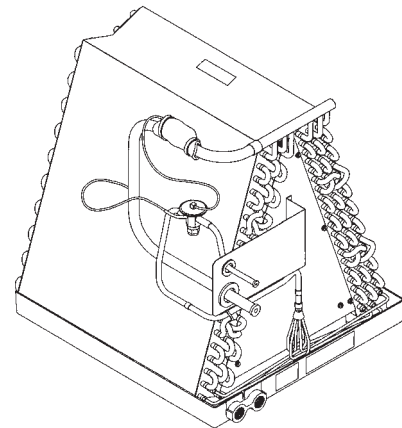
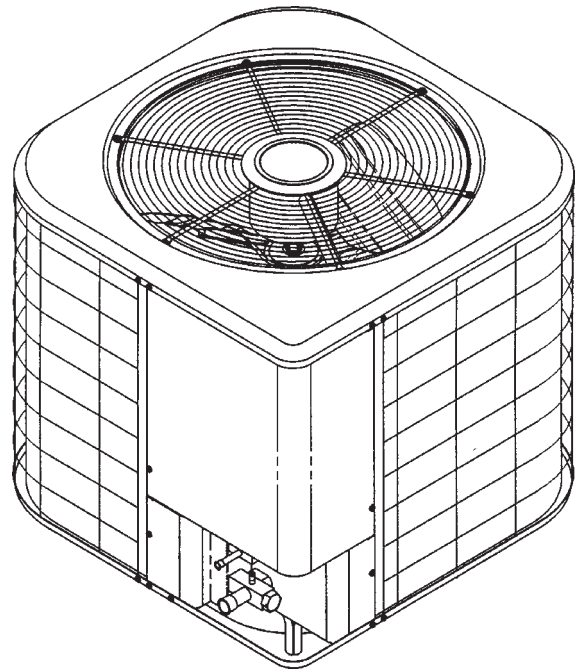
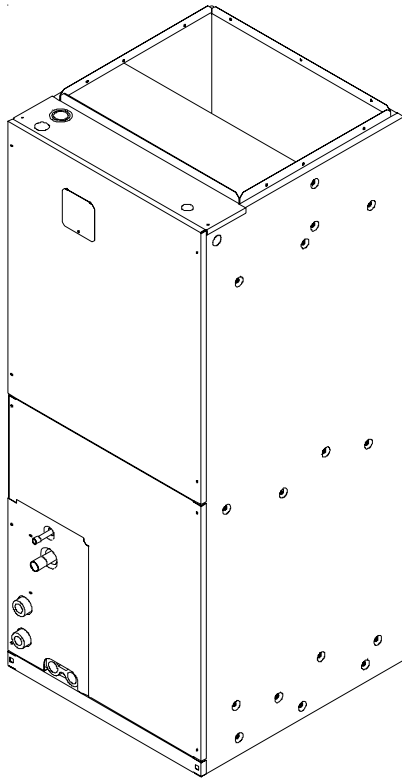


Service Instructions

RCA, RCB, RCC, & RCE Model Remote Coolers
RHA, RHD, & RHE Model Remote Heat Pumps
Blowers, Coils, & Accessories



This manual is to be used by qualified HVAC technicians only. Amana does not assume any responsibility for property damage or personal injury for improper service procedures done by an unqualified person.

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Heating • Air Conditioning
BUILT BETTER THAN IT HAS TO BE™

RS6200003
June 1999

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IMPORTANT INFORMATION

Pride and workmanship go into every product to provide our customers with quality products. It is possible, however, that during its lifetime a product may require service. Products should be serviced only by a qualified service technician who is familiar with the safety procedures required in the repair and who is equipped with the proper tools, parts, testing instruments and the appropriate service manual. **REVIEW ALL SERVICE INFORMATION IN THE APPROPRIATE SERVICE MANUAL BEFORE BEGINNING REPAIRS.**

IMPORTANT NOTICES FOR CONSUMERS AND SERVICERS

RECOGNIZE SAFETY SYMBOLS, WORDS AND LABELS



DANGER - Immediate hazards which **WILL** result in severe personal injury or death.



WARNING - Hazards or unsafe practices which **COULD** result in severe personal injury or death.



CAUTION - Hazards or unsafe practices which **COULD** result in minor personal injury or product or property damage.

IMPORTANT INFORMATION



IF REPAIRS ARE ATTEMPTED BY UNQUALIFIED PERSONS, DANGEROUS CONDITIONS (SUCH AS EXPOSURE TO ELECTRICAL SHOCK) MAY RESULT. THIS MAY CAUSE SERIOUS INJURY OR DEATH.



AMANA WILL NOT BE RESPONSIBLE FOR ANY INJURY OR PROPERTY DAMAGE ARISING FROM IMPROPER SERVICE OR SERVICE PROCEDURES. IF YOU PERFORM SERVICE ON YOUR OWN PRODUCT, YOU ASSUME RESPONSIBILITY FOR ANY PERSONAL INJURY OR PROPERTY DAMAGE WHICH MAY RESULT.

To locate an authorized servicer, please consult your telephone book or the dealer from whom you purchased this product. For further assistance, please contact:

CONSUMER AFFAIRS DEPT.
AMANA REFRIGERATION, INC.
AMANA, IOWA 52204

**OR
CALL**

1-319-622-5511
and ask for
Consumer Affairs

If outside the United States contact:

AMANA REFRIGERATION, INC.
ATTN: INTERNATIONAL DIVISION
AMANA, IOWA 52204, USA
TELEX: 4330076 AMANA
CABLE: "AMANA", AMANA, IOWA, USA



SYSTEM CONTAMINANTS, IMPROPER SERVICE PROCEDURE AND/OR PHYSICAL ABUSE AFFECTING HERMETIC COMPRESSOR ELECTRICAL TERMINALS MAY CAUSE DANGEROUS SYSTEM VENTING.

System contaminants, improper Service Procedure and/or physical abuse affecting hermetic compressor electrical terminals may cause dangerous system venting.

The successful development of hermetically sealed refrigeration compressors has completely sealed the compressor's moving parts and electric motor inside a common housing, minimizing refrigerant leaks and the hazards sometimes associated with moving belts, pulleys, or couplings.

Fundamental to the design of hermetic compressors is a method whereby electrical current is transmitted to the compressor motor through terminal conductors which pass through the compressor housing wall. These terminals are sealed in a dielectric material which insulates them from the housing and maintains the pressure tight integrity of the hermetic compressor. The terminals and their dielectric embedment are strongly constructed, but are vulnerable to careless compressor installation or maintenance procedures and equally vulnerable to internal electrical short circuits caused by excessive system contaminants.

In either of these instances, an electrical short between the terminal and the compressor housing may result in the loss of integrity between the terminal and its dielectric embedment. This loss may cause the terminals to be expelled, thereby venting the vaporous and liquid contents of the compressor housing and system.

A venting compressor terminal normally presents no danger to anyone providing the terminal protective cover is properly in place.

If, however, the terminal protective cover is not properly in place, a venting terminal may discharge a combination of

- (a) hot lubricating oil and refrigerant
- (b) flammable mixture (if system is contaminated with air)

in a stream of spray which may be dangerous to anyone in the vicinity. Death or serious bodily injury could occur.

Under no circumstances is a hermetic compressor to be electrically energized and/or operated without having the terminal protective cover properly in place.

See Service Section S-17 for proper servicing.

PRODUCT IDENTIFICATION

This section will identify the models that are covered and the changes per each model group from one release to the next.

Model #	Manufacturing #	Description
RCA**A*A	P1173301C-P1173313C	Remote <u>C</u> ooling (A) 10 Seer Outdoor Units. Featuring new cubed coil design and lower speed fan motors for quieter operation
RCB**A*A	P1205201C-P1205213C	
RCB**A*B	P1205301C-P1205314C	
RCB**A*B	P1218601C-P1218613C	
RCB**B*A	P1223301C-P1223307C	Remote <u>C</u> ooling (B) 11 Seer Outdoor Units. The " B " design series features 5/16" diameter tubing cubed coil design for reduced system refrigerant charge and a more compact footprint. Prepainted sheetmetal and coil enhance finish durability
RCC**A*A	P1172401C-P1172412C	Remote <u>C</u> ooling (C) 12 Seer Outdoor Units. Featuring new cubed coil design and lower speed fan motors for quieter operation
RCC**A*A	P1220701C-P1220705C	
RCC**A*B	P1172413C-P1172422C	
RCC**A*B	P1218501C-P1218510C	
RCE**A*A	P1218701C-P1218706C	Remote <u>C</u> ooling (E) 14 Seer Outdoor Units. Featuring new cubed coil design, Copeland scroll compressors in all sizes, compressor sound blankets, and lower speed fan motors for quiet operation.
VCB**A*A	P1219201C-P1219207C	Vortex <u>C</u> ooling (B) 10 Seer outdoor units. Designed for the new construction market. Similar to RCB line except for gray sheetmetal, unpainted coil, less compressor crankcase heater, and pressure switches.
VCA**B*A	P1221301C-P1221319C	Vortex <u>C</u> ooling (B) 10 Seer outdoor units. Designed for the new construction market. Similar to RCB**B*A line except for gray sheetmetal, unpainted coil, less compressor crankcase heater, and pressure switches.
VCA**B3A	P1224801C-P1224802C	
RHA**A*A	P1180201C-P1180213C	Remote <u>H</u> eatpump (A) 10 Seer Outdoor Units. Featuring new cubed coil design and lower speed fan motors for quieter operation
RHA**A*B	P1180217C-P1180226C	
RHA**A*B	P1218801C-P1218813C	
RHA**B*A	P12215--C	Remote <u>H</u> eat-pump (A) 10 Seer Outdoor Units. The " B " design series features 5/16" diameter tubing cubed coil design for reduced system refrigerant charge and a more compact footprint. Prepainted sheetmetal and coil enhance finish durability
RHD**A*A	P1188001C-P1188007C	Remote <u>H</u> eatpump (D/E) 13-14 Seer Outdoor Units. Featuring new cubed coil design and lower speed fan motors for quieter operation.
RHE**A*A	P1217401C-P1217407C	
RHE**A*A	P1219101C-P1219107C	

PRODUCT IDENTIFICATION

This section will identify the models that are covered and the changes per each model group from one release to the next.

Model #	Manufacturing #	Description
BCA**TA002A	P1177201C-P1177207C	<u>B</u> lower <u>C</u> ooling <u>A</u> irhandler. One piece air handler with TXV Coil, PCS motor. Not for heat pump applications
BHA**FA002A	P1180301C-P1180305C	<u>B</u> lower <u>H</u> eat-pump <u>A</u> ir-handler. One piece air handler. FA designator includes flowrator coil and PCS motor. TA designator features TXV coil and PCS motor. TB designator features TXV coil and variable speed (ECM) motor.
BHA**TA002A	P1180306C-P1180307C	
BHA**TB002A	P1188102C-P1188107C	
BBA**A2A	P1206401C-P1206404C	<u>B</u> lower (B) Multi position (A) Standard efficiency. Two pieceblower coil arrangement, matching coil is purchased separately. Features solid-state control board which modulates electric heat elements to control discharge air temperature for improved efficiency.
BBC**A*A	P1206405C-P1206407C	<u>B</u> lower (B) Multi position (C) Variable Speed, High efficiency. Two piece blower coil arrangement, matching coil is purchased separately. Features solid-state control board which modulates blower speed and electric heat elements to control discharge air temperature for additional efficiency.
CCA**FUA	P1111001C-P1111007C	<u>C</u> oil <u>C</u> ooling " A " coil. The " F " designator (6 th character) indicates Flowrator, " T " designator indicates TXV. The " U " or " C " designator indicates cased or uncased coil.
CCA**TCA	P1178601C-P1178607C	
CCA**TCB	P1178701C-P1178710C	
CHA**TUA	P1124901C-P1124908C	<u>C</u> oil <u>H</u> eatpump " A " coil. Similar to CCA**TUA coils, except for a check valve circuit for heat-pump operation.
CCA**FCC	P1203901C-P1203909C	<u>C</u> oil (C)Standard Efficiency " A " coil. The " F " designator (6th character) indicates Flowrator. The (7th character) " C " designator indicates cased coil, " S " indicates Stand Alone or uncased coil, " D " indicates wide bodied coil, and " K " indicates extra wide or "King Size" coil. Similar to the CCA**FUA coils except these coils use a "Chatliff" style orifice and allow for field installation of the TXV**A kits.
CCA**FDC	P1203910C-P1203913C	
CCA36FKC	P1203917C	
CCA**FSC	P1204001C-P1204009C	
CHA**TCC	P1203801C-P1203809C	<u>C</u> oil <u>H</u> igh Efficiency " A " coil. The " T " designator (6th character) indicates factory installed TXV valve. The (7th character) " C " designator indicates cased coil, " S " indicates Stand Alone or uncased coil.
CHA**TSC	P1204101C-P1204109C	
CCF**FCC	P1210901C-P1210907C	<u>C</u> oil <u>H</u> igh Efficiency " F " horizontal A coil or <u>C</u> oil (C)Standard Efficiency " F " horizontal A coil. The (6th character) " F " designator indicates a flowrator coil, " T " designator indicates a factory installed TXV. These coils use a "Chatliff" style orifice and allow for field installation of the TXV**A kits.
CCF**FDC	P1210908C-P1210910C	
CHF**TCC	P1210911C-P1210916C	
CCH**FCC	P1203301C-P1203306C	<u>C</u> oil (C)Standard Efficiency <u>H</u> orizontal Slab coil. The (6th character) " F " designator indicates flowrator or orifice style coil. The (8th character or last letter), " C " designator indicates the coil used "Aeroquip" style flowrator, " D " designator indicates the coils use a "Chatliff" style orifice and allow for field installation of the TXV**A kits.
CCH**FCD	P1210101C-P1210106C	
CHH**TCC	P1203501C-P1203506C	<u>C</u> oil <u>H</u> igh Efficiency <u>H</u> orizontal Slab coil. The (6th character) " T " designator indicates factory installed TXV valve. The (8th character or last letter), " C " designator indicates the coil used "Sporland" TXV valve, " D " designator indicates the coils used a "Parker" TXV valve the same as the TXV**A kits.
CHH**TCD	P1210107C-P1210110C	

PRODUCT IDENTIFICATION

This section will identify the models that are covered and the changes per each model group from one release to the next.

Model #	Manufacturing #	Description
ASC01A	P1200601C	<u>A</u> nti <u>S</u> hort <u>C</u> ycle Kit. Kit contains a 3 minute off cycle timer to prevent short cycling of the compressor. Factory installed in RCE, RHE units with scroll compressors. Also included in PCK__A pressure control kits.
ATK05A	P6443902C	<u>A</u> mbient <u>T</u> emperature <u>K</u> it. Kit is designed for heat pump applications to prevent energizing auxiliary electric heating elements when the ambient temperature is above set point. Also included in FFK__A Fossil Fuel Kits.
CSB__A	P1176802C - P1176809C	<u>C</u> ompressor <u>S</u> ound <u>B</u> lanket kit. Reduces the operation sound transmitted through the air by the compressor. Factory installed in many of the higher efficiency models.
HSK__A	P1180002C - P1180014C	<u>H</u> ard <u>S</u> tart <u>K</u> it. Hard start kits dramatically increase the starting torque of compressors. Recommended for use in systems which use TXV valves to control refrigerant flow.
FSK01A	P1207101C	<u>F</u> reeze Protection <u>K</u> it. Installed on indoor coils, kit prevents compressor operation when coil temperature drops below 32 degrees.
PCK__A	P1180101C - P1180103C	<u>P</u> ressure <u>C</u> ontrol <u>K</u> it. Kit includes hi and low pressure switches, necessary connectors, and anti short cycle timer. Higher efficiency models have these components factory installed.
LAC__A	P1180103C - P1180106C	<u>L</u> ow <u>A</u> mbient <u>C</u> ontrol kit. Allows cooling operation in ambient temperatures between 50 degrees and 32 degrees. This kit is for TXV systems only. Not designed for ambient below 32 degrees.
LSK01A	P1206901C	<u>L</u> iquid line <u>S</u> olenoid <u>K</u> it. This kit improves system efficiency and prevents compressor oil migration in the off cycle. Recommended for installations where oil migration could occur. Compressor must have a Hard Start Kit when this kit is used.
FFK__A	P1122302C - P1122303C	<u>F</u> ossil <u>F</u> uel <u>K</u> it. Fossil fuel kits are designed for heat pump installations with gas or oil furnaces as the back up or reserve heating system. The FFK02A will not function correctly on RHA__B_A heat pumps. However, the FFK03A is backward compatible to all RHA, RHD or RHE heat pump systems.
ROK__A	P1208401C -P1208417C	<u>R</u> estrictor <u>O</u> rifice <u>K</u> it. ROK01A contains an assortment of "Aero-Quip" orifices. ROK49A - ROK98A contain 3 ea. of "Chatliff" orifices, the kit number indicates the orifice size. See model/accessory list for correct kit for specific coil model.
TXV__A	P1206501C - P1206503C	<u>T</u> hermo-e <u>X</u> pansion <u>V</u> alve Kit. Improves the efficiency of restrictor orifice style coils. Valves are heat pump compatible. See model/accessory list for correct kit for specific coil model.
DSK01A	P1187207C	<u>D</u> i <u>S</u> connect <u>K</u> it. This kit is designed to be used with BCA/BHA air handlers with 5, 7, or 10 kW electric heat only.
SPK__A	P1208801C - P1208802C	<u>S</u> ingle <u>P</u> oint wiring <u>K</u> it. Allows one single electrical connection for power for BBA/BBA air handlers and auxiliary electric heater. SPK02A is a "six-pack" of SPK01A.
EHK__A	P1187201C - P1187206C	<u>E</u> lectric <u>H</u> eat <u>K</u> it. Auxiliary electric heat for BCA/BHA air handlers
EHK__B/C	P1206301C - P1206307C P1221601C - P1221607C	<u>E</u> lectric <u>H</u> eat <u>K</u> it. Auxiliary electric heat for BBA/BBA air handlers
CCD__A__	P1203914C - P1203916C	<u>C</u> oil <u>C</u> ase Kit (" <u>D</u> " design series). Accessory coil case allows installer to add a case to Amana Uncased up flow/down flow coils, "C" design series and later.

PRODUCT DESIGN

This section gives a basic description of cooling unit operation, its various components and their basic operation. Ensure your system is properly sized for heat gain and loss according to methods of the Air Conditioning Contractors Association (ACCA) or equivalent.

CONDENSING UNIT

These units are designed for free air discharge. Condensed air is pulled through the condenser coil by a direct drive propeller fan and then discharged from the cabinet top. The unit requires no additional resistance (i.e. duct work) and should not be added.

The RHA, RHD, and RHE Remote Heat Pump condensing units are designed for 208-230 dual voltage single phase applications. The units range in size from 1.5 to 5-ton and have a rating of 10, 12 and 13 SEER. The RHA and VHA models have a 10 SEER rating, the RHD a 12, and the RHE a 13 SEER rating. SEER ratings are dependent upon the unit and its components. Refer to the "Technical Information" manual of the unit you are servicing for further details. The RHA 3-, 4-, and 5-ton models are also available for 230V and 460V applications.

The RCA, RCB, RC, VCA, and VCB Remote Condensing Units are made in 1.5 through 5 ton sizes. RCE models are available in 2 through 5 ton sizes. They are designed for 208-240 volt single phase applications. The RCA/RCB 3, 4, and 5 ton models are also available for 230V and 460V 3 phase applications. The RCC 3, 4, and 5 ton models are also available for 230V 3 phase applications.

Suction and Liquid Line Connections

The suction and liquid line connections of the unit are set up for field piping with refrigerant-type copper. Non-back seating valves were factory-installed to accept the field-run copper. The total refrigerant charge needed for a normal

operation is also factory-installed. For additional refrigerant line set information, refer to the "Technical Information" manual of the unit you are servicing.

Compressors

All RHA*A units, and RHA*B, RHD, and RHE, 1 through 3 ton, units use reciprocating compressors. The RHA*B, RHD and RHE 4 and 5 ton units use compliant scroll compressors. There are a number of design characteristics which differentiate the scroll compressor from the reciprocating compressor. One is the scroll. A scroll is an involute spiral which, when matched with a mating scroll form, generates a series of crescent-shaped gas pockets between the members (see following illustration). During compression, one scroll remains stationary while the other form orbits. This motion causes the resulting gas pocket to compress and push toward the center of the scrolls. When the center is reached, the gas is discharged out a port located at the compressor center.



PRODUCT DESIGN

COILS AND BLOWER COILS

Amana CCA, CHA, CCH, CHH, CCF, and CHF coils are designed to be installed with a furnace or air handler unit and matched with Amana's condensing units to provide high efficiency heating and cooling. Thermal expansion valves on the CCA_T, CHA_T, CHH, and CHF coils and restrictor orifices on the CCA_F, CCH, and CCF coils and BHA_F blower coils give accurate refrigerant control and provide reliable operation over a wide range of conditions.

Amana CCA and CHA "A" coils are designed for upflow and counterflow operation. The CCH and CHH slab coils, and the CCF and CHF cased "A" coils are designed for horizontal applications.

The CCA*T, CHA*T, CHH, and CHF units along with BCA*T blower cabinets include non-bleed thermal expansion valves.

CCA30F*A and CCA60FUA coils have restrictors factory-installed. The restrictor is sized from the matching 10 SEER cooling application. Oversized-undersized coils and heat pump applications will require a change in the restrictor.

Note: To avoid poor operation and/or equipment damage, any single-phase reciprocating compressor used with an expansion valve coil must include hard start components.

BBA and BBC blower cabinets are designed as a two-piece blower coil. Either the BBA or BBC blower section can be attached to a CCA*FC*, CHA*TC*, or CHF*TC* cased evaporator coil. This two piece arrangement allows for a variety of mix-matching possibilities providing greater flexibility.

The BBC blower cabinet uses a variable speed motor that maintains a constant airflow despite duct static. It is approved for applications with cooling coils of up to 0.8 inches

W.C. external static pressure and includes a feature that allows airflow to be changed by $\pm 15\%$.

The BBC is intended to be used with a cased evaporator coil and a condensing unit or heat pump. The blower section of the cabinet can also be used as an electric furnace. The electric heating elements are field-installed. Electric heater kits (EHK-B and ECB_B) are available as sales accessories for supplemental electric heat.

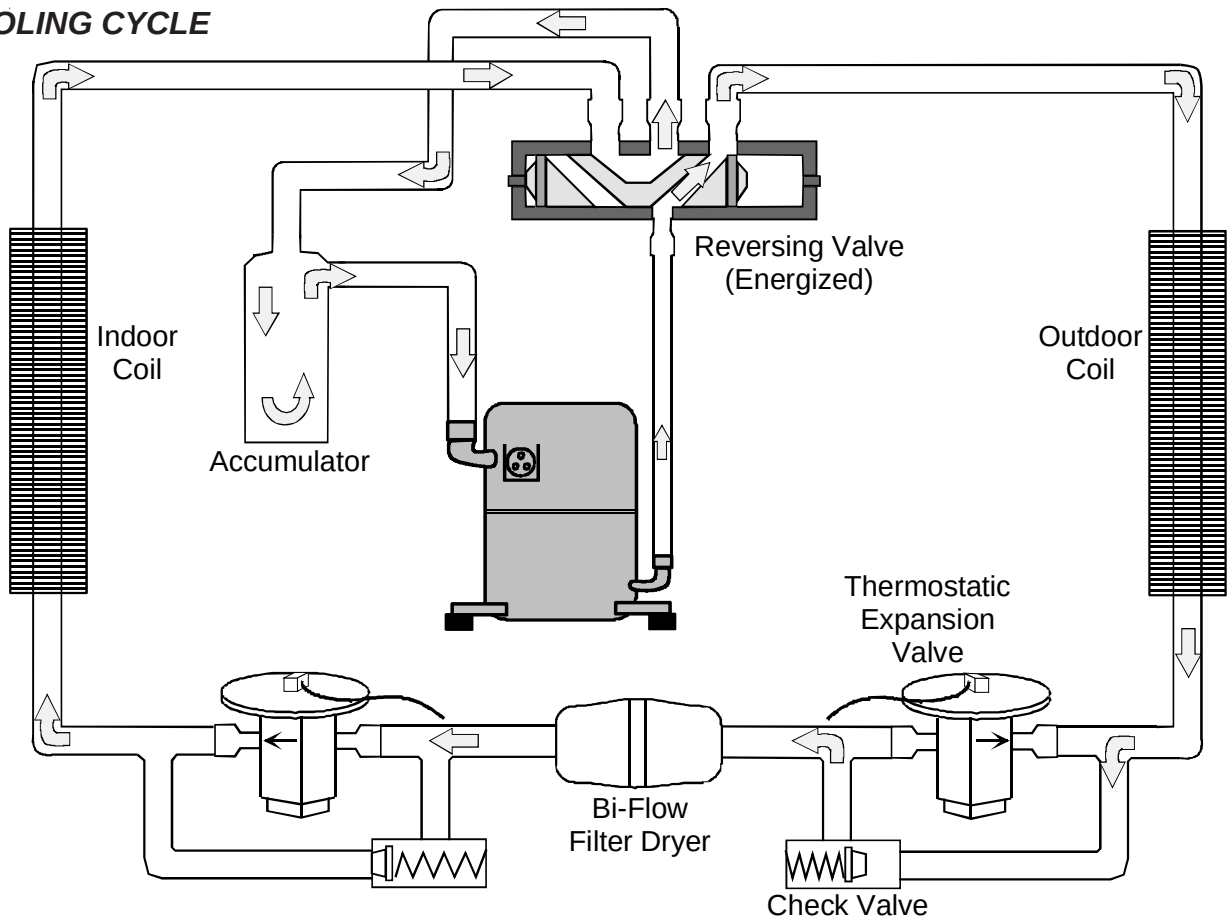
The BBA and BBC blower cabinets can be positioned for upflow, counterflow, horizontal right or horizontal left operation. All units are constructed with R-4.2 insulation. In areas of extreme humidity (greater than 80% consistently), the installer should insulate the exterior of the blower with insulation having a vapor barrier equivalent to ductwork insulation, providing local codes permit.

The BHA-T coils are equipped with a thermostatic expansion and check valve assembly for refrigerant metering. The BHA-F coils are equipped with a restrictor orifice.

