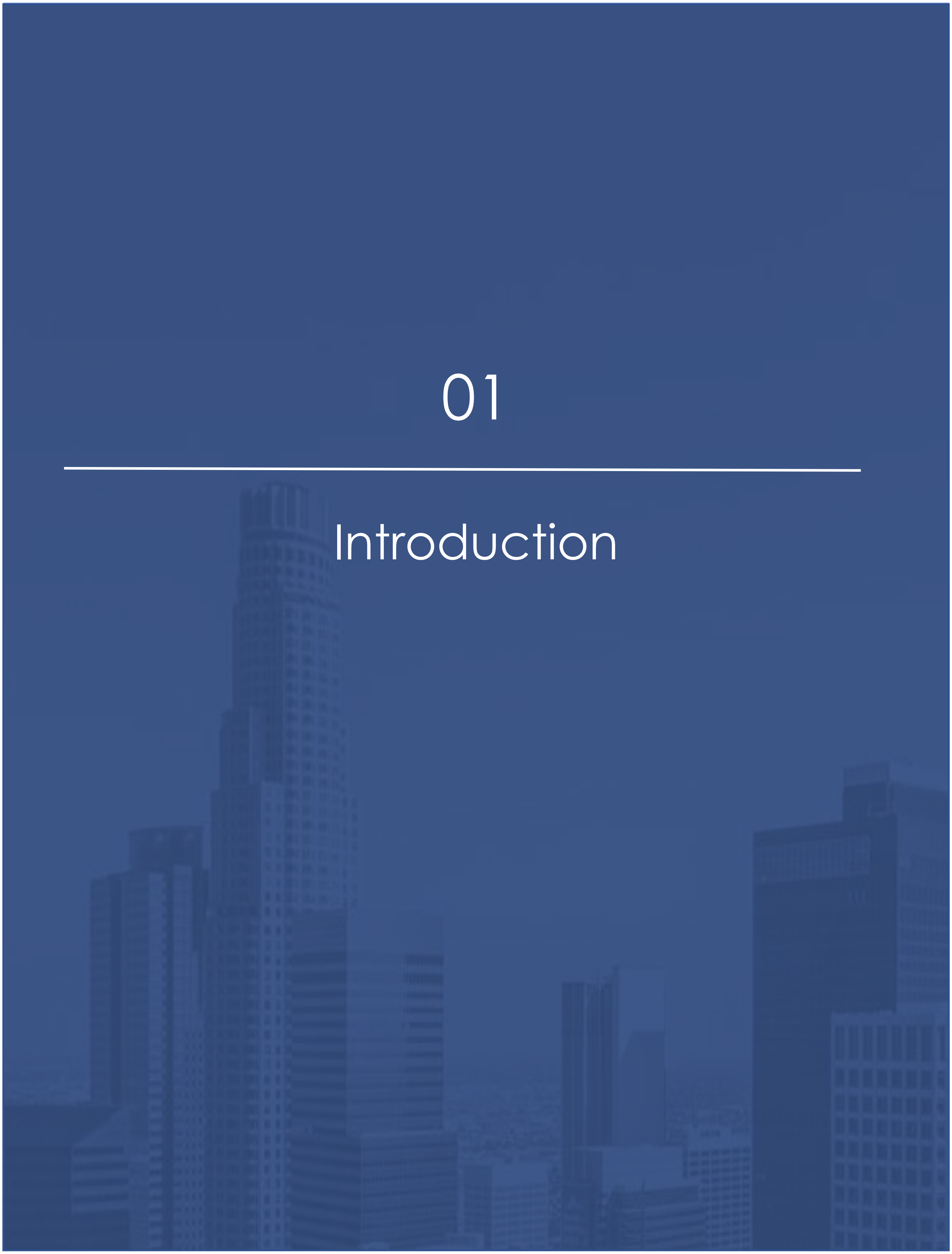
Residential Single and Two Stage Heat Pump Package Systems

Field Reference Guide

Updated October 2023

Johnson Controls

Table of Contents



01

Introduction

Introduction

This field reference guide contains technical information regarding Unitary Products residential single and two stage heat pump package systems.

This guide is not designed to replace the documentation provided with the equipment. The technician should always refer to the installation and service instructions during the installation and service of any air conditioning equipment.

Follow all local, state, and federal laws, codes, rules, and regulations when performing work on any of the equipment described in this guide.

Safety is always a concern when working on HVAC (Heating Ventilation and Air Conditioning) equipment. In Section 2 (Safety), many factors regarding workplace safety are reviewed. It is the employer and technician's responsibility to identify potential safety hazards in the workplace. This is not an all-inclusive safety document.

Only qualified technicians with proper safety training should install, service or maintain the equipment described in this guide.

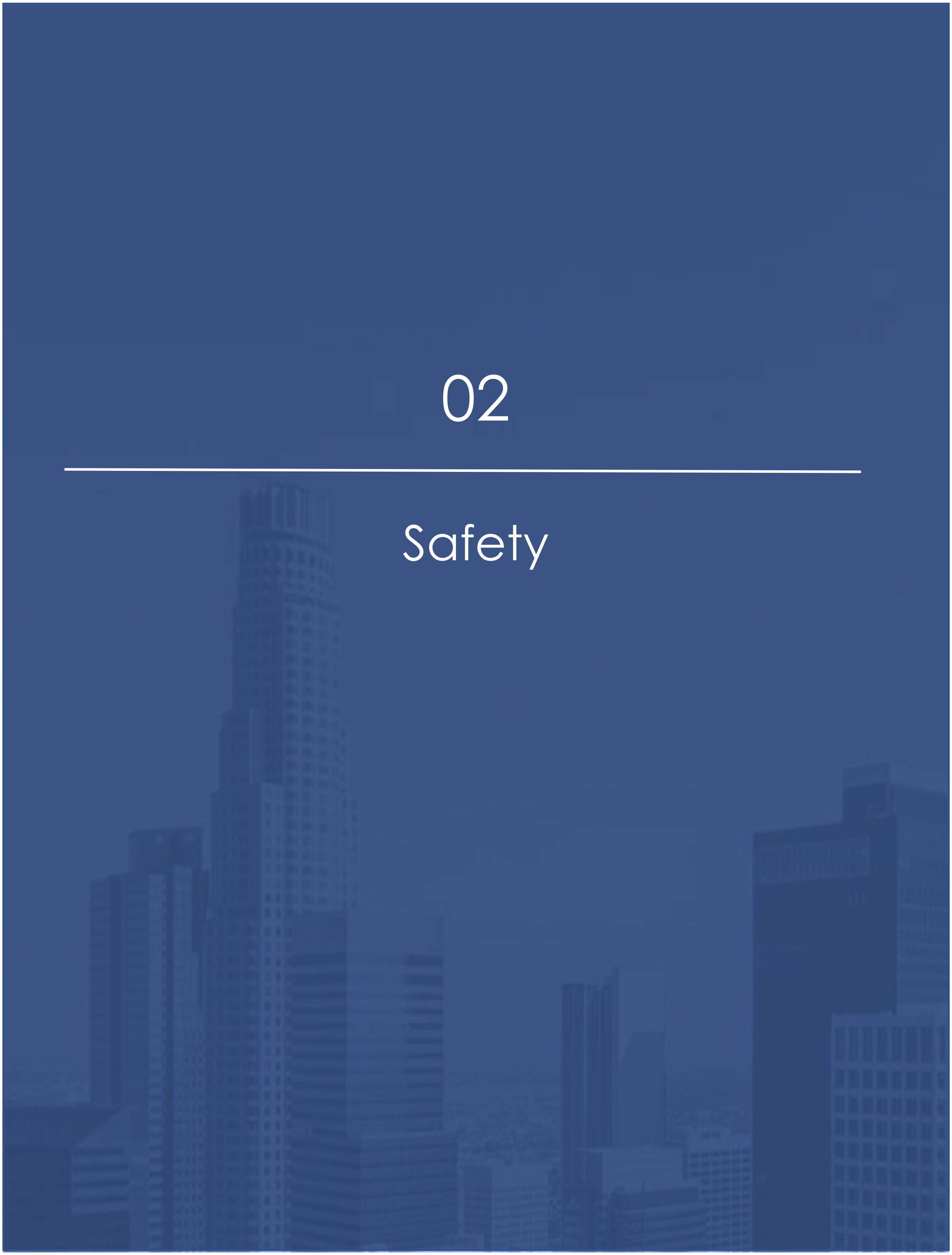
Proper installation and service of air conditioning systems requires a thorough understanding of electrical and mechanical components and system operation. In Section 3 (Component Familiarization), the air conditioning cycle, electrical components, and field installed accessories are reviewed.

In Section 4 (Installation) and Section 5 (Start Up), basic installation and start up procedures (including residential and commercial equipment) are discussed.

Section 6 (Sequence of Operation) provides info on the sequence of operation.

Section 7 (Troubleshooting) offers insights into troubleshooting techniques and

Section 8 (Maintenance) provides an overview of maintenance procedures for the various components within the air conditioning unit.



02

Safety

Safety Symbols

Reminder – use this manual in conjunction with the technical literature for each product. This manual Does Not Supersede the Installation Manual and Technical Guide provided with the equipment. Always read and follow all instructions before installing equipment. Understand and pay particular attention to the signal words **DANGER**, **WARNING** or **CAUTION**.

DANGER

An overpressure protection device, such as a pressure regulator, must be installed in the gas piping system upstream of the furnace and must act to limit the downstream pressure to the gas valve so it does not exceed 0.5 psig [14" w.c. (3.48 kPa)]. Pressures exceeding 0.5 psig [14" w.c. (3.48 kPa)] at the gas valve will cause damage to the gas valve, resulting in a fire or explosion or cause damage to the furnace or some of its components that will result in property damage and loss of life.

Sample Danger Label

DANGER indicates an imminently hazardous situation which could result in death or serious injury.

WARNING

The duct system must be properly sized to obtain the correct airflow for the furnace size that is being installed.

Refer to the furnace rating plate for the correct rise range and static pressures or to Table 6 for the correct rise range.

If the ducts are undersized, the result will be high duct static pressures and/or high temperature rises which can result in a heat exchanger OVERHEATING CONDITION. This condition can result in premature heat exchanger failure, which can result in personal injury, property damage, or death.

Sample Warning Label

WARNING indicates a potentially hazardous situation which could result in death or serious injury.

CAUTION

The indoor coil must be installed in the supply air duct, downstream of the furnace. Cooled air may not be passed over the heat exchanger.

Sample Caution Label

CAUTION indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It is also used to alert against unsafe practices and hazards involving only property damage.

Safety Specific Rules

Follow these specific safety rules for a safe application:

- Air conditioning systems utilizing gas heating can only use natural gas or propane (LP) gasses as an approved fuel. LP applications require installation of the appropriate LP conversion kit. Refer to the unit rating plate or Installation Manual for information on proper inlet and manifold pressures.
- Install air conditioning systems only in locations and positions as specified in the Installation Manual.
- Provide adequate clearances for service, combustion, and ventilation air to the unit. The recommended clearances are specified in the Installation Manual.
- Test for gas leaks as specified in the Installation Manual.
- Only connect the equipment to a duct system which has an external static pressure within the allowable range as specified in the Installation Manual.
- These unites are not to be used for temporary heating or cooling of buildings or structures under construction. Improper installation will shorten equipment life, reduce product efficiency, and void the warranty.
- Always install the systems to operate within the equipment's intended temperature and operating ranges.
- The size of the unit should be based on an acceptable and approved heat load calculation for the structure being conditioned.

Safety Requirements

Follow these safety requirements for a safe application:

- All equipment should be installed in accordance with all national and local building/safety codes and requirements, local plumbing or wastewater codes, and other applicable codes. In the absence of local codes, install in accordance with the most recent National Electrical Code, National Fuel Gas Code and/or Natural Gas and Propane Installation Code (latest editions). Furnaces have been certified to the latest edition of standard ANSI and CSA standards.
- Only approved heat accessories shall be installed on these air conditioning units local.
- Refer to the unit rating plate for the equipment model number, and refer to the Installation Manual for proper air plenum dimensions.
- Provide clearances from combustible materials as listed under Clearances to Combustibles in the Installation Manual and the equipment rating plate.
- Provide clearances for servicing ensuring that service access is allowed for both the burners and indoor fan motor.
- Provides clearances for servicing.
- Failure to carefully read and follow all instructions in this manual and the equipment Installation Manual can result in equipment malfunction, death, personal injury and/or property damage.
- Check the rating plate and power supply to be sure that the electrical characteristics match. All commercial 15 through 25-ton units distributed in North America use nominal 208/230 volts AC, nominal 460 volts AC, or nominal 575 volts AC 3 Phase, 60-Hertz power supply. DO NOT CONNECT THIS APPLIANCE TO A POWER SUPPLY OR A VOLTAGE OTHER THAN THE RANGE SPECIFIED ON THE UNIT DATA TAG.
- The equipment shall be installed so the access panels are readily available, and the electrical components are protected from water infiltration.
- Installing and servicing HVAC equipment can be hazardous due to the electrical and mechanical components. Only trained and qualified personnel should install, repair, or service HVAC equipment. When working on equipment, observe precautions in the manuals and on the labels attached to the unit and other safety precautions that may apply.
- The Installation manual covers minimum requirements needed to conform to existing national standards and safety codes. In some instances, these instructions exceed certain local codes and ordinances. These instructions are required as a minimum for safe installation and operation.

General Awareness

Safety is ALWAYS the primary concern for everyone. On the job injuries can be significantly reduced when proper guidelines are followed. Always be aware of all company, local, state and/or OSHA (Occupational Safety and Health Administration) regulations.

Jobsite Safety

Keeping the job site clean of trash, extra tools and equipment will significantly reduce the chance for injuries. Since each job is unique and has its own hazards, all new workers to the area should be made aware of the location of hire and first-aid equipment, fire escape routes, and other dangers.

Hazardous Materials

Many different chemicals and compounds are used in the service and installation of HVAC systems. Please read the directions and use caution along with PPDs whenever handling these materials. Read and understand the MSDS for all materials used.

Confined Spaces

Never enter or work in a confined space without taking the appropriate precautions. Have someone available outside the space ready to assist or summon help if necessary. Even spaces that seem relatively safe can quickly become hazardous if a pipe were to break and fill the space with refrigerant, steam, poisonous fumes or other gasses. Welding or brazing in a confined space is especially hazardous.

Pressure

High pressures have always been part of the HVAC profession. Wear the proper personal protective devices including safety glasses and gloves. Proper hose ratings and manifolds are required for high-pressure refrigerants.

Electrical Safety

Jewelry should be removed prior to any electrical work being performed. Ensure that the equipment disconnect switch removes the primary power source prior to taking resistance readings or disconnecting any wires or connections. Removal of system power should be verified with the voltage function of a multimeter. All electrical safety guidelines should be always followed. Only trained, qualified technicians should perform electrical maintenance, installation, inspections and troubleshooting of electrical equipment.

Electrocution occurs when a current as low as 6 to 200mA flows through the heart, disrupting its normal operation and causing death. Electrical shock is an injury that occurs because of exposure to an electrical current. Inspect all extension cords and power tools regularly. Fuses and circuit breakers are designed to protect equipment, not people. For personal electrical protection, GFCI or Ground Fault Circuit Interrupters are highly recommended.

Lock-Out Tag-Out

OSHA Standards cover the servicing and maintenance of machines and equipment, in which unexpected energizing or startup of the machines or equipment, or release of stored energy, could cause injury to employees.

These standards establish minimum requirements for the control of such hazardous energy. To ensure safety, put a lock that is tagged with the technician's name on the electrical disconnect or breaker of the equipment or circuit which is being serviced.

Be aware of others who may be working on the same circuit or other circuits served by the same electrical panel. The technician should also be aware that other technicians may not have used the proper Lock-Out, Tag-Out procedures.

Fire Safety & Burns

While brazing, keep the area clear of combustible material or use a heat shield to help reduce risk of fire.

Check equipment regularly and never try to modify or repair regulators.

While servicing the refrigeration circuit, improper use of equipment and tools can result in serious burns that are associated with refrigerants. This may include frostbite, which is a deep tissue injury. Proper personal protection devices must be in use when servicing the refrigeration system.

Personal Safety

Personal safety always includes remaining aware of the surroundings, using properly maintained tools, and correct use of items designed for personal protection.

Personal Protection Devices (PPD)

- Hard Hat: Hard hats must be worn when there is a danger of head injury.
- Safety Glasses: Eye protection should be worn at all times while on a job site.
- Gloves: Assist in the prevention of serious injury to the hands from serious cuts as well as injuries from high-pressure gasses such as refrigerants. Rubber gloves can protect the technician’s hands from chemicals when inspected and worn properly.
- Safety Shoes: Work shoes with steel toes for foot protection. There are also electrical safety shoes that can aid in protecting the technician against electrical shock and/or electrocution. At a minimum, leather work shoes with rubber soles are required.
- Respirator: Used in a confined space where the air can be dissipated by refrigerant which can cause asphyxiation.
- Safety Harness: Used when working above grade level. Ladders must be tied down. Ensure that PPDs provide the intended protection. They should be inspected regularly, used properly and never altered or modified in any way.

Clothing

Rotating and moving components pose a serious risk. Loose fitting clothing and ties should not be worn when servicing rotating equipment. If any clothing becomes entangled in moving parts, serious injury or death is a likely result.

Jewelry

Serious injury or death can result if jewelry contacts an energized circuit or is caught in moving parts. Leave jewelry at home or in your service bag or service vehicle.

