Residential Single and Two Stage Gas Electric Package

Field Reference Guide

Updated October 2023

Johnson Controls

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Introduction

Introduction

This Guide provides service and installation reference for the single and two stage gas electric package systems. This guide references the PCG4 (14 SEER single stage) and PCG6 (16 SEER two stage) models.

This Field Reference Guide is not to replace the installation and maintenance documentation provided with the equipment. For model specific information, refer to the installation manuals and technical guides during installation and service of any air conditioning equipment.

Safety is always a concern when working on HVAV equipment. In Section 2 (Safety), many factors regarding workplace safety are reviewed. This is not an all-inclusive safety document. The employer and technician are responsible for identifying potential safety hazards that may change from one job site to the next. The procedures in this guide provide additional basic safety awareness tips when installing and servicing gas electric residential package units. Only qualified technicians with proper safety training should install, service or maintain the equipment described in this Guide.

Proper installation and service of heating and air conditioning systems requires a thorough understanding of electrical and mechanical components and system operation.

In Section 3 (Component Familiarization), the refrigeration cycle, electrical components and field installed accessories are reviewed.

In Section 4 (Installation) and Section 5 (Start Up), basic installation and start up procedures are discussed. This document is not intended to replace the installation instructions and other documentation provided with the equipment. Always fully read and understand the provided instructions prior to installation, start-up, or service of any HVAC (Heating Ventilation and Air Conditioning) product.

In Section 6 (Sequence of Operations), a detailed sequence of operation for cooling and gas heating operations for single and two stage package systems is provided.

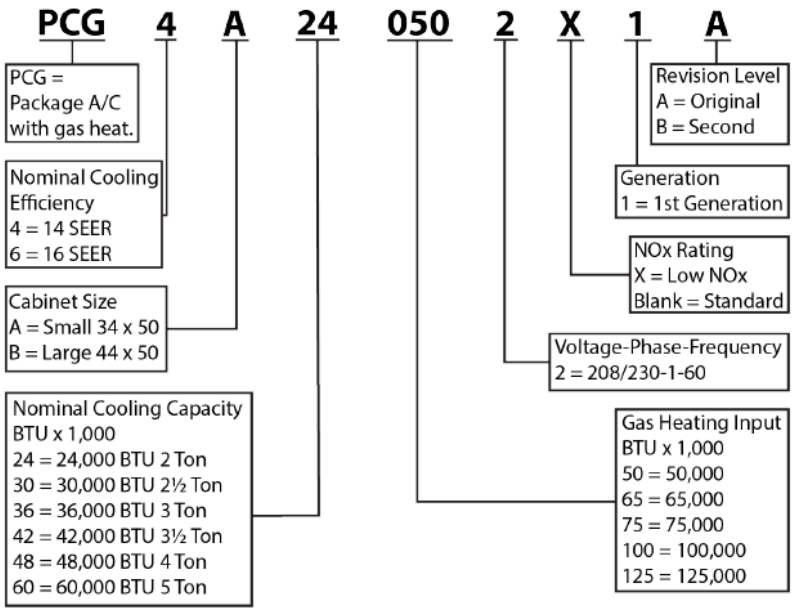
Section 7 (Diagnostics) provides common techniques to help identify problems within the refrigeration cycle, electrical components, airflow problems, and flash codes.

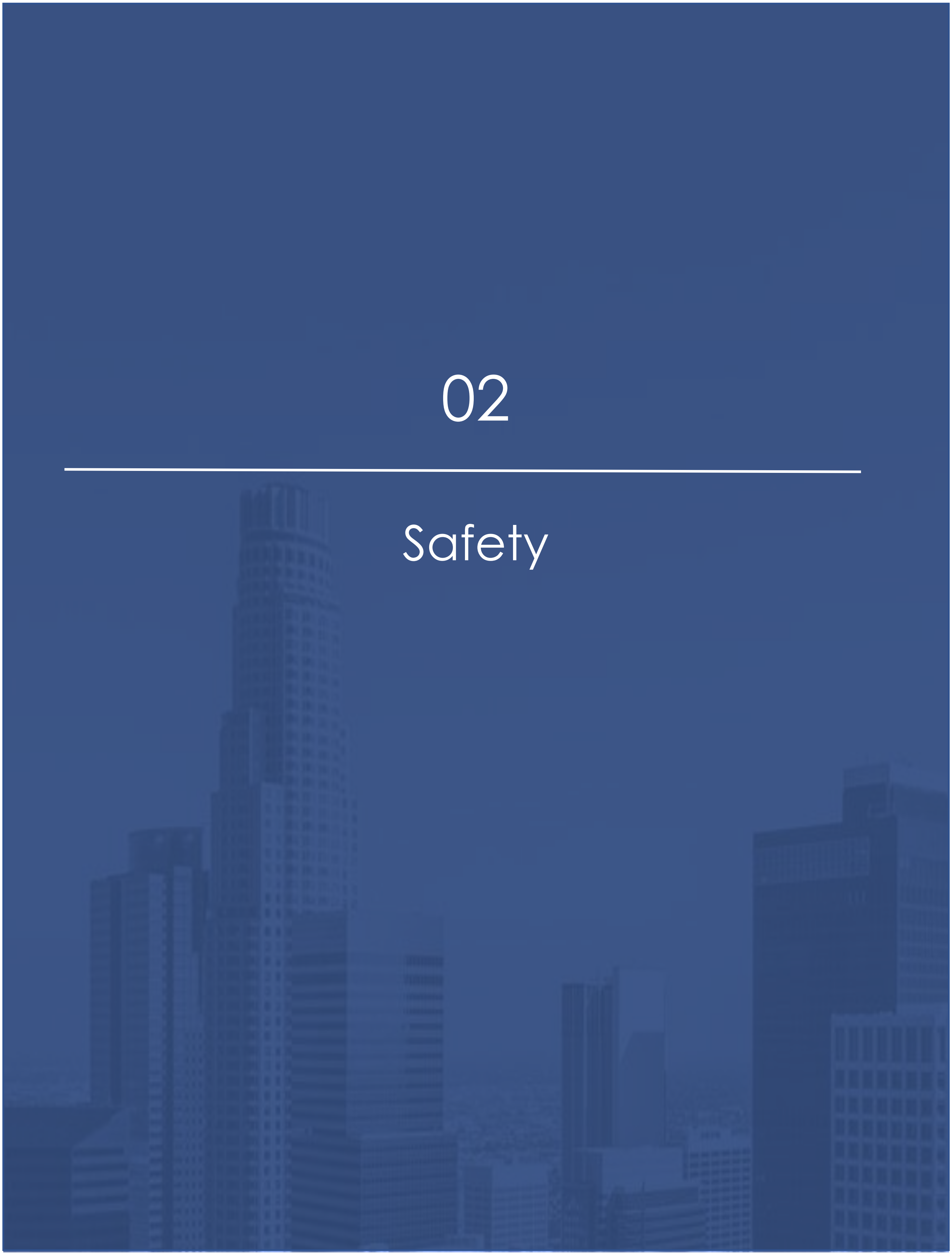
Section 8 (Maintenance) gives an overview of maintenance procedures for the various components within the residential gas electric package units.

The appendix contains additional product information, such as the PWM (Pulse Width Modulation) values to expect on the two stage models using the Enhanced ECM (Electronically Commutated Motors) blower motor.

Nomenclature

Every digit in the model number has significance. Please review the following structure to understand the capabilities of the residential gas electric package unit by model:





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

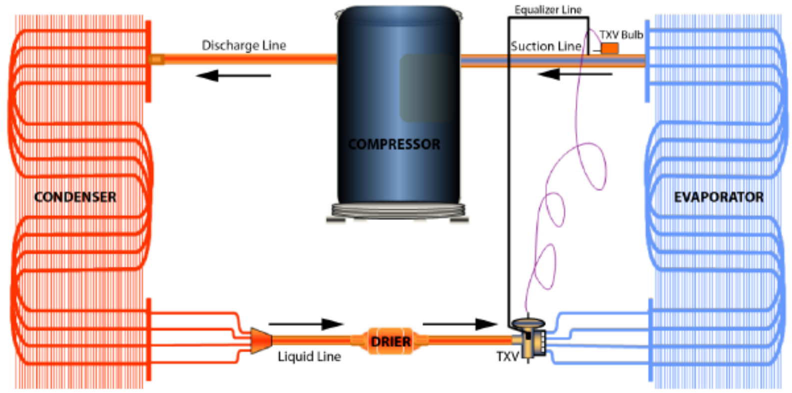
To avoid back injuries, always adhere to proper lifting techniques. Be aware of personal limitations and seek help with items that are too heavy to safely lift. A back support belt may provide additional protection.

03

Component Familiarization

Air Conditioning Cycle

The air conditioning cycle provides cooling by moving heat from indoors to outdoors. The evaporator coil absorbs heat from the return air from the interior of the structure. The condenser coil rejects the heat outside of the structure. The reduced temperature, reduced humidity supply air is then reintroduced into the structure.

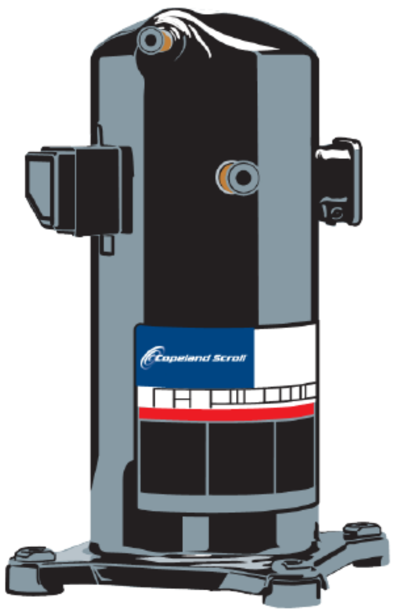


There are five major components within the air conditioning system:

- Compressor
- Condenser
- Metering Device
- Evaporator
- Refrigerant

Compressor

The compressor transforms refrigerant from low pressure vapor to high pressure vapor and moves the refrigerant through the system. 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 hot, high pressure discharge gas.



Compressor

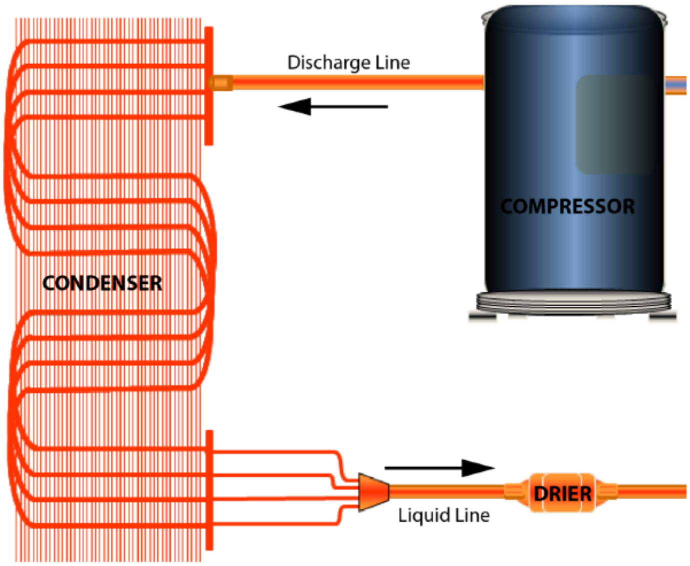
Single stage models use a single stage scroll or reciprocating compressor. Two stage models use a two stage scroll compressor that operates at either 67% capacity (first stage cooling) or 100% capacity (second stage cooling).

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.

Dual Run Capacitor

Condenser Coil

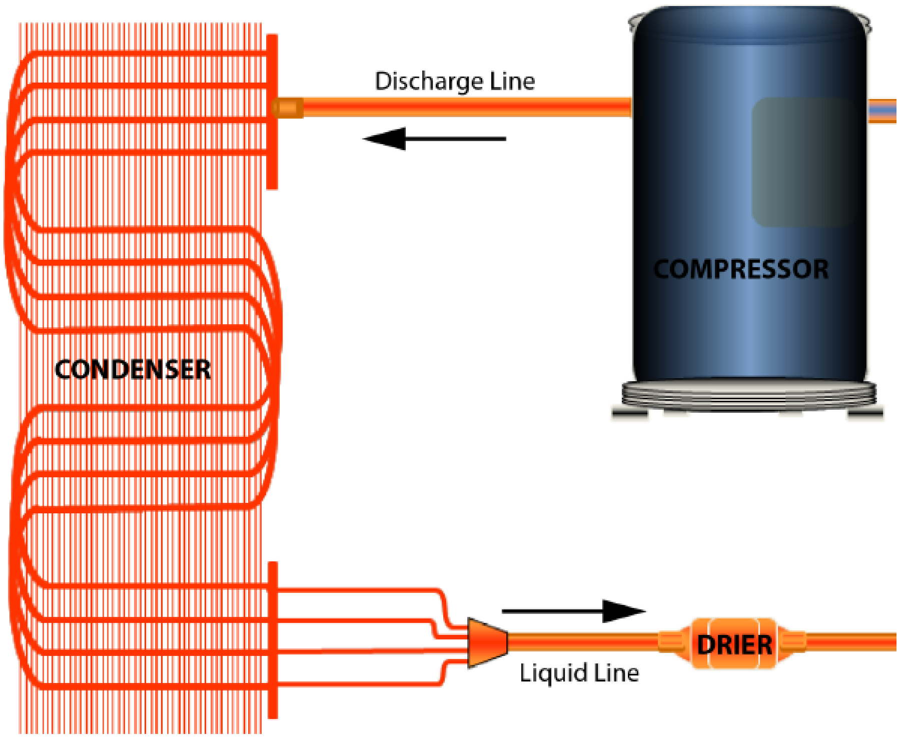


Condenser

Refrigerant enters the condenser coil as hot, high-pressure vapor. This vapor is much higher in temperature than the ambient air. The heat contained in the refrigerant is then rejected through the coil surface to the ambient air. As heat is rejected from the refrigerant, the refrigerant condenses to a high-pressure liquid.

A clean, unobstructed condenser coil is critical to maintaining heat transfer capabilities and overall efficiency of the system. Ensure the condenser coil remains free of debris and restriction. During installation, follow all recommendations regarding minimum spacing from the structure, obstructions, and other equipment.

Liquid Line Filter Drier



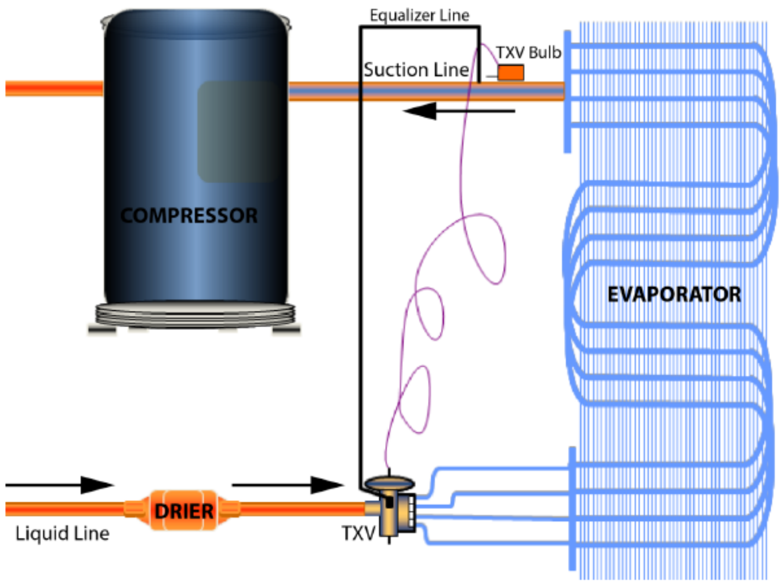
Condenser

Filter Drier

Upon leaving the condenser, the high-pressure liquid enters a liquid drier. The liquid line filter traps moisture, acid, and small particles; effectively stopping the contaminants from traveling through the system and causing damage. 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 5 degrees F) between the inlet and outlet of the filter drier, the drier should be replaced.

Metering Device/TXV

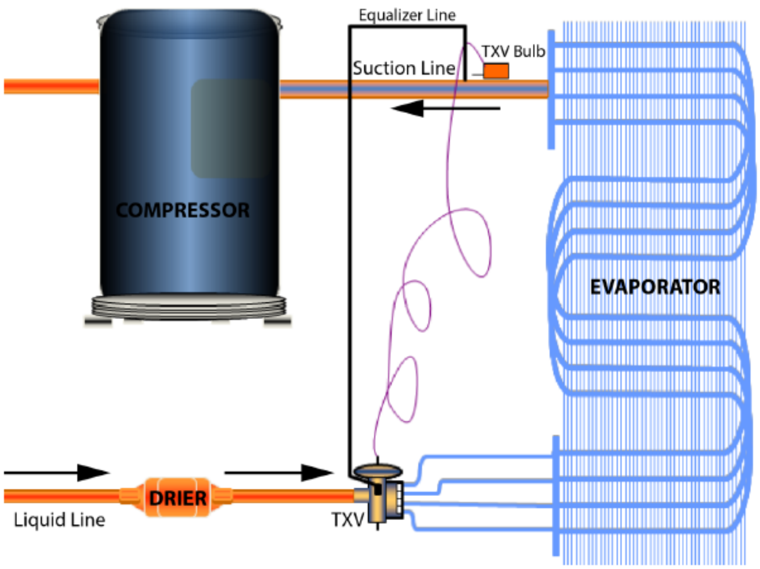


TXV

Upon exiting the liquid drier, liquid refrigerant enters the Thermostatic Expansion Valve (TXV). The TXV is a refrigerant metering device that 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.

Technician Notes
The TXV only controls superheat. It DOES NOT control suction pressure. Suctino pressure is a function of the load imposed on the refrigerant. The external equalizer line DOES NOT equalize high side and low side pressures. It only provides a closing force to the valve. If the TXV is applied with a reciprocating compressor, a start capacitor and potential relay (a “hard start” kit) MUST be used.

Evaporator



Evaporator Coil

Evaporator Coil

The TXV meters refrigerant enters the evaporator (indoor) coil. Refrigerant in the evaporator absorbs heat from the warm return air flowing over it. During the heat absorbing process the refrigerant changes state into a low-pressure cool gas. This cool gas is returned to the compressor, where the cycle repeats.

Under normal operating conditions, the evaporator coil temperature is approximately 40 degrees F. The 40 degrees F coil temperature is often below dew point, which causes moisture in the air to condense into water droplets – condensate. The water is then routed into a condensate drain.

When airflow and refrigerant charge is correct, the air temperature (discharge) leaving the evaporator is 15-20 degrees 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 dehumidification of the air, leading to discomfort in the conditioned space. Insufficient airflow may lead to coil icing and eventual compressor failure.

Refrigerant R-410A

The fifth component of any refrigeration system is the refrigerant. Refrigerant is the medium through which heat is absorbed, transferred, and rejected. The gas/electric units discussed in this guide use Refrigerant 410A (R-410A).

