Residential Modulating Gas Furnaces

Field Reference Guide

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Johnson Controls

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01

Introduction

Available Models

The 33” modulating gas furnace is available in four models, which include:

- 80% PSC
- 80% ECM
- 97% PSC
- 97-98% ECM

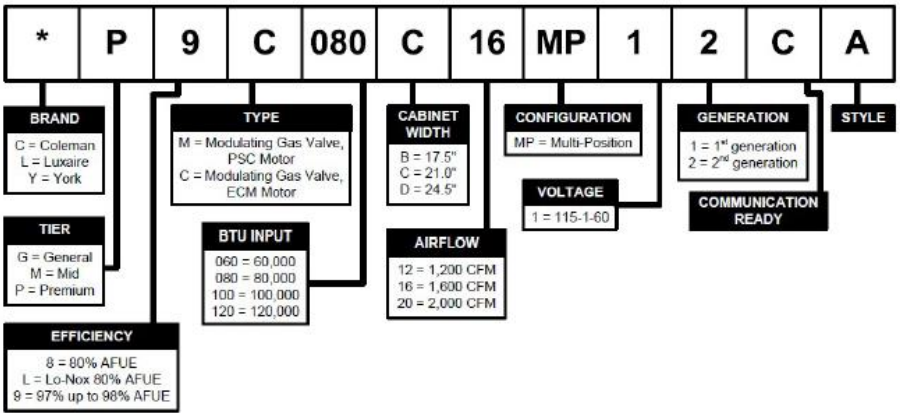
The PSC models use a permanent split capacitor blower motor and are speed controlled using triacs on the PSC control board.

The ECM models use a variable speed, electronically commutated blower motor.

Both the PSC and ECM models utilize an inducer that operates at variable speeds to provide proper combustion air based on the installed venting system and firing rate requirements.

Nomenclature

The image below provides information to distinguish between the various models.



Modulating Gas Furnace Nomenclature

Features

There are no requirements for exotic, expensive thermostats with Unitary Products modulating gas furnaces. The system may use a single stage heat-cool thermostat. In addition, Generation 2 models have communication capabilities to function with the Johnson Controls Residential Communicating Control System.

Firing Rates

The 97% - 998% AFUE models offer modulation in 0.65% increments and 80% AFUE models offer modulation in 0.5% increments:

- 80% AFUE models – 50% - 100% firing rate.
- 97% - 98% AFUE models – 35% - 100% firing rate.

Multi-position

Unitary Products modulating gas furnaces are approved for installation in upflow, downflow, horizontal left, and horizontal right applications. Simplified conversion allows efficient installation in all four positions. Detail on configuring the furnace for various applications can be found in the furnace Installation Manual and the “Installation” section of this Guide.

Four-way Collector Box

The 97% - 98% AFUE 33” furnaces use an innovative four-way collector box at the outlet of the secondary heat exchanger. The collector box allows condensate drainage in all four installed positions.

Component Access

The burner access panel seals to the cabinet, allowing sealed combustion operation without a traditional burner box.

Blocked Drain Sensing

The 97% - 98% AFUE models use a second pressure switch to monitor the status of the condensate drain system. The “blocked drain” switch breaks at 0.1” w.c. and opens if condensate is not properly draining from the collector box.

Pressure Transducer

The remote transducer measures combustion air pressure and works with the furnace control board to dictate inducer speed and gas firing rate based on conditions present.

Enhanced Control Features

When the 33” modulating gas furnace is matched with a heat pump system, the “HEAT PUMP” jumper on the furnace control board must be placed in the “YES” position. An “O” terminal is provided for heat pump operation. When the system mode selector is set to “COOL”, the control board receives 24 volts AC at the “O” terminal from the system thermostat. 24 volts AC at the “O” terminal indicates that the system is in cooling mode and the appropriate heat pump cooling code algorithm is used. Zero volts AC at the “O” terminal indicates that the system is in heating mode and the appropriate heat pump heating mode algorithm is used.

The control board logic will recognize heat pump heating mode. If a “W” signal is received with a “Y1” signal, the board will recognize this as a call for supplemental heat and provide normal modulation between the 35% and 100% range 997% - 98% AFUE models) or 50% and 100% range (80% AFUE models). When a defrost cycle is initiated, the specialized programs for defrost mode will operate the furnace at an 80% firing rate to maintain comfort within the space.

When the “HEAT PUMP” jumper is in the “NO” position, the control board utilizes “furnace only” algorithms for heating mode. However, if the “W” signal occurs when the heat pump receives a call from “Y/Y2”, the board will recognize this as a call for defrost and will immediately go to an 80% firing rate to ensure appropriate heating during the defrost cycle.

Run 2 Operation

Upon completion of a call for heat from the thermostat, the heating cycle continues to operate at a reduced firing rate for a period determined by the control. This additional run time, known as “Run 2”, allows very close tolerance to the thermostat setpoint, within ½°F.

Zoning Switch

When placed in the “YES” position, the control board will expand low fire timing to 10 minutes (from the normal 6 minutes) and slowly ramp to the full firing rate for up to 30 minutes (from 16 minutes). It will also eliminate “Run 2” operation.

Two stage air conditioning operation is possible with a single stage thermostat. The “LO COMP” and “HI COMP” terminals provide multistage compressor control. To engage the two-stage logic, connect a jumper between “Y1” and “LO COMP” on the terminal strip. “LO COMP” and “HI COMP” terminals are not used with two stage heat pump operation – two stage heat pumps require a two-stage heat pump thermostat.

Humidification

The “Humidifier ‘Hot’ terminal” is energized during furnace heating and heat pump heating.

De-humidification

If a humidistat is connected between the “DE-HUM” terminal and “R” and the “De-Humidistat” jumper is in the “YES” position, the algorithm will respond to the humidistat signal and will reduce fan speed during air conditioning mode to control de-humidification.

EMI Protection

An on-board EMI protection (inductor) eliminates low frequency AM radio noise.

Improved High Altitude Performance

The pressure transducer reacts to altitude change with less deration at altitude, allowing operation at altitudes of up to 10,000 feet above sea level.

Pulse Width Modulation (PWM)

Pulse Width Modulation (PWM) is used on Generation 1 and 2 ECM models for blower motor control, and on Generation 2 models for gas valve operation.

COMM Capable

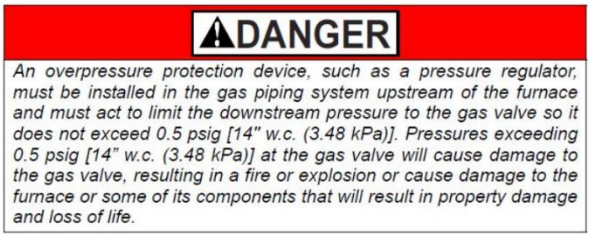
The Generation 2 33” modulating gas furnace can be used with a Johnson Controls Residential Communicating Control System. Detailed information regarding the communication system is available in the Residential Communicating Control System Field Reference Guide.

02

Safety

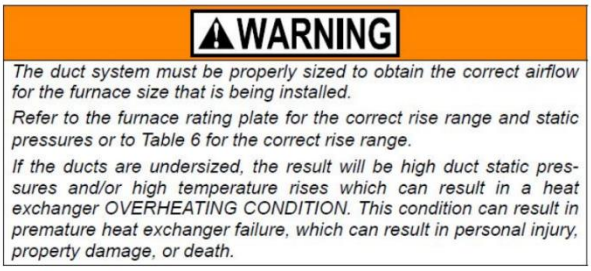
Safety Symbols

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**.



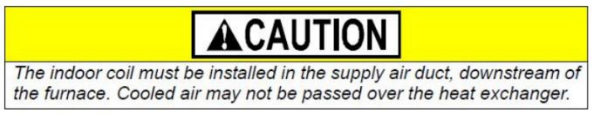
Sample Danger Label

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



Sample Warning Label

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



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

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.

Primary Heat Exchanger

Second Heat Exchanger (97-95% 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 condensate 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.

Outlet of the Secondary Heat Exchanger, with the Turbulator Strips Visible

Gas Valve

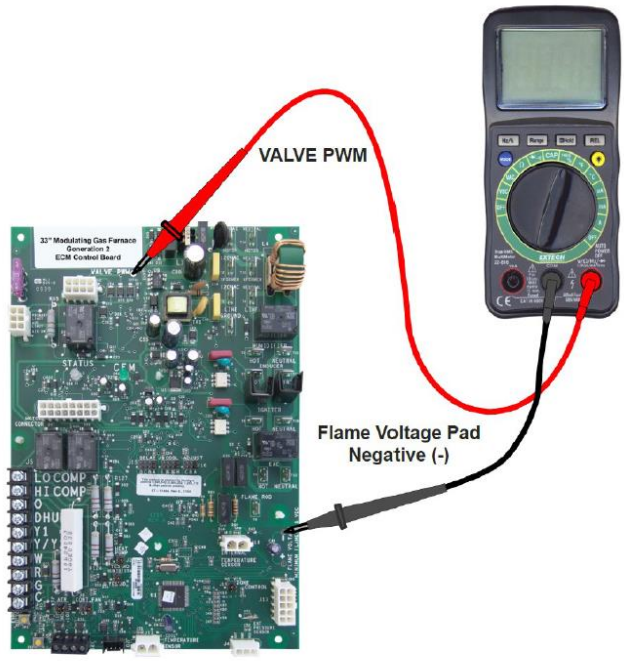
During the heating sequence, the gas valve provides regulated control of the gas flow after the ignitor warm-up period. The gas valve is energized with 24 volts AC and capacity controlled by the furnace control board based on heating requirements.

On Generation 1 units, the firing rate of the furnace is verified through measurement of the milliamp DC (mADC) current flowing to the modulation coil of the gas valve. The following charts illustrate the mADC signals expected at various firing rates for both the 80% and 97% - 98% AFUE models.

Generation 1 Gas Valve Milliamp Firing Fate

	97 – 98% AFUE	80% AFUE
40mADC	35%	-
57mADC	40%	-
90mADC	50%	50%
107mADC	60%	60%
125mADC	70%	70%
142mADC	80%	80%
160mADC	90%	90%
177mADC	100%	100%

On Generation 2 units, the gas valve uses Pulse Width Modulation (PWM) to drive a stepper motor for gas flow modulation. The gas valve using PWM has an eight-pin plug which connects to the board. To verify the commanded firing rate of the furnace by measuring the PWM signal, place the positive (+) meter lead on the round connection labeled “Valve PWM” and the negative (-) meter lead at the negative terminal for the “FLAME VOLTAGE”. Then convert the meter reading into the actual firing rate using the PWM Meter Reading to Firing Rate Conversion table.



Generation 2 Gas Valve Pulse Width Modulation (PWM) Measurement

Generation 2 Model PWM/Firing Rate Conversion

Meter Reading % PWM	Gas Valve Status % Firing
0	Disconnected or waiting for input
5	OFF
15	IFC to gas valve – Request for position
25	Gas valve to IFC – Done response
30	35%
40	45%
45	50%
50	55%
55	60%
60	65%
65	70%
70	75%
75	80%
80	85%
85	90%
90	95%
95	100%

Burner

The 33” modulating gas furnaces use inshot burners, which require no air adjustment and are easy to maintain.

Gas 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.

Inshot burners have a flame carryover channel that is built into each burner. The carryover channel allows the flame to spread from burner to burner and must always remain clean and unobstructed.

Hot Surface Ignitor (HSI)

The 33” gas furnaces use hot surface ignition. During a trial for ignition, the hot surface ignitor is energized with 120 volts AC by the furnace control board “IGNITOR HOT” and “NEUTRAL”. At the end of the 17 second warmup period, the furnace control board energizes the gas valve and allows gas to flow to the burners. When the gas meets the hot surface ignitor, the gas ignites.

As with all hot surface ignitors, care should be used when handling.

The hot surface ignitor is removed by disconnecting the plastic plug connector and removing one Phillips head screw. The hot surface ignitor drops straight down out of the burner area.

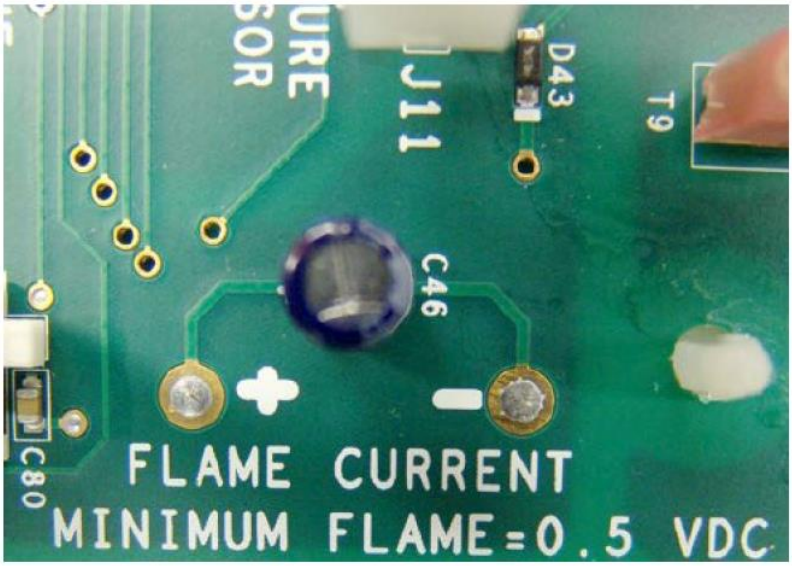
Hot Surface Ignitor

Flame Sensor

The 33” modulating 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.

Flame Sensor

A flame current pad is built into the furnace control board. This pad allows the technician to measure the flame current using a DC voltmeter = 1 uA (microamp).



Flame Current Pad

Under normal condition, 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 0.5 volts DC (0.5 microamps) to allow the heating cycle to continue.

Discharge Air Sensor

The discharge air temperature sensor extends through the vestibule panel, into the heat exchanger section. The sensor monitors the temperature of the air being supplied to the structure. If the sensor detects discharge air temperature out of range, the furnace control will increase the speed of the blower motor to try to increase the amount of airflow being delivered, thereby reducing the discharge air temperature. If the blower motor is already operating at full speed, the control will reduce the firing rate to reduce the air temperature. If the supply air temperature is too high, even at the minimum input rate (35% for 97% - 98% AFUE models, 50% for 80% AFUE models), the control will de-energize the gas valve.