Lifting

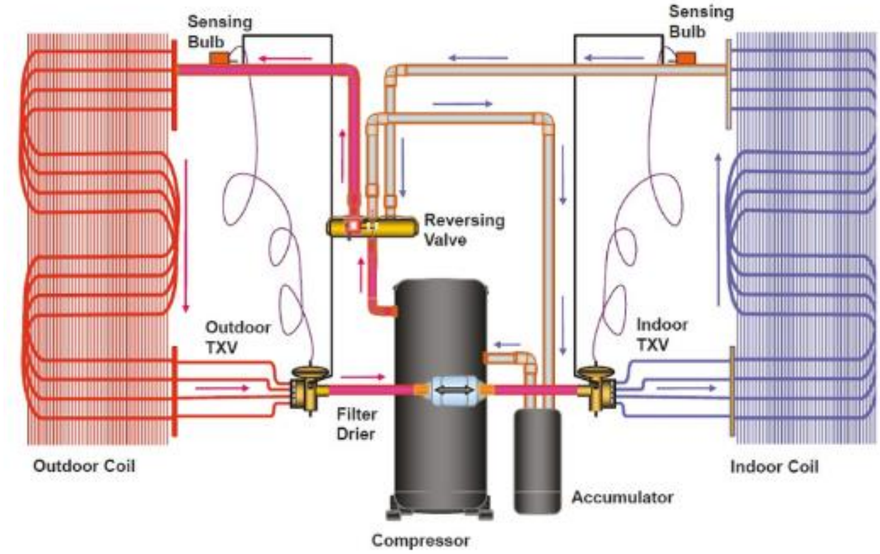
To avoid back injuries, always adhere to proper lifting techniques. Be aware of personal limitations and seek help with items that are too heavy to safely lift. A back support belt may provide additional protection.

03

Component Familiarization

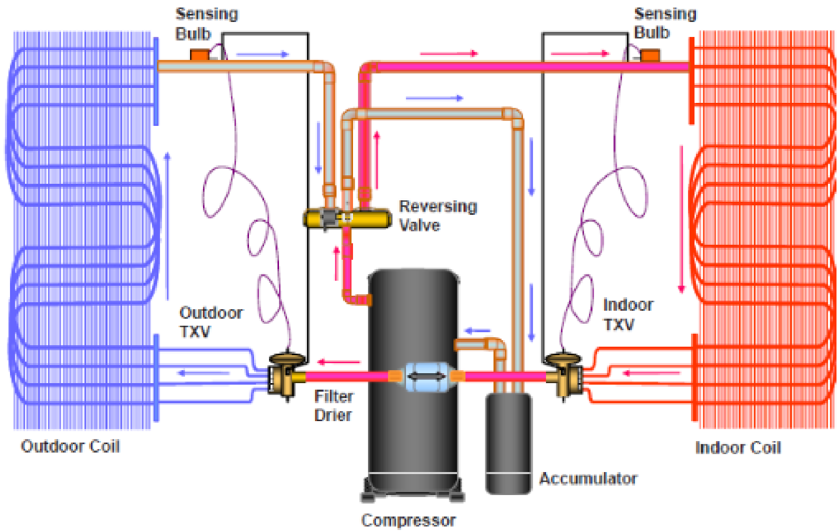
Heat Pump Cycle: Cooling Mode

In cooling mode, compressor discharge is directed to the outdoor coil. The heat pump moves the heat from indoors to outdoors as the indoor coil absorbs heat from the return air from the interior of the structure and the outdoor coil rejects outside of the structure. The reduced temperature, reduced humidity supply air is then reintroduced into the structure.



Heat Pump Cycle: Heating Mode

In heating mode, the flow of refrigerant is reversed by the reversing valve, with the compressor discharge directed to the indoor coil. The heat pump moves heat from outdoors to indoors as the outdoor coil absorbs heat from the outdoor air, and the indoor coil rejects heat inside of the structure.



Heat Pump Cycle: Heating Mode

Heat Pump System Components

Metering Device (Outdoor)

Residential package units utilize a thermostatic expansion valve (TXV) for outdoor coil refrigerant metering. The outdoor TXV meters refrigerant in the heating mode only. During cooling mode operation, the outdoor TXV is bypassed.

TXV General Operation

The TXV reduces refrigerant pressure from a high-pressure liquid to a low-pressure liquid while maintaining constant superheat in the evaporator, adapting to varying load conditions.

TXV Operating Forces

The TXV has three operating forces (one opening force and two closing forces):

1. Sensing Bulb Pressure (Opening):

   The sensing bulb is the opening force of the TXV. It is located at the outlet of the coil, on the suction line, as close to the coil as possible downstream of the header. It is mounted as close to the top of the suction line as possible and measures the temperature of the suction line. As the load increases on the coil, the superheat will increase.

   As the load increases and the sensing bulb pressure rises, the suction line temperature rises. When the sensing bulb pressure increases, pressure is exerted on the TXV diaphragm, opening the valve and allowing more refrigerant to flow into the coil as required, thus maintaining the proper amount of superheat.

2. Spring Pressure (Closing):

   Spring pressure is a "closing force" on the TXV. The TXV assemblies have a factory-adjusted spring installed in the body of the valve which exerts pressure on a set of push rods which are in direct contact with the diaphragm. The pressure of the spring opposes the sensing bulb pressure.

3. Coil Pressure (Closing):

   Coil pressure is a "closing force" on the TXV. The externally equalized TXV has three connections:

   - The liquid line - inlet port: The liquid line port is attached to the liquid line leaving the liquid line filter drier.
   - The distributor connection: The distributor connection has multiple feeder tubes at the outlet of the TXV which provides refrigerant to each refrigerant circuit of the coil.
   - The external equalizer line: The external equalizer line is a small capillary line which is attached to the top of the line at the outlet of the coil and downstream of the sensing bulb. The external equalizer references coil pressure at the outlet of the evaporator coil. The pressure of the coil opposes the sensing bulb pressure.

Liquid Line

The liquid line filter drier traps moisture, acid, and small particles; effectively stopping the contaminants from traveling through the system and causing damage.

The liquid line filter drier is in the liquid line between the indoor and outdoor metering devices. Filter driers are designed for specific refrigerants and pressures. Do not install a drier that is not designed for use on the system being serviced.

To determine if a liquid line filter drier is restricted, take a temperature reading on both sides of the drier. If there is a temperature difference (greater than 3° F Fahrenheit) between the inlet and outlet of the filter drier, the drier should be replaced.

Schrader Valves

Residential heat pump package units have Schrader valves within the compressor compartment to provide access to both the high and low side of the system. These valves must only be attached to the appropriate pressure gauge on the manifold gauge set. Improper installation of the manifold gauge set can cause damage to the gauges.

Reversing Valve

The reversing valve changes the direction of the refrigerant flow through the system based on the required system mode.

During the cooling cycle, the reversing valve is energized, and hot discharge gas is directed to the outdoor coil and the cool suction vapor is being pulled from the indoor coil. The reversing valve is also energized during defrost mode.

During the heating cycle, the reversing valve is de-energized. The suction vapor is pulled from the outdoor coil which has absorbed heat from the outdoor air. The hot gas is discharged to the indoor coil to provide heat for the conditioned space.

The reversing valve is controlled with a 24-volt AC solenoid. When the reversing valve is energized, an internal slide is shifted from one side of the valve to the other. When the reversing valve is de- energized, the internal slide shifts back to the original position.

Compressor

The compressor transforms refrigerant from low pressure vapor to high pressure vapor. The pressure of the refrigerant entering the inlet (suction) side of the compressor is referred to as low side pressure (suction pressure). The low-pressure vapor refrigerant is compressed and discharged from the compressor as high-pressure discharge gas.

Indoor Coil

In cooling mode, the indoor coil removes heat from the return air flowing through it. Under normal operating conditions, the evaporator coil temperature is approximately 40° F. The warmer return air passing through the coil rejects heat into the coil surface and into the refrigerant. When airflow and refrigerant charge is correct, the air temperature (discharge) leaving the indoor coil is approximately 15-20° F less than the air entering the evaporator.

Proper airflow setup (350-450 CFM/ton of cooling capacity) is critical for system performance and customer comfort. Excessive airflow may not allow proper de-humidification of the air, leading to discomfort in the conditioned space. Insufficient airflow may lead to coil icing and eventual compressor failure.

In heating mode, the reversing valve directs hot discharge gas to the indoor coil. The heat is transferred to the return air moving through the coil. The heated return air is then moved into the conditioned space.

Metering Device (Indoor)

The indoor coil metering device on heat pump residential package units is also a thermostatic expansion valve (TXV). In the heating mode, the indoor TXV is bypassed and does not meter refrigerant.

High Pressure Switch

The high-pressure switch protects the system against excessive high side or discharge pressures. There are multiple conditions which could cause this switch to open and de-energize the compressor. 24 volts AC is sent from the control board HPS terminal to the loss of charge switch and expects return of 24 volts AC on pin HPSG to confirm closure of the switch.

If the compressor is operating and the high-pressure switch is recognized as open for greater than 40ms, the control will de-energize the compressor contactor output (and the defrost outputs if they are active). The compressor contactor will remain off until the high-pressure switch has re- closed, and the 5-minute ASCD timer has been satisfied.

When the control continues the call for heating, the control restarts the defrost cycle and the timer at the point at which the call for heating was interrupted (if the liquid line (coil) temperature conditions allow defrost to occur).

If the control recognizes two HPS faults within six hours of accumulated compressor run-time, the control will enter the HPS lockout. The 2nd HPS fault must be open greater than 160ms to be recognized for this lockout fault condition. During the lockout period, the defrost and compressor relays remain de-energized.

Excessive head pressure is most caused by poor air flow across the high side coil. This may be the result of a dirty filter, dirty coil, a failed fan motor, or improper fan speed. It is also possible for the excessive discharge pressure caused by overcharging the system and/or a non-condensable such as air or nitrogen in the system.

The high-pressure switch opens at 625 +/- 25 psig and resets at 500 +/-25 psig.

Schraeder Valve

Residential heat pump package units have Schrader valves within the compressor compartment to provide access to both the high and low side of the system. These valves must only be attached to the appropriate pressure gauge on the manifold gauge set. Improper installation of the manifold gauge set can cause damage to the gauges.

Loss of Charge Switch

The normally closed loss of charge switch halts system operation upon increased line temperature indicative of significant loss of refrigerant charge. 24 volts AC is sent from the control board LPS terminal to the loss of charge switch and expects return of 24 volts AC on the second LPS terminal to confirm closure of the switch.

The control ignores the LPS input when the outdoor ambient temperature is below 5° F. This will prevent loss of charge lockouts while the unit is operating in heating mode in very cold conditions. The discharge temperature sensor continues to provide loss of charge protection. If the loss of charge switch is open for more than five seconds under conditions when the control is not ignoring the PS input, the control enters soft lockout mode.

Refrigerant R-410A

Components designed for use with R-410A are usually tagged with a rose pink label; the same color as a cylinder of R-410A.

R-410A systems use polyol ester (POE) synthetic oil. POE is not compatible with mineral oil as used in R-22 systems; therefore, service tools that touch the refrigerant side of the system (such as the manifold gauge set, recovery cylinders and recovery machine) should be dedicated to a single refrigerant only.

POE oil has a great affinity for water. Any moisture in the system may cause system problems. Do not leave the system open to the atmosphere.

Due to the higher pressures, any required refrigerant-side repairs must be made with brazing alloy that has a minimum of 5% silver content. Soft solder must not be used for connections in R-410A systems.

Accurate charging on package systems is best conducted by weighing in the exact charge as indicated on the unit data plate. Systems are shipped factory-charged and should not require charge modification except in the instance of a leak or component replacement within the refrigeration system.

When adding refrigerant to an R-410A system, R-410A must be taken out of the cylinder in liquid form. This eliminates any possibility for the refrigerant to fractionate (separate into its individual components). A quick-charge adapter will flash the liquid R-410A into a vapor before it enters the suction line. Alternately, the liquid may be "throttled" into the suction line. Use caution when allowing the liquid refrigerant to enter the suction line while throttling the low side manifold valve. Throttling the valve properly allows the refrigerant to flash to vapor prior to entering the suction side of the compressor.

R-410A QUICK REFERENCE

- Refer to Installation Instructions for specific installation requirements.
- R-410A refrigerant operates at 50 - 70% higher pressures than R-22. Be sure that servicing equipment and replacement components are designed to operate with R-410A.
- R-410A refrigerant cylinders are rose colored.
- Recovery cylinder service pressure rating must be 400 psig, DOT 4BA400, or DOT BW400
- Recovery equipment must be rated for R-410A.
- DO NOT use R-410A service equipment on R-22 systems. All hoses, gages, recovery cylinders, charging cylinders and recovery equipment must be dedicated for use on R-410A systems only.
- Manifold sets must be at least 700 psig high side, and 180 psig low side, with 550 psig retard.
- All hoses must have a service pressure rating of 800 psig
- Leak detectors must be designed to detect HFC refrigerants.
- Systems must be charged with liquid refrigerant. Use a commercial type.
- metering device in the manifold hose
- R-410A can only be used with POE type oils.
- POE type oils rapidly absorb moisture from the atmosphere.
- Vacuum pumps will NOT remove moisture from R-410A refrigerant oils.
- Do not use liquid line driers with a rated working pressure rating less than 600 psig
- Do not install suction line driers in the liquid line.
- A liquid line drier is required on every unit.
- Do not use a R-22 TXV. If a TXV is to be used, it must be a R-410A TXV.
- Never open system to atmosphere when under a vacuum
- If system must be opened for service, evacuate system then break the vacuum with dry nitrogen and replace all filter driers.

Transformer

The supplied transformer is wired for 230 volts AC line voltage. If the unit is installed in a location with 208 volts AC, the primary voltage tap must be moved to the 208-volt AC connection.

Transformer

Thermistor Inputs

All thermistor inputs are provided by a 10k NTC thermistors. As temperature increases, resistance decreases. The temperature / resistance relationship is documented below.

Thermistor Temperature / Resistance

Temperature	Resistance (Ohms)	Temperature	Resistance (Ohms)
-25F	196871	55F	17434
-20F	16487	60F	15310
-15	39576	65	13474
-10	118108	70	1883
-5	100260	75	10501
0	85371	80	9299
5	72910	85	8250
10	62449	90	7334
15	53640	95	631
20	46200	100	5827
25	39898	105	5208
30	34545	110	4663
35	29986	115	4182
40	26092	120	3757
45	22758	125	3381
50	19896	130	3047

The control detects open or shorted thermistors based on the following values:

Thermistor Input	Shorted Thermistor Definition (Resistance in Ohms)	Open Thermistor Definition (Resistance in Ohms)
Liquid Line	<1000	>350,000
Outdoor Ambient	<1000	>350,000

Timers & Delays

The control accumulates compressor run time whenever the M relay contacts are closed. All defrost timers are based on accumulated compressor run time. The control resets all timers when power (24VAC) is removed from the control.

Power Interruption

If the power to the control is interrupted for less than 20 milliseconds, the control resumes operation at the same point in the timing cycle. The control will not change modes of operation due to a power interruption of less than 20 milliseconds. Relays may temporarily drop out during the power interruption.

Power interruptions over 20 but less than 50 milliseconds are to reset the short cycle timer. If the compressor was energized, it de-energizes for the short cycle time period to prevent the compressor contactor from chattering. Defrost timing is not to be affected below 100ms.

Power interruptions greater than 100 milliseconds may reset the control as a power- up sequence. Power interruptions of any duration are not to cause lockout.

Anti Short Cycle Delay (ASCD) Timer

The ASCD timer prevents the compressor from starting within the timer duration after power loss or the completion of a compressor cycle. The duration of the timer is 5 minutes.

Low Voltage Sensing

The control senses low voltage conditions. If the average voltage drops below 19.2VAC (+/- 1.0V) for longer than 125ms, the control will not energize any relay outputs. If a relay is already energized, it remains energized unless the average voltage drops below 16VAC (+/- 1.0V) for longer than 125ms. If the average voltage drops below 16VAC (+/- 1.0V) for longer than 125ms, the relays open and de-energize any relay outputs. The ASCD period is initiated. The control will not re-energize the outputs until the average voltage is above 19.2VAC (+/- 1.0V) for longer than 125ms and the ASCD expires for the compressor outputs. Note that the specified voltages are for room temperature conditions. Voltages may vary more than +/- 1.0 VAC at temperature extremes.

If the average voltage is between 16 VAC and 19.2 VAC and the control needs to change the outputs based on thermostat inputs or any other condition changes, the control de-energizes the relay outputs as if the voltage dropped to below 16 VAC.

Liquid Line Sensor

A 10K NTC thermistor is present on the liquid line to detect the presence of frost or ice and is used to determine initiation and duration of defrost cycle.

Liquid Line (Coil) Sensor Temperature/Resistance/Voltage – Conversion Chart

Temperature (F)	Resistance (Ohms)	Voltage DC	Temperature (F)	Resistance (Ohms)	Voltage DC
-25	196,871	3.71	45	22,758	1.25
-20	165,487	3.54	50	19,896	1.13
-15	139,576	3.36	5	17,434	1.02
-10	118,108	3.17	60	15,310	0.91
-5	100.260	2.98	65	13,474	0.82
0	85.371	2.78	70	11,883	0.74
5	72,910	2.58	75	10,501	0.66
10	62,449	2.39	80	9,299	0.54
15	53,640	2.20	85	8.250	0.54
20	46,200	2.02	90	7,334	0.48
25	39,898	1.84	95	6,531	0.43
30	34,545	1.68	100	5,827	0.39
35	29,986	1.52	105	5,208	0.35
40	26,092	1.38	110	4,663	0.32

Outdoor Ambient Sensor

The outdoor ambient sensor is a 10K NTC thermistor that connects to the “Ambient terminals on the defrost control. Input from this sensor is used in the determination of defrost frequency.

