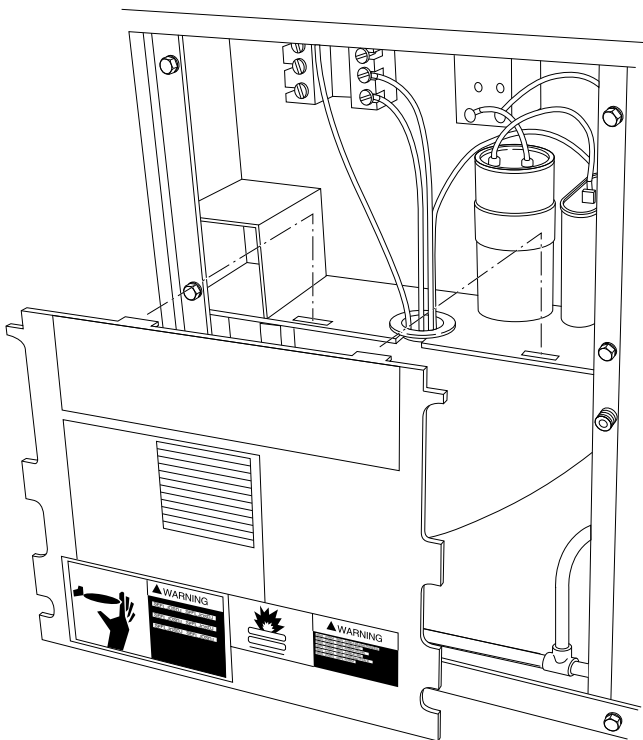
II. CONTACTORS

NOTE: This section applies to single-speed models only.

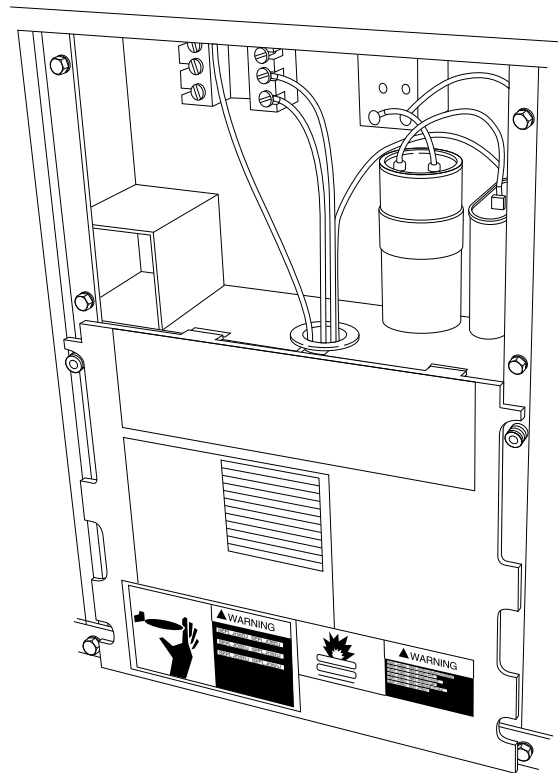
The contactor provides a means of applying power to unit using low voltage (24v) from transformer in order to power the contactor coil. (See Fig. 4.) Depending on unit model, you may encounter single-, double-, or triple-pole contactors to break power. One side of the line may be electrically energized, so exercise extreme caution when troubleshooting.

The contactor coil for residential air conditioning units and heat pumps is powered by 24 vac. If contactor does not operate:

1. With power off, check whether contacts are free to move. Check for severe burning or arcing on contact points.
2. With power off, use ohmmeter to check for continuity of coil. Disconnect leads before checking. A low-resistance reading is normal. Do not look for a specific value, as different part numbers have different resistance values.

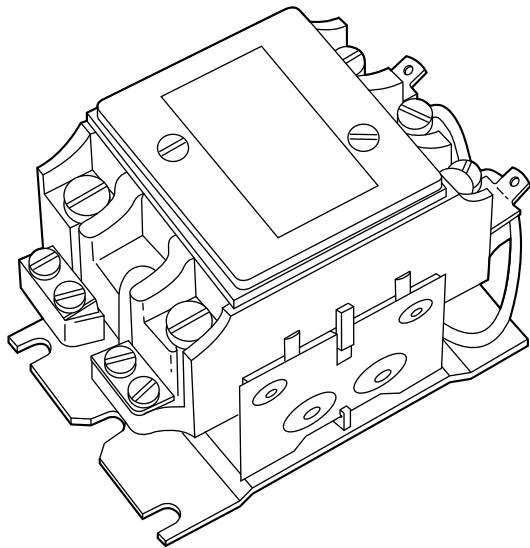


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Fig. 3—Information Plate Removed/Installed Below Control Box



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Fig. 4—Contactor

3. Reconnect leads and apply low-voltage power to contactor coil. This may be done by leaving high-voltage power to outdoor unit off, and turning thermostat to heat or cool. Check voltage at coil with voltmeter. Reading should be between 20v and 30v. Contactor should pull in if voltage is correct and coil is good. If contactor does not pull in, change contactor.
4. With high-voltage power off and contacts pulled in, check for continuity across contacts with ohmmeter. A very low or zero resistance should be read. Higher readings could indicate burned or pitted contacts which may cause future failures.

III. CAPACITORS

CAUTION: Capacitors can store electrical energy when power is off. Electrical shock can result if you touch the capacitor terminals and discharge the stored energy. Exercise extreme caution when working near capacitors. With power off, discharge stored energy by shorting across the capacitor terminals with a 15,000-ohm, 2-watt resistor.

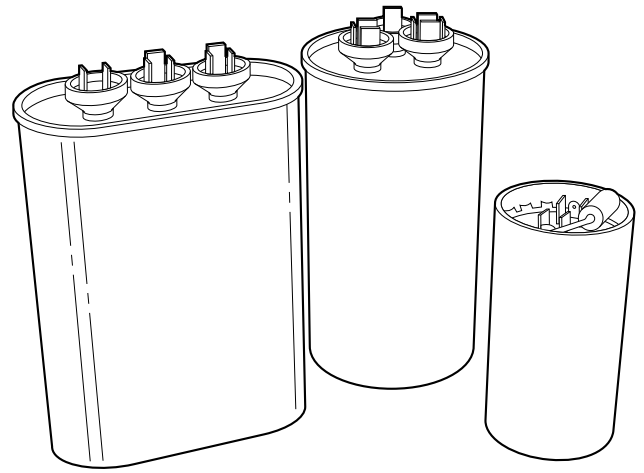
NOTE: If bleed resistor is wired across start capacitor, it must be disconnected to avoid erroneous readings when ohmmeter is applied across capacitor.

(See Fig. 5.)

CAUTION: Always check capacitors with power off. Attempting to troubleshoot a capacitor with power on can be dangerous. Defective capacitors may explode when power is applied. Insulating fluid inside is combustible and may ignite, causing burns.

Capacitors are used as a phase-shifting device to aid in starting certain single-phase motors. Check capacitors as follows.

1. After power is off, discharge capacitors as outlined above. Disconnect capacitor from circuit. Put ohmmeter on R X 10k scale. Using ohmmeter, check each terminal to ground (use capacitor case). Discard any capacitor which measures 1/2 scale deflection or less. Place ohmmeter leads across capacitor and place on R X 10k scale. Meter should jump to a low resistance value and slowly climb to higher value. Failure of meter to do this indicates an open capacitor. If resistance stays at zero or a low value, capacitor is internally shorted.



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Fig. 5—Capacitors

2. Capacitance testers are available which read value of capacitor. If value is not within ± 10 percent value stated on capacitor, it should be changed. If capacitor is not open or shorted, the capacitance value is calculated by measuring voltage across capacitor and current it draws.

WARNING: Exercise extreme caution when taking readings while power is on. Electrical shock can cause personal injury or death.

Use following formula to calculate capacitance:

$$\text{Capacitance (mfd)} = \frac{2650 \times \text{amps}}{\text{volts}}$$

3. Remove any capacitor that shows signs of bulging, dents, or leaking. Do not apply power to a defective capacitor as it may explode.

A. Start Capacitors and PTC Devices

Sometimes under adverse conditions, a standard run capacitor in a system is inadequate to start compressor. In these instances, a start assist device is used to provide an extra starting boost to compressor motor. The first device is called a positive temperature coefficient (PTC) or thermistor. (See Fig. 6.) It is a resistor wired in parallel with the run capacitor. As current flows through the PTC at start-up, it heats up. As it heats up, its resistance increases greatly until it effectively lowers the current through it to an extremely low value. This, in effect, removes it from the circuit.

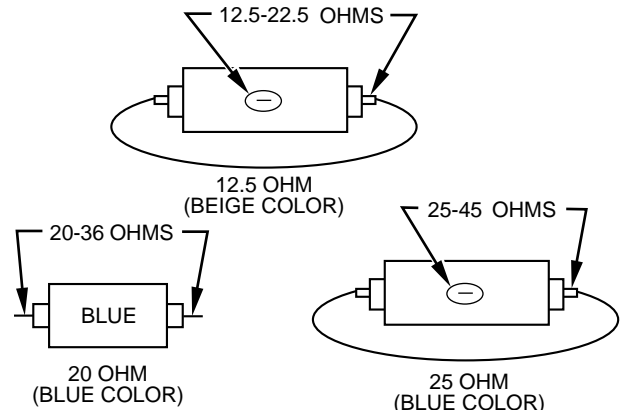


Fig. 6—PTC Devices

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After system shutdown, resistor cools and resistance value returns to normal until next time system starts. If indoor coil does not have a bleed-type expansion device, it may be necessary to remove start

thermistor and replace with accessory start capacitor and relay. Consult pre-sale literature for application of start kits. Thermistor device is adequate for most conditions, however, in systems where off cycle is short, device cannot cool fully and becomes less effective as a start device. It is an easy device to troubleshoot.

1. Shut off all power to system.
2. Check thermistor with ohmmeter as described below.
3. Shut off all power to unit.
4. Remove PTC from unit. Wait at least 10 minutes for PTC to cool to ambient temperature.
5. Measure resistance of PTC with ohmmeter as shown in Fig. 6.

The cold resistance (R_T) of any PTC device should be approximately 100-180 percent of device ohm rating.

- 12.5-ohm PTC = 12.5-22.5 ohm resistance - beige color
- 25-ohm PTC = 25-45 ohm resistance - blue color
- 20-ohm PTC = 20-36 ohm resistance - blue color

If PTC resistance is appreciably less than rating or more than 200 percent higher than rating, device is defective.

If thermistor is good and compressor does not start:

1. Disconnect thermistor from starting circuit.
2. Give compressor a temporary capacitance boost (see next section).
3. Run compressor for 10 minutes, shut off, and allow system pressure to equalize.
4. Reconnect start thermistor.
5. Try restarting compressor without boost capacitor. If after 2 attempts compressor does not start, remove thermistor. Add an accessory start capacitor relay package.

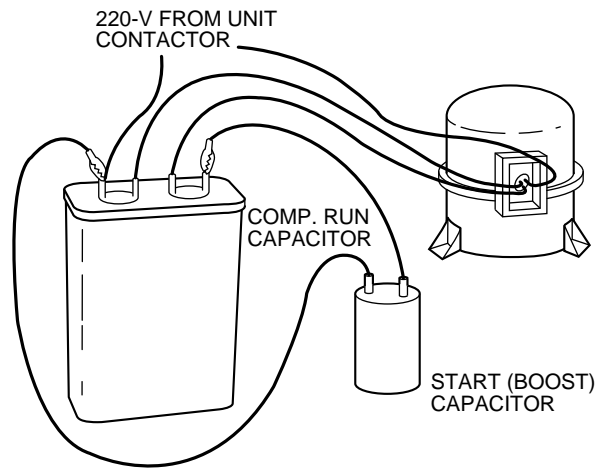
B. Temporary Capacitance Boost

There are times when a temporary capacitance boost is needed to get compressor started. (See Fig. 7.) Do not under any circumstances attach temporary boost capacitor directly across compressor terminals. Serious personal injury can result. Exercise extreme caution with this procedure when high-voltage power is on. If compressor motor does not start, it may be due to low-line voltage, improper pressure equalization, or weak run capacitor. Check each possibility and attempt capacitance boosting before adding auxiliary start capacitor and relay.

NOTE: Do not use start capacitor and relay on units with Millennium scroll compressors.

1. Turn off power.
2. Check compressor for ground or open. If it is not, proceed.
3. Obtain a start capacitor approved by compressor manufacturer. Connect wires with insulated probes to each terminal. Touch probes to each side of run capacitor.
4. Energize and start compressor, then pull probes away after 3 sec.
5. Discharge start capacitor.
6. Run compressor 10 minutes. Stop and allow to sit idle for 5 minutes.
7. Check system pressure equalization.
8. Attempt to restart without capacitance boost. If compressor does not start after several attempts, add proper auxiliary start capacitor and relay.

If PTC thermistor device is inadequate as start device, a start capacitor and relay may be added to system to ensure positive start. Capacitor is wired in parallel with run capacitor through normally closed set of contacts on a device called start relay. The relay coil



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Fig. 7—Capacitance Boosting

is wired across start and common terminals of compressor. The added capacitance gets the compressor started. As compressor comes up to speed, voltage across start and common terminals increases to a value high enough to cause start relay to energize. This opens normally closed contacts and removes start capacitor from circuit. In actual practice, this occurs in a fraction of a sec.

NOTE: If bleed resistor is wired across start capacitor, it must be disconnected to avoid erroneous readings when ohmmeter is applied across capacitor.

To check start relay and capacitor:

1. Turn off all power to unit.
2. Discharge start and run capacitors as outlined earlier.
3. Most start capacitors will have a 15,000-ohm, 2-watt bleed resistor. Disconnect these devices from system.

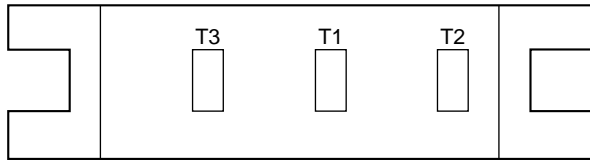
Start capacitor can be inspected visually. It is designed for short duration or intermittent duty. If left in circuit for prolonged period, start capacitor blows through a specially designed bleed hole. If it appears blown, check for welded contacts in start relay. Start capacitor can be checked by ohmmeter method discussed earlier. Start relay is checked with ohmmeter. Check for continuity across coil of relay. You should encounter a high resistance. Since relay contacts are normally closed, you should read low resistance across them. Both PTC device and capacitor relay start system are standard equipment on some of these units. They are also available as accessories and may be field installed.

IV. CYCLE PROTECTOR

Solid-state cycle protector device protects unit compressor by preventing short cycling. After a system shutdown, cycle protector provides for a 5 ± 2 -minute delay before compressor restarts. On normal start-up, a 5-minute delay occurs before thermostat closes. After thermostat closes, cycle protector device provides a 3-sec delay on HN67PA025, HN67ZA003, and HN67ZA008. (See Fig. 8, 9, and 10.)

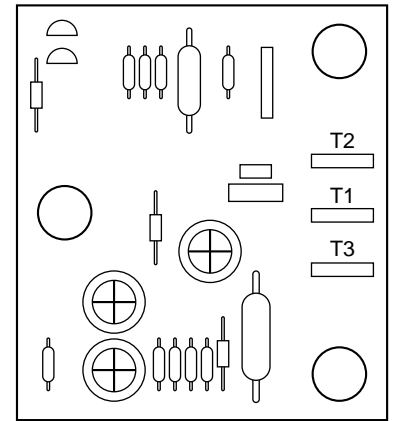
Cycle protector device is simple to troubleshoot. Only a voltmeter capable of reading 24v is needed. Device is in control circuit, therefore, troubleshooting is safe with control power (24v) on and high-voltage power off.

With high-voltage power off, attach voltmeter leads across T1 and T3, and set thermostat so that Y terminal is energized. Make sure all protective devices in series with Y terminal are closed. Voltmeter should read 24v across T1 and T3. With 24v still applied, move voltmeter lead from T1 terminal to T2 terminal across T2 and T3. After 5 ± 2 minutes, voltmeter should read 24v, indicating control is functioning normally. If no time delay is encountered or device never times out, change control.



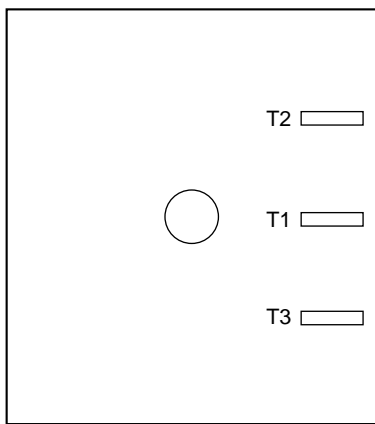
HN67ZA002

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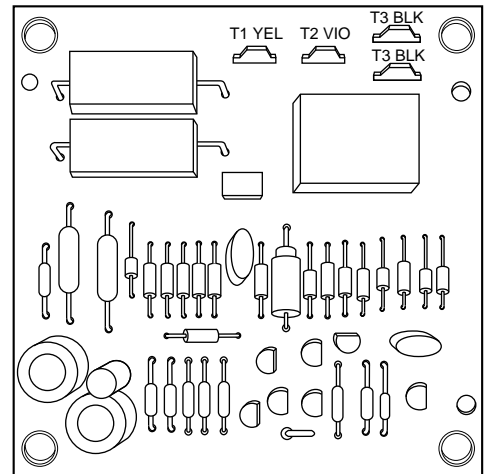
HN67ZA008

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HN67ZA003

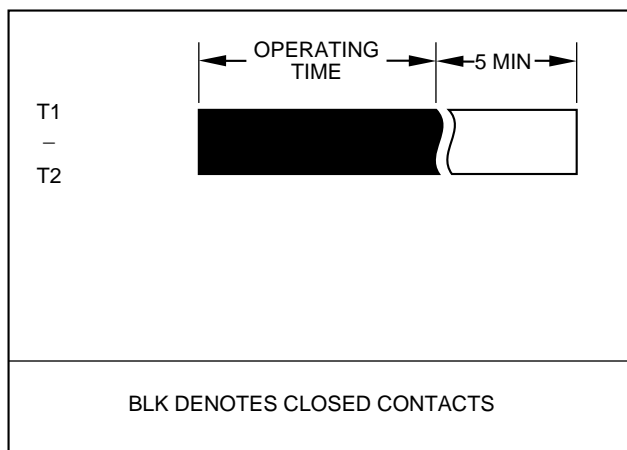
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HN67PA025

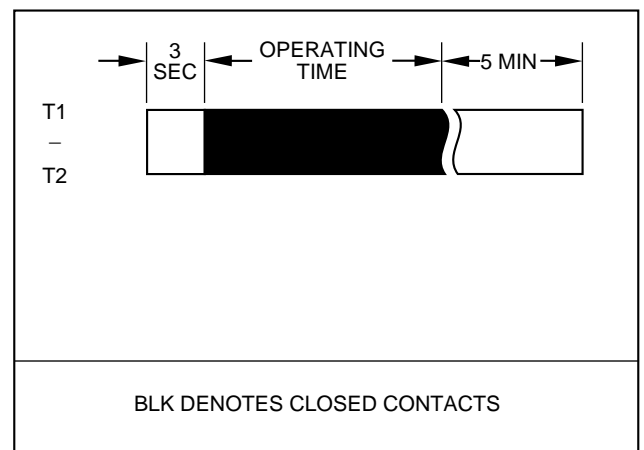
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Fig. 8—Cycle Protector Device



HN67ZA002

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HN67PA025, HN67ZA003, HN67ZA008

A91437

Fig. 9—Cycle Protector Sequence

V. CRANKCASE HEATER

Crankcase heater is a device for keeping compressor oil warm. By keeping oil warm, refrigerant does not migrate to and condense in compressor shell when the compressor is off. This prevents flooded starts which can damage compressor.

Crankcase heaters come in 2 basic types: wraparound (bellyband) type that is wrapped externally around compressor shell, and insertion type that is inserted into compressor oil well in shell of compressor. Both types are used in outdoor units.

On units that have a single-pole contactor, the crankcase heater is wired parallel with the contactor contacts and in series with the compressor. (See Fig. 11.) When the contacts are open, a circuit is completed from the line side of the contactor, through the crankcase heater, through the run windings of the compressor, and to the other side of the line. When the contacts are closed, there is no circuit through the crankcase heater because both leads are connected to the same side of the line. This allows the heater to **operate** when the system is **not** calling for heating/cooling. The

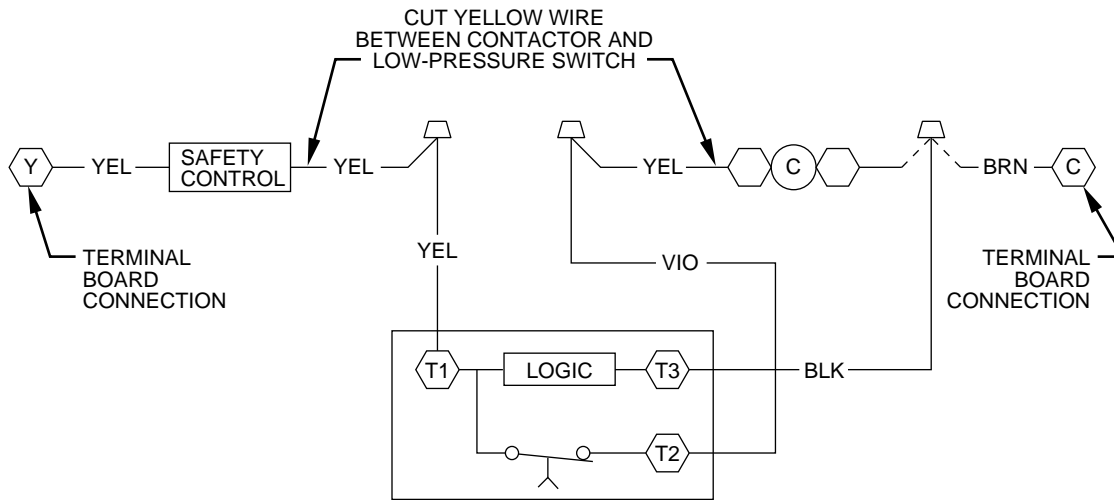
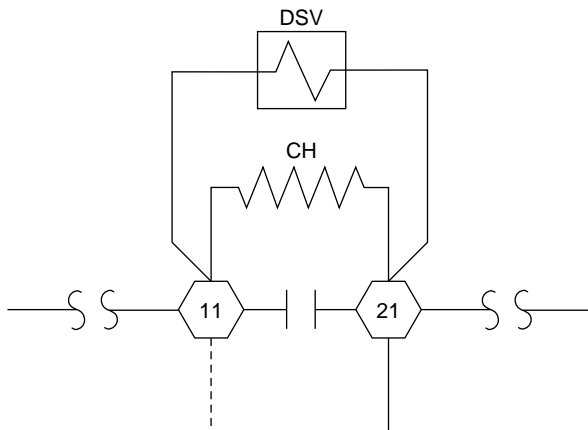


Fig. 10—Cycle Protector Wiring

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heater **does not operate** when the system is calling for heating/cooling. On units with 2 or 3 pole contactors, the crankcase heater is connected to the line side of the contactor and is not controlled by the contactor contacts.



