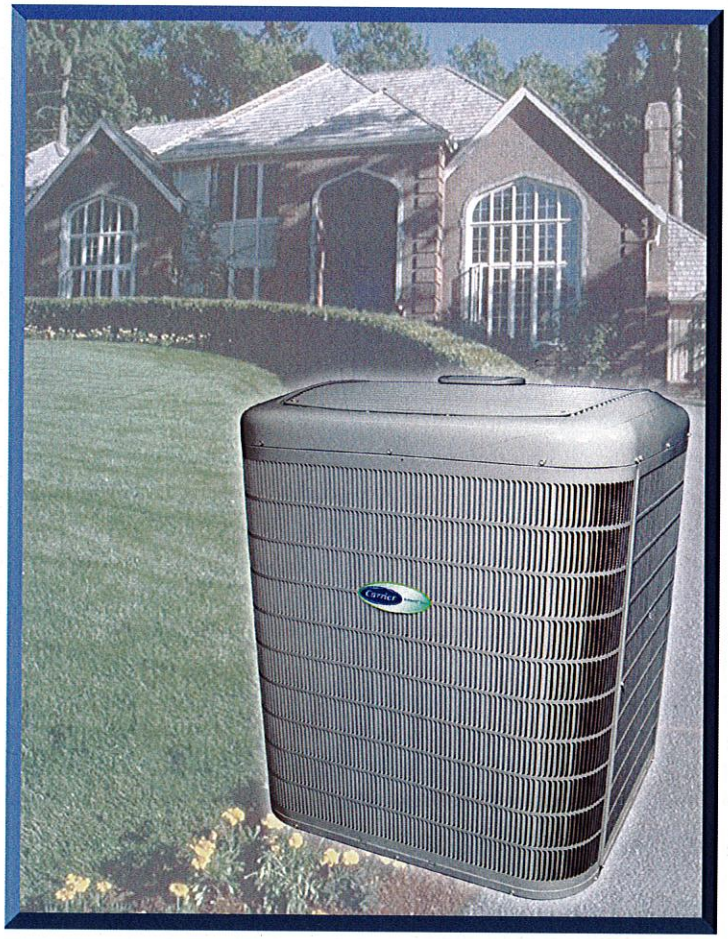
CARRIER

SERVICE

Training



25VNA

INFINITY™ HEAT PUMP UNIT

FAMILIARIZATION • CONTROLS • OPERATION • START-UP • MAINTENANCE • TROUBLESHOOTING

25VNA-01

06-C20-665

Infinity with Greenspeed™ Intelligence 25VNA

This training consists of a PowerPoint™ presentation on CD, Form No. 25VNA-02CD, Catalog No. 06-C29-666 and this book, Form No. 25VNA-01, Catalog No. 06-C20-665. The primary purpose of this program is to familiarize you with this product, its components and its operation so that you can install and start-up a new unit, provide service and maintenance for this unit, and troubleshoot problems. This training covers the 25VNA Infinity Heat Pump with Greenspeed Intelligence.

Table of Contents

Objectives

At the completion of this program the student will be able to:

1. Identify basic components of the Infinity with Greenspeed Intelligence heat pump.
2. Describe the operation of the inverter drive compressor and state the precautions to observe when servicing the unit.
3. Describe the function of the charge compensator and how it functions in heating and cooling.
4. Identify the proper operating sequences for cooling and heat pump operation.
5. Describe proper service procedures for checking, charging, and troubleshoot cooling and heat pump problems.
6. Describe proper service and troubleshooting procedures for EXV and variable speed outdoor fan.
7. Explain how to troubleshoot the variable speed compressor using the error codes.

Presentation Instructions

1. Obtain necessary audiovisual equipment, training aids, handout materials, and books for each participant.
2. To run the CD-ROM training program follow the instructions printed on the label or in the "READ ME" file. Show images section-by-section. Review, discuss and ask questions at the end of each section highlighting topics of importance.
3. Distribute and review handout materials (see suggested list of additional materials below).

Handout Materials/Additional Training Materials

1. Additional workbooks.
2. Visual aids and appropriate tools to support discussion and demonstrations.
3. Service, Installation, and Start-Up Instructions.

Self-Instruction

When using this program for self-instruction, view the narrated PowerPoint™ or read the workbook in its entirety and complete the quiz. Quiz answers with page references are located in the back of this manual.

Introduction

Introduction

- 25VNA Heat Pump Condensing Unit
- Variable Speed Compressor
- Variable Speed Drive
- Infinity™ Communicating Controls
- Highest Efficiency Air Source Heat Pump
- HSPF's up to 13
- SEER up to 20.5

This service-training program introduces Carrier's model 25VNA high-efficiency heat pump condensing units. The 25VNA units feature variable speed compressors driven by a variable speed drive and utilize Infinity® communicating controls. The ability to modulate the compressor speed with the load on the system allows the unit to achieve the highest efficiency of air source heat pump currently available, with HSPF (Heating Seasonal Performance Factor) of up to 13 and SEER (Seasonal Energy Efficiency Ratio) up to 20.5.

These products are designed for residential and light commercial applications.

Benefits

- Comfortable supply air temperatures
- Less dependence upon auxiliary heating
- Performance approaches water source heat pump
- No high cost to provide water source
- Simple installation, operation, and service

With the ability to modulate the compressor speed with the load on the system, the 25VNA unit achieves HSPFs up to 13 and SEERs up to 20.5, which result in more comfortable air temperatures supplied to the conditioned space even at low outdoor ambient temperature conditions. Less dependence on auxiliary heating sources, such as a furnace or electric heat, results in low operating costs.

Although these units are air source heat pumps, through the use of variable speed technology the system performance can be compared to the high performance of water source heat pump systems, also known as geothermal systems. However, geothermal systems incur the high cost of digging and burying underground water loops or drilling wells to obtain the water source; the air source heat pump is not burdened with those costs.

The 25VNA heat pump is simple to install, only requiring line sets to the indoor coil, single-phase electrical power and communications on a two-wire bus. Operation is easy utilizing the User Interface and service is also made simple through the service menus in the User Interface.

Overview

- Familiarization
- Controls and Hardware
- Unit Operation
- Start-Up
- Service and Maintenance
- Troubleshooting

In this program you will become familiar with the components within these heat pump units. You will take an in-depth look at the controls and controls hardware specific to the operation of this unit and learn the unit operation. You will go through a checklist of start-up procedures and learn some service and maintenance procedures that should be performed on these heat pump products. In turn, this will allow you to do the troubleshooting when necessary.

At the completion of this training program you will be able to conduct the initial start-up of these products, understand the basic operation of the products, provide the maintenance and service to the product, and perform troubleshooting when necessary.

Variable Speed Capability

- 25VNA Heat Pump Condensing Unit
- New Outdoor Cabinet
- Copeland Full Variable Speed Compressor
- Variable Speed Outdoor Fan
- Variable Speed Indoor Fan
- Emerson™ Variable Frequency Drive
- Electronic Expansion Valve

These heat pump products feature a new outdoor cabinet that can help to achieve higher efficiencies and Copeland full variable speed compressors matched with variable indoor fan and outdoor fan airflows. The compressor is driven by an Emerson variable speed drive (VSD), also known as an inverter. An electronic expansion valve (EXV) metering device is used in the outdoor coil for the heating mode. This combination of controls achieves higher heating capacities in low ambient outdoor air temperatures resulting in lower balance points.

The system provides enhanced heating capacities and precision humidity control. Greater control of system capacity and airflow are achieved.

For simplicity, communications between the indoor unit and the outdoor unit is performed utilizing only a 2-wire connection.

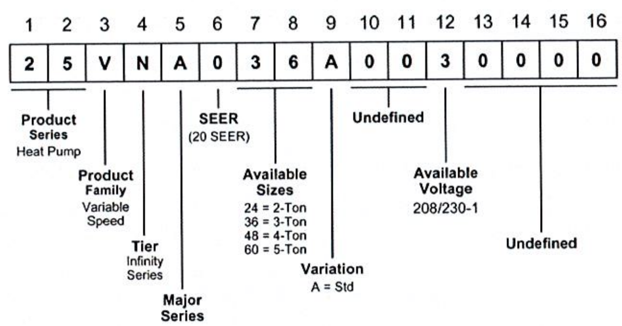
All Copeland variable speed scroll compressors use Puron® refrigerant (R-410A), an environmentally sound HFC refrigerant. The scroll compressors do not utilize an internal line break overload protection, rather they are protected by the variable speed control monitoring compressor current and temperatures together with the variable speed heat pump board (VSHP) monitoring a high pressure switch, low pressure transducer and through communications with the variable speed drive measuring compressor motor current and temperature.

Electrical, Cooling, Heating Capacity Offerings

- ELECTRICAL POWER: 208-230/1/60
- COOLING CAPACITIES: 2, 3, 4, and 5-Tons
- HEATING CAPACITIES: Up to 55,000 BTUs

These units are available in 208-230-volts, single phase with cooling capacities of 2, 3, 4 and 5 tons (24,000, 36,000, 48,000 and 60,000 Btuh) and heating capacities up to 55,000 Btuh at 47° F outdoor air temperatures to meet most residential and light commercial applications.

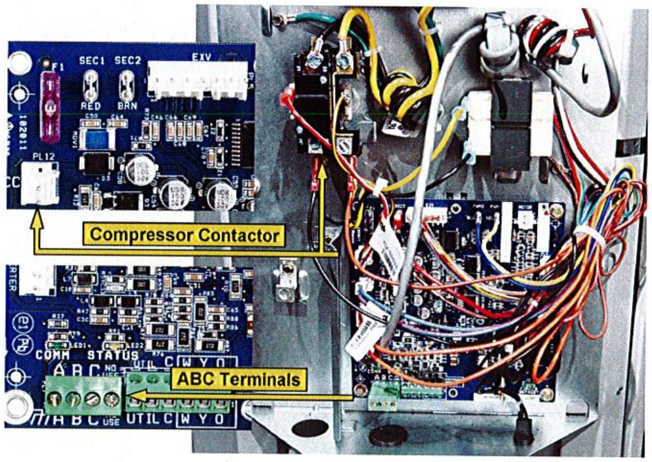
Model Numbers



The model number contains 16 digits for production but only 12 digits are used in the price pages to order the equipment.

Digits 13 through 16 shown above as "unidentified" are used for a number of different options available from the factory, which when combined result in a variable speed heat pump that is customized for job requirements. Note that all 16 digits of the model number have significance. It is very important that all 16 digits of the model number are used to identify the construction of the product that is being serviced. The model number should only be recorded from the unit informative data plate. If the entire model number is not used, there is a risk that incorrect information or incorrect parts may be provided.

Heat Pump Overview



The 25VNA units have have wrap-around outdoor coils. The outdoor fan draws air through the coil and discharges it vertically through the top fan guard. Single-phase 208 or 230-volt power is brought into the units from a field installed disconnect wired to the compressor contactor. The ground wire is secured to the ground lug mounted on the back of the control box. Two-wire communication wiring is brought into the unit from the A and B terminals on the indoor unit board to the A and B terminals of the VSHP board. However, it is always good practice during installation to run extra communication wires so that if one wire breaks, an extra wire is available as a replacement. Since the outdoor unit has its own 24-volt power supply, the C and D power does not have to be provided by the indoor unit.

On some older indoor units, it may be necessary to provide a wire between the indoor unit and the outdoor unit common C terminals of the ABCD connector. The reason is that when the new unit is installed with an existing indoor unit, the ground wire of the existing unit and the ground wire of the new unit may have a different resistance to ground (the earth). If the resistance to earth between the two units is close and falls between a window or a range, the communicating control recognizes it as a common ground. If the resistance to earth between the two units is outside of this window or range, the two units are not recognized by the communicating control to be together in the system. An indication of this is that the communicating control will not be able to find the outdoor unit even though wires at A and B are wired correctly. If this occurs, connect a wire between the C terminals of both the indoor and outdoor units. This is another good reason to run additional communication wires during the initial installation.

Safety

Improper installation, adjustments, alterations, service, maintenance, or use can cause explosion, fire, electrical shock, or other conditions which may cause death, personal injury or property damage. Follow all safety codes. Wear safety glasses, protective clothing and work gloves. Warning labels are displayed prominently on panels of the units to provide the service technician with the necessary information to prevent accidents. Warnings are also printed in the Installation Instructions and Service Manuals available for these products. On all units, labels alert the technician that the variable speed drive contains charged capacitors that must be allowed to discharge at least 2 minutes before performing service to the variable speed drive. Systems containing Puron® refrigerant operate at higher pressures than standard R-22 systems. Do not use R-22 service equipment or components on Puron refrigerant systems. Read and understand all warning labels that are attached to the outer panels, as well as any warning labels located on the inner panels of these units.

Failure to read or understand these warnings could result in damage to the products, and injury or even death to the service technician. If you do not understand any of the warnings, contact your product distributor for better interpretation of the warnings.

Before installing, modifying or servicing these systems turn the main electrical disconnect switch to the OFF position, lock the electrical disconnect switch in this off position and install a tag with a suitable warning label. And remember, there may be more than one disconnect switch for the system.

Installation

Wind baffles may be required for:

- Rooftop units
- High wind areas
- Aiding in defrost and operation in low ambient cooling mode
  - Prevents the water from refreezing to the coil during the defrost mode

In geographical areas that experience prolonged sub-freezing temperatures, the heat pump should be installed on risers so that the unit is above the buildup of ice that occurs during defrost cycles.

If conditions or local codes require the unit be attached to a pad, tie down bolts should be used and fastened through knockouts in the unit's base pan.

On rooftop applications, mount the unit on a level platform or frame positioning the unit above a load-bearing wall and isolate the unit and the refrigeration piping from the structure of the building. The supporting members should be arranged adequately to support the unit and minimize transmission of vibration into the building. Rooftop applications require that the unit be located at least 6 inches above the roof surface.

In high-wind areas, roof mounted units should utilize wind baffles. Wind baffles should also be used in high wind areas to prevent re-freezing the moisture on the coil in the defrost mode.

For hurricane tie downs, contact your local heating and air conditioning distributor for details and Professional Engineering Certification, if required.

All units must be level to within plus or minus 2° F which equates to plus or minus $^{3}/_{8}$-inch per linear foot.

The installation of the unit must allow for sufficient clearances for proper operation, wiring, piping and service to the unit. For service, allow for 24 inches at the end of the unit and 24 inches above the unit. For proper airflow, a 6-inch clearance on one side of the unit and 12 inches on all remaining sides must be maintained. On applications where multiple units are installed, maintain 24 inches between units. Units should be positioned so that water, snow or ice from roof eaves cannot fall directly on the unit.

Unit Sizing Consideration

COOLING LOAD (TONS)	EQUIPMENT SIZE FOR HEATING
2	36,000
2.5	36,000
3	48,000
3.5	60,000
4	60,000
5	60,000

When selecting and sizing the equipment for the application, consideration must be given to whether the load in the conditioned space is primarily a cooling load or primarily a heating load.

If the application is primarily for a cooling load, size the equipment the same as it would be sized for an air conditioning system. If the application is primarily a heating load, then in some applications the equipment should be sized to take advantage of additional heating capacity using the chart shown above. Typically, sizing the equipment for a primary heating load results in oversized equipment to handle the cooling load, but because both the compressor and indoor fan are variable speed the system will operate to match the load, and is less sensitive to oversizing.

Note that both the indoor fan and the compressor are variable speed, and change speed according to conditions. Therefore, it is important to make sure that both the maximum and minimum airflows can be handled by the ductwork in the conditioned building.

Airflow Considerations

3-TON COOLING COMFORT AIRFLOWS							
O.D. Temp		55	67	82	87	95	125
Minimum		467	498	455	441	418	499
Maximum		1168	1124	1138	1102	1045	950
3-TON HEATING COMFORT AIRFLOWS							
O.D. Temp	-20	0	5	17	35	47	62
Minimum	275	275	275	397	520	608	440
Maximum	321	453	453	610	928	1065	1350

Since it is important to size and select the equipment based upon the primary heating or cooling load in the conditioned space and because the indoor fan and the compressor are variable speed, there are other considerations that must be addressed when applying this equipment.

Many applications will require selections made for heating loads; as a result, the CFM ranges of the units will be wider than conventional heat pump systems. The high end will be higher and the low end will be lower.

Higher, high-end airflow (CFM) could result in applications with undersized duct systems, making them noisy during heating or cooling. Trying to deliver more airflow through a duct system than it was designed for will also result in higher static pressures and actually deliver less airflow.

Lower, low-end CFM could result in little or negligible airflow to condition rooms, especially on long duct runs. This could be very troublesome on zoned systems not capable of delivering the required airflow to each zone when all zones require air.

Shown above is a table of minimum and maximum fan speeds of a 3-ton variable speed heat pump setup for comfort airflow over a range of temperatures. If the unit was selected and applied in a location where cooling is required between 67° F and 95° F, the minimum airflow that will be delivered during cooling is 418 CFM with a maximum delivered airflow during cooling of 1138 CFM. If the same application required heating between 0° F and 62° F, the minimum delivered airflow during heating is 275 CFM with a maximum delivered airflow during heating of 1350 CFM.

Typically, a 3-ton system would be designed to deliver up to 400 CFM per ton or a maximum of about 1200 CFM. As you can see, the variable speed 3-ton heat pump maximum air delivery approaches that CFM during the cooling mode with 1138 CFM but during the heating mode the maximum CFM of 1350 exceeds the 1200 CFM by another 150 CFM. This may not sound like much but it is another 50 CFM per ton.

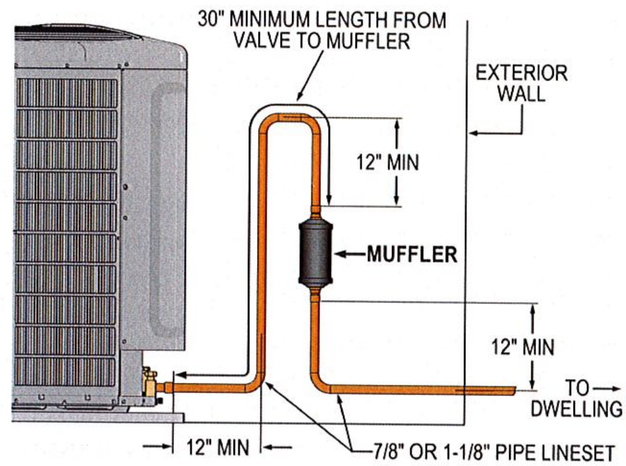
On the low end, the minimum delivered airflow can drop to 275 CFM during heat pump heating which will result in very comfortable supply air temperatures during heat pump heating. However, the low CFM delivery could result in uncomfortable conditioned spaces because of the lack of sufficient outlet air velocities to the conditioned space or spaces. Recommended air outlet velocities for a residence should be between 500 and 750 feet per minute.

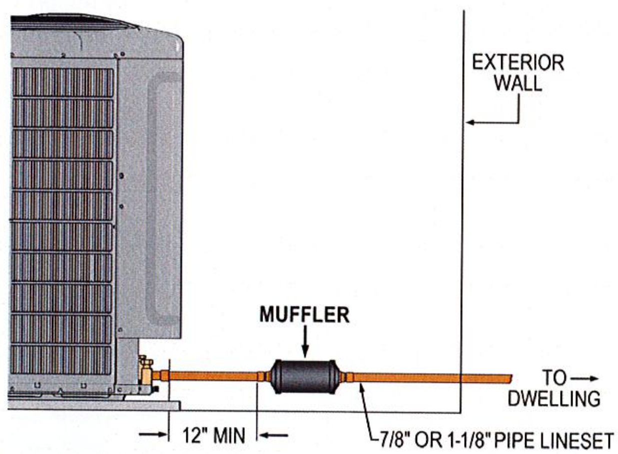
The low CFM is not applicable to a Hybrid Heat® system utilizing a gas furnace because the gas furnace airflows are utilized when the system is in the gas heat mode. For example, if the 3-ton heat pump was used with a 58MVP gas furnace with the capacity sized at 57,000 Btu output, the minimum CFM would be 500 CFM with a maximum CFM of 1070 during heating operation.

Utilize Carrier's Duct Design Guide, Manual D, for the design of the duct system.

Refer to the Product Data literature for comfort and efficiency airflows for the 2, 4, and 5-ton products.

Vapor Line Muffler





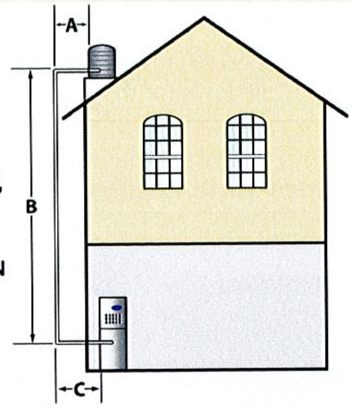
To eliminate any objectionable noise transmitted indoors from the vapor line, always install a muffler in the vapor line as close to the outdoor unit as possible while also meeting certain minimum and maximum refrigerant line criteria. The muffler may be installed in a vertical or horizontal direction. A minimum of 12 inches of straight length of refrigerant line, from any bend in the refrigerant line, must be provided before the inlet to the muffler and after the outlet from the muffler.

Either $^7/_8$ inch or 1-$^1/_8$ inch refrigeration tubing should be used. It may also be necessary to secure the refrigeration line to keep it in the installed position.

When installing the refrigerant line, avoid blocking access to the outdoor unit controls. Do not run the refrigerant line directly up from the vapor valve. Turn the vapor line to the side from where it exits the vapor valve, providing adequate access to the unit controls.

Long Line Applications

- IF B EXCEEDS 20', LIQUID LINE SOLENOID VALVE REQUIRED
- IF A + B + C EXCEEDS 80', LIQUID LINE SOLENOID VALVE REQUIRED
- REFER TO INSTALLATION INSTRUCTIONS FOR GUIDELINES

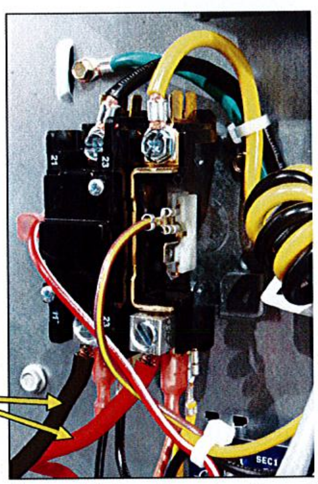


These products are approved for use with line lengths separating the indoor unit and the outdoor unit for up to 200 feet. If either the elevation difference exceeds 20 feet or the separation of the two units requires a line length of over 80 feet, a liquid line solenoid shut-off valve will be required. Additionally, whenever the elevation difference of 20 feet is exceeded and or the separation of two units requiring a line length of 80 feet of separation is exceeded, refer to the unit's Installation Instructions for the proper guidelines for the application and any other limitations that may apply.

Unit Electrical Power

Voltage to the system:

- No lower than 187-volts
- No higher than 253-volts



Power wires from unit's disconnect, connected to contactor

Ensure that field wiring complies with local and national fire, safety, and electrical codes with the voltage to the system no lower than 187 volts and no higher than 253 volts. Operation of the unit on improper line voltage could affect variable speed compressor control and unit reliability. If the voltage to the unit is not within these limits, the local power company must be contacted for the correction of the improper voltage.

The installed circuit protection device must be the one specified on the unit rating plate.

Power wires from the unit's disconnect should be routed through the power wiring hole provided at the bottom of the unit's control box. Connect the ground wire to the ground connection in the control box and connect the power wiring to the compressor contactor as shown on the wiring diagram supplied with the unit and the Installation Instructions supplied with the unit.

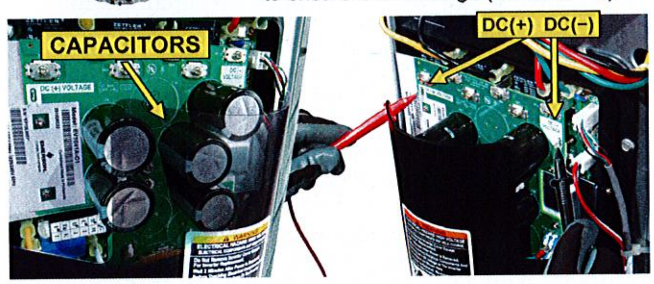
Connect the communication control wire connections A and B from the indoor unit to the outdoor unit VSHP board.

Familiarization

In the Familiarization section of this program we will take the unit apart and review all of the components utilized within the variable speed heat pump system. We will discuss how some of the components operate and how they function to protect and control operation of the entire system.

Removing Control Box Cover

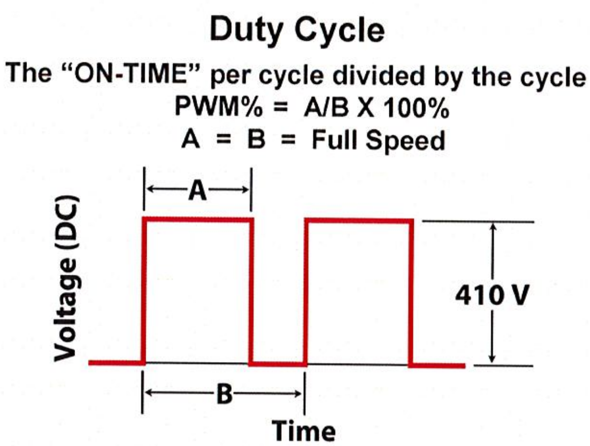
- Capacitors maintain a **lethal** high-voltage charge
- Remove power at least <u>two minutes</u> before service
- <u>Lockout and tag</u> electrical disconnect
- Take readings at DC+ and DC− terminals to ensure full discharge (DC VDC = 0)



We have removed the access panel covering the unit's control box. Precautions must be taken when servicing components within the control box of this unit. The variable speed drive (VSD) contains several capacitors for converting electrical current and these capacitors maintain a **lethal** high voltage charge. These capacitors are covered with a protective shield that is designed to be permanent and must not be removed. If service is to be performed near the VSD, **power must be removed from the unit at least two minutes before the service is to be performed, to allow the capacitors to slowly discharge.** Then, before any work is performed on or near the VSD electrical meter readings must be taken at the DC + VOLTAGE and DC - VOLTAGE terminals on the VSD adjacent to the capacitors to ensure that they have totally discharged. The volts DC must be 0 (zero).

The technician performing the service must determine that it is safe to work on or near the VSD. The electrical disconnect that provides power to the unit must not only be turned off, but also locked and tagged off. This will also ensure that no damage will occur to the VSD, controls or the equipment and that no one will get hurt if they come into contact with the electrical equipment.

Variable Speed Drive (VSD) Advantage

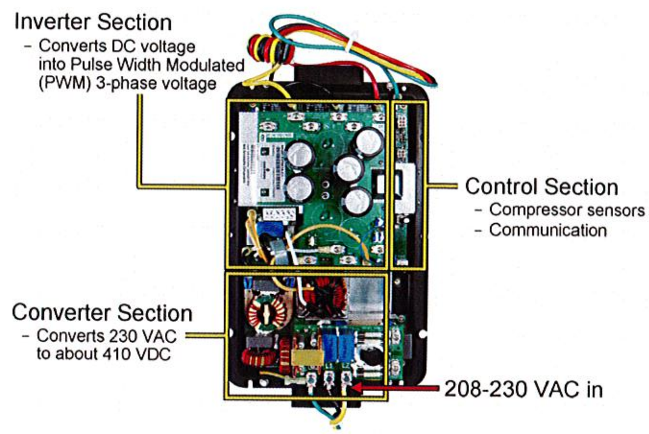


The primary purpose of the variable speed drive (VSD) is to convert the 60 Hz AC input voltage into a variable frequency/variable voltage ouptut to power the variable speed scroll compressor. Through a series of processes, the drive conditions the incoming alternating current (AC) power to arrive at the desired output. The drive first converts the AC input voltage into a DC bus. The DC bus voltage is then pulse-width modulated to replicate a sinusoidal current at the desired frequency and voltage. Switching the DC power to the motor windings on and off at various rates is known as a pulse-width modulation (PWM). The DC output voltage is approximately 410 volts.

The PWM signal is created by turning a DC signal on and off once within a given period of time. The signal sent to the motor would look very similar to the "square wave" in this slide. The speed of the motor is determined by the width of the "A" signal sent to the motor electronics. The point from where the first square waves starts to the point where the second square wave starts, "B", is a constant. The ratio of the length of "A" to "B" is the speed that the motor will run. The wider the "A" signal, the faster the motor will run. If A = B the motor will run at 100% torque, which would be the maximum speed that the motor is programmed. The torque of the motor is determined by the height (voltage) of the wave. At full torque the DC voltage would measure approximately 410 volts.

If we had a continuous, A = B, DC signal at the motor, then the motor would be operating at full speed, in our case up to 7000 RPM in heating on some units. If the DC signal is on for 4 milliseconds of the 5-millisecond period the motor will only see the 80% signal and the motor will operate at 80% speed or 5600 RPM. By changing the duration of time that the signal is on to the full time period the motor speed can be varied from zero up to its full speed.