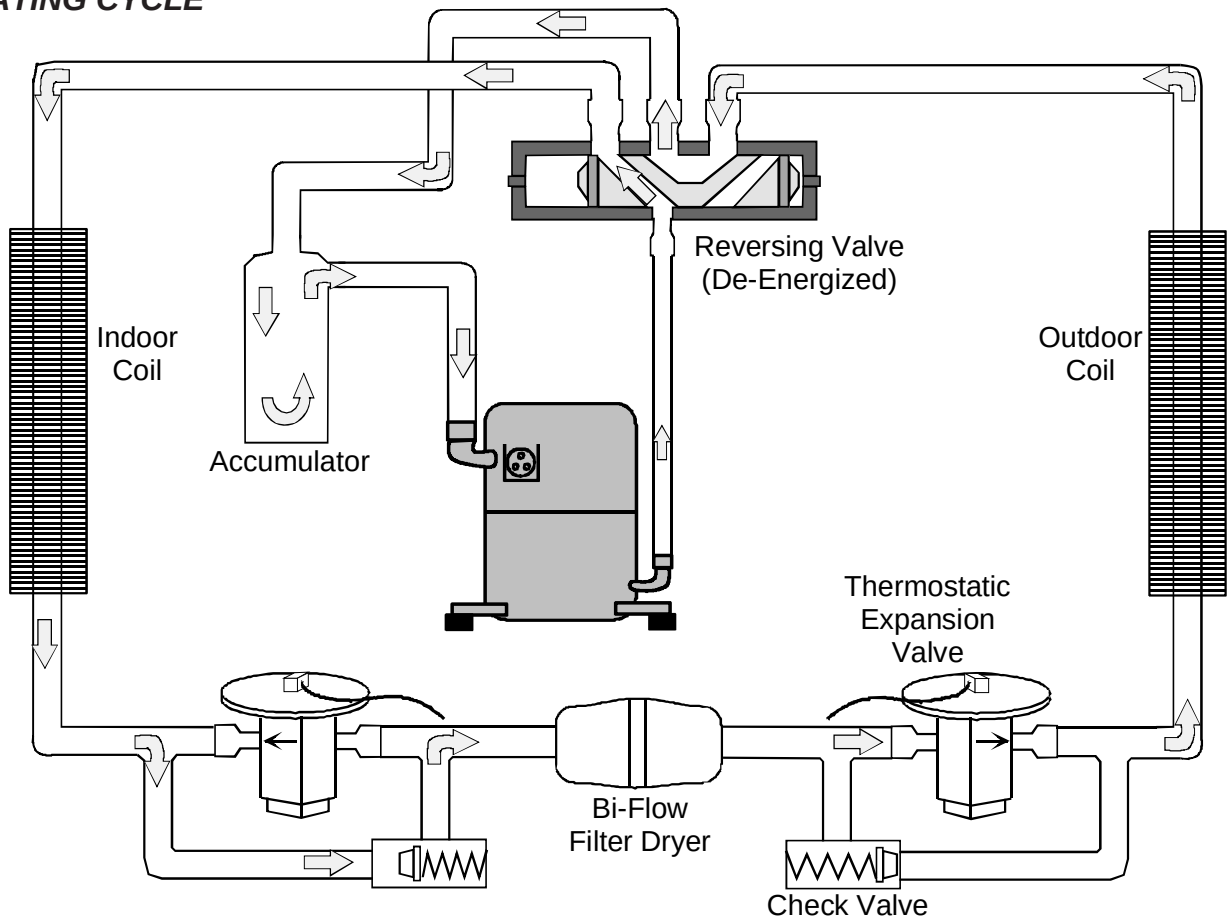
The coils are designed for upflow, counterflow, or horizontal application, using two speed direct drive motors on the BHA-FA & TA models, and BPM (Brushless Permanent Magnet) or ECM motor on the BHA-TB models.

SYSTEM OPERATION

COOLING CYCLE



HEATING CYCLE



SYSTEM OPERATION

COOLING

The refrigerant used in the system is R-22. It is a clear, colorless, non-toxic, non-irritating, and non-explosive liquid. The chemical formula is CHClF_2 . The boiling point, at atmospheric pressure is -41.4°F .

A few of the important principles that make the refrigeration cycle possible are: heat always flows from a warmer to a cooler body, under lower pressure a refrigerant will absorb heat and vaporize at a low temperature, the vapors may be drawn off and condensed at a higher pressure and temperature to be used again.

The indoor evaporator coil functions to cool and dehumidify the air conditioned spaces through the evaporative process taking place within the coil tubes.

NOTE: The pressures and temperatures shown in the refrigerant cycle illustrations on the following pages are for demonstration purposes only. Actual temperatures and pressures are to be obtained from the "Expanded Performance Chart."

Liquid refrigerant at condensing pressure and temperatures, (270 psig and 122°F), leaves the outdoor condensing coil through the drier and is metered into the indoor coil through the metering device. As the cool, low pressure, saturated refrigerant enters the tubes of the indoor coil, a portion of the liquid immediately vaporizes. It continues to soak up heat and vaporizes as it proceeds through the coil, cooling the indoor coil down to about 48°F .

Heat is continually being transferred to the cool fins and tubes of the indoor evaporator coil by the warm system air. This warming process causes the refrigerant to boil. The heat removed from the air is carried off by the vapor.

As the vapor passes through the last tubes of the coil, it becomes superheated, that is, it absorbs more heat than is necessary to vaporize it. This is assurance that only dry gas will reach the compressor. Liquid reaching the compressor can weaken or break compressor valves.

The compressor increases the pressure of the gas, thus adding more heat, and discharges hot, high pressure superheated gas into the outdoor condenser coil.

In the condenser coil, the hot refrigerant gas, being warmer than the outdoor air, first loses its superheat by heat transferred from the gas through the tubes and fins of the coil. The refrigerant now becomes saturated, part liquid, part vapor and then continues to give up heat until it condenses to a liquid alone. Once the vapor is fully liquefied, it continues to give up heat which subcools the liquid, and it is ready to repeat the cycle.

HEATING

The heating portion of the refrigeration cycle is similar to the cooling cycle. By energizing the reversing valve solenoid coil, the flow of the refrigerant is reversed. The indoor coil now becomes the condenser coil, and the outdoor coil becomes the evaporator coil.

The check valve at the indoor coil will open by the flow of refrigerant letting the now condensed liquid refrigerant bypass the indoor expansion device. The check valve at the outdoor coil will be forced closed by the refrigerant flow, thereby utilizing the outdoor expansion device.

The restrictor orifice used with the CCA-F, CCH-F and BHA-F coils will be forced onto a seat when running in the cooling cycle, only allowing liquid refrigerant to pass through the orifice opening. In the heating cycle it will be forced off the seat allowing liquid to flow around the restrictor. A check valve is not required in this circuit.

COOLING CYCLE

When the contacts of the room thermostat close making terminals R to Y & G, the low voltage circuit of the transformer is completed. Current now flows through the magnetic holding coils of the compressor contactor (CC) and fan relay (RFC).

This draws in the normally open contact CC, starting the compressor and condenser fan motors. At the same time contacts RFC close starting the indoor fan motor.

When the thermostat is satisfied, it opens its contacts, breaking the low voltage circuit, causing the compressor contactor and indoor fan relay to open, shutting down the system.

If the room thermostat fan selector switch should be set on the "on" position, then the indoor blower would run continuous rather than cycling with the compressor.

RHA, RHD & RHE models energize the reversing valve thorough the "O" circuit in the room thermostat. Therefore the reversing valve remains energized as long as the thermostat subbase is in the cooling position. The only exception to this is during defrost.

DEFROST CYCLE

The defrosting of the outdoor coil is jointly controlled by the defrost timing board, defrost (30/60) control, and compressor run time.

HEATING CYCLE

The RHA & RHD model heat pumps use a different control circuit than preceding heat pump models. These models do not use a reversing relay to energize the reversing valve. Also many previous models energized the reversing valve off the "B" terminal on the thermostat, and all previous models energized the reversing valve in the heating cycle.

The reversing valve on the RHA, RHD & RHE models is energized in the cooling cycle thorough the "O" terminal on the room thermostat.

These models have a 24 volt reversing valve coil. When the thermostat selector switch is set in the cooling position, the "O" terminal on the thermostat is energized all the time.

Care must be taken when selecting a room thermostat. Refer to the installation instructions shipped with the product for approved thermostats.

If electric heaters are utilized, a two stage heating and single stage cooling thermostat should be used.

SYSTEM OPERATION

Should the second stage heating contacts in the room thermostat close, the first stage of electric heat would become energized. If additional electric heaters are used, they would be controlled by the sequencer on the proceeding heater. If installed, the electric heaters may be controlled by outdoor thermostats.

BBA Standard Efficiency Blower Section Sequence of Operation

BBA Cooling-Only Operations

The cooling operation is fairly straight forward. With the thermostat in the FAN—AUTO position and a “Y” or “G” call, the blower starts within three seconds. When the “Y” call is satisfied, the blower will stay on until the supply temperature is greater than 65°F or up to a maximum of forty-five seconds, whichever occurs first.

BBA Electric Heat-Only Operations

As in the cooling-only operations, with the thermostat in the FAN—AUTO position and a “W2” or “E” call, the blower starts within three seconds. The board then starts turning-on banks of electric heat, one every ten seconds, until the supply temperature reaches 90°F. If the “W2” or “E” call has not been satisfied within the next five minutes, the board turns-on additional banks of heaters and increases the minimum supply temperature from 90°F to 105°F. If an additional five minutes passes and the “W2” or “E” call has not been satisfied, the board will raise the minimum supply temperature to 120°F and once again turns-on additional banks of electric heaters.

Should the temperature at the thermistor go above 140°F, the control logic will start turning off one bank of heaters every ten seconds until the temperature falls below 140°F. If the temperature climbs above 150°F, the control logic turns off all electric heat. If the temperature goes above 170°F, probably due to a component failure, the control logic turns off all power to the heaters and keeps the blower on until the temperature falls below 90°F.

BBA Heat Pump Only Operations

The control process for heat pump operations is very similar to the electric heat only operations, with the thermostat in the FAN—AUTO position and a “Y” call, the blower starts within three seconds. When the “Y” call is satisfied, the blower will stay on until the supply temperature is less than 90°F or up to a maximum of forty-five seconds, whichever occurs first.

BBA Heat Pump Operations with Back-up Electric Heat

The major difference when electric heat is added is that the board can be preset for electric heat lockout and minimum supply air temperatures of 85°F, 90°F, 95°F, or 100°F. This discharge air temperature setting will be used to lock-out the electric heaters as long as the heat pump cycle satisfies the minimum supply air temperature.

Two conditions must exist for the electric heat to be activated:

1. The thermistor is sensing temperatures below the set point with the heat pump heating operation, and
2. There is a **W2** call.

So, if the heat pump cycle fails to satisfy the “**W2**” call, the board shifts to integrated heating operation which is just like the electric heater only operation except that the initial minimum supply air for the heat pump cycle plus the electric heaters will be 105°F instead of 90°F.

BBA Fan Idle Option

The control board has a special option for the BBA models. The blower motor is wired for only one speed for heating and cooling operations. Another tap for the motor can be used to connect the lower or “idle” speed. With the thermostat in the FAN—AUTO position, the board allows the motor to operate at the lower speed during system off cycles for minimum circulation air. When the thermostat is switched to the FAN—ON position, the blower motor will operate at the higher cooling speed.

SYSTEM OPERATION

BBC High Efficiency Blower Section

Sequence of Operation

It is important to note that the operational logic for the control board for the BBC's is different from the BBA board, hence, they are not interchangeable.

The BBC's, like the BHA**TB's with the ECM variable speed motor, use the variable speed to maintain constant CFM. However, there is a new twist to the BBC's with the control board logic that changes the CFM in response to "over-temperature" and "under-temperature" conditions with help from the discharge air temperature readings from the new **discharge air thermistor**.

BBC Cooling-Only Operations

With the thermostat in the FAN—AUTO position and a "Y" or "G" call, the blower ramps up to speed over a 30 second period. The acceptable cooling operation temperature range is 45 to 65°F. If the supply air temperature is above the acceptable range, 65°F, the control logic decreases the CFM, until the "Y" or "G" call is satisfied. Then, on the next "Y" or "G" call the CFM will return to the preset level. If the supply air temperature is below the acceptable range, 45°F, the control logic increases the CFM until the "Y" call is satisfied. Then, on the next "Y" or "G" call the CFM will return to the preset level. In both cases, the blower will stay on at nominal CFM until the supply temperature is greater than 65°F or up to a maximum of forty-five seconds, whichever occurs first. At that time the motor will ramp the CFM down over the next 30 seconds.

BBC Electric Heat-Only Operations

As in the cooling-only operations, with the thermostat in the FAN—AUTO position and a "W2" or "E" call, the first bank of electric heat is energized as the blower ramps up to speed over a 30 second period. The control logic continues turning-on banks of electric heat, one every ten seconds, until the supply temperature reaches a set point of 85° to 100°F. The board will then keep all existing banks of electric heaters on until the "W2" or "E" call has been satisfied.

If the supply air temperature is above the upper limit of the acceptable range, 140°F, the control turns off one bank of heaters every 10 seconds until the temperature falls below 140°F. Should the temperature exceed 150°F, the control logic will shut-off all electric heat and runs the fan continuously until the temperature is back below 90°F.

BBC Heat Pump Only Operations

The control process for heat pump operations is very similar to the cooling only operations, with the thermostat in the FAN—AUTO position and a "Y" call, the blower ramps up to speed over 30 second period. The acceptable heating operation temperature range is 90 to 105°F. If the supply air temperature is above the acceptable range (105°F) the control logic increases the CFM until the "Y" call is satisfied. If the supply air temperature is below the acceptable range (90°F) the control decreases the CFM. In either case the airflow returns to the preset level on the next call for heating.

BBC Heat Pump Operations with Back-up Electric Heat

The major difference when electric heat is added is that the board can be preset for minimum supply air temperatures of 85°F, 90°F, 95°F, or 100°F. This discharge air temperature setting will be used to lock-out the electric heaters as long as the heat pump cycle satisfies the minimum supply air temperature. If the heat pump cycle fails to satisfy the "W2" call, the control will first decrease the airflow to try to obtain the minimum supply temperature. If a lower airflow is unsuccessful, the control board then returns to the preset airflow level and shifts to integrated heating operation which is just like the electric heater only operation except that the initial minimum supply air for the heat pump cycle plus the electric heaters will be 105°F instead of 90°F. The control logic will then operate as for the electric heat only operation.

BBC Manual Fan Operation

The control board has a special option for the BBC models. When the thermostat is switched to the FAN—ON position, the blower motor will operate at either 50% or 100% of the cooling speed. This is accomplished with the use of the "Low Speed Manual Fan" jumper located just below the indicator light on the control board. With the jumper in place (as shipped) the blower will operate at 50% of the nominal cooling speed selected. With the jumper removed the blower will operate at 100% of the nominal blower speed selected.

ACCESSORIES

Model Number	ASC01A	CSB02A	CSB04A	CSB05A	CSB06A	CSB08A	CSB09A		HSK02A	HSK03A	HSK04A	HSK06A	HSK12A	HSK13A	FSK01A	PCK01A	LAC01A	LAC02A	LAC03A	LSK01A
Description	Anti Short Cycle Kit	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Factory installed Hard Start	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Freeze Protection Kit	Pressure Control Kit	Low Ambient Control	Low Ambient Control	Low Ambient Control	Liquid Line Solenoid Kit
RCA/B18A2A	X			X					X						X	X		X		
RCA/B24A2A	X			X										X	X	X		X		
RCA/B30A2A	X		X		X							X			X	X		X		
RCA/B36A2A	X		X							X					X	X		X		
RCA/B42A2A	X	X									X				X	X		X		
RCA/B48A2A	X	X									X				X	X		X		
RCBA/60A2A	X	**									X				X	X		X		
RCA/B36A3A			X												X	X	X			
RCA/B48A3A		X													X	X	X			
RCA/B36A4A			X												X	X	X			
RCA/B60A3A		**													X	X	X			
RCA/B48A4A		X													X	X	X			
RCA/B60A4A		**													X	X	X			
RCB18A2B	X			X					X						X	X		X		X
RCB24A2B	X			X										X	X	X		X		X
RCB30A2C	X			X								X			X	X		X		X
RCB30A2B	X			X					X						X	X		X		X
RCB36A2B	X			X								X			X	X		X		X
RCB42A2B	X	X									X				X	X		X		X
RCB48A2B	X	**									X				X	X		X		X
RCB60A2B	X	**									X				X	X		X		X
RCB36A3B				X											X	X	X			X
RCB48A3B		**													X	X	X			X
RCB36A4B				X											X	X				X
RCB60A3B		**													X	X	X			X
RCB48A4B		**													X	X				X
RCB60A4B		**													X	X				X
RCB18B2A	X		X					**							X	X	X			X
RCB24B2A	X		X					**							X	X	X			X
RCB30B2A	X		X					**							X	X	X			X
RCB36B2A	X		X					**							X	X	X			X
RCB42B2A	X		X					**							X	X	X			X
RCB48B2A	X					X							X		X	X	X			X
RCB60B2A	X						X						X		X	X	X			X
RCC18A2A	**			X				**							X	**		X		X
RCC24A2A	**			X				**							X	**		X		X
RCC30A2A	**			X				**							X	**		X		X
RCC36A2A	**		X					**							X	**		X		X
RCC42A2A	**					**		**							X	**		X		X
RCC48A2A	**	**						**							X	**		X		X
RCC60A2A	**						**	**							X	**		X		X

x Available for this model

** Factory installed

 Not used in this application or not available

ACCESSORIES

Model Number	ASC01A	CSB02A	CSB04A	CSB05A	CSB07A	CSB08A	CSB09A	HSK02A	HSK04A	HSK06A	HSK10A	HSK11A	HSK12A	HSK13A	HSK14A	FSK01A	PCK01A	PCK02/03A	LAC01A	LAC02A	LAC03A	LSK01A
Description	Anti Short Cycle Kit	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Freeze Protection Kit	Pressure Control Kit	Pressure Control Kit	Low Ambient Control	Low Ambient Control	Low Ambient Control	Liquid Line Solenoid Kit
RCC36A3A			X													X	**		X			X
RCC48A3A		**														X	**		X			X
RCC60A3A							**									X	**		X			X
RCC18A2B	**			X				**								X	**			X		X
RCC24A2B	**			X				**								X	**			X		X
RCC30A2B	**			X				**								X	**			X		X
RCC36A2B	**		X					**								X	**			X		X
RCC42A2B	**					**					X					X	**			X		X
RCC48A2B	**	**						**								X	**			X		X
RCC60A2B	**						**						X			X	**			X		X
RCC36A3B			X													X	**		X			X
RCC48A3B		**														X	**		X			X
RCC60A3B							**									X	**		X			X
RCE24A2A	**				**						X					X	**			X		
RCE30A2A	**				**						X					X	**			X		
RCE36A2A	**					**					X					X	**			X		
RCE42A2A	**					**					X					X	**			X		
RCE48A2A	**					**							X			X	**			X		
RCE60A2A	**						**						X			X	**			X		
VCA18B2A	X			X							X						X			X		X
VCA24B2A	X			X						X							X			X		X
VCA30B2A	X			X											X		X			X		X
VCA36B2A	X			X											X		X			X		X
VCA42B2A	X	X							X								X			X		X
VCA48B2A	X	X										X					X			X		X
VCA60B2A	X	X										X					X			X		X
VCA36B3A				X													X		X			X
VCA48B3A		X															X		X			X
VCA60B3A		X															X		X			X
VCB18A2A	X			X				X									X			X		X
VCB24A2A	X			X										X			X			X		X
VCB30A2A	X			X						X							X			X		X
VCB36A2A	X			X						X							X			X		X
VCB42A2A	X	X							X								X			X		X
VCB48A2A	X	X							X								X			X		X
VCB60A2A	**	X							X								X			X		X

x Available for this model

** Factory installed

 Not used in this application or not available

ACCESSORIES

Model Number	ASC01A	ATK05A	CSB02A	CSB04A	CSB05A	CSB07A	CSB08A	CSB09A	HSK04A	HSK06A	HSK07A	HSK08A	HSK09A	HSK10A	HSK11A	HSK12A	FSK01A	PCK02/03A	LAC03A	LSK01A	FFK02A	FFK03A
Description	Anti Short Cycle Kit	Ambient Temperature Kit	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Freeze Protection Kit	Pressure Control Kit	Low Ambient Control	Liquid Line Solenoid Kit	Fossil Fuel Kit	Fossil Fuel Kit
RHA18A2A	X	X				X								X			X	X	X	X	X	X
RHA24A2A	X	X			X					X							X	X	X	X	X	X
RHA30A2A	X	X			X					X							X	X	X	X	X	X
RHA36A2A	X	X		X							X						X	X	X	X	X	X
RHA42A2A	X	X		X								X					X	X	X	X	X	X
RHA48A2A	X	X	X												**		X	X	X	X	X	X
RHA60A2A	X	X	X						**								X	X	X	X	X	X
RHA36A3A		X		X													X	X		X	X	X
RHA48A3A		X	X														X	X		X	X	X
RHA60A3A		X	X														X	X		X	X	X
RHA36A4A		X		X													X	X		X	X	X
RHA48A4A		X	X														X	X		X	X	X
RHA60A4A		X	X														X	X		X	X	X
RHA18A2B	X	X		X									**				X	X	X	X	X	X
RHA24A2B	X	X		X									X				X	X	X	X	X	X
RHA30A2B	X	X		X									X				X	X	X	X	X	X
RHA36A2B	X	X		X							X						X	X	X	X	X	X
RHA42A2B	X	X		X								X					X	X	X	X	X	X
RHA48A2B	X	X	X												X		X	X	X	X	X	X
RHA60A2B	**	X					X							X			X	X	X	X	X	X
RHA36A3B		X		X													X	X	X	X	X	X
RHA48A3B		X	X														X	X	X	X	X	X
RHA60A3B		X					X										X	X	X	X	X	X
RHA36A4B		X		X													X	X	X	X	X	X
RHA48A4B		X	X														X	X	X	X	X	X
RHA60A4B		X					X										X	X	X	X	X	X
RHA18B2A	X	X		X									**				X	X	X			X
RHA24B2A	X	X		X									**				X	X	X			X
RHA30B2A	X	X				X								X			X	X	X			X
RHA36B2A	X	X				X								X			X	X	X			X
RHA42B2A	X	X					X							X			X	X	X			X
RHA48B2A	X	X		X												X	X	X	X			X
RHA60B2A	X	X						X								X	X	X	X			X

x Available for this model

** Factory installed

 Not used in this application or not available

ACCESSORIES

Model Number	ASC01A	ATK05A	CSB02A	CSB04A	CSB05A	CSB07A	CSB08A	CSB09A	HSK04A	HSK06A	HSK07A	HSK08A	HSK09A	HSK10A	HSK11A	HSK12A	FSK01A	PCK02/03A	LAC03A	LSK01A	FFK02A	FFK03A
Description	Anti Short Cycle Kit	Ambient Temperature Kit	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Compressor Sound Blanket	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Hard Start Kit	Freeze Protection Kit	Pressure Control Kit	Low Ambient Control	Liquid Line Solenoid Kit	Fossil Fuel Kit	Fossil Fuel Kit
RHD18	**	X				X								X			X	X			X	X
RHD24	**	X				X								X			X	X			X	X
RHD30	**	X				X								X			X	X			X	X
RHD36	**	X					X							X			X	X			X	X
RHD42	**	X					X							X			X	X			X	X
RHD48	**	X						X								X	X	X			X	X
RHD60	**	X						X								X	X	X			X	X
RHE18	**	X				X								X				**	X		X	X
RHE24	**	X				X								X				**	X		X	X
RHE30	**	X				X								X				**	X		X	X
RHE36	**	X					X							X				**	X		X	X
RHE42	**	X					X							X				**	X		X	X
RHE48	**	X						X								X		**	X		X	X
RHE60	**	X						X								X		**	X		X	X
Model Number	FSK01A	SPK01A	SPK02A	DSK01A	EHK05A	EHK07A	EHK10A	EHK15A	EHK20A	EHK25A	EHK30A	EHK05B/C	EHK07B/C	EHK10B/C	EHK15B/C	EHK20B/C	EHK25B/C	EHK30B/C				
Description	Freeze Protection Kit	Single Point Wiring Kit	Single Point Wiring Kit	Disconnect Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit	Electric Heat Kit			
BBA24A2A		X	X									X	X	X	X							
BBA36A2A		X	X									X	X	X	X	X						
BBA48A2A		X	X									X	X	X	X	X	X	X				
BBA60A2A		X	X									X	X	X	X	X	X	X				
BBC36A2A		X	X									X	X	X	X	X						
BBC48A2A		X	X									X	X	X	X	X	X	X				
BBC60A2A		X	X									X	X	X	X	X	X	X				
BHA24TB	X			X	X	X	X	X														
BHA30TB	X			X	X	X	X	X														
BHA36TB	X			X	X	X	X	X	X													
BHA42TB	X			X	X	X	X	X	X													
BHA48TB	X			X	X	X	X	X	X	X	X											
BHA60TB	X			X	X	X	X	X	X	X	X											

x Available for this model

** Factory installed

 Not used in this application or not available

ACCESSORIES

Model Number	CCD16A22	CCD20A22	CCD24A26	ROK01A	ROK49 to 98A	TXV01A	TXV02A	TXV03A	FSK01A
Description	Accessory Coil Cabinet	Accessory Coil Cabinet	Accessory Coil Cabinet	Restrictor Orifice Kit	Restrictor Orifice Kit	Thermo-Expansion Valve Kit	Thermo-Expansion Valve Kit	Thermo-Expansion Valve Kit	Freeze Protection Kit
CCA18FUA				X					X
CCA24FUA				X					X
CCA30FUA				X					X
CCA36FUA				X					X
CCA42FUA				X					X
CCA48FUA				X					X
CCA60FUA				X					X
CHA18TUA									X
CHA24TUA									X
CHA30TUA									X
CHA36TUA									X
CHA42TUA									X
CHA48TUA									X
CHA57TUA									X
CHA60TUA									X
CCA18TCA/B									X
CCA24TCA/B									X
CCA30TCA/B									X
CCA36TCA/B									X
CCA42TCA/B									X
CCA48TCA/B									X
CCA60TCA/B									X
CHA18T_C	X					X			X
CHA24T_C	X					X			X
CHA30T_C	X						X		X
CHA36T_C	X						X		X
CHA42T_C		X					X	X	X
CHA48T_C			X					X	X
CHA54T_C			X					X	X
CHA57T_C			X					X	X
CHA60T_C			X					X	X
CCA18F_C	X				X	X			X
CCA24F_C	X				X	X			X
CCA30F_C	X				X		X		X
CCA36F_C	X				X		X		X
CCA42F_C	X				X		X		X
CCA48F_C		X			X				X
CCA54F_C			X		X				X
CCA57F_C			X		X				X

Model Number	CCD16A22	CCD20A22	CCD24A26	ROK01A	ROK49 to 98A	TXV01A	TXV02A	TXV03A	FSK01A
Description	Accessory Coil Cabinet	Accessory Coil Cabinet	Accessory Coil Cabinet	Restrictor Orifice Kit	Restrictor Orifice Kit	Thermo-Expansion Valve Kit	Thermo-Expansion Valve Kit	Thermo-Expansion Valve Kit	Freeze Protection Kit
CCA60F_C			X		X				X
CCH24FCC				X					X
CCH30FCC				X					X
CCH36FCC				X					X
CCH48FCC				X					X
CCH60FCC				X					X
CCH24FCD					X	X			X
CCH30FCD					X		X		X
CCH36FCD					X		X		X
CCH48FCD					X			X	X
CCH60FCD					X			X	X
CHH24TCC									X
CHH30TCC									X
CHH36TCC									X
CHH48TCC									X
CHH60TCC									X
CHH24TCD									X
CHH30TCD									X
CHH36TCD									X
CHH48TCD									X
CHH60TCD									X
CCF24FCC					X	X			X
CCF30FCC					X		X		X
CCF36FCC					X		X		X
CCF42FCC					X		X	X	X
CCF48FCC					X			X	X
CCF60FCC					X			X	X
CCF24FDC					X	X			X
CCF36FDC					X		X		X
CCF48FDC					X			X	X
CHF24TCC									X
CHF30TCC									X
CHF36TCC									X
CHF42TCC									X
CHF48TCC									X
CHF60TCC									X

SCHEDULED MAINTENANCE

The owner should be made aware of the fact that, as with any mechanical equipment the remote air conditioner requires regularly scheduled maintenance to preserve high performance standards, prolong the service life of the equipment, and lessen the chances of costly failure.