R410A pressures are approximately 60% higher than a compatible R-22 system. All components in the system must be rated to handle higher pressure.

R-410A Refrigerant Cylinder

Technicians servicing R-410A systems must use manifold gauge sets and recovery equipment designed for R-410A. Due to the unique oil characteristics (discussed below) equipment used for servicing R-410A systems should not be used when servicing systems using other refrigerant types – specifically R-22.

Due to higher pressures, all field connections should be made with brazing rod that has a minimum of 5% silver content. Soft solder must not be used for connections in R-410A systems. 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-40A is not compatible with mineral based refrigerant oil as used in R-22 systems. 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 is very hygroscopic, which means that it has a great affinity for water. Any moisture in the system may cause system problems. Do not leave the system open to the atmosphere.

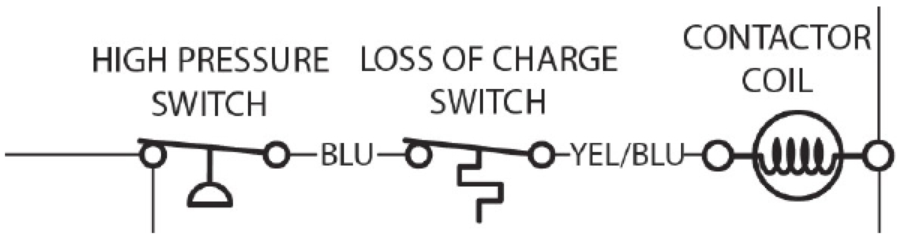
Access (Schrader) Valves

The residential gas electric package units have access (Schrader) valves to provide access to both the high and low side of the system. These valves should only be attached to the appropriate pressure gauge on the manifold gauge set. Improper installation of the manifold gauge set may damage the gauges.

High Pressure Switch

The high-pressure switch protects the system against excessive high side or discharge pressures. The high-pressure switch opens at 625 +/- 25 psig and resets at 500 +/- 25 psig. There are multiple conditions which could cause this switch to open and de-energize the compressor.

Excessive head pressure is most often caused by poor airflow across the high side coil. This may be a 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 switch is wired in series with the loss of charge switch and the contactor coil. On a call for cooling, 24 volts AC from Y1 is sent through the high-pressure switch and the loss of charge switch prior to energizing the contactor coil. As they are wired in series, either switch opening de-energizes the contactor coil to interrupt the cooling cycle.



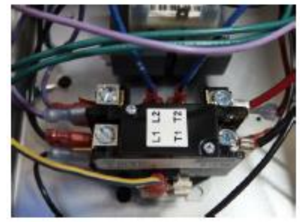
High Pressure Switch Wiring

Transformer

Transformer

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

Contactor



The contactor is energized on a call for cooling by a 24-volt AC signal from “Y” (cooling call) on the thermostat.

When 24 volts AC is applied to the contactor coil, the contacts close, allowing L1 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 though the T2 connection.

If 24 volts Ac is present at the contactor coil and the contactor does not pull in, further evaluation is required. Lock out the unit at the equipment disconnect and 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.

Common Heating Components

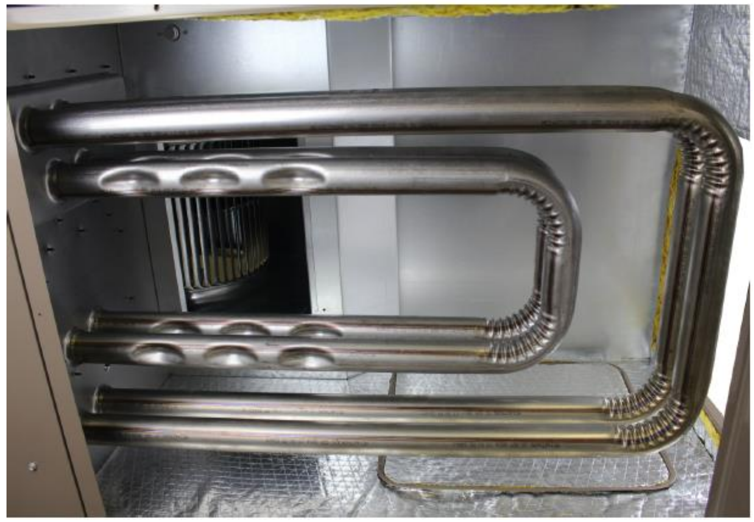
Single and Two Stage Product

The following section describes heating components common to the single and two-stage models. Components unique to single or two stage systems are described under Single Stage Components and Two Stage Components.

Heat Exchanger

The heat exchanger allows the heat from combustion to conduct through the steel and transfer to the air within the conditioned space. Obtaining the optimal airflow during the heating cycle (maintaining a temperature rise within the range on the unit data plate) is necessary for proper performance and peak efficiency.

If the supply air is inadequate, the temperature rise will be above the that listed on the rating plate. If left unresolved, excessive stress of the heat exchanger will occur, which will lead to heat exchanger failure.



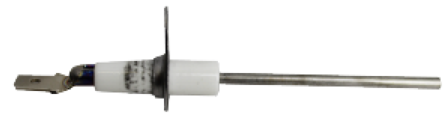
If the supply air is moving too quickly, the temperature rise will be below that listed on the data plate. The air will feel cool to the customer and flue gases can begin to condense within the heat exchanger. Any condensate produces destructive acids which will result in heat exchanger failure.

Spark Ignitor

Direct spark ignition is used in the gas electric residential package units. After proof of induced draft motor operation, the ignition control board energizes the gas valve with 24 VAC and the spark ignitor with 17kW. The spark created directly ignites the main burner.

After the flame is detected (minimum 1.5 uA), the flame sensor detects that a flame is present, and the spark is de-energized.

Flame Sensor



Burner flame is confirmed through a process known as flame rectification. The flame sensor is energized with 120 VAC. When a flame is present a small current is passed through the flame.

The process rectifies the AC power into a DC (Direct Current) microamp current. The unit control detects the small current to confirm flame presence. Typically, the current is 3uA – 4uA. A higher microamp reading is NOT an indication of a problem.

A flame signal of < 1.5 uA is considered a weak flame. At microamp < 0.5 uA is considered “no flame present” the control de-energizes the gas valve if a heating call exists. Measuring and diagnosing flame current issue is discussed in the Flame Signal Diagnostics page of this guide.

Note
The flame sensor is always powered. This enables the control to detect flame presence even when a heat call is not present, such as it might occur if the gas valve does not close.

Burners

The inshot burners mix fuel from the gas valve and primary air for combustion. Proper manifold pressure (3.5” w.c. for natural gas, 10” w.c. for propane gas on single stage systems) must be provided for the establishment of a stable, blue flame.

Burner Assembly

Burner Installed

Limit Switch

The limit switch (LS), also known as the high temperature limit, is the primary temperature safety control. Located in the blower compartment, the limit switch extends into the heating compartment – sensing air temperature in the heat exchanger section. The auto resetting limit is a temperature actuated switch that interrupts the heating cycle, if exposed to excessive temperatures, such as burner operation without blower operation, or restricted airflow (plugged air filter, restrictions in the air delivery system).

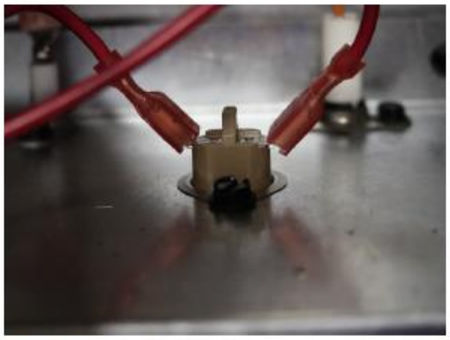
Common causes of limit switch opening are:

- Dirty return air filter
- Blocked supply air ducts
- Dirty evaporator
- Excessive manifold pressure
- Debris deflecting airflow away from the limit switch.

Note
A limit switch opening temperature is carefully selected during product development. If a replacement switch is required, use only the one specified. DO NOT use a switch with a different rating.

Rollout Switch

The rollout switch (RS) is a manually reset limit located above the burner. The normally closed switch opens when excessive heat is detected in the burner area. It is important to note that while termed a Rollout Switch, burner flame does not actually have to “rollout” to trip the switch. The normally closed switch opens when excessive heat is detected in the burner area.



Rollout Switch

The most common causes for rollout switch tripped are lack of combustion air or a flue restriction. Other probable causes are:

- Burner over-firing
- Improper panel installation
- Cracked heat exchanger.

Inducer Pressure Switch

The inducer pressure switch provides proof of inducer motor operation and open heat exchanger/vent system before gas introduction and energization of the direct spark ignitor.

The normally open switch closes when the inducer creates a negative pressure on the diaphragm. The switch closure point is typically indicated on the switch label.

More than 90% of pressure switches returned under warranty have no defect found…before changing a switch the switch circuit must be diagnosed with a manometer of Magnehelic gauge. The manometer is “teed” into the pressure switch circuit in parallel to determine the pressure present at the switch.

A fault code indicating that the pressure switch did not close RARELY suggests that the switch is defective. Rather, there is a condition present that is reducing the combustion airflow, such as a restriction in the combustion air or flue gas pathway.

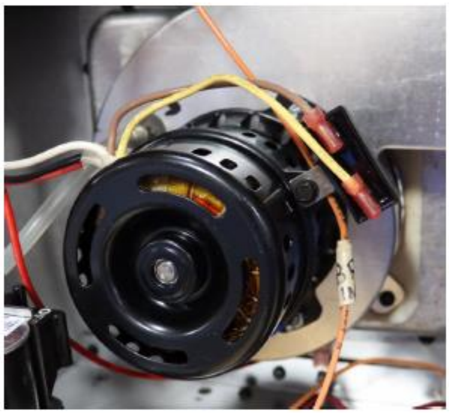
Single Stage Components

This section identifies those components unique to single stage systems.

Gas Heating Components: Single Stage

Improper servicing of gas heating equipment can result in property damage, personal injury and/or loss of life. Only qualified service technicians should install, service, or repair gas heating equipment.

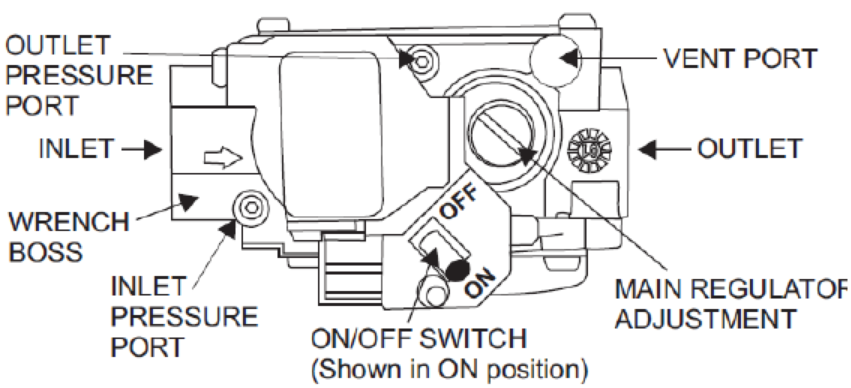
Induced Draft Motor (DM)



The induced draft motor, also referred to an inducer motor or combustion blower motor, provides two functions: bringing air in for combustion into the burner area and moving the products of combustion through the heat exchanger and expels them to the outdoors. The induced draft motor is 208/230 volts AC single phase. The single stage package gas heat model uses a single speed PSC (Permanent Split Capacitor) motor. The run capacitor is mounted to the motor housing.

Induced draft operation is proven with the inducer pressure switch, which may be verified with a Magnehelic gauge or manometer.

Note
The induced draft motor must be energized and proven prior to fuel and ignition being introduced to the burners. This is proven with the inducer pressure switch (PS).



Gas Valve

The gas valve is powered by the unit control. When 24 VAC is applied a solenoid valve opens allowing gas to flow into the manifold and the burners. The gas valve also contains a pressure regulator which reduces the inlet gas pressure.

The Manifold Pressure Verification and Adjustments section of this guide provides step-by-step instructions on how to properly set up the valve.

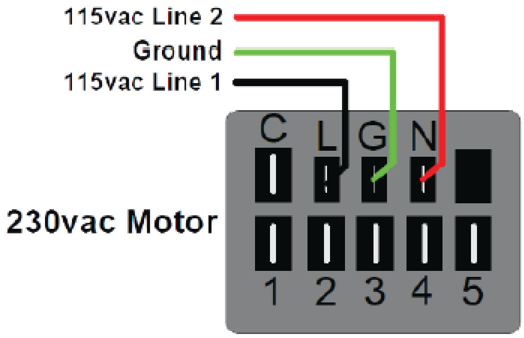
Unit Control Board

Shown under the Single Stage Control Board heating.

Blower Motor: Standard ECM (Electronically Commutated Motors)

The Standard ECM (S-ECM) motor is used in the indoor fan section of single stage package units. This motor operates with 208/230 volts AC line voltage. The allowable voltage range on these motors is 1960264 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 is like a PSC motor. However, airflow will not decrease as dramatically as with a PSC motor since torque is being maintained.



S-ECM Motor Connections

The Standard ECM motor has a 10-pin connector, but only utilizes none of the pins. The line voltage terminals are labeled "L," "G" and "N." The "L" terminal is line, and the "N" terminal is line 2 for 230 volts AC. The "G" terminal is the ground terminal.

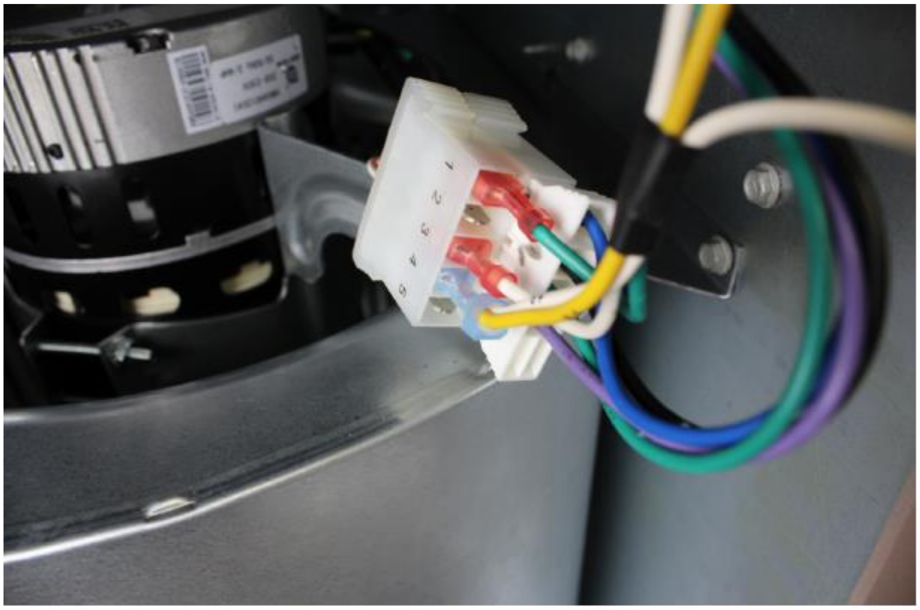
A reading of 230 volts AC is measured between the "L" and the "N" terminals.

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 volts AC are sent from the control board to engage the proper fan torque for the mode of operation.

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.

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).



S-ECM Blower Motor Speed Tap Selection

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.

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

Two Stage Components

This section provides details on components that are unique to residential two stage gas electric package systems.

Two Stage Control Board

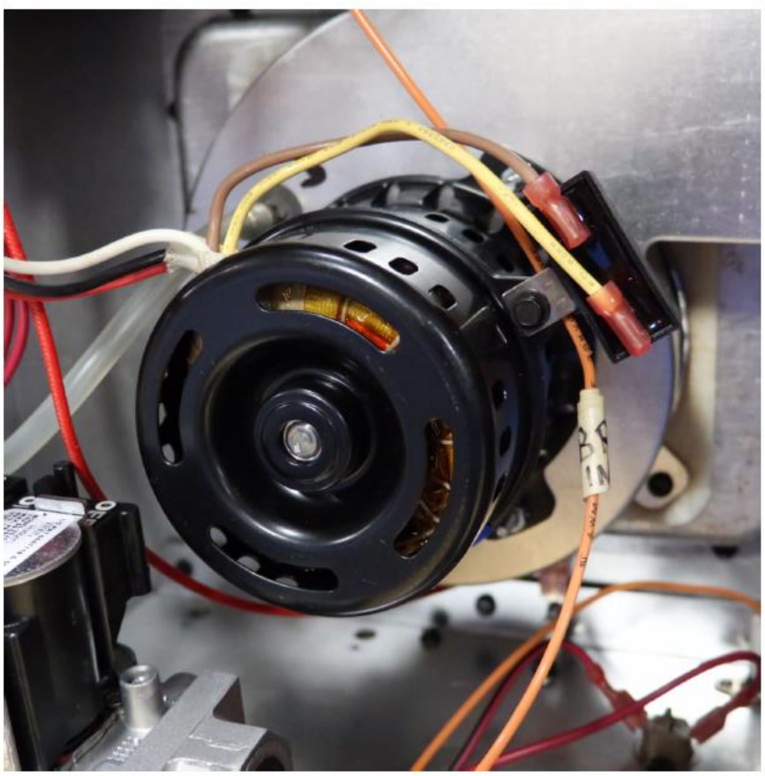
The two-stage gas electric package system control board offers features unique to two stage heating and cooling operation. Designed for use with Enhanced ECM motors, the control allows the technician to customize the unit operating parameters for each application. Control setup is discussed in detail in the Start Up section of this guide.

Gas Heating Components Two Stage

Improper servicing of gas heating equipment can result in property damage, personal injury and/or loss of life. Only qualified service technicians should install, service, or repair gas heating equipment.

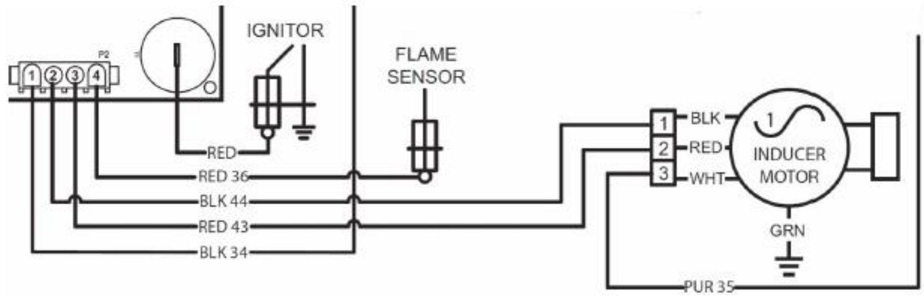
Induced Draft Motor (DM)

The induced draft motor brings air for combustion into the burner area and moves the products of combustion through the heat exchanger and expels them to the outdoors. The induced draft motor on the two-stage gas electric model is a 208/230 volts AC single phase, two speed PSC motor.



