Residential Two-Stage Gas Furnace

Field Reference Guide

Updated August 2023

Johnson Controls

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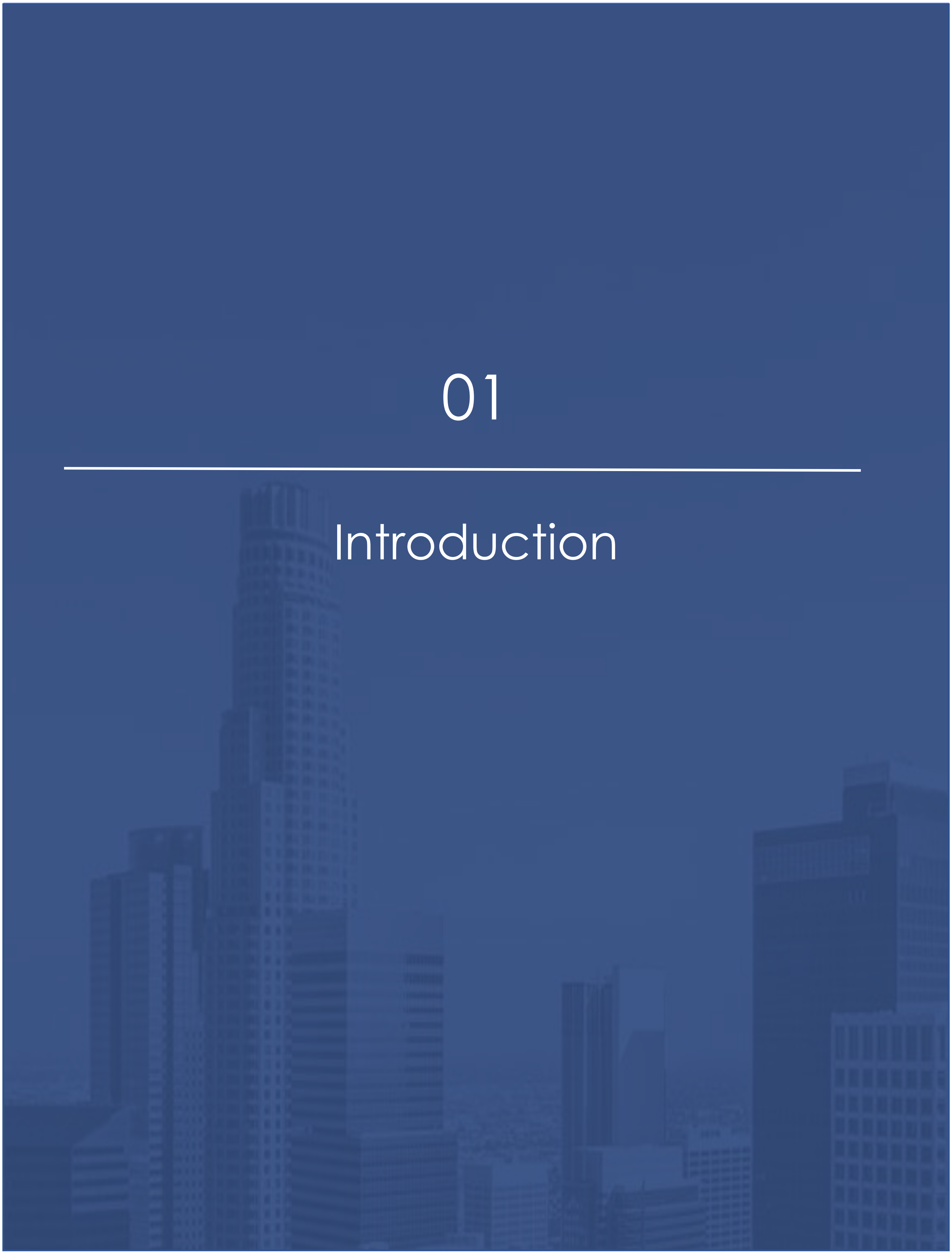

01

Introduction

Two-Staged Defined

A two-stage gas furnace operates at one of two firing rates based on demand. Upon a call for second stage heat and furnace ignition, the full rated BTUH input capacity is delivered. A first stage heat call delivers approximately 50% of the furnace output capacity. When the call for heat expires, the heating output ceases.

Available 33” Two-Stage Furnace Models

The 33” two-stage gas furnace is available in two major models.

80% Two-Stage

The 80% AFUE model is available with a Standard ECM or (legacy models) PSC blower motor and contains a hi-tech tubular aluminized steel primary heat exchanger. It is easily applied in upflow, horizontal left or right, or downflow installation with minimal conversion necessary. It contains built-in, high level self-diagnostics with fault code displays standard on integrated control model for reliable operation.

95% Two-Stage

The 95% AFUE is available with a Standard ECM, variable speed ECM, or (legacy models) PSC blower motor and contains a hi-tech tubular aluminized steel primary heat exchanger. The secondary heat exchanger is made of corrosion resistant stainless-steel materials. It is easily applied in upflow, horizontal left or right, or downflow installation with minimal conversion necessary. It may be installed as an either 2-pipe (sealed combustion) or single-pipe vent (using indoor combustion air). It contains built-in, high level self-diagnostics with fault code displays standard on integrated control module for reliable operation.

This Field Reference Guide covers 80% and 95% two-stage furnaces. Single stage and modulating models are discussed in separate Field Reference Guides.

80% Two-Stage Gas Furnace Features

- Two-stage heating operation includes two-stage gas valve, two-stage inducer operation and 4 speed, direct drive STD ECM motor blower operation.
- Adjustable delay timer allows two stage operation with a single stage thermostat.
- Easily applied in upflow, horizontal left or right, or downflow installation with minimal conversion necessary.
- Compact, easy to install, ideal height 33” tall cabinet.
- Blower-off delay for cooling SEER improvement.
- Easy access to controls to connect power/control wiring.
- Built-in, high level self-diagnostics with fault code display.
- Low unit amp requirement for easy replacement application.
- All models are convertible to use propane (LP) gas.
- Electronic Hot Surface Ignition saves fuel cost with increased dependability and reliability.
- 100% shut off main gas valve for extra safety.
- 24V, 40 VA control transformer/blower relay supplied for add-on cooling.
- Hi-tech tubular aluminized steel primary heat exchanger.
- Solid removable bottom panel allows easy conversion.
- Airflow leakage is less than 1% of nominal airflow at duct blaster conditions.
- No knockouts to deal with, making installation easier.
- Movable duct connector flanges for application flexibility.
- Quiet inducer operation.
- Inducer rotates for easy conversion of venting options.
- Full supported blower assembly for easy access and removal of blower.
- External air filters used for maximum flexibility to meet customers IAQ needs.
- Insulated blower compartment for thermal and acoustic performance.
- ¼ turn knobs provided for easy independent door removal.

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- 100% shut off main gas valve for extra safety.
- 24V, 40 VA control transformer and blower relay supplied for add-on cooling.
- Hi-tech tubular aluminized steel primary heat exchanger with stainless steel tube/aluminum fin secondary heat exchanger for outstanding efficiency.
- Solid removable bottom panel allows easy conversion.
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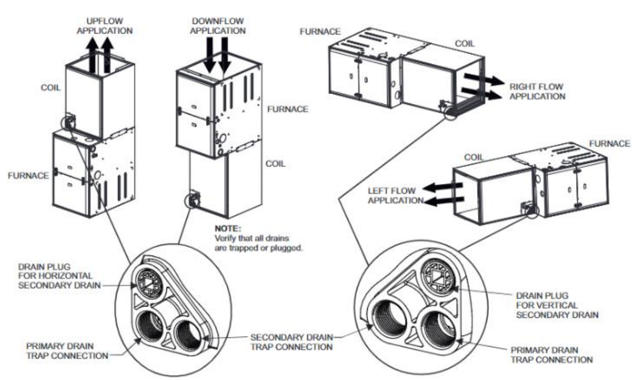
- No knockouts to deal with, making installation easier.
- Movable duct connector flanges for application flexibility.
- Quiet inducer operation.
- Inducer rotates for easy conversion of venting options.
- Fully supported blower assembly for easy access and removal of blower.
- External air filters used for maximum flexibility in meeting customers’ IAQ needs.
- Insulated blower compartment for thermal and acoustic performance.
- ¼ turn knobs provided for easy independent door removal.
- Internal condensate trap design (patent pending) provides condensate management options, easy visual operation check, and is self-priming to prevent nuisance problems.
- Protection included from air intake, exhaust vent or condensate blockage.
- Venting applications may be installed as either 2-pipe sealed combustion or single pipe vent using indoor combustion air.

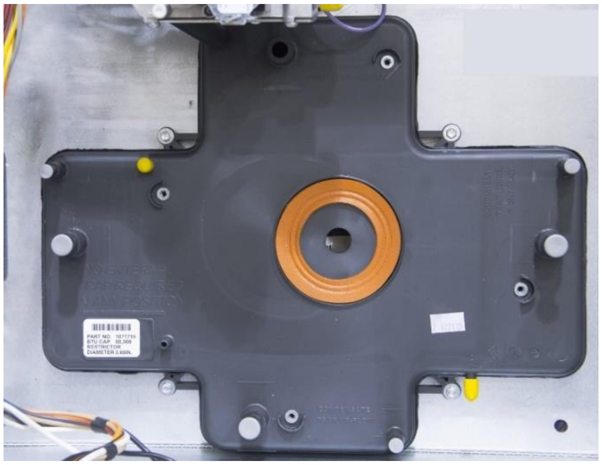
Multi-Position Installation

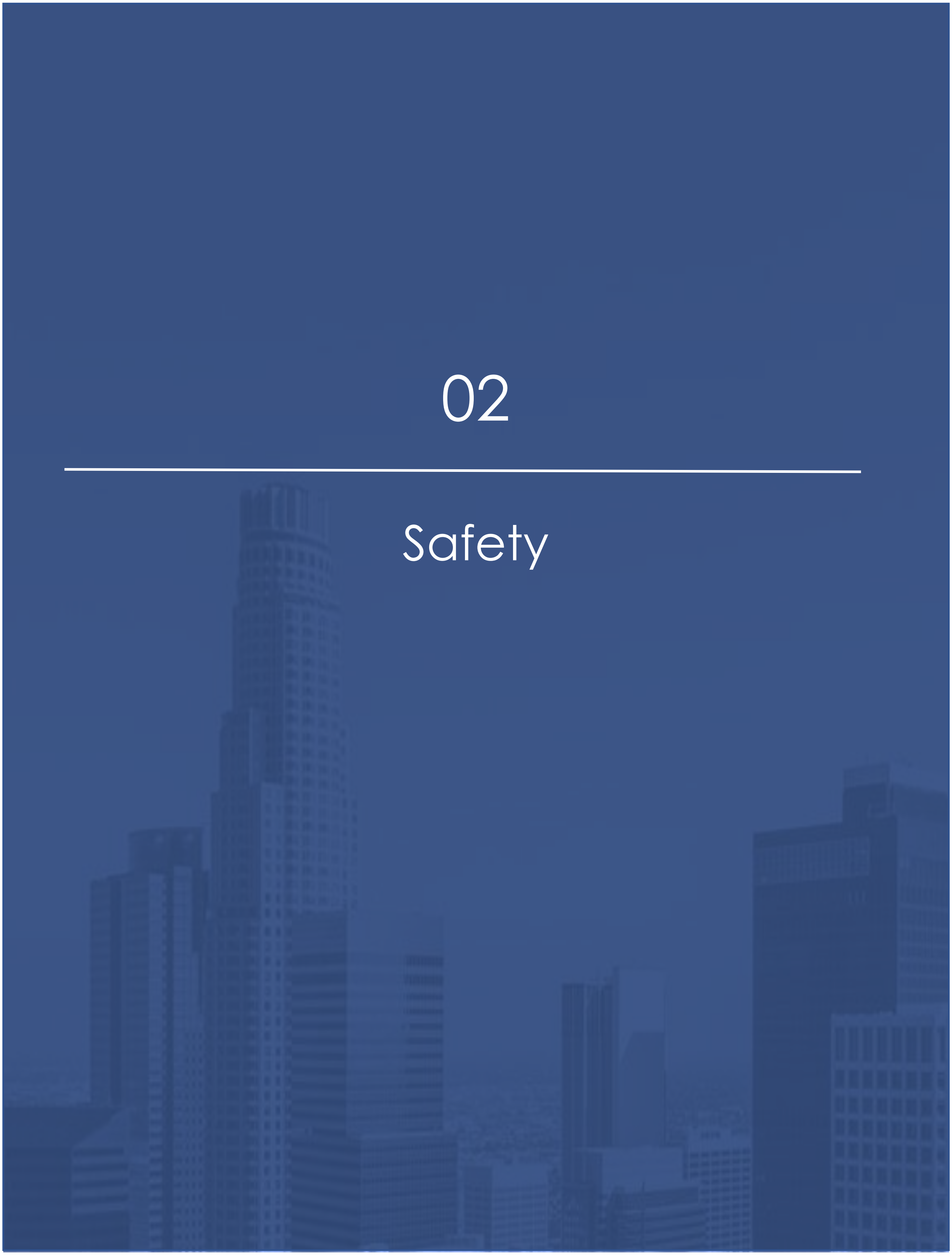
All models are approved for installation in upflow, downflow, horizontal left, and horizontal right applications. Simplified conversion allows efficient installation in all four positions. Details on configuring the furnace for various applications are found in the furnace Installation Manual and the “Installation” stage of this Field Reference Guide.



No External Trap

The 95% AFUE 33” furnaces use an innovative four-way collector box at the exit of the secondary heat exchanger. The design of the collector box eliminates the necessity of an external drain trap for the secondary heat exchanger. The collector box allows condensate drainage in any of the four installation configurations.





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

Introduction

Note
An understanding of the operation of individual furnace components enhances the understanding of system operation, providing enhanced diagnostic capabilities and efficient service.

Primary Heat Exchanger

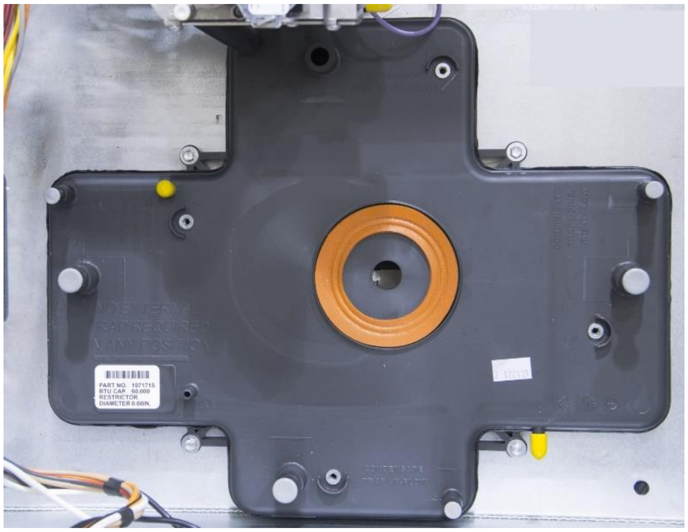
The tubular aluminized steel primary heat exchanger transfers heat from the products of combustion (inside the tubes) to the air circulated to the home (passing outside the tubes). Higher heating capacity models contain a greater quantity of primary heat exchanger tubes. One primary heat exchanger tube is present for each burner.

Secondary Heat Exchanger (95% Models)

The secondary (condensing) heat exchanger is constructed with high-grade stainless steel. It is designed to extract additional heat from the products of combustion. This additional heat reduction reduces the temperature of the flue gases below their dew point, causing the moisture in the flue gas to condense. The moisture is drained away through the collector box and condensate tubing. The tubes of the secondary heat exchanger contain turbulator strips, which cause the flue products to contact more of the internal surface of the secondary heat exchanger tubes. This allows additional heat to be extracted from the flue products prior to exiting the furnace.

Collector Box

The design of the collector box eliminates the necessity of an external drain trap, allowing condensate drainage of the four installation configurations.



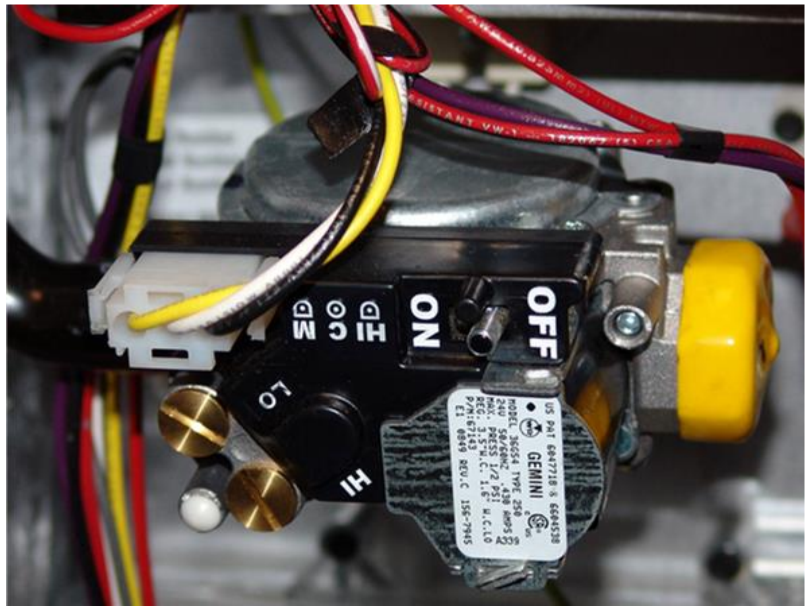
Installation in the horizontal left, horizontal right, or downflow configuration requires field modification of the condensate drain connection points. Detail is provided in the Installation Section of this Guide and allow in the Installation Manual provided with the product and in the Product Center on HVAC Navigator.

Gas Valve

During the heating sequence, the gas valve provides regulated control of the gas flow after the ignitor warm-up period. The gas valve is energized with 24 volts AC to start the flow of gas to the burners. The gas valve is de-energized (stopping the gas flow) when the heating sequence is complete (or earlier, if a condition exists within the system that may create a safety or performance issue).

The gas valve on the 33" two stage gas furnace is shipped for use with natural gas. If LP gas use is required, the appropriate LP gas conversion kit must be installed and set up prior to furnace operation.

The high fire and low fire manifold gas pressures, adjustable at the gas valve, must ALWAYS be properly set up during furnace installation and verified during service. For detailed information, see the Start-Up section of this Guide.



Burner Orifice

The burner orifices guide the flow of gas from the manifold into the burner. Ducted Systems gas furnaces ship with natural gas orifices. When LP gas is used, the natural gas orifices must be replaced with LP gas orifices, following the instructions provided in the LP gas conversion kit for the furnace model used.

Orifices must be threaded straight into the manifold, with each orifice inserted into the manifold the same number of turns.

The orifice size is stamped on the body of the orifice. Always use factory-supplied orifices – do not attempt to modify the orifice size if converting from LP back to natural gas.

Burners

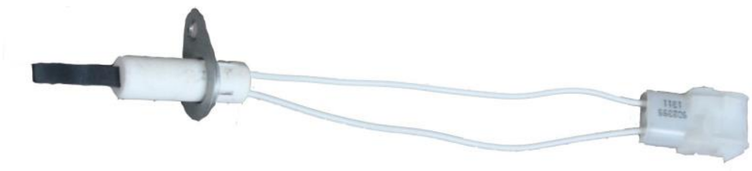
The 33” to stage gas furnaces are used with in-shot burners, which require no air adjustment and are easy to maintain.

After gas moves through the manifold and orifices, it mixes with combustion air in the burner assembly. The gas and air are mixed in the throat of the burner and are directed out of the opposite end where the gas, air, and ignition source combine to create flame.

In shot burners contain a flame carryover channel to spread flame from burner to burner. The channel must remain clean and unobstructed for proper operation. If it is restricted, delayed ignition can result. The channel may be cleaned with a wire brush if required.

Hot Surface Ignitor

During a trial for ignition, the hot surface ignitor is energized with 120 volts AC from the furnace control board (terminals 2 and 4 on the 4-pin plug connector). The ignitor will glow orange hot. At the end of the warm-up period, the furnace control board energizes the gas valve, allowing gas to flow to the burners. When the gas makes contact with the hot surface ignitor, the gas ignites.



Hot Surface Ignitor

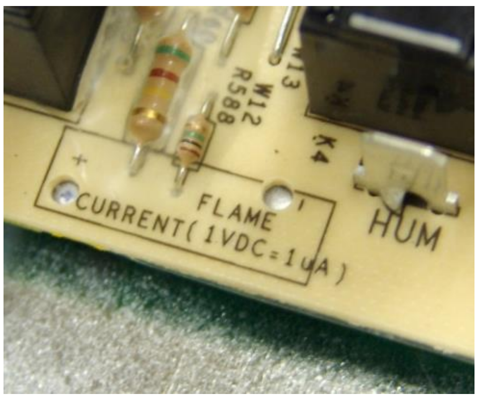
As with all hot surface ignitors, care should be used when handling. The resistance of the ignitor (when cold) should be between 40 and 80 ohms.

The HSI is removed by disconnecting the plastic plug connector and removing one Philips head screw. The HSI drops straight down out of the burner area.

Flame Sensor

The 33” two stage gas furnaces use flame rectification for flame proving. The control board energizes the flame sensor with 120 volts AC. This AC input is rectified through the flame to DC.