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Fig. 11—Wiring for Single-Pole Contactor

The crankcase heater is powered by high-voltage power of unit. Use extreme caution troubleshooting this device with power on. The easiest method of troubleshooting is to apply voltmeter across crankcase heater leads to see if heater has power. Do not touch heater. Carefully feel area around crankcase heater. If warm, crankcase heater is probably functioning. Do not rely on this method as absolute evidence heater is functioning. If compressor has been running, the area will still be warm.

With power off and heater leads disconnected, check across leads with ohmmeter. Do not look for a specific resistance reading. Check for resistance or an open circuit. Change heater if an open circuit is detected. Some crankcase heaters in this series of units are equipped with a crankcase heater switch installed in series with heater. This energy-saving device shuts off power to heater when temperatures are high enough that heater is not needed. Be sure this switch is functioning normally before condemning crankcase heater.

VI. TIME-DELAY RELAY

The time-delay relay (TDR) is a solid-state controlled recycle delay timer which keeps the indoor blower operating for 90 sec after thermostat is satisfied. This delay enables the blower to remove residual cooling in the coil after compression shutdown, thereby improving the efficiency of the system. The sequence of

operation is that on closure of the wall thermostat and at the end of a fixed on delay of 1 sec, the fan relay is energized. When the thermostat is satisfied, an off delay is initiated. When the fixed delay of 90 ± 20 sec is completed, the fan relay is de-energized and fan motor stops. If the wall thermostat closes during this delay, the TDR is reset and the fan relay remains energized. The TDR is a 24-v device that operates within a range of 15 to 30v and draws about 0.5 amps.

If the blower runs continuously instead of cycling off when the fan switch is set on AUTO, the TDR is probably defective and must be replaced.

VII. PRESSURE SWITCHES

Pressure switches are protective devices wired into control circuit (low voltage). They shut off compressor if abnormally high or low pressures are present in the refrigeration circuit. Depending on unit model, you may find a low- and/or high-pressure switch in system.

A. Low-Pressure Switch

Located on suction line of condensing unit only, the low-pressure switch protects against low suction pressures caused by such events as loss of charge, low airflow across indoor coil, dirty filters, etc. It opens on a pressure drop at about 27 psi. If system pressure is above this, switch should be closed. To check switch, turn off all power to unit, disconnect leads on switch, and apply ohmmeter leads across switch. You should have continuity on a good switch. Because these switches are attached to refrigeration system under pressure, it is not advisable to remove this device for troubleshooting unless you are reasonably certain that a problem exists. If switch must be removed, remove and recover all system charge so that pressure gages read 0 psi.

CAUTION: Wear safety glasses and gloves when working with refrigerants.

Apply heat with torch to solder joint and remove switch. Wear safety glasses when using torch. Have quenching cloth available. Oil vapor in line may ignite when switch is removed.

Braze in 1/4-in. flare fitting and screw on replacement pressure switch.

B. High-Pressure Switch

Located on discharge line, the high-pressure switch protects against high discharge pressures caused by such events as over-charge, condenser fan motor failure, system restriction, etc. It opens on pressure rise at about 435 psi. If system pressures go above this setting during abnormal conditions, the switch opens.

Do not attempt to simulate these system abnormalities as high pressures pose a serious safety hazard. High-pressure switch is also checked with an ohmmeter similar to checking low-pressure switch. If system pressure is below 435 psi, the switch shows continuity. It is replaced in the same manner as low-pressure switch. Observe all safety precautions.

C. Liquid Line Pressure Switch

Located on liquid line of heat pump only, the liquid line pressure switch functions similar to conventional low-pressure switch. Because heat pumps experience very low suction pressures during normal system operation, a conventional low-pressure switch cannot be installed on suction line. This switch is installed in liquid line instead and acts as loss-of-charge protector. The liquid line is the low side of the system in heating mode. It operates identically to low-pressure switch except it opens at 7 psi when the heating piston is in the liquid valve or 27 psi when the heating piston is in the liquid line. Troubleshooting and removing this switch is identical to procedures used on other switches. Observe same safety precautions.

VIII. DEFROST THERMOSTATS

Defrost thermostat signals heat pump that conditions are right for defrost or that conditions have changed to terminate defrost. It is a thermally actuated switch clamped to outdoor coil to sense its temperature. Normal temperature range is closed at $30^{\circ} \pm 3^{\circ}\text{F}$ and open at $80^{\circ} \pm 5^{\circ}\text{F}$.

NOTE: The defrost thermostat must be located on the liquid side of the outdoor coil on the bottom circuit and as close to the coil as possible.

IX. DEFROST CONTROL BOARD

Solid-state defrost boards used on heat pumps replace electromechanical timer and defrost relay found on older defrost systems. The defrost control board can be field set to check need for defrost every 30, 50, or 90 minutes of operating time by connecting the jumper (labeled W1 on the circuit board) to the terminal for the defrost time desired. The board is set at factory for 90 minutes. The defrost period is field selectable, depending upon geographic areas and defrost demands. Two types of defrost boards are used. Their functions are described in the sections to follow.

Troubleshooting defrost control involves a series of simple steps that indicate whether or not board is defective.

NOTE: This procedure allows the service technician to check control board and defrost thermostat for defects. First, troubleshoot to make sure unit operates properly in heating and cooling modes. This ensures operational problems are not attributed to the defrost control board.

A. HK32FA003, 006 Defrost Control

This control board utilizes screw terminals for the low-voltage field wiring. The board has a feature that allows the heat pump to restart in defrost if room thermostat is satisfied during defrost. To troubleshoot the board, perform the following items.

1. Turn thermostat to OFF. Shut off all power to outdoor unit.
2. Remove control box cover for access to electrical components and defrost control board.
3. Disconnect defrost thermostat leads from control board and connect to ohmmeter. Thermostat leads are the black, insulated wires connected to DFT and R terminals on control board. Resistance reading may be zero (indicating closed defrost thermostat) or infinity (∞ for open thermostat) depending on outdoor temperature.
4. Jumper between DFT and R terminals on control board as shown in Fig. 12.
5. Disconnect outdoor fan motor lead from OF2. Tape lead to prevent grounding.

6. Turn on power to outdoor unit.
7. Restart unit in heating, allowing frost to accumulate on outdoor coil.
8. After a few minutes in heating, liquid line temperature at defrost thermostat should drop below closing set point of defrost thermostat of approximately 30°F . Using ohmmeter, check resistance across defrost thermostat leads. Resistance of zero indicates defrost thermostat is closed and operating properly.
9. Remove protective cover from TP1 and TP2 speed-up terminals. Install jumper wire on speed-up terminals. This reduces the timing sequence to 1/60 of original time. (See Fig. 13.) Since Fig. 13 shows timing cycle set at 30 minutes, unit initiates defrost within approximately 30 sec; if setting is at 50 minutes, within 50 sec; 90 minutes, within 90 sec. When you hear the reversing valve change position, remove protective cover/jumper. Otherwise, control will terminate normal 10-minute defrost cycle in approximately 10 sec.

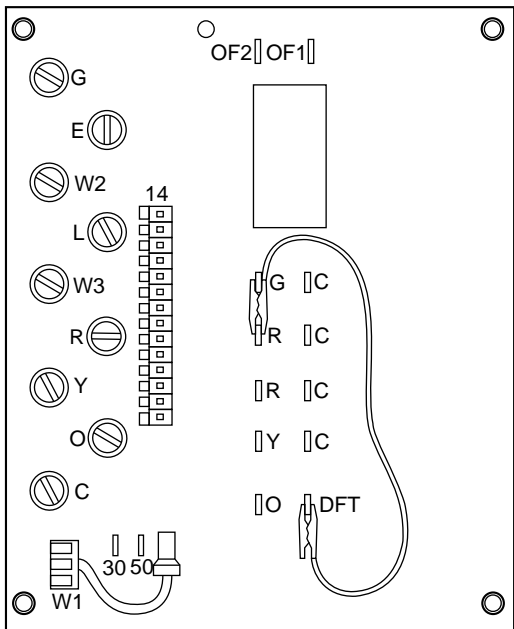


CAUTION: Exercise extreme caution when shorting speed-up pins. If pins are accidentally grounded, damage to the control board will occur.

10. Unit is now operating in defrost mode. Using voltmeter, check between C and W2 as shown in Fig. 14. Reading on voltmeter should indicate 24v. This step ensures defrost relay contacts have closed, energizing supplemental heat (W2) and reversing valve solenoid (O).
11. Unit should remain in defrost no longer than 10 minutes. Actual time in defrost depends on how quickly speed-up jumper is removed. If it takes 3 sec to remove speed-up jumper after unit has switched to defrost, only 7 minutes of defrost cycle remains.
12. After a few minutes in defrost (cooling) operation, liquid line should be warm enough to have caused defrost thermostat contacts to open. Check resistance across defrost thermostat. Ohmmeter should read infinite resistance, indicating defrost thermostat has opened at approximately 80°F .
13. Shut off unit power and reconnect fan lead.
14. Remove jumper wire from speed-up terminal and reinsert cover on speed-up terminals. Failure to remove jumper causes unit to speed up operating cycles continuously.
15. Remove jumper between DFT and R terminals. Reconnect defrost thermostat leads.
16. Replace control box cover. Restore power to unit.

If defrost thermostat does not check out following above items or incorrect calibration is suspected, check for a defective thermostat as follows.

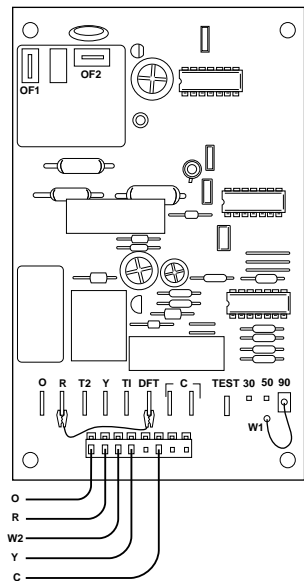
1. Follow items 1-5 above.
2. Using thermocouple temperature measuring device, route sensor or probe underneath coil (or other convenient location). Attach to liquid line near defrost thermostat. Insulate for more accurate reading.
3. Turn on power to outdoor unit.
4. Restart unit in heating mode.
5. Within a few minutes, liquid line temperature drops within a range causing defrost thermostat contacts to close. Temperature range is from 33°F to 27°F . Notice temperature at which ohmmeter reading goes from ∞ to zero ohms. Thermostat contacts close at this point.
6. Remove protective cover from TP1 and TP2 speed-up terminals, and install jumper wire on the speed-up terminals.



HK32FA003/HK32FA006

A88402

Fig. 12—Jumper DFT and R Terminals



CES0110063,
CES0130024

A91442

7. Unit changes over to defrost within 90 sec (depending on timing cycle setting). Liquid line temperature rises to range where defrost thermostat contacts open. Temperature range is from 75°F to 85°F. Resistance goes from zero to ∞ when contacts open.

8. If either opening or closing temperature does not fall within above ranges or thermostat sticks in 1 position, replace thermostat to ensure proper defrost operation.

B. CES0110063 Defrost Control

Some heat pumps built in 1991 and later incorporate a new defrost control. The screw terminals found on the previous control board have been replaced by a connector plug with stripped wire leads. This control board also contains the feature that allows the heat pump to restart in defrost if the room thermostat is satisfied during defrost. The board also contains a 5-minute cycle protector that prevents the unit from short cycling after it cycles off or after a power interruption. To troubleshoot the board, perform the following items:

1. Turn thermostat to OFF. Shut off all power to outdoor unit.
2. Remove control box cover for access to electrical components and defrost control board.
3. Disconnect defrost thermostat leads from control board, and connect to ohmmeter. Thermostat leads are the black, insulated wires connected to DFT and R terminals on control board. Resistance reading may be zero (indicating closed defrost thermostat), or infinity (∞ for open thermostat) depending on outdoor temperature.
4. Jumper between DFT and R terminals on control board as shown in Fig. 12.
5. Disconnect outdoor fan motor lead from OF2. Tape lead to prevent grounding.
6. Turn on power to outdoor unit.
7. Restart unit in heating mode, allowing frost to accumulate on outdoor coil.
8. After a few minutes in heating mode, liquid line temperature at defrost thermostat should drop below closing set point of defrost thermostat of approximately 30°F. Check resistance across defrost thermostat leads using ohmmeter. Resistance of zero indicates defrost thermostat is closed and operating properly.

9. Short between the speed-up terminals using a thermostat screwdriver. This reduces the timing sequence to 1/256 of original time. (See Fig. 13 and Table 1.)

NOTE: Since Fig. 13 shows timing cycle set at 90 minutes, unit initiates defrost within approximately 21 sec. When you hear the reversing valve change position, remove screwdriver immediately. Otherwise, control will terminate normal 10-minute defrost cycle in approximately 2 sec.

CAUTION: Exercise extreme caution when shorting speed-up pins. If pins are accidentally shorted to other terminals, damage to the control board will occur.

10. Unit is now operating in defrost mode. Check between C and W2 using voltmeter as shown in Fig. 14.

Reading on voltmeter should indicate 24v. This step ensures defrost relay contacts have closed, energizing supplemental heat (W2) and reversing valve solenoid (O).

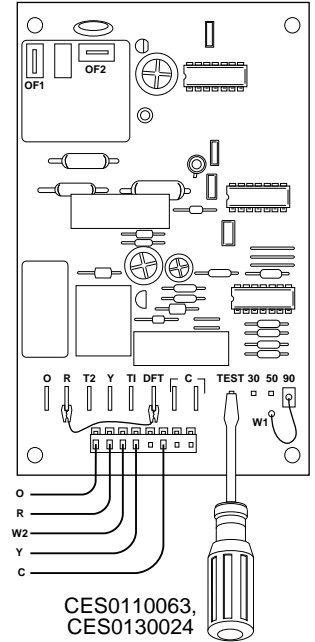
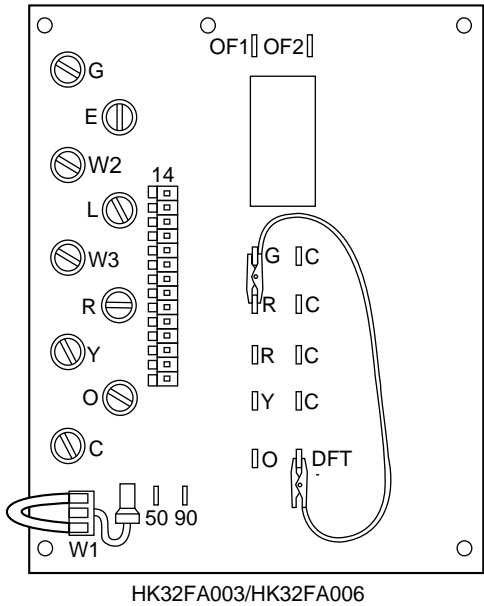
11. Unit should remain in defrost no longer than 10 minutes. Actual time in defrost depends on how quickly speed-up jumper is removed. If it takes 2 sec to remove speed-up jumper after unit has switched to defrost, the unit will switch back to heat mode.
12. After a few minutes in defrost (cooling) operation, liquid line should be warm enough to have caused defrost thermostat contacts to open. Check resistance across defrost thermostat. Ohmmeter should read infinite resistance, indicating defrost thermostat has opened at approximately 80°F.
13. Shut off unit power and reconnect fan lead.
14. Remove jumper between DFT and R terminals. Reconnect defrost thermostat leads. Failure to remove jumper causes unit to switch to defrost every 30, 50, or 90 minutes and remain in defrost for full 10 minutes.
15. Replace control box cover. Restore power to unit.

If defrost thermostat does not check out following above items or incorrect calibration is suspected, check for a defective thermostat as follows:

1. Follow items 1-5 above.

TABLE 1—DEFROST CONTROL SPEED-UP TIMING SEQUENCE FOR CES0110063/CES0130024

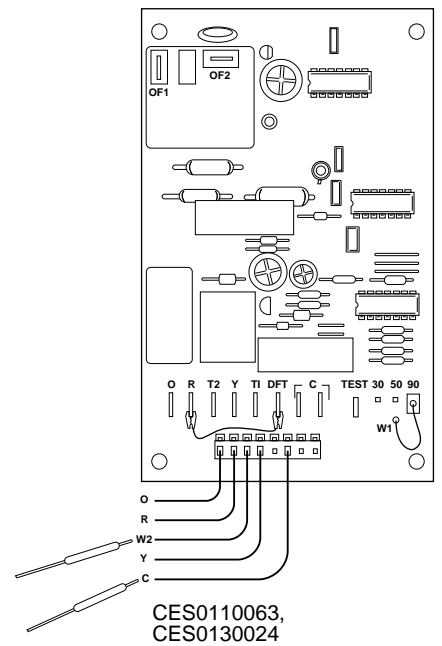
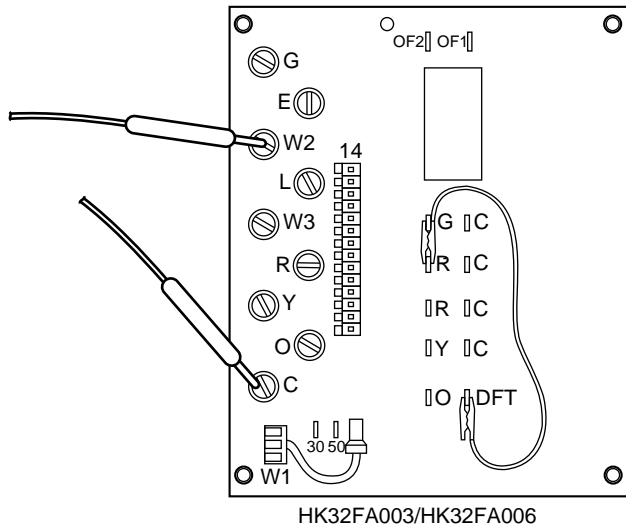
PARAMETER	MINIMUM	MAXIMUM	SPEED-UP (NOMINAL)
30-minute cycle	27	33	7 sec
50-minute cycle	45	55	12 sec
90-minute cycle	81	99	21 sec
10-minute cycle	9	11	2 sec
5 minutes	4.5	5.5	1 sec



A88404

Fig. 13—Inserting Jumper Wire

A91444



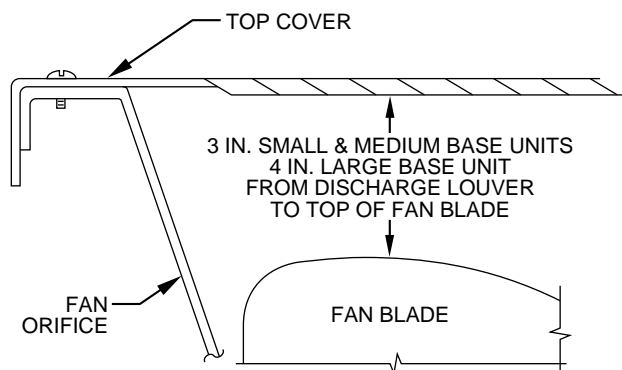
A88403

Fig. 14—Checking Between C and W2

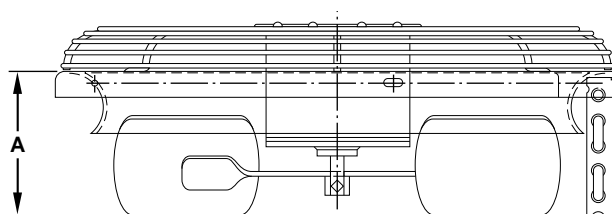
A91444

- Route sensor or probe underneath coil (or other convenient location) using thermocouple temperature measuring device. Attach to liquid line near defrost thermostat. Insulate for more accurate reading.
- Turn on power to outdoor unit.
- Restart unit in heating.

- Within a few minutes, liquid line temperature drops within a range causing defrost thermostat contacts to close. Temperature range is from 33°F to 27°F. Notice temperature at which ohmmeter reading goes from ∞ to zero ohms. Thermostat contacts close at this point.



STAR BURST TOP



BASKET TOP

A88347

A91428

Fig. 15—Fan Position

6. Short between the speed-up terminals using a small slotted screwdriver.
7. Unit changes over to defrost within 21 sec (depending on timing cycle setting). Liquid line temperature rises to range where defrost thermostat contacts open. Temperature range is from 75°F to 85°F. Resistance goes from zero to ∞ when contacts open.
8. If either opening or closing temperature does not fall within above ranges or thermostat sticks in 1 position, replace thermostat to ensure proper defrost operation.

C. CES0130024 Defrost Control

Some heat pumps built in 1993 and later incorporated a new defrost control similar to the CES0110063 except the 5-minute cycle protector has been removed. This control is used on heat pump units with reciprocating compressors where short cycle protection is not required.

Troubleshooting this control will be the same as the CES0110063 control except for the cycle protector function. The CES0130024 control is identical to the CES0110063 except the T2 terminal and cycle protector logic have been removed.

X. FAN MOTORS

Fan motor rotates the fan blade that either draws or blows air through outdoor coil to perform heat exchange. Motors are totally enclosed to increase reliability. This also eliminates need for rain shield. For the correct position of the fan blade assembly, see Fig. 15 and Table 2.

WARNING: Turn off all power to unit before servicing or replacing fan motor. Be sure unit main power switch is turned off. Failure to do so may result in electric shock, death, or injury from rotating fan blade.

The bearings are permanently lubricated, therefore, no oil ports are provided.

For suspected electrical failures, check for loose or faulty electrical connections, or defective fan motor capacitor. Fan motor is equipped with thermal overload device in motor windings which may open under adverse operating conditions. Allow time for motor to cool so device can reset. Further checking of motor can be done with an ohmmeter. Set scale on R X 1 position, check for continuity between 3 leads. Replace motors that show an open circuit in any of the windings. Place 1 lead of ohmmeter on each motor lead. At same time, place other ohmmeter lead on motor case (ground). Replace any motor that shows resistance to ground, signs of arcing, burning, or overheating.

