CleaverBrooks

Model CFC

ClearFire
Condensing Boiler

Operation, Service, and Parts

Manual Part No. 750-263 04/2012

⚠ WARNING

If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

— 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.
- 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 Cleaver-Brooks, service agency or the gas supplier.

⚠ WARNING

To minimize the possibility of serious personal injury, fire or damage to the equipment, never violate the following safety rules.

— Always keep the area around the boiler free of combustible materials, gasoline, and other flammable liquids and vapors

— Never cover the boiler, lean anything against it, stand on it or in any way block the flow of fresh air to the boiler.

Notice

Where required by the authority having jurisdiction, the installation must conform to the Standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1.

⚠ WARNING

Improper installation, adjustment service or maintenance can cause equipment damage, personal injury or death. Refer to the Operation and Maintenance manual provided with the boiler. Installation and service must be performed by a qualified Cleaver-Brooks service provider.

⚠ WARNING

Be sure the fuel supply which the boiler was designed to operate on is the same type as specified on the boiler name plate.

⚠ WARNING

Should overheating occur or the gas supply valve fail to shut off. **Do not** turn off or disconnect the electrical supply to the boiler. Instead turn off the gas supply at a location external to the boiler.

⚠ WARNING

Do not use this boiler if any part has been under water. Immediately call your Cleaver-Brooks service representative to inspect the boiler and to replace any part of the control system and any gas control which has been under water.

Notice

This manual must be maintained in legible condition and kept adjacent to the boiler or in a safe place for future reference. Contact your local Cleaver-Brooks representative if additional manuals are required.

⚠ WARNING

A hot water boiler installed above radiation level or as required by the Authority having jurisdiction, must be provided with a low water cutoff device either as a part of the boiler or at the time of boiler installation.

⚠ WARNING

The installation must conform to the requirements of the authority having jurisdiction or, in the absence of such requirements, to the National Fuel Gas Code, ANSI Z223.1 and/or CAN/CSA B149 Installation Codes.

⚠ WARNING

The boiler and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of 1/2 psi (3.5 kPa).

WARNING

DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

DO NOT ALLOW OTHERS TO OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS THEY FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

TO: Owners, Operators and/or Maintenance Personnel

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

It is the responsibility of the owner to train and advise not only his or her personnel, but the contractors' personnel who are servicing, repairing or operating the equipment, in all safety aspects.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in handling and firing of fuel.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely free him of certain repetitive chores and give him more time to devote to the proper upkeep of equipment.

It is solely the operator’s responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Because of state, local, or other applicable codes, there are a variety of electric controls and safety devices which vary considerably from one boiler to another. This manual contains information designed to show how a basic burner operates.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage and, in most cases, these conditions can be traced directly to carelessness and deficiencies in testing and maintenance.

It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly and yearly maintenance activities and recording of any unusual operation will serve as a valuable guide to any necessary investigation.

Most instances of major boiler damage are the result of operation with low water. We cannot emphasize too strongly the need for the operator to periodically check his low water controls and to follow good maintenance and testing practices. Cross-connecting piping to low water devices must be internally inspected periodically to guard against any stoppages which could obstruct the free flow of water to the low water devices. Float bowls of these controls must be inspected frequently to check for the presence of foreign substances that would impede float ball movement.

The waterside condition of the pressure vessel is of extreme importance. Waterside surfaces should be inspected frequently to check for the presence of any mud, sludge, scale or corrosion.

The services of a qualified water treating company or a water consultant to recommend the proper boiler water treating practices are essential.

The operation of this equipment by the owner and his or her operating personnel must comply with all requirements or regulations of his insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.