In many instances the owner may be able to perform some of the maintenance, however, the advantage of a service contract, which places all maintenance in the hands of a trained serviceman, should be pointed out to the owner.



DISCONNECT POWER SUPPLY BEFORE SERVICING

ONCE A MONTH

1. Inspect the return filters of the evaporator unit and clean or change if necessary. **NOTE:** Depending on operation conditions, it may be necessary to clean the filters more often. If permanent type filters are used, they should be washed with warm water, dried and sprayed with an adhesive according to manufacturers recommendations.
2. When operating on the cooling cycle, inspect the condensate line piping from the evaporator coil. Make sure the piping is clear for proper condensate flow.

ONCE A YEAR

Qualified Service Personnel Only

1. Clean the indoor and outdoor coils.
2. Clean the casing of the outdoor unit inside and out.
3. Motors used on Amana products are considered to be permanently lubricated and do not require lubrication. Most current motors no longer have oil ports on the motors.
4. Manually rotate the outdoor fan and indoor blower to be sure they run freely.
5. Inspect the control panel wiring, compressor connections, and all other component wiring to be sure all connections are tight. Inspect wire insulation to be certain that it is good.
6. Check the contacts of the compressor contactor. If they are burned or pitted, replace the contactor.
7. Using a halide or electronic leak detector, check all piping and etc. for refrigerant leaks.
8. Start the system and run a Cooling Performance Test. If the results of the test are not satisfactory, see the "Ser-

SERVICING

vice Problem Analysis" Chart for the possible cause.

TEST EQUIPMENT

Proper test equipment for accurate diagnosis is as essential as regular hand tools.

The following is a must for every service technician and service shop:

1. Thermocouple type temperature meter - measure dry bulb temperature.
2. Sling psychrometer- measure relative humidity and wet bulb temperature.
3. Amprobe - measure amperage and voltage.
4. Refrigeration test cord - check compressors, motors, and continuity testing.
5. Volt-Ohm meter - testing continuity, capacitors, and motor windings.
6. Accurate Leak Detector - testing for refrigerant leaks.

7. High evacuation pump - evacuation.
8. Electric vacuum gauge, manifold, and high vacuum hoses - to measure and obtain proper vacuum.
9. Accurate charging cylinder or electronic scale - measure proper refrigerant charge.
10. Inclined manometer - measure static pressure and pressure drop across coils.

Other recording type instruments can be essential in solving abnormal problems, however, in many instances they may be rented from local sources.

Proper equipment promotes faster, more efficient service, and accurate repairs with less call backs.

COOLING & HEATING PERFORMANCE TEST

Before attempting to diagnose an operating fault, run a Cooling and/or Heating Performance Test and apply the results to the Service Problem Analysis Guide.

SCHEDULED MAINTENANCE

Complaint	No Cooling						Unsatisfactory Cooling	System Operating Pressures				Test Method Remedy	See Service Procedure Reference						
POSSIBLE CAUSE DOTS IN ANALYSIS GUIDE INDICATE "POSSIBLE CAUSE"	SYMPTOM	System will not start	Compressor will not start - fan runs	Compressor and Condenser Fan will not start	Evaporator fan will not start	Condenser fan will not start	Compressor runs - goes off on overload	Compressor cycles on overload	System runs continuously - little cooling	Too cool and then too warm	Not cool enough on warm days			Certain areas to cool others to warm	Compressor is noisy	Low suction pressure	Low head pressure	High suction pressure	High head pressure
Power Failure	●																	Test Voltage	S-1
Blown Fuse	●		●															Impact Fuse Size & Type	S-4
Loose Connection	●			●			●											Inspect Connection - Tighten	S-2
Shorted or Broken Wires	●	●	●	●	●	●	●											Test Circuits With Ohmmeter	S-3
Open Overload	●	●			●	●												Test Continuity of Overloads	S-17A
Faulty Thermostat	●				●					●								Test continuity of Thermostat & Wiring	S-3
Faulty Transformer	●			●														Check control circuit with voltmeter	S-4
Shorted or Open Capacitor		●				●	●											Test Capacitor	S-15
Internal Overload Open	●																	Test Continuity of Overload	S-17A
Shorted or Grounded Compressor			●				●											Test Motor Windings	S-17B
Compressor Stuck	●						●											Use Test Cord	S-17C
Faulty Compressor Contactor	●	●				●	●											Test continuity of Coil & Contacts	S-7, S-8
Faulty Fan Relay					●													Test continuity of Coil And Contacts	S-7
Open Control Circuit					●													Test Control Circuit with Voltmeter	S-4
Low Voltage			●				●	●										Test Voltage	S-1
Faulty Evap. Fan Motor					●									●				Repair or Replace	S-16
Shorted or Grounded Fan Motor						●											●	Test Motor Windings	S-16
Improper Cooling Anticipator							●	●		●								Check resistance of Anticipator	S-3
Shortage or Refrigerant								●	●					●	●			Test For Leaks, Add Refrigerant	S-103
Restricted Liquid Line								●	●					●	●			Replace Restricted Part	S-113
Undersized Liquid Line									●		●			●				Replace Line	S-120
Undersized Suction Line														●			◆	Replace Line	S-120
Dirty Air Filter									●		●	●		●			◆	Inspect Filter-Clean or Replace	
Dirty Indoor Coil									●		●	●		●			◆	Inspect Coil - Clean	
Not enough air across Indoor Coil									●		●	●		●			◆	Speed Blower, Check Dust Static Pressure	S-200
Too much air across Indoor Coil																	●	Reduce Blower Speed	S-200
Overcharge of Refrigerant							●	●					●			●	●	Release Part of Charge	S-114
Dirty Outdoor Coil							●	●						◆			●	Inspect Coil - Clean	
Noncondensibles								●			●						●	Remove Charge, Evacuate, Recharge	S-115
Recirculation of Condensing Air								●			●						●	Remove Obstruction to Air Flow	
Infiltration of Outdoor Air									●		●	●						Check Windows, Doors, Vent Fans, Etc.	
Improperly Located Thermostat							●			●								Relocate Thermostat	
Air Flow Unbalanced										●		●						Readjust Air Volume Dampers	
System Undersized									●		●							Refigure Cooling Load	
Broken Internal Parts													●					Replace Compressor	
Broken Valves														●				Test compressor Efficiency	S-104
Inefficient Compressor									●						●	●		Test Compressor Efficiency	S-104
High Pressure Control Open				●												●	●	Reset And Test Control	S-12
Unbalanced Power, 3PH			●				●	●										Test Voltage	
Wrong Type Expansion Valve							●	●			●							Replace Valve	
Expansion Valve Restricted							●	●		●				●	●			Replace Valve	
Oversized Expansion Valve													●			●		Replace Valve	
Undersized Expansion Valve							●	●	●	●				●				Repalce Valve	
Expansion Valve Bulb Loose													●				●	Tighten Bulb Bracket	
Inoperative Expansion Valve							●		●					●				Check Valve Operation	S-110
Loose Hold-down Bolts													●					Tighten Bolts	

◆ Heat Pump Mode Only

SERVICING

S-1 CHECKING VOLTAGE



Disconnect Electrical Power Supply:

1. Remove outer case, control panel cover, etc. from unit being tested.

With power ON:



LINE VOLTAGE NOW PRESENT

2. Using a voltmeter, measure the voltage across terminals L1 and L2 of the contactor for the condensing unit or at the field connections for the air handler or heaters.
3. No reading - indicates open wiring, open fuse(s) no power or etc. from unit to fused disconnect service. Repair as needed.
4. With ample voltage at line voltage connectors, energize the unit.
5. Measure the voltage with the unit starting and operating, and determine the unit Locked Rotor Voltage. **NOTE:** If checking heaters, be sure all heating elements are energized.

Locked Rotor Voltage is the actual voltage available at the compressor during starting, locked rotor, or a stalled condition. Measured voltage should be above minimum listed in chart below.

To measure Locked Rotor Voltage attach a voltmeter to the run "R" and common "C" terminals of the compressor, or to the T₁ and T₂ terminals of the contactor. Start the unit and allow the compressor to run for several seconds, then shut down the unit. Immediately attempt to restart the unit while measuring the Locked Rotor Voltage.

6. Lock rotor voltage should read within the voltage tabulation as shown. If the voltage falls below the minimum voltage, check the line wire size. Long runs of undersized wire can cause low voltage. If wire size is adequate, notify the local power company in regard to either low or high voltage.

REMOTE CONDENSING UNITS BLOWER COILS		
VOLTAGE	MIN.	MAX.
208/230	198	253
115	104	127

NOTE: When operating electric heaters on voltages other than 240 volts refer to the System Operation section on electric heaters to calculate temperature rise and air flow. Low voltage may cause insufficient heating.

Three phase units require a balanced 3 phase power supply to operate. If the percentage of voltage imbalance exceeds 3% the unit must not be operated until the voltage condition is corrected.

$$\% \text{ Voltage Imbalance} = \frac{\text{Max. Voltage Deviation From Average Voltage}}{\text{Average Voltage}} \times 100$$

To find the percentage of imbalance, measure the incoming power supply.

$$L1 - L2 = 240V$$

$$L1 - L3 = 232V$$

$$L2 - L3 = 238V$$

$$\text{Total } 710V$$

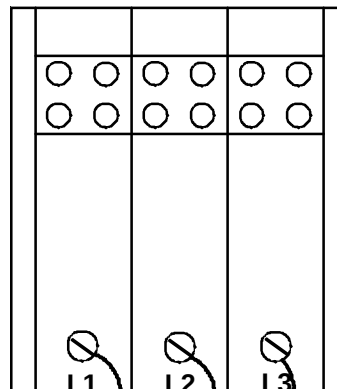
$$\text{Avg. } V = \frac{710}{3} = 236.7$$

$$\begin{aligned} \text{To find Max. deviation: } & 240 - 236.7 = +3.3 \\ & 232 - 236.7 = -4.7 \\ & 238 - 236.7 = +1.3 \end{aligned}$$

Max deviation was 4.7V

$$\% \text{ Voltage Imbalance} = \frac{4.7}{236.7} \times 100 = 1.99\%$$

If the percentage of imbalance had exceeded 3%, it must be determined if the imbalance is in the incoming power supply or the equipment. To do this, rotate the legs of the incoming power and retest voltage as shown below.

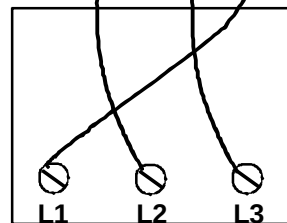


$$L1 - L2 = 240V$$

$$L1 - L3 = 227V$$

$$L2 - L3 = 238V$$

Rotate all 3 incoming legs as shown.



$$L1 - L2 = 227V$$

$$L1 - L3 = 238V$$

$$L2 - L3 = 240V$$

By the voltage readings we see that the imbalance rotated or traveled with the switching of the incoming legs. Therefore the power imbalance lies within the incoming power supply.

SERVICING

S-2 CHECKING WIRING



Disconnect Electrical Power Supply:

1. Check wiring visually for signs of overheating, damaged insulation and loose connections.
2. Use an ohmmeter to check continuity of any suspected open wires.
3. If any wires must be replaced, replace with comparable gauge and insulation thickness.

S-3 CHECKING THERMOSTAT, WIRING, AND ANTICIPATOR

THERMOSTAT WIRE SIZING CHART	
LENGTH OF RUN	MIN. COPPER WIRE GAUGE (AWG)
25 feet	18
50 feet	16
75 feet	14
100 feet	14
125 feet	12
150 feet	12

S-3A Thermostat and Wiring



LINE VOLTAGE NOW PRESENT

With power ON, thermostat calling for cooling

1. Use a voltmeter to check for 24 volts at thermostat wires C and Y in the condensing unit control panel.
2. No voltage indicates trouble in the thermostat, wiring or external transformer source.
3. Check the continuity of the thermostat and wiring. Repair or replace as necessary.

Indoor Blower Motor

With power ON:



LINE VOLTAGE NOW PRESENT

1. Set fan selector switch at thermostat to "ON" position.
2. With voltmeter, check for 24 volts at wires C and G.
3. No voltage, indicates the trouble is in the thermostat or wiring.
4. Check the continuity of the thermostat and wiring. Repair or replace as necessary.

Resistance Heaters

1. Set room thermostat to a higher setting than room temperature so both stages call for heat.
2. With voltmeter, check for 24 volts at each heater relay.
3. No voltage, indicates the trouble is in the thermostat or wiring.
4. Check the continuity of the thermostat and wiring. Repair or replace as necessary.

NOTE: Consideration must be given to how the heaters are wired (O.D.T. and etc.). Also safety devices must be checked for continuity.

S-3B Cooling Anticipator

The cooling anticipator is a small heater (resistor) in the thermostat. During the "off" cycle it heats the bimetal element helping the thermostat call for the next cooling cycle. This prevents the room temperature from rising too high before the system is restarted. A properly sized anticipator should maintain room temperature within 1 1/2 to 2 degree range.

The anticipator is supplied in the thermostat and is not to be replaced. If the anticipator should fail for any reason, the thermostat must be changed.

S-3C Heating Anticipator

The heating anticipator is a wire wound adjustable heater which is energized during the "ON" cycle to help prevent overheating of the conditioned space.

The anticipator is a part of the thermostat and if it should fail for any reason, the thermostat must be replaced. See the following tables for recommended heater anticipator setting in accordance to the number of electric heaters installed.

HEATER KIT ANTICIPATOR TABLE

EHK_A	05A	07A	10A	15A	20A	25A	30A
HEATER KW	4.8	7.2	9.6	14.4	19.2	24	28.8
FIRST STAGE	0.4	0.4	0.4	0.4	0.4	0.4	0.4
SECOND STAGE	0.4	0.6	0.6	0.6	0.8	0.9	0.9

ECB/C / EHK_B/C	05B	07B	10B	15B	20B	25B	30B
HEATER KW	4.8	7.2	9.6	14.4	19.2	24	28.8
FIRST STAGE	0.4	0.4	0.4	0.4	0.4	0.4	0.4
SECOND STAGE	0.4	0.4	0.4	0.4	0.4	0.4	0.4

S-4 CHECKING TRANSFORMER AND CONTROL CIRCUIT

A step-down transformer (208/240 volt primary to 24 volt secondary) is provided with each indoor unit. This allows ample capacity for use with resistance heaters. The out-

SERVICING

door sections do not contain a transformer.



Disconnect Electrical Power Supply:

1. Remove control panel cover or etc. to gain access to transformer.

With power ON:



LINE VOLTAGE NOW PRESENT

2. Using a voltmeter, check voltage across secondary voltage side of transformer (R to C).
3. No voltage indicates faulty transformer, bad wiring, or bad splices.
4. Check transformer primary voltage at incoming line voltage connections and/or splices.
5. If line voltage available at primary voltage side of transformer and wiring and splices good, transformer is inoperative. Replace.

S-5 CHECKING CYCLE PROTECTOR

Some models feature a solid state, delay-on make after break time delay relay installed in the low voltage circuit. This control is used to prevent short cycling of the compressor under certain operating conditions.

The component is normally closed (R_1 to Y_1). A power interruption will break circuit (R_1 to Y_1) for approximately three minutes before resetting.



Disconnect Electrical Power Supply:

1. Remove wire from Y_1 terminal.
2. Wait for approximately four (4) minutes if machine was running.

With power ON:



LINE VOLTAGE NOW PRESENT

1. Apply 24 VAC to terminals R_1 and R_2 .
2. Should read 24 VAC at terminals Y_1 and Y_2 .
3. Remove 24 VAC at terminals R_1 and R_2 .
4. Should read 0 VAC at Y_1 and Y_2 .
5. Reapply 24 VAC to R_1 and R_2 - within approximately three (3) to four (4) minutes should read 24 VAC at Y_1 and Y_2 .

If not as above - replace relay.

S-6 CHECKING TIME DELAY RELAY

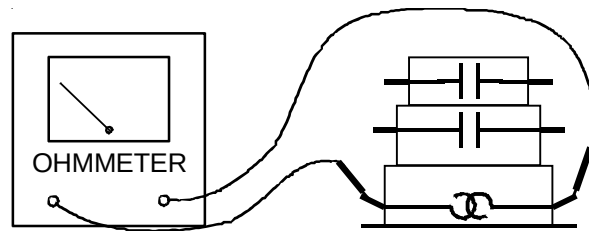
Time delay relays are used in some of the blower cabinets to improve efficiency by delaying the blower off time. Time delays are also used in electric heaters to sequence in multiple electric heaters.



Disconnect Electrical Power Supply:

1. Tag and disconnect all wires from male spade connections of relay.
2. Using an ohmmeter, measure the resistance across terminals H1 and H2. Should read approximately 150 ohms.
3. Using an ohmmeter, check for continuity across terminals 3 and 1, and 4 and 5.
4. Apply 24 volts to terminals H1 and H2. Check for continuity across other terminals - should test continuous. If not as above - replace.

NOTE: The time delay for the contacts to make will be approximately 20 to 50 seconds and to open after the coil is de-energized is approximately 40 to 90 seconds.



TESTING COIL CIRCUIT

S-7 CHECKING CONTACTOR AND/OR RELAYS

The compressor contactor and other relay holding coils are wired into the low or line voltage circuits. When the control circuit is energized, the coil pulls in the normally open contacts or opens the normally closed contacts. When the coil is de-energized, springs return the contacts to their normal position.

NOTE: Most single phase contactors break only one side of the line (L1), leaving 115 volts to ground present at most internal components.



Disconnect Electrical Power Supply:

1. Remove the leads from the holding coil.
2. Using an ohmmeter, test across the coil terminals.

If the coil does not test continuous, replace the relay or contactor.

SERVICING

S-8 CHECKING CONTACTOR CONTACTS

WARNING

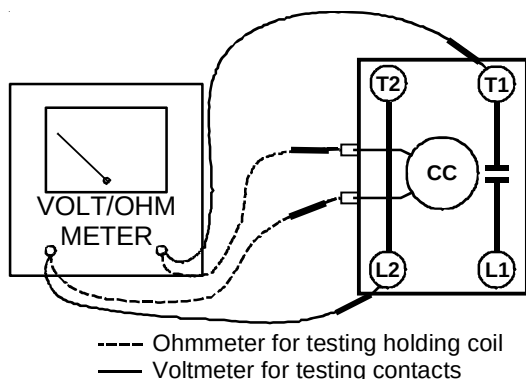
Disconnect Electrical Power Supply:

1. Disconnect the wire leads from the terminal (T) side of the contactor.
2. With power ON, energize the contactor.

WARNING

LINE VOLTAGE NOW PRESENT

3. Using a voltmeter, test across terminals.
 - A. L2 - T1 - No voltage indicates CC1 contacts open.
 If a no voltage reading is obtained - replace the contactor.



TESTING COMPRESSOR CONTACTOR

S-9 CHECKING FAN RELAY CONTACTS

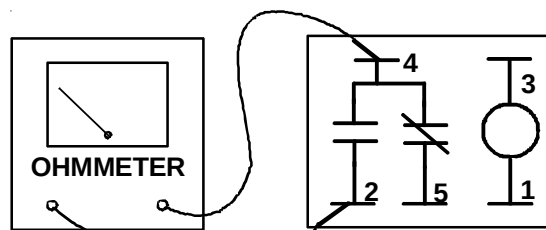
WARNING

Disconnect Electrical Power Supply:

1. Disconnect wires leads from terminals 2 and 4 of Fan Relay Cooling and 2 and 4, 5 and 6 of Fan Relay Heating.
2. Using an ohmmeter, test between 2 and 4 - should read open. Test between 5 and 6 - should read continuous.
3. With power ON, energize the relays.
4. Using an ohmmeter, test between 2 and 4 - should read continuous. Test between 5 and 6 - should read open.
5. If not as above, replace the relay.

WARNING

LINE VOLTAGE NOW PRESENT.



TESTING FAN RELAY

S-12 CHECKING HIGH PRESSURE CONTROL (some models)

The high pressure control capillary senses the pressure in the compressor discharge line. If abnormally high condensing pressures develop, the contacts of the control open, breaking the control circuit before the compressor motor overloads. This control is manually reset.

WARNING

Disconnect Electrical Power Supply:

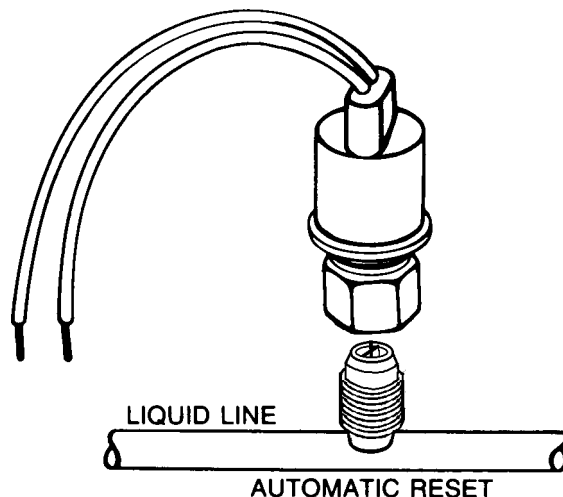
1. Using an ohmmeter, check across terminals of high pressure control, with wire removed. If not continuous, the contacts are open.
2. Reset high pressure control.
3. Attach a gauge to the dill valve port on the base valve.

With power ON:

WARNING

LINE VOLTAGE NOW PRESENT.

4. Start the system and place a piece of cardboard in front of the condenser coil, raising the condensing pressure.
5. Check pressure at which the high pressure control cuts-out



If it cuts-out at 440 PSIG (400 PSIG some models) $\pm$ 10 PSIG, it is operating normally (See causes for high head pressure in Service Problem Analysis Guide). If it cuts out below this pressure range, replace the control.

SERVICING

S-13 CHECKING LOW PRESSURE CONTROL (some models)

The low pressure control senses the pressure in the suction line and will open its contacts on a drop in pressure. The low pressure control will automatically reset itself with a rise in pressure.

The low pressure control is designed to cut-out (open) at approximately 35 PSIG. It will automatically cut-in (close) at approximately 85 PSIG.

On heat pump models, the low pressure control is designed to cut-out (open) at approximately 10 PSIG. It will automatically cut-in (close) at approximately 40 PSIG. The system is designed to bypass the low pressure control in the defrost mode.

Test for continuity using a VOM and if not as above, replace the control.

S-14 CHECKING SCROLL COMPRESSOR DISCHARGE THERMOSTAT

Phase 1 scroll compressors are equipped with an internal thermostat located beneath the top cap on the compressor. Phase 2 Scroll compressors will not have a discharge thermostat.

This thermostat is designed to sense dangerous discharge temperatures reached under some extreme operating conditions (such as loss of charge or extremely high compression ratio).

If maximum safe operating temperatures are exceeded, the thermostat will open removing power to the compressor. Once the discharge temperature has cooled, the thermostat will close and normal operation will resume.



Disconnect Electrical Power Supply:

1. Check for continuity across the terminals of the compressor thermostat. If continuity is not read the thermostat contacts are open.
2. If the contacts read open, allow the thermostat to cool to 140°F. and retest. If the thermostat continues to read open it should be replaced.

NOTE: This protective device should never be bypassed for any purpose.

The approximate thermostat cut-out/cut-in temperatures are 290/140°F.

S-15 CHECKING CAPACITOR CAPACITOR, RUN

A run capacitor is wired across the auxiliary and main windings of a single phase permanent split capacitor motor. The capacitors primary function is to reduce the line current while greatly improving the torque characteristics of a motor. This is accomplished by using the 90° phase relationship between the capacitor current and voltage in conjunction with the motor windings so that the motor will give two phase operation when connected to a single phase circuit. The capacitor also reduces the line current to the motor by improving the power factor.

The line side of this capacitor is marked with a red dot and is wired to the line side of the circuit.

CAPACITOR, START

SCROLL COMPRESSOR MODELS

In most cases hard start components are not required on Scroll compressor equipped units due to a non-replaceable check valve located in the discharge line of the compressor. However in installations that encounter low lock rotor voltage, a hard start kit can improve starting characteristics and reduce light dimming within the home.

This check valve closes off high side pressure to the compressor after shut down allowing equalization through the scroll flanks. Equalization requires only about one or two seconds during which time the compressor may turn backwards.

To prevent the compressor from starting and running backwards a Time Delay Relay (Cycle Protector) has been added to the low voltage circuit.

OTHER MODELS

A start capacitor is wired in parallel with the run capacitor to increase the starting torque. The start capacitor is of the electrolytic type, rather than metallized polypropylene as used in the run capacitor.

A switching device must be wired in series with the capacitor to remove it from the electrical circuit after the compressor starts to run. Not removing the start capacitor will overheat the capacitor and burn out the compressor windings.

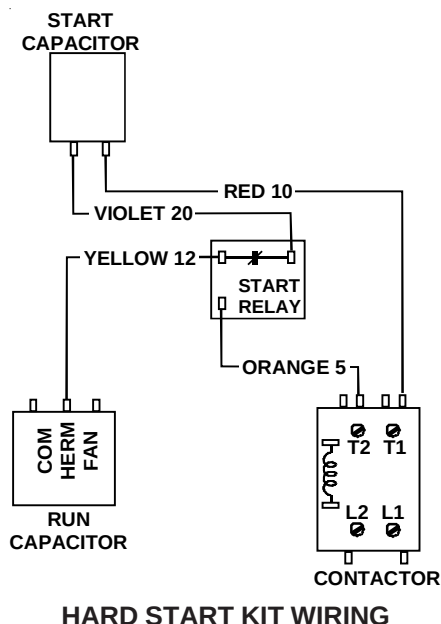
These capacitors have a 15,000 ohm, 2 watt resistor wired across its terminals. The object of the resistor is to discharge the capacitor under certain operating conditions, rather than having it discharge across the closing of the contacts within the switching device such as the Start Relay, and to reduce the chance of shock to the servicer. See the Servicing Section for specific information concerning capacitors.

SERVICING

RELAY, START

A potential or voltage type relay is used to take the start capacitor out of the circuit once the motor comes up to speed. This type of relay is position sensitive. The normally closed contacts are wired in series with the start capacitor and the relay holding coil is wired parallel with the start winding. As the motor starts and comes up to speed, the increase in voltage across the start winding will energize the start relay holding coil and open the contacts to the start capacitor.