Variable Speed Drive Operation



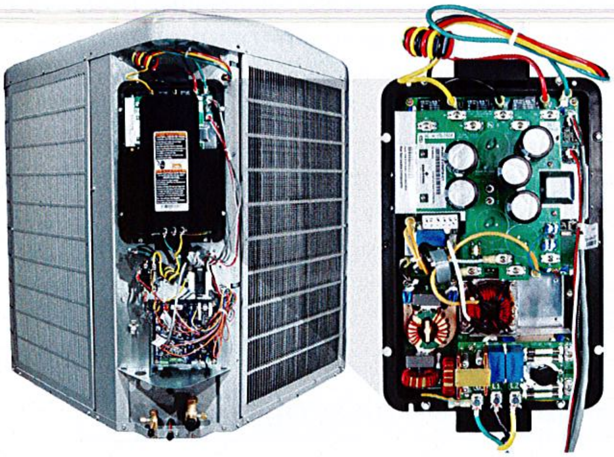
The variable speed drive contains three functionally defined areas.

At the bottom of the VSD, 208-230-volt alternating current (VAC) power is brought into the drive. This bottom section of the drive is the converter section and it takes the incoming 208-230 VAC power and converts it up to approximately 410-volt direct current (VDC) power.

The upper left side of the VSD is the inverter section which converts the DC voltage into pulse-width modulated (PWM) 3-phase voltage. At the top of this section, 3-phase DC voltage is supplied as output to the compressor.

To the right of the converter section is the control section which receives inputs from the different sensors in the unit and provides the communications to the VSD for its operation.

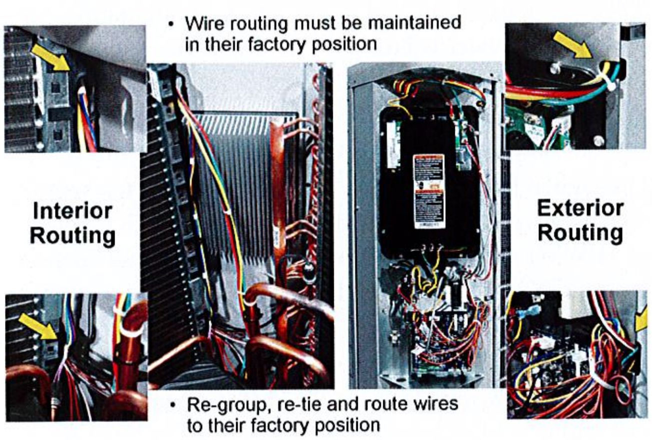
Servicing the Variable Speed Drive



Troubleshoot the VSD **application**; do not troubleshoot the VSD.

The VSD is ***not*** serviceable! If it has been determined that it is not operational, it must be replaced. Individual replacement components are not available for the VSD and cannot be obtained for replacement. The complete VSD must be changed if it is determined that a problem exists. Remember, when replacing the VSD, allow two minutes after power shut down for the capacitors to discharge and check the capacitors with an electrical meter before removing the VSD.

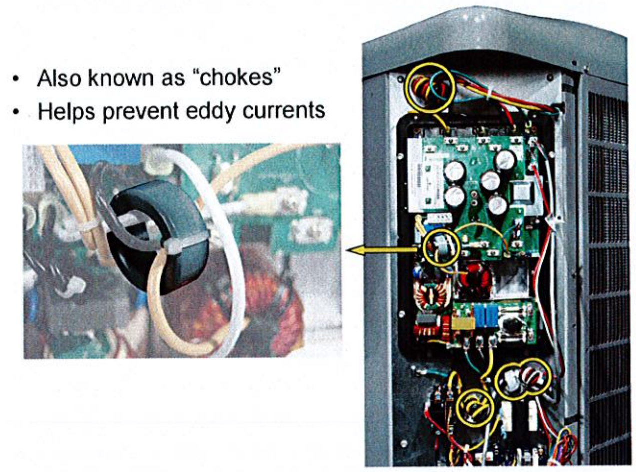
Wire Routing Around the Variable Speed Drive



Wire routing, wire tie downs, wire restraints and wire separation are very important to the operation of this product. Wire routing from the factory MUST be maintained and wires must not be moved from their factory installed position. The same is true with the utilization of wire tie downs and restraints. If during service, tie downs are cut and removed or restraints are removed, they must be replaced in exactly the same place where the factory placed them. Wire separation is also extremely important and wires cannot be bundled together when replacing wire ties because power source wires could easily interrupt unit communication through the communication bus wires.

It is recommended that you make copies of portions of this training program that display wire routing so that they can be used on the job site as visual examples of the original factory wiring.

Ferrite Cores



A closer look in five places around the VSD reveal wires wrapped several times through and around grey cylinders. These grey cylinders are known as ferrite cores (also called chokes). A ferrite core is a structure on which the windings of electric transformers and other wound components are formed. They are used for their properties of high magnetic power of conducting lines of magnetic force coupled with low electrical conductivity, which helps prevent eddy currents.

Because of the job that a VSD performs turning a single phase alternating current into a three phase direct current, much electro-magnetic interference (EMI) and radio frequency interference (RFI) is produced. Ferrite cores are EMI and RFI chokes, that is, the electrical interference absorbing properties of ferrite cores interact with high frequency energy and effectively dissipate the unwanted radio frequency while allowing data signals to pass unimpeded.

The ferrite cores are being used in two different applications on our variable speed drive, one as signal transformers and the other as power transformers. There are two signal transformers just below the VSD where the communication bus from the VSHP board and the temperature sensor from the compressor are shielded. There are also power transformers located in the center to shield the power to the VSD and above the VSD to shield the power supply from the VSD.

When performing service or replacing the VSD, ensure that the ferrite cores remain in their factory position and also ensure that the wire turns through and around the ferrite cores remain the same as their factory installation.

Outdoor Fan Motor

The outdoor fan, located at the top of the unit, draws air from outside of the unit through the outdoor coil and also across the fins on the heat sink of the VSD heat exchanger, cooling the VSD. The air is discharged upwards through the protective grille covering the fan motor. This grille provides protection to anyone placing their hands or fingers on top of the unit. The motor is totally enclosed for increased reliability and eliminates the need for a rain shield. The bearings are permanently lubricated and require no maintenance.

The outdoor fan motor is an electronically commutated motor (ECM), a variable speed motor that operates from 500 to 900 RPM. The motor is a DC permanent magnet-type motor with integrated electronic controls. Just like the compressor, this motor speed is varied through PWM.

The motor speed is controlled through the VSHP board in the outdoor unit. The motor speed is slowed as the building load decreases, maintaining the proper condensing temperature for both cooling and dehumidification. As the building load increases, the motor will increase speed until it is at maximum speed at the maximum building load. Motor speed, as well as motor on and off, is also controlled in low ambient cooling.

When the outdoor ambient temperature is more than 100° F, the outdoor fan will continue to operate for one minute after the compressor shuts off.

The fan is also ON when the outdoor coil temperature is above 80° F, the high side pressure is determined to be too high by the VSHP board or if the outdoor fan has been OFF for 30 minutes. This allows the refrigerant system to stabilize.

If LOW AMBIENT COOLING is enabled, the fan may not begin to cycle until about 40° F outdoor air temperature based upon the outdoor coil and outdoor air temperatures.

The outdoor fan is OFF when the outdoor coil temperature is low (below 55° F), the saturated suction pressure indicates a freezing indoor coil or the outdoor fan has been ON for 30 minutes. This allows the refrigerant system to stabilize.

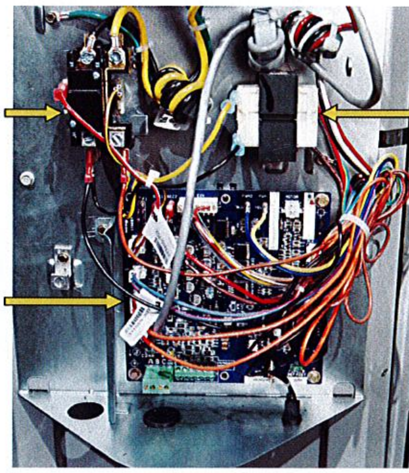
There also is a 20-second delay after termination of defrost before the outdoor fan is energized for heating, unless the fan delay feature is turned off.

Main Control Box

24-volt Compressor Contactor

24-vac Transformer

Variable Speed Heat Pump Board

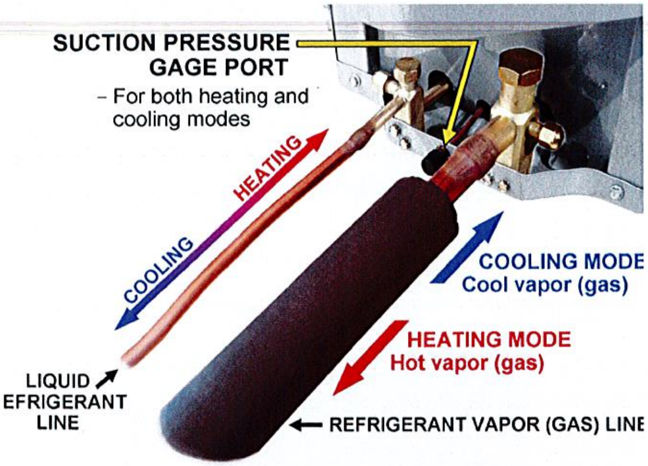


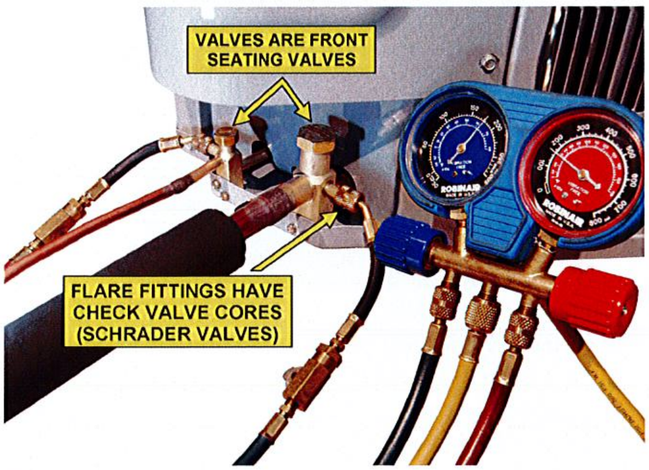
Located below the VSD is the unit's main control box. The variable speed heat pump board and electrical components can be seen. To the top left of the variable speed heat pump board is the 24-volt compressor contactor, controlled by the VSHP board, and to the right of the contactor is the step down 24-vac transformer. An outdoor air thermistor is located through the bottom of the control box exposed to the outdoor air temperature.

In this variable speed application the compressor contactor does not provide power directly to the compressor but it does provide power to the VSD. The power to the compressor is provided through the VSD. The contactor will close periodically without starting the unit and when this closure occurs is dependent upon the outdoor air temperature. When the contactor closes it will do so for a minimum of 30 seconds to allow the variable speed control board to read data from the VSD and the compressor without starting the compressor. When the VSHP board reads the data it will determine if it is necessary to energize the compressor sump heater. Only after all conditions are correct and there is a call for either heating or cooling will the VSD energize and start the compressor.

The outdoor unit's main power enters the unit through the bottom of the control box and connects to the primary terminals of the compressor contactor. The communication control wires from the indoor unit enter into the bottom of the control box then attach to the communicating control connector which then slides over the ABCD pins on the variable speed heat pump board.

Refrigerant Service Valves



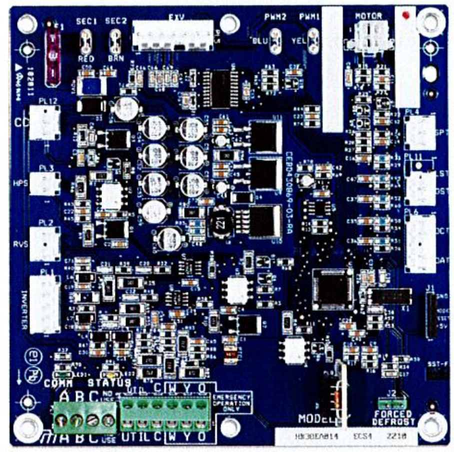


The two brass service valves serve as the connection point of the refrigerant line set from the indoor unit coil to the outdoor unit. Cool refrigerant vapor at low pressures flows to the heat pump from the indoor unit through the larger valve while refrigerant liquid at higher pressures flows from the heat pump unit out to the indoor unit through the smaller valve in the cooling cycle. But during the heating cycle, hot refrigerant vapor at high pressures flows from the heat pump out to the indoor unit through the same larger valve while refrigerant liquid at slightly lower pressures flows from the indoor unit back to the heat pump through the smaller valve.

Gage ports are located on the sides of each valve for connection of refrigerant gages. However, since low pressure vapor flows through the large valve during the cooling cycle and high pressure vapor flows through the same valve during the heating cycle, the technician servicing the product would have to change low side and high side gage connections each time the unit was checked from heating to cooling and back to heating. To simplify taking pressure readings, a third gage port has been added between the two valves which is the suction pressure in both the heating and cooling modes.

These valves are front seating to close the valves. Check valve cores, also known as Schrader valves, are provided within the flare connections on the service valves.

Variable Speed Heat Pump Board



The variable speed heat pump board (VSHP) is located directly below the variable speed drive. The controller is a two-wire serial communicating device that receives capacity demands from the user interface (UI) and communicates the corresponding speed request to the VSD that controls the compressor speed. With the use of the suction pressure transducer, the outdoor suction line thermistor, the outdoor air temperature thermistor, the outdoor coil thermistor and feedback from the VSD, the controller proactively tries to prevent fault trip events. Together with the electronic expansion valve (EXV), the VSHP provides control of the heating superheat.

Integration of the indoor blower speed with the compressor speed in the cooling mode results in increased dehumidification of the occupied space.

With the extended compressor speed range and motor speeds up to 7,000 RPM on some units during the heating cycle at low outdoor ambient temperatures, more heating comfort can be provided to the occupied space because the higher compressor speeds will maintain higher suction and discharge pressures which will provide higher heating temperatures at the lower outdoor air temperature conditions.

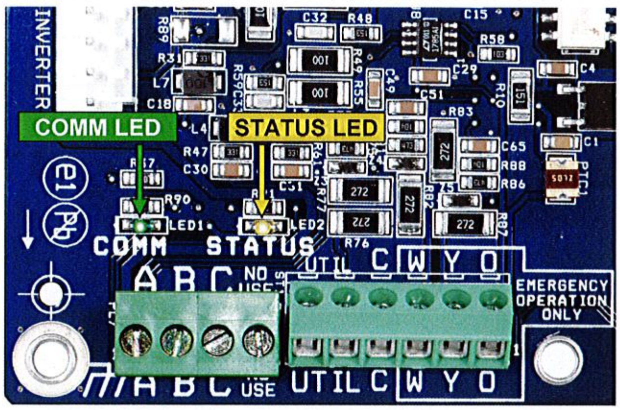
The VSHP board is also capable of intelligent defrost which is covered in detail later.

Providing a service aid for the installer and service technician, a charge assist mode feature is built into the control that runs the system at fixed settings, provides subcooling targets for outdoor ambient temperatures, and provides the charge weigh-in amount. In the refrigerant charge evacuation mode, the EXV is held open for complete refrigerant charge removal from the system.

Through the user interface, the EXV can be opened or closed on command to the heat pump controller, allowing the service technician to check the operation of the EXV audibly in the OFF mode.

Fault code detection and diagnostics is provided through heat pump and VSD fault codes passed back to the user interface with the description, recording the last ten events with the date, time and frequency. These fault codes are listed in the Installation Instructions for these products.

VSHP Board LEDs



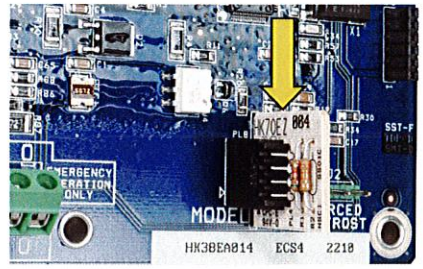
The VSHP board contains two light-emitting diodes (LEDs) a green LED that signals communications identified as COMM and an amber LED that signals status identified as STATUS.

The green colored LED will remain off until communications is established. Once a valid communication is received, the green LED will turn on. A time of 2 minutes is given for the communication to be established and if no communication is established, the green LED will be off. A steady green light indicates that successful communications with the other system products has been established. If communication of the control is lost with the user interface (UI), the control will flash the appropriate fault code.

The amber colored LED is used to display the operation mode and the fault codes. Only one fault code will be displayed on the outdoor unit control board, the most recent with the highest priority. However, the UI will retain the last ten system faults in its memory. These can be viewed through the UI.

If the VSHP board fails, the board will display the appropriate fault code and the UI will display the fault as well. If this occurs, the VSHP board should be replaced.

VSHP Board Model Plug



Model Number	Model Plug Number	Pin Resistance (Ohms)	
		Pins 1 – 4	Pins 2 – 3
25VNA024	HK70EZ001	5.1K	11K
25VNA036	HK70EZ002	5.1K	18K
25VNA048	HK70EZ003	5.1K	24K
25VNA060	HK70EZ004	5.1K	33K

Every control board contains a model plug and the correct model plug must be installed for the system to operate properly. The model plug is used to identify the type and size of the unit to the control. If a model plug is lost or missing at initial installation, the unit will operate according to the information input at the factory and the appropriate fault code will flash temporarily. However, the model plug takes priority over the information input at the factory. If the model plug is removed after initial power-up, the unit will operate according to the last valid model plug installed, and flash the appropriate fault code.

If the model plug part number is illegible or missing or if the VSHP board does not recognize the unit with the model plug in place, the model plug can be identified and the resistances verified by checking the resistance values across pins 1 and 4, then 2 and 3, as indicated in the chart.

On new units, the model and serial number are input into the board's memory, not the model plug, at the factory. A Replacement Component Division replacement board contains no model and serial number information and also does not contain a model plug. If the factory control board is replaced, the model plug must be removed from the original board and transferred to the replacement board for the unit to operate.

VSHP Ideal Defrost

AUTO Defrost Demand

- Outdoor coil temperature monitored
- Demand = or < 32°F for 4 minutes
- Demand = OAT < 50°F
- Terminated at 65°F or after 10 minutes
- Terminated if OAT > 35°F and OCT > 50°F
- Terminated if OAT < 35°F and OCT > 40°F
- OFM 20-second OFF after defrost when in heat mode
- Interval starts over if coil temperature > 65°F

AUTO Defrost Interval

- Initial power up = 30 minutes first interval
- Defrost time < 3 minutes = 120 minutes
- Defrost time 3 to 5 minutes = 90 minutes
- Defrost time 5 to 7 minutes = 60 minutes
- Defrost time > 7 minutes = 30 minutes

In the past, defrost intervals have been selectable from 30 minutes to 120-minutes in 30-minute intervals. The communicating control system has added the new Ideal Defrost which is the AUTO selection for an intelligent defrost interval made by the controls. AUTO is the default setting when used in a heat pump with the communicating control system.

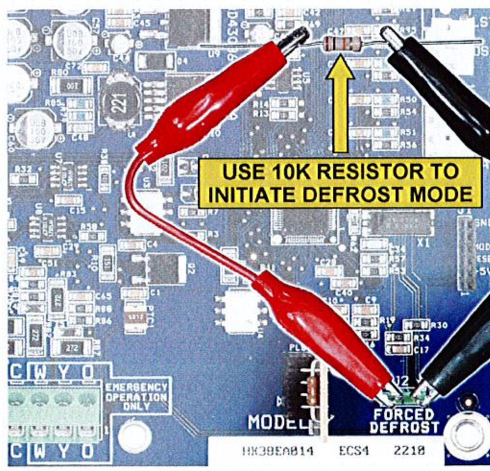
The communicating control system monitors (counts) the compressor run time minutes and as the accumulated run time approaches the defrost interval time the communicating control system monitors the outdoor coil temperature sensor for a defrost demand. If the outdoor coil temperature sensor is 32° F or lower for a period of 4 minutes, and the outdoor air temperature is below 50° F, a defrost demand has been established. If a defrost demand exists, the defrost cycle will initiate at the end of the selected time interval. Failure to sense 32° F or 32° F for 4 minutes defeats the defrost demand. At this point the interval timer will reset the accumulated time to zero (0) and the defrost interval time will start over.

When the communicating control heat pump is first commissioned and power is provided to the unit and the communicating control system, the first defrost interval will occur after a 30-minute time period until a defrost time interval is established. After the defrost time interval has been established, the defrost interval will be set to a 120-minute interval if the defrost time took less than 3 minutes, a 90-minute interval for a defrost time of 3 to 5 minutes, a 60-minute interval for a defrost time of 5 to 7 minutes, and when the defrost time was greater than 7 minutes, the defrost interval will be set to 30 minutes.

The defrost cycle is terminated when the coil temperature reaches 65° F or after 10 minutes has elapsed. The defrost cycle is also terminated if the outdoor air temperature is greater than 35° F and the outdoor coil temperature is greater than 50° F, or if the outdoor air temperature is less than 35° F and the outdoor coil temperature is greater than 40° F.

The outdoor fan motor will remain off for 20 seconds after termination of defrost to allow the system to capture the heat from the outdoor coil and reduce the "steam cloud" effect that may occur on transition from defrost to the heating cycle.

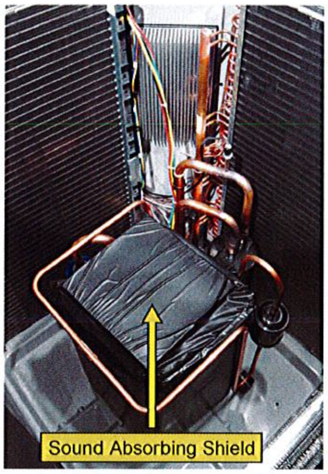
VSHP Board Forced Defrost



The defrost control contains a quick-test feature, speed-up pins located at the bottom of the board, which technicians can use to check for proper control operation in a shortened time period. There are two sequences to speed up the defrost cycle. One is a relative speed-up that shortens the defrost cycle by a factor of 0.1 seconds per minute. This means that a 90-minute run period is reduced to 9-seconds. The other places the unit immediately into a full defrost.

Speed-up is initiated by shorting the two jumpers at the bottom right of the board marked J2 for a short period of time with a 10k ohm resistor. Holding the resistor across these two wires for 1 to 3 seconds will place the unit into the relative speed-up defrost cycle. The defrost control board will step the unit through a Heating cycle and Defrost cycle using the reduced time periods. This mode ends after the Defrost cycle. Holding the 10k ohm resistor across the terminals for a longer period of time will place the unit into a forced defrost.

Compressor Section

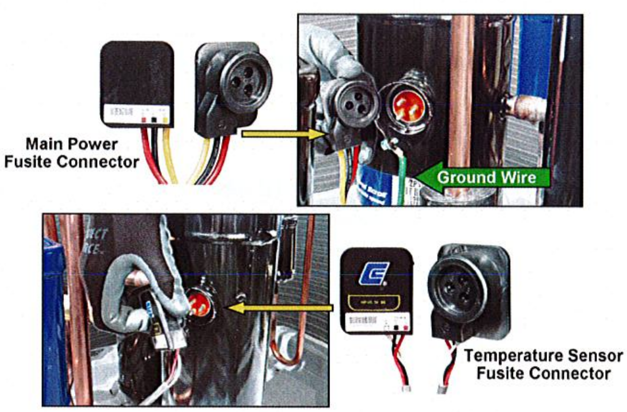


We have removed the top cover with the fan guard and the outdoor fan motor and fan along with the control panel and the outdoor condenser coil to gain access to the compressor section.

In the center of the unit's base pans sits the compressor. All compressors are encased in a sound absorbing shield to muffle some of the high pitched sound that is emitted at the extremely high operating speeds.

All units utilize scroll compressors with Puron® refrigerant, also known as R-410A refrigerant, with polyolester (POE) oil for lubrication. Beyond that, they have little in common with conventional scroll compressors. This compressor contains a three (3) phase direct current (DC) motor, not an alternating current (AC) motor.

Compressor Fusite Connections

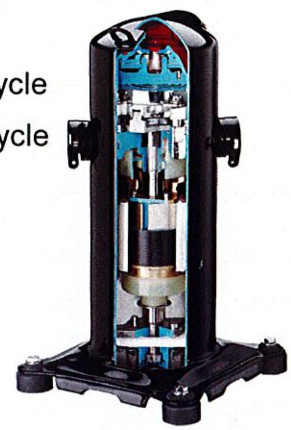


Unlike other conventional scroll compressors, this compressor has not one, but two fusite connections. One is for the main power for the compressor while the other is for the temperature sensors within the compressor. Also, the metal shroud around the power fusite is where the compressor green ground wire is connected and secured. The wire actually attaches to the shroud surrounding the fusite. The ground wire **MUST** be attached to the shroud and not to other metal surfaces for proper operation of the compressor.

Now, should the compressor power connector and the temperature sensor connector get reversed, the compressor will not operate, but additionally, no damage will occur to the compressor, to the VSD or to the wiring. Simply reverse the connections. A helpful hint here is that the compressor power connection is connected to the fusite inside of the shroud with the ground screw in it.

Hidden Compressor Differences

- Internal Motor Heater
- 4500 RPM Cooling Cycle
- 7000 RPM Heating Cycle



Some differences to this compressor from other scroll compressors cannot be seen because they are internal to the compressor shell.

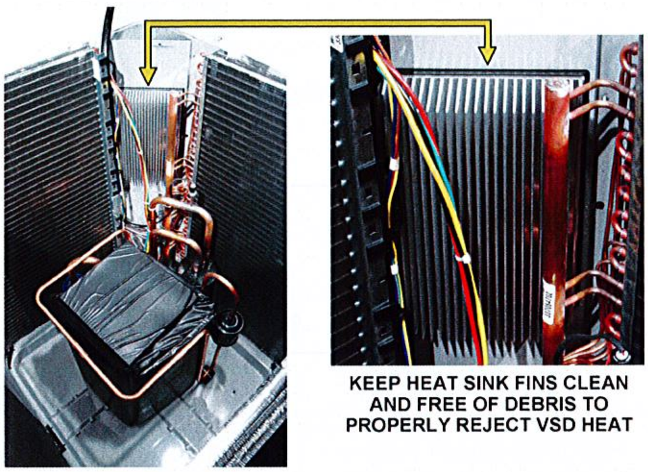
The heater for the compressor is internal to the compressor utilizing the motor windings which are energized through the VSD during the off cycle and on demand by the system to prevent the compressor from becoming the coldest part of the system. This is done by comparing the indoor air temperature at the UI and adding 40° F to it, then taking the outdoor air temperature and adding 25° F to it. So if the outdoor air temperature is 55° F and the indoor air temperature is 70° F the board will compare 80° F (55° + 25°) to 110° F (70° + 40°) indicating that the compressor is the coldest spot and turn the crankcase heater on.

If the compressor internal temperature sensor measures that the compressor sump is 15° F or colder, it will assume that the crankcase contains liquid refrigeration. When this happens, compressor sump heating will be activated to energize the crankcase heater for 2 hours before starting the compressor. When Compressor Sump Heating Active is in effect, the flash code will be displayed by the STATUS LED during the sump heating time.

Rather than being protected by an internal pressure relief, the protection is provided by the system high pressure switch and compressor torque management through the VSD and the scroll over temperature thermistor.

The operational speed of the motor in this compressor is considerably higher than other scroll compressors. Other scroll compressors incorporate two (2) pole AC motors which operate at around 3450 RPM, the synchronous speed of 3600 RPM after slippage occurs. The compressors incorporated into these variable speed heat pumps operate at speeds up to 4500 RPM in the cooling cycle and all the way up to 7000 RPM on some units in the heating cycle. Maximum speeds in the heating cycle are limited by the selection of the type of indoor fan CFM mode selected for unit operation and the outdoor temperature.

Compressor Section VSD

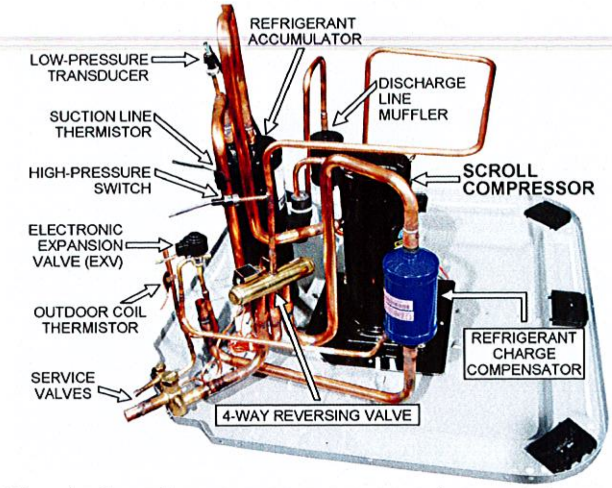


KEEP HEAT SINK FINS CLEAN AND FREE OF DEBRIS TO PROPERLY REJECT VSD HEAT

Take a close look at the top of this visual between the header end of the outdoor coil on the right and the hairpin end of the outdoor coil on the left. This is the backside of the VSD which is the heat sink and those are fins to reject heat from the VSD.

In order to properly reject the heat developed by the VSD, these fins must be kept clean and free of debris.