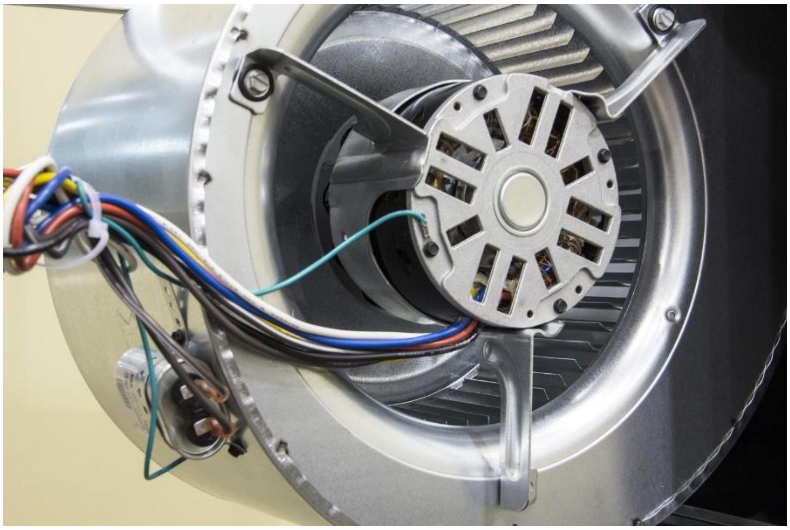
A flame current pad is built into the furnace control board for flame signal measurement. This pad allows the technician to measure the flame current using a DC voltmeter .1-volt DC = 1 ua (microamp).



Under normal conditions, approximately 3.7 volts DC (3 volts DC, which equals 3.7 microamps) should be measured at the flame current pad. The furnace control board requires at least .1 volts DC (.1 microamps) to allow the heating cycle to continue.

Blower Motor (PSC) Legacy

The two stage PSC (permanent split capacitor) 33” gas furnaces use a four-speed PSC blower motor. The blower speeds are field selectable on the furnace control board by moving the chosen blower speed taps to the LO HEAT, HI HEAT, LO COOL, and HI COOL terminals.



Speed tap selection for heating mode is determined during furnace installation and start-up. After proper manifold gas pressure set-up, in both “low fire” and “high fire”, both LO HEAT and HI HEAT blower speeds are selected. The temperature rise must always remain within the limitations on the furnace data plate.

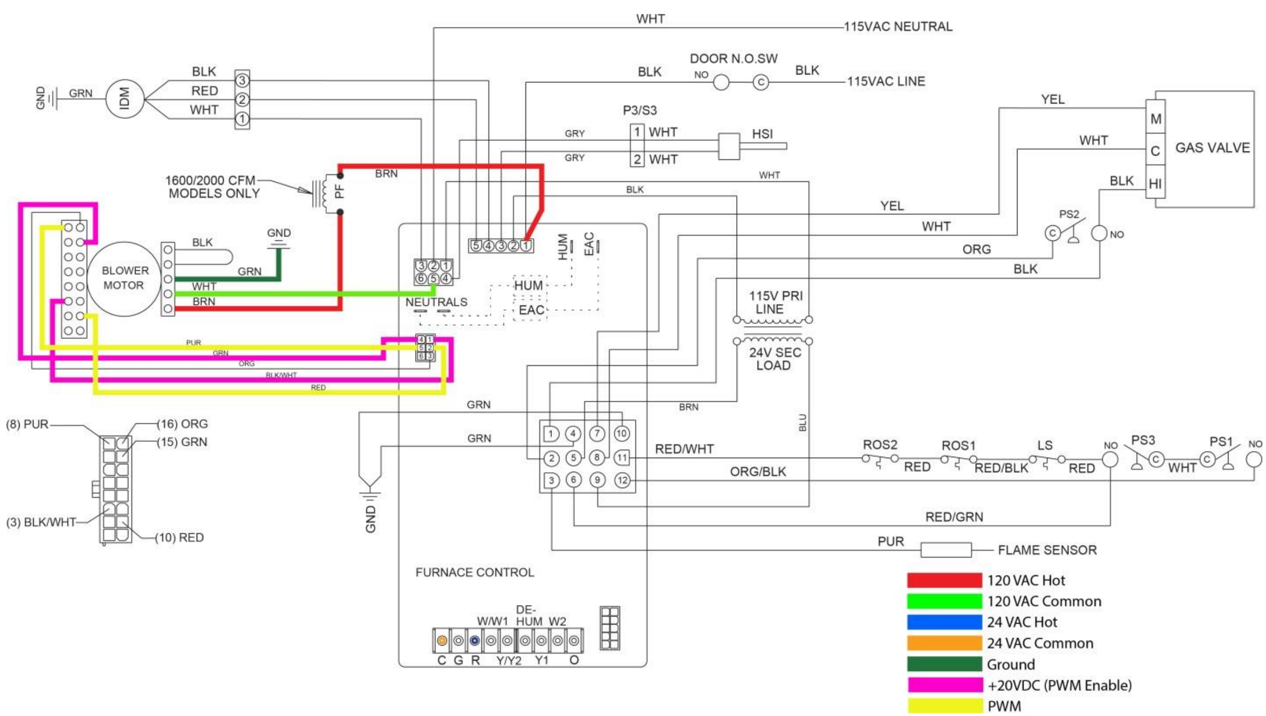
Speed tap selection for cooling mode is determined by the capacity of the air conditioning system, and the external static pressure (ESP) present in the duct system. Blower speeds must be selected that provide 400 CFM (+/- 50 CFM) per ton of cooling capacity. In two stage cooling applications, the selected LO COOL airflow must match the reduced capacity of first stage cooling capacity, and the selected HI COOL airflow must match the full cooling capacity of the installed cooling system.

Note on Airflow Capabilities
The airflow designator in the equipment model number indicates the design airflow delivery at .5” w.c. total external static pressure with the “high” blower speed selected. All Unitary Products residential furnaces, as most all competitive equipment, are designed to deliver rated airflow at .5” w.c. external static pressure. External static pressure more than .5” w.c. will reduce the maximum potential airflow output of the furnace.

Blower Motor (Variable Speed ECM)

The ECM model 33” two stage gas furnaces use an electronically commutated motor that is variable speed. The speed of the motor is controlled PWM signals from the furnace control board (between pins 2 and 5 on the control board 6 pin plug connector). These values are referenced in the Extras section of this Guide. A 20 VDC PWM ENABLE signal is measurable between pins 1 and 4 of the control board 6 pin plug connector. Line voltage is available to the motor at all times on the 5-pin plug connector.

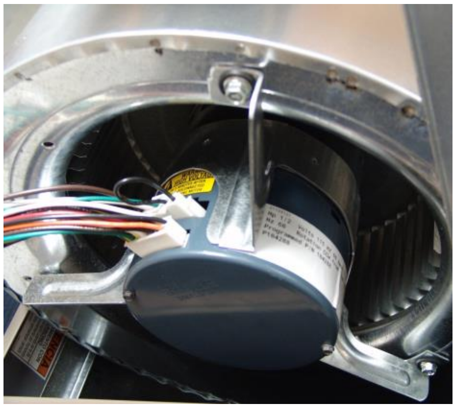
During commanded blower operation, both the PWM ENA and PWM control signals are required for the motor to operate.



Variable Speed Motor Connection

Blower speeds are field-selectable and through the COOL, ADJUST, HEAT, and FAN SPEED jumpers on the furnace control board.

Two stage gas furnaces, like all residential furnaces, provide their rated airflow up to .5” total ESP (external static pressure). Higher ESP results in greater power consumption, noise operation, and reduced airflow.

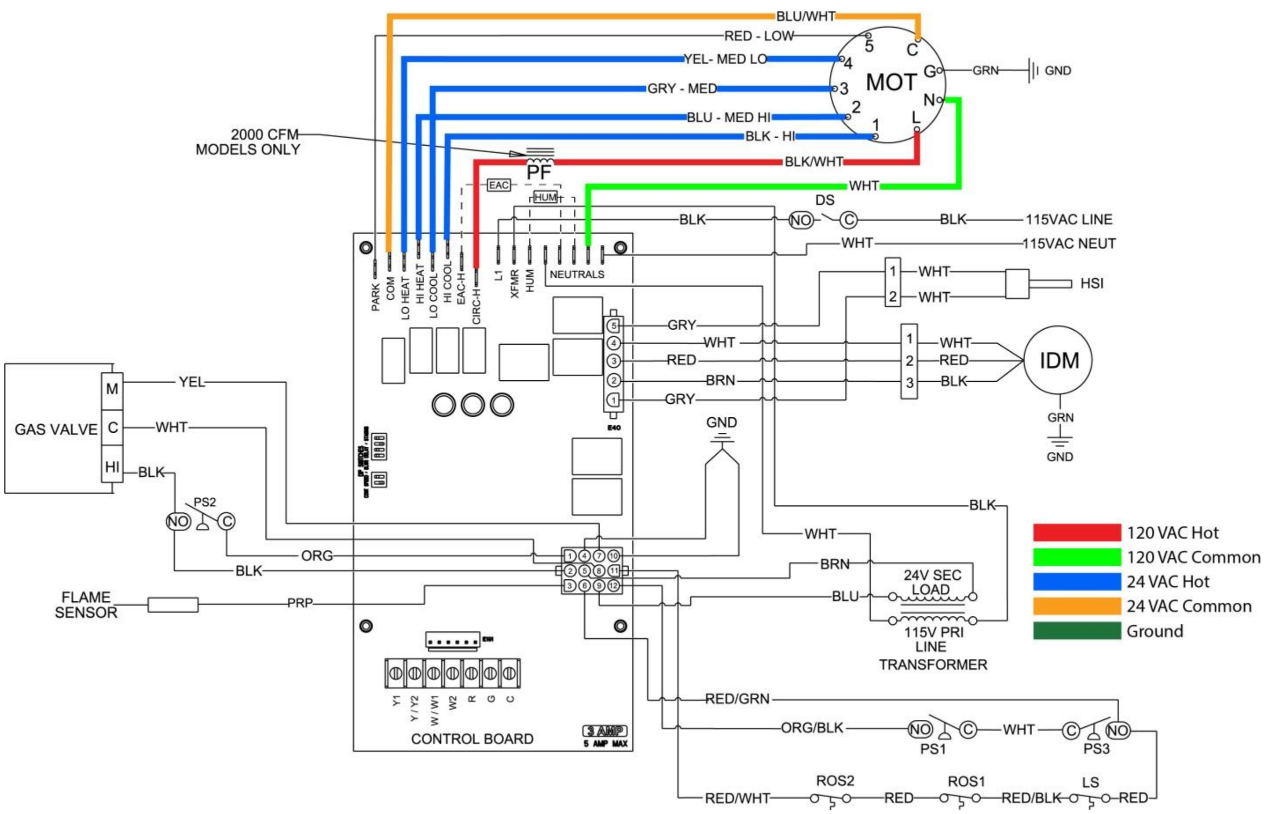


Blower Motor (Standard ECM)

Standard ECM motors offer enhanced electrical performance, quiet ramping, and improved performance across a larger range of external static pressure. All motors have static limitations and must operate within allowable ranges stated on the equipment rating plate.

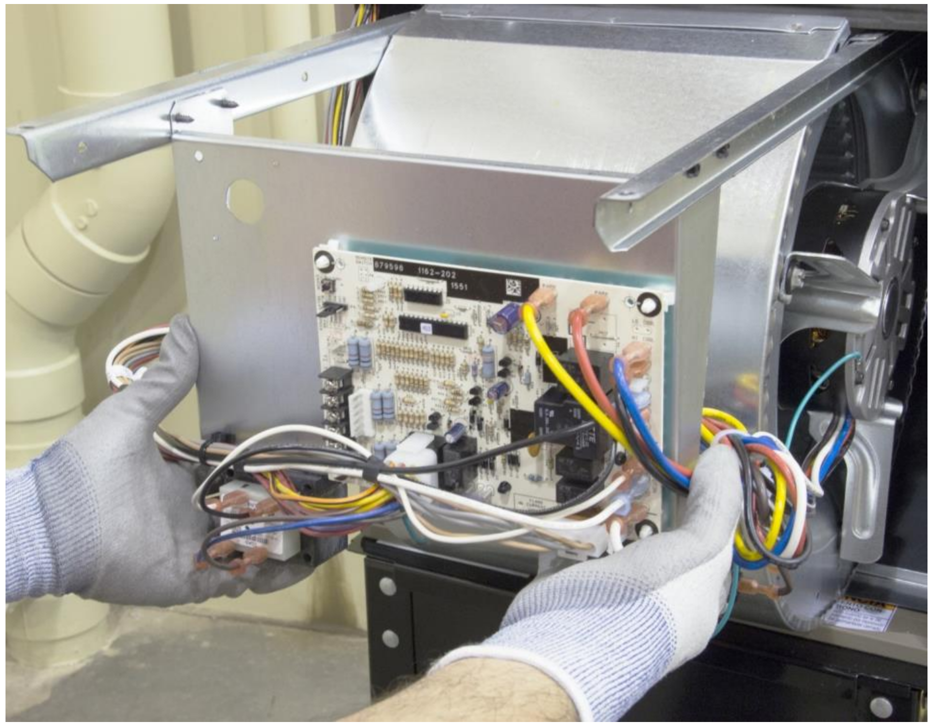
The Standard ECM motor is programmed to provide constant torque. If the static pressure changes, the motor will only maintain the factory programmed torque. This should not be confused with constant airflow. Even though the Standard ECM can maintain torque, if static pressure increases, airflow will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

The applied line voltage is measured between the “L” and “N” terminals on the motor terminal block. This is a 120-volt AC connection. The control terminals are labeled “C”, “1”, “2”, “3”, “4”, “5”. Terminal “C” is common for the 24-volt AC control voltage, while terminals labeled “1” through “5” are the preprogrammed torque settings, energized through the “HEAT”, “HI COOL”, “LO COOL”, and “G” or “CONT” blower motor connections on the furnace control board based on the system mode.



Blower Assembly Removal

The entire blower assembly slides out on rails. To slide the blower assembly out, two ¼” hexhead retaining screws are removed (one on the left and one on the right). Pull the blower assembly straight out. Enough wiring is provided that disconnection from the furnace control board is not necessary for most service procedures.



The blower motors on Unitary Products residential gas furnaces are permanently lubricated and require no oil during routine furnace maintenance.

Primary Limit

The primary limit switch is mounted on the left side of the furnace vestibule panel. This auto-reset limit switch will open and interrupt the heating cycle if it detects excessive air temperature in the furnace. Primary limit trips are caused by the following conditions:

- Dirty filter
- Dirty evaporator coil
- Dirty secondary heat exchanger
- Debris deflecting airflow away from the switch
- Failure of the circulating blower motor or wheel
- Too many supply or return registers closed or blocked (leading to high external static pressure)
- Excessive manifold gas pressure

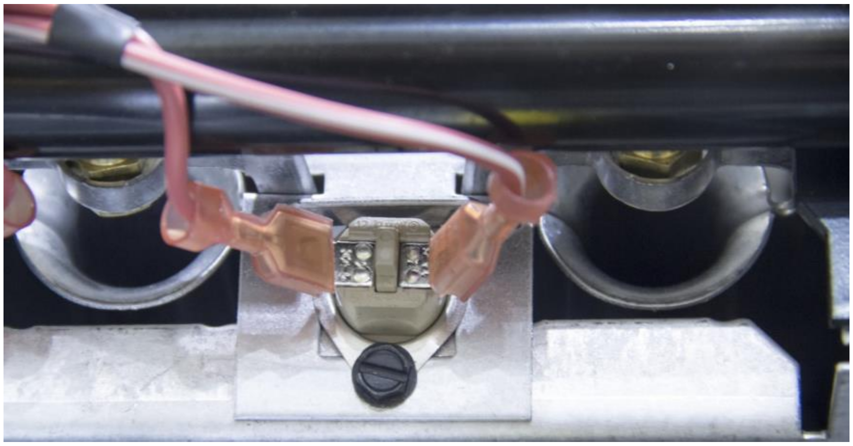
If the primary limit switch opens, the cause must be determined and corrected. If the limit switch is replaced, the exact Source 1 part number (and limit settings) must be used as specified.

Rollout Limit

Rollout limits are mounted near the burner assembly. If the temperature in the burner area exceeds the rollout switch set point, the ignition control and the gas valve are de-energized.

If the rollout limit opens, the cause must be determined and corrected. Rollout limits opening may indicate a problem with the gas setup (manifold pressure), a problem with the induced draft assembly, heat exchanger, or venting system.

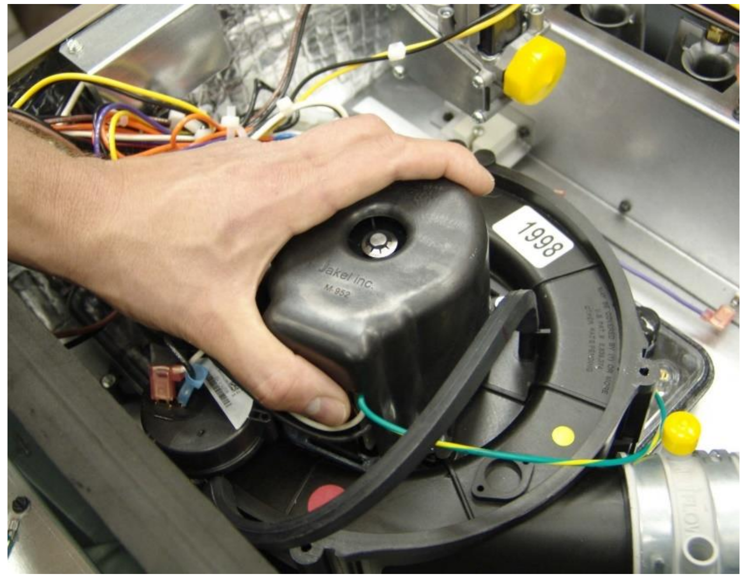
Because a rollout limit opening can indicate a potentially serious condition, the rollout limits are manually reset.



Inducer

The inducer (also referred to as an induced draft blower, combustion blower, or vent blower) provides two functions. It brings air for combustion into the burner box and moves the products or combustion through the heat exchangers, expelling them outdoors.

The inducer on two stage gas furnaces uses a two-speed motor, low and high speeds. During a trial for ignition and during a call for second stage heat, the inducer is energized on high speed. The inducer is energized at low speed during a call for first stage heat.



For installation flexibility, the inducer on the 33” gas furnaces may be rotated 90 degrees clockwise (CW) or counterclockwise (CCW). For upflow applications, the exhaust may exit through the top or either side of the cabinet. Downflow applications require the inducer is rotated so the exhaust exits through the left or right side of the cabinet.

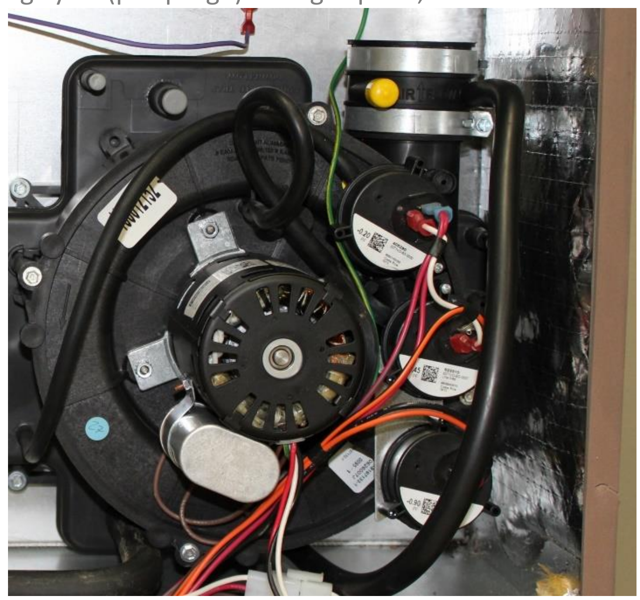
On a call for heat, after the furnace control board performs internal and system diagnostics (including checking the pressure switch(es) is open), the first step in the sequence of operation is to energize the inducer on high speed. The inducer motor is energized through pins 4 and 2 of the five-pin plug connector on the furnace control board.

If a first stage heating call exists, the inducer drops to low speed with 120-volt AC input coming measurable between pins 4 and 3 of the 5-pin plug connector.

Pressure Switch: Combustion Air

The 33” two stage gas furnaces are equipped with two combustion air pressure switches located on the front of the inducer assembly. These switches are “normally open” (N/O) and are referred to as the “high fire” and “low fire” pressure switches.

During first stage heating (W1 call) and after initiation of the heating cycle (pre-purge) on high speed, the inducer is energized at low speed, resulting in closure of the “low fire” pressure switch.



During a second stage heating call (W2) and during pre-purge, the inducer operates at high speed, at which time both the “low fire” and “high fire” pressure switches must be closed.

The “make” (closing) point of the switch is printed on the label on the face of the switch. The switch may be diagnosed using a Magnehelic gauge, incline, or U-tube manometer.

Details on diagnosing pressure switch operation can be found in the Troubleshooting section of this guide.

Never attempt to jump a pressure switch to allow the furnace to operate. Doing so could allow the furnace to operate under hazardous conditions leading to bodily injury, property damage, or loss of life.

Inducer-Pressure Switch-Gas Valve-Blower Relationship

Furnace components work together to provide consistent heat regardless of first or second stage heat call, and directly control the next component in the chain.

The thermostat determines the heating mode (high or low), which determines the inducer speed. The inducer speed dictates the position of the pressure switches, which determine the firing rate.

Single and Two Stage Operation

Mode	Inducer	Pressure Switch Closed	Firing Rate	Blower
Pre-purge	High	High/Low	-	-
Ignition	High	High/Low	High	-
First Stage	Low	Low	Low	1st Stage Heat
Second Stage	High	High/Low	High	2nd Stage Heat
Post-purge	High	High/Low	-	1st or 2nd As Above

Pressure Switch: Blocked Drain

The 33” two stage gas furnaces (95% models) utilize a third pressure switch wired in series with the combustion air pressure switches. If the secondary heat exchanger of the furnace is not draining properly, the blocked drain switch opens, resulting in a fault code of 3 on the furnace control board.