Two quick ways to test a capacitor are a resistance and a capacitance check.



HARD START KIT WIRING

S-15A Resistance Check



WARNING

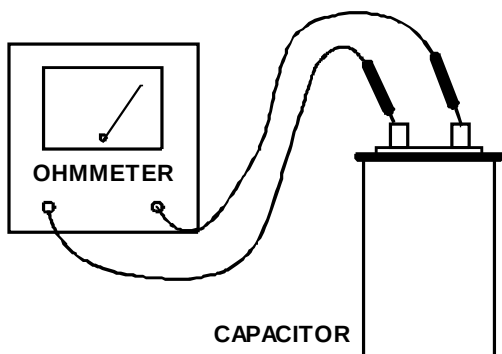
Disconnect Electrical Power Supply:

1. Discharge capacitor and remove wire leads.



WARNING

DISCHARGE CAPACITOR THROUGH A 20 TO 30 OHM RESISTOR BEFORE HANDLING.



TESTING CAPACITOR RESISTANCE

2. Set an ohmmeter on its highest ohm scale and connect the leads to the capacitor -

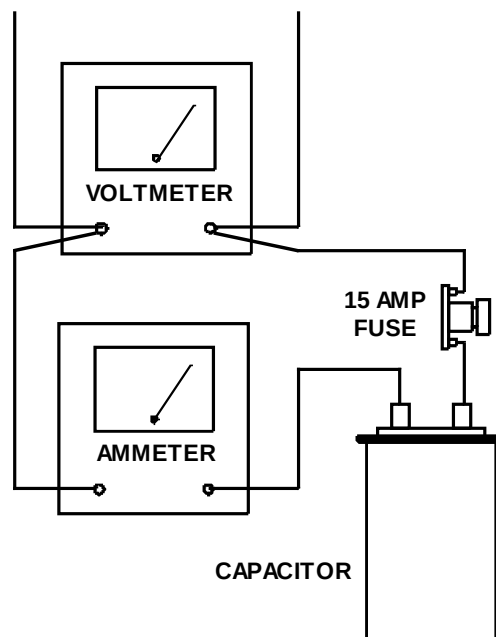
A. Good Condition - indicator swings to zero and slowly returns to infinity. (Start capacitor with bleed resistor will not return to infinity. It will still read the resistance of the resistor).

B. Shorted - indicator swings to zero and stops there - replace.

C. Open - no reading - replace. (Start capacitor would read resistor resistance).

S-15B Capacitance Check

Using a hookup as shown below, take the amperage and voltage readings and use them in the formula:



TESTING CAPACITANCE



WARNING

DISCHARGE CAPACITOR THROUGH A 20 TO 30 OHM RESISTOR BEFORE HANDLING.

$$\text{Capacitance (MFD)} = \frac{2650 \times \text{Amperage}}{\text{Voltage}}$$

S-15B PTCR Device

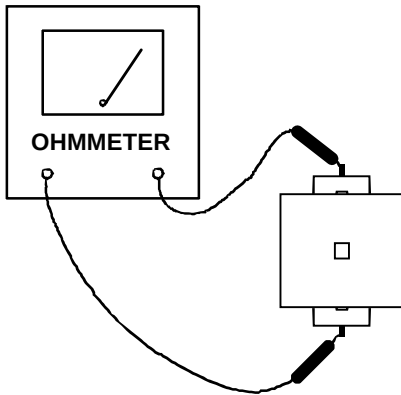
The PTCR functions in a manner similar to a traditional hard start kit. The PTCR device improves a P.S.C. motors starting ability by momentarily increasing the current supplied to the start winding. When voltage is applied, the PTCR immediately heats up due to current flow and changes from a very low to a very high resistance. As the resistance increases the PTCR becomes essentially nonconductive, permitting the motor to return to P.S.C. operation.

SERVICING

WARNING

Disconnect Electrical Power Supply:

1. Allow device to cool to the surrounding ambient temperature, at least 15 minutes. Device can be very hot if recently energized.
2. Disconnect leads from PTCR device. Using an ohmmeter, test across terminals as shown in the following illustration.



3. Resistance should be approximately $30\Omega \pm 30\%$. Resistance can range from 10 to 100 ohms depending on device temperature.

S-16 CHECKING FAN AND BLOWER MOTOR WINDINGS

The auto reset fan motor overload is designed to protect the motor against high temperature and high amperage conditions by breaking the common circuit within the motor, similar to the compressor internal overload. However, heat generated within the motor is faster to dissipate than the compressor, allow at least 45 minutes for the overload to reset, then retest.

WARNING

Disconnect Electrical Power Supply:

1. Remove the motor leads from its respective connection points and capacitor (if applicable).
2. Check the continuity between each of the motor leads.
3. Touch one probe of the ohmmeter to the motor frame (ground) and the other probe in turn to each lead.

If the windings do not test continuous or a reading is obtained from lead to ground, replace the motor.

S-17 CHECKING COMPRESSOR WINDINGS

WARNING

HERMETIC COMPRESSOR ELECTRICAL TERMINAL VENTING CAN BE DANGEROUS. WHEN INSULATING MATERIAL WHICH SUPPORTS A HERMETIC COMPRESSOR ELECTRICAL TERMINAL SUDDENLY DISINTEGRATES DUE TO PHYSICAL ABUSE OR AS A RESULT OF AN ELECTRICAL SHORT BETWEEN THE TERMINAL AND THE COMPRESSOR HOUSING, THE TERMINAL MAY BE EXPELLED, VENTING THE VAPOROUS AND LIQUID CONTENTS OF THE COMPRESSOR HOUSING AND SYSTEM.

If the compressor terminal PROTECTIVE COVER and gasket (if required) are not properly in place and secured, there is a remote possibility if a terminal vents, that the vaporous and liquid discharge can be ignited, spouting flames several feet, causing potentially severe or fatal injury to anyone in its path.

This discharge can be ignited external to the compressor if the terminal cover is not properly in place and if the discharge impinges on a sufficient heat source.

Ignition of the discharge can also occur at the venting terminal or inside the compressor, if there is sufficient contaminant air present in the system and an electrical arc occurs as the terminal vents.

Ignition cannot occur at the venting terminal without the presence of contaminant air, and cannot occur externally from the venting terminal without the presence of an external ignition source.

Therefore, proper evacuation of a hermetic system is essential at the time of manufacture and during servicing.

To reduce the possibility of external ignition, all open flame, electrical power, and other heat sources should be extinguished or turned off prior to servicing a system.

If the following test indicates shorted, grounded or open windings, see procedures S-19 for the next steps to be taken.

S-17A Resistance Test

Each compressor is equipped with an internal overload.

The line break internal overload senses both motor amperage and winding temperature. High motor temperature or amperage heats the disc causing it to open, breaking the common circuit within the compressor on single phase units. The three phase internal overload will open all three legs.

Heat generated within the compressor shell, usually due to recycling of the motor, high amperage or insufficient gas to cool the motor, is slow to dissipate. Allow at least three to four hours for it to cool and reset, then retest.

Fuse, circuit breaker, ground fault protective device, etc. has not tripped -

SERVICING



WARNING

Disconnect Electrical Power Supply:

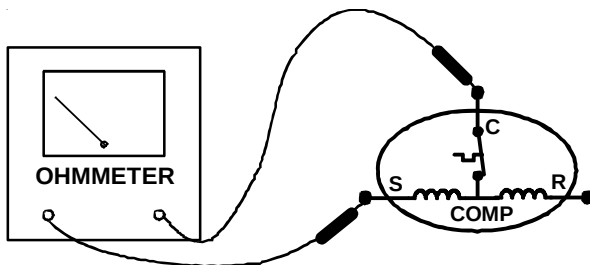
1. Remove the leads from the compressor terminals.



WARNING

SEE WARNING S-17 PAGE 26 BEFORE REMOVING COMPRESSOR TERMINAL COVER.

2. Using an ohmmeter, test continuity between terminals S-R, C-R, and C-S, on single phase units or terminals T2, T2 and T3, on 3 phase units.



TESTING COMPRESSOR WINDINGS

If either winding does not test continuous, replace the compressor.

NOTE: If an open compressor is indicated allow ample time for the internal overload to reset before replacing compressor.

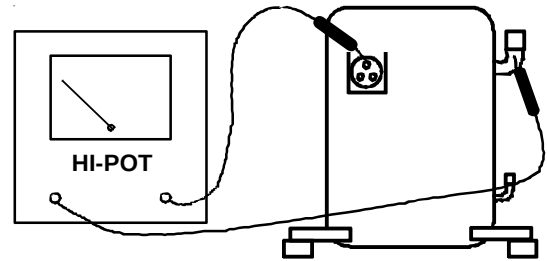
S-17B Ground Test

If fuse, circuit breaker, ground fault protective device, etc., has tripped, this is a strong indication that an electrical problem exists and must be found and corrected. The circuit protective device rating must be checked, and its maximum rating should coincide with that marked on the equipment nameplate.

With the terminal protective cover in place, it is acceptable to replace the fuse or reset the circuit breaker ONE TIME ONLY to see if it was just a nuisance opening. If it opens again, DO NOT continue to reset.

Disconnect all power to unit, making sure that **all** power legs are open.

1. DO NOT remove protective terminal cover. Disconnect the three leads going to the compressor terminals at the nearest point to the compressor.
2. Identify the leads and using a Megger, Hi-Potential Ground Tester, or other suitable instrument which puts out a voltage between 300 and 1500 volts, check for a ground separately between each of the three leads and ground (such as an unpainted tube on the compressor). Do not use a low voltage output instrument such as a volt-ohmmeter.



COMPRESSOR GROUND TEST

3. If a ground is indicated, then carefully remove the compressor terminal protective cover and inspect for loose leads or insulation breaks in the lead wires.
4. If no visual problems indicated, carefully remove the leads at the compressor terminals.



WARNING

DAMAGE CAN OCCUR TO THE GLASS EMBEDDED TERMINALS IF THE LEADS ARE NOT PROPERLY REMOVED, WHICH CAN RESULT IN THE TERMINAL VENTING AND HOT OIL DISCHARGING.

Carefully retest for ground, directly between compressor terminals and ground.

5. If ground is indicated, replace the compressor.

S-17C Operation Test

If the voltage, capacitor, overload and motor winding test fail to show the cause for failure:



WARNING

Disconnect Electrical Power Supply:

1. Remove unit wiring from disconnect switch and wire a test cord to the disconnect switch.

NOTE: The wire size of the test cord must equal the line wire size and the fuse must be of the proper size and type.

2. With the protective terminal cover in place, use the three leads to the compressor terminals that were disconnected at the nearest point to the compressor and connect the common, start and run clips to the respective leads.
3. Connect good capacitors of the right MFD and voltage rating into the circuit as shown.
4. With power ON, close the switch.



WARNING

LINE VOLTAGE NOW PRESENT

- A. If the compressor starts and continues to run, the cause for failure is somewhere else in the system.
- B. If the compressor fails to start - replace.

SERVICING

Compressor Serial Number Identification

COPELAND COMPRESSOR

E : 93 J 123456
 Motor Shift Year Month Serial No

TECUMSEH COMPRESSOR

T: G 22 93C 123456
 Month Day Year Serial No

BRISTOL COMPRESSOR

291 93 123456
 Day of Year Serial No
 Year

S-18 TESTING CRANKCASE HEATER

The crankcase heater must be energized a minimum of four (4) hours before the condensing unit is operated.

Crankcase heaters are used to prevent migration or accumulation of refrigerant in the compressor crankcase during the off cycles and prevents liquid slugging or oil pumping on start up.

A crankcase heater will not prevent compressor damage due to a floodback or over charge condition.



WARNING

Disconnect Electrical Power Supply:

1. Disconnect the heater lead in wires.
2. Using an ohmmeter, check heater continuity - should test continuous, if not, replace.

NOTE: The positive temperature coefficient crankcase heater is a 40 watt 265 voltage heater. The cool resistance of the heater will be approximately 1800 ohms. The resistance will become greater as the temperature of the compressor shell increases.

S-20 CHECKING DEFROST RELAY CONTACTS

With power OFF:

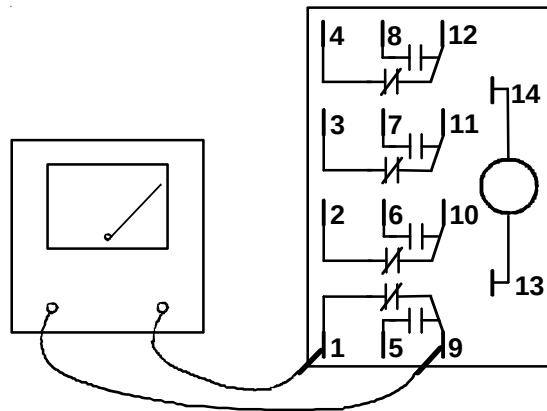


WARNING

Disconnect Electrical Power Supply:

1. Remove the wire leads from the defrost relay terminals.

2. Using an ohmmeter, test continuity between terminals. Contact positions are shown in the following drawing. If not as above, replace relay.



TESTING DEFROST RELAY



WARNING

LINE VOLTAGE NOW PRESENT.

3. Energize the relay by applying 24 volts to the relay coil.
4. With power on, retest with ohmmeter, readings should be opposite that read in step 2, (N.O. contacts should be closed, N.C. contacts should be open). If not as above, replace the relay.

S-21 CHECKING REVERSING VALVE AND SOLENOID

Occasionally the reversing valve may stick in the heating or cooling position or in the mid-position.

When stuck in the mid-position, part of the discharge gas from the compressor is directed back to the suction side, resulting in excessively high suction pressure. An increase in the suction line temperature through the reversing valve can also be measured. Check operation of the valve by starting the system and switching the operation from COOLING to HEATING and back again.

If the valve fails to change its position, test the voltage at the valve coil terminals, while the system is in the COOLING cycle.

NOTE: Refer to unit wiring diagram for proper voltage, 24V for RHA & RHD models, some previous designs used a 240V solenoid coil.

If no voltage is registered at the coil terminals, check for 24V at "O" on the low voltage terminal board.

SERVICING

If voltage is registered at the coil, tap the valve body lightly while switching the system from HEATING to COOLING, etc. If this fails to cause the valve to switch positions, remove the coil connector cap and test the continuity of the reversing valve solenoid coil. If the coil does not test continuous - replace it.

If the valve is inoperative - replace it.

S-22 REVERSING VALVE REPLACEMENT



Disconnect Electrical Power Supply:

Capture the refrigerant charge from the system.

When brazing a reversing valve into the system, it is of extreme importance that the temperature of the valve does not exceed 250°F. at any time.

Wrap the reversing valve with a large rag saturated with water. "Rewet" the rag and thoroughly cool the valve after each brazing operation of the four joints involved. The wet rag around the reversing valve will eliminate conduction of heat to the valve body when brazing the line connection.

The use of a wet rag sometimes can be a nuisance. There are commercial grades of heat absorbing paste that may be substituted.

After the valve has been installed, leak test, evacuate and recharge.

S-23 DEFROST TIMER BOARD

The Defrost Timer Board is an electronic device which is not field repairable. If a malfunction should occur the complete board must be replaced.

DEFROST CYCLE

The defrosting of the outdoor coil is jointly controlled by the defrost timer board, defrost (30/60) control, and compressor run time.

Solid State Timer RHA-A2A Models

The defrost timer board can be connected for one of three (3) time intervals. Post T_1 = 30 minutes, Post T_2 = 60 minutes, and Post T_3 = 90 minutes (Factory connected).

The timing interval can not commence until the outdoor coil temperature reaches approximately 30°F. (initiation temperature) at the defrost terminator (30/60) control point of contact. As long as this point of contact does not reach 60°F. (termination temperature), the defrost timer board will count the number of minutes that the compressor runs.

At the end of this (one of three) time interval, the defrost timer board will call for defrost and energize the defrost (DFR) relay. This relay has four sets of contacts of which one is in the line voltage circuit (normally closed) in series with the outdoor fan motor. When this contact opens, the outdoor fan motor stops. The other three sets of contacts (normally open) are in the low voltage circuit. One set of contacts con-

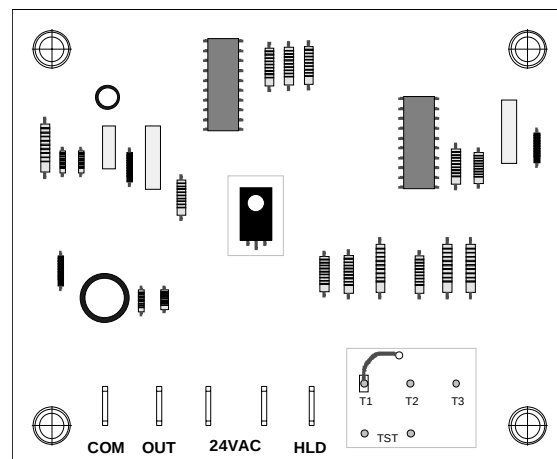
trol the reversing valve. When closed, the reversing valve energizes, switching over to the cooling position sending hot refrigerant gas to the outdoor coil, which will start to melt any frost accumulation. Another set of contacts close, locking in the compressor until defrost is completed. The third set will energize the electric heat if available.

The defrost timer board will keep the defrost (DFR) relay energized until the outdoor coil temperature reaches approximately 60°F at the 30/60 control, or a maximum of 10 minutes compressor run time.

If the defrost cycle is terminated by temperature, then a new time interval count cannot begin until the defrost (30/60) control again reaches approximately 30°F. If the defrost cycle was terminated by time, then a new time interval would begin immediately.

The following has been simplified in order to illustrate the Electronic functions:

TIME TEMPERATURE DEFROST CONTROL (RHA-A mdls)



1. When the defrost (30/60) control closes (coil temperature at approximately 30°F.), the solid state board becomes programmed.
2. Whenever the (CC) compressor contactor is energized, the solid state timer counts the compressor run time. If (CC) cycles those accumulated minutes are retained as long as the Defrost (30/60) control stays closed.

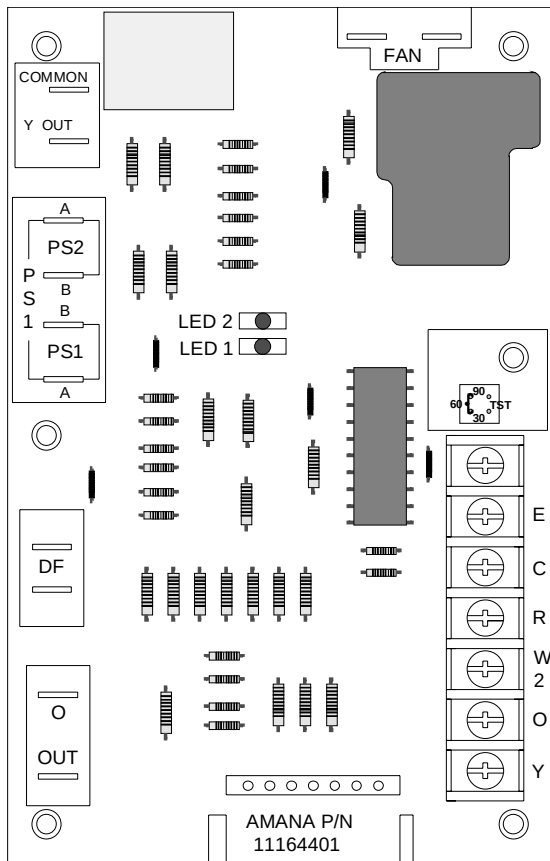
With the wire connected to T_3 terminal, the count time is for 90 minutes (factory wired). Terminal T_2 = 60 minutes, terminal T_1 = 30 minutes (field changeable) - Timer count time may be accelerated for testing only, by shorting TST Terminals. (Example: 90 minutes = approximately 21 seconds).

3. At end of the programmed time, common circuit (C) is made to the (OUT) terminal. The defrost (DFR) relay becomes energized and will stay energized until defrost (30/60) control opens by coil temperature, or after 10 minutes of run time. Maximum defrost time limited to 10 minutes compressor run time.

SERVICING

INTEGRATED DEFROST CONTROL

RHA-A-B



The operation of the integrated defrost control used on the RHA-A2B & RHA-B-A models is very similar to that of the solid state control used in the RHA--A2A models. The time interval is determined by the position of the time select jumper which is factory set to the specific unit design. The control will default to 90 minutes if the jumper is missing or if the jumper is left in the test position for more than 5 minutes. The 20214301 control, used in the RHA-B-A models is physically smaller than the 11164401 control and does not include the LED diagnostic display.

The board counts the compressor run time in the heating mode after the 30/60 control closes. If the 30/60 control opens, the timer will reset. The board will terminate defrost when the 30/60 control opens or after 14 minutes compressor run time which ever occurs first. If the thermostat is satisfied during the defrost cycle, timing is suspended, the board does not reset.

NOTE: RHA30 & 36 A2B units are factory set to 30 minutes. It is not recommended to change the defrost times on these units. All other models are factory set for 90 minutes and can be adjusted to accommodate local conditions.

During the defrost mode, the fan relay on the control board opens contacts which stop the fan motor. The reversing valve solenoid is energized to place the unit in the cooling mode. Also W2 is energized for signaling electric heat operation.

The defrost mode will be temporally suspended if the thermostat cycles off, or a pressure switch opens. Upon closure of pressure switches or resumption of thermostat demand, defrost activity will resume, as soon as the 5 minute short cycle time is satisfied.

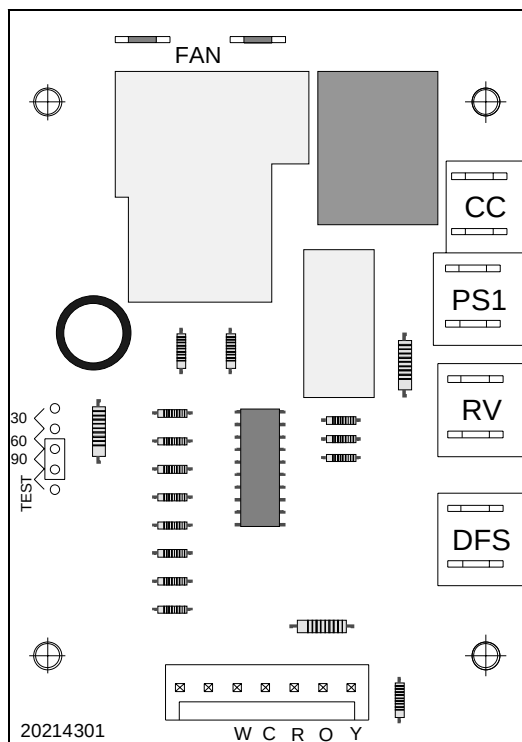
Test Mode - Placing the jumper in the test position will accelerate the timing by a factor of 128. With the 30/60 control closed a 90 minute defrost interval will time out in approximately 42 seconds, a 14 minute defrost will time out in approximately 7 seconds. If the jumper is in the test position at power up of the board, the jumper will be ignored. To reenter the test mode briefly remove the jumper and replace in test mode.

Some additional features that are built into this control are:

Short cycle protection - The integrated defrost control includes short cycle protection. A five minute lockout will occur when the 24 VAC power to the contactor is removed by the thermostat demand cycling off or by the opening of a pressure switch.

Pressure switch protection - When a pressure switch opens, the contactor is locked out for five minutes. After 5 minutes, if the pressure switch is closed, normal operation will resume. **Note:** The RHA__A2B units have a second 30/60 control which bypasses the low pressure control at the start of the defrost mode to avoid nuisance tripping of the low pressure switches in this phase of the defrost function. The RHA-B-A units do not have factory installed pressure switches.

RHA-B-A



SERVICING

Three time Lockout Feature - After 3 pressure switch openings within a single heating or cooling cycle, all functions will be locked out. Lockout is reset by cycling off the thermostat or by removing 24 VAC power to the board. **Note:** The Ranco board requires interrupt of 24 VAC to the board to reset.

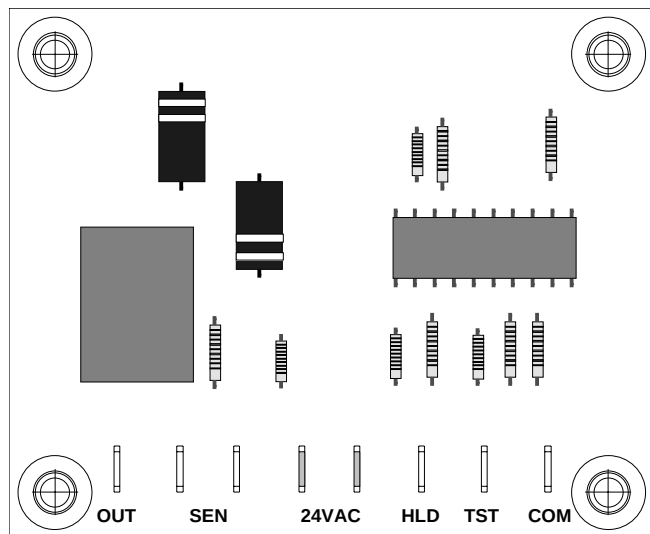
11164401 LED Diagnostic Display			
LED 1	LED 2	FAULT	
ON	ON	CONTINUOUS	Board Malfunction
OFF	OFF	CONTINUOUS	Board Malfunction or No Power
ON	OFF	CONTINUOUS	Pressure Switch 3 Time Lockout
OFF	ON	CONTINUOUS	Pressure Switch Open
ON/OFF	ON/OFF	ALTERNATING FLASHES	Anti Short Cycle Lockout
ON/OFF	ON/OFF	FLASHING TOGETHER	Normal Operation / Power to Board

Adaptive Defrost Control-RHD/RHE Models

The adaptive defrost board works in much the same way as the standard solid state timer except that it is not set to a fixed time between defrosts. Defrosts may be a minimum of 30 minutes apart, to a maximum of 180 or 360 minutes apart based on ambient conditions.

The optimum defrost time is programmed into the defrost control (5.5 or 7 minutes). If the defrost takes less than the optimum defrost time, the defrost board will increase the time before the next defrost. If the next defrost also is less than the optimum defrost time, the board will again increase the time before the next defrost.

As conditions change increasing the frost build up on the coil, the length of defrost will also increase above the optimum defrost time, causing the defrost cycles to come more frequently.



When the control is powered on, or after a power interruption (longer than 30 seconds), the first frost build interval is 30 minutes.

Amana part number 10865001 defrost controls, used through 9412 production. After the initial 30 minute frost build interval the second and subsequent frost build intervals will be adaptive to a target 7 minute defrost time.

Amana part number 10865002 defrost controls, used after 9412. After the initial 30 minute frost build interval, the second and third frost build intervals will be 90 minutes. Subsequent frost build intervals will be adaptive to a target 5.5 minute defrost.

For either version of the control, the adaptive logic will essentially add or subtract 26 minutes to the previous frost build interval, for every minute under or over the target defrost time. The maximum increase in the frost build interval is 37.5% of the last frost build interval. The maximum frost build interval is 360 minutes for the -01 through -03 controls.