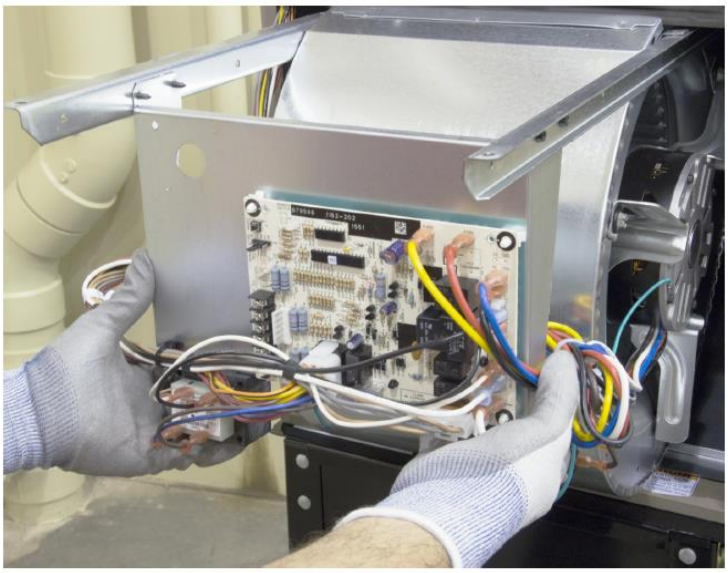
The sensor is a Negative Temperature Coefficient thermistor. This means that as the measured temperature goes up, the resistance value of the sensor goes down.

The following temperature and resistance chart may be used to determine if the expected resistance value is present at a given temperature.

Temperature (F)	Resistance in Ohms
70°F	11832 Ohms (11.8K)
110°F	4633 Ohms (4.64K)
120°F	3733 Ohms (3.74K)
130°F	3027 Ohms (3.01K)
140°F	2470 Ohms (2.49K)
150°F	2028 Ohms (2.05K)
160°F	1674 Ohms (1.65K)
170°F	1390 Ohms (1.40K)
180°F	1160 Ohms (1.15K)

Blower Motor (PSC Models)

The PSC model 80% and 97% 33” modulating gas furnaces use a four speed PSC (permanent split capacitor) ball bearing blower motor. Speed selection is accomplished through the “ATR”, “COOL”, and “CONT FAN” jumpers only. Do not attempt to adjust blower speeds by relocating blower speed taps, as improper operation will result.



Slideout Blower Assembly

The entire blower assembly slides out on rails for simplified service. To slide the blower assembly out, the ¼” hex head retaining screws, one on the left and one on the right, must be removed. Pull the blower assembly straight out. Enough wiring is if disconnection from the furnace control board is not necessary for most service procedures.

A single screw secures the blower wheel to the blower motor shaft.

Blower Wheel / Motor Shaft / Set Screw

The blower motors on the 33” modulating gas furnaces are permanently lubricated and require no oil during routine furnace maintenance.

Blower Motor (ECM Models)

The ECM model 80% and 97% - 98% 33” modulating gas furnaces use an electronically commutated motor that is variable speed. The speed of the motor is controlled by the modulating furnace control board through the use of pulse width modulation. Speed selection is accomplished through the “ATR”, “COOL”, “ADJUST”, “DELAY”, and “CONT FAN” jumpers.

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 can be caused by the following conditions:

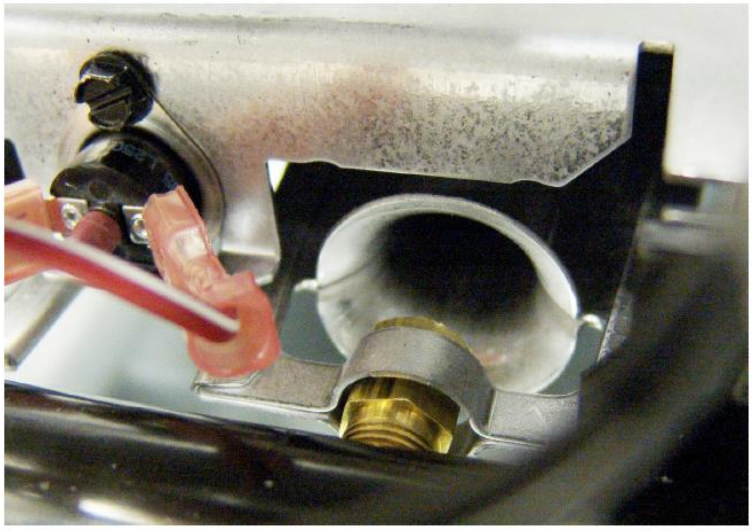
- Dirty filter.
- Dirty evaporator coil.
- Dirty secondary heat exchanger.
- Debris deflecting airflow away from the switch.
- Failure of the circulating blower motor or wheel.
- Too many supply or return registers closed or blocked (high external static pressure).
- Excessive manifold gas pressure.

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

Rollout Limits

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

If the rollout limit opens, the cause must be determined and corrected.



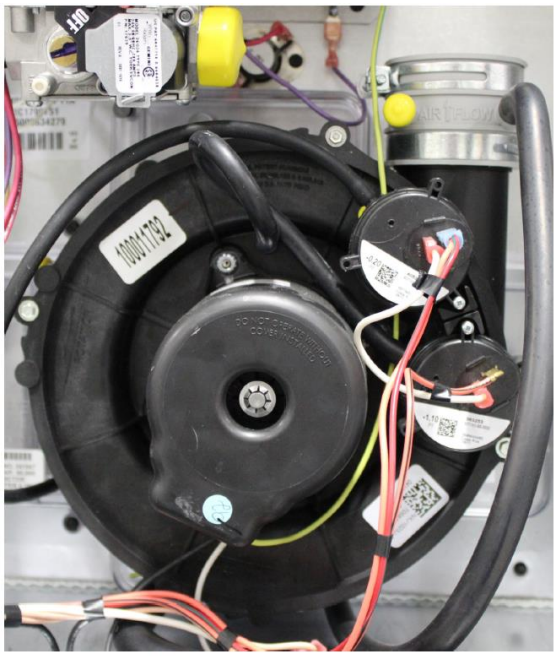
Rollout Limit and Manifold, Orifice, Burner

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.

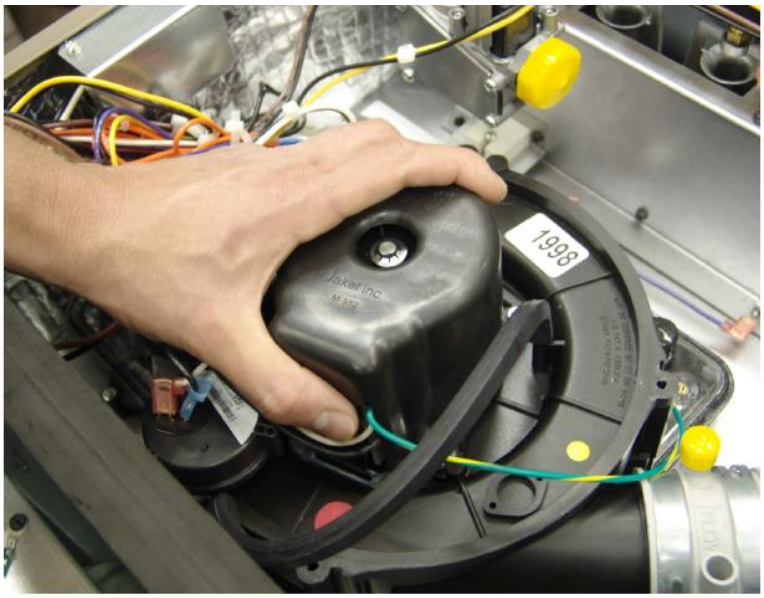
Because a rollout limit opening can indicate a potentially serious condition, the rollout limits are manually reset.

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 of combustion through the heat exchangers, and expels them outdoors.

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 of either side of the cabinet. Downflow applications require that the inducer is rotated so that the exhaust exits through the left or right side of the cabinet.



Inducer (95% AFUE Models)



Inducer Rotation Clockwise

On a call for heat, after the furnace control board performs internal and system diagnostics (including check that the pressure switches are open), the first step in the sequence of operation is to energize the inducer.

The speed of the inducer is dictated by the heating requirement of the structure and the amount of restriction in the vent system, and is controller by a variable voltage output form the furnace control board, ranging from 52 to 113 volts.

The inducer motor is energized through the “Inducer Hot” and “Inducer Neutral” terminals on the furnace control board.

Pressure Switch: Combustion Air

After the inducer beings its ramp up in speed, the pressure transducer must sense at least 0.5” w.c. differential on 80% AFUE models, and approximately 0.7” w.c. on 97% - 98% AFUE models. When the proper differential is sensed, the ignition sequence is allowed to begin.

The 33” gas furnaces are equipped with a combustion air pressure switch mounted on the front of the inducer assembly. This switch monitors the flow through the combustion air/vent system. The switch will close at the beginning of each cycle when adequate combustion airflow is established. 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.

Detail on diagnosing pressure switch operation can be found in the Troubleshooting Stage of this Guide.

Never attempt to jumper 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.

Pressure Switches and High Altitude

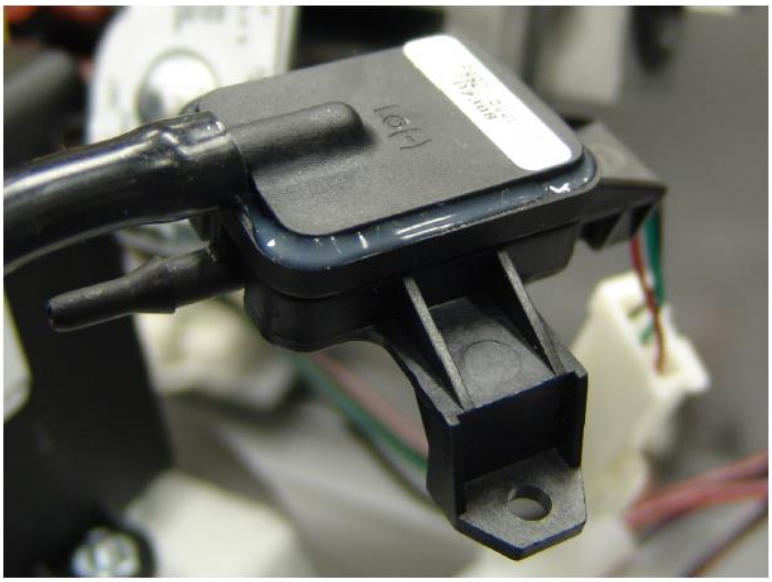
The 33” modulating furnaces are factory equipped to operate without changes and at full nameplate input rate at altitudes up to 4,000 feet above sea level.

The 33” modulating furnace pressure transducer measures inducer pressure to determine the amount of combustion air that is available. If the amount of combustion air available is reduced, whether due to a restriction in the vent and intake system or due to reduced air at high altitude, the control will speed up the inducer to attempt to provide the correct amount of combustion air. If the inducer is at full speed and the pressure indicates there is still not enough combustion air to support proper combustion at full input rate, the control will reduce the firing rate of the gas valve; thus, reducing input rate to the level necessary to maintain proper combustion.

The modulating furnace control board status light will indicate five amber flashes whenever the input rate is reduced due to combustion airflow that is insufficient to support full rate operation, whether caused by a restriction or by thin air at high altitude. At elevations above 4,000 feet, this “5 amber” code does not necessarily indicate a problem, but may be just indicating the normal de-rate for altitude.

During installation, modulating furnaces, like all furnaces, should have the input rate checked by clocking the gas meter. If the measured input rate is less than the nameplate input rate, minus any altitude de-ration, as can happen in areas where the heating value of the gas is low, it may be necessary to change orifice sizes to obtain the proper input rate.

Pressure Transducer

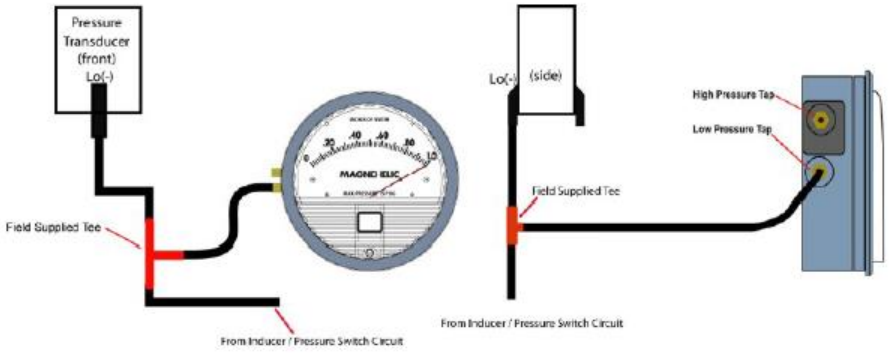


Pressure Transducer

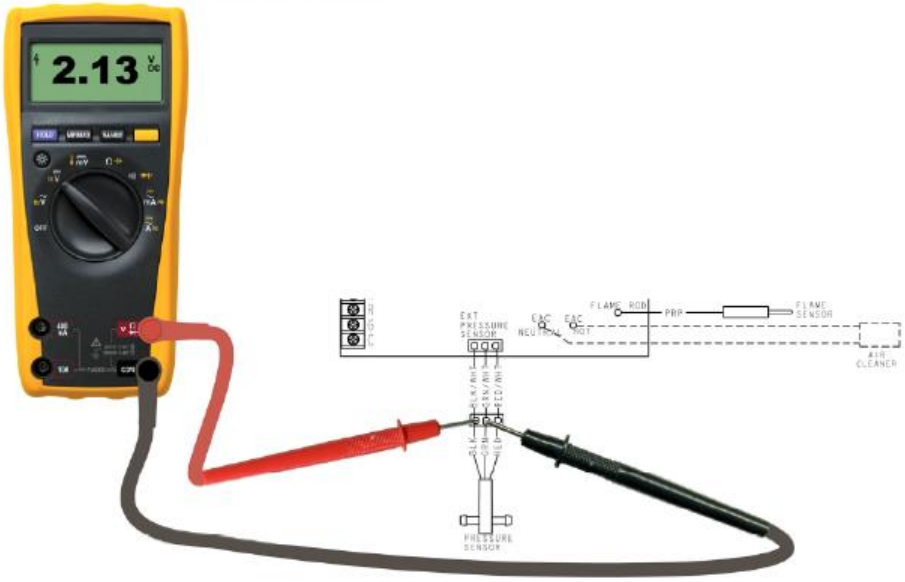
The pressure transducer measures inducer pressure to determine the amount of combustion air that is available. If the amount of combustion air available is reduced, whether due to a restriction in the vent and intake system or due to reduced air at high altitude, the control speeds up the inducer to attempt to provide the correct amount of combustion air.