TABLE 2—FAN POSITION

BASKET TOP			
Fan Motor Part No.	Fan Blade Part No.	Dimension A (In.)	
		Brookside	Revcor
HC29GE208	LA01EB023	4-5/32	—
	LA01EC019	5-1/8	—
HC31GE230/231	LA01EA026	4-5/8	—
	LA01RA015	4-7/8	4-5/8
HC33GE208	LA01EW049	5-1/4	—
HC33GE232	LA01RA015	4-29/32	4-17/32
HC34GE231	LA01RA015	5-5/32	4-25/32
HC34GE460		—	—
HC35GE208	LA01EW048	4-15/16	—
HC35GE232	LA01EA025	5-7/8	—
	LA01RA024	5-11/32	5-3/32
	LA01RA026	5-9/16	4-11/16
HC37GE208	LA01EA025	6-1/8	—
HC37GE230	LA01EW042	6-5/32	6-1/8
HC38GE221	LA01EA031	7-25/32	—
HC39GE232	LA01EC018	5-11/16	—
	LA01RA026	5-1/2	4-3/4
	LA01EA036	5-9/16	—
HC39GE234	LA01EA024	5-3/32	4-27/32
	LA01EC018	5-1/2	—
HC39GE461	LA01EA036	6-1/16	—
	LA01EC018	6-1/4	—
	LA01RA026	6-1/16	5-7/32
HC40GE230	LA01EA024	5-9/32	5-11/32
HC40GE461	LA01EA024	5-27/32	5-19/32
BASEPAN DIMENSIONS FOR STAR BURST TOP (IN.)			
Small	22-1/2 x 26-3/16		
Medium	30 x 33		
Large	38-5/8 x 42-1/16		

XI. SERVICE ALARM CONTROL BOARD

NOTE: If the proper night setback thermostat is not used, the service alarm control will work, but there will be no light indication on thermostat.

The service alarm control provides immediate warning when outdoor heat pump requires servicing. It turns on indoor thermostat malfunction light if compressor does not operate for either heating or cooling. This enables owner to obtain timely heat pump service during heating season, reducing supplementary electric heat costs, and during cooling season, reducing period of heat discomfort.

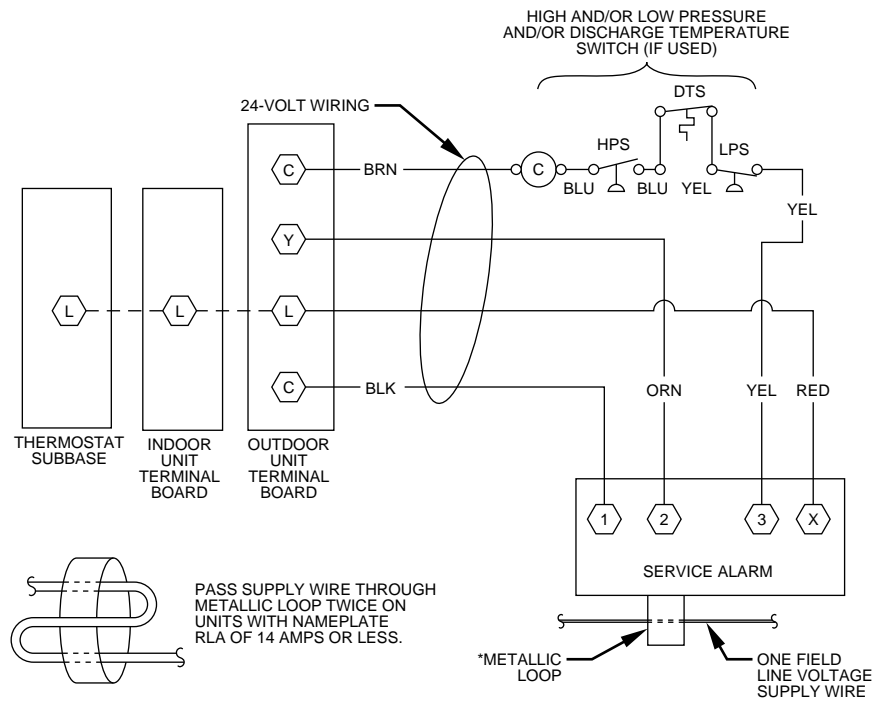


Fig. 16—Service Alarm Wiring Connections

A88340

The service alarm is an accessory device. Service alarm locks out compressor under certain adverse operating conditions. System is manually reset by shutting it off at thermostat subbase, then turning it back on. If adverse condition is corrected, system restarts.

One example of an adverse condition would be a system located in a desert climate where high operating temperatures may cause system to shut down on the high-pressure switch or on the compressor internal overload.

Connect service alarm to outdoor unit control circuit terminal board. (See Fig. 16 and wiring diagram on unit.)

Connect all field line power wires to unit in usual manner. Route 1 field line power supply wire through metallic loop on bottom of service alarm then to normal unit connection. Units with RLA of less than 14 amps will require 2 passes through the metallic loop.

Refer to Fig. 16 or 17 for wiring connections for service alarm or service alarm with solid-state cycle protector accessories, when used.

NOTE: The wire from the X terminal on the service alarm to L on the outdoor terminal board, indoor terminal board, and thermostat subbase is field supplied and wired when using defrost controls HK32FA003 or HK32FA006. When defrost control CES0110063 or CES0130024 is used, field-supplied wire from X terminal on service alarm to L on indoor thermostat subbase is required.

Service alarm requires 2 inputs.

1. It must sense a 24-v input from thermostat. As thermostat calls for heating or cooling, it supplies 24v to service alarm device.
2. A current transformer (or induction loop) similar to a clamp-on ammeter senses current draw in the compressor lead. Induction loop must sense a minimum current draw when thermostat is calling for heating or cooling.

NOTE: On a **single-phase** compressor, induction loop senses current in common leg. On a **3-phase** compressor, induction loop senses current in any 1 of the phases.

WARNING: If service alarm needs replacing, shut off all power to unit before attempting removal. Electrical shock can cause personal injury or death.

Troubleshooting service alarm device is easy. With thermostat calling for heating or cooling and compressor running, indoor thermostat light should be off. If on, check for wiring errors or replace the service alarm.

To check for correct operation, shut off circuit breaker or disconnect switch to outdoor unit while it is running. Signal light on thermostat should light. If this does not occur, check for wiring errors or replace the service alarm.

XII. OUTDOOR THERMOSTAT(S)

The outdoor thermostat(s) is/are installed in the control box. The sensing bulb(s) remain in the control box. Outdoor thermostat brings on stages of electric heat as outdoor temperature and heat pump output drops. Setting at which thermostat closes is variable, depending on design of system. It is set at time of installation and should not be changed without good reason. Up to 2 outdoor thermostats may be installed. Some systems may not have any thermostat. An outdoor thermostat can also be used to lock out compressor operation at low ambients in condensing unit not equipped with low-ambient control.

Although these devices are installed in control circuit (24v), turn off all power to unit before attempting to troubleshoot thermostat. Use a standard ohmmeter to check for continuity through thermostat. If you suspect thermostat is out of calibration, use calibrated electronic thermometer to determine correct outdoor temperature. Turn thermostat dial knob until switch closes. Observe this using ohmmeter across switch. Read temperature setting when switch closes. It should be close to reading observed using electronic thermometer. Any setting within $\pm 5^{\circ}\text{F}$ is acceptable.

XIII. COMPRESSOR PLUG

The compressor electrical plug provides a quick-tight connection to the compressor terminals. The plug completely covers the compressor terminals, and the mating female terminals are completely encapsulated in the plug. Therefore, the terminals are

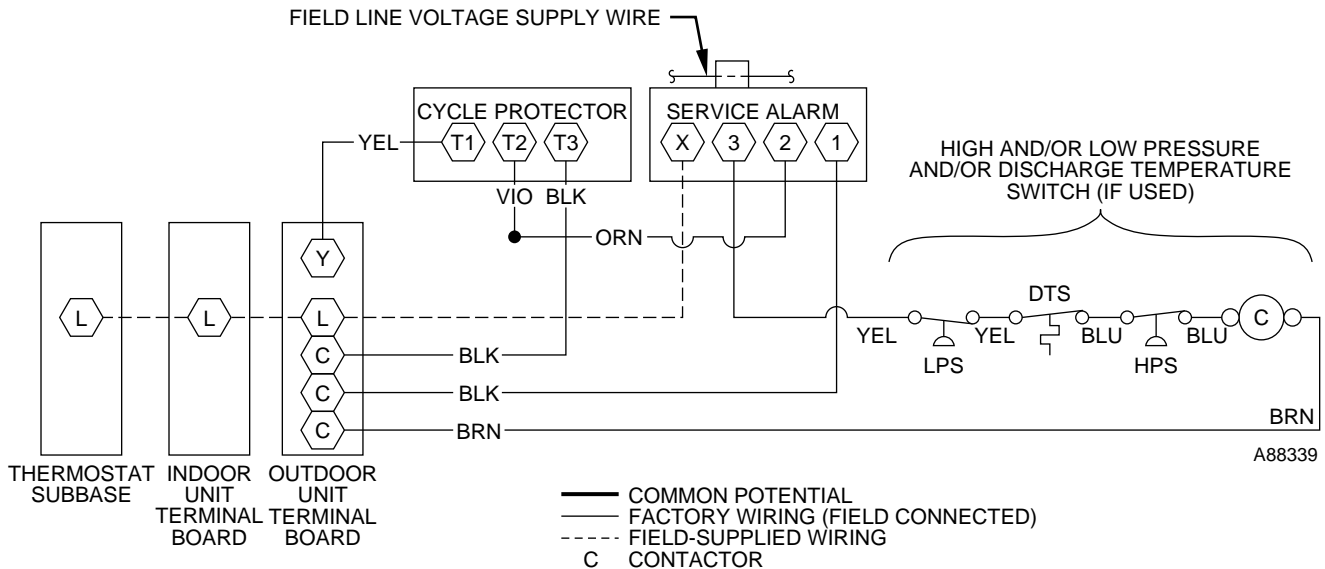


Fig. 17—Wiring Connections for Service Alarm and Cycle Protector

A88339

isolated from any moisture so corrosion and resultant pitted or discolored terminals are reduced. The plug is oriented to the relief slot in the terminal box so the cover cannot be secured if wires are not positioned in slot, assuring correct electrical connection at the compressor. The plug can be removed by simultaneously pulling while "rocking" the plug. However, these plugs are specialized and vary in terminal orientation in the plug. Therefore plugs can be used on only the specific compressor or group as shown in Fig. 18. You will notice that for the Carlyle and Bristol compressors in Fig. 18, the triangle formed by the fusite terminals points down, and the plug is likewise oriented. The fusite terminals and plug terminal orientation shown for the Tecumseh compressor is shown with the triangle formed by the terminals pointing toward the top. The configuration around the fusite terminals is the outline of the terminal covers used on the specific compressors. The slot through which the wires of the plug are routed is oriented on the bottom or slightly to the left or right. The correct plug can be connected easily to the compressor terminals and plug wires routed easily through the slot in the terminal cover. Therefore, if a Carlyle or Bristol compressor is substituted for a Tecumseh compressor, a new plug must be installed. If the plug is not changed, proper connection and routing of the plug wires through the terminal cover will be impossible.

XIV. LOW-VOLTAGE TERMINALS

The low-voltage terminal designations and their description/function are used on all split-system condensers and heat pumps.

- G—Energizes blower circuit from indoor thermostat.
- E—Energizes emergency heat relay.
- W2—Energizes first-stage supplemental heat through defrost relay (wht).
- L—Energizes light on thermostat with service alarm.
- W3—Energizes second- or third-stage supplemental heat.
- R—Energizes 24-v power from transformer (red).
- Y—Energizes contactor for first-stage cooling or first-stage heating for heat pumps (yel).
- O—Energizes reversing valve on heat pumps (orn).
- C—Common side of transformer (blk).

RECIPROCATING COMPRESSOR

The compressor is the heart of the refrigeration system. It pumps refrigerant through the system. If it malfunctions, system capacity and efficiency could be negatively affected.

CAUTION: The compressor is an electrical (as well as mechanical) device. Exercise extreme caution when working near compressors. Power should be shut off, if possible, for most troubleshooting techniques. Refrigerants in system present other safety hazards. Always wear safety glasses and gloves when handling refrigerants.

Compressor failures are classified in 2 broad failure categories: mechanical and electrical. Both types are discussed below.

I. MECHANICAL FAILURES

A compressor is a mechanical pump driven by an electric motor contained in a welded or hermetic shell. In a mechanical failure, motor or electrical circuit appears normal, but compressor does not function normally.

CAUTION: Exercise extreme caution when reading compressor currents when high-voltage power is on. Correct any of the problems described below before installing and running a replacement compressor. Wear safety glasses and gloves when handling refrigerants.

A. Locked Rotor

In this type of failure, compressor motor and all starting components are normal. When compressor attempts to start, it draws locked rotor current and cycles off on the internal protection. Locked rotor current is measured by applying a clamp-on ammeter around common (blk) lead of the compressor on a single-phase compressor, or any 1 of the leads on a 3-phase compressor. Current drawn when it attempts to start is then measured. LRA (locked rotor amp) value is stamped on compressor nameplate.

If compressor draws locked rotor amps and all other external sources of problems have been eliminated, compressor must be replaced. Because compressor is a sealed unit, it is impossible to determine exact mechanical failure. However, complete system should be checked for abnormalities such as incorrect refrigerant charge, restrictions, insufficient airflow across indoor or outdoor coil, etc., which could be contributing to the failure.

B. Runs, Does Not Pump

In this type of failure, compressor motor runs and turns compressor, but compressor does not pump the refrigerant. A clamp-on ammeter on common leg of a single-phase compressor, or any 1

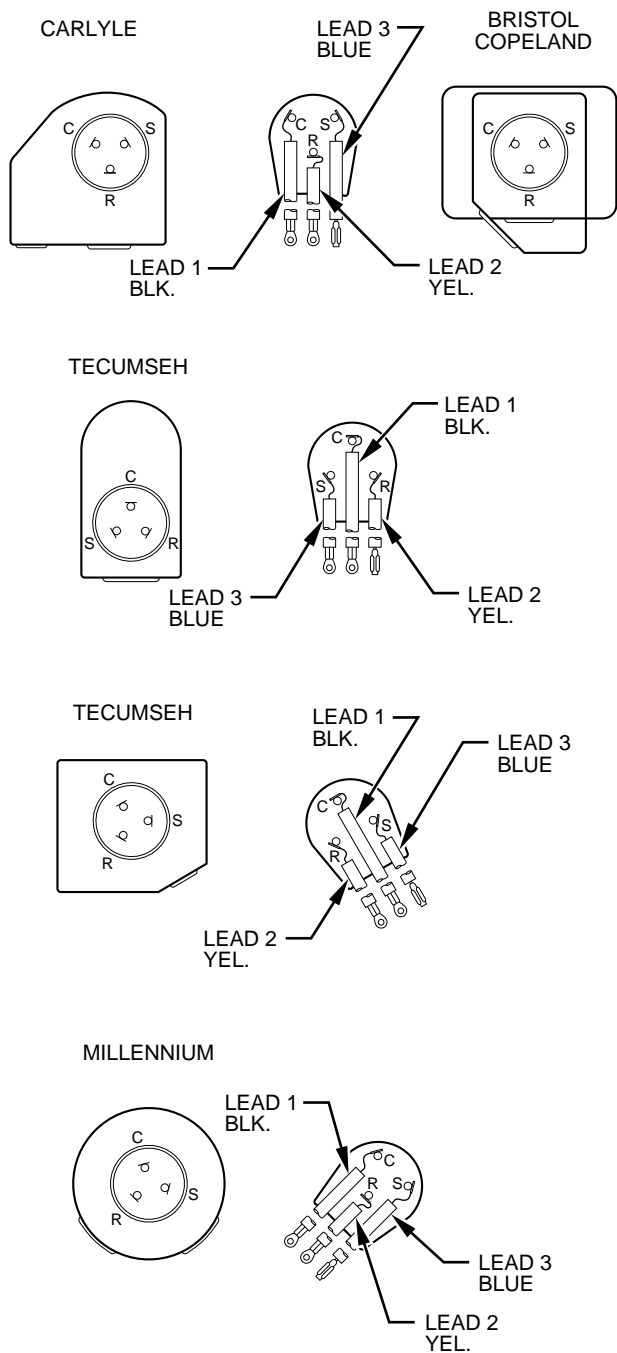


Fig. 18—Compressor Plug

A94002

lead of a 3-phase compressor, shows a very low current draw, much lower than RLA (rated load amps) value stamped on compressor nameplate. Because no refrigerant is being pumped, there is no return gas to cool compressor motor. It eventually overheats and shuts off on its internal protection.

C. Runs, Does Not Pump, High-to-Low Side Leak

In this type of failure, compressor motor runs and turns compressor, and compressor is pumping. Usually, an internal problem such as blown head gasket or broken internal discharge line causes compressor to pump hot discharge gas back into its own shell rather than through system.

Using pressure gages on service valves shows high suction and low discharge pressure readings. Motor currents are lower than normal. Because hot gas is being discharged into shell, the shell becomes hot. The hot gas causes compressor motor to cycle off on its internal protection.

D. Runs and Pumps, Low Capacity

This failure type is difficult to pinpoint because extent of damage varies. Compressor is a pump with internal valves that enable compressor to pump properly. The cylinder has a set of suction and discharge valves. Any of these parts may become damaged or broken, causing loss in pumping capacity. Severity of damage determines amount of capacity loss. Use pressure gages to find any abnormal system pressures if system charge and other conditions are normal.

An owner may complain that a unit is not handling the building's heating or cooling load. The compressor current draw may be abnormally low or high. Although this type of failure does occur, all other possible causes of capacity loss must be eliminated before condemning compressor.

E. Noisy Compressor

Noise may be caused by a variety of internal problems such as loosened hardware, broken mounting springs, etc. System problems such as overcharged compressor (especially at start-up) or too much oil in compressor may also cause excessive noise. Excess oil in compressor is normally encountered only after a replacement compressor has been added without purging oil from previous compressor. As new compressor pumps, excess oil in system returns and adds to volume already present, causing noise.

F. Compressor Leaks

CAUTION: Use safety glasses and gloves when handling refrigerants.

Sometimes a leak is detected at weld seam around girth of compressor or a fitting that joins compressor shell. Many of these leaks can be repaired and the compressor saved if correct procedure is followed.

1. Turn off all power to unit.
2. Remove and recover all refrigerant from system so that gage pressures are 0 psi.
3. Clean area around leak to bare metal.
4. Apply flux and repair joint with silver solder. Do not use low temperature solder such as 50-50.
5. Clean off excess flux, check for leaks, and apply paint over repaired area to prevent corrosion.

Do not use this method to repair a compressor leak due to severe corrosion. Never attempt to repair a compressor leaking at electric terminals. This type of failure requires compressor replacement.

II. ELECTRICAL FAILURES

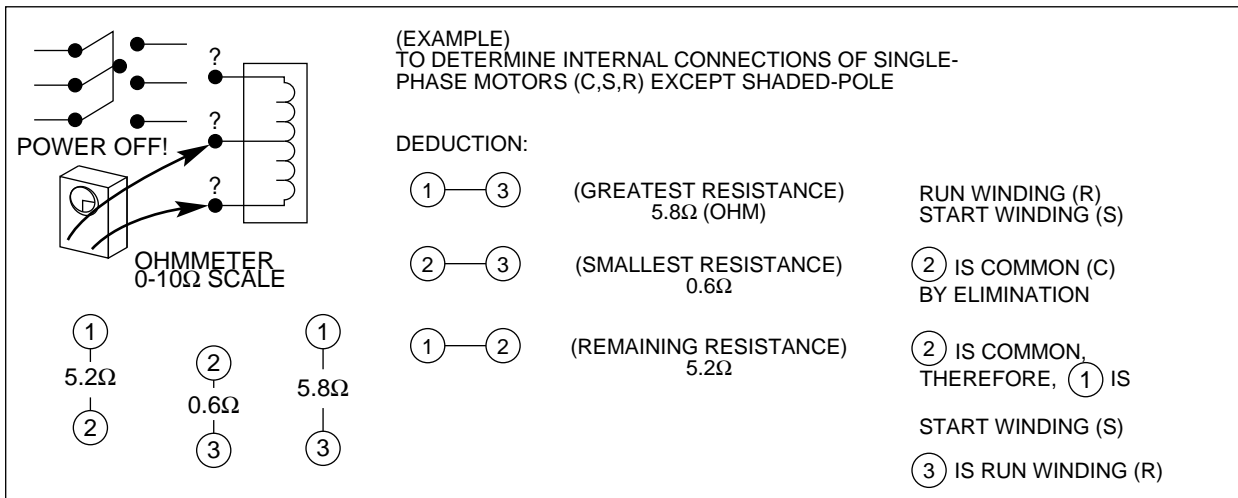
The compressor mechanical pump is driven by an electric motor within its hermetic shell. In electrical failures, compressor does not run although external electrical and mechanical systems appear normal. Compressor must be checked electrically for abnormalities.

Before troubleshooting compressor motor, review this description of compressor motor terminal identification.

A. Single-Phase Motors

To identify terminals C, S, and R:

1. Turn off all unit power.
2. Short the run and start capacitors to prevent shock.
3. Remove all wires from motor terminals.
4. Read resistance between all pairs of terminals using an ohmmeter on 0-10 ohm scale.
5. Determine 2 terminals that provide greatest resistance reading.



A88344

Fig. 19—Identifying Internal Connections

Through elimination, remaining terminal must be common (C). Greatest resistance between common (C) and another terminal indicates start winding because it has more turns. This terminal is start (S). Remaining terminal will be run winding (R). (See Fig. 19.)

NOTE: If compressor is hot, allow time to cool and internal line break to reset. There is an internal line break protector which must be closed.

B. Three-Phase Motors

Resistance readings between all 3 sets of windings should be the same.

All compressors are equipped with internal motor protection. If motor becomes hot for any reason, protector opens. Compressor should always be allowed to cool and protector to close before troubleshooting. Always turn off all power to unit and disconnect leads at compressor terminals before taking readings.

Most common motor failures are due to either an open, grounded, or short circuit. Directions below are specifically for single-phase units, however, they also apply to 3-phase compressors. When a single-phase compressor fails to start or run, 3 tests can help determine the problem. First, all possible external causes should be eliminated, such as overloads, improper voltage, pressure equalization, defective capacitor(s), relays, wiring, etc. Compressor has internal line break overload so be certain it is closed.

C. Open Circuit

To determine if any winding has a break in the internal wires and current is unable to pass through:

1. Be sure all power is off.
2. Discharge all capacitors.
3. Remove wires from terminals C, S and R.
4. Check resistance from C-R, C-S and R-S using an ohmmeter on 0-1000 ohm scale.

Because winding resistances are usually less than 10 ohms, each reading appears to be approximately 0 ohm. If resistance remains at 1000 ohms, an open or break exists and compressor should be replaced.

CAUTION: Be sure internal line break overload is not temporarily open.