To reduce the possible perception of improper operation due to heavy frost, two additional software changes have been made in the -04 & -05 controls. These changes include a maximum defrost interval of 3 hours (180 minutes) rather than the 6 hour (360 minutes) defrost interval used on previous controls. Also, if the defrost sensor remains open for 6 hours or longer, the control resets itself to a 90 minutes defrost interval. This means that after the defrost sensor closes the next defrost will be in 90 minutes, subsequent defrosts will be adaptive.

A defrost termination of 10.5 minutes will occur if the sensor does not open. If a time termination occurs, the next frost build interval will be 30 minutes and will be adaptive thereafter.

S-24 TESTING DEFROST TIMER BOARD

To check the defrost timer board for proper sequencing, proceed as follows: With power ON; unit running.



WARNING

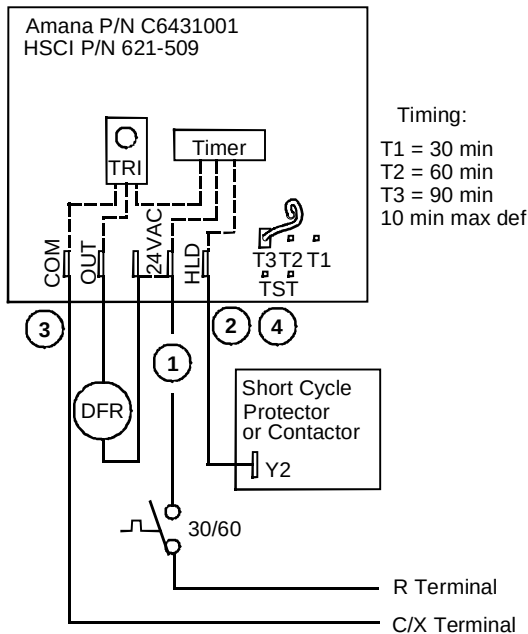
LINE VOLTAGE NOW PRESENT.

TIME TEMPERATURE DEFROST CONTROL (RHA-A mdls)

1. Jumper defrost control (30/60) by placing jumper wire from (R) wire of low voltage terminal board, to (24VAC) terminal of defrost timer board.
2. Using a VOM, measure voltage between (24VAC) terminal and (COM) terminal of defrost timer board - should read 24 VAC.
3. Connect VOM between (24VAC) terminal and (OUT) terminal - should read 0 VAC. If it reads 24 VAC, board may be in defrost mode.

SERVICING

4. With VOM still connected, and the unit in operation, short or jumper two TST terminals on board. (Test Terminals Jumpered - Count time speeds up - 90 minutes = approximately 21 seconds).
5. Watch VOM - should read 24 VAC at end of frost build interval, - then read 0 VAC at end of defrost interval (about 2 to 3 seconds after first reading).

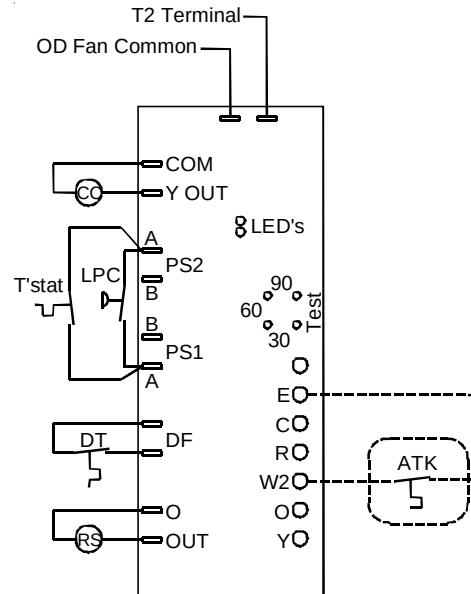


1. 24VAC - power is connected through the 30/60 sensor.
2. HOLD - accumulation of compressor run time.
3. OUT - connect common to defrost relay.
4. TEST - accelerate time, does not change sequence.

INTEGRATED DEFROST CONTROL (RHA-B mdl's)

1. The following checks may be made with a VOM. Measuring the voltage between:
 - a) (C) common terminal to the lower (DF) terminal, reads 24VAC if the defrost sensor is closed (only if the contactor coil is energized).
 - b) (C) common terminal to (W2) will read 24VAC during defrosting.
 - c) (C) common terminal to either (O) terminals will read zero in the heating mode and 24VAC in cooling or defrost.
 - d) (C) common terminal to (PS2 terminal A) will read 24VAC when all pressure switches are closed.
 - e) (C) common terminal to (Y OUT) will read 24VAC when the contactor coil is energized.
 - f) (FAN) left and (FAN) right terminals will read zero when not in defrost and 230VAC when in defrost.
2. If the defrost sensor is not closed, place a jumper wire between both terminals marked "DF".
3. The contactor coil must be energized to initiate a defrost cycle. Also a coil load must be on the (O and OUT) terminals, if bench testing the defrost control.

4. With a VOM connected to (C) and (W2), move the time select jumper to the "TEST" position. Test time will take up to 42 seconds, depending on prior run time, before initiating defrost. (Ranco board will take up to 14 seconds). Remove the jumper quickly when defrost starts, to allow the control to terminate defrost when the sensor opens. If the jumper is left on "TEST", the defrost mode will end in about 7 seconds.



NOTES:

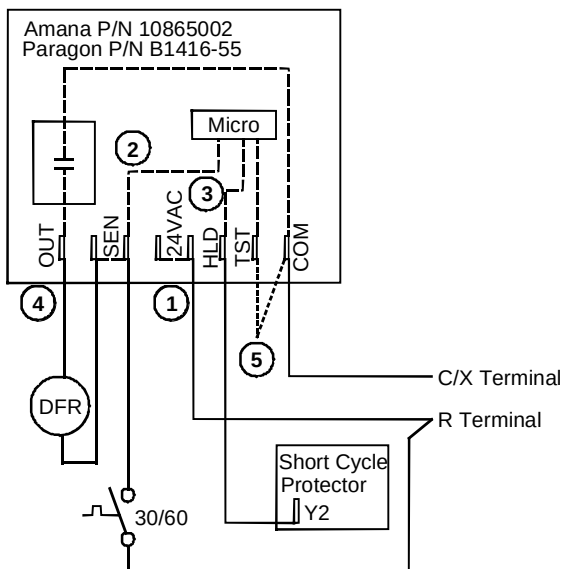
1. The board will ignore the jumper if left in the test position for more than 5 minutes. It will go back to normal timing, using a 90 minute defrost interval. To start over, remove the jumper and cycle 24VAC power off for 1 minute. (Ranco board remove and replace the jumper to start over)
2. The board will ignore the test speed up mode if powered up with the jumper in the "TEST" position.
3. If the jumper is missing from the board, the control will default to a 90 minute defrost interval.
4. The "TEST" position of the jumper may be used to speed up the short cycle lockout time.
5. The (FAN) terminals are the only high voltage terminals on the board.

ADAPTIVE DEFROST CONTROL (RHD/RHE mdl's)

1. Jumper defrost control (30/60) by placing jumper wire from (R) wire of low voltage terminal board, to (SEN) terminal of defrost timer board.
2. Using a VOM, measure voltage between (SEN) terminal and (COM) terminal of defrost timer board - should read 24 VAC.
3. Connect VOM between (SEN) terminal and (OUT) terminal - should read 0 VAC. If it reads 24 VAC, board may be in defrost mode.

SERVICING

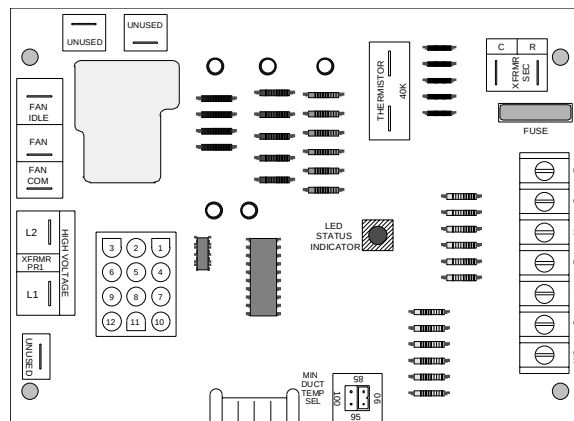
- With VOM still connected, and the unit in operation, short or jumper two TST terminals on board. (Test Terminals Jumpered - Count time speeds up - 90 minutes = approximately 21 seconds).
- Watch VOM - should read 24 VAC at end of frost build interval, - then read 0 VAC at end of defrost interval (about 2 to 3 seconds after first reading).



S-25 TESTING DEFROST CONTROL (30°/60°)

- Install a thermocouple type temperature test lead on the tube adjacent to the defrost control. Insulate the lead point of contact.
- Check the temperature at which the control closes its contacts (30°F. $\pm$ 5°F.)
- Raise the temperature of the control until opens (60°F. $\pm$ 5°F.)
- If not as above, replace control.

S-40 BBA/BBC CONTROL BOARD OPERATION



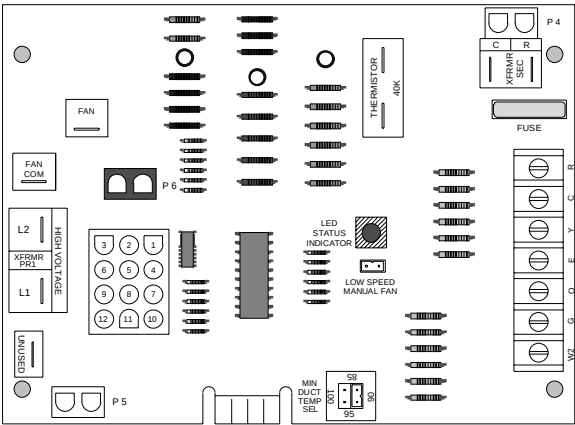
BBA Control Board 11074205

The BBA control board contains a relay that is operated based on inputs from the room thermostat and thermistor. The relay and therefore the blower is controlled per the following table.

Input	Control Board Action
"G" on	Relay energized instantly
"G" off	Relay de-energized instantly
"Y" on	Relay energized instantly
"Y" off while "O" has been on	Relay de-energized after supply air rises above 65°F or 45 seconds, whichever is shorter.
"Y" off no "O"	Relay de-energizes after supply air rises above 85°F or 45 seconds, whichever is shorter.
Thermistor Error	Relay energized until thermistor operation is restored. Blower runs continuously.
Supply Air > 170°	Relay energized until supply air is < 85°F.
"W2" or "E" on	Relay energized instantly
"W2" or "E" off	Relay de-energized instantly

SERVICING

The BBC control board works in conjunction with the BBC interface board to control the blower motor and heaters based on inputs from the room thermostat and thermistor.



Both the BBA and BBC control boards have an LED for indicating operating status. The following table shows the codes that may be displayed by the LED.

MODE	LED SIGNAL	
	ON TIME	OFF TIME
Normal Operation	1/2 second	1/2 second
Thermistor and/or Board Error	2 Flashes	3 seconds
Thermistor Error	4 Flashes	3 seconds
System Error	6 Flashes	3 seconds
Control Board Malfunction	Continuous	None

If the LED indicates a continuous **1/2 second on, 1/2 second off flash code**, then the control is in a normal operating mode and no adjustments need be made.

If the LED indicates **2 flashes** (thermistor and/or board error) then the thermistor connections should be verified first. At 70°F the resistance of the thermistor should be 40 KW (as temperature increases, resistance decreases). The resistance should be checked between the terminations of the thermistor leads at the control board, making sure that the terminals are securely attached insuring a good connection. If the resistance is out of range false signals will be sent to the control board, thus causing improper operation of the unit. In that case, the thermistor must be replaced. If, however, the resistance is correct, then the control board has malfunctioned and must be replaced.

If the LED indicates **4 flashes** (thermistor error) then the resistance should be checked between the terminations of the thermistor leads at the control board, making sure that the terminals are securely attached insuring a good connection. Failures such as opens, shorts across the device, shorts to ground, shorts to power and leakage path to ground shall be sensed. The thermistor (or wire(s)) should be replaced for proper operation.

If the LED indicates **6 flashes** (system error) then the setup and configuration of the system should be checked. This error mode could indicate an abnormal operating condition such as a restricted inlet, blocked outlet, or possibly a leak in the unit or ductwork. The system should be checked for such a condition.

If the LED is in a **continuous on** mode (control board malfunction), then all field and factory connections should be checked. If the error mode still occurs after a power reset, then the control board should be replaced.

NOTE: After an error mode occurs, the system requires a power reset for normal operation after the problem has been corrected.

The control board is programmed with a certain range of acceptable values from the thermistor, depending on the mode of operation. The control board “knows” the mode of operation based on the thermostat inputs, and thus “knows” the acceptable range of resistance readings from the thermistor.

Temp °F	Thermistor Res. Φ	Temp °F	Thermistor Res. Φ
50	79600	90	29610
65	54720	95	26130
75	41800	100	23100
80	36660	105	20470
85	33640	120	14970

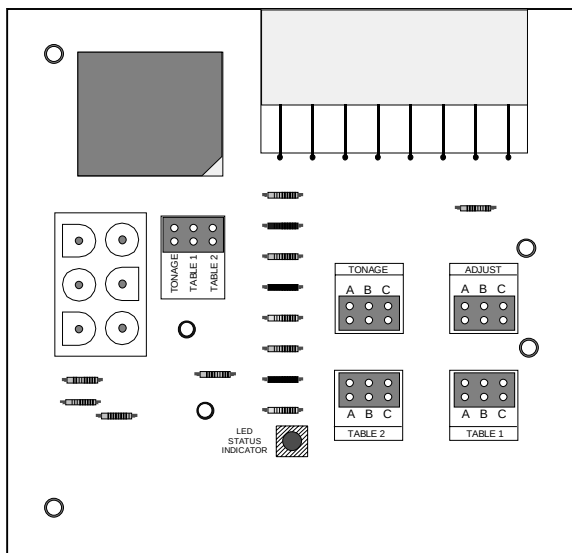
Thermistor Resistance Table

Also included on the BBC model control boards is a two-pin header that allows for either 50% or 100% of nominal airflow during fan only mode. The board is shipped with the connection for 50% airflow during fan only mode.

S-41 BBC INTERFACE BOARD OPERATION

The BBC*A2A model blowers have an interface board incorporated into the control circuitry. This board serves as a selector for the various tonnage selections available (see unit wiring diagram). The unit wiring diagram indicates the appropriate pin-positioning for each available tonnage selection. The board also contains an “adjust” tap, which allows for a $\pm 15\%$ variation in airflow. This feature allows for an increase / decrease of the airflow over the entire operating range. See the tables in the "Airflow" section for the available airflow ranges.

SERVICING



BBC Interface Board 11106901

There is a LED included on the interface board on the BBC models, in addition to the one found on the main control. The LED serves to indicate the airflow that the motor is supposed to be delivering, depending upon the positioning of the pin selectors on the interface board. The number of blinks multiplied by 100 yields the programmed CFM. The indicated CFM may vary, depending on the mode of operation and the signals being sent to the control board at the time. The variable speed motor is controlled via a PWM (Pulse Width Modulated) signal from the control board. Nominal CFM is at an 80% PWM output.

S-60 ELECTRIC HEATER (OPTIONAL ITEM)

Optional electric heaters may be added, in the quantities shown in the specifications section to provide electric resistance heating. Under no condition shall more heaters than the quantity shown be installed.

The low voltage circuit in the air handler is factory wired and terminates at the location provided for the electric heater(s). A minimum of field wiring is required to complete the installation.

Other components such as a Heating/Cooling Thermostat and Outdoor Thermostats are available to complete the installation.

The system CFM can be determined by measuring the static pressure external to the unit. The installation manual supplied with the blower coil, or the blower performance table in the service manual shows the CFM for the static measured.

Alternately, the system CFM can be determined by operating the electric heaters and indoor blower **WITHOUT** having the compressor in operation. Measure the temperature rise as close to the blower inlet and outlet as possible.

If other than a 240V power supply is used, refer to the **BTUH**

CAPACITY CORRECTION FACTOR chart below.

BTUH CAPACITY CORRECTION FACTOR				
SUPPLY VOLTAGE	250	230	220	208
MULTIPLICATION FACTOR	1.08	.92	.84	.75

EXAMPLE: Five (5) heaters provide 24.0 KW at the rated 240V. Our actual measured voltage is 220V, and our measured temperature rise is 42°F. Find the actual CFM:

Answer: 24.0KW, 42°F Rise, 240 V = 1800 CFM from the **TEMPERATURE RISE** chart on the right.

Heating output at 220 V = 24.0KW x 3.413 x .84 = 68.8 MBh.

Actual CFM = 1800 x .84 Corr. Factor = 1400 CFM.

NOTE: The temperature rise table is for sea level installations. The temperature rise at a particular KW and CFM will be greater at high altitudes, while the external static pressure at a particular CFM will be less.

TEMPERATURE RISE (F°) @ 240V							
CFM	4.8 KW	7.2 KW	9.6 KW	14.4 KW	19.2 KW	24.0 KW	28.8 KW
600	25	38	51	-	-	-	-
700	22	33	43	-	-	-	-
800	19	29	38	57	-	-	-
900	17	26	34	51	-	-	-
1000	15	23	30	46	-	-	-
1100	14	21	27	41	55	-	-
1200	13	19	25	38	50	-	-
1300	12	18	23	35	46	-	-
1400	11	16	22	32	43	54	65
1500	10	15	20	30	40	50	60
1600	9	14	19	28	38	47	57
1700	9	14	18	27	36	44	53
1800	8	13	17	25	34	42	50
1900	8	12	16	24	32	40	48
2000	8	12	15	23	30	38	45
2100	7	11	14	22	29	36	43
2200	7	11	14	21	27	34	41
2300	7	10	13	20	26	33	39

ELECTRIC HEATER CAPACITY BTUH							
HTR KW	4.8 KW	7.2 KW	9.6 KW	14.4 KW	19.2 KW	24.0 KW	28.8 KW
BTUH	1638	2491	3276	4915	6553	8191	9829

SERVICING

FORMULAS:

Heating Output = KW x 3413 x Corr. Factor

Actual CFM = CFM (from table) x Corr. Factor

BTUH = KW x 3413

BTUH = CFM x 1.08 x Temperature Rise (ΔT)

$CFM = \frac{KW \times 3413}{1.08 \times \Delta T}$

$\Delta T = \frac{BTUH}{CFM \times 1.08}$

CHECKING HEATER LIMIT CONTROL(S)

Each individual heater element is protected with a limit control device connected in series with each element to prevent overheating of components in case of low airflow. This limit control will open its circuit at approximately 150°F.



Disconnect Electrical Power Supply:

1. Remove the wiring from the control terminals.
2. Using an ohmmeter test for continuity across the normally closed contacts. No reading indicates the control is open - replace if necessary.

IF FOUND OPEN - REPLACE - DO NOT WIRE AROUND.

S-61 CHECKING HEATER FUSE LINK (OPTIONAL ELECTRIC HEATERS)

Each individual heater element is protected with a one time fuse link which is connected in series with the element. The fuse link will open at approximately 333°.



Disconnect Electrical Power Supply:

1. Remove heater element assembly so as to expose fuse link.
2. Using an ohmmeter, test across the fuse link for continuity - no reading indicates the link is open. Replace as necessary.

NOTE: The link is designed to open at approximately 333°F. DO NOT WIRE AROUND - determine reason for failure.

S-62 CHECKING HEATER ELEMENTS

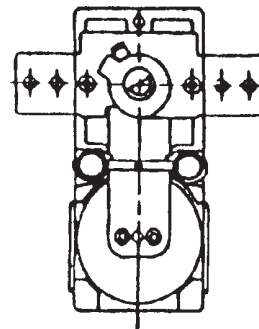


Disconnect Electrical Power Supply:

1. Disassemble and remove the heating element.
2. Visually inspect the heater assembly for any breaks in the wire or broken insulators.
3. Using an ohmmeter, test the element for continuity - no reading indicates the element is open. Replace as necessary.

S-63 AMBIENT TEMPERATURE CONTROL (OPTIONAL ITEM)

ATK05 or ODTK02 This kit includes an ambient thermostat and mounting bracket. It can be installed on the control boxes of all Amana remote heat pumps to prevent the operation on the electric heaters when the ambient temperature is above the control set point. This kit is also used to control change over temperatures in FFK02 and 03A and is included in the FFK02 and 03 kits.



AMBIENT TEMPERATURE CONTROL



Disconnect Electrical Power Supply:

1. Remove field connected low voltage wires from control terminals.
2. In ambient temperature below 60°F., set the knob to correspond with the actual temperature of the control.
3. Using an ohmmeter, test for continuity between the control terminals. Should not test continuous. The control is designed to open at this point with a manual differential of approximately 4°F.
4. In ambient temperature above 60°F., it will be necessary to chill the control.

S-64 LAC__A, LOW AMBIENT CONTROL (OPTIONAL ITEM)

The LAC kits are used to provide cooling operation down to **outdoor ambients as low as 35°F.** . As shipped, Amana remote cooling and heatpump units are suitable for cooling operation at outdoor temperatures of 50°F and above. With the addition of the Low Ambient Control, these units will be suitable for operation at **outdoor ambients as low as 35°F.**

SERVICING

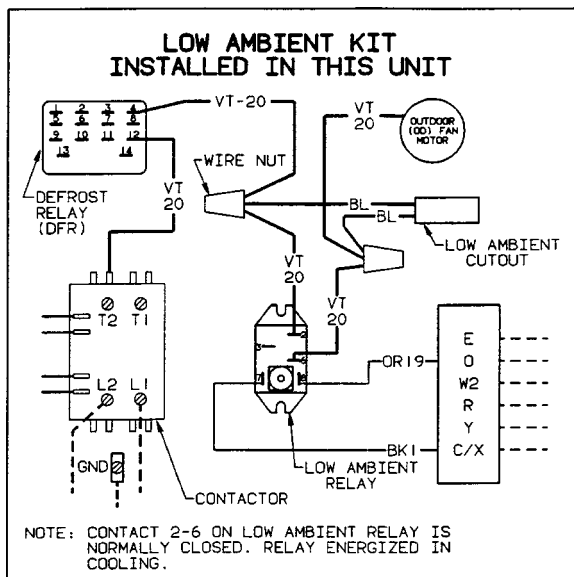
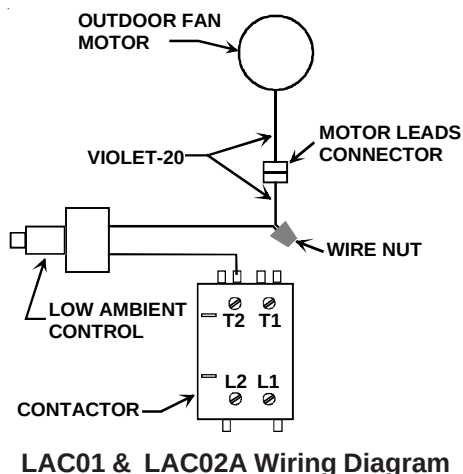
The LAC01A kit is for use with any Amana RCB, RCC, or RCE three phase remote cooling unit which is installed with an indoor coil that includes a thermal expansion valve.

The LAC02A kit is for use with any Amana RCB, RCC, or RCE single phase remote cooling unit which is installed with an indoor coil that includes a thermal expansion valve.

The LAC03A kit is for use with any Amana RHA, RHD, RHE, or single phase heat pump unit which is installed with an indoor coil that includes a thermal expansion valve.

If this kit is installed in a system with an indoor coil that does not include a thermal expansion valve, compressor damage could occur resulting in loss of warranty coverage.

This control operates by stopping the outdoor fan when the high side pressure becomes too low. The outdoor fan will automatically restart when the high side pressure rises.



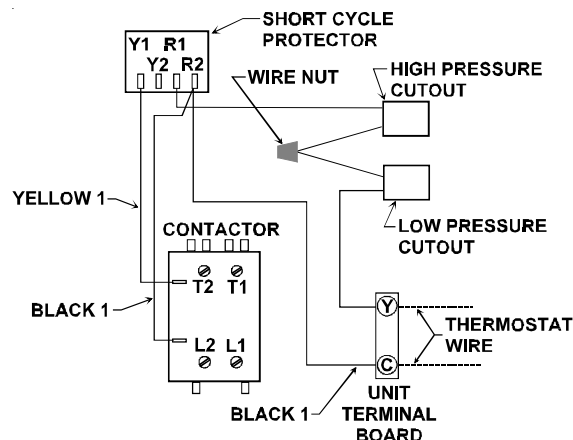
S-65 PCK__A, PRESSURE CONTROL KIT & ASC__A, ANTI SHORT CYCLE KIT (OPTIONAL ITEM)

These kits are for use with Amana remote cooling and heat pump units that do not have high or low pressure cutouts or factory-installed short cycle protector. The PCK01A is for use on cooling only units, and the PCK02A kit is for use on remote heat pumps.

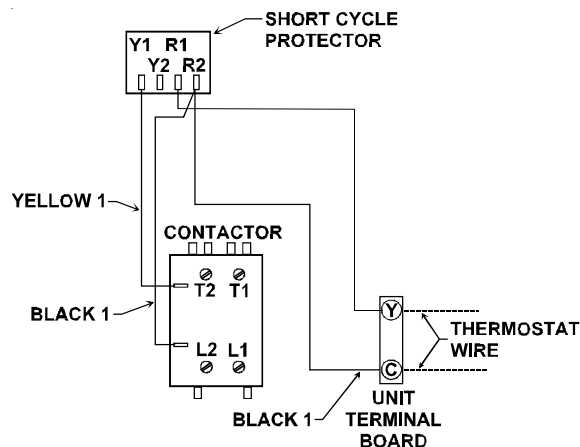
PCK kits include a high pressure cutout, low pressure cutout, and a short cycle protector. It also includes tees for mounting the pressure cutouts on the outdoor unit service valves. The tees allow a gauge manifold to be attached when servicing is necessary.

Both the high and low pressure cutouts reset automatically. All wiring to the pressure cutouts and the short cycle protector is 24 volt.

The pressure cutouts will be installed outside the unit casing. They are weatherproof but not tamperproof. Tampering with the pressure cutouts could cause a refrigerant leak and possible equipment damage. If possible, discuss this with the building owner before installing these controls.



ASC kits contain a short-cycle protector for use on units with reciprocating compressors (most units with scroll compressors have anti-short cycle protectors installed at the factory).



SERVICING

S-66 FFK02A & FFK03A, FOSSIL FUEL KITS (OPTIONAL ITEM)

The fossil fuel kit controls are designed for use with Amana remote Heat Pumps in conjunction with oil, electric or gas furnaces. FFK02A's are for use with RHA/RHDA2B models. FFK03A are for use with all RHA, RHD, & RHE models. The controls in the kit, when correctly installed and electrically connected, should operate to minimize the annual heating cost by operating the most economical heating system (heat pump or the fossil fuel furnace). The FFK02A kit cannot be used on RHA--B2A units, the FFK03A kit must be used.