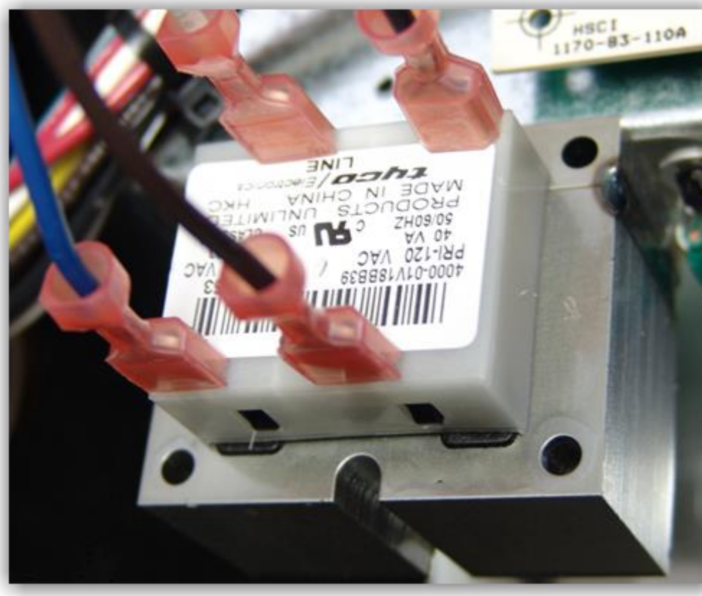
The pressure switch is diagnosed with a Magnehelic gauge or an incline manometer. An improperly configured or restricted drain system causes this switch to open, as well as improper field leveling of the furnace. Check all field connections and condensate tubing, and make sure the furnace is installed level or at a very slight pitch towards the front of the furnace.

Transformer

The transformer steps down the supplied 120-volts AC line voltage to 24-volts AC control voltage used to supply power to the ignition control, gas valve, thermostat, and other controls. Line power is connected to the line (or primary) side of the transformer. 24-volt power is supplied out of the load (secondary) side of the transformer.

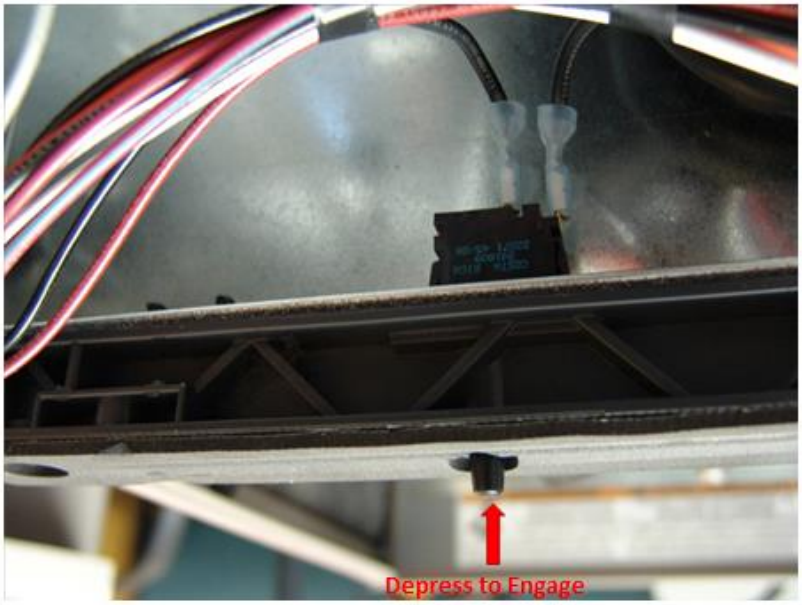
The “VA” rating of the transformer indicates the maximum voltage (V) times amperage (A) of the components it is supplying power to. For example, the 40 VA transformer rating (as provided on the 33” gas furnaces), indicates that the output voltage (24 volts AC) multiplied by the amp draw of the components it is providing power to cannot exceed 40. 24-volts multiplied by 1.667 amps equals 40, so the maximum amp draw of all components on the 24-volt side cannot exceed 1.667 amps.

A 3-amp automotive type fuse on the furnace control board helps to protect the transformer from damage due to severe over-current conditions on the secondary (24-volt) circuit.



Blower Door Switch

The blower door switch interrupts all power to the furnace when the panel covering the blower compartment is removed.



Rain Gutter (95% Model)

The rain gutter is located at the outlet side of the induced draft blower. It captures condensate present in the exhaust piping and drains it away before it reaches the induced draft blower.

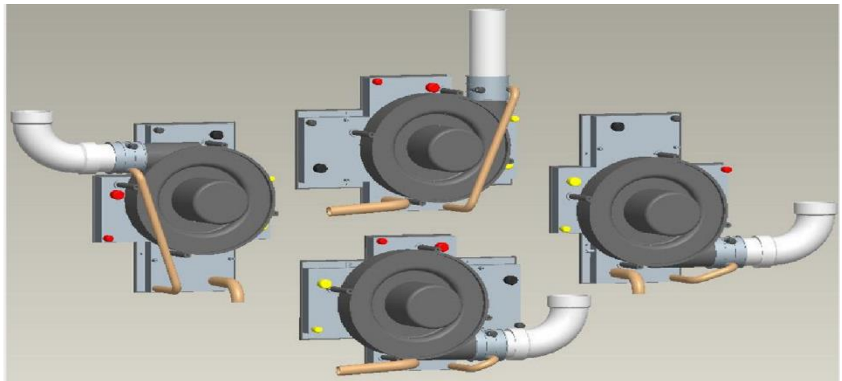
Collector Box (95% Models)

The collector box ("drain pan") is mounted to the outlet of the secondary heat exchanger. The unique design allows secondary heat exchanger condensate drainage without an external drain trap.

Condensate Tubing (95% Models)

The collector box contains many connection points for condensate drainage. The connection points used are determined by the chosen furnace position.

Regardless of the furnace configuration or inducer position, the rain gutter connected is connected from the rain gutter to the tap at the BOTTOM of the collector box for the position the furnace is installed in. When reconfiguring the factory connected drain system, remove the black cap from the desired collector box tap and place on the unused tap.



Drain Tubing and Venting Configuration

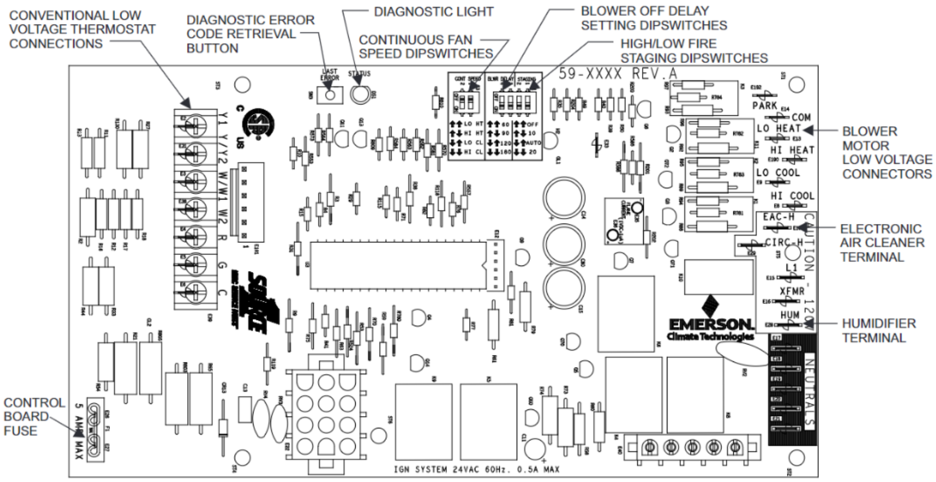
Furnace Control Board (PSC Blower Models)

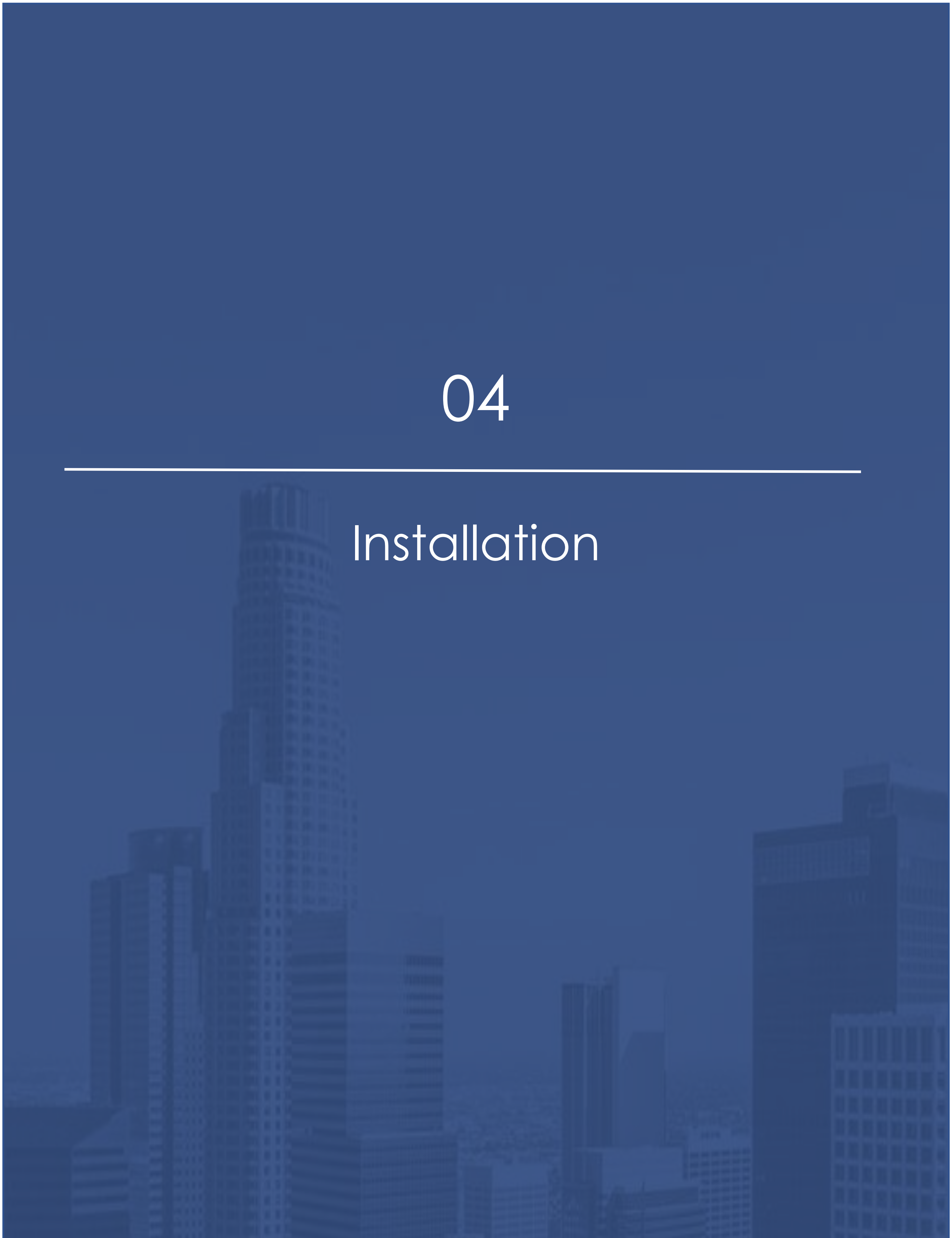
The integrated furnace control board controls all furnace functions, including component cycling, safety limit monitoring, flame sensing, blower delays, system mode and fault code displays. Fan speeds are as identified below:

Mode	Staging
LO Heat	First stage heating, or “low fire”
HI Heat	Second stage heating, or “high fire”
LO Cool	First stage cooling
HI Cool	Second stage cooling

Furnace Control Board (Standard ECM Blower Models)

The integrated furnace control board controls all furnace functions, including component cycling, safety limit monitoring, flame sensing, blower delays, system mode and fault code display.



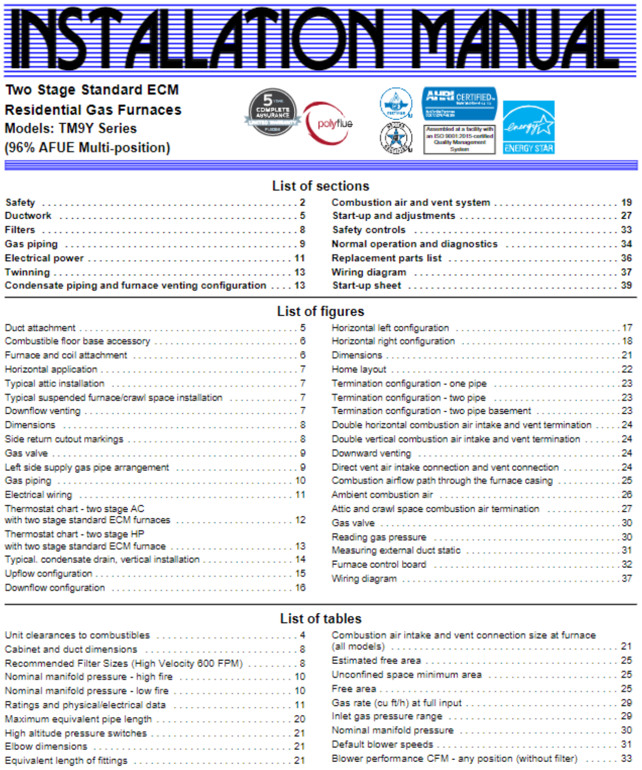


04

Installation

Introduction

Taking the time to properly install and start up the 33" two stage gas furnace ensures the equipment is operating at peak efficiency and provides the end user with the comfort and efficiency they expect from the installation.



INSTALLATION MANUAL

Two Stage Standard ECM
Residential Gas Furnaces
Models: TM9Y Series
(96% AFUE Multi-position)

List of sections

List of figures

List of tables

This section DOES NOT REPLACE THE INSTALLATION MANUAL of the furnace model you are working with. The Field Reference Guide is designed to be a companion tool to the model specific Installation Manual.

Be sure to thoroughly read the instructions provided with the furnace.

Do NOT Use for Temporary Heat
Materials used in the construction process, when brought into the furnace, greatly reduce furnace efficiency and operational life. Drywall dust, varnishes, paints, and sawdust rob the end user of the investment they have made in their comfort system. Use a different source of temporary heat for construction, such as a stand-alone furnace used only for this purpose.

Inspection

When a furnace is received, it should be inspected for possible damage during transit. If damage is evident, the extent of the damage should be noted on the carrier’s freight bill. Also, before installation, the unit should be checked for screws, bolts or wiring connections which may have loosened in transit. There are no shipping or spacer brackets requiring removal.

Furnace Location and Clearances

The furnace shall be located using the following guidelines:

1. Where a minimum amount of air intake/vent piping and elbows will be required.
2. As centralized with the air distribution system as possible.
3. Where adequate combustion air will be available (particularly when the appliance is not using outdoor combustion air).
4. Where it will not interfere with proper air circulation in the confined space.
5. Where the outdoor combustion air/vent terminal will not be blocked or restricted.
6. Where the unit will be installed in a level position with no more than ¼” (6.4 mm) slope side-to-side and front-to-back to provide proper condensate drainage.

Installation in Freezing Temperatures

- Temperatures in the furnace location (95% AFUE) must not fall below 32°F (0°C) unless the condensate system is protected from freezing.
- The return air temperature must not drop below 55°F (13°C) for extended periods. Low return air temps may cause condensation in the primary heat exchanger, leading to premature heat exchanger failure.

Recommended Minimum Clearances

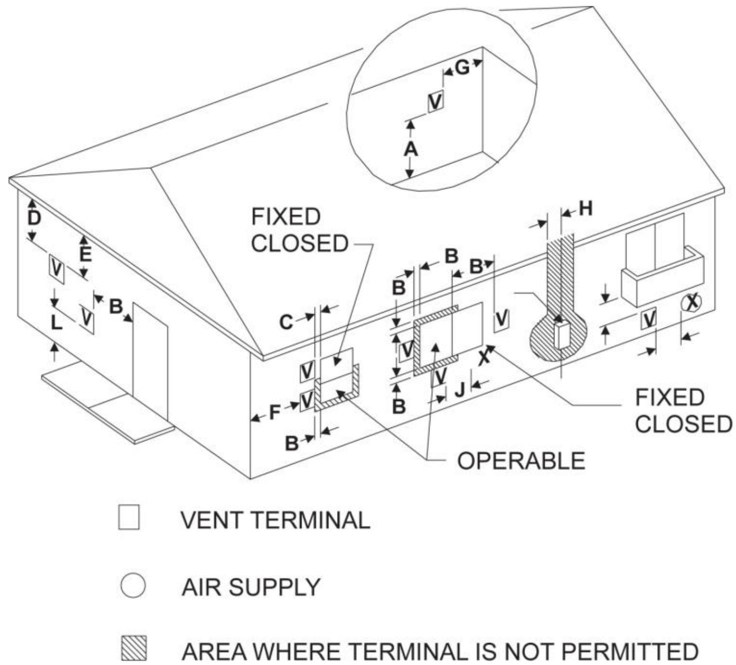
Ample clearances should be provided to permit easy access to the unit.

The following minimum clearances are recommended:

- Twenty-four (24) inches (61 cm) between the front of the furnace are an adjacent wall or another appliance, when access is required for servicing and cleaning.
- Eighteen (18) inches (46 cm) at the side where access is required for passage to the front when servicing or in inspection or replacement of flue/vent connections. In all cases, accessibility clearances shall take precedence over clearances for combustible materials where accessibility clearances are greater.

Vent Clearances

Always consult the Installation Manual for model-specific vent clearances. The image and table below are presented as reference.



Direct Vent Terminal Clearances	Canadian Installation	US Installation
A. Clearance above grade, veranda, porch, deck, or balcony	12” (30.5 cm)	12” (30.5 cm)
B. Clearance to window or door that may be opened	12” (30.5 cm) for models less than or equal to 100,000 BTUH (30 kw), 36” (91.4 cm) for models > 100,000 BTUH (30 kw)	Two-pipe (direct vent) applications: 12” (30.5 cm) *Single-pipe applications: 4 feet (1.2 m)
C. Clearance to permanently closed window.	12” (30.5 cm)	12” (30.5 cm)
D. Vertical clearance to be ventilated soffit located above the terminal within a horizontal distance of 2 feet (61 cm) from the center line of the terminal.	12” (30.5 cm) or in accordance with local installation codes and the requirements of a gas supplier.	12” (30.5 cm) or in accordance with local installation codes and the requirements of a gas supplier.
E. Clearance to unventilated soffit.	12” (30.5 cm) or in accordance with local installation codes and the requirements of a gas supplier.	12” (30.5 cm) or in accordance with local installation codes and the requirements of a gas supplier.
F. Clearance to outside corner	12” (30.5 cm) or in accordance with local installation codes and the requirements of a gas supplier.	12” (30.5 cm) or in accordance with local installation codes and the requirements of a gas supplier.
G. Clearance to inside corner	3 feet (91.4 cm)	3 feet (91.4 cm)
H. Clearance to each side of center line extended above meter/regulator or assembly	Above a meter/regulator assembly within 3 feet (91.4 cm) horizontally of the vertical center line of the regulator vent outlet to a maximum vertical distance of 15 feet (4.5 m) above the meter/regulator assembly	Above a meter/regulator assembly within 3 feet (91.4 cm) horizontally of the vertical center line of the regulator vent outlet to a maximum vertical distance of 15 feet (4.5 m) above the meter/regulator assembly
I. Clearance to service regulator vent outlet	3 feet (91.4 cm)	3 feet (91.4 cm) or in accordance with local installation codes and the requirements of the gas supplier
J. Clearance to non-mechanical air supply inlet to building or the combustion air inlet to any other appliance	12” (30.5 cm) for models less than or equal to 100,000 BTUH (30 kw), 36” (91.4 cm) for models > 100,000 BTUH (30 kw)	Two-pipe (direct vent) applications: 12” (30.5 cm) Single-pipe applications 4 feet (1.2 m)
K. Clearance to a mechanical supply inlet.	6 feet (1.83 m)	3 feet (91.4 cm) above if within 10 feet (3 m) horizontally
L. Clearance above paved sidewalk or paved driveway located on public property	7 feet (2.13 m)**	7 feet (2.13 m) or in accordance with local installation codes and the requirements of the gas supplier
M. Clearance under veranda, porch, deck, or balcony	12” (30.5 cm)	12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier

1. In accordance with the current CSA B149.1-00, Natural Gas and Propane Installation Code.
2. In accordance with the current ANSI Z223.1/NFPA 54, Natural Gas Code.
3. In accordance with the current ANSI Z21.47 CSA 2.3 American National Standard.

*12” (30.5 cm) up from the bottom edge of the structure for two-pip (direct vent) applications per ANSI Z223.1/NFPA 54, National Gas Code.
**A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.
¥Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor and the distance between the top of the vent termination and the underside of the veranda, porch, or deck is greater than 12” (30.5 cm) as specified in CSAB149.1-00.

