

Bosch 96% AFUE Gas Furnace BGH96 Model

Condensing Gas Furnace



BOSCH

Installation, Operation, and Maintenance Manual



Table of Contents

1 Key to Symbols and Safety Instructions	4		
1.2 Safety	4		
2 Dimensions	7		
3 Introduction	8		
4 Codes and Standards	9		
4.1 Safety	9		
4.2 General Installation	9		
4.3 Combustion and Ventilation Air	10		
4.4 Duct Systems	10		
4.5 Acoustical Lining and Fibrous Glass Duct	10		
4.6 Gas Piping and Gas Pipe Pressure Testing	10		
4.7 Electrical Connections	10		
4.8 Electrical Power Supply	10		
4.9 Venting	10		
5 Electrostatic Discharge (ESD) Precautions Procedure	10		
6 Location	11		
6.1 General	11		
7 Installation	13		
7.1 Upflow Installation	13		
7.2 Horizontal Installation	14		
7.3 Condensate Line and Over Flow Pressure Switch	17		
7.4 Filter Arrangement	22		
7.5 Air Ducts	23		
8 Combustion Air and Vent System	26		
8.1 Combustion Air and Vent Safety	26		
8.2 Combustion Air/Vent Pipe Sizing	26		
8.3 Combustion Air And Vent Piping Assembly	28		
8.4 Combustion Air / Venting	29		
8.5 Vent System	30		
8.6 Combustion & Ventilation Air Requirements	31		
8.7 Vent and Supply (Outside) Air Safety Check Procedure	34		
9 Gas Supply and Piping	35		
9.1 General	35		
9.2 High Altitude Derate	36		
9.3 Propane Gas (LP) Conversion	37		
9.4 Gas Piping Connections	37		
9.5 Gas Piping Checks	38		
10 Electrical Connections	39		
10.1 115V Wiring	39		
10.2 Electrical Connection to J-box	40		
10.3 Power Cord Installation in Furnace J-box	40		
10.4 BX Cable Installation in Furnace J-box	40		
10.5 24-V Wiring	40		
10.6 Accessories (Field Supplied)	40		
10.7 Grounding	40		
11 Start-Up, Adjustment, and Safety Check	43		
11.1 General	43		
11.2 Start-Up Procedures	43		
11.3 Furnace Start-Up	43		
11.4 Sequence of Operation	44		
11.5 Gas Manifold Pressure Measurement and Adjustment	45		
11.6 Gas Input Rate Measurement (Natural Gas Only)	46		
11.7 Temperature Rise Adjustment	46		
11.8 Circulator Blower Speed Adjustment	47		
12 Operational Checks	48		
13 Safety Circuit Description	48		
13.1 General	48		
13.2 Integrated Control Module	48		
13.3 Chamber Limit Switch - Fixed	48		
13.4 Fan Mounted Limit Switch	48		
13.5 Rollout Switch - Resettable	48		
13.6 Overflow Protection Pressure Switch (Overflow Switch)	48		
13.7 Pressure Switches	48		
13.8 Flame Sensor	48		
14 Troubleshooting	49		
14.1 Electrostatic Discharge (ESD) Precautions	49		
14.2 Resetting From Lockout	49		
14.3 Troubleshooting Chart	49		
15 Service and Maintenance Procedures	52		
15.1 Annual Inspection	52		
15.2 Filters	52		
15.3 Induced Draft And Circulating Blower Motors	52		
15.4 Flame Sensor (Qualified Service Technicians Only)	52		
15.5 Ignitor (Qualified Service Technicians Only)	53		
15.6 Burners	53		
15.7 Inspecting the Heat Exchanger (Qualified Service Technicians Only)	53		
15.8 Condensate Drain	53		
15.9 Repair and Replacement Parts	53		
16 Before Leaving Installation	53		
17 Wiring Diagram	55		

1 Key to Symbols and Safety Instructions

1.1 Key to Symbols

Warnings



Warnings in this document are identified by a warning triangle printed against a grey background. Keywords at the start of a warning indicate the type and seriousness of the ensuing risk if measures to prevent the risk are not taken.

The following keywords are defined and can be used in this document:

- ▶ **DANGER** indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- ▶ **WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- ▶ **CAUTION** indicates a hazardous situation which, if not avoided, could result in minor to moderate injury.
- ▶ **NOTICE** is used to address practices not related to personal injury.

Important information



This symbol indicates important information where there is no risk to people or property.

1.2 Safety

Please read all instruction in the manual and retain all manuals for future reference.



INSTALLER: Use the information in this booklet to install the appliance and affix this booklet adjacent to the appliance after installation.

USER: Keep this booklet of information for future reference. Refer to the User's Information Manual for more information.

SERVICER: Use the information in this booklet to service the appliance and affix the booklet adjacent to the appliance after servicing.



WARNING: FIRE OR EXPLOSION HAZARD

- ▶ Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- ▶ **WHAT TO DO IF YOU SMELL GAS:**
 - Do not try to light any appliance.
 - Do not touch any electrical switch; do not use any phone in your building.
 - Leave the building immediately.
 - Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
 - If you cannot reach your gas supplier, call the fire department.
- ▶ Installation and service must be performed by a qualified installer, service agency, or the gas supplier.



WARNING: FIRE OR EXPLOSION HAZARD

- ▶ Do not use this furnace if any part has been under water. A flood-damaged furnace is extremely dangerous. Attempts to use the furnace can result in fire or explosion. A qualified service agency should be contacted to inspect the furnace and to replace all gas controls, control system parts, and electrical parts that have been wet, or the furnace if deemed necessary.



WARNING: FIRE OR EXPLOSION HAZARD

- ▶ The furnace is designed and approved for use with Natural Gas and (LP) Propane Gas ONLY.
- ▶ **DO NOT BURN ANY LIQUID FUEL OR SOLID FUEL IN THIS FURNACE.**
- ▶ Burning any unapproved fuel will result in damage to the furnace's heat exchanger, which could result in Fire, Personal Injury, and/or Property Damage.

**WARNING: FOLLOW ALL SAFETY CODES**

- ▶ Wear safety glasses, protective clothing, and work gloves. Have a fire extinguisher available. Read these instructions thoroughly and follow all warnings or cautions included in literature and attached to the unit. Consult local building codes as well as the current editions of the National Fuel Gas Code (NFGC) NFPA 54/ANSI Z223.1 and the National Electrical Code (NEC) NFPA 70.

**WARNING: FIRE, EXPLOSION, ELECTRICAL SHOCK, AND CARBON MONOXIDE POISONING HAZARD**

- ▶ Failure to follow this warning could result in dangerous operation, serious injury, death, or property damage. Improper installation, adjustment, alteration, maintenance, or use could cause carbon monoxide poisoning, explosion, fire, electrical shock, or other conditions which may cause personal injury or property damage. Consult a qualified service agency, local gas supplier, or your distributor for information or assistance.

**CAUTION: CUT HAZARD**

- ▶ Failure to follow this caution may result in personal injury. Sheet metal parts may have sharp edges or burrs. Use care and wear appropriate protective clothing, safety glasses and gloves when handling parts and servicing furnaces.

**CAUTION: INSTALLATION REQUIREMENTS**

- ▶ Use only with type of gas approved for this furnace. Refer to the furnace rating plate.
- ▶ Install this furnace only in a location and position as specified in Section 6 "Location" of these instructions.
- ▶ Provide adequate combustion and ventilation air to the furnace space as specified in Section 8.4 "Combustion Air / Venting".
- ▶ Combustion products must be discharged outdoors. Connect this furnace to an approved vent system only, as specified in Section 8.5 "Vent System" of this manual.
- ▶ When a furnace is installed so that supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by duct(s) sealed to the furnace cabinet and terminating outside the space containing the furnace. See Section 7.5 "Air Ducts".
- ▶ A gas-fired furnace for installation in a residential garage must be installed as specified in the warning box in Section 6 "Location".
- ▶ The furnace may be used for construction heat provided that the furnace installation and operation complies with the first CAUTION in Section 6 "Location" of these instructions.

**WARNING: FIRE HAZARD**

- ▶ Always install furnace to operate within the furnace's intended temperature-rise range with a duct system which has an external static pressure within the allowable range, as specified in Section 11 "Start-Up, Adjustments, and Safety Check" or the furnace rating plate.

**WARNING: FIRE HAZARD**

- ▶ The furnaces must be kept free and clear of insulating materials. Inspect surrounding area to ensure insulation material is at a safe distance when installing furnaces or adding insulation materials. Insulation materials may be combustible.
See Section 3, Fig. 3 for required clearances to combustible construction.
Maintain a 1 in. clearance from combustible materials to supply air ductwork for a distance of 36 in. horizontally from the furnace. See NFPA 90B or local code for further requirements.
- ▶ These furnaces SHALL NOT be installed directly on carpeting, tile, or any other combustible material other than wood flooring. This furnace SHALL NOT be installed in the downflow orientation.

NOTICE: FURNACE RELIABILITY HAZARD

- ▶ Improper installation or misapplication of furnace may require excessive servicing or cause premature component failure. Application of this furnace should be indoors with special attention given to vent sizing and material, gas input rate, air temperature rise, unit leveling, and unit sizing.

**WARNING: FIRE, EXPLOSION**

- ▶ Check entire gas assembly for leaks after lighting this appliance.
- ▶ Never test for gas leaks with an open flame. Use a commercially available soap solution made specifically for the detection of leaks to check all connections, as specified in Section 9 "Gas Supply and Piping" section.

NOTICE:

- ▶ The condensate from this unit is acidic, ensure that all local and national codes are adhered to when draining condensate. If proper procedures are not followed, this may lead to property damage.

**CAUTION:**

- Before heating season begins, examine the furnace to ensure that:
 1. All flue gas carrying areas external to the furnace (i.e. chimney, vent connector) are clear and free of obstructions.
 2. The vent connector is in place, slopes upward and is physically sound without holes or excessive corrosion.
 3. The return-air duct connection(s) is physically sound, is sealed to the furnace cabinet, and terminates outside the space containing the furnace.
 4. The physical support of the furnace is sound without sagging, cracks, gaps, etc around the base so as to provide a seal between the support and the base.
 5. There are no obvious signs of deterioration of the furnace.
 6. The burner flames are positioned correctly by comparing with pictorial sketches of the main burner flame (see Section 12, Fig 42).

**WARNING: FIRE, EXPLOSION**

- See instructions for lighting/shutdown operation (as shown at the bottom of this page, as well as on a sticker directly on the inside of the furnace panel). Should the gas supply fail to shut off or if overheating occurs, shut off the gas valve to the furnace before shutting off the electrical supply.

**WARNING: CARBON MONOXIDE POISONING HAZARD**

- Furnace operation requires air for combustion and ventilation. Do not block or obstruct air openings on furnace or spacing around furnace required for supplying sufficient combustion air and ventilation.

**WARNING:**

- This product can expose you to chemicals including Lead and Lead components, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

Instructions for lighting/shutdown operation:**FOR YOUR SAFETY READ BEFORE OPERATING**

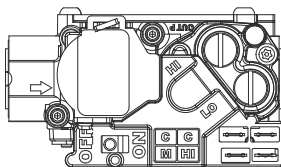
If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

- A. This appliance does not have a pilot, it is equipped with an ignition device which automatically lights the burner. **Do not** try to light the burner by hand.
- B. **BEFORE OPERATING** smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle to the floor.

FOR YOUR SAFETY
"WHAT TO DO IF YOU SMELL GAS"
 - Do not try to light any appliance.
 - Do not touch any electrical switch; do not use any phone in your building.
 - Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
 - If you cannot reach your gas supplier, call the fire department.
- C. Use only your hand to push the gas control switch. Never use tools. If the switch will not move by hand, don't try to repair it; call a qualified service technician. Force or attempted repair may result in a fire or explosion.
- D. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.

OPERATING INSTRUCTIONS

1. **STOP!** Read the safety information above on this label.
2. Set the thermostat to lowest setting.
3. Turn off all electric power to the appliance.
4. This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.



SWITCH SHOWN IN THE "OFF" POSITION

5. Remove access panels.
6. Push gas control switch to "OFF".
7. Wait five (5) minutes to clear out any gas. Then smell for gas, including near the floor. If you smell gas, **STOP!** Follow "B" in the safety information above on this label. If you don't smell gas, go to the next step.
8. Push gas control switch to "ON".
9. Replace access panels.
10. Turn on all electric power to the appliance.
11. Set thermostat to desired setting.
12. If the appliance will not operate, follow the instructions "To Turn Off Gas To Appliance" and call your service technician or gas supplier.

TO TURN OFF GAS TO APPLIANCE

1. Set the thermostat to lowest setting.
2. Turn off all electric power to the appliance if service is to be performed.
3. Remove access panels.
4. Push gas control switch to "OFF".
5. Replace access panels.

202082290022

2 Dimensions

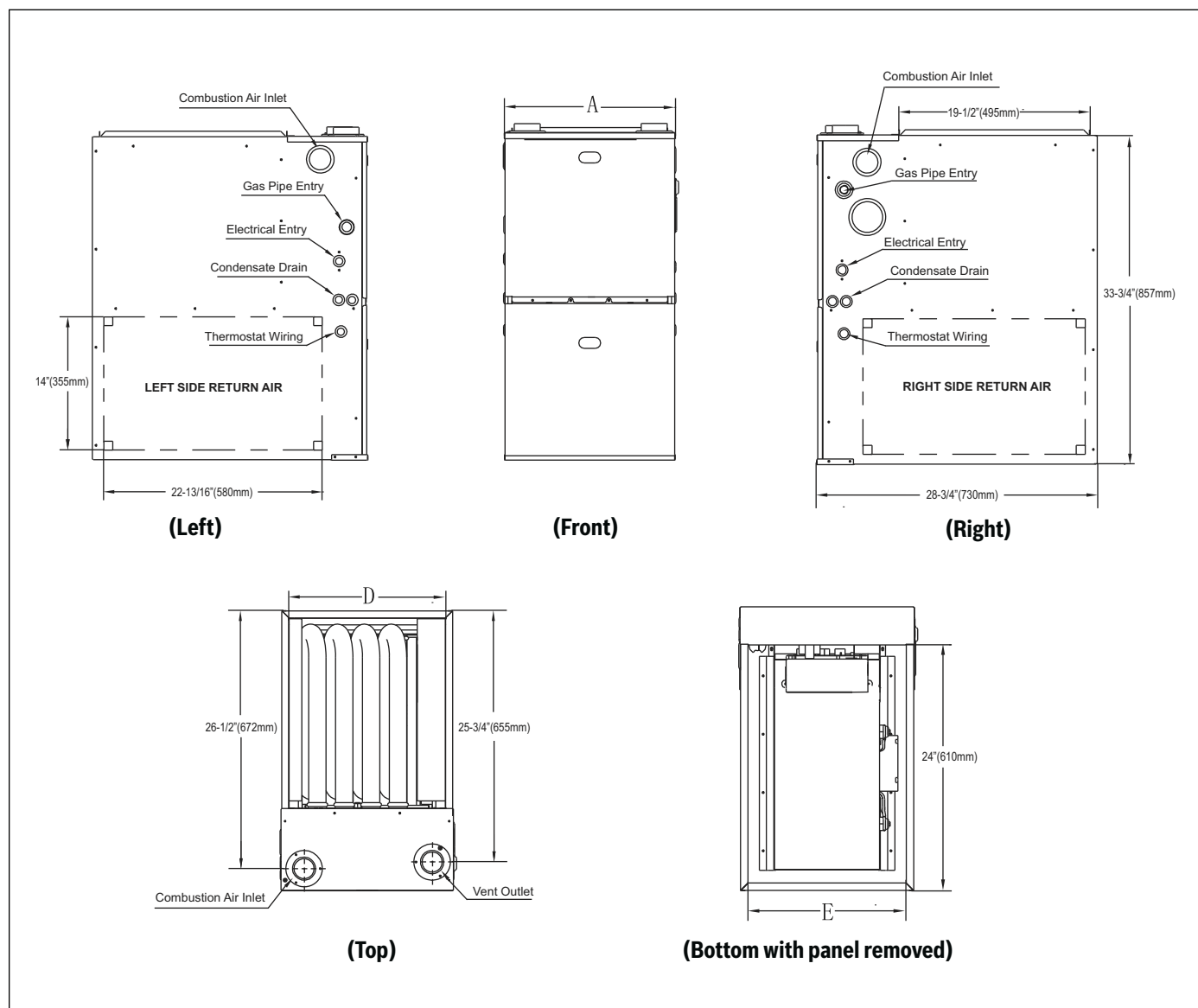


Figure 1 Dimensions

Furnace Model	"A" Cabinet Width In. (mm)"	"D" Supply-Air Width In. (mm)"	"E" Return-Air Width In. (mm)"	Shipping Weight lbs (kgs)
BGH96M060B3A	17.5 (445)	16 (406)	15-27/32 (402)	162.5 (73.7)
BGH96M080B3A	17.5 (445)	16 (406)	15-27/32 (402)	168.5 (76.4)
BGH96M080C4A	21 (533)	19.5 (495)	19-13/32 (493)	184.6 (83.7)
BGH96M100C5A	21 (533)	19.5 (495)	19-13/32 (493)	194.6 (88.3)
BGH96M100D5A	24.5 (622)	23 (584)	22-27/32 (580)	205.1 (93.0)
BGH96M120D5A	24.5 (622)	23 (584)	22-27/32 (580)	209.5 (95.0)

Table 1 Dimensions & Weight

3 Introduction

This 3-way Multipoise Category IV Fan-assisted furnace is AHRI and ETL design-certified. A Category IV Fan-assisted furnace is an appliance equipped with an integral mechanical means to either draw or force products of combustion through the combustion chamber and/or heat exchangers. This furnace is factory-shipped for use with natural gas.

This furnace is not approved for installation in mobile homes, recreational vehicles, or outdoors. This furnace is designed for minimum continuous return-air temperature of 60°F (16°C) (DBT) or intermittent operation down to 55°F (13°C) (DBT) such as when used with a night setback thermostat. Return-air temperature must not exceed 85°F (29°C) (DBT). Failure to follow these return-air temperature limits may affect reliability of heat exchangers, motors, and controls. (See Section 4.1, Fig.).

For accessory installation details, refer to the applicable instruction literature. A Natural Gas to LP conversion kit, supplied by the manufacturer with every furnace unit, shall be used to convert to propane gas (LP).

This furnace is for indoor installation in a building constructed on-site.

This furnace may be installed on combustible flooring in alcove or closet at minimum clearance as indicated by Figure 3.

This furnace requires a special venting system. Refer to Section 8, "Vent System" of this manual for installation instructions related to venting. In the US this furnace is for use with schedule-40 PVC, PVC-DWV, CPVC, or ABS-DWV pipe, and must not be vented in common with other gas-fired appliances. For installations in Canada, refer to Section 8.4, "Combustion Air/Venting" of this manual. Construction through which vent/air intake pipes may be installed is maximum 24 inches (610 mm), minimum 3/4 inches (19 mm) thickness (including roofing materials).



Remove all shipping brackets and materials before operating the furnace.



WARNING: FIRE, EXPLOSION, ASPHYXIATION HAZARD

- ▶ Improper adjustment, alteration, service, maintenance, or installation can cause serious injury or death. Read and follow instructions and precautions in User's Information Manual provided with this furnace. Installation and service must be performed by a qualified service agency or the gas supplier.



This product is not to be sold or installed in the State of California in the South Coast Air Quality Management District or San Joaquin Valley Air Basin territory.



CAUTION:

▶ **INSTALLATION**

1. This furnace must be installed in accordance with the manufacturer's instructions and local codes. In the absence of local codes, follow the National Fuel Gas Code ANSI Z223.1/NFPA54.
2. This furnace must be installed so there are provisions for combustion and ventilation air. See manufacturer's installation information provided with this appliance.

▶ **OPERATION**

This furnace is equipped with manual reset limit switch(es) in burner compartment to protect against overheat conditions that can result from inadequate combustion air supply or blocked vent conditions.

1. Do not bypass limit switches.
2. If a limit opens, call a qualified service technician to correct the condition and reset the limit switch.

This furnace is approved for UPFLOW and HORIZONTAL installations.



WARNING: FIRE HAZARD

- ▶ Do not install the furnace on its front or back. See Figure 2.

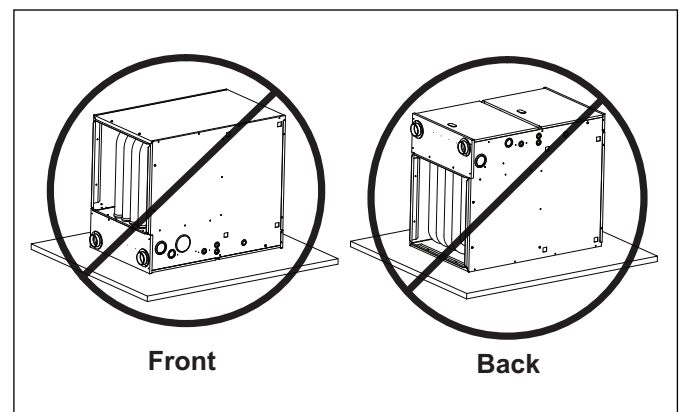


Figure 2

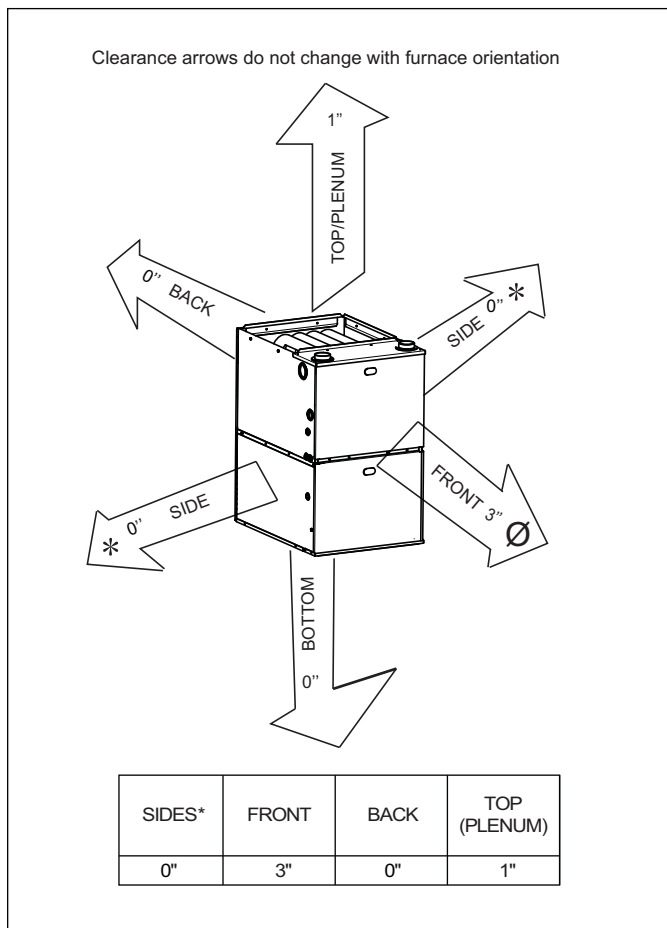


Figure 3 Minimum clearance from combustible construction

* When the unit is installed in the horizontal orientation, there must be 7" clearance in order to install the externally mounted drain trap.

* * If installed in an alcove or closet

|| 24 inches is required for service and maintenance.

Horizontal installation in attic or crawl space

* Indicates supply or return sides when furnace is in the horizontal position. Line contact only permissible between lines formed by intersections of the side and back of the furnace cabinet and building joists, studs or frame.

Horizontal applications require a solid, supportive structure for installation (refer to Section 7.2 "Horizontal Installation").

For upflow and horizontal applications, the furnace must be pitched a minimum of 1/2" (12.7 mm) to a maximum of 3/4" (19 mm) forward for proper drainage. See Section 7, "Installation" of this manual for more information.