Ambient (Outdoor) Sensor Temperature/Resistance/Voltage – Conversion Chart

Temperature (F)	Resistance (Ohms)	Voltage DC	Temperature (F)	Resistance (Ohms)	Voltage DC
-25	196,871	3.89	55	17,434	1.18
-20	165,487	3.73	60	15,310	1.07
-15	139,576	33.56	65	13,474	0.96
-10	118,108	3.39	70	11,883	0.87
-5	100,260	3.20	75	10,501	0.70
0	85,371	3.01	80	9,299	0.71
5	72,910	2.82	85	8,250	0.64
10	62,449	2.63	90	7,334	0.58
15	53,640	2.44	95	6,531	0.52
20	46,200	2.25	100	5,827	0.47
25	39,898	2.07	105	5,208	0.42
30	34,545	1.90	110	4,663	0.38
35	29,986	1.74	115	4,182	0.34
40	26,092	1.58	120	3,757	0.31
45	22,78	1.44	125	3,381	0.28
50	19,896	1.30	130	3,047	0.25

Outdoor Ambient Sensor

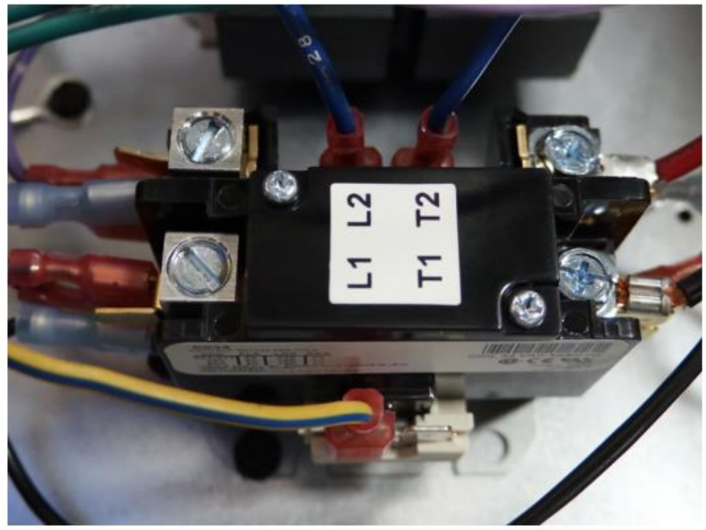
Contactor

The contactor is energized on a call for cooling 24 volts AC from "Y" on the thermostat. When 24 volts AC is applied to the contactor coil, the contacts close. This allows L1 of line voltage to pass through to T1 and energize the compressor and condenser fan.

There are no contacts between L2 and T2, indicating that L2 line voltage is always present at the compressor and condenser fan through the T2 connection.

If 24 volts AC is present at the contactor coil and the contactor does not pull in, further evaluation of the contactor coil should be completed. The unit should be locked out at the equipment disconnect before any resistance readings are taken.

Use an ohmmeter to measure the resistance across the contactor coil. An infinite reading indicates the coil is open, while a reading of zero ohms indicates a shorted coil. If either of these readings is present, the contactor must be replaced. The line voltage on the load side of the contactor should match the line voltage on the line side of the contactor. If it does not, check the contacts for pitting, dirt, or corrosion.

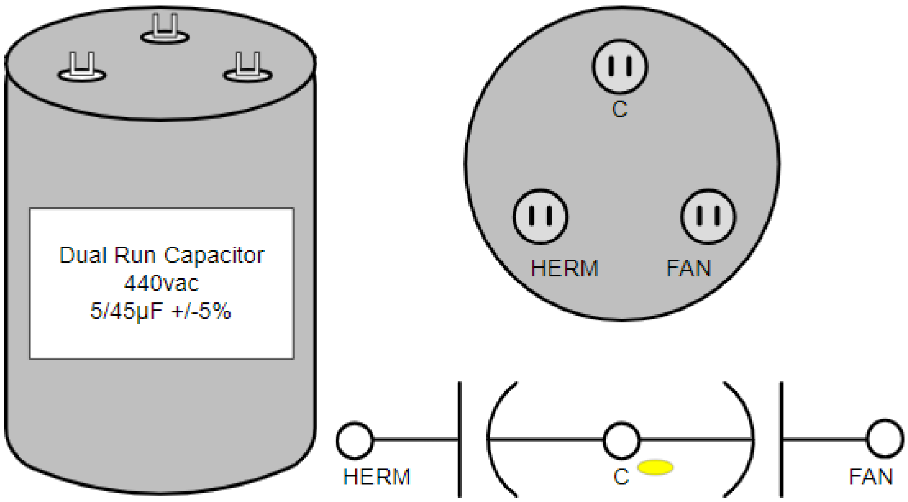


Contactor

Dual Run Capacitor

The dual run capacitor provides enhanced running torque to the compressor and condenser fan motor. The terminals are marked “Fan” (condenser fan), “Herm” (compressor), and “C” common.

The dual run capacitor is not used on three phase models.



Dual Run Capacitor

Unit Control Board (Single Stage)

The unit control is a central connection point for all system components. It manages system mode inputs, safeties, diagnostics, and defrost operation.

Blower Motor (Standard ECM) – Single Stage Models

The Standard ECM (S-ECM) motor is used in the indoor fan section on the single stage models. The S-ECM is controlled by 24-volt AC inputs from the unit control board as required for various system modes.

This motor operates with 208/240 volts AC line voltage. The allowable voltage range is 196-264 volts AC.

The Standard ECM motor is programmed to provide constant torque. If the static pressure changes, the motor will only maintain the factory programmed torque. This should not be confused with constant airflow. Even though the Standard ECM can maintain torque, **if static pressure increases, airflow will decrease.** This characteristic is like a PSC motor.

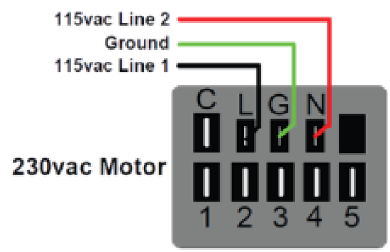
Airflow will not decrease as dramatically as with a PSC motor since torque is being maintained.

S-ECM Blower

The line voltage terminals are labeled "L", "G" and "N". The "L" terminal is line 1, and the "N" terminal is the line 2 for 230 volts AC. The "G" terminal is the ground terminal. A reading of 230 volts AC is measured between the "L" and "N" terminals.

The control terminals are labeled "C", "1", "2", "3", "4" and "5". The terminal labeled "C" is common for the 24 volts AC control voltage, while terminals labeled "1" through "5" are pre-programmed torque settings. 24-volt AC signals are sent from the control board to engage the proper fan torque for the mode of operation.

To adjust the motor speed for heating, cooling, and continuous fan, the blower motor wire for each mode is connected to the selected terminal (1-5). Blower speeds for various system modes are established through selection of the appropriate speed taps on the speed selection plug as noted below.

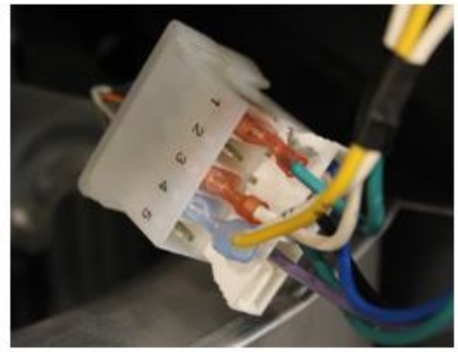


S-ECM Motor Connections

Blower Tap	Blower Speed
1	Low
2	Med Low
3	Medium
4	Medium High
5	High

If the motor is wired improperly, the control module and/or the motor module may be permanently damaged.

The speed of the motor must be adjusted within the minimum and maximum limits approved for the evaporator coil, electric heat, and outdoor unit. The settings and blower capacities are provided in the air flow data tables listed in the unit Installation Manual.



S-ECM Connector

For cooling mode airflow establishment, consult the airflow performance tables in the Installation Instructions to select the blower speed that provides 350-450 CFM/ Ton of airflow.

In heating mode, the proper blower speed selection is one that will deliver the rated temperature rise (as specified on the unit data plate) when in steady state heating.

Continuous fan speed is dependent on customer preference, though is often selected as the lowest available speed.

Unit Control Board (Two Stage)

The two-stage heat pump control features a status LED for diagnostics and connection points for unit components and safety controls. The operation of the blower motor is controlled by a separate two stage blower control board.

Enhanced ECM PWM Controller Blower (Two Stage Models)

The Enhanced ECM blower motor speed is modified through pulse width modulation (PWM) control.
The motor has line voltage supplied to it at all times and is controlled though the connection to the three pin terminal block on the unit control board. The PWM signal is an 80Hz, +20VDC modulated signal. The PWM common is not tied to the (24-volt AC) common terminals on the board.

The commanded PWM varies depending on system mode and setup and is measurable using a multimeter capable of reading Duty Cycle. A PWM ENA (enable) +20VDC signal is sent from the PWM ENA terminal on the two-stage blower control during a call for blower operation in any mode.

Expected Values

The expected PWM values vary depending on system mode, jumper selection, and thermostat inputs. The approximate PWM values for various models and conditions are found in the Extras section of this guide. Confirmation of these values, along with validation of line voltage to the motor, provides the basis of troubleshooting the control – motor interaction.

Two Stage Blower Control

The two stage blower control coordinates blower operation for all system modes. The connection points illustrated below receive inputs during various modes.

The blower speed is commanded through modification of the PWM (Pulse Width Modulation) signal sent to the blower via the PWM terminal.

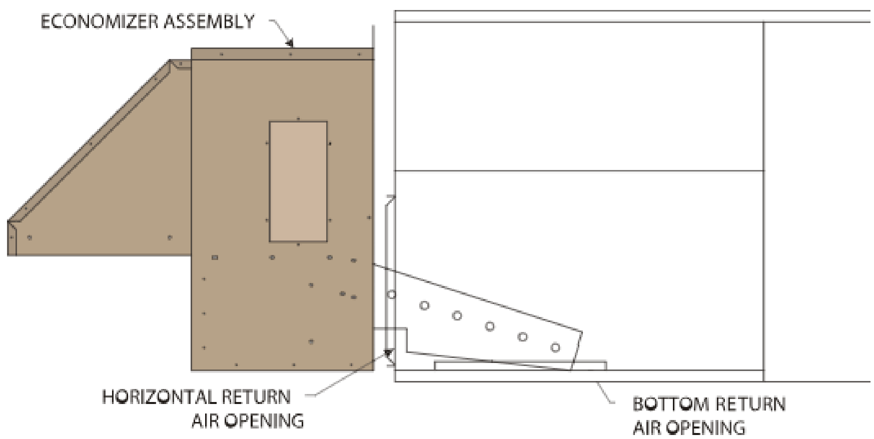
PWM (Pulse Width Modulation)

The blower speed is controlled by pulse width modulation (PWM) and requires a PWM ENA (enable) signal along with a PWM signal value based on the requirements of the current operational mode.

PWM ENA is a 20 Volt DC 'enable signal' to the blower motor. This signal enables blower operation and is present during a call for blower operation.

The PWM signal is a 20VDC square wave with a frequency of 80Hz and provides duty cycles ranging between 2% and 98% in 1% increments. The PWM signal is supplied between PWM and PWM COM. The specific PWM values are described in the Extras section of this Guide.

Economizers



Economizer

Economizer kits are equipped with a 24-volt AC controller, a modulating damper actuator, and either a single blade or a interposing blade damper configuration.

The economizer has two main modes of operation. The economizer provides minimum outside air positioning for fresh air ventilation. This introduces fresh air into the building and can assist in maintaining indoor air quality. The economizer also provides outdoor air for cooling when ambient conditions permit.

When the outdoor air temperature or the enthalpy (total heat content) is at a sufficient level, the air can be used for cooling the conditioned space. This can reduce the demand for mechanical cooling and limit compressor run time.

The standard economizer kits are shipped with an ambient dry bulb temperature sensor. The economizers have optional enthalpy kits which will convert the system with single or dual enthalpy sensing capabilities.

Note
If installation of an economizer is going to occur on a package unit with the burglar bar accessory, an economizer equipped with interposing blades must be used. Otherwise, the burglar bars will obstruct the single blade economizer damper and the economizer will not operate properly.

Dry Bulb Operation

The dry bulb temperature sensor, which is shipped standard with the economizer kit, senses ambient air temperatures. When the ambient air is within the temperature range setting on the control module, the economizer will use the ambient air to condition the space.

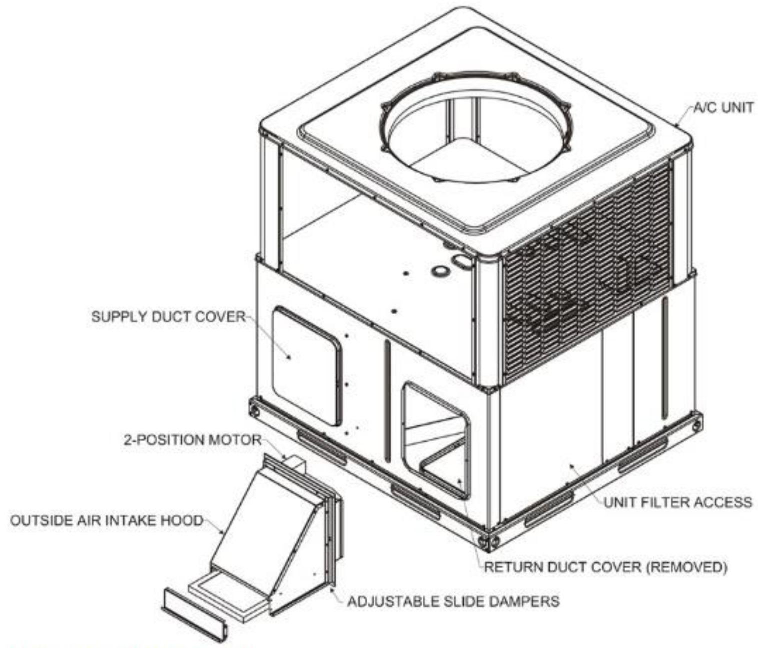
Single Enthalpy Kit

The single enthalpy kit contains an enthalpy sensor only. The enthalpy sensor replaces the dry bulb sensor and is capable of not only measuring the temperature, but also the humidity of the ambient air. The enthalpy sensor is providing the controller with the total heat content of the outside air. If the heat content of the outside air is within the range setting on the control module, the economizer will introduce fresh air to be sued to cool the conditioned space.

Manual Fresh Air Damper Kit

The manual fresh air damper may be installed on both downflow and side return air applications. The slide damper can be adjusted to allow zero to 50% outside air to mix with the return air that is being supplied to the conditioned space. This kit can be installed to provide minimum fresh air. The intake panel is insulated and has a protective screen at the inlet of the damper.

In some applications, it may be desirable to close off the outside air when the unit is not in operation. To achieve this, a motorized fresh air damper kit may be more suitable for the application.



Manual Fresh Air Damper Kit

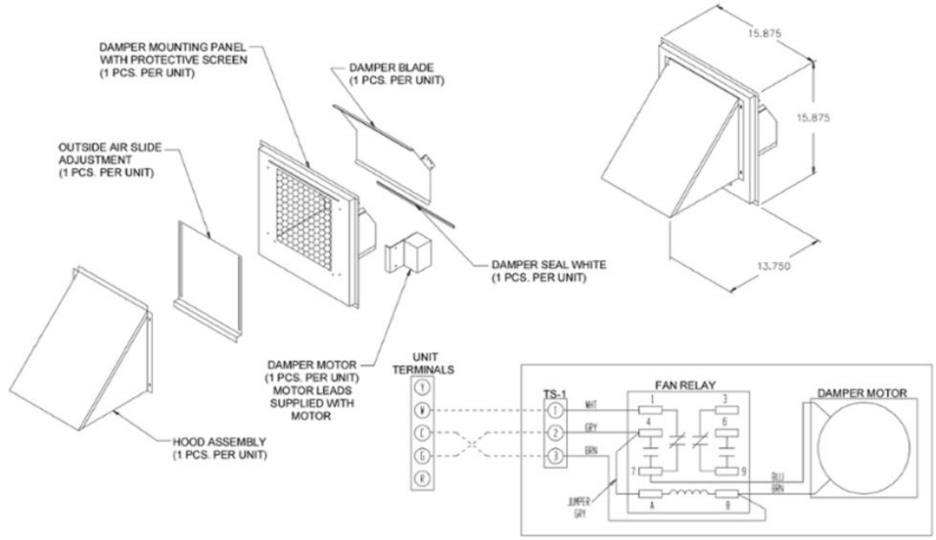
Dual Enthalpy Kit

The dual enthalpy kit contains an enthalpy sensor, electrical wires, and self-drilling screws. The enthalpy sensor will be installed to sense the total heat content of the return air. The total heat of the return air is compared to the total heat of the outside air. When the controller senses the enthalpy of the return and outside air, the economizer will modulate to use the air with the least amount of heat content.

Note
If the economizer is to be used with dual enthalpy control, both the single and dual enthalpy kit must be installed to provide both the ambient and return air enthalpy sensors. Each kit has only one enthalpy sensor.

Motorized Fresh Air Damper Kit

The motorized fresh air damper is available for downflow and side return air applications. The damper can be installed to allow zero to 50% outside air and provide fresh air to the conditioned space. The damper has a two position damper motor that is actuated when the indoor fan is in operation.



Motorized Fresh Air Damper Kit

The two positions are either open or closed. The kit has a fixed slide damper that can be adjusted to regulate the volume of outside air flow entering the return air stream. The damper motor can be field wired to provide fresh air during the heating mode, fan on, or cooling operation. The damper closes on a loss of power. The intake panel is insulated and has a protective screen at the inlet of the damper.