If the inducer is at full speed and the pressure indicates that there is still not enough combustion air to support proper combustion at full input rate, the control reduces the firing rate of the gas valve; thus, reducing input rate to the level necessary to maintain proper combustion.

Below is the procedure to validate the VDC output of the pressure transducer at various pressures.



Pressure Measurement at Transducer



Pressure Transducer VDC Output Measurement

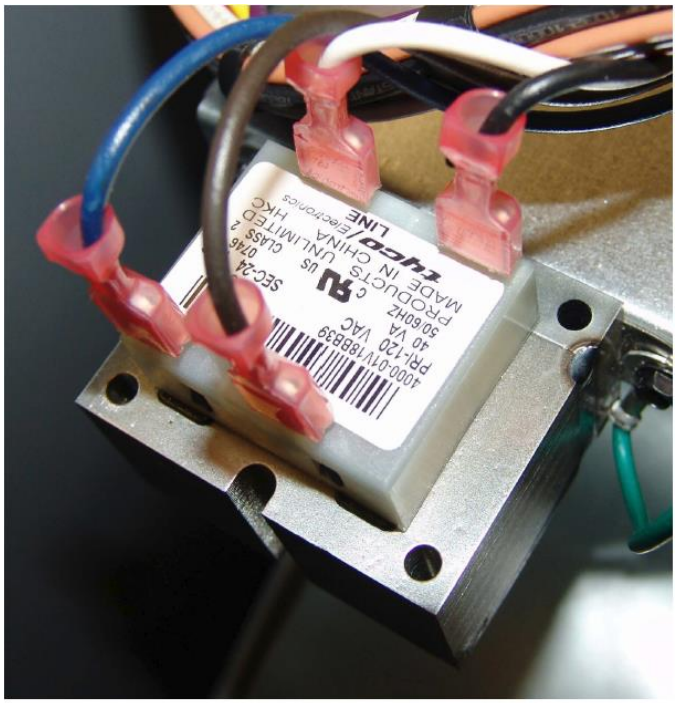
Pressure (in w.c.)	Voltage (VDC)
0.00	0.25
0.40	1.00
0.45	1.09
0.50	1.19
0.55	1.28
0.60	1.38
0.65	1.47
0.70	1.56
0.75	1.66
0.80	1.75
0.85	1.84
0.90	1.94
0.95	2.03
1.00	2.13
1.05	2.22
1.10	2.31
1.15	2.41
1.20	2.50
1.25	2.59
1.30	2.69
1.35	2.78
1.40	2.88
1.45	2.97
1.50	3.06
1.55	3.16
1.60	3.25

Pressure Switch: Blocked Drain

The 33” 97% - 98% AFUE modulating gas furnaces utilize a second pressure switch wired in series with the rollout switch. If the secondary heat exchanger of the furnace is not draining properly, the blocked drain switch will open. This results in a fault code of five red flashes on the furnace control board. This pressure switch may be diagnosed with a Magnehelic gauge or an incline manometer. An improperly field leveled, restricted drain system may cause this switch to open. Check all field connections and condensate tubing, and verify the furnace is level.

Transformer

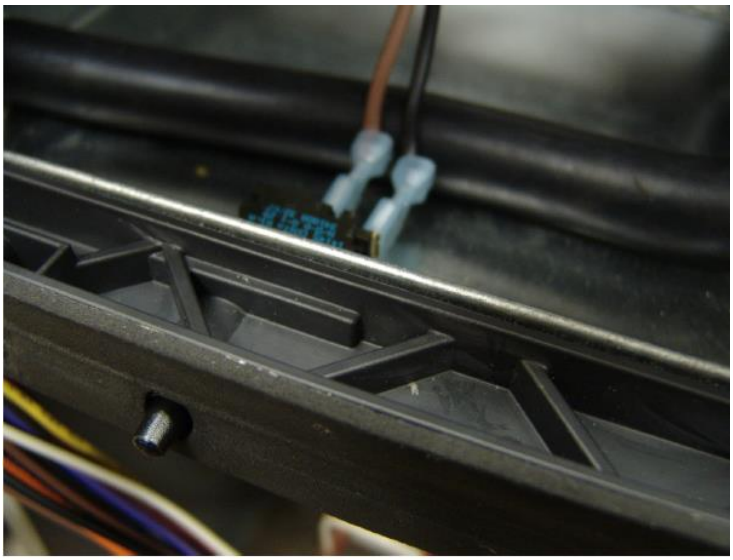
The transformer steps down the supplied line voltage to the 24-volt control voltage used to supply power to the ignition control, gas valve, thermostat, and other controls. Line power is connected to the line (or primary) side of the transformer. 24-volt power is supplied out of the load, or secondary,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



Transformer

Blower Door Switch

The 33” furnaces are equipped with an electrical interlock switch mounted in the blower compartment. This switch interrupts all power to the furnace when the panel covering the blower compartment is removed. Electrical supply to the furnace is dependent upon the panel that covers the blower compartment being in place and properly positioned.



Blower Door Switch

A service tool to depress the door switch during furnace service is available through Source 1.

Raingutter

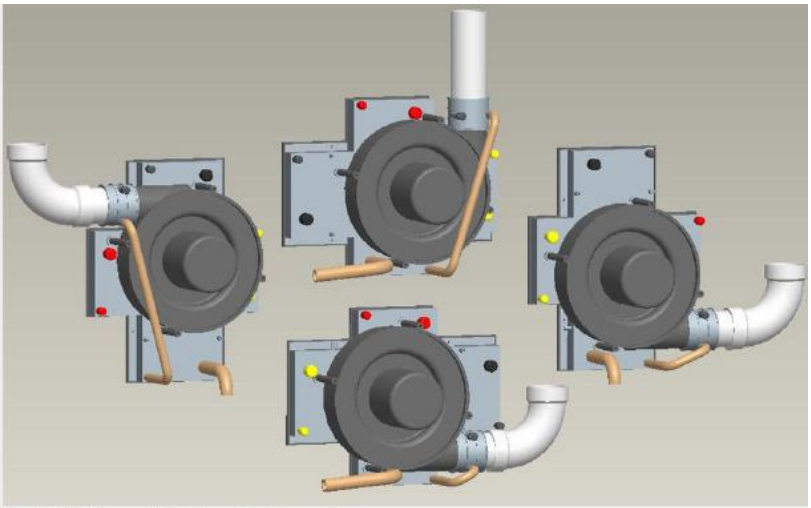
The raingutter is located at the outlet side of the induced draft blower. The raingutter captures condensate that is present in the exhaust piping and drains the condensate away before it reaches the induced draft blower.

Raingutter

Collector Box (97-98%)

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.

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



Drain Tubing and Venting Configuration

Regardless of the furnace configuration or inducer position, the raingutter connection is connected from the raingutter 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.

Furnace Control Board Layout and Functions

The integrated furnace control board controls all furnace functions, including component operation, safety limit monitoring, flame sensing, blower delays, and all LED code displays.

The onboard components for the 80% PSC version are identical to those of the 97% - 98% PSC version. The onboard components for Generation 1 and 2 ECM versions differ. Specific operational characteristics are NOT identical between the 80% and 97% - 98 models, and are detailed in the “Sequence of Operation” chapter of this manual.

Both the PSC and ECM furnace controls integrate the operation of the gas valve, blower motor, and inducer to fire the furnace at the precise level required to heat the space. Information from the thermostat, plenum temperature sensor and pressure transducer are used in determining the appropriate firing rate.

The PSC and ECM controls calculate the firing rate at every transition between ON and OFF, based on information from the thermostat and past demand. Unlike conventional systems, the furnace not only responds to demand from the thermostat, but will also fire the furnace during portions of the thermostat “off” cycle.

Furnace operation when the thermostat is not calling is known as a “Run 2” cycle.

Note
When the Zoning option is selected on the control board, the “Run 2” cycle is eliminated.

The PSC furnace control provides variable speed control of a PSC blower motor. The blower speed is controlled in response to the furnace plenum temperature. The blower motor is energized at minimum speed when flame is proven. The blower speed increases and decreases in response to the plenum temperature to maintain a temperature rise of approximately 45 degrees F (at minimum firing rate) to 55 degrees F (at maximum firing rate).

Inducer motor speed is controlled in response to heating demand and pressure. The inducer speed will increase and decrease to provide the combustion air required to satisfy the calculated demand, and adjust for supply or exhaust air variations.

PSC Version Control Board Detail

The easiest way to identify the PSC version control board is by the presence of a large heat sink on the board. The heat sink is used to dissipate heat from the onboard triacs, which are used for circulating air blower (four triacs), inducer speed control (one triac) and hot surface ignitor voltage control (one triac).

ECM Gen Control Board Detail

The easiest way to distinguish the ECM control board (Generation 1) from the PSC control board is that the ECM control board does not have the large heat sink used by the PSC version control board.

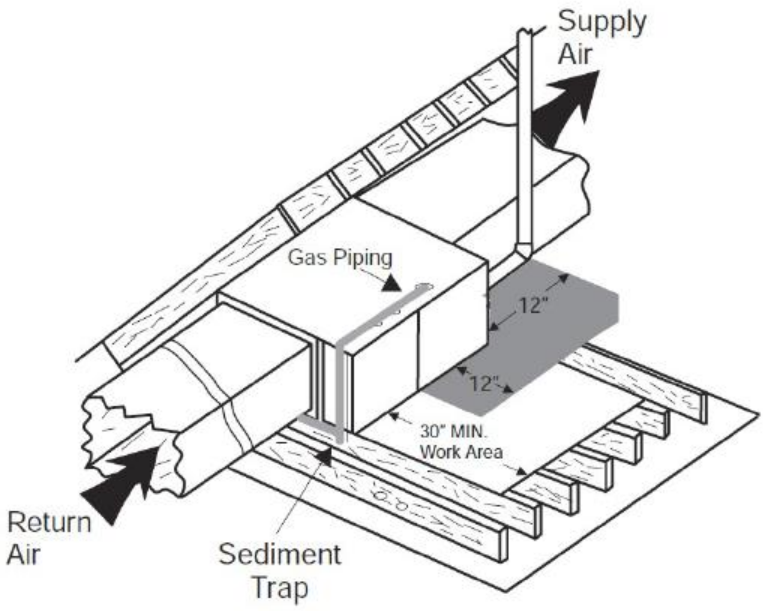
ECM Gen 2 Control Board Detail

The easiest way to distinguish the Generation 1 ECM control board from the Generation 2 ECM control board is that the Generation 2 control board has an eight-pin plug gas valve connection (J10) instead of the six pin plug found on the Generation 1 board. Another difference is that the four-pin plug connector – limit strings (Generation 1) changes to a six-pin plug connector (J7) on the Generation 2 board.

04

Installation

Installation



Typical Attic Installation

Proper installation and start up enables the equipment to operate at peak efficiency, providing the end user with the comfort and efficiency expected from the system.

Important
This section DOES NOT REPLACE THE INSTALLLATION INSTRUCTIONS for the specific furnace model. This Guide is designed to be a companion to the model-specific Installation Instructions. Be sure to THOROUGHLY READ the instructions provided with the furnace.

For specific start up details, see Section 5 – Start-up.

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 that require removal.

Location and Clearances

The furnace shall be located using the following guidelines:

- Where a minimum amount of air intake/vent piping and elbows will be required.
- As centralized with the air distribution system as possible.
- Where adequate combustion air will be available (particularly when the appliance is not using outdoor combustion air).
- Where it will not interfere with proper air circulation in the confined space.
- Where the outdoor combustion air/vent terminal will not be blocked or restricted.
- 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.
- The 33" modulating gas furnaces are NOT approved for HUD, mobile or modular homes. This would require a convertible gas valve and the modular gas valve is not available for this application.

Installation in Freezing Temperatures

Temperatures in the furnace location (97% - 98 AFUE) must not fall below 32 degrees F (0 degrees C) unless the condensate system in protected from freezing.

The return air temperature must not drop below 55 degrees F (13 degrees C) for extended periods. Low return air temps may cause condensation in the primary heat exchanger, leading to premature heat exchanger failure.

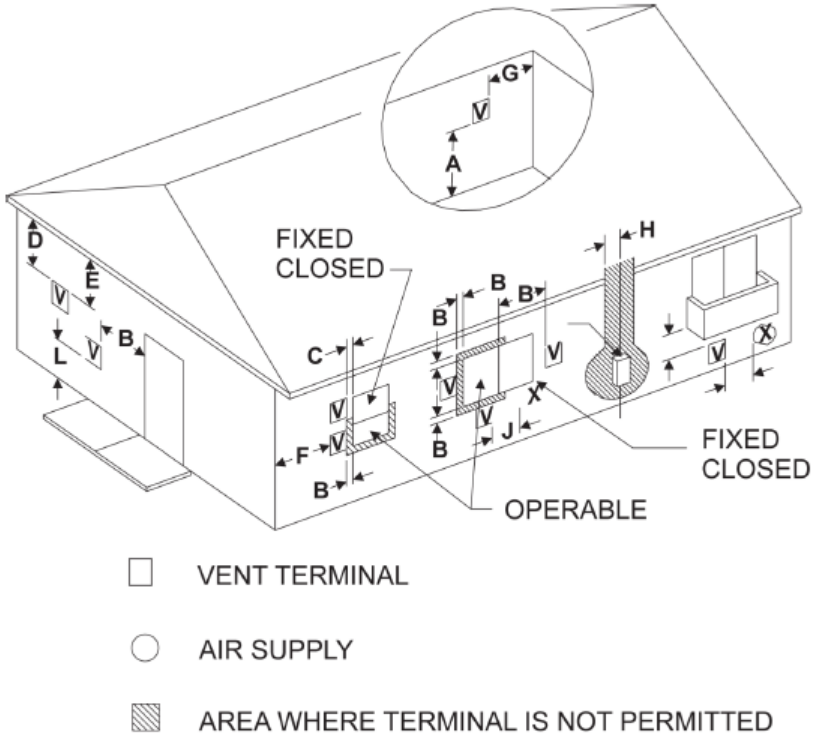
Recommended Minimum Clearances

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 and 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 for 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.