- A vent shall not terminate less than 12” (30.5 cm) above a grade level.
- Any fresh air or make up inlet for dryer or furnace area is considered to be forced air inlet.
- Avoid areas where condensate drippage may cause problems such as above planters, patios, or adjacent to windows where steam may cause fogging.
- The terminus of a vent shall be fitted with a cap in accordance with the vent manufacturer’s installation instructions, or in accordance with the installation instructions for a special venting system.
- Responsibility for the provision of proper adequate venting and air supply for application shall rest with the installer.
- Vent shall extend high enough above building, or a neighboring obstruction, so that wind from any direction will not create a positive pressure in the vicinity of the vent.

Vent System: 95% Model

The 95% AFUE 33” gas furnaces are Category IV, dual certified appliances and are designed for residential application. The combustion air and vent system must be installed in accordance with Section 5.3, Air for Combustion and Ventilation, of the National Fuel Gas code Z223.1/NFPA 54 (latest edition), or Sections 7.2, 7.3, or 7.4 of CBA B149.1, National Gas and Propane Codes (latest edition) or applicable provisions of the local building code and the furnace Installation Manual.

The 95% AFUE 33” gas furnaces may not be commonly vented with any other appliance, and require separate, properly sized combustion air intake and exhaust (vent) piping. Refer to the furnace Installation Manual for specific detail on venting specific furnace models.

Vent System: 80% Model

The venting system for the 80% AFUE single stage gas furnaces use type “B” vent pipe, or approved type “B” connector to a line masonry chimney of the correct size.

The 80% AFUE model may only be vented to a lined masonry chimney if a source of dilution air is provided, such as common venting with a draft hood equipped water heater. If no source of dilution air is available, a masonry chimney vent kit must be used. Refer to the kit instructions for application and installation requirements.

The 80% AFUE single stage gas furnaces are approved for horizontal, sidewall termination with an approved auxiliary power venter. Consult the furnace Installation Manual for application information.

The vent system must be installed in accordance with Section 5.3, Air for Combustion and Ventilation, of the National Fuel Gas Code Z223.1/NFPA 54 (latest edition), or Sections 7.2, 7.3, or 7.4 of CBA B149.1, National Gas and Propane Codes (latest edition) or applicable provisions of the local building code and the furnace Installation Manual.

Combustion Air Quality

The 95% AFUE 33” gas furnaces are dual certified, meaning that combustion air may be taken from either outdoors (preferably) or inside the structure. If considering taking combustion air from within the structure, there are many factors to consider.

OUTDOOR AIR for combustion will be required when the furnace is in any of the following environments:

- Commercial buildings
- Buildings with indoor pools
- Laundry rooms
- Hobby or craft rooms
- Chemical storage areas

The furnace will require OUTDOOR AIR for combustion when the furnace is in an area where the furnace is being exposed to the following substances and/or chemicals:

- Permanent wave solutions
- Chlorinated waxes and cleaners
- Chlorine based swimming pool chemicals
- Water softening chemicals
- De-icing or chemicals
- Carbon tetrachloride
- Halogen type refrigerants
- Cleaning solvents
- Printing inks, paint removers, varnishes, etc.
- Hydrochloric acid
- Cements and glues
- Antistatic fabric softeners for clothes dryers
- Masonry acid washing materials

Ductwork Installation

To properly design the ductwork for the building, refer to the ASHRAE Fundamentals Handbook chapter on “DUCT DESIGN”, or ACCA Manual D.

It is imperative that the duct system is designed properly per these methods. As with all residential equipment, the 33” single stage gas furnaces are designed to deliver their rated airflow up to 0.5” w.c. total external static pressure. Higher external static values can cause problems with system performance and customer comfort. This may include:

- Temperature rise outside of the allowable range on the furnace rating plate, causing undue stress on the heat exchangers.
- Inadequate cooling performance, including evaporator coil frosting/freezing in the cooling mode, possibly leading to liquid refrigerant getting back to the compressor and eventual compressor failure.
- Inadequate airflow to the conditioned space.
- Customer complaints about noisy operation. If whistling is heard in and around the furnace area during blower operation, it is likely that there is an airflow problem.

For more information on determining where problems are in the air distribution, see Section 5, Start-Up. Included is a discussion on measuring external static pressure (ESP) in the duct system.

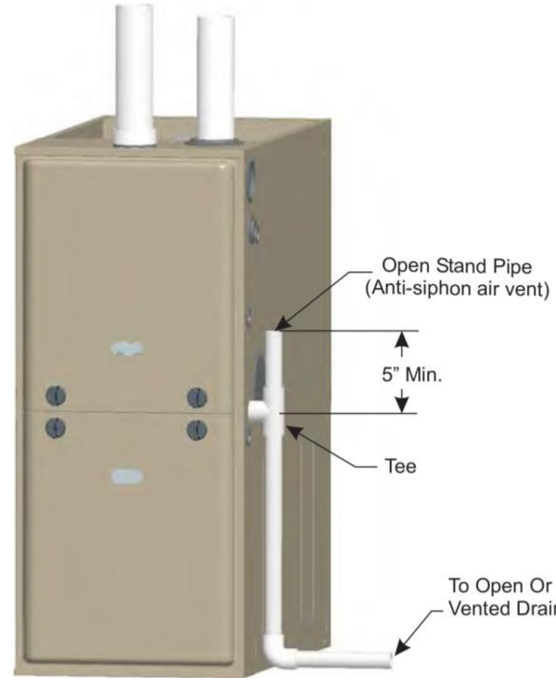
Furnace Configuration and Conversion

The 33" single stage gas furnaces are multi-position, meaning that they may be installed in upflow, downflow, horizontal left, and horizontal right applications with little modifications. The furnace as shipped from the factory is configured for upflow application. The illustrations shown below, taken from the furnace Installation Manual, indicate inducer and condensate tube locations for various furnace positions.

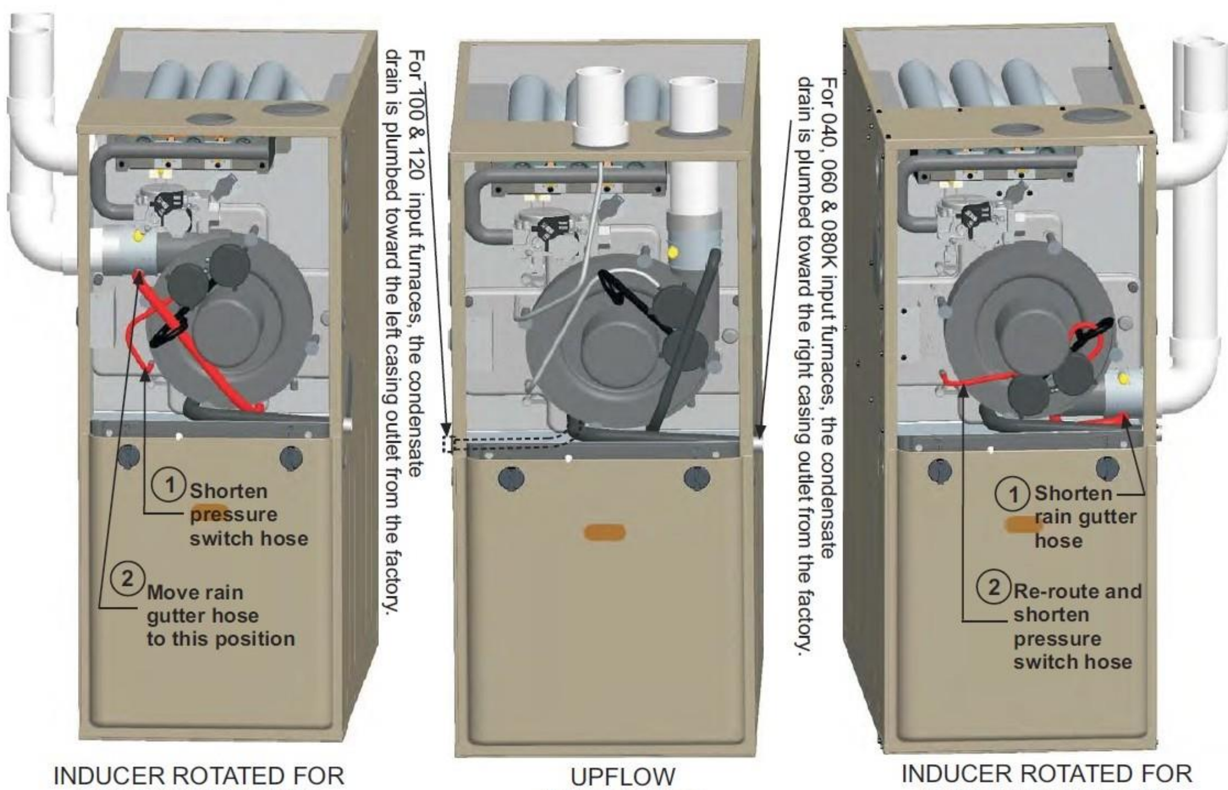
Condensate Management – 95% Models

The illustrations below illustrate the condensate drain arrangement for the various possible furnaces and inducer positions. The furnace condensate pan is self-priming and contains an internal trap to prevent flue gas leakage.

The condensate will flow to the drain more efficiently if an open tee, or short length of pipe is installed in the drain line external to the furnace.



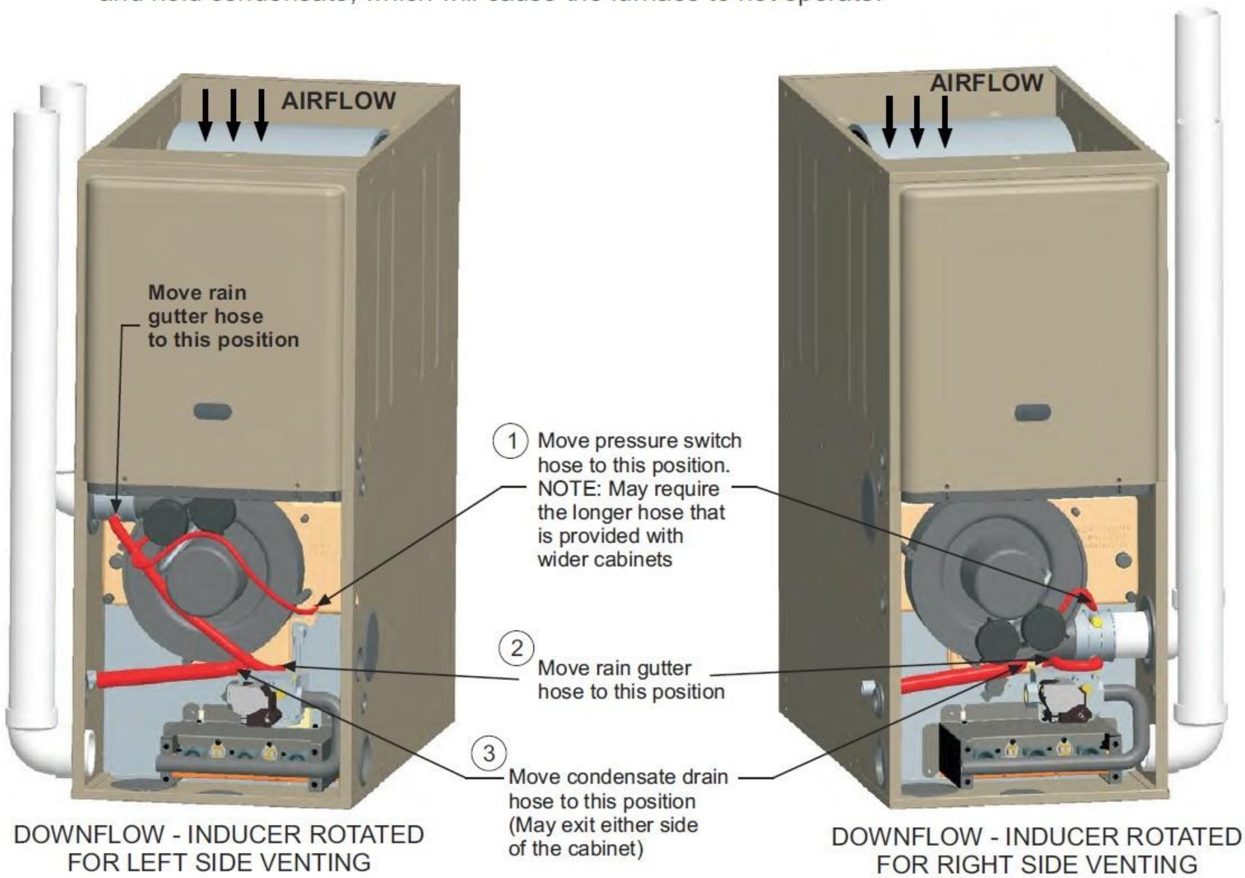
When drain hose routing changes are required, be sure to cap all un-used openings. If rerouting hoses - excess length should be cut off so that no sagging loops will collect and hold condensate, which will cause the furnace to not operate.



Condensate drain may exit cabinet on either side.

When drain hose routing changes are required, be sure to cap all un-used openings.

If rerouting hoses - excess length should be cut off so that no sagging loops will collect and hold condensate, which will cause the furnace to not operate.



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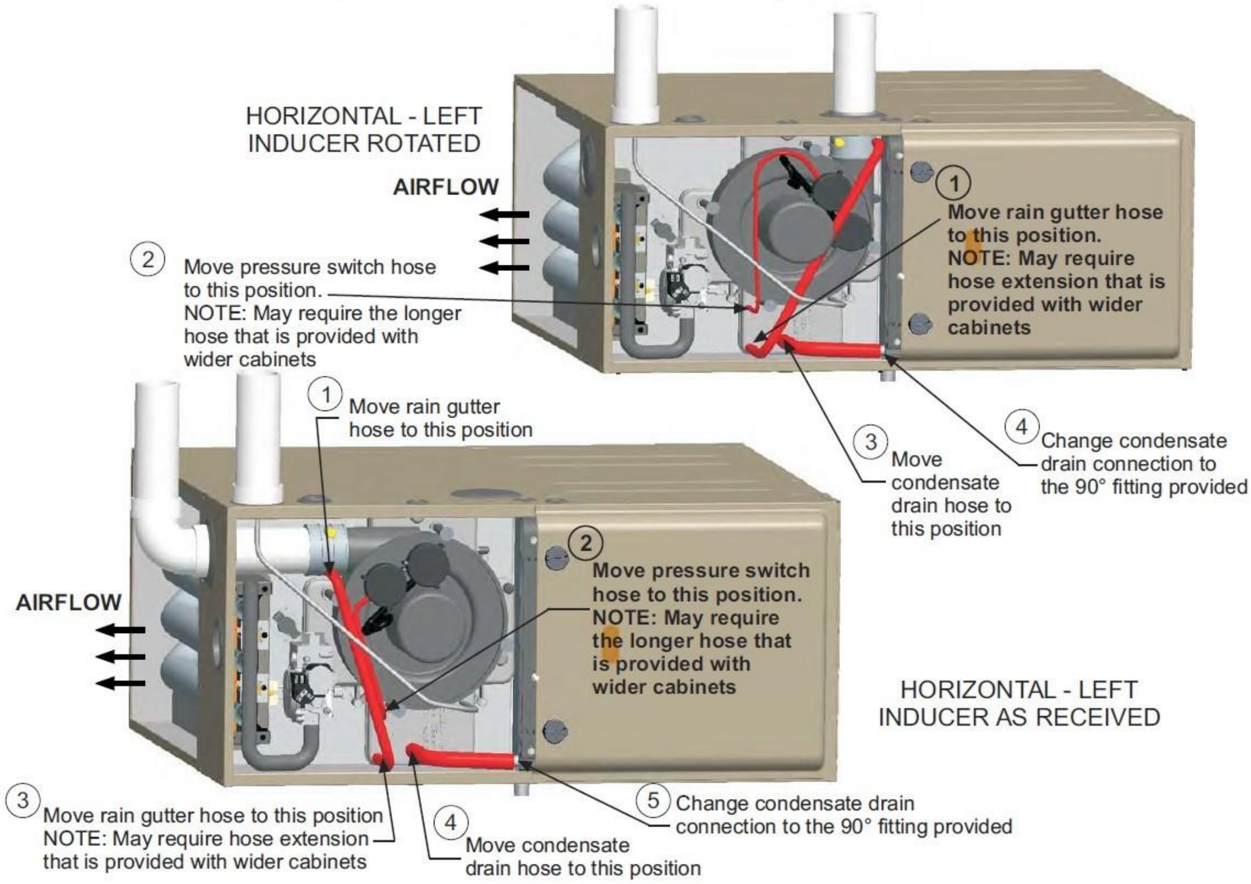

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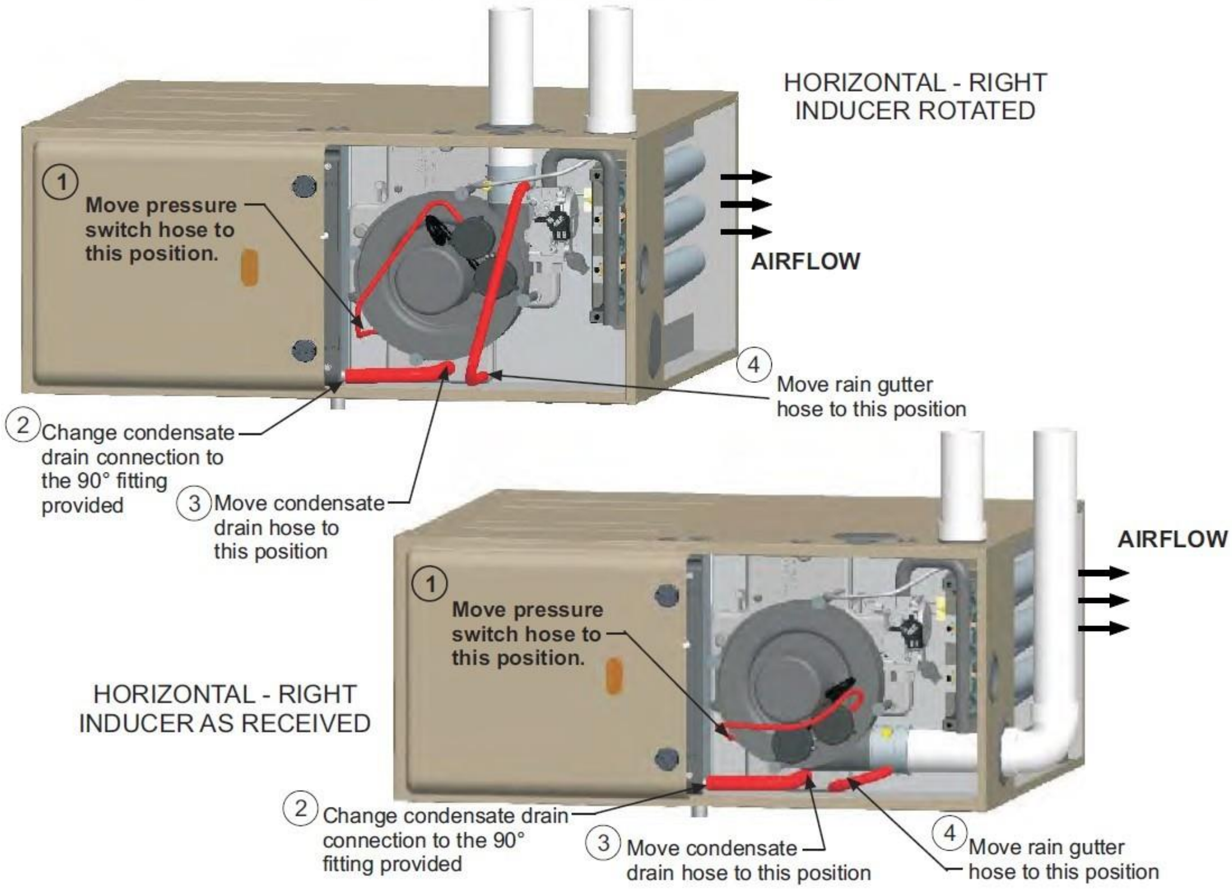


Evaporator Coil Installation

If a matching evaporator coil is used, it may be placed directly on the furnace outlet and sealed to prevent leakage. The evaporator coil must only be installed in the supply air duct, downstream of the furnace.

Follow the coil installation instructions for installing the supply plenum. On all installations without a coil, a removable access panel is recommended in the outlet duct such that smoke or reflected light would be observable inside the casing to indicate the presence of leaks in the heat exchanger. This cover shall be attached in such a manner as to prevent leaks.

Line (Supply) Voltage

Field wiring to the unit must be grounded.

Provide a power supply separate from all other circuits. Install overcurrent protection and disconnect switch per local/national electrical codes. The switch should be close to the unit for convenience in servicing. With the disconnect or fused switch in the OFF position, check all wiring against the unit wiring label.

Remove the screws retaining the junction box cover. Route the power wiring through the opening in the unit into the junction box with a conduit connector or other proper connection. In the junction box there are three wires: black, white, and green.

The black furnace lead must be connected to the L1 (hot) wire from the power supply. The white furnace lead must be connected to neutral. Connect the green furnace lead (equipment ground) to the power supply ground. An alternate wiring method is to use an approved field provided 2" (5.08 cm) x 4" (10.2 cm) box and cover on the outside of the furnace. Route the furnace leads into the box using a protective bushing where the wires pass through the furnace panel. After making the wiring connections replace the wiring box cover and screws.

The furnace control system requires correct polarity of the power supply and a proper ground connection. The furnace will not operate until the polarity is correct. To verify, measure voltage between L1 and neutral, then compare the reading with L1 and ground. These readings should be within three volts of each other. A reading taken between neutral and ground should read zero volts.

Control Wiring

Install the field-supplied thermostat by following the instructions that come with the thermostat. Use of a quality thermostat is recommended for best performance and occupant comfort. Triac-switching and power stealing thermostats should be avoided since these thermostats may have compatibility issues.