Filter Frame Kit

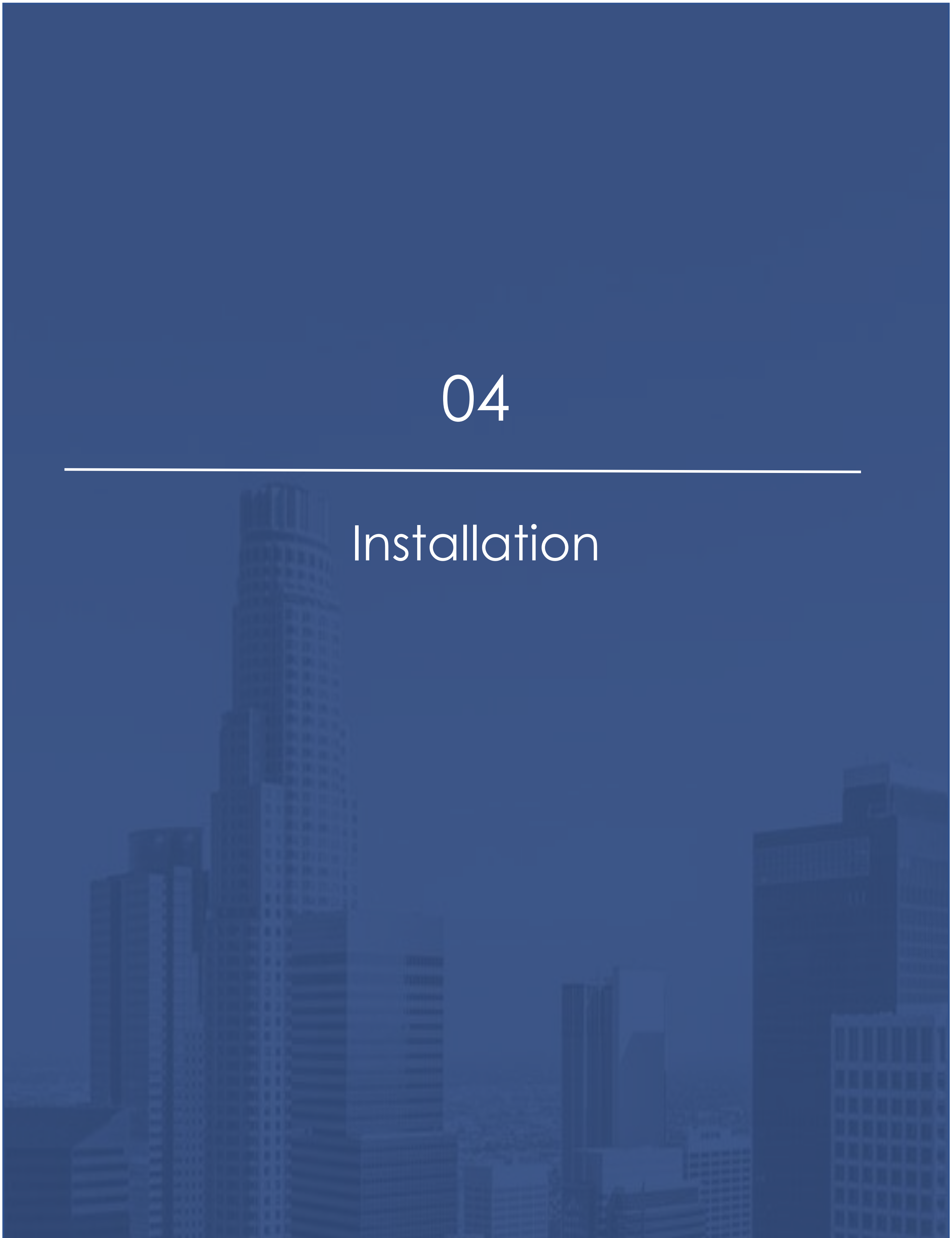
The filter frame kit available for installation installed on downflow and horizontal units. The filter kits are available in more than one size (large and small footprint). The filter kits may be installed on units with or without economizers and should be installed according to the installation instructions provided with the kit.

Roof Curb Kit

Roof curbs for residential package units (8” and 14”) must be installed according to the Installation Manual and should meet all National Roofing Contractors Associations (NRCA) standards. These field installed kits must be matched to the equipment model being installed. The roof curbs are shipped unassembled and have corner hinge pin construction for easy assembly. The kit provides unit duct support for both supply and return air duct connections. The curb is also constructed with a full perimeter wood nailer that will allow the base flashing to be tied back into the roofing system.

It is the responsibility of the contractor to ensure that the building construction can accommodate the additional weight load of the equipment being installed.

If care is not taken to ensure that the building will provide proper support for the equipment, damage to property, personal inquiry, or death may occur.



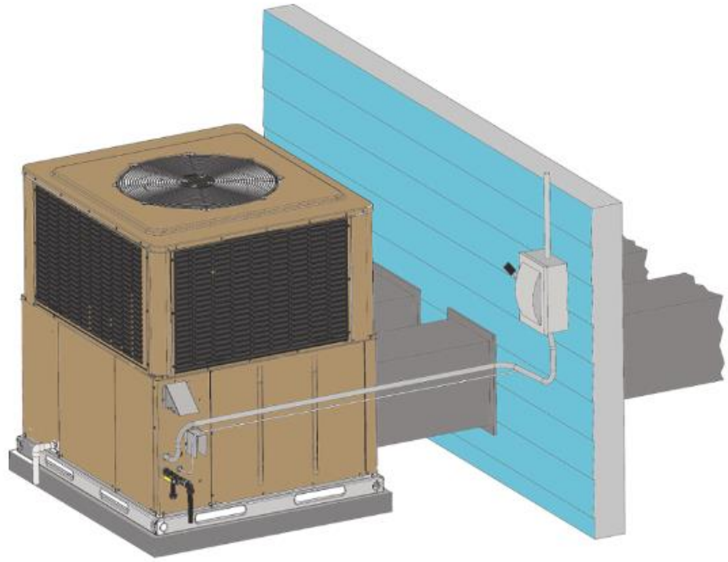
04

Installation

Introduction

Residential package units must be installed in accordance with all current local, city, state and national laws and code requirements. If the equipment is installed outside of the United States, adhere to all laws and codes within the country of origin.

Follow the installation procedures specified in the Installation Manual. If the manufacturer's specifications are exceeded by code, or if code is exceeded by the manufacturer's specifications, the most restrictive code requirements must be used.



Typical Package Unit Installation

Thermostat

The thermostat is a critical component within the electrical system. If the thermostat is not selected to match the equipment's operating requirements or if the thermostat is not installed properly, the system cannot provide adequate comfort within the structure.

Thermostats should be mounted on an interior wall. Thermostats mounted on walls around the perimeter of a structure will not sense accurate temperatures and the length of the run cycles will increase. This will cause overshooting of the thermostat settings, decreased comfort levels and inefficient system operation.

The thermostat should be eye level and away from supply air registers. A thermostat that is in the supply air stream will short cycle the equipment and result in uncomfortable space temperatures and equipment failure.

If the thermostat is equipped with a heat anticipator, the anticipator should be set according to the value specified in the unit Installation Instructions. Some electronic thermostats do not have adjustable heat anticipators. They may have cycle rate adjustment settings rather than anticipator settings. The cycle rate adjustment setting should be set to six cycles per hour.

Electrical Wiring

All electrical connections and components shall be installed in accordance with current national electrical code requirements within the United States, or current national codes within the country in which the equipment is being installed.

The power supply should be a dedicated circuit with the proper equipment grounding and circuit protection. Failure to provide adequate wire sizing, circuit protection and equipment grounding will result in improper system operation, property damage, personal injury and/ or loss of life.

All electrical conduits entering the controls section of the package unit should be sealed with an approved, non-conducting electrical sealant. This will prevent moisture from being pulled through the conduit and corroding electrical components within the controls section.

Prior to connecting the main power supply to the unit, verify that the primary voltage taps to the transformer are wired properly for 208/ 230 volts AC. If the transformer is not wired properly, electrical component failure can occur.

Control Wiring

Install the field supplied thermostat by following the installation instructions that accompany the thermostat.

With the thermostat and the electrical disconnect set to the OFF position and locked out, connect the thermostat wiring from the wiring connections on the thermostat to the electrical connections in the control section of the package unit.

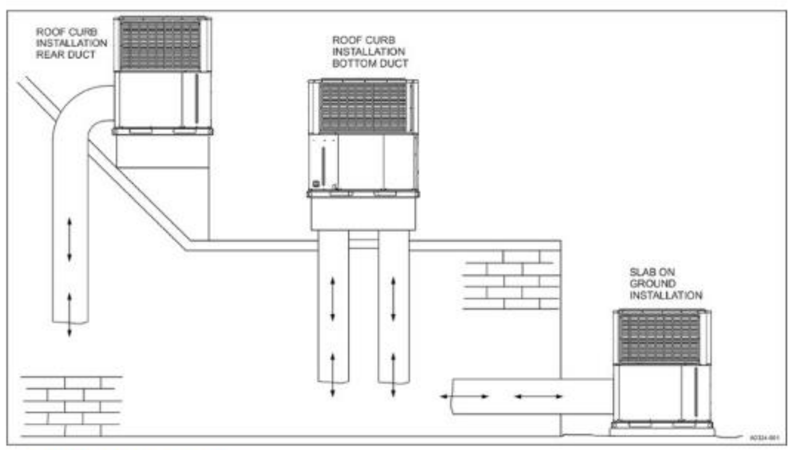
Electronic thermostats may require the common wire from the transformer's 24 volts AC secondary side to be connected to the "C" terminal. The digital display and electronics within the thermostat are powered by the transformer at the "R" and "C" terminals of the thermostat. All control wiring should have a minimum of 18-gauge wire.

Ductwork Installation

To properly design the duct work for the structure, refer to the ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) Fundamentals Handbook chapter on “DUCT DESIGN,” or Air Conditioning Contractors of American (ACCA) “Manual D.”

Down and Side Discharge Connections (Bottom Unit View)

Sizing, installation and insulating the duct work should also be provided in accordance with industry recognized procedures identified by the equipment specifications and duct manufacturer specifications.



Package Unit Duct System

The residential heat pump package units may be ducted horizontally as shipped or converted to downflow by relocating the blank off panels from the down discharge openings to the side discharge openings.

The duct system must be designed properly per approved methods and matched to the equipment being installed. Improperly sized duct systems will result in loss of efficiency, equipment damage, structural damage, and indoor air quality problems.

Note
Residential package systems are designed to deliver their rated airflow up to 0.5” w.c. total external static pressure. Restrictive duct will increase external static pressure and will cause operational issues and customer discomfort. At all times, the equipment must be permitted to operate within stated design tolerances to ensure operation per the published performance ratings.

Location & Clearances

Package units are designed to be installed outdoors only. Proper clearances for airflow and servicing should be provided according to the installation manual.

Install all ground level package systems on a level pad or slab designed to withstand the equipment's weight and dimensions. Ensure the pad or slab location dimensions meet local code requirements.

Some installations may require additional clearances from ground or roof level to the bottom of the unit. This is dependent on local code requirements regarding snow line data which could affect the defrost capabilities of the unit.

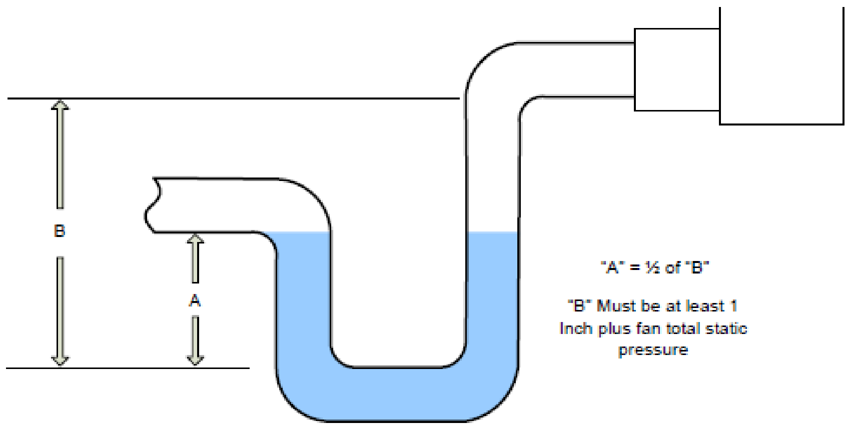
Condensate Drain

Residential package units must be installed with a condensate drain plumbed from the unit and piped to an open drain.

The condensate drain must have a condensate trap in the line.

If an open drain is not available when installed on a roof, contact the local authority having legal control and identify local requirements for the condensate drain. Equipment installed at grade level must have a condensate drain piped to an open drain or an approved drain which meets local code requirements. The condensate drain should be sized properly, and all fittings and connections sealed with an approved sealing compound. After installation, the trap should be primed with water.

Condensate Drain



Condensate Drain Trap

Filters

Filters may be installed with an approved filter kit properly sized for the system. Filter sizes should be entered on the start-up sheet when the system is installed. Never operate the unit without a suitable air filter system. Additionally, the equipment owner must be instructed concerning the importance of regular filter cleaning or replacement as appropriate.

Sizing of Equipment

Sizing equipment must be based on heat loss and heat gain calculations made in accordance with industry recognized procedures identified by the Air Conditioning Contractors of America (ACCA).

Accessories

All accessories and any future accessories that may become available should be installed according to the installation instructions provided to ensure safe operation and customer satisfaction.

05

Start-up

Introduction

Online Unitary Products Residential Startup Form

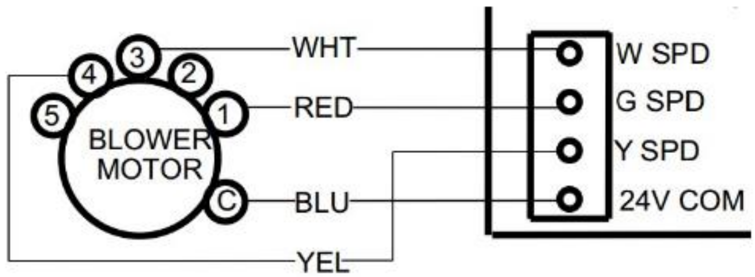
The online form is found at the back of the installation manual. This is for use with all Unitary Products residential units. Completed form data is sent to your inbox for archive purposes.

Airflow Setup: Standard ECM Blower Motor (Single Stage) Blower Speed Setup

The Standard ECM (Electronically Commutated Motors) motor is programmed to provide constant torque. If the static pressure changes, the Standard ECM motor attempts to maintain the factory programmed torque. This should not be confused with constant airflow. Even though the Standard ECM can maintain torque, if static pressure increases, airflow will decrease. This is like a PSC (Permanent Split Capacitor) motor. However, airflow will not decrease as dramatically as with a PSC motor since torque is being maintained.

Line Voltage

Line voltage is always available between the "L" and "N" terminals, even during no call for blower operation.



Standard ECM Line Voltage Connections

Control Voltage and Tap Selection

The control terminals are labeled "C","1","2","3","4" and "5". The terminal labeled "C" is common for the 24 volts AC control voltage, while terminals labeled "1" through "5" are pre-programmed torque settings. 24-volt AC signals are sent from the control board to engage the proper fan torque for the mode of operation.

Standard ECM Low Voltage Connections

If the motor is wired improperly, the control module and / or the motor module may be permanently damaged.

To adjust the motor speed for heating, cooling, and continuous fan, the blower motor wire for each mode is connected to the selected terminal (1-5).

Blower speeds for various system modes are established through selection of the appropriate speed taps on the speed selection plug as noted below.

Blower Tap	Blower Speed
1	Low
2	Med Low
3	Medium
4	Medium High
5	High

Airflow in all modes of operation MUST be established upon installation in all instances. Do not assume anything is "factory set". **Each job varies and as such, blower speed selections must be properly established in the field for each mode of system operation without exception.**

Proper airflow establishment involves measurement of external static pressure (ESP) in cooling mode and selection of appropriate blower speed taps that provide 350- 450 CFM per ton of cooling in the cooling mode, and provide a temperature rise within the range listed on the unit data plate in the heating mode.

Refer to the airflow tables in the installation instructions that correspond with the duct configuration (side or down discharge).

Continuous Fan Speed Selection

Continuous fan speed is dependent on customer preference, though it is often selected as the lowest available speed.

Cooling Speed Selection

Airflow performance charts are provided in the Installation Manual that outlines CFM performance based on the model, application, and external static pressure. The blower speed is selected based on the system cooling capacity and static pressure to provide approximately 400 CFM per ton of system cooling capacity.

Heating Speed Selection

Heating mode airflow is selected to maintain a system heating mode temperature rise within the allowable range on the system rating plate.

BLOWER DELAY Adjustment

The BLOWER DELAY adjustment establishes the heating mode heating blower off delay. The positions are labeled "60", "90", "120", and "180". A jumper not connected in any of the four positions defaults to the "120" position. The control is shipped from the with the jumper in the "60" position.

Airflow Setup: Enhanced ECM (Two Stage)

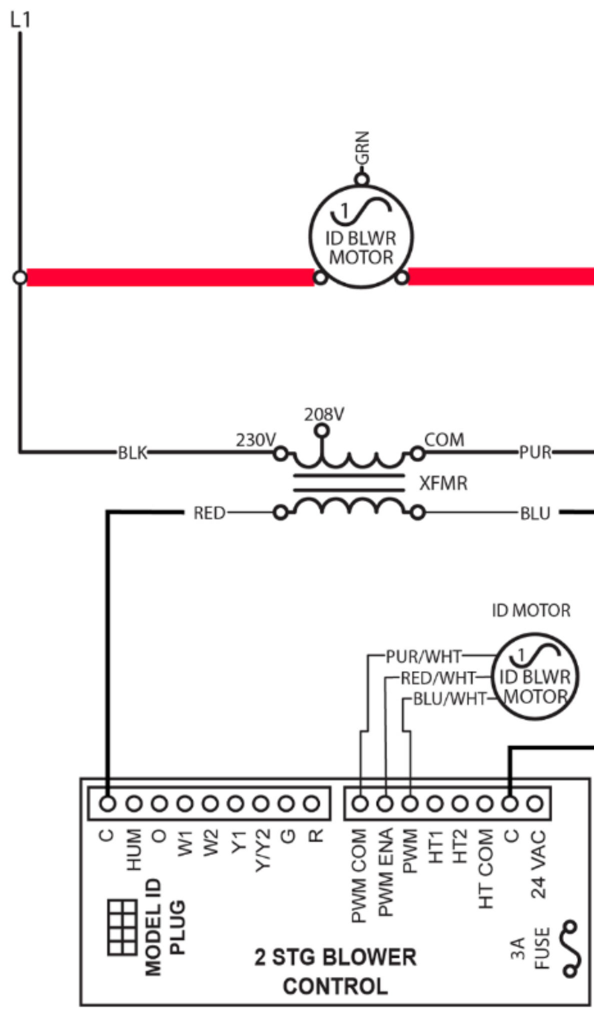
The Enhanced ECM blower motor speed is modified through pulse width modulation (PWM) control.