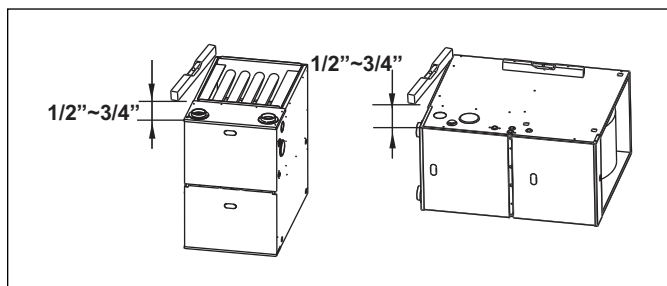


Figure 4

4 Codes and Standards

Follow all national and local codes and standards in addition to these instructions. The installation must comply with regulations of the serving gas supplier, local building, heating, plumbing, and other codes. In absence of local codes, the installation must comply with the national codes listed below and all authorities having jurisdiction. Follow all codes and standards for the following:

4.1 Safety

- ▶ US: National Fuel Gas Code (NFGC) NFPA 54-Latest/ANSI Z223.1-latest edition and the Installation Standards, Warm Air Heating and Air Conditioning Systems ANSI/NFPA 90B
- ▶ CANADA: National Standard of Canada Natural Gas and Propane Installation Codes (CAN/CSA-B149.1-05)

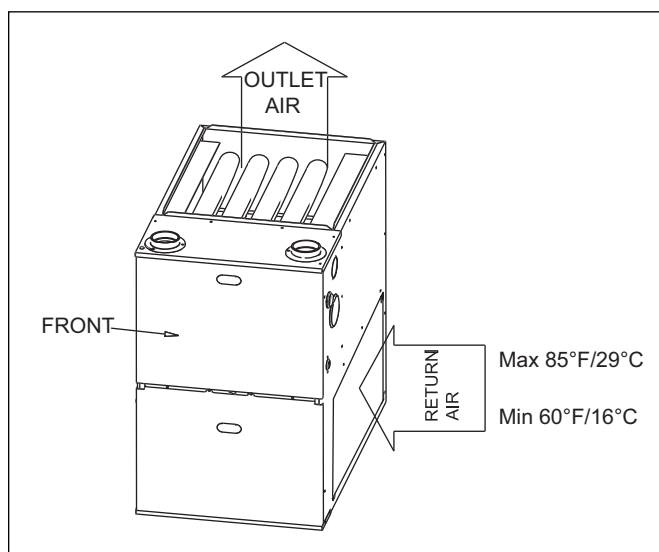


Figure 5 Return Air Temperature

4.2 General Installation

- ▶ US: Current edition of the NFGC and the NFPA 90B. For copies, contact the National Fire Protection Association Inc., 1 Batterymarch Park, Quincy, MA 02169; (www.NFPA.org) or for only the NFGC, contact the American Gas Association, 400 North Capital Street, NW, Suite 450, Washington, DC 20001 (www.AGA.org)
- ▶ CANADA: NSCNGPIC. For a copy, contact Standard Sales, CSA International, 178 Rexdale Boulevard, Etobicoke (Toronto), Ontario, M9W 1R3 Canada

4.3 Combustion and Ventilation Air

- ▶ US: Section 9.3 of the NFGC, NFPA 54/ANSI Z223.1-latest edition Air for Combustion and Ventilation
- ▶ CANADA: Part 8 of CAN/CSA-B149.1-05, Venting Systems and Air Supply for Appliances.

4.4 Duct Systems

- ▶ US and CANADA: Air Conditioning Contractors Association (ACCA) Manual D, Sheet Metal and Air Conditioning Contractors National Association (SMACNA), or American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) 2001 Fundamentals Handbook Chapter 34 or 2000 HVAC Systems and Equipment Handbook Chapters 9 and 16

4.5 Acoustical Lining and Fibrous Glass Duct

- ▶ US and CANADA: Current edition of SMACNA and NFPA 90B as tested by UL Standard 181 for Class I Rigid Air Ducts

4.6 Gas Piping and Gas Pipe Pressure Testing

- ▶ US: NFPA 54/ANSI Z223.1-latest edition Chapters 5, 6, 7, and 8 and National Plumbing Codes
- ▶ CANADA: CAN/CSA-B149.1-05 Parts 4, 5 and 6 and Appendices A, B, E, and H.

4.7 Electrical Connections

- ▶ US: National Electrical Code (NEC) ANSI/NFPA 70-latest edition
- ▶ CANADA: Canadian Electrical Codes CSA C22.1.

4.8 Electrical Power Supply

- ▶ Voltage: ANSI C84.1-latest edition (104-127 volt)

4.9 Venting

- ▶ US: NFPA 54/ANSI Z223.1-latest edition; Chapters 12 and 13
- ▶ CANADA: CAN/CSA-B149.1-05 Part 8 and Appendix C.

5 Electrostatic Discharge (ESD) Precautions Procedure

NOTICE: FURNACE RELIABILITY HAZARD

- ▶ Improper installation or service of furnace may cause premature furnace component failure.
- ▶ Electrostatic discharge can affect electronic components. Follow the electrostatic discharge precautions procedure listed below during furnace installation and servicing to protect the furnace electronic control. Precautions will prevent electrostatic discharges from personnel and hand tools which are held during the procedure. These precautions will help to avoid exposing the control board to electrostatic discharge by putting the furnace, the control board, and the person at the same electrostatic potential.

1. Disconnect all power to the furnace. Multiple disconnects may be required. **DO NOT TOUCH THE CONTROL OR ANY WIRE CONNECTED TO THE CONTROL PRIOR TO DISCHARGING YOUR BODY'S ELECTROSTATIC CHARGE TO GROUND.**
2. To discharge your body's electrostatic charge to ground, firmly touch the clean, unpainted, metal surface of the furnace chassis which is close to the control board. Tools held in a person's hand during grounding will be satisfactorily discharged.
3. After touching the chassis, you may proceed to service the control board or connecting wires as long as you do nothing to recharge your body with static electricity (for example; **DO NOT** move or shuffle your feet, do not touch ungrounded objects, etc.).
4. If you touch ungrounded objects (and recharge your body with static electricity), firmly touch a clean, unpainted metal surface of the furnace again before touching control board or wires.

Use this procedure for installed and uninstalled (ungrounded) furnaces. In the case of control board replacement, before removing the replacement control board from its packaging, discharge your body's electrostatic charge to ground to protect the control from damage. If the control is to be installed in a furnace, follow steps 1 through 4 before bringing the control board or yourself in contact with the furnace. Put all used and new control boards into containers before touching ungrounded objects.

An ESD service kit (field supplied) may also be used to prevent ESD damage.

6 Location

6.1 General

This multipoise furnace is shipped in packaged configuration. Some assembly and modifications are required when used in any of the three applications. This furnace must:

- ▶ Be installed so the electrical components are protected from water.
- ▶ Not be installed directly on any combustible material other than wood flooring. Refer to Section 3 Fig 3. for required clearances.
- ▶ Horizontal installation in attics and crawl spaces have additional requirements. Refer to Section 7.
- ▶ Be located close to the chimney or vent and attached to an air distribution system. Refer to Section 7.5 "Air Ducts".
- ▶ Be provided ample space for servicing and cleaning. Always comply with minimum fire protection clearances shown on the furnace clearance to combustible label. Refer to Section 3, Fig 3.

The following types of furnace installations may require OUTDOOR AIR for combustion due to chemical exposures:

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



WARNING: CARBON MONOXIDE POISONING HAZARD

- ▶ Failure to follow this warning could result in personal injury or death, and unit component damage.
- ▶ Corrosive or contaminated air may cause failure of parts containing flue gas, which could leak into the living space. Air for combustion must not be contaminated by halogen compounds, which include fluoride, chloride, bromide, and iodide. These elements can corrode heat exchangers and shorten furnace life. Air contaminants are found in aerosol sprays, detergents, bleaches, cleaning solvents, salts, air fresheners, and other household products. Do not install furnace in a corrosive or contaminated atmosphere. Make sure all combustion and circulating air requirements are met, in addition to all local codes and ordinances.

If air is exposed to the following substances, it should not be used for combustion air, and outdoor air may be required for combustion:

- ▶ 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 (such as perchloroethylene)
- ▶ Printing inks, paint removers, varnishes, etc.
- ▶ Hydrochloric acid
- ▶ Cements and glues
- ▶ Antistatic fabric softeners for clothes dryers
- ▶ Masonry acid washing materials

All fuel-burning equipment must be supplied with air for fuel combustion. Sufficient air must be provided to avoid negative pressure in the equipment room or space. A positive seal must be made between the furnace cabinet and the return-air duct to prevent pulling air from the burner area and from draft safeguard opening. Also see Section 7.5 "Air Ducts".

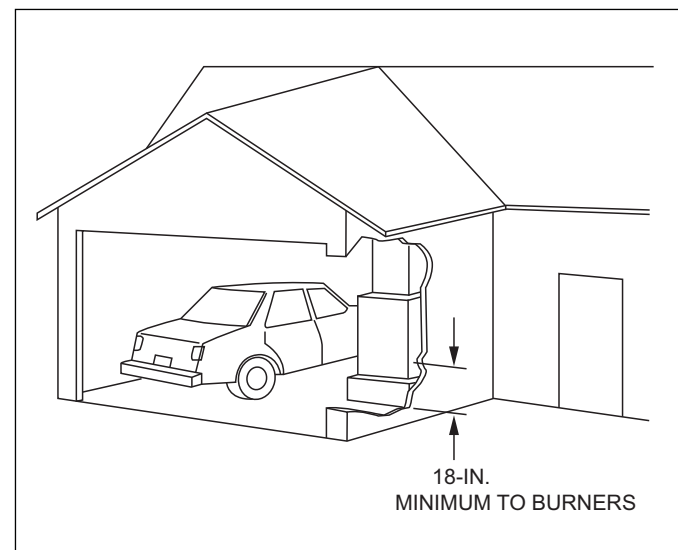


Figure 6 Installation in a garage

**WARNING: FIRE, INJURY OR DEATH HAZARD**

- ▶ When the furnace is installed in a residential garage, the burners and ignition sources must be located at least 18 inches above the floor. The furnace must be located or protected to avoid damage by vehicles. When the furnace is installed in a public garage, airplane hangar, or other building having a hazardous atmosphere, the furnace must be installed in accordance with the NFGC. (See Fig. 6).

**CAUTION: INJURY AND/OR PROPERTY DAMAGE HAZARD**

- ▶ Improper use or installation of this furnace may cause premature furnace component failure. This gas furnace may be used for heating buildings under construction provided that:
 - The furnace is permanently installed with all electrical wiring, piping, venting and ducting installed according to these installation instructions. A return air duct is provided, sealed to the furnace cabinet, and terminated outside the space containing the furnace. This prevents a negative pressure condition as created by the circulating air blower, causing a flame rollout and/or drawing combustion products into the structure.
 - The furnace is controlled by a thermostat. It may not be "hot wired" to provide heat continuously to the structure without thermostatic control.
 - Clean outside air is provided for combustion. This is to minimize the corrosive effects of adhesives, sealers and other construction materials. It also prevents the entrainment of drywall dust into combustion air, which can cause fouling and plugging of furnace components.
 - The temperature of the return air to the furnace is maintained between 60°F (16°C) and 85°F (29°C), with no evening setback or shutdown.
 - The use of the furnace while the structure is under construction is deemed to be intermittent operation per our installation instructions.
 - The air temperature rise is within the rated rise range on the furnace rating plate, and the gas input rate has been set to the nameplate value.
 - The filters used to clean the circulating air during the construction process must be either changed or thoroughly cleaned prior to occupancy.
 - The furnace, ductwork and filters are cleaned as necessary to remove drywall dust and construction debris from all HVAC system components after construction is completed.
 - Verify proper furnace operating conditions including ignition, gas input rate, air temperature rise, and

7 Installation

This furnace can be installed in upflow or horizontal orientations. (see Section 7.3, Fig 13-18).

7.1 Upflow Installation

Bottom return air inlet

These furnaces are shipped with the bottom closure panel installed in bottom return-air opening. Remove and discard this panel when bottom return air is used. To remove bottom closure panel, perform the following:

1. Tilt or raise furnace and remove the screw holding bottom filler panel. (See Fig. 7.)
2. Remove bottom closure panel.

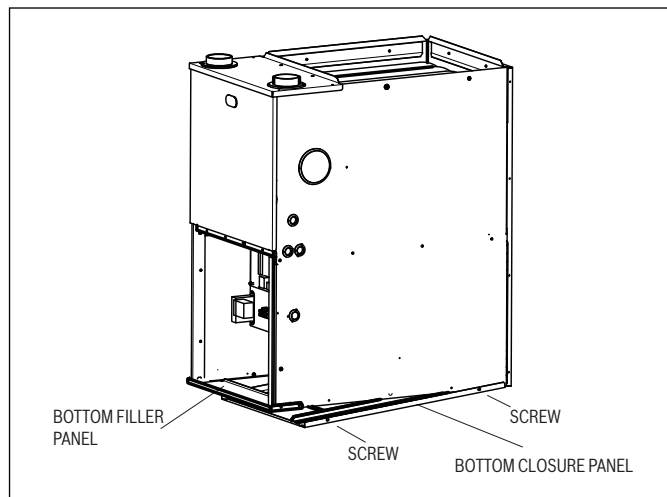


Figure 7 Removing bottom closure panel

Side return air inlet

These furnaces are shipped with bottom closure panel installed in bottom return-air opening. This panel MUST be in place if only side return air is used.



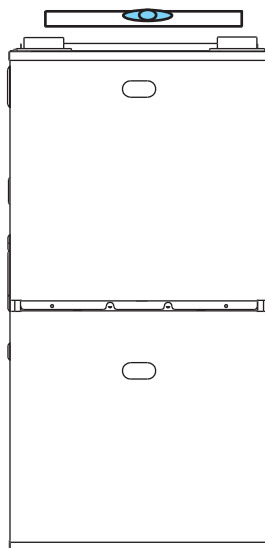
Depending on the installation requirements, side return-air openings can be used in UPFLOW and most HORIZONTAL configurations.



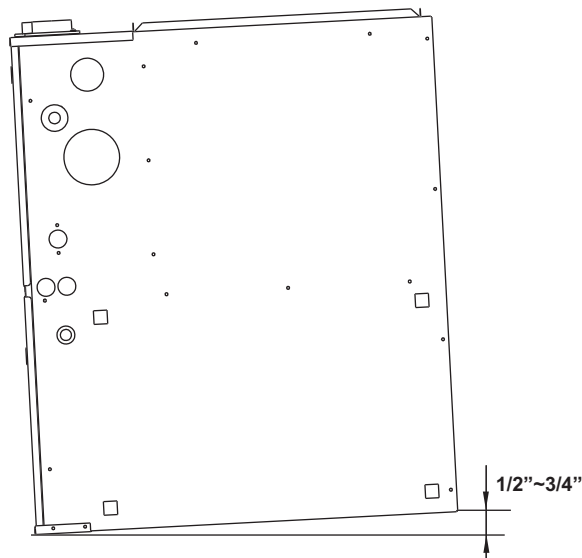
These furnaces come standard with knockout holes to aid in right/left return configurations. To do this, knockout the holes and cut the sheet metal and insulation accordingly.

Upflow Installation

Tilt the unit slightly (minimum 1/2" (12.7 mm) to maximum of 3/4" (19 mm)) from back to front to aid in the draining of the heat exchanger.



FRONT VIEW



SIDE VIEW

Figure 8 Upflow Application-Setting Equipment

7.2 Horizontal Installation



WARNING: FIRE, EXPLOSION, AND CARBON MONOXIDE POISONING HAZARD

- ▶ Failure to follow this warning could result in personal injury, death, and/or property damage. Do not install the furnace on its back or hang furnace with control compartment facing downward. Safety control operation will be adversely affected. Never connect return-air ducts to the back of the furnace.

The furnace can be installed horizontally in an attic or crawl space on bottom or either the left-hand (LH) or right-hand (RH) side (See Figure 9). The furnace can be hung from floor joists, rafters or trusses or installed on a non-combustible platform, blocks, bricks or pad.

7.2.1 Furnace Suspension

If suspending the furnace from rafters or joists, use 3/8" threaded rod and 2"x2"x1/8" angle iron as shown in Figure 10. The length of rod will depend on the application and the clearances necessary. (See Fig. 10 and 11)

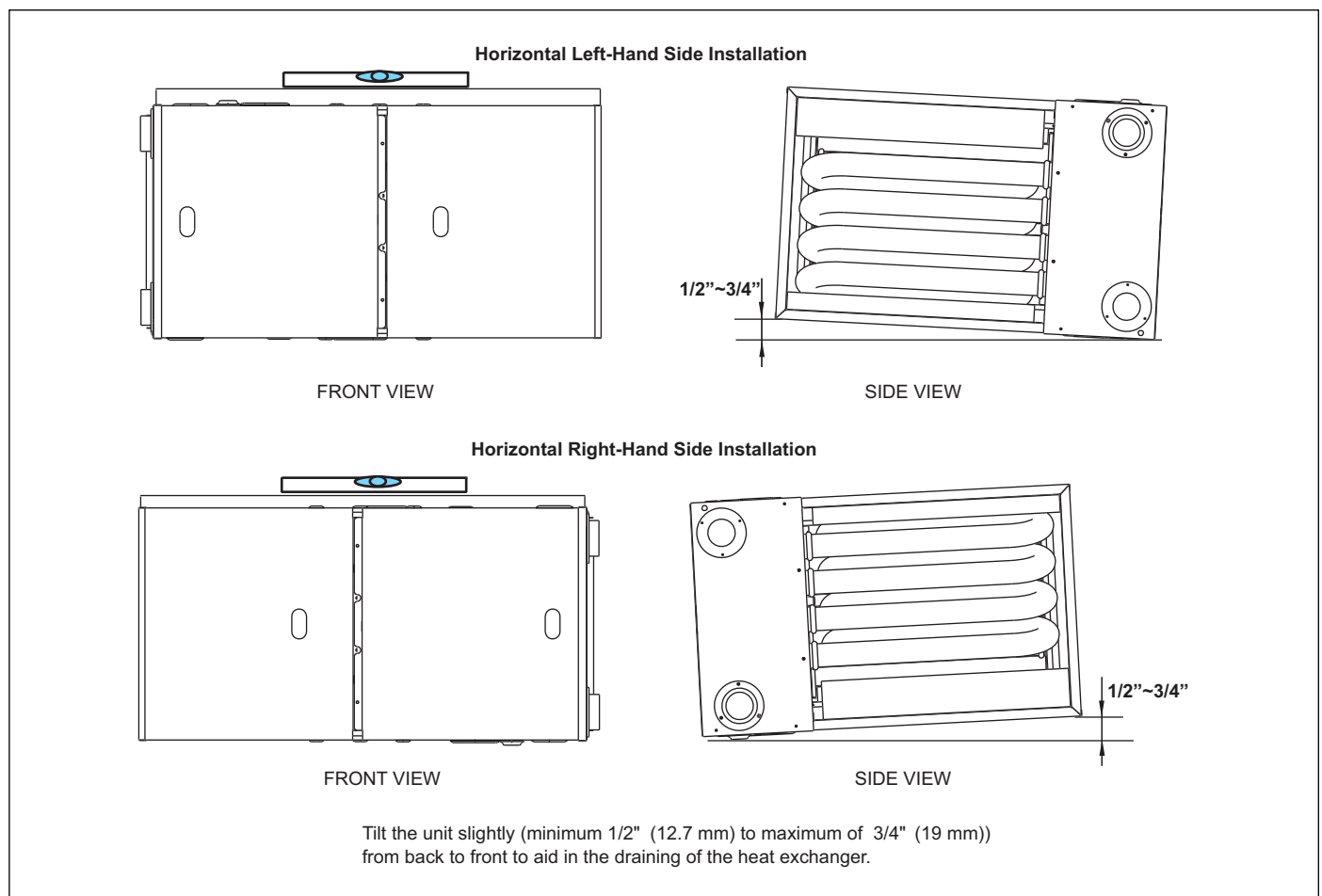


Figure 9 Horizontal Application-Setting Equipment

7.2.2 Horizontal Applications

Horizontal applications, in particular, may dictate many of the installation's specifics such as airflow direction, ductwork connections, flue and combustion air pipe connections, etc. The basic application of this furnace as a horizontal furnace differs only slightly from an upright installation. When installing a furnace horizontally, additional consideration must be given to the following:

Drain Trap and Lines

In horizontal applications the condensate drain trap is secured to the furnace side panel, suspending it below the furnace.



A minimum clearance of 7 inches below the furnace must be provided for the drain trap.

Additionally, the appropriate downward piping slope must be maintained from the drain trap to the drain location. Refer to Section "Condensate Drain Line & Drain Trap".

NOTICE:

- If the drain trap and drain line will be exposed to temperatures near or below freezing, adequate measures must be taken to prevent condensate from freezing. In this scenario, it is recommended to add foam insulation around the drain line, and heat tracing may also be necessary based on the application.

Leveling

Leveling ensures proper condensate drainage from the heat exchanger and induced draft blower. For proper flue pipe drainage, the furnace must be level lengthwise from end to end. The furnace should also have a slight tilt with the access doors downhill ((minimum 1/2" (12.7 mm) to maximum of 3/4" (19 mm)) from the back panel. The slight tilt allows the heat exchanger condensate, generated in the recuperator coil, to flow forward to the recuperator coil front cover. Refer to Figure 9.

Alternate Electrical And Gas Line Connections

This furnace has provisions allowing for electrical and gas line connections through either side panel. In horizontal applications the connections can be made either through the "top" or "bottom" of the furnace.

Drain Pan

A drain pan must be provided if the furnace is installed above a conditioned area. The drain pan must cover the entire area under the furnace (and air conditioning coil if applicable).

Furnace Suspension

If the furnace is installed in a crawl space it must be suspended from the floor joist or supported by a concrete pad. Never install the furnace on the ground or allow it to be exposed to water. See Furnace Suspension for further details (See Fig. 10).

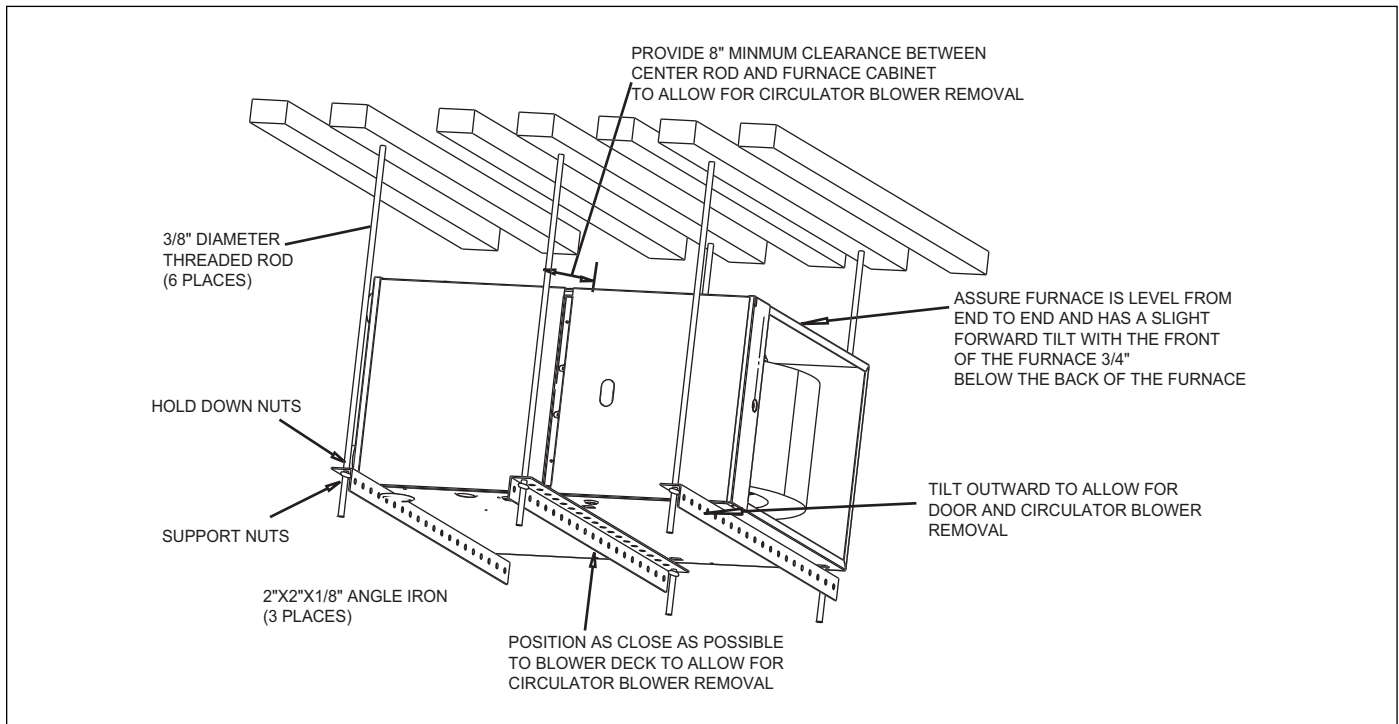


Figure 10 Horizontal Installation

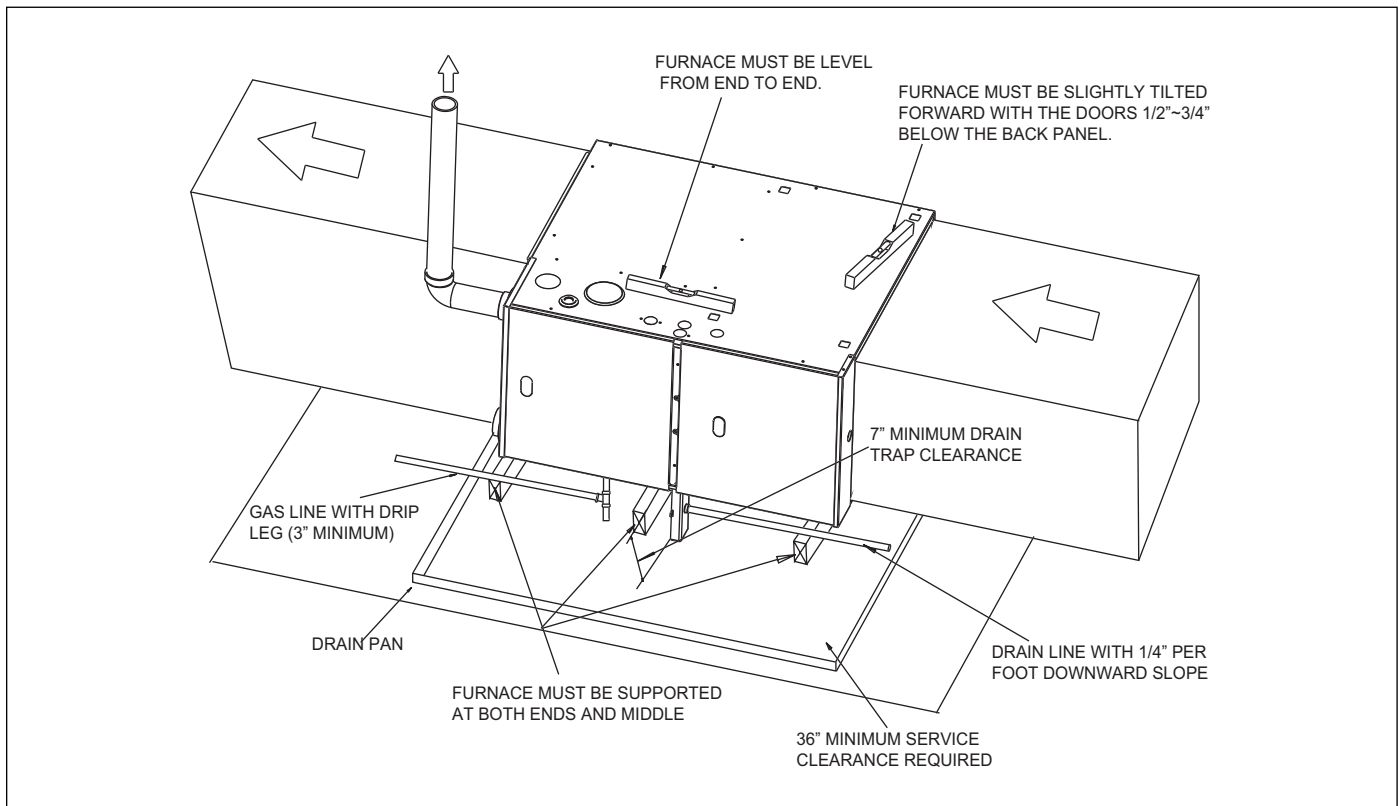


Figure 11 Horizontal Installation

7.3 Condensate Line and Over Flow Pressure Switch

NOTICE

- ▶ For horizontal left hand installation (air discharge to the left), condensate overflow pressure switch hoses need to be rerouted (see Figure 17).