With the thermostat set in the OFF position and the main electrical source disconnected, connect the thermostat wiring from the wiring connections on the thermostat to the terminal strip on the furnace control board.

Apply strain relief to the thermostat wires passing through cabinet. If air conditioning equipment is installed, use thermostat wiring to connect the Y and C terminals on the furnace control board to the outdoor unit.

The 24-volt, 40 VA transformer is sized for the furnace components only, and should not be connected to power auxiliary devices such as humidifiers, air cleaners, etc. The transformer may provide power for an air conditioning unit contactor.

For additional connection diagrams for all Unitary Products equipment refer to “Line Voltage System Wiring” document available online at www.solutionnavigator.com in the Product Catalog Section.

Control Wiring: Communicating

Two-stage furnace models with the “C” designator in the model number are communication capable. When installed with the Unitary Products Residential Communicating Control System, the four-wire connection from the system is wired to the COMM terminals on the furnace control board, either through the plug connection or the four-wire terminal block labeled A+, B-, R, C.

Electronic Air Cleaner (EAC)

A ¼" spade terminal labeled EAC is provided for electronic air cleaner connection on the control board. This terminal provides 120 volts AC (1.0 amp maximum) during circulating blower operation. 120 volts AC neutral for the EAC is provided on the "NEUTRALS" ¼" terminals on the control board.

Humidifier (HUM)

A ¼" spade terminal labeled HUM is provided for humidifier connection on the control board. This terminal provides 120 volts AC (1.0 amp maximum) during heating system operation after the gas valve is energized and flame has been sensed. 120 volts AC neutral for the humidifier is provided on the "NEUTRALS" ¼" terminals on the control board.

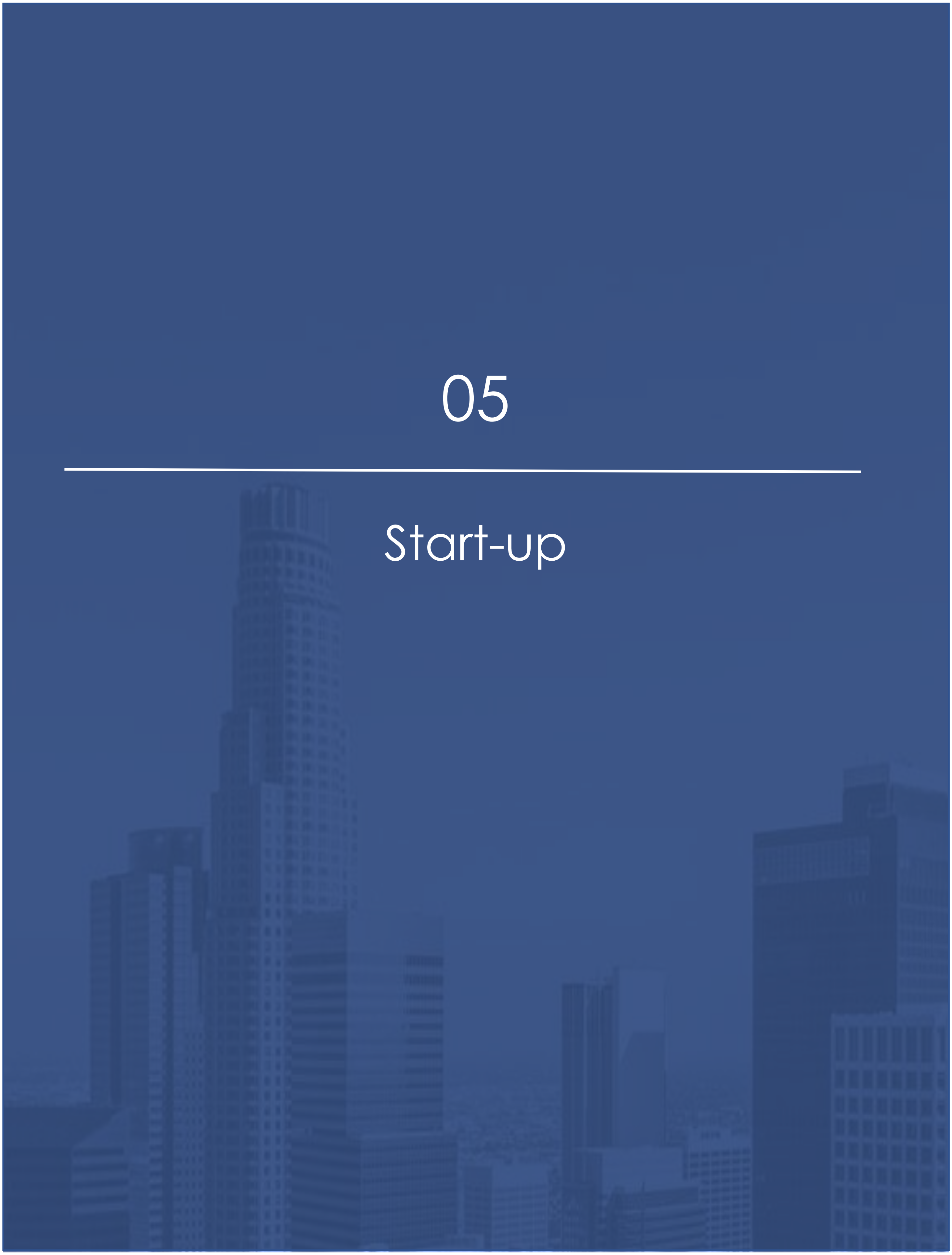
Twinning (Legacy PSC Models Only)

Twinning is only allowed on two stage furnaces with PSC blower motors. Do not twin two stage furnaces that use variable speed blower motors. If the heat loss of the structure indicates that two furnaces are required, either the furnaces must use a common duct system with one thermostat or the furnaces must be used with separate duct systems and thermostats.

In twinning applications, the furnaces must be identical with the same model number, BTU output, and CFM capacity. In addition, the boards on the two furnaces must be from the same vendor. If the boards are not the same, they will fail to properly communicate.

When two furnaces are twinned, the total system airflow is decreased to around 85% of the sum of the individual furnaces. For example, two 2000 CFM units will not yield the full 4000 CFM, but approximately 3400 CFM. Further considerations regarding the twinning of 33” two stage gas furnaces include:

- Twined furnaces must be on the same power source or line leg (phase). It is imperative that the electrician is aware of this requirement in order to properly balance the electrical load. Failure to do this may result in control voltage polarity issues and a “rapid red” flash vault code.
- The “TWIN” and “C” terminals must be connected between each board and “W” of the slave unit. Use isolation relays to prevent the slave unit’s safety from being bypassed. This will also protect from any chance of low voltage back feed.



05

Start-up

Ducted Systems Residential Start-up Form

The Start-up Form is for use with all Ducted Systems Residential Products. The Start-up form is found on the last pages of the Installation Manual. The questions asked in this form will help you complete and do a thorough start-up of the gas furnace.

Before Continuing…
Prior to start-up, all of the installation procedures outlined in the furnace Installation Manual must be completed. This includes gas piping, electrical wiring, venting, duct connections, and condensate drain connection.

Required Tools and Information

Contact the local gas supplier to obtain the heating value of the natural gas. This information will be needed in calculating the input to the furnace. If the heating value varies greatly from 1030 btu/cu ft, an orifice change may be required to make sure that the furnace has 100% of its nameplate input rating available to it. See the section in the Installation Manual entitled “Calculating Furnace Input”.

The following instruments are required to properly set up the 33” single stage gas furnace:

- Thermometer or portable digital thermometer to verify the supply and return air temperatures. For best accuracy, use thermocouple-type thermometers and probes.
- U-tube manometer or digital manometer should have the ability to read pressures between 0 – 15” w.c. (0-3.73 kPa) to measure the gas line and the manifold pressures.
- Allen wrench (3/32”) for manifold pressure adjustment
- Digital multimeter
- Philips head screwdriver
- ¼” nut driver (all hex head screws on the 33” furnace is ¼”, except for the blower motor bracket screws).

Gas Pipe Leak Check and Bleed

Repair any gas leaks before continuing the start-up process.

With the furnace in operation, check off the pipe joints, gas valve connections and manual valve connections for leakage using an approved gas detector, a non-corrosive leak detection fluid or other leak detection methods. Take appropriate action to stop any leak. If a leak persists, replace the faulty component. The furnace must be isolated from the gas supply piping system by closing the equipment shutoff valve during any pressure testing of the gas supply system.

To bleed air from the gas line, it is recommended that when the gas supply is first connected to the furnace, the ground union is loosened until the odor of gas is detected. When the gas is detected, immediately tighten the union, and check for gas leaks. Allow five minutes for any gas to dissipate before continuing with the start-up procedure. Be sure that proper ventilation is available to dilute and carry away any vented gas.

Line Pressure Management

Line pressure is measured on the inlet side of the gas valve. Line pressure to the valve should not exceed the values on the furnace rating plate. The minimum and maximum supply pressures are listed on the furnace's rating plate.

To attain the full nameplate input of the furnace, the inlet pressures should be between 4.5" – 7" w.c. for natural gas applications, 11" – 14" w.c. for LP. The minimum inlet pressure should be checked with all appliances on the building operating at full capacity.

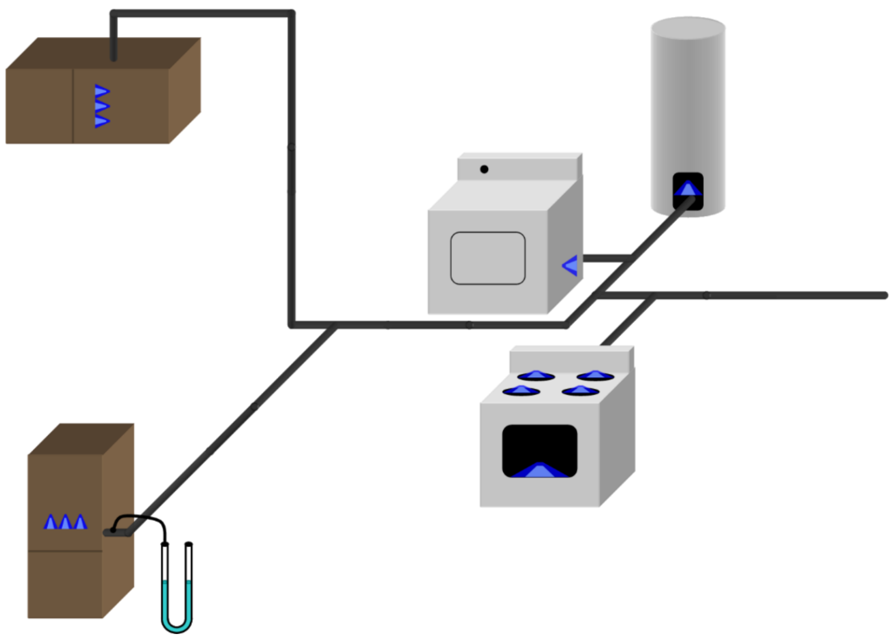
Inlet Gas Pressure

Before measuring the gas line pressure, ensure that the furnace is properly equipped to utilize the gas type being supplied. Refer to the furnace's rating plate for this information. The 33" gas furnaces require a gas conversion kit for use with propane (LP) gas.

Turn off the manual shut off valve in the gas line. Loosen the 3/32" allen plug ONE FULL TURN, but do not remove.

Place the manometer tube (or boot) over the inlet pressure fitting. Slowly open the manual gas shut off valve and observe the line pressure. Turn on all other gas appliances in the structure if accessible to ensure that line pressure does not drop with the other appliances in operation. If it drops significantly with the other appliances in operation, a problem with the gas supply and/or pipe sizing may be indicated and must be corrected.

After the line pressure has been verified and is adequate, the proper gas manifold pressure must be established.



Nominal Manifold Pressure

The manifold gas pressure must ALWAYS be properly set up during furnace installation and verified during service. All 33" two stage gas furnaces are shipped for use with natural gas. If LP 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 pressure must ALWAYS be properly set up during furnace installation and verified during service.

High Fire 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
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.)

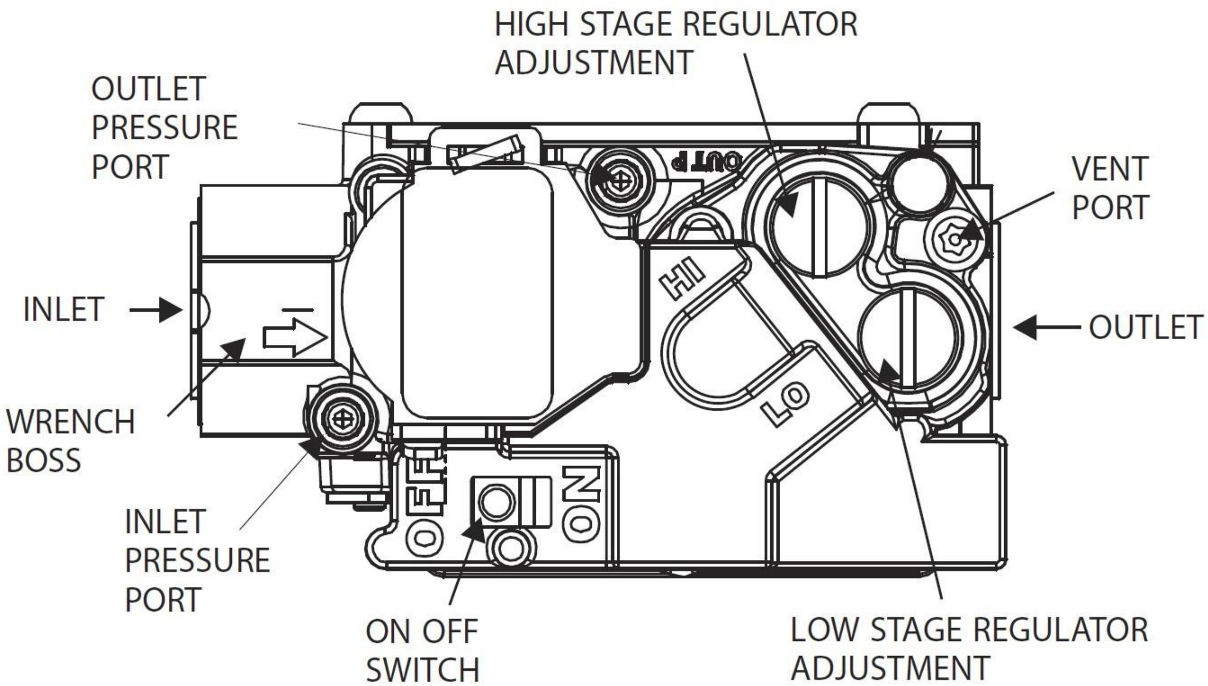
Heating Value (BTU/cu ft.)	0-7999 feet	8000-8999 feet	9000-9999 feet
800	1.7	1.7	1.7
850	1.7	1.7	1.7
900	1.7	1.7	1.7
950	1.7	1.7	1.5
1000	1.6	1.5	1.4
1050	1.5	1.4	1.3
1100	1.3	1.2	1.1
2500 (LP)	4.1	3.8	3.5

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 the furnace Installation Manual.

The furnace may be locked into high fire for testing purposes by energizing W/W1 and W2 simultaneously. When connected to a Residential Communicating Control System, the mode of operation may be selected through the Forced Operation sub screen of Service mode access.

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

The regulator adjustments for both high and "low fire" are underneath separate slotted screwcaps. To measure manifold gas pressure, remove the furnace door covering the vestibule area.



Two Stage Gas Valve

Loose the 3/32" outlet pressure tap Allen plug ONE FULL TURN, but do not remove. Place the manometer tube (or boot) over the outlet pressure fitting.

Adjustments to the manifold pressure are made by removing the screw cap from the high or "low fire" regulator adjustment, turning the 3/32" Allen adjustment clockwise to increase manifold pressure, and counterclockwise to reduce manifold pressure. The "high fire" and "low fire" regulators are adjusted independently.

After adjusting the manifold pressure to the recommended setting, be sure to replace the screw caps on the gas valve and tighten the outlet pressure tap fitting(s).

Burner Flame Inspection

The flames must be blue in color and extend from the burner directly through the openings in the vestibule panel and into the heat exchanger. A yellow or lazy flame indicates a combustion problem, which must be investigated and corrected.

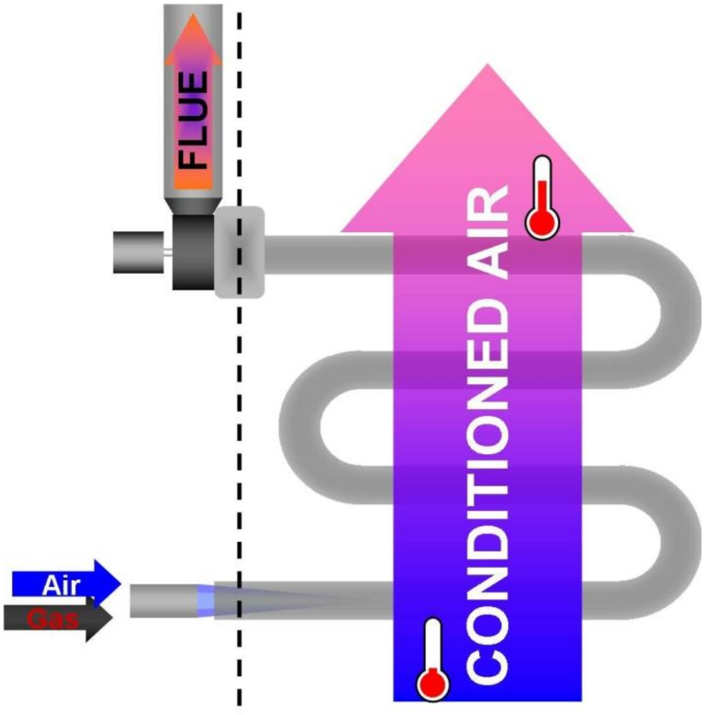
Calculating Furnace Input (Clocking the Meter)

Be sure to follow the procedure outlined in the furnace Installation Manual for clocking the gas meter. This process confirms that the furnace is firing at 100% of the nameplate input.

Burner orifices are sized to provide proper input rate using natural gas with a heating value of 1030 BTU/Ft3 (38.4 MJ/m3). If the heating value of the gas is significantly different, it may be necessary to replace the orifices.

Temperature Rise Measurement

Temperature is the difference between the temperature of the return air and the heated supply air leaving the furnace. Temperature rise must be measured during installation and must be within the range on the furnace rating plate. This is important not only for the longevity of the furnace but also for customer comfort.



Temperature Rise

The furnace should be operating in the heating mode for approximately 20 minutes prior to taking temperature measurements. Take readings of both the return air and the heated air in the ducts, about six feet (1.83 m) from the furnace where they will not be affected by radiant heat. Subtract the return air temperature from the supply air temperature to determine the temperature rise.

Temperature Rise Adjustment

The temperature rise must be within the range shown on the furnace rating plate and within the application limitations shown on the furnace rating plate.

The blower motor speed is increased to reduce the temperature rise, and the blower speed is reduced to increase the temperature rise.

The ECM model “HEAT” control board jumper must be set to a value that allows the “high fire” temperature rise to be within the temperature rise range listed on the furnace data plate. “Low fire” heating blower speed is automatically calculated based on the selected HEAT (high fire) jumper setting. The (legacy) PSC model control board provides taps for heating blower speed selection for both HI HEAT and LO HEAT. Selected blower speeds must allow the temperature rise to remain within the range indicated on the furnace data plate in both first and second stage heating modes.

The blower motor speed taps are located at the furnace control board. Refer to the unit-wiring label to change the blower speed. Blower motor speeds commonly follow these color codes:

To use the same speed tap for heating and cooling, the “HEAT” terminal and “COOL” terminal must be connected using a jumper wire and connected to the desired motor lead. Place all unused motor leads on Park terminals.

If the temperature rise cannot be brought within the range allowed on the furnace rating plate, make sure there are no problems in the duct system (i.e., high external static pressure) restricting proper airflow through the system.

To check for airflow problems:

- Verify that filters are clean, and all registers and heat runs are open.
- Check duct system for excessive restriction with the use of a Magnehelic gauge or incline manometer.

Standard ECM and Legacy PSC Indoor Fan Motors

Speed tap adjustments are made at the blower speed selections on the furnace control board as noted.

Cooling Blower Speed: Standard ECM and Legacy PSC Models

It is often believed that the cooling blower speed should always be positioned at the highest setting. This is not true for every application. If the airflow is set too high for the application, proper dehumidification of the return air won't occur, and the desired temperature drop across the evaporator coil will not be obtained. If the airflow is set too low, frost and ice may form on the evaporator coil, which will lead to eventual refrigerant flood back to the compressor. For the best possible comfort and equipment longevity, the ESP should be measured and used with the blower charts provided to determine the best speed to use for the application.

Cooling CFM

For optimum performance, 400 CFM per ton of air conditioning is generally used. For instance, a 3-ton system should have 1200 CFM of air moving through the evaporator coil.

To determine the total external static pressure, both the supply and return static pressures must be measured.