The kit consists of a control board and outdoor thermostat. The function of the outdoor thermostat is to permit on the job site setting of the economic break-even outdoor temperature based on current fossil fuel and electric rates. For the system to operate properly, a two-stage heating and one-stage cooling thermostat is required (not part of this kit) for single stage furnaces. A three-stage heating and one-stage cooling room thermostat is also required (not a part of this kit) for two-stage furnaces

S-100 REFRIGERATION REPAIR PRACTICE



ALWAYS REMOVE THE REFRIGERANT CHARGE IN A PROPER MANNER BEFORE APPLYING HEAT TO THE SYSTEM.

When repairing the refrigeration system:



Disconnect Electrical Power Supply:

1. Never open a system that is under vacuum. Air and moisture will be drawn in.
2. Plug or cap all openings.
3. Remove all burrs and clean the brazing surfaces of the tubing with sand cloth or paper. Brazing materials do not flow well on oxidized or oily surfaces.
4. Clean the inside of all new tubing to remove oils and pipe chips.
5. When brazing, sweep the tubing with dry nitrogen to prevent the formation of oxides on the inside surfaces.
6. Complete any repair by replacing the liquid line drier in the system, evacuate and charge.

BRAZING MATERIALS

Copper to Copper Joints - Sil-Fos used without flux (alloy of 15% silver, 80% copper, and 5% phosphorous). Recommended heat 1400°F.

Copper to Steel Joints - Silver Solder used without a flux (alloy of 30% silver, 38% copper, 32% zinc). Recommended heat - 1200°F.

S-101 LEAK TESTING

Refrigerant leaks are best detected with a halide or electronic leak detector.

However, on outdoor installed systems, provisions must be made to shield the copper element of an halide torch from the sun and wind conditions in order to be able to see the element properly.

NOTE: The flame of the halide detector will glow green in the presence of R-22 refrigerant.

For a system that contains a refrigerant charge and is suspected of having a leak, stop the operation and hold the exploring tube of the detector as close to the tube as possible, check all piping and fittings. If a leak is detected, do not attempt to apply more brazing to the joint. Remove and capture the charge, unbrazed the joint, clean and rebrazed.

For a system that has been newly repaired and does not contain a charge, connect a cylinder of refrigerant through a gauge manifold to the liquid and suction line dill valves and/or liquid line dill valve and compressor process tube.

NOTE: Refrigerant hoses must be equipped with dill valve depressors or special adaptors must be used. Open the valve on the cylinder and manifold and allow the pressure to build up within the system. Check for and handle leaks, as described above. After the test has been completed, remove and capture the leak test refrigerant.

S-102 EVACUATION

This is the most important part of the entire service procedure. The life and efficiency of the equipment is dependent upon the thoroughness exercised by the serviceman when evacuating air (non-condensables) and moisture from the system.

Air in a system causes high condensing temperature and pressure resulting in increased power input and reduced performance.

Moisture chemically reacts with the refrigerant and oil to form corrosive hydrofluoric and hydrochloric acids. These attack motor windings and parts, causing breakdown.

The equipment required to thoroughly evacuate the system is a high vacuum pump, capable of producing a vacuum equivalent to 25 microns absolute and a thermocouple vacuum gauge to give a true reading of the vacuum in the system

NOTE: Never use the system compressor as a vacuum pump or run when under a high vacuum. Motor damage could occur.

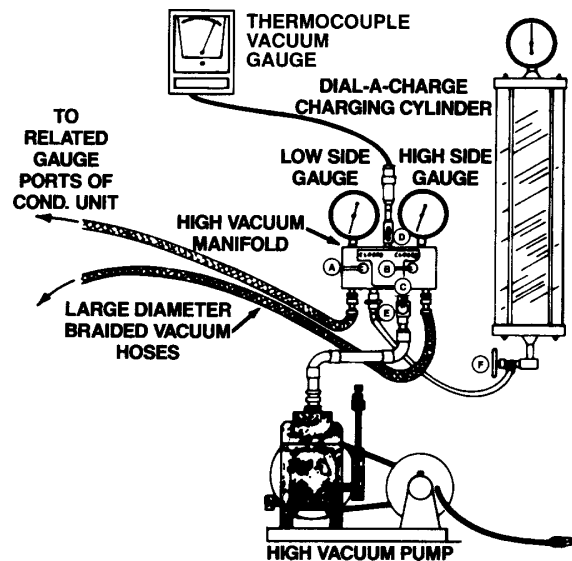
SERVICING

SCROLL COMPRESSORS



DO NOT FRONT SEAT THE SERVICE VALVE(S) WITH THE COMPRESSOR OPERATING IN AN ATTEMPT TO SAVE REFRIGERANT. WITH THE SUCTION LINE OF THE COMPRESSOR CLOSED OR SEVERELY RESTRICTED, THE SCROLL COMPRESSOR CAN AND WILL DRAW A DEEP VACUUM VERY QUICKLY. THIS VACUUM CAN CAUSE INTERNAL ARCING OF THE FUSITE RESULTING IN A DAMAGED OR FAILED COMPRESSOR.

1. Connect the vacuum pump, vacuum tight manifold set with high vacuum hoses, thermocouple vacuum gauge and charging cylinder as shown.
2. If the service dill valves are to be used for evacuation, it is recommended that a core remover be used to lift the core for greater efficiency. Later production "A" models and all subsequent models have an access port on the compressor process tube for suction processing in both heating and cooling modes.
3. Start the vacuum pump and open the shut off valve to the high vacuum gauge manifold only. After the compound gauge (low side) has dropped to approximately 29 inches of vacuum, open the valve to the vacuum thermocouple gauge. See that the vacuum pump will blank-off to a maximum of 25 microns. A high vacuum pump can only produce a good vacuum if its oil is non-contaminated.
4. If the vacuum pump is working properly, close the valve to the vacuum thermocouple gauge and open the high and low side valves to the high vacuum manifold set. With the valve on the charging cylinder closed, open the manifold valve to the cylinder.
5. Evacuate the system to at least 29 inches gauge before opening valve to thermocouple vacuum gauge.
6. Continue to evacuate to a maximum of 250 microns. Close valve to vacuum pump and watch rate of rise. If vacuum does not rise above 1500 microns in three to five minutes, system can be considered properly evacuated.
7. If thermocouple vacuum gauge continues to rise and levels off at about 5000 microns, moisture and non-condensables are still prevent. If gauge continues to rise a leak is present. Repair and re-evacuate.
8. Close valve to thermocouple vacuum gauge and vacuum pump. Shut off pump and prepare to charge.



EVACUATION

S-103 CHARGING

Charge the system with the exact amount of refrigerant.

Refer to the specification section or check the unit nameplates for the correct refrigerant charge.

An inaccurately charged system will cause future problems.

1. When using an ambient compensated calibrated charging cylinder, allow liquid refrigerant only to enter the high side.
2. After the system will take all it will take, close the valve on the high side of the charging manifold.
3. Start the system and charge the balance of the refrigerant through the low side. DO NOT charge in a liquid form.
4. With the system still running, close the valve on the charging cylinder. At this time, you may still have some liquid refrigerant in the charging cylinder hose and will definitely have liquid in the liquid hose. Reseat the liquid line core. Slowly open the high side manifold valve and transfer the liquid refrigerant from the liquid line hose and charging cylinder hose into the suction service valve port. CAREFUL: Watch so that liquid refrigerant does not enter the compressor.
5. With the system still running, reseal the suction valve core, remove hose and reinstall both valve core caps.
6. Check system for leaks.

NOTE: This charging procedure can only be done in the cooling mode of operation. (Early production "a" models only) all models with compressor process tube access valve can be processed in heating cycle if this valve is used.

SERVICING

When charging a remote condensing unit with a non-matching evaporator coil, or a system where the charge quantity is unknown, alternate charging methods must be used. These systems must be charged according to subcooling or superheat.

Coils having capillary tubes or flow control restrictors should be charged to match the Desired Superheat vs. Outdoor Temperature Chart in this section. Coils with thermostatic expansion valves (TEV's) should be charged by subcooling. See "Checking Subcooling and Superheat" sections in this manual.

Due to their design Scroll compressors are inherently more tolerant of liquid refrigerant.

NOTE: Even though the compressor section of a Scroll compressor is more tolerant of liquid refrigerant, continued floodback or flooded start conditions may wash oil from the bearing surfaces causing premature bearing failure.

If a restriction is located, replace the restricted part, replace drier, evacuate and recharge.

S-104 CHECKING COMPRESSOR EFFICIENCY

The reason for compressor inefficiency is broken or damaged suction and/or discharge valves, or scroll flanks on Scroll compressors, reducing the ability of the compressor to pump refrigerant vapor.

The condition of the valves or scroll flanks is checked in the following manner.

1. Attach gauges to the high and low side of the system.

2. Start the system and run a "Cooling Performance Test.

If the test shows:

- a. Below normal high side pressure.
- b. Above normal low side pressure.
- c. Low temperature difference across coil.
- d. Low amp draw at compressor.

and the charge is correct. The compressor is faulty - replace the compressor. **NOTE:** THIS TEST CANNOT BE DONE IN THE HEATING MODE

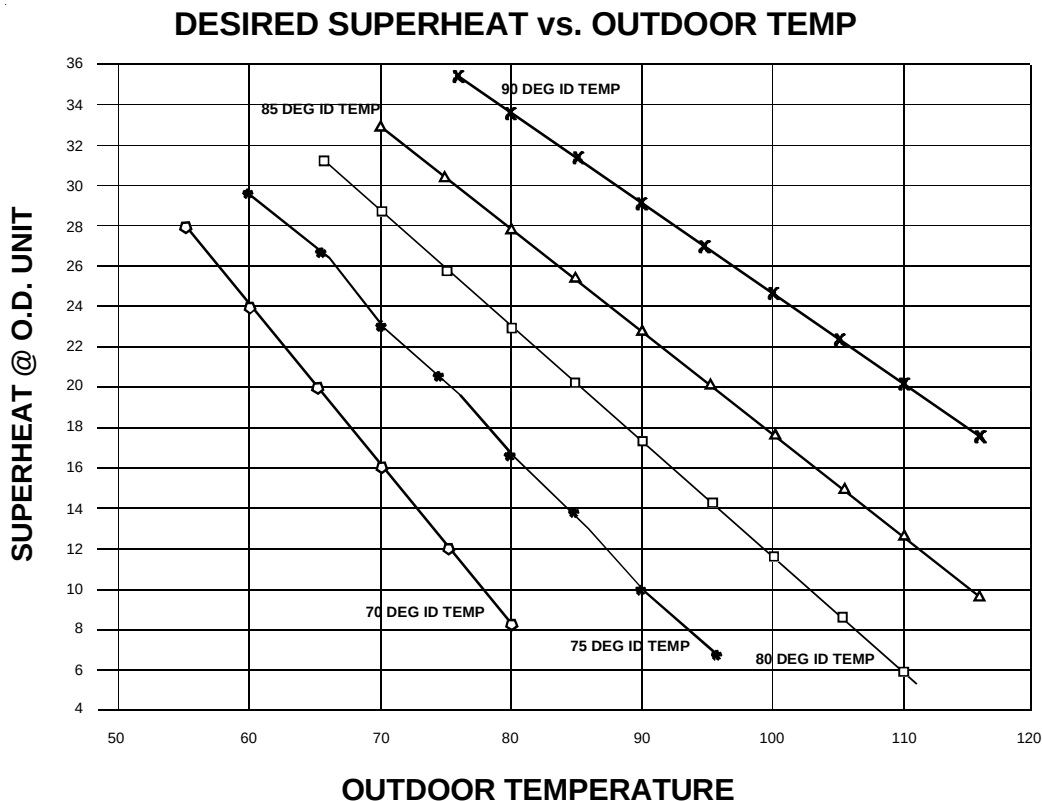
Verification of proper rotation of Scroll Compressors is made as follows.

NOTE: The compressor may run backwards (noisy operation) for 1 or 2 seconds at shutdown. This is normal and does not harm the compressor.

1. Install gauges and verify that the suction pressure drops while the discharge pressure increases.
2. Listen for normal compressor sound levels. Reverse rotation results in elevated or unusual sound levels.
3. Reverse rotation will result in substantially reduced amp draw from tabulated values.

To correct improper rotation, switch any two power supply leads at the outdoor unit contactor.

The 3 phase Scroll Compressors are direction of rotation sensitive. They will rotate in either direction depending on the phasing of the power. There is no negative impact on durability caused by operating 3 phase compressors in reversed rotation. The compressors internal protector will trip, de-energizing the compressor.

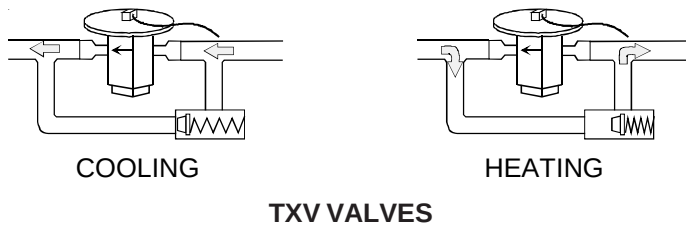


SERVICING

S-105 THERMOSTATIC EXPANSION VALVE

The expansion valve is designed to control the rate of liquid refrigerant flow into an evaporator coil in exact proportion to the rate of evaporation of the refrigerant in the coil. The amount of refrigerant entering the coil is regulated since the valve responds to temperature of the refrigerant gas leaving the coil (feeler bulb contact) and the pressure of the refrigerant in the coil. This regulation of the flow prevents the return of liquid refrigerant to the compressor.

The illustration below shows typical heatpump TXV/check valve operation in the heating and cooling modes.



Some TXV valves contain an internal check valve thus eliminating the need for an external check valve and bypass loop. The three forces which govern the operation of the valve are: (1) the pressure created in the power assembly by the feeler bulb, (2) evaporator pressure, and (3) the equivalent pressure of the superheat spring in the valve.

0% bleed type expansion valves are used on indoor and outdoor coils. The 0% bleed valve will not allow the system pressures (High and Low side) to equalize during the shut down period. The valve will shut off completely at approximately 100 PSIG.

30% bleed valves used on some previous models will continue to allow some equalization even though the valve has shut-off completely because of the bleed holes within the valve. This type of valve should not be used as a replacement for a 0% bleed valve, due to the resulting drop in performance.

The bulb must be securely fastened with two straps to a clean straight section of the suction line. Application of the bulb to a horizontal run of line is preferred. If a vertical installation cannot be avoided, the bulb must be mounted so that the capillary tubing comes out at the top.

All single phase reciprocating compressors must use a hard start kit when matched with a expansion valve indoor coil .

THE VALVES PROVIDED BY AMANA ARE DESIGNED TO MEET THE SPECIFICATION REQUIREMENTS FOR OPTIMUM PRODUCT OPERATION. **DO NOT USE SUBSTITUTES.**

S-106 OVERFEEDING

Overfeeding by the expansion valve results in high suction pressure, cold suction line, and possible liquid slugging of the compressor.

If these symptoms are observed:

1. Check for an overcharged unit by referring to the cooling performance charts in the servicing section.
2. Check the operation of the power element in the valve as explained in S-26 Checking Expansion Valve Operation.
3. Check for restricted or plugged equalizer tube.

S-107 UNDERFEEDING

Underfeeding by the expansion valve results in low system capacity and low suction pressures.

If these symptoms are observed:

1. Check for a restricted liquid line or drier. A restriction will be indicated by a temperature drop across the drier.
2. Check the operation of the power element of the valve as described in S-26 Checking Expansion Valve Operation.

S-108 SUPERHEAT

The expansion valves are factory adjusted to maintain 12 to 18 degrees superheat of the suction gas. Before checking the superheat or replacing the valve, perform all the procedures outlined under Air Flow, Refrigerant Charge, Expansion Valve - Overfeeding, Underfeeding. These are the most common causes for evaporator malfunction.

CHECKING SUPERHEAT

Refrigerant gas is considered superheated when its temperature is higher than the saturation temperature corresponding to its pressure. The degree of superheat equals the degrees of temperature increase above the saturation temperature at existing pressure. See Temperature - Pressure Chart (next page).

1. Attach an accurate thermometer or preferably a thermocouple type temperature tester to the suction line at a point at least 6" from the compressor.
2. Install a low side pressure gauge on the suction line service valve at the outdoor unit.
3. Record the gauge pressure and the temperature of the line.
4. Convert the suction pressure gauge reading to temperature by finding the gauge reading in Temperature - Pressure Chart and reading to the left, find the temperature in the °F. Column.
5. The difference between the thermometer reading and pressure to temperature conversion is the amount of superheat.

SERVICING

EXAMPLE:

- Suction Pressure = 84
- Corresponding Temp. °F. = 50
- Thermometer on Suction Line = 63°F.

To obtain the degrees temperature of superheat subtract 50.0 from 63.0°F.

Temp. °F.	Gauge Pressure (PSIG) Freon-22	Temp. °F.	Gauge Pressure (PSIG) Freon-22
-40	0.61	60	102.5
-38	1.42	62	106.3
-36	2.27	64	110.2
-34	3.15	65	114.2
-32	4.07	68	118.3
-30	5.02	70	122.5
-28	6.01	72	126.8
-26	7.03	74	131.2
-24	8.09	76	135.7
-22	9.18	78	140.5
-20	10.31	80	145.0
-18	11.48	82	149.5
-16	12.61	84	154.7
-14	13.94	86	159.8
-12	15.24	88	164.9
-10	16.59	90	170.1
-8	17.99	92	175.4
-6	19.44	94	180.9
-4	20.94	96	186.5
-2	22.49	96	192.1
0	24.09	100	197.9
2	25.73	102	203.8
4	27.44	104	209.9
6	29.21	106	216.0
8	31.04	108	222.3
10	32.93	110	228.7
12	34.88	112	235.2
14	36.89	114	241.9
16	38.96	116	248.7
18	41.09	118	255.6
20	43.28	120	262.6
22	45.53	122	269.7
24	47.85	124	276.9
26	50.24	126	284.1
28	52.70	128	291.4
30	55.23	130	298.8
32	57.83	132	306.3
34	60.51	134	314.0
36	63.27	136	321.9
38	66.11	136	329.9
40	69.02	140	338.0
42	71.99	142	346.3
44	75.04	144	355.0
46	78.18	146	364.3
48	81.40	158	374.1
50	84.70	150	384.3
52	88.10	152	392.3
54	91.5	154	401.3
56	95.1	156	411.3
58	98.8	158	421.8
		160	433.3

The difference is 13° Superheat. The 13° Superheat would fall in the ± range of allowable superheat.

SUPERHEAT ADJUSTMENT

The expansion valves used on Amana coils are factory set and are not field adjustable. If the superheat setting becomes disturbed, replace the valve.

On systems using capillary tubes or flow control restrictors, superheat is adjusted in accordance with the "DESIRED SUPERHEAT vs. OUTDOOR TEMP" chart as explained in section S-103 CHARGING

S-109 CHECKING SUBCOOLING

Refrigerant liquid is considered subcooled when its temperature is lower than the saturation temperature corresponding to its pressure. The degree of subcooling equals the degrees of temperature decrease below the saturation temperature at the existing pressure.

- Attach an accurate thermometer or preferably a thermocouple type temperature tester to the liquid line as it leaves the condensing unit.
- Install a high side pressure gauge on the high side (liquid) service valve at the front of the unit.
- Record the gauge pressure and the temperature of the line.
- Convert the liquid line pressure gauge reading to temperature by finding the gauge reading in Temperature - Pressure Chart and reading to the left, find the temperature in the °F. Column.
- The difference between the thermometer reading and pressure to temperature conversion is the amount of subcooling.

EXAMPLE:

- Liquid Line Pressure = 260
- Corresponding Temp. °F. = 120°
- Thermometer on Liquid line = 109°F.

To obtain the amount of subcooling subtract 109°F from 120°F.

The difference is 11° subcooling. The normal subcooling range is 9° - 13° subcooling for heat pumps units.

S-110 CHECKING EXPANSION VALVE OPERATION

- Remove the remote bulb of the expansion valve from the suction line.
- Start the system and cool the bulb in a container of ice water, closing the valve. As you cool the bulb the suction pressure should fall and the suction temperature will rise.
- Next warm the bulb in your hand. As you warm the bulb the suction pressure should rise and the suction temperature will fall.

SERVICING

4. If a temperature or pressure change is noticed, the expansion valve is operating. If no change is noticed, the valve is restricted, the power element is faulty, or the equalizer tube is plugged.
5. Capture the charge, replace the valve and drier, evacuate and recharge.

S-111 CAPILLARY TUBES/RESTRICTOR ORIFICES

The capillary tubes/restrictor orifices used in conjunction with the indoor and outdoor coil, are a predetermined length and bore (I.D.).

They are designed to control the rate of liquid refrigerant flow into an evaporator coil.

The amount of refrigerant that flows through the capillary tube/restrictor orifice is regulated by the pressure difference between the high and low sides of the system.

In the cooling cycle when the outdoor air temperature rises, the high side condensing pressure rises. At the same time, the cooling load on the indoor coil increases, causing the low side pressure to rise, but at a slower rate.

Since the high side pressure rises faster when the temperature increases, more refrigerant flows to the evaporator, increasing the cooling capacity of the system.

When the outdoor temperature falls, the reverse takes place. The condensing pressure falls, and the cooling loads on the indoor coil decrease, causing less refrigerant flow.

A strainer is placed on the entering side of the tubes to prevent any foreign material from becoming lodged inside the capillary tubes.

If a restriction should become evident, proceed as follows:

1. Capture the refrigerant charge.
2. Remove the capillary tubes/restrictor orifice or tube strainer assembly. and replace.
3. Replace liquid line drier, evacuate and recharge.

Capillary Tubes/Orifice Assembly



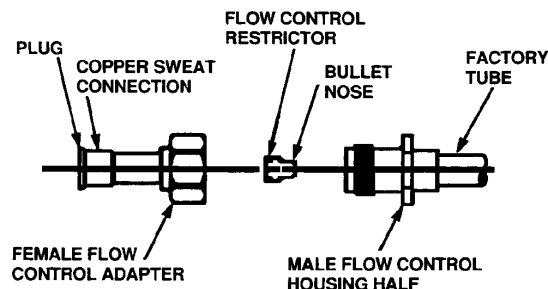
CHECKING EQUALIZATION TIME

During the "OFF" cycle, the high side pressure bleeds to the low side through the capillary tubes/restrictor orifices. Check equalization time as follows:

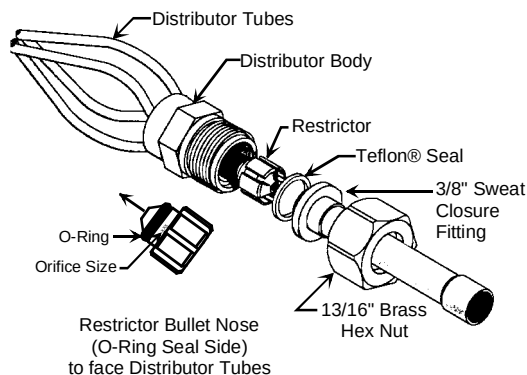
1. Attach a gauge manifold to the suction and liquid line dill valves.
2. Start the system and allow the pressures to stabilize.
3. Stop the system and check the time it takes for the high and low pressure gauge readings to equalize.

If it takes more than seven (7) minutes the capillary tubes/restrictor orifices are inoperative. Replace, install a liquid line drier, evacuate and recharge.

AeroQuip Flow Control Assembly



Chatleff Flow Control Assembly



S-113 CHECKING RESTRICTED LIQUID LINE

When the system is operating, the liquid line is warm to the touch. If the liquid line is restricted, a definite temperature drop will be noticed at the point of restriction. In severe cases, frost will form at the restriction and extend down the line in the direction of the flow.

Discharge and suction pressures will be low, giving the appearance of an undercharged unit. However, the unit will have normal to high subcooling.

If a restriction is located, replace the restricted part, replace drier, evacuate and recharge.

S-114 OVERCHARGE OF REFRIGERANT

An overcharge of refrigerant is normally indicated by an excessively high head pressure.

An evaporator coil, using an expansion valve metering device, will basically modulate and control a flooded evaporator and prevent liquid return to the compressor.

An evaporator coil, using a capillary tube metering device, could allow refrigerant to return to the compressor under extreme overcharge conditions. Also with a capillary tube metering device, extreme cases of insufficient indoor air can cause icing of the indoor coil and liquid return to the compressor, but the head pressure would be lower.

SERVICING

There are other causes for high head pressure which may be found in the "Service Problem Analysis Guide."

If other causes check out normal, an overcharge or a system containing non-condensables would be indicated.

If this system is observed:

1. Start the system.
2. Remove and capture small quantities of gas from the suction line dill valve until the head pressure is reduced to normal.
3. Observe the system while running a cooling performance test, if a shortage of refrigerant is indicated, then the system contains non-condensables.

S-115 NON-CONDENSABLES

If non-condensables are suspected shut down the system and allow the pressures to equalize. Wait at least 15 minutes. Compare the pressure to the temperature of the coldest coil sense this is where most of the refrigerant will be. If the pressure indicates a higher temperature than that of the coil temperature, non-condensables are present.

Non-condensables are removed from the system by first removing the refrigerant charge, replacing and/or installing liquid line drier, evacuating and recharging.

S-116 COMPRESSOR BURNOUT

When a compressor burns out, high temperature develops causing the refrigerant, oil and motor insulation to decompose forming acids and sludge.

If a compressor is suspected of being burned-out, attach a refrigerant hose to the liquid line dill valve and properly remove and dispose of the refrigerant.

Now determine if a burn out has actually occurred. Confirm by analyzing an oil sample using a Sporlan Acid Test Kit, AK-3 or its equivalent.

Remove the compressor and obtain an oil sample from the suction stub. If the oil is not acidic, either a burnout has not occurred or the burnout is so mild that a complete clean-up is not necessary.

If acid level is unacceptable, the system must be cleaned by using the clean-up drier method.



DO NOT ALLOW THE SLUDGE OR OIL TO CONTACT THE SKIN, SEVERE BURNS MAY RESULT.

NOTE: The Flushing Method using R-11 refrigerant is no longer approved by Amana Heating-Cooling.

Suction Line Drier Clean-Up Method

Use AMANA part number R0157057 Suction Line Drier Clean-Up Kit (41 cubic inches). This drier should be installed as close to the compressor as possible, either in a vertical or horizontal position. It may be necessary to use new tubing and form as required.

In all applications, the drier inlet must be above the drier outlet to provide proper oil return to the compressor.

NOTE: At least twelve (12) inches of the suction line immediately out of the compressor stub must be discarded due to burned residue and contaminants.