To achieve higher energy efficiency than non-condensing furnaces, condensing furnaces will generate a significant amount of condensate water from combustion to recover latent heat in the flue. Condensate generated from the flue must be collected and discharged to the drain line. For some venting directions and furnace installations, rerouting of the condensate and/or overflow pressure switch hoses may be required. Follow the instructions below and Figures 13-17 for each installation.

Follow the information listed below when installing the drain system. Refer to the following sections for specific details concerning furnace drain trap installation and drain hose hook ups.

- ▶ The drain trap supplied with the furnace must be used.
- ▶ The drain line between furnace and drain location must be constructed of 3/4" PVC or CPVC.
- ▶ Ensure that the condensate hose connections between the pressure switches/inducer drain port and the condensate trap are sloped downward toward the drain to allow for proper drainage.
- ▶ The drain line between furnace and drain location must maintain a 1/4" per foot downward slope toward the drain.
- ▶ Do not trap the drain line in any other location than at the drain trap supplied with the furnace.
- ▶ Do not route the drain line outside where it may freeze.

- ▶ If the drain line is routed through an area which may see temperatures near or below freezing, precautions must be taken to prevent condensate from freezing within the drain line. In this scenario, it is recommended to add foam insulation around the drain line, and heat tracing may also be necessary based on the application.
- ▶ If an air conditioning coil is installed with the furnace, a common drain may be used. An open tee must be installed in the drain line, near the cooling coil, to relieve positive air pressure from the coil's plenum. This is necessary to prohibit any interference with the function of the furnace's drain trap.

NOTICE

- ▶ The condensate from this unit is acidic, adhere to all local and national codes when draining condensate. If proper procedures are not followed, this may lead to property damage.

NOTICE

- ▶ Condensate trap at furnace must be PRIMED for proper draining may not occur. The condensate trap can ONLY be primed by pouring water into the inducer drain side of condensate trap.

7.3.1 Standard Right-Hand or Left-Hand Side Drain Hose Connections

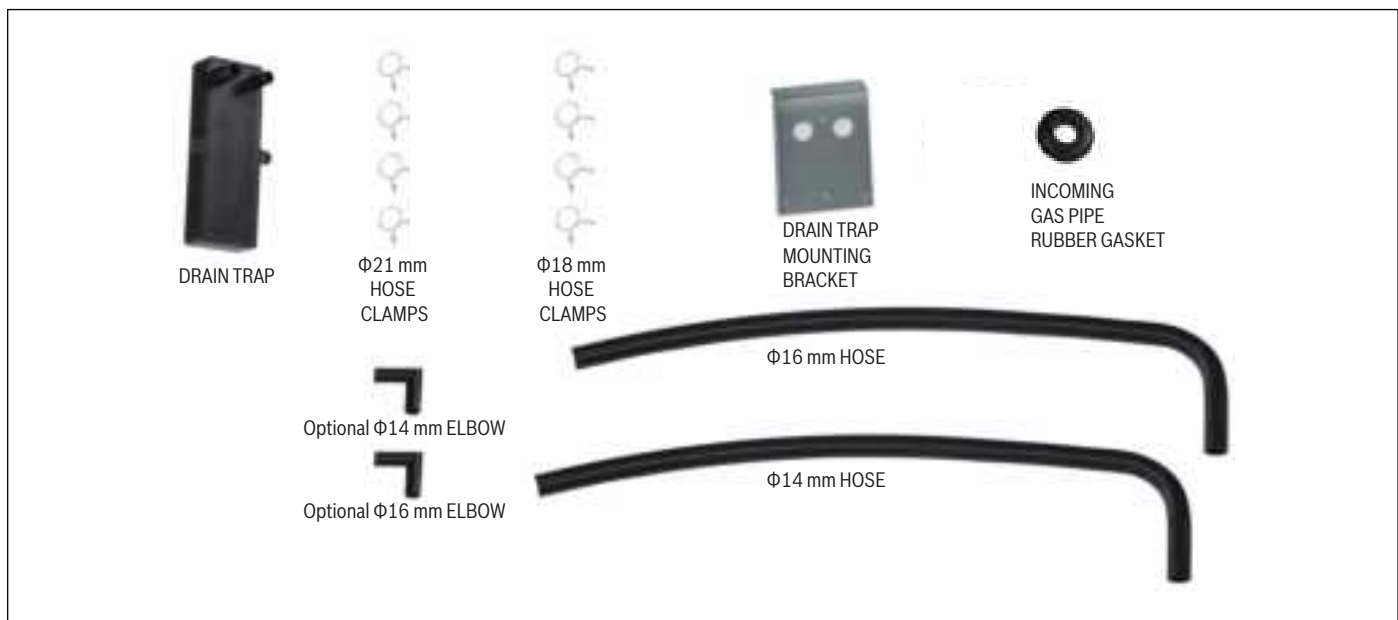


Figure 12 Included Accessories for Condensate Drain Trap Installation

* Only used when exhaust pipe is vented out of the side of the furnace's cabinet (regardless of installation orientation).

7.3.2 For Upflow Installation

Top venting (see Fig. 14)

1. Connect vent pipe and air intake pipe (if applicable) to the couplers on the furnace top panel.
2. Use field supplied straight 2" diameter pipe. If 3" pipes are used, use a field supplied transition.
3. Depending on which side the condensate trap is mounted, remove 2 caps on the side where trap is mounted. Mount trap with manufacturer provided screws.
4. Remove cap from the inducer drain port (see Fig. 13).

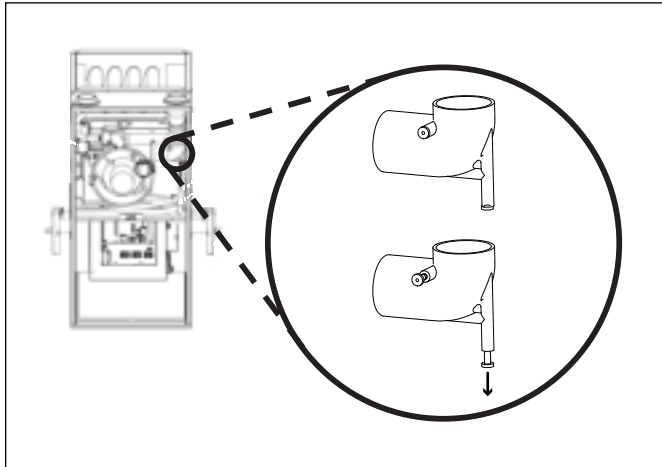


Figure 13

5. Connect $\Phi 16$ mm hose between condensate collector box and drain trap and connect $\Phi 14$ mm hose between inducer drain port and drain trap. (see Fig. 14).
6. Cut the excess hoses as needed.
7. Secure and tighten all hoses using manufacturer provided hose clamps.

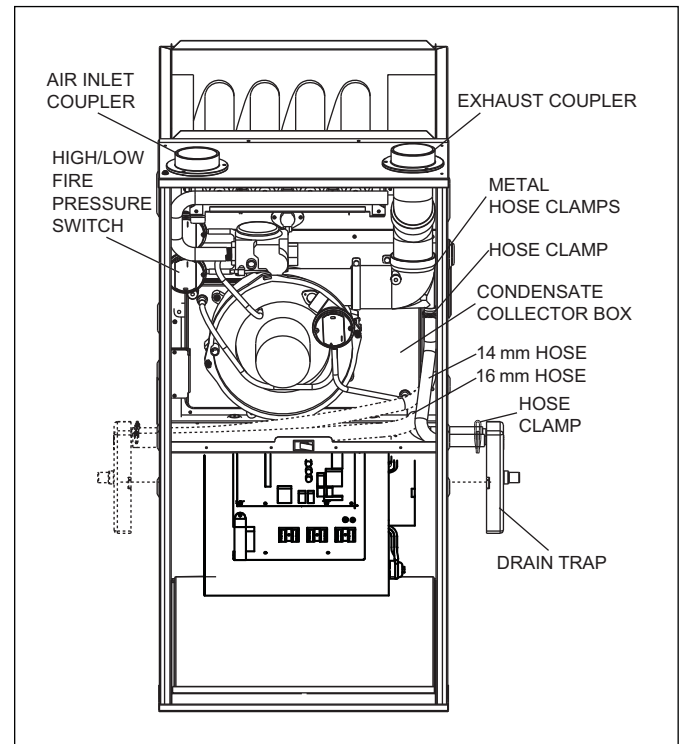


Figure 14 Upflow Installation, Top Venting

7.3.3 For Horizontal Installations

For installations with right air discharge and venting outlet through furnace top panel (see Figure 15).

1. Remove cap from left side panel of furnace and cut the insulation accordingly.
2. Remove 3 screws securing air inlet coupler on top panel and remove coupler.
3. Mount air inlet coupler to the left side of the furnace cabinet using the same screws saved from last step. Connect air inlet pipe to air inlet coupler.
4. Seal the top panel air intake hole using the caps removed from side panel.
5. Use field supplied elbow and metal hose clamps to make flue vertical. Elbows should be as close to the furnace as possible. Connect the vent outlet pipe. Use field supplied straight 2" diameter pipe. If 3" diameter pipes are used, use a field supplied transition.
6. Use provided or field supplied (if applicable) mounting bracket to mount drain trap to the proper location on right side panel.
7. Screws for mounting bracket should not interfere with any components inside the furnace.
8. Cut and remove 1/4" from the end of the inducer drain port. Reference Figure 13.
9. Connect (using hose clamps) 16 mm hose between condensate collector box and drain trap.
10. Connect (using hose clamps) 14 mm hose between the drain port and drain trap.
11. Cut the excess hose as needed.
12. Secure and tighten all hoses

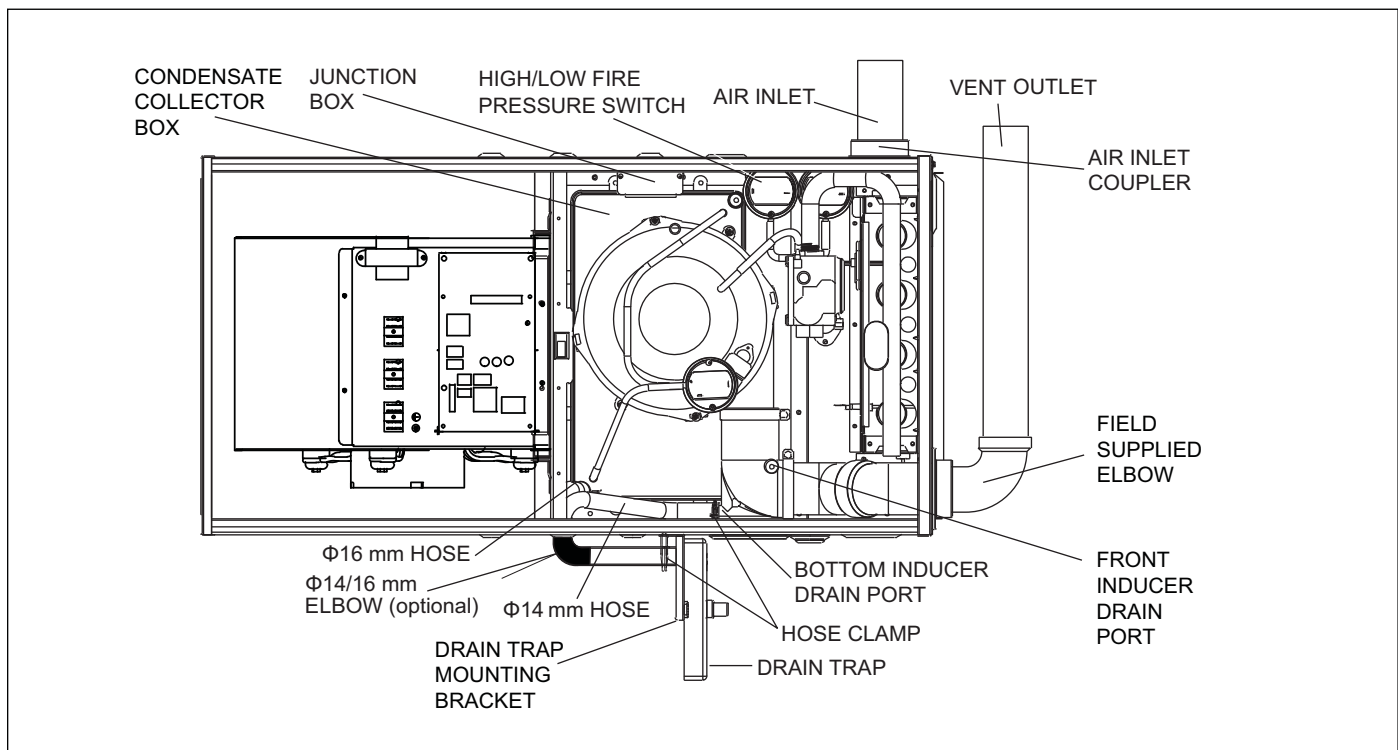


Figure 15 Horizontal Right-Hand Side Installation

For installations with left air discharge and venting outlet through furnace top panel (see Figures 16 and 17).

NOTICE:

- ▶ In this installation, hoses connecting between ports of overflow protection pressure switch (overflow switch) and pressure tabs on the condensate collector box **MUST** be switched. The overflow switch has two ports, which is different from two other regular pressure switches that have only one port. Make sure that black port (positive) is connected to the lower position tap on condensate collector box and gray port (negative) to higher tap of condensate box. Connecting incorrectly will result in failure to protect condensate overflow.

NOTICE:

- ▶ Two pressure switches (one port type switches) should be relocated to other side of furnace side panel to ensure pressure switches are above water tap of condensate collector box.

1. Remove cap from left side panel of furnace and cut the insulation accordingly.
2. Remove 3 screws securing air inlet coupler on top panel and remove coupler.
3. Mount coupler to the right side using the same screws saved from last step. Connect air inlet pipe to air inlet coupler.
4. Seal the top panel air intake hole using the caps removed from side panel.
5. Use field supplied elbow and metal hose clamp to make flue vertical. Elbows should be as close to the furnace as possible. Connect the vent outlet pipe.
6. Use provided or field supplied (if applicable) mounting bracket to mount condensate trap on the proper location of the left side panel.

7. Screws for mounting bracket should not interfere with any components inside the furnace.
8. Connect 16 mm hose between condensate collector box and drain trap. Cut the excess hose to correct length prior to connection.
9. Connect 14 mm hose between the side inducer drain port (remove black rubber plug to connect hose) and drain trap. Refer to Figure 16.
10. Plug both holes on inducer elbow using provided plugs.
11. Cut the excess hoses as needed.
12. Secure and tighten all hoses.
13. Relocate junction box to the other side of cabinet if necessary.
14. Relocate the High/Low Fire Pressure Switches (2) to the opposite side of the cabinet (as shown in Figure 16 and 17). Screws for mounting these switches should not interfere with any components inside the furnace.

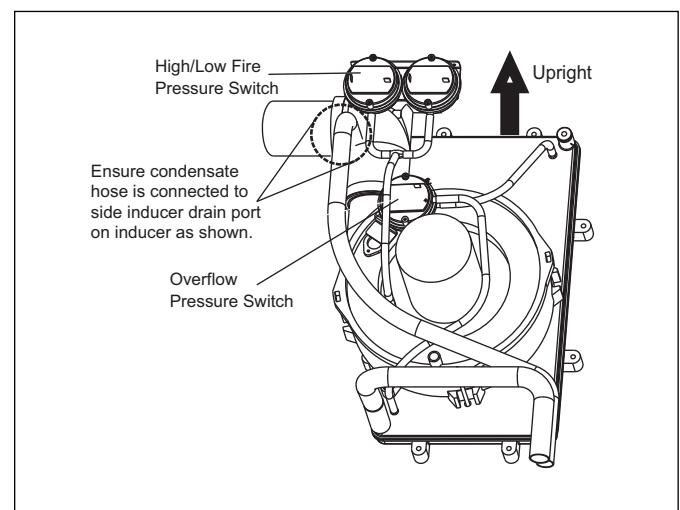


Figure 17 Pressure Switch Position

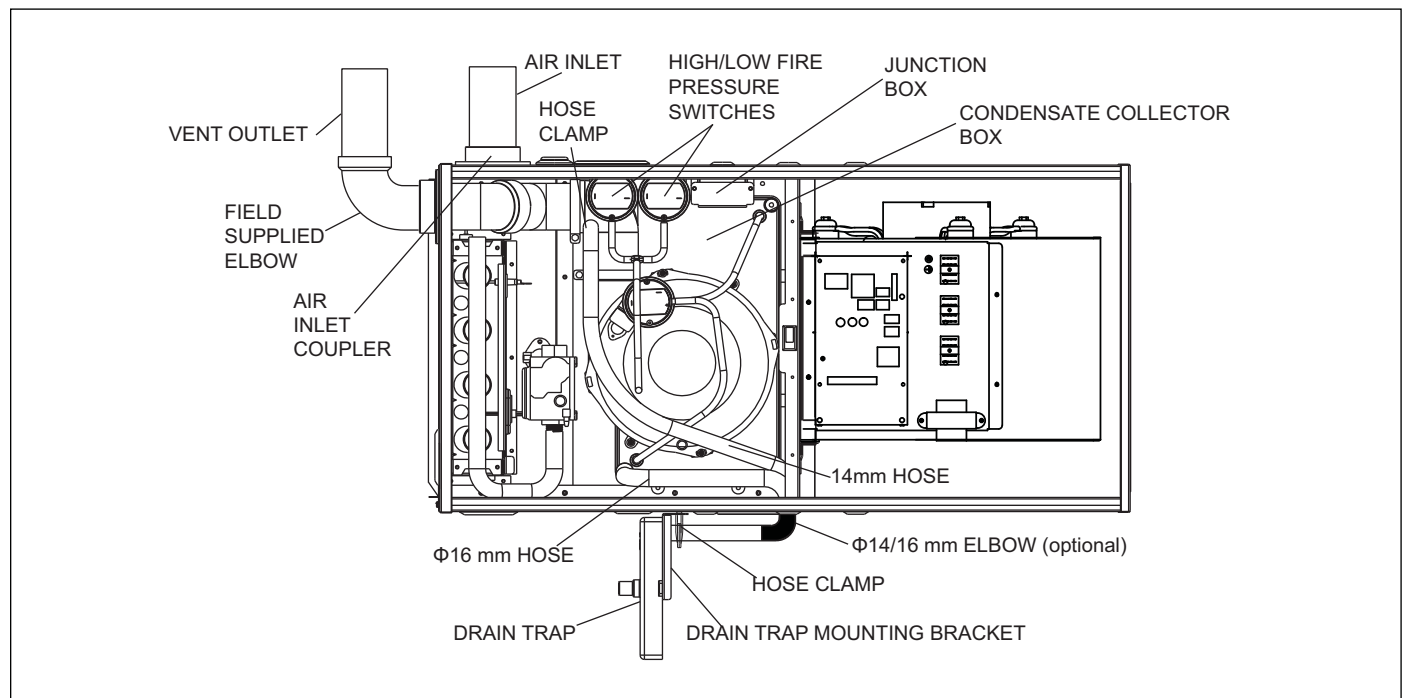


Figure 16 Horizontal Left Side Installation, Vent Through Top Panel

NOTICE:

- In this installation, hoses connecting between ports of overflow protection pressure switch (overflow switch) and pressure tabs on the condensate collector box **MUST** be switched. The overflow switch has two ports, which is different from two other regular pressure switches that have only one port. Make sure that black port (positive) is connected to the lower position tap on condensate collector box and gray port (negative) to higher tap of condensate box. Connecting incorrectly will result in failure to protect condensate overflow. See Fig. 19.

Upflow & Horizontal Right side:

A to + P1(black port)

B to – P2(grey port)

Horizontal Left side:

A to – P2(grey port)

B to + P1(black port)

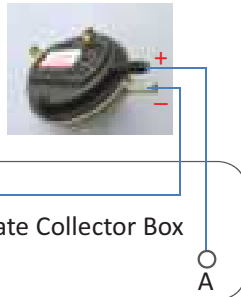


Figure 18

NOTICE:

- Two pressure switches (one port type switches) should be relocated to other side of furnace side panel to ensure pressure switches are above water tap of condensate collector box.

7.4 Filter Arrangement



CAUTION: FIRE HAZARD

- ▶ Never install a filter on the supply air side. Filters should always be installed on return air side of system.



WARNING: CARBON MONOXIDE AND POISONING HAZARD

- ▶ Never operate a furnace without a filter or with filter access door removed.

Filter size

The Bosch 96% AFUE Gas Furnace BGH96 series does not include a filter from the manufacturer. The filter and filter rack must be field supplied and field installed. A high velocity filter is recommended, see recommended filter size and type in Table 2. One of the most common causes of furnace malfunctions is a blocked or dirty filter. The filter must be inspected monthly for dirt accumulation and replaced if necessary.

Filter type

Air velocity through disposable filters may not exceed 300 feet per minute (FPM). All velocities over this require the use of high velocity filters. If a normal speed disposable filter is used and air speed exceeds 300 feet per minute (FPM), two side returns or one side return and the bottom return may be needed. For airflow, refer to Tables 3 & 4.

NOTICE:

- ▶ If disposable filters are used, air passage through filters should be increased to twice the size of original air opening by using a transition duct or using two filters in V shape (see Fig. 19) in normal duct size.

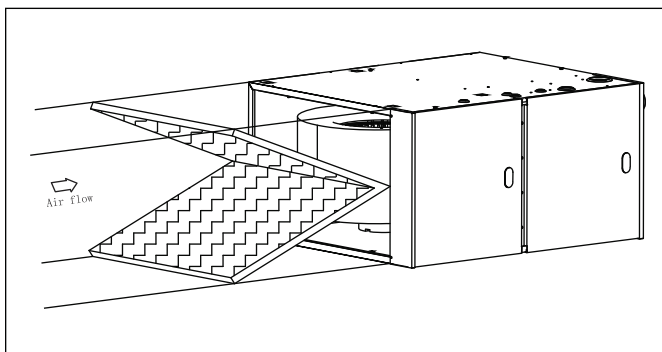


Figure 19

Side return

Locate the 4 knockout locations. These indicate the size of the cut-out to be made in the furnace side panel. Refer to Fig 20, "Side Return Knockout Markings".

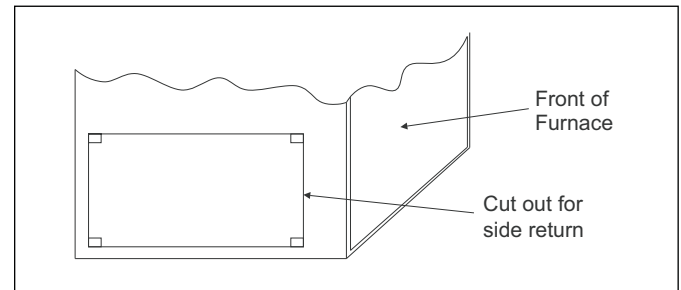


Figure 20 Side return knockout markings



Dimensions of return air "cut out" must match those shown in Figure 1. DO NOT cut outside of the "knockout" markings.

Install the side filter rack (field supplied) following the instructions provided with that accessory. If a filter(s) is provided at another location in the return air system, the duct work may be directly attached to the furnace side panel.

Bottom Return filters

Filter(s) may be located in the duct system outside the furnace using an external duct filter box attached to the furnace plenum or at the end of the duct in a return filter grille(s). The use of straps and/or supports is required to support the weight of the external filter box.