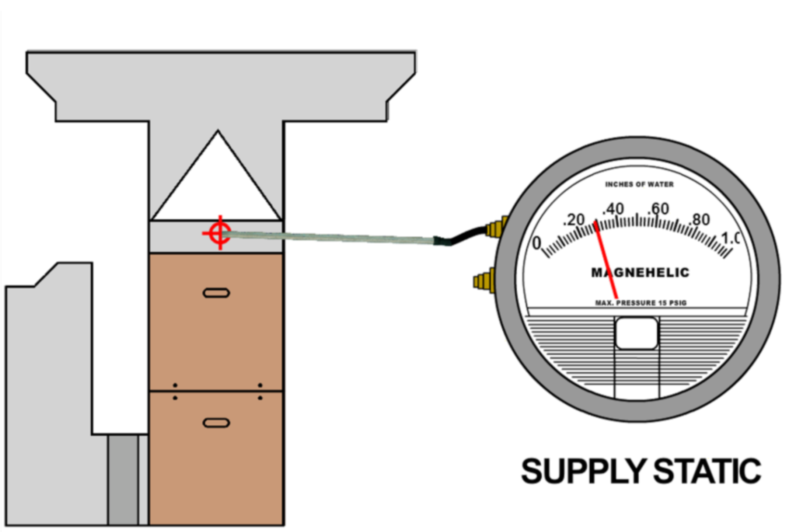
Legacy PSC and Standard ECM Models: Both stages require airflow selection

For two stage air conditioning systems, the first stage cooling blower airflow selection should provide approximately 67% of the second stage cooling blower capacity.

As an example, on a 3-ton system (1200 CFM), the HI COOL tap selected should deliver 1200 CFM, the LOW COOL tap selected should deliver approximately 804 CFM (1200* .67).

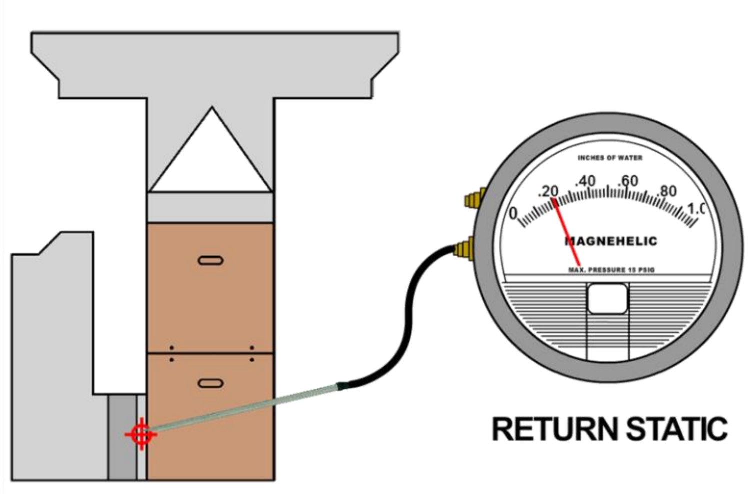
Since airflow is being set up for the cooling mode, create a call for cooling. If outdoor conditions are too cold for outdoor unit operation, switch off the outdoor unit disconnect switch.

To measure the supply static pressure, connect the Magnehelic gauge probe to the port marked "high". The probe is inserted immediately off the supply duct connection, under the evaporator coil if possible. This allows the measurement of the supply static pressure and resistance to airflow imposed by the evaporator coil, supply duct, fittings, and registers. A common supply value for the properly designed supply duct system with a clean, dry, evaporator coil is .3" to .35" w.c.



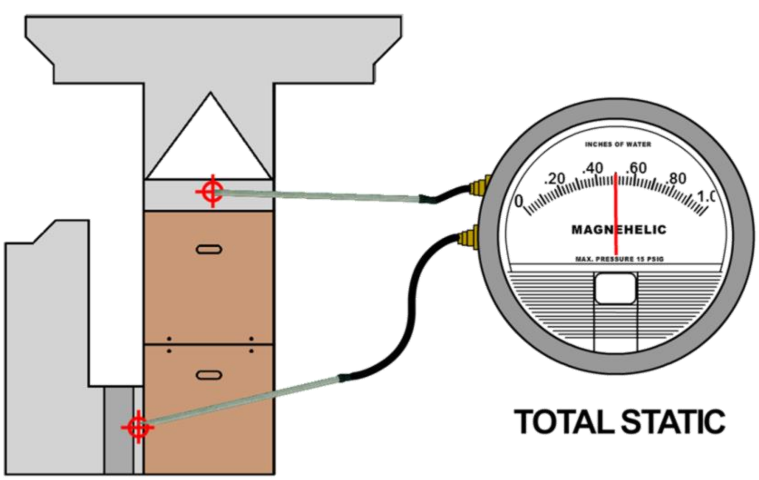
Supply Static Measurement

To measure the return static pressure, connect the Magnehelic probe to the port marked “low”. The probe is inserted between the filter and the furnace. This allows the measurement of the return static pressure and resistance to airflow imposed by the filter, return drop, return ductwork, fittings and grilles. If access cannot be obtained between the furnace and the filter, another location to measure return static is through a grommet on the side of the blower section.



Return Static Measurement

The total external static pressure is determined either by taking the supply and return static pressures individually and adding them, or simply by using two probes and noting the reading on the gauge.



Total Static Measurement

After the total external static pressure has been determined, apply the total static pressure to the blower performance chart for the furnace or air handler model being serviced. The CFM being delivered will be where the ESP reading intersects with the blower speed being used.

Remember that 400 CFM per ton is the target value for second stage cooling. If required, change the blower speed to get as close as possible to 400 CFM per ton.

The blower performance charts provided with the 33" single stage gas furnaces indicate blower performance without filters in place. To determine the CFM performance at the blower speed being used, take the external static measurements without the filter(s) in place. Then follow the procedure outlined in the Installation Manual to adjust for the pressure drop (loss of CFM) through the filter type used.

After a blower speed change, recheck the total ESP and consult the blower performance chart to verify CFM.

If working with a furnace and the blower charts are not available, use the following procedure to determine an approximate CFM.

- Verify the furnace is firing at 100% of its nameplate input.
- Set the blower speed to the speed tap intended for use for cooling.
- After 15 minutes of furnace operation, measure the temperature rise across the furnace.
- Put the temperature rise into this formula: BTU Output/1.085 x Temp Rise.
- 400 CFM/Ton is the desired target value.

For example: an 80,000 BTUH furnace that has an AFUE of 90, gives us 72,000 BTUH net output. 72,000 divided by (1.085 x the temp rise (50). 72,000 divided by 54.25 is 1327.19 CFM. At 400 CFM per ton, this is more than adequate airflow for a three-ton system, which requires 400 CFM for second stage cooling. Adjust the blower speed as required to attain approximately 400 CFM per ton.

Cooling Blower Speed: Variable Speed ECM Models

On variable speed ECM models, the cooling blower speed is established by adjustment of the COOL, ADJUST, and DELAY jumpers on the furnace control board. The blower programmed airflow target is matched to the capacity of the air conditioning system installed and provides 400 CFM per ton of air conditioning. For two stage air conditioning systems, the first stage cooling blower airflow target is proportionally reduced to provide 67% of the second stage cooling blower speed. Jumper selection charts are provided in the model-specific Installation Manual.

On communication-capable furnace models ("C" in the model number) and when installed with the Unitary Products Residential Communicating Control System, airflows may be established with the touchscreen Master control. Consult the Residential Communicating Control System Field Reference Guide for instructions as to the method of entering ServiceMode on the touchscreen and configuring airflow for the application. Settings established through the touchscreen will take precedence over hard-jumper values present on the control board.

Continuous Fan Operation

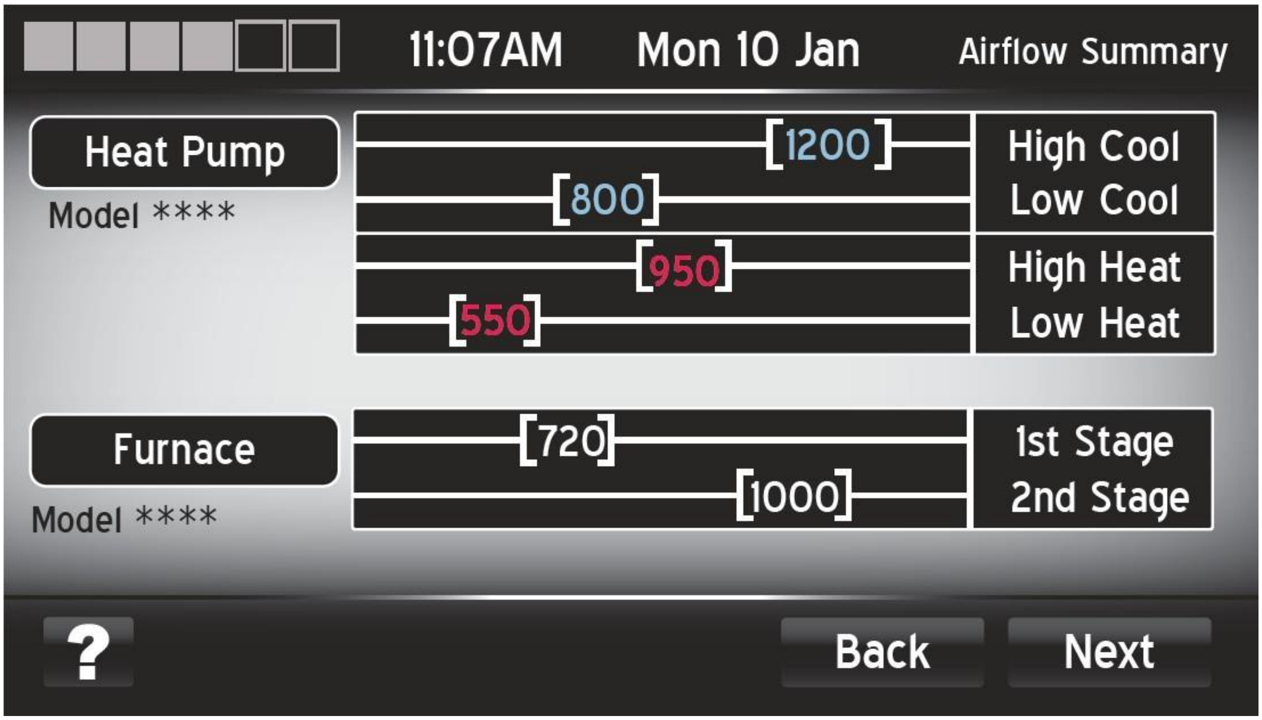
On PSC models, the airflow delivered by the furnace during continuous fan operation (“Fan On”) is the selected heating speed on control boards without a “Cont Fan” blower speed connection. Control boards with a “Continuous Fan” terminal will energize the blower speed that is connected to it with a “Fan On” call.

Variable speed ECM models use the “FAN SPEED” jumper to determine the continuous fan speed. Standard ECM models use the “BLOWER SPEED” jumper for continuous fan speed selection.

Service Access in a Legacy Communicating System

When the two-stage furnace is installed with the Legacy Residential Communicating Control System, the Communicating Control Master touchscreen serves as the basis of set-up and system diagnosis.

Service Mode allows view and evaluation of all system operation, including fault codes in history. Additionally, system operation may be forced from the Master and “hard” jumpers on the furnace control board may be overridden with the selection of “soft” jumper settings on the touchscreen.



Airflow Summary Screen – Heat Pump and Two Stage Furnace

Through this interface, airflow may be precisely tailored to the functional requirements of the installation site. For additional information on configuration within the Communicating Control System, refer to the Residential Communicating Control Field Reference Guide.

06

Sequence of Operation

Introduction

Important
A complete understanding of the sequence of operation of the product being serviced is imperative to success as a service technician. This chapter provides insight on the heating mode, cooling mode, and continuous fan sequence of operation of Unitary Products two stage gas furnaces.

Heating Mode

Most of today's induced draft gas furnaces, no matter the ignition system type, use a similar sequence of operation for heating mode. The 33" two stage gas furnaces are no different. The basic sequence of operation is as follows:

1. A call for heat occurs when the thermostat closes the R-W1/W2 circuit.
2. The induced draft blower starts.
3. The operation of the induced draft blower is proven with a pressure switch.
4. The ignition sequence begins.
5. Flame is established and proven.
6. The main blower is energized.

The sequence of operation between the Standard ECM, variable speed ECM, and PSC models is identical except for the circulating air blower operation. The following section reviews ECM model operation, with PSC model differences commented as applicable.

System Standby – 120 Volts AC

During system standby, after passing through the blower door switch, 120 volts AC is provided to the furnace control board at the L1 terminal. L1 is sent to the ECM blower motor at pin 5, the furnace transformer through the XFMR terminal, and the flame sensor through pin 3 of the 12-pin plug connector.

120 volts AC common is connected to the “Neutrals” terminal block. This provides 120 volts AC common to the ECM blower motor at pin 4 of the 5-pin blower motor plug connector, the hot surface ignitor through pin 5 of the 5-pin plug connector, the inducer, the primary side of the furnace transformer, and the EAC and HUM (if installed).

System Standby – 24 Volts AC

The transformer sends 24 volts AC to the control board through pin 5 “hot” and pin 9 “common” on the 12-pin plug connector.

24 volts AC “hot” is present at the “R” terminal on the control board terminal strip, and at the “C” of the “high fire” pressure switch, sent through pin 1 of the 12-pin plug connector.

When there is no call for heat, cooling, or continuous fan from the wall thermostat, the primary limit and rollout switch string are monitored continuously. This is accomplished by sending 24 volts AC out on pin 6 of the 12-pin plug connector. The control board expects to see the 24 volts AC back on pin 11 of the 12-pin plug connector. 24 volts AC common is connected to “C” on the furnace terminal strip and “C” on the gas valve.

System Standby – Ground

Pins 4 and 10 on the 12-pin plug connector are connected to “ground”, a sheet metal connection within the cabinet. This connection is critical for proper flame sensing. This, of course, is also dependent that an adequate ground has been connected to the furnace.

The ECM blower and the inducer are also connected to ground. These connections are important for technician safety. If a motor winding is shorted to ground, the circuit breaker will open, preventing electrical shock.

First Stage Heat Call

A call for first stage heat is initiated by 24 volts AC passing through the thermostat to the W1 terminal. The control board initiates the following sequence.

Start of Cycle: Pressure Switches Must Be Open

The pressure switch strings are verified to make sure the switches are open and have not failed (closed) or bypassed with a jumper wire. If one ore more of the switches is closed, the heating cycle is halted and a fault code of two red flashes is displayed. The control looks for the absence of 24 volts AC at pins 2 and 12 of the 12-pin plug connector for this verification.

Induced Draft Blower Starts

The inducer is energized on high speed through pin 2 of the 5-pin plug connector. This is pre-purge, and the inducer is energized at high speed at this time, even with a single stage heat call. The HUM terminal is energized with 120 volts AC.

Pressure Switches Close

The control checks closure of the “low fire” and “high fire” pressure switches by 24-volt AC input at pin 12 of the 12-pin plug connector (blocked drain and “low fire” pressure switches) and pin 2 of the 12-pin plug connector (“high fire” pressure switch). Closure of the “high fire” pressure switch sends 24 volts to the HI terminal of the gas valve; however, the gas valve does not open without the “M” (“low fire”) terminal energized.

Ignition Sequence Begins

The hot surface ignitor (HSI) is energized with 120 volts AC through pin 1 of the 5-pin plug connector, and is allowed to warm up for 17 seconds.

24 volts AC is sent from pin 7 of the 12-pin plug connector to the “M” terminal on the gas valve. With both the “M” and “HI” gas valve terminals energized, the gas valve opens at “high fire” manifold pressure.

Flame Proof

Presence of flame must be proven within a few seconds. The flame sensor sends 120 volts AC into the flame, and is rectified through the flame to DC to ground. The DC current flow is picked up by the furnace control board connections to ground.

A flame current pad is present on the furnace control board. This pad allows measurement of flame current using a DC voltmeter .1 volt DC (1 uA (microamp).

Under normal conditions, approximately 3.7 volts DC (3.7 volts DC, which equals 3.7 microamps) should be measured at the flame current pad. The furnace control board requires at least .1 volts AC (.1 microamps) to allow the heating cycle to continue, and will indicate a weak flame signal (via amber flash code on the LED) if the flame current drops below 1.5 microamps.

Inducer Speed is Reduced

The inducer speed is dropped to “low fire” heat speed by de-energizing pin 2 (high speed) of the 5-pin plug, while energizing pin 3 (low speed). The “high fire” pressure switch opens, de-energizing the HI terminal on the gas valve. The gas valve reduces the manifold pressure to “low fire”.

Blower Energizes

The blower motor is energized at the “low fire” heat speed 30 seconds after the flame proof. The control board initiates circulating air blower operation as follows:

PSC Motors

120-volt AC output to “LO HEAT” terminal.

Standard ECM Motors

24-volt AC output to “LO HEAT” terminal.

Variable Speed ECM Motors

A “PWM Enable” signal of approximately 20-volt DC is sent to the motor between pins 1 and 4, and should be measurable at every blower run cycle.

The PWM signal, measurable between pins 2 and 5 with a digital multimeter with a Duty Cycle setting, corresponds to the commanded blower speed in CFM as shown.

During blower operation, the EAC terminal is energized with 120 volts AC.

Second Stage Heat Call

A second stage heat call is initiated by the thermostat sending 24 volts AC to the "W2" terminal and "W1" terminal simultaneously.

- The pressure switch strings are verified to make sure the switches are open, and have not failed "closed" or are bypassed with a jumper wire. If one or more of the switches is closed, the heating cycle is halted and a fault code of two red flashes is displayed. The control looks for absence of 24 volts AC at pins 2 and 11 of the 12-pin plug connector for this verification.
- The inducer is energized on high speed through pin 2 of the 5-pin plug connector. This is considered "pre-purge".
- The HUM terminal is energized with 120 volts AC.
- The control checks for closure of the "low fire" and "high fire" pressure switches by 24-volt AC input at pin 12 of the 12-pin plug connector ("high fire" pressure switch). Closure of the "high fire" pressure switch sends 24 volts to the HI terminal of the gas valve; however, the gas valve does not open with the "M" ("low fire") terminal energized.
- The HSI is energized with 120 volts AC through pin 1 of the 5-pin plug connector, and is allowed to warm up for 17 seconds.
- 24 volts AC is sent from pin 7 of the 12-pin plug connector to the "M" terminal on the gas valve. With both the "M" and "HI" gas valve terminals energized, the gas valve opens at "high fire" manifold pressure.
- Presence of flame must be proven within a few seconds. The flame sensor sends 120 volts AC into the flame, and is rectified through the flame to DC to ground. The DC current flow is picked up by the furnace control board.

Blower operation is as follows for the blower types noted:

PSC Motors

120-volt AC output to "HI HEAT" terminal.

Standard ECM Motors

24-volt AC output to "HI HEAT" terminal.

Variable Speed ECM Motors

A "PWM Enable" signal of approximately 20-volt DC is sent to the motor between pins 1 and 4, and should be measurable at every blower run cycle.

The PWM signal, measurable between pins 2 and 5 with a digital multimeter with a Duty Cycle setting, corresponds to the commanded blower speed in CFM as shown.

During blower operation, the EAC terminal is energized with 120 volts AC.

- The EAC terminal is energized with 120 volts AC.
- The thermostat terminates the call for heat by opening the R-W1-W2 circuit. The gas valve is de-energized immediately, and the inducer is energized on high speed for a 15-second post purge. At the conclusion of the post purge period, the inducer is de-energized, the HUM terminal is de-energized, and both the "high fire" and "low fire" pressure switches open.
- The selected "blower off-delay" timing begins, and the blower motor will continue to run until the selected delay time expires. The EAC terminal is de-energized with the blower.

Cooling Mode

First Stage Cooling (Single Stage System)

"R" to "Y" thermostat contacts close and compressor "Y/Y2" terminal is energized.

The outdoor unit compressor contactor is directly connected to the "Y/Y2" and "C" terminals, and is energized immediately, starting the compressor and the condenser fan.

Blower operation is as follows for the blower types noted:

PSC Motors
120-volt AC output to "LO COOL" terminal.

Standard ECM Motors
24-volt AC output to "LO COOL" terminal.

Variable Speed ECM Motors
A "PWM Enable" signal of approximately 20-volt DC is sent to the motor between pins 1 and 4, and should be measurable at every blower run cycle.

The blower begins operation at 67% of the selected cooling blower speed, with the PWM Enable signal (approximately 20 volts DC between pins 1 and 4) and a PWM signal between pins 2 and 5. The PWM signal, measurable between pins 2 and 5 with a digital multimeter with a Duty Cycle setting and corresponds to the commanded blower speed in CFM as shown.

During blower operation, the EAC terminal is energized with 120 volts AC.

Cooling Mode – First Stage (Two Stage Cooling System)

First stage cooling mode is initiated when 24 volts AC is received at the "Y1" terminal. The "Y1" terminal is connected to "Y1" on the outdoor unit and is energized immediately, starting the first stage compressor and the condenser fan.

Blower operation is as follows for the blower types noted:

PSC Motors
120-volt AC output to "LO COOL" terminal.

Standard ECM Motors
24-volt AC output to "LO COOL" terminal.

Variable Speed ECM Motors
A "PWM Enable" signal of approximately 20-volt DC is sent to the motor between pins 1 and 4, and should be measurable at every blower run cycle.

The blower begins operation at 67% of the selected cooling blower speed, with the PWM Enable signal (approximately 20 volts DC between pins 1 and 4) and a PWM signal between pins 2 and 5. The PWM signal, measurable between pins 2 and 5 with a digital multimeter with a Duty Cycle setting and corresponds to the commands blower speed in CFM as shown.

During blower operation, the EAC terminal is energized with 120 volts AC.

Second Stage Cooling (if equipped)

Second stage cooling mode is initiated when 24 volts AC is received at the “Y/Y2” terminal. The “Y/Y2” terminal is connected to “Y2” on the outdoor unit and is energized immediately, starting the second stage compressor and the condenser fan.

Blower operation is as follows for the blower types noted:

PSC Motors
120-volt AC output to “HI COOL” terminal.