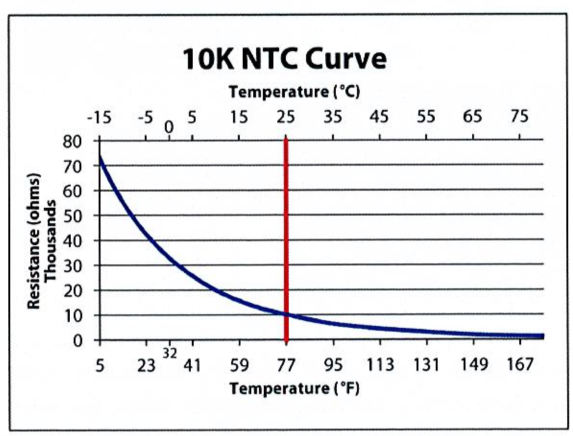
Compressor Section Components



Now look at the components arranged around the compressor in this section.

Directly in front of the compressor is the four-way reversing valve and just above the reversing valve is a high pressure switch in the discharge line. To the right of the compressor is the refrigerant accumulator with a low pressure transducer mounted in the suction line entering the accumulator. Clockwise around the compressor is a discharge line muffler and two weights secured to the discharge line. To the left of the compressor is the refrigerant charge compensator, something new in the refrigerant system. A suction line thermistor is also attached to the suction line, while an outdoor coil thermistor is attached to the liquid line where liquid refrigerant enters the distributor at the condenser coil (the distributor has been removed with the condenser coil). A new electronic expansion valve (EXV) is located in the liquid line just ahead of the outdoor coil thermistor.

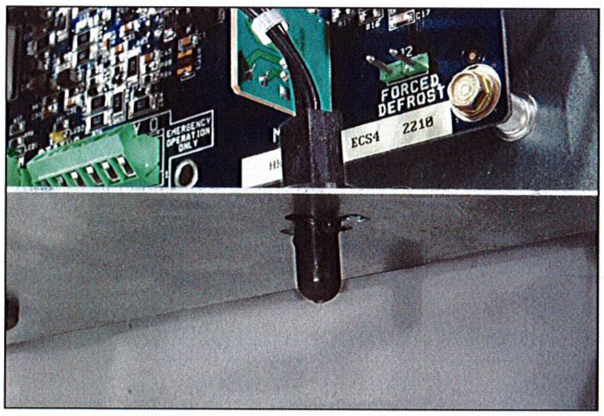
Temperature Thermistors



Thermistors are electrical devices that incorporate a resistor that changes resistance when sensing temperatures. The thermistors used on this product are negative temperature coefficient (NTC) temperature sensors, meaning that the resistance through the thermistor rises as the temperature decreases.

All of the thermistors are 10,000-ohm resistors used for multiple operations. This product utilizes six temperature thermistors, one to sense outdoor air temperature (OAT), one to sense the outdoor coil temperature (OCT), one to sense outdoor suction line temperature (OST), and three inside of the compressor. Two of the 10,000-ohm thermistors located inside of the compressor are connected in series inside the compressor motor and will measure as 20,000-ohm thermistors. The other thermistor is located in the scroll discharge to sense the scroll temperature and will measure as the conventional 10,000-ohm thermistor.

Outdoor Air Thermistor (OAT)



The outdoor air thermistor takes its reading of the outdoor air temperature and feeds that information back to the VSHP board and the UI allowing the communicating control to make decisions and commands driven by the outdoor air temperature

When performing service to the outdoor air thermistor, check and note that it should be mounted exactly in the position shown in this visual. The thermistor must be locked in place with the spherical nib end facing towards the front of the control box. This is very important for the operation of this unit.

If the outdoor air thermistor should fail, low ambient cooling will not be allowed and the one-minute outdoor fan off delay will not occur. Defrost will be initiated based upon the coil temperature and time.

If the outdoor air thermistor should fail, the control will flash fault code 53.

Outdoor Coil Thermistor (OCT)

OUT OF RANGE

COOLING MODE:	OAT = or > OCT + 10
	OAT = or < OCT - 20
HEATING MODE:	OAT = or > OCT + 35
	OAT = or < OCT - 10

The outdoor coil thermistor provides the coil liquid line temperature to the VSHP board and the UI. It is the main device that puts the heat pump into defrost and takes it out of defrost and cycles the outdoor fan motor for low ambient operation. For some functions it works in conjunction with the outdoor air temperature thermistor. It also serves as a calibration check on itself with the outdoor air thermistor.

The control continuously monitors and compares the outdoor air temperature sensed with the outdoor coil temperature sensed to ensure proper operating conditions. For example, in the cooling mode if the outdoor air temperature sensed is 10° F or more warmer than the coil temperature sensed or if the outdoor air temperature sensed is 20° F or more cooler than the coil temperature sensed, the sensors are out of range. In the heating mode if the outdoor air sensed is 35° F or more warmer than the coil temperature sensed or if the outdoor air sensed is 10° F or more cooler than the coil temperature sensed, the sensors are out of range. The thermistor comparison is not performed during low ambient cooling or during the defrost operation.

The control continuously monitors and compares the outdoor air temperature sensed with the outdoor coil temperature sensed to ensure that they are operating within their designed range. If the sensors are out of range, the control will flash fault code 56.

When performing service to the outdoor coil thermistor, check and note that it should be mounted to the tube connecting the EXV and the distributor exactly as shown in this visual. The thermistor must be secured tight on the tube. This is very important for the operation of this unit.

If the outdoor coil thermistor should fail, low ambient cooling will not be allowed. Defrost will occur at each time interval during heating operation, but it will terminate after 5 minutes.

If there is a thermistor out-of-range fault, defrost will occur at each time interval during heating operation, but defrost will terminate after 5 minutes.

If the outdoor coil thermistor should fail, the control will flash fault code 55.

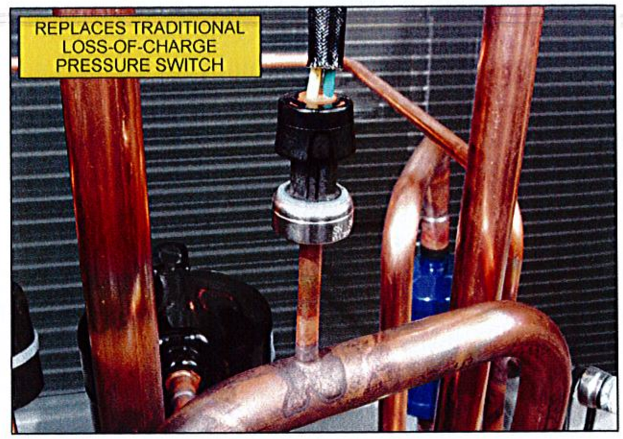
Suction Line Thermistor (OST)

The suction line thermistor is located on the suction line between the accumulator and the reversing valve a short distance from the suction line transducer. The outdoor suction line thermistor is used for assisting in the electronic expansion valve (EXV) control and system refrigeration charge determination.

When performing service to the outdoor suction line thermistor, check and note that it should be mounted exactly in the position shown in this visual. It must be secured tightly to the suction line aligned longitudinally along the tube axis in the vertical position. The curved surface of the thermistor must hug the curved surface of the suction line and secured tightly using the UV resistant black wire tie fished through the original slot of the insulating polymer body in order to minimize the influence of ambient temperatures. This is very important for the operation of this unit.

If the outdoor suction line thermistor should fail, the control will flash fault code 57.

Suction Line Pressure Transducer

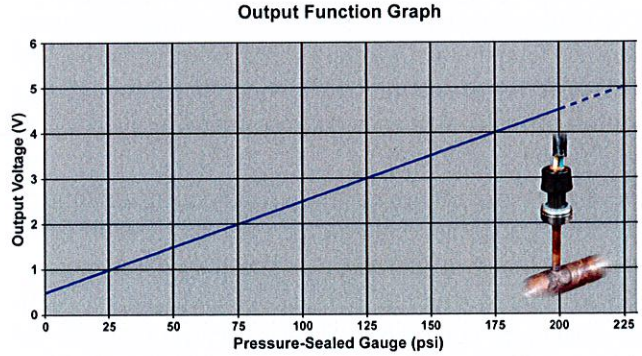


Each model has a suction line pressure transducer mounted on the suction line between the accumulator and the reversing valve. This replaces the traditional loss-of-charge pressure switch ordinarily used on the liquid line of a heat pump.

The suction line low pressure transducer interprets the pressure data used by the VSHP board for low pressure cutout, loss of refrigerant charge protection, oil circulation and lubrication management, EXV control and compressor overall envelope management.

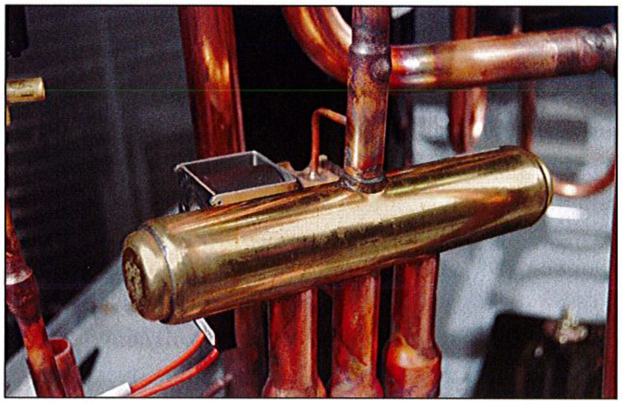
Pressure Transducer Interpretation

Output Function Graph



This low pressure transducer provides a 0.4 to 5 VDC signal to the VSHP board. The VSHP control board then translates this 0.4 to 5-volt signal to pressure proportionally from 0 to 200 psig. This translated pressure is then used by the VSHP board to shut down the unit at the appropriate low pressure setting; and for protection and management of loss of charge, management of compressor overall envelope operation, management of oil circulation, lubrication and the control of the electronic expansion valve (EXV).

Reversing Valve



The four-way reversing valve is provided with a removable and replaceable solenoid coil. Simply remove the screw holding the coil assembly to the valve body and remove the coil assembly; there is no need to remove the entire valve should the solenoid coil fail.

High Pressure Switch (HPS)

The high pressure switch is located in the discharge line from the compressor and shuts down the compressor under abnormally high, high side system pressures. It is brazed directly to the discharge line and should it fail, the refrigerant in the outdoor unit will require removal and recovery before the failed switch can be removed and replaced.

If the VSHP board senses that the high pressure switch has opened, it will respond as follows:

- De-energize the compressor contactor.
- Continue to keep the outdoor fan running for 15 minutes.
- Display the appropriate fault code.
- After 15 minutes, if the high pressure switch has closed and if there is a call for heating or cooling the compressor contactor will energize.
- After 15 minutes, if the high pressure switch has not closed the outdoor fan motor will be turned off. If the open high pressure switch closes anytime after the 15-minute delay, the unit will resume operation with a call for cooling or heating at a temporary reduced capacity.
- If the high pressure switch trips three consecutive cycles, the operation of the unit will be locked out for 4 hours.

Electronic Expansion Valve (EXV)

MODE	ELECTRONIC EXPANSION VALVE POSITION
Cooling	EXV is wide open
Heating Pre Set	Control board determines target position, depending on speed and ambient temperatures for 120-seconds
After Heating Pre Set	Control board controls EXV as needed to control suction superheat and/or compressor load
Defrost	EXV is wide open

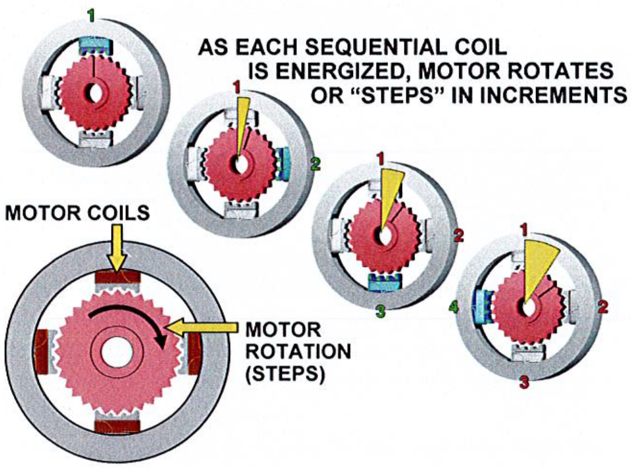
In the outdoor unit there is an expansion device used in the heating mode but unlike a thermal expansion valve (TXV) that operates on system pressures and temperatures, this is an electronic expansion valve (EXV) and it operates on an electronic command from the VSHP board with pressure and temperature inputs. The operation of the EXV is similar to a TXV.

The operation of the TXV is simply a needle valve that moves in and out in relationship to an orifice in the internal body of the valve, thereby throttling the amount of refrigerant that is allowed through the valve. This is controlled by the refrigerant temperature and refrigerant pressure. The operation of the EXV is the same; a needle valve moves in and out in relationship to an orifice in the body of the valve throttling the amount of refrigerant that is allowed through the valve. The difference is that a small electric motor, called a stepper motor, drives the needle valve in and out of the orifice. This is performed by the motor turning an inside threaded cylinder, the female screw, over a threaded shaft, the needle valve. The linear movement opens and closes the needle valve-orifice assembly.

From the factory, the unit is shipped with the EXV in the open position. At power up the VSHP board reset the position of the EXV and sets the valve logic to close by attempting to over close the valve. All open positions of the EXV during the heating, cooling and defrost cycle are derived from this closed position. When the heating, cooling or defrost cycle are terminated and the unit is turned off, the VSHP board again attempts to over close the EXV, then repositions it to a partially open position. There are a total of 600 steps of the stepper motor from the closed to the full open position.

In the cooling mode, the control board controls the EXV to its full open position. In the heating mode, the control board initially operates through a Pre Set condition that closes the EXV to a target position, the position that is dependent upon the compressor speed and the outdoor air temperature, and maintains that target for 120 seconds. Upon completion of the Pre Set position the control board controls the EXV as needed to control the suction superheat and/or the compressor load. During defrost the control board controls the EXV to its full open position.

Stepper Motor

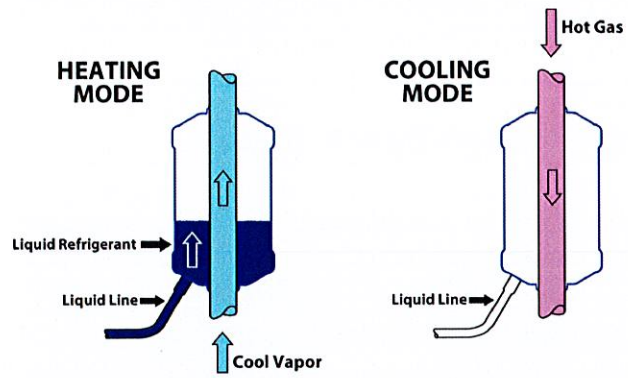


A stepper motor is a brushless, synchronous electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled without any feedback mechanism. Stepper motors operate differently from DC motors. Stepper motors have multiple toothed electromagnets arranged around an iron shaped gear. The electromagnets are energized by an external control circuit, in our case, the VSHP board. In our example we will use four magnetic poles, an even number, and a gear with 25-teeth, an odd number, so that when the teeth are aligned with the first pole, they will be offset at the second pole.

To make the motor shaft turn, first one electromagnet is given power, which makes the gear's teeth magnetically attracted to the electromagnet's teeth. When the gear's teeth are thus aligned to the first electromagnet, at 1, they are slightly offset from the next electromagnet, at 2. So when the next electromagnet, at 2, is turned on and the first is turned off, the gear rotates slightly to align with the gear at 2. The process is repeated because when the gear's teeth are aligned, at 2, they are slightly offset at 3, and when the gear's teeth are aligned, at 3, they are slightly offset at 4. When the top electromagnet, at 1, is again enabled, the teeth in the sprocket will have rotated by one tooth position. Each of these slight rotations is called a "step." Since it took four steps to rotate the gear one tooth, because our motor has 25 teeth, it will take 100 steps, four times the number of teeth, to make a full rotation.

Stepper motors exhibit a slight audible noise as the discrete step tends to snap the rotor from one position to another causing a vibration. This is because the rotor is being held in a magnetic field. On each step the rotor overshoots and bounces back and forth. As service technicians, this vibration is a benefit for you when troubleshooting since you will be able to hear the stepper motor during operation, and conversely, it will be quiet when it is not operating, even though it should be operating.

Charge Compensator

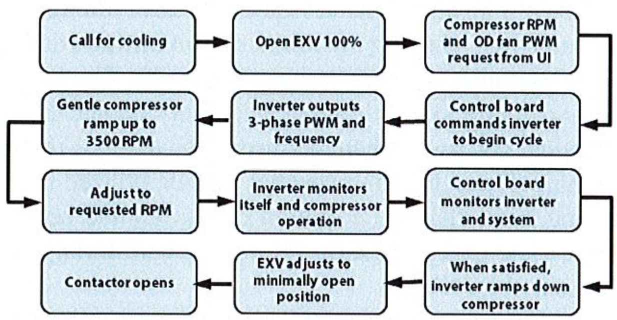


The unit incorporates the addition of a device called a refrigerant charge compensator. It looks a little like a liquid line filter drier but serves a completely different purpose. Also note, that unlike a filter drier that has an entering and leaving refrigerant line, there is a third line near the inlet tube, in the heating mode, of the charge compensator. The charge compensator is a refrigerant storage device located between the liquid service valve and the expansion device (EXV) to store excess liquid refrigerant ***only*** in the heating mode.

The charge compensator is sized to store the difference in the expected refrigerant charge required in the heating mode between an ideally matched largest indoor application and the smallest indoor application, preventing a refrigerant charge imbalance. The refrigerant, if not stored, would cause an imbalance to the system leading to a high system head pressure and depending upon the operating condition, could lead to excessive compressor flooding in an attempt by the EXV to manage the head pressure, resulting in poor compressor reliability and poor system performance.

In the heating mode, excess refrigerant charge is drawn in through the liquid port with the help of the cooler refrigerant passing through the center tube. The colder refrigerant from the evaporator coil, the outdoor coil in the heating mode, enters and passes through the compensator. The colder refrigerant leaves the compensator and returns to the compressor section. Hot refrigerant enters the compensator in the cooling mode from the compressor after changing flow direction through the reversing valve. The hot refrigerant then leaves the compensator driving out the stored refrigerant from the heating mode and enters the condenser coil, the outdoor coil in the cooling mode.

Sequence of Operation - Cooling



Upon a call for cooling through the UI the VSHP board will open the EXV to the full open position and close the compressor contactor. Then based upon the indoor space demand and the outdoor conditions, the UI will request a compressor speed (RPM) and the outdoor fan motor pulse-width modulation signal. If the conditions are right for operation, the control board will allow the requested operation to begin, but if the control board determines that the conditions are not correct the board will decide what conditions are acceptable.

The VSD then outputs the three-phase PWM signal and frequency which gently ramps the compressor speed up to 3500 RPM, to achieve scroll seal, and then will adjust to the demanded speed. The gentle ramp up results in no locked rotor amps to the compressor motor. The unit nameplate for compressor LRA will be stamped N/A (not applicable).

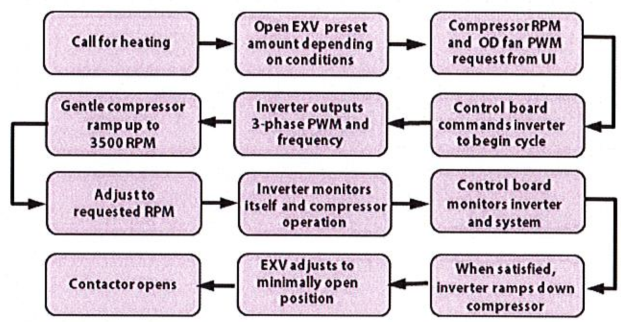
During cooling operation the VSD monitors itself and the compressor operation while the VSHP board monitors the VSD along with the system pressures and temperatures. During cooling operation the compressor speed will be adjusted to meet the changes to the demand for cooling.

When the cooling demand is satisfied, the VSD will ramp down the compressor speed and stop. The EXV will adjust to its minimally open position and the contactor will open.

There is a 5-minute time delay to start cooling operation when there is a call from the UI or when the unit returns from a brownout condition. This can be bypassed by momentarily shorting the Forced Defrost pins.

When the outdoor ambient temperature is below 75° F, the compressor contactor will close occasionally to monitor the compressor temperature and energize the stator heater if conditions require.

Sequence of Operation - Heating



Upon a call for heating through the UI the VSHP board will open the EXV to a preset position depending upon the conditions and close the compressor contactor. Then based upon the indoor space demand and the outdoor conditions, the UI will request a compressor speed (RPM), and the outdoor fan motor pulse width modulation signal. If the conditions are right for operation, the control board will allow the requested operation to begin, but if the control board determines that the conditions are not correct the board will decide what conditions are acceptable.

The VSD then outputs the three-phase PWM signal and frequency which gently ramps the compressor speed up to 3500 RPM, to achieve scroll seal, and then will adjust to the demanded speed. The gentle ramp up results in no locked rotor amps to the compressor motor. The unit nameplate for compressor LRA will be stamped N/A (not applicable).

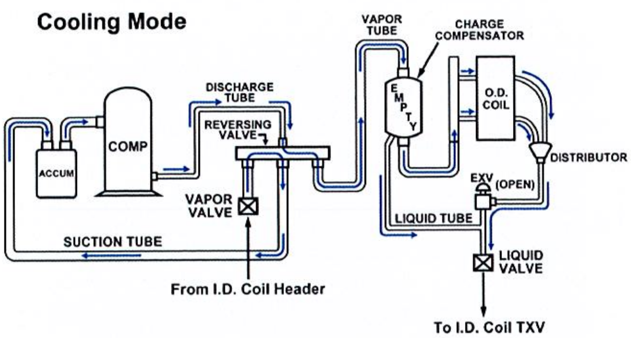
During heating operation the VSD monitors itself and the compressor operation while the VSHP board monitors the VSD along with the system pressures and temperatures. During heating operation the compressor speed will be adjusted to meet the changes to the demand for heating.

When the heating demand is satisfied, the VSD will ramp down the compressor speed and stop. The EXV will adjust to its minimally open position and the contactor will open.

There is a 5-minute time delay to start heating operation when there is a call from the UI. This can be bypassed by momentarily shorting the Forced Defrost pins.

When the outdoor ambient temperature is below 75° F, the compressor contactor will close occasionally to monitor the compressor temperature and energize the stator heater if conditions require.

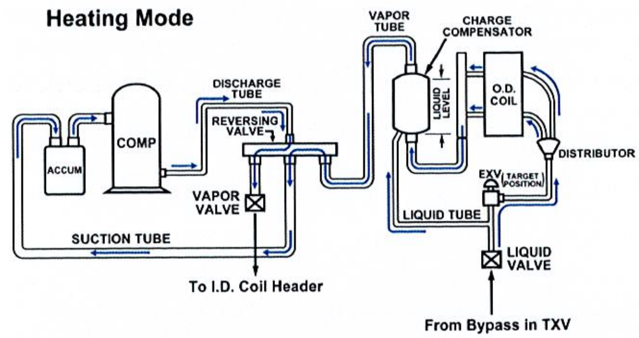
Refrigerant Management - Cooling Mode



The refrigerant hot gas leaves the compressor through the discharge tube entering the reversing valve which directs the refrigerant through the tube that goes through the charge compensator. At the same time, any liquid refrigerant that was stored in the charge compensator in the heating mode will start to be drawn back into the refrigeration system. Since the refrigerant vapor going through the middle tube of the charge compensator is hot, it will serve to help drive the liquid refrigerant out of the chamber of the charge compensator.

The hot vapor refrigerant will enter the outdoor coil cooling as it passes through the coil and exit through the feeder tubes and refrigerant distributor. The EXV is driven full open in the cooling mode therefore the liquid refrigerant will pass through the EXV and flow to the TXV of the indoor coil. After passing through the TXV of the indoor coil, the refrigerant will cool, flowing through the indoor coil exiting and flowing back to the outdoor unit reversing. The reversing valve will direct the refrigerant to the suction tube, through the accumulator and back to the compressor.

Refrigerant Management - Heating Mode



The refrigerant hot gas leaves the compressor through the discharge tube entering the reversing valve which directs the refrigerant to the indoor unit coil header. The heated refrigerant provides heat to the indoor air circulated over the indoor coil and is then returned to the outdoor unit as a liquid. The indoor unit contains a TXV utilized in the cooling mode that has a built-in bypass for the heating mode. The refrigerant exits the indoor coil through the bypass in the TXV.

The liquid enters the EXV which is open depending upon the unit load and throttles the refrigerant to the refrigerant distributor, through the feeder tubes through the outdoor coil. At the same time excess liquid refrigerant is drawn through the liquid tube into a chamber in the charge compensator. As the colder refrigerant leaves the outdoor coil it flows through a tube that goes through the liquid chamber of the charge compensator which helps to draw liquid refrigerant into the liquid chamber of the charge compensator.

The charge compensator is sized to hold the maximum amount of charge that needs to be stored between the size of the outdoor unit and the difference in size of the smallest and largest indoor unit that can be installed into the system. Therefore, during the heating mode the amount of refrigerant in the charge compensator could partially to fully fill the charge compensator.

After exiting the charge compensator the cold refrigerant vapor will flow through the reversing valve, through the accumulator and back to the compressor.

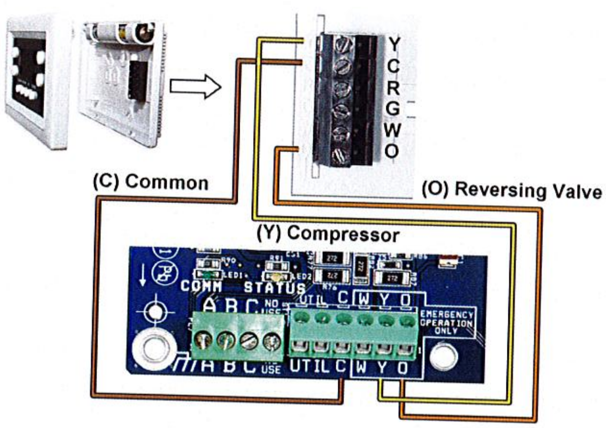
Complete the Introduction and Familiarization Quiz at the back of the book and then check your answers to see how familiar you are with the variable speed heat pump. With the information in this section you will be able to know these products with confidence.

Controls and Hardware

In the Controls and Hardware section of this program, you will be introduced to the communicating controls utilized within the system. We will cover the process that the communicating control system goes through upon start-up as well as the parameters that both the homeowner and the technician can set during the commissioning of the system.

User Interface Overview

- User interface used with:
  - Communicating (ABCD wired) split systems
  - Communicating (ABCD wired) small packaged product system
  - Partially communicating split system
    - Communicating indoor unit (ABCD wired)
    - Non-communicating outdoor unit (No ABCD wires)
- Full system features available through ABCD wiring
- Limited system features without ABCD wiring
- User interface may be replaced by normal thermostat in an emergency situation

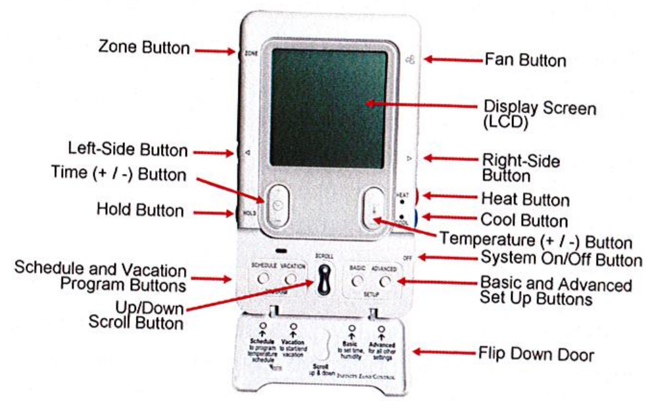


A fully communicating system requires ABCD communication bus wiring between the UI and the system's indoor and outdoor equipment components.

In addition to controlling indoor temperature for these systems, the UI also provides features that include the ability to humidify, dehumidify, control ventilation air, and provide system diagnostics. The UI provides dirty filter detection, establishes relative duct size in a zoning system, and notifies the user when maintenance is required. Many of the above features rely upon direct communication between the UI and the indoor unit and blower motor through the ABCD bus.

The UI normally performs thermostat type functions for the system. However, after the units have been configured with the communicating control UI, they can be made to work under emergency situations with a heat pump room thermostat. To operate the system with a room thermostat, connect thermostat wires from the Y, C, and O terminals on the VSHP board.

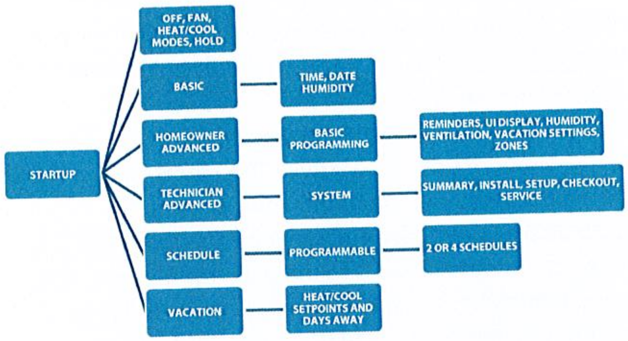
User Interface



The UI control consists of a display screen and several buttons. The screen and buttons provide normal UI with the communicating control system. The display screen shows operational information, and menu choices consistent with buttons pushed by the user. Navigation through menu choices is accomplished with the Left Side, Right Side, Time (+ / -), Temp (+ / -) and Scroll buttons.