D. Ground Circuit

To determine if a wire has broken or come in direct contact with shell, causing a direct short to ground:

1. Be sure all power is off.

2. Discharge all capacitors.

3. Remove wires from terminals C, S, and R.

4. On hermetic compressors, allow crankcase heaters to remain on for several hours before checking motor to ensure windings are not saturated with refrigerant.

5. Use an ohmmeter on R X 10,000 ohm scale. A megohmmeter may be used in place of ohmmeter. Follow manufacturer's instructions.

6. Place 1 meter probe on ground or on compressor shell. Make a good metal-to-metal contact. Place other probe on terminals C, S, and R in sequence.

7. Note meter scale.

8. If reading of zero or low resistance is obtained, motor is grounded. Replace compressor.

A compressor of 1 ton capacity or less is probably grounded if resistance is below 1 million ohms. On larger sized single-phase compressors, resistance to ground should not be less than 1000 ohms per volt of operating voltage.

Example:

$$230 \text{ volts} \times 1000 \text{ ohms/volt} = 230,000 \text{ ohms minimum.}$$

E. Short Circuit

To determine if any wires within windings have broken through their insulation and made contact with other wires, thereby shorting all or part of the winding(s), be sure the following conditions are met:

1. Correct motor winding resistances must be known before testing, either from previous readings or from manufacturer's specifications.
2. Temperature of windings must be as specified, usually about 70°F.
3. Resistance measuring instrument must have an accuracy within $\pm 5-10$ percent. This requires an accurate ohmmeter such as a Wheatstone bridge or null balance-type instrument.
4. Motor must be dry or free from direct contact with liquid refrigerant.

F. Make This Critical Test

(Not advisable unless above conditions are met.)

1. Be sure all power is off.
2. Discharge all capacitors.

3. Remove wires from terminals C, S, and R.
4. Place instrument probes together and determine probe and lead wire resistance.
5. Check resistance readings from C-R, C-S, and R-S.
6. Subtract instrument probe and lead resistance from each reading.

If any reading is within ± 20 percent of known resistance, motor is probably normal. Usually a considerable difference in reading is noted if a turn-to-turn short is present.

III. SYSTEM CLEAN-UP AFTER BURNOUT

CAUTION: Turn off all power to unit before proceeding. Wear safety glasses and gloves when handling refrigerants. Acids formed as a result of motor burnout can cause burns.

NOTE: To analyze level of suspected contamination from compressor burnout, use Total Test™. See your distributor/branch.

Some compressor electrical failures can cause motor to overheat. When this occurs, byproducts, which include sludge, carbon, and acids, contaminate system. If burnout is severe enough, system must be cleaned before replacement compressor is installed. The 2 types of motor burnout are classified as mild or severe.

In mild burnout, there is little or no detectable odor. Compressor oil is clear or slightly discolored. An acid test of compressor oil will be negative. This type of failure is treated the same as mechanical failure. Liquid line strainer should be removed and liquid line filter drier installed.

In a severe burnout, there is a strong, pungent, rotten egg odor. Compressor oil is very dark. Evidence of burning may be present in tubing connected to compressor. An acid test of compressor oil will be positive. Complete system must be reverse flushed with refrigerant. Check-Flo-Rater or TXV must be cleaned or replaced. In a heat pump, accumulator and reversing valve are replaced. These components are also removed and bypassed during reverse flushing procedure. Remove and discard liquid line strainer. After system is reassembled, install liquid and suction line filter driers. Run system for 2 hrs. Discard both driers and install new liquid line drier only.

IV. COMPRESSOR REMOVAL AND REPLACEMENT

Once it is determined that compressor has failed and the reason established, compressor must be replaced.

CAUTION: Wear safety glasses and gloves when handling refrigerants and when using brazing torch.

1. Shut off all power to unit.
2. Remove and recover all refrigerant from system until pressure gages read zero psi. Use all service ports.
3. Disconnect electrical leads from compressor. Disconnect or remove crankcase heater and remove compressor holddown bolts.
4. Cut compressor from system with tubing cutters. Do not use brazing torch for compressor removal. Oil vapor may ignite when compressor is disconnected.
5. Scratch matching marks on stubs in old compressor. Make corresponding marks on replacement compressor.
6. Use torch to remove stubs from old compressor and to reinstall them in replacement compressor.
7. Use copper couplings to tie compressor back into system.
8. Evacuate system, recharge, and check for normal system operation.

9. Copeland CR-6 and scroll compressors have copper plated steel suction ports. Excess heat during brazing will burn off copper plating. See Brazing section for additional information.

COPELAND SCROLL COMPRESSOR

I. FEATURES

The scroll compressor pumps refrigerant through the system by the interaction of a stationary and an orbiting scroll. (See Fig. 20.) The scroll compressor has no dynamic suction or discharge valves, and it is more tolerant of stresses caused by debris, liquid slugging, and flooded starts. Due to the design of the scroll compressor, the internal compression components unload (equalize pressure) on shutdown. The white oil (Sontex 200LT) used in the scroll is compatible with 3GS oil, which can be used if additional oil is required. (See Table 3 for oil recharge requirements.)

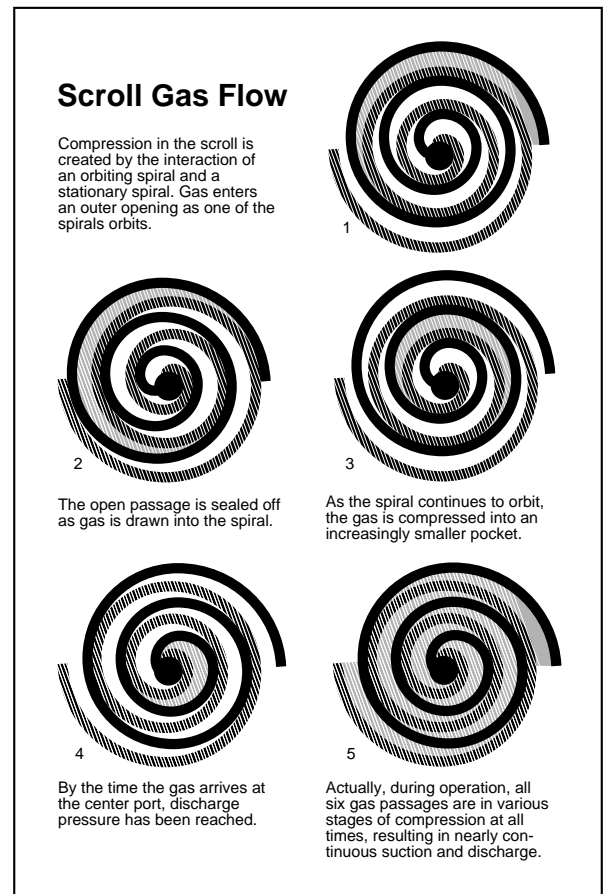


Fig. 20—Scroll Compressor Refrigerant Flow

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II. TROUBLESHOOTING

Troubleshooting mechanical or electrical problems in a scroll compressor is the same as for a reciprocating compressor, except that a scroll compressor should never be allowed to pump into a vacuum. If a pumpdown procedure is used, the scroll compressor is capable of pumping into a vacuum very quickly, which could cause fusite arcing and compressor failure. See Section IV of Reciprocating Compressor for removal and replacement.

III. DISCHARGE THERMOSTAT

Some scroll compressors have a discharge thermostat that reciprocating compressors do not have. This thermostat is mounted in a well in the top of the compressor shell to sense if the discharge temperature reaches 290°F and shuts down the compressor to prevent damage to the compressor. When the temperature of the

TABLE 3—COMPRESSOR OIL RECHARGE

COMPRESSOR MODEL	RECHARGE (FL. OZ.)	OIL TYPE
Carlyle "J" Type	44	SUNISO 3GS
Copeland		
CRG3, CRH3, CRJ3, CRK3, CRL3	51	SUNISO 3GS
CRN5, CRP5, CRT5	66	
CTH1, CTL1, CTM1	66	
CRC4, CRZ4	36	
CR16K6 THROUGH CR42K6	42	
*ZR18K1	19	
*ZR23K1, ZR28K1	24	
*ZR34K1	30	
*ZR40K1	34	
*ZR49K1-PFV	56	
*ZR49K2-TF5, ZR49K2-TFD	56	
*ZR61K2-PFV	56	
*ZR61K2-TF5, ZR61K2-TFD	66	
Tecumseh		
AV	30	SUNISO 3GS
AW	51	
AG	60	
Millennium		
SC	34	Zerol 150 w/3 percent Syn-0-Ad
SR	52	

* Copeland scrolls are charged initially with Sontex 200LT white oil. Since this oil is not commercially available, use 3GS.

thermostat reaches 140°F, power is restored to the compressor. To determine if the thermostat is operating properly, attach the thermocouple of an electronic thermometer to the dome of the compressor near the thermostat, or remove the thermostat and place the thermocouple inside the well. The electronic thermometer must be capable of reading at least 300°F. Start the unit and let it run for at least 15 minutes to obtain normal operating conditions. Watch the thermometer to see if it is approaching 270°F. If your thermocouple is located on the dome near the discharge thermostat, there could be a 20° difference between well temperature and dome temperature. If the temperature approaches 270°F, repair system problem such as low charge, blocked condenser coil, etc. If the temperature does not approach 270°F, replace discharge thermostat.

REPLACING DISCHARGE THERMOSTAT

To replace the discharge thermostat, refer to the Installation Instructions packaged with the replacement discharge thermostat kit. (See Fig. 21.)

IV. DISCHARGE SOLENOID VALVE

Some larger units equipped with scroll compressors contain a solenoid valve that is piped between the discharge tube and suction tube of the compressor. The purpose of the solenoid valve is to cause a rapid pressure equalization around the compressor thus reducing the normal shut down sound created by reverse rotation of the scroll. The solenoid valve is normally closed and is wired across high-voltage line 1 to load terminals of the contactor. (See Fig. 11.) The solenoid valve assembly also requires a check valve piped in the discharge tube between the solenoid valve tee and the condenser coil, or reversing valve on heat pumps. The purpose of the check valve is to prevent refrigerant from bypassing through the solenoid valve into the suction tube when the unit cycles off.

MILLENNIUM SCROLL COMPRESSOR

I. FEATURES

The scroll compressor pumps refrigerant through the system by the interaction of a stationary and an orbiting scroll. (See Fig. 20.) The scroll compressor has no dynamic suction or discharge valves, and

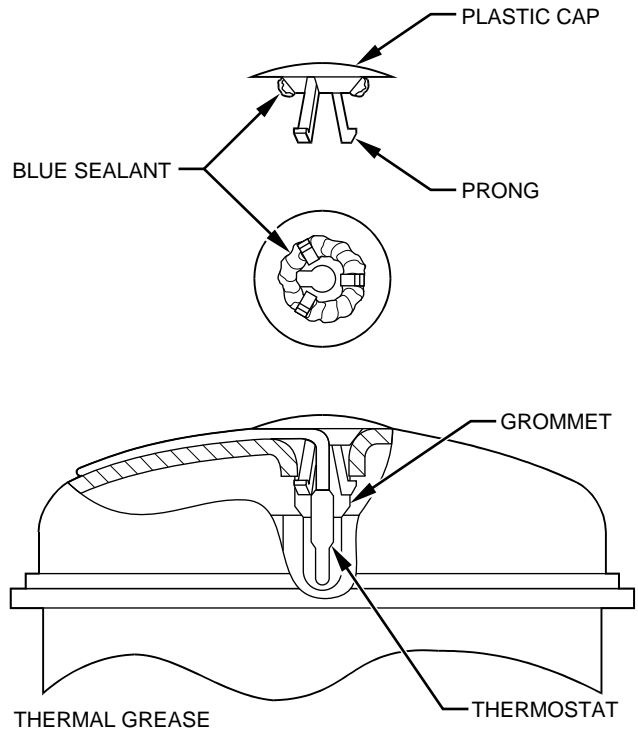


Fig. 21—Location of Discharge Thermostat

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it is more tolerant of stresses caused by debris, liquid slugging, and flooded starts. The Millennium scroll varies from the Copeland scroll in that the Millennium has a shutdown flapper valve located between the scroll plates and the discharge head, whereas the Copeland has a check device at the discharge connection after the discharge head. The Copeland discharge head unloads when the compressor shuts down. The scroll plate actually runs backwards while it unloads. A 1 to 3 second unloading of refrigerant occurs. The Millennium flapper valve eliminates the refrigerant unloading by not allowing the discharge head to run backwards because of its location. The Millennium scroll compressor uses Zerol 150 oil with 3 percent Syn-0-Ad and is the only oil recommended for oil recharge. See Table 3 for recharge requirements.

II. COMPRESSOR PROTECTION

Millennium scroll compressors are protected by an internal line-break mounted on the motor windings. Internal protectors respond to overcurrent and high temperature. These protectors are automatic reset devices containing a snap-action, bimetal switch.

III. TROUBLESHOOTING

Troubleshooting mechanical and electrical problems in a scroll compressor is similar to a reciprocating compressor, except that a scroll compressor should never be allowed to pump into a vacuum. The scroll compressor is capable of pumping into a vacuum very quickly, which could cause fusite arcing and compressor failure. See Section IV of Reciprocating Compressor section for removal and replacement.

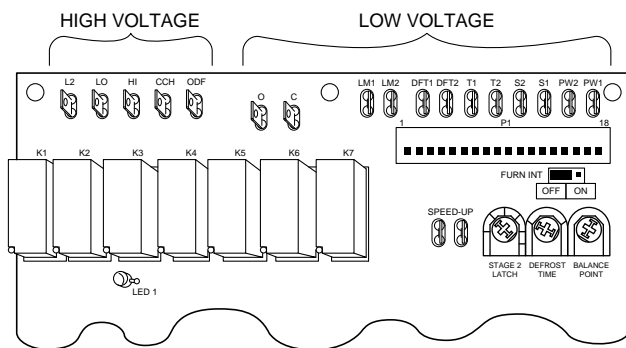


Fig. 22—2-Speed Control Board

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TWO-SPEED SYSTEM

I. CAUTIONS AND WARNINGS

CAUTION: For proper unit operation and reliability, the 2-speed units must be installed with the factory-supplied balance port, hard shut-off TXV. Do not install with indoor coils having piston or capillary tube metering devices.

CAUTION: Do not install equivalent interconnecting tubing lengths greater than 100 ft. Do not decrease or increase interconnecting tubing diameters.

CAUTION: To avoid electrical shock, bleed resistor must be connected across run capacitor. Replace if missing or damaged.

CAUTION: Contactor is mechanically interlocked. Do not disable mechanical interlock. Compressor damage may occur.

WARNING: Contactor control voltage is 240vac.

WARNING: Do not attempt to operate this equipment below 55°F outdoor ambient temperature.

NOTE: The sections that follow describe the 598A (Series C) and 698A (Series B) products which started production March 1994. For 598A (Series A and B) and 698A (Series A) products, refer to the Split-System Service Manual dated 4-1-92, Catalog No. BDP-3359-024.

II. SYSTEM FUNCTIONS

A. Cooling Operation

The 2-speed products utilize a 2-stage cooling indoor thermostat. With a call for first-stage cooling (Y1), the outdoor fan and low-speed compressor are energized. If low speed cannot satisfy the cooling demand, high speed will be energized (Y1 and Y2) by

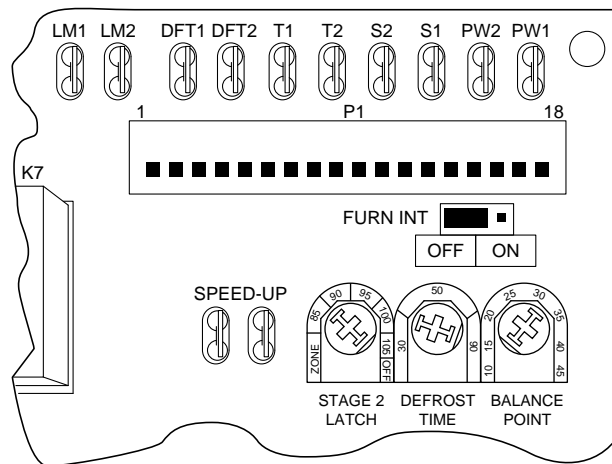


Fig. 23—Speed-Up Terminals

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the second stage of the indoor thermostat. The thermostat has a 2° differential between first and second stages. After second stage is satisfied, the unit returns to low-speed operation, until first stage is satisfied, or until second stage is again required.

B. Heating Operation (Heat Pump Only)

The 2-speed products utilize a 2-stage heating indoor thermostat. The first stage of heating is heat pump operation (Y1). Auxiliary back-up heat is controlled by second stage (W2). There is a 2° differential between first and second stage. The control board determines the compressor speed based on ambient temperature. See Table 4 for ambient temperatures at which speed changes occur. When high-speed heat pump heating is required, the control provides a Y2 (24-vac) signal back to the thermostat to energize high-speed indicator LED.

TABLE 4—AMBIENT TEMPERATURE FOR HIGH- AND LOW-SPEED OPERATION

UNIT SIZE	AMBIENT TEMPERATURE (°F)	
	High Speed	Low Speed
036	30 or less	31 or greater
048	33 or less	34 or greater
060	40 or less	41 or greater

C. LED Function Lights

When using the factory-authorized indoor thermostats with the 2-speed outdoor units, there are 2 locations where system function LED indicator lights are available. The indoor thermostat provides indicator lights for high- and low-speed operation, system malfunction, and auxiliary heat for heat pumps. The 2-speed control board has an LED which provides signals for several system operations. See Table 5 for LED functions, indicator locations, and definitions. Table 5 also provides the order of signal importance if more than 1 signal should occur. The signal to the indoor thermostat is supplied by the low-voltage "L" lead.

D. Three-Sec Time Delay

Any time the control receives a 24-v input, such as Y1 or Y2, there is a 3-sec time delay before the control function is initiated. This helps prevent nuisance trips and thermostat "jiggling."

E. One-Minute Speed Change Time Delay

When the compressor changes speeds from high to low or low to high, there is a 1-minute time delay before the compressor restarts. The outdoor fan motor remains running.

TABLE 5—FUNCTION LIGHT CODE AND DISPLAY LOCATION

CODE	T'STAT	UNIT	DEFINITION	*	POSSIBLE CAUSE
Constant flash No pause	—	X	No demand Stand by	9	
1 flash w/pause	—	X	Low-speed operation	8	
2 flashes w/pause	—	X	High-speed operation	7	
3 flashes w/pause	X	X	Ambient thermistor failure	6	
4 flashes w/pause	X	X	Coil thermistor failure	5	
3 flashes pause 4 flashes	X	X	Thermistor out of range**	4	Thermistor drift, wrong location Incorrect wiring Incorrect refrigerant charge Dirty indoor/outdoor coil
5 flashes w/pause	X‡	X	Pressure switch trip (LM1/LM2)	3	Dirty outdoor coil Refrigerant overcharge Wrong indoor coil
6 flashes w/pause†	X	X	Compressor PTC's out of limit	2	Low refrigerant charge Compressor mechanical problem Dirty indoor/outdoor coil
Constant light No pause No flash	X	X	Board Failure	1	Equipment or electrical service not grounded

* Function light signal order of importance in case of multiple signal request: 1 is most important.
 † Signal at thermostat will occur after 3 consecutive attempted restarts and lockout has occurred.
 ‡ Will be energized if pressure switch remains open for 1 hr.
 ** Check both thermistors to determine which is faulty.

F. Five-Minute Time Delay

The 2-speed control logic contains a 5-minute time delay that prevents the unit from short cycling after a thermostat off cycle or power interruption. The unit can be forced to operate immediately by momentarily touching a jumper between the speed-up terminals of the control board. (See Fig. 22 and 23.) The speed-up feature will not bypass any other function or time delay.

G. Two-Minute Low-Speed Minimum

If the unit has not operated within the past 30 minutes, the unit operates for a minimum of 2 minutes in low speed upon the next thermostat high or low demand.

H. Crankcase Heater Operation

The 2-speed control energizes the crankcase heater during the unit's off cycle when the outdoor ambient is below 75°F.

I. Outdoor Fan Motor Operation

The 2-speed control energizes the outdoor fan any time the compressor is operating. The outdoor fan remains energized during the 1-minute speed change time delay and if a pressure switch or compressor PTC overload should trip.

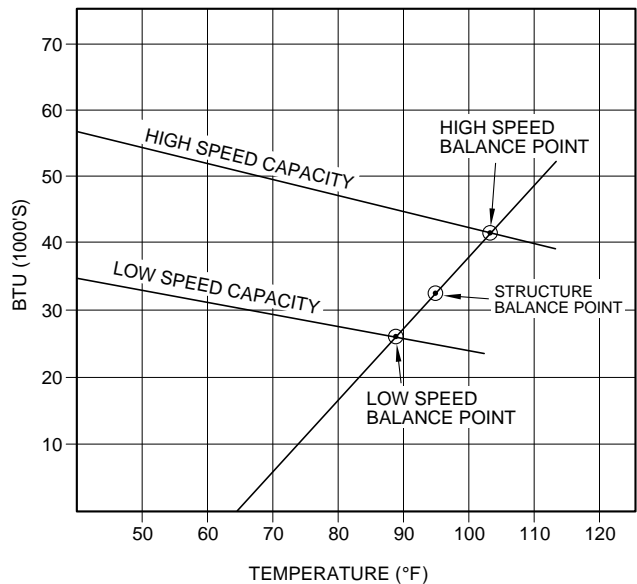
HEAT PUMPS

After the termination of a defrost cycle, the outdoor fan delays coming on for 20 sec. This allows the refrigeration system to recover the outdoor coil heat and minimize the "steam cloud" effect.

J. Second-Stage Latching

When low-speed cooling operation no longer satisfies the first stage of the indoor thermostat, the indoor temperature will increase by 2° until second stage is energized. After high-speed cooling satisfies second stage, it returns to low-speed cooling operation. If desired, the installer may select to have high-speed cooling by energizing Y1. High speed will stay energized until Y1 is satisfied. This eliminates the temperature drop between the first and second stages of indoor thermostat, holding room temperature closer to set point.

To utilize this function, the unit capacity should be plotted versus the heat gain of the structure which provides the system's balance point when the structure requires high-speed capacity. (See Fig. 24.)



A91282

Fig. 24—Typical Cooling Balance Points

Second-stage latching can be selected by rotating the potentiometer (POT) to the desired outdoor second-stage latching temperature (See Fig. 23.) The temperatures that can be selected are 85°, 90°, 95°, 100°, and 105°F. The POT is factory set at 105°F.

K. Zone Selection

If the stage 2 latch POT is set to ZONE position, the compressor operating speed in either heat or cool mode is determined by the Y1 and/or Y2 inputs. The system operates in low speed with a Y1 input and high speed with Y2 or Y1-and-Y2 input. This allows the multistage zoning system to determine what speed is needed regardless of outdoor temperature or switchover point.