Induced Draft Motor

During a first stage heating call, the lower speed of the inducer is energized through pin three of the P2 four pin plug connector. During a second stage heating call, the high speed of the inducer is energized through pin two of the P2 four pin plug connector.



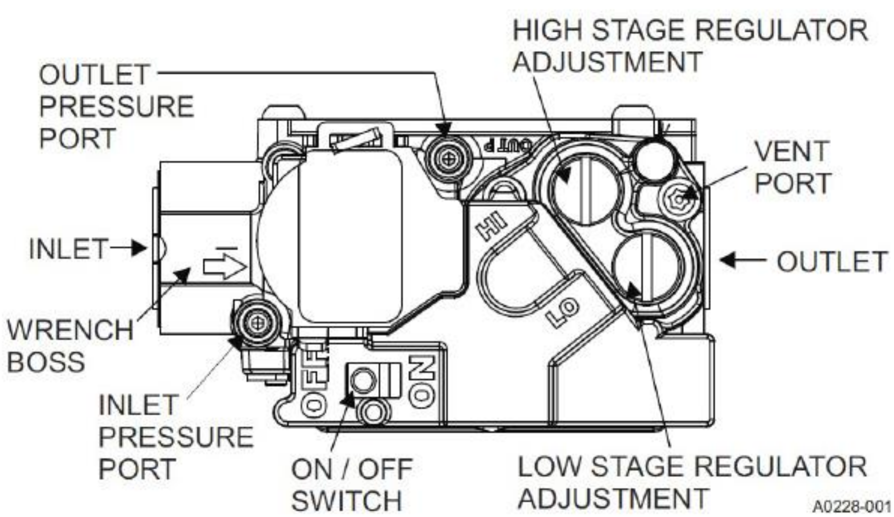
Two Stage Model Inducer Motor Wiring

Induced draft motor operation is proven with the inducer pressure switch, which may be verified with a Magnehelic gauge or incline manometer.

Note
The induced draft motor must be energized and proven prior to fuel and ignition being introduced to the burners. This is proven with the inducer pressure switch (PS).

Two Stage Gas Valve

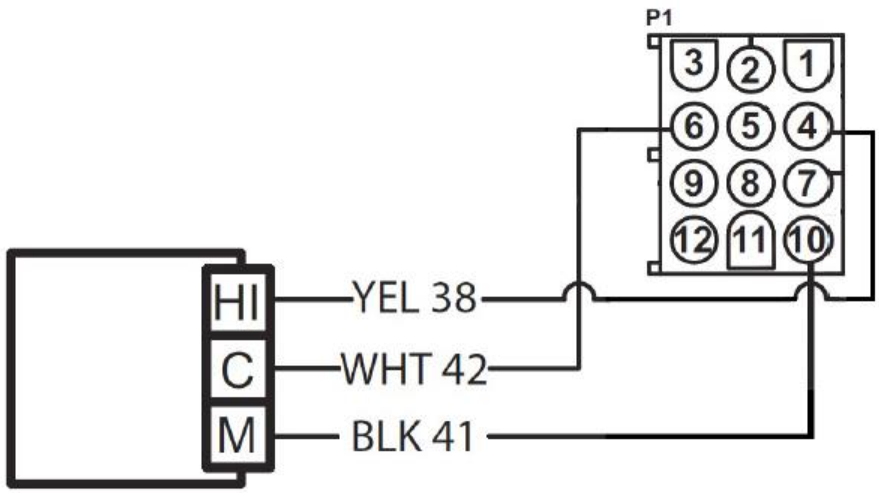
The two-stage gas electric package systems control the first and second stage firing rates with a two-stage gas valve as described below.



Two Stage Gas Valve

Gas Valve Electrical Connections

The two-stage gas valve is controlled with 24 volts AC from the control board. Pin 6 of the 12-pin plug connector is 24 volts AC common. During ignition and a call for second stage heat, 24 volts AC is sent from Pin 4 of the P1 12 pin plug connector to the HI gas valve terminal and from Pin 10 of the P1 12 pin plug connector to the M gas valve terminal. During a first stage heat call and following the ignition sequence, 24 volts AC is present on the M gas valve terminal.



Two Stage Gas Valve Electrical Connections

Manifold Pressure

The manifold gas pressure must ALWAYS be properly set up during furnace installation and verified during service. All Unitary Products residential gas electric package units are shipped for use with natural gas. If LP (Low Pressure) gas use is required, the appropriate LP gas conversion kit must be installed prior to furnace operation.

The following manifold pressure (gas valve outlet) values are required during furnace operation. The manifold gas pressures must ALWAYS be properly set up during furnace operation and verified during service. Information on setting manifold pressure is found in the Manifold Pressure Verification and Adjustments section of this guide.

High Fire (Second Stage) Manifold Pressures (in w.c.)

Heating Value (BTU/cu ft.	0-7999 feet	8000-8999 feet	9000-9999 feet
800	3.5	3.5	3.5
850	3.5	3.5	3.5
900	3.5	3.5	3.5
1000	3.5	3.2	2.9
1050	3.5	2.9	2.7
1100	3.2	2.7	2.4
2500 (LP)	9.8	8.2	7.5

Low Fire (Second Stage) Manifold Pressures (in w.c.)

Heating Value (BTU/cu ft.	0-7999 feet	8000-8999 feet	9000-9999 feet
800	1.7	1.7	1.7
850	1.7	1.7	1.7
900	1.7	1.7	1.7
1000	1.6	1.5	1.4
1050	1.5	1.4	1.3
1100	1.3	1.2	1.1
2500 (LP)	4.1	3.8	3.5

These values may vary slightly depending on the altitude of the area the furnace is installed in and/or the BTU/cubic foot value of the gas used. The exact value for these conditions may be found in this guide and the furnace Installation Manual.

Two Stage Control Board

Shown under Two Stage Control Board heading.

Cooling Components

Two Stage

This section describes components unique to the models that contain two stage cooling.

Two Stage Compressor

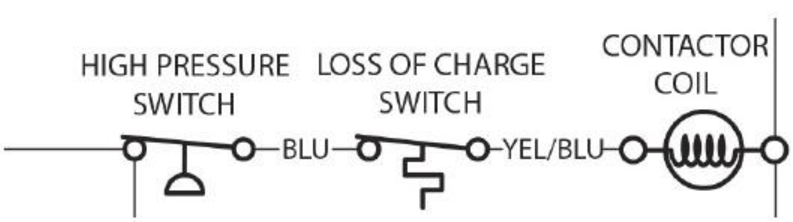
Two Stage Compressor

The Copeland two stage scroll compressor has two internal bypass ports. Then the bypass ports are open, the compressor operates at 67% capacity. When the bypass ports are closed, the compressor operates at 100% capacity. A call for 1st stage operation energizes the contractor which starts the compressor at 67% capacity. A call for 2nd stage operation energizes an internal solenoid, which closes the bypass ports for 100% capacity.

Loss of Charge Switch

The loss of charge switch is mounted on the suction line and opens upon rise in suction line temperature caused by refrigerant loss.

On a call for cooling, 24 volts AC from Y1 is sent through the high-pressure switch and the loss of charge switch prior to energizing the contactor coil. As they are wired in series, either switch opening de-energizes the contactor coil to interrupt the cooling cycle.



Loss of Charge Switch Wiring

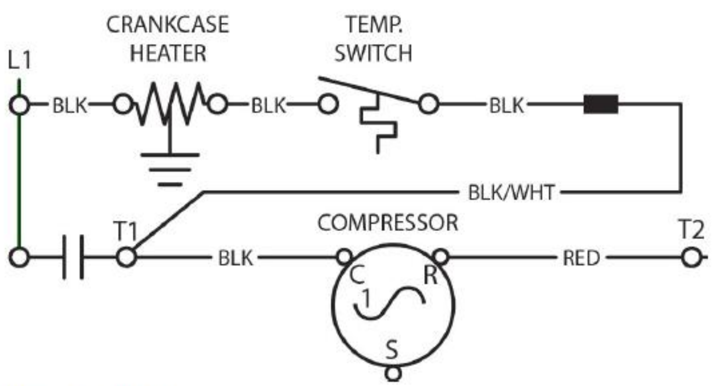
Crankcase Heater

Optional Accessory on Single Stage Models, Included with Two Stage Models

The crankcase heater prevents accumulation of liquid refrigerant in the sump of the compressor by warming the sump in the cooling off-cycle. The heat from the crankcase heater causes refrigerant in the compressor oil to boil off a vapor.

The crankcase heater is wired in parallel with the contactor normally open contacts between L1 and T1. In the off cycle, the crankcase heater is energized between L1, through the compressor run winding to L2. The operation of the crankcase heater is thermostatically controlled by a temperature switch wired in series with the heater.

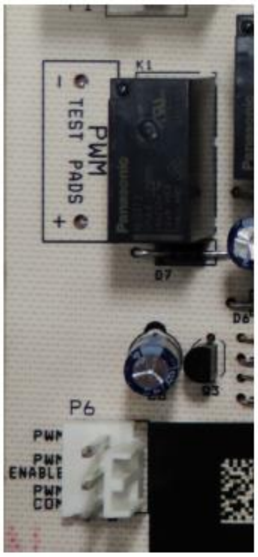
During a call for cooling, the normally open contacts between L1 and T1 are closed, removing the crankcase heater from the circuit. This contact closure places both leads of the crankcase heater circuit at the same point electrically, disabling energization.



Crankcase Heater Wiring

Enhanced ECM

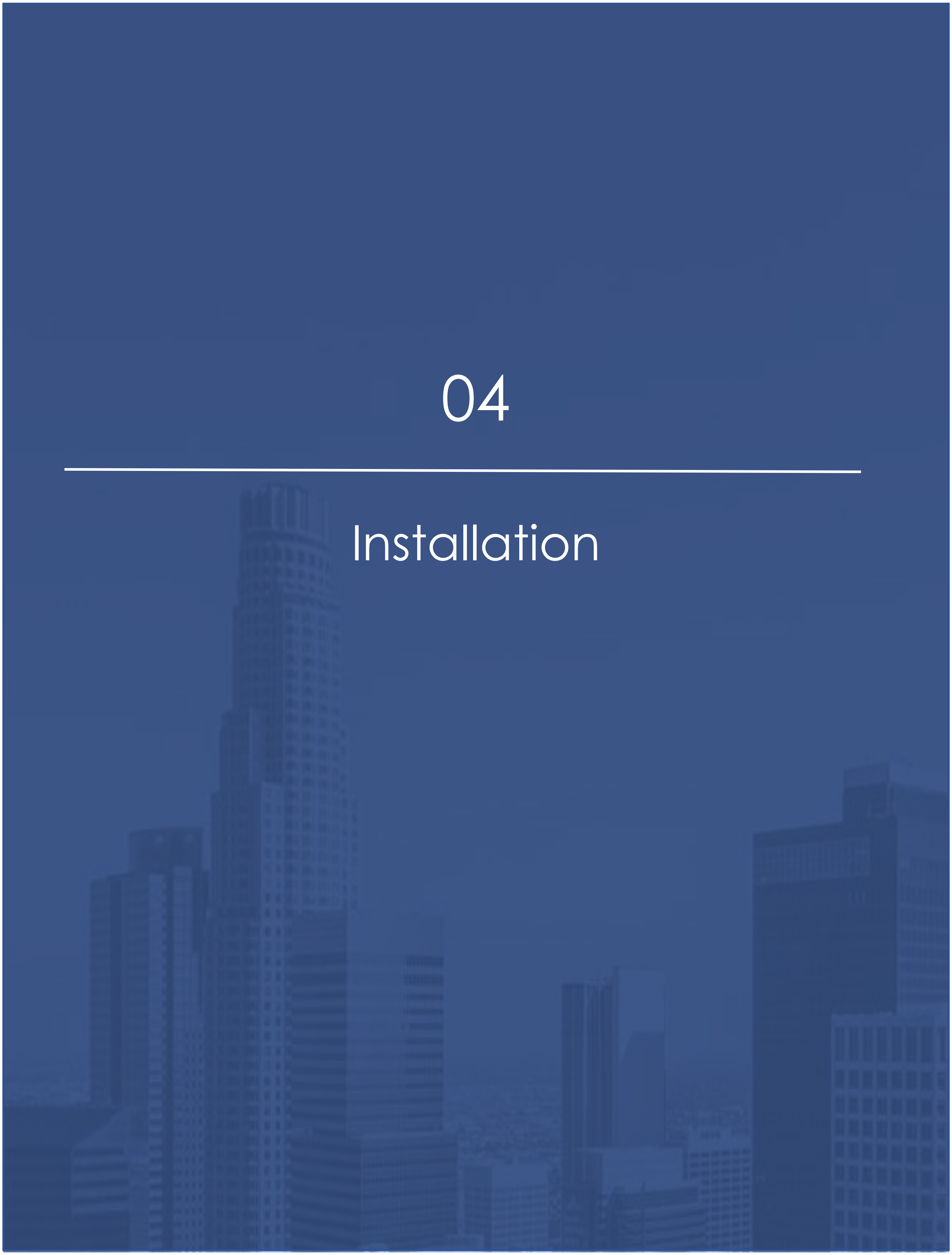
PWM (Pulse Width Modulation) Controlled Blower



The Enhanced ECM blower motor speed is controlled by pulse width modulation (PWM) signal. The PWM signal is sent through the PWM and PWM COM connections. The commanded PWM varies depending on system mode and setup. A PWM Test Pad on the control board permits measuring the PWM signal with a multimeter capable of reading Duty Cycle.

The PWM signal is an 80Hz, +20VDC modulated signal. The PWM common is not tied to the (24-volt AC) common terminals on board. The motor does not require the PWM Enable and is not used at this time. The approximate PWM values for various models and conditions are found in the Appendix section of this guide. Conformation of these values, along with validation of line voltage to the motor, provides the basis for diagnosing the control motor interaction.

Line voltage is always supplied through a three-pin connection on the control board.



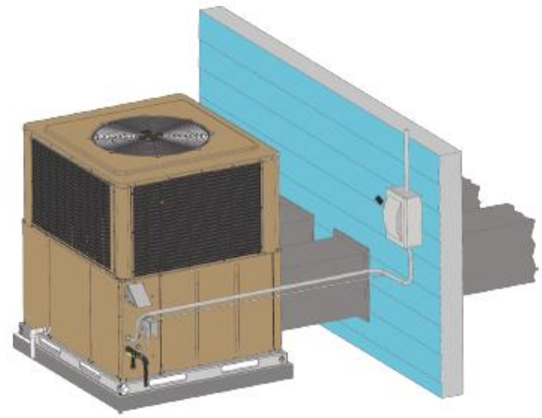
04

Installation

Introduction

Residential package units shall be installed by current local, city, state and national laws and code requirements. If the equipment is installed outside of the United States, all laws, and codes within the country of origin must be followed.

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

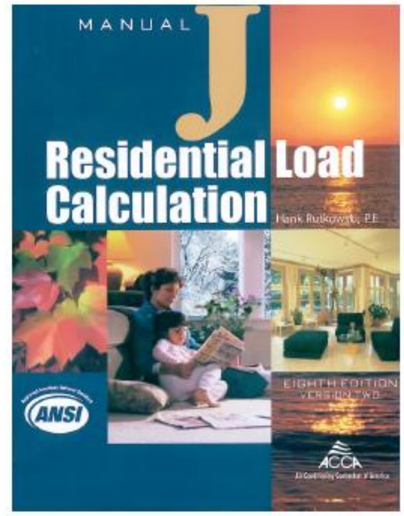


Package Unit Installation

Equipment Selection

Each application is unique. Selecting the correct equipment will help ensure proper performance and customer comfort. Equipment selection must be based on heat loss and heat gain calculations made by industry recognized procedures.

Air Conditioning Contractors of America (ACCA) Manual J is widely considered the industry standard for such calculations.



Locations and Clearances

The package units are designed to be installed outdoors only. Proper clearances for airflow and servicing shall be provided following the Installation Manual which accompanies the unit.

All package systems installed at ground level shall be on a level pad or slab designed to withstand the equipment's weight and dimensions. The pad or slab location and dimensions shall also meet local code requirements.

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

Clearances Table

Direction	Distance
Top	36"
Side Opposite Ducts	36"
Duct Panel	0"
Power Entry (Right Side)	36"
Left Side	24"
Bottom	1"

Thermostat

Overview

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 proper cycle rate adjustment is six cycles per hour.

Two-Stage Products

Two-Stage heating and cooling thermostats are recommended for two-stage products. A two-stage thermostat optimizes the product design features.

The product can be applied with a single stage thermostat. However, two-stage cooling functionality is lost, and heat staging is accomplished through a time setup. Refer to the Two-Stage Heat Delay section of this guide for more information.

Electrical Wiring

All electrical connections and components must be installed in accordance with current national, state, and local electrical code requirements.

The power supply must be a dedicated circuit with the proper equipment grounding and circuit protection. Failure to provide adequate wire sizing, circuit protection, and equipment grounding may 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.

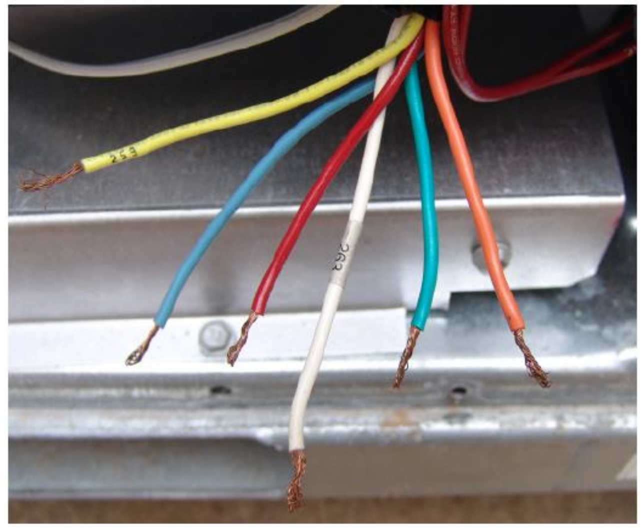
Prior to energizing the unit, verify that the primary voltage taps to the transformer are wired properly configured for the applied voltage. The unit is shipped with the transformer configured for 240 VAC. For 208 VAC applications relocated the wired attached to the 240 VAC tap to the 208 VAC tap. If the transformer is configured properly, erratic operation and/or 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 must be a minimum of 18-gauge wire.



Low Voltage Thermostat Connections

Ductwork Installation

The single largest issue in the HVAC (Heating Ventilation and Air Conditioning) industry is improper ductwork. Improperly sized and installed duct systems will result in loss of efficiency, equipment damage, structural damage, and indoor air quality problems. The importance of properly sized ductwork cannot be overemphasized. To properly design the ductwork for the structure, refer to the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) (American Society of Heating, Refrigeration, and Air Conditioning Engineers)) Fundamentals Handbook chapter on DUCT DESIGN, or Air Conditioning Contractors of America (ACCA) Manual D.

Note
Residential package systems are designed to deliver their rated airflow at up to 0.5” w.c. total external static pressure. A restrictive duct (>0.5” w.c.) increases external static pressure and causes operation 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 rating.