TABLE OF CONTENTS

Section 1 — Introduction

Section 2 — Installation

Section 3 — Stack and Intake Vent Sizing and Installation

Section 4 — Commissioning

Section 5 — Service and Maintenance

Section 6 — Parts

Appendix A — CB Falcon Hydronic Control

Appendix B — CB Falcon Display/Operator Interface

Appendix C — CB Falcon Plug-In Module

Appendix D — Gas Valve

Appendix E — CB Falcon Lead Lag Operation

Appendix F — CB Falcon Modbus Communication

Section 1
Introduction

A. CFC FEATURES AND BENEFITS

Figure 1-1 CFC Boiler

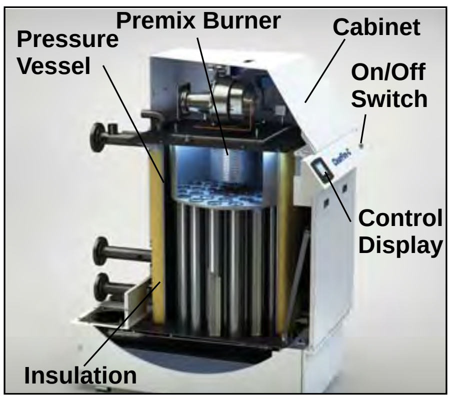


Figure 1-2 CFC Cutaway

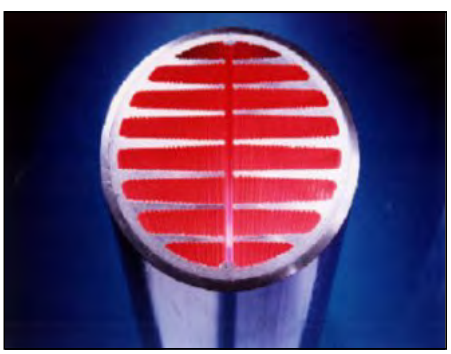


Figure 1-3 AluFer Tube Cross Section

Compact Firetube Design

The CFC boiler is a single pass down fired durable Firetube boiler. The extended heating surface tubes provide for very high levels of performance in a compact space. The boiler is designed to fire natural gas or propane.

High Efficiency

With the extended heating surface tubes the boiler can produce fuel to water efficiency of up to 99% depending upon operating conditions.

Advanced Construction

Constructed to ASME standards, the CFC Boiler will provide many years of trouble free service. Single-pass design provides excellent thermal shock protection.

Tubes are made from UNS S32101 Duplex Stainless Steel with AluFer extended heating surface inserts for maximum heat transfer.

Dual Temperature Return

Two return pipes - high and low temperature - allow condensing performance with as little as 10% return water at condensing temperature.

Ease of Maintenance

The steel enclosures are readily removable for access to all key components. A flip down step (or ladder on size 3300) and hinged burner door provide access to all key components.

Quality Construction

ASME construction ensures high quality design, safety, and reliability.

ISO 9001 certified manufacturing process ensures the highest degree of manufacturing standards is always followed.

Full Modulation

The burner and combustion fan modulate to provide only the amount of heat required, providing quiet and efficient operation under all conditions.

Premix Technology

The ClearFire-C Boiler utilizes "Premix" technology to mix both fuel and combustion air prior to entering the firing chamber. This technology provides clean, efficient combustion with very low emission levels.

Designed For Heating Applications

The pressure vessel is constructed of durable ASTM Graded Steel and Stainless Steel materials to provide many years of operating life.

The vessel is designed to prevent hot spots and has no minimum flow requirements; required for vessel stress protection.

B. STANDARD EQUIPMENT

1. The Boiler

The boiler is designed for a Maximum Allowable Working Pressure (MAWP) of 125 psig (8.6 Bar) in accordance with the ASME Code for Low Pressure Section IV Hot Water Boilers and is stamped accordingly. Operating pressure shall be less than 112 psig (7.7 Bar).

The vessel is mounted on a steel base with insulation & casing provided including trim and controls. Trim and controls include safety relief valve, pressure/temperature gauge, probe type low water control, and CB Falcon hydronic boiler control with associated sensors.

2. The Burner (See Figure 1-4)

Incorporating "premix" technology, the burner utilizes a venturi, dual safety shutoff-single body gas valve, variable speed blower, and Fecralloy metal fiber burner head.

Integral variable speed combustion air fan provides 5:1 turndown.

Combustion canister of the burner is constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame, which provides low emissions.

At maximum firing rate, the sound level of the burner is less than 70 dBA, measured in front of the boiler at a distance of 3 feet.

Provision for direct vent combustion is furnished.