Furnace cabinet width	Filter size		Filter type
	Side return	Bottom return	
17-1/2	16X25	16X25	High Velocity (600 FPM)
21	16X25	20X25	High Velocity (600 FPM)
24.5	16X25	24X25	High Velocity (600 FPM)

Table 2 Manufacturer recommended high velocity filter sizes - Inch

7.5 Air Ducts

General requirements

The duct system should be designed and sized according to accepted national standards such as those published by: Air Conditioning Contractors Association (ACCA), Sheet Metal and Air Conditioning Contractors National Association (SMACNA) or American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) or consult The Air Systems Design Guidelines reference tables available from your local distributor. The duct system should be sized to handle the required system design CFM at the design external static pressure. The furnace airflow rates are provided in Tables 3 & 4 "Air Delivery - CFM (Without Filter)".

When a furnace is installed so that the supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by duct(s) sealed to the furnace cabinet and terminating outside the space containing the furnace.

Secure ductwork with the proper fasteners for type of ductwork used. Seal supply and return-duct connections to furnace with code approved tape or duct sealer.



Flexible connections should be used between duct work and furnace to prevent transmission of vibration. Duct work passing through unconditioned space should be insulated and sealed to enhance system performance. When air conditioning is used, a vapor barrier is recommended.

Maintain a 1-inch clearance between combustible materials and the supply air ductwork for a distance of 36 inch horizontally from the furnace. See NFPA 90B or local code for further requirements.

Ductwork acoustical treatment



Metal duct systems that do not have a 90 degree elbow and 10 ft. of main duct to the first branch take-off may require internal acoustical lining. As an alternative, fibrous duct work may be used if constructed and installed in accordance with the latest edition of SMACNA construction standard on fibrous glass ducts. Both acoustical lining and fibrous duct work shall comply with NFPA 90B as tested by UL Standard 181 for Class 1 Rigid air ducts.

Supply air connections

For a furnace not equipped with a cased coil, the outlet duct shall be provided with a removable access panel. This opening shall be accessible when the furnace is installed and shall be of such a size that the heat exchanger can be visually checked for possible damage using light assistance or a probe that can be inserted for sampling the airstream. The cover attachment shall prevent leaks.

Upflow and horizontal furnaces

Connect supply-air duct to flanges on furnace supply-air outlet. Bend flange upward to 90° with wide duct pliers. The supply-air duct must be connected to ONLY the furnace supply-outlet-air duct flanges or cased coil cabinet (when used).

NOTICE:

- ▶ DO NOT cut main furnace cabinet side to attach supply air duct, humidifier, or other accessories. All accessories MUST be connected to duct external to main furnace cabinet.



For horizontal applications, the top-most flange may be bent past 90 degrees to allow the evaporator coil to hang on the flange temporarily while the remaining attachment and sealing of the coil are performed.

Furnace size	Return-air inlet	Speed		External static pressure (in. WC)									
				0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
60B	Bottom or Sides	H	CFM	1430	1390	1350	1320	1280	1240	1200	1160	1110	1065
			Temp Rise-1st stage †	--	--	--	--	--	--	--	30.7	32.2	33.6
			Temp Rise-2nd stage †	37	37.4	38.6	39.3	40.7	41.7	43.4	45.1	47.1	49.1
		Mid-H	CFM	1245	1205	1165	1130	1100	1050	1010	960	920	865
			Temp Rise-1st stage †	--	--	30	31.1	32.1	33.2	35.1	37	38.7	40.4
			Temp Rise-2nd stage †	42.7	43.4	45	46.5	48.3	50.1	52.6	55.1	58	--
		Mid	CFM	1075	1035	1000	955	910	860	820	780	730	685
			Temp Rise-1st stage †	32.1	33.4	35.5	37.6	39.3	41	43.1	45.1	48.2	51.3
			Temp Rise-2nd stage †	49.4	52.9	55.4	58	--	--	--	--	--	--
		Mid-L	CFM	885	830	780	735	690	650	590	550	520	470
			Temp Rise-1st stage †	39.1	41.7	44.9	48	51.2	54.5	59.1	--	--	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--
		Low	CFM	780	707	640	579	500	466	403	356	320	253
			Temp Rise-1st stage †	48.3	52.8	58	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--
80B	Bottom or Sides	H	CFM	1411	1374	1339	1303	1271	1233	1190	1148	1102	1054
			Temp Rise-1st stage †	--	--	--	35.5	36.4	37.5	38.8	40.3	41.9	43.8
			Temp Rise-2nd stage †	50.5	51.8	53.2	54.6	56.0	57.8	59.8	62.0	64.6	--
		Mid-H	CFM	1215	1178	1144	1108	1071	1029	985	945	898	854
			Temp Rise-1st stage †	38.0	39.2	40.4	41.7	43.2	44.9	46.9	48.9	51.5	54.2
			Temp Rise-2nd stage †	56.6	58.4	60.2	62.3	64	--	--	--	--	--
		Mid	CFM	1044	1002	968	931	886	841	805	767	718	677
			Temp Rise-1st stage †	40.8	43.4	45.8	50.5	50.9	54.0	57.6	60.8	64.4	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--
		Mid-L	CFM	825	790	743	698	649	608	457	527	491	463
			Temp Rise-1st stage †	50.5	53.7	58.4	62.9	--	--	--	--	--	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--
		Low	CFM	786	720	645	598	539	503	436	385	348	302
			Temp Rise-1st stage †	56.8	62.2	--	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--
80C	Bottom or Sides	H	CFM	1516	1467	1418	1367	1312	1261	1201	1144	1086	1029
			Temp Rise-1st stage †	--	--	--	--	35.1	36.2	38	39.8	41.6	43.3
			Temp Rise-2nd stage †	46.7	47.4	48.8	50.1	52.5	54.8	57.4	59.9	62.7	--
		Mid-H	CFM	1316	1259	1203	1149	1092	1031	976	909	855	791
			Temp Rise-1st stage †	35	37	38.2	39.4	41.1	42.7	45.2	47.7	50.9	54
			Temp Rise-2nd stage †	53.8	53.2	55.8	58.4	62	--	--	--	--	--
		Mid	CFM	1142	1076	1014	960	894	823	765	702	651	597
			Temp Rise-1st stage †	40.3	43.1	45.4	47.7	51.2	54.6	58.2	61.8	--	--
			Temp Rise-2nd stage †	60	61.1	--	--	--	--	--	--	--	--
		Mid-L	CFM	901	829	767	692	625	562	506	463	409	345
			Temp Rise-1st stage †	49	49.9	55.7	61.5	--	--	--	--	--	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--
		Low	CFM	800	674	618	498	455	400	360	300	240	--
			Temp Rise-1st stage †	57	--	--	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--

Table 3 Air Delivery - CFM (Without Filter) * **

* A filter is required for each return air inlet. This table shows the airflow performance without a filter. To determine airflow performance with a filter, if a 3/4 inch (19 mm) washable media filter is used, assume an additional 0.1 in. WC available external static pressure.

** The manufacturer default fan settings are based on model, refer to Table 24.

Furnace size	Return-air inlet	Speed		External static pressure (in. WC)									
				0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
100C	Bottom or Sides	H	CFM	2195	2158	2116	2072	2031	1985	1940	1896	1852	1862
			Temp Rise-1st stage †	--	--	--	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	40.3	41.0	41.8	42.7	43.6	44.6	45.6	46.7	47.8	47.5
		Mid-H	CFM	2008	1963	1924	1882	1836	1791	1744	1697	1648	1603
			Temp Rise-1st stage †	--	--	--	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	44.1	45.1	46.0	47.0	48.2	49.4	50.8	52.2	53.7	55.2
		Mid	CFM	1753	1709	1666	1627	1573	1530	1487	1444	1395	1347
			Temp Rise-1st stage †	--	--	--	35.4	36.6	37.6	38.7	39.9	41.3	42.7
			Temp Rise-2nd stage †	50.5	51.8	53.1	54.4	56.3	57.9	59.5	61.3	63.5	65.8
		Mid-L	CFM	1447	1388	1338	1286	1241	1186	1137	1083	1029	983
			Temp Rise-1st stage †	39.8	41.5	43.0	44.7	46.4	48.5	50.6	53.2	55.9	58.5
			Temp Rise-2nd stage †	61.2	63.8	--	--	--	--	--	--	--	--
		Low	CFM	1089	1021	946	883	820	751	685	625	565	520
			Temp Rise-1st stage †	52.8	56.4	60.8	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--
100D	Bottom or Sides	H	CFM	2283	2239	2193	2143	2095	2049	1998	1947	1897	1847
			Temp Rise-1st stage †	--	--	--	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	38.8	39.5	40.4	41.3	42.3	43.2	44.3	45.5	46.7	48.0
		Mid-H	CFM	2086	2038	1988	1942	1889	1841	1792	1745	1695	1637
			Temp Rise-1st stage †	--	--	--	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	42.4	43.5	44.5	45.6	46.9	48.1	49.4	50.7	52.3	54.1
		Mid	CFM	1813	1760	1711	1657	1609	1560	1506	1453	1402	1350
			Temp Rise-1st stage †	--	--	--	--	35.8	36.9	38.2	39.6	41.0	42.6
			Temp Rise-2nd stage †	48.8	50.3	51.8	53.4	55.0	56.8	58.8	60.9	63.1	--
		Mid-L	CFM	1487	1417	1360	1296	1241	1183	1123	1064	1005	941
			Temp Rise-1st stage †	38.7	40.6	42.3	44.4	46.4	48.7	51.3	54.1	57.2	61.1
			Temp Rise-2nd stage †	59.5	62.5	--	--	--	--	--	--	--	--
		Low	CFM	1122	1036	977	889	802	731	646	586	532	485
			Temp Rise-1st stage †	55.6	58.9	64.7	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--
120D	Bottom or Sides	H	CFM	2290	2253	2213	2170	2127	2080	2031	1985	1937	1888
			Temp Rise-1st stage †	--	--	--	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	46.4	47.2	48.0	49.0	50.0	51.1	52.3	53.5	54.9	56.3
		Mid-H	CFM	2079	2037	1993	1950	1907	1856	1813	1767	1726	1675
			Temp Rise-1st stage †	--	--	--	--	--	--	--	--	40.0	41.2
			Temp Rise-2nd stage †	51.1	52.2	53.3	54.5	55.7	57.3	58.6	60.1	61.6	63.4
		Mid	CFM	1809	1764	1719	1668	1620	1572	1528	1487	1432	1364
			Temp Rise-1st stage †	--	--	40.2	41.4	42.6	43.9	45.2	46.5	48.2	50.6
			Temp Rise-2nd stage †	58.7	60.2	61.8	63.7	65.6	67.6	69.6	--	--	--
		Mid-L	CFM	1489	1429	1373	1311	1265	1208	1137	1083	1032	972
			Temp Rise-1st stage †	46.4	48.3	50.3	52.7	54.6	57.2	60.7	63.8	66.9	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--
		Low	CFM	1123	1051	1352	899	814	741	688	605	551	507
			Temp Rise-1st stage †	61.5	65.7	--	--	--	--	--	--	--	--
			Temp Rise-2nd stage †	--	--	--	--	--	--	--	--	--	--

Table 4 Air Delivery - CFM (Without Filter) * **

* A filter is required for each return air inlet. This table shows the airflow performance without a filter. To determine airflow performance with a filter, if a 3/4 inch (19 mm) washable media filter is used, assume an additional 0.1 in. WC available external static pressure.

** The manufacturer default fan settings are based on model, refer to Table 24.

8 Combustion Air and Vent System

8.1 Combustion Air and Vent Safety

This Category IV, dual certified (AHRI and ETL) direct vent furnace is designed for residential applications. It may be installed without modification to the condensate system in a basement, garage, equipment room, alcove, attic or any other indoor location where all required clearance to combustibles and other restrictions are met. The combustion air and the venting 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 CSA B149.1, National Gas and Propane Codes (latest edition) or applicable provisions of the local building code and these instructions.

NOTICE:

- ▶ The "VENT SYSTEM" must be installed as specified in these instructions for Residential and Non HUD Modular Homes. The direct vent system is the only configuration that can be installed in a Non HUD Modular Home.

NOTICE:

- ▶ Do not discharge exhaust gases directly into any chimney or vent stack. If vertical discharge through an existing unused chimney or stack is required, insert piping inside chimney until the pipe open end is above top of chimney and terminate properly. In any exterior portion of chimney, the exhaust vent must be insulated.

NOTICE:

- ▶ When combustion air pipe is installed above a suspended ceiling or when it passes through a warm and humid space, the pipe must be insulated with 1/2" Armaflex or other heat resistant type insulation if two feet or more of pipe is exposed. Vent piping must be insulated if it will be subjected to freezing temperatures such as routing through unheated areas or through an unused chimney.

NOTICE:

- ▶ Prior to installing the exhaust vent pipe, ensure that the black plastic cap is removed from the coupler on furnace cabinet. The cap is only used to prevent debris from falling into the vent opening and into the inducer during installation. Refer to Figure 21.

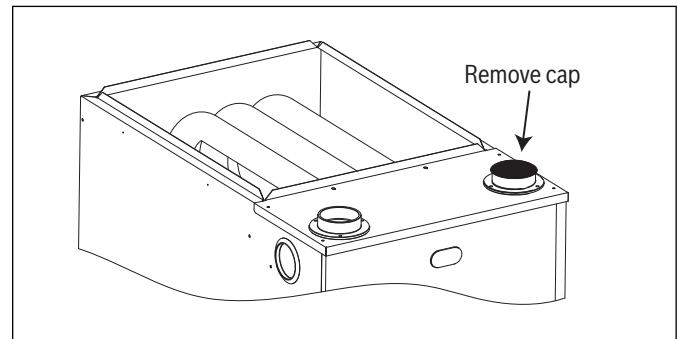


Figure 21 Protective Cap Removal

8.2 Combustion Air/Vent Pipe Sizing

The size of pipe required will be determined by the furnace model, the total length of pipe required and the number of elbows required. Table 5, "Maximum Equivalent Pipe Length" lists the maximum equivalent length of pipe allowed for each model of furnace. The equivalent length of elbows is shown in Table 7, "Equivalent Length of Fittings".

The equivalent length of the vent system is the total length of straight pipe PLUS the equivalent length of all of the elbows. The following rules must also be followed:

1. Long radius (sweep) elbows are recommended. Standard elbows may be used, but since they have a longer equivalent length, they will reduce the total length of pipe that will be allowed. Short radius (plumbing vent) elbows are not allowed. The standard dimensions of the acceptable elbows are shown below.
2. The maximum equivalent length listed in Table 5, "Maximum Equivalent Pipe Length" is for the vent piping and the air intake piping separately. For example, if the table allows 60 equivalent feet for a particular model, then the vent can have 60 equivalent feet of pipe, AND the combustion air intake can have another 60 equivalent feet of pipe.
3. Three vent terminal elbows (two for the vent and one for the combustion air intake) are already accounted for and need not be included in the equivalent length calculation.
4. All combustion air and vent pipes and fittings must conform to American National Standards Institute (ANSI) and American Society for Testing and Materials (ASTM) standards, D1785 (Schedule 40 PVC, including IPEX System 1738 Schedule 40 PVC), F441 (Schedule 40 CPVC), D2665 (PVC-DWV), F891 (PVC-DWV Cellular Core), D2661 (ABS-DWV) or D1527 (Schedule 40 ABS). Pipe cement and primer must conform to ASTM Standard D2564 (PVC), F493 (CPVC) or D2235 (ABS). If ABS pipe is to be used, any joint where ABS pipe is joined to PVC pipe must be glued with cement that is approved for use with BOTH materials. As an alternate, use all purpose cement, to bond ABS, PVC, or CPVC pipe when using fittings and pipe made of the same materials. Metallic materials must not be used for venting or air intake.
5. If a flexible connector is used in the vent system, it must be made of a material that is resistant to acidic exposure and to at least 225°F temperature. Flexible connectors are also allowed in the combustion air pipe.
6. All models are supplied with 2" vent connections. When the pipe must be increased to 3" diameter, the transition from 2" to 3" must be done as close to the furnace as possible. For upflow models, the transition from 2" to 3" should be done immediately above the furnace. For downflow or horizontal models, the transition from 2" to 3" pipe should be done immediately after exiting the furnace.

7. In Canada, vents shall be certified to ULC S636, Standard for Type BH Gas Venting Systems. IPEX System 636 PVC is certified to this standard.
8. In Canada, the first three feet (900 mm) of the vent must be readily accessible for inspection.
9. Minimum vent length for all models is 5 feet.



For single pipe systems it is recommended to install the combustion air coupling provided and install approximately 18" of pipe on the furnace. In addition to the vent/flue pipe, a single 90° elbow should be secured to the combustion air intake to prevent inadvertent blockage.

Model Input - kBTU/H (kW)	Pipe Size - Inches (cm)	Maximum Equivalent Length - Feet (m)
60 (17.6)	2 (5.1)	60 (18.2)
60 (17.6)	3 (7.6)	90 (27.4)
80 (23.4)	2 (5.1)	60 (18.2)
80 (23.4)	3 (7.6)	90 (27.4)
100 (29.3)	2 (5.1)	30 (9.1)
100 (29.3)	3 (7.6)	90 (27.4)
120 (35.1)	2 (5.1)	N/A
120 (35.1)	3 (7.6)	90 (27.4)

Table 5 Maximum Equivalent Pipe Length

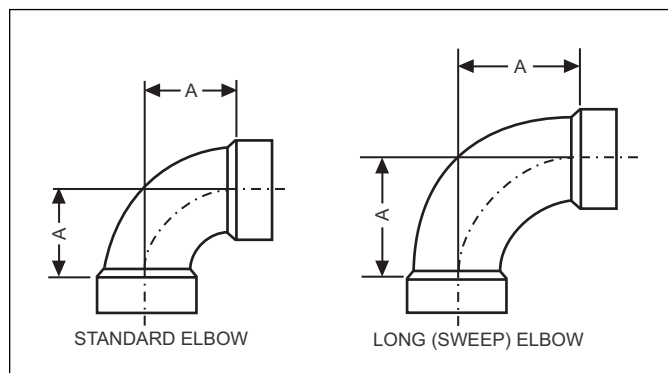


Figure 22

Elbow	"A" Dimension
2" Standard	2-5/16"
3" Standard	3-1/16"
2" Sweep	3-1/4"
3" Sweep	4-1/16"

Table 6 Elbow Dimensions

Fitting	Equivalent Length
2" 90° sweep elbow	5 feet of 2" pipe
2" 45° sweep elbow	2-1/2 feet of 2" pipe
2" 90° standard elbow	10 feet of 2" pipe
2" 45° standard elbow	5 feet of 2" pipe
3" 90° sweep elbow	5 feet of 3" pipe
3" 45° sweep elbow	2-1/2 feet of 3" pipe
3" 90° standard elbow	10 feet of 3" pipe
3" 45° standard elbow	5 feet of 3" pipe
2" corrugated connector	10 feet of 2" pipe
3" corrugated connector	10 feet of 3" pipe

Table 7 Equivalent Length of Fittings

Example:

An 80,000 BTUH furnace requires 32 feet of pipe and four 90° elbows. Using 2" pipe and standard elbows, the total equivalent length will be:

32 feet of 2" pipe =	32 equivalent feet
4 - 90° standard 2" elbows =	(4x10) = 40 equivalent feet
Total =	72 equivalent feet of 2" pipe

This exceeds the 65 foot maximum equivalent length of 2" pipe allowed for that model and is thus not acceptable.

By using sweep elbows, the total equivalent length will be:

32 feet of 2" pipe =	32 equivalent feet
4 - 90° sweep 2" elbows =	(4x5) = 20 equivalent feet
Total =	52 equivalent feet of 2" pipe

This is less than the 65 foot maximum equivalent length of 2" pipe allowed for that model and is thus acceptable.

Alternatively, using 3" pipe and standard elbows, the total equivalent length will be:

32 feet of 3" pipe =	32 equivalent feet
4 - 90° standard 3" elbows =	(4x10) = 40 equivalent feet
Total =	72 equivalent feet of 3" pipe

This is less than the 90 foot maximum equivalent length of 3" pipe allowed for that model and is thus acceptable.

Connection Type	Size - Inches (cm)
Intake Pipe	2" (5.1)
Vent Pipe	2" (5.1)

Table 8 Combustion Air Intake & Vent Connection Size (All Models)



Furnace vent pipe connections are sized for 2" (5.1 cm) pipe. Any pipe size change must be made outside the furnace cabinet in a vertical pipe section to allow proper drainage of condensate. An offset using two 45° (degree) elbows will be required for plenum clearance when the vent is increased to 3" (7.6 cm).

8.3 Combustion Air And Vent Piping Assembly

The final assembly procedure for the combustion air and vent piping is as follows:

1. Cut piping to the proper length beginning at the furnace.
2. Deburr the piping inside and outside.
3. Chamfer (bevel) the outer edges of the piping.
4. Dry-fit the vent piping assembly from the furnace to the outside termination checking for proper fit support and slope.
5. Dry-fit the combustion air piping assembly checking for proper fit, support and slope on the following systems:
 - a. Sealed combustion air systems from the furnace to the outside termination.
 - b. Ventilated combustion air systems from the furnace to the attic or crawl space termination.



CAUTION:

- ▶ Solvent cements are flammable and must be used in well-ventilated areas only. Keep them away from heat, sparks and open flames. Do not breathe vapors and avoid contact with skin and eyes.

6. Disassemble the combustion air and vent piping, apply cement primer and the cement per the manufacturer's instructions. Primer and cement must conform to ASTM D2564 for PVC, F493 for CPVC or ASTM D2235 for ABS piping.
7. All joints must provide a permanent airtight and watertight seal.
8. **Support the combustion air and vent piping such that it is angled a minimum of 1/4" per foot (21 mm/m) so that condensate will flow back towards the furnace.** Piping should be supported with pipe hangers to prevent sagging.
9. Seal around the openings where the combustion air and / or vent piping pass through the roof or sidewalls.

8.4 Combustion Air / Venting

Vent Clearances

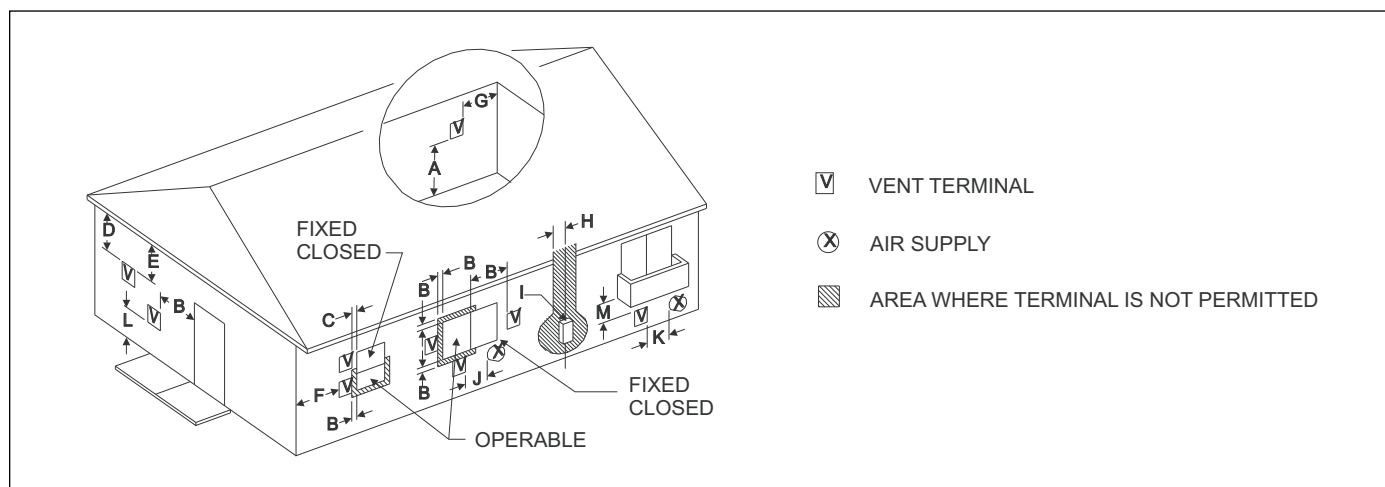


Figure 23 Direct Vent Terminal Clearances

Direct Vent Terminal Clearances	Canadian Installations ^{1,3}	US Installation ^{2,3}
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 <100,000 BTUH (30 kW), 36" (91 cm) for models >100,000 BTUH (30 kW)	Two-pipe (direct vent) applications: 9" (23 cm) for models <50,000 BTUH (15 kW), 12" (30.5 cm) for models >50,000 BTUH (15 kW). ** 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 within a horizontal distance of 2 feet (61 cm) from the center line of the terminal	12" (30.5 cm) or in accordance with local installation codes and the requirements of 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	36" (91.4 cm)	36" (91.4 cm)
H. Clearance to each side of center line extended above meter/regulator assembly	Above a meter/regulator assembly within 36" (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 36" (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	36" (91.4 cm)	36" (91.4 cm) or in accordance with local installation codes and the requirements of the gas supplier
J. Clearance to nonmechanical air supply inlet to building or the combustion air inlet to any other appliance	12" (30.5 cm) for models <100,000 BTUH (30 kW), 36" (91.4 cm) for models >100,000 BTUH (30 kW).	Two-pipe (direct vent) applications: 9" (23 cm) for models <50,000 BTUH (15 kW), 12" (30.5 cm) for models >50,000 BTUH (15 kW) Single-pipe applications: 4 feet (1.2 m)
K. Clearance to a mechanical supply inlet	6 feet (1.83 m)	3 feet (91.4 cm) above if within 10 feet (3 m) horizontally
L. Clearance above paved sidewalk or paved driveway located on public property	7 feet (2.13 m)†	7 feet (2.13 m) or in accordance with local installation codes and the requirements of the gas supplier.
M. Clearance under veranda, porch, deck, or balcony	12" (30.5 cm)†	12" (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier

Table 9 Direct Vent Terminal Clearances

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 American National Standard.