Home Layout: Vent Clearances

Vent Clearances Key

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 ventilated soffit located above the terminal with 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 the gas supplier	12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier
E. Clearance to unventilated soffit	12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier	12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier
F. Clearance to outside corner	12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier	12” (30.5 cm) or in accordance with local installation codes and the requirements of the 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 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 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 and the requirements of the gas supplier.
M. Clearance under veranda, porch, deck, or balcony	12” (30.5 cm) ǂ	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, National Gas Code.
3. In accordance with the current ANSI Z21.47 CSA 2.3 National American Standard.

Ŧ 12” (30.5 cm) up from the bottom edge of the structure for two-pipe (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.

ǂ 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 CSA B140.1-00.

- 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.
- A 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

97 – 98% AFUE Models

The 97% - 98% AFUE 33” gas furnaces are Category IV dual certified appliances and are designed for residential applications. 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 Instructions.

A 97% - 98% AFUE furnace vented as a “1 pipe” system is defined as a “mechanical vent”, a 2-pipe system is a direct vent application. The clearance required from a direct vent installation to a fixed or openable window, or any supply air or combustion air opening to another appliance is 9” to 12” depending on unit capacity. For mechanical vent installations, the clearance is 4 feet when below or to the side of the opening and 1 foot if above the opening. Always adhere to the appropriate national and local codes regarding all aspects of furnace installation.

The 97% – 98% AFUE 33” gas furnaces may not be common vented with any other appliance, and require separate, properly sized combustion air intake and exhaust (vent) piping. Refer to the furnace installation instructions for specific detail on venting specific furnace models.

80% AFUE Models

Only DOUBLE WALL vent pipe is allowed with the 80% modulating gas furnaces. Single wall vent pipe is NOT allowed.

The 80% AFUE model may NOT be vented to any masonry chimney, whether tile-lined or not. The Installation Instructions state “This furnace may not be connected to any masonry chimney”. An existing chimney used as a chase, through which the double wall vent pipe (B vent) passes, is permitted.

The 80% AFUE modulating gas furnaces are NOT approved for use with sidewall power venters.

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 instructions.

Combustion Air Quality

The 95% AFUE 33” gas furnaces are dual certified, meaning that combustion air may be taken from either outdoors (preferable) 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 located 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 located 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 salts 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 aide 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 ride outside 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 of noisy operation. If whistling is heard in and around the furnace area during blower operation, it is likely there is an airflow problem.

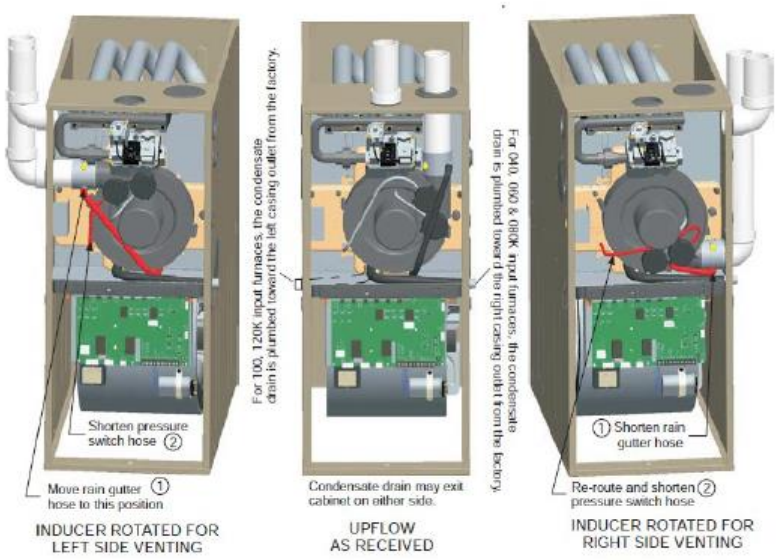
For more information on determining where problems are in the air distribution, see Section 5, Start-up. Included is a discussion on measuring external static pressure (ESP) in the duct system.

Furnace Configuration and Conversion

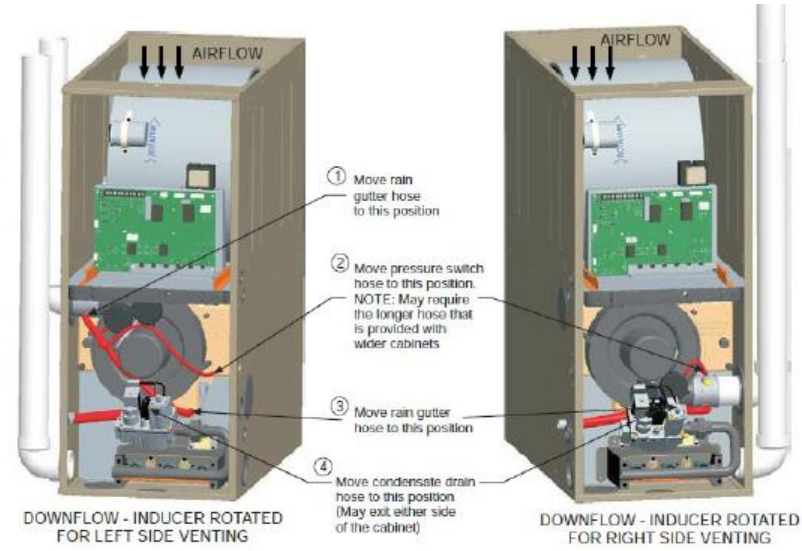
The 33” single stage gas furnaces are multiposition, meaning they may be installed in upflow, downflow, horizontal left, and horizontal right applications with little modification. The furnace as shipped from the factory is configured for upflow application. The illustrations on the following pages indicate inducer and condensate tube locations for various furnace positions.

Condensate Management – 95% Models

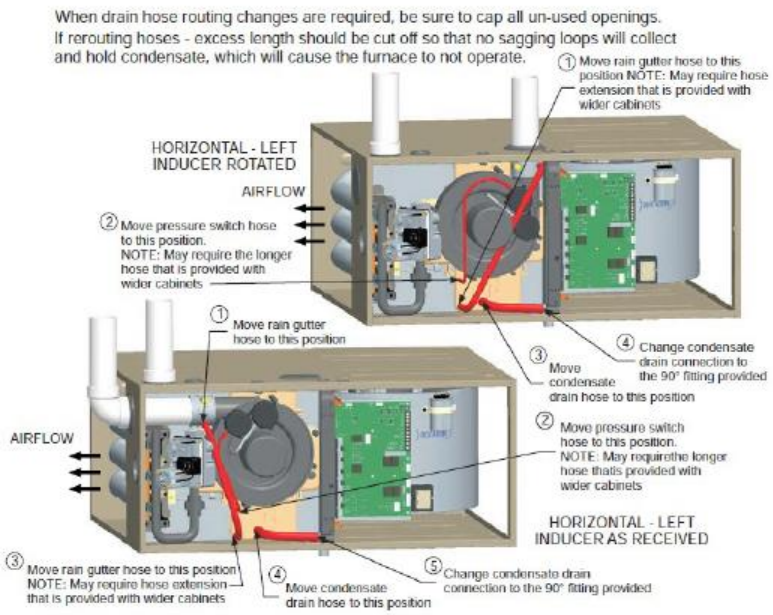
The illustrations show the condensate drain arrangement for the various possible furnace and vent blower positions. The furnace condensate pan is self-priming and contains an internal trap to prevent flue gas leakage.



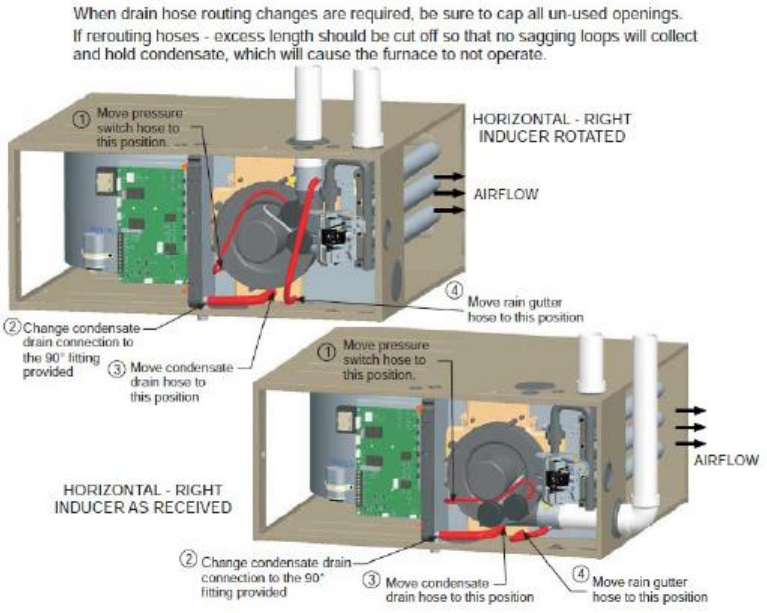
Upflow Drain Configuration



Downflow Drain Configuration



Horizontal Left Drain Configuration



Horizontal Right Drain Configuration

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.

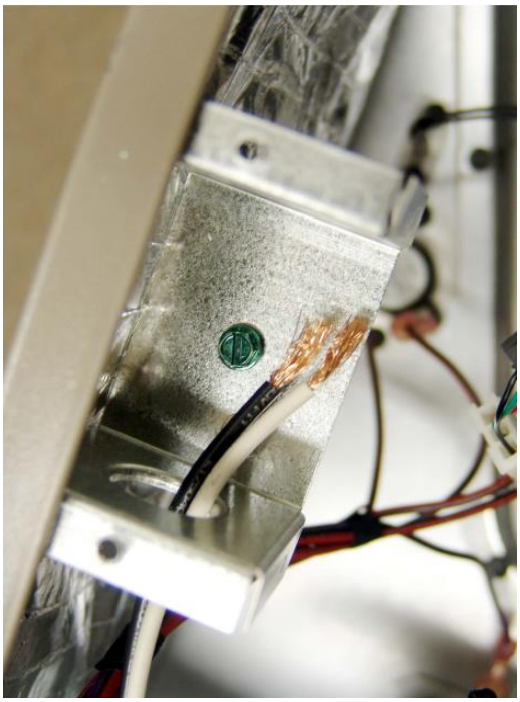
Evaporator Coil Installation

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 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 the 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 thermostat wires passing through cabinet. If air condition 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.upgnet.com in the Product Catalog section.

Single Stage Thermostat/Two Stage Cooling

The use of a single stage thermostat for two stage cooling provides two excellent benefits. First, no additional wires need to be run from the stat to the furnace when installed as a retrofit. Second, allowing the control board to decide on second stage cooling operation will provide more consistent comfort control of the space, like the superior comfort control the modulating furnace provides in heating mode.

Second stage cooling cannot be initiated by the consumer with a single stage thermostat, and can only be “forced on” (for charging and start up purposes) by the installer using a jumper. This means on start-up, or when turning on the cooling after a long absence, it will take longer to bring the house down to the desired temperature. This should be explained to the consumer on start-up. If this type of delay and control of second stage is not considered desirable, a two-stage cooling thermostat should be used on Generation 1 models. On Generation 2 models, either a two-stage cooing thermostat or communicating thermostat should be used. On Generation 2 units with a communicating thermostat, the consumer can call for “Quick Cool” which will initiate full cooling capacity until the thermostat setpoint is reached. Upon completion of “Quick Cool” the thermostat will revert to normal cooling operation.

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

Electronic Air Cleaner (EAC)

A ¼" spade terminals 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

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 NEUTRAL ¼" terminals on the control board.

Natural Gas to LP Conversion

The natural gas to LP conversion on Generation 1 units differs from the conversion process on Generation 2 units. Unlike the gas valve used on Generation 1 units, the 36J gas valve used on the Generation 2 units may be converted in the field. The 36J valve and Generation 2 control board are not backward compatible with Generation 1 units.

To convert Generation 1 33” modulating gas furnaces from natural gas to LP the following steps must be followed:

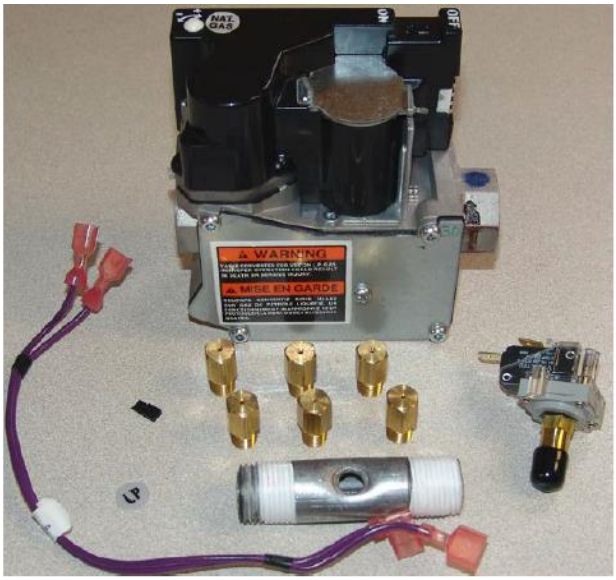
1. Remove the access door.
2. Shut off the gas supply to the valve and then disconnect the electrical power.

Important
The gas supply must be shut off prior to disconnecting the electrical power, before proceeding with the conversion.

3. Disconnect the electrical power from the gas valve.
4. Carefully remove the wires from the gas valve and note their location so they may be properly replaced.
5. Remove the screws that hold the manifold to the manifold brackets and slide the manifold off the burners.
6. On 80% Low-NOx models, remove the NOx screens by removing the entire burner assembly, removing, and discarding the NOx screens from the heat exchanger tubes, and reinstalling the burner assembly.
7. Remove the natural gas valve from the manifold.
8. Install the LP gas valve from the conversion kit, making sure the gas valve is tightly connected and in the same position as the old valve.
9. Remove the main burner orifices from the manifold and retain for future use.
10. Install the propane main burner orifices in the manifold and tighten them. Any leftover propane orifices may be discarded.
11. Reinstall the manifold in the assembly by reversing the removal process.
12. Reconnect the wires to the proper terminals on the gas valve.
13. Install the tapped gas pipe nipple (supplied with kit) into the inlet fitting of the gas valve.
14. Install the gas line pressure switch (supplied with kit) into the 1/8 NPT tapped hold in nipple after applying pipe dope to the switch fitting. Tighten the switch to make sure the connection does not leak.