The UI is available in a non-zoned and zoned version. The zoned and non-zoned versions look the same with one exception - on the zoned version, the button located at the top left that allows the user to switch between displaying outside air temperature and room relative humidity is labeled ZONE. The zoned version is shown above.

System Display Roadmap



To better help you understand the approach that we will be taking navigating through the UI display screens, we are presenting an outline of what to expect.

First, when power is applied to the UI for the very first time, several screens will be displayed where only information will be provided. When the UI stops displaying information, you will be asked to input information identifying equipment that may or may not be installed into the system. Air filter type is one example. Also, accessories will have to be identified since it is not possible for the system to self identify these installed accessories. This is the STARTUP menu. This menu will also include information that is accessible with the Off, Fan, Vacation, Schedule, Hold and the Heat and Cool Mode buttons.

The second set of screens, displayed through the BASIC button, will be used to set the current time, date and desired humidity control.

The third set of screen displays will access the settings that the homeowner should be able to perform with the Homeowner's ADVANCED button. The Homeowner's ADVANCED screen displays can be accessed by momentarily pressing the ADVANCED button. These screens include the basic programming that is outlined in the Homeowner's Guide which includes setting reminders, adjusting the screen display, setting humidity levels, ventilation and a vacation schedule. If the residence has a zoned system, there will be zone information that the homeowner can change, such as naming the zones.

The fourth set of screen displays is very comprehensive and access is intended only for the service technician, through the Technician's ADVANCED button. The Technician's ADVANCED screen displays can be accessed by pressing and holding the ADVANCED button down for at least 10 seconds. These displays include viewing the summary of equipment that is installed in the system, installing and/or removing equipment to the system, setting up the different equipment in the system, performing checkout tests to the equipment along with accessing service information.

Check Before Start-up

1. Complete checklist
2. Check field-installed accessories
3. System leak-checked and tight
4. Refrigeration gages in place
5. Electrical power source agrees with unit nameplate
6. Voltage within limits
7. Fan motors
8. All electrical terminals, plugs, and connections secure
9. Check all field-installed control wiring against wiring labels
10. HEAT and COOL set points verified
11. Air filters in position
12. Condensate trap filled
13. Check gas lines for leaks (Hybrid Heat® unit)
14. Check bumer alignment (Hybrid Heat unit)
15. Attach gas manometer to gas manifold (Hybrid Heat unit)
16. Remove tools and replace all panels

IMPORTANT: Complete the Start-Up Checklist for this unit in the back of the Installation Instructions that accompanied the unit. The Checklist assures proper start-up of the unit, and provides a record of the unit condition, application requirements, system information, and operation at initial start-up.

If the system has field-installed accessories, ensure that all are installed and wired correctly.

Be sure to use a leak detector suitable for R-410A when leak checking. Repair any leaks following the Refrigerant Service Procedures. Install a filter drier whenever the system has been opened for repair.

At this time, refrigeration gages should be connected to the suction and discharge tube to the compressor.

Verify that the electrical power servicing the unit agrees with the nameplate on the unit. Voltage to the units must be within the limits shown on the unit nameplate.

Make sure that the outdoor-fan blade is correctly positioned in the condenser fan orifice.

During shipment the unit experiences considerable vibration, which could loosen electrical terminals. Electrical terminals must be checked prior to start-up.

Make sure that the indoor air filters are properly installed.

Make sure that water has been added into the condensate drain pan and the condensate "P" trap is filled with water to ensure proper drainage.

For Hybrid Heat® unit, check all joints in the gas line system for any leaks. NEVER check using a flame, but instead, use water mixed with soap. Check to see that burners did not move during shipment. Realign burners if necessary. Install a gas pressure manometer to the gas manifold to check for proper pressures and flow after start-up.

Make sure that all tools and miscellaneous loose parts have been removed from within the units and all panels are in place.

INITIAL POWER UP

Installed Equipment

In order for the UI to control the installed system, the system it controls must first be configured in its memory by identifying the installed equipment components.

Upon initial power up of this split system, the UI automatically searches the A and B bus to find communicating equipment control boards. The interface then informs the user that it is searching for equipment and then the outdoor unit. If the electric heater is not self identifiable, but does exist, the UI prompts the user to identify the size of the heater in KW. The software will not allow an electric heater size that exceeds the normal range of capacity designed to fit with that indoor unit size. If the "OUTDOOR UNIT NOT IDENTIFIED" message appears, and you are sure that communication-capable equipment is installed, check the ABCD wiring.

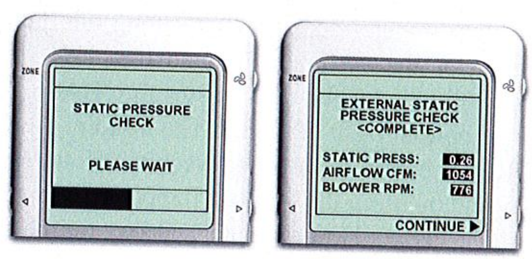
The identification of installed accessories must be entered manually with the UI. This generally includes air filter type, humidifier installed, ultra violet lamp installed or a network interface module (NIM). After prompting the installer to identify all accessories provided and after searching for zoned equipment, the UI displays an EQUIPMENT SUMMARY screen. Note that for our equipment the outdoor unit is identified as a 60,000 Btu variable speed heat pump, HP VARSPD 60 KBTU. If zone dampers were detected ZONE would also appear on this screen.

If any errors have been made, the installer can move back through the screens to make appropriate changes. If everything is satisfactory, the installer presses the button adjacent to "EXIT" on the display to exit the EQUIPMENT SUMMARY screen, and save the equipment settings. The UI is now accurately configured for the installed equipment, and ready to operate.

Static Pressure Check

At the desired airflow measures:

Duct static pressure, system cfm, and motor rpm



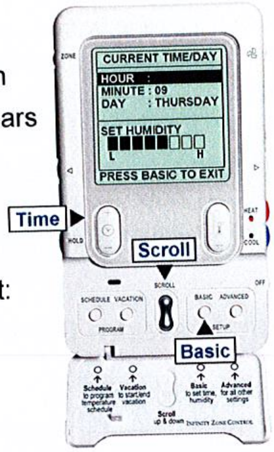
The STATIC PRESSURE CHECK screen will appear after SETUP is exited. A static pressure check of the system will only take a few minutes. The system will deliver the installed equipment maximum airflow, and perform a static pressure check. During this check, the control instructs the indoor fan motor to increase speed until the desired airflow is reached, and calculates the resultant external static pressure of the system. This process will take only a minute or two to complete.

When completed, a screen will appear displaying the static pressure, in inches water, airflow in CFM, and blower motor speed in RPM, at the system's highest delivered airflow.

For a zone system, the DUCT ASSESSMENT CHECK will start after the STATIC PRESSURE CHECK is completed.

Basic Setup

- Drop lower door on UI
- Press the "BASIC" button
- Basic setup screen appears
- Press BLUE (COOL) or RED (HEAT) button for Humidity Set Point
- Use (+,-) "TIME" and "SCROLL" buttons to set:
  - Hour
  - Minute
  - Day
  - Humidity



A quick start of the system is obtained by performing a BASIC Setup which involves setting the UI clock to the current hour, minute, and day, and setting the humidity set points for the system. To enter the Basic Setup screens within the UI the user presses the "BASIC" button on the bottom right of the UI. The installer then uses the SCROLL button to move between the Hour, Minute and Day and by using the Time or Temp (+ / -) button to establish the correct Hour, Minute, and Day for the UI internal clock.

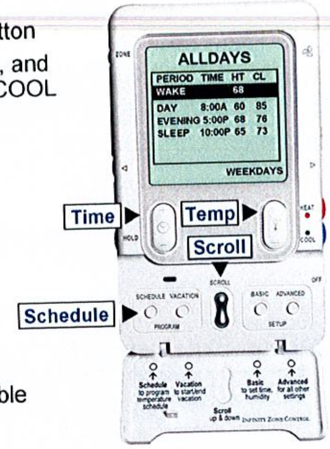
By using the Scroll button, the user moves the setup choice down to the SET HUMIDITY choice. The cooling dehumidification set point is adjusted by first pressing the mode button adjacent to the blue light. The cooling humidity set point can be adjusted by pressing the Time or Temp (+ / -) button.

The heating humidification set point is adjusted in a similar manner by first pressing the mode button adjacent to the red light. The heating humidity set point can be adjusted by pressing the Time or Temp (+ / -) button.

Pressing the BASIC button again causes the UI to leave the Basic Setup function and prompt the user if they want to save the changes they made.

Schedules

- Press "SCHEDULE" button
- Use "SCROLL", "TIME", and "TEMP" buttons to set COOL and HEAT set points for periods:
  - Wake
  - Day
  - Evening
  - Sleep
- Program for:
  - All days
  - Weekend days
  - Individual days
- Copy command available

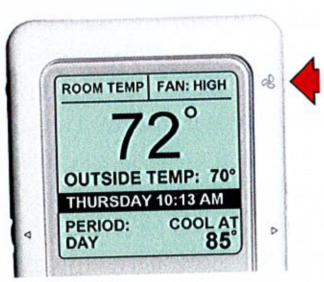


The user programs the set point schedules by pressing the SCHEDULE button. Using this display, the user may program heat and cool set points for 2 or 4 periods of each day of the week for both occupied and unoccupied periods. For a zoned system, these periods may be programmed for each zone.

By pressing the SCHEDULE button, a set point schedule period screen appears displaying day choices at the top of the menu, ALL DAYS in this case, and four or two occupied time periods in a vertical manner. In a zoned system, the pre-selected zone name will appear at the top of the screen.

Programmable Fan and Fan Speeds

- Press "FAN MODE" button
  - AUTO (Cool or Heat speed)
  - LOW (50% HIGH speed)
  - MED (LOW + 40% [High-Low])
  - HIGH (100% Cool or Heat speed)
  - Back to AUTO
- AUTO:
  - Airflow set by cool/heat routines
  - Fan OFF when no call for cool or heat
- HIGH/MED/LOW:
  - CONTINUOUS fan
  - Call for cool or heat
    - Airflow set by cool/heat routines
  - No call
    - Airflow set by fan speed chosen for non-zoned system
    - Airflow set sum of zone fan speed airflows for zoned system



With the PROGRAMMABLE FAN value set to ON, the user may program a continuous fan speed for each zone and each period. This programmed speed will automatically be used to provide continuous fan operation whenever there is no call for cooling or heating. Scheduling the fan speed follows the same basic steps as programming time and temperature settings. When PROGRAMMABLE FAN is set to OFF, pre-programming of fan speed is NOT possible.

The homeowner may choose fan speeds by depressing the FAN button at the upper right of the UI. The fan speed may be switched in sequence from AUTO to LOW to MED to HIGH and back to AUTO. By choosing a fan speed other than AUTO, the user has decided to manually intervene with how the software normally handles system airflow.

Selecting a fan speed creates **continuous fan** operation with the fan always ON - whether or not there is a call for cooling or heating.

Vacation Schedule

- Press "VACATION" button
- Press "TIME" button to set number of days
- Press "COOL" or "HEAT" button to choose set point mode
- Press "TEMP" button to choose set point
- Press "VACATION" button to start vacation period

A vacation period may be programmed into the UI starting with the present day displayed on the screen. For example, if the normal display screen says it is Thursday, a vacation of 4 days may be created that starts on Thursday, the first day, and ends on Monday, the fifth day. Pressing the VACATION button at the lower left of the UI displays the VACATION definition screen. By using the Time (+ / -) button, the user may define the number of days for this vacation period, starting with today being a vacation day.

System Mode

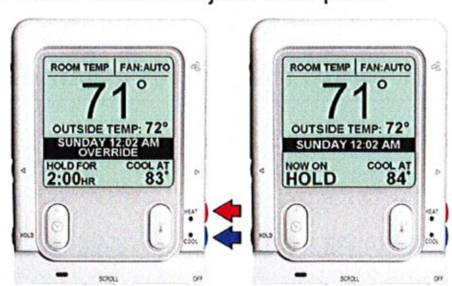
- Press "COOL" button for cooling mode
- Press "HEAT" for heating mode
- Press "COOL" and "HEAT" simultaneously for AUTO mode
  - User Interface selects mode based on room temp vs. room set point

The system mode may be selected by the user as COOL, HEAT, or AUTO. By pressing the COOL button, the system will be fixed in the cooling mode of operation. Additionally, the programmed cooling set point appears on the screen below the system mode. By pressing the HEAT button, the system will be fixed in the heating mode of operation and the programmed heating set point appears on the screen below the system mode.

By simultaneously pressing the HEAT and COOL buttons, the user places the system in the AUTO heat/cool changeover mode. Both heating and cooling set points will appear on the screen below the system mode.

Override and Hold

- Temporarily alter set point
- Press "COOL" or "HEAT" button
- Press "TEMP" button to set mode set point
- HOLD appears
- Press "TIME" button to adjust HOLD period



The user may temporarily alter the system's mode of operation and the appropriate programmed set point by overriding the set point, for example placing a 2 hour OVERRIDE on the system, or by placing an indefinite HOLD on the system. This is accomplished by pressing the required mode button, COOL or HEAT, to establish the mode of the system. Next, the user presses the Temp (+ / -) button, and the display increases/decreases the set point in 1° F increments. At the same time, the screen also displays OVERRIDE under the date and time with the message "HOLD FOR 2:00 HR". By pressing the Time (+ / -) button the user may increase/decrease the amount of time the adjusted set point will be utilized in 15-minute increments, up to 24 hours.

USER INTERFACE — HOMEOWNER ADVANCED SETUP

Advanced Setup for the Homeowner

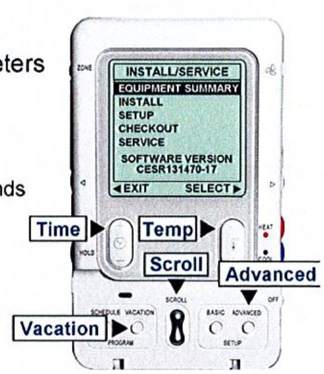
The UI includes an "ADVANCED" Setup function, designed for the homeowner, that contains a number of **default settings**. These settings influence how the communicating control system operates during both the Occupied and Unoccupied periods of each day, and include:

- Reminder prompts (screen 1)
- UI display settings (screen 2)
- Heating humidity set point (screen 3)
- Cooling humidity set point (screen 4)
- Ventilation air ON/OFF when with an HRV/ERV, (screen 3 for heating, screen 4 for cooling)
- Vacation default settings (screen 5)
- Heat source (screen 6) for a Hybrid Heat® non- zoned system
- Unoccupied zone period settings (screen 6)
- Zone names (screen 7)
- Heat Source (screen 8) for a Hybrid Heat® zoned system.

USER INTERFACE — TECHNICIAN ADVANCED SETUP

Advanced Setup for the Technician

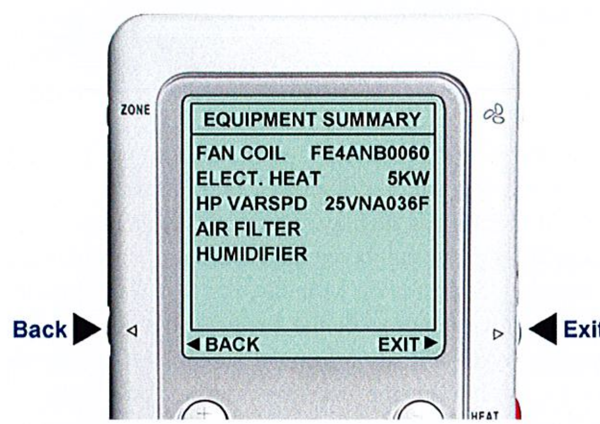
- For technician
- System operating parameters
- Troubleshooting data
- Activate:
  - Advanced button 10 seconds
- No activity 60 minutes
  - Menus close



The menus displayed after pressing and holding down the ADVANCED button for 10 seconds are designed for the technician and NOT for the homeowner and are not included in the Homeowner's Guide. These menu choices contain vital information that defines the operating parameters of the communicating control system. Operating parameters provide the ability to customize the control to match the exact needs of the installation. Troubleshooting information provides the service technician with helpful information for problem resolution.

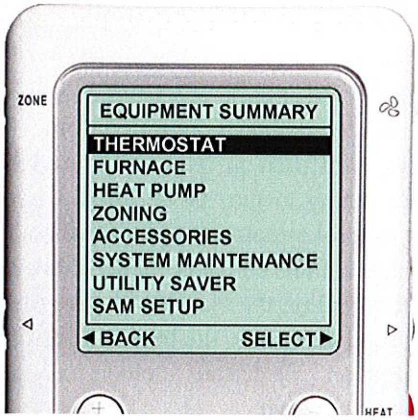
Since these menu choices are designed to be used by the technician and not the homeowner, these menu choices can only be accessed by holding down the UI ADVANCED button for 10 seconds. After pressing and holding the ADVANCED button for 10 seconds, if no push button activity takes place for 60 minutes, the UI software will automatically exit these menus. The menus include EQUIPMENT SUMMARY, INSTALL, SETUP, CHECKOUT and SERVICE.

Equipment Summary



The EQUIPMENT SUMMARY shows all the equipment that has been identified by the UI and defined during the system power-up. This summary is also useful for the first time service person to see what accessories have been installed. However, additional accessories may have been installed or removed and that information can be updated here.

Equipment Setup



The SETUP Menu allows the technician to alter the default values that define equipment and system operating parameters to match the exact needs of the installation.

The THERMOSTAT will be set up to meet the needs of the homeowner. The indoor unit, a FURNACE for example, and the outdoor unit, a HEAT PUMP for example, will be set up to operate in a preselected manner. If this were a zone system, ZONING would be displayed to set up the different zones. ACCESSORIES can be added, deleted or changed in the system. Reminders can be placed on the system for routine SYSTEM MAINTENANCE and on accessories for replacement of items like filters. UTILITY SAVER can be turned on or off to curtail the use of power during peak demand periods. The heat pump can either be turned off or limited to one-half capacity for a 2-stage heat pump.

If this were a zoned system, ZONING would be displayed right after HEAT PUMP.

Thermostat Setup

- Auto mode
- Deadband
- Offsets = sensor calibration
- Cycles per hour
- Programming schedules
- Smart recovery
- English/Metric
- Reset factory default

The THERMOSTAT SETUP Menu allows the technician to set the UI to respond as a room thermostat. Automatic changeover from heat to cool can be set by enabling the AUTO MODE or disabling it if the homeowner wants to control it. If the AUTO MODE is enabled, there are menus to allow the installer to adjust the time delay between system CHANGEOVER TIME, from 5 to 120 minutes, in 5-minute increments.

The DEADBAND between cooling off and on and heating off and on can be changed. The DEADBAND can be set from 0° F (zero) to 6° F in 1° F increments. However, there is a minimum difference of 2° F between the heating and cooling set point temperatures.

OFFSETS can be used to calibrate the indoor room air sensor, outside air sensor and the humidity sensor. The offset temperature range is from -5 to + 5° F with a humidity offset range from -10 to +10% all with a factory default setting of zero.

The installer may change the number of CYCLES PER HOUR during which the equipment may start, run and stop from 4, the factory default value, to 6.

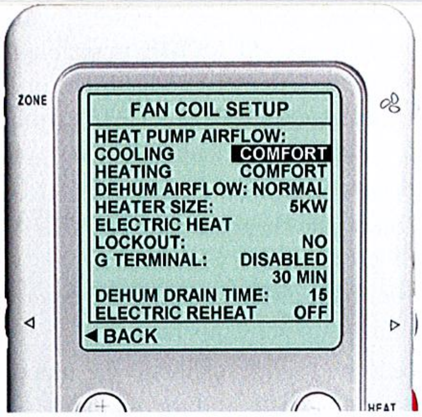
If PROGRAMMING is set to ON, the UI SCHEDULE button is functional and the user may program occupied and unoccupied set points for up to four periods of each day of the week, including each zone with a zoned system. When set to OFF, the schedule button may not be operated, and schedule programming is NOT possible.

SMART RECOVERY can be activated to ensure that the space temperature is at its set point when each schedule is activated. SMART RECOVERY starts the system 90 minutes prior to the programmed schedule start time for both cooling and heating modes.

The ENGLISH/METRIC Menu allows the installer to select whether the temperature values should be displayed in either Celsius or Fahrenheit; the factory default is ° F.

There is always the possibility that someone entered the Technician ADVANCED menus and made a number of changes that are adversely affecting the operation of the HVAC system. Rather than entering and reviewing all of the menus, the technician could start reprogramming the UI by first resetting the factory default values.

Fan Coil Setup



Selecting FAN COIL from the SETUP menu allows the technician to set the desired HEAT PUMP AIRFLOW for cooling, heating, and dehumidification. Selections are COMFORT, MAXIMUM and EFFICIENCY for heating. COMFORT is airflow used to enable full dehumidification and comfort capabilities of the system. The airflow varies depending upon the outdoor temperature to maximize comfort. MAXIMUM is operation at 400 CFM per ton. EFFICIENCY is the airflow used to meet specified ratings.

Cooling airflow selections, AIR COND: AIRFLOW, are COMFORT, EFFICIENCY and MAXIMUM. COMFORT airflow provides airflow that varies depending upon temperature and humidity demands. This enables full dehumidification and comfort capabilities of the system. When COMFORT is not selected, the unit will not operate at reduced airflow for dehumidification. EFFICIENCY is fixed airflow used to achieve specific ratings. This is normally 350 CFM/ton but will vary when applied with a two-stage or variable speed outdoor unit. MAXIMUM is 400 CFM/ton.

Dehumidification airflow selections are HIGH and NORMAL. NORMAL, the factory default, allows the airflow to adjust to a minimum to satisfy a dehumidification call. On HIGH, the minimum airflow during the dehumidification mode is increased to reduce duct and register sweating.

HEATER SIZE would be displayed on the heat pump unit only if the indoor unit had electric heaters installed AND if the size had to be entered manually during the Manual Configuration process. The size can be changed but it is limited to the capacities that can be matched with the indoor unit. This value is used by the controls to limit the airflow to meet the recommended minimum airflow for the kilowatt value of the heater installed. If the electric heater is a self-identifying type, ENTERED SIZE will not be displayed.

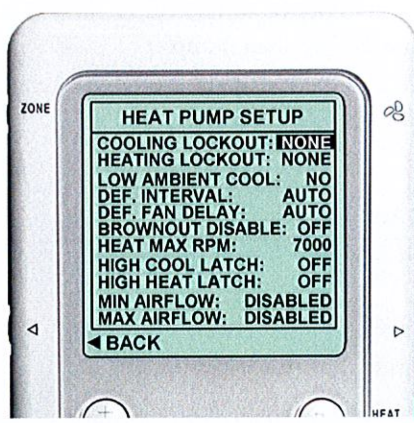
ELECTRIC HEAT LOCKOUT is displayed on the fan coil unit should the indoor unit have electric heaters installed. The available options are NO, or an outdoor temperature setting from +5 to 55° F in 1° F increments. At outdoor air temperatures above the set temperature, the heaters will not be allowed to operate except for defrost.

The G TERMINAL option is a feature used only on fan coils and furnaces with the control system. The indoor unit control board used in the furnace and fan coil includes functionality to the "G" terminal when the communicating control system is used. By the addition of a relay or switch with its contacts connected between the R and the G terminal on the board, a change of state of the switch will send a signal to the board to perform a predetermined function. Selections include low fan speed or complete unit shutdown.

DEHUM DRAIN TIME turns off the continuous fan operation at the end of cooling for a preselected time in order to allow the indoor coil condensate water to flow into the condensate drain pan. The time selections are 0 (zero) to 60 minutes in 5-minute intervals. The fan will only be turned off if there was a dehumidify demand at the start of the cooling cycle.

If the electric heat reheat accessory has been installed, it can be turned ON through the ELECTRIC HEAT REHEAT menu. The factory default is OFF.

Heat Pump Setup



COOLING LOCKOUT is the outdoor air temperature that can be set to prevent operation of the outdoor unit below that temperature. The selections are NONE (the factory default), 45, 50 or, 55° F. HEATING LOCKOUT is the outdoor air temperature that can be set to prevent operation of the outdoor unit above that temperature. The selections are NONE (the factory default), and <-20 through <55° F in 5° F intervals.

Low ambient cooling, LOW AMBIENT COOL, is available with the communicating control system. Under this menu the low ambient cooling default value of NO can be changed to YES to enable low ambient cooling. A low ambient cooling kit is not necessary when this feature is on. Also when LOW AMBIENT COOL is selected, ensure that the COOLING LOCKOUT is set to NONE, as shown, and not to one of the other three temperature settings, 45, 50 or 55° F. Failure to set COOLING LOCKOUT to NONE will result in failure to achieve low ambient mechanical cooling.

The DEFROST INTERVAL is the time the system waits to check for the need to defrost. The selectable intervals are 30, 60, 90, 120 and AUTO. AUTO is the Ideal Defrost selection which is an intelligent defrost interval selection made by the communicating control system. AUTO is the default setting used with a communicating control heat pump.

HEAT MAX RPM can be set to limit the maximum speed that the compressor can operate in the heating cycle. The factory default setting is 7000, but the technician can set this to a lower speed down to 4250 RPM in 50 RPM increments if it is desired.

HIGH COOL LATCH is the outside temperature in cooling where only the high speed of a variable speed compressor will operate. The selections are OFF, the factory default value; ON, from >80 to >110° F in 5° F increments; and DISABLED. OFF turns off this feature. The ON setting places the unit in high stage at all times if it is a non-zoned system. Temperatures >80 through >110° F allow the user to select the temperature above which the unit will operate only at high speed, for non-zoned systems. The DISABLED setting prevents the use of the high cool stage. HIGH COOL LATCH setting of ON will not function in zoned systems.

HIGH HEAT LATCH can be set for a variable speed heat pump where only full speed operation of the compressor will occur above a preset outside ambient temperature. Full speed operation varies with the outdoor temperature. This prevents the unit from operating and trying to heat on lower speeds when the outdoor ambient temperature is very low. The OFF setting is the factory default value which turns the option off. The ON setting limits the heat speed to high at all times in a non-zoned system at the user selectable temperature. The temperature selections are from <20° F up to <50° F in 5° F increments. HIGH HEAT LATCH setting of ON will not function in zoned systems.

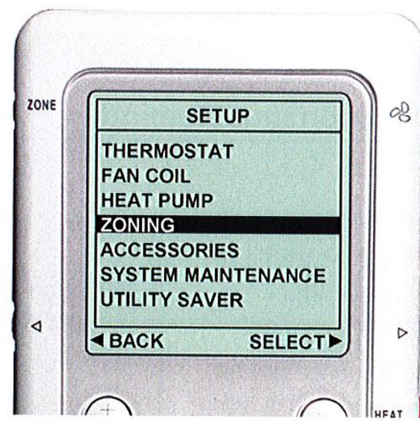
If it is necessary to maintain airflow above a required minimum, MIN AIRFLOW can be set from 1160 down to 240 CFM in 10 CFM increments. When the minimum airflow is set, the compressor capacity adjusts to match the airflow adjustments.

If it is necessary to maintain airflow below a required maximum, MAX AIRFLOW can be set from 1160 to 2250 CFM in 10 CFM increments. When the maximum airflow is set, the compressor capacity adjusts to match the airflow adjustments.

The outdoor fan motor will remain off for 20 seconds after termination of defrost to allow the system to capture the heat from the outdoor coil and reduce the "steam cloud" effect that may occur on transition from defrost to the heating cycle. DEFROST FAN DELAY can disable this feature, allowing the outdoor fan motor to turn at the end of defrost to the heating cycle

BROWN-OUT PROTECTION turns off the low line voltage brownout detection function in the outdoor unit VSHP board. Brown-out protection is for a line voltage that is less than 187 volts for at least 4 seconds, opening the compressor contactor and de-energizing the outdoor fan motor. The factory default is ENABLED, but it can be DISABLED (turned off.) This should only be turned off as a last resort to solving the noisy power condition.

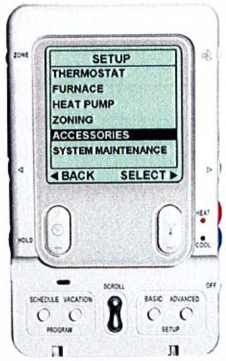
Zoning Setup



If this system was installed on a zoned system, ZONING would be displayed in the SETUP menu on the Zone UI. Selecting ZONING will allow the user to DISABLE ZONING should it be necessary; set ZONE OFFSETS, which essentially recalibrates the zone temperature sensors; set the zone AIRFLOW LIMITS; and change the DUCT ASSESSMENT TIME of the day.