The motor has line voltage supplied to it and is controlled through the connection to the three-pin terminal block on the unit control board.

The diagram below illustrates the line and control connections to the Enhanced ECM blower motor.

The PWM (Pulse Width Modulation) ENA (enabled) signal is commanded from the blower control (+20VDC) during any call for blower operation. The PWM control signal is sent through the PWM and PWM COM connections. The commanded PWM varies depending on system mode and setup and is measurable at the PWM Test Pad on the control board using a multimeter capable of reading Duty Cycle.

The PWM common is not tied to the (24-volt AC) common terminals on the control board.



Enhanced ECM Connections

Diagram Simplified to Isolate Connections

Expected Values

The expected PWM values vary depending on system mode, jumper selection, and thermostat inputs. The approximate PWM values for various models and conditions are found in the Extras section of this guide. Confirmation of these values, along with validation of line voltage to the motor, provides the basis of troubleshooting the control – motor interaction.

External Static Pressure (ESP)

As with most all residential equipment, residential package systems are designed to provide their rated airflow at up to .5" w.c. total external static pressure.

Important
External static pressures greater than 0.5" w.c. will cause a reduction in indoor airflow volume and may lead to comfort and operational issues.

Understanding airflow configuration and limitations is a critical element of HVAC service work. This knowledge must be at the forefront of service and installation activities.

All systems, including those that utilize the ECM indoor fan motors, have airflow limitations. If a system does not have the proper ductwork, the unit will not meet the designed seasonal energy efficiency ratings, system operational sound will be greater than expected, and the system may also experience component failures.

The measurement of external static pressure (ESP) and proper adjustment is of the utmost importance if the system is going to operate to design conditions.

On the supply side of the indoor fan, the pressure is pushing out in all directions on the interior of the supply system.

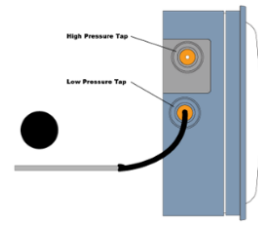
On the return side of the indoor fan, the pressure is pulling inward on the interior of the return system.

Restrictions in the duct system, such as undersized ducts, dirty filters, dirty indoor coil and closed or blocked registers, will cause the external static pressure to increase. As the external static pressure increases, the unit's ability to move air decreases.

Common tools of choice for measuring ESP are the Magnehelic© gauge or incline manometer. A digital manometer is another popular choice for static pressure measurement.

Using the Magnehelic

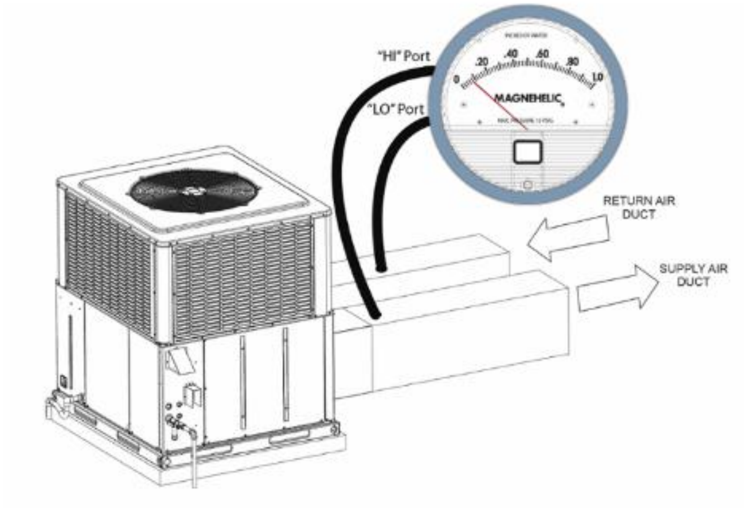
The Magnehelic© gauge has two ports, labeled "High" and "Low". The "High" port registers positive pressure and is connected to the supply side of the system. The port marked “Low” registers negative pressure and is connected to the return side of the system as close to the unit as possible.



Magnehelic© Gauge Side View

Supply Static Pressure Measurement

To measure the supply static pressure, connect the Magnehelic© gauge probe to the port marked "HI". The probe is inserted immediately off the supply duct connection or as close to the takeoff as possible.

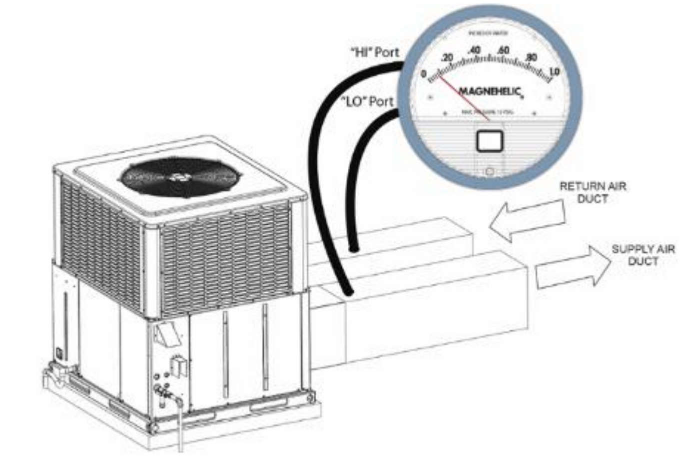


Static Pressure Measurement

Return & Total Static Pressure Measurement

Return Static Pressure Measurement

To measure the return static pressure, the Magnehelic© probe is connected to the port marked "LO". The probe should be inserted in the return air duct as close to the unit as possible.



Static Pressure Measurement

Total External Static Pressure

To measure the total external static pressure, add the supply air static pressure to the return air static pressure.

Example:

Supply Air Static:	.3" W.c.
Return Air Static:	+ -.2" W.c.
= Total ESP	= .5" W.c.

If the total pressure exceeds the designed maximum allowable ESP on the equipment data plate, evaluate the duct system and ensure that it is sized properly. Systems with excessive ESP display increased operational sound and will not provide published performance.

Temperature Rise

A package unit that is operating properly must have a heating mode temperature rise that is within the allowable range listed on the data plate.

The temperature rise is measured by subtracting the return air dry bulb temperature from the supply air dry bulb temperature as seen in the following example. Supply and return air temperatures should be measured as close to the package unit as possible without being in direct view of the heat source. If the readings are taken in direct line of sight to the heat source, the temperature will be of the radiant heat generated rather than the air temperature entering or leaving the unit.

Example:	Supply air dry bulb	115°F
	Return air dry bulb	-70°F
	=Temperature Rise	= 45°F ΔT - Rise

Temperature Drop

A package unit with proper airflow established and the nameplate refrigerant charge will have an 18-degree F to 20-degree F temperature drop across the indoor coil during cooling operation. The temperature drop is measured by subtracting the supply air dry bulb temperature from the return air dry bulb temperature as seen in the following example.

Example: Return air dry bulb 75°F
Supply air dry bulb -55°F

____

=Temperature Rise = 20°F ΔT - Drop

Proper Leaving Air Temperature +/-3°F Cooling Mode

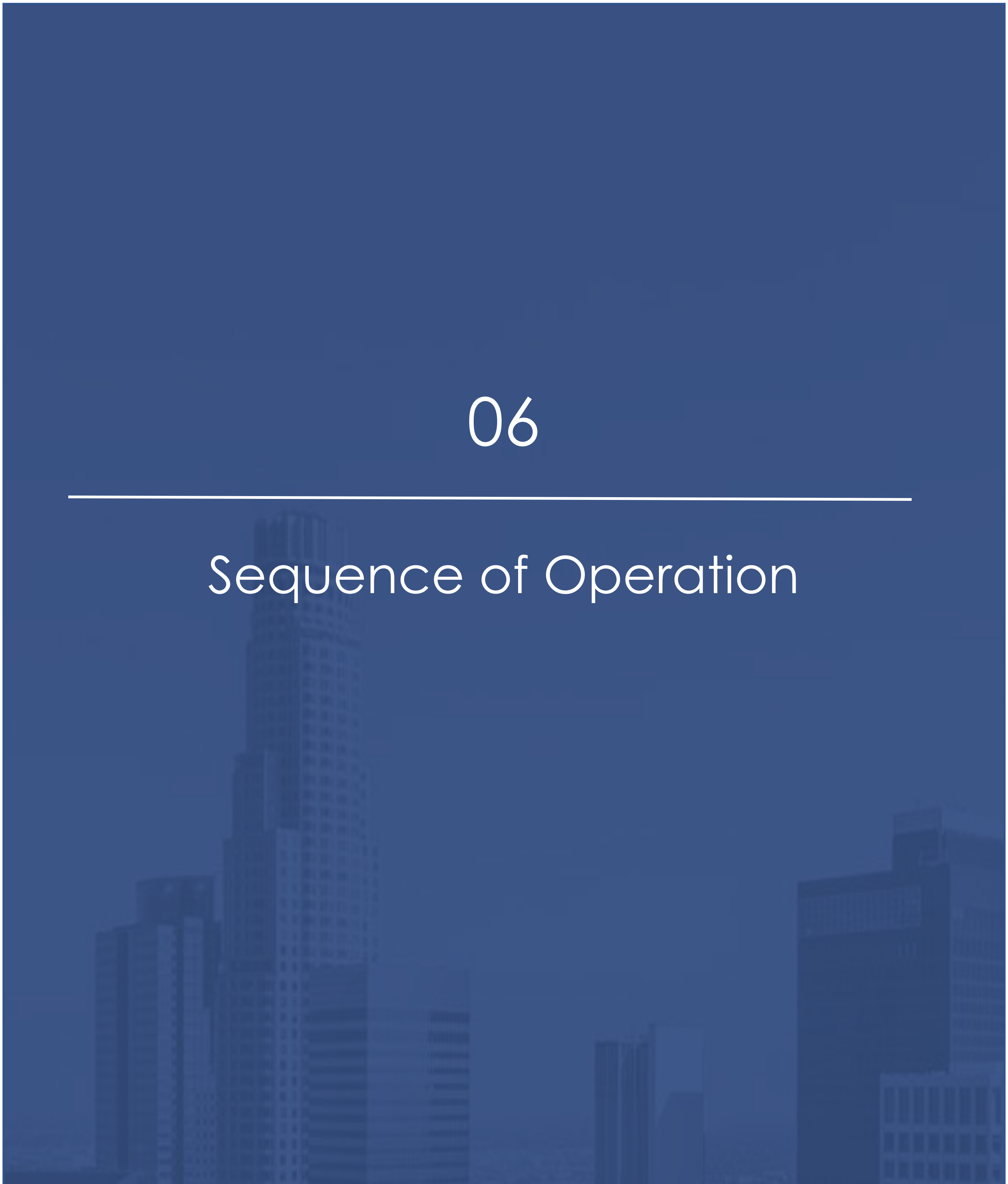
LAT Calculator: Return Air Dry Bulb °F; Return Air Entering Wet Bulb °F; Leaving Air Dry Bulb Temperature

Return Air Entering Wet Bulb Temperature °F	Return Air Entering Dry Bulb Temperature °F							
°F	70°	72°	74°	76°	78°	80°	82°	84°
57°	51	52	53	54	55	56	57	*
58°	51	52	53	54	55	56	57	58
59°	52	53	53	54	55	56	57	59
60°	52	53	54	55	56	56	57	59
61°	53	54	55	55	56	57	58	60
62°	53	55	55	56	57	58	59	60
63°	54	55	56	57	57	58	60	61
64°	55	56	57	57	58	59	60	61
65°	55	57	58	58	59	60	61	62
66°	56	57	58	59	60	61	62	63
67°	57	58	59	60	61	62	63	63
68°	58	59	60	61	62	63	64	64
69°	59	60	61	62	63	64	65	65
70°	60	61	62	63	64	65	66	66
71°	*	62	63	64	65	66	67	67
72°	*	63	64	65	66	67	68	68
73°	*	*	65	66	67	68	69	69
74°	*	*	*	67	68	69	70	70
75°	*	*	*	*	69	69	71	71

Leaving Air Temperature +/-3°F for Nominal 400 CFM Per Ton of Cooling

During certain conditions, the temperature drop may be increased or decreased depending on the return air wet bulb temperatures.

The chart will indicate the dry bulb temperature within +/- 3 degrees F leaving the coil if the system is operating within design specifications.



06

Sequence of Operation

Sequence of Operation (Single Stage Product)

The control controls the defrost operation based on accumulated compressor run time, outdoor coil temperature, and outdoor ambient temperature. The control allows the unit to operate in the normal heating mode until the control determines that a defrost cycle is needed. The demand for defrost will exist when the coil temperature falls below the initial set point at a given ambient temperature based on an initial curve.

Thermostat Signal Assumptions

- A call for compressor cooling is defined as a Y/Y2 or Y1 and an O signal.
- A call for compressor heating is defined as a Y/Y2 or Y1 signal only.
- A call for aux heating is defined as a Y and a W signal.
- A call for emergency heating is defined as a W only signal.

Compressor Heating Mode

During normal compressor heating mode, the control causes all the following to occur.

- Outdoor fan motor is energized (except in defrost)
- Compressor contactor outputs is energized.
- Reversing valve is de-energized.

Compressor Cooling Mode

During normal cooling mode for a heat pump, the control causes all the following to occur:

- Outdoor fan motor is energized.
- Compressor contactor outputs is energized.
- Reversing valve is energized.

Additionally:

- If the control receives an O input without a Y input, it energizes the reversing valve only.
- If the control receives a W input and an O input, it energizes the reversing valve and WOUT. This is technically an error condition for heat pumps and air conditioners since O and W should never be energized at the same time.

Emergency Heat

A call for emergency heat is defined as a W signal without a Y signal. The control energizes WOUT immediately when an emergency heat signal (W) is received.

Auxiliary Heat

During auxiliary heating mode, the control causes all the following to occur.

- Outdoor fan motor is energized.
- Compressor contactor outputs is energized.
- Reversing valve is de-energized.
- WOUT output is energized.

Test Input Operation with Thermostat Signals Present

Duration of Connection (Seconds)	Control Behavior with Thermostat Signals Present
<2	No response
2-5	Bypass ASCD (Reduce timer to zero immediately). If Y1 is present and high-pressure switch is closed, contactors will be energized.
	Clear Pressure Switch Lockout and reset the 6-hour PS timer.
>5	Initiate defrost cycle ignoring the COIL temp and record that defrost cycle was initiated by TEST short. Energize WOUT and begin defrost cycle immediately upon expiration of timer.

Test Pin Short removed	Terminate defrost as normal.
Test pin Short not	Continue defrost cycle until TEST connection removed.

When the TEST input is shorted for over five seconds, the control will activate a defrost and remain in defrost if it remains shorted. This will occur if the Y signal is present, and the control is in forced defrost mode and if no other thermostat signals are present. Other sections of this document describe the details of this feature.

Test Input Operation - Thermostat Signals NOT Present

Duration of Connection (Seconds)	Control Behavior with Thermostat Signals Present
<2	No response
2-5	The control sequentially flashes, on the STATUS LED, the series of stored error codes (up to the last 5 since active error codes were last cleared) starting with the most recent. If there are no error codes stored in memory, the STATUS LED flashes 3 times (0.1 sec ON/0.1 sec OFF).
>5	The control immediately clears the stored error code array, reset the 6 hour PS timer and flash the STATUS LED 6 times (0.1 sec ON/0.1 sec OFF) to indicate that the error memory has been cleared.

Hot Heat Pump Operation

The control implements the Hot Heat Pump Mode by controlling the indoor airflow level (for single and two-stage compressor systems) and the stage of compressor operation (for two-stage compressor systems). These two control features are called the forced second stage feature and the reduced indoor airflow feature. These features are independent of one another, but both function to increase the indoor discharge air temperature.

Because the control interacts with the compressor operation signals and the indoor airflow level signals, a Hot Heat Pump system cannot directly use the Y1 and Y/Y2 thermostat signals to control the compressor stage or the indoor airflow level. The control must be present. For a single stage compressor Hot Heat Pump the control must be present to control the indoor airflow level.

Forced Second Stage

The control determines the behavior of the forced second stage feature based on the Switch Point of 37°F. Based on the Switch Point setting and the liquid line temperature, the control will lock the compressor to second stage operation. This forced second stage feature ensures that the compressor will always be in second stage during a defrost cycle. If the compressor were allowed in the first stage during defrost, the outdoor coil would not defrost as quickly as in the second stage. The maximum defrost cycle length timer could expire before the defrost cycle is complete.

The forced second stage feature also prevents first stage heating operation at low temperature and avoids cold indoor discharge air. Testing has shown that the indoor discharge air temperature is too cold when the liquid line temperature is below the switch point and the compressor is running in first stage even with low indoor airflow.

The control forces second stage compressor operation when the liquid line temperature is below the switch point even if the thermostat is calling only for first stage. The liquid line temperature must be below the switch point continuously for 30 seconds. If the liquid line temperature exceeds the switch point 30 seconds before it has expired, the control resets the timer and restarts the timer when the liquid line falls below the switch point again.

The control implements this behavior during a call for heating (Y1 or Y1 + Y2). The control does not cause the compressor to run in second stage cooling mode with a first stage call for cooling based on the switch point.

The control does not force the two-stage compressor when all the following conditions are true continuously for 30 seconds. If any of the conditions are no longer true before the 30-second timer expires, the control resets the timer and restarts it when all of them are again true. That is, if the liquid line temperature exceeds the switch point temperature and then falls below the switch point temperature before the 30-second timer expires, the control resets the timer when the control falls below the switch point. The control restarts the 30-second timer when the liquid line temperature exceeds the switch point temperature again.

1. The liquid line temperature exceeds the switch point temperature.
2. The outdoor ambient temperature exceeds the values corresponding to each switch point setting.
3. The unit is not in defrost mode. If the other exit conditions are met while the unit is in defrost mode, the control completes the defrost cycle and then exits the forced second-stage feature.