Important
The gas line pressure switch will cause the furnace to lock out if the gas supply pressure drops below 6” w.c. The ignition control will display a fault code 7, and will reset after one hour.

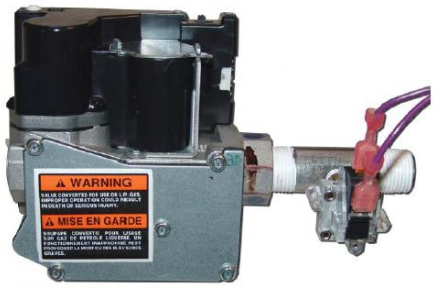
15. Disconnect the purple wire from the flame sensor.
16. Using the wiring harness supplied with the kit, connect the purple wire from the flame sensor into the insulated male connector. Connect the two ¼” insulated terminals to the pressure switch; and connect the remaining insulated terminal to the flame sensor.
17. Install the propane gas conversion label to the gas valve.



Generation 2 LP Conversion Kit Components

To convert Generation 2 33” modulating gas furnaces from natural gas to LP the following steps must be followed:

1. Remove the upper access door.
2. Unplug the wires from the gas valve.
3. Remove the screws that hold the manifold to the manifold bracket and slide the manifold off the burners.
4. On 80% Low-NOx models, remove the NOx screens by removing the entire burner assembly, removing, and discarding the NOx screens from the heat exchanger tubes, and reinstalling the burner assembly.
5. Move the switch located on the gas valve to the OFF position.
6. Remove the NAT.GAS label from the top of the gas valve.
7. Using a pair of tweezers or needle nose pliers, place the jumper (supplied with kit) on the receptable located beneath the label that was removed in Step 5.
8. Place the LP label (supplied with kit) on the gas valve over the opening to the jumper.
9. Attach the WARNING label (supplied with kit) to the gas valve where it can be readily seen.
10. Move the switch located on the gas valve back to the ON position.
11. Remove the main burner orifices from the manifold and retain for future use.
12. Install the propane main burner orifices in the manifold and tighten them. Any leftover propane orifices may be discarded.
13. Reinstall the manifold in the assembly by reversing the removal process.
14. Reconnect the wires to the proper terminals on the gas valve.
15. Install the tapped gas pipe nipple (supplied with kit) into the inlet fitting of the gas valve.
16. Install the gas line pressure switch (supplied with kit) into the 1/8 NPT tapped hold in nipple after applying approved thread sealant to the switch fitting. Tighten the switch make sure the connection does not leak.
17. Disconnect the purple wire from the flame sensor.
18. Using the wiring harness supplied with the kit, connect the purple wire from the flame sensor into the insulated male connector. Connect the two ¼” insulated terminals to the pressure switch; and connect the remaining insulated terminal to the flame sensor.



Gas Line Pressure Switch Installed

Gas Line Pressure Switch
The gas line pressure switch will cause the furnace to lock out if the gas supply pressure drops below 6” w.c. The ignition control will display a fault code 7, and will reset after one hour.

05

Start-up

Online Ducted Systems Residential Start-up Form

The online form is for use with all Ducted Systems residential products. The form allows savings for later completion. Completed form data is sent to your inbox for archive purposes.

http://bit.ly/res-startup

Before Continuing…
Prior to start-up, all 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/cubic foot, an orifice change may be required to make sure the furnace has 100% of its nameplate input rating available to it. See the section in the Installation Instructions entitled Calculating Furnace Input.

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

- A 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 that can read pressures between 0-15” w.c. (0-3.73 kPa) to measure the gas line and the manifold pressures.
- Allen wrench (3/16”) for gas valve pressure taps.
- Allen wrench (3/32”) or small pocket screwdriver for manifold pressure adjustment.
- Digital multimeter
- ¼” nut driver
- Phillips head screwdriver

Gas Pipe Leak Check

Burner ignition may not be satisfactory on first start-up dur to residual air in the gas line or until gas manifold pressure is adjusted. The ignition control will make three attempts to light before locking out.

To bleed air from the gas line, the ground union is loosened until the odor of gas is detected. When 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.

With the furnace in operation, check all the pipe joints, gas valve connections and manual valve connections for leakage using an approved gas detector, non-corrosive leak detection fluid, or other leak detection methods. 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.

Burner Flame Inspection

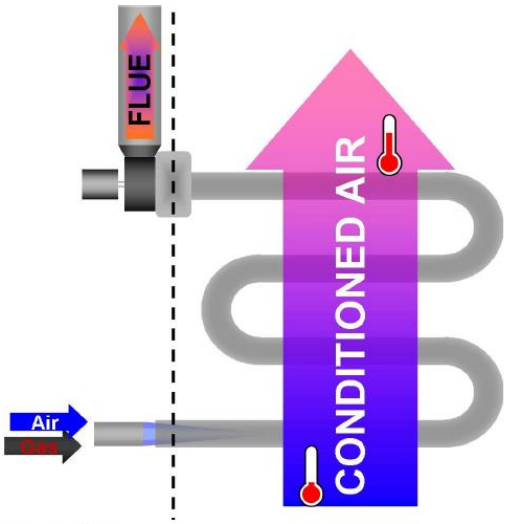
The flames must be blue in color and extend from the burner directly through the openings in the vestibule panel and into the heat exchanger. A yellow or lazy flame indicates a combustion problem, which must be investigated and corrected.

Calculating Furnace Input (Clocking the Meter)

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.

Be sure to follow the procedure outlined in the furnace Installation Instructions for clocking the gas meter. Clocking the gas meter is also performed when the furnace is firing at 100% during TEST mode. This will verify that the furnace is firing at 100% of nameplate input.

Temperature Rise Measurement



Temperature Rise

Temperature rise 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.

The furnace should be operating in the heating mode for five minutes prior to taking temperature measurements. Take readings of both the return air and the heated air in the ducts, about six feet 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 and ATR Setting

The discharge air thermistor, extending into the heat exchanger section, constantly monitors the discharge air temperature. If the discharge air temperature becomes too high, the blower speed is increased. If the blower is already operating at full speed, the manifold pressure to be reduced (reducing heating capacity) until the temperature sensor indicates the discharge temperature is within normal limits. For this reason, it MUST be verified that there are no problems in the duct system (i.e., restrictions) reducing proper airflow through the system.

The temperature rise adjustment on the modulating gas furnaces (ATR setting) is primarily for customer comfort. If a warmer temperature rise is desired, the ATR jumper is moved to the (+10) position. If a lower temperature rise is desired, the jumper is moved to the (-10) position. In the NOM position, the furnace temperature rise will range between 40-55°F. In the +10 position, the temperature rise will range between 40-65°F. In the -10 position, the temperature rise will range between 40-45°F.

Do NOT attempt to adjust the furnace temperature rise by moving blower speed taps, as erratic system operation may result.

Continuous Fan Operation

The airflow delivered by the furnace during continuous fan operation (Fan On) is the speed selected with the CONT FAN jumper or through COMM mode with a communicating thermostat. In conventional mode, the choices for continuous fan blower speed, L (low=40%), M (medium=70%), and H (high=100%). If this jumper is missing, the blower speed will default to High.

All the start-up information should be documented on the Start-up Sheet in Appendix of this manual.

Cooling Blower Speed

The airflow delivered by the furnace during cooling operation is adjusted to match the cooling capacity of the outdoor condensing unit. This is done by moving the COOL and ADJ (ECM models) jumpers on the control board.

The COOL jumper has four positions, which will deliver sufficient airflow in cooling mode for the cooling capacities shown in the furnace Installation Instructions.

The ADJ jumper (ECM models) has three positions which can be used to make further adjustments to the cooling blower airflow. See the furnace Installation Instructions for further information.

Delay Tap Selection (ECM Models)

The set of jumper pins on the control board labeled DELAY are used to maximize comfort and sound levels for various climates.

Tap A is the default profile. It provides a 30-second ramp-up from zero airflow to full capacity and a 30-second ramp-down from full capacity back to zero airflow. The motor will take 30 seconds to ramp from one speed to the other.

Normal Climate Profile Tab A Thermostat Satisfied 100% Airflow (until thermostat satisfied) Start (60 Second Off Delay) 30 sec ramp-up 30 sec ramp-down.

Tap B is the humid profile. This profile is best suited for installations where the humidity is frequently very high during cooling season. On a call for cooling, the blower will ramp up to 50% of full capacity and will stay there for two minutes, then will ramp up to 82% of full capacity and will stay there for five minutes, and then will ramp up to full capacity, where it will stay until the wall thermostat is satisfied.

Humid Climate Profile Tab B100% Airflow (until thermostat satisfied) 82% Airflow (for 5 minutes) 50% Airflow (for 2 minutes) 30 sec ramp-up 30 sec ramp-up 30 sec ramp-up 30 sec ramp-up 30 sec ramp-down (60 Second Off Delay) Thermostat Satisfied Start

Tap C is the dry profile. This profile is best suited where excessive humidity is not generally a problem, where the summer months are usually dry.

On a call for cooling, the motor will ramp up to full capacity and will stay there until the thermostat is satisfied. At the end of the cooling cycle, the blower will ramp down to 50% of full capacity where it will stay for 60 seconds. Then it will ramp down to zero. In every case, it will take the motor 30 seconds to ramp from one speed to another.

Tap D is the normal profile, best suited for most areas, where neither excessive humidity nor extremely dry conditions are the norm.

On a call for cooling, the motor will ramp up to 63% of full capacity and will stay there for 90 seconds, then will ramp up to full capacity. At the end of the cooling cycle, the motor will ramp down to 63% of full capacity and will stay there for 30 seconds, then will ramp down to zero. In every case, it will take the motor 30 seconds to ramp from one speed to another.

De-Humidistat Connection (Cooling Mode)

When the De-Humidistat jumper is moved to the YES position, cooling mode blower motor is reduced 15% during high humidity in the air conditioning season to provide improved humidity removal. A standard humidistat is wired between “R” and “DEHUM” on the control board to indicate relative humidity more than the desired value.

Thermostat Heat Anticipator/Cycle Rate Adjustment

Thermostats with a cycle rate adjustment must be set to 6 cycles per hour. Mechanical heat anticipators must be set to .1 amps for proper system operation.

COMM System Soft Jumper Adjustment

When a Residential Communicating Control System is utilized with the 33” modulating gas furnace, the DELAY, COOL, ADJ, and ATR soft jumpers can be adjusted from the COMM thermostat display.

06

Sequence of Operation

Introduction

A complete understanding of the sequence of operation of the product being serviced is critical to success as a service technician.

This chapter provides insight on the heating mode, cooling mode, and continuous fan sequence of operation of the 33” modulating gas furnaces. Since the firing rates differ between 80% and 97%-98% AFUE models, the firing rates or the 80% and 97%-98% AFUE models will be indicated as such throughout the sequence.

Each element of the sequence is discussed in detail, along with helpful troubleshooting techniques.

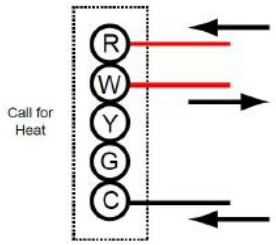
Sequence of Operation: Generation 1

Heating Sequence

The basic sequence of operation is as follows:

- A call for heat occurs when the thermostat closed the “R-W” circuit.
- The induced draft blower starts.
- The operation of the induced draft blower is proven with a pressure switch.
- The pressure transducer monitors the opening and closing of the pressure switch.
- The ignition sequence begins.
- Flame is established and proven.
- The circulating air blower is energized.
- Call for heat ends (“R-W” breaks)
- Control board determines firing rate for “Run 2” cycle and additional run time.
- Run 2 is terminated (gas valve de-energized, inducer post purge, blower runs until discharge air temp is 95°F.
- Inducer post-purge.

Call for Heat Occurs when the Thermostat Closed the R-W Circuit



Thermostat During Call for Heat

Figure 5-1 Thermostat During Call for Heat the “R” Terminal on the furnace control board provides 24-volt power to the thermostat. On a call for heat, the 24-volt power from the “R” circuit is allowed to pass through the thermostat to the “W” circuit, initiating the furnace heating cycle. 24 volts AC measure between “W” and “C” on the furnace terminal strip indicates that a call for heat is present.

The Induced Draft Blower Starts

The induced draft blower is energized with variable voltage (52-113 volts AC), through terminal connector “Inducer Hot” and “Inducer Neutral” on the modulating furnace control boards.

The voltage to the inducer is ramped until the combustion air pressure switch closes.


Induced Draft Blower

The Operation of the Induced Draft Blower is Proven

The combustion air pressure switch is present to ensure that the induced draft motor is coming up to speed and there are no restrictions within the vent system. The combustion air pressure switch is normally open (N/O) and closes after the inducer motor is energized, allowing the ignition sequence to continue. The pressure differential is also verified by the pressure transducer.

The Ignition Sequence Begins

After the pressure switch proves that the inducer has come up to speed and there are no significant restrictions in the system, the trial for ignition begins.

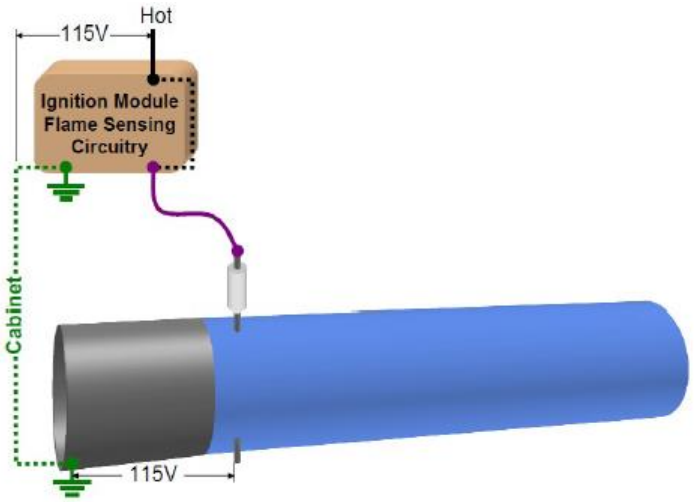
The hot surface ignitor is energized with 120 volts AC from terminals “Ignitor Hot” and “Ignitor Neutral” on the modulating furnace control board. The hot surface ignition system has a 17 second ignitor warm up period before the gas valve is energized.