Standard ECM Motors
24-volt AC output to “HI COOL” terminal.

Variable Speed ECM Motors
A “PWM Enable” signal of approximately 20-volt DC is sent to the motor between pins 1 and 4, and should be measurable at every blower run cycle.

The blower begins operation at 100% of the selected cooling blower speed, with the PWM Enable signal (approximately 20-volts DC between pins 1 and 4) and a PWM signal between pins 2 and 5. The PWM signal, measurable between pins 2 and 5 with a digital multimeter with a Duty Cycle setting and corresponds to the commanded blower speed in CFM as shown.

During blower operation, the EAC terminal is energized with 120-volts AC.

Continuous Fan (Recirculation Mode)

Continuous fan operation is initiated when 24 volts AC is received at the “G” terminal. Blower operation is as follows for the blower types noted:

PSC Motors
120-volt AC output to “CONT” terminal.

Standard ECM Motors
24-volt AC output to speed tap selected with the “CONT SPEED” selector switches on the furnace control board.

Variable Speed ECM Motors
The blower speed for continuous fan operates at the speed selected with the FAN SPEED jumper on the furnace control board.

A “PWM Enable” signal of approximately 20-volt DC is sent to the motor between pins 1 and 4, and should be measurable at every blower run cycle.

The blower begins operation at the selected continuous fan blower speed, with the PWM Enable signal (approximately 20 volts DC between pins 1 and 4) and a PWM signal between pins 2 and 5. The PWM signal, measurable between pins 2 and 5 with a digital multimeter with a Duty Cycle setting and corresponds to the commanded blower speed in CFM as shown.

During blower operation, the EAC terminal is energized with 120-volts AC.

07

Troubleshooting

Introduction

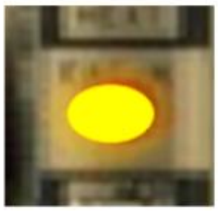
All 33” two stage gas furnace control boards have built-in self-diagnostic capability, which is provided through a tri-color LED. The LED flashes red, green, and amber to indicate various conditions.

Regarding LED Codes
Do not use the LED codes blindly. The LEDs point the technician in the right direction, but a solid foundation of fundamental troubleshooting techniques is critical to effective service. As an example, a flash code of three red flashes indicates that the normally open pressure switch contact did not close after the inducer was energized. This is not an indication to replace the switch! There is more than likely a reason that the switch has not closed, such as a restriction in the vent system, disconnected pressure switch tubing, etc.

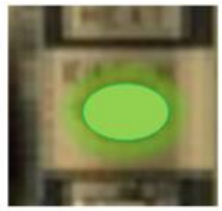
Tri-Color LED

The LED is mounted on the furnace control board and is visible through the clear view port in the blower compartment door. If a system problem occurs, a blinking LED shows a RED flash code. GREEN flashes indicates normal standby operation. AMBER flashes are used to indicate system status.

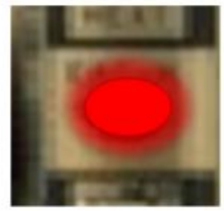
Red Flash: System Fault
Slow Green Flash: Normal Operation
Slow Amber Flash: Normal operation with call for heat



Amber LED



Green LED



Red LED

The control continuously monitors its own operation and the operation of the system. If a failure occurs, the LED will indicate the failure code. If the failure is internal to the control, the light will stay on continuously. Before continuing, power to the control board should be disconnected and re-energized. If the light comes back on continuously, the entire control has failed and should be replaced. The control is not field repairable.

Flash sequence codes 1 through 10 are as follows: LED will turn “ON” for ¼ second and “OFF” for ¼ second. This pattern will be repeated the number of times equal to the code. For example, six “on” flashes equals a number 6 fault code. All flash code sequences are broken by a 2 second “OFF” period.

Flash Code	Description
Rapid Red	Twinning error, incorrect 24-volt phasing. Check twinning wiring.
Rapid Amber	Flame sense current is below 1.5 microamps. Check for proper gas flow. Check and clean flame sensor. Normal flame sense current is approximately 3.7 microamps DC. Low flame signal warning starts at 1.5 microamps. Low flame signal control lockout point is 0.1 microamps DC.
4 Amber	The control board is receiving a “Y” signal from the thermostat without a “G” signal, indicating improper thermostat wiring.
1 Red	This indicates that flame was sensed when there was not a call for heat. With this fault code the control will turn on both the inducer motor and supply air blower. A gas valve that leaks through or is slowly closing would typically cause this fault.
2 Red	This indicates that the normally open pressure switch contacts are stuck in the closed position. The control confirms these contacts are open at the beginning of each heat cycle. This would indicate a faulty pressure switch or miswiring.
3 Red	This indicates the normally open pressure switch contactdid not close after the inducer was energized. This could be caused by a number of problems: faulty inducer,blocked vent pipe, broken pressure switch hose or faultypressure switch.
4 Red	This indicates that a primary or auxiliary limit switchhas opened its normally closed contacts. With this faultcode, the control will operate the supply air blower andinducer. This condition may be caused by a dirty filter, improperly sized duct system, incorrect blower speed setting, incorrect firing rate, or faulty blower motor.
5 Red	This fault is indicated if the normally closed contact in the rollout switches open. The rollout control is manually reset. If it has opened, check for proper combustion air, proper inducer operation, and primary heat exchanger failure or burner problem. Be sure to reset the switch after correcting the failure condition.
6 Red	This indicates after the furnace was operating, the pressure switch opened 4 times during the call for heat. If the main blower is in a “delay on” mode it will complete it, and any subsequent delay off period. The furnace will lock out for one hour and then restart.
7 Red	This fault code indicates that the flame could not be established. This no-light condition occurred 3 times (2 retries) during the call for heat before locking out. Low gas pressure, faulty gas valve, faulty hot surface ignitor or burner problem may cause this code. The furnace will lock out for one hour and then attempt another heating cycle if a call for heat is still present.
8 Red	This fault is indicated if the flame is lost 5 times (4 recycles) during the heating cycle. This could be caused by low gas pressure or faulty gas valve. The furnace will lock out for one hour and then attempt another heating cycle if a call for heat is still present.
9 Red	Indicates reversed line voltage polarity or grounding problem. Both heating and cooling operations will be affected. Check polarity at the furnace and breaker panel. Check furnace grounding. Check that the flame probe is not shorted to chassis.
10 Red	The gas valve is energized with no call for heat. Check the gas valve and gas valve wiring.
11 Red	This indicates that a primary or auxiliary limit switch has opened its normally closed contacts and has remained open for more than five minutes. This condition is usually caused by a failed blower motor or blower wheel.
12 Red	This code indicates an open ignitor circuit, which could be caused by a disconnected or loose wire or by a cracked or broken ignitor.
Steady on Red	Control failure. Replace the control board.
Slow Green	Normal operation.
Slow Amber	Normal operation with a call for heat.

60-Minute Automatic Reset from Lockout

The furnace control includes a “watchdog” type circuit that will reset from a lockout condition after 60 minutes. Operational faults 6, 7, 8 will be reset. This provides protection to an unoccupied structure if a temporary condition exists causing a furnace malfunction. An example would be a low incoming gas supply pressure preventing furnace operation. When the gas pressure is restored, at some point the “watchdog” would recycle the call for heat and provide heat for the structure.

Last ERROR Button

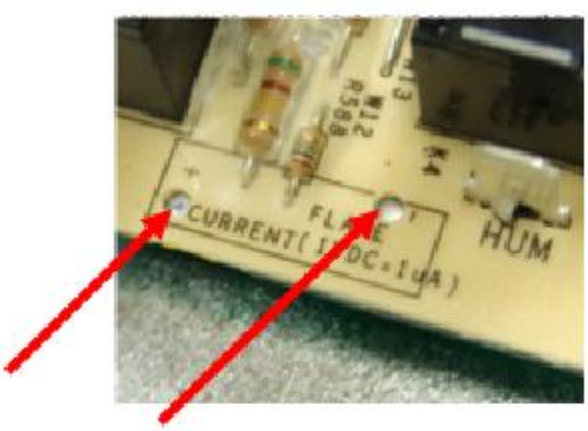
The control is equipped with memory that will store up to five error codes to allow a service technician to diagnose problems more easily. The memory will be retained even if power to the furnace is lost. This feature should only be used by a qualified service technician. The control stores up to five separate error codes. If more than five error codes have occurred since the last reset, only the five most recent faults will be retained. The furnace control board “LAST ERROR” button is used to retrieve error codes. This function will only work if there are not active thermostat signals. Any call for heating, cooling, or continuous fan must be terminated before attempting to retrieve error codes.

Error codes are retrieved by pressing the LAST ERROR button. The LED on the control will flash the error codes that are in memory, starting with the most recent. There will be a two-second pause between each flash code. After the errors codes have been displayed, the LED will resume the normal slow green flash after a five second pause. To repeat the series of error codes, push the button again. If there are no error codes in memory, the LED will flash two green flashes. To clear the memory, push the LAST ERROR button and hold it for more than five seconds. The LED will flash three green flashes when the memory has been cleared, then will resume the normal slow green flash after a five-second pause.

The flame sensor proves the presence of flame during the trial for ignition. The flame sensor consists of a metal flame rod and a ceramic insulator. The flame sensor must be immersed in the flame to perform its function.

During a call for heat, the flame sensor is energized with 120-volts AC from the furnace control board. In the presence of flame, this AC voltage is rectified through the flame to DC current. This is known as flame rectification. This rectified signal is read in DC microamps, but for ease of service, may be read on the furnace control board “test pad” with a multimeter set to DC volts. 1 DC volt = 1 microamp (μA).

Normal μA values are in the 2-4 μA range, with a minimum of .1 μA required for flame proof. If the measured value is negative, the meter leads are reversed. Simply swap their positions on the flame current pad to view the flame signal as a positive number.



There are many factors that cause a low microamp signal. These factors include:

- Line voltage polarity must be correct.
- A dedicated ground wire runs form the furnace junction box to the breaker panel.
- The flame sensor must be clean and in the flame. If cleaning is required, use steel wool.
- The ceramic must be intact with no cracks.
- AC voltage must be present between the flame sensor and ground.

Hot Surface Ignitor (HSI)

If not glowing during warm up, check the ignitor resistance when cold, it should be approximately 40 – 80 ohms cold.

Verify that the correct line voltage is being supplied to the ignitor during warm up. This can be measured by setting a multimeter to AC volts and measuring the AC voltage available to the ignitor at the plastic plug connector that connects the ignitor to the furnace control board.

Gas Valve

The valve must have the proper gas pressure available on the inlet side, and properly set up manifold pressure on the outlet side to function properly. When checking supply/inlet pressure have other nearby or large gas appliances operating to detect possible pressure reduction.

The gas valve used in the 33” single stage gas furnace, is energized with 24-volts AC from the furnace control board during the trial for ignition after the ignitor warm-up period.

Gas Pressure

The valve must have the proper gas pressure available on the inlet side, and properly set up manifold pressure on the outlet side (in both “high fire” and “low fire”). When checking inlet pressure, have all other gas appliances operating to detect possible pressure reduction.

Burners

Discoloration on heat exchanger vestibule may indicate misalignment of burners. Delayed ignition may indicate blockage of crossover ‘wings’ of burners.

Line Voltage Supply

For any modern electronic ignition furnace to work properly, it must have:

- A dedicated electrical circuit. Gas furnaces require their own power supply without any other loads connected.
- Correct Polarity: Line 1 – Hot, must be attached to the black power lead of the furnace.
- Neutral: The neutral/common of line voltage must be connected to the white power lead of the furnace.
- Good/Clean Dedicated Ground: It is absolutely necessary to have a dedicated ground wire run back to ground on the electrical panel.

Safety Switches

Never bypass any safety device. The position of a safety switch (such as a limit switch, rollout switch, or pressure switch) may be verified using one of two preferred methods.

- With an AC voltmeter, take a voltage reading across the terminals of the switch. A closed switch will indicate zero (0) volts AC. An open switch will be indicated by the applied voltage displayed on the meter.
- Turn system power off, disconnect the wiring connected to the switch, and take a resistance reading across the switch with an ohmmeter. An open switch will be indicated as an “infinite” or “open” circuit with an ohmmeter. A closed switch will be indicated an “continuity” or zero ohms resistance.

Pressure Switch Diagnosis (General)

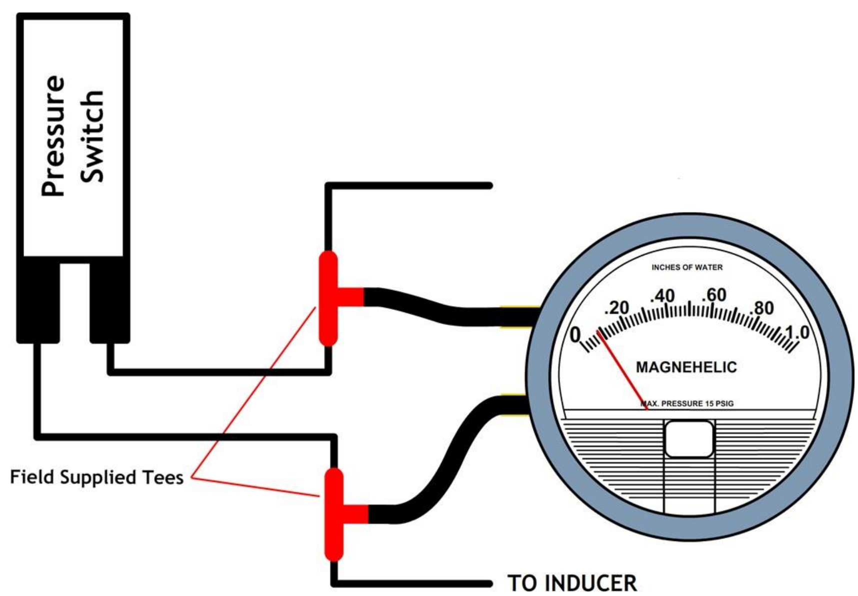
The pressure switch is present to verify that the induced draft motor is coming up to speed and that there are no restrictions within the vent system. Pressure switches are commonly normally open and close upon normal operation after the inducer motor is energized, allowing the ignition sequence to continue.

Information about the closure or “make” pressure of the switch is usually on the switch body. If not, check the literature for the furnace model being serviced.

Closure of the pressure switch contacts can be verified by taking a voltage reading across the switch. 24 volts will be read across the switch. 24 volts will be read across an open switch and will read zero volts if the switch is closed. The wiring to the switch may also be disconnected to test for continuity across the switch with an ohmmeter. A closed switch will read continuity or zero resistance with an ohmmeter.

If the switch is not closing with the inducer operating, the technician must determine if there is a problem with the switch itself, or if there is another problem causing the switch to not close. The best method of doing this is with a Magnehelic gauge or incline manometer. A scale of 0-5” w.c. will work well for testing pressure switches in most applications.

The Magnehelic or incline manometer should be teed into the pressure switch tubing on both sides using 1/8” tees. Doing so puts the Magnehelic gauge in parallel with the pressure switch, and it will read the same pressure that is being seen at the pressure switch.



After the Magnehelic gauge is connected to the pressure switch, the gauge tubing must be run outside the furnace cabinet and the panel must be put back in place. If this is not done, the gauge reading will not reflect actual system operating conditions.

Create a call for heat and observe the pressure on the gauge. If the reading on the gauge is in excess of the make point of the switch and the switch is not closing, it is defective and must be replaced.

If the reading on the gauge is a lower value than the make point of the pressure switch, a problem exists that is not allowing sufficient combustion air to flow through the furnace.

A common cause of this is obstruction in the intake or exhaust piping, which could be any of the following:

- Rocks, balls, or other items that may have been placed in the pipe.
- Snow or ice restrictions
- Rodents, insects, or insect nests.
- Improper support of exhaust piping on condensing furnaces, allowing condensate to remain in the piping.
- Undersized piping, too long of piping run, or too many elbows in the piping run.

The best way to determine if one of these items is a problem is to disconnect the intake and exhaust piping from the furnace. If the reading on the gauge greatly increases with the piping disconnected, the problem lies in the vent system. Reconnect the intake and exhaust upon completion of testing.

If the pressure reading on the gauge doesn't increase enough to close the pressure switch even with the vent pipe disconnected, check for the following:

- Pressure switch tubing cracked, kinked, obstructed, or disconnected.
- Inducer wheel loose on the motor shaft.
- Blades missing on the inducer wheel.
- Tight bearings on the inducer motor.
- Restricted pressure tap ports.
- Blocked condensate drain.

Never attempt to adjust a pressure switch or use a different switch than the one specified for the furnace model being serviced. Never attempt to jump the switch to allow the furnace to operate. Doing so could allow the furnace to operate under hazardous conditions leading to bodily injury, property damage, or loss of life.

Primary Limit

Limits are used to stop furnace operation in the event of abnormal temperatures.

The primary limit is mounted to the vestibule panel. It usually is an auto-reset switch that opens a control circuit in the event that there is excessive heat in the heat exchanger section.

If the primary limit is tripping, first verify that the gas input and manifold pressures are correct. Next, ensure that the blower speed is set up correctly to provide the proper temperature rise across the furnace. If the blower speed is already on high and the temperature rise is above the allowable range, most likely a problem lies in the air distribution system and should be investigated by measuring the ESP of both the supply and return ductwork.

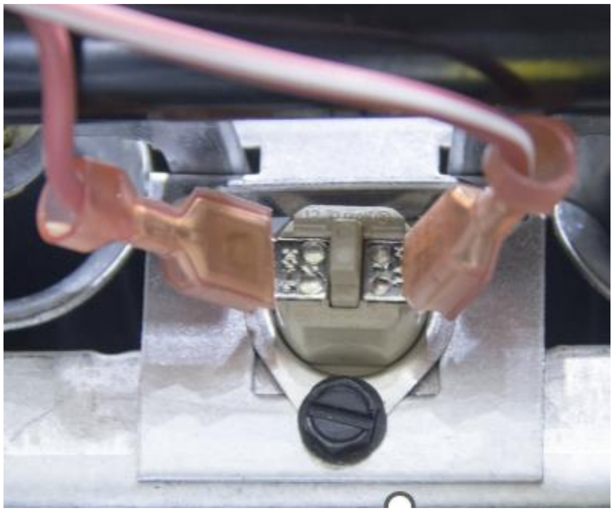
Check that the furnace is properly sized for the application. A grossly oversized furnace will tend to bump limit before the thermostat is satisfied, especially in combination with undersized ductwork.

Verify that the blower is functioning properly, and the blower wheel is clean. Make sure that nothing is deflecting airflow away from the limit, such as cabinet insulation or debris.

These items will resolve 99% of limit trip problems. If the limit switch itself is defective, be sure to replace it with a limit with the exact same limit settings. Installing incorrect limits may cause the furnace to operate under unsafe conditions, and the technician or the technician's company will be liable for the damage or loss of life that may result.

Rollout Limit

Rollout limits are located in the burner area. Depending on the model, there may be one or more rollout switches present. The rollout limit will open in the event of an abnormal flame pattern. On systems with inshot burners, the flames should be fired directly through the vestibule panel and into the heat exchanger. If burners are misaligned, gas pressure is incorrect, orifices are the incorrect size or misaligned, or a restriction or leak is present in the heat exchanger, rollout can occur.



A rollout switch trip needs to be thoroughly investigated and corrected. Never bypass any limit switch to allow operation to continue. Doing so can result in hazardous conditions leading to bodily injury, property damage, or loss of life.

Blower Door Switch

Taping or bypassing the door switch can cause a serious safety risk. If the door switch has been taped closed during service, be sure that the tape is removed upon completion of the repair and reinstalling the blower compartment panel.

Condensate Drainage

Check the condensate drainage system for blocked, cracked, and kinked tubing.

Ensure the drain is not “double trapped” preventing the proper drainage of condensate. If the condensate drain lines becomes plugged or if a secondary trap is placed in the drain piping, the secondary heat exchanger and inducer motor will fill with water and the pressure switch trips and erratic operation will occur.

The condensate drain from the furnace may be connected in common with the drain from an air conditioning coil only if allowed by local code.

Standard ECM Motor – Connections and Communications

There is one connection block on the Standard ECM motor with two rows of terminals. The terminals are two different sizes.

The power inputs (high voltage) to the motor connect through the 3/16” terminals on the following terminals:
(L) – Line 1
(G) – Ground
(N) – Neutral or Line 2

The line voltage is present at these terminal whenever the system is powered, regardless of thermostat demand. The control inputs (low voltage) to the motor connect through the ¼” terminals. Terminal “C” is used for common and terminals 1-5 are used to select airflow settings programmed into the motor.

Communication to the Standard ECM motor is the low voltage 24 volts AC that is provided to taps 1 through 5. The purpose of this voltage is to communicate to the motor only, not to operate it. The 24 volts AC provided to each tap is a communication signal used to select five different torque values. The motor’s control board uses this signal to determine which torque value it should deliver, and then uses the line voltage (high voltage that is continuously connected) to operate the motor according to that program.

Each motor has a unique program. If the motor taps are changed in the same way on two different unit models, the results will differ. The tap settings must never be changed to adjust airflow without checking the airflow charts for the system installed.

Example 1:
If tap 1 provides airflow for the heating mode, and the torque required to provide the airflow for a proper temperature rise in that furnace is 76% of the maximum torque ability of the motor, that will be the value programmed into the tap.

Example 2:
If tap 2 provides the airflow for the cooling mode, and the torque required to provide the airflow for a specified tonnage is 88% of the maximum torque ability of the motor, then that will be the value programmed into the tap.

Even though changing tap connections does change the speed of the motor, it is important, in theory at least, to understand that these are programmed levels of torque. Each tap can have a unique amount of torque programmed for a specific purpose.