* A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.

** 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.

† 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 B149.1-00.

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 drip page 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.

**CAUTION:**

- The vent must be installed with the minimum required clearances, and must comply with local codes and requirements.

**CAUTION:**

- Consideration must be given for degradation of building materials by flue gases. Sidewall termination may require sealing or shielding of building surfaces with a corrosion resistant material to protect against combustion product corrosion. Consideration must be given to wind direction in order to prevent flue products and/or condensate from being blown against the building surfaces. If a metal shield is used it must be a stainless steel material at a minimum dimension of 20 inches (51 cm). It is recommended that a retaining type collar be used that is attached to the building surface to prevent movement of the vent pipe.

8.5 Vent System

This furnace is certified to be installed with one of two possible vent configurations.

1. Horizontal vent system. This vent system can be installed completely horizontal or combinations of horizontal, vertical, or offset using elbows.
2. Vertical vent system. This vent system can be installed completely vertical or a combination of horizontal, vertical, or offset using elbows.

Vent Applications And Termination

When selecting the location for a horizontal combustion air / vent termination, the following should be considered:

1. Observe all clearances listed in vent clearances in these instructions.
2. Termination should be positioned where vent vapors will not damage plants or shrubs or air conditioning equipment.
3. Termination should be located where it will not be affected by wind gusts, light snow, airborne leaves or allow recirculation of flue gases.
4. Termination should be located where it will not be damaged or exposed to flying stones, balls, etc.
5. Termination should be positioned where vent vapors are not objectionable.
6. Horizontal portions of the vent system must slope upwards and be supported to prevent sagging.
7. Direct vent systems must be installed so the vent and the combustion air pipes terminate in the same atmospheric zone. Refer to Figures 25 or 26.

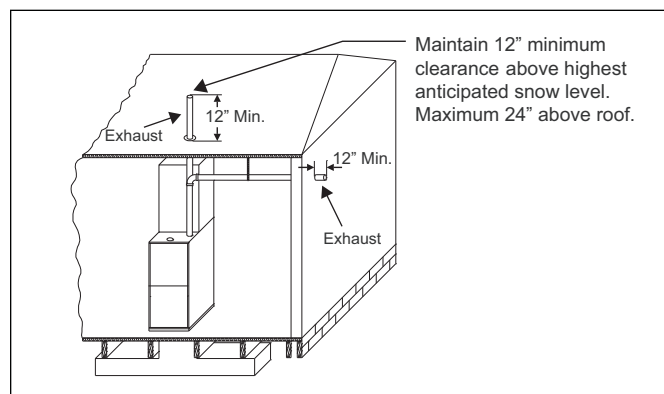


Figure 24 Termination Configuration - 1 Pipe, No

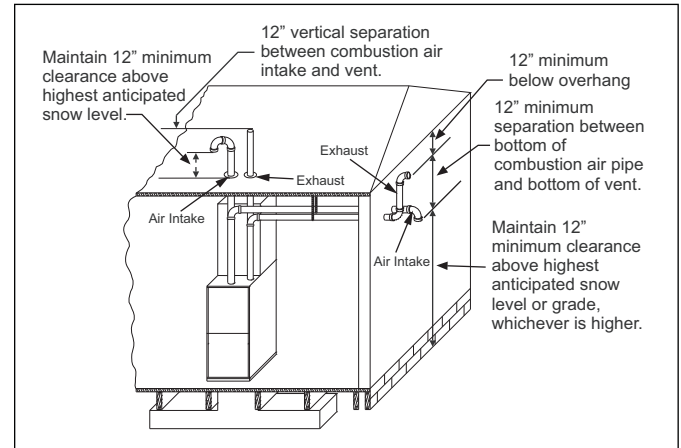


Figure 25 Termination Configuration - 2 Pipe

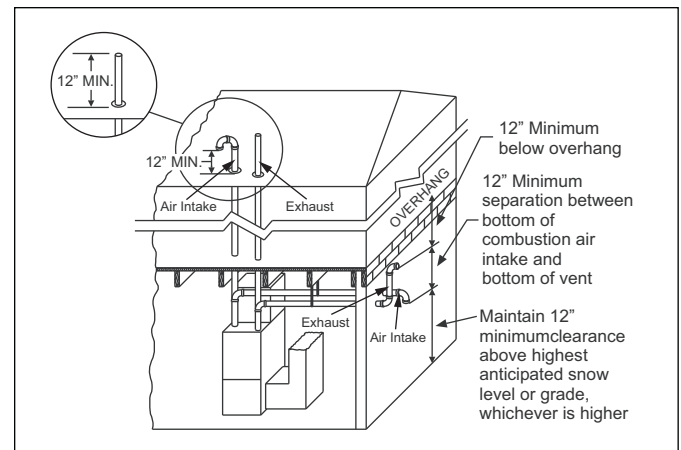


Figure 26 Termination Configuration - 2 Pipe Basement

Venting Multiple Units

Multiple units can be installed in a space or structure as either a single pipe configuration or a two-pipe configuration. The combustion air side of the single pipe configuration shown in Figure 24 is referred to in these instructions as ambient combustion air supply. Follow the instructions for ambient combustion air installations, paying particular attention to the section on air source from inside the building. The vent for a single pipe system must be installed as specified in the venting section of these instructions with the vent terminating as shown in Figure 24. Each furnace must have a separate vent pipe. Under NO circumstances can the two vent pipes be tied together.

If air from outside is brought in for combustion and ventilation, the confined space shall be provided with two permanent openings.

Follow the instructions for outdoor combustion air or ventilated combustion air and the instructions for installing the vent system with the vent terminating as shown in Figures 27 or 28. The two-pipe system must have a separate combustion air pipe and a separate vent pipe for each furnace. Under NO circumstances can the two combustion air or vent pipes be tied together. The combustion air and vent pipes must terminate in the same atmospheric zone.

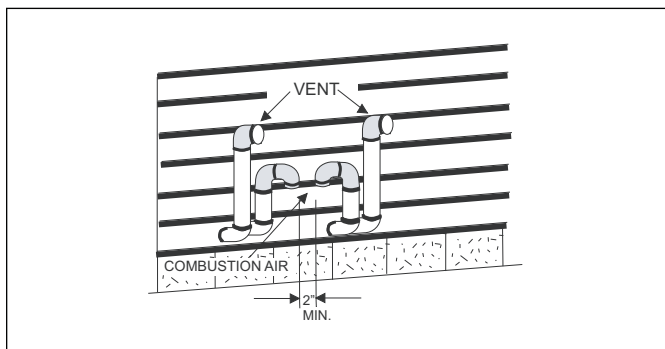


Figure 27 Double Horizontal Combustion Air Intake and Vent Termination

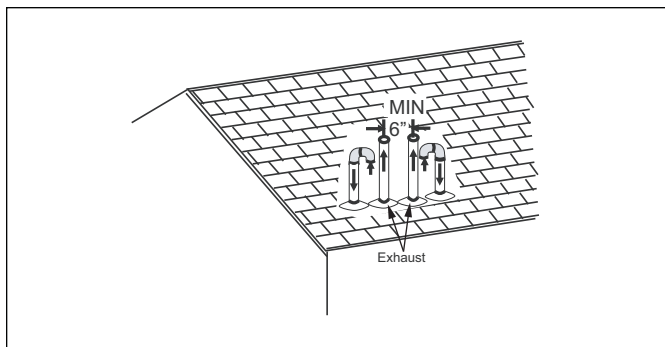


Figure 28 Double Vertical Combustion Air Intake and Vent Termination

8.6 Combustion & Ventilation Air Requirements

8.6.1 Combustion Air Supply

All installations must comply with Section 5.3, Air for Combustion and Ventilation of the National Fuel Gas Code, ANSI Z223.1 or Sections 7.2, 7.3 or 7.4 of CAN/CGA B149.1 or .2 Installation Code - latest editions.

This furnace is certified to be installed with one of three possible combustion air intake configurations.

1. Outdoor Combustion Air:

This is a direct vent configuration where the combustion air is supplied through a PVC, CPVC or ABS pipe that is connected to the PVC coupling attached to the furnace and is terminated in the same atmospheric zone as the vent. This type of installation is approved on all models. Refer to Figure 29.

2. Ambient Combustion Air:

Combustion air is supplied from the area surrounding the furnace through openings in the furnace cabinet. The combustion air and the vent pipes are not terminated in the same atmospheric zone. Refer to Figure 24 for vent terminations. Refer to Section "Ambient Combustion Air Supply" for proper installation. Refer to Figure 30 and 31.

3. Ventilated Combustion Air:

Combustion air is supplied through a PVC, CPVC or ABS pipe that is connected to the PVC coupling attached to the burner box and is terminated in a ventilated attic or crawl space. The combustion air and the vent pipes are not terminated in the same atmospheric zone. Refer to Figure 31 for attic and crawl space termination. Only the combustion air intake may terminate in the attic. The vent must terminate outside.

8.6.2 Outdoor Combustion Air

Combustion Air Intake/Vent Connections

This installation requires combustion air to be brought in from outdoors. This requires a properly sized pipe (shown in Figure 29) that will bring air in from the outdoors to the furnace combustion air intake collar on the burner box. The second pipe (Shown in Figure 29) is the furnace vent pipe.

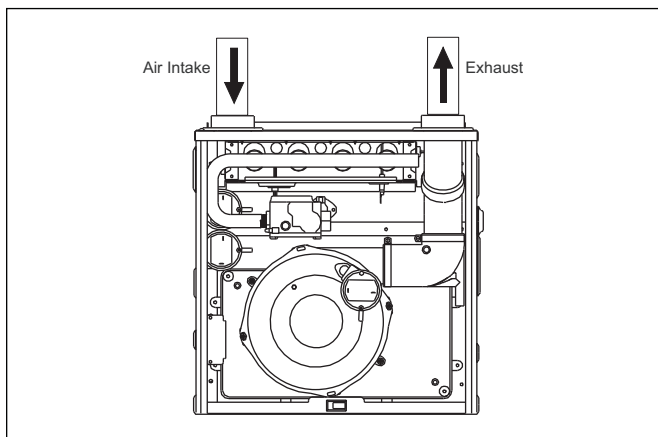


Figure 29 Direct Vent Air Intake Connection and Vent Connection

The combustion air intake pipe should be located either through the wall (horizontal or side vent) or through the roof (vertical vent). Care should be taken to locate side vented systems where trees or shrubs will not block or restrict supply air from entering the terminal. Also, the terminal assembly should be located as far as possible from a swimming pool or a location where swimming pool chemicals might be stored. Be sure the terminal assembly follows the outdoor clearances listed in Table 9.

8.6.3 Ambient Combustion Air

This type of installation will draw the air required for combustion from within the space surrounding the appliance and from areas or rooms adjacent to the space surrounding the appliance. This may be from within the space in a non-confined location or it may be brought into the furnace area from outdoors through permanent openings or ducts. It is not piped directly into the furnace. A single, properly sized pipe from the furnace vent connector to the outdoors must be field supplied.



WARNING: CARBON MONOXIDE POISONING HAZARD

- It is recommended that the supplied intake coupling and 18" of pipe be attached to the furnace to prevent accidental blockage of the combustion air intake.

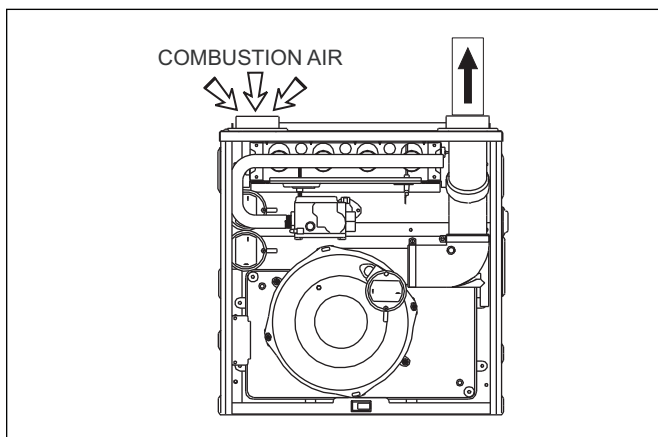


Figure 30 Combustion Airflow Path Through The Furnace Cabinet

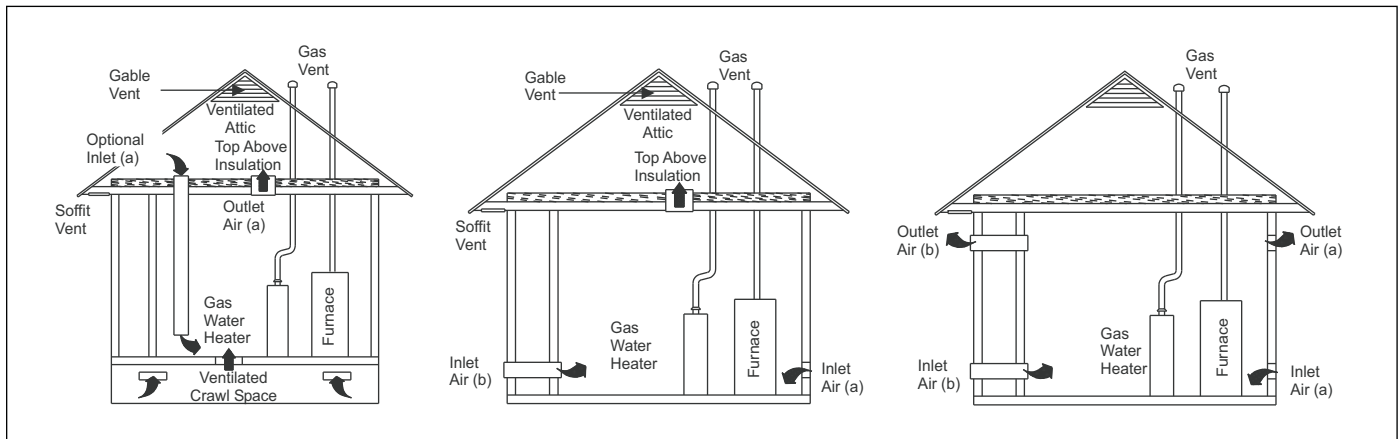


Figure 31 Ambient Combustion Air

**WARNING: CARBON MONOXIDE POISONING HAZARD**

- This type of installation requires that the supply air to the appliance(s) be of a sufficient amount to support all of the appliance(s) in the area. Operation of a mechanical exhaust, such as an exhaust fan, kitchen ventilation system, clothes dryer or fireplace may create conditions requiring special attention to avoid unsatisfactory operation of gas appliances. A venting problem or a lack of supply air will result in a hazardous condition, which can cause the appliance to soot and generate dangerous levels of CARBON MONOXIDE, which can lead to serious injury, property damage and/or death.

An **unconfined space** is not less than 50 cu.ft (1.42m³) per 1,000Btu/hr (0.2928 kW) input rating for all of the appliances installed in that area. Rooms communicating directly with the space containing the appliances through openings not furnished with doors are considered a part of the unconfined space. In unconfined spaces (see definition below) in buildings, infiltration may be adequate to provide air for combustion ventilation and dilution of flue gases. However, in buildings of tight construction (for example, weather stripping, heavily insulated, caulked, vapor barrier, etc.), additional air may need to be provided using the methods described in "A confined space" section.

A **confined space** is an area with less than 50 cu. ft (1.42m³) per 1,000 Btu/hr (0.2928 kW) input rating for all of the appliances installed in that area. The following must be considered to obtain proper air for combustion and ventilation in confined spaces.

Equipment Located in Confined Spaces:**a) All air from inside the building:**

The confined space shall be provided with two permanent openings communicating directly with an additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria. The total input of all gas utilization equipment installed in the combined space shall be considered in making this determination. Each opening shall have a minimum free area of 1 square inch per 1,000 BTU per hour of the total input rating of all gas utilization equipment in the confined space. One opening shall be within 12 inches of the top and one within 12 inches of the bottom of the enclosure (See Table 10).

BTUH Input Rating	Minimum Free Area in Square Inch Required for Each Opening
60,000	60 sq.in (387 sq.cm)
80,000	80 sq.in (516 sq.cm)
100,000	100 sq.in (645 sq.cm)
120,000	120 sq.in (516 sq.cm)

Table 10 Minimum Area in Square Inches Required for Each Opening

b) All air from outdoors:

BTUH Input Rating	Minimum Free Area Required for Each Opening		
	Horizontal Duct (2,000 BTUH)	Vertical Duct or Opening to Outside (4,000 BTUH)	Round Duct (4,000 BTUH)
60,000	30 sq.in (193 sq.cm)	15 sq.in (193 sq.cm)	5" (13 cm)
80,000	40 sq.in (193 sq.cm)	20 sq.in (129 sq.cm)	5" (13 cm)
100,000	50 sq.in (193 sq.cm)	25 sq.in (161 sq.cm)	6" (15 cm)
120,000	60 sq.in (193 sq.cm)	30 sq.in (194 sq.cm)	7" (18 cm)

Table 11 Minimum Area in Square Inch Required for Each Opening

EXAMPLE: Determining Free Area.

Appliance 1 Appliance 2 Total Input
 100,000 + 30,000 = (130,000 ÷ 4,000) = 32.5 Sq. In. Vertical

Appliance 1 Appliance 2 Total Input
 100,000 + 30,000 = (130,000 ÷ 2,000) = 65 Sq. In. Horizontal

Air Supply Openings and Ducts

1. An opening may be used in lieu of a duct to provide the outside air supply to an appliance unless otherwise permitted by the authority having jurisdiction. The opening shall be located within 12" (30.5 cm) horizontally from the burner level of the appliance.
2. The duct shall be either metal or a material meeting the class 1 requirements of CAN4-S110 Standard for Air Ducts.
3. The duct shall be at least the same cross-sectional area as the free area of the air supply inlet opening to which it connects.
4. The duct shall terminate within 12 in (30.5 cm) above, and within 24 in (61 cm) horizontally from, the burner level of the appliance having the largest input.
5. A square or rectangular shaped duct shall only be used when the required free area of the supply opening is 9 in 2 (58.06 cm²) or larger. When a square or rectangular duct is used, its small dimension shall not be less than 3 in (7.6 cm).
6. An air inlet supply from outdoors shall be equipped with a means to prevent the direct entry of rain and wind. Such means shall not reduce the required free area of the air supply opening.
7. An air supply inlet opening from the outdoors shall be located not less than 12 in (30.5 cm) above the outside grade level.

Combustion Air Source from Outdoors

1. Two permanent openings, one within 12 in (305 mm) of the top and one within 12 in (305 mm) of the bottom of the confined space, shall communicate directly or by means of ducts with the outdoors, crawl spaces or attic spaces.
2. One permanent opening, commencing within 12 in (305 mm) of the top of the enclosure shall be permitted where the equipment has clearances of at least 1 in (25.4 mm) from the sides and back and 6 in (152.4 mm) from the front of the appliance. The opening shall communicate directly with the outdoors and shall have a minimum free area of:
 - a. 1 square inch per 3000 Btu per hour (734 mm²/kW) of the total input rating of all equipment located in the enclosure.
 - b. Not less than the sum of all vent connectors in the confined space.
3. The duct shall be at least the same cross-sectional area as the free area of the air supply inlet opening to which it connects.
4. The blocking effects of louvers, grilles and screens must be given consideration in calculating free area. If the free area of a specific louver or grille is not known, refer to Table 21, "Estimated Free Area" to estimate free area.

Wood or Metal Louvers or Grilles	Wood 20-25%, Metal 60-70%
Screens	1/4" mesh or larger 100%

Table 12 Estimated Free Area

8.6.4 Ventilated Combustion Air

The ventilated attic space or a crawl space from which the combustion air is taken must comply with the requirements specified in "**Combustion Air Source from Outdoors**" in this instruction or in Section 7.4, Air for Combustion and Ventilation of the National Fuel Gas Code, ANSI Z223.1 (latest edition). This type installation requires two properly sized pipes. One brings combustion air from a properly ventilated attic space or crawl space and a second pipe that extends from the furnace vent connection (top right of unit) to the exterior of the building.

8.7 Vent and Supply (Outside) Air Safety Check Procedure

For Category IV furnaces, vent installations shall be in accordance with Parts 7 and 11 of the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or Section 7 and Appendix B of the CAS B 149.1, Natural Gas and Propane Installation Codes, the local building codes, and furnace/vent manufacture's instructions. Multi-story systems must be installed in accordance with the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and / or the CSA B 149.1, Natural Gas and Propane Installation Codes, and the manufacturer's instructions.

Horizontal portions of the venting system shall be supported to prevent sagging using hangers or perforated straps and must slope upwards no less than 1/4 in. per foot (0.635 cm/m) from the furnace to the vent terminal. It is recommended that you follow the venting safety procedure below. This procedure is designed to detect an inadequate ventilation system that can cause the appliances in the area to operate improperly causing unsafe levels of Carbon Monoxide or an unsafe condition to occur.

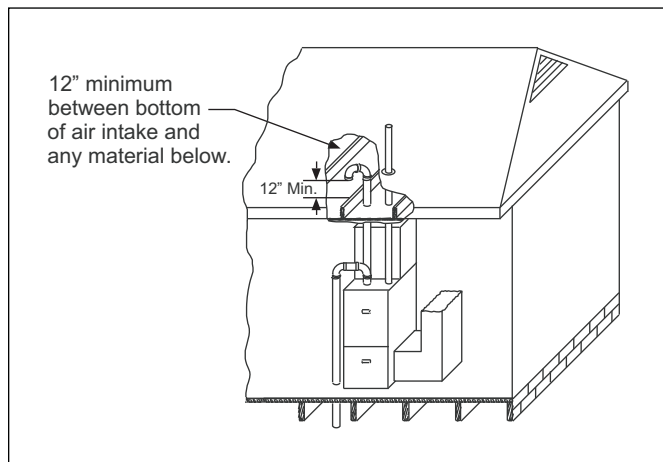


Figure 32 Attic and Crawl Space Combustion Air Termination

Specially Engineered Installations

The above requirements shall be permitted to be waived where special engineering, approved by the authority having jurisdiction, provides an adequate supply of air for combustion and ventilation.



WARNING: CARBON MONOXIDE POISONING HAZARD

- ▶ Be sure to instruct the owner not to block this intake pipe.



WARNING: CARBON MONOXIDE POISONING HAZARD

Failure to follow the steps outlined below for each appliance connected to the venting system being placed into operation could result in carbon monoxide poisoning or death. The following steps shall be followed for each appliance connected to the venting system being placed into operation, while all other appliances connected to the venting system are not in operation:

1. Inspect the venting system for proper size and horizontal pitch. Determine that there is no blockage, restriction, leakage, corrosion or other deficiencies which could cause an unsafe condition.
2. Close all building doors and windows and all doors.
3. Turn on clothes dryers and TURN ON any exhaust fans, such as range hoods and bathroom exhausts, so they shall operate at maximum speed. Open the fireplace damper. Do not operate a summer exhaust fan.
4. Follow the lighting instructions. Place the appliance being inspected in operation. Adjust thermostat so the appliance shall operate continuously.
5. Test each appliance (such as a water heater) equipped with a draft hood for spillage (down-draft or no draft) at the draft hood relief opening after 5 minutes of main burner operation. Appliances that do not have draft hoods need to be checked at the vent pipe as close to the appliance as possible. Use a combustion analyzer to check the CO₂ and CO levels of each appliance. Use a draft gauge to check for a downdraft or inadequate draft condition.
6. After it has been determined that each appliance properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers and any other gas burning appliance to their normal condition.
7. If improper venting is observed during any of the above tests, a problem exists with either the venting system or the appliance does not have enough combustion air (Supply Air from outside) to complete combustion. This condition must be corrected before the appliance can function safely. NOTE: An unsafe condition exists when the CO reading exceeds 40 ppm and the draft reading is not in excess of -0.1 in. W.C. (-25 kPa) with all of the appliance(s) operating at the same time.
8. Any corrections to the venting system and / or to the supply (outside) air system must be in accordance with the National Fuel Gas Code Z223.1 or CAN/CGA B149.1 Natural Gas and Propane Installation Code (latest editions). If the vent system must be resized, follow the appropriate tables in Appendix G of the above codes or for this appliance.

9 Gas Supply and Piping



WARNING: FIRE OR EXPLOSION HAZARD

- ▶ Never purge a gas line into a combustion chamber. Never test for gas leaks with an open flame. Use a commercially available soap solution made specifically for the detection of leaks to check all connections.



WARNING: FIRE OR EXPLOSION HAZARD

- ▶ Use proper length of pipe to avoid stress on gas control manifold and to prevent a gas leak.



CAUTION: FURNACE OVERHEAT HAZARD

- ▶ Connect gas pipe to gas valve using a backup wrench to avoid damaging gas controls and to avoid burner misalignment.



WARNING: FIRE OR EXPLOSION HAZARD

- ▶ If local codes allow the use of a flexible gas appliance connector, always use a new listed connector. Do not use a connector which has previously served another gas appliance. Black iron pipe shall be installed at the furnace gas control valve and extend a minimum of 2 inches outside the furnace.

NOTICE:

- ▶ Adjusting the minimum supply pressure below the limits in Table 12 could lead to unreliable ignition. Gas input to the burners must not exceed the rated input shown on the rating plate. Overfiring of the furnace can result in premature heat exchanger failure. Gas pressures in excess of 13 in. WC can also cause permanent damage to the gas valve.

At all altitudes and with either fuel (natural gas or LP), the air temperature rise must be within the range listed on the furnace nameplate. Should this appliance be converted to LP, refer to the instructions included in the factory authorized natural gas to LP conversion kit.