The gas valve is energized with 24 volts AC, measurable between pins 3 and 6 on the 6-pin plug connector. The modulation signal during ignition will be approximately 125mADC, which represents a 70% firing rate.

Once the gas valve is opened, there is a window of a few seconds for flame to become established and stable. The furnace control then looks for proof that flame has been established.

Flame is Established and Proven

During a call for heat the flame sensor is energized with 120 volts AC. In the presence of flame, this AC voltage is rectified through the flame to DC current (flame rectification). This rectified signal is read in DC microamps (uA).



Flame Proving

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 0.5 volts DC (0.5 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.

Circulating Air Blower Starts

The circulating blower is energized at a minimum (40% fan speed) immediately after the flame has been proven and ramps to maintain a consistent temperature rise.

The furnace fires at 70% of full rate for 30 seconds, then drops to a minimum firing rate for 6 minutes.

The minimum firing rate on the 97%-98% AFUE is 35%, with a continuous range of 35% to 100%. The minimum firing rate on the 80% AFUE is 50%, with a continuous range of 50% to 100%.

The firing rate is automatically adjusted to meet demand, increasing gradually to maximum (100%) firing rate if the thermostat is not satisfied over the next 10 minutes (16 minutes total).

Call for Heat Ends

The thermostat ends the call for heat by breaking the “R” to “W” circuit. 24 volts AC is removed from the “W” terminal on the furnace control board. The modulating furnace will then go to “Run 2”. The system will continue to operate, reducing the firing rate slowly down to 35% and then OFF. The “Run 2” ramp down can take up to 12 minutes before the system turns off.

When the system is OFF, the gas valve is de-energized immediately and the furnace control begins the blower off cool down, when the temperature of the discharge air is below 95 degrees, the blower will shut off. The control also confirms the flame signal is lost immediately after the gas valve is de-energized. The duration of “Run 2” will vary depending on the last “Run 1” firing rate.

Run 2 Heating (80% AFUE Furnaces)

If the firing rate is above 65%, the burners will continue to fire at a recalculated reduced firing rate (approximately a 15% reduction). The gas valve capacity will remain at the “Run 2” firing rate position for 6 minutes if the thermostat remains OFF and then ramp down at a reduced rate of approximately 1% every 12 seconds until it reaches minimum position (50%), then shuts off. The blower RPM is ramped down to maintain a constant supply temperature. The blower will continue to run until the supply air temperature is less than 95°F.

If the previous “Run 1” demand did not exceed the firing rate of 65%, the system will immediately go to “Run 2” at the minimum 50% firing rate. The duration of “Run 2” will vary based on the previous firing rate, i.e., if the previous firing rate was at 64% the time in “Run 2” would be 6 minutes maximum and it takes approximately 26 seconds per firing rate percent.

- 64% = 360 seconds (6 minutes) at 50%
- 63% = 334 seconds (5 minutes and 34 seconds) at 50%
- 52% = 52 seconds run time at 50%
- 51% = 26 seconds run time at 50%

Heat Pump Operation

A jumper located at J17 (J22 on the ECM model) is provided to select a special heat pump program.

- No = heat pump “O” signal not present.
- Yes = heat pump “O” signal present, activate the Special logic for heat pump heating.

24 volts AC present – cooling mode, 0 volts – heating mode.
24 volts AC present on “O” input: System is in the cooling mode.
0 volts AC present on the “O” input: System is in the heating mode.

The jumper is set in the factory to the NO position which indicates that the home has a standard gas furnace, and the normal heating program is used. If the Heat Pump Jumper is in the Yes position, it indicates that there is a heat pump present, and the furnace is used as a secondary heat source. In addition, the Yes Heat Pump Jumper allows the system to read the presence of the "O" terminal signal as a heat pump heating operation. In heat Pump operation, the following special program logic applies:

- Supplemental heat: Both a "W" signal and a "Y1" signal are present, the modulating firing rate will operate as normal, except there will be no "Run 2". Occasionally a "Run 2" may occur if the wiring set up allows "Y1" to drop off a fractional second before the "W" signal is removed.
- Defrost cycle: Both a "W" signal and a "Y2" signal are present, the modulating firing rate will operate at a constant 80% firing rate and there will be no "Run 2".
- The hot heat pump feature will not function when the control is wired to a single stage thermostat and a 2-stage heat pump. A two-stage heat pump will require installation of a two-stage heat pump thermostat.

Cooling Mode: Single Stage Cooling

The thermostat "Y" terminal is connected to the furnace control board "Y/Y2" terminal, which is also connected to "Y/Y2" on the outdoor condensing unit. Alternately, the HI COMP terminal may be connected to "Y/Y2" on the outdoor condensing unit.

When the "R" to "Y/Y2" thermostat contacts close, the furnace control board "Y/Y2" terminal is energized. The 24 volt AC signal is sent through the furnace control board to the outdoor condensing unit. The blower motor operates at speed selected on furnace control board jumper block COOL.

Cooling Mode: Second Stage Cooling

The thermostat Y1 contact is connected to the furnace control board Y1 terminal and Y1 on the furnace control board is connected to Y1 on the compressor. Alternately, the LO COMP terminal may be connected as output to Y1 on the outdoor condensing unit.

The thermostat Y2 contact is connected to the furnace control board Y2 terminal, and Y2 on the furnace control board is connected to Y2 on the compressor. Alternately, the HI COMP terminal may be connected as output to Y2 on the outdoor condensing unit.

When R and Y1 contacts close, the 24-volt AC signal is sent to the furnace control board Y1 terminal and Y1 on the outdoor condensing unit. First stage compressor is energized, and the furnace circulating air blower operates at approximately 65% of the selected COOL jumper position.

Two Stage Cooling with a Single Stage Thermostat

To activate this feature, a jumper wire must be installed between terminals Y1 and LO COMP on the modulating control board.

When R and Y contacts close, 24 volts is received at terminal Y/Y2. The LO COMP output energizes the outdoor condensing unit Y1 terminal. The blower operates at approximately 65% of the selected COOL jumper position.

The furnace control board initiates second stage cooling based on the logic illustrated in the chart below. In second stage cooling mode, 24 volts Ac is sent from the HI COOL to Y2 outdoor condensing unit terminal. The furnace circulating air blower operates at 100% of the selected COOL jumper position.

When operating in Step 1 – On a call for cooling, the LO COMP terminal is energized. When the call for cooling ends, the LO COMP terminal is de-energized. The control will transition to Step 2 if the call for cooling exceeds 25 minutes.

When operating in Step 2 – On a call for cooling the HI COMP terminal is energized. The control will transition back to Step 1 if the thermostat is off for longer than 10 minutes or transition forward to Step 3 if the thermostat call for cooling is longer than 60 minutes.

When operating in Step 3 – On a call for cooling the HI COMP terminal is energized. When the call for cooling ends, the HI COMP terminal is de-energized, and the LO COMP terminal remains energized. If there is no call for cooling for 15 minutes the LO COMP terminal is de-energized. The control will transition back to Step 2 if the no call for cooling lasts longer than 20 minutes.

Cooling Mode “Run 2”

The 15-minute time period is Step 3 (compressor runs with no call for cooling) is known as the “Run 2” cycle. There is no “Run 2” cycle in Steps 1 or 2. Therefore, when the call for cooling by the thermostat ends in Step 1 or Step 2 there is no compressor operation.

Sequence of Operation: Generation 2

Heating Sequence

The basic sequence of operation is as follows:

- A call for heat occurs when the thermostat closes the “R-W” circuit.
- The induced draft blower starts.
- The operation of the induced draft blower is proven with a pressure switch.
- The pressure transducer monitors the opening and closing of the pressure switch.
- The ignition sequence begins.
- Flame is established and proven.
- The circulating air blower is energized.
- Call for heat ends (“R-W” opens).
- The control board determines the firing rate for Run 2 cycle and additional run time. (**Note**: The Run 2 cycle is eliminated when the Zone Control jumper on the control board is in the Yes position.)
- Run 2 is terminated (gas valve is de-energized, inducer post purge, blower runs until discharge air temp is 95°F).

Following is detailed information on each step of the sequence.

A Call for Heat Occurs when the Thermostat Closes the R-W Circuit

The R terminal on the furnace control board provides 24 volts AC to the thermostat. On a call for heat, 24 volts AC is sent to the furnace control board “W” circuit, initiating the furnace heating cycle. 24 volts AC measured between W and C on the furnace terminal strip indicates that a call for heat is present.

The Induced Draft Blower Starts

The induced draft blower is energized with variable voltage (52-113 volts AC), through terminal connector Inducer Hot & Inducer Neutral on the modulating furnace control boards. The voltage to the inducer is ramped until the combustion air pressure switch closes.

The Operation of the Induced Draft Blower is Proven

The combustion air pressure switch is present to ensure that the induced draft motor is coming up to speed and that there are no restrictions within the vent system. The combustion air pressure switch is normally open (“N/O”) and closes after the inducer motor is energized, allowing the ignition sequence to continue. The pressure differential is verified by the pressure transducer.

The Ignition Sequence Begins

After the pressure switch proves that the inducer has come up to speed and there are no significant restrictions in the system, the trial for ignition begins.

The hot surface ignitor is energized with 120 volts AC from terminals Ignitor Hot and Ignitor Neutral on the modulating furnace control board. The hot surface ignitor is allowed to warm up for 17 seconds. The gas valve is sent a 24-volt AC On signal, measurable between pins 4 and 8 on the 8-pin plug connector. The modulation signal during ignition will be approximately a 70% firing rate. This will be indicated as a 65% PWM signal. The measurement procedure is indicated below.

Using a Fluke 87 or similar multimeter with PWM capability, measure between the Flame Voltage (-) test point and the Valve PWM test point. The Flame Voltage (-) test point is in the lower right-side section of the board, and the Valve PWM test point is located just below the label in the upper center section. A Fluke 87 multimeter has a Hz % key, and when it is pushed twice it will display the PWM signal. The meter will alternate between three signals during operating including: request for position (15), operating range (30-95), and the Done signal of 25. Depending upon the multi-meter used to take PWM measurements, various intermediate readings may flash while the meter settles.

In run mode the control is constantly issuing the firing rate command (30 to 95 PWM percent) and the valve echoes this input followed by the Done respond (25 PWM percent). Therefore, read the PWM output and add 5 to get the firing rate; ignore the 25 Done signal.

When the gas valve is energized, there is a window of a few seconds for flame to become established and stable, which is verified by a furnace control.

Flame is Established and Proven

During a call for heat the flame sensor is energized with 120 volts AC. In the presence of flame, the AC voltage is rectified through the flame to DC current (flame rectification).

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 0.5 volts DC (0.5 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.

Circulating Air Blower Starts

The circulating blower is energized at a minimum speed immediately after the flame has been proven, and ramps to maintain a consistent temperature rise.

The furnace fires at 70% of full rate for 30-45 seconds, then drops to the minimum firing rate for 6 minutes.

The minimum firing rate on the 97%-98% AFUE is 35% with a continuous range of 35% to 100%. The minimum firing rate on the 80% AFUE is 50% with a continuous range of 50% to 100%.

The firing rate is automatically adjusted to meet demand, increasing gradually to maximum (100%) firing rate if the thermostat is not satisfied over the next 10 minutes (16 minutes total).

Call for Heat Ends

The thermostat ends the call for heat by breaking the R to W circuit. 24 volts AC is removed from the W terminal on the furnace control board. The 24-volt AC gas valve On signal is removed from pin 8 of the 8-pin plug connector. The furnace will then go to Run 2. The system will continue to operate, reducing the firing rate slowly down to 35% and then OFF. The Run 2 ramp down can take up to 12 minutes before the system turns off.

When the system is OFF, the gas valve is de-energized immediately and the furnace control begins the blower off cool down, when the temperature of the discharge air is below 95 degrees, the blower will shut off. The control also confirms that the flame signal is lost immediately after the gas valve is de-energized. The duration of Run 2 will vary depending on the last Run 1 firing rate.

Run 2 Heating (97% - 98% AFUE Furnaces)

If the firing rate is 55% or above, the burners will continue to fire at a recalculated reduced firing rate, (approximately a 20% reduction). The gas valve capacity will remain at the Run 2 firing rate position for about 6 minutes if the thermostat remains OFF. The blower RPM is ramped to maintain a constant supply temperature. After 6 minutes, the gas valve capacity is reduced 1% every 9 seconds until it reaches minimum position (35% for 97%-98%) AFUE), then shuts off. The blower will continue to run until the supply air temperature is less than 95°F.

If the previous Run 1 demand did not exceed the firing rate of 54%, the system will immediately go to Run 2 at the minimum 35% firing rate. The duration of Run 2 will vary based on the previous firing rate, i.e., if the previous firing rate was at 54% the time in Run 2 would be 6 minutes maximum and it takes approximately 12 seconds per firing rate percent.

- 54% = 360 seconds (6 minutes) at 35%
- 53% = 342 seconds (5 minutes and 42 seconds) at 35%
- 18.37% = 36 seconds run time at 35%
- 19.36% = 18 seconds run time at 35%

Run 2 Heating (80% AFUE Furnaces)

If the firing rate is above 65%, the burners will continue to fire at a recalculated reducing firing rate (approximately a 15% reduction). The gas valve capacity will remain at the Run 2 firing rate position for 6 minutes if the thermostat remains OFF and then ramp down at a reduced rate of approximately 1% every 12 seconds until it reaches minimum position (50%), then shuts off. The blower RPM is ramped down to maintain a constant supply temperature. The blower will continue to run until the supply air temperature is less than 95°F.

If the previous Run 1 demand was 64% or below, the system will immediately go to Run 2 at the minimum 50% firing rate. The duration of Run 2 will vary based on the previous firing rate, i.e., if the previous firing rate was at 64% the time in Run 2 would be 6 minutes maximum and it takes approximately 26 seconds per firing rate percent.

- 64% = 360 seconds (6 minutes) at 50%
- 63% = 334 seconds (5 minutes and 34 seconds) at 50%
- 52% = 52 seconds run time at 50%
- 51% = 26 seconds run time at 50%

Heat Pump Operation

A jumper located at J22 is provided to select a special heat pump program.

- No = heat pump “O” signal not present.
- Yes = heat pump “O” signal present, activate the Special logic for heat pump heating
- 24 volts AC present on “O” input: System is in the cooling mode.
- 0 volts AC present on the “O” input: System is in the heating mode.