L. Defrost Time Selection

The defrost interval can be field selected, depending on local or geographic requirements. It is factory set at 90 minutes and can be changed to either 30 or 50 minutes by rotating the defrost time POT. (See Fig. 23.)

M. Defrost

The 2-speed control logic for the defrost function is the standard time and temperature initiated, time or temperature terminated. Defrost occurs only at outdoor temperatures less than 50°F. The control initiates defrost when the outdoor coil thermistor is 30°F (± 2) or less, and the selected defrost time (interval) has been accumulated during unit operation. Termination occurs when the coil thermistor reaches 80°F (± 5) or the defrost period reaches a maximum of 10 minutes.

Defrost always occurs in high speed unless the stage 2 latch POT is set at ZONE. During defrost the unit operates in high speed, energizes the reversing valve (O) and auxiliary heat (W2), and de-energizes the outdoor fan. Upon termination there is a 20-sec delay in the outdoor fan being energized. If the stage 2 latch POT is set to ZONE and the heat pump is in low speed, it defrosts in low speed.

N. Field-Initiated Forced Defrost

By placing a jumper across the speed-up terminals for a minimum of 5 sec and then removing it, the unit initiates a defrost cycle. (See Fig. 23.) The cycle occurs only if the outdoor ambient is less than 50°F, regardless of outdoor coil temperature. The cycle terminates when the coil thermistor reaches 80°F (± 5) or the defrost period reaches a maximum of 10 minutes.

O. Furnace Interface

This feature provides a heat pump lock-out upon a demand for auxiliary heat (W2) and must be used when interfacing a heat pump with a gas/oil furnace. Field selection of the furnace interface option is done by connecting the factory-supplied jumper to the ON position of the 3 terminal connectors. (See Fig. 22.)

When the option is selected, the heat pump will be locked out of operation any time there is a thermostat demand for W2 or the outdoor ambient is below the balance point POT setting selection. (See Fig. 23.) When the unit requires defrost, auxiliary heat (W2) energizes the furnace. After defrost is terminated, the heat pump shuts down and the furnace satisfies the thermostat. To utilize this function, the economic and/or thermal balance point must be determined. See the appropriate heat pump balance point worksheet available from your distributor or branch.

P. Balance Point

This feature can be used in 2 different options: furnace interface or electric heat staging. Refer to the Furnace Interface section for its application. If the heat pump is installed with a fan coil with multistages of electric heat, this option can be used to stage the banks of heat by outdoor ambient. This eliminates the need for accessory outdoor thermostats.

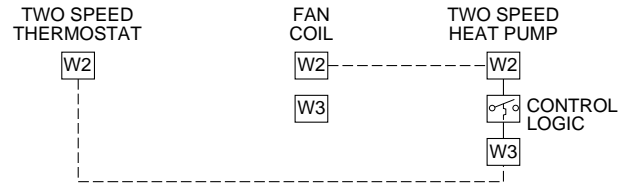
When using this option to stage electric heat, first stage is energized by a W2 demand, and second stage is energized by a W3 demand. Select the W3 desired temperature by rotating the balance point POT. (See Fig. 23.) Temperatures that may be selected are 10°, 15°, 20°, 25°, 30°, 35°, 40°, and 45°F. The POT is factory set at 45°F.

Q. Low-Speed Heating with Auxiliary Heat

If the system is operating in low-speed heating and there is a demand for auxiliary heat (W2), the system changes to high-speed operation. W2 is energized unless the low-voltage control wiring is configured as described in Fig. 25.

R. Auxiliary Heat (W2) Lockout

In some areas, it is necessary to disable the auxiliary heat, except for defrost, until the outdoor ambient is less than the structure's balance point. This is accomplished by using the low-voltage wiring as shown in Fig. 25. Wire the 24-vac W2 signal from the indoor thermostat to W3 of the control, and W2 of the control to W2 of the indoor unit. When the outdoor ambient is less than the setting of the balance point POT, the 24-vac signal energizes the auxiliary heat (W2) of the indoor unit.



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Fig. 25—Low-Voltage Control Wiring

S. Emergency Heat

If the 2-speed control receives a call for auxiliary heat (W2) without a heat pump heating (Y1) call, the second auxiliary stage (W3) is energized. This ensures all available heat is energized if the indoor thermostat is switched to emergency heat.

T. Compressor PTC Overload Protection

The control senses the resistance of the compressor internal positive temperature coefficient (PTC) overloads. If the resistance of the PTC's is out of range, the control shuts off the unit until the resistance range is acceptable. See Table 6 for compressor PTC ranges.

TABLE 6—COMPRESSOR PTC RANGES

COMPRESSOR INTERNAL PTC RESISTANCE	
Safe Range (77°F)	1.5k to 7.8k ohms
To trip	26k to 34k ohms
To reset	8.4k to 10k ohms

When the control turns off the outdoor unit due to out of range PTC's, the unit remains off for 15 minutes with the outdoor fan running. After 15 minutes, the control checks the resistance every 5 minutes until it reaches the reset range. During this time, a malfunction signal appears on the control board. If this happens, remove the wires on control board at S1 and S2 and measure the resistance across the leads. When the resistance reaches 8,400 to 10,000 ohms, system operation may be resumed. If the resistance remains outside this range, a quick check of the leads at the compressor should be made. Loose connections can cause inaccurate readings. If a PTC trip occurs 3 times, the control will lock out the outdoor unit operation and provide malfunction signals at both the control and indoor thermostat.

U. Pressure Switch Protection

The outdoor unit is equipped with high- and low-pressure switches, wired in series. If a pressure switch opens, the control provides a 5-minute time delay in outdoor unit operation with the outdoor fan running. A malfunction signal appears on the control when a pressure switch opens. If the switch remains open for 1 hr or longer, a malfunction signal is provided at the L terminal of the indoor thermostat.

III. FACTORY DEFAULTS

Factory defaults have been provided in the event of failure of the ambient thermistor, outdoor coil thermistor, and/or furnace interface jumper. Refer to Table 7 for default and function.

IV. MAJOR COMPONENTS

A. Two-Speed Control

The 2-speed control board controls the following functions:

- High and low compressor contactor operation
- Outdoor fan motor operation
- Crankcase heater operation
- Compressor protection
- Pressure switch monitoring
- Second-stage latching

TABLE 7—FACTORY DEFAULTS

FAILED COMPONENT	FUNCTION	DEFAULT
Ambient Thermistor	Crankcase Heater	Energized during any off cycle
	Second-Stage Latching	Does not function
	Furnace Interface	Balance point does not function, but interface still energizes furnace and locks out heat pump with a call for W2
	Heating Switchover Speed Point	Unit only runs in high compressor speed
	Defrost Initiation	Defrost is initiated based on coil temperature only
	Outdoor Thermostat for Auxiliary Heat	Anytime there is a call for W2, W3 is also energized
Outdoor Coil Thermistor	Defrost Initiation and Termination	Defrost occurs at each time interval, but terminates after 5 minutes
Furnace Interface Jumper	Furnace Interface	Does not function

- Time delays
- 5-minute time delay speed-up (bypass)

Heat pumps:

- Time/temperature defrost
- Defrost interval selection
- Furnace interface
- Electric heat staging

B. Header Pin Housing

The header pin housing is the plastic assembly which holds the stripped lead ends for field connections. The 2-speed control receives the 24-vac low-voltage control system inputs through the housing/pins. The housing also contains jumpers which the control uses for system configuration, such as heat pump versus air conditioner. See Fig. 26 for header pin housing configurations.

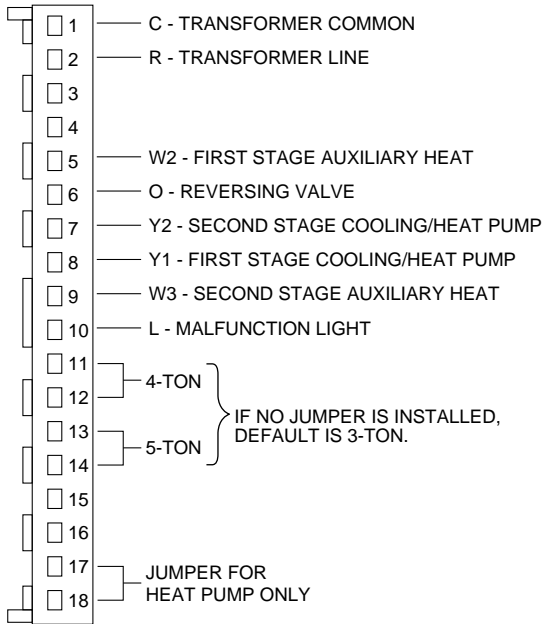


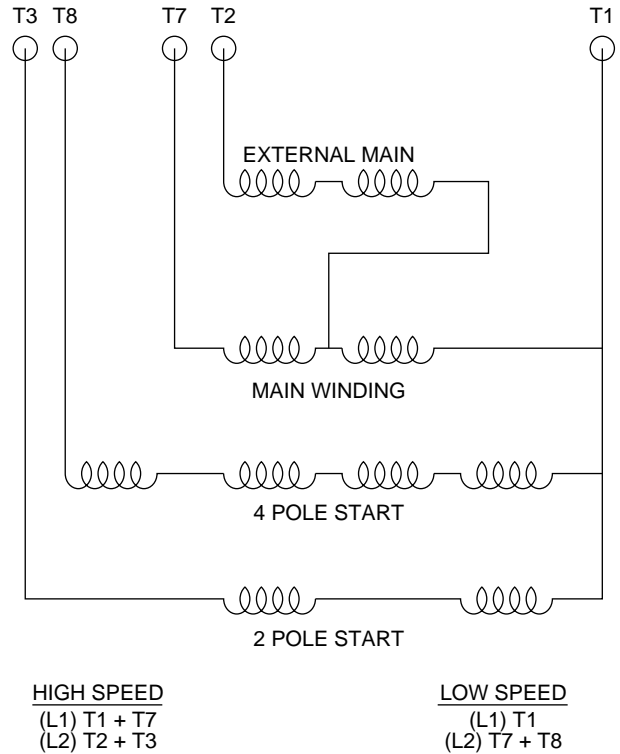
Fig. 26—Header Pin Housing

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C. Two-Speed Compressor

The 2-speed compressor contains motor windings that provide low-speed 4 pole (1750 rpm) and high-speed 2 pole (3500 rpm) operation. Refer to Fig. 27 to determine which windings are energized at each speed. Refer to Compressor Winding Check section under Troubleshooting and Table 8 for appropriate winding resistances.

The 2-speed compressor is also protected by an internal pressure relief (IPR), which relieves discharge gas into the compressor shell (low side) when the differential between suction and discharge pressures exceed 500 psi. The compressor is also protected by 3 PTC devices attached to the motor windings. The PTC's resistance is sensed by the 2-speed control board. See Table 6 for resistance ranges.



HIGH SPEED
(L1) T1 + T7
(L2) T2 + T3

LOW SPEED
(L1) T1
(L2) T7 + T8

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Fig. 27—Energizing Windings

TABLE 8—TWO-SPEED COMPRESSOR (WINDING RESISTANCE AT 70°F ± 2°)

WINDING	3 TON	4 TON	5 TON
T1-T2	0.80	0.70	0.60
T1-T3	3.20	2.20	1.80
T1-T7	1.30	1.00	1.00
T1-T8	3.10	2.20	2.00

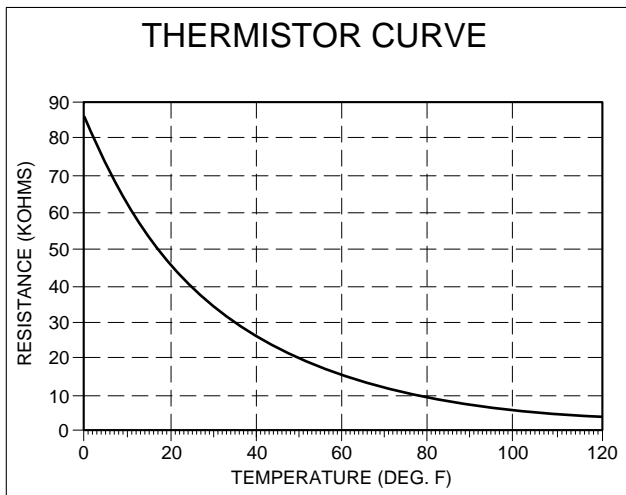
D. Mechanically Interlocked Contactors

The 2-speed products are equipped with mechanically interlocked contactors. Each contactor has interconnecting linkage, providing independent interlocks.

The 2-speed control provides the electrical interlock. The contactors are supplied with 240-v coils, which reduce the va requirements of the low-voltage (24-vac) control system.

E. Temperature Thermistors

Thermistors are electronic devices which sense temperature. As the temperature increases, the resistance decreases. Two thermistors are used to sense temperature: one senses outdoor ambient, and the other senses coil temperature (heat pump only). Refer to Fig. 28 for resistance values versus temperature.



A91431

Fig. 28—Resistance Values Versus Temperature

If the outdoor ambient thermistor should fail, a malfunction signal appears on the indoor thermostat and 2-speed control. The control does not initiate second-stage latching, crankcase heater is turned on during all off-cycles, heating defaults to high speed, and defrost initiates on demand from coil thermistor. (See Table 7.)

If the outdoor coil thermistor should fail, a malfunction signal appears on the indoor thermostat and 2-speed control. The control defrosts every 90 minutes of heating operation and terminates in 5 minutes. (See Table 7.)

V. LED FUNCTION/MALFUNCTION LIGHTS

The 2-speed control is equipped with an LED function/malfunction light.

NOTE: Only malfunction signal appears at thermostat. Both function and malfunction signals appear at control board. (See Fig. 22 for LED location.) Table 5 provides the function/malfunction code, location, and definition.

VI. TROUBLESHOOTING

A. Compressor Winding Check

The 2-speed compressor is nothing more than 2 single-phase motors within 1 compressor shell. When the compressor fails to start or run, there are 3 tests that can be made: open, ground, or short. This compressor has no internal line break overload, however, it does have PTC motor protectors. See Compressor PTC Overload Protection section for PTC overload information.

NOTE: To ensure accurate ohm measurements, place ohmmeter probes on flat surface of compressor terminal tabs, not the brass mounting screw.

OPEN

To determine if a winding has an actual break in the internal wires and current is unable to pass through:

1. Be sure all power is off.
2. Discharge all capacitors.
3. Remove wires from terminals T1, T2, T3, T7, and T8.
4. Use an ohmmeter on 0-1000 ohm scale to check resistance. (See Fig. 27, 29 and 30 and Table 8.)

Because winding resistances are usually less than 10 ohm, each reading will appear to be approximately zero ohm. If during any check the resistance remains at 1000 ohm, an open or break exists and the motor or compressor should be replaced.

GROUND

To determine if any wire has broken and come in direct contact with the housing or shell, causing a direct short to ground:

1. Be sure all power is off.

2. Discharge all capacitors.
3. Remove wires from T1, T2, T3, T7, and T8.
4. Allow crankcase heater to remain on for several hours before checking motor to ensure that windings are not saturated with refrigerant.
5. Using an ohmmeter on R X 10,000 ohm scale, place 1 meter probe on "ground" motor or compressor frame. Make a good metal-to-metal contact. Place other probe on terminals T1, T2, T3, T7, and T8 in sequence. Note meter scale.

If any reading of zero or low resistance is obtained, the motor is grounding. Replace the compressor.

SHORT

This is an extremely critical test and is not advised unless the following conditions are met:

The correct motor winding resistances must be known before testing. See Table 8 for cold motor winding resistance.

The temperature of the windings must be specified, $70^{\circ}\text{F} \pm 2^{\circ}\text{F}$.

The resistance measuring instrument must have an accurate ohmmeter (such as a Wheatstone bridge or null balance-type instrument).

The motor must be dry or free from direct contact with liquid refrigerant.

To determine if any wires have broken through their insulation and come in direct contact with each other, thereby "shorting" all or part of the winding(s):

1. Be sure all power is off.
2. Discharge all capacitors.
3. Remove wires from terminals T1, T2, T3, T7, and T8.
4. Subtract instrument probe and lead resistance from each reading.

If any reading is within ± 20 percent of the known resistance from Table 8, the motor probably does not have a short. Usually a considerable difference will be noted if a turn-to-turn short is present.

B. Control Board Failure

The control board continuously monitors its own operation and the operation of the system. The diagnostic feature allows easy troubleshooting of the control and system in the field. If a failure occurs, the LED light on the control will flash a failure code. If the failure is internal to the control board, the light will stay on continuously (no flash). Before replacing control board, reset the 24-v power. If the fault clears, check to ensure the indoor and outdoor unit and electrical service are properly grounded. If the entire system is grounded, the control board should be replaced, as the control is not field repairable. If the control board light is flashing, see LED and Table 5 for function/malfunction definition. Cycling 24 vac to control board resets previous error messages and any lockouts which have occurred. See Table 9 for more information regarding control board operation.

C. Control Board Power Inputs and Outputs

See Fig. 22 and 26 for inputs and outputs.

D. Bleed Resistor

The bleed resistor is a 150k-2 watt resistor across the compressor run capacitor to protect service technician from injury by electrical shock. Capacitor will bleed-off approximately 1 minute after power to outdoor unit is turned off. If run capacitor is changed out, be sure to place bleed resistor on new capacitor. If bleed resistor is damaged, replace resistor.

E. Start Capacitor and Relay

The 2-speed system has a second start relay in the control box. One start relay is for low-speed start, and the second is for high-speed start. Both start relays use a common start capacitor. When servicing this equipment, be certain system starts in both low- and high-speed operation.

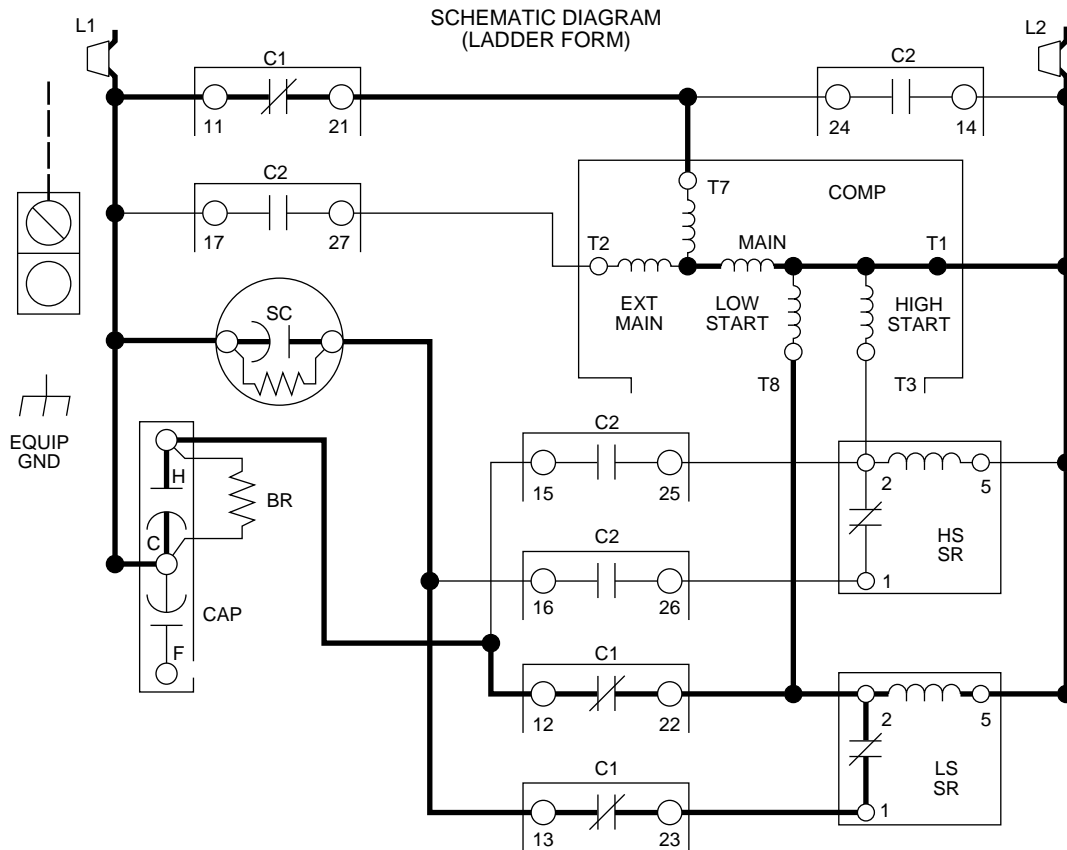


Fig. 29—Low-Speed Windings

A91446

REFRIGERATION SYSTEM

I. REFRIGERATION CYCLE

In a refrigeration system, refrigerant moves heat from 1 place to another. It is useful to understand flow of refrigerant in a system. In a straight cooling system, compressed hot gas leaves compressor and enters condensing coil. As gas passes through condenser coil, it rejects heat and condenses into liquid. The liquid leaves condensing unit through liquid line and enters metering device at indoor coil. As it passes through metering device, it becomes a gas-liquid mixture. As it passes through indoor coil, it absorbs heat and refrigerant and is again compressed to a hot gas. The cycle then repeats.

In a heat pump, the basic cycle is the same. (See Fig. 31.) Reversing valve in system decides which coil, indoor or outdoor, becomes evaporator or condenser. It rejects heat into the home after heat is absorbed by outdoor evaporator coil, thus the home is heated.

In cooling cycle, the indoor coil becomes the evaporator. It absorbs heat from the home and rejects it through the outdoor condenser coil, thus the home is cooled.

A unique feature of the heat pump is that metering devices are designed to meter refrigerant in 1 direction of flow and allow refrigerant to pass unhindered in the other direction. If indoor metering device is metering refrigerant, the outdoor device bypasses refrigerant and vice versa. This allows both coils to serve a dual function.

II. LEAK DETECTION

CAUTION: Always wear safety glasses and gloves when handling refrigerants.

New installations should be checked for leaks prior to complete charging.