9.1 General

The furnace rating plate includes the approved furnace gas input rating and gas types. The furnace must be equipped to operate on the type of gas applied. This includes any conversion kits required for alternate fuels and/or high altitude.

Inlet gas supply pressures must be maintained within the ranges specified in Table 13. The supply pressure must be constant and available with all other household gas-fired appliances operating. The minimum gas supply pressure must be maintained to prevent unreliable ignition. The maximum must not be exceeded to prevent unit overfiring.

	Inlet Gas Supply Pressure	
	Minimum: 4.5 in. WC	Maximum: 10.5 in. WC
Natural Gas		
Propane Gas	Minimum: 11.0 in. WC	Maximum: 13.0 in. WC

Table 13 Inlet Gas Supply Pressure

9.2 High Altitude Derate

Alternately, in high altitude applications, a standard derate for altitude from National Fuel Gas Code ANSI Z223.1 of 4% per 1000 feet above sea level may be taken. Refer to the most recent version of ANSI Z223.1 for correct gas orifice based on your specific application. The orifices must be selected using the specifications listed in the table below. The furnace derate is 4% for each 1,000 feet above sea level.

Table 14 is based upon a heating value of approximately 1,000 Btu/ft³.

In Canada, the input rating must be derated by 10 percent for altitudes of 2,000 ft. to 4,500 ft. above sea level by an authorized Gas Supplier or Dealer.

When an appliance is installed at elevations above 4500 ft, the certified high-altitude input rating shall be reduced at the rate of 4% for each additional 1000 ft.

In some areas the gas supplier may artificially derate the gas in an effort to compensate for the effects of altitude. If the gas is artificially derated, the appropriate orifice size must be determined based upon the BTU/ft³ content of the derated gas and the altitude. Refer to the latest version of NFPA54/ANSI Z223.1 and information provided by the gas supplier to determine the proper orifice size.

US installation

Input Rate KBtu/H	Number of burners	Elevation (Ft)		Elevation (Ft)		Elevation (Ft)		Elevation (Ft)		Elevation (Ft)	
		0-2000		2000-4000		4000-6000		6000-8000		8000-10000	
		NG**	LP*	NG**	LP*	NG**	LP*	NG**	LP*	NG**	LP*
60	3	45	55	47	56	48	57	49	58	50	59
80	4	45	55	47	56	48	57	49	58	50	59
100	5	45	55	47	56	48	57	49	58	50	59
120	6	45	55	47	56	48	57	49	58	50	59

Table 14 High Altitude Derate Orifice Size Chart (Natural and LP Gas*)

* LP orifice based on 10 in. WC manifold pressure

- The input to the furnace must be checked AFTER reorificing.

** NG denotes natural gas

Canada installation

Input Rate KBtu/H	Number of burners	Elevation (Ft)		Elevation (Ft)		Elevation (Ft)		Elevation (Ft)		Elevation (Ft)	
		0-2000		2000-4000		4000-6000		6000-8000		8000-10000	
		NG**	LP*	NG**	LP*	NG**	LP*	NG**	LP*	NG**	LP*
60	3	45	55	47	56	48	57	49	58	50	59
80	4	45	55	47	56	48	57	49	58	50	59
100	5	45	55	47	56	48	57	49	58	50	59
120	6	45	55	47	56	48	57	49	58	50	59

Table 15 High Altitude Derate Orifice Size Chart (Natural and LP Gas*)

* LP orifice specification based on 10 in. WC manifold pressure (as specified on the unit's rating plate for LP).

- The input to the furnace must be checked AFTER reorificing.

** NG denotes natural gas



For Canada applications, regulation requires 10% derating between 2000-4500 ft. When an appliance is installed at elevations above 4500 ft, the certified high altitude input rating shall be reduced at the rate of 4% for each additional 1000 ft.

9.3 Propane Gas (LP) Conversion


WARNING: FIRE OR EXPLOSION HAZARD

- Possible property damage, personal injury or death may occur if the correct conversion kits are not installed. The appropriate kits must be applied to ensure safe and proper furnace operation. All conversions must be performed by a qualified installer or service agency.

This unit is configured for natural gas. However, all furnaces come standard with a conversion kit for propane gas (LP). The appropriate manufacturer's propane gas conversion kit must be applied for propane gas (LP) installations. For high altitude installations (above 2000 ft), refer to the "High Altitude Derate" section for details.

The indicated kits must be used to ensure safe and proper furnace operation. All conversions must be performed by a qualified installer, or service agency. Refer to the installation instructions supplied with the conversion kit.

9.4 Gas Piping Connections

To avoid possible unsatisfactory operation or equipment damage due to underfiring of equipment, use the proper size of natural/propane gas piping needed when running pipe from the meter/tank to the furnace.

When sizing a trunk line, be sure to include all appliances which will operate simultaneously (see Table 16).

The gas piping supplying the furnace must be properly sized based on the gas flow required, specific gravity of the gas, and length of the run. The gas line installation must comply with local codes or in their absence, refer to the latest version of NFPA54/ANSI Z223.1.

Nominal iron pipe size in.	Internal DIA. in.	Length of pipe-ft				
		10	20	30	40	50
1/2	0.622	175	120	97	82	73
3/4	0.824	360	250	200	170	151
1	1.049	680	465	375	320	285
1-1/4	1.380	1400	950	770	660	580
1-1/2	1.610	2100	1460	1180	990	900

Table 16 Natural Gas Capacity of Pipe in Cubic Feet of Gas Per Hour (CFH)

(Pressure 0.5 psig or less and pressure drop of 0.3 in. WC; Based on 0.60 Specific Gravity Gas)

$$\text{CFH} = \frac{\text{BTUH Furnace input}}{\text{Heating Value of Gas (BTU/Cubic Foot)}}$$

To connect the furnace to the building's gas piping, the installer must supply a ground joint union, drip leg, manual shutoff valve and line and fittings to connect to gas valve. In some cases, the installer may also need to supply a transition piece from 1/2" pipe to a larger pipe size.

The following stipulations apply when connecting gas piping.

- ▶ Use pipe joint compound on male threads only. Pipe joint compound must be resistant to the action of the fuel used.
- ▶ Use ground joint unions.
- ▶ Install a drip leg to trap dirt and moisture before it can enter the gas valve. The drip leg must be a minimum of three inches long.
- ▶ Install a 1/8" NPT pipe plug fitting, accessible for test gage connection immediately upstream of the gas supply connection to the furnace.
- ▶ Use two pipe wrenches when making connection to the gas valve to keep it from turning. The orientation of the gas valve on the manifold must be maintained as shipped from the factory.
- ▶ Install a manual shutoff valve between the gas meter and unit within six feet of the unit. If a union is installed, the union must be downstream of the manual shutoff valve, between the shutoff valve and the furnace.
- ▶ Tighten all joints securely.
- ▶ Connect the furnace to the building piping by one of the following methods:
 1. Rigid metallic pipe and fittings.
 2. Semi-rigid metallic tubing and metallic fittings. Aluminum alloy tubing must not be used in exterior locations.
 3. Use listed gas appliance connectors in accordance with their instructions. Connectors must be fully in the same room as the furnace.
 4. The installation of piping shall be in accordance with piping codes and the regulations of the local gas company. Pipe joint compound must be resistant to the chemical reaction with liquefied petroleum gases.

When the gas piping enters through the right side of the furnace, the installer must supply the following fittings (starting from the gas valve):

- ▶ 90 degree elbows (2).
- ▶ Close nipple.
- ▶ Straight pipe to reach the exterior of the furnace.

A ground joint union, drip leg, and manual shutoff valve must also be supplied by the installer. In some cases, the installer may also need to supply a transition piece from 1/2" to another pipe size.

When the gas piping enters through the left side of the furnace, the installer must supply the following fittings (starting from the gas valve):

- ▶ Straight pipe to reach the exterior of the furnace.
- ▶ A ground joint union, drip leg, and manual shutoff valve must also be supplied by the installer. In some cases, the installer may also need to supply a transition piece from 1/2 inch to another pipe size.

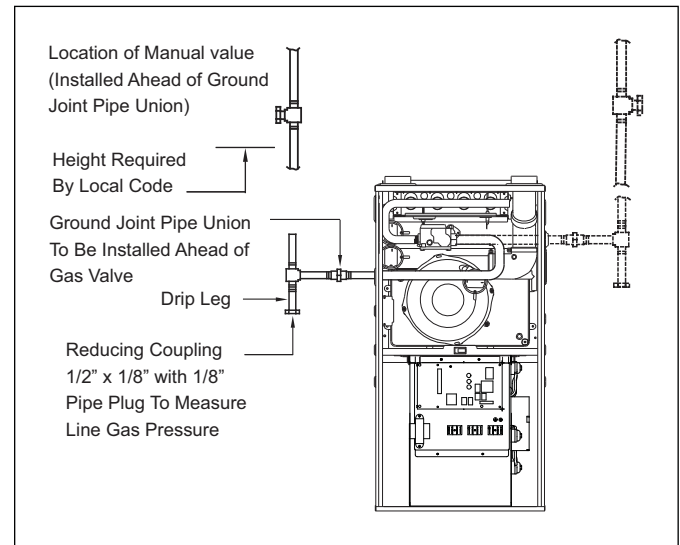


Figure 33 Typical Gas Pipe Arrangement

9.5 Gas Piping Checks

Before placing unit in operation, leak test the unit and gas connections.



WARNING: FIRE OR EXPLOSION HAZARD

- ▶ Never test for gas leaks with an open flame. Use a commercially available soap solution made specifically for the detection of leaks to check all connections.

Check for leaks using an approved chloride-free soap and water solution, an electronic combustible gas detector, or other approved testing methods.

NOTICE:

- ▶ Never exceed specified pressures for testing. Higher pressures may damage the gas valve and cause subsequent overfiring, resulting in heat exchanger failure.

This furnace must be isolated from the gas supply system by closing its manual shutoff valve before pressure testing of gas supply piping system with test pressures equal to or less than 1/2 psig (3.48 kPa).

10 Electrical Connections



WARNING: ELECTRICAL SHOCK HAZARD

- ▶ Blower access panel door switch opens 115V power to control. No component operation can occur. Do not bypass or close the blower access panel door switch with panel removed.

See Fig. 36, (page 42) for field wiring diagram showing typical field 115V wiring. Check all factory and field electrical connections for tightness. Field-supplied wiring shall conform with the limitations of 63°F (35°C) rise.



WARNING: ELECTRICAL SHOCK AND FIRE HAZARD

- ▶ The cabinet MUST have an uninterrupted or unbroken ground according to NEC ANSI/NFPA 70-latest edition or local codes to minimize personal injury if an electrical fault should occur.

This may consist of electrical wire, conduit approved for electrical ground or a listed, grounded power cord (where permitted by local code) when installed in accordance with existing electrical codes. Refer to the power cord manufacturer's ratings for proper wire gauge. Do not use gas piping as an electrical ground.

NOTICE: FURNACE MAY NOT OPERATE

- ▶ Furnace control must be grounded for proper operation or else control will lock out. Control must remain grounded through green/yellow wire routed to gas valve and manifold bracket screw.

10.1 115V Wiring

Verify that the voltage, frequency, and phase correspond to that specified on unit rating plate. Also, check to be sure that service provided by utility is sufficient to handle load imposed by this equipment. Refer to rating plate or Table 17 (page 41) for equipment electrical specifications.

Make all electrical connections in accordance with National Electrical Code (NEC) ANSI/NFPA 70-latest edition and any local codes or ordinances that might apply.



WARNING: FIRE HAZARD

- ▶ Do not connect aluminum wire between disconnect switch and furnace. Use only copper wire.

Use a separate, fused branch electrical circuit with a properly sized fuse or circuit breaker for this furnace. See Table 17 for wire size and fuse specifications. A readily accessible means of electrical disconnect must be located within sight of the furnace.



Proper polarity must be maintained for 115V wiring. If polarity is incorrect, control LED status indicator light will flash rapidly and furnace will NOT operate.

Junction box relocation



If factory location of J-Box is acceptable, go to next section
Electrical Connection to J-box.



On 14" wide cabinet models, the J-Box shall not be relocated to other side of furnace cabinet when the vent pipe is routed within the cabinet.

1. Remove and save two screws holding J-Box (See Figure 34).



The J-Box cover need not be removed from the J-Box in order to move the J-Box. Do NOT remove green ground screw inside J-Box. The ground screw is not threaded into the cabinet flange and can be lifted out of the clearance hole in cabinet while swinging the front edge of the J-Box cover away from the cabinet.

2. Move J-Box to desired location.
3. Fasten J-Box to cabinet with two screws removed in Step 1.
4. Route J-Box wires within furnace away from sharp edges, rotating parts and hot surfaces.

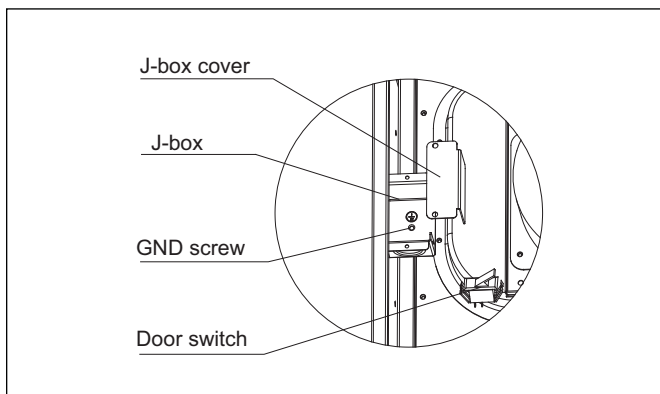


Figure 34 J-Box

10.2 Electrical Connection to J-box

Field-Supplied Electrical Box on Furnace J-Box Bracket

See Fig. 34 on previous page.

1. Remove cover from furnace J-Box.
2. Attach electrical box to furnace J-Box bracket with at least two field-supplied screws through holes in electrical box into holes in bracket. Use blunt-nose screws that will not pierce wire insulation.
3. Route furnace power wires through holes in electrical box and J-Box bracket, and make field-wire connections in electrical box. Use best practices (NEC in U.S.) for wire bushings, strain relief, etc.
4. Route and secure field ground wire to green ground screw on J-Box bracket, OR FURNACE WILL FAIL TO OPERATE.
5. Connect line voltage leads as shown in Fig. 36.
6. Reinstall cover to J-Box. Do not pinch wires between cover and bracket.

Electrical Box on Furnace Cabinet Side.

See Fig. 35 and Fig 36.



WARNING: FIRE OR ELECTRICAL SHOCK HAZARD

- ▶ If field-supplied manual disconnect switch is to be mounted on furnace cabinet side, select a location where a drill or fastener cannot damage electrical or gas components.

1. Select and remove a knockout hole in the cabinet where the electrical box is to be installed.



Check that duct on side of furnace will not interfere with installed electrical box.

2. Remove the desired electrical box hole knockout and position the hole in the electrical box over the hole in the furnace cabinet.
3. Fasten the electrical box to cabinet by driving two field-supplied screws from inside electrical box into cabinet steel.
4. Remove and save two screws holding J-Box. (See Fig. 34.)
5. Pull furnace power wires out of 1/2-inch diameter hole in J-Box. Do not loosen wires from strain-relief wire-tie on outside of J-Box.
6. Route furnace power wires through holes in cabinet and into electrical box.
7. Pull field power wires into electrical box.
8. Remove cover from furnace J-Box.
9. Route field ground wire through holes in electrical box and cabinet, and into furnace J-Box.
10. Reattach furnace J-Box to furnace cabinet with screws removed in Step 4.
11. Secure field ground wire to green ground screw on J-Box Bracket.
12. Complete electrical box wiring and installation. Connect line voltage leads as shown in Fig. 36. Use best practices (NEC in U.S.) for wire bushings, strain relief, etc.
13. Reinstall cover to J-Box. Do not pinch wires between cover and bracket.

10.3 Power Cord Installation in Furnace J-box



Power cords must be able to handle the electrical requirements listed in Table 16. Refer to power cord manufacturer's listings.

1. Remove cover from J-Box.
2. Route listed power cord through 7/8-inch diameter hole in J-Box.
3. Secure power cord to J-Box bracket with a strain relief bushing or a connector approved for the type of cord used.
4. Secure field ground wire to green ground screw on J-Box bracket.
5. Connect line voltage leads as shown in Fig. 36.
6. Reinstall cover to J-Box. Do not pinch wires between cover and bracket.

10.4 BX Cable Installation in Furnace J-box

1. Remove cover from J-Box.
2. Route BX cable into 7/8-inch diameter hole in J-Box.
3. Secure BX cable to J-Box bracket with connectors approved for the type of cable used.
4. Secure field ground wire to green ground screw on J-Box bracket.
5. Connect line voltage leads as shown in Fig. 36.
6. Reinstall cover to J-Box. Do not pinch wires between cover and bracket.

10.5 24-V Wiring

Make field 24V connections at the 24V terminal strip (See Fig. 35.). Connect terminal Y as shown in Fig. 36 for proper cooling operation. Use only 18 AWG, color-coded, copper thermostat wire.

The 24V circuit contains an automotive-type, 3-Amp. fuse located on the control. Any direct shorts during installation, service, or maintenance could cause this fuse to blow. If fuse replacement is required, use ONLY a 3-Amp. fuse of identical size.

10.6 Accessories (Field Supplied)

1. Electronic Air Cleaner (EAC)

For connection to an Electronic Air Cleaner (if needed), use ¼-inch female quick connect terminals to engage with the two ¼-inch male quick connect terminals on the control board marked EAC-H and one of NEUTRALS. The terminals are rated for 115 VAC, 1.0 amps maximum and are energized when blower motor is in operation (see Figure 35).

2. Humidifier (HUM)

Connect an accessory humidifier using the ¼-inch male quick connect terminals marked HUM and one of NEUTRALS, respectively, on the control board. The HUM is energized when gas valve relay is energized. The terminals are rated for 115VAC, 1.0 amps maximum (See Figure 35).

10.7 Grounding

The furnace must be electrically grounded in accordance with local codes or, in the absence of local codes, with the National Electrical Code, ANSI/NFPA 70, if an external electrical source is utilized.

Input		Output		Nominal Airflow	MAX. Unit Amps	AFUE	Air Temp. Rise		Max. Over-Current Protection	Min. Wire Size (AWG) @ 75 ft	Max. Outlet Air Temp	
MBH	kW	MBH	kW	CFM			°F	°C	Amps		°F	°C
60B3	17.6	57	16.7	1200	8	96	30-60	17-33	15	14	160	71
80B3	23.4	76	22.3	1200	8	96	35-65	19-36	15	14	165	74
80C4	23.4	76	22.3	1600	7.8	96	35-65	19-36	15	14	165	74
100C5	29.3	95	27.8	2000	11.5	96	35-65	19-36	20	14	165	74
100D5	29.3	95	27.8	2000	10.5	96	35-65	19-36	20	14	165	74
120D5	35.2	106.5	31.2	2000	10.5	95	40-70	22-39	20	14	170	77

Table 17 Ratings & Physical / Electrical Data

Annual Fuel Utilization Efficiency (AFUE) numbers are determined in accordance with DOE Test procedures.

National Electrical Code (NFPA-70-latest edition) and all local codes.

The furnace shall be installed so that the electrical components are protected from water.

Optional Switch Positions

DIP Switch (SW)		NOMINAL (MINUTES)
SW1-1	SW1-2	
OFF	OFF	OFF*
ON	OFF	10
OFF	ON	AUTO
ON	ON	20

Table 18 W2 Delay

*The factory default settings

DIP Switch (SW)		NOMINAL (SECONDS)
SW1-3	SW1-4	
OFF	OFF	90
ON	OFF	120
OFF	ON	150
ON	ON	180*

Table 19 Heat Off Delay

*The factory default settings

DIP Switch (SW)		NOMINAL (SECONDS)
SW3-1	SW3-2	
OFF	OFF	60
ON	OFF	90*
OFF	ON	120
ON	ON	150

Table 20 Cool Off Delay

*The factory default settings

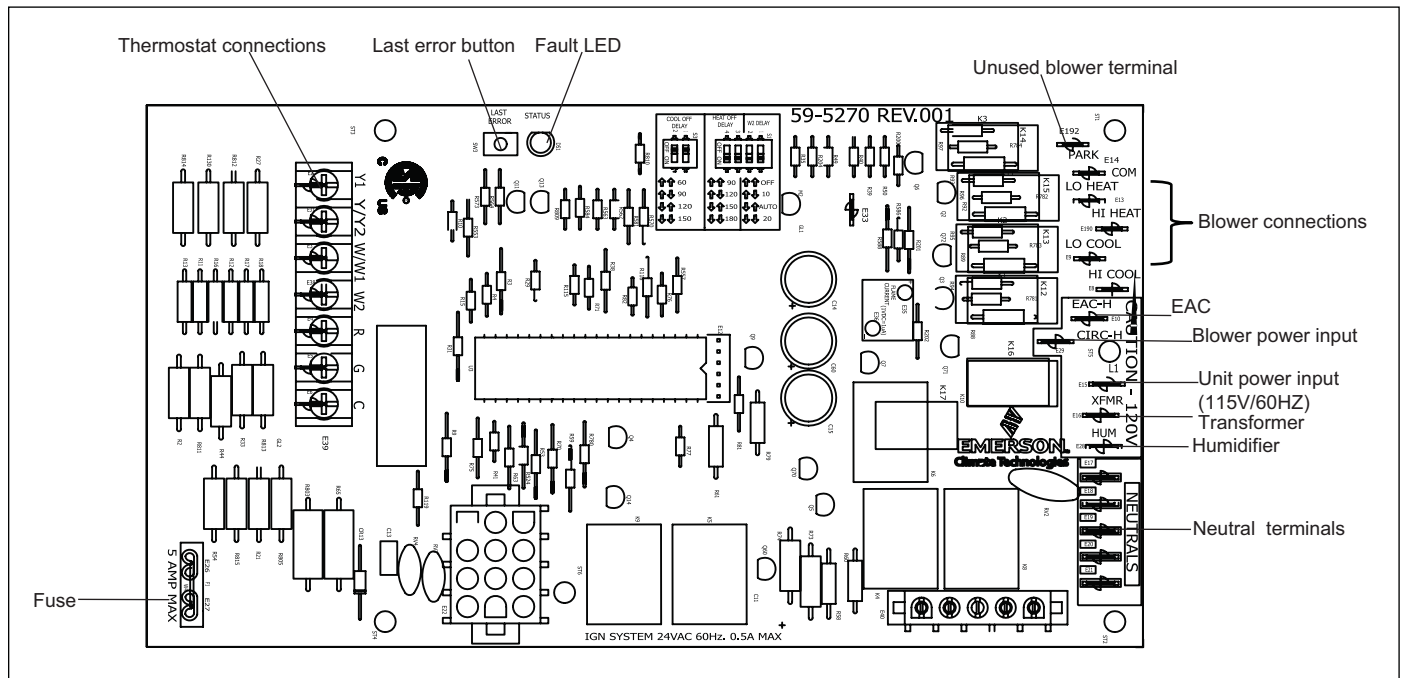


Figure 35 Furnace Control

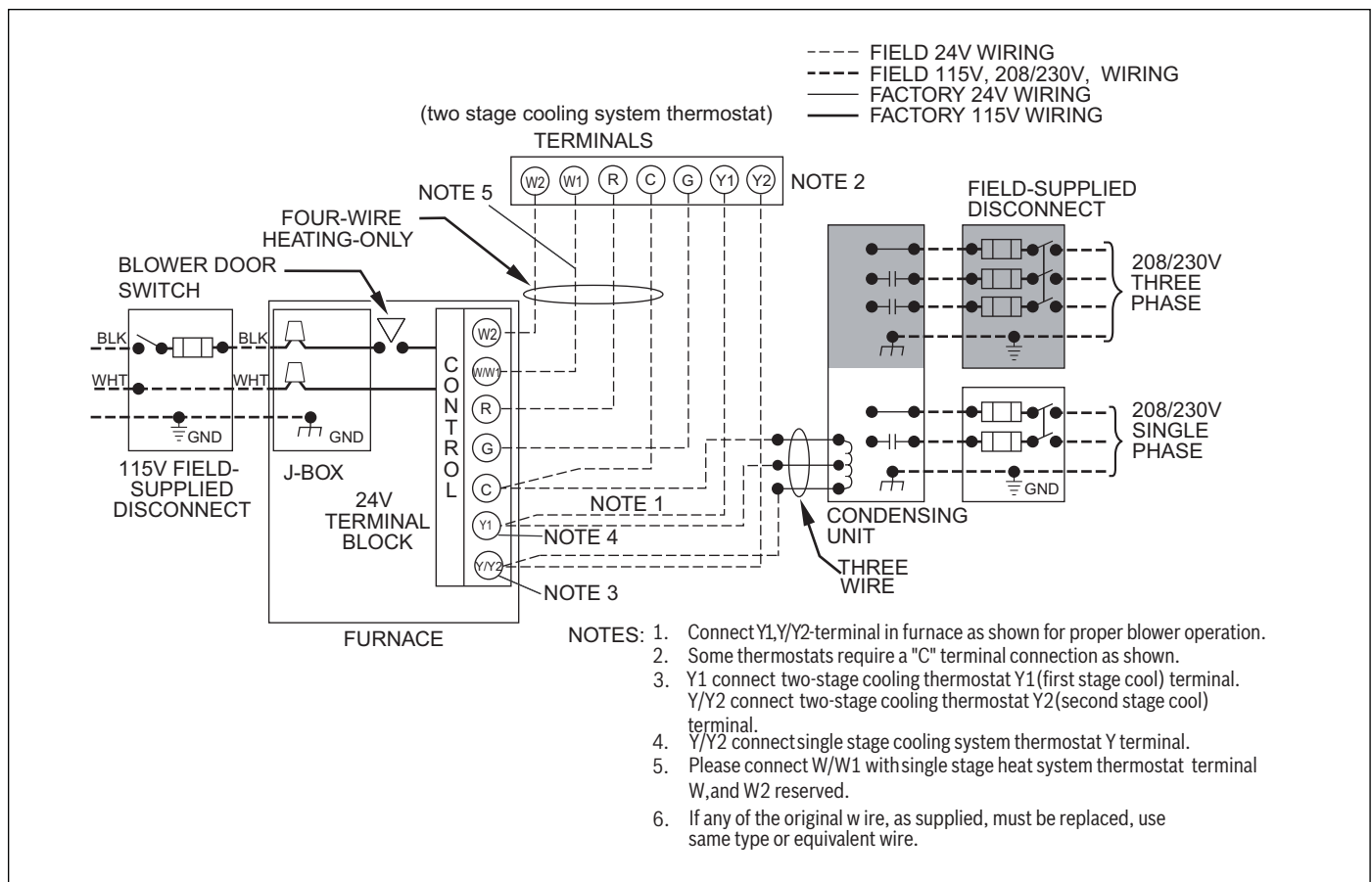


Figure 36 Heating and Cooling Application Wiring Diagram with 2-Stage Thermostat

11 Start-Up, Adjustment, and Safety Check

11.1 General



WARNING: FIRE HAZARD

- This furnace is equipped with manual reset limit switches in the gas control area. The switches open and shut off power to the gas valve if a flame rollout or overheating condition occurs in the gas control area. **DO NOT** bypass the switches. Correct inadequate combustion air supply problem before resetting the switches.