These examples also do not show a tap specifically programmed for continuous fan selection. Depending on the application, the heating or cooling selection may be used for continuous fan blower speed. The percentage used for continuous fan operation is found in the Installation Manual for each unit.

Standard ECM Connections

Connectors:
As discussed in Stage 2, the high voltage connections contain the three terminals labeled “L”, “G”, and “N”. The low voltage connections contain one terminal labeled “C” for the 24 volts AC common and five torque settings labeled “1” through “5”.

The high voltage plug is used when troubleshooting the low voltage input to the motor, since the 24 volts AC common terminal “C” is in this plug.

The plugs are designed to prevent improper connection. The high voltage plug has a full blank tab on the opposite end from the “C” terminal. This prevents it from being installed on the low voltage terminals.

Both the high and low voltage plugs, if equipped, have tabs on the bottom of them. When the high voltage plug is installed properly, the low voltage plug can only be installed with its tab down, or opposite from the high voltage plug. This will properly orient the low voltage terminals “1” through “5”.

Servicing the Standard ECM Motor

The Standard ECM motor is operated by 115 volts AC. Applying incorrect line voltage to the Standard ECM motor may prevent the motor from operating or may cause damage to the motor.

The Installation Manual and wiring schematics must be consulted for proper set up, wiring, operation, and troubleshooting. Checking all system limits, rollouts, and safety switches before troubleshooting the motor is important.

Troubleshooting this motor will be simply if the following information is known:

1. Which tap(s) have programs and what are their purposes (heating airflow, cooling airflow, continuous fan airflow)?
2. Where on the controls or circuit board do the line voltage and control voltage come from?
3. What is the sequence of operation of the controls or circuit boards (when the control voltage is sent to the motor from each thermostat demand and if there are any delays)?

Troubleshooting the voltage at the Standard ECM motor comes down to two simple factors:

1. Line voltage (115 volts AC), which must be always present with or without a demand for heating, cooling, or continuous fan. Make sure proper line voltage is present between the "L" and "N" terminals as shown for the specific model being serviced. Line voltage must be present at the motor with or without a demand from the thermostat. The allowable voltage variance is between 98- and 132-volts AC.
2. 24 volts AC low (control) voltage at the appropriate tap, with the appropriate thermostat demand call. Control voltage is present between terminals "1" through "5" and the "C" terminal. The allowable voltage variance can be as much as +/- 10% of the nominal 24 volts AC. If the voltage is present below this range, confirm that the control voltage is present at the unit transformer, and at the thermostat low voltage connections on the unit control board.

If the motor is operating with high voltage present at the motor and low (control) voltage present on a programmed tap, then any airflow issues must be addressed first. This includes high or low temperature rise, main limit trips, freezing coils, or compressor overload tripping.

The Standard ECM is not a contact CFM motor. Airflow will decrease if static pressure rises too high in the system.

The Installation Manual provides low voltage wiring connection diagrams. If high voltage and the low (control) voltage are present at the appropriate electrical connections, but the motor will not operate, the motor must be replaced. A direct replacement motor from the manufacturer for the same model and size unit is required.

Replacing the Standard ECM Motor

The Standard ECM motor is a one-piece motor that is replaced as a whole and is not field repairable.

When replacing the Standard ECM motor, use a direct replacement for the specific unit model. If a bellyband is used for mounting, the band should not be located in the area identified in the “Keep Out Area”.

The wheel key must be tightened on the flat side of the motor shaft with the blower wheel centered in the housing.

If the wheel sits too close to the motor when centered or if the wheel cannot be centered because it hits the motor, the motor must be adjusted in the bellyband. The blower assembly must be reinstalled into the HVAC system.

All wires and plugs must be reconnected to the motor by confirming connection to proper terminals per demand.

A drip-loop must be formed so water cannot enter the motor by draining down the cables. Condensate or droplets can accumulate in the harness and may find their way into the motor.

Duct System

Improperly sized ducts and restrictions in the duct system can lead to numerous system problems.

There are limitations to the airflow the blower may provide if installed in systems with improperly sized ductwork of other system restrictions. The measurement is of utmost importance to determine if the furnace will be able to perform under its designed external static pressure, or ESP.

On the supply (positive) side of the blower, this pressure is pushing out in all directions on the interior of the supply system. On the return (negative) side of the blower, this pressure is pulling inward on the interior of the return system. Restrictions in the duct system such as undersized ducts, dirty filters, or evaporator coil, or closed or blocked registers will cause the external static pressure to increase. As the external static pressure increases, the furnace blower's ability to move air decreases. Most residential furnaces (including the 33" gas furnaces) are designed to deliver their rated airflow up to .5" w.c. total external static pressure.

A common tool of choice for measuring ESP is the Magnehelic gauge of incline manometer. The example below illustrates use of the Magnehelic gauge, although the measurement procedure (probe placement) will be identical with an incline manometer.

Using the Magnehelic

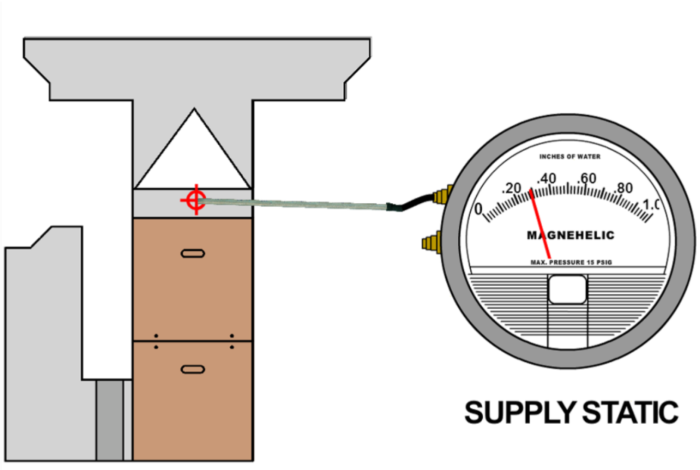
The Magnehelic gauge has two ports, labeled “HI” and “LO”.

The “HI” port causes the value shown by the needle to increase if pressure is being put into the port. This port is connected to the supply side of the system.

The port marked “LO” causes the value shown by the needle to increase if there is a negative pressure on the port. This port is connected to the return side of the system.

Supply Static Measurement

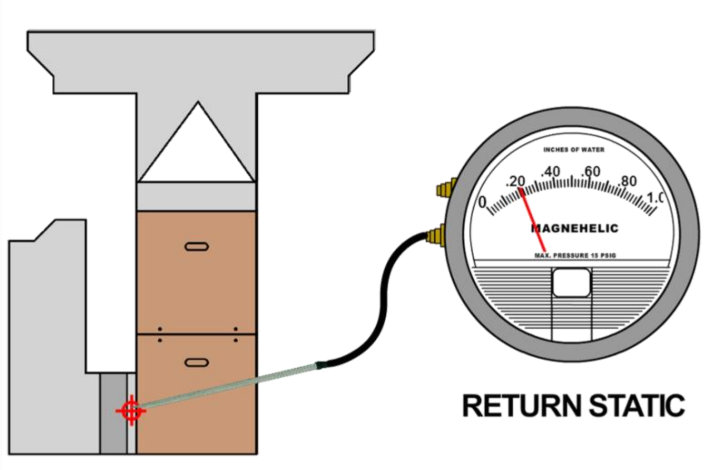
To measure the supply static pressure, connect the Magnehelic gauge probe to the port marked “HI”. The probe should be inserted immediately off the supply duct connection, under the evaporator coil if possible. This will allow measurement of the supply static and resistance to airflow imposed by the evaporator coil, supply duct, fittings, and registers. The supply system, when properly sized, should be near .1” w.c. (without the evaporator coil). A clean, dry, evaporator coil will add about .2” w.c. static, bringing the supply static to a total of .3” w.c. (.1” + .2” = .3”).



Return Static Measurement

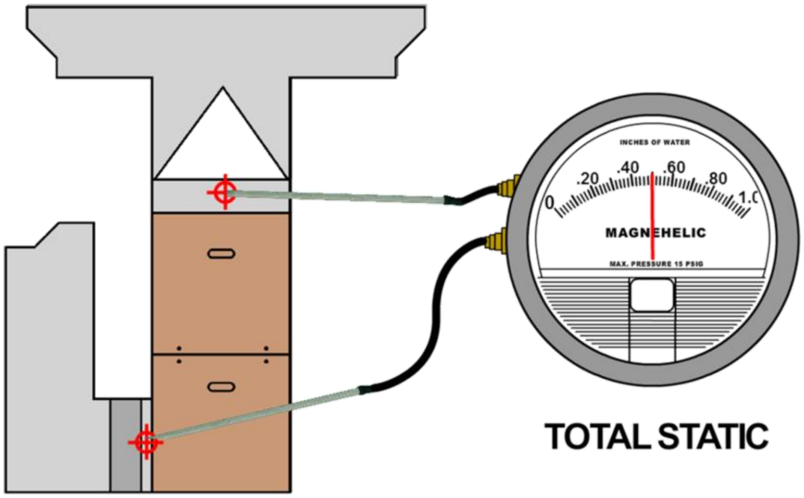
To measure the return static pressure, connect the Magnehelic probe to the port marked “LO”. The probe should be inserted between the filter and the furnace. This will allow you to read the return static and resistance to airflow imposed by the filter, return drop, return ductwork, fittings, and grilles.

If access cannot be obtained between the furnace and the filter, a non-invasive place to measure return static is through a grommet on the side of the furnace cabinet in the blower section.



Total Static Measurement

The total external static pressure can be determined either by taking the supply and return statics individually and adding them, or simply by using two probes and noting the reading on the gauge.



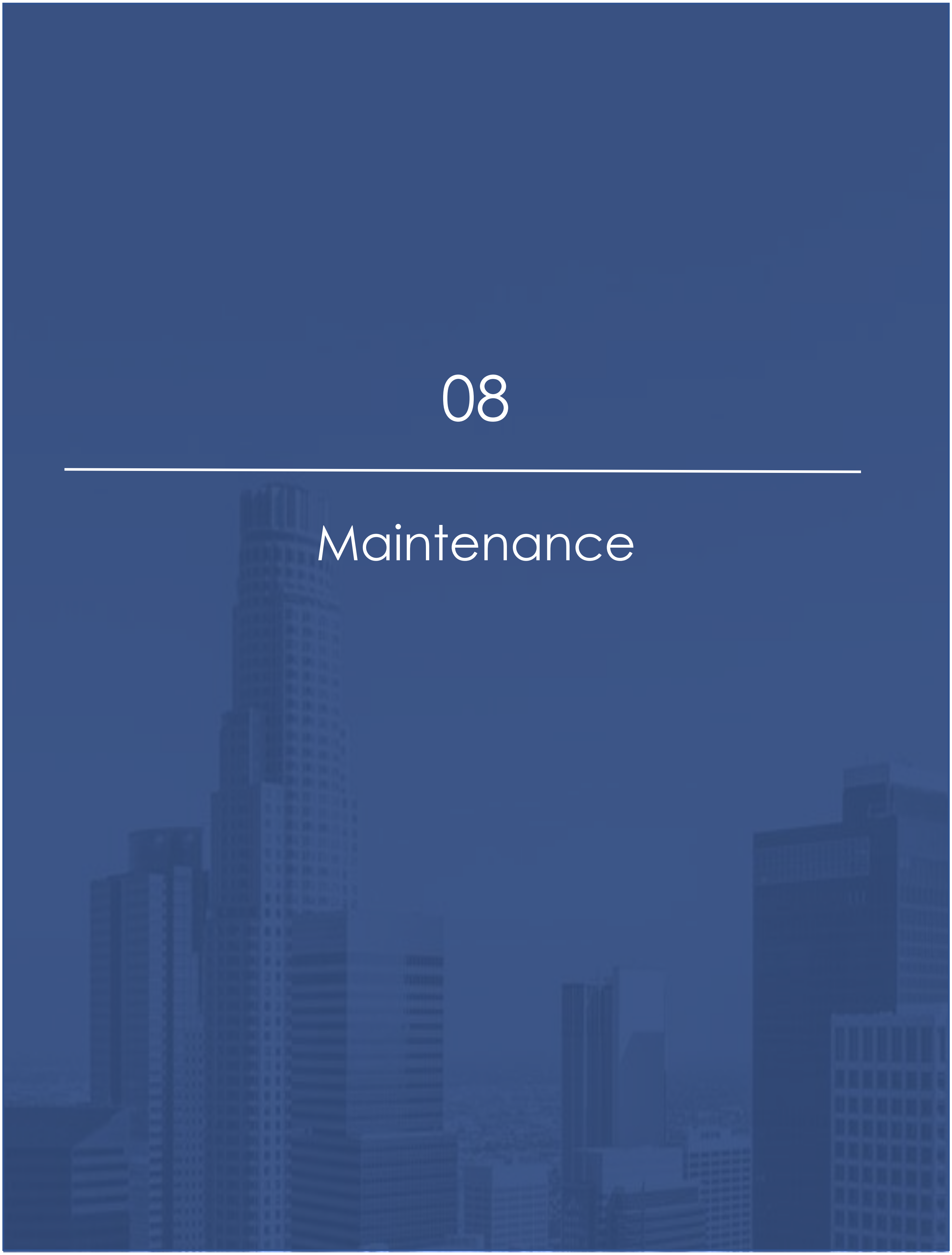
ESP as a Diagnostic Tool

In addition to using the Magnehelic gauge to properly set up the blower speed for air conditioning. It can also be used to diagnose problems within the air distribution system.

For instance, if the furnace is continuously tripping high limit even with the blower on high speed, the Magnehelic gauge will help indicate where the problem lies. Measure the supply and return static pressures as previously mentioned. If the supply static is high, take an additional reading after the evaporator coil. The difference between the reading before the coil and after the coil should be no more than approximately .2 - .25" w.c. when the coil is dry (check the specs for the coil that is being used) or approximately .3" w.c. when the coil is wet. If the drop is much greater than that, the plenum should be opened to visually inspect the evaporator coil, as it may be restricted.

If the static pressure drops across the coil is within limits and the reading downstream of the coil is far in excess of .1" - .15" w.c., the supply duct system may be restricted or undersized.

If the return static is high, verify that the filter is clean. A reading can also be taken upstream of the return air filter to determine if a problem lies in the return system. If the return static is far more than .1 - .15" w.c. the return system could be restricted or undersized.



08

Maintenance

Introduction

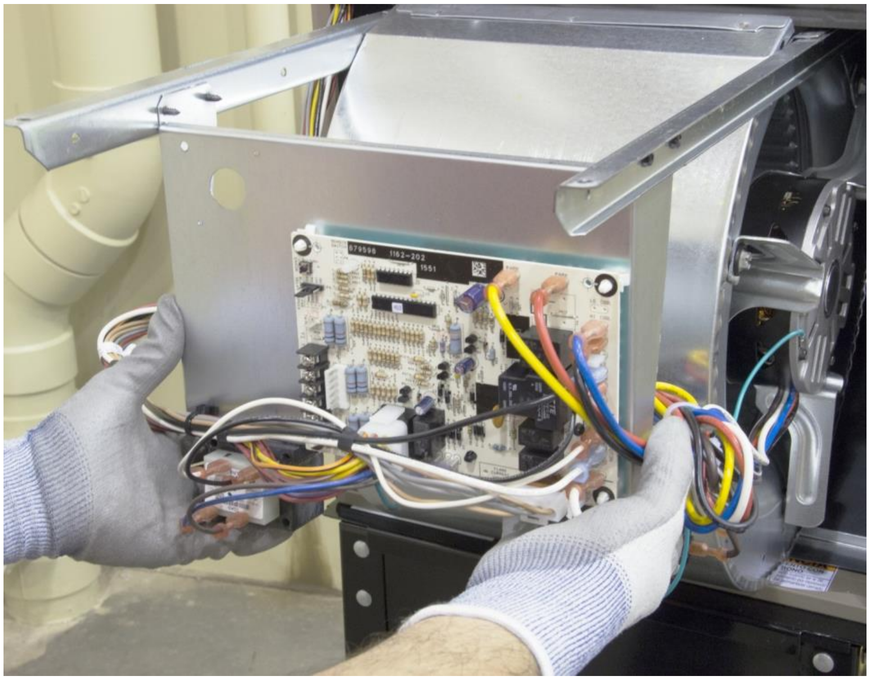
Gas furnaces should be cleaned and checked once a year before the start of the heating system.

Blower Assembly

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

Blower Assembly Removal

- Turn off the external electrical power to the unit.
- Remove the bottom furnace panel.
- Remove the two screws from the blower mounting rails. It is not necessary to remove the 12 pin and 4 pin plug from the furnace control to make the blower assembly easier to remove. It may be necessary to loosen some of the wires. It should not be necessary to cut the ties.
- The blower assembly will pull completely out for service.



Motor Lubrication

The blower motor and inducer motor on the 33” two stage gas furnaces are permanently lubricated and require no periodic oiling. Check the horizontal play of the shaft for excessive wear.

Burners

The main burners should be checked periodically for dirt accumulation. If cleaning is required, follow this procedure:

- Turn off the external electrical power to the unit.
- Remove the upper access panel.
- Turn off the gas supply at the manual shutoff valve and loosen the ground union joint.
- Remove the flame sensor and ignitor. Handle carefully.
- Disconnect wires to the rollout switch(es).
- Disconnect the gas ground union.
- Remove the screws that hold the manifold to the vestibule.
- Remove burners from the burner assembly.
- The burners may be cleaned by rinsing in hot water.
- Reassemble the burner assembly in the reverse order.

Flame Sensing Rod

Clean with fine to medium steel wool. Do not use emery cloth, which may leave residue on the sensor rod. Inspect for pitting, especially on LP gas applications.

Primary Heat Exchanger

Under normal conditions, the interior of the primary heat exchanger should not require regular cleaning. If the furnace has been operating in a mild sooting condition, loose soot may be removed with a stiff wire brush and a vacuum.

If cleaning is required, use the following procedure:

- Turn off the manual gas valve external to the furnace.
- Turn off the external electrical power.
- Remove the upper access panel.
- Disconnect wires from flame sensor, rollout switches, and HSI. Remove the sensor and HSI.
- Disconnect the gas union.
- Remove the screws that hold the manifold assembly to the vestibule panel and remove the assembly.
- Remove the burners as described above.
- Use a long, flexible, wire brush to clean the inside of each primary heat exchanger tube. Push the brush as far into the heat exchanger tubes as possible. If the brush will not make it around the bends in the heat exchanger, vacuum loose scale and dirty from each tube. Use nitrogen or compressed air to loosen scale or dirt that may be stuck in the tubes. Be sure to wear safety glasses.

Secondary Heat Exchanger (95% Models)

To inspect the underside of the secondary heat exchanger, remove the blower housing. If the owner has neglected to perform proper maintenance, dust and debris can be carefully removed with a vacuum. Use caution not to bend the fins on the heat exchanger.

Under normal conditions, the interior of the secondary heat exchanger should not require cleaning. If the furnace has been operating in a mild sooting condition, loose soot may be removed with a stiff wire brush and a vacuum. Access to the secondary heat exchanger tubes is gained by removing the inducer assembly and collector box from the outlet of the secondary heat exchanger. The turbulators strips may VERY CAREFULLY be removed during heat exchanger cleaning and MUST be carefully reinstalled upon completion of the cleaning process.

If the secondary heat exchanger has become very sooted dur to improper gas side setup or low gas pressure, it must be replaced…do not attempt to clean a heavily sooted secondary heat exchanger.

Vent and Combustion (95% Models) Piping

Gas furnaces require a watertight vent/air intake system. Inspect for unsealed joints, cracked pipe or blocked terminations. Horizontal runs require ¼ inch per foot slope back to the furnace. The termination outside must be clear of obstructions and 12” above grade or highest snow level. Be aware of shrubs or new construction (such as a deck) or other restrictions that may interfere with proper venting.

On 80% AHUE models, inspect the vent system for signs of deterioration, including corrosion at 90-degree elbows, which is indicative of condensation in the vent system. Condensation may be due to under firing, excessive airflow, oversized vent piping, vent connector, or oversized masonry chimney.

Condensate Collection (95% Models)

Inspect all drain hoses inside the cabinet, condensate drain pan and condensate drain piping outside of the furnace cabinet.

Vestibule and Blower Compartments

The vestibule area and blower compartments should be vacuumed to remove all debris.

Air Filters

Never operate gas furnaces without a suitable air filter. Filters used with the 33” single stage gas furnaces must be installed external to the furnace casing.

DO NOT attempt to install filters inside the furnace cabinet. The filters should be checked and/or replaced every 3 months or as needed. Gas furnaces are not to be used for temporary heat during construction.

High-velocity filters (hogs hair) may be cleaned with a vacuum cleaner or washed. Be sure to shake off excess water and allow filter to completely dry before re-installing the filter.

Replacing Filters

When replacing the filter(s), be sure to install the right size filter for the furnace. Dirty filters greatly restrict the flow of air and may cause damage to the moving parts of the furnace. If the filters become clogged the heat exchangers and blower motor could overheat resulting in a potentially dangerous situation.

Replace throw away filter(s) with the same size new filter(s).

Thermostats

Thermostats must be level and secured to the wall. Gently blow out any dust accumulation and check exposed contacts of snap acting thermostats for deterioration.

Verify the heat anticipator setting (if available on the thermostat used). The heat anticipator is set to the value read after the circulating air blower is energized during the heating cycle.

Some electronic thermostats do not have adjustable heat anticipators. The may have a cycle rate adjustment setting rather than anticipator setting, and in most cases require no adjustment.