TABLE 9—24-V PIN CONNECTION TROUBLESHOOTING

MODE OF OPERATION 18-PIN CONNECTOR	TERMINAL DESIGNATION	LOCATION ON CONTROL BOARD	VOLTAGE PATH	VOLTAGE REQUIRED	POSSIBLE SOURCE OF PROBLEM
All	R-C	2-1	Input	24	Check transformer (secondary)
Low-speed Cooling	Y1,0-C	8,6-1	Input	24	Check thermostat
High-speed Cooling	Y1,Y2,0-C	8,7,6-1	Input	24	Check thermostat
Low-speed Heating	Y1-C	8-1	Input	24	Check thermostat
High-speed Heating	Y1-C	8-1	Input	24	Check thermostat
	Y2-C	7-1	Output	24	Outdoor temperature below speed change temperature
Defrost	Y1-C	8-1	Input	24	Check thermostat
	Y2, W2, 0-C	7,5,6-1	Output	24	Outdoor temperature below 50°F; Coil temperature less than 30°F
Second Stage of Auxiliary Heat	Y1, W2-C	7,5-1	Input	24	Check thermostat
	W3, Y2-C	9,8-1	Output	24	Check balance point setting
Cooling Second-stage Latching	Y1, Y2, 0-C	8,7,6-1	Input	24	Ambient thermistor failure Check second-stage POT

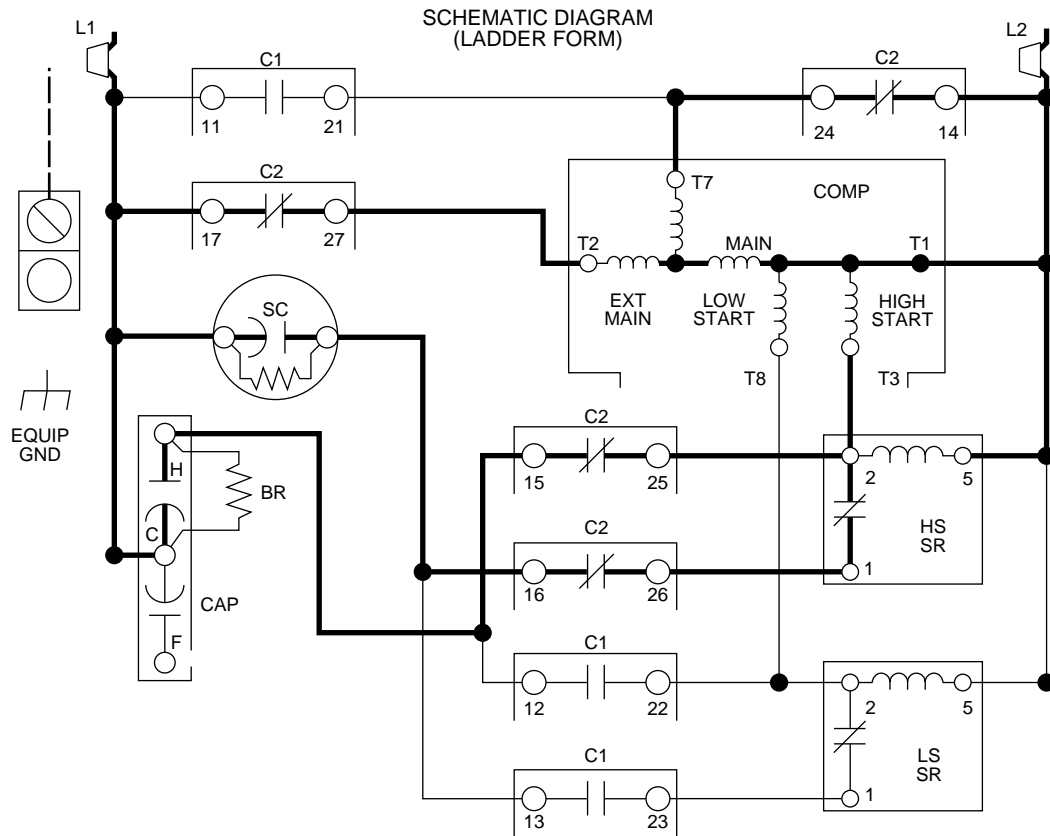


Fig. 30—High-Speed Windings

A91445

If a system has lost all or most of its charge, system must be pressurized again, up to approximately 150 lb minimum. This can be done by adding refrigerant using normal charging procedures, or it may be pressurized with nitrogen (less expensive than refrigerant). Nitrogen also leaks faster than R-22 and is not absorbed by refrigeration oil. Nitrogen cannot, however, be detected by a leak detector. (See Fig. 32.)

CAUTION: Due to the high pressure of nitrogen, it should never be used without a pressure regulator on the tank.

Leaks in a system pressurized with refrigerant can be spotted with a leak detector which detects extremely small refrigerant leaks. This discussion assumes that system is pressurized with either all refrigerant or a mixture of nitrogen and refrigerant.

If system has been operating for some time, make first check for a leak visually. Since refrigerant carries a small quantity of oil, traces of oil at any joint or connection is an indication that refrigerant is leaking at that point.

A simple and inexpensive method of testing for leaks is to use soap bubbles. Any solution of water and soap may be used. Soap solution is applied to all joints and connections in system. A small pinhole leak is located by tracing bubbles in soap solution around leak.

Use electronic leak detector to check for leaks. This unquestionably is the most efficient and easiest method for checking leaks. There are various types of electronic leak detectors. Generally speaking, they are all portable, most are lightweight, and consist of a box with several switches and a probe or sniffer. Detector is turned on and probe is passed around all fittings and connections in system. Leak is detected by either a movement of a pointer on detector dial, by a buzzing sound, or a light.

In all instances, when a leak is found, system charge must be bled down and leak repaired before final charging and operation. After leak testing or leak is repaired, evacuate system, and recharge with correct refrigerant charge.

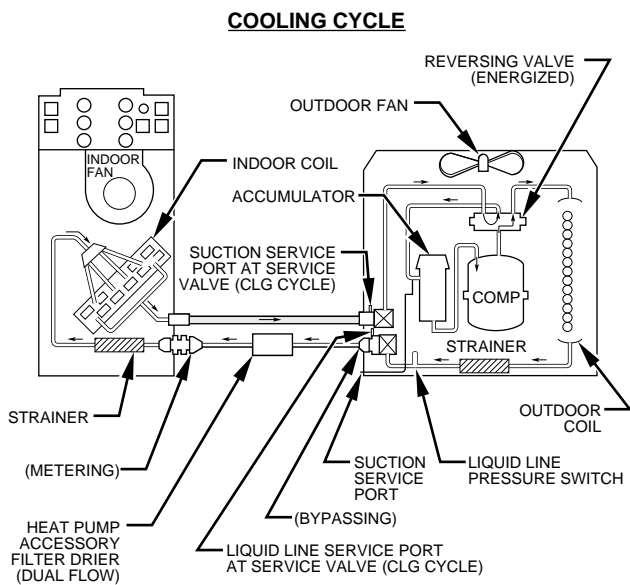


Fig. 31—Heat Pump Refrigerant Flow Diagrams

A88400

III. BRAZING

When brazing is required in the refrigeration system, certain basics should be remembered. The following are a few of the basic rules.

1. Clean joints make the best joints. To clean:
 - a. Remove all oxidation from surfaces to a shiny finish before brazing.
 - b. Remove all flux residue with brush and water while material is still hot.
2. Use "sil-fos" or "phos-copper" for copper-to-copper only. No flux is required.
3. Silver solder is used on copper-to-brass, copper-to-steel, or copper-to-copper. Flux is required when using silver solder.
4. Fluxes should be used carefully. Avoid excessive application and do not allow fluxes to enter into the system.
5. Proper brazing temperature of copper is when it is heated to a dull red color.

This section of brazing is not intended to teach a technician how to braze. There are books and classes which teach and refine brazing techniques. The basic points above are listed only as a reminder.

IV. SERVICE VALVES

Service valves provide a means for holding original factory charge in outdoor unit prior to hookup to indoor coil. They also contain gage ports for measuring system pressures and provide shut-off convenience for certain types of repairs. (See Fig. 33.)

Two types of service valves are used in outdoor residential equipment. The first type is a front seating valve, which has a service port that contains a Schrader fitting. The service port is always pressurized after the valve is moved off the front seat position.

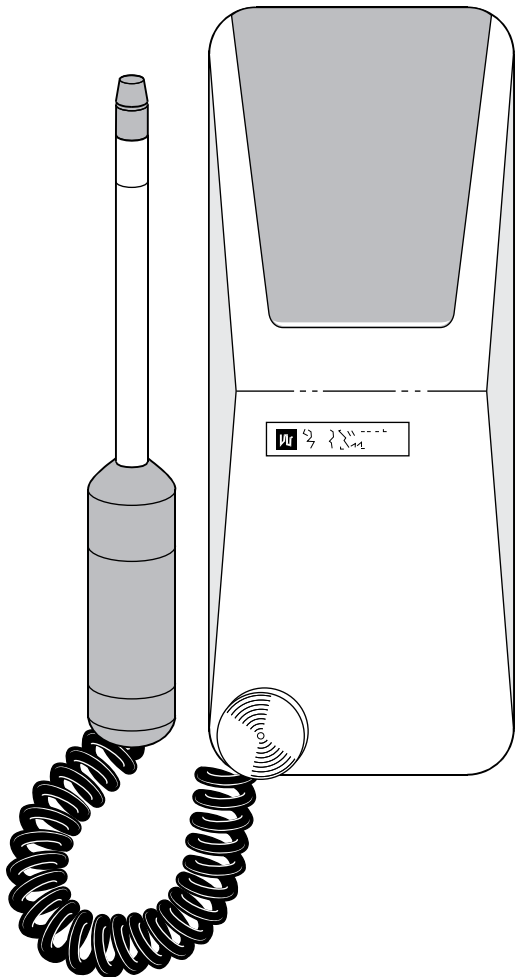


Fig. 32—Leak Detector

A88401

The second type is a combination front seating/back seating valve, which has a metal-to-metal seat in both the open and closed positions. When it is fully back seated, the service port is not pressurized. To pressurize the service port, this valve must be moved off the back seating position. This valve does not contain a Schrader fitting. Both types of service valves are designed for sweat connection to the field tubing.

The service valves in the outdoor unit come from the factory front seated. This means that the refrigerant charge is isolated from the line set connection ports. Some heat pumps are shipped with sweat adapter tube. This tube must be installed on the liquid service valve. After connecting the sweat adapter to the liquid service valve of a heat pump, the valves are ready for brazing. The interconnecting tubing (line set) can be brazed to the service valves using either silver bearing or non-silver bearing brazing material. Consult local codes. Before brazing the line set to the valves, the belled ends of the sweat connections on the service valves must be cleaned so that no brass plating remains on either the inside or outside of the bell joint. To prevent damage to the valve and/or cap "O" ring, use a wet cloth or other acceptable heat-sinking material on the valve before brazing. To prevent damage to the unit, use a metal barrier between brazing area and unit.

After the brazing operation and the refrigerant tubing and evaporator coil have been evacuated, the valve stem can be turned counterclockwise until it opens or back seats, which releases refrigerant into tubing and evaporator coil. The system can now be operated.

Back seating service valves must be back seated (turned counterclockwise until seated) before the service port caps can be removed and hoses of gage manifold connected. In this position, refrigerant has access from and through outdoor and indoor unit.

The service valve stem cap is tightened to 20 ± 2 ft/lb torque and the service port caps to 9 ± 2 ft/lb torque. The seating surface of the valve stem has a knife set edge against which the caps are tightened to attain a metal-to-metal seal. If accessory pressure switches are used, the service valve must be cracked. Then, the knife set stem cap becomes the primary seal.

The service valve cannot be field-repaired, therefore only a complete valve or valve stem and service port caps are available for replacement.

If the service valve is to be replaced, a metal barrier must be inserted between the valve and the unit to prevent damaging the unit exterior from the heat of the brazing operations.

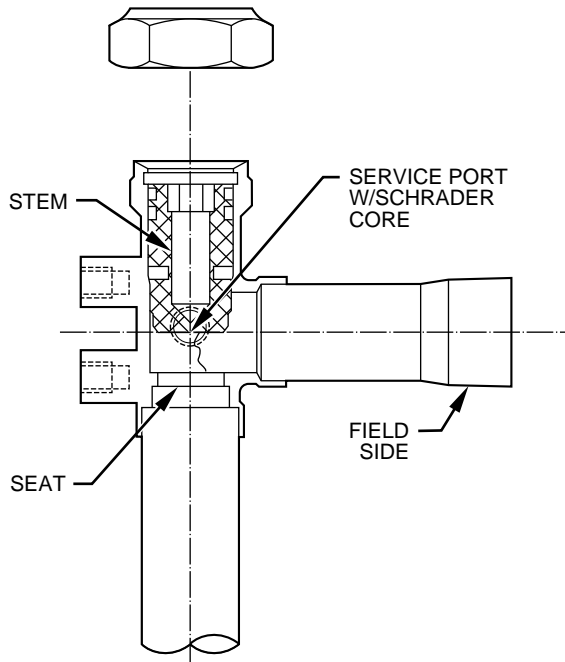
CAUTION: Wear safety glasses and gloves when handling refrigerants.

PUMPDOWN PROCEDURE

Service valves provide a convenient shut-off valve useful for certain refrigeration system repairs. System may be pumped down to make repairs on low side without losing complete refrigerant charge.

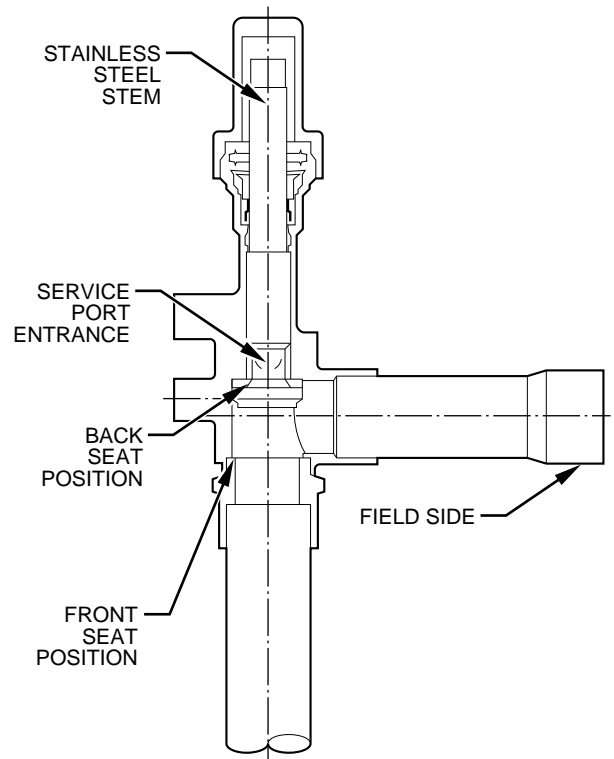
1. Attach pressure gage to suction service valve gage port.
2. Front seat liquid line valve.
3. Start unit in cooling mode. Run until suction pressure reaches 5 psig (35kPa). Do not allow compressor to pump to a vacuum.
4. Shut unit off. Front seat suction valve.

NOTE: All outdoor unit coils will hold only factory-supplied amount of refrigerant. Excess refrigerant, such as in long-line applications, may cause unit to relieve pressure through internal pressure relief valve (indicated by sudden rise of suction pressure) before suction pressure reaches 5 psig (35kPa). If this occurs, shut off unit immediately, front seat suction valve, and recover remaining pressure.



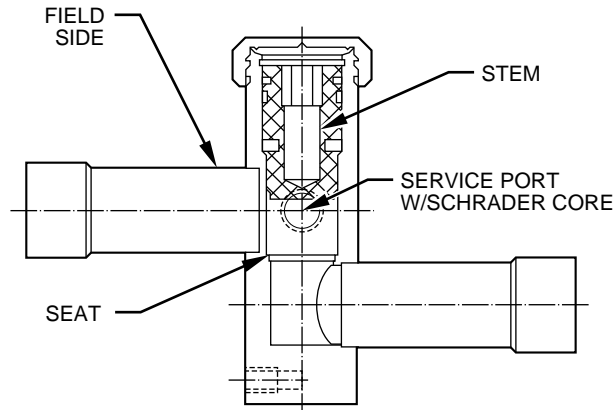
FORGED FRONT SEATING VALVE

A91448



FORGED BACK SEATING VALVE

A91435



BAR STOCK FRONT SEATING VALVE

A91447

Fig. 33—Service Valves

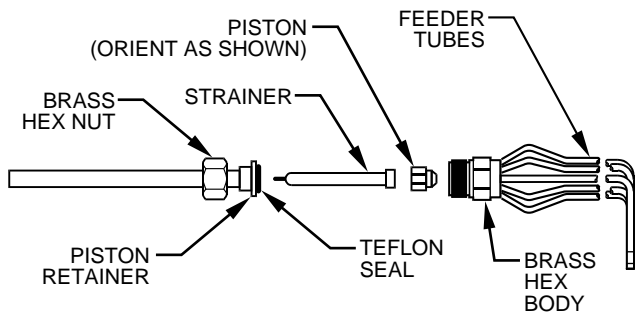
V. CHECK-FLO-RATER (BYPASS TYPE) HEAT PUMPS ONLY

Check-Flo-Rater piston has a refrigerant metering hole through it. The retainer forms a stop for piston in refrigerant bypass mode and a sealing surface for liquid line flare connection. (See Fig. 34.) To check, clean or replace piston:

A. Reliant/Endura Products Except 1992 Production

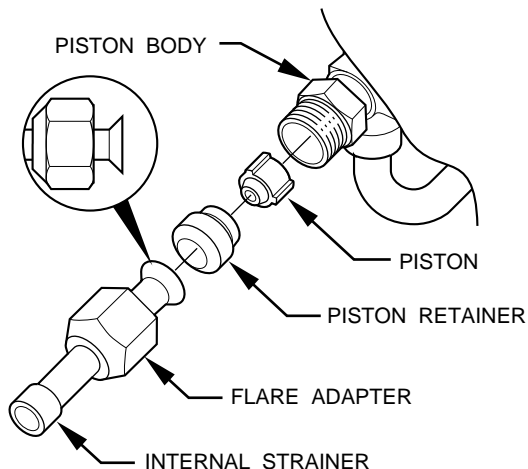
1. Shut off power to unit.
2. Pump unit down using pumpdown procedure described in this service manual.
3. Loosen nut and remove liquid line flare connection from Check-Flo-Rater.

4. Pull retainer out of body, being careful not to scratch flare sealing surface. If retainer does not pull out easily, carefully use locking pliers to remove it.
5. Slide piston out by inserting a small soft wire with small kinks through metering hole. Do not damage metering hole, sealing surface around piston cones, or fluted portion of piston.
6. Clean piston refrigerant metering hole.
7. Install a new retainer O-ring or retainer assembly before reassembling bypass-type Check-Flo-Rater.



1992 PRODUCTION

A91138



PRODUCTION
EXCEPT 1992

A94004

Fig. 34—Check-Flo-Rater Components
B. Reliant/Endura and Cube Products
Produced in 1992

1. Shut off power to unit.
2. Reclaim outdoor unit refrigerant.
3. Loosen brass hex nut and remove line from brass hex body.
4. Slide piston out by inserting a small soft wire with small kinks through metering hole. Do not damage metering hole, sealing surface around piston cones or fluted portion of piston.
5. Clean piston refrigerant metering hole.
6. Always replace Teflon seal with new seal. Never try to reuse old seals.
7. Reassemble brass nut and brass hex body. Be sure orientation is as shown in Fig. 34.

VI. REVERSING VALVE

In heat pumps, changeover between heating and cooling modes is accomplished with a valve that reverses flow of refrigerant in system. (See Fig. 35.) This reversing valve device is easy to troubleshoot and replace. The reversing valve solenoid can be checked with power off with an ohmmeter. Check for continuity and shorting to ground. With control circuit (24-v) power on, check for correct voltage at solenoid coil. Check for overheated solenoid.

With unit operating, other items can be checked, such as frost or condensate water on refrigerant lines.

The sound made by a reversing valve as it begins or ends defrost is a "whooshing" sound, as the valve reverses and pressures in system equalize. An experienced service technician detects this sound and uses it as a valuable troubleshooting tool.

Using a remote measuring device, check inlet and outlet line temperatures. DO NOT touch lines. If reversing valve is operating normally, inlet and outlet temperatures on appropriate lines should be close. Any difference would be due to heat loss or gain across valve body. Temperatures are best checked with a remote reading electronic-type thermometer with multiple probes. Route thermocouple leads to inside of coil area through service valve mounting plate area underneath coil. Fig. 36 and 37 show test points (TP) on reversing valve for recording temperatures. Insulate points for more accurate reading.

If valve is defective:

1. Shut off all power to unit and remove all charge from system.
2. Check valve design. If valve is of the 3-port design and new replacement is of the 4-port design, replacement of the solenoid coil and wire leads is necessary. Valve bodies are interchangeable, but solenoid and wires are not. Three-port reversing valve and solenoid coil with leads must be used together. New solenoid coil cannot be used on a 3-port valve. Four-port reversing valve uses solenoid with quick-connect terminals for leads connection. Old solenoid coil cannot be used on 4-port reversing valve. If for any reason a new wire cord is not available, cut the leads on the old solenoid coil as close to the coil as possible. Terminate the leads with 2 female 1/4-in. quick-connects. Connect terminals to new solenoid and tape connection to insulate and provide moisture barrier. Replace these wires as soon as wire cord is available. See RCD Replacement Component Catalog for proper cord part number.
3. Remove solenoid coil from valve body. Remove valve by cutting it from system with tubing cutter. Repair person should cut in such a way that stubs can be easily rebrazed back into system. Do not use hacksaw. This introduces chips into system that cause failure. After defective valve is removed, wrap it in wet rag and carefully unbrazed stubs. Save stubs for future use. Because defective valve is not overheated, it can be analyzed for cause of failure when it is returned.
4. Braze new valve onto used stubs. Keep stubs oriented correctly. Scratch corresponding matching marks on old valve and stubs and on new valve body to aid in lining up new valve properly. When brazing stubs into valve, protect valve body with wet rag to prevent overheating.
5. Use slip couplings to install new valve with stubs back into system. Even if stubs are long, wrap valve with a wet rag to prevent overheating.
6. After valve is brazed in, check for leaks. Evacuate and charge system. Operate system in both modes several times to be sure valve functions properly.