Accessories Setup

- Enable/Disable ACCESSORIES
- Change service interval notification to user
  - Clean filter
    - 30-180, days
    - default 90
  - Change humidifier pad
    - 1 to 24 months
    - Default 12 months
  - Clean ventilator prefilter
    - 60 to 180 days
    - Default 90 days
  - Change UV lights
    - 6 to 48 months
    - Default 12 months



The ACCESSORIES menu is the same for all units; the only difference between systems is that each system will display only the installed accessories in the system. That is, some systems will have one accessory while others may have multiple accessories. Systems with a filter may either have a media filter, electrostatic air cleaner filter or even an air purifier.

All systems will display ACCESSORIES and all systems will be limited to indoor air FILTER type, HUMIDIFIER installed and UV, ULTRA VIOLET, LIGHTS installed. VENTILATOR will also be displayed if one is installed into the system.

System Maintenance Reminder

- Routine maintenance notification to user
  - 6 to 24 months
  - Default 12 months
  - Time Interval Elapse
    - Percentage of duration
    - Resettable

In the SYSTEM MAINTENANCE menu, a reminder can be set so that the homeowner can be reminded to have routine maintenance performed after a pre-selected time period, or it can be simply turned OFF. When the reminder for the routine maintenance and maintenance time interval is set, and the interval time has elapsed, a reminder will be displayed on the UI. This time interval can be set from 6 months to 24 months in one-month intervals with a factory default value of 12 months.

Also, the service technician can also see the percentage of that time interval that has elapsed.

Maintenance can be performed prior to the notification reminder message, and before 100% of the time interval is used. When routine maintenance is performed, the percentage of the time used can be reset by pressing the Right Side button.

Utility Saver

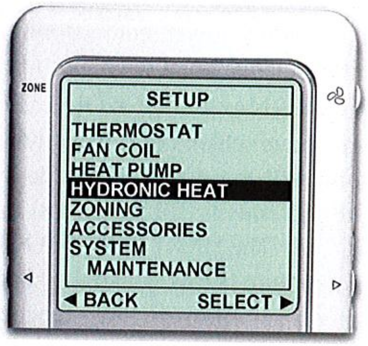
- Available only on cooling units and heat pumps
- Requires input from power company
- Limited to:
  - Turn off
- Will not shut off compressor in heating mode

UTILITY SAVER, or Utility Curtailment, will be displayed on heat pump units including the hydronic heat - heat pump, the Hybrid Heat® - heat pump and the variable speed compressor heat pump. A signal is usually sent from the power company to the utility saver supplied by the local utility and the communicating control will respond to the input when applied.

The selection available when the utility saver is applied is TURN OFF, to shut down the equipment. However, UTILITY SAVER will never shut the compressor off in the heating mode and drive the heat pump to electric heat, heating.

Hydronic Heat

- Requires Hydronic Heat Kit
  - Kit consists of:
    - Circuit board
    - Relay
    - Wire Harness

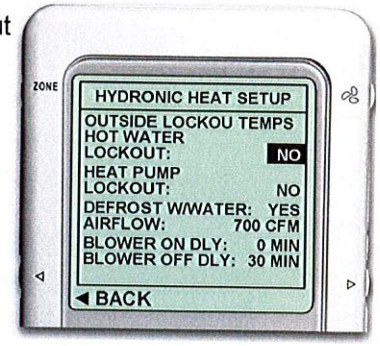


A kit can be applied to the control system so that the system can be applied to a current communicating control fan coil unit that will allow the use of a hot water heat exchanger to provide heat in an air conditioning or heat pump system. This is known as the Hydronic Heat Kit, part no. KFAIF0101HWC. The kit simply consists of a rectifier circuit board with a 22-VDC relay along with a wiring harness that is pre-wired to the relay and terminated with a 12-pin AMP, Inc. Mate-N-Lock® connector. The relay is also fitted with two 16-gage wire leads that connect into the hydronic system control circuit. When the circuit board and relay are mounted in the fan coil unit and wired into the system, the communicating control recognizes that the fan coil unit has hydronic heat and will display HYDRONIC HEAT. Additionally, HEAT PUMP, ACCESSORIES, SYSTEM MAINTENANCE and ZONING, only with the zone UI, will be displayed.

The current communicating control UI must be used and the FE fan coil must have the hydronic heat FE fan coil board, part no. HK38EA012 installed. Fan coil units manufactured compatible with the control system will have the new fan coil boards. Older FE3 and FE4 fan coils will require system changes to use hydronic heat. Contact your local equipment distributor for details on making the necessary changes to these units.

Hydronic Heat Setup

- Hot Water Lockout
  - No, >5 to 55° F
- Heat Pump Lockout
  - No, <5 to 55° F
- Defrost with Water
  - Yes or No
- Heating Airflow
  - Off, 500cfm (MIN) to 400cfm/ton
- Blower On Delay
  - 0 to 240 seconds
- Blower Off Delay
  - 0 to 240 seconds



When HYDRONIC HEAT is selected in the SETUP menu, the HYDRONIC HEAT SETUP menu shown here is displayed.

HOT WATER LOCKOUT temperature locks out the hot water so that hot water heat would not be utilized above a selected outdoor temperature, while HEAT PUMP LOCKOUT temperature locks out the heat pump so that it will not operate below a selected temperature. HOT WATER LOCKOUT temperature is ignored during the defrost cycle. When NO is selected for either lockout temperature, it changes to a temperature value that can be set from 5° to 55° F in 1° increments.

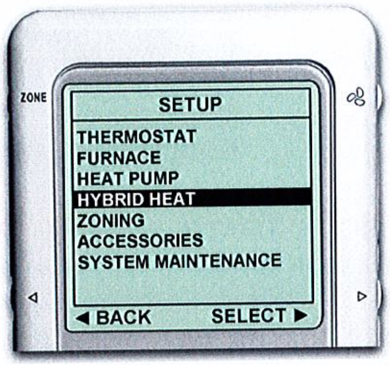
The DEFROST W/WATER selection provides hot water heat during defrost with YES and prevents it from operating during defrost with NO. Keep in mind that selecting NO will result in a "cold blow" during a defrost cycle. This selection only appears if the outdoor unit is a heat pump otherwise this will not be displayed.

AIRFLOW allows for the selection of the desirable airflow during hydronic heating. The selections available are OFF, 500 CFM (which is the minimum allowed), up to a maximum of 400 CFM per ton of cooling in 50 CFM increments (with a factory default value of 350 CFM per ton). OFF can be used for standalone radiant heat in a space, but during defrost the airflow will still be on.

BLOWER ON DELAY allows the user to select the amount of time that the indoor fan will wait until it turns on after hot water heating is initiated This selection allows the hydronic heat exchanger to warm up sufficiently, providing warm airflow during fan operation. Settings that can be selected are from zero (0) seconds to 240 seconds in 30-second intervals, with 30 seconds as the factory default value.

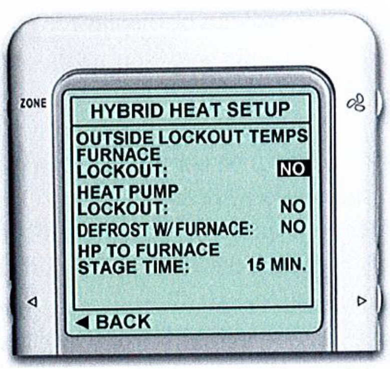
BLOWER OFF DELAY allows the user to select the amount of time that the indoor fan waits to turn off after the heating with hot water is terminated. Selections are zero (0) to 240 seconds in 30-second increments with the factory default value of zero (0). Since the hydronic heat exchanger is still warm when heating is terminated, the heated residence is capable of capturing some of this heat to continue to heat until the hydronic heat exchanger cools down.

Hybrid Heat



The variable speed heat pump can also be applied with a gas furnace as a HYBRID HEAT unit. Hybrid heat allows the use of the heat pump at higher outdoor air temperatures when heating is necessary and with the gas furnace at lower outdoor air temperatures for indoor comfort.

Hybrid Heat Setup



In order to economize on heating cost, the Hybrid Heat® unit supplies heat pump heat during the intermediate season, that is when outdoor temperatures are moderate yet heating is required. When the outdoor temperature drops below a temperature that is difficult to heat using a heat pump, the Hybrid Heat unit turns off the operation of the heat pump and the gas heating furnace is turned on. A gas furnace utilized with a variable speed heat pump has the advantage of operating of the heat pump at considerably lower outdoor ambient temperatures for a lower balance point over a standard heat pump.

The FURNACE LOCKOUT temperature, the temperature above which the furnace will not operate, can be set from NO, the default value, to > 5° through >55° F in 1° F increments. In the defrost cycle, this setting will be ignored. The HEAT PUMP LOCKOUT temperature, the temperature below which the heat pump will not operate, can be set from NONE, the default value, to < -20° through <55° F in 1° F increments. The FURNACE LOCKOUT temperature is also known as the AUXILIARY HEAT LOCKOUT temperature and the HEAT PUMP LOCKOUT temperature is also known as the Balance Point.

The FURNACE LOCKOUT temperature and the HEAT PUMP LOCKOUT temperature can be the same value or, if they are not the same value, the system will stage up and down normally between heat pump and furnace when the outdoor air temperature is between the two settings. The UI will not allow the heat pump lockout setting to be above the furnace lockout setting.

Even though a furnace lockout temperature may be set, the system will still use the furnace in defrost operation, and may stage back down to heat pump when defrost is completed after a 2-minute time interval. Under the DEFROST W/FURNACE menu, when YES (the default value) is selected the furnace will operate during defrost. Selecting NO will keep the furnace from operating during defrost. Keep in mind that selecting NO will result in a "cold blow" during a defrost cycle.

The Hybrid Heat® unit should run as long as possible on heat pump heating before using the gas furnace. However, in order to ensure that the residence is comfortable, there is a setting to control the amount of time that the compressor will be allowed to run on high stage before the gas furnace is allowed to provide the heat. This selection is made under the HP TO FURNACE STAGE TIME. The amount of time allowed ranges from 15 minutes (the default value) up to 60 minutes in one-minute increments. However, if the UI heat set point, the demand, is greater than 5° F above the actual room temperature, the staging timer will be overridden and the gas furnace will turn on.

System Access Module (SAM)

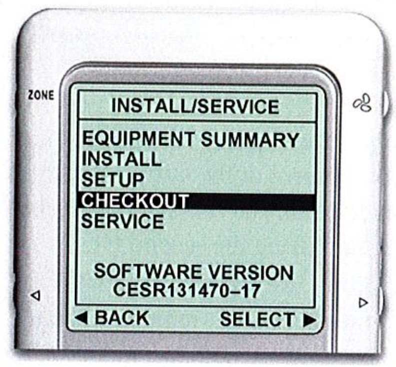
The variable speed heat pump can also be applied with the CAT-5 SAM or the Wi-Fi SAM and both the Wi-Fi SAM and the CAT-5 SAM will support the use of a dry set of contacts. Every time that the system's power is turned on the UI of the communicating control will automatically find the Wi-Fi SAM and the CAT-5 SAM. It will enter the system installation screens automatically and will display the EQUIPMENT SUMMARY when finished. The EQUIPMENT SUMMARY screen will display REMOTE ACCESS near the bottom.

CHECKOUT

CHECKOUT is a unique section of the communicating controls that allows the service technician to perform various tests on both the unit and some of the components utilized within the unit. Not only will the technician operate the unit, but the technician will also be able to see temperatures, pressures and speeds for proper operation.

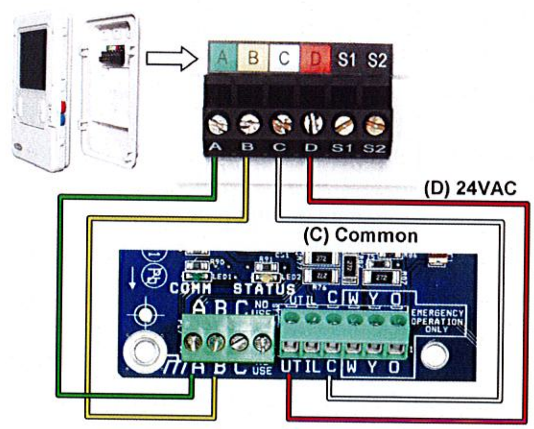
To access CHECKOUT the technician must press and hold down the ADVANCED button for at least 10 seconds.

Checkout



Equipment CHECKOUT in the INSTALL/SERVICE menu is the technician's tool for troubleshooting the system. The menu choices allow the technician to run an operating test of each piece of equipment in the system - one piece at a time. During each test, the equipment will be run through its sequence of operation and the sequence will be displayed on the UI screen. Default run times of 5 minutes are established for heating and cooling equipment. However, this time may be adjusted up to 120 minutes if desired.

Second User Interface



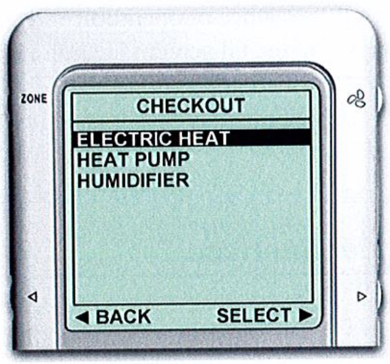
When working on an outdoor unit of split systems with communicating controls and the UI is mounted and located indoors, it is time consuming operating the UI indoors and running outdoors to check unit operation. To overcome this, the communicating control has the ability to add a second UI outside wired into the VSHP board.

To utilize a second UI, connect the A and B communication bus wires from the second UI to the terminals marked A and B on the terminal strip located in the bottom left corner of the VSHP board. But instead of connecting the wires on the second UI to the terminals marked C and D, connect the C wire from the second UI to the terminal strip to the right of the ABCD terminal strip at the terminal marked C. Connect the D wire from the second UI to the terminal marked UT, the far left terminal, on the same terminal strip that the wire from the C terminal was connected.

When the second UI is connected and powered up, the UI inside of the occupied space will "go to sleep" and let the second UI take control of the system. In this manner the service technician can run the diagnostic checkouts right at the outdoor unit using the second UI.

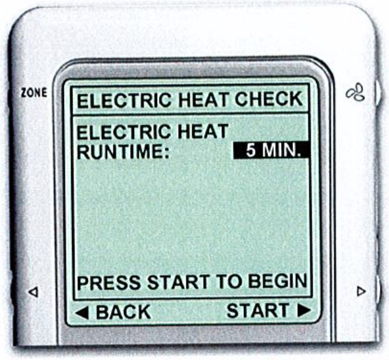
After the checkouts are completed and it is no longer necessary to use the second UI, remove it from the communicating control system and the indoor UI will regain control in about a 2-minute timeframe.

Checkout Equipment



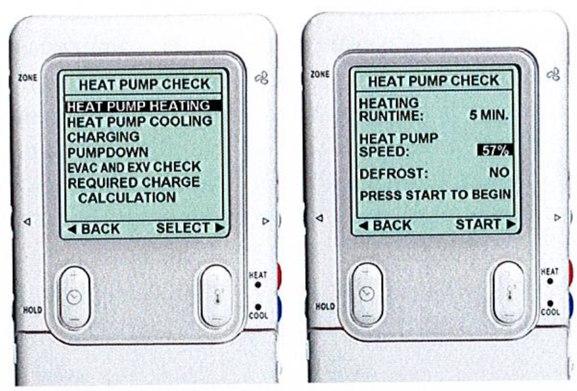
For the variable speed heat pump there are several display screens that simplify checkout of the equipment. First, if electric heaters were installed, a check of the heaters can be accomplished. Next, the heat pump can be checked in the heat pump heating mode, followed by the heat pump cooling mode. The system charge can be checked and adjusted by using the UI. Since the outdoor unit has an EXV in the refrigeration system, the outdoor system can be shut off and pumped down through the UI, or the EXV can simply be checked by forcing it open and closed through the UI. The unit is pre-charged with refrigerant for a 15-foot, $^{5}/_{8}$-inch diameter vapor line. After the technician inputs the line set length and vapor line diameter, the system will inform the technician whether to add or remove charge.

Electric Heat Check



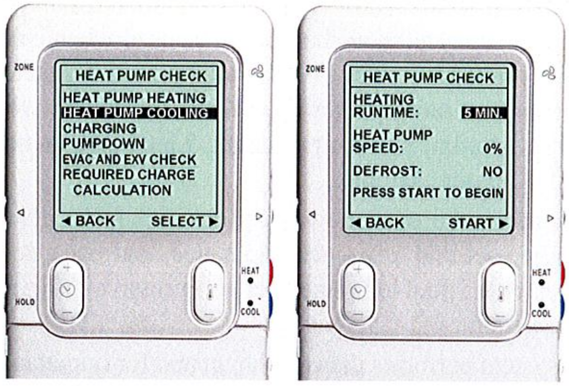
Indoor units that have been identified containing electric heaters can perform this checkout. Self identifying heaters will have up to three stages of electric heat to be exercised while non-identifying heaters will only exercise one stage of heat. The run time can be set from zero to 120 minutes, with a recommended factory default of 5 minutes per heater stage. After the check is started, the display will change to indicate the heater status.

Heat Pump Heating Check



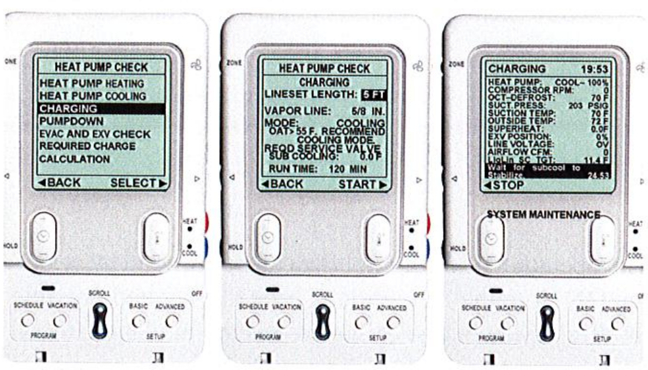
When heating checkout of the heat pump is performed, checkout will operate for a minimum time of 5 minutes to allow conditions to stabilize. However, if it is determined that a 5-minute time will not be long enough, this time can be increased up to 120 minutes. A DEFROST cycle is also selectable with a 5-minute operational time. During checkout, the heat pump airflows are performed in the EFFICIENCY mode. If other airflows need to be checked, the heat pump must be placed into operation with a heating or cooling demand.

Heat Pump Cooling Check



When the cooling checkout of the heat pump is performed, cool checkout will operate for a minimum time of 5 minutes to allow the conditions to stabilize. However, if it is determined that a 5-minute time will not be long enough, this time can be increased up to 120 minutes. The HEAT PUMP SPEED can also be forced from 57% up to 100% in 1% increments. Similar to the heat pump heating checkout, during heat pump cooling checkout the heat pump airflows are performed in the EFFICIENCY mode. If other airflows need to be checked, the heat pump must be placed into operation with a heating or cooling demand.

Refrigerant Charging Check



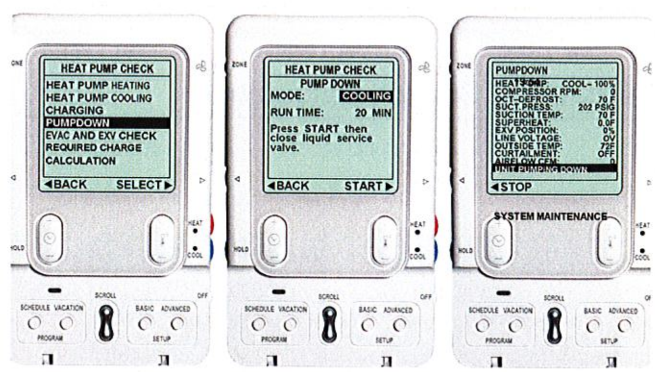
The refrigerant charging calculation takes into account the sizes of the indoor and outdoor units as well as the size (diameter and length) of the vapor line between the indoor and outdoor units. The liquid line size must be $^3/_8$-inch OD. If the liquid line and vapor line are different in their lengths, use the liquid line length for the vapor line length.

In order to check the refrigerant charge the technician will have to select the actual line set length to meet their application of the installed unit and also the vapor line diameter. The factory defaults are 200 feet of line with a $^5/_8$-inch diameter. Here we have changed them to a 5-foot length, keeping the $^5/_8$-inch diameter line because this is our application.

The system indicates that the mode is cooling and that the outside air temperature should be above 55° F. Favorable charging conditions exist when the outdoor air temperature is between 55° F and 100° F, and the indoor air temperature is between 70° F and 80° F. If the temperatures are outside of these ranges, the charge must be weighed in. If charge confirmation is required, return and check the subcooling when the temperatures are within the desired range. Refrigerant charge can only be added during the cooling cycle.

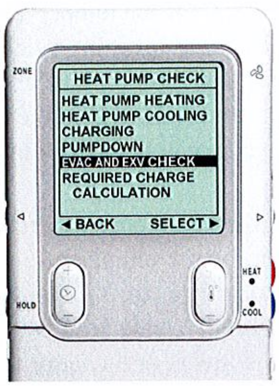
The system will measure the outside ambient temperature and display a subcooling target for the temperature and system configuration. In this example, the temperature and pressure measurements should equate to a 5.0° F subcooling. If the subcooling is lower, add charge until 5.0° F sub-cooling is achieved. Tolerance on the subcooling temperature is ±2° F. If any adjustment is necessary, adjust charge slowly, no greater than $^1/_2$-lb per minute, and allow the system to operate for 15 minutes for stabilization to achieve a properly charged system. As opposed to performing a check of the refrigeration system, when adding refrigerant charge the time to wait for stabilizing the system is increased to 15 minutes to give the added refrigerant time to mix with the other oil and refrigerant in the system.

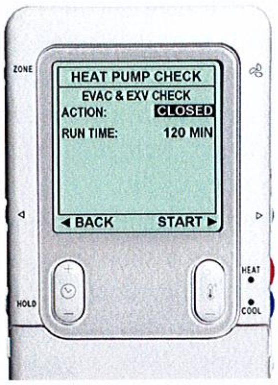
Refrigerant Pump Down Check



At times it may be necessary to isolate as much of the refrigerant in the outdoor coil to break into the refrigeration system. In this case we can operate the unit in cooling to contain the refrigerant in the outdoor coil. Start the pump down procedure and then close the EXV. The system will display several parameters that you can observe and as the suction pressure drops the suction pressure transducer will be ignored. At the conclusion of the pump down check, close the liquid and vapor valves on the unit to store the refrigerant in the outdoor coil. Almost the entire refrigerant is stored in the outdoor coil.

Evacuation and EXV Check

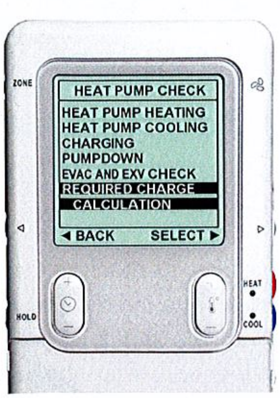


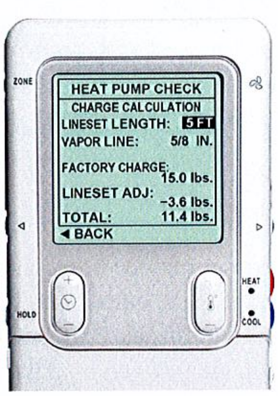


When the evacuation and EXV check (EVAC AND EXV CHECK) is displayed, the EXV can be forced to be opened (OPEN) or forced closed (CLOSED). This check is performed in the OFF mode and the EXV will exhibit a small amount of chatter because of the motor steps. The technician can verify audibly that the EXV "appears" to be opening and closing. Although the EXV can be heard to be moving, a stuck EXV that cannot move will also exhibit a small amount of chatter. Further diagnosis, as explained under Troubleshooting, may have to be performed to verify that the valve is indeed opening and closing.

To assist in refrigerant charge evacuation, the EXV can be driven open to efficiently evacuate the system.

Refrigerant Charge Calculation





The refrigerant charge calculation display can be used for a quick and easy means to charge the refrigeration system after the system has been opened and the charge was removed and recovered or at the time of initial installation. This charge calculation should also be used when charge cannot be added during the cooling mode. Just like checking the refrigeration charge, the technician would set the vapor line size for the length, 5 feet, and diameter, $^{5}/_{8}$-inch, in our example.

Remember, the system was pre-charged for a 15-foot long line set and a $^{5}/_{8}$-inch vapor line, and because we only have a 5-foot long line, there is excessive refrigerant in the system.

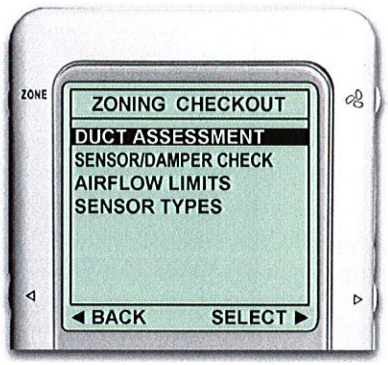
The system performs the calculation and for our example the system is telling the technician that the original factory charge on this unit was 15.0 lb, and because of our short line set, -3.6 lb of refrigerant must be removed; that is it will be weighed into a closed refrigerant container for reclaiming. Note that the minus sign (-) in front of the 3.6 (-3.6) tells the technician to remove charge. This will leave a total charge in the system of 11.4 lb. 15.0 lb minus 3.6 lb = 11.4 lb.

Accessory Checkout

The operation of the humidifier can be checked by selecting ON from the Humidifier Check display and pressing the Right Side button to start its operation. The fan coil will turn on and the humidifier will also turn on even if there is no call for humidifying.

The operation of the ventilator can be checked by selecting the fan speed. From the Ventilator Check display select LOW or HIGH speed. The ventilator check will be made at the selected fan speed.

Zoning Checkout



If we had a zoned system the ZONING CHECKOUT would allow the user to perform a DUCT ASSESSMENT. This is the same check that is made during the initial start-up.

The second ZONING CHECKOUT is the SENSOR/DAMPER CHECK that allows the installer to check each zone damper for operation and to confirm that the correct zone sensor is wired to a particular zone.

Since there is no bypass damper, the Zone Airflow Limit check will allow the installer to assess the airflow noise generated by the system. The Zoned communicating control provides the maximum amount of airflow to each zone individually. The technician can then modify the maximum amount of airflow to each zone by changing the Zone Airflow Limit setting.

The type of sensor can be validated through the SENSOR TYPE under ZONING CHECKOUT. If the wiring of a sensor is broken or loosened, instead of displaying the type of sensor, NONE will be displayed.

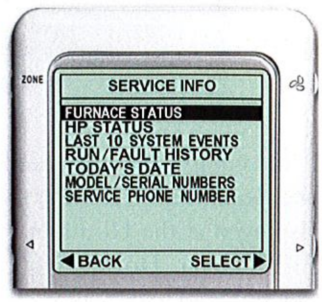
Complete the Controls and Hardware Quiz at the back of the book and then check your answers to see how familiar you are with the variable speed heat pump. With the information in this section you will be able to operate the controls for these products with confidence.

SERVICE

In the Service section of this program, we will cover the helpful tools built into the communicating controls to assist the service technician to diagnose some of the problems that may have occurred during unit operation. We will also cover some of the unique service requirements to this type of equipment.

To access SERVICE the technician must press and hold down the ADVANCED button for at least 10 seconds.

Service

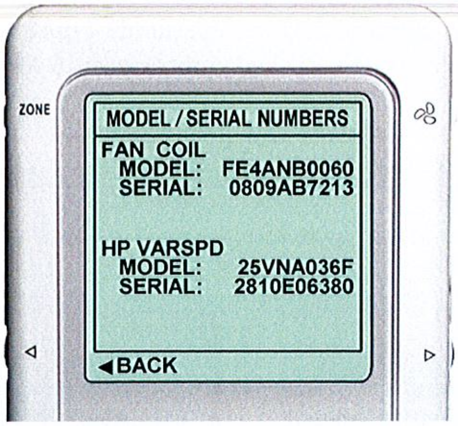


The SERVICE section of the INSTALL/SERVICE software displays several categories of useful information to the technician that can be used to troubleshoot the system.

The SERVICE information that can be displayed includes the STATUS of each piece of equipment that is installed into the system, the LAST 10 SYSTEM EVENTS that occurred during operation of the equipment, the RUN/FAULT HISTORY which captures unit operation times, TODAY'S DATE to record when service was last performed, the system's unit MODEL/SERIAL NUMBERS and the SERVICE PHONE NUMBER that can be called to have the communicating control system checked.

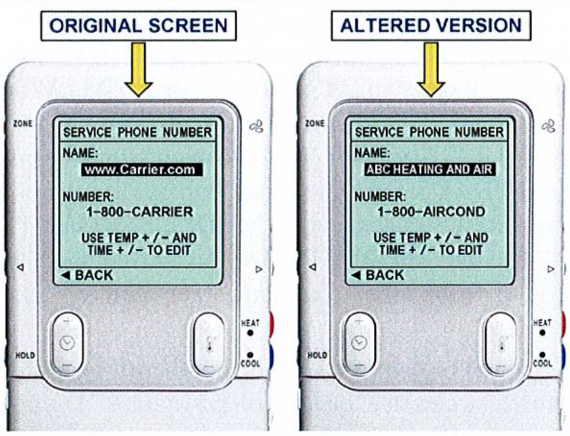
Cycle counters keep track of the number of heat or cool and power cycles that the unit has performed. As you can see with this furnace, the number of low heat, medium heat and high heat cycles are also recorded. Run times display the lifetime hours of operation of the cycles shown in the previous visual. Used together, cycle counts and lifetime hours could also be a helpful tool to assist the service technician with diagnosing a problem that may be difficult to reproduce.