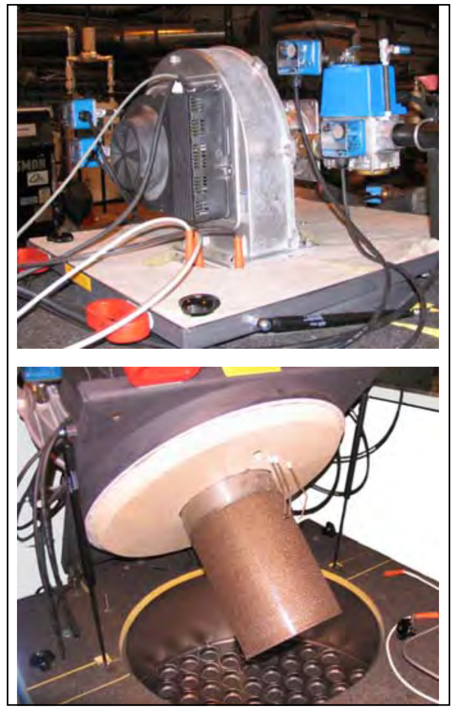


Figure 1-4 Burner

3. Burner Gas Train (See Figure 1-5 & Figure 1-6)

The gas train assembly is provided in accordance with UL certification and complies with ASME CSD-1. The gas train assembly is factory assembled and wired, consisting of the following components:

A. Low Gas Pressure Switch - manual reset
B. High Gas Pressure Switch - manual reset
C. Single body, dual safety shutoff gas valve with integral trim regulator
D. Integral Venturi
E. Manual Shutoff Ball Valve
F. CSD-1 Test Cocks

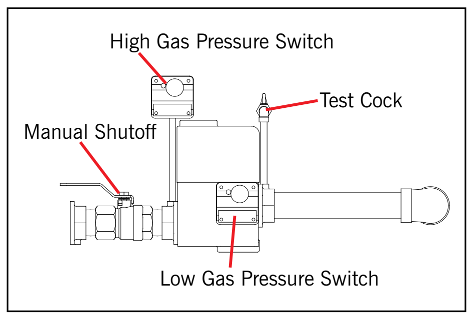


Figure 1-5 Standard Gas Train

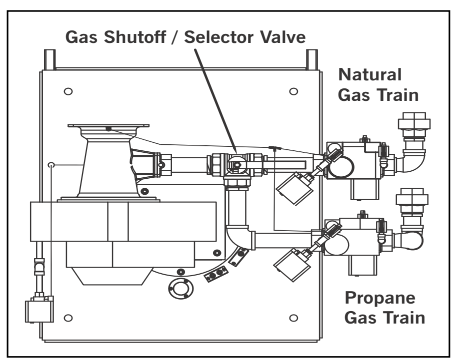


Figure 1-6 Optional dual gas train

4. Control (See Figure 1-7)

The CB Falcon hydronic control is an integrated burner management and modulation control with a touch-screen display/operator interface.

The controller is capable of the following functions:

- Two (2) heating loops with PID load control.
- Burner sequencing with safe start check, pre-purge, direct spark ignition, and post purge.
- Electronic ignition.
- Flame Supervision.
- Safety shutdown with time-stamped display of lockout condition.
- Variable speed control of the combustion fan.
- Supervision of low and high gas pressure, air proving, stack back pressure, high limit, and low water.
- First-out annunciator.
- Real-time data trending.
- (3) pump/auxiliary relay outputs.
- Modbus communication capability.
- Outdoor temperature reset.
- Remote firing rate or setpoint control
- Setback/time-of-day setpoint
- Lead/Lag for up to 8 boilers