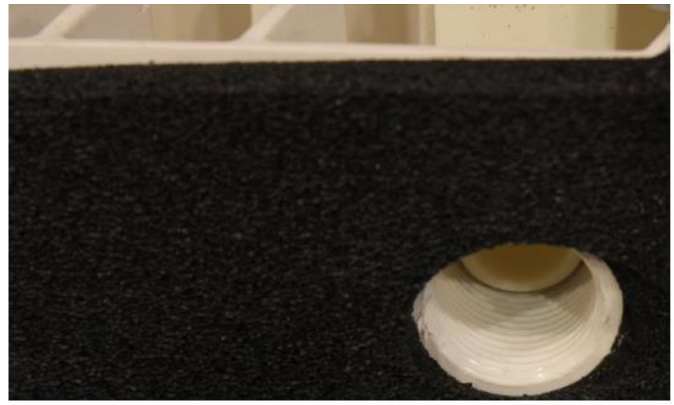
Downflow and Horizontal Discharge Connections (Bottom Unit View)

The residential gas electric 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.

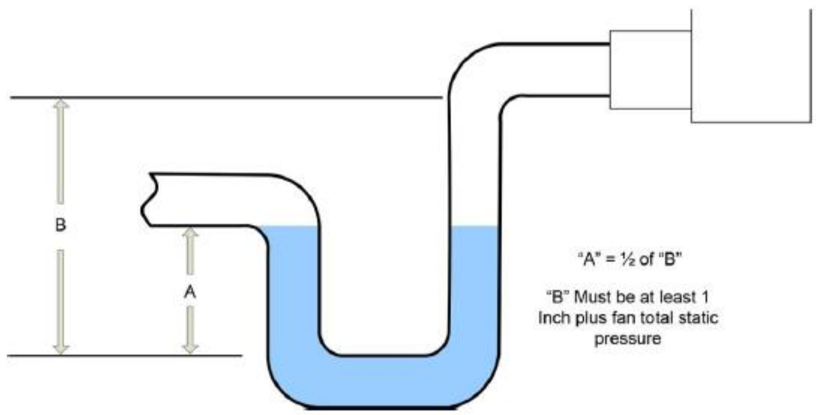
Condensate Drain

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.



Drain Connection



Proper Condensate Drain

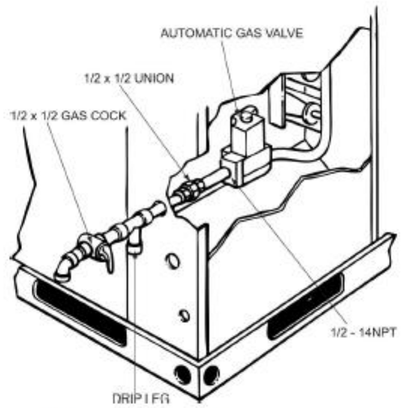
Filters

Package units are shipped without filters. Filters must be installed with an approved filter kit properly sized for the system. Filter sizes should be entered on the startup 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.

Gas Piping

Gas piping must be completed in accordance with the National Fuel Gas Code unless superseded by local codes or the local authority having legal control.

Equipment installed outside of the United States should follow all local codes, rules, and regulations within the origin of the installation. Proper pipe sizing will depend on BTU content, the type of fuel and the required cubic feet per hour of fuel.



Gas Piping Configuration

The gas piping supplying the unit should also meet the natural gas or propane (LP (Low Pressure)) gas pipe sizing charts in the Installation Manual.

The gas-electric residential package units should have a shutoff valve, union and drip leg installed. The drip leg shall be a minimum of 3” in length. All gas piping connections should be sealed with an approved pipe joint compound. The pipe compound is applied to the male threads only, not to the inside of fittings or gas valve.

Flue Vent Hood

The flue vent hood is shipped with the gas-electric package unit and must be field installed according to the Installation Manual to provide proper discharge of flue gases.

Proper clearances must be kept preventing the hot hood and flue gas temperatures from damaging property or causing personal injury. Caution the equipment owner as to the location and temperatures that may be present.

Propane Conversion Kit

An LP (propane) conversion kit MUST be installed anytime the unit is applied with LP fuel. Failure to properly install and set up the LP conversion will result in erratic operation or no operation, and in extreme cases lead to property damage, injury and even death.

LP conversion requires careful adherence to the provided instructions. Be sure to use the proper kit for the unit being converted.

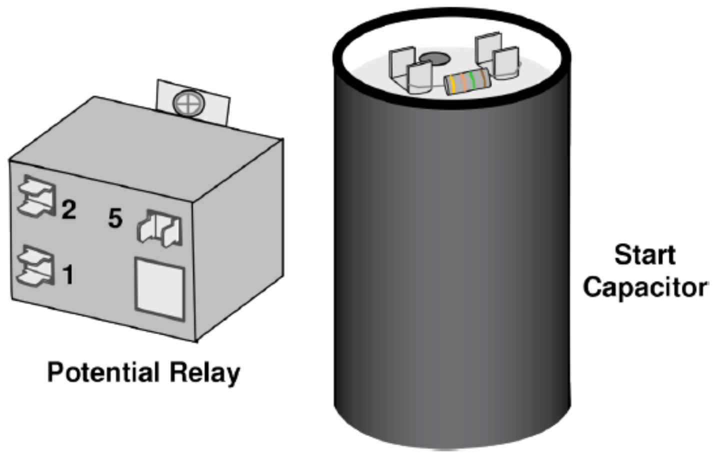
Propane Conversion Kit Warning

Hard Start Kit

Note
Hard Start Kits are typically not required for this product. The information below provides an overview of the components, should it become necessary to install a kit.

The start capacitor provides additional starting torque to the compressor and is only in the circuit on startup; therefore, the start capacitor must have a relay to remove the capacitor from the circuit. Collectively, the start capacitor and start relay are referred to as a “hard start kit.” The hard start kit may be factory or field installed.

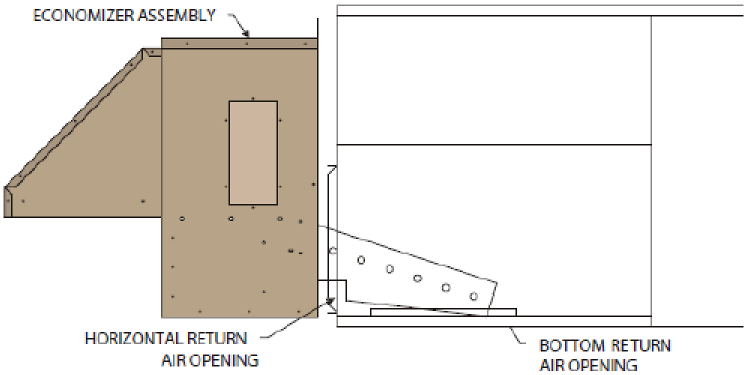
When the compressor is energized, line voltage is applied to the start capacitor. The start capacitor increases the starting torque of the motor and the rotor beings to turn. When the rotor has reached 75% of running speed, the potential relay coil is energized, and the normally closed set of points opens; thus, removing the start capacitor from the circuit.



Hard Start Kit

Caution
Be aware that the capacitor may have stored energy even though the electrical disconnect has been locked out and line voltage has been removed from the system. A resistor should be used to bleed the stored voltage from the capacitor. The recommended resistor is a 20,000 ohm 2-watt resistor. The technician should not use a screwdriver to bleed the capacitor. Improper bleeding of the capacitor can cause damage to the capacitor and to the motor itself.

Economizers



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

Economizer

Note
If an economizer is applied on a roof with burglar bars, then an economizer equipped with interposing blades must be used. The burglar bars will obstruct the single blade economizer damper and the economizer will not operate properly.

The economizer has two main modes of operation. The economizer can provide 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 can also be installed to provide 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 from single to dual enthalpy sensing capabilities.

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 uses the outdoor 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 can measure the temperature and humidity of the ambient air. The enthalpy sensor provides 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 used to cool the conditioned space.

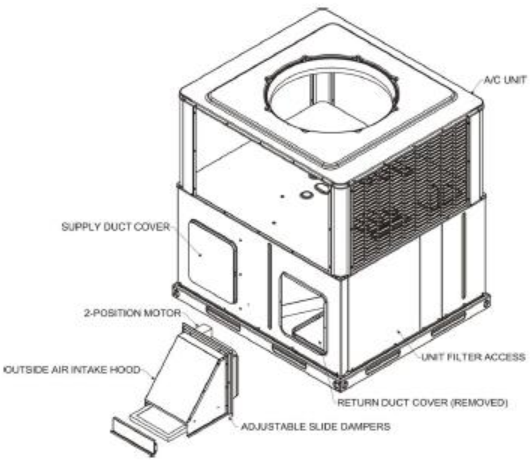
Dual Enthalpy Kit

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 outside air's total heat. 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.

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.

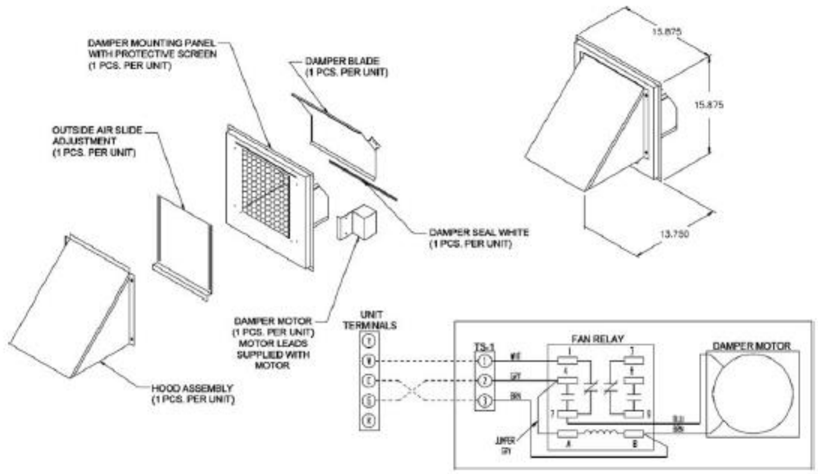


Manual Fresh Air Damper Kit

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.

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 actuates when the indoor fan is in operation. 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.



Motorized Fresh Air Damper Kit

Filter Frame Kit

The filter frame kits available for installation installed on downflow and horizontal applications. 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.

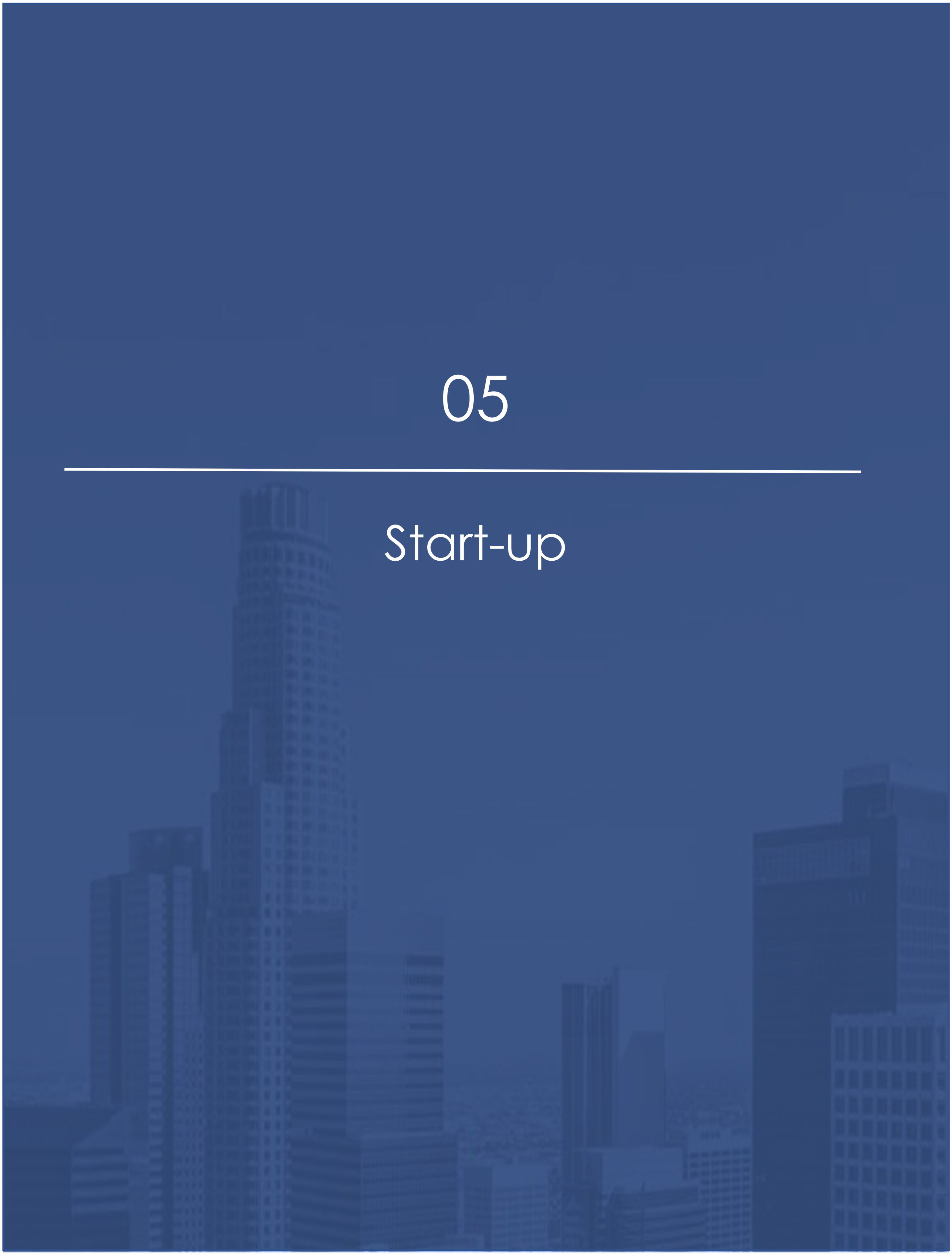
Roof Curb Kit

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 properly, personal injury, or death may occur.



05

Start-up

Introduction

The online form is for use with all Unitary Products residential products. This form is found on the last pages of the installation manual. The form allows savings for later completion. Completed form data is sent to your inbox for archive purposes.

Note
Before start-up, all installation procedures outlined in the Installation Manual must be completed.

Airflow Setup

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.

Speed Selection Plug: Standard ECM Motor

Proper airflow establishment involves measurement of external static pressure (ESP) in cooling mode and selection of appropriate blower speed traps 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). Information on Standard ECM (Electronically Commutated Motors) and Enhanced ECM setup follows the review of External Static Pressure (ESP).

External Static Pressure (ESP)

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

Important
Total external static pressure greater than 0.5” w.c. will cause a reduction in maximum indoor airflow volume and may lead to comfort and operational issues. Be sure to locate and correct the source(s) or airflow restriction prior to placing the system in operation.

Understanding airflow configuration and limitations is a critical element of HVAC (Heating Ventilation and Air Conditioning) 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 operation will be louder 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 duct, dirty filters, dirty evaporator 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.

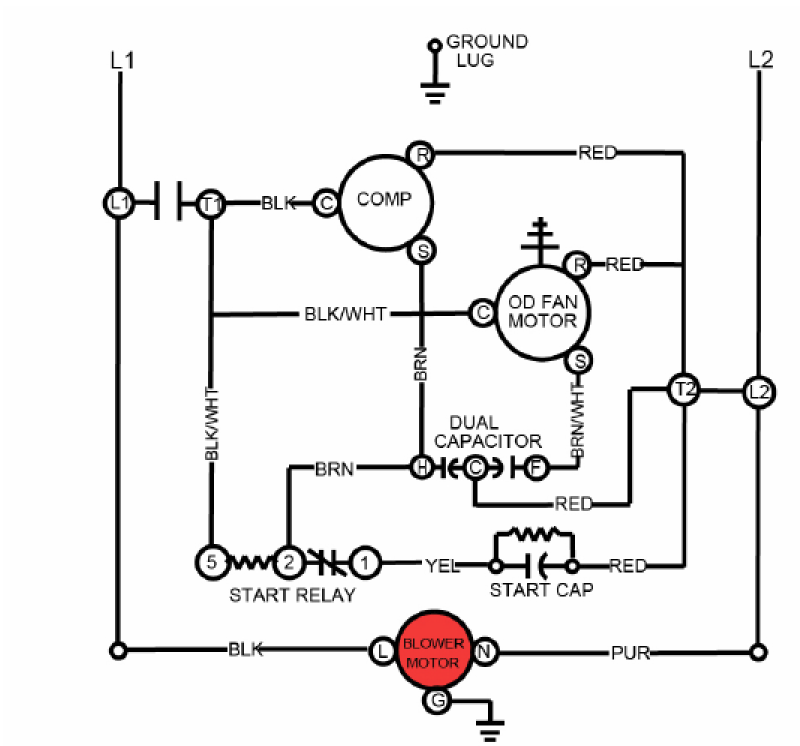
Common tools of choice for measuring ESP are the Magnehelic gauge or electronic manometer.

Blower Setup
Standard ECM Blower Motor

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 the constant airflow of the Enhanced ECM. 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

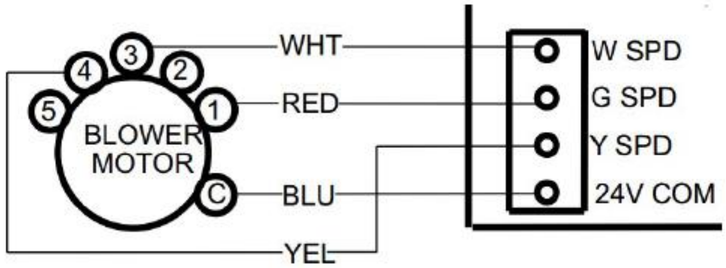
Line voltage is always applied to the motor, even during no call for blower operation. The wiring diagram below reflects the power connections. The motor is controlled via 24 VAC inputs. See below for more information on the 24 VAC connections.



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

S-ECM Blower Motor Speed Tap Selection

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 int eh 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, through 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.

SECTION V: AIRFLOW PERFORMANCE

Table 12: Airflow Performance - Side Duct Application

Model	Motor Speed	External Static Pressure (Inches WC)								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0
		SCFM	SCFM	SCFM	SCFM	SCFM	SCFM	SCFM	SCFM	SCFM
24050	Low (1)	732	667	624	567	517	470	415	369	277
	Low/Medium (2)	818	771	723	674	628	579	530	482	386
	Medium (3)	823	774	721	676	631	583	533	505	448
	Medium/High (4)	994	948	906	865	823	778	739	700	622
	High (5)	1148	1108	1071	1035	996	960	925	901	853
24075	Low (1)	887	847	802	750	705	664	613	563	463
	Low/Medium (2)	978	941	898	850	803	759	713	667	575
	Medium (3)	1171	1114	1074	1039	993	949	906	864	780
	Medium/High (4)	1349	1297	1265	1224	1185	1146	1107	1063	975
	High (5)	1487	1462	1392	1331	1318	1281	1241	1201	1121
30050	Low (1)	700	657	599	554	512	461	411	365	273
	Low/Medium (2)	906	868	825	779	735	692	650	608	524
	Medium (3)	992	951	911	868	826	787	747	712	642
	Medium/High (4)	1075	1032	1000	958	918	874	837	800	726
	High (5)	1136	1089	1053	1018	978	941	903	869	801

Sample Airflow Performance Chart

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.