Model/Serial Numbers



If the equipment still retains its original system control boards, the model numbers and the serial numbers can be displayed at the UI under the MODEL/SERIAL NUMBERS menu. However, once the equipment system control boards are replaced, the model number and serial number will only be available from the equipment's nameplate.

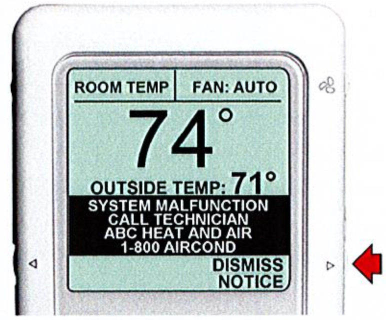
Service Phone Numbers



The Service Phone Number display defaults to the manufacturer's web site and 800 number. Both of these menu items can be changed to display the installing contractor's name and phone number for the homeowner to call for future service of the system. This name and phone number will appear to the homeowner whenever a service reminder pop-up message is displayed, for example, to Change Filter.

System Notification

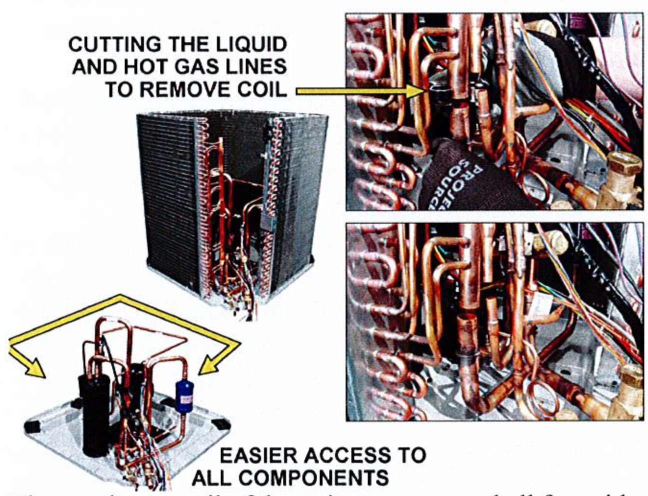
- Screen shows after a malfunction
- Clear by pressing right side button
- May clear on its own
- Check system if it reoccurs
- Caused by specific fault codes



If the UI indicates an active system malfunction, it is a malfunction that is currently in effect. This notification may also clear itself, but it can be cleared by depressing the Right Side button. If system malfunction keeps on occurring, a check of the system is required. This displays only after a critical fault occurs; not all faults will cause this display.

Unit Service

Replacing Components



The condenser coil of the unit wraps around all four sides of the unit, with the exception of where the VSD and control box are located. The condenser coil is also quite high, making it difficult to replace components by removing the unit's outdoor fan motor and unit top cover and fan guard. To replace components like the compressor, reversing valve and electronic expansion valve, as examples, the removal of the condenser coil will be required to gain adequate access to these and possibly other components when replacement is necessary.

Replacement of the compressor, reversing valve, EXV, as well as some other components will require removing and recovering the refrigerant in the system so the condenser coil can be easily removed by cutting the lines to the coil. To remove the condenser coil from the unit, it is recommended to cut the liquid line just below the refrigerant distributor and to cut the vapor line just below the coil header as shown here where we cut our coil.

Removing the condenser coil to gain access to components will allow the service technician to actually save time making changes in the refrigeration system. And because all of the components will be readily accessible the work performed can actually be neater and cleaner than trying to reach difficult to access components.

By not removing the condenser coil, the service technician risks damaging the coil as well as putting themselves into positions that could be unsafe.

Service

This family of variable speed heat pumps can be serviced like any other heat pump unit. The differences arise when servicing products containing Puron refrigerant. In this section of the program we will cover the service procedures unique to Puron refrigerant. We will also cover the use of charging and other charging issues for equipment using Puron refrigerant.

When servicing the refrigerant system which is under pressure, always wear gloves and safety glasses.

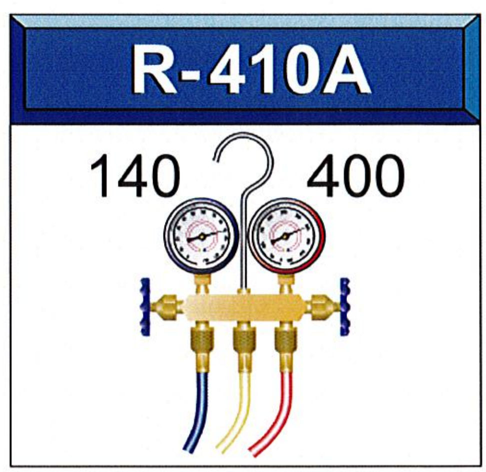
Puron® Refrigerant

ONLY CHARGE WITH LIQUID (TANK INVERTED)

Puron® refrigerant, also known as R-410A, has replaced R-22. This new refrigerant is an HFC and does not contain any ozone-depleting chlorine. The operating pressures of Puron refrigerant are higher, so special service training and equipment is needed to ensure technician safety. As an HFC, this new refrigerant requires different compressors. The compressor lubricating oil is a POE (polyolester) type and requires some specific service procedures to protect the system from moisture infiltration.

Since Puron refrigerant is a "near" azeotropic refrigerant, all products using Puron refrigerant must be charged with liquid. All or as much of the charge as possible should be "dumped" into the high side of the system after a 500-micron vacuum is obtained. Any remaining refrigerant should be charged as a liquid, through a flow-restricting device, into the suction side of the system with the compressor running.

Typical Operating Pressures

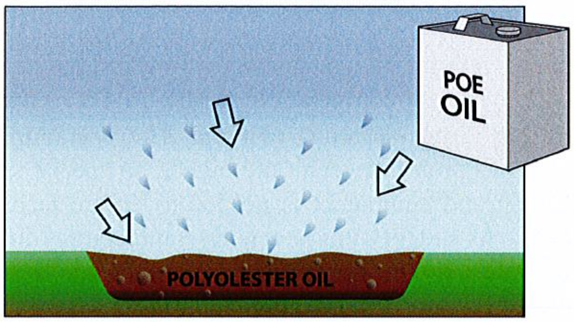


The operating pressures for Puron refrigerant (typically suction pressures of 140 psi and discharge pressures of 400 psi) are higher than can be measured with a standard gage manifold. Instead, a high-pressure gage manifold and high-pressure hoses **must** be used.

When recovering refrigerant, use a recovery machine and recovery tank rated for the higher pressures of Puron refrigerant.

Since Puron refrigerant does not contain chlorine, many leak detectors cannot be used to detect R-410A refrigerant leaks. Whenever checking for leaks, make sure the leak detector is capable of detecting HFC refrigerants.

Polyolester (POE) Lubricating Oil



Puron® Refrigerant units contain a polyolester (POE) lubricating oil. This oil readily absorbs moisture from the air.

Puron units contain a polyolester (POE) lubricating oil. This oil is very hydroscopic, meaning that it readily absorbs moisture from the air. Water or moisture in sealed refrigerant systems causes many harmful side effects such as breakdown of the compressor oil and deterioration of compressor motor windings. This will lead to acid and sludge formation in the system. Clearly, moisture or moisture-contaminated oil must not be allowed into the sealed system.

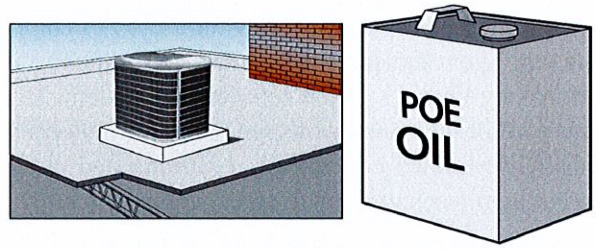
Storing POE oil in the wrong container can also cause it to absorb moisture. Never store POE oil in plastic containers; always use metal containers appropriately marked to indicate contents.

If the sealed system is opened for a service procedure, for example: replacing a compressor, moisture may enter. Moisture that has not been absorbed by the POE oil can be removed using the deep vacuum (500-micron) method. If the system has been open for an extended period, it can be assumed that the POE oil has absorbed moisture. The only way to remove moisture from the oil is to add a factory-approved Puron-rated liquid line filter drier, let the system run for 24 to 48 hours then change the filter drier again. Evacuation will not remove moisture from POE oil. DO NOT use filter driers for use with other refrigerants. These contain filtering material that can contaminate a Puron refrigerant system.

Protect Roof From POE Oil Spills

To protect roof during service:

- Cover roof in work area with plastic (poly) drop cloth
- Cover area in front of service access panel with absorbent cloths
  - To soak up oil spills
  - To protect drop plastic drop cloth



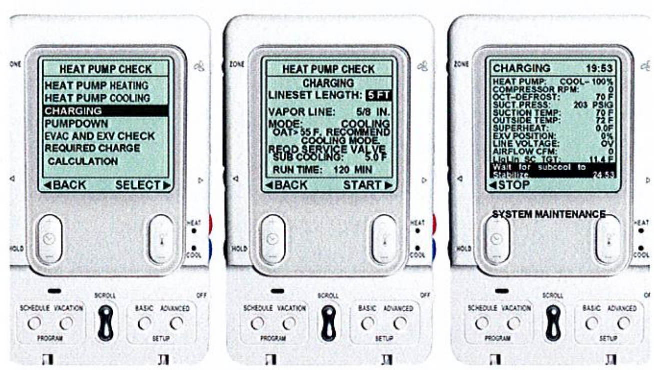
The POE oil in Puron® products can cause skin irritation. Wear safety glasses and gloves when working with Puron refrigerant. Wash any exposed skin with soap and water to remove the oil.

POE oil can damage rubberized or synthetic membrane roofing materials. Even if an oil spill is immediately cleaned up, the exposure to oil is enough to trigger a slow deterioration of the roof. To prevent this damage, roofs must be protected during any service procedure where the chance of an oil spill is present. Follow these steps to protect the roof.

Cover the roof in the work area with a 10' x 10' polyethylene (plastic) drop cloth.

Cover an area in front of the service access panel with absorbent cloths to soak up oil spills and to protect the drop cloth from damage.

Refrigerant Charging



Charging can only be performed in the **cooling** mode and charging can only be performed using liquid refrigerant.

Unit refrigerant charging is accomplished with the use of the UI. Remember to set the LINESET LENGTH to the application being serviced as well as the correct VAPOR

LINE diameter. Make sure there is a surface probe temperature measuring device on the liquid line and a gage manifold on the liquid and suction ports. Check the target sub cooling on the UI and slowing add charge in the liquid state.

Monitor the subcooling and when the desired sub cooling is achieved, stop adding charge.

In order to read accurate pressures, make sure that the front access panel is in place. Charging hoses do not have to be routed through holes since the service valve charging ports are readily accessible. Add or remove refrigerant charge slowly, about $^1/_2$ lb per minute, and allow the unit to operate for about 15 minutes so temperatures and pressures can stabilize before checking the charge. If charge is added, allow an additional 15 minutes after adding the charge so that the system pressures can stabilize again.

The use of a commercial charge metering device restrictor, such as Imperial liquid low side charger model 535-C or Watsco ChargeFaster™ model CH-200 is recommended when adding refrigerant to an operating system.

If it is determined that a heat pump operating in the **heating** mode is low on charge, first find the leak. Then recover the charge, repair the leak, evacuate the system to 500 microns, and weigh in the refrigerant amount displayed on the UI CHECK CHARGE display.

Maintenance

There are some areas that require checking frequently, like indoor air filters that can build up with dirt, especially in a dusty environment or when high efficiency filters are used. Some areas require checking less frequently but cannot wait for an annual check or beginning of season check. Other areas only require checking at the beginning of the heating or cooling season.

One Month/Three Month Maintenance

Every Month

- Check coils for debris
- Check indoor air filter

Every Three Months

- Check all refrigerant joints and valves for leaks
- Check all fans and motors and clean blower wheel
- Check indoor air filters
- Check indoor coil, drain pan, and trap
- Check filter drier pressure drop
- Check heater operation

Every month check coils for debris and clean as necessary with an approved cleaner.

Check indoor air filter and replace if necessary.

In addition to the one-month checks, every three months check all refrigerant joints and valves for leaks. Repair using standard refrigerant procedures if necessary.

Check both the indoor air and outdoor air fans and motors for proper operation. Clean the indoor blower wheel if dirt is building up on the blades. Fan motors are permanently lubricated, so lubrication should not be necessary for the life of the motor. Check the blower belt for proper alignment and tension.

Check the indoor air filters for dirt build-up. Replace if dirt is building up on the filter media.

Check indoor evaporator coil for build-up of dirt or mold. Clean with a proper coil cleaner if necessary. If dirt or mold is seen on the indoor coil, it may also be on the condensate drain pan and within the condensate trap. A thorough cleaning of all of these components will be necessary.

The pressure drop across the filter drier should be checked especially after three months of operation after initial start-up. If pressure taps are not available to check the pressures, the temperature of the liquid line just before and right after the filter drier can be used. If the difference between the inlet temperature and the outlet temperature exceeds 5° F, the filter drier should be replaced.

The compressor winding that is energized serves as the heat source to the compressor so it cannot be checked like a conventional crankcase heater. Additionally, the heat will only be turned on when the compressor is determined to be the cold spot of the system. This is done by comparing the indoor air temperature at the UI and adding 40° F to it, then taking the outdoor air temperature and adding 25° F to it. If the outdoor air temperature is 55° F and the indoor air temperature is 70° F the board will compare 80° F (55° + 25°) to 110° F (70° + 40°) indicating that the compressor is the coldest spot and turn the heater on. If the compressor has been off and allowed to stabilize to the outdoor ambient temperature at these conditions, the heater should be on. The heater can be checked by touching the upper part of the compressor and working your hand down to the base, the base should feel warmer than the upper portion of the compressor. Care should be taken by moving the hands slowly to prevent burns should the compressor heat be excessive.

Twelve Month Maintenance

1. Check all electrical connections
2. Inspect compressor contactor
3. Check outdoor fan
4. Check refrigerant charge
5. Check outdoor coil thermistor
6. Check suction line thermistor

In addition to the checks being made every month and every three months, these additional checks should be made every 12 months.

Check all electrical connections and tighten as necessary. Replace any connections that may be damaged.

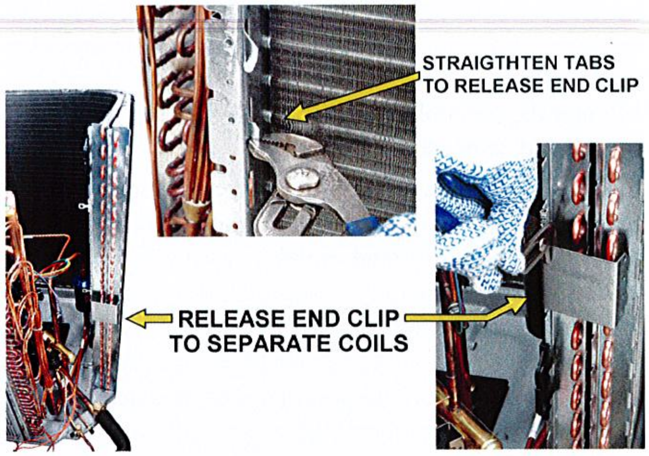
Inspect the compressor contactor for proper operation. Plunger should move freely. Replace component if necessary.

Check the condition of the outdoor fan blades and that the fan is securely fastened to the motor shaft.

Check the refrigerant charge prior to the start of the cooling season using the user interface (UI).

The outdoor coil thermistor should be check to insure it is making proper contact to the tube that it is mounted on. The suction line thermistor should also be checked to ensure that it is attached to the curvature of the suction line and tightly secured with a black wire tie.

Access Inner Condenser Coil



The condition of the outdoor coil is vital to the life expectancy and operational efficiency of the unit. These heat pump condensing units utilize a two-row formed condenser coil, so proper cleaning requires getting between the two rows of coils. To accomplish this, remove the louvered panels protecting the coils. Next, remove the panel on which the VSD and main control box are mounted in order to get access to the hairpin ends of the coils, the ends opposite the coil headers. Remove the outdoor fan motor from the top cover. Finally, remove the top cover.

On the tube sheets of the hairpin ends of the coils you should see a clip holding the tube sheets together. Straighten the tabs on this clip so that it can be removed from the tube sheet. Then remove this clip with a pair of pliers.

Clean Condenser Coil

1. Use vacuum cleaner or soft bristle brush
2. Clean fibers before using water rinse
3. Rinse coils regularly in coastal locations
4. Clean monthly
5. Use environmentally sound cleaners
6. DO NOT use harmful chemicals

Gently, separate the two coils so that access can be gained to the inside of the outer coil. This is the best way to clean the inside of a two-row coil. Elimination of contamination and removal of harmful residues will greatly increase the life of the coil and extend the life of the unit.

Surface loaded fibers and dirt should be removed with a vacuum cleaner. If a vacuum cleaner is not available, a soft non-metallic bristle brush may be used. In either case, the tool should be applied in the direction of the fins. Coil surfaces can easily damage if the tool is applied across the fins.

If fin damage is present, straighten bent fins with a fin comb. Fin combs are available to suit a multitude of fin spacing, so the fin comb with the correct fin spacing should be used.

Do not use a water stream, such as a hose, against a surface loaded coil. It will only drive the fibers and dirt into the coil. Surface loaded fibers must be completely removed prior to using low velocity clean water rinse.

A periodic clean water rinse is very beneficial for coils that are applied in coastal or industrial environments. However, it is extremely important that the water rinse is made with very low velocity water stream to avoid damaging the fin edges.

Cleaning with Totaline® environmentally sound coil cleaner is essential to extend the life of the standard aluminum fin/copper tube coil. This cleaner is available at your local distributorship. This cleaner is a non-flammable, hypo-allergenic, non-bacterial, and USDA accepted biodegradable agent that will not harm the coil or surrounding components such as electrical wiring, painted metal surfaces, or insulation. Avoid the use of:

Coil brighteners

Acid cleaning prior to painting

High-pressure washers

Poor quality water for cleaning

Complete the Service Quiz at the back of the book and then check your answers to see how familiar you are servicing the variable speed heat pump. With the information in this section you will be able to service these products with confidence.

Troubleshooting

In the Troubleshooting section of the training we will cover the communicating control, then the variable speed drive followed by troubleshooting of some of the components utilized in the equipment.

In communicating control troubleshooting we will cover the features built into the system that the technician can use to identify what may be happening or what may have happened if the system cleared itself since the last occurance.

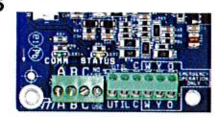
In variable speed drive (VSD) troubleshooting we will cover the faults that may be seen and list the causes that would have provoked the faults. Rather than troubleshooting the VSD itself, in all likelihood, we will find that the VSD is simply doing what it is designed to do.

We have utilized some new components in this system with which some technicians may not have working experience, such as a charge compensator or an EXV, as examples. We will cover the manner in which these components operate and what to look for to determine whether the component is operating properly or improperly.

COMMUNICATING CONTROL

Troubleshooting the Communicating Control

- System tracks malfunctions
  - Equipment circuit boards fault code sequences
  - System stores malfunctions as fault codes in user interface

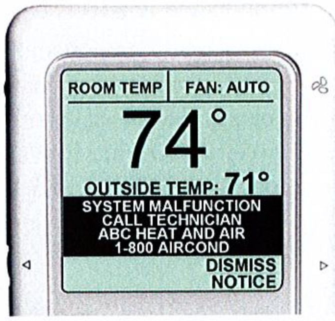


- User interface messages and fault codes provide probable cause
- Following user interface screens is helpful

The communicating control system is designed to record and store system malfunctions and events that may be used to help lead a technician to the root cause of a real or perceived system problem. These fault codes are recorded in the UI and displayed by LED flash sequences on the circuit board of each piece of equipment in the system.

There are a variety of fault codes that relate to a fan coil, furnace, outdoor unit, zone board, or to the UI itself. For further information on fault codes, refer to the installation and start-up literature for each piece of equipment installed in the system. It should be understood, however, that not all recorded events represent system problems. Thus, fault codes should be used as a clue to guide the technician to the appropriate malfunctioning part of the system.

System Malfunction Screen



Certain system events can result in the pop-up message SYSTEM MALFUNCTION CALL TECHNICIAN. A system malfunction is an event that could be related to a failed component, or an event that may not necessarily indicate an equipment problem. If this message clears on its own and the equipment operates normally, it should be ignored. If it does not clear, or comes back repeatedly after being dismissed, the system should be checked as soon as possible.

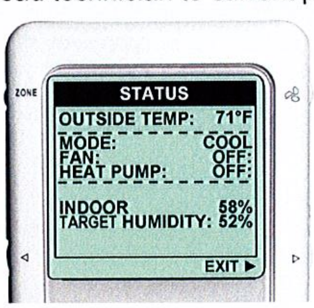
The user can press the Right Side button to dismiss the notice. The regular run mode screen will then appear except "SYSTEM MALFUNCTION" will appear in place of the day/time. If the error has not disappeared within 24 hours, the above display will return.

If the error code disappears, "SYSTEM MALFUNCTION" will disappear and the day/time will reappear.

This message may be generated from any of the communicating system components, and will be displayed as shown.

Equipment Status

- Hold right side button 3 seconds
- User Interface telling system to:
  - Compare to actual operation
  - Lead technician to current problem



To check equipment status from the normal display screen, push the Right Side button. This will show what the UI is telling the system to do. Compare this information to what is actually happening. This can help lead you to a component problem.

Checkout Menus

- Hold ADVANCED button down for 10 seconds
- Scroll to CHECKOUT
- Press right sidebutton
- Test equipment components desired

The CHECKOUT menus give the technician the ability to run all the system components briefly to verify proper operation. Access this by pressing the ADVANCED button for 10 seconds, and selecting the CHECKOUT menu item with the Right Side button. Select the equipment that you wish to check and follow screen prompts.

Airflow during CHECKOUT mode defaults to EFFICIENCY regardless of AIRFLOW setting.

Service Menus

- Access:
  - Hold ADVANCED button down for 10 seconds
  - Scroll to SERVICE
  - Press Right side button
- Functions:
  - Check equipment status
  - Review fault history
  - Enter name and service number for owner to call

The Service Menus provide system information to aid in troubleshooting. To access the Service Menus, press and hold the ADVANCED button for 10 seconds, then use the Scroll button to display SERVICE and select SERVICE with the Right Side button. The SERVICE INFO screen allows the technician to check the status of individual system components, view the Last 10 System

Events, and review the systems Run/Fault History. A name and telephone number can be entered for the UI to display when the system malfunctions or requires regular service.

User Interface Does Not Power Up

- Check wiring to ABCD terminals
- Match all colors at all terminals
- Indoor unit power on
- Indoor amber LED lit
- Check fuse at indoor unit circuit board
- 24 vac at C-D terminals, Zone Control Terminal
- 24 vac at C-D terminals, Damper Control Module

Common problems associated after successful UI operation can be resolved using the appropriate troubleshooting approach. If the UI does not power up, be sure to follow this procedure before concluding that there is a product problem.

First, recheck to be sure the wiring is connected properly to the A, B, C, and D terminals on all devices, making sure the colors match for every A, B, C, and D terminal. Variable speed compressor heat pumps will not have wires routed to the C and D terminals since the VSHP board gets its power from the power in the outdoor unit. Make sure that power is applied to the indoor unit. The amber LED on the indoor unit control circuit board should be lit. If it is not, check to see if the fuse at the indoor unit circuit board is missing or blown.

Indoor Unit Not Found

- Display: INDOOR UNIT NOT FOUND
- Check for green led at indoor unit circuit board
- Check wiring to ABCD terminals
- Match all colors at all terminals
- Avoid communication bus run next to power wiring
- Press User Interface left-hand button and try again
- If still "INDOOR UNIT NOT FOUND"
  - Disconnect electronic devices from indoor unit
  - Leave only indoor unit connected
  - Try again
- If still "INDOOR UNIT NOT FOUND":
  - Connect User Interface direct to indoor unit
- If for furnace, CANNOT COMMUNICATE WITH EQUIPMENT:
  - Turn off all DIP-switches at SW-4

When using a communicating control, variable speed indoor unit, fan coil or furnace, you may face a situation where the UI display says INDOOR UNIT NOT FOUND. This means the communicating control communications features have searched for the indoor unit and not found it. This may be caused by wiring problems at any of the system components or accessories. In brief summary, here is the troubleshooting routine to follow for this situation.

First, check to see if the green communications LED light is lit at the indoor unit circuit board. This LED should be lit to show that it is recognized as a part of the communicating bus. Recheck to be sure that the wiring is connected properly to the A, B, C, and D terminals on all devices, making sure that all colors match for every terminal. Make sure that the communication bus does not run in close proximity to the power wiring for the house, wherever it is connected (lighting, appliances, air conditioning equipment, alarm systems, etc.). When it is run close to power wiring, it can cause communications problems by polluting the signal running down the communication bus.

Now press the UI Left Side button and try again. If the UI display still reads INDOOR UNIT NOT FOUND, then electrically disconnect all devices and accessories from the indoor unit, leaving only the indoor unit connected.

Now press the UI Left Side button and try again. If the UI display still reads Indoor UNIT NOT FOUND, then try directly connecting the UI to the indoor unit with a small piece of thermostat wire, as follows.

Use thermostat wire with at least 4 wires, because you will be making a 4-wire jumper connection directly between the indoor unit and the UI. Make the direct connection by first disconnecting the green, 4-wire plug from the indoor unit circuit board. Now you will directly connect the UI to the indoor unit circuit board by taking a short piece of thermostat wire (your jumper wire), that you know is good, and connecting it to the A, B, C, and D terminals of the spare UI back plate. Now, remove the four wires from the green plug that you removed from the indoor unit circuit board and plug the four wires from your jumper wire into the green plug. An alternative is to carry a spare green indoor unit plug and use it instead. Be sure to match color for color on the A, B, C and D terminals. Now install the UI on the spare back plate and plug the green plug attached to your jumper into the indoor unit circuit board. Now try again.

If, during the start-up of a furnace installation, a CANNOT COMMUNICATE WITH EQUIPMENT message is displayed on the screen of the UI, make sure all DIP switches are in the off position on SW-4.

Outdoor Unit Not Found

Display says OUTDOOR UNIT NOT FOUND when the system does include a communicating outdoor unit. This may be due to a wiring problem with any of the system components or accessories.

Recheck wiring to ABCD connector on outdoor unit. Make sure all colors match for every terminal. A variable speed heat pump will not have wires connected at terminals C and D.

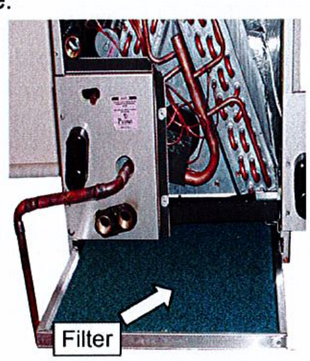
If the indoor unit is an older communicating control unit, a wire may have to connect between the C terminal of the indoor unit and the C terminal on the outdoor unit. This is one reason that it was recommended to run the 4-bus wiring with more than 4-wires.

Make sure wiring is not in close proximity to high voltage wire, or other such device wiring such as an alarm system. This can cause communications problems on the bus.

Clean or Replace Filter

CLEAN OR REPLACE FILTER is displayed after a short period of time:

- Probable cause:
  - System static pressure approaching equipment capability
    - Check/replace filter
    - Evaluate ductwork to lower system static pressure
    - Change filter type to EAC to eliminate filter pressure measurement
      - EAC based on time



These systems have a feature called True Sense filter detection. This feature reads the change in static pressure caused by the filter accumulating dirt. At a preset time every day, or at the factory default setting of 1:00 PM, the system will take a reading and record the change in static pressure. The "CLEAN OR REPLACE FILTER" message will pop up when the filter is full.

SAM Troubleshooting

STATUS CODE	DESCRIPTION	RESOLUTION
45	Board Failure	Replace SAM
62	Loss of communication with Ethernet device	Ensure that cable between SAM circuit boards are seated properly Replace SAM
64	Auxiliary sensor active	Auxiliary sensor terminals are shorted by external device
66	Ethernet network not detected	Make sure network parameters are correct in SAM setup screens
67	No communications with server	Make sure router is connected to the internet and network parameters are correct

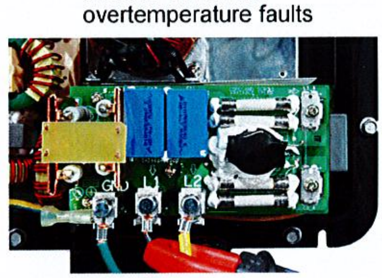
Under normal operation, the yellow and green LEDs on the SAM will be ON continuously, not flashing. If the SAM does not receive communications with the communicating control system, the green LED will not be ON. If there are faults present, the yellow LED will flash a two-digit status code. The first digit will flash at a fast rate, while the second digit will flash at a slow rate. The two-digit code will flash repeatedly until the fault is corrected.