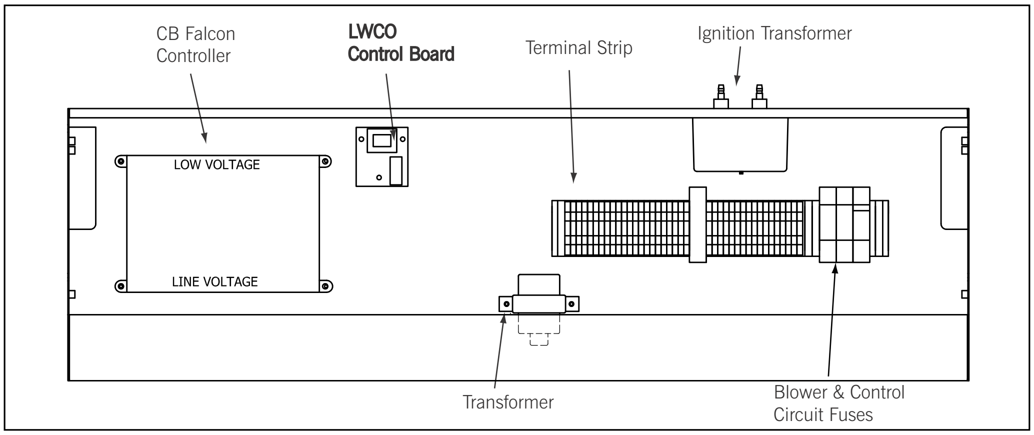


Figure 1-7 Control panel interior (1500/1800 shown)

5. Component/Connection Locations

Figure 1-8 shows the CFC component orientation and heat flow path. Note the downfired design of the burner and the orientation of the hot water outlet and return connections. The return water connection is at the bottom of the vessel and the hot water outlet is near the top.

Figure 1-9 shows the locations of the safety valve and air vent connection. **Figure 1-10** shows the location of the return water temperature sensor. Looking at the top of the boiler, near the rear, **Figure 1-11** shows the three hole sensor well for the outlet temperature sensor.

When standing at the back of the boiler, the stack can be connected on the right side of the boiler (**Figure 1-12**) or on the left side. Refer to Chapter 3 of this manual for recommended vent sizes and lengths for the specific boiler installation.

6. Optional Equipment

Certain project-specific options may have been supplied with the boiler if these options were specified at the time of order entry. In addition, some options may have been provided (by others) that are not part of Cleaver-Brooks' scope of supply. In either case, the Cleaver-Brooks authorized representative should be consulted for project specifics.

These are the options that are available for the CFC boiler from Cleaver-Brooks:

A. Dual gas train for quick and easy fuel switchover.
B. Reusable air filter.
C. Condensate neutralization tank assembly - consists of neutralizing media, filter, and PVC condensate holding tank with integral drain trap. This assembly is mounted beneath the boiler and is further described in Chapter 2.
D. Outside air intake for direct vent combustion.
E. Outdoor temperature sensor for indoor/outdoor control.
F. Header temperature sensor for multiple boiler Lead/Lag operation.
G. Auxiliary Low Water Control (shipped loose) for field piping by others into the system piping.
H. Alarm Horn for safety shutdown.
I. Relays for output signal for burner on, fuel valve open.
J. Stack Thermometer.
K. Stack temperature limit-sensor.
L. Auto air vent.
M. Boiler drain valve.