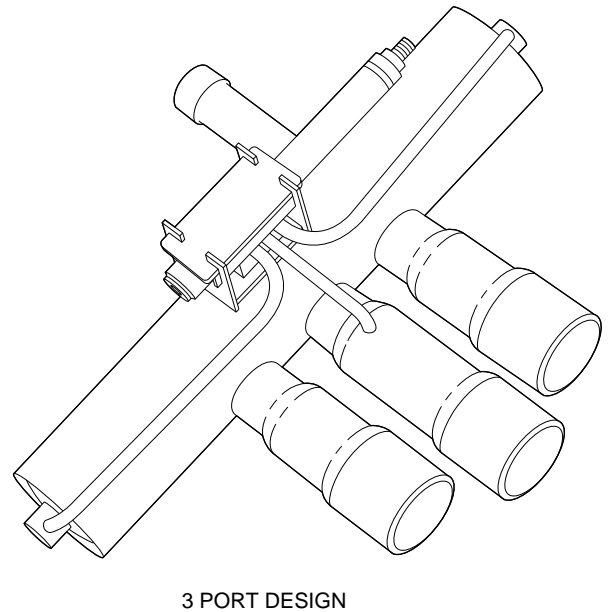
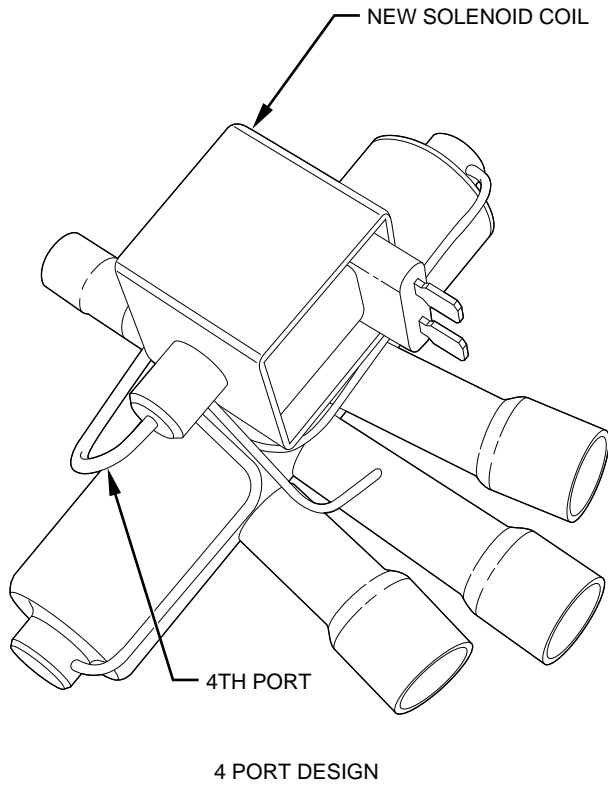
VII. THERMOSTATIC EXPANSION VALVES (TXV)

The types of thermostatic expansion valves used in condensing unit and heat pump systems are as follows:

Rapid Pressure Balance (RPB)—Has a special bleed port that allows rapid bleed-through of pressure after system shutdown until pressure equalization occurs within approximately 1 to 2 minutes.

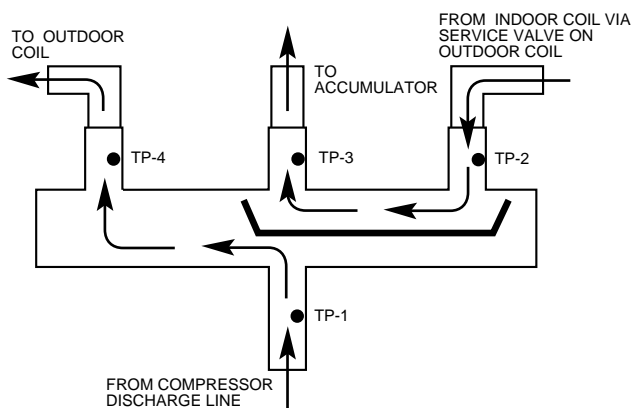
Hard Shut-off (HSO)—Has no bleed port and allows no bleed-through after system shutdown. No pressure equalization occurs. Because of unequalized system pressures, a start capacitor and relay must be installed on single-phase reciprocating compressors to start the compressor.

See Table 10 for thermostatic expansion valve superheat settings. These settings are factory set and are not field adjustable. Table 10 settings are for BDP-approved accessories and factory-installed TXV's only.



A91456
Fig. 35—Reversing Valve

A91457

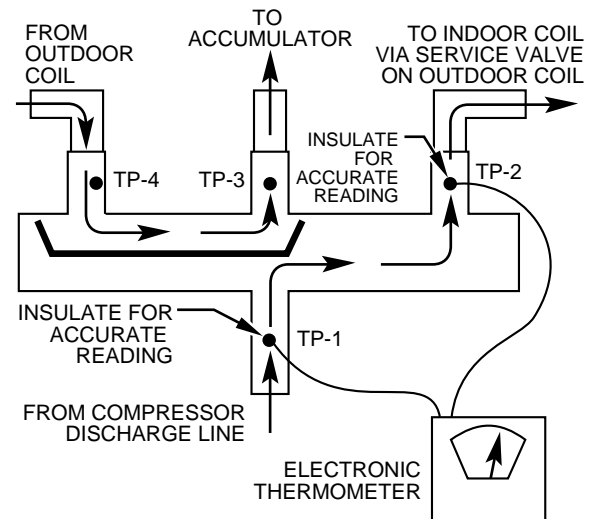


A88342
Fig. 36—Reversing Valve (Cooling Mode or Defrost Mode, Solenoid Energized)

VIII. THERMOSTATIC EXPANSION VALVE (BI-FLOW TXV)

The standard thermostatic expansion valve is a metering device that is used in condensing and heat pump systems to adjust to changing load conditions by maintaining a pre-set superheat temperature at the outlet of the evaporator coil. The volume of refrigerant metered through the valve seat is dependent upon:

1. Superheat temperature sensed by cap tube sensing bulb on suction tube at outlet of evaporator coil. As long as this bulb and cap tube contains some liquid refrigerant, this temperature is converted into suction pressure pushing downward on the diaphragm, which tends to open the valve via the pushrods.



A88341
Fig. 37—Reversing Valve (Heating Mode, Solenoid De-Energized)

2. The suction pressure at the outlet of the evaporator coil is transferred via the external equalizer tube to the underside of the diaphragm.
3. The needle valve on the pin carrier is spring-loaded, which also exerts pressure on the underside of the diaphragm via the pushrods, which tends to close the valve. Therefore, bulb pressure equals evaporator pressure (at outlet of coil) plus spring pressure. If the load increases, the temperature increases at the bulb, which increases the pressure on the topside of the diaphragm, which pushes the pin carrier away from the seat, opening the valve and increasing the flow of refrigerant. The increased refrigerant flow causes increased leaving evaporator pressure which is transferred via the

TABLE 10—TXV SUPERHEAT SETTING AT OUTLET OF EVAPORATOR COIL

INSTALLATION	TXV TYPE	PRODUCT USAGE	SUPERHEAT SETTING
Field Accessory	RPB/HSO	Air Conditioner Indoor Unit	10°
Field Accessory	RPB/HSO	Heat Pump Indoor Unit	6°
Field Accessory/Factory Installed	HSO	Indoor Fan Coil Unit	6°
Factory Installed	HSO	2-Speed Heat Pump Outdoor Unit	4°
Factory Shipped/Field Installed	HSO	2-Speed Indoor Unit	4°

equalizer tube to the underside of the diaphragm., This tends to cause the pin carrier spring pressure to close the valve. The refrigerant flow is effectively stabilized to the load demand with negligible change in superheat. The bi-flow thermostatic expansion valve is used on split-system heat pumps. In the cooling mode, the TXV operates the same as the standard TXV previously explained. (See Fig. 38.) However, when the system is switched to the heating mode of operation, the refrigerant flow is reversed. The bi-flow TXV has an additional internal check valve and external tubing. (See Fig. 39.) These additions allow the refrigerant to bypass the TXV when refrigerant flow is reversed with only a 1- to 2-psig pressure drop through the device. When the heat pump switches to the defrost mode, the refrigerant flows through a completely open (un-throttled) TXV, and the bulb senses the residual heat of the outlet tube of the coil that had been operating in the heating mode (about 85°F and 155 psig). This temporary un-throttled valve decreases the indoor pressure drop, which in turn increases the refrigerant flow rate, decreases overall defrost time, and enhances defrost efficiency.

IX. COIL REMOVAL

Coils on this family of units are easy to remove if required for compressor removal, or replacement coil.

CAUTION: Wear safety glasses and gloves when handling refrigerants.

To remove or replace coil:

1. Shut off all power to unit.
2. Remove and recover refrigerant from system through service valves.
3. Remove top cover. (See Remove Top Cover section.)
4. Remove screws in base pan to coil grille.
5. Remove coil grille from unit.
6. Remove screws on corner post (Reliant/Endura) service valve panel (Cube unit) holding coil tube sheet.

CAUTION: Cut tubes to reduce the possibility of fire and personal injury.

7. Use midget tubing cutter to cut liquid and vapor lines at both sides of coil. Cut in convenient location for easy reassembly with copper slip couplings.
8. Lift coil vertically from basepan. Place aside carefully.
9. Reverse procedure to reinstall coil.

X. LIQUID LINE STRAINER (HEAT PUMPS ONLY)

The liquid line strainer is upstream of the heating piston. The strainer catches debris in the liquid line during heating mode. If it becomes plugged, system operation and pressure become abnormal and the compressor may become hot and cycle off on the overloads or pressure relief.

If the strainer must be replaced, shut off all power to the unit. See Fig. 34 for strainer location.

XI. ACCUMULATOR

The accumulator is a device always found in heat pumps and found in some condensing unit models. Under some light load conditions on indoor coils and on outdoor coil with heat pump in heating mode, some liquid refrigerant is present in suction gas returning to compressor. The accumulator stores liquid and allows it to boil off into a vapor so it can be safely returned to compressor. Since a compressor is designed to pump refrigerant in its gaseous state, introduction of liquid into it could cause severe damage or total failure of compressor.

The accumulator is a passive device which seldom needs replacing. Occasionally its internal oil return orifice or bleed hole may become plugged. Some oil is contained in refrigerant returning to compressor. It cannot boil off in accumulator with liquid refrigerant. The bleed hole allows a small amount of oil and refrigerant to enter the return line where velocity of refrigerant returns it to compressor. If bleed hole plugs, oil is trapped in accumulator, and compressor will eventually fail from lack of lubrication. If bleed hole is plugged, accumulator must be changed. Bleed hole is so tiny that cleaning efforts are usually not successful. The accumulator has a fusible element located in the bottom end bell. (See Fig. 40.) This fusible element melts at 430°F and vents the refrigerant if this temperature is reached either internal or external to the system. If fuse melts, the accumulator must be replaced.

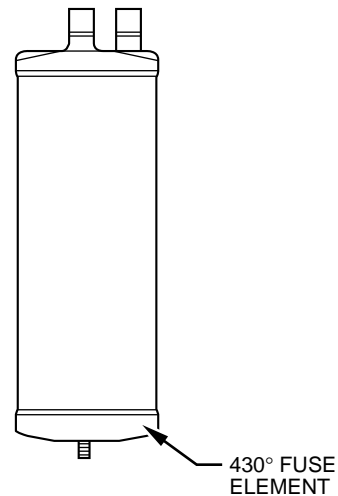


Fig. 40—Accumulator

A88410

To change accumulator:

1. Shut off all power to unit.
2. Remove and reclaim all refrigerant from system.

NOTE: Coil may be removed for access to accumulator. Refer to appropriate sections of service manual for instructions.

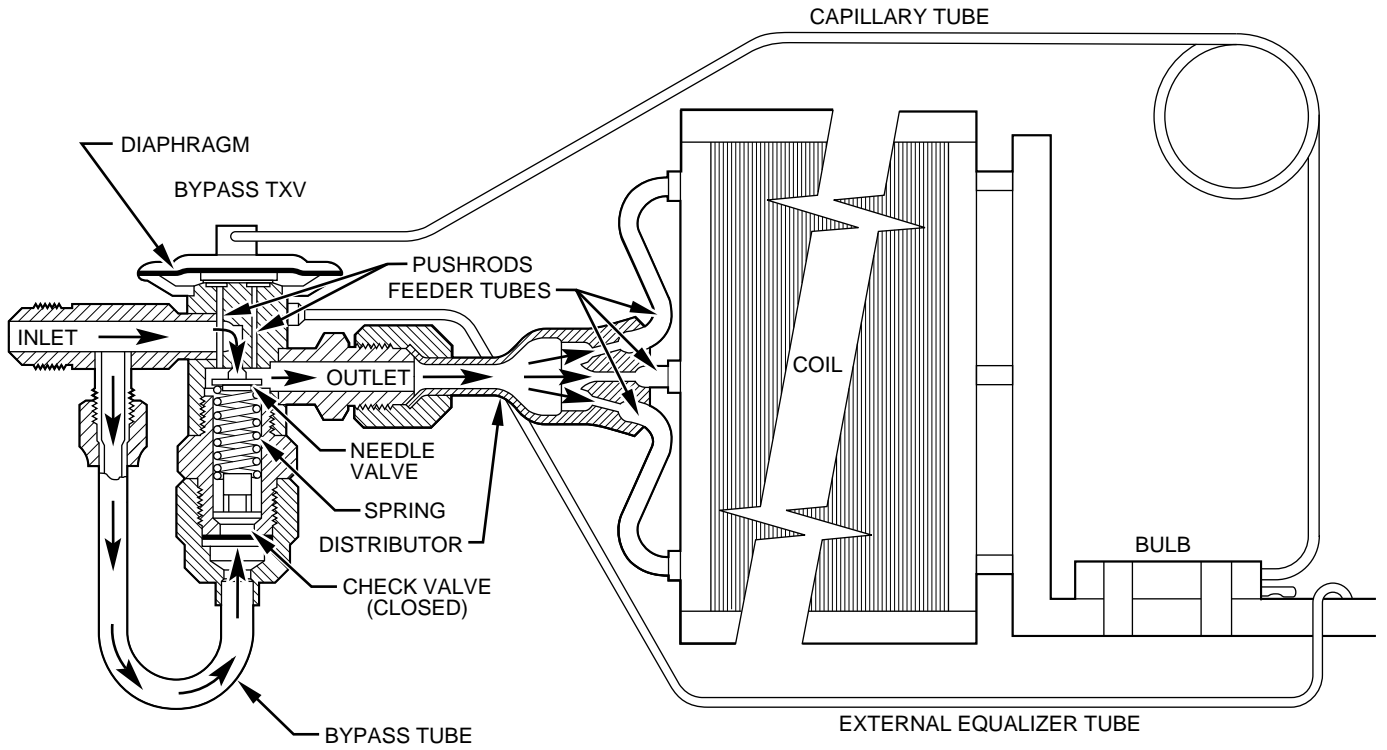


Fig. 38—TXV in Cooling Mode

A88406

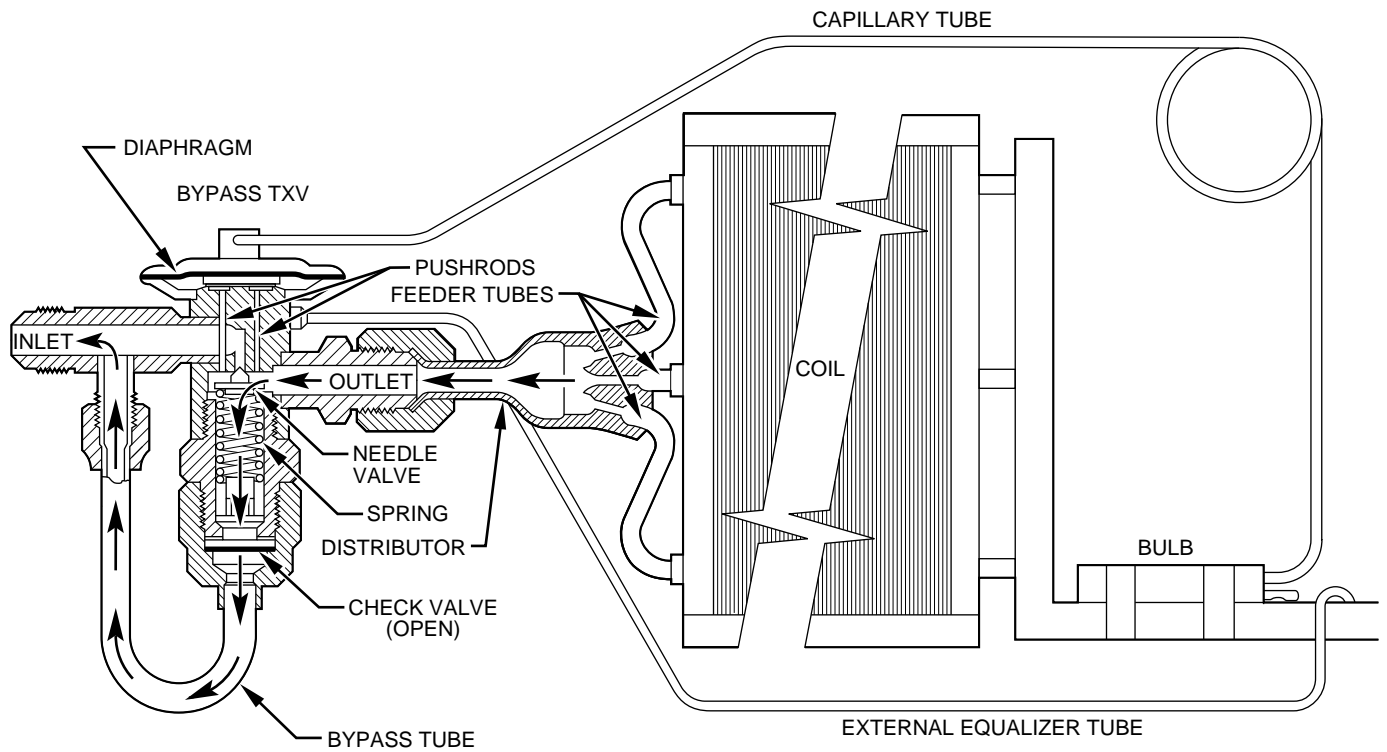



Fig. 39—TXV in Heating Mode

A88405

 **CAUTION:** Wear safety glasses and gloves when working on refrigerants and when using brazing torch.

3. When accumulator is exposed, remove it from system with tubing cutter.
4. Scratch matching marks on tubing stubs and old accumulator. Scratch matching marks on new accumulator. Unbraze stubs from old accumulator and braze into new accumulator.
5. Thoroughly rinse any flux residue from joints and paint with corrosion-resistant coating such as zinc-rich paint.
6. Reinstall accumulator into system with copper slip couplings.
7. Evacuate and charge system.
8. Pour and measure oil quantity (if any) from old accumulator. If more than 20 percent of oil charge is trapped in accumulator, add oil to compressor to make up for this loss.

XII. CONTAMINANT REMOVAL

Proper evacuation of a unit removes non-condensibles and assures a tight, dry system before charging. The 2 methods used to evacuate a system are the deep vacuum method and the triple evacuation method.

A. Deep Vacuum Method

The deep vacuum method requires a vacuum pump capable of pulling a vacuum of 1000 microns and a vacuum gage capable of accurately measuring this vacuum depth. The deep vacuum method is the most positive way of assuring a system is free of air and liquid water.

B. Triple Evacuation Method


The triple evacuation method can be used where the vacuum pump is capable of pumping down to only 28 in. of mercury vacuum, and the system does not contain any liquid water. The procedure is as follows.

1. Pump the system down to 28 in. of mercury vacuum and allow pump to continue to operate for additional 15 minutes.
2. Close service valves and shut off vacuum pump.
3. Connect a refrigerant cylinder to the system and open until system pressure is 2 psig.
4. Close the service valve.
5. Allow system to stand for 1 hr, during which time the dry refrigerant will be able to diffuse throughout the system, absorbing moisture.

This procedure is repeated 3 times after which the system will be free of any contaminants and water vapor.

XIII. SYSTEM CHARGING

For all approved combinations, system must be charged correctly for normal system operation and reliable operation of components.

 **CAUTION:** Always wear safety glasses and gloves when handling refrigerants.

If system has lost all charge, weigh in charge using dial-a-charge or digital scale.

System charge should be fine-tuned by using the superheat or subcooling method, whichever is appropriate. These methods are covered in the Checking Charge section below.

NOTE: Heat pump check charts are for checking charge and performance and for adding a small amount of charge. During heating mode, correct method of charging is the weight method. In

heating mode, check should be made approximately 15 minutes after a defrost with unit running with a clean coil. In cooling cycle, system should run at least 10 minutes for temperatures and pressures to stabilize. All charts assume there are no system abnormalities and indoor coil airflows are correct. If system abnormalities exist, correct them before checking system charge.

XIV. CHECKING CHARGE

Superheat charging is the process of charging refrigerant into a system until the temperature (superheat) of the suction gas entering the compressor reaches a prescribed value. Small variations of charge affect suction gas superheat temperatures greatly. Therefore, this method of charging is very accurate. This method can be used only on split-system condensing units and heat pumps (operating in the cooling mode) with fixed restrictor type metering devices such as Check-Flo-Rater, cap tube, etc. For units using a TXV, the subcooling method must be used. Heat pumps must be operating in the cooling mode. To charge by superheat, a service technician needs an accurate superheat thermocouple or thermistor-type thermometer, a sling psychrometer, and a gage manifold. Do not use mercury or small dial type thermometers as they are not adequate for this type of measurement. Then use 1 of the following procedures:

A. Superheat Charging Method

1. Operate a unit a minimum of 10 minutes before checking charge.
2. Measure vapor pressure by attaching a gage to vapor valve service port.
3. Measure vapor line temperature by attaching a service thermometer to unit vapor line near vapor valve. On a heat pump, attach to the suction tube between the accumulator and the compressor. Insulate thermometer for accurate readings.
4. Measure outdoor air dry-bulb temperature with a second thermometer.
5. Measure indoor air (entering indoor coil) wet-bulb temperature with a sling psychrometer.
6. Locate outdoor temperature and evaporator entering air wet-bulb temperature in Table 11. At this intersection note the superheat.
7. Locate superheat temperature located in previous step and vapor pressure in Table 12. At this intersection note vapor line temperature.
8. If unit has a higher vapor line temperature than charted temperature, add refrigerant until charted temperature is reached.
9. If unit has a lower vapor line temperature than charted temperature, bleed refrigerant until charted temperature is reached.
10. If outdoor air temperature or pressure at vapor valve changes, charge to new vapor line temperature indicated on chart.

This procedure is valid, independent of indoor air quantity.

B. Subcooling Charging Method

1. Operate unit a minimum of 15 minutes before checking charge.
2. Measure liquid service valve pressure by attaching an accurate gage to the service port.
3. Measure the liquid line temperature by attaching an accurate thermistor-type or electronic thermometer to the liquid line near the outdoor coil.
4. Refer to unit rating plate to find required subcooling temperature for units produced during or after January 1993. For units produced through December 1992, refer to Table 13. Find the point at which the required subcooling temperature intersects the measured liquid service valve pressure on Table 14.