The jumper is set in the factory to the NO position which indicates that the home has a standard gas furnace, and the normal heating program is used. If the Heat Pump Jumper is in the YES position, it indicates that there is a heat pump present, and the furnace is use as a secondary heat source. In addition, the YES Heat Pump Jumper allows the system to read the presence of the “O” terminal signal as a heat pump heating operation. In Heat Pump operation, the following special program logic applies:

- Supplemental heat: Both a W and a Y1 signal are present, the modulating firing rate will operate as normal, except there will be a no Run 2. (Occasionally a Run 2 may occur if the wiring set up allows Y1 to drop off a fractional second before the W signal is removed.
- Defrost cycle: Both a W signal and a Y2 signal are present, the modulating firing rate will operate at a constant 80% firing rate and there will be no Run 2.
- The hot heat pump feature will not function when the control is wired to a single stage thermostat and a 2-stage heat pump. A two-stage heat pump will require installation of a two stage heat pump thermostat.

Cooling Mode: Single Stage Cooling

The thermostat Y terminal is connected to the furnace control board Y/Y2 terminal, and is connected to the Y/Y2 on the outdoor condensing unit. Alternately, the HI COMP terminal may be connected to Y/Y2 on the outdoor condensing unit.

When the R to Y/Y2 thermostat contacts close, the furnace control board Y/Y2 terminal is energized. The 24-volt AC signal is sent through the furnace control board to the outdoor condensing unit. The blower motor operates at speed selected on furnace control board jump block COOL.

Cooling Mode: Second Stage Cooling

The thermostat Y1 contact is connected to the furnace control board Y1 terminal and Y1 on the furnace control board is connected to Y1 on the outdoor unit control board. Alternately, the LO COMP terminal may be connected as output to Y1 on the outdoor unit.

The thermostat Y2 contact connects to the furnace control board Y2 terminal, and Y2 on the furnace control board connects to Y2 on the outdoor unit control board. Alternately, the HI COMP terminal may be connected as output to Y2 on the outdoor unit.

When R and Y1 contacts close, 24 volts is sent to the furnace control board Y1 terminal and Y1 on the outdoor unit. The first stage compressor is energized, and the furnace circulating air blower operates at approximately 65% of the selected COOL jumper position.

When R and Y2 contacts close, 24 volts AC is sent to the furnace control board Y2 terminal and Y2 on the outdoor unit. The second stage compressor is energized, and the furnace circulating air blower operates at 100% of the selected COOL jumper position.

Two Stage Cooling with a Single Stage Thermostat

To activate this feature, a jumper wire is connected between terminals Y1 and LO COMP on the modulating control board.

When R and Y contacts close, 24 volts AC is received at terminal Y/Y2. The LO COMP output energizes the outdoor unit Y1 terminal. The blower operates at approximately 65% of the selected COOL jumper position.

The furnace control board initiates second stage cooling based on the logic illustrated in the chart below. In second stage cooling mode, 24 volts AC is sent from the HI COOL to Y2 outdoor condensing unit terminal. The furnace circulating air blower operates at 100% of the selected COOL jumper position.

When operating in Step 1 – On a call for cooling, the LO COMP terminal is energized. When the call for cooling ends, the LO COMP terminal is de-energized. The control will transition to Step 2 if the call for cooling exceeds 25 minutes.

When operating in Step 2 – On a call for cooling the HI COMP terminal is energized. The control will transition back to Step 1 if the thermostat is off for longer than 10 minutes, or transition forward to Step 3 if the thermostat call for cooling is longer than 60 minutes.

When operating in Step 3 – On a call for cooling the HI COMP terminal is energized. When the call for cooling ends, the HI COMP terminal is de-energized, and the LO COMP terminal remains energized. If there is no call for cooling for 15 minutes, the LO COMP terminal is de-energized. The control will transition back to Step 2 if the no call for cooling lasts longer than 20 minutes.

Cooling Mode Run 2

The 15 minutes time in Step 3 (compressor runs with no call for cooling) is known as the Run 2 cycle. There is no Run 2 cycle in Steps 1 or 2. When the call for cooling by the thermostat ends in Step 1 or Step 2, there is no compressor operation.

07

Troubleshooting

Status LED

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

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, the LED shows a RED flash code. GREEN flashes indicate normal standby operation. AMBER flashes are used to indicate system status.

Do not use the LED codes blindly – expertise and experience of technicians is very important to the proper servicing of the 33” modulating gas furnaces. The LEDs will point the technician in the right direction, but a solid foundation of fundamental troubleshooting techniques is critical to effective service.

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 as continuous, the entire control has failed and should be replaced, as it is not field repairable.

Flash codes and their meanings are available in the Extras section of this Guide.

If a flame is detected the control flashes the LED for 1/8 of a second and then enters a flame stabilization period.

ERROR Button

The furnace control board is equipped with memory that will store up to five error codes to allow a service technician to diagnose problems more easily. This memory will be retained even is power to the furnace is lost. This feature should only be used by a qualified service technician. If more than five error codes have occurred since the last reset, only the five most recent will be retained. The furnace control board button labeled ERROR is used to retrieve error codes. This function will only work if there are no active thermostat signals. Any call for heating or cooling must be terminated before attempting to retrieve error codes.

To retrieve error codes, push the ERROR button once. The LED on the control will then flash the error codes that are in memory, starting with the most recent. There will be a two-second pause between each flash code on Generation 1 units, and a one and a half second pause on Generation 2 units. After the error codes have all 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, press and hold the ERROR button 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.

Flame Current

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

The flame sensor is always energized with 120 volts AC. 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 volts DC. 1 volt DC = 1 microamp (µA).

Normal µA values are in the 2-4 µA range, with a minimum of 0.5 µA required for flame proof. Below 1.5 µA (1.5 volts DC on the flame current pad), the furnace control board LED will flash rapid amber, indicating a low flame signal.

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

- Line voltage polarity must be correct.
- A dedicated ground wire run from 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 crack.
- AC voltage must be present between the flame sensor and ground.

Hot Surface Ignitor (HSI)

If not glowing during warm up, check ignitor resistance – it should be approximately 40 – 80 ohms at room temperature.

Verify that the correct line voltage is being supplied to the ignitor during warmup. This can be measured by setting a multimeter to volts AC and measuring the AC voltage available to the ignitor at the plastic plug connector that connects the ignitor to the furnace control board. For accurate voltage measurement, the ignitor must remain connected.

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.

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 and capacity controlled by the furnace control board based on heating requirements.

On Generation 1 units, the technician may verify the firing rate of the furnace by measurement of the milliamp DC (mADC) current flowing to the modulation coil of the gas valve. The following charts illustrate the mADC signals expected at various firing rates for both the 80% and 97% - 98% AFUE models.

Generation 1 Gas Valve mADC Values

	97 – 98% AFUE	80% AFUE
40mADC	35%	-
57mADC	40%	-
90mADC	50%	50%
107mADC	60%	60%
125mADC	70%	70%
142mADC	80%	80%
160mADC	90%	90%
177mADC	100%	100%

A digital multimeter set to mADC may be placed in series with the modulator coil of the gas valve by disconnecting the male/female spade connectors.

On Generation 2 units, the gas valve uses Pulse Width Modulation (PWM) to drive the stepper motor for gas flow modulation instead of the 40-180 mA signal used in the Generation 1 valve. The gas valve using PWM has an eight-pin plug which connects to the board. To verify the firing rate of the furnace by measuring the PWM signal, place the positive (+) meter lead on the round connection labeled Valve PWM and the negative (-) meter lead at the negative terminal for the FLAME VOLTAGE. Then convert the meter reading into the actual firing rate using the PWM Meter Reading to Firing Rate Conversion on the following page.

Generation 2 Gas Valve PWM Values

Meter Reading % PWM	Gas Valve Status % Firing
0	Disconnected or waiting for output
5	OFF
15	IFC to gas valve – Request for position
25	Gas valve to IFC – Done response
30	35%
40	45%
45	50%
50	55%
55	60%
60	65%
65	70%
70	75%
75	80%
80	85%
85	90%
90	95%
95	100%

Burners

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

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 as follows:

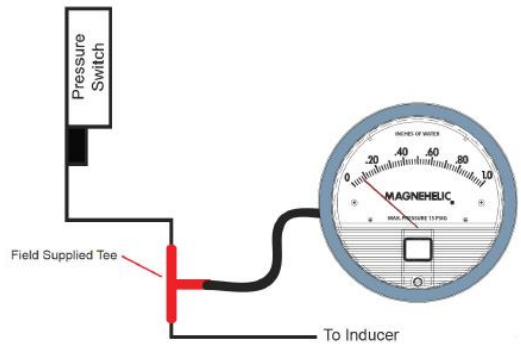
- With an AC voltmeter, take a voltage reading across the terminals of the switch. A closed switch will indicate zero (0) volts AC. An open switch will be indicated by the applied voltage displayed on the meter.
- Turn system power off, disconnect the wiring connected to the switch and take a resistance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

Pressure Switch Diagnosis (General)

The pressure switch is present to ensure that the induced draft motor is coming up to speed and that there are no restrictions within the vent system. Pressure switches are normally open (N/O) and close after the inducer motor is energized. Pressure switch closure must occur to allow the ignition sequence to continue.

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 0-1" w.c. will work well for testing pressure switches on the modulating gas furnaces.

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 present at the switch.



Teeing Magnehelic Into 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 more than 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 the 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.

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 jumper 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.

Polarity and Ground

The furnace control system requires correct polarity of the power supply and proper ground connection. The furnace will not operate properly until polarity is correct.

Proper grounding is critical. Connection to a water or gas pipe is illegal and unsafe in many cases. To verify proper grounding, measure voltage between L1 and neutral, then compare the reading with L1 and ground. These readings should be within two volts of each other. A reading taken between neutral, and ground should read zero volts.

Primary and Rollout Limits

Limits are used to stop the heating cycle in the event of abnormal temperatures in the heat exchanger area.

The primary limit switch 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 main limit is opening, 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 open the limit before the thermostat is satisfied, especially in combustion 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 most limit opening problems. If the limit switch itself is defective, be sure to replace 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 damages or loss of life that may result.

Rollout limits are in the burner area. There may be one or more rollout switches present. The rollout limit will open in the event of an abnormal flame pattern. 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. A service tool is available through Source 1 that will temporarily hold the door switch closed during service and will prevent the replacement of the blower compartment panel before the tool is removed. This tool prevents the permanent disabling of the door switch safety feature. 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. The tubing must not contain sags which would prevent proper condensate drainage. The tubing from the rain gutter to the collector box and collector box to external drain piping should be routed as directly as possible.

Ensure that the drain is not double trapped and preventing the proper drainage of condensate. If the condensate drain line 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 will not close.

Duct System

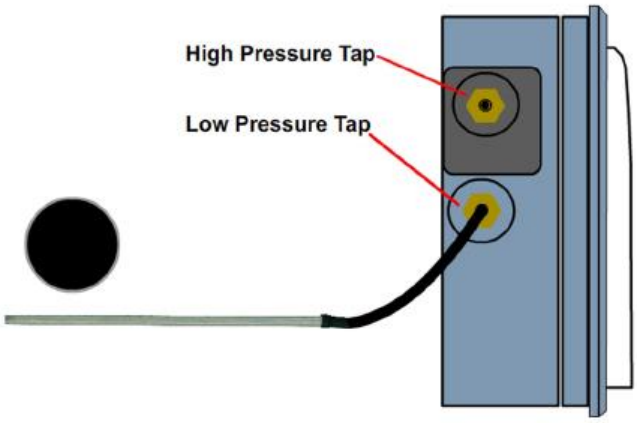
There are limitations to the airflow that a blower may provide if installed in systems with improperly sized ductwork or other system restrictions.

The measurement of static pressure will help 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 duct, dirty filters, dirty evaporator coil or closed/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 0.5" w.c. total external statis pressure.

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

Using the Magnehelic



Magnehelic Side View

The high power 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 Low 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 and Return Static Measurement

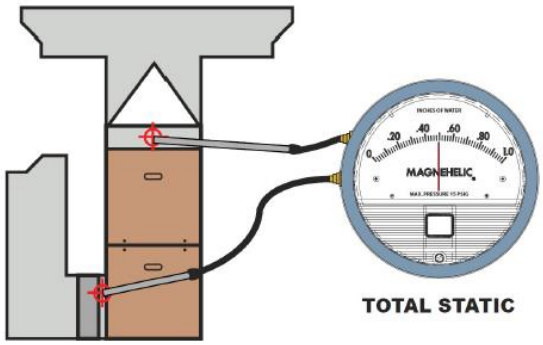
To measure the supply static pressure, connect the Magnehelic gauge probe to the port marked High. The probe should be inserted immediately off the supply duct connection, under the evaporator coil if possible. This will allow measurement of the supply static and resistance to airflow imposed by the evaporator coil, supply duct, fittings, and registers. The supply system, when properly sized, should be near 0.1” w.c. (without the evaporator coil). A clean, dry evaporator coil will add about 0.2” w.c. static, bringing the supply static to a total of 0.3” w.c. (0.1” + 0.2” = 0.3”).

To measure the return static pressure, connect the Magnehelic probe to the port marked Low. The probe should be inserted between the filter and the furnace. This will allow the technician 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.

Total Static Measurement

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



Pulse Width Modulation (PWM) Motor Signal

A PWM signal is a fixed period waveform in which the on-time is described as a percent of the total run time. The information is communicated to the motor by the control board in percent duty cycle.

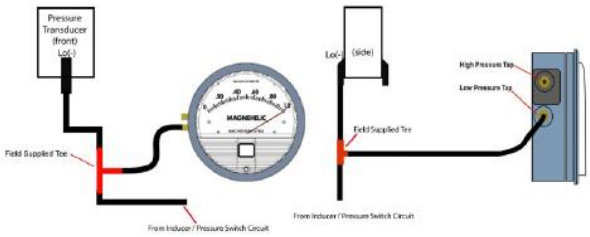
A multimeter with PWM capability is used to determine the PWM motor signal. The programmed CFM delivery that corresponds to their respective PWM signals can be found in the Extras section of this Guide.