The table above, which is also located in the SAM Installation Instructions, should be used to diagnose and resolve problems when the status code is being displayed.

VSD TROUBLESHOOTING

Troubleshooting The VSD

- Troubleshoot applications
- Overcurrent faults are most common
  - Overcurrent faults go hand-in-hand with overtemperature faults



As mentioned earlier in this program, if the system appears to be having VSD problems rather than troubleshooting the VSD, troubleshoot the VSD application. The application is everything surrounding the VSD.

Overcurrent faults are the most common fault that will shut down a VSD and overcurrent faults go hand-in-hand with overtemperature faults. Finding the actual problem is the challenge. A drive shut down is usually caused by external conditions.

Recordings of VSD line voltage, motor currents and temperature readings of the heat sink can track the health of the VSD over its life and even provide an indication of an upcoming problem.

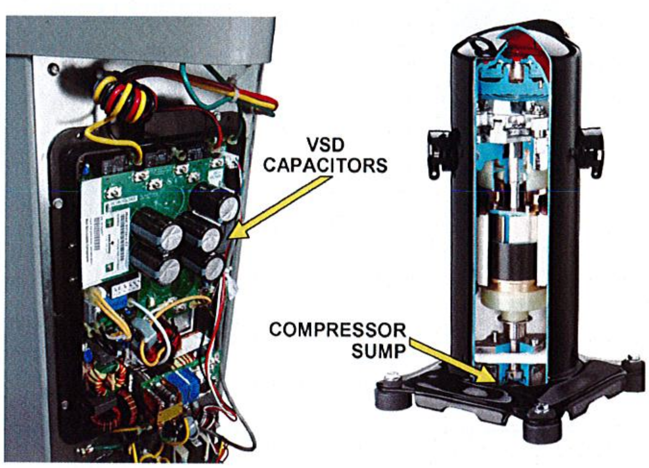
Unit Fault Codes

When troubleshooting refer to the Unit Fault Codes Table in Appendix A.

Fault code detection and diagnostics is provided through heat pump and VSD fault codes passed back to the user interface with the description, recording the last ten events with the date, time and frequency. These fault codes are also listed in the Installation Instructions for these products. The VSHP board contains a green LED for communications and an amber LED used to display the operation mode and the fault codes. Only one fault code will be displayed on the outdoor unit VSHP board, the most recent with the highest priority. However, the UI will retain the last ten system faults in its memory and can be viewed through the UI.

A log of faults contained within the UI can serve as a historical tracking of recurring problems. It should be understood, however, that not all recorded events represent system problems. Thus, fault codes should be used as a clue to guide the technician to the appropriate malfunctioning part of the system.

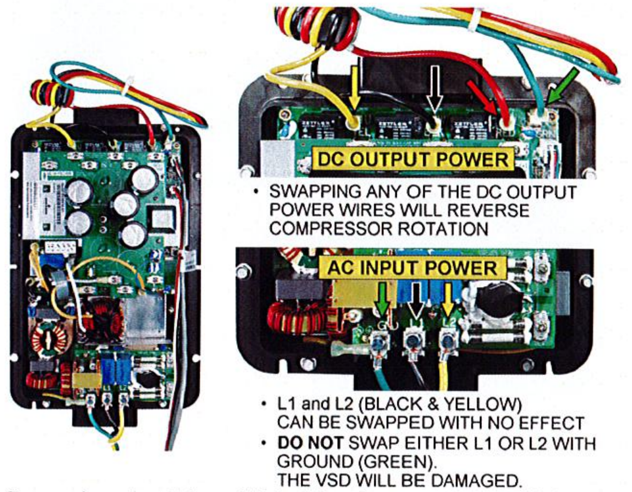
Cold Ambient Extended Standby



If the unit enters an extended standby mode at very cold outdoor ambient temperatures, temperatures below 0° F, the temperatures of the capacitors of the VSD can be driven below 0° F. Zero degrees is too cold for the capacitors to run normal operation. To determine if the capacitors are too cold, the VSD will check to see of the power factor correction (PFC) module A, B or C thermistors are less than 0° F. If this condition is seen to exist, compressor sump heating will be initiated to warm up the capacitors and also energize the compressor heater. The sump heater will be in place for 2 hours before allowing the compressor to start.

When "Compressore Sump Heating Active" is in effect, the control will display flash code 68 during the 2-hour warm-up period.

Mis-Wire Protection



Swapping the L1 and L2 drive input power will have no effect on the operation of the VSD, however, if either L1 or L2 is swapped with the ground wire, the VSD will be damaged. Because of the fact that the VSD output is a 3-phase DC voltage, swapping the compressor power leads will cause the compressor to operate backwards just like 3-phase AC power. It is advisable not to change the 3-phase DC voltage wires since that will cause the compressor motor to turn backwards.

As mentioned earlier in this program, it is possible to swap the compressor power plug with the compressor temperature sensor plug. If this occurs, it will trip the drive and not start the compressor, nor will it damage the compressor, drive or the wiring. Swap the molded plugs to correct the problem. Remember, the power plug attaches to the fusite where the green ground wire is connected.

VSD Communications Lost

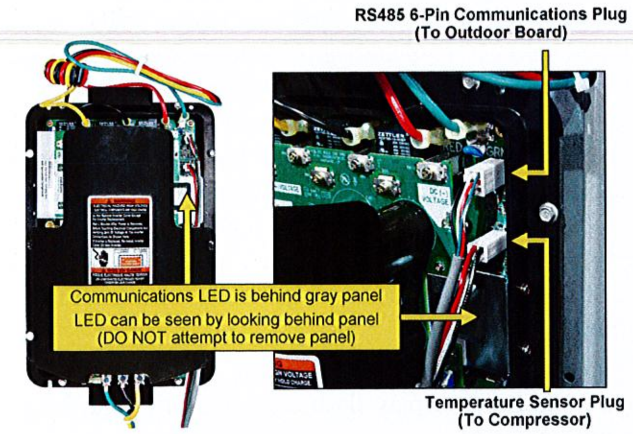


Figure 1

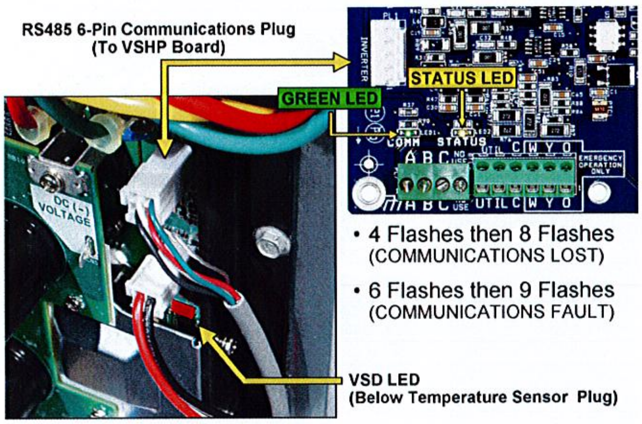


Figure 2

If the Lost Inverter Communications fault is present (code 48), or if the Inverter Internal Communications fault is present (code 69), status flash sequence 4 then 8 on the VSHP board or status flash sequence 6 then 9 on the VSHP board will be displayed respectively; refer to Figure 2. Check to ensure that line electrical power is provided to the drive and that the voltage is between 187 and 253 volts. If line voltage is outside of this range, the utility company should be contacted to make the necessary adjustments.

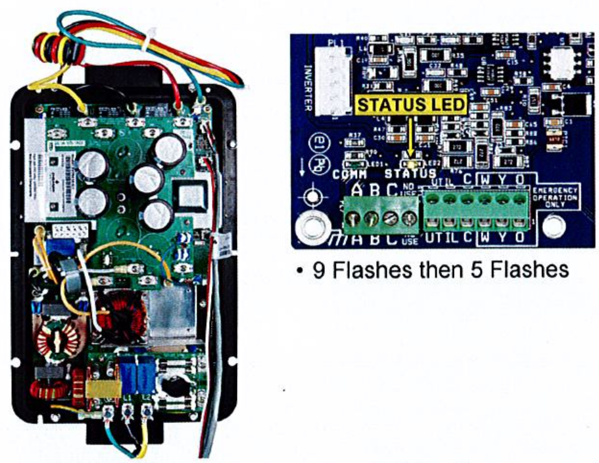
If the incoming line power is within the 187 to 253-volt limits, check the red LED on the drive behind the gray panel, refer to Figures 1 and 2. DO NOT attempt to remove the gray panel. If the red LED is blinking the drive is communicating with the VSHP board. Next check the green LED on the VSHP board to see if it is blinking, refer to Figure 2. If the green LED is blinking the drive is communicating with the VSHP board and the system can be put back into operation. But the drive may have to be replaced; consult with your equipment distributor service department.

If the incoming line power is within the 187 to 253-volt limits and the red LED behind the gray panel is on steady, turn the power off for the entire system for 2 minutes to allow the system to reboot on power-up. With the power off, check for loose and disconnected communication plugs on the drive. Next, turn the power to the entire system on and check the red and green LEDs to see of they are blinking. If they are both blinking, put the system back in operation. If the problem still persists, consult with your equipment distributor service department.

If the incoming line power is within the 187 to 253-volt limits and the red LED is not on steady and is not blinking, then the drive is not communicating with the VSHP board. Remove the RS485 connection plug from the drive, refer to Figure 2, and measure the DC voltage between the red and black wires in the plug; the voltage should be 5 VDC. Be careful not to short the red and black wires together. If there is 5 VDC between the red and black wires check the UI for faults and correct any faults not related to communications or inverter. If the problem still persists, consult with your equipment distributor service department.

If 5 VDC cannot be measured, check for 5 VDC on the VSHP board. If there is not 5 VDC on the VSHP board, troubleshoot the VSHP board.

VSD Overcurrent



The overcurrent fault usually occurs when the compressor is operating outside of the design envelope for a given speed. Check and monitor the suction and discharge pressures to ensure that they look normal for the conditions present. Check the refrigerant charge to make sure that it contains the proper amount.

Never rule out the incoming power voltage making sure that it is within the operating envelope of the unit. If there is reason to believe that the incoming voltage is outside of the operating envelope, make a request to the local utility to place a voltage monitor on the incoming lines.

Check for loose or incorrect wire connections between the incoming power leads and outgoing power leads to the compressor molded plug.

Lastly, troubleshoot the compressor.

The VSD overcurrent is considered an event, flash 95, and will automatically reset in 15 minutes.

VSD Overvoltage

The overvoltage fault occurs when the bus voltage supplied to the compressor motor exceeds 440 VDC, shutting down the compressor. Generally, this happens when the compressor is operating above 3000 RPM and a sudden unloading of the compressor takes place. If this occurs, check that the service valves are fully open. If the valves are fully open, then troubleshoot the compressor. If the valves are fully open and nothing is wrong with the compressor, it is possible that the VSD may have a malfunction.

The VSD overvoltage fault is considered an event, flash 91, and will automatically reset in 15 minutes.

VSD Undervoltage

The undervoltage fault occurs when the voltage supplied to the compressor motor falls below 250 VDC, shutting down the compressor. Generally, this happens when there is an interruption to the main voltage. If this occurs on multiple occasions, ask the local utility to install a voltage monitor on the incoming power line.

The VSD undervoltage fault is considered an event, flash 92, and will automatically reset in 15 minutes.

DC Output Voltage

The DC output voltage lockout occurs when the VSD voltage supplied to the compressor motor is lower than a predetermined low limit or higher than a predetermined high limit. The flash code is 96 for an undervoltage and 97 for an overvoltage. If this occurs on multiple occasions, make a request to the local utility to place a voltage monitor on the incoming lines.

The VSD DC output voltage fault is considered a malfunction, flash 96 for undervoltage or 97 for overvoltage, and will automatically reset in 2 hours.

High Compressor Current

The high compressor current lockout occurs when the current supplied to the compressor motor reaches approximately a 39-amp limit. The compressor will be shut down and will be accompanied by a fault flag. The flash code is 95. Generally, this happens when a sudden voltage supply change occurs or a sudden load change of the compressor takes place. Verify that the VSD is operating within the desired envelope.

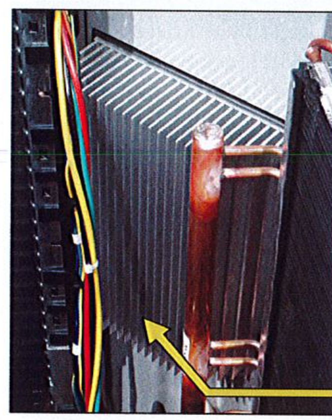
The high compressor current fault is considered a malfunction, flash 95, and will automatically reset in 2 hours.

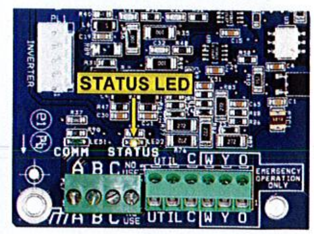
AC Over/Undervoltage

The AC over/undervoltage fault occurs when the incoming voltage supplied to the VSD is lower than 187 volts AC or higher than 253 volts AC. The flash code is 93 for undervoltage and 94 for overvoltage. If this occurs on multiple occasions, make a request to the local utility to place a voltage monitor on the incoming lines.

The AC over/undervoltage fault is considered an event, flash 93 for undervoltage or 94 for overvoltage, and will automatically reset in 15 minutes.

VSD Overtemperature





• 8 Flashes then 8 Flashes

VSD HEAT SINK

Overtemperature faults can appear on the VSD PFC module or the VSD board and are usually attributable to improper airflow across the VSD heat sink located in the compressor compartment on the backside of the VSD. The fault, flash code 88, will occur when the VSD recognizes an overtemperature condition and will lock out the VSD. This malfunction will automatically reset in 4 hours.

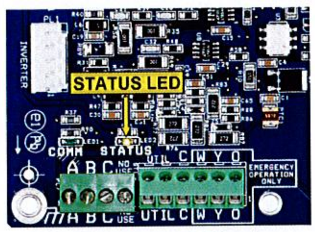
Check to make sure that the heat sink fins are not blocked with dirt or debris. If it is, remove any dirt and debris that may be restricting the airflow. It was mentioned earlier in this program that measuring and recording the heat sink temperature can track the health of the VSD over its life and even provide an indication of an upcoming problem. This data could be referred to if the overtemperature fault appears.

Ensure that the outdoor fan motor is operating properly and air is actually being drawn over the VSD heat exchanger fins and make sure that something did not change for the airflow to bypass the heat sink. Also check the outdoor fan blade to make sure that it was not replaced with an improper fan blade.

Check to make sure that the suction and discharge pressures are correct for the conditions that the unit is operating. Also ensure that the condition that the unit is running at is within the design specifications. Check the refrigerant charge to make sure that it contains the proper amount.

Lastly, this fault could be an indication of a VSD malfunction, however, one of the above problems are more likely.

High Torque Event and Lockout



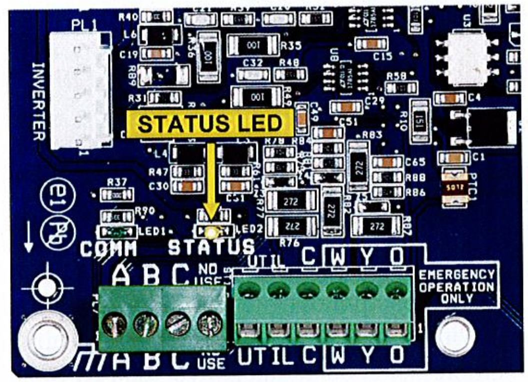
- 9 Flashes then 8 Flashes (EVENT)
- 9 Flashes then 9 Flashes (MALFUNCTION)

This fault could occur when the compressor tries to operate outside of its design envelope because of a commanded speed. If this fault occurs, check the condenser fan motor and make sure that it is operating properly. Also check the outdoor fan blade to make sure that it was not replaced with an improper fan blade.

Check for any other airflow and or refrigerant blockage in the high side of the refrigeration system. Check the refrigerant charge to make sure that it contains the proper amount.

The high torque first fault is considered an event, flash 98, and reset automatically in 10 minutes. The high torque repeated fault within 2 hours is considered a malfunction, will lock out the system and flash 99, but will automatically reset in 2 hours.

Brownout Protection



- 4 Flashes then 6 Flashes

If the brown out feature is not turned off, and if the line voltage is less than 187 volts for at least 4 seconds, the compressor contactor and fan operation are de-energized and the VSHP board will display fault code 46.

The compressor and fan operation will not be allowed to turn on until the line voltage is a minimum of 190 volts. There will be a 5-minute time delay to start cooling operation when there is a call from the UI or when the unit returns from a brownout condition. This can be bypassed by momentarily shorting the Forced Defrost pins.

The brownout feature can be defeated if needed for severe noisy power conditions. This defeat should always be a last resort to solving the problem. The defeat is available on the UI SETUP menu.

COMPRESSOR TROUBLESHOOTING

Scroll Overtemperature - Inoperable

DO NOT use megohmmeter to measure resistance

4-Pin Scroll and Motor NTC Thermistor Plug

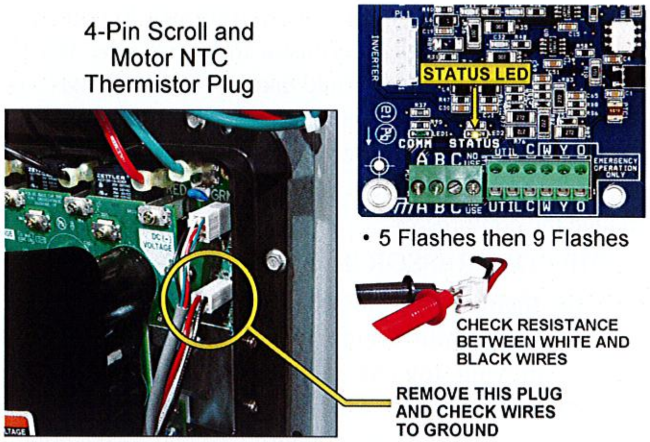


Figure 3

Removing NTC Thermistor Molded Plug

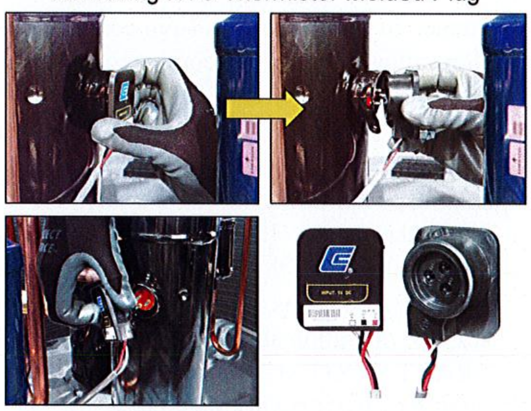


Figure 4

Checking NTC Circuit for Grounded Condition

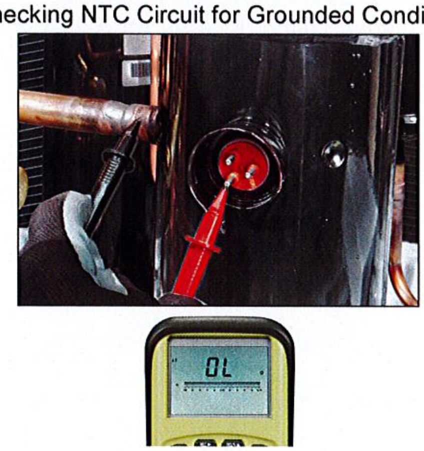


Figure 5

Thermistor Resistance Values

SCROLL			
Ω Value	Temp °C	Temp °F	HW TRIP
412314	(43.0)	(45.5)	SW TRIP
336936	(40.0)	(40.0)	
177072	(30.0)	(22.0)	
97088	(20.0)	(4.0)	
55325	(10.0)	14.0	
32654	0.0	32.0	
19903	10.0	50.0	
12492	20.0	68.0	
10000	25.0	77.0	CALIBRATION
6531	35.0	95.0	
4368	45.0	112.0	
2987	55.0	131.0	
2084	65.0	149.0	
1482	75.0	167.0	
1072	85.0	185.0	
788	95.0	203.0	
589	105.0	221.0	
446	115.0	239.0	
342	125.0	257.0	
265	135.0	275.0	SW TRIP
235	140.0	284.0	
185	150.0	302.0	HW TRIP

Figure 6

Measuring Scroll NTC Resistance — Measuring Motor NTC Resistance

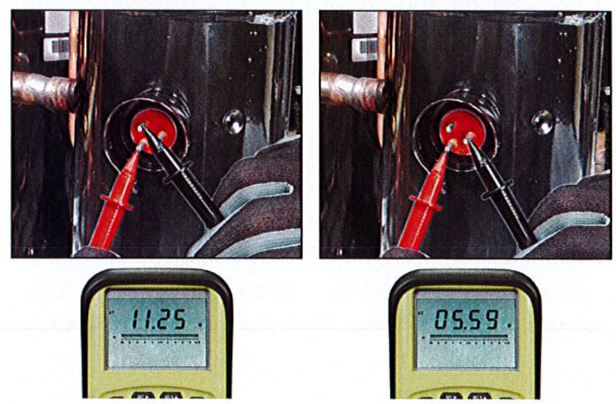


Figure 7

High Voltage Input-Output Connections on Drive

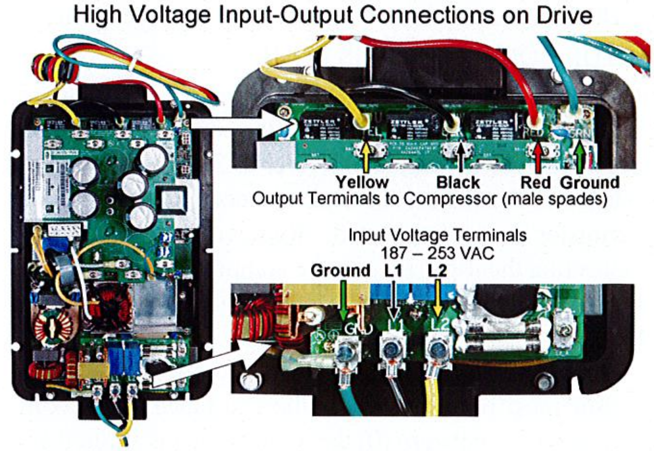


Figure 8

NEVER use a megohmmeter when checking the internal compressor thermistor resistance. A megohmmeter produces an approximately 1,000-volt potential and will destroy the internal compressor thermsitor, resulting in replacement of the compressor. Check resistances using a standard volt-ohmmeter.

If a compressor scroll Overtemperature fault 59 is present status flash 5 then 9 on the VSHP board and if the system is inoperable, disconnect and lock out the main power to the unit. Remove the thermistor 4-pin plug from the drive and measure the resistance between the unit ground and each of the black, white and red wires in the plug. Refer to Figure 3. A good reading is equal to infinite ohms, a bad reading is continuity to ground, zero ohms.

IF THERE IS CONTINUITY TO GROUND

If there is continuity to ground, remove the molded plug at the compressor end of these wires (Figure 4) and measure the resistance between each of the three pins to ground (Figure 5). If there is continuity between any of the pins and ground, the compressor is bad and must be replaced. If there is no continuity between the pins and ground, the molded plug wire harness is grounded and must be replaced.

Replace the molded plug wire assembly, carefully making sure that the routing of the wires is exactly like the routing of the wires of the original assembly from the factory. Then reset the scroll temperature fault and place the system back into operation.

IF THERE IS NO CONTINUITY TO GROUND

You have previously removed the thermistor 4-pin plug from the drive and measured the resistance between the unit ground and each of the black, white and red wires in the plug, but have found no continuity to ground. A good reading is infinite ohms. With the thermistor 4-pin plug removed from the drive, measure the resistance between the black and white wires, refer to Figure 3; the resistance should be between 265 ohms and 33,700 ohms. If the resistance is outside of this range, check to see of the compressor shell is hot or cool to the touch. BE VERY CAREFUL, a very hot compressor could cause burns.

IF THE COMPRESSOR IS COOL

If the compressor shell is cool to the touch, check the resistance value measured against the resistance temperature data chart for validation, refer to Figure 6. If the resistance in the thermistor 4-pin connector is zero (0) the thermistor circuit is shorted. Remove the molded plug connecting the 4-pin plug to the compressor and measure the resistance in the thermistor circuit between each of the compressor 3-pins, refer to Figure 7. If the resistance is zero (0) the thermistor circuit is shorted and the compressor must be replaced. If the resistance at the compressor pins is not zero (0) the molded plug is shorted and requires replacement. Replace the molded plug wire assembly carefully, making sure that the routing of the wires is exactly like the routing of the wires of the original assembly from the factory.

If the resistance in the thermistor 4-pin connector is not zero (0) ohms allow time for the compressor to cool and for the resistance of the thermistor to fall into the 365 to 33,700-ohm range. This could take about 60 minutes. If the resistance measurement is not moving towards ambient temperature, power down the entire system for 2 minutes to reboot the drive. If the problem still persists, change the compressor.

IF THE COMPRESSOR IS HOT

With the thermistor 4-pin plug removed from the drive and with the compressor temperature cooling and the resistance moving towards ambient temperature, allow time for the compressor to cool and the resistance to fall into the 365 to 33,700-ohm range. This could take about 60 minutes. After the compressor has been allowed to cool and the resistance decreasing, measure the resistance between the black and white wires in the 4-pin plug, refer to Figure 3.

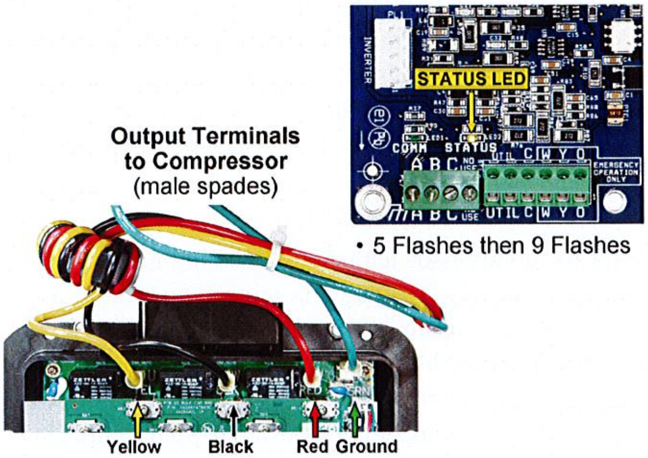
If the resistance in the thermistor 4-pin connector is not zero (0) ohms allow time for the compressor to cool and for the resistance of the thermistor to fall into the 365 to 33,700-ohm range. This could take about 60-minutes. If the resistance measurement is not moving towards ambient temperature, power down the entire system for 2 minutes to reboot the drive. If the problem still persists, change the compressor. If the resistance is now between 265 ohms and 33,700 ohms, then reset the fault, put the system back into operation and proceed to CHECK THE REFRIGERANT SYSTEM.

CHECK THE REFRIGERANT SYSTEM

If a scroll Overtemperature fault 59 is present, status flash 5 then 9 on the VSHP board, refer to Figure 3, reset the fault and put the system back into operation. Check the system refrigerant charge looking for a restriction in the refrigerant system while also checking for high superheat. Check the system airflow insuring that there are no blockages. Also measure the discharge temperature leaving the compressor. The discharge temperature must be measured at the maximum compressor speed and no more than 6 inches from the compressor. If the discharge temperature is 250° F or less, the operation of the compressor is considered to be normal.

If the discharge temperature is greater than 250° F, the scroll of the compressor may be operating in reverse causing the problem. Confirm that the DC three-phase power to the compressor is correct, with the yellow wire connected to the left terminal, the black wire connected to the middle terminal and the red wire connected to the right terminal, refer to Figure 8. Confirm that the compressor is operating within the temperature and speed range; however, if the problem persists, change the compressor.

Scroll Overtemperature - Operable



If a compressor scroll Overtemperature fault 59 is present, status flash 5 then 9 on the VSHP board, and if the system is cycling on the fault reset the fault and put the system back into operation.

Check the system refrigerant charge looking for a restriction in the refrigerant system while also checking for high superheat. Also measure the discharge temperature leaving the compressor. The discharge temperature must be measured at the maximum compressor speed and no more than 6 inches from the compressor. If the discharge temperature is 250° F or less, the operation of the compressor is considered to be normal.

If the discharge temperature is greater than 250° F, then the scroll of the compressor may be operating in reverse causing the problem. Confirm that the DC three-phase power to the compressor is correct, with the yellow wire connected to the left terminal, the black wire connected to the middle terminal and the red wire connected to the right terminal. Confirm that the compressor is operating within the temperature and speed range; however, if the problem persists, change the compressor.