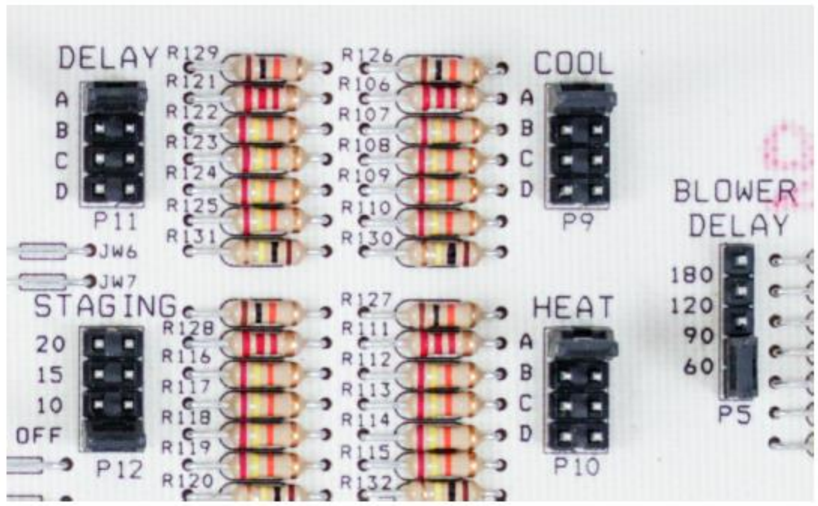
Sample Temperature Rise from System Rating Plate

Heat OFF BLOWER DELAY

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

Airflow Configuration

As with any heating and cooling system it is important to know that the unit is not factory set. The factory default settings are configured to ensure maximum airflow to the largest unit. It must be understood that each installation and application is unique. Properly configuring the airflow is essential for proper system operation.

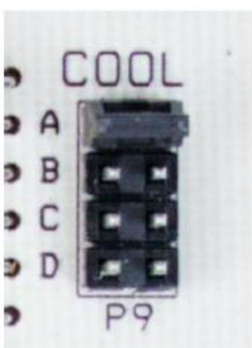


Blower Jumpers - Enhanced ECM Model Control Board

Blower speed selections for the Enhanced ECM blower motor are made on the system control board. The COOL and HEAT jumpers establish the blower speeds for cooling and heating modes, respectively. The DELAY and BLOWER jumpers provide further comfort customizations.

Three tap settings are provided in the form of four-position shunt jumpers to adjust the blower speed from the motor. These taps are labeled HEAT, COOL, and DELAY. Each tap has four positions labeled A, B, C and D. The control can sense all four positions on each tap, and the ability to sense when no jumper is present. If the jumper is not installed, the control operates as if it were in position A.

COOL (Cooling Mode) Adjustment



Airflow performance charts are provided in the Installation manual that outlines CFM performance based on the model, application, and external static pressure. The COOL (P9) jumper selection is based on providing approximately 400 CFM per ton of cooling capacity on a second stage cooling call. During a first stage cooling call, the blower is commanded to deliver approximately 63% of the selected COOL speed selection. Cooling airflow adjustments are made independent upon heating airflow adjustments by moving the COOL jumper pin. The factory default setting is the A position, which provides maximum airflow.

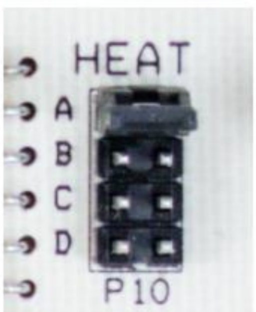
SECTION V: AIRFLOW PERFORMANCE

Table 11: Airflow Performance - Side Duct Application

Model	Jumper Position		External Static Pressure (Inches WC)									
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
			SCFM	SCFM	SCFM	SCFM	SCFM	SCFM	SCFM	SCFM	SCFM	SCFM
24050	High Cool	A	991	957	913	863	809	768	717	662	630	598
		B	902	858	809	753	703	659	615	570	513	496
		C	826	779	719	664	616	570	531	478	434	417
		D	693	642	571	529	466	430	390	357	309	275
	Low Cool	A	808	761	699	645	597	552	512	455	420	401
		B	718	668	599	554	495	457	416	375	334	304
		C	615	556	489	450	390	358	311	281	221	181
		D	562	494	436	395	348	317	259	217	155	113
	High Heat	A	862	815	761	702	655	607	571	524	463	450
		B	768	721	654	604	553	511	469	411	386	362
		C	680	628	557	516	451	416	376	348	296	261
		D	655	602	530	491	422	389	350	330	271	232
	Low Heat	A	862	815	761	702	655	607	571	524	463	450
		B	756	708	640	591	539	498	456	402	373	347
		C	628	571	503	464	400	368	324	298	238	198
		D	602	540	476	436	379	348	298	265	204	164

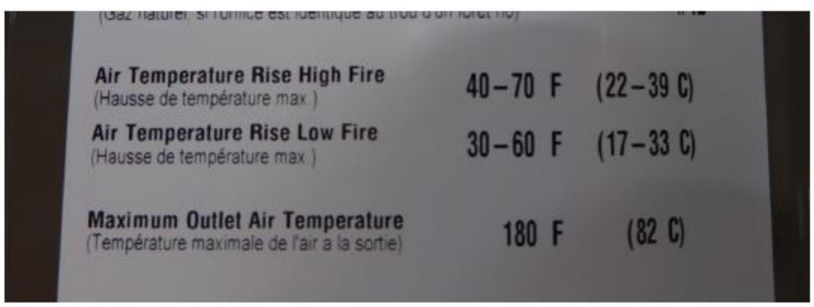
Sample Airflow Performance Chart

HEAT (Heating Mode) Adjustment



Heating mode airflow is selected to maintain a system heating temperature rise within the allowable range on the system rating plate. The HEAT jumper pins allow for four airflows. When selecting heating airflow, verify the unit is operating within the specified temperature range by checking the temperature rise with heating operation on high fire (second stage).

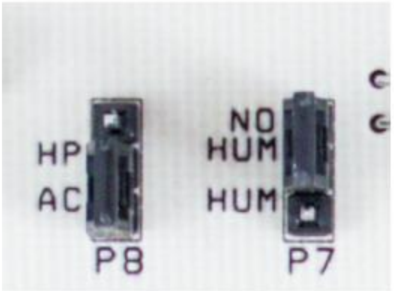
If the temperature rise is too low, decreasing the airflow will increase the temperature rise. If the temperature rise is too high, increasing the airflow will lower the temperature rise. The A setting offers the highest airflow, which in turn is the lowest temperature rise. The other settings B, C, and D offer progressively lower airflows with the D setting being the lowest.



Sample Temperature Rise from System Rating Plate

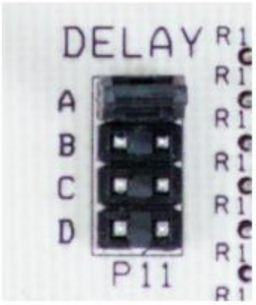
Dehumidification Setting

Unique to Enhanced ECM product is the ability to reduce indoor airflow to increase the systems dehumidification ability based on environmental demand. Two movable jumpers are provided on the control board for enabling the feature. Identified as HP/AC (P8) and NO HUM/HUM (P7), the jumper's function together for enabling dehumidification. The P8 jumper must be set to AC and the P7 jumper set to HUM.

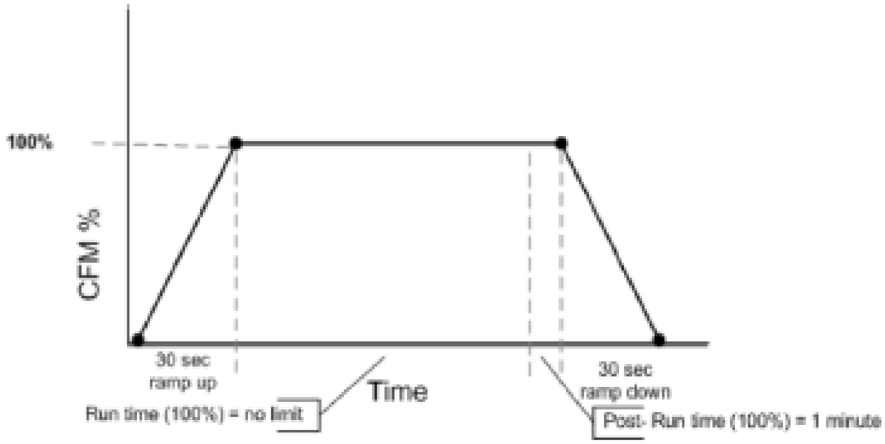


Typically, this feature is implemented with a thermostat that offers a build in humidity sensor with a 24 VAC output when humidity rises above setpoint. With the jumpers configured, anytime 24 VAC is placed on the HUM thermostat terminal, the airflow is reduced by 15%.

Blower Delay Profiles

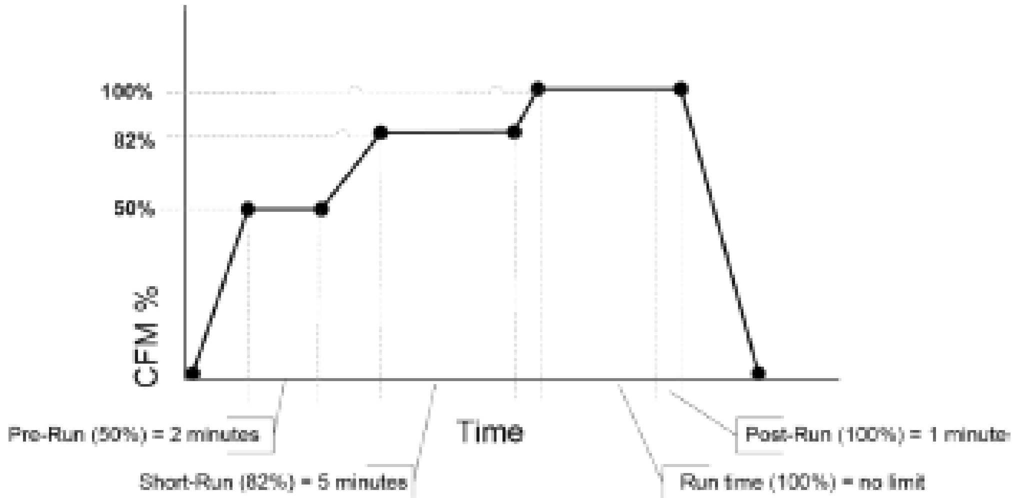


Applicable to the cooling operation of Enhanced ECM products, blower delay profiles optimize system performance by climate type. The blower delay profile is applied to the beginning and ending of blower operations. The selections are made by the technician using the DELAY jumper.



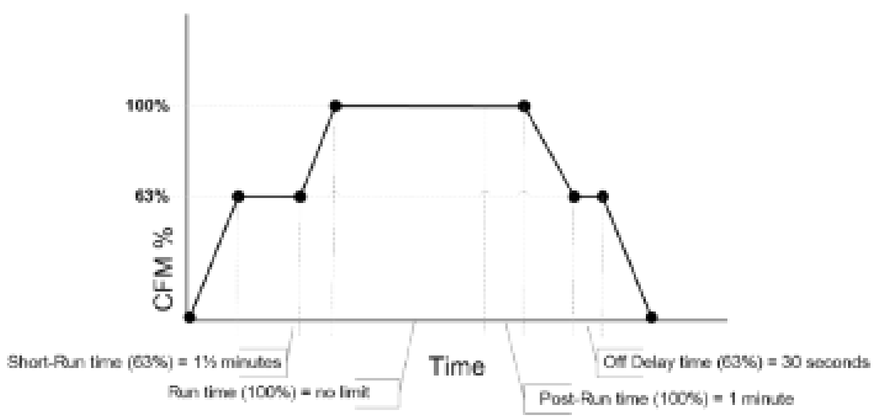
“A” Normal (Default)

This profile is suitable for most applications. It provides a uniform on and off delays.



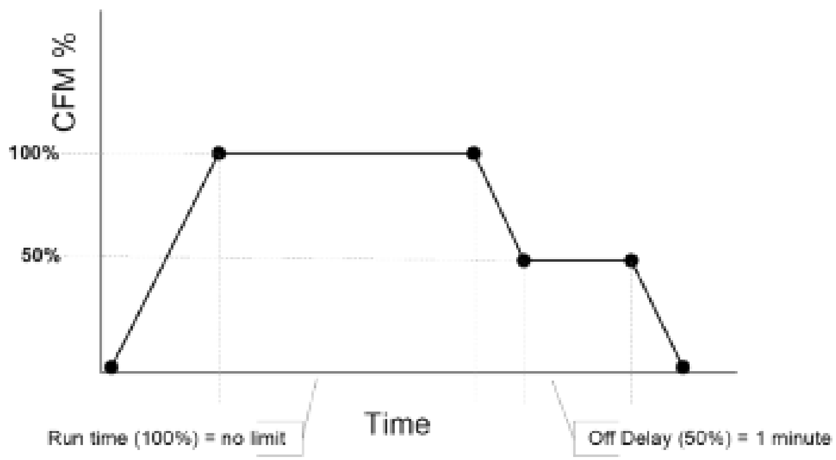
“B” Humid

The Humid profile is designed to offer the greatest dehumidification of the four profiles.



“C” Temperate

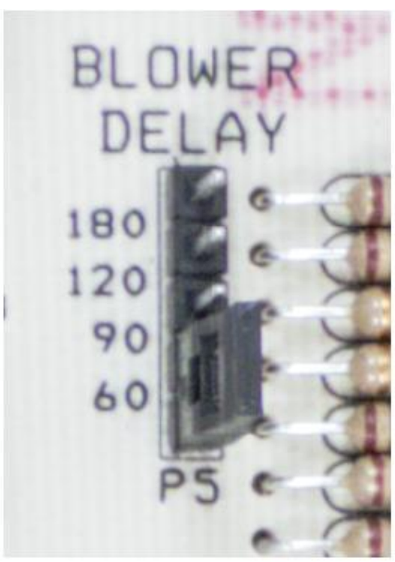
The Temperate profile offers dehumidification that falls between the Normal and Humid profiles.



“D” Arid

Applications in arid climates typically do not have dehumidification requirements. The Dry profile maximizes sensible cooling.

Heat Blower Off Delay

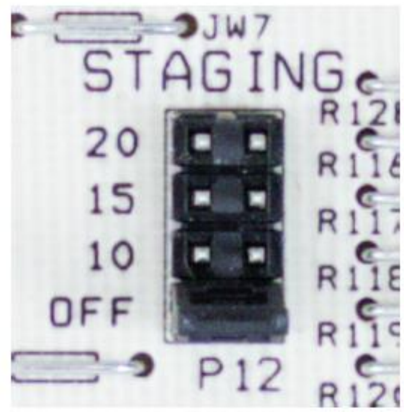


The BLOWER DELAY adjustment establishes the heating mode heating blower off delay. The positions are labeled 60, 90, 120 and 180. A jumper not connected in any of the four positions defaults to the 120 position. The control is shipped from the jumper in the 60 position.

Two Stage Heat Delay
Two Stage Units Only

Two-stage units may be applied with a single stage heating thermostat. In such applications, high fire is enabled a few minutes after low fire – assuming the heat call remains on W1. The time is selected by moving the Staging jumper from OFF to either 10, 15, or 20 minutes. If the jumper is left in the OFF configuration, high fire operations will not be enabled.

For more information, refer to the Sequence of Operation – Two Stage section.



Temperature Rise

Overview

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.

Temperature Rise on Two Stage System Rating 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. The supply and return air temperatures should be measured as close to the package unit as possible without being in direct view of the heat exchanger. If the readings are taken in the direct line of sight to the heat exchanger, the temperature will be of the radiant heat generated rather than the air temperature entering or leaving the unit.

Example:	Supply air dry bulb	115ºF
	Return air dry bulb	-70ºF
	=Temperature Rise	= 45ºFΔT – Rise

In single and two stage systems, the heating mode temperature rise must reside within the allowable range on the system rating plate.

Single Stage Systems

On a single stage system to lower the temperature rise, select a higher blower speed for the W speed tap. Selecting a lower blower speed for the W speed tap will increase temperature rise.

Two Stage Systems

Measuring temperature rise on a two-stage system requires an additional step. Always measure the temperature rise with the system operating at high fire (2nd stage energized). Once the high fire temperature rise is confirmed acceptable, the lower fire (1st stage) temperature rise must be validated. If the low fire temperature rise is not acceptable, it will be necessary to select a different airflow, re-evaluate high fire, and low fire temperature rise.

Changing the temperature rise on a two-stage system requires moving the HEAT jumper. The "A" setting offers the most airflow which results in the least temperature rise. The D setting offers the least airflow which results in the most temperature rise. Always verify the lower fire (1st stage) temperature rise is acceptable before finalizing the process.

Temperature Drop

A package unit with proper airflow established and the nameplate refrigerant charge will have an 18°F to 20°F temperature drop across the evaporator 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	75ºF
	Supply air dry bulb	-55ºF
	=Temperature Drop	=20ºFΔT - Drop

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

The measured temperature drop should remain consistent on two stage cooling as the cooling blower speed is reduced to approximately 63% of the selected COOL speed and the first stage compressor operation is reduced to approximately 67% of full capacity.

Heating Mode Airflow Calculation

$$\text{Formula:} \quad \frac{\text{BTU Output}}{1.08 \times \text{Temp Rise}} = \text{CFM}$$

This formula provides a means of evaluating the CFM produced during heating. The CFM formula requires the BTU output from the heating unit and a temperature rise measurement across the heating section.

First, verify the BTU content of the fuel supplying the equipment. The BTU content may vary depending on the production of the natural gas and is verified by contacting the local utility.

In this example, the BTU content of the fuel is 1030 BTU per cubic foot for natural gas. If the gas heating unit has a BTU input rating of 60,000 BTU/H and has an 80% Annual Fuel Utilization Efficiency (AFUE) rating, the unit would have a 48,000 BTU/H output.

Formula: 60,000 Input X .80 = 48,000 BTU/H Output

In this example, if the BTU/H output is 48,000 and the unit has 45°FΔT (Temperature Rise), the formula indicates an airflow of 987.65 CFM.

$$60{,}000 \times .80 = \frac{48{,}000 \text{ BTU/H Output}}{1.08 \times 45^{\circ}\text{F}\Delta\text{T} = 48.6} = 987.65 \text{ CFM}$$

Calculating Gas Heat Input (Clocking the Meter)

When clocking the gas meter:

- All other gas appliances must be in the OFF position to calculate the exact input to the heater.
- The unit must be fired at full capacity (high fire).
- Log the cubic feet of gas utilized in 6 minutes of operation. Keep in mind, 6 minutes if $1/10^{th}$ of one hour.
- Multiply the cubic feet of gas by 10.