Pressure Transducer Verification

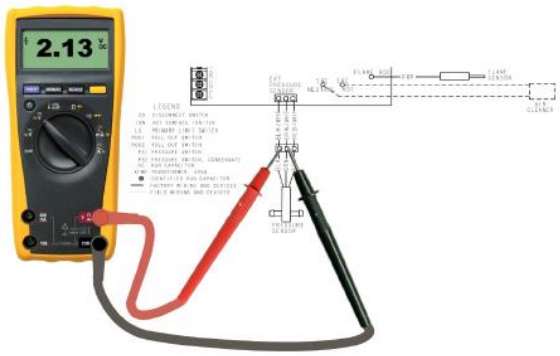
The following procedure uses the DC voltage readings that corresponds to specific static pressure points to determine if the pressure transducer is operating properly.

Preparation:

- Multimeter MSUT be set to Volts DC
- Multimeter leads are placed on Black and green on the three-pin plug connector.
- If DC voltage reading is negative, the meter probes are reversed.
- Tee a Magnehelic or incline manometer as shown.
- Compare the DC voltage to the pressure measured – they should correspond to +/- 0.1” w.c.



Magnehelic or Manometer Connection to Pressure Transducer



Pressure Transducer Verification

Important
When checking a transducer, the meter must be set for DC volts. If the meter is set to “Ohms”, the meter’s battery voltage will be applied to the microprocessor on the control board resulting in a failed board.

Compare the DC voltage to the pressure measured in the pressure/voltage table. They should correspond to +/- 0.1” w.c.

Pressure (in w.c.)	Voltage (VDC)
0.00	0.00
0.40	1.00
0.45	1.09
0.50	1.19
0.55	1.28
0.60	1.38
0.65	1.47
0.70	1.56
0.75	1.66
0.80	1.75
0.85	1.84
0.90	1.94
0.95	2.03
1.00	2.13
1.05	2.22
1.10	2.31
1.15	2.41
1.20	2.50
1.25	2.59
1.30	2.69
1.35	2.78
1.40	2.88
1.45	2.97
1.50	3.06
1.55	3.16
1.60	3.25

08

Maintenance

Introduction

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

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 plugs 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 completed out for service.

Motor Lubrication

The blower motor and inducer motor on the 33” single 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 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 dirt 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 filter 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 turbulator 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 due 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% AFUE 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.

Do not neglect to inspect the condensate pump accessory if present. Rinse out and flush with clean water.

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 blower out any dust accumulation and check exposed contacts or 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. They may have a cycle rate adjustment setting rather than anticipator setting, and in most cases require no adjustment.

09

Appendix

Status Codes – 33” Modulating Gas Furnace

Error Status Codes – 33” Modulating Gas Furnace

Flash(es)	Color	Condition
Off	N/A	No Power to Control
1	Red	Flame Present with Gas Off
2	Red	Pressure Switch Closed with Inducer Pressure Below Allowed Tolerance
3	Red	Pressure Switch Open with Inducer Pressure Above Allowed Tolerance
4	Red	High Limit Switch Open or Fuse Open
5	Red	Auxiliary Limit String or Safety Relay Open when it should be Closed
6	Red	Modulated Gas Valve Current Failure
7	Red	Lockout Due to No Ignition
8	Red	Lockout Due to No Many Flame Dropouts
9	Red	Incorrect Line Voltage Polarity
10	Red	Gas Valve Circuit Shorted
11	Red	Main Blower Failure
12	Red	Identity Plug Loose or Not Connected
Steady On	Red	Control Fault Detected; No 24 VAC Power
Slow	Green	Normal Operation – No Call for Heat
Rapid	Green	Standby or Test Mode
1	Amber	Call for Cooling
2	Amber	Gas ON – Call for Heat
3	Amber	Gas ON – No Call for Heat (Run 2)
4	Amber	Suppressed Firing Rate Due to Soft Limit or Reduced Firing Rate
5	Amber	Suppressed Firing Rate Due to Low Combustion Air
6	Amber	Heat Pump Heating
7	Amber	Compressor ON – No Call for Cooling/Heat Pump (Run 2)
Rapid	Amber	Flame Sense Current is Below 1.5 Microamps

Thermistor Temperature vs. Resistance

Temperature (F)	Resistance in Ohms
70°F	11832 ohms (11.8K)
110°F	4633 Ohms (4.64K)
120°F	3733 Ohms (3.74K)
130°F	3027 Ohms (3.01K)
140°F	2470 Ohms (2.49K)
150°F	2028 Ohms (2.05K)
160°F	1674 Ohms (1.65K)
170°F	1390 Ohms (1.40K)
180°F	1160 Ohms (1.15K)

Pressure Transducer VDC Values

Pressure (in w.c.)	Voltage (VDC)
0.00	.25
0.40	1.00
0.45	1.09
0.50	1.19
0.55	1.28
0.60	1.38
0.65	1.47
0.70	1.56
0.75	1.66
0.80	1.75
0.85	1.84
0.90	1.94
0.95	2.03
1.00	2.13
1.05	2.22
1.10	2.31
1.15	2.41
1.20	2.50
1.25	2.59
1.30	2.69
1.35	2.78
1.40	2.88
1.45	2.97
1.50	3.06
1.55	3.16
1.60	3.25

Blower PWM Values

The airflow corresponds with the measured PWM. Note that these values are model-specific as noted in the column headers.

Blower Motor PWM Signals and Airflow Delivery (ECM) Models												
Minimum fan control signal, [PWM %] 5%												
Maximum fan control signal, [PWM %] 95%												
Minimum airflow limit all furnaces [CFM] 400 (minimum CFM for proper operation of electronic air cleaner)												
Fan control signal accuracy, [PWM %] +/-1 (deviation of fan blower control PWM signal from programmed curve)												
ID Plug number indicates furnace model -- (9=97/98%, 8=80%, A-D=Cab. Width, 12-20=Nom. CFM, 60-120=Htg Cap.)												
ID Plug	**9D20N120**	**9C20N100**	**9C16N100**	**9C16N080**	**9B12N080**	**9B12N060**	**8D20N120**	**8C20N100**	**8C16N100**	**8C16N080**	**8B12N080**	**8A12N060**
control signal [PWM %]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]
0	187	512	411	305	310	298	239	0	210	101	341	279
1	187	512	411	305	310	298	239	0	210	101	341	279
2	187	512	411	305	310	298	239	0	210	101	341	279
3	187	512	411	305	310	298	239	0	210	101	341	279
4	187	512	411	305	310	298	239	0	210	101	341	279
5	223	519	412	335	323	311	269	92	234	123	351	286
6	259	525	413	364	336	324	298	184	257	144	362	293
7	282	527	421	369	347	337	321	208	273	165	373	300
8	308	529	428	375	358	350	343	232	289	186	383	306
9	325	565	442	396	370	367	368	266	304	211	395	321
10	345	601	457	417	382	385	394	300	319	235	407	335
11	371	608	462	458	397	396	412	314	339	265	419	342
12	398	615	466	500	411	407	430	329	359	295	431	348
13	421	618	471	504	425	422	451	359	379	319	441	367
14	444	621	476	508	439	438	472	389	399	344	452	386
15	484	630	495	525	451	451	499	423	420	374	470	391
16	523	639	514	543	464	464	525	458	442	405	489	397
17	552	641	517	563	482	475	565	500	461	424	498	420
18	581	643	519	583	500	486	605	542	481	443	506	442
19	607	663	537	592	512	498	627	584	500	464	521	447
20	634	683	555	602	525	511	649	627	518	486	535	453
21	664	691	557	622	537	521	673	649	543	512	548	464
22	693	700	559	642	549	531	697	671	568	538	561	476
23	717	716	581	665	558	540	719	703	585	558	575	493
24	740	732	603	689	568	549	742	734	602	578	590	511
25	764	748	623	699	582	564	766	758	623	597	601	525
26	788	764	643	709	597	580	791	782	644	616	613	539
27	810	781	654	717	607	590	814	808	661	635	623	549
28	832	800	665	724	616	601	838	833	678	653	633	559

ID Plug	9D20N120	9C20N100	9C16N100	9C16N080	9B12N080	9B12N060	8D20N120	8C20N100	8C16N100	8C16N080	8B12N080	8A12N060
control signal [PWM %]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]
29	853	810	685	751	626	613	861	857	698	673	644	577
30	873	821	704	778	635	625	884	880	719	692	655	596
31	904	841	714	789	652	636	899	898	734	709	665	615
32	936	859	724	800	670	646	915	916	748	726	676	634
33	957	882	740	810	682	663	936	939	760	743	699	642
34	977	904	756	821	694	680	957	963	771	759	722	650
35	1002	920	769	844	707	694	970	982	785	776	727	664
36	1027	935	782	867	719	708	983	1000	800	793	733	679
37	1049	954	790	881	731	721	1003	1024	820	813	746	695
38	1070	974	797	895	742	734	1023	1048	840	832	760	711
39	1099	986	813	914	766	743	1037	1067	856	853	769	725
40	1128	998	829	934	789	753	1051	1085	872	874	779	738
41	1148	1007	850	953	804	769	1069	1107	891	896	795	750
42	1168	1016	871	971	820	785	1088	1129	910	918	811	761
43	1188	1034	890	986	835	800	1106	1156	929	937	824	776
44	1208	1052	910	1000	851	814	1125	1184	947	956	836	791
45	1231	1066	928	1022	863	827	1158	1205	964	971	853	804
46	1254	1080	947	1045	875	841	1190	1226	981	986	870	816
47	1283	1110	956	1058	887	847	1211	1244	994	1002	884	823
48	1312	1140	964	1072	899	853	1232	1262	1007	1018	898	831
49	1330	1162	983	1087	915	866	1250	1285	1024	1033	908	849
50	1349	1185	1003	1102	931	880	1268	1309	1041	1049	918	868
51	1372	1197	1016	1118	942	886	1282	1333	1056	1066	929	873
52	1395	1209	1029	1134	952	893	1297	1357	1071	1083	941	878
53	1415	1235	1041	1148	963	901	1327	1383	1087	1098	952	885
54	1435	1262	1054	1162	974	910	1357	1409	1102	1113	963	891
55	1456	1275	1076	1177	984	918	1378	1429	1117	1133	976	908
56	1478	1294	1099	1192	994	926	1395	1450	1131	1154	989	920
57	1496	1313	1111	1207	1006	942	1413	1467	1151	1166	1001	937
58	1514	1332	1123	1222	1019	958	1432	1484	1170	1178	1014	954
59	1531	1354	1139	1234	1025	969	1455	1504	1183	1193	1024	966
60	1547	1320	1156	1245	1032	980	1478	1524	1195	1207	1035	978
61	1566	1391	1178	1258	1041	988	1495	1543	1213	1222	1042	979
62	1585	1364	1201	1271	1050	996	1512	1562	1230	1236	1048	980
63	1594	1429	1224	1285	1066	1009	1534	1571	1245	1248	1058	994
64	1604	1455	1247	1299	1083	1022	1556	1579	1260	1260	1069	1008
65	1631	1472	1266	1305	1090	1032	1571	1599	1275	1263	1077	1019
66	1659	1489	1284	1310	1097	1043	1587	1619	1290	1265	1085	1030
67	1676	1509	1306	1325	1111	1054	1601	1631	1300	1287	1103	1043

ID Plug	9D20N120	9C20N100	9C16N100	9C16N080	9B12N080	9B12N060	8D20N120	8C20N100	8C16N100	8C16N080	8B12N080	8A12N060
control signal [PWM %]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]	air flow [CFM]
68	1694	1529	1328	1340	1125	1065	1615	1643	1309	1309	1120	1056
69	1716	1549	1349	1348	1140	1080	1631	1666	1320	1318	1133	1067
70	1737	1540	1370	1356	1155	1095	1647	1689	1330	1327	1147	1077
71	1759	1608	1420	1366	1164	1105	1663	1708	1344	1343	1157	1088
72	1782	1648	1471	1377	1173	1116	1679	1728	1358	1359	1168	1098
73	1800	1661	1493	1392	1188	1126	1695	1746	1371	1375	1178	1110
74	1819	1676	1515	1408	1203	1137	1712	1765	1383	1391	1188	1123
75	1837	1698	1518	1419	1215	1148	1736	1782	1393	1406	1201	1135
76	1856	1719	1521	1431	1227	1159	1760	1800	1402	1420	1213	1147
77	1876	1744	1545	1445	1240	1171	1775	1824	1417	1435	1228	1158
78	1897	1769	1568	1460	1253	1182	1790	1849	1432	1451	1243	1170
79	1917	1790	1586	1471	1270	1191	1810	1870	1447	1468	1252	1178
80	1937	1810	1603	1482	1287	1200	1829	1891	1463	1485	1262	1186
81	1958	1836	1620	1498	1304	1204	1852	1910	1478	1502	1279	1201
82	1979	1862	1637	1515	1320	1207	1875	1929	1493	1518	1295	1216
83	2005	1876	1657	1525	1330	1220	1898	1948	1506	1532	1304	1221
84	2031	1890	1678	1536	1340	1233	1921	1967	1518	1545	1314	1227
85	2050	1915	1706	1550	1347	1244	1935	1988	1537	1563	1328	1240
86	2069	1941	1734	1564	1354	1256	1949	2008	1556	1582	1341	1253
87	2090	1963	1757	1582	1355	1266	1964	2023	1568	1597	1353	1260
88	2111	1985	1781	1601	1355	1277	1980	2039	1580	1612	1364	1267
89	2128	2012	1803	1624	1358	1284	2008	2060	1598	1628	1366	1280
90	2145	2040	1826	1647	1360	1292	2036	2082	1616	1644	1369	1292
91	2173	2061	1848	1661	1362	1292	2059	2103	1631	1659	1371	1304
92	2200	2082	1871	1675	1363	1292	2082	2124	1646	1674	1373	1317
93	2220	2105	1896	1683	1364	1293	2098	2149	1659	1688	1373	1328
94	2239	2129	1921	1692	1364	1294	2114	2174	1673	1703	1373	1340
95	2257	2151	1946	1695	1365	1298	2141	2199	1690	1717	1375	1346
96	2275	2174	1970	1697	1366	1303	2168	2225	1707	1731	1378	1351
97	2302	2194	1974	1717	1366	1305	2188	2244	1723	1749	1378	1375
98	2329	2214	1977	1736	1366	1307	2208	2263	1739	1768	1378	1400
99	2329	2214	1977	1736	1366	1307	2208	2263	1739	1768	1378	1400
100	2329	2214	1977	1736	1366	1307	2208	2263	1739	1768	1378	1400