Reduced Indoor Airflow Feature

The control determines the behavior of the reduced indoor airflow feature based on the Hot Heat Pump Enable jumper input. If the HOT HEAT PUMP jumper is in the ON position, the Y2Out signal from the outdoor control is not delivered to the indoor unit. Therefore, the indoor unit delivers low airflow while the compressor is running in the second stage. This creates higher temperature indoor discharge air. The HOT HEAT PUMP jumper may also be placed in the OFF position to override this portion of the Hot Heat Pump mode, as necessary. This is the only Hot Heat Pump feature that applies to the single stage compressor hot heat pump.

Anti-Short Cycle Delay

The ASCD prevents the compressor from starting within the timer duration after power loss or the completion of a compressor cycle. The duration of the ASCD timer is 5 minutes. The control accumulates compressor off time whenever the compressor contactor output is not energized. The ASCD timer delay is present when the control is powered up and immediately following the completion of a compressor cycle.

The outdoor fan is not energized during the ASCD timer delay. The outdoor fan should be energized when the compressor is energized.

When the TEST terminals are shorted with a Y input energized and the pressure switch closed, the ASCD will be bypassed, and the compressor contactor outputs will be energized within two seconds based on the input signals present.

Sequence of Operation (Two Stage Product)

The control controls the defrost operation based on accumulated compressor run time, outdoor coil temperature, and outdoor ambient temperature. The control allows the unit to operate in the normal heating mode until the control determines that a defrost cycle is needed. The demand for defrost will exist when the coil temperature falls below the initial set point at a given ambient temperature based on an initial curve.

Thermostat Signal Assumptions

- A call for compressor cooling is defined as a Y/Y2 or Y1 and an O signal.
- A call for compressor heating is defined as a Y/Y2 or Y1 signal only.
- A call for aux heating is defined as a Y and a W signal.

Compressor Heating Mode

During normal compressor heating mode, the control causes all the following to occur:

- Outdoor fan motor is energized (except in defrost)
- Compressor contactor outputs is energized.
- Reversing valve is de-energized.

Compressor Cooling Mode

During normal cooling mode for a heat pump, the control causes all the following to occur:

- Compressor contactor output is energized.
- Reversing valve is energized.
- If the control receives an O input without a Y input, it energizes the reversing valve only
- If the control receives a W input and an O input, it energizes the reversing valve and WOUT. This is technically an error condition for heat pumps and air conditioners since O and W should never be energized at the same time
- Outdoor fan motor is energized.

Emergency Heat

A call for emergency heat is defined as a W signal without a Y signal. The control energizes WOUT immediately when an emergency heat signal (W) is received.

Auxiliary Heat

During auxiliary heating mode, the control causes all the following to occur.

- Outdoor fan motor is energized.
- Compressor contactor outputs is energized.
- Reversing valve is de-energized.
- WOUT output is energized.

Hot Heat Pump Mode

The control implements the Hot Heat Pump Mode by controlling the indoor airflow level (for single and two-stage compressor systems) and the stage of compressor operation (for two-stage compressor systems). These two control features are called the forced second stage feature and the reduced indoor airflow feature. These features are independent of one another, but function to increase the indoor discharge air temperature.

Because the control interacts with the compressor operation signals and the indoor airflow level signals, a Hot Heat Pump system cannot directly use the Y1 and Y/Y2 thermostat signals to control the compressor stage or the indoor airflow level. The control must be present. For a single stage compressor Hot Heat Pump the control must be present to control the indoor airflow level.

Forced Second Stage

The control determines the behavior of the forced second stage feature based on the Switch Point of 37°F. Based on the Switch Point setting and the liquid line temperature, the control will lock the compressor to second stage operation. This forced second stage feature ensures that the compressor will always be in second stage during a defrost cycle. If the compressor were allowed in the first stage during defrost, the outdoor coil would not defrost as quickly as in the second stage. The maximum defrost cycle length timer could expire before the defrost cycle is complete.

The forced second stage feature also prevents first stage heating operation at low temperature and avoids cold indoor discharge air. Testing has shown that the indoor discharge air temperature is too cold when the liquid line temperature is below the switch point and the compressor is running in first stage even with low indoor airflow.

The control forces second stage compressor operation when the liquid line temperature is below the switch point even if the thermostat is calling only for first stage. The liquid line temperature must be below the switch point continuously for 30 seconds. If the liquid line temperature exceeds the switch point 30 seconds before it has expired, the control resets the timer and restarts the timer when the liquid line falls below the switch point again.

The control implements this behavior during a call for heating (Y1 or Y1 + Y2). The control does not cause the compressor to run in second stage cooling mode with a first stage call for cooling based on the switch point.
The control does not force the two-stage compressor when all the following conditions are true continuously for 30 seconds. If any of the conditions are no longer true before the 30-second timer expires, the control resets the timer and restarts it when all of them are again true. That is, if the liquid line temperature exceeds the switch point temperature and then falls below the switch point temperature before the 30-second timer expires, the control resets the timer when the control falls below the switch point. The control restarts the 30-second timer when the liquid line temperature exceeds the switch point temperature again.

1. The liquid line temperature exceeds the switch point temperature.
2. The outdoor ambient temperature exceeds the values corresponding to each switch point setting.

Switch Point Setting	OD Ambient Exit Temp
37 F	47 F

3. The unit is not in defrost mode. If the other exit conditions are met while the unit is in defrost mode, the control completes the defrost cycle and then exits the forced second-stage feature.

Defrost Mode

The parameters for the defrost are based on requirements of individual heat pump models. These requirements are referred to as defrost curves. All defrost timings referenced are based on accumulated compressor run time.

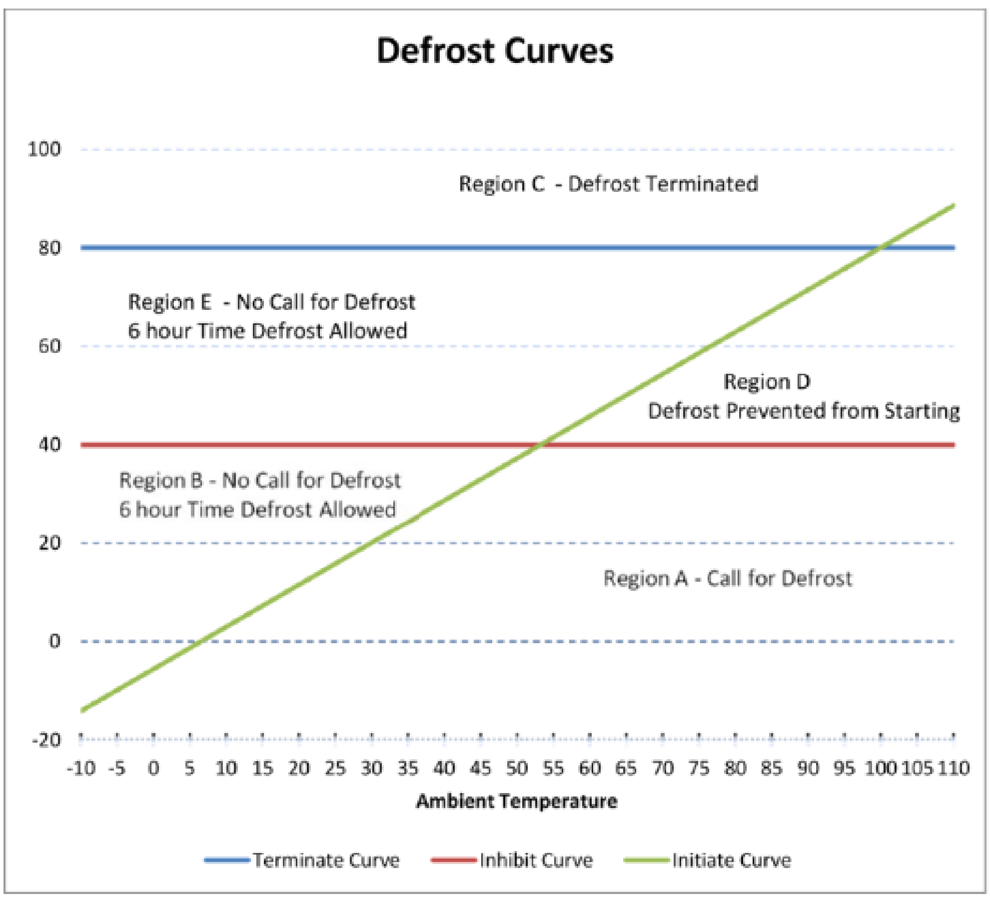
The defrost mode is equivalent to the cooling mode except that the outdoor fan motor is de-energized. The control provides the following action initiates a defrost cycle.

- De-energize the outdoor fan.
- Energize the reversing valve.
- Energize the WOUT output as described in another section of this document.
- Begin the maximum defrost cycle length timer.

If the call for heating is removed from the control during the defrost cycle, the control terminates the defrost cycle and stops compressor operation. The control stops the defrost cycle length timer but does not reset it. When the control receives another call for heating, it restarts the defrost cycle and the timer at the point at which the call for heating was removed if the liquid line temperature conditions allow defrost to occur.

Demand Defrost Curve Selection

The defrost operation parameters of the control are defined as data sets or "curves" that will be assigned to specific heat pump model numbers. The control stores four unique, selectable curves. The control has jumper pins that allow the installer to select the active demand defrost curve to be used by the control. If no jumper is present, the control operates as Defrost Curve 1.



Defrost Curves

Defrost Initiation

The control allows the heat pump to operate in the heating mode until the combination of outdoor ambient and outdoor coil temperatures indicate that a defrost cycle is necessary, unless the previous defrost was terminated based on the Maximum Defrost Cycle Time allowed for the selected curve.

The control initiates a defrost cycle when the Defrost Inhibit Time Limit has elapsed if the previous defrost cycle was terminated based on the Maximum Defrost Cycle Time. This occurs regardless of the liquid line (coil) temperature reading. The coil does not have to be cold for the unit to be forced into defrost. Once the defrost cycle begins, the control follows the normal defrost cycle routine.

The control initiates a defrost cycle when the liquid line (coil) temperature is below the initiate point for the measured ambient temperature continuously for 4-1/2 minutes. The 4-1/2-minute delay eliminates unnecessary defrost cycles caused by refrigeration surges such as those that occur at the start of a heating cycle.

The control initiates a defrost cycle every 6 hours and 4 minutes of accumulated compressor run time to recirculate refrigerant lubricants. This forced defrost timer is reset and restarted following the completion or termination of a defrost cycle. If this defrosts cycle continues through the maximum defrost cycle time, it re-enters another defrost cycle based on the minimum inhibit timer.

The control also initiates a defrost cycle when the TEST terminals are shorted. This feature allows an installer or service technician to start a defrost cycle immediately as required. When the TEST terminals are shorted with a Y input energized and the pressure switch closed, the ASCD is bypassed, and the compressor contactor outputs are energized after two seconds. When the control is forced into defrost cycle with the TEST terminals, the control records this mode to distinguish between a forced defrost cycle and a defrost cycle that occurs based on conditions present. The control uses this information to behave differently in a forced or regular defrost condition.

When the TEST terminals are shorted for more than five seconds with a Y input energized, the control begins a defrost cycle. When the defrost, cycle is forced using the TEST input, the control energizes WOUT immediately when it begins the defrost cycle. This allows faster run test cycles. When the TEST inputs are used to force a defrost cycle, the state of the liquid line temperature input is ignored. The coil does not have to be cold for the unit to be forced into defrost. After the TEST input is removed (remove short), the defrost mode is terminated as normal. The defrost cycle length timer will not be started until the TEST input is removed. If the TEST terminals remain shorted, the control keeps the unit in defrost mode.

Defrost Inhibition

The control will not initiate a defrost cycle if the liquid line temperature is above the inhibit curve. However, the control begins a defrost cycle regardless of liquid line temperature when a defrost cycle is forced using the TEST pins or if the previous defrost cycle was terminated based on the Maximum Defrost Cycle Time.

The inhibit curve is a flat line (one temperature) unique for each defrost curve selection. The control includes a timed inhibit feature that prevents a defrost cycle from being initiated too soon after the termination of the previous defrost cycle. After the inhibit time has expired, the control applies the 4-1/2-minute timer described above and initiates a defrost cycle if the appropriate conditions still exist. The timer duration is specified for each part number in this document's defrost curve data section. This timer is applied when power is applied to the control and after the completion or termination of each defrost cycle. The timer is based on accumulated compressor run time.

Defrost Termination

The control terminates the defrost cycle immediately after the liquid line temperature goes above the defrost termination curve. The liquid line temperature used to terminate the defrost cycle may be filtered to improve the performance of the system. The terminate curve is a flat line (one temperature) unique for each defrost curve selection. The control terminates the defrost cycle when the maximum defrost cycle length timer expires. If the defrost was initiated by shorting the test pins, the defrost cycle is terminated normally when the short is removed. The control will not terminate a normal defrost cycle if it receives an O signal during the defrost cycle.

The control terminates a defrost cycle as follows:

- Energize the outdoor fan.
- De-energize the reversing valve.
- De-energize the auxiliary heat outputs (unless required by heating call present)
- Reset and restart defrost inhibit timer.

Defrost Curve Data Sets

The control behaves according to the defrost initiate curve when the liquid line temperature is within the specified temperature range for the curve. The control will not enter a defrost cycle (inhibit defrost) when the outdoor ambient temperature is outside of the specified operating range shown in the table below:

1157-912 Model Curve Selection				
Jumper position	1	2	3	4
Initiate 1	33.5 @ 50°F amb	37.2 @ 50°F amb	41.5 @ 50°F amb	41.5 @ 50°F amb
Initiate 2	-3.3 @ 0°F amb	-5.6 @ 0°F amb	-7.4 @ 0°F amb	-7.4 @ 0°F amb
Defrost Inhibit Temp	40°F (Coil)	40°F (Coil)	40°F (Coil)	40°F (Coil)
Defrost Inhibit Time Limit	40 min.	40 min.	40 min.	40 min.
Defrost Terminate Temp	55°F	55°F	55°F	55°F
Maximum Defrost Cycle Time	8 min.	8 min.	8 min	8 min
Compressor Delay Time	N/A	N/A	N/A	N/A

07

Troubleshooting

Status Code Display

The control provides status codes using the LED (Light Emitting Diode). Status codes indicate the state of operation of the unit but do not represent a fault. The table below describes the system status code as displayed by the LED.

System Status	LED Display
No power to the control	No faults active
Nothing energized	OFF
Compressor Operation Active	No faults active
M energized	ON
Control normal operation – no call for compressor	No faults active
Y not present	2s ON / 2s OFF
Control normal operation – in ASCD period	No faults active, Y present, ASCD timer not expired. 0.1 sec ON / 0.1 sec OFF

Fault Code Display

The control stores the five most recent fault codes in non-volatile memory for review by the service technician for 30 days. These codes will be stored while power is removed from the control and will remain in memory until the control has been powered for 30 consecutive days or if the codes are cleared.

The control provides fault codes using the Status LED. The table below describes the LED displays during fault codes. Unless otherwise specified, the control provides flashes that are a 1/3 second on and 1/3 second off for fault codes. The control only displays a single fault code on the LED. The control displays the fault code on the LED repeatedly with a 2 second off period between repetitions of the fault code. If multiple fault codes are present at the same time, the LED displays only the most recent fault.

Description	Status LED
High - pressure switch fault (not in lockout yet)	2 Flashes
System in high-pressure switch lockout (last mode of operation was normal compressor)	3 Flashes
System in high-pressure switch lockout (last mode of operation was defrost)	4 Flashes
System in low-pressure switch lockout (last mode of operation was normal compressor)	5 Flashes
Low Voltage (<19.2VAC) preventing further relay outputs for > 2 seconds	6 Flashes
Low Voltage (<16VAC) stopped current relay outputs for > 2 seconds	7 Flashes
Liquid Line sensor failure (Open or Shorted)	8 Flashes
Outdoor ambient sensor failure (Open or Shorted)	9 Flashes
Control Failure	10 Flashes

Fault Code History

When the TEST pins are shorted for longer than 2 seconds but less than 5 seconds, and no thermostat signals are currently active, the control will sequentially flash, on the STATUS LED, the series of stored error codes (up to the last 5 since active error codes were last cleared) starting with the most recent. There will be a 1.5 second delay between error codes. The series may be repeated by shorting the TEST pins again. If one of the thermostat signals becomes active while the control is flashing stored error codes, the error code flashing mode will immediately terminate, and normal operation of the control will resume. The control ignores the TEST pins in all modes except Standby. If there are no error codes stored in memory, the STATUS LED flashes 3 times (0.1 sec ON/0.1 sec OFF).

If the TEST pins are shorted for longer than 5 seconds, the control immediately clears the stored error code array and flashes the STATUS LED 6 times (0.1 sec ON / 0.1 sec OFF) to indicate that the error memory has been cleared. The control will not wait until the TEST pins are opened to execute this behavior.

Faults & Lockout Modes

High Pressure Switch (HPS) Fault

If the compressor is operating and the high-pressure switch is recognized as open for greater than 40ms, the control de-energizes the compressor contactor output (and the defrost outputs if they are active). The compressor contactor remains off until the high-pressure switch has re-closed, and the 5-minute ASCD timer has been satisfied.

When the control continues the call for heating, the control restarts the defrost cycle and the timer at the point at which the call for heating was interrupted (if the liquid line (coil) temperature conditions allow defrost to occur).

High Pressure Switch Lockout

If the control recognizes two HPS faults within six hours of accumulated compressor run-time, the control will enter the HPS lockout. The 2nd PS fault must be open greater than 160ms to be recognized for this lockout fault condition. During the lockout period, the defrost and compressor relays remain de-energized. While the control is locked out, the STATUS LED flashes the appropriate code to indicate the fault that caused the lockout condition.

If the duration of the opening is greater than 40ms and less than or equal to 160ms, the control responds in the same way as the first pressure switch fault (de-energize compressor contactor and cause ASCD timer period).

The six-hour timing starts after the ASCD has expired following the first PS fault. The timer only accumulates when the compressor is running. If the control recognizes a second opening of the PS before the six-hour timer expires, the control enters the PS lockout. The control will not differentiate between PS faults that occur in heating or defrost modes. If the control does not recognize a second opening of the PS before the six-hour timer expires, the six-hour timer is cleared, and the PS fault counter is reset.