If the unit uses 5 cubic feet of gas in $1/10^{th}$ of one hour, the 5 cubic feet is multiplied by 10. This indicates an input of 50 cubic feet of gas in one hour.

10
x 5
= 50 cubic feet per hour input

- Multiply the BTU content of the fuel by the cubic feet per hour.

If the BTU content was verified to be 1030 BTU per cubic foot, the 1030 BTU per cubic foot is multiplied by the 50 cubic feet input per hour.

1030
x 50
= 51,500 BTU/H Input

This indicates a 51,500 BTU/H input to the unit.

- Multiply the BTU/H input by the AFUE rating.

If this unit had an AFUE rating of 80%, the output would be approximately 41,200 BTU/H.

51,500
x .80
= 41,200 BTU/H Output

Total Amperes

The total amperes are measured and recorded when the unit has been operating in the cooling mode for at least 10 minutes. The total amperes are measured either at the equipment electrical disconnect or the package unit's contactor.

Once the unit has been operating at full capacity for approximately 10 minutes, the amp draw can be measured and recorded on the startup sheet. The current for each leg of power should be close to the run load amps (RLA) or full load amps (FLA) rating on the equipment rating plate.

Table 5: Electrical Data

Model	Voltage	Compressor			Outdoor Fan Motor	Indoor Fan Blower Motor	MCA[1] (Amps)	Max Fuse[2]/ Breaker[3] Size (Amps)
		RLA	LRA	MCC	FLA	FLA		
24050	208/230-1-60	8.7	45.0	14.4	1.3	2.6	14.8	20
24075	208/230-1-60	8.7	45.0	14.4	1.3	3.8	16.0	20
30050	208/230-1-60	9.8	57.0	15.1	1.3	2.6	16.2	25
30075	208/230-1-60	9.8	57.0	15.1	1.3	3.8	17.4	25
36050, 36075	208/230-1-60	13.0	78.0	23.0	1.3	3.8	21.4	30
36100	208/230-1-60	13.0	78.0	23.0	1.3	5.4	23.0	35
42075, 42100	208/230-1-60	17.9	112.0	28.0	1.3	5.4	29.1	45
48065, 48100, 48125	208/230-1-60	21.8	117.0	34.0	1.7	5.4	34.4	50
60065, 60100, 60125	208/230-1-60	24.4	144.2	38.0	1.7	7.0	39.2	60

1. Minimum Circuit Ampacity.
2. Maximum Over Current Protection per standard UL 1995.
3. Fuse or HACR circuit breaker size installed at factory or field installed.

Sample Electrical Data from Installation Manual

If the equipment is operating under light load conditions, the amp draw may be lower than the (RLA) or (FLA) shown in the unit specifications and rating plate.

Gas Pipe Leak Testing

When the system has been installed to the Installation Manual specifications and all local, city, state and federal codes, the gas piping must be tested for leaks as described in the Installation Manual provided with the equipment.

Check all the pipe joints, gas valve connections and manual valve connections for leakage. Only approved gas leak testing equipment and non-corrosive leak detection solvents shall be used.

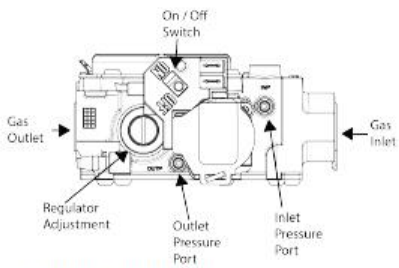
If a leak is detected, the unit should be locked out including the electrical power and gas supplying the unit and the leak repaired before any further start-up is completed.

Caution
Do NOT use a match, cigarette lighter, or other open flame when leak checking

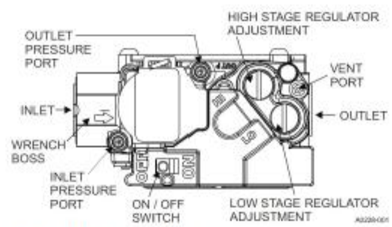
Gas Line Pressure Measurement

Incoming gas pressure (line pressure) is measured on the inlet side of the gas valve. Line pressure supplying fuel to the gas valve should be between 4.5” w.c. and 10.5” w.c. for natural gas and between 11” w.c. and 14” w.c. for propane (LP (Low Pressure)) gas.

When measuring supply line pressure, all other gas appliances in the structure should be turned on to ensure that line pressure does not drop too low when the other appliances are in operation.



Single Stage Gas Valve



Two-Stage Gas Valve

The process for determining the inlet gas pressure for single and two-stage gas valves is the same. The process is outlined below with unique differences between the valve styles noted.

- Disconnect power and turn off the manual gas shut off valve in the gas line supplying the package unit.
- Using a 3/32” hex wrench (Allen wrench) opens the Inlet Pressure Port on one full turn counterclockwise.
    - Do NOT remove the screw.
- Connect a manometer hose over the port.
- Reapply power and open the manual gas shut off valve.
    - It is necessary to operate all other gas fired appliances in the building at 100% fire during testing. This will ensure adequate gas pressure will always be applied to the unit.
- Operate the unit at full fire (2nd stage heat for two-stage systems).
    - If the line pressure is not within the required range as indicated in the installation manual or the above text, a problem with the gas supply and/or pipe sizing may be indicated and must be corrected.
    - If the line pressure is within the required pressure range, it is time to verify the gas manifold pressure.
- With the test complete, cycle the heat off.
- Disconnect power and close the manual gas valve inlet line shut off valve.
- Remove the manometer hosing.
- Using a 3/32” hex wrench closes the Inlet Pressure Port by turning the screw clockwise.
- Reapply power and open the manual gas shut off valve.
- Cycle unit to confirm operation.

Manifold Pressure Verification and Adjustments

Overview

Setting the proper burner manifold pressure is essential to ensure proper heat operation. Before attempting to set the manifold pressure, the gas inlet pressure must first be confirmed. Refer to the Gas Line Pressure Measurement section of this guide for detailed instructions.

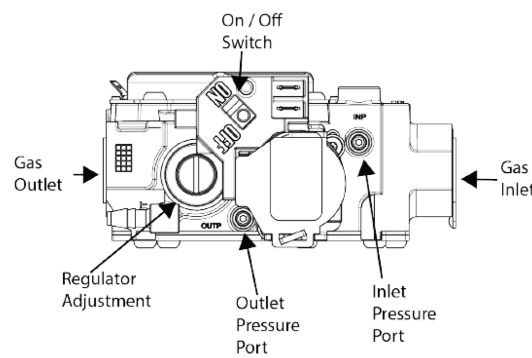
The gas valve must have a minimum of 4.5” w.c. for natural gas and 11” w.c. for propane (LP) available at the inlet of the gas valve and should not exceed an inlet pressure of ½ PSI. If the inlet fuel pressure is not sufficient or exceeds the maximum ½ PSI inlet pressure, the local utility should be notified, or a regulator must be installed.

Note
All Unitary Products residential gas electric package units are shipped for use with natural gas. If LP gas use if required, the appropriate LP gas conversion kit must be installed prior to furnace operation.

Single Stage Gas Valve

The outlet manifold pressure must be set to 3.5” w.c. for natural gas and 10” w.c. for propane as measured at the outlet manifold pressure tap. Measuring and setting the manifold pressure is as follows:

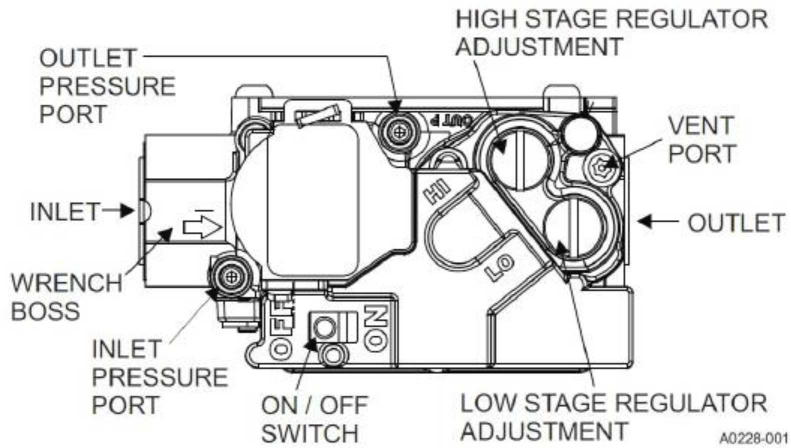
- Disconnect power to the unit.
- Using a 3/32” hex wrench (Allen wrench) opens the Outlet Pressure Port one full turn counterclockwise.
  - Do not remove the screw.
- Place a connected manometer hose over the port.
- Reapply power and operate the heat while measuring the manifold (outlet) gas pressure with a manometer.
- If adjustment is necessary, remove the Regulator Adjustment cap.
  - Using a thin screwdriver, turn the adjustment screw clockwise to increase the pressure. Turn the screw counterclockwise to lower the pressure.
  - It is recommended to replace the adjustment cap to determine to what extent cap installation impacts the pressure.
- Once testing and adjustment are complete, cycle the furnace section off.
- Disconnect power, remove the manometer hose, and replace the Regulator Adjustment cap, if necessary.
- Tighten Outlet Pressure Port screw using a 3/32” hex wrench turning the screw clockwise.
  - Do not overtighten.
- Restore power and verify operation.



Single Stage Gas Valve

Two Stage Gas Valve

The process for measuring and adjusting a two-stage gas valve requires a few more steps than a single stage gas valve. However, the process remains the same. High and low fire pressures are adjusted independently based on the information in the tables below.



- Disconnect power to the unit.
- Using a 3/32” hex wrench (Allen wrench) opens the Outlet Pressure Port one full turn counterclockwise.
  - Do not remove the screw.
- Place a connected manometer hose over the port.
- Reapply power and operate the heat on 1st stage (low fire) while measuring the manifold (outlet) gas pressure with a manometer.
- If adjustment is necessary, remove the Low Stage Regulator Adjustment cap.
  - Using a thin screwdriver, turn the adjustment screw clockwise to increase the pressure. Turn the screw counterclockwise to lower the pressure.
  - It is recommended to replace the adjustment cap to determine to what extent cap installation impacts the pressure.
- Operate the system on 2nd stage (high fire) while measuring the manifold (outlet) gas pressure with a manometer.
- If adjustment is necessary, remove the High Stage Regulator Adjustment cap.
  - Using a thin screwdriver, turn the adjustment screw clockwise to increase the pressure. Turn the screw counterclockwise to lower the pressure.
  - It is recommended to replace the adjustment cap to determine to what extent cap installation impacts the pressure.
- Once testing and adjustment are complete, cycle the furnace section off.
- Disconnect power, remove the manometer hose, and replace the Regulator Adjustment cap, if necessary.
- Tighten Outlet Pressure Port screw using 3/32” hex wrench turning the screw clockwise.
  - Do not over tighten.
- Restore power and verify operation.

Two Stage Nominal Manifold Pressure

The following manifold pressure (gas valve outlet) values are required during heating operation. The manifold gas pressure must ALWAYS be properly set up during furnace installation and verified during service.

These values may vary slightly depending on the altitude of the area the furnace is installed in and/or the BTU/cubic foot value of the gas used. The exact value for these conditions may be found in this guide and the furnace Installation Manual.

High Fire Manifold Pressures (in w.c.)

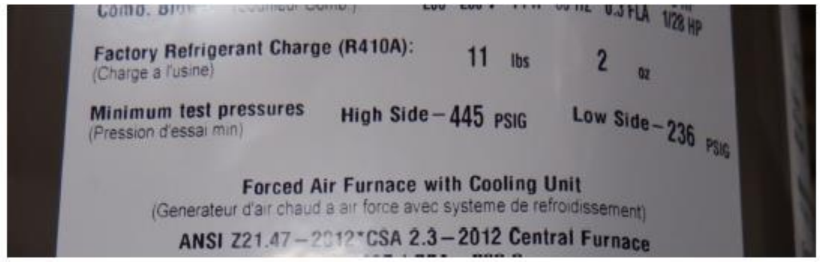
Heating Value (BTU/cu ft.)	0-7999	8000-8999	9000-9999
800	3.5	3.5	3.5
850	3.5	3.5	3.5
900	3.5	3.5	3.5
950	3.5	3.5	3.3
1000	3.5	3.2	2.9
1050	3.5	2.9	2.7
1100	3.2	2.7	2.4
2500 (LP)	9.8	8.2	7.5

Low Fire Manifold Pressures (in w.c.)

Heating Value (BTU/cu ft.)	0-7999	8000-8999	9000-9999
800	1.7	1.7	1.7
850	1.7	1.7	1.7
900	1.7	1.7	1.7
950	1.7	1.7	1.5
1000	1.6	1.5	1.4
1050	1.5	1.4	1.3
1100	1.3	1.2	1.1
2500 (LP)	4.1	3.8	3.5

Refrigerant Charging

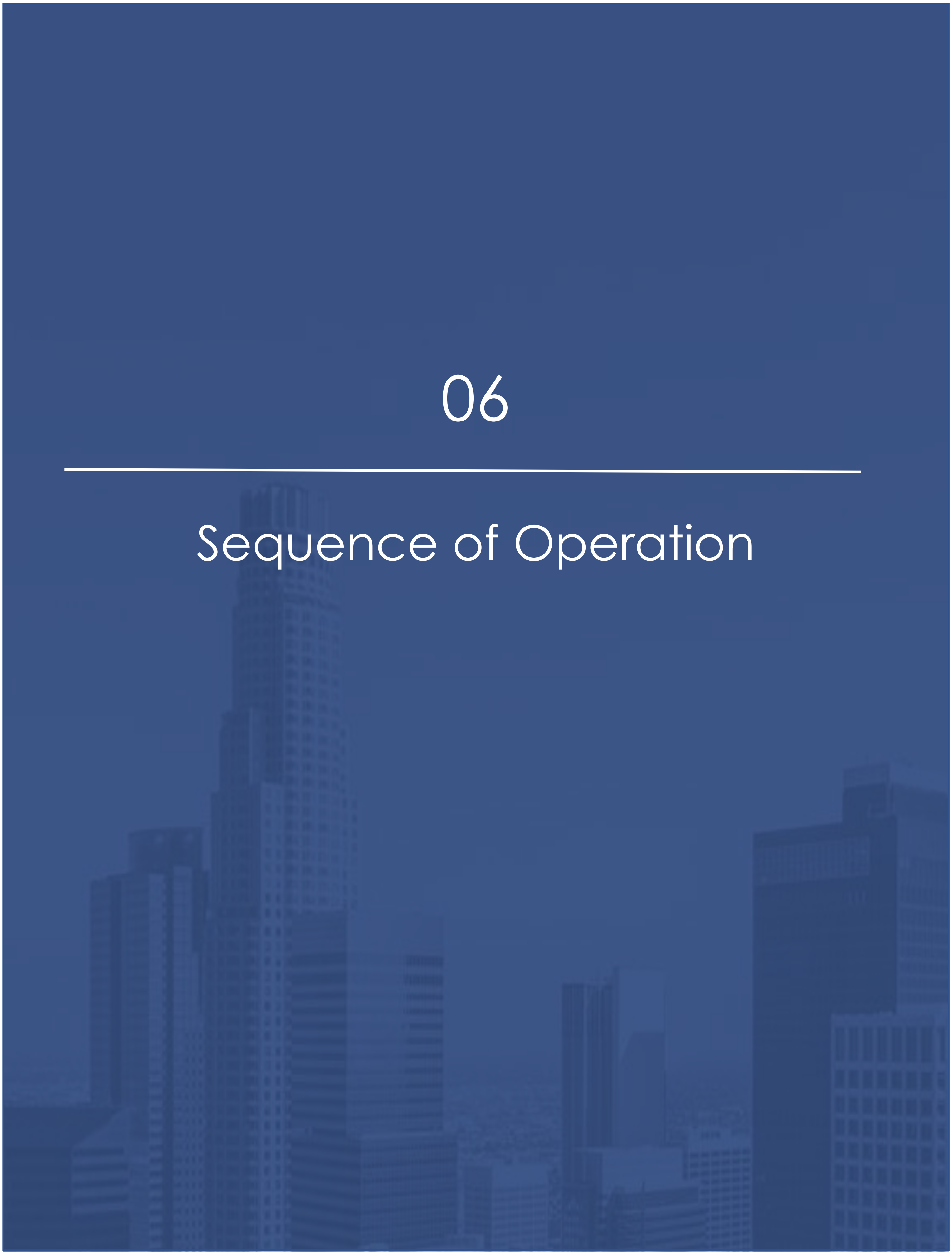
Package equipment is pre-charged during production with the correct amount of refrigerant. Additional refrigerant is not required except in the instance of a refrigerant leak or refrigerant component replacement. However, it is strongly recommended to verify the refrigerant charge and system operation at installation. Accurate charging on package systems is best conducted by weighing in the exact charge as indicated on the unit data plate.



Rating Plate: Refrigerant Charge Data

Important Note
Before attempting to evaluate the refrigerant charge, the correct indoor airflow must be set and confirmed.

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 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 before entering the suction side of the compressor.



06

Sequence of Operation

Single Stage Systems

Power Up

Upon initial power up, or power up following a power loss, the control performs a self-check routine. During this time, the Status LED (Light Emitting Diode) display is a solid green.

Standby Mode

When there is no demand from the thermostat for fan, cool, or heat operation, the control is in Standby Mode. In this mode, all outputs are de-energized until a thermostat call. In standby, the control continually monitors all thermostat inputs, and the Status LED will flash a green heartbeat – 2 seconds on/2 seconds off.

Fan Only Operation

When there is a thermostat demand for fan only operation G, the control will immediately energize the G Speed terminal with 24 VAC. When the fan only operation is removed, the G Speed terminal is immediately de-energized. If a call for heating is sent to the control during continuous fan operation, the control continues to energize the G Speed output if the G call is present.

Cooling Operation

The control energizes the YSPD with 24 VAC one second after receiving a thermostat call for cooling (Y or Y+G without W). When the demand for cooling is removed, the control continues to energize the Y SPD output for 60 seconds, which is the Off Delay period. If a Y call is received without a G call, the control energizes the Y SPD output and displays a 4 amber flash code, indicating a Y call is present without a G call.