1. Remove compressor discharge line strainer, liquid line strainer and/or dryer and capillary tubes from indoor and outdoor coils.
2. On an expansion valve coil, remove the liquid line drier and expansion valve.
3. Purge all remaining components with dry nitrogen or carbon dioxide until clean.
4. Install new components including liquid liner drier.
5. Install suction line drier.
6. Braze all joints, leak test, evacuate, and recharge system.
7. Start up the unit and record the pressure drop across the clean-up drier.
8. Continue to run the system for a minimum of twelve (12) hours and recheck the pressure drop across the drier. Pressure drop should not exceed 6 - 8 PSIG.
9. Continue to run the system for several days repeatedly checking pressure drop across the suction line drier. If the pressure drop never exceeds the 6 - 8 PSIG, the drier must be adequate and is trapping the contaminants and it is permissible to leave it in the system.
10. If the pressure drop becomes greater, then it must be replaced and steps 5 through 9 repeated until it does not exceed 6 - 8 PSIG.

NOTICE: Regardless, the cause for burnout must be determined and corrected before the new compressor is started.

S-120 REFRIGERANT PIPING

The piping of a refrigeration system is very important in relation to system capacity, proper oil return to compressor, pumping rate of compressor and cooling performance of the evaporator.

The maximum length of tubing to be used with a remote Heat Pump system is 50 feet; this includes a minimum of turns with a maximum permissible rise of 20 feet for the liquid line.

1. All horizontal suction line runs must be pitched towards the compressor (one inch per ten feet). This aids the return of the oil to the compressor.
2. Avoid long running traps in horizontal suction line.

SERVICING

- The liquid line must not be attached to an uninsulated suction line.
- If the liquid line is routed through an area which has an ambient higher than 120°F., then that portion of the liquid line has to be insulated.
- Suction line sizes should allow for sufficient internal line velocity (approximately 1500 FPM) to return oil to the compressor. An oil trap by the indoor coil is necessary to aid in oil return when the outdoor unit is located above the indoor coil.
- In sizing refrigeration piping determine the number of 90° and 45° elbows required and add their equivalent lengths to the length of straight pipe. Find the equivalent length of fittings in the following table:

**EQUIVALENT LENGTH IN FEET
SUCTION LINE ELBOWS**

Fitting Size I.D. Inches Sweat, Copper	3/8	1/2	5/8	3/4	7/8	1-1/8
90° Short Radius	1.2	1.4	1.5	1.7	2.0	2.3
90° Long Radius	0.8	0.9	1.0	1.5	1.7	1.6
45°	0.4	0.5	0.6	0.7	0.8	1.0

EXAMPLE: One 7/8" 90° short radius copper sweat ell is equal to the resistance of two foot of 7/8" O.D. straight pipe.

To obtain the total equivalent length, add length of straight pipe to equivalent length of fittings.

NOTE: The outdoor unit's refrigerant holding charge is for the matched indoor coil plus 25 feet (15 feet for VCA/B units) of liquid line. If the piping run is longer than 25 feet (15 feet for VCA/B units), additional refrigerant may be needed depending on the indoor coil that is used. The following charge correction chart

REFRIGERANT LINES IN EXCESS OF 50 FEET

NOTE: Long line sets apply to straight cooling (AC) only. Heat Pumps are not rated for line sets in excess of 50 feet.

It is always best to keep refrigerant lines to 30 feet or less, however this is not always possible. The following information should be used to size refrigerant lines in excess of 50 feet.

- Sketch the system and determine the number of traps required. Traps are required only if the condensing unit is above the evaporator coil. Traps are only necessary in the suction line.

SUCTION LINE TRAPS CONDENSER UNIT ABOVE EVAPORATOR

VERTICAL LIFT (FEET)	TRAPS REQUIRED
0 - 5	0
6 - 19	1
20 - 39	2
40 - 59	3

The first trap goes at the outlet of the evaporator coil. The remaining traps go halfway up the riser (2 traps total), or 1/3 and 2/3 the way up the riser (3 traps total).

- Estimate the effective length of pipe. Remember, each trap will have a substantial equivalent length. The suction line effective length could therefore be considerably greater than the liquid line effective length.
- Size the suction line per the Suction Line Sizing Chart.

SUCTION LINE SIZING

EFFECTIVE LENGTH	50	75	100	125	150
18	5/8	5/8	3/4	3/4	3/4
24	5/8	3/4	3/4	3/4*	-
30	3/4	7/8	7/8	7/8	7/8
36	3/4	7/8	7/8	7/8*	-
42	7/8	7/8	7/8*	-	-
48	7/8	1 1/8	1 1/8	1 1/8	1 1/8
60	1 1/8	1 1/8	1 1/8	1 1/8	-

*Use size shown for vertical portion of run. Use next size larger for horizontal portion of the run.

- Size the liquid line per the following Liquid Line Sizing charts. If the evaporator coil is above the condensing unit, the chart will show the maximum permissible vertical lift, and liquid line combination for that unit. Be sure to use the proper chart.

LIQUID LINE SIZING CONDENSING UNIT ABOVE EVAPORATOR

EFFECTIVE LENGTH	50	75	100	125	150
18	3/8	3/8	3/8	3/8	3/8
24	3/8	3/8	3/8	3/8	3/8
30	3/8	3/8	3/8	3/8	3/8
36	3/8	3/8	3/8	3/8	3/8
42	3/8	3/8	3/8	3/8	3/8
48	3/8	3/8	3/8	3/8	3/8
60	3/8	3/8	3/8	1/2*	1/2**

* If overall drop is 10 feet or more, the next smaller size may be used.

** If overall drop is 30 feet or more, the next smaller size may be used.

SERVICING

LIQUID LINE SIZING EVAPORATOR ABOVE CONDENSING UNIT MAXIMUM VERTICAL LIFT

EFFECTIVE LENGTH	LINE SIZE	50	75	100	125	150
18	3/8	47	46	45	45	42
24	3/8	45	42	40	40	35
30	3/8	43	40	37	37	30
36	3/8	40	35	30	30	20
42	3/8	37	31	25	25	12
48	3/8	33	25	17	17	0
48	1/2	47	45	43	43	40
60	3/8	25	12	0	0	-
60	1/2	45	45	40	40	35

The previous table is based on a maximum liquid line pressure drop of 25 lbs. Any portions of the liquid line which will pass through a high ambient area must be insulated to prevent loss of subcooling.

- Determine the amount of additional refrigerant the system will require using the Refrigerant Correction Chart and example shown.

REFRIGERANT CORRECTION CHART

Liquid Line Size, O.D.	Oz. Refrig/Ft Liquid Line
1/4	0.20
3/8	0.60
1/2	1.30

EXAMPLE: The liquid line to be used with an RCA48A2A will have a linear length of 65 feet, an effective length of 75 feet, and a vertical lift of 30 feet, with the evaporator above the condensing unit.

The maximum vertical lift for a 4 ton unit with an effective liquid line length of 75 feet is 25 feet of a 3/8" line, or 45 feet for a 1/2" line. Our lift is 30 feet, so a 1/2" liquid line must be used.

Additional refrigerant will be -

$$\begin{aligned}
 &65 \text{ feet of } 1/2" \text{ line} = 1.3 \times 65 \text{ feet} = 85 \text{ oz.} \\
 &- 25 \text{ feet of } 3/8" \text{ line} = 0.6 \times 25 \text{ feet} = \underline{15} \text{ oz.*} \\
 &(*\text{already in condensing unit}) = 70 \text{ oz.}
 \end{aligned}$$

70 oz. charge will need to be added to the system.

- Check the system nameplate. An accumulator must be added to the system if-
 - you are adding more than 15% to the system charge listed on the nameplate,
 - or more than 125 linear feet of liquid line of the size originally on the unit,
 - or any time a non-matching indoor coil is used.

REFRIGERANT LINE SIZING

Known Factors:

- RCC48A2A and CCA48TUA coil. Evaporator above Condenser.
- Liquid Line 65 linear feet w/ 8 short radius elbows, and 30 ft. vertical lift.
- Suction Line 65 linear feet w/ 8 long radius elbows.

Determine Suction and Liquid Line sizes:

Procedures:

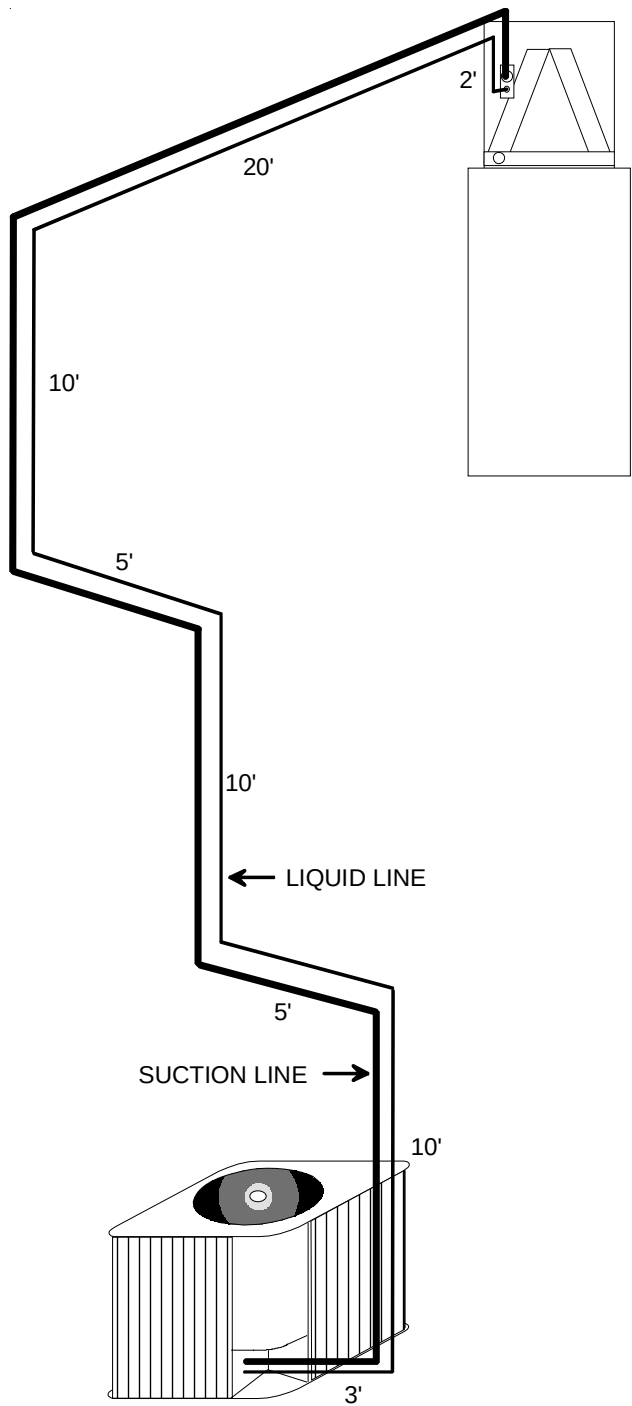
- Measure length of suction line. (65 ft.)
- Count the number of suction line elbows. (8 long radius)
- Calculate the equivalent length of fittings using the Fitting Losses in Equivalent Feet Chart. (Calculate using the recommended suction line size for each unit, and long radius elbows.) $8 \times 1.7 = 13.6$ equivalent feet.
- Add suction line length (A) and equivalent feet of fittings (C). $65 + 13.6 = 78.6$ effective feet.
- The total effective length of Suction Line is 78.6 feet. Refer to the Suction Line Sizing Chart to determine the actual suction line required. (1 1/8")
- Measure liquid line length. (65 ft.)
- Count the number of liquid line elbows. (8 short radius)
- Calculate the equivalent length of fittings using the Suction Line Elbow chart. (Calculate using the recommended liquid line size for each unit.) $8 \times 1.2 = 9.6$ equivalent feet.
- Add liquid line length (F), equivalent feet of fittings (H). $65 + 9.6 = 74.6$ effective feet.
- The total effective length of liquid line is 74.6 ft. Refer to the Liquid Line Sizing Chart (Evaporator Above Condensing Unit) to determine the liquid line size. 75 effective feet with 30 ft. lift will require a 1/2" liquid line.
- To determine the additional charge required, multiply the linear feet of liquid line to the refrigerant correction factor, and subtract the factory charge for the line set.

$$65 \times 1.3 = 84.5$$

$$25 \times .60 = \underline{15.0}$$

$$= 69.5 \text{ oz. additional charge}$$

SERVICING



SERVICING

REFRIGERANT LINE SIZING

Known Factors:

1. RCC36A2A and matching "A" coil. Condenser above Evaporator.
2. Liquid Line 72 linear feet w/ 9 long radius elbows
3. Suction Line 72 linear feet, and 43 ft. vertical lift.

Determine Suction and Liquid Line sizes:

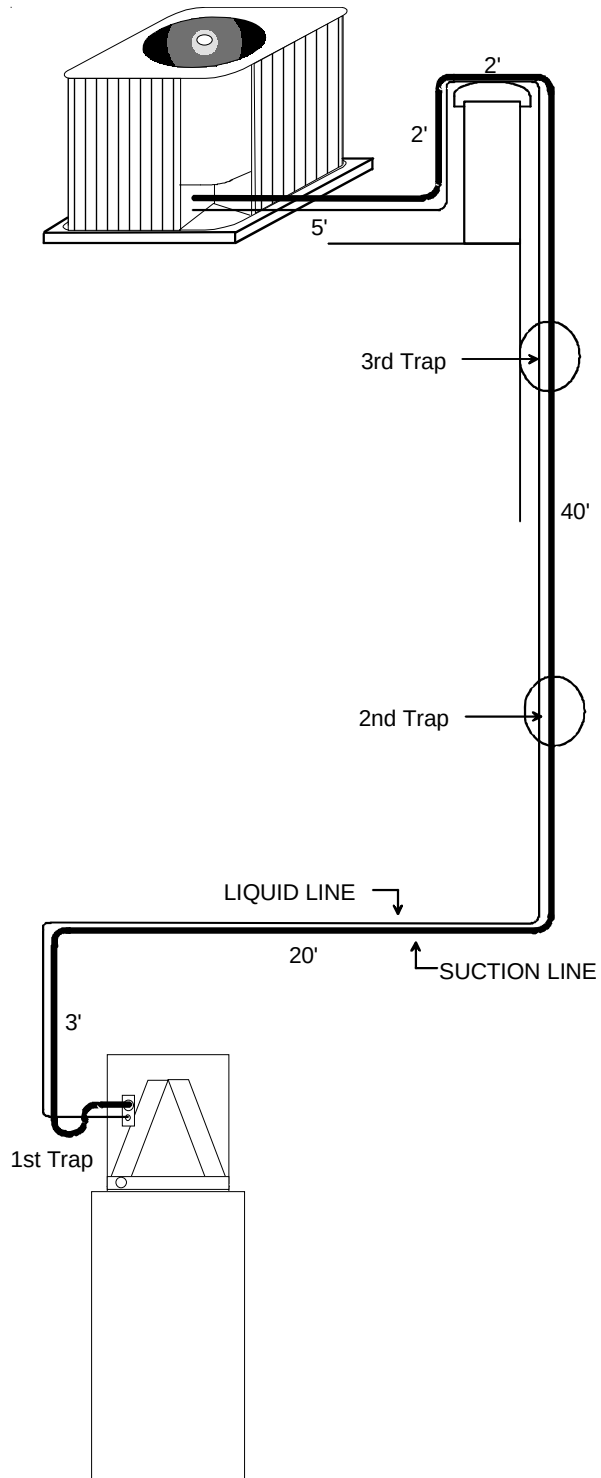
Procedures:

- A. Measure length of suction line. (72 ft.)
- B. Measure the vertical lift of the suction line (43'). Using the Suction Line Traps Chart determine the number of traps required in the suction line (3). Count the number of suction line elbows. (12 long radius)
- C. Calculate the equivalent length of fittings using the Fitting Losses in Equivalent Feet Chart. (Calculate using the recommended suction line size for each unit.) $12 \times 1.7 = 20.4$ equivalent feet.
- D. Add suction line length (A) and equivalent feet of fittings (C). $72 + 20.4 = 92.4$ effective feet.
- E. The total equivalent length of Suction Line is 92.4 feet. Refer to the Suction Line Sizing Chart to determine the actual suction line required. (Since 92.4' is greater than 75' but less than 100', use the 100' column). A 7/8" Suction line will be adequate.
- F. Measure liquid line length. (72 ft.)
- G. Count the number of liquid line elbows. (9 long radius)
- H. Calculate the equivalent length of fittings using the Fitting Losses in Equivalent Feet Chart. (Calculate using the recommended liquid line size for each unit.) $9 \times .8 = 7.2$ equivalent feet.
- I. Add liquid line length (F) equivalent feet of fittings (H). $72 + 7.2 = 79.2$ effective feet.
- J. The total effective length of liquid line is 79.2 ft. Refer to the Liquid Line Sizing Chart (Condensing Unit Above Evaporator) to determine the liquid line size. 79.2 effective feet will require a 3/8" liquid line.
- K. To determine the additional charge required, multiply the linear feet of liquid line to the refrigerant correction factor, and subtract the factory charge for the line set.

$$72 \times .60 = 43.2$$

$$25 \times .60 = \underline{15.0}$$

$$= 28.2 \text{ oz. additional charge}$$



ACCUMULATOR SIZING CHART

UNIT SIZE	ACCUMULATOR PART NUMBER	MAX. ADDED REFRIGERANT
18 - 30	11190801	120 oz.
36	11190803	150 oz.
42 - 48	11190807	180 oz.
60	11190808	225 oz.

SERVICING

If the calculation in step 5 requires you to add more refrigerant than the accumulator referenced above can hold, you must relocate the system components so a shorter or smaller diameter liquid line may be used.

7. Make the final charge adjustment. Subcooling at the condensing unit must be 14° to 18°F. If the indoor coil has a capillary tube the superheat must also be measured. Adjust charge as explained in section **S-103 CHARGING**.

S-200 DUCT STATIC PRESSURES AND/OR STATIC PRESSURE DROP ACROSS COIL

This minimum and maximum allowable duct static pressure for the indoor sections are found in the specifications section.

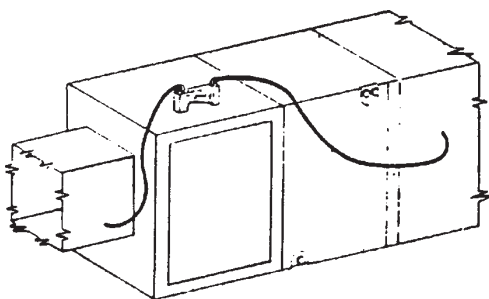
Tables are also provided for each coil, listing quantity of air (CFM) versus static pressure drop across the coil.

Too great an external static pressure will result in insufficient air that can cause icing of the coil. Too much air can cause poor humidity control and condensate to be pulled off the evaporator coil causing condensate leakage. Too much air can also cause motor overloading and in many cases this constitutes a poorly designed system.

S-201 AIR HANDLER EXTERNAL STATIC

To determine proper air movement, proceed as follows:

1. Using a draft gauge (inclined manometer) measure the static pressure of the return duct at the inlet of the unit, (Negative Pressure).
2. Measure the static pressure of the supply duct, (Positive Pressure).
3. Add the two readings together.

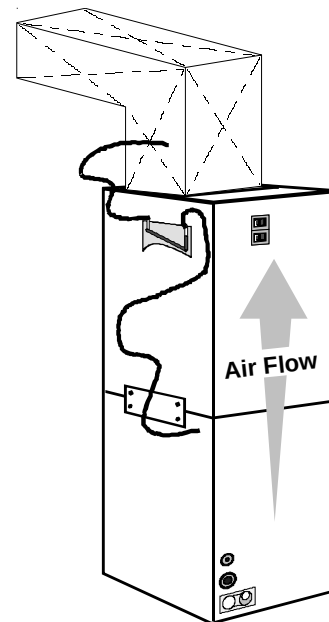


TOTAL EXTERNAL STATIC

NOTE: Both readings may be taken simultaneously and read directly on the manometer if so desired.

4. Consult proper table for quantity of air.

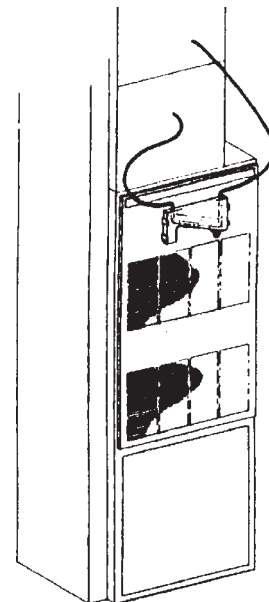
If external static pressure is being measured on a furnace to determine airflow, supply static must be taken between the "A" coil and the furnace.



TOTAL EXTERNAL STATIC

S-202 COIL STATIC PRESSURE DROP

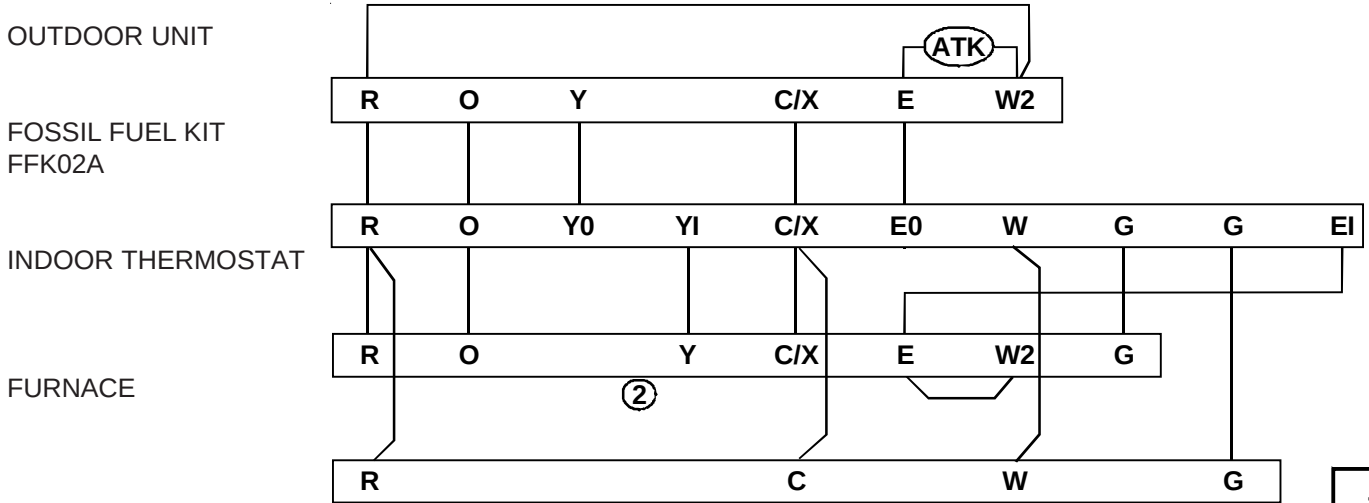
1. Using a draft gauge (inclined manometer), connect the positive probe underneath the coil and the negative probe above the coil.
2. A direct reading can be taken of the static pressure drop across the coil.
3. Consult proper table for quantity of air.



STATIC PRESSURE DROP

If the total external static pressure and/or static pressure drop exceeds the maximum or minimum allowable statics, check for closed dampers, dirty filters, undersized or poorly laid out duct work.

ACCESSORIES WIRING DIAGRAMS



NOTES:

1. Thermostat requirements:
 - a. Must be minimum 1 stage cool and 2 stage heat.
 - b. Must continuously energize "O" terminal in cooling mode.
 - c. Must not continuously energize "O" when in Automatic changeover mode.
 - d. Should have adjustable heat anticipator(s).
 - e. Must automatically bypass compressor heat (W1/Y1) when in the emergency heat mode.
 - f. Emergency heat mode must not continuously energize the "E" terminal when in emergency heat mode.

Amana Thermostat THSADC1H2BA shown.

The following Amana thermostats also meet the above requirements:

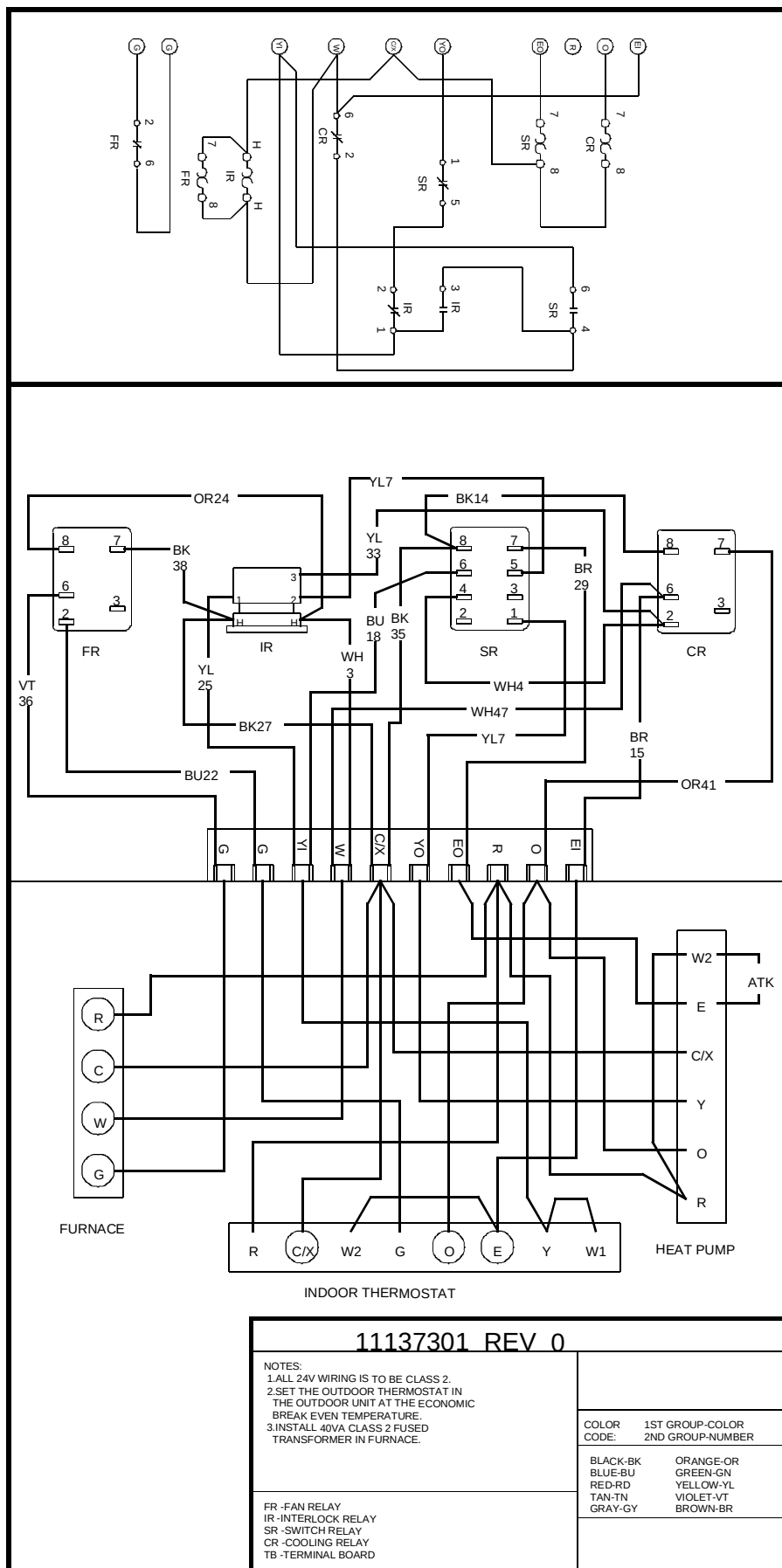
THSMDC1H2BA	THSMEC1H2BA
THPADC1H3BA	THSMDC1H3BA
THPMFC1H2BA	

2. If W1 terminal present on room thermostat, jumper W1 to Y (or Y1).

TO AVOID POSSIBLE ELECTRICAL SHOCK, PERSONAL INJURY,
OR DEATH, DISCONNECT THE POWER BEFORE SERVICING.