To reset the lockout condition:

1. The thermostat "y" input must be removed for more than two seconds. This will reset the PS fault counter to 1, meaning that the next PS opening (within 6 hours) will be a soft lockout.
2. The power "R" input must be removed for more than two seconds. This will reset the PS fault counter (all counters and timers are reset) to 0.
3. A connection of a 1k ohm or smaller resistance between 2 and 5 seconds must be made between the "TEST" terminals with Y present. This will reset the PS fault counter (all counters and timers are reset) to 0.
4. A connection of a 1k ohm or smaller resistance longer than 5 seconds must be made between the "TEST" terminals with Y not present. This will clear all fault codes and set the PS timer to 0.

Low Pressure Switch (LPS) Fault

During defrost operation, the control ignores the low-pressure switch (LPS) input. If the LPS opens during defrost operation, the control will not consider this to be an LPS fault. The control also ignores the LPS input for the first 90 seconds of compressor operation and for 90 seconds following the completion of a defrost cycle. It also ignores the LPS input while the TEST input is shorted while any Y input (Y1 or Y2) is energized. The control ignores the LPS input when the outdoor ambient temperature is below 5° F. This prevents LPS lockouts while the unit is operating in heating mode in very cold conditions. The discharge temperature sensor will continue to provide loss of charge protection. If the LPS is open for more than five seconds under conditions when the control is not ignoring the PS input, the control enters soft lockout mode.

Wiring or Setting Related Lockouts

The control will not operate the compressor when the following faults occur.
X Shorted or open liquid line sensor
X Shorted or open outdoor ambient sensor

08

Maintenance

Introduction

Preventative maintenance is crucial to proper system operation and to meet the required equipment efficiency standards.

Provide the owner with the equipment owner-operators maintenance procedures that accompanied the equipment.

Offer to provide the customer with service contracts to have the system cleaned and serviced on a regular maintenance schedule.

Thermostats

Thermostats must be evaluated during an annual maintenance inspection. The thermostat should be level and tightly secured to the wall. Gently blow out any dust accumulation and check exposed contacts of snap acting thermostats for deterioration.

Return Air Filters

Most single-phase equipment is shipped without a return air filter. The installation technician is responsible for providing a return air filter and filter/frame kit for the equipment.

Return air filters must always be sued and kept clean. Filters should be checked monthly and changed or cleaned when filters become dirt laden. Dirty filters will reduce system efficiency and increase energy consumption.

Refer to the Installation Manual for filter sizing and proper filter/frame kits to be installed when applicable.

Indoor Coil

The indoor coil absorbs heat from the conditioned space during cooling operation and rejects heat to the conditioned space during mechanical heating operation. It is essential that the required airflow is maintained across the coil. If this is to be achieved, the coil must be kept clean and free of debris.

The indoor coil can be kept clean with constantly changed return air filters. If the coil should become restricted and must be cleaned, it should only be cleaned using approved methods.

They include:

- Coil brushes
- Vacuum cleaner attachments.
- Water
- Approved non-acid coil cleaners.

Note
If water or cleaners are used to clean the coil, lock-out tag-out procedures must be followed to remove the supply voltage to prevent personal injury. The Material Safety Data Sheets (MSDS) should be read, and the proper Personal Protective Devices (PPDs) utilized prior to and during the application of chemical cleaners.

Outdoor Coil

The outdoor coil is designed to reject heat from the refrigerant to the outdoor air during cooling operation and absorb heat from the outdoor air during mechanical heating operation. It is essential that the equipment has a designed airflow across the coil to facilitate rejection of heat. If this is to be achieved, the coil must be kept clean and free of debris. The coil should be cleaned according to the approved methods.

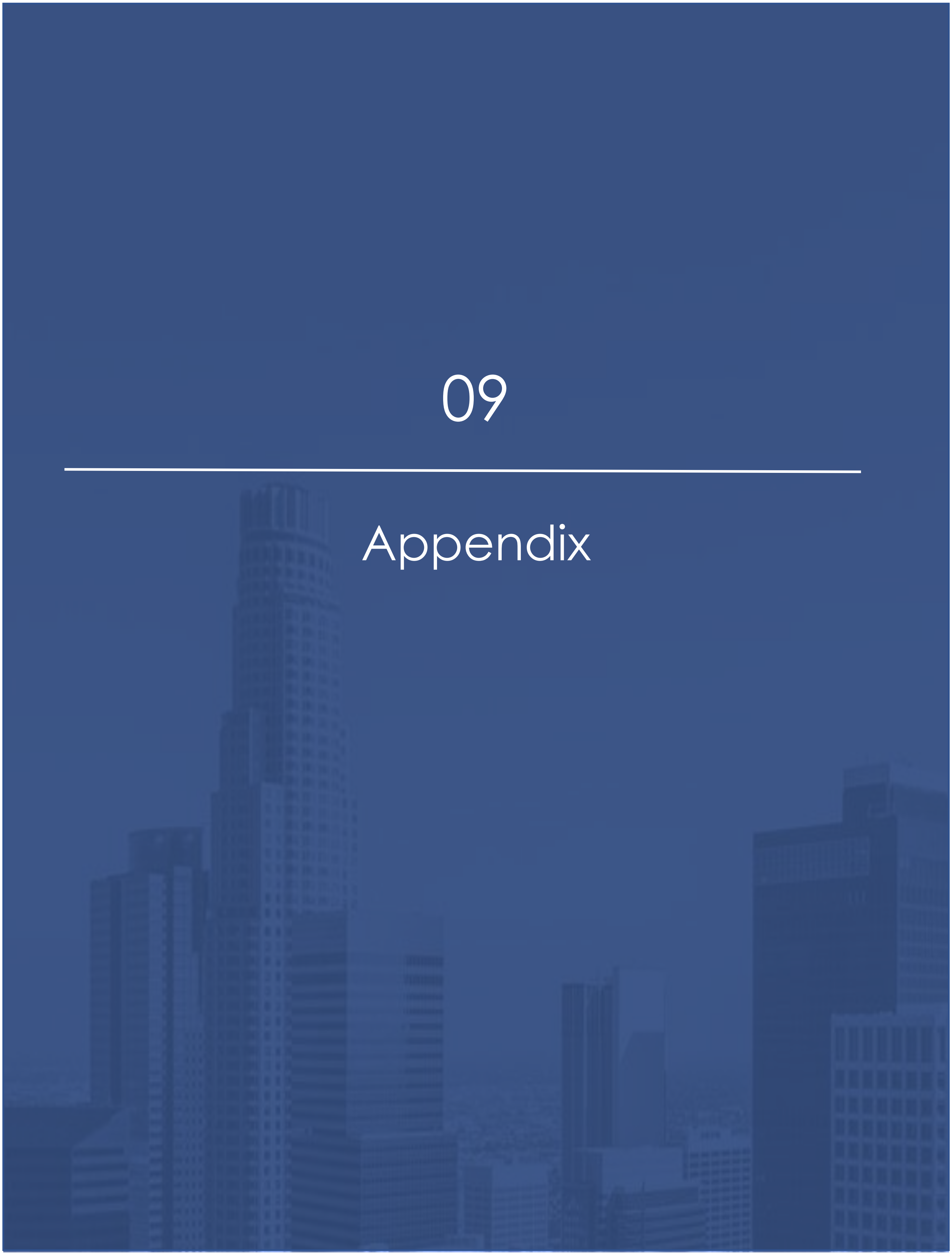
Note
If water or coil cleaners are being used, the unit should have supply voltage removed and proper lock-out tag-out procedures followed to prevent personal injury. The technician should read the Material Safety Data Sheets (MSDS) and wear the proper Personal Protective Devices (PPD) prior to applying chemical cleaners.

Fan Motors

The outdoor and indoor fan motors are permanently lubricated and require no maintenance.

Even with good filters properly in place, blower wheels and motors will become dust covered after months of operation. The entire blower assembly should be inspected annually. If the motor and wheel are heavily coated with dust, they can be brushed and cleaned with a vacuum cleaner. In extreme conditions, a hose can be used after the motor is removed to clean the blower wheel.

Caution
Caution must be taken to lock-out tag-out the unit when evaluating the fan motors for cleanliness and for excessive play or wear to the motors shaft assembly.



09

Appendix

Thermistor Resistance Charts

Thermistor Definitions NTC = Negative Temperature Coefficient				
Thermistor	Condition: Shorted (Ohms)	Condition: Open (Ohms)	Primary Range (Degrees F)	Accuracy (Over Primary Range) (Degrees F)
Outdoor	< 1000	> 350,000	-20 to 50	1 Deg. F
Liquid Line	< 1000	> 350,000	-25 to 45	1 Deg. F

Ambient (Outdoor) Sensor Temperature / Resistance / Voltage – Conversion Chart

Temperature Degrees F	Resistance Ohms	Voltage DC	Temperature Degrees F	Resistance Ohms	Voltage DC
-25	196,871	3.89	55	17,434	1.18
-20	165,487	3.73	60	15,310	1.07
-15	139,576	3.56	65	13,474	0.96
-10	118,108	3.39	70	11,883	0.87
-5	100,260	3.20	75	10,501	0.79
0	85,371	3.01	80	9,299	0.71
5	72,910	2.82	85	8,250	0.64
10	62,449	2.63	90	7,334	0.58
15	53,640	2.44	95	6,531	0.52
20	46,200	2.25	100	5,827	0.47
25	39,898	2.07	105	5,208	0.42
30	34,545	1.90	110	4,663	0.38
35	29,986	1.74	115	4,182	0.34
40	26,092	1.58	120	3,757	0.31
45	22,758	1.44	125	3,381	0.28
50	19,896	1.30	130	3,047	0.25

Liquid Line (Coil) Sensor Temperature / Resistance / Voltage – Conversion Chart

Temperature Degrees F	Resistance Ohms	Voltage DC	Temperature Degrees F	Resistance Ohms	Voltage DC
-25	196,871	3.71	45	22,758	1.25
-20	165,487	3.54	50	19,896	1.13
-15	139,576	3.36	55	17,434	1.02
-10	118,108	3.17	60	15,310	0.91
-5	100,260	2.98	65	13,474	0.82
0	85,371	2.78	70	11,883	0.74
5	72,910	2.58	75	10,501	0.66
10	62,449	2.39	80	9,299	0.60
15	53,640	2.20	85	8,250	0.54
20	46,200	2.02	90	7,334	0.48
25	39,898	1.84	95	6,531	0.43
30	34,545	1.68	100	5,827	0.39
35	29,986	1.52	105	5,208	0.35
40	26,092	1.38	110	4,663	0.32

PWM Values

Enhanced ECM Blower Models

The following tables provide blower PWM for various system modes. These values apply to the Enhanced ECM blower motors used on two stage models.

The left side of each table contains the active modes and jumper settings. The right side of each table contains expected PWM values by model.

FAN ONLY (63% of CFM TARGET FOR HI COOLING)															
TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X							A	X	X	32	50	54	45	57	80
X							B	X	X	28	32	38	34	45	64
X							C	X	X	24	24	25	25	34	51
X							D	X	X	19	15	18	17	24	40

FULL COMPRESSOR HEATING (+ DHUM)															
TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X	X				X	A	X	X	39	55	63	46	68	84
X	X	X				X	B	X	X	30	48	54	41	59	76
X	X	X				X	C	X	X	18	30	34	31	41	53
X	X	X				X	D	X	X	26	45	48	42	56	70

FULL COMPRESSOR HEATING															
TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X	X					A	X	X	39	55	63	46	68	84
X	X	X					B	X	X	30	48	54	41	59	76
X	X	X					C	X	X	18	30	34	31	41	53
X	X	X					D	X	X	26	45	48	42	56	70

MULTIPLIER FOR COOLING OPERATION ("O" PRESENT) *SAME AS FULL HP*

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X	X	X				A	X	X	39	55	63	46	68	84
X	X	X	X				B	X	X	30	48	54	41	59	76
X	X	X	X				C	X	X	18	30	34	31	41	53
X	X	X	X				D	X	X	26	45	48	42	56	70

MULTIPLIER FOR HI HUMIDITY = 85% OF CFM TARGET FOR FULL COOLING

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X	X	X				A	X	X	24	37	43	32	48	58
X	X	X	X				B	X	X	19	31	37	28	42	51
X	X	X	X				C	X	X	10	19	23	20	27	37
X	X	X	X				D	X	X	10	30	34	27	38	46

FULL COMPRESSOR HEATING

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X		X				X	A	X	X	39	55	63	46	68	84
X		X				X	B	X	X	30	48	54	41	59	76
X		X				X	C	X	X	18	30	34	31	41	53
X		X				X	D	X	X	26	45	48	42	56	70

FULL COMPRESSOR HEATING

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X		X					A	X	X	39	55	63	46	68	84
X		X					B	X	X	30	48	54	41	59	76
X		X					C	X	X	18	30	34	31	41	53
X		X					D	X	X	26	45	48	42	56	70

MULTIPLIER FOR COOLING OPERATION ("O" PRESENT) SHOULD BE THE SAME AS TARGET FOR FULL HP

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X		X	X			X	A	X	X	39	55	63	46	68	84
X		X	X			X	B	X	X	30	48	54	41	59	76
X		X	X			X	C	X	X	18	30	34	31	41	53
X		X	X			X	D	X	X	26	45	48	42	56	70

MULTIPLIER FOR HI HUMIDITY = 85% OF CFM TARGET FOR FULL COOLING

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X		X	X				A	X	X	24	37	43	32	48	58
X		X	X				B	X	X	19	31	37	28	42	51
X		X	X				C	X	X	10	19	23	20	27	37
X		X	X				D	X	X	10	30	34	27	38	46

CFM TABLES/ TARGETS FOR LOW HP (MULTIPLIER = 65% OF CFM TARGET FOR FULL HP)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X					X	A	X	X	24	41	39	31	44	47
X	X					X	B	X	X	18	32	30	25	40	41
X	X					X	C	X	X	10	25	22	22	37	39
X	X					X	D	X	X	7	23	20	21	36	38

MULTIPLIER FOR COOLING OPERATION ("O" PRESENT) = SHOULD BE THE SAME AS TARGET FOR LO HP

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X		X			X	A	X	X	24	41	39	31	44	47
X	X		X			X	B	X	X	18	32	30	25	40	41
X	X		X			X	C	X	X	10	25	22	22	37	39
X	X		X			X	D	X	X	7	23	20	21	36	38

MULTIPLIER FOR HI HUMIDITY = 85% OF CFM TARGET FOR LO COOLING

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X		X				A	X	X	8	25	25	20	31	34
X	X		X				B	X	X	7	20	20	17	27	30
X	X		X				C	X	X	5	18	18	12	23	26
X	X		X				D	X	X	5	15	12	11	23	24

W1 HEATING TABLE VALUES

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X				X		X	X	A	X	43	50	42	43	43	55
X				X		X	X	B	X	36	41	35	36	36	38
X				X		X	X	C	X	28	25	22	28	28	34
X				X		X	X	D	X	22	10	15	23	23	27

W1 HEATING TABLE VALUES

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X				X			X	A	X	43	50	42	43	43	55
X				X			X	B	X	36	41	35	36	36	38
X				X			X	C	X	28	25	22	28	28	34
X				X			X	D	X	22	10	15	23	23	27

W2 HEATING TABLE VALUES

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X					X	X	X	A	X	43	50	42	43	43	55
X					X	X	X	B	X	36	41	35	36	36	38
X					X	X	X	C	X	28	25	22	28	28	34
X					X	X	X	D	X	22	10	15	23	23	27

W2 HEATING TABLE VALUES

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X					X		X	A	X	43	50	42	43	43	55
X					X		X	B	X	36	41	35	36	36	38
X					X		X	C	X	28	25	22	28	28	34
X					X		X	D	X	22	10	15	23	23	27

SECOND STAGE OR AUX HEAT (SAME AS W2 HEATING)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X				X	X	X	X	A	X	43	50	42	43	43	55
X				X	X	X	X	B	X	36	41	35	36	36	38
X				X	X	X	X	C	X	28	25	22	28	28	34
X				X	X	X	X	D	X	22	10	15	23	23	27

SECOND STAGE OR AUX HEAT (SAME AS W2 HEATING)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X				X	X		X	A	X	43	50	42	43	43	55
X				X	X		X	B	X	36	41	35	36	36	38
X				X	X		X	C	X	28	25	22	28	28	34
X				X	X		X	D	X	22	10	15	23	23	27

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X	X		X	X	X	A	A	X	43	55	63	46	68	84
X	X	X		X	X	X	B	A	X	43	50	54	43	59	76
X	X	X		X	X	X	C	A	X	43	50	42	43	43	55
X	X	X		X	X	X	D	A	X	43	50	48	43	56	70
X	X	X		X	X	X	A	B	X	39	55	63	46	68	84
X	X	X		X	X	X	B	B	X	36	48	54	41	59	76
X	X	X		X	X	X	C	B	X	36	41	35	36	41	53
X	X	X		X	X	X	D	B	X	36	45	48	42	56	70
X	X	X		X	X	X	A	C	X	39	55	63	46	68	84
X	X	X		X	X	X	B	C	X	30	48	54	41	59	76
X	X	X		X	X	X	C	C	X	28	30	34	31	41	53
X	X	X		X	X	X	D	C	X	28	45	48	42	56	70
X	X	X		X	X	X	A	D	X	39	55	63	46	68	84
X	X	X		X	X	X	B	D	X	30	48	54	41	59	76
X	X	X		X	X	X	C	D	X	22	30	34	31	41	53
X	X	X		X	X	X	D	D	X	26	45	48	42	56	70