Heating Operation

Upon receiving a thermostat call for heating W is energized; the heating sequence is as follows:

- After one second, the microprocessor runs a self-check routine.
- If a fault condition exists, the control will display the appropriate codes on the Status LED. The heating sequence is halted until the fault condition is resolved.
- The control confirms the limit circuit is closed, verifies the gas valve is closed, and the pressure switch is open.
- The control energizes the inducer motor.
- The control monitors the pressure switch, checks for it to close.
    - If the pressure switch does not close within 5 seconds, the control displays a 3-flash code on the LED and continues to energize the inducer.
    - If the pressure switch does not close within 60 seconds, the control cycles the inducer off for 60 seconds. During which time, the 3-flash code is displayed. After 60 seconds the control restarts the ignition sequence, a call for heating remains.
- Once the pressure switch is detected as closed, the control starts a 15 second pre-purge.
- Following the pre-purge, a trial for ignition is initiated. The gas valve and spark igniter are simultaneously energized for 5 seconds. After 5 seconds the igniter is de-energized.
- Burner ignition is verified by the flame sensor detecting a valid micro amp (>0.5) signal for 2 seconds.

    - If a valid flame signal is not detected, the gas valve is de-energized, and the ignition sequence restarted following an additional pre-purge sequence.
    - After 3 failed ignition attempts the control energizes the inducer for 15 seconds, displays a 7 red flash code, and enters a Soft Lockout.
- The W SPD terminal is energized with 24 VAC 30 seconds after the gas valve is energized.
- Furnace operations remain until the call for heating is removed. Once the heating call is removed, the unit commences a shutdown sequence.
    - The gas valve is de-energized immediately.
    - The inducer motor is de-energized after a 15 second post-purge.
    - The blower W Speed terminal is de-energized following the blower off delay.
        - The blow off delay is field selectable – 60, 90, 120 or 180 seconds.
- Following shut down the control returns to standby mode, if there are no other thermostat calls, such as cooling.

Pressure Switch Opening Mid-Cycle

If the pressure switch opens for less than 2 seconds, the gas valve is momentarily de-energized. This will likely cause a flame loss – interrupting the heating cycle. If the flame is lost, the control will respond as if the pressure switch opened.

If the control detects the low pressure switch open for more than 2 seconds or a flame loss outlined above, it will execute the following steps.

- Continues to energize the main blower for the blower off time.
- Restart the ignition process at the switch proving sequence.
- De-energize the gas valve.

Multiple Pressure Switch Openings During Single Call for Heat

The control counts the number of pressure switch openings during a single call for heating. If five pressure switch openings occur during a single call for heating the unit will enter a soft lockout and display a fault code. During this time, the blower will continue to operate.

Flame Loss Mid-Cycle

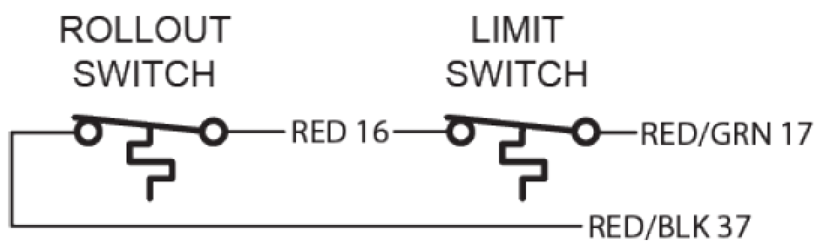
If the control detects a loss of flame, it will execute the following steps:

- De-energizes the gas valve.
- Energizes the inducer motor.
- Continue operating the blower.
- Initiate another ignition cycle at the switch proving sequence.

If flame is lost 5 times during a single heating call, the unit will enter a soft lockout.

Limit Circuits

- The image below shows the rollout and main limit circuit. Note that the limits are in series.
- System response to an open circuit is time dependent.
  - The main limit will automatically reset.
- The rollout limit is a manual reset.
- If the circuit is open for an extended time, it is assumed the rollout limit has opened.



Limit Circuit

Multiple Limit Openings During Single Call for Furnace Heating

If the control detects that the limit circuit has opened 5 times during a single call for heating, the furnace will perform the following operations:

- Energize the inducer if the limit is open, then perform a post-purge.
- Energize the blower if the limit is open, then run a Heat Off-Delay.
- Display a 4 Red Flash code.
- Store the Fault Code in memory.
- Enter Soft Lockout.

Two Stage Systems

Power Up

Upon initial power up, or power up following a power loss, the control performs a self-check routine. During this time, the Status LED display is solid green.

Standby Mode

When there is no demand from the thermostat for fan, cool, or heat operation, the control is in Standby Mode. In this mode, all outputs are de-energized until a thermostat call. In standby, the control continually monitors all thermostat inputs, and the Status LED will flash a green heartbeat – 2 seconds on/2 seconds off.

Fan Only Operation

When there is a thermostat demand for fan only operation G, the control immediately energizes the Enhanced ECM (Electronically Commutated Motors) motor with the associated G signal from the PWM (Pulse Width Modulation) COM and PWM terminals. If a demand for furnace heating is sent to the control during continuous fan operation, the control shall continue to energize the G PWM signal during the warm-up period and then ramp to the W/W1 or W2 PWM signal. When a furnace heating signal is removed, the control resumes the G PWM signal following the blower off delay.

When the thermostat demand for fan only operation is removed, the control immediately de-energizes the G PWM signal output.

PWM Values
PWM values for various system modes are in the Appendix section of this guide.

First Stage Cooling Operation

When there is a thermostat demand for first stage compressor operation (Y1 or Y1+G without W), after one second, the control sends the associated PWM signal to the motor. The 1st stage control circuit to the compressor contactor is energized through the high pressure and loss of charge switches.

When the thermostat demand for compressor operation is removed, the compressor contactor is de-energized. The Y1 PWM output remains energized for a 60 second off delay.

If the control senses call for Y1 without G, it continues to output the associated Y1 PWM and displays a 4 amber flash code, indicating the Y1 call without a G call.

Second Stage Cooling Operation

Where there is a thermostat demand for second stage compressor operation (Y1+Y2 or Y1+Y2+G without W), after one second, the control supplies the associate Y2 PWM signal to the motor. Y1 directly energizes the circuit containing the high-pressure switch, loss of charge switch, and the contactor coil. When the contactor coil is energized, Y1 power is sent to the compressor and outdoor fan motor. Y2 directly energizes the compressor solenoid 1 second following Y1 energizing the contactor. Energizing the solenoid closes the compressor bypass ports and allows operation at 100% capacity.

When the thermostat demand for compressor operation is removed, the compressor contactor is de-energized. The Y2 PWM output remains energized for a 60 second off delay.

If the control senses a cooling call (Y) without a G input output the associated Y2 PWM is sent and displays a 4 amber flash code, which indicates a Y call without a G call. The compressor will not operate without a Y1 call.

Transition Between Cooling Stages

A Y1 thermostat call is necessary to energize the compressor contactor. The compressor starts and runs at full speed. Capacity control is accomplished by a solenoid closing the bypass ports. The Y2 circuit only powers the internal solenoid. The compressor transitions between 67% and 100% capacity based on the Y2 circuit being energized. When transitioning the compressor continues to operate.

Heating Operation

Upon receiving a thermostat call for heating on W1 or W1 and W2, the heating sequence is as following:

- If a W2 call is detected without a W1 call, the control remains in Standby mode without setting a fault code.
- After one second, the microprocessor runs a self-check routine.
- If a fault condition exists, the control will display the appropriate codes on the Status LED. The heating sequence is halted until the fault condition is resolved.
- The control confirms the limit circuit is closed, verifies the gas valve is closed, and the pressure switch is open.
- The control energizes the inducer motor at high speed.
- The control monitors the pressure switch, checks for it to close.
    - If the pressure switch does not close within 5 seconds, the control displays the 3-flash code on the LED and continues to energize the inducer.
    - If the pressure switch does not close within 60 seconds, the control cycles the inducer off for 60 seconds. During which time, the 3-flash code is displayed. After 60 seconds the control restarts the ignition sequence if a call for heating remains.
- Once the pressure switch is detected as closed, the control starts a 15 second pre-purge.
- Following a pre-purge, a burner ignition attempt is made. The gas valve and spark igniter are energized simultaneously. The gas valve is energized at 100% firing rate.
- After 5 seconds, the igniter is de-energized.
- Burner ignition is verified by the flame sensor detecting a valid micro amp (>0.5) signal for 2 seconds.
    - If a valid flame signal is not detected, the gas valve is de-energized, and the ignition sequence restarted following an additional pre-purge sequence.
    - After 3 failed ignition attempts the control energizes the inducer for 15 seconds, displays a 7 red flash code, and enters a Soft Lockout.
- If the control senses flame, it continues to energize the gas valve and inducer, and initiate a 0 second heat blower on delay.
- If only W1 call:
    - After 10 seconds of gas valve operation the unit will shift to low fire operation. The burner shifts to low fire rate, low speed inducer, and low blower operation associated with W1 speed.
- If W1 and W2 call:
    - The system remains at 100% furnace operation until the W2 call is removed.
    - During 100% operation the gas valve is energized at 00%, the inducer is powered at high speed, and the blower operates at the speed associated with W2.
- The unit transitions up by changing the inducer speed to high, energizing the second stage on the gas valve, and ramping the blower to the speed associated with W2.
- The unit transitions from W1 & W2 call to only W1 call in the follow manner:
    - De-energizing the gas valve second stage. The first stage remains.
    - Shifting inducer speed from high to low.
    - 30 following the removal of W2, the blower ramps to the speed associated with W1.
- Furnace operations remains until the W1 thermostat call is removed. Once the thermostat call is removed the unit commences a shutdown process.
    - Gas valve is de-energized immediately (both stages)

- The inducer operates for 15 seconds.
- The blower continues to operate for the blower off cycles at the speed associated to the last call. For example, if W1 and W2 call were energized and the call for both removed, the blower will operate at the W2 speed for the blower off time. The blower off time is based on that selected during unit commissioning.

Two-Stage Heat w/Single Stage Thermostat

Unique to two-stage heating systems is the ability to provide two-stage heating with a single stage thermostat. The Staging jumper is used to set the time (seconds) between low fire and high fire operations.

When a heating call is received on W1, the heat section will ignite normally. The heating will operate on low fire until the time set at the Staging time has expired. Once the time has elapsed, the unit will transition to high fire operation.

If system is applied with a two-stage thermostat, and W2 is energized during the staging time, the heat operations is automatically transferred to high fire – regardless of time elapsed.

- If the jumper remains in the OFF position, the unit will not transition to high fire operation.
- If the jumper is missing, the control default is OFF.

Pressure Switch Open Mid-Cycle

If the pressure switch opens for less than 2 seconds, the gas value is momentarily de-energized. This will likely cause a flame loss – interrupting the heating cycle. If the flame is lost, the control will respond as if the pressure switch opened.

If the control detects the lower pressure switch open for more than 2 seconds or a flame loss outlined above, it will execute the following steps:

- De-energize the gas valve.
- Continue to energize the main blower for the blower off time.
- Restart the ignition process at the switch proving sequence.

Flame Loss Mid-Cycle

If the control detects a loss of flame, it will execute the following steps:

- De-energizes the gas valve.
- Energizes the inducer motor.
- Continue operating the blower.
- Initiate another ignition cycle at the switch proving sequence.

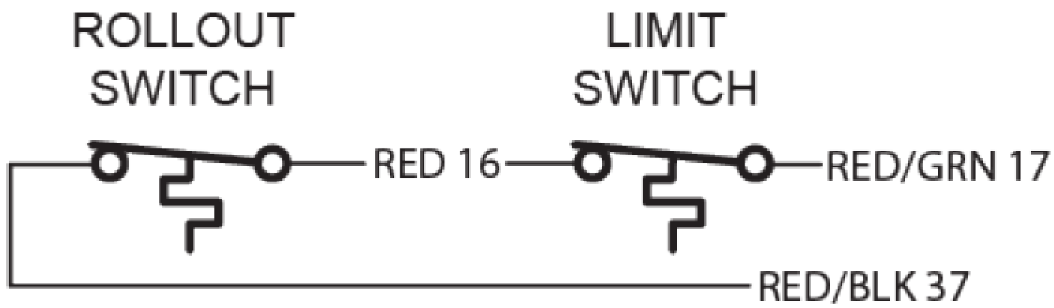
If flame is lost 5 times during a single heating call, the unit will enter a soft lockout.

Multiple Pressure Switch Openings During Single Call for Heat

The control counts the number of pressure switch openings during a single call for heating. If five pressure switch openings occur during a single call for heating the unit will enter a soft lockout and display a fault code. During this time, the blower will continue to operate.

Limit Circuit

- The image below shows the rollout and main limit circuit. Note that the limits are in series.
- System response to an open circuit is time dependent.
- The main limit will automatically reset.
- The rollout limit is a manual reset.
- If the circuit is open for an extended time, it is assumed the rollout limit has opened.



Limit Circuit

Multiple Limit Openings During Single Call for Furnace Heating

If the control detects that the limit circuit has opened 5 times during a single call for heating, the furnace performs the following operations:

- Energize the inducer if the limit is open, then perform a post-purge.
- Energize the blower if the limit is open, then run a Heat Off Delay.
- Display a 4 Red Flash code.
- Enter Soft Lockout.

Lockout – Single and Two Stage Systems

Overview

A lockout condition is implemented due to an undesirable operating condition in heating mode. Soft lockouts are considered performance issues and will permit the system to attempt additional ignition attempts after an hour.

Hard lockouts are considered a series of issues. The system will not attempt to re-ignite until the fault is manually cleared. Both conditions are discussed below. The information applies equally to single and two-stage systems.

Soft Lockout

Soft lockout is the result of repeated fault occurrences. The faults are:

- Pressure switch opening 5 times during a single heating call.
- Three failed ignition attempts.
- Five loss of flame events during a single heating call.
- Limit circuit opening 5 times during a single heating call.
- Gas valve fault.

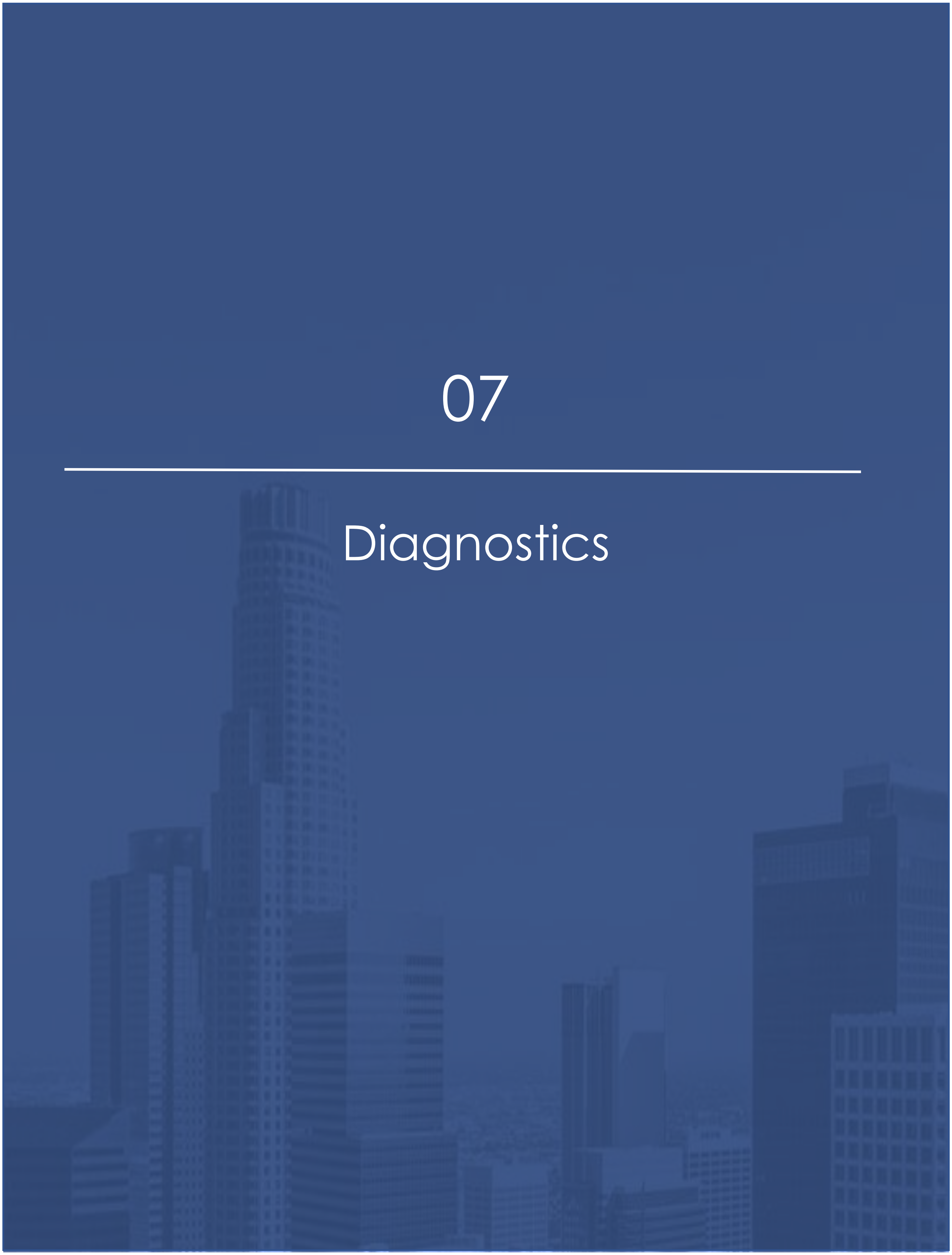
During soft lockout, the heating system cycles off for an hour. The appropriate fault code is displayed. The control will continue to monitor and react to flame, limit, and gas valve operations. During this time fan only and cooling operations are permitted. Soft lockout is cleared by cycling power to the control, cycling all thermostat demands, or allowing the 1-hour timer to expire.

Hard Lockout

A hard lockout is like a soft lockout in that all heating operations are stopped. However, cooling and fan only operations are permitted. A hard lockout is entered when:

- The limit circuit is open > 5 minutes (high limit)
- The limit circuit is open > 15 minutes (roll out limit)
- Runaway flame.
- Gas valve fault.

Any of the above conditions is a serious matter that should be investigated and addressed by a qualified technician. Thus, clearing a hard lockout requires human intervention. A hard lockout is only cleared by cycling power to the control.



07

Diagnostics

Diagnostic Codes

Overview

The control displays operational and fault codes on the Status LED (Light Emitting Diode). Operational codes, also known as heartbeat codes, flash at a rate of 2 seconds on followed by 2 seconds Off. Fault codes typically flash at a rate of 1/3 second on followed by 1/3 Off. Rapid flashing, 1/10 On followed by 1/10 second Off provides a combined fault and status information. The table below provides additional information.

Flash Rate	Type
2 seconds on followed by 2 Seconds Off	Heartbeat
1/3 Second On followed by 1/3 Second Off	Fault
1/10 Second on Followed by 1/10 Second Off	Combined

The codes may also be manually cleared by a technician. This process is discussed in the Fault Code History section.