TABLE 11—SUPERHEAT CHARGING TABLE

OUTDOOR TEMP (°F)	INDOOR COIL ENTERING AIR TEMP (°F WET BULB)													
	50	52	54	56	58	60	62	64	66	68	70	72	74	76
55	9	12	14	17	20	23	26	29	32	35	37	40	42	45
60	7	10	12	15	18	21	24	27	30	33	35	38	40	43
65	—	6	10	13	16	19	21	24	27	30	33	36	38	41
70	—	—	7	10	13	16	19	21	24	27	30	33	36	39
75	—	—	—	6	9	12	15	18	21	24	28	31	34	37
80	—	—	—	—	5	8	12	15	18	21	25	28	31	35
85	—	—	—	—	—	—	8	11	15	19	22	26	30	33
90	—	—	—	—	—	—	5	9	13	16	20	24	27	31
95	—	—	—	—	—	—	—	6	10	14	18	22	25	29
100	—	—	—	—	—	—	—	—	8	12	15	20	23	27
105	—	—	—	—	—	—	—	—	5	9	13	17	22	26
110	—	—	—	—	—	—	—	—	—	6	11	15	20	25
115	—	—	—	—	—	—	—	—	—	—	8	14	18	23

Where a dash appears, do not attempt to charge system under these conditions or refrigerant slugging may occur.

TABLE 12—REQUIRED VAPOR TEMPERATURE (°F)

SUPERHEAT TEMP (°F)	VAPOR PRESSURE AT SERVICE PORT (PSIG)									
	61.5	64.2	67.1	70.0	73.0	76.0	79.2	82.4	85.7	
0	35	37	39	41	43	45	47	49	51	
2	37	39	41	43	45	47	49	51	53	
4	39	41	43	45	47	49	51	53	55	
6	41	43	45	47	49	51	53	55	57	
8	43	45	47	49	51	53	55	57	59	
10	45	47	49	51	53	55	57	59	61	
12	47	49	51	53	55	57	59	61	63	
14	49	51	53	55	57	59	61	63	65	
16	51	53	55	57	59	61	63	65	67	
18	53	55	57	59	61	63	65	67	69	
20	55	57	59	61	63	65	67	69	71	
22	57	59	61	63	65	67	69	71	73	
24	59	61	63	65	67	69	71	73	75	
26	61	63	65	67	69	71	73	75	77	
28	63	65	67	69	71	73	75	77	79	
30	65	67	69	71	73	75	77	79	81	
32	67	69	71	73	75	77	79	81	83	
34	69	71	73	75	77	79	81	83	85	
36	71	73	75	77	79	81	83	85	87	
38	73	75	77	79	81	83	85	87	89	
40	75	77	79	81	83	85	87	89	91	

- To obtain the required subcooling temperature at a specific liquid line pressure, add refrigerant if liquid line temperature is higher than indicated or remove refrigerant if temperature is lower. Allow a tolerance of 3°F.

XV. CARE AND MAINTENANCE

To assure high performance and minimize possible equipment malfunction, it is essential that maintenance be performed periodically on this equipment. The frequency with which maintenance is performed is dependent on such factors as hours of operation, geographic location, and local environmental conditions.

⚠ WARNING: Disconnect all electrical power to unit before performing any maintenance or service on outdoor unit. Remember to disconnect power supply to air handler as this unit supplies low-voltage power to the outdoor unit. Electric shock can cause personal injury or death.

- Check outdoor coil for cleanliness each month during the heating (heat pump only) or cooling season and clean as necessary, but clean at least once each heating (heat pump only) and cooling season.
- Check fan motor and blade for cleanliness each heating and cooling season and clean as necessary.
- Check electrical connections for tightness and controls for proper operation each heating (heat pump only) or cooling season and service as necessary.

⚠ CAUTION: Because of possible damage to the equipment or personal injury, maintenance should be performed by qualified personnel only.

A. Coil Cleaning

- Remove top cover. See Remove Top Cover section.

The minimum maintenance that should be performed on this equipment is as follows.

TABLE 13—SUBCOOLING AT LIQUID SERVICE VALVE FOR UNITS PRODUCED THROUGH DECEMBER 1992

RELIANT/ENDURA—AIR CONDITIONERS																							
Model	590A			591A/592A				593A/594A				593B		593C		594C		595A	596A	597A	597B	598A High	598A Low
Series	A	B	C	A	B	C	D	A	B	C	D	A	B	A	B	A	B	A	A	A	A	A	A
014	14	14	—	14	14	14	—	6	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
018	17	17	—	14	14	14	—	7	7	—	—	11	—	9	9	—	—	9	8	—	—	—	—
024	13	13	—	17	17	17	—	8	8	—	—	13	—	16	21	12	—	13	12	11	13	—	—
030	15	15	—	9	10	10	—	6	6	10	13	11	—	15	15	14	—	10	9	10	11	—	—
036	13	12	—	16	16	16	—	12	12	5	—	9	—	13	12	16	—	14	13	12	14	12	9
038	—	—	—	—	—	—	—	—	—	—	—	16	—	—	—	—	—	—	—	—	—	—	—
042	13	13	14	16	19	19	15	12	12	—	—	11	—	13	—	21	—	11	11	15	15	—	—
048	15	14	—	18	14	18	—	14	14	—	—	18	—	17	—	14	—	10	10	11	11	12	9
060	19	22	—	18	18	18	—	14	14	—	—	11	—	16	—	19	—	—	—	12	11	12	9

RELIANT/ENDURA—HEAT PUMPS																	
Model	690A				691A/692A		693A/694A		693B	693C	694C	697A	697B	698A Cooling		698A Heating	
Series	A	B	C	D	A	B	A	B	A	A	A	A	A	High	Low	High	Low
014	7	7	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—
018	18	18	18	—	16	16	11	11	10	9	7	9	10	—	—	—	—
024	18	18	18	—	16	16	11	11	13	6	5	11	11	—	—	—	—
030	13	13	13	—	20	20	10	10	11	10	10	9	10	—	—	—	—
036	18	18	18	—	14	14	10	10	11	13	12	9	10	12	7	18	15
042	13	11	11	—	18	18	15	15	12	10	12	11	12	—	—	—	—
048	22	17	15	14	19	14	13	13	—	15	12	10	11	14	9	25	18
060	23	23	23	—	13	13	14	14	—	15	10	12	7	14	9	22	21

MODEL	CUBE UNIT—AIR CONDITIONERS				CUBE UNIT—HEAT PUMPS				HORIZONTAL AIR CONDITIONERS					
	561A/571A				661A/671A				566D		566E			
Series	A		B		A		B		C		D		A	
014	—		—		—		—		10		—		—	
018	15		16		11		14		12		—		17	
024	14		11		14		8		—		—		19	
030	12		12		9		10		—		12		—	
036	18		16		11		7		—		—		—	
042	18		17		7		—		—		—		—	
048	—		17		12		—		—		—		—	
060	—		21		10		—		—		—		—	

CAUTION: Coil fin damage can result in higher operating costs or compressor damage. Do not use flame, high-pressure water, steam, or volatile or corrosive cleaners on fins or tubing.

- Clean coil using vacuum cleaner and its crevice tool. Move crevice tool vertically, close to area being cleaned, making sure tool touches only the dirt on the fins and not the fins. To prevent fin damage, do not scrub fins with tool or move tool horizontally against fins.
- If oil deposits are present, spray coil with ordinary household detergent. Wait 10 minutes, and proceed to next step.
- Using garden hose, spray coil vertically downward with constant stream of water at moderate pressure. Keep nozzle at a 15° to 20° angle, about 3 in. from coil face and 18 in. from tube. Spray so debris is washed out of coil and basepan.
- Restore power to unit.

B. Cleaning Outdoor Fan Motor and Blade

- Remove fan motor and blade. Refer to Remove Fan Motor Assembly section of this manual. Be careful not to bend or dent fan blade.
- Clean motor and blade with soft brush or cloth. Be careful not to disturb balance weights on fan blade.

- Check fan blade setscrew for tightness.
- Reinstall fan motor and blade to top cover and check for alignment.
- Reinstall top cover and position blade as per Fig. 15.
- Reconnect electrical power and check for proper operation.

C. Electrical Controls and Wiring

- Disconnect power to both the outdoor and indoor units.
- Check all electrical connections for tightness. Tighten all screws on electrical connections. If any connections appear to be burned or smokey, disassemble the connection, clean all parts and stripped wires, and reassemble. Use a new connector if old one is burned or corroded and crimp tightly.
- Reconnect electrical power to the indoor and outdoor units and observe unit through 1 complete operating cycle.
- If there are any discrepancies in the operating cycle, troubleshoot to find the cause, and correct.

D. Refrigerant Circuit

- Check the refrigerant charge using the superheat or subcooling method, whichever is applicable. If low on charge, check unit for leaks using an electronic leak detector.
- If any leaks are found, recover or isolate charge (pump-down) if applicable and make necessary repairs.

TABLE 14—REQUIRED LIQUID LINE TEMPERATURE

PRESSURE (PSIG) AT SERVICE FITTING	REQUIRED SUBCOOLING TEMPERATURE (°F)					
	0	5	10	15	20	25
134	76	71	66	61	56	51
141	79	74	69	64	59	54
148	82	77	72	67	62	57
156	85	80	75	70	65	60
163	88	83	78	73	68	63
171	91	86	81	76	71	66
179	94	89	84	79	74	69
187	97	92	87	82	77	72
196	100	95	90	85	80	75
205	103	98	93	88	83	78
214	106	101	96	91	86	81
223	109	104	99	94	89	84
233	112	107	102	97	92	87
243	115	110	105	100	95	90
253	118	113	108	103	98	93
264	121	116	111	106	101	96
274	124	119	114	109	104	99
285	127	122	117	112	107	102
297	130	125	120	115	110	105
309	133	128	123	118	113	108
321	136	131	126	121	116	111
331	139	134	129	124	119	114
346	142	137	132	127	122	117
359	145	140	135	130	125	120

3. Evacuate, recharge, and operate unit through entire cycle.

E. Final Check-Out

After the unit has been operating, the following items should be checked:

1. Check that unit operational noise is not excessive due to vibration of components, tubing, panels, etc. If present, isolate problem and correct.
2. Check to be sure caps are installed on service valves and that they are tight.
3. Check to be sure tools, loose parts, and debris are removed from the unit.
4. Check to be sure all panels and screws are in place and tight.

DESERT AND SEACOAST LOCATIONS

Special consideration must be given to the installation and maintenance of condensing units and heat pumps installed in seacoast or desert locations. This is because the salt and alkali content of the sand adheres to the aluminum fins of the coil and can cause premature coil failure due to corrosion from salt, alkali, and moisture.

Preventive measures can be taken during installations, such as:

1. Locating the unit on side of structure opposite the prevailing winds.
2. Elevating the unit to height where drifting sand cannot pile up against coil. Four-in. high mounting feet or an 18-in. high mounting rack are available as accessories and can be used to elevate the unit.
3. Addition of coastal filter (see pre-sale literature for accessory listing).

Special maintenance requirements are as follows:

1. Frequent inspection of coil and base pan especially after storms and/or high winds.
2. Cleaning coil by flushing out sand from between coil fins and out of base pan as frequently as inspection determines necessary.
3. Protecting the unit in "off season" with cover that allows air to circulate through but prevents sand from sifting in (such as canvas material). Do not use plastic as plastic will hold moisture.

AIR CONDITIONER TROUBLESHOOTING CHART

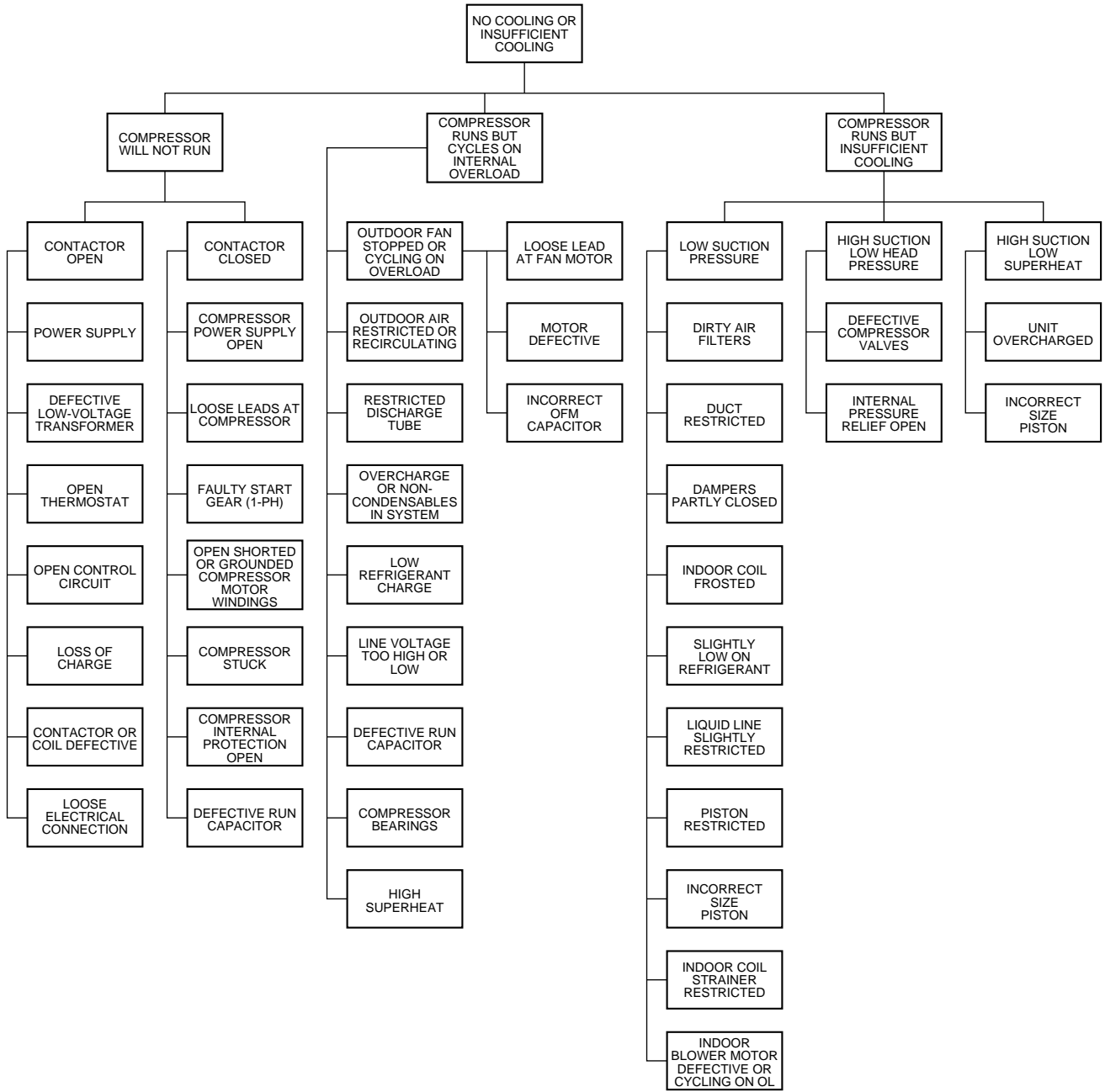


Fig. 41—Air Conditioner Troubleshooting Chart

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HEAT PUMP TROUBLESHOOTING—COOLING CYCLE

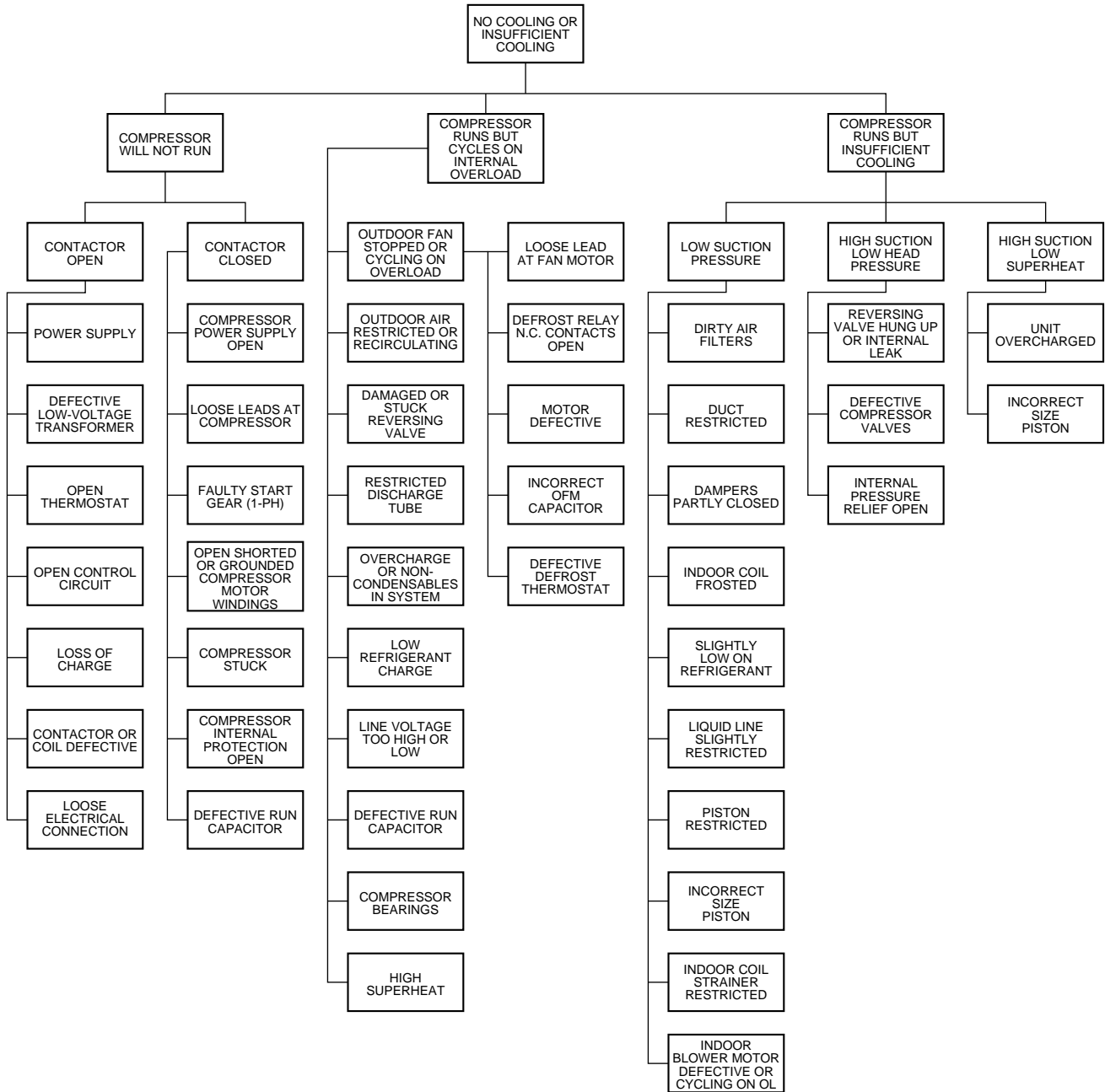


Fig. 42—Heat Pump Troubleshooting Chart—Cooling Cycle

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HEAT PUMP TROUBLESHOOTING—HEATING CYCLE

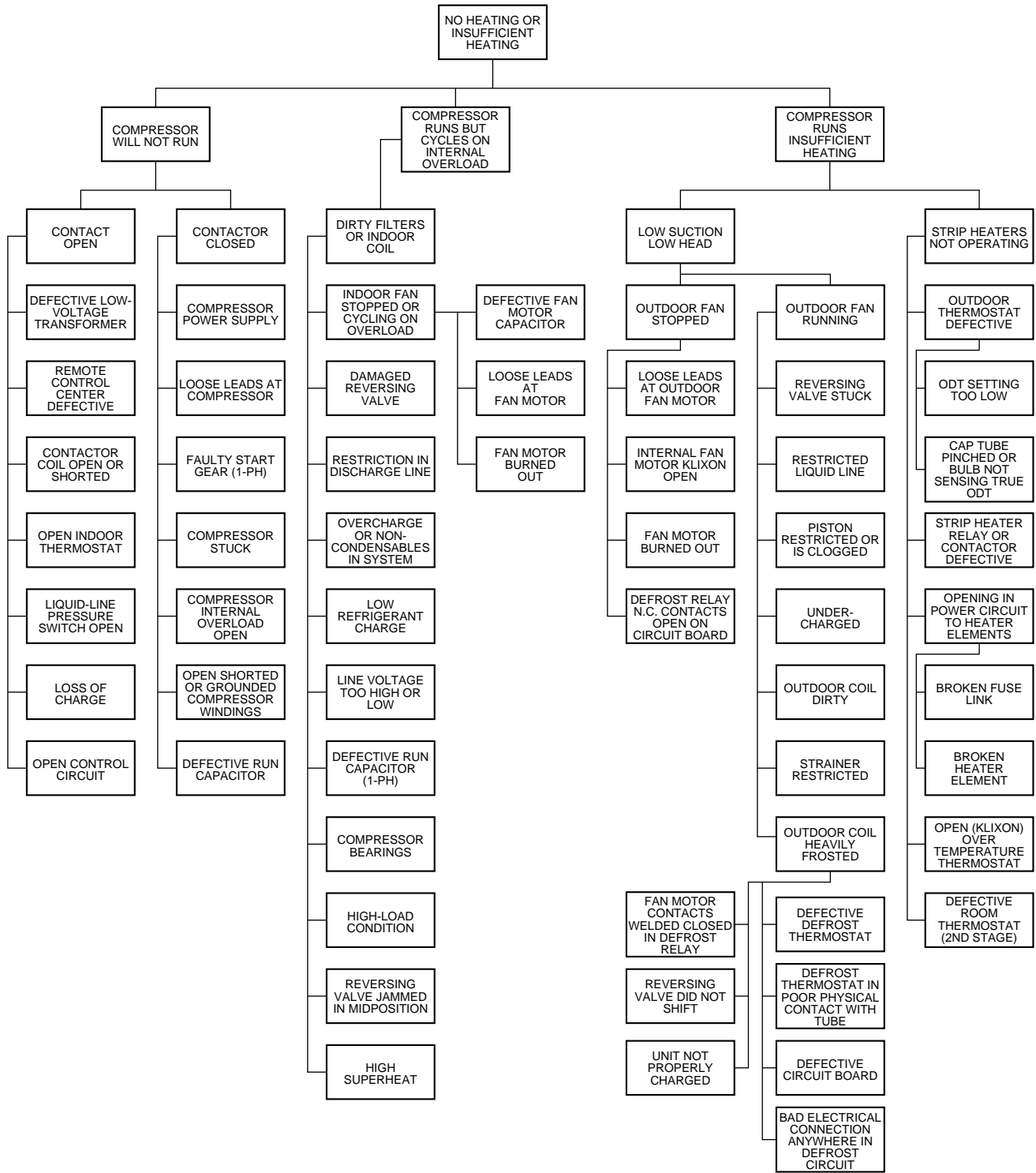


Fig. 43—Heat Pump Troubleshooting Chart—Heating Cycle

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