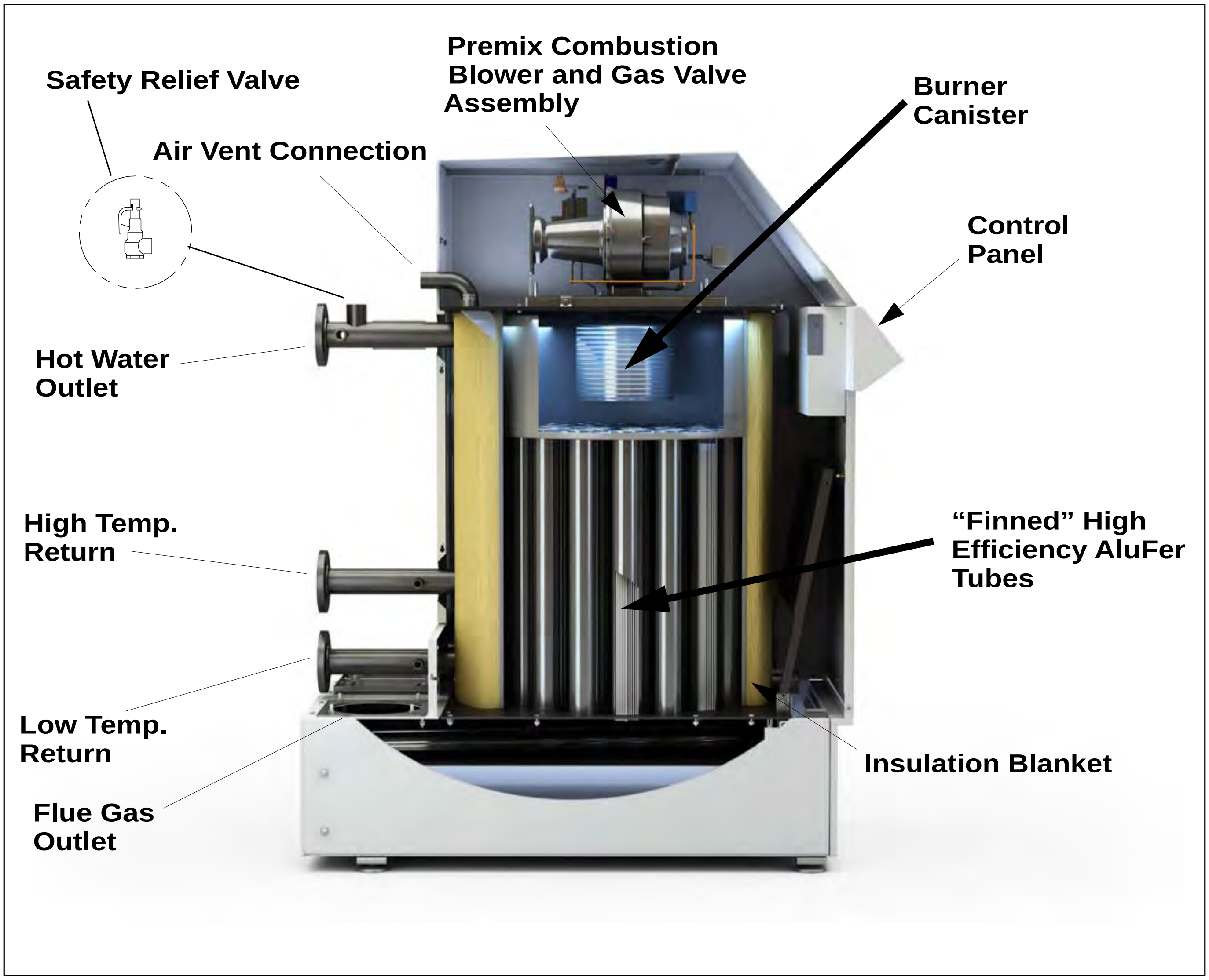


Figure 1-8 CFC Cutaway View

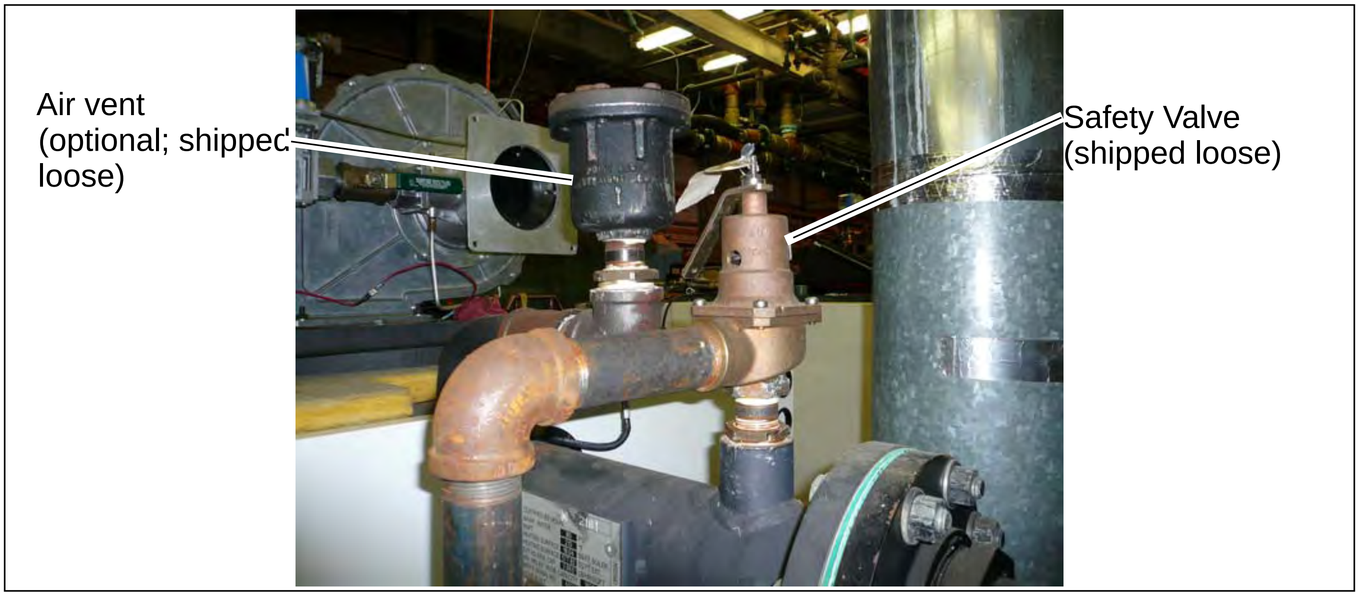


Figure 1-9 Boiler safety valve & air vent

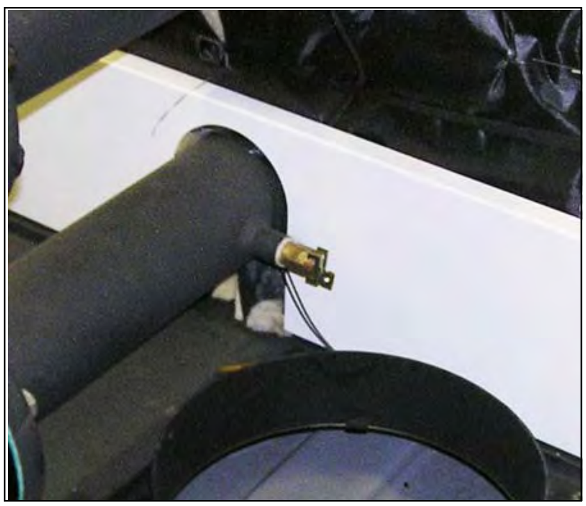


Figure 1-10 Return Temperature Sensor Mounting

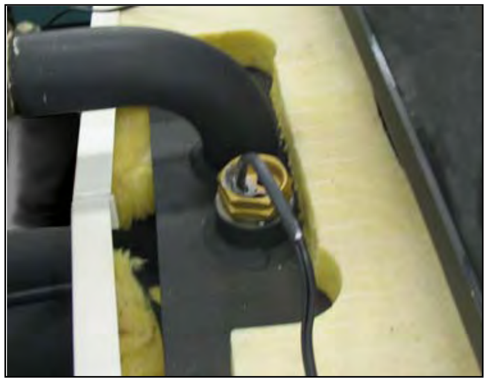


Figure 1-11 Outlet Temperature Sensor, Top of Pressure Vessel

The stack can be mounted on the right (**Figure 1-12**) or left side on the back of the boiler base.

The flue gas duct sizes may be reduced at the vent connection.

See also **Chapter 3 - Stack and Intake Vent Sizing and Installation**.

Figure 1-12 Stack Right Side (viewed from rear)

Section 2

Installation

⚠ Warning

Provisions for combustion and ventilation air must be in accordance with the National Fuel Gas Code, ANSI Z223.1, or the CAN/CSA B149 Installation Codes, or applicable provisions of the local building codes. *Failure to follow this warning could result in personal injury or death.*

Caution

The boiler must be installed such that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and sevice. Failure to follow this warning could result in equipment failure.

⚠ Warning

If an external electrical source is utilized, the boiler when installed must be electrically bonded to ground in accordance with the requrements of the authority having jurisdiction, or in the absence of such requirements with the National Electrical Code ANSI/NFPA 70 and/or the Canadian Electrical Code Part I CSA C22.1.

⚠ Warning

The installation must conform to the requirements of the authority having jurisdiction, or in the absence of such requirements, to the National Fuel Gas Code, ANSI Z223.1 and/or CAN/CSA B149 Installation Codes.

A. ASSEMBLY