Motor Overtemperature - Inoperable

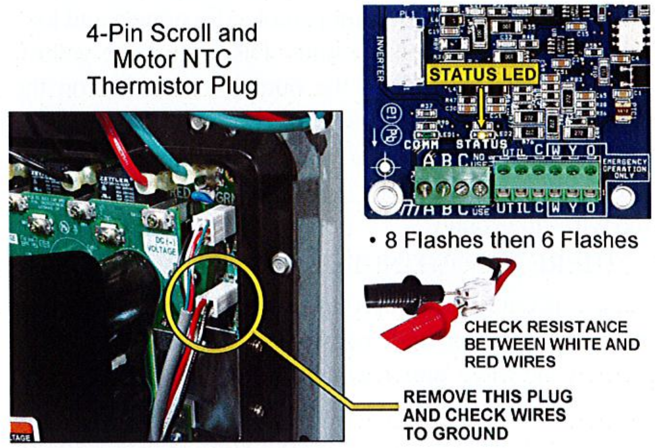


Figure 9

Thermistor Resistance Values

SCROLL			
Ω Value	Temp °C	Temp °F	
412314	(43.0)	(45.4)	HW TRIP
336936	(40.0)	(40.0)	SW TRIP
177072	(30.0)	(22.0)	
97088	(20.0)	(4.0)	
55325	(10.0)	14.0	
32654	0.0	32.0	
19903	10.0	50.0	
12492	20.0	68.0	
10000	25.0	77.0	CALIBRATION
6531	35.0	95.0	
4368	45.0	112.0	
2987	55.0	131.0	
2084	65.0	149.0	
1482	75.0	167.0	
1072	85.0	185.0	
788	95.0	203.0	
589	105.0	221.0	
446	115.0	239.0	
342	125.0	257.0	
265	135.0	275.0	SW TRIP
235	140.0	284.0	
185	150.0	302.0	HW TRIP

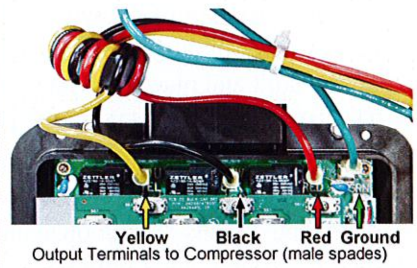


Figure 10

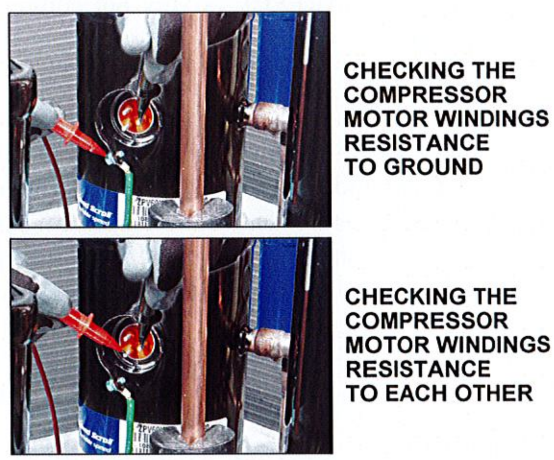


Figure 11

If a compressor motor Overtemperature fault 86 is present, status flash 8 then 6 on the VSHP board, refer to Figure 9, and if the system is inoperable, disconnect and lock out the main power to the unit. Disconnect the yellow, black and red wire from the output connection on the drive and verify motor winding continuity between the yellow, black and red ends, refer to Figure 10. Also check continuity between each of the yellow, black and red wires to ground.

IF THERE IS CONTINUITY TO GROUND

If there is continuity to ground, remove the molded plug at the compressor and measure the resistance between each of the three pins then between each of the pins to ground, refer to Figure 11. If there is continuity between any of the pins and if there is continuity between any of the pins and ground, the compressor is bad and must be replaced. If there is no continuity between the pins and the pins to ground, the molded plug wire harness is grounded and must be replaced.

Replace the molded plug wire assembly carefully making sure that the routing of the wires is exactly like the routing of the wires of the original assembly from the factory. Reset the fault and place the system back into operation.

IF THERE IS NO CONTINUITY TO GROUND

You have previously disconnected the yellow, black and red wire from the output connection on the drive and verified that the circuits are not open and the circuits are not shorted to ground. Next remove the 4-pin plug from the drive and measure the resistance between the red and white wires, refer to Figure 9.

The resistance should be between 459 ohms and 16,800 ohms. If the resistance is outside of this range, check to see of the compressor shell is hot or cool to the touch. BE VERY CAREFUL, a very hot compressor could cause burns.

IF THE COMPRESSOR IS COOL

If the compressor shell is cool to the touch, check the resistance value measured against the resistance temperature data chart for validation, refer to Figure 10. If the resistance in the thermistor 4-pin connector is zero (0) the thermistor circuit is shorted. Remove the molded plug connecting the 4-pin plug to the compressor and measure the resistance in the thermistor circuit at the compressor pins, refer to Figure 7 in the Scroll Overtemperature - Inoperable training. If the resistance is zero (0) the thermistor circuit is shorted and the compressor must be replaced. If the resistance at the compressor pins is not zero (0) the molded plug is shorted and requires replacement. Replace the molded plug wire assembly carefully, making sure that the routing of the wires is exactly like the routing of the wires of the original assembly from the factory.

If the resistance in the thermistor 4-pin connector is not zero (0) ohms, allow time for the compressor to cool and for the resistance of the thermistor to fall into the 459 to 16,800-ohm range. This could take about 60 minutes. If the resistance measurement is not moving towards ambient temperature, power down the entire system for 2 minutes to reboot the drive. If the problem still persists, change the compressor.

IF THE COMPRESSOR IS HOT

With the compressor temperature cooling and the resistance moving towards ambient temperature, allow time for the compressor to cool and the resistance to fall into the 459 to 16,800-ohm range. This could take about 60 minutes. If the resistance measurement is not moving towards ambient temperature, power down the entire system for 2 minutes to reboot the drive. If the problem still persists, change the compressor.

After the compressor has been allowed to cool and the resistance dropping, measure the resistance between the red and white wires in the 4-pin plug, refer to Figure 9. If the resistance is now between 459 ohms and 16,800 ohms proceed to CHECK THE REFRIGERATION SYSTEM.

CHECK THE REFRIGERATION SYSTEM

If a motor Overtemperature fault 86 is present reset the fault and check and verify the correct drive part number. Confirm that the DC three-phase power to the compressor is correct, with the yellow wire connected to the left terminal, the black wire connected to the middle terminal and the red wire connected to the right terminal, refer to Figure 10.

Put the system into operation and check the system refrigerant charge, looking for a restriction in the refrigerant system while also checking for high superheat. Check the system airflow ensuring that there are no blockages. Confirm that the compressor is operating within the temperature and speed range. Measure the input current to the drive and if it is more than the full load amp rating of the compressor, replace the compressor.

If the input current to the drive is less than the full load amp rating but the system continues to have an overtemperature fault, remove the molded plug connecting the 4-pin plug to the compressor and measure the resistance in the thermistor circuit at the compressor pins, refer to Figure 7 in the Scroll Overtemperature - Inoperable training. If the resistance is zero (0), the thermistor circuit is shorted and the compressor must be replaced. If the resistance at the compressor pins is not zero (0), the molded plug is shorted and requires replacement. Replace the molded plug wire assembly carefully making sure that the routing of the wires is exactly like the routing of the wires of the original assembly.

Motor Overtemperature - Operable

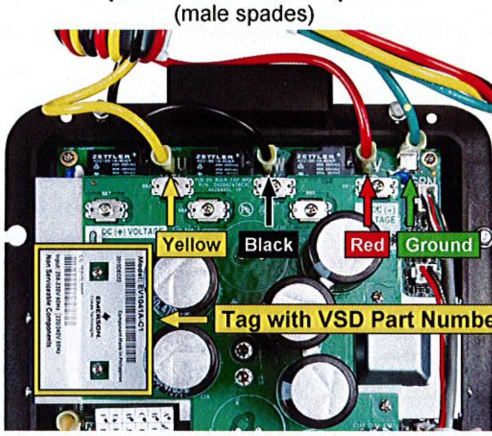


Figure 12

Figure 13

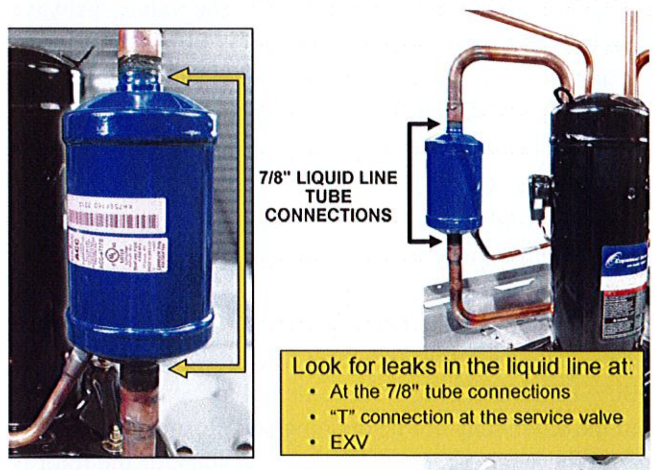
If a compressor motor Overtemperature fault 86 is present and if the system is operable, reset the fault and verify that the drive is correct by checking the part number, refer to Figure 12. Confirm that the DC three-phase power to the compressor is correct, with the yellow wire connected to the left terminal, the black wire connected to the middle terminal and the red wire connected to the right terminal, refer to Figure 12.

Put the system into operation and check the system refrigerant charge, looking for a restriction in the refrigerant system while also checking for high superheat. Check the system airflow ensuring that there are no blockages. Confirm that the compressor is operating within the temperature and speed range. Check the input current to the drive. If the input current to the drive is more than the full load amp rating, replace the compressor.

If the input current to the drive is less than the full load amp rating but the system continues to have an overtemperature fault, remove the molded plug connecting the 4-pin plug to the compressor and measure the resistance in the thermistor circuit at the compressor pins, refer to Figure 13. If the resistance is zero (0), the thermistor circuit is shorted and the compressor must be replaced. If the resistance at the compressor pins is not zero (0), the molded plug is shorted and requires replacement. Replace the molded plug wire assembly carefully, making sure that the routing of the wires is exactly like the routing of the wires of the original assembly.

COMPONENT TROUBLESHOOTING

Charge Compensator Troubleshooting



The charge compensator should be filled with liquid refrigerant in the heating mode of operation and empty in the cooling mode of operation. Operating properly, the compensator shell temperature is lower than the liquid line temperature in the heating mode. And conversely, in the cooling mode the shell of the charge compensator will be warmer than the liquid line temperature.

If the charge compensator is not working properly, remove all refrigerant charge completely from the unit, utilizing both service valves. Look for refrigerant leaks in the liquid tube including the "T" connection at the service valve and EXV. Also, look for leaks at the $^{7}/_{8}$-inch tube connections surrounding the compensator.

If refrigerant leaks are found, do not replace the charge compensator; repair the leaks and evacuate and re-charge the system.

If no refrigerant leaks are found, replace the refrigerant compensator with only the original Carrier part number, KH75GF160. Substitutions are not allowed and if performed could void the unit warranty.

EXV Troubleshooting

- Check first that plastic cap is firmly attached to the top of the EXV brass body
- EXV solenoid coil's electrical resistance should be between 45 and 55 ohms

The EXV assembly consists of two components, the EXV brass body valve containing the stepper motor and the EXV black plastic cap that houses the solenoid coil to energize the stepper motor inside of the valve. Always check first that this black plastic cap is firmly attached to the top of the EXV brass body. The electrical resistance of the EXV solenoid coil can be checked and its value should fall between 45 and 55 ohms.

Utilizing the CHECKOUT feature of the UI, the EXV can be driven open or closed. Stepper motors exhibit a slight audible noise as the discrete step tends to snap the rotor from one position to another, causing a vibration. This vibration can be heard by ear and felt by hand on the valve. This vibration indicates electrical viability, but not 100% of the time. The movement may be heard and felt but the valve may not be opening and closing. This is because the stepper motor rotor may be stuck or the rotor is skipping steps. This will require testing of the EXV.

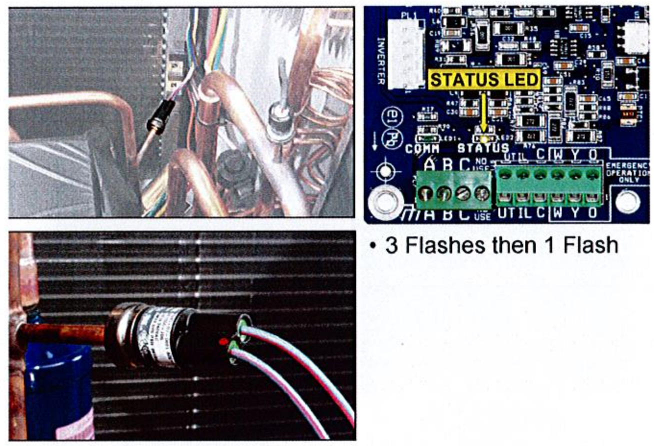
To test the EXV for movement and operation, with the unit off close the EXV with the UI. Next remove the EXV coil connector from the VSHP board and turn the unit on in the heating mode. Since the EXV is supposed to be closed, the refrigerant will be pumped into the indoor coil, possibly cycling on the low pressure protection. If any of this does not occur, the EXV is not closed.

With the EXV operating properly and closed, after the unit is pumped down and stopped, reinstall the EXV coil connector to the VSHP board and open the EXV using the UI. Reset any error codes that may have been created. Then operate the unit in the heating mode to confirm that the valve is open. If the unit will not operate, the valve is still closed.

Before condemning the valve, check the wire leads to the EXV coil and the plastic cap on the EXV body. Check the wire connections on the VSHP board and at the coil as well as check along the length of wire for nicks, cuts or breaks.

If during the EXV test the valve appears to move but does not open or close completely, try flushing the valve by opening the valve and operating the unit in the cooling mode in an attempt to flush any debris out of the valve. Then repeat the test to ensure that the valve opens and closes fully.

High-Pressure Switch Troubleshooting



- 3 Flashes then 1 Flash

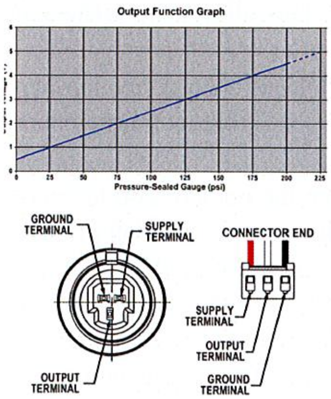
If the VSHP board senses that the high-pressure switch has opened, it will de-energize the compressor contactor, continue to keep the outdoor fan running for 15-minutes and display fault code 31.

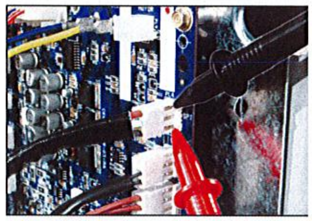
After 15 minutes, if the high-pressure switch has closed and if there is a call for heating or cooling the compressor contactor will energize, if the high-pressure switch has not closed the outdoor fan motor will be turned off. If the open high-pressure switch closes anytime after the 15-minute delay, the unit will resume operation with a call for cooling or heating at a temporary reduced capacity.

If the high-pressure switch trips three consecutive cycles, the operation of the unit will be locked out for 4 hours.

In the event of a high-pressure switch trip or high-pressure switch lockout, check the refrigerant charge and check the outdoor fan motor operation. Keep in mind that the outdoor fan motor may work properly until it heats up. Check the outdoor coil in cooling for airflow restrictions and the indoor airflow in heating for airflow restrictions.

Pressure Transducer Troubleshooting





GROUND AND SUPPLY TERMINAL

If the accuracy of the transducer is questioned, the technician can check it while it is attached to the VSHP board. Connect a gage manifold to the suction valve gage port fitting.

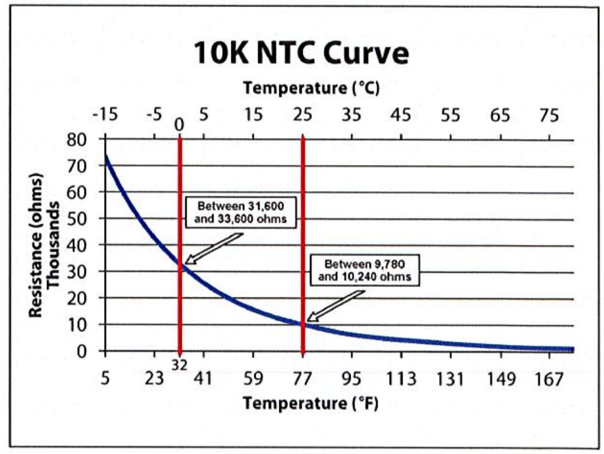
At the VSHP board, with the wire harness receptacle exposing a portion of the three pins on the VSHP board, a DC voltmeter can read the DC voltage between ground and the supply (input) terminal. Ensure that the input voltage is 5 VDC. Next read the DC voltage across the ground and output terminal. Record the output voltage.

The suction pressure that the pressure transducer is reading can be calculated by taking the output voltage and subtracting 0.5 from it then taking that difference and multiplying it by 50. Pressure (psig) = 50.0 x (DCVout - 0.5). For example if the measured voltage is 3.0 VDC: 50 x (3.0 - 0.5) = 50 x 2.5 = 125 psig.

This can then be compared to the actual suction pressure from the gage manifold.

In the event of a low pressure trip or low pressure lockout, check the refrigerant for an under charge. If the charge is found to be correct, check for low indoor airflow in cooling and the outdoor fan for proper operation in heating and outdoor coil in heating for airflow restrictions. Keep in mind that the outdoor fan motor may run normally until it heats up.

Suction Thermistor Troubleshooting

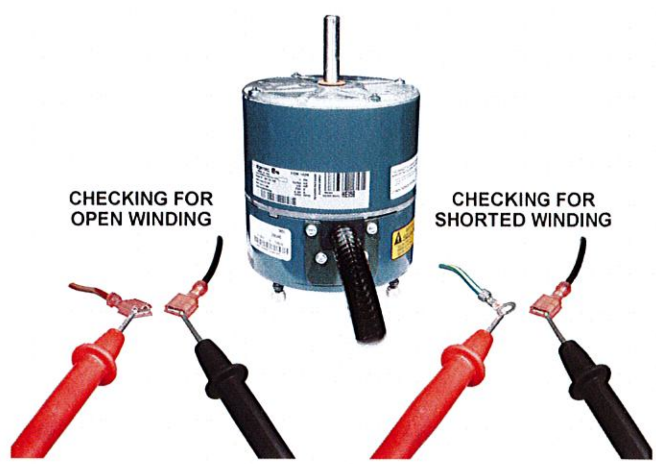


If for some reason it appears that the suction line thermistor is not operating properly, the first thing that should be checked is the mounting on the suction line. The suction line thermistor is designed to be secured to a 7/8-inch diameter refrigerant line aligned longitudinally. The thermistor must also be secured tight on the line with the curved surface hugging the pipe surface. A black UV resistant wire tie is routed through the slot in the insulating plastic body to tightly attach the thermistor to the suction line to minimize the influence of the ambient temperature.

The thermistor wire leads should be checked for nicks, cuts or breaks as well as the connections at the VSHP board.

The resistance of the thermistor can also be checked first by placing the thermistor in an ice bath. The resistance should be between 31,600 and 33,600 ohms. A second measurement at 77° F can be made and the resistance values should be between 9,780 and 10,240 ohms.

Outdoor Fan Motor Troubleshooting



The fan motor is equipped with a thermal overload device located in the motor windings which may open under adverse operating conditions. An open overload will close when the motor temperature cools. Sufficient time should be allowed for the overload to reset.

Further checking of the motor can be accomplished with a volt-ohmmeter (VOM). Set the scale on R x 1 ohm position and check for continuity between the three power terminals. An open circuit is an indication of a failed motor. The VOM can also check the motor windings to ground. Place one lead of the VOM on each of the motor terminals and the other lead of the VOM to the metallic case of the motor, for ground. Replace the motor if it shows a resistance to ground other than infinity. Replace the motor if it shows signs of arcing, burning or overheating.

The outdoor fan motor is also commanded to operate to certain parameters programmed in the VSHP board. These parameters are as follows:

When the outdoor ambient temperature is more than 100° F, the outdoor fan will continue to operate for one minute after the compressor shuts off.

The fan is also ON when the outdoor coil temperature is above 80° F, the high side pressure is determined to be too high by the VSHP board or if the outdoor fan has been OFF for 30 minutes. This allows the refrigerant system to stabilize.

If LOW AMBIENT COOLING is enabled the fan may not begin to cycle until about 40° F outdoor air temperatures.

The outdoor fan is OFF when the outdoor coil temperature is low (below 55° F), the saturated suction pressure indicates a freezing indoor coil or the outdoor fan has been ON for 30 minutes. This allows the refrigerant system to stabilize.

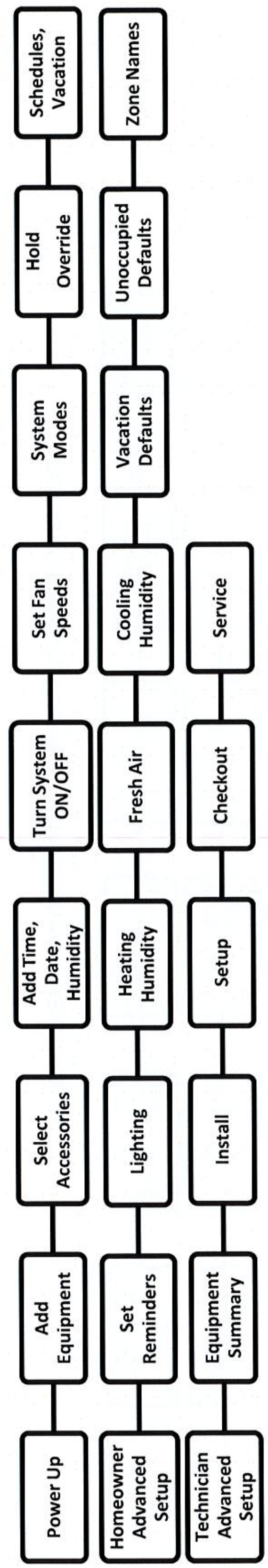
There is also a 20-second delay after termination of defrost before the outdoor fan is energized for heating, unless the fan delay feature is turned off.

Complete the Troubleshooting Quiz at the back of the book and then check your answers to see how well you can troubleshoot the variable speed heat pump. With the information in this section you will be able to troubleshoot these products with confidence.

Appendix A — Unit Fault Codes

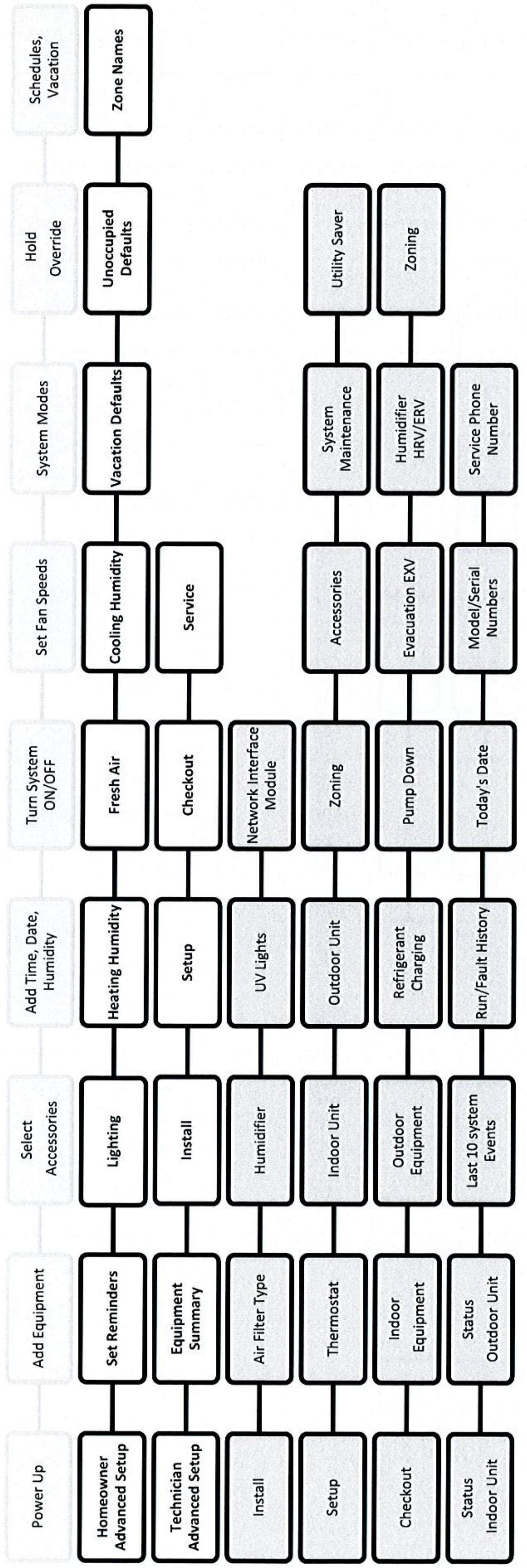
FLASH CODE * (Amber LED)	FAULT DESCRIPTION	RESET TIME (Minutes)
ON, no flash	Standby/Charging	-
1, pause	Variable Capacity	-
1 (1 second ON), longer pause (2 seconds OFF)	Pressure Trip Cutback, High Load Cutback, Flank Loading Cutback, Oil Circulation Cutback	-
Continuous Flash		NA
16	Communications Loss	NA
25	Invalid Model Plug	NA
31	High-Pressure Switch Open	15
32	Low-Pressure Trip	15
45	Control Fault (Internal Board Failure)	NA
46	Brownout	Revert to 5-minute cycle delay
48	Lost Inverter Communications	Revert to 5-minute cycle delay
49	230VAC Dropout-Reset Event	Revert to 5-minute cycle delay
53	Outside Air Temperature Sensor Fault	NA
54	Suction Temperature Sensor Fault	15
55	Coil Temperature Sensor Fault	NA
56	OAT-OCT Thermistor Out of Range	NA
57	Suction Pressure Sensor Fault	15
58	OAT-OST Thermistor Out of Range	5
59	Compressor Scroll Temperature Out-of-Range Event	15
68	Compressor Sump Heating Active	2 Hours
69	Inverter Internal Fault	15
71	Compressor Motor Temperature Out of Range	15
72	Suction Overtemperature	15
75	Inverter Temperature Out-of-Range Event	15
77	Inverter Overcurrent	15
79	Compressor No-Pump Event	15
82	Suction Overtemperature Lockout	4 Hours
83	Low-Pressure Lockout for 4 Hours	4 Hours
84	High-Pressure Lockout for 4 Hours	4 Hours
85	Compressor Temperature Lockout	4 Hours
86	Compressor Temperature Sensor Fault	15
88	Inverter Temperature Lockout	4 Hours
91	Inverter VDC-Out Overvoltage	15
92	Inverter VDC-Out Undervoltage	15
93	230 VAC Undervoltage	15
94	230 VAC Overvoltage	15
95	High-Current Lockout	2 Hours
96	VDC Undervoltage Lockout	2 Hours
97	VDC Overvoltage Lockout	2 Hours
98	High-Torque Event	10
99	High-Torque Lockout	2 Hours
OFF		NA
* Short Flashes (0.25 seconds) indicate the first digit in the status code followed by long flashes (1.0 seconds), indicating the second digit of the status code.		

Appendix B — Screen Display Maps



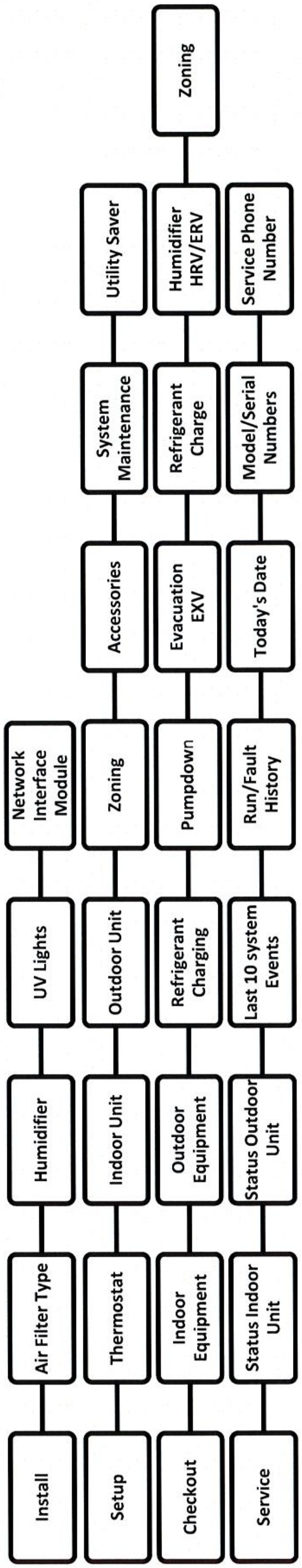
POWER-UP, HOMEOWNER ADVANCED AND TECHNICIAN ADVANCED SCREENS

Appendix B — Screen Display Maps (cont)



HOMEOWNER ADVANCED AND TECHNICIAN ADVANCED SCREENS

Appendix B — Screen Display Maps (cont)



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