CAUTION: CUT HAZARD

- Sheet metal parts may have sharp edges or burrs. Use care and wear appropriate protective clothing, safety glasses, and gloves when handling parts and servicing furnaces.

1. Maintain 115V wiring and ground. Improper polarity will result in rapid flashing LED and no furnace operation (See Fig. 36).
2. Make thermostat wire connections at the 24-V terminal block on the furnace control. Failure to make proper connections will result in improper operation (See Fig. 36).
3. Gas supply pressure to the furnace must follow Table 13 "Inlet Gas Supply Pressure" in Section 9.1.
4. Check all manual-reset switches for continuity.
5. Install blower and burner access panels. Panels must be in place to operate furnace.

11.2 Start-Up Procedures



WARNING: FIRE AND EXPLOSION HAZARD

- Never test for gas leaks with an open flame. Use a commercially available soap solution made specifically for the detection of leaks to check all connections.

1. Purge gas lines after all connections have been made.
2. Check gas lines for leaks.



WARNING: ELECTRICAL SHOCK HAZARD

- Blower access panel switch opens 115V power to control. No component operation can occur unless the switch is closed. Caution must be taken when manually closing this switch for service purposes.

3. This furnace is also equipped with a self-diagnosing electronic control module. In the event a furnace component is not operating properly, the control module LED will flash on and off in a factory programmed sequence, depending on the problem encountered. This light can be viewed through the observation window in the blower access panel. Refer to the Troubleshooting Chart on pages 50-51 for further explanation of the lighting codes. Follow the start-up and adjustment items in Section 11. Refer to Section 12 for further information on Operational Checks.

11.3 Furnace Start-Up

1. Close the manual gas shutoff valve external to the furnace.
2. Turn off the electrical power to the furnace.
3. Set the room thermostat to the lowest possible setting.
4. Remove the burner access panel.



WARNING:

- This furnace is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.

5. Push the gas valve switch to the OFF position.
6. Wait five minutes to clear out any gas. Then smell for gas, including near the floor.
7. If gas can be smelled following the five minute waiting period, repeat step 6. If you have waited more than 10 minutes and still smell gas, check for leaks using a soap and water solution.
8. If you do not smell gas after five minutes, push the gas valve switch to the ON position.



WARNING: FIRE AND EXPLOSION HAZARD

- Never test for gas leaks with an open flame. Use a commercially available soap solution made specifically for the detection of leaks to check all connections.

9. Replace the burner access panel on the front of the furnace.
10. Open the manual gas valve external to the furnace.
11. Turn on the electrical power supply to the furnace.
12. Set the room thermostat to slightly above room temperature. After some delay, the furnace will start.
13. Refer to Section 11.4 "Sequence of Operation" for specific details on how the furnace operates.



There is an approximate 48 second delay between thermostat energizing and burner firing.

Furnace shutdown

In case of furnace malfunction, use the following steps to shut the unit down:

1. Set the thermostat to OFF or it's lowest temperature setting.
2. Turn off the electrical power supply to the furnace.
3. Remove the burner access panel.
4. Close manual gas shutoff valve external to the furnace.
5. Push the gas valve switch to the OFF position.
6. Replace burner access panel.

11.4 Sequence of Operation



Furnace control must be grounded for proper operation or control will lock out. Control is grounded through green wire routed to gas valve and manifold bracket screw. Follow the sequence of operation through the heating, cooling, and fan only modes.

Read and follow the wiring diagram (Fig. 36) very carefully.

The blower access panel must be installed for power to be conducted through all electrical components.

1. Heating mode

In a typical system, a call for first stage heat is initiated by closing the W1 thermostat contacts. The inducer blower is energized at high speed and the control waits for the low pressure switch contacts to close. The humidifier (optional) is also energized at this time. Once the low pressure switch contacts close, a 15-second pre-purge is initiated. Then the inducer changes to low speed and the 120V ignitor is powered. At the end of the ignitor warm-up time, the first stage of the two-stage manifold gas valve is energized (low fire). Flame must be detected within 4 seconds. If flame is detected, the 45-second HEAT delay-to-fan-on period begins. After the delay-to-fan-on period ends, the control will energize the circulator fan at low heat speed. The electronic air cleaner (optional) will also energize at this time. For a two-stage thermostat, a call for second stage heat (W1 and W2) after a call for first stage heat will energize the inducer at high speed and the circulator at high heat speed. The second stage pressure switch contacts will close and energize the second stage gas valve (high fire). For a single-stage thermostat, when a call for heat occurs (W1), a 10, 20 minute or auto mode heat staging timer will be activated (timing is selectable with option switches S1-1 and S1-2 positions). Following this delay, the second stage heat is energized as above.

When the second stage of the thermostat is satisfied, the inducer motor is reduced to low speed and the second stage gas valve is de-energized. On the control, the circulator will remain at high heat speed for 30 seconds following the opening of the second stage gas valve and then is reduced to low heat speed. When the first stage of the thermostat is satisfied, the first stage gas valve is de-energized and the HEAT delay-to-fan-off begins timing. The inducer will postpurge for an additional 15 seconds, then the inducer and humidifier will turn off. Upon completion of the HEAT delay-to-fan-off period, the circulator is turned off. The electronic air cleaner on the control is also de-energized at this time.

If flame is not detected during the trial-for-ignition period or if the flame is detected/sensed and then lost before completion of 10 seconds of establishment, the gas valve is de-energized, the ignitor is turned off, and the control goes into the "retry" sequence. The "retry" sequence provides a 60-second wait with the inducer interpurge following an unsuccessful ignition attempt (flame not detected). After this wait, the ignition attempt is restarted. Two retries will be attempted before the control goes into system lockout. If flame is established for more than 10 seconds after ignition, the controller will clear the ignition attempt (or retry) counter. If flame is lost after 10 seconds, the control will restart the ignition sequence.

A momentary loss of gas supply, flame blowout, or a shorted or open condition in the flame probe circuit will be sensed within 2 seconds. The gas valve will de-energize and the control will restart the ignition sequence. Recycles will begin and the burner will operate normally if the gas supply returns, or the fault condition is corrected, before the last ignition attempt. Otherwise, the control will go into system lockout. If the control has gone into system lockout, it may be possible to reset the control by a momentary power interruption of 10 seconds or longer.

Timing specifications

(All times are in seconds, unless noted otherwise)

Event	Definition	50M58-400
Pre-purge Time	The period of time intended to allow for the dissipation of any unburned gas or residual products of combustion at the beginning of a furnace operating cycle prior to initiating ignition	15
Ignitor Warm-up Time	The length of time allowed for the ignitor to heat up prior to the ignition of gas flow.	17
Trial for ignition Period(TFI)	The period of time between initiation of gas flow and the action to shut off the gas flow in the event of failure to establish proof of the supervised ignition source or the supervised main burner flame.	4
Ignition Activation Period(IAP)	The period of time between energizing the main gas valve and deactivation of the ignition means prior to the end of TFI	3
Retries	The additional attempts within the same thermostat cycle for ignition when the supervised main burner flame is not proven within the first trial for ignition period.	2 times
Valve Sequence period	Value sequence period equals 4 seconds trial for ignition period x (1 initial try + 2 retries)+12 seconds.	12
Inter-purge	The period of time intended to allow for the dissipation of any unburned gas or residual products of combustion between the failed trial for ignition and the retry period.	60
Post-purge Time	The period of time intended to allow for the dissipation of any unburned gas or residual products of combustion at the end of a furnace burner operating cycle, Post-purge begins at the loss of flame sense.	15
Lock-Out Time	ANSI standard rated module timing.	300
Heat Delay-To-Fan-On	The period of time between proof of the supervised main burner flame and the activation of the blower motor at heat speed.	30
Heat Delay-To-Fan-Off*	The period of time between the loss of a call for heat and the deactivation of the blower motor at Heat speed.	*90/120/ 150/180
Cool Delay-To-Fan-On	The period of time after a thermostat demand for cool before energizing the circulator blower motor at cool speed.	1
Cool Delay-To-Fan-Off	The period of time between the loss of a call for cool and the deactivation of the blower motor at cool speed.	60/*90/ 120/150
Automatic Reset Time	After one (1) hour of internal or external lockout, the control will automatically reset itself and go into an auto restart purge for 60 seconds.	60 minutes

Table 21

* These times will vary depending on option switch position.

When using a single stage thermostat, second stage delay is based on the setting of switch S1-1, S1-2 shown below.

Option Switches S1-1 & S1-2 Positions

Delay Time:	On "S1" set switch #	
	1	2
Off*	Off	Off
10 min	On	Off
Auto min	Off	On
20 min	On	On

Table 22 2nd Stage Delay For Single Stage Thermostats

* Factory default setting—two stage thermostat

2. Cooling Mode (if applicable)

In a typical single stage cooling system (Y connection), a call for cool is initiated by closing the thermostat contacts. This energizes the compressor and the electronic air cleaner (optional).

The circulator will be energized at cool speed after the COOL delay-to-fan-on period. After the thermostat is satisfied, the compressor is de-energized and the COOL delay-to-fan-off period begins. After the COOL delay-to-fan-off period ends, the circulator and the electronic air cleaner are de-energized.

3. FAN Mode

If the thermostat fan mode is set to ON, the circulator fan (low heat speed) and optional electronic air cleaner are energized. When the fan mode is returned to AUTO, the circulator fan and electronic air cleaner (optional) are deenergized.

11.5 Gas Manifold Pressure Measurement and Adjustment

NOTICE:

- To prevent unreliable operation or equipment damage, the gas manifold pressure must be as specified on the unit rating plate. Only minor adjustments should be made by adjusting the gas valve pressure regulator.

This valve is shipped from the factory with the regulator preset to 3.5 in. WC. Consult the appliance rating plate to ensure burner manifold pressure is as specified. If another outlet pressure is required, follow these steps (see Table 23 and Fig. 37):

1. Turn OFF all electrical power to the system.
2. Using a 3/32 inch hex wrench, loosen outlet pressure tap screw one turn. Do not remove screw.
3. Attach a hose and manometer to the outlet pressure barb fitting of valve to overlap at least 3/8"
4. Turn ON system power and set thermostat to a call for heat.
5. Using a leak detection solution or non-chlorine soap suds, check for leaks at hose connection. Bubbles forming indicate a leak. SHUT OFF GAS AND FIX ALL LEAKS IMMEDIATELY!
6. Remove burner access panel.
7. Remove regulator screw cover. Turn regulator screw either clockwise to increase pressure or counter clockwise to decrease. Always adjust regulator to provide the correct pressure according to the original equipment manufacturer specifications listed on the appliance rating plate.

8. Replace regulator screw cover and finger-tighten securely.
9. Turn OFF all electrical power to the system.
10. Remove manometer and hose from outlet pressure tap.
11. Tighten outlet pressure tap clockwise 7 in-lbs minimum to seal port.
12. Replace burner access panel.
13. Turn ON system power and set thermostat to call for heat.
14. Using a leak detection solution or non-chlorine soap suds, check for leaks at hose connection. Bubbles forming indicate a leak. SHUT OFF GAS AND FIX ALL LEAKS IMMEDIATELY!

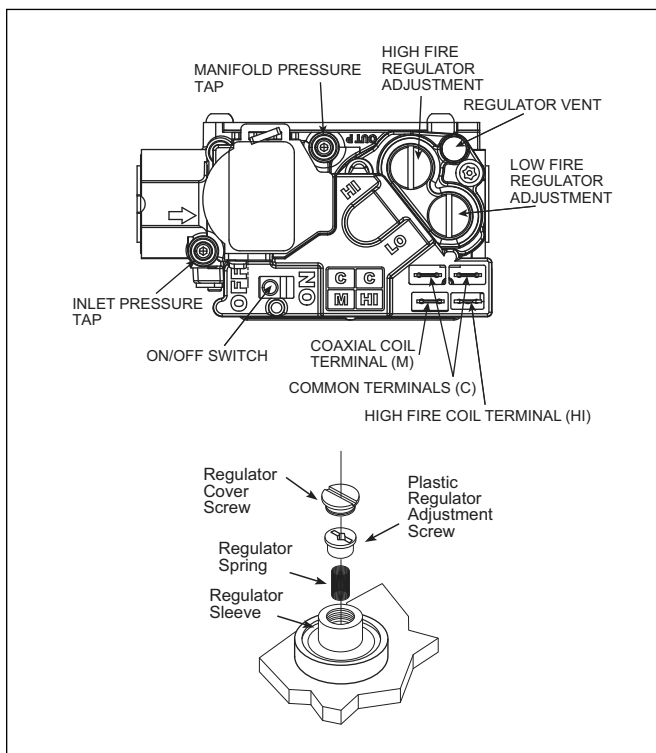


Figure 37 Gas valve and regulator adjustment

15. Measure gas manifold pressure with burners firing. Adjust manifold pressure per the Manifold Gas Pressure table.

Input Rating KBTU/H	Furnace Model	Range		Orifice Size	
		Natural Gas	Propane Gas	Natural Gas	Propane Gas
60	BGH96M060B3A	3.5" W.C	10" W.C	45	55
80	BGH96M080B3A	3.5" W.C	10" W.C	45	55
80	BGH96M080C4A	3.5" W.C	10" W.C	45	55
100	BGH96M100C5A	3.5" W.C	10" W.C	45	55
100	BGH96M100D5A	3.5" W.C	10" W.C	45	55
120	BGH96M100D5A	3.5" W.C	10" W.C	45	55

Table 23 Manifold Gas Pressure

The final manifold pressure must not vary more than ± 0.3 in. WC from specified manifold pressure.

Any necessary major changes in gas flow rate should be made by changing the size of the burner orifice.

11.6 Gas Input Rate Measurement (Natural Gas Only)

The gas input rate to the furnace must never be greater than that specified on the unit rating plate. To measure natural gas input using the gas meter, use the following procedure.

1. Turn OFF the gas supply to all other gas-burning appliances except the furnace.
2. While the furnace is operating, time and record one complete revolution of the smallest gas meter dial.
3. Calculate the number of seconds per cubic foot (sec/ft³) of gas being delivered to the furnace. If the dial is a one cubic foot dial, divide the number of seconds recorded in step 2 by one. If the dial is a two cubic foot dial, divide the number of seconds recorded in step 2 by two.
4. Calculate the furnace input in BTUs per hour (BTU/hr). Input equals the installation's gas heating value multiplied by a conversion factor (hours to seconds) divided by the number of seconds per cubic foot. The measured input must not be greater than the input indicated on the unit rating plate.

Example:

Installation's gas heating (HTG) value: 1,000 BTU/ft³ (Obtained from gas supplier)

Installation's seconds per cubic foot: 34 sec/ft³

Conversion Factor (hours to seconds): 3600 sec/hr

Input = (Htg. value x 3600) ÷ seconds per cubic foot

Input = (1,000 BTU/ft³ x 3600 sec/hr) ÷ 34 sec/ft³

Input = 106,000 BTU/hr

This measured input must not be greater than the input indicated on the unit rating plate.

5. Turn ON gas and relight appliances turned off in step 1. Ensure all the appliances are functioning properly and that all pilot burners are operating.

4. Adjust temperature rise by adjusting the circulator blower speed. Increase blower speed to reduce temperature rise. Decrease blower speed to increase temperature rise. Refer to the following section for speed changing details.

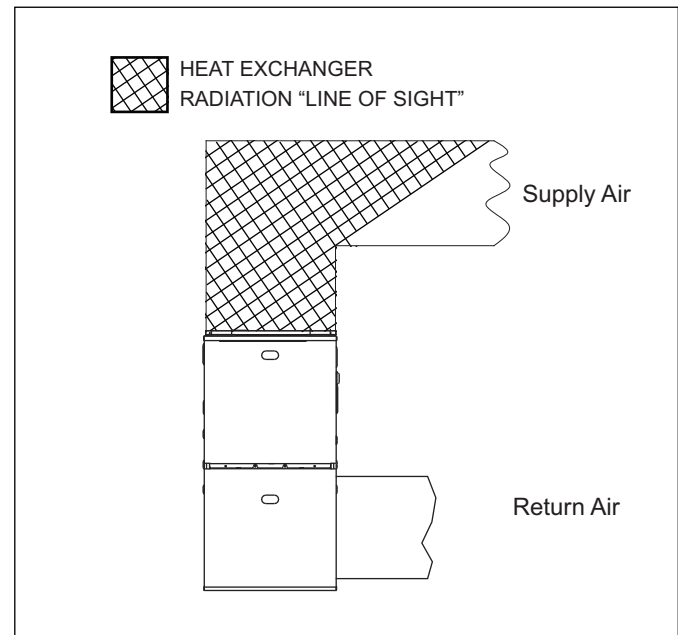


Figure 38 Temperature rise measurement

11.7 Temperature Rise Adjustment

Air temperature rise is the temperature difference between supply and return air. The proper amount of temperature rise is usually obtained when the unit is operated at the rated input with the "as shipped" blower speed. If the correct amount of temperature rise is not obtained, it may be necessary to change the blower speed.

NOTICE:

- An incorrect temperature rise can cause condensing in or overheating of the heat exchanger. Determine and adjust the temperature rise as follows. The temperature rise must be within the range specified on the rating plate.

Temperature Rise Adjustment

1. Operate furnace with burners firing for approximately 15 minutes. Ensure all registers are open and all duct dampers are in their final (fully or partially open) position.
2. Place thermometers in the return and supply ducts as close to the furnace as possible. Thermometers must not be influenced by radiant heat by being able to "see" the primary heat exchanger (see Fig. 38).
3. Subtract the return air temperature from the supply air temperature to determine the air temperature rise. Allow adequate time for thermometer readings to stabilize.

11.8 Circulator Blower Speed Adjustment



WARNING: ELECTRICAL SHOCK HAZARD

- Turn OFF power to the furnace before changing speed taps.

This furnace is equipped with an X13 ECM circulator blower motor. This blower provides ease in adjusting blower speeds. Refer to the table below for blower speed factory settings. These blower speeds should be adjusted by the installer to match the installation requirements so as to provide the correct heating temperature rise and the correct cooling CFM (Refer to Tables 3 & 4, (pages 24-25) - Air Delivery - CFM (Without Filter)*.

Model	HI COOL	LOW COOL	HI HEAT	LOW HEAT
BGH96M060B3A	Mid-H(4)	Mid(3)	Mid-H(4)	Mid(3)
BGH96M080B3A	Mid-H(4)	Mid(3)	High(5)	Mid(3)
BGH96M080C4A	Mid-H(4)	Mid(3)	High(5)	Mid(3)
BGH96M100C5A	Mid(3)	Mid-L(2)	Mid-H(4)	Mid-L(2)
BGH96M100D5A	Mid(3)	Mid-L(2)	Mid(3)	Mid-L(2)
BGH96M120D5A	Mid-H(4)	Mid(3)	Mid-H(4)	Mid(3)

Table 24 Blower Speed Factory Settings

To adjust the circulator blower speed, proceed as follows:

1. Turn OFF power to the furnace.
2. Select the heating and cooling blower speeds that match the installation requirements from Tables 3 & 4 - Air Delivery - CFM (Without Filter)*
3. If it is necessary to change the default settings, pull out the wire leads from the second row of terminals located below the control board (refer to Figure 39). Find the correct terminal and connect the leads.

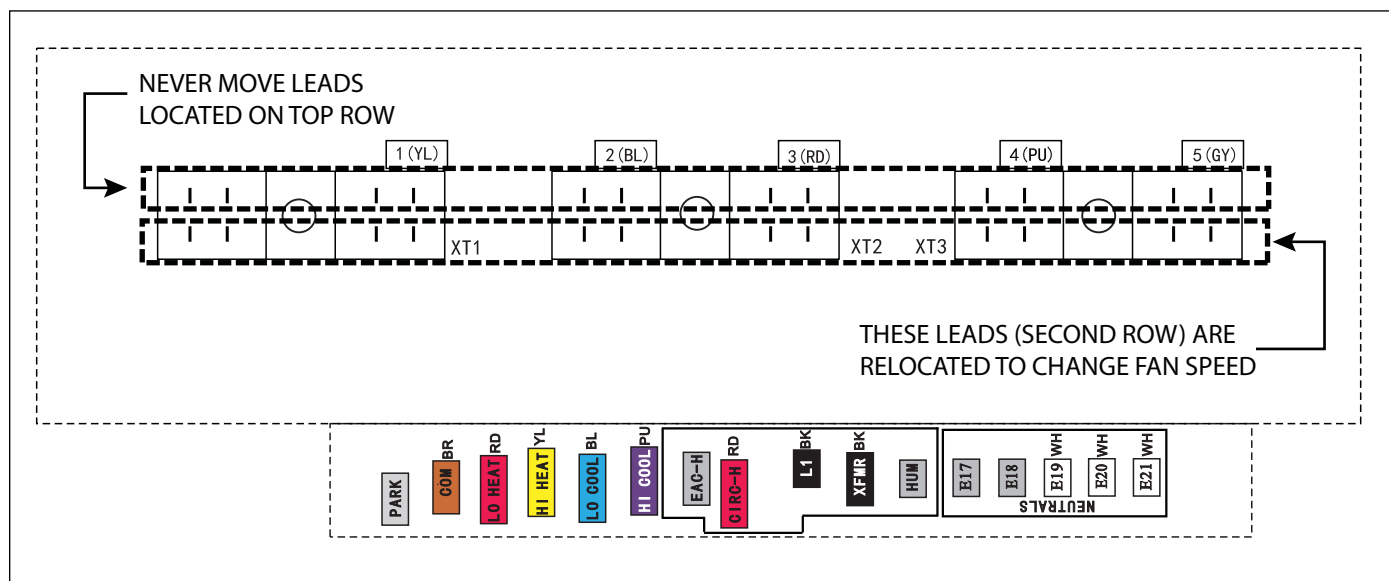


Figure 39

4. Turn ON power to furnace.
5. Verify proper temperature rise is as outlined in Temperature Rise section and on the unit nameplate.

12 Operational Checks

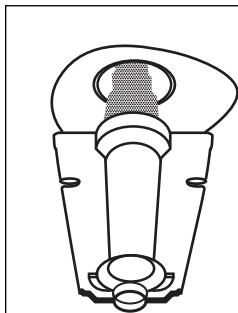


DANGER: FIRE, EXPLOSION, ELECTRICAL SHOCK, AND CARBON MONOXIDE POISONING HAZARD

- ▶ To avoid personal injury or death. Do not remove any internal component covers or attempt any adjustment. Electrical compartments are contained in both compartments. Contact a qualified service agent at once if an abnormal flame appearance should develop.

Burner Flame

The burner flames should be inspected with the burner access panel installed. Flames should be stable, quiet, soft, and blue (dust may cause orange tips but they must not be yellow). Flames should extend directly outward from the burners without curling, floating, or lifting off, and should enter heat-exchanger tube. Flames must not impinge on the sides of the heat exchanger firing tubes.



Check the burner flames for:

1. Stable, soft and blue
2. Not curling, floating, or lifting off

Figure 40 Burner Flame

13 Safety Circuit Description

13.1 General

A number of safety circuits are employed to ensure safe and proper furnace operation. These circuits serve to control any potential safety hazards and serve as inputs in the monitoring and diagnosis of abnormal function. These circuits are continuously monitored during furnace operation by the integrated control module.

13.2 Integrated Control Module

The integrated control module is an electronic device which controls all furnace operations. Responding to the thermostat, the module initiates and controls normal furnace operation, and monitors and addresses all safety circuits. If a potential safety concern is detected, the module will take the necessary precautions and provide diagnostic information through an LED.

13.3 Chamber Limit Switch - Fixed

The chamber limit switch - fixed control is located on the partition panel and monitors heat exchanger compartment temperature (it is an automatic reset temperature sensor). The limit guards against the overheating resulting from insufficient air passing over the heat exchanger.