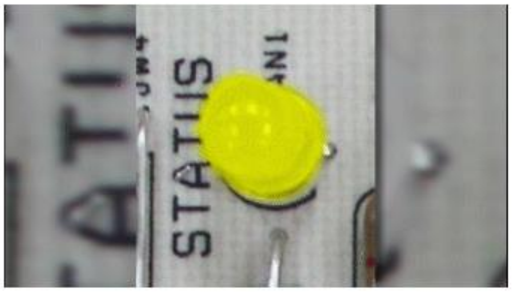
Description	Flash Code
Standby mode	Green Heartbeat
Call for furnace heat active	Amber Heartbeat
Call for cool active	Green Heartbeat
Call for fan active	Green Heartbeat
Control in Factory Test mode	Rapid Green Flash
Control failure	Red Solid
Low flame current	Rapid Amber Flash
Flame sensed with gas valve off (runaway flame)	1 Red Flash
Pressure switch closed with inducer off	2 Red Flashes
Pressure switch open with inducer on	3 Red Flashes
Limit/Rollout switch open <5 minutes	4 Red Flashes
Limit/Rollout switch open > 15 minutes	5 Red Flashes
Pressure switch cycle lockout	6 Red Flashes
Lockout due to failed ignition	7 Red Flashes
Lockout due to too many flame dropouts	8 Red Flashes
Gas valve fault code	10 Red Flashes
Limit/Rollout switch open between 5 and 15 minutes	1 Red Flashes
Model Plug Not Installed	12 Red Flashes
Incorrect line voltage polarity	9 Red Flashes
Y thermostat demand without a G	4 Amber Flashes

Control Fault

Red Solid

If the control detects a fault on the control board (including a fault within the microprocessor), it will immediately de-energize all outputs, ignore all inputs, display a Solid Red Fault code, and enter a 1-hour Hard Lockout. If possible, the control will reset itself after 1 hour to clear the fault.

Low Flame Current



Rapid Amber Flash

Less than .5 uA for more than 4.25 seconds after a successful ignition is considered low flame current. This code is unique in that heating operations are permitted unless the flame current is < 0.5 uA. Yet, this is a fault condition that requires addressing. The most common causes of this issue are poor grounding and/or a dirty flame sensor.

Flame Sensed with Gas Valve Off (Runaway Flame)

1 Red Flash

The occurrence of this fault is highly unlikely. The control board has detected flame current (>0.5 u) for 4 seconds after de-energizing the gas valve. If this condition occurs, it is assumed the gas valve has stuck open. The control will:

- Energize the inducer on high speed.
- Energize the blower on the speed designated for W2.

The unit will remain in this configuration until the flame is no longer detected. Once the flame is no longer detected, the unit will cycle off as described in the Heat Sequence of Operation section. A hard lockout is declared.

Pressure Switch Closed with Inducer Off

2 Red Flashes

The control monitors the pressure switch status at the beginning of a heating cycle. If the control detects the switch closed for longer than 5 seconds, prior to the energizing of the inducer motor, a 2 Red Flash fault code is displayed, and the ignition sequence stopped.

Once the pressure switch is detected to be open, the control will remove the fault code indication and proceed with a new ignition sequence, if the heating call remains.

Pressure Switch Open with Inducer On

3 Red Flashes

If the control detects that the pressure switch does not close during the first 15 seconds of the pressure proving sequence, a 3 Red LED flash is displayed. If the switch does not close within 60 seconds a soft lockout is declared.

Limit/Rollout Switch Circuit Open < 5 Minutes

4 Red Flashes

The main limit and rollout limit(s) are in series. Anytime this circuit opens heating operations are immediately cycled off. However, the inducer and blower motor remain powered to aid in cooling the heat exchanger. If the circuit is open <5 minutes), heating can resume.

Open Limit > 15 Minutes – Rollout Switch

5 Red Flashes

If the limit circuit is open for more than 15 minutes, it is assumed that a rollout switch has been opened. Since rollout switches require a manual reset, this is a hard lockout. The control will:

- Continue to energize the blower.
- Continue normal blower operation for compressor heating and cooling calls.
- Display a 5 Red Flash code.

Pressure Switch Cycle Lockout

6 Red Flashes

The control counts every time the vent pressure switch opens. If the switch opens 5 times during a single heating call, the 6 red flash code is displayed, and the unit enters a soft lockout.

Lockout Due to Failed Ignition

7 Red Flashes

After three failed ignition attempts the control will enter a soft lockout. The gas valve, igniter, and inducer are de-energized. The blower will continue to operate for the selected Blower Off delay.

Lockout Due to Too Many Flame Dropouts

8 Red Flashes

If 5 flame loses occurs after ignition is established during a single heating call, the heat cycles off as outlined in the sequence of operation. The unit enters a soft lockout.

Incorrect Line Voltage Polarity

9 Red Flashes

The control verifies that the 24 VAC power output (red wire) is in phase with the 208/230 VAC line output. The control also verifies that the 24 VAC Common (blue wire) does not show voltage with respect to earth ground. If the control detects a fault with the voltage connections, it will display a 9 Red Flash code, store the fault in memory, and stop all furnace heating operation. There is a 12 second delay prior to declaring a fault to allow time to confirm a polarity issue.

Gas Valve Fault Code

10 Red Flashes

The control always monitors the gas valve status. If the control detects that the gas valve is energized when it should not be for more than 1 second, the following occurs:

- De-energize the inducer to force open the pressure switch if flame is not present.
  - The vent pressure switch is in series with the gas valve. Opening the switch will de-energize the gas valve.
- If the appropriate heating speed is energized. It will run for the duration of the heating blower off delay.
- The unit enters a hard lockout.

If the control continues to sense that the gas valve has not de-energized 10 seconds after de-energizing the inducer motor or if flame is detected while the gas valve is energized when it should not be, it will re-energize the inducer to vent any unburned gas. The control will enter a hard lockout.

Limit Switch Open > 5, < 15 Minutes

11 Red Flashes

The main limit and rollout limit(s) are in series. Anytime this circuit opens heating operations are immediately cycled off. However, the inducer and blower motor remain powered to aid in cooling the heat exchanger.

If the circuit is open > 5 minutes but < 15 minutes, it is assumed the blower has failed. Once the limit resets or heating call removed, the heating call removed, heating operations will cycle off normally. The control enters a hard lockout.

Model Plug Not Inserted

12 Red Flashes

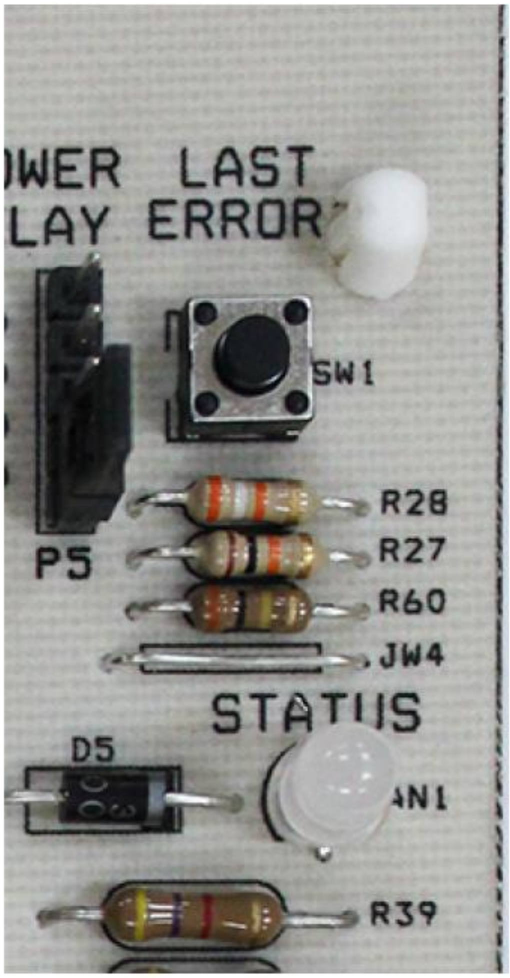
This is applicable only to the two-stage models. If the model data plug is not inserted, the unit will not permit any operation.

Y1 or Y2 Thermostat Demand without G

4 Amber Flashes

The control has received a Y and/or a Y2 thermostat call without a G call. Typically, a thermostat will send a G call with the Y1 call. When this fault occurs, the unit is still permitted to operate. However, the reason a G call was not received should be investigated and resolved.

Fault Code History



Up to 5 fault codes are stored in the buffer for 30 days, unless manually cleared. With no thermostat calls, the codes are accessed by depressing the LAST ERROR button of more than 1/5 of a second, but less than 5 seconds. The control will ignore the LAST ERROR push button during any mode except for Standby mode.

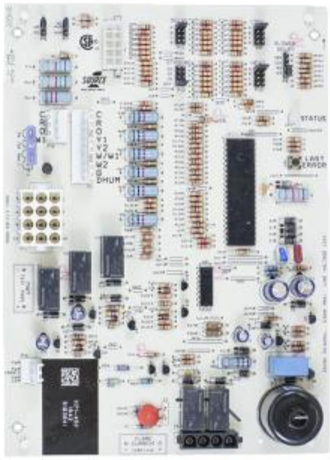
The control will sequentially flash any error codes with the most recent. There will be a 2-second delay between error codes. If there are no error codes stored in memory, the LED will give a 2 Green Flash code.

The series may be repeated by pressing LAST ERROR push button 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 resumes.

If the LAST ERROR push button is pressed for longer than 5 seconds, the control will immediately clear the stored error code array and flash the green LED 3 times to indicate that the error memory has been cleared.

Two Stage Control Board Replacement

In the unlikely event, the control board fails, replacement is straightforward. Inserted in the control is the model plug. When replacing the control, reusing the model plug is recommended. The replacement control is shipped with several model plugs. If you are not reusing the original plug, use the included instructions to select the appropriate model plug.



Two-Stage Control Board

Single Model Plug

Model Plug Package

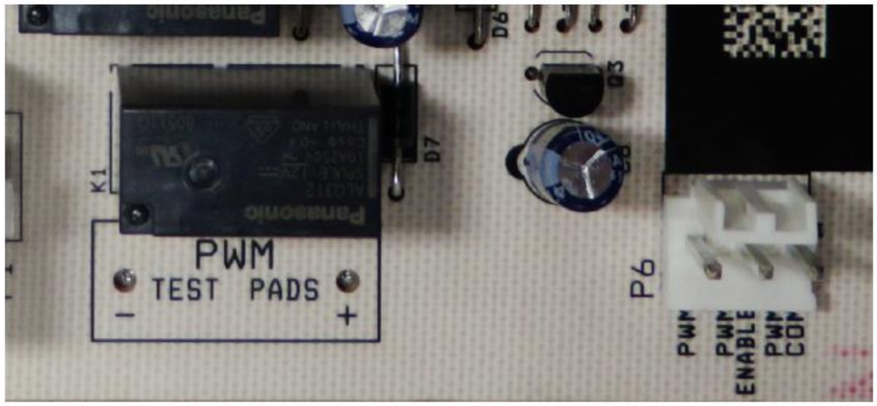
Blower Motor PWM (Pulse Width Modulation)

Two-Stage Models

The blower motor Pulse Width Modulated (PWM) values are measurable at the PWM Test Pads on the system control board. The expected and measured values are based on the system mode and unit configuration. These values are measurable with a multimeter capable of reading frequency %, or Duty Cycle.

The PWM signal is an 80Hz, +20VDC modulated signal. The PWM common is not tied to the (24 volts AC) common terminals on the board. The motor does not require the PWM Enable and is not used now.

The expected values for various models and system modes are illustrated in the Appendix section of this guide.



PWM Test Pads and Motor Connections on the Two Stage Control

Flame Signal

The test procedure outlined below requires working with energized electrical circuits and burner firing. This test should only be conducted by qualified technicians.

Two test pinpoints on the control board identified as Flame Current allow the technician to confirm flame signal strength. Using a conventional voltmeter set on the VDC (Volts DC (Direct Current)) scale, with the burner firing place the negative meter lead on the negative (-) terminal and positive meter lead on the positive (+) terminal. Each volt displayed equates to one microamp.

- A reading of <0.5 VDC (0.5 uA) indicates at flame signal below the operating threshold.
  - Heating operation is not permitted.
- A reading >0.5 VDC (0.5uA) but <1.5VDC (1.5 uA) is considered a weak signal.
  - Heating operation is permitted, but a fault code is displayed.
- A reading >1.5 DC (1.5 uA) is considered normal.
  - A reading of 3 to 5 uA is typical. However, a reading of 7 uA or more is possible. Such a reading is not considered problematic.

Possible causes of a weak flame signal are:

- No equipment ground.
- Lose (floating) equipment ground.
- Contaminates sensor ceramic.
- Cracked sensor ceramic.
- Ground wire to flame sensor.

08

Maintenance

Introduction

Maintenance is crucial to proper system operation and meeting 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.

General Maintenance

It is recommended that the heating system is inspected once a year by a qualified service person. For proper and safe operation, the gas heating section needs air for combustion and ventilation.

Ensure that combustion air openings and spacing around the unit is not blocked or otherwise obstructed. Keep the area around the gas heating system clear and free of combustible materials, gasoline, and other flammable vapors and liquids.

Snow or debris should not be allowed to accumulate in or around the unit. Do not permit overhanging structures or shrubs to obstruct outdoor air discharge or vent outlet on the unit.

It is recommended that the cooling system be serviced annually by a qualified service technician to ensure optimal system performance.

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 thermostat for deterioration.

Return Air Filters

Return air filters must always be used 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.

Indoor Coil

The indoor coil absorbs heat from the conditioned space during cooling operation. It is essential that the coil's ability to transfer heat is not negatively impacted. Dirt accumulation on the coil will impede the coil's ability to absorb heat. The indoor coil can be kept clean with constantly changed return air filters.

In many cases the coil may appear clean, but dirt is lodged between the fins. 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 evaporator coil cleaners.

Note
If water or evaporator coil cleaners are being used, the unit should have supply voltage removed and proper lockout tagout procedures followed to prevent personal injury. The technician should read the Material Safety Data Sheets (MSDS) and wear the proper Personal Protective Devices (PPDs) before applying chemical cleaners.

Outdoor Coil

The outdoor coil rejects heat from the refrigerant during cooling operation and is used to 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.

Cleaning the outdoor coil annually as part of a routine maintenance program is encouraged. The coil should be cleaned according to the approved methods. Do not use traditional condenser coil clean with MicroChannel condenser coils.

Note
If water or condenser coil cleaners are being used, the unit should have supply voltage removed and proper lockout tagout 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 induced draft fan motor, outdoor fan motor, 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 to clean the blower wheel after removal of the motor.

Caution must be taken to lockout tagout the unit when evaluating the fan motors for cleanliness and excessive play or wear to the motors shaft assembly.

Natural Gas and Propane (LP – Low Pressure) Heating Systems

It is recommended that all heating systems have a maintenance inspection performed annually by a qualified service technician.

During the initial inspection, ensure all supply and return air registers are free of obstructions and in an open position.

The return air filters should be clean, and coils must have unrestricted airflow.

The combustion air vent should be visually inspected to ensure proper circulation through the heat exchanger. If excessive soot and dirt is present, clean the discharge of the stack assembly and inspect the burner assembly and heat exchanger.

Burners

Inshot burners do not have adjustable shutters. If the burners do not have proper flame and the manifold gas pressure is correct, the burners should be removed and cleaned.

The inshot burners have flame cross-over ports that allow the flame to transfer from one burner to the next. The cross-over ports must be kept clean to provide proper burner ignition. Cleaning the cross-over ports may be accomplished with a wire brush.

Heat Exchanger

The heat exchanger tubes should be visually inspected for defects or cracks in the tubing and cleaned if excessive soot, debris, or moisture is present.

If any cracks or splits are present within the tubing of the heat exchanger, the system must be put out of service until the heat exchanger is replaced.

Flame Sensor

The flame sensing rod can be cleaned with a fine to medium steel wool. Do not use emery cloth, which may leave residue on the rod. Inspect for pitting, especially on the propane (LP) gas applications.

Cleaning Flue Passages

With proper combustion adjustment, the heating element of a gas fired unit seldom needs cleaning. If the element should become sooted due to issues with gas supply, it can be cleaned as follows:

1. Remove the burner assembly as outlined in BURNER INSTRUCTIONS for the unit being serviced.
2. Remove the screws securing the restrictor plate to the tube sheet.
3. Using a wire brush on a flexible wand, brush out the inside of each heat exchanger from the burner inlet and flue outlet ends.
4. Brush out the inside of the restrictor plate to the tube sheet.
5. If soot build-up is particularly bad, remove the vent motor and clean the wheel and housing.
6. After brushing is complete, blow all brushed areas with air or nitrogen. Use a vacuum as needed.
7. Install the parts in reverse order from which they were removed in steps 1 through 3.

08

Appendix

Enhanced ECM Blower
Expected PWM Values
Segmented by Mode and Model

The following links provide Blower PWM for the Enhanced ECM as featured on the two-stage model. PWM values are determined by model and system mode.

PCG6A24050 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	29	60	46	41	32
B	28	54	41	32	27
C	25	46	37	29	25
D	22	39	31	26	23
PCG6A2475 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	5	25	14	10	5
B	5	20	5	5	5
C	5	13	5	5	5
D	5	10	5	5	5
PCG6A30050 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	41	82	62	59	44
B	37	78	59	49	39
C	29	59	45	40	32
D	26	49	38	34	27
PCG6A30075 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	10	47	30	24	12
B	10	37	23	12	10
C	5	24	11	10	10
D	5	17	10	5	10
PCG6A36050 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	20	57	40	29	20
B	18	47	35	24	19
C	15	34	25	20	14
D	12	29	21	15	15

PCG6B36100 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	10	36	25	16	10
B	7	29	19	10	5
C	5	19	12	6	5
D	5	15	10	5	5

PCG6B4206 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	10	36	25	16	10
B	7	29	19	10	5
C	5	19	12	6	5
D	5	15	10	5	5

PCG6B42065 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	13	44	30	21	14
B	11	37	25	16	10
C	7	28	19	12	7
D	5	21	14	8	5

PCG6B42100 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	13	44	30	21	14
B	11	37	25	16	10
C	7	28	19	12	12
D	5	21	14	8	8

PCG6B48065 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	20	58	40	35	24
B	17	51	36	32	21
C	12	40	27	20	12
D	8	32	21	12	5

PCG6B48100 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	20	58	40	35	24
B	17	54	36	32	21
C	12	40	27	20	12
D	8	32	21	12	5

PCG6B48125 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	20	58	40	35	24
B	17	51	36	32	21
C	12	40	27	20	20
D	8	32	2	12	12
PCG6B60065 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	25	69	47	36	26
B	23	63	44	34	23
C	17	47	33	22	14
D	12	37	26	18	12
PCG6B60100 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	25	69	47	36	26
B	23	63	44	34	23
C	7	47	33	22	14
D	12	37	26	18	12
PCG6B30125 Expected PWM					
Setting	Fan Only	High Cool	High Cool w/Dehumidification	Low Cool	Low Cool w/Dehumidification
A	25	69	47	36	26
B	23	63	44	34	23
C	17	47	33	22	14
D	12	37	26	18	12