WARNING

ACCESSORIES WIRING DIAGRAMS

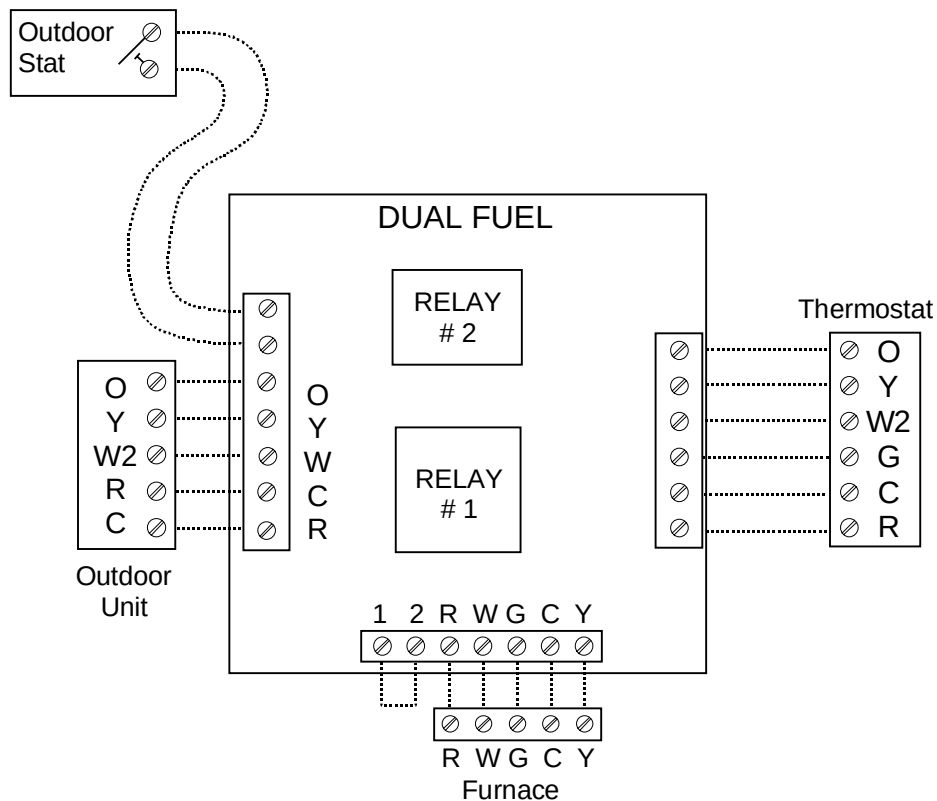


TO AVOID POSSIBLE ELECTRICAL SHOCK, PERSONAL INJURY, OR DEATH, DISCONNECT THE POWER BEFORE SERVICING.

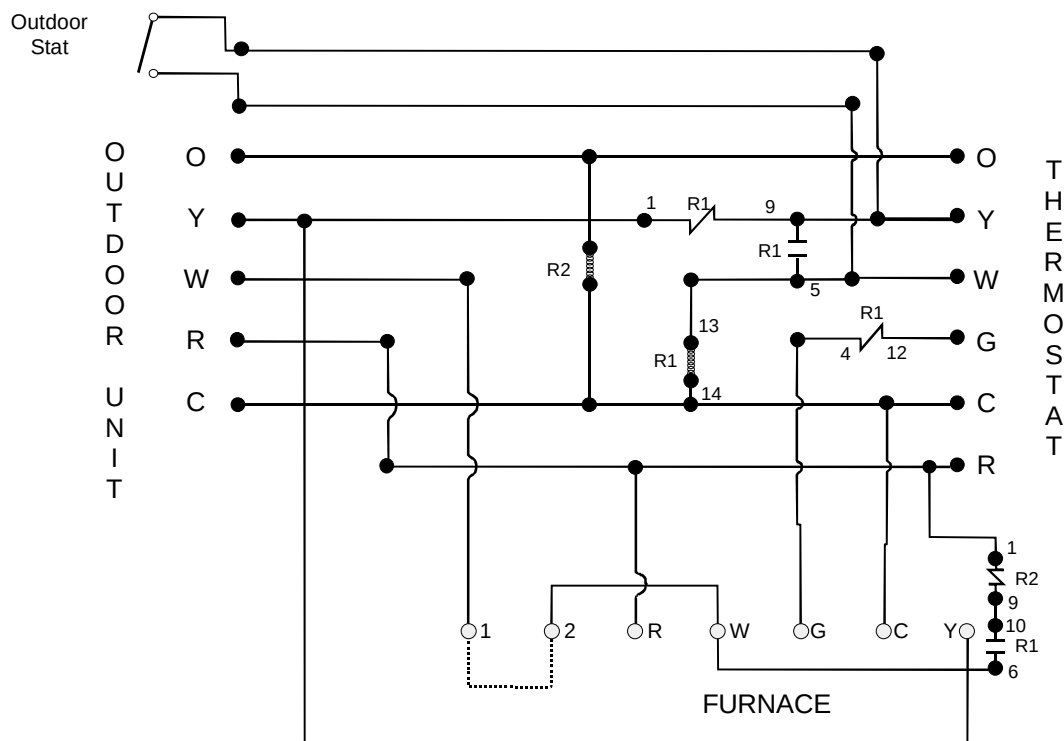
! WARNING

ACCESSORIES WIRING DIAGRAMS

NOTE: Use N/O circuit in OD Stat



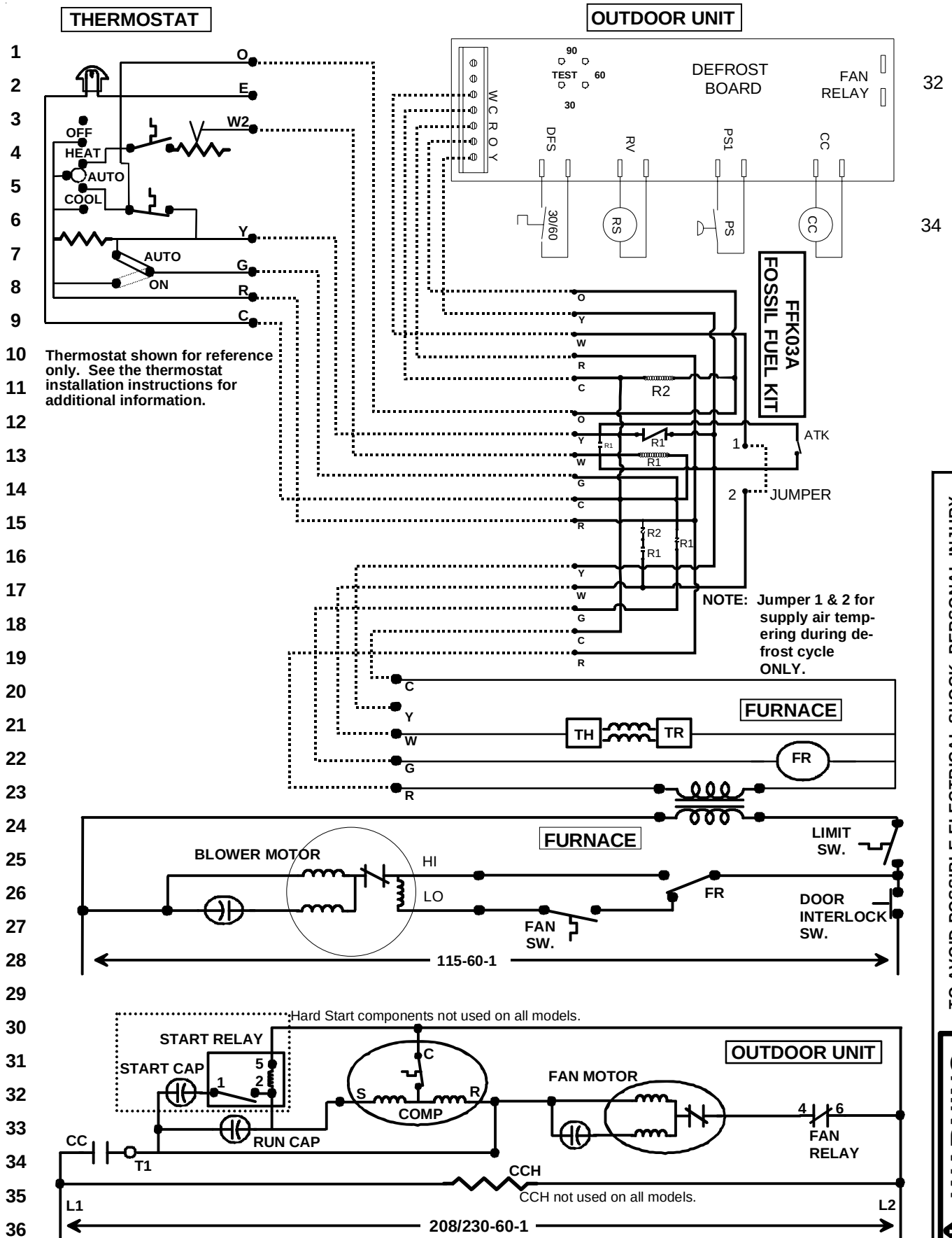
NOTE: Jumper 1 & 2 for supply air tempering during defrost cycle **ONLY**



TO AVOID POSSIBLE ELECTRICAL SHOCK, PERSONAL INJURY, OR DEATH, DISCONNECT THE POWER BEFORE SERVICING.



SCHEMATICS

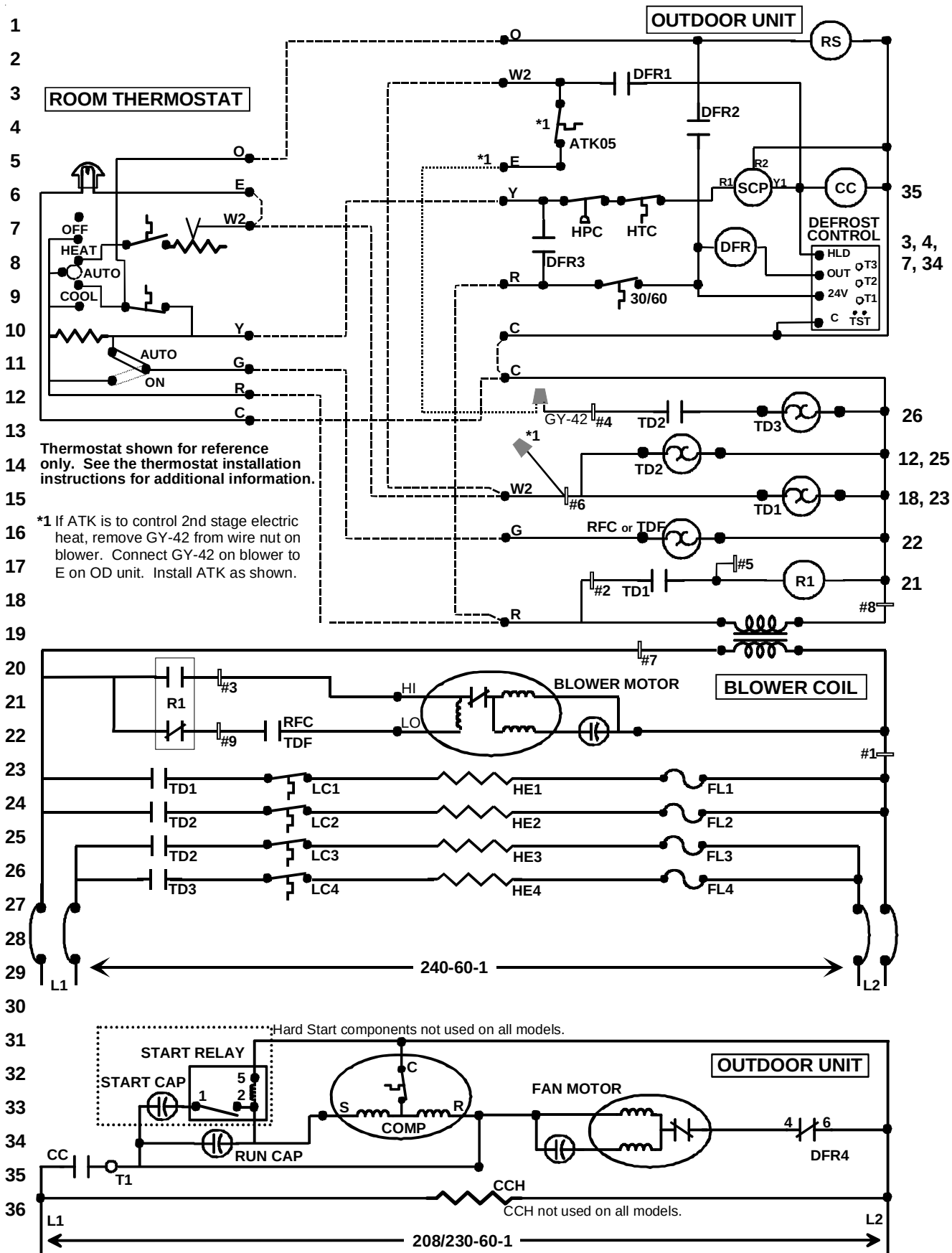


TYPICAL SCHEMATIC - RHA/RHD/RHE MODEL HEAT PUMP - GAS FURNACE
FFK03A FOSSIL FUEL KIT - ATK05A CONTROLLING CHANGE OVER SET POINT - THERMOSTAT
*RHD Defrost Control Wiring not as shown, see appropriate wiring diagram for further information.

TO AVOID POSSIBLE ELECTRICAL SHOCK, PERSONAL INJURY, OR DEATH, DISCONNECT THE POWER BEFORE SERVICING.

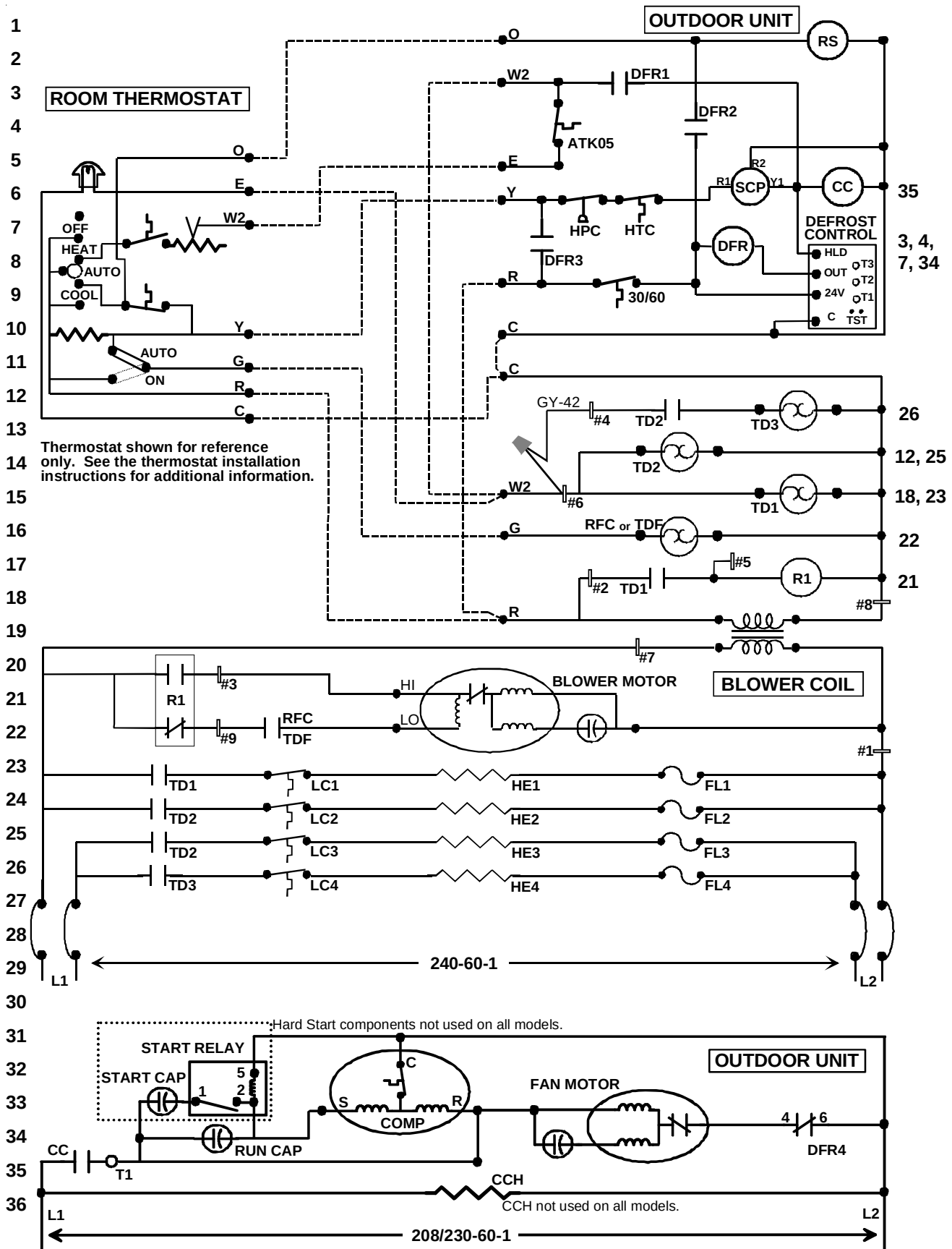
WARNING

SCHEMATICS



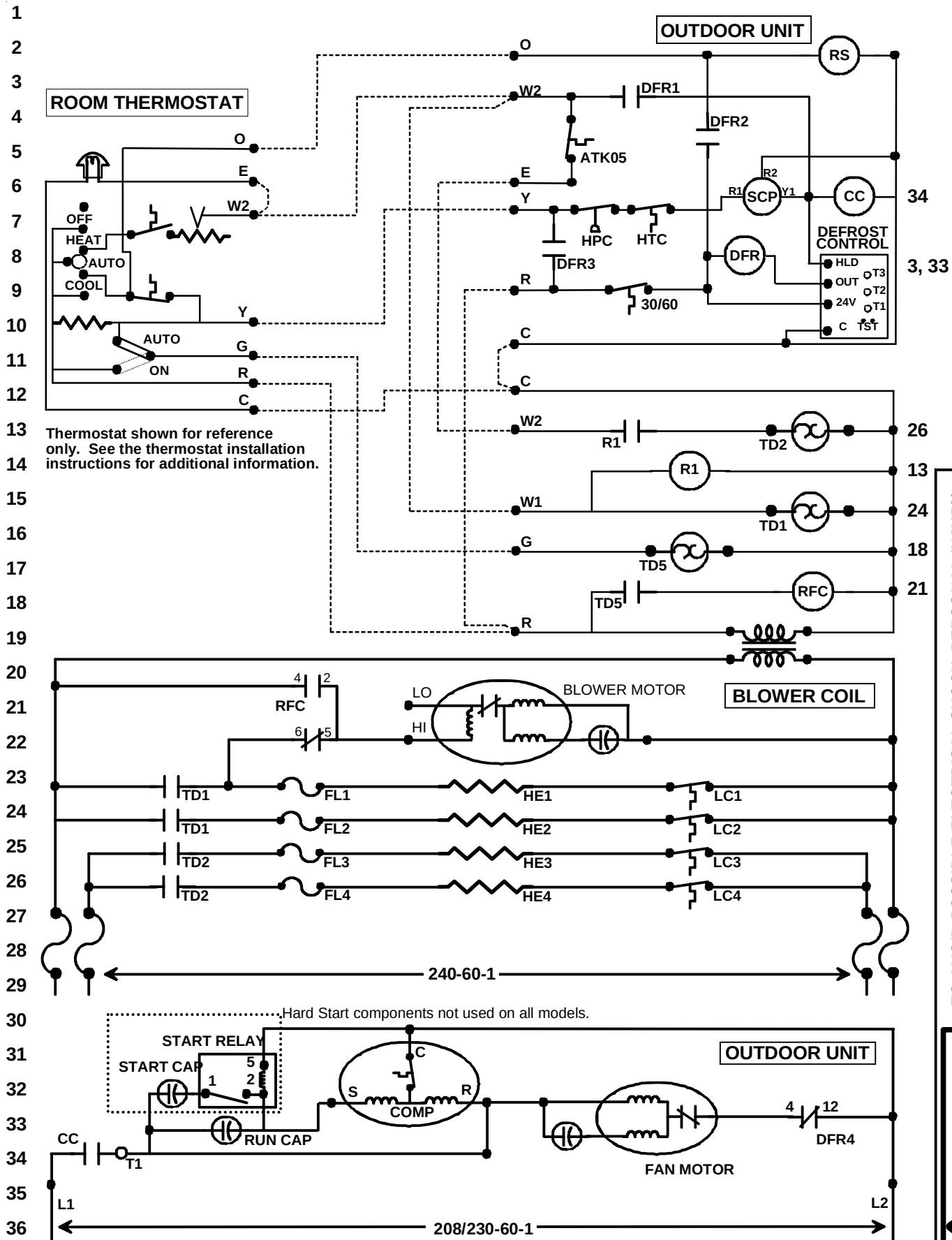
TYPICAL SCHEMATIC - RHA/RHD* MODEL HEAT PUMP - BHA BLOWER COIL
 EHK20A HEATER KIT - ATK05A CONTROLLING 2nd STAGE ELECTRIC HEAT - THERMOSTAT
 *RHD Defrost Control Wiring not as shown, see appropriate wiring diagram for further information.

SCHEMATICS



TYPICAL SCHEMATIC - RHA/RHD* MODEL HEAT PUMP - BHA BLOWER COIL
 EHK20A HEATER KIT - ATK05A CONTROLLING ALL ELECTRIC HEAT - THERMOSTAT
 *RHD Defrost Control Wiring not as shown, see appropriate wiring diagram for further information.

SCHEMATICS

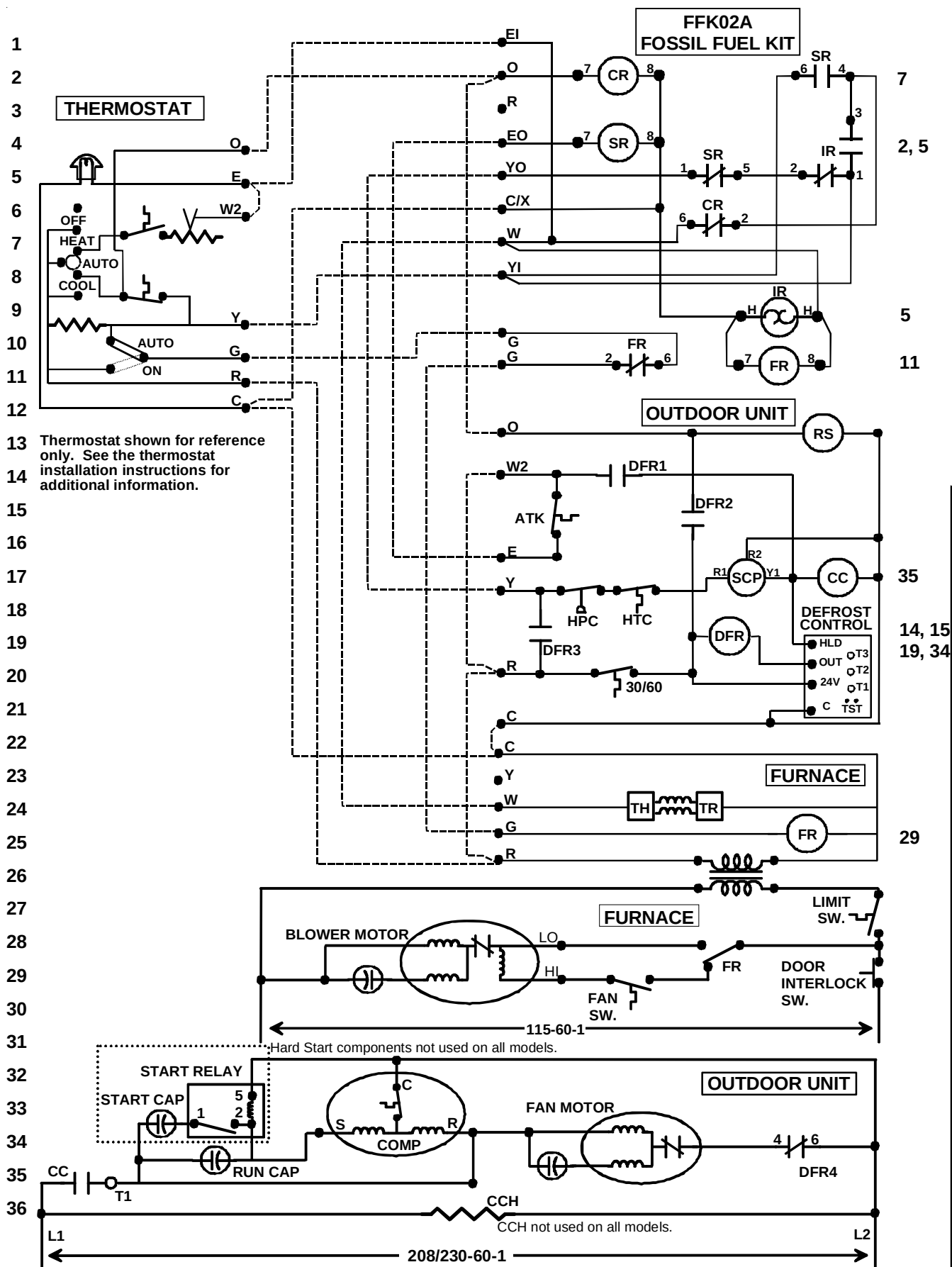


TO AVOID POSSIBLE ELECTRICAL SHOCK, PERSONAL INJURY, OR DEATH, DISCONNECT THE POWER BEFORE SERVICING.

WARNING

TYPICAL SCHEMATIC - RHA/RHD* MODEL HEAT PUMP - BHAA or BHAS BLOWER COIL
 AHK20 HEATER KIT - ATK05A CONTROLLING 2nd STAGE ELECTRIC HEAT - THERMOSTAT
 *RHD Defrost Control Wiring not as shown, see appropriate wiring diagram for further information.

SCHEMATICS



TYPICAL SCHEMATIC - RHA/RHD* MODEL HEAT PUMP - CCA/CHA INDOOR COIL
GAS FURNACE - FFK02A FOSSIL FUEL KIT - THERMOSTAT

*RHD Defrost Control Wiring not as shown, see appropriate wiring diagram for further information.