13.4 Fan Mounted Limit Switch

The fan mounted limit switches are located beside the blower housing. They are temperature sensors which are automatically reset. They are used to prevent overheating by hot air when the furnace is installed horizontally.

13.5 Rollout Switch - Resettable

The rollout switch - resettable controls are mounted on the burner/manifold assembly and monitor the burner flame. They are manual-reset temperature sensors. This limit guards against burner flames not being properly drawn into the heat exchanger.

13.6 Overflow Protection Pressure Switch (Overflow Switch)

Overflow switch is a differential pressure switch. The shape and dimension of the overflow switch is similar to the two other pressure switches except it has two pressure ports, one in gray color (negative) and the other in black color (positive). The overflow switch is normally closed. When condensate hoses/trap is blocked and condensate is stopped flowing to drain system, the level of condensate inside the condensate collector box will rise. When the condensate reaches too high of a level in condensate collector box, the overflow switch will open and shut off the furnace. Make sure that black port (positive) is connected to the lower position tap on the condensate collector box and gray port (negative) to higher tap of condensate box. [add the following in warning box]: The manufacturer's default setting is for upflow and horizontal right installations only. For horizontal left installation, hoses for overflow switch are required to switch (see horizontal left installation). Connecting hoses incorrectly will result in failure to protect condensate overflow.

13.7 Pressure Switches

The pressure switches are normally open, negative air pressure activated switches. They monitor the airflow (combustion air and flue products) through the heat exchanger via pressure taps located on the induced draft blower. These switches guard against insufficient airflow (combustion air and flue products) through the heat exchanger.

13.8 Flame Sensor

The flame sensor is a probe mounted to the burner/manifold assembly which uses the principle of flame rectification to determine the presence or absence of flame.



WARNING: FIRE, EXPLOSION, OR CARBON MONOXIDE POISONING HAZARD

- ▶ Replace ONLY with the same model number or as specified by the manufacturer.

14 Troubleshooting

14.1 Electrostatic Discharge (ESD) Precautions

NOTICE:

- Discharge body's static electricity before touching unit. An electrostatic discharge can adversely affect electrical components.

Use the following precautions during furnace installation and servicing to protect the integrated control module from damage. By putting the furnace control and the person at the same electrostatic potential these steps will help avoid exposing the integrated control module to electrostatic discharge. This procedure is applicable to both installed and uninstalled (ungrounded) furnaces.

1. Disconnect all power to the furnace. Do not touch the integrated control module or any wire connected to the control prior to discharging your body's electrostatic charge to ground.
2. Firmly touch a clean, unpainted metal surface of the furnace away from the control. Any tools held in a person's hand during grounding will be discharged.
3. Service integrated control module or connecting wiring following the discharge process in step 2. Use caution not to recharge your body with static electricity; (i.e., do not move or shuffle your feet, do not touch ungrounded objects, etc.). If you come in contact with an ungrounded object, repeat step 2 before touching control or wires.
4. Discharge your body to ground before removing a new control from its container. Follow steps 1 through 3 if installing the control on a furnace. Return any old or new controls to their containers before touching any ungrounded object.

14.2 Resetting From Lockout

Furnace lockout results when a furnace is unable to achieve ignition after three attempts. It is characterized by a non-functioning furnace, refer to the Troubleshooting chart (pg 50-51) which describes what errors LED flashes correspond to. If the furnace is in "lockout" it will (or can be) reset in any of the following ways.

1. Automatic reset. The integrated control module will automatically reset itself and attempt to resume normal operations following a one hour lockout period.
2. Manual power interruption. Interrupt 115 volt power to the furnace for 1 - 20 seconds.
3. Manual thermostat cycle. Lower the thermostat so that there is no longer a call for heat for 1 - 20 sec.



If the condition which originally caused the lockout still exists, the control will return to lockout. Refer to the Troubleshooting Chart (Table 24-26) on the following page for aid in determining the cause.



WARNING: FIRE, EXPLOSION AND ASPHYXIATION HAZARD

- Installation and service must be performed by a qualified service agency or the gas supplier.

14.3 Troubleshooting Chart

Refer to the troubleshooting chart on the following pages for assistance in determining the source of unit operational problems. The red diagnostic LED blinks to assist in troubleshooting the unit. The number of blinks refers to a specific code (See Tables 25 & 26).

Symptoms of Abnormal Operation	Associated LED	Fault Description(s)	Possible Reason	Corrective Action	Cautions And Notes
Furnace fails to operate	NONE	<ul style="list-style-type: none"> No 115 volt power to furnace, or no 24 volt power to integrated control module Blown fuse or circuit breaker Integrated control module has an internal fault 	<ul style="list-style-type: none"> Door switch open, or 24 volt wires improperly connected or loose. Blown fuse or circuit breaker Integrated control module has an internal fault 	<ol style="list-style-type: none"> Assure 115 and 24 volt power to furnace's integrated control module. Check integrated control module's fuse (3A). Replace if necessary. Check for possible shorts in 115 and 24 volt circuits. Repair as necessary OR replace bad integrated control module. 	<ul style="list-style-type: none"> Turn power OFF prior to repair. Replace integrated control module's fuse with 3A automotive fuse. Read precautions in Electrostatic Discharge section of manual.
Furnace fails to operate	1 FLASH	<ul style="list-style-type: none"> Flame sensed with gas valve off 	<ul style="list-style-type: none"> Short to ground in flame sense circuit. 	<ol style="list-style-type: none"> Correct short at flame sensor or in flame sensor wiring 	<ul style="list-style-type: none"> Turn power OFF prior to repair.
Furnace fails to operate	2 FLASH	<ul style="list-style-type: none"> Pressure switch closed with inducer off 	<ul style="list-style-type: none"> Induced draft blower pressure switch contacts "stuck". Shorts in pressure switch circuit. 	<ol style="list-style-type: none"> Replace induced draft blower's pressure switch. Repair short. 	<ul style="list-style-type: none"> Turn power OFF prior to repair. Replace pressure switch with proper replacement part.
Induced draft blower runs continuously with no further furnace operation.	3 FLASH 6 FLASH 13 FLASH	<ul style="list-style-type: none"> Low fire pressure switch open with inducer on Pressure switch cycle lockout High fire pressure switch open with high inducer on 	<ul style="list-style-type: none"> Pressure switch hose blocked, pinched or connected improperly, blocked flue, or weak induced draft blower. Incorrect pressure switch setpoint or malfunctioning switch contacts. Loose or improperly connected wiring. 	<ol style="list-style-type: none"> Inspect pressure switch hose. Repair if necessary. Inspect flue for blockage, proper length, elbows, and termination. Replace pressure switch. Tighten or correct wiring connection. 	<ul style="list-style-type: none"> Turn power OFF prior to repair. Replace pressure switch with proper replacement part.
Furnace fails to operate.	4 FLASH 5 FLASH 11 FLASH	<ul style="list-style-type: none"> Limit/Rollout switch open less than 5 mins Limit/Rollout switch open more than 15 mins Limit/Rollout switch open from 5 to 15 mins 	<ul style="list-style-type: none"> Faulty chamber limit switch or fan mounted limit switch. Insufficient conditioned air over the heat exchanger. Blocked filters, restrictive ductwork, improper circulator blower speed or failed circulator blower Misaligned burners, blocked flue, or failed induced draft blower. Faulty rollout switch - resettable. Faulty inducer. Loose or improperly connected wiring. 	<ol style="list-style-type: none"> Check chamber limit switch or fan mounted limit switch. Replace if necessary. Check filters and ductwork for blockage. Clean filters or remove obstruction. Check circulator blower speed and performance. Correct speed or replace blower if necessary. Check burners for proper alignment. Check flue and air inlet piping for blockage, proper length, elbows and termination. Correct as necessary. Check rollout switch - resettable. Replace if necessary. Check induced draft blower for proper performance. Replace if necessary. Tighten or correct wiring connection. 	<ul style="list-style-type: none"> Turn power OFF prior to repair. Replace pressure switch with proper replacement part.

Table 25 Troubleshooting Chart

Symptoms of Abnormal Operation	Associated LED	Fault Description(s)	Possible Reason	Corrective Action	Cautions And Notes
RED					
Furnace fails to operate	7 FLASH 8 FLASH	<ul style="list-style-type: none"> — Lockout due to failed ignition — Lockout due to too many flame dropouts 	<ul style="list-style-type: none"> — The gas valve switched off — Ignitor failure — Orifices are blocked/clogged — Flame sensor dirty or broken — Furnace improperly grounded — Manifold gas pressure does not meet the requirement — Inlet gas pressure does not meet the requirement 	<ol style="list-style-type: none"> 1. Turn the gas valve switch to "On" 2. Replace ignitor 3. Remove the blockage 4. Clean with steel wool.or replace the flame sensor. 5. Properly ground the wire 6. Adjust the gas valve. Replace the gas valve. 7. Check incoming gas supply quality. Adjust the inlet gas pressure to meet requirement on nameplate. 	<ul style="list-style-type: none"> — Turn power OFF prior to repair.
Furnace fails to operate	9 FLASH	<ul style="list-style-type: none"> — Incorrect line voltage polarity 	<ul style="list-style-type: none"> — Wrong L1/L2 connection 	<ol style="list-style-type: none"> 1. Correct the wire connection 	<ul style="list-style-type: none"> — Turn power OFF prior to repair.
Furnace fails to operate	10 FLASH	<ul style="list-style-type: none"> — Gas valve fault code 	<ul style="list-style-type: none"> — Valve receives voltage from a short — Control module failure 	<ol style="list-style-type: none"> 1. Correct the wire connection 2. Replace control module 	<ul style="list-style-type: none"> — Turn power OFF prior to repair.
Furnace fails to operate	SOLID	<ul style="list-style-type: none"> — Control failure 	<ul style="list-style-type: none"> — Control module failure 	<ol style="list-style-type: none"> 1. Replace control module 	<ul style="list-style-type: none"> — Turn power OFF prior to repair.
AMBER					
Normal Operation	1 FLASH	<ul style="list-style-type: none"> — Call for heat active 	—	—	—
Normal Operation	4 FLASH	<ul style="list-style-type: none"> — Y thermostat demand without G 	<ul style="list-style-type: none"> — G wire not connected properly — Thermostat failure 	<ol style="list-style-type: none"> 1. Correct the wire connection 2. Replace thermostat 	—
Abnormal furnace operation	RAPID	<ul style="list-style-type: none"> — Low flame sense current 	<ul style="list-style-type: none"> — Flame sensor is coated/oxidized — Flame sensor is incorrectly positioned in the burner flame. — Lazy burner flame due to improper gas pressure or combustion air. 	<ol style="list-style-type: none"> 1. Clean/sand flame sensor with steel wool. 2. Inspect for proper sensor alignment. 3. Compare current gas pressure to rating plate info. Adjust as needed. 	<ul style="list-style-type: none"> — Turn power OFF prior to repair. — Clean flame sensor with steel wool. — See Section 8 for piping details. — See rating plate for proper gas pressure.
GREEN					
Abnormal furnace operation	RAPID	<ul style="list-style-type: none"> — Control in Factory Test mode 	<ul style="list-style-type: none"> — Control board error — Control module failure 	<ol style="list-style-type: none"> 1. Restart furnace 2. Replace control module 	<ul style="list-style-type: none"> — Turn power OFF prior to repair.
Normal Operation	1 FLASH	<ul style="list-style-type: none"> — Standby mode 	—	—	—

Table 26 Troubleshooting Chart

15 Service and Maintenance Procedures



WARNING: ELECTRICAL SHOCK, FIRE OR EXPLOSION HAZARD

Improper servicing could result in dangerous operation, serious injury, death or property damage.

- ▶ Before servicing, disconnect all electrical power to furnace.
- ▶ When servicing controls, label all wires prior to disconnecting. Reconnect wires correctly.
- ▶ Verify proper operation after servicing.



WARNING: FIRE, EXPLOSION OR CARBON MONOXIDE POISONING HAZARD

- ▶ Failure to replace with proper control could result in fire, explosion or carbon monoxide poisoning.
- ▶ Replace **ONLY** with the same model number or as specified by the manufacturer.

15.1 Annual Inspection

The furnace must be inspected by a qualified installer or service agency at least once per year. Inspect the furnace at the beginning of the heating season. This will ensure that all furnace components are in proper working order and that the heating system functions appropriately. Pay particular attention to the following items. Repair or service as necessary.

- a. All flue gas carrying areas external to the furnace (i.e. chimney, vent connector, vent pipe) are clear and free of obstructions.
- b. Check for any loose wiring, and correct as needed.
- c. Inspect heat exchangers and blowers for corrosion, deterioration, or deposits of debris. Remove any obstructions.
- d. The vent connector is in place, slopes upward and is physically sound without holes or excessive corrosion.
- e. The return-air duct connection(s) is physically sound, is sealed to the furnace cabinet, and terminates outside the space containing the furnace.
- f. The physical support of the furnace is sound without sagging, cracks, gaps, etc. around the base so as to provide a seal between the support and the base.
- g. There are no obvious signs of deterioration of the furnace.
- h. The pilot and burner flames are in good adjustment (by comparison with pictorial sketches or drawings of the main burner flame and, if applicable, the pilot burner flame, refer to the Installation, Operation, and Maintenance Manual for more information).
- i. Check the condensate drain and trap for leaks and cracks. Fill the trap with water. Clean the drain and trap. The trap must be filled with water and the drain and trap should be cleaned.

15.2 Filters

A return air filter is not supplied with this furnace; however, there must be a means of filtering the return air. The installer must supply filter(s) at the time of installation.

Filter maintenance

Improper filter maintenance is the most common cause of inadequate heating or cooling performance. Clean permanent filter or replace disposable filter once a month or more frequently as required. When replacing a filter, it must be replaced with a filter of the same type and size.

Become familiar with filter location and procedures for removal, cleaning and replacing them. If help is needed, contact the installer of the furnace or a qualified service person.

Filter removal

Depending on the installation, differing filter arrangements can be applied. A media air filter or electronic air cleaner can be used as an alternate filter.

Follow the filter sizes given in the Recommended Minimum Filter size (Table 2, page 22) to ensure proper unit performance.

For further details, see your distributor.

Upright filter removal

To remove filters from an external filter rack in an upright upflow installation, follow the directions provided with external filter rack kit.

Clean, wash and dry a permanent filter. When using a permanent filter, both sides should be sprayed with a dust adhesive as recommended on the adhesive container. Spray adhesives for use with permanent filters can be found at some hardware stores. **BE SURE AIRFLOW DIRECTION ARROW POINTS TOWARDS THE BLOWER.**

Inspect filter. If your dirty filter is the disposable type, replace dirty filter with the same type and size filter. If your dirty filter is a permanent filter, clean as follows:

- ▶ Clean, wash, and dry a permanent filter. When using a permanent filter, both sides should be sprayed with a dust adhesive as recommended on the adhesive container.
- ▶ If badly torn or uncleanable, these filters must be replaced by equal size permanent, high velocity filters. Throwaway filters must not be used as replacement for permanent filters.

15.3 Induced Draft And Circulating Blower Motors

The bearings in the induced draft blower and circulator blower motors are permanently lubricated by the manufacturer. No further lubrication is required. Check motor windings for accumulation of dust which may cause overheating. Clean as necessary.

15.4 Flame Sensor (Qualified Service Technicians Only)

Under some conditions, the fuel or air supply can create a nearly invisible coating on the flame sensor. This coating acts as an insulator causing a drop in the flame sense signal. If the flame sense signal drops too low, the furnace will not sense the flame and will lock out. The flame sensor should be carefully cleaned by a qualified service technician using emery cloth or steel wool. Following cleaning, the flame sense signal should be 1 to 6 microamps at 115 volts.

15.5 Ignitor (Qualified Service Technicians Only)

If the ignitor and the surrounding air are at about 70°F and the ignitor wires are not connected to any other electrical components, the resistance of the ignitor should not exceed 200 ohms. If it does, the ignitor should be replaced.

15.6 Burners



WARNING: FIRE, EXPLOSION, ELECTRICAL SHOCK OR CARBON MONOXIDE POISONING HAZARD

- ▶ To avoid personal injury or death. Do not remove any internal compartment covers or attempt any adjustment. Electrical components are contained in both compartments. Contact a qualified service agent at once if an abnormal flame appearance should develop.

Periodically during the heating season, perform a visual check of the burner flames. Turn the furnace on at the thermostat. Wait a few minutes, since any dislodged dust will alter the normal flame appearance. Flames should be stable, quiet, soft and blue with slightly orange tips. They should not be yellow. They should extend directly outward from the burner ports without curling downward, floating or lifting off the ports. See Figure 40 (page 48). Contact a qualified service agent at once if an abnormal flame appearance should develop or the burners have a heavy accumulation of soot and carbon.



WARNING:

- ▶ Only a qualified contractor, installer or service agency can clean the burners.

15.7 Inspecting the Heat Exchanger (Qualified Service Technicians Only)

NOTICE:

- ▶ If the heat exchangers get a heavy accumulation of soot and carbon, they must be replaced rather than cleaning them. A heavy build-up of soot and carbon indicates that a problem exists which needs to be corrected, such as improper adjustment of manifold pressure, insufficient or poor quality combustion air, incorrect size or damaged manifold orifice(s), improper gas, or a restricted heat exchanger. In these scenarios, the heat exchanger must be replaced.

Inspect the heat exchanger for excessive rust, cracks, or holes. Visual inspection is always best, but requires training and practice. There are tools (field supplied) available to assist, such as inspection cameras and dye penetration inspection systems. Inspect the metal flue for rust or holes, and make sure it's supported properly.

15.8 Condensate Drain

- ▶ Inspect all condensate drain tubes and condensate trap assembly for leaks and proper drainage.

15.9 Repair and Replacement Parts

- ▶ When ordering any of the listed functional parts, be sure to provide the furnace model and serial numbers with the order.
- ▶ Parts are available from your distributor.
- ▶ Flame sensors and ignitors are considered serviceable items.

16 Before Leaving Installation

- ▶ Cycle the furnace with the thermostat at least three times. Verify cooling (if applicable) and fan only operation.
- ▶ Review the manual with the homeowner and discuss proper furnace operation and maintenance.
- ▶ Leave literature packet near furnace.

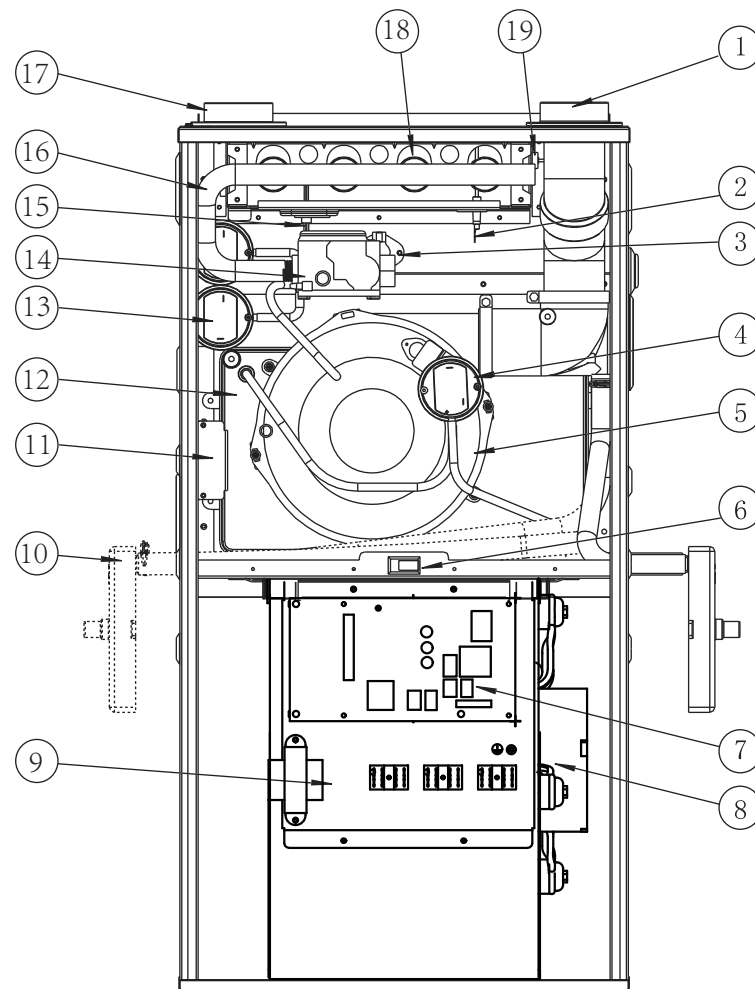


Figure 41

COMPONENT IDENTIFICATION:

- | | |
|-------------------------------|--------------------------|
| 1. Outlet Flue Vent | 12. Condensate Collector |
| 2. Flame Sensor | 13. Pressure Switch |
| 3. Chamber Limit Switch-Fixed | 14. Two-Stage Gas Valve |
| 4. Condensate Overflow Switch | 15. Hot Surface Ignitor |
| 5. Inducer | 16. Gas Manifold |
| 6. Door Switch | 17. Air Inlet |
| 7. Integrated Control Module | 18. Burner |
| 8. Blower | 19. Rollout Limit Switch |
| 9. Transformer | |
| 10. Condensate Trap | |
| 11. Junction Box | |

Please contact your local installer or dealer for replacement parts.

17 Wiring Diagram

Wiring is subject to change. Always refer to the wiring diagram on the unit for the most up-to-date schematic.



High Voltage:
Disconnect all power before servicing or installing this unit. Multiple power sources may be present. Failure to do so may cause property damage, personal injury, or death.

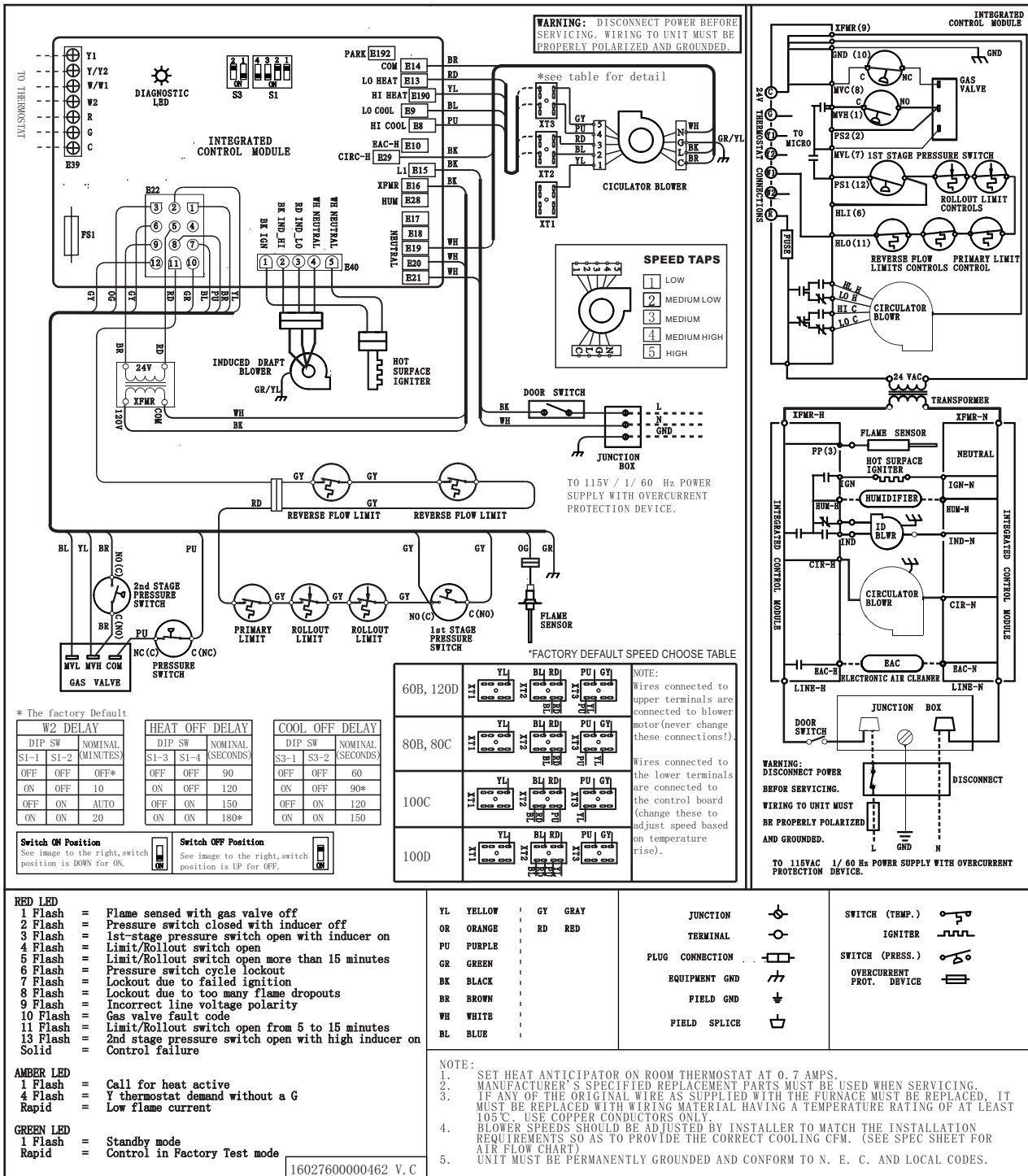


Figure 42

United States and Canada

Bosch Thermotechnology Corp.
65 Grove Street
Watertown, MA 02472

Tel: 866-642-3198
Fax: 603-965-7581
www.boschheatingandcooling.com