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X	X		X	X		A	A	X	43	55	63	46	68	84
X	X	X		X	X		B	A	X	43	50	54	43	59	76
X	X	X		X	X		C	A	X	43	50	42	43	43	55
X	X	X		X	X		D	A	X	43	50	48	43	56	70
X	X	X		X	X		A	B	X	39	55	63	46	68	84
X	X	X		X	X		B	B	X	36	48	54	41	59	76
X	X	X		X	X		C	B	X	36	41	35	36	41	53
X	X	X		X	X		D	B	X	36	45	48	42	56	70
X	X	X		X	X		A	C	X	39	55	63	46	68	84
X	X	X		X	X		B	C	X	30	48	54	41	59	76
X	X	X		X	X		C	C	X	28	30	34	31	41	53
X	X	X		X	X		D	C	X	28	45	48	42	56	70
X	X	X		X	X		A	D	X	39	55	63	46	68	84
X	X	X		X	X		B	D	X	30	48	54	41	59	76
X	X	X		X	X		C	D	X	22	30	34	31	41	53
X	X	X		X	X		D	D	X	26	45	48	42	56	70

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X	X			X	X	A	A	X	43	55	63	46	68	84
X	X	X			X	X	B	A	X	43	50	54	43	59	76
X	X	X			X	X	C	A	X	43	50	42	43	43	55
X	X	X			X	X	D	A	X	43	50	48	43	56	70
X	X	X			X	X	A	B	X	39	55	63	46	68	84
X	X	X			X	X	B	B	X	36	48	54	41	59	76
X	X	X			X	X	C	B	X	36	41	35	36	41	53
X	X	X			X	X	D	B	X	36	45	48	42	56	70
X	X	X			X	X	A	C	X	39	55	63	46	68	84
X	X	X			X	X	B	C	X	30	48	54	41	59	76
X	X	X			X	X	C	C	X	28	30	34	31	41	53
X	X	X			X	X	D	C	X	28	45	48	42	56	70
X	X	X			X	X	A	D	X	39	55	63	46	68	84
X	X	X			X	X	B	D	X	30	48	54	41	59	76
X	X	X			X	X	C	D	X	22	30	34	31	41	53
X	X	X			X	X	D	D	X	26	45	48	42	56	70

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X	X			X		A	A	X	43	55	63	46	68	84
X	X	X			X		B	A	X	43	50	54	43	59	76
X	X	X			X		C	A	X	43	50	42	43	43	55
X	X	X			X		D	A	X	43	50	48	43	56	70
X	X	X			X		A	B	X	39	55	63	46	68	84
X	X	X			X		B	B	X	36	48	54	41	59	76
X	X	X			X		C	B	X	36	41	35	36	41	53
X	X	X			X		D	B	X	36	45	48	42	56	70
X	X	X			X		A	C	X	39	55	63	46	68	84
X	X	X			X		B	C	X	30	48	54	41	59	76
X	X	X			X		C	C	X	28	30	34	31	41	53
X	X	X			X		D	C	X	28	45	48	42	56	70
X	X	X			X		A	D	X	39	55	63	46	68	84
X	X	X			X		B	D	X	30	48	54	41	59	76
X	X	X			X		C	D	X	22	30	34	31	41	53
X	X	X			X		D	D	X	26	45	48	42	56	70

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X		X		X	X	X	A	A	X	43	55	63	46	68	84
X		X		X	X	X	B	A	X	43	50	54	43	59	76
X		X		X	X	X	C	A	X	43	50	42	43	43	55
X		X		X	X	X	D	A	X	43	50	48	43	56	70
X		X		X	X	X	A	B	X	39	55	63	46	68	84
X		X		X	X	X	B	B	X	36	48	54	41	59	76
X		X		X	X	X	C	B	X	36	41	35	36	41	53
X		X		X	X	X	D	B	X	36	45	48	42	56	70
X		X		X	X	X	A	C	X	39	55	63	46	68	84
X		X		X	X	X	B	C	X	30	48	54	41	59	76
X		X		X	X	X	C	C	X	28	30	34	31	41	53
X		X		X	X	X	D	C	X	28	45	48	42	56	70
X		X		X	X	X	A	D	X	39	55	63	46	68	84
X		X		X	X	X	B	D	X	30	48	54	41	59	76
X		X		X	X	X	C	D	X	22	30	34	31	41	53
X		X		X	X	X	D	D	X	26	45	48	42	56	70

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X		X		X	X		A	A	X	43	55	63	46	68	84
X		X		X	X		B	A	X	43	50	54	43	59	76
X		X		X	X		C	A	X	43	50	42	43	43	55
X		X		X	X		D	A	X	43	50	48	43	56	70
X		X		X	X		A	B	X	39	55	63	46	68	84
X		X		X	X		B	B	X	36	48	54	41	59	76
X		X		X	X		C	B	X	36	41	35	36	41	53
X		X		X	X		D	B	X	36	45	48	42	56	70
X		X		X	X		A	C	X	39	55	63	46	68	84
X		X		X	X		B	C	X	30	48	54	41	59	76
X		X		X	X		C	C	X	28	30	34	31	41	53
X		X		X	X		D	C	X	28	45	48	42	56	70
X		X		X	X		A	D	X	39	55	63	46	68	84
X		X		X	X		B	D	X	30	48	54	41	59	76
X		X		X	X		C	D	X	22	30	34	31	41	53
X		X		X	X		D	D	X	26	45	48	42	56	70

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X		X			X	X	A	A	X	43	55	63	46	68	84
X		X			X	X	B	A	X	43	50	54	43	59	76
X		X			X	X	C	A	X	43	50	42	43	43	55
X		X			X	X	D	A	X	43	50	48	43	56	70
X		X			X	X	A	B	X	39	55	63	46	68	84
X		X			X	X	B	B	X	36	48	54	41	59	76
X		X			X	X	C	B	X	36	41	35	36	41	53
X		X			X	X	D	B	X	36	45	48	42	56	70
X		X			X	X	A	C	X	39	55	63	46	68	84
X		X			X	X	B	C	X	30	48	54	41	59	76
X		X			X	X	C	C	X	28	30	34	31	41	53
X		X			X	X	D	C	X	28	45	48	42	56	70
X		X			X	X	A	D	X	39	55	63	46	68	84
X		X			X	X	B	D	X	30	48	54	41	59	76
X		X			X	X	C	D	X	22	30	34	31	41	53
X		X			X	X	D	D	X	26	45	48	42	56	70

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W2 SPEED)															
TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X		X			X		A	A	X	43	55	63	46	68	84
X		X			X		B	A	X	43	50	54	43	59	76
X		X			X		C	A	X	43	50	42	43	43	55
X		X			X		D	A	X	43	50	48	43	56	70
X		X			X		A	B	X	39	55	63	46	68	84
X		X			X		B	B	X	36	48	54	41	59	76
X		X			X		C	B	X	36	41	35	36	41	53
X		X			X		D	B	X	36	45	48	42	56	70
X		X			X		A	C	X	39	55	63	46	68	84
X		X			X		B	C	X	30	48	54	41	59	76
X		X			X		C	C	X	28	30	34	31	41	53
X		X			X		D	C	X	28	45	48	42	56	70
X		X			X		A	D	X	39	55	63	46	68	84
X		X			X		B	D	X	30	48	54	41	59	76
X		X			X		C	D	X	22	30	34	31	41	53
X		X			X		D	D	X	26	45	48	42	56	70

REDUCED AIRFLOW W/ AUX HEAT OR BELOW LTCO (GREATER OF LOW COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X			X	X	X	A	A	X	43	50	42	43	44	55
X	X			X	X	X	B	A	X	43	50	42	43	43	55
X	X			X	X	X	C	A	X	43	50	42	43	43	55
X	X			X	X	X	D	A	X	43	50	42	43	43	55
X	X			X	X	X	A	B	X	36	41	39	36	44	47
X	X			X	X	X	B	B	X	36	41	35	36	40	41
X	X			X	X	X	C	B	X	36	41	35	36	37	39
X	X			X	X	X	D	B	X	36	41	35	36	36	38
X	X			X	X	X	A	C	X	28	41	39	31	44	47
X	X			X	X	X	B	C	X	28	32	30	28	40	41
X	X			X	X	X	C	C	X	28	25	22	28	37	39
X	X			X	X	X	D	C	X	28	25	22	28	36	38
X	X			X	X	X	A	D	X	24	41	39	31	44	47
X	X			X	X	X	B	D	X	22	32	30	25	40	41
X	X			X	X	X	C	D	X	22	25	22	23	37	39
X	X			X	X	X	D	D	X	22	23	20	23	36	38

REDUCED AIRFLOW W/ AUX HEAT OR BELOW LTCO (GREATER OF LOW COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X			X	X		A	A	X	43	50	42	43	44	55
X	X			X	X		B	A	X	43	50	42	43	43	55
X	X			X	X		C	A	X	43	50	42	43	43	55
X	X			X	X		D	A	X	43	50	42	43	43	55
X	X			X	X		A	B	X	36	41	39	36	44	47
X	X			X	X		B	B	X	36	41	35	36	40	41
X	X			X	X		C	B	X	36	41	35	36	37	39
X	X			X	X		D	B	X	36	41	35	36	36	38
X	X			X	X		A	C	X	28	41	39	31	44	47
X	X			X	X		B	C	X	28	32	30	28	40	41
X	X			X	X		C	C	X	28	25	22	28	37	39
X	X			X	X		D	C	X	28	25	22	28	36	38
X	X			X	X		A	D	X	24	41	39	31	44	47
X	X			X	X		B	D	X	22	32	30	25	40	41
X	X			X	X		C	D	X	22	25	22	23	37	39
X	X			X	X		D	D	X	22	23	20	23	36	38

REDUCED AIRFLOW W/ AUX HEAT OR BELOW LTCO (GREATER OF LOW COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X				X	X	A	A	X	43	50	42	43	44	55
X	X				X	X	B	A	X	43	50	42	43	43	55
X	X				X	X	C	A	X	43	50	42	43	43	55
X	X				X	X	D	A	X	43	50	42	43	43	55
X	X				X	X	A	B	X	36	41	39	36	44	47
X	X				X	X	B	B	X	36	41	35	36	40	41
X	X				X	X	C	B	X	36	41	35	36	37	39
X	X				X	X	D	B	X	36	41	35	36	36	38
X	X				X	X	A	C	X	28	41	39	31	44	47
X	X				X	X	B	C	X	28	32	30	28	40	41
X	X				X	X	C	C	X	28	25	22	28	37	39
X	X				X	X	D	C	X	28	25	22	28	36	38
X	X				X	X	A	D	X	24	41	39	31	44	47
X	X				X	X	B	D	X	22	32	30	25	40	41
X	X				X	X	C	D	X	22	25	22	23	37	39
X	X				X	X	D	D	X	22	23	20	23	36	38

REDUCED AIRFLOW W/ AUX HEAT OR BELOW LTCO (GREATER OF LOW COMPRESSOR OR W2 SPEED)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X				X		A	A	X	43	50	42	43	44	55
X	X				X		B	A	X	43	50	42	43	43	55
X	X				X		C	A	X	43	50	42	43	43	55
X	X				X		D	A	X	43	50	42	43	43	55
X	X				X		A	B	X	36	41	39	36	44	47
X	X				X		B	B	X	36	41	35	36	40	41
X	X				X		C	B	X	36	41	35	36	37	39
X	X				X		D	B	X	36	41	35	36	36	38
X	X				X		A	C	X	28	41	39	31	44	47
X	X				X		B	C	X	28	32	30	28	40	41
X	X				X		C	C	X	28	25	22	28	37	39
X	X				X		D	C	X	28	25	22	28	36	38
X	X				X		A	D	X	24	41	39	31	44	47
X	X				X		B	D	X	22	32	30	25	40	41
X	X				X		C	D	X	22	25	22	23	37	39
X	X				X		D	D	X	22	23	20	23	36	38

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W1 HEATING)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X	X		X		X	A	A	X	43	55	63	46	68	84
X	X	X		X		X	B	A	X	43	50	54	43	59	76
X	X	X		X		X	C	A	X	43	50	42	43	43	55
X	X	X		X		X	D	A	X	43	50	48	43	56	70
X	X	X		X		X	A	B	X	39	55	63	46	68	84
X	X	X		X		X	B	B	X	36	48	54	41	59	76
X	X	X		X		X	C	B	X	36	41	35	36	41	53
X	X	X		X		X	D	B	X	36	45	48	42	56	70
X	X	X		X		X	A	C	X	39	55	63	46	68	84
X	X	X		X		X	B	C	X	30	48	54	41	59	76
X	X	X		X		X	C	C	X	28	30	34	31	41	53
X	X	X		X		X	D	C	X	28	45	48	42	56	70
X	X	X		X		X	A	D	X	39	55	63	46	68	84
X	X	X		X		X	B	D	X	30	48	54	41	59	76
X	X	X		X		X	C	D	X	22	30	34	31	41	53
X	X	X		X		X	D	D	X	26	45	48	42	56	70

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W1 HEATING)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X	X	X		X			A	A	X	43	55	63	46	68	84
X	X	X		X			B	A	X	43	50	54	43	59	76
X	X	X		X			C	A	X	43	50	42	43	43	55
X	X	X		X			D	A	X	43	50	48	43	56	70
X	X	X		X			A	B	X	39	55	63	46	68	84
X	X	X		X			B	B	X	36	48	54	41	59	76
X	X	X		X			C	B	X	36	41	35	36	41	53
X	X	X		X			D	B	X	36	45	48	42	56	70
X	X	X		X			A	C	X	39	55	63	46	68	84
X	X	X		X			B	C	X	30	48	54	41	59	76
X	X	X		X			C	C	X	28	30	34	31	41	53
X	X	X		X			D	C	X	28	45	48	42	56	70
X	X	X		X			A	D	X	39	55	63	46	68	84
X	X	X		X			B	D	X	30	48	54	41	59	76
X	X	X		X			C	D	X	22	30	34	31	41	53
X	X	X		X			D	D	X	26	45	48	42	56	70

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W1 HEATING)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X		X		X		X	A	A	X	43	55	63	46	68	84
X		X		X		X	B	A	X	43	50	54	43	59	76
X		X		X		X	C	A	X	43	50	42	43	43	55
X		X		X		X	D	A	X	43	50	48	43	56	70
X		X		X		X	A	B	X	39	55	63	46	68	84
X		X		X		X	B	B	X	36	48	54	41	59	76
X		X		X		X	C	B	X	36	41	35	36	41	53
X		X		X		X	D	B	X	36	45	48	42	56	70
X		X		X		X	A	C	X	39	55	63	46	68	84
X		X		X		X	B	C	X	30	48	54	41	59	76
X		X		X		X	C	C	X	28	30	34	31	41	53
X		X		X		X	D	C	X	28	45	48	42	56	70
X		X		X		X	A	D	X	39	55	63	46	68	84
X		X		X		X	B	D	X	30	48	54	41	59	76
X		X		X		X	C	D	X	22	30	34	31	41	53
X		X		X		X	D	D	X	26	45	48	42	56	70

DEFROST OR AUX HEAT (GREATER OF FULL COMPRESSOR OR W1 HEATING)

TERMINAL ENERGIZED							COOL Tap	HEAT Tap	DELAY Tap	PWM BY MODEL					
G	Y1	Y/Y2	O	W1	W2	DEHUM				PHE6 *24*	PHE6 *30*	PHE6 *36*	PHE6 *42*	PHE6 *48*	PHE6 *60*
X		X		X			A	A	X	43	55	63	46	68	84
X		X		X			B	A	X	43	50	54	43	59	76
X		X		X			C	A	X	43	50	42	43	43	55
X		X		X			D	A	X	43	50	48	43	56	70
X		X		X			A	B	X	43	50	48	43	56	70
X		X		X			B	B	X	36	48	54	41	59	76
X		X		X			C	B	X	43	50	63	43	56	70
X		X		X			D	B	X	43	50	35	43	56	70
X		X		X			A	C	X	39	55	48	46	68	84
X		X		X			B	C	X	43	50	48	43	59	70
X		X		X			C	C	X	43	50	48	43	59	70
X		X		X			D	C	X	28	45	48	42	59	70
X		X		X			A	D	X	43	50	48	43	59	70
X		X		X			B	D	X	43	50	48	43	59	70
X		X		X			C	D	X	22	30	34	31	41	53
X		X		X			D	A	X	43	50	48	43	56	70
X		X		X			D	A	X	43	50	48	43	56	70
X	X			X		X	A	A	X	43	50	42	43	44	55
X		X		X			D	A	X	43	50	48	43	56	70
X		X		X			D	A	X	43	50	48	43	56	70
X	X			X		X	D	A	X	43	50	42	43	43	55
X		X		X			D	A	X	43	50	48	43	56	70
X		X		X			D	A	X	43	50	48	43	55	70
X	X			X		X	C	B	X	36	41	35	36	37	39

X		X		X			D	A	X	43	50	48	43	56	70
X		X		X			D	A	X	43	50	48	43	56	70
X	X			X		X	B	C	X	28	32	30	28	40	41
X		X		X			D	A	X	43	50	48	43	56	70
X		X		X			D	A	X	43	50	48	43	56	70
X	X			X		X	A	D	X	24	41	39	31	44	47
X		X		X			D	A	X	43	50	48	43	56	70
X		X		X			D	A	X	43	50	48	43	56	70
X	X			X		X	D	D	X	22	23	20	23	36	38
X		X		X			D	A	X	43	50	48	43	56	70
X		X		X			D	A	X	43	50	48	43	56	70
X	X			X			B	A	X	43	50	42	43	43	55
X		X		X			D	A	X	43	50	48	43	56	70
X		X		X			D	A	X	43	50	48	43	56	70
X	X			X			A	B	X	36	41	39	36	44	47
X	X			X			B	B	X	36	41	35	36	40	41
X	X			X			C	B	X	36	41	35	36	37	39
X	X			X			D	B	X	36	41	35	36	36	38
X	X			X			A	C	X	28	41	39	31	44	47
X	X			X			B	C	X	28	32	30	28	40	41
X	X			X			C	C	X	28	25	22	28	37	39
X	X			X			D	C	X	28	25	22	28	36	38
X	X			X			A	D	X	24	41	39	31	44	47
X	X			X			B	D	X	22	32	30	25	40	41
X	X			X			C	D	X	22	25	22	23	37	39
X	X			X			D	D	X	22	23	20	23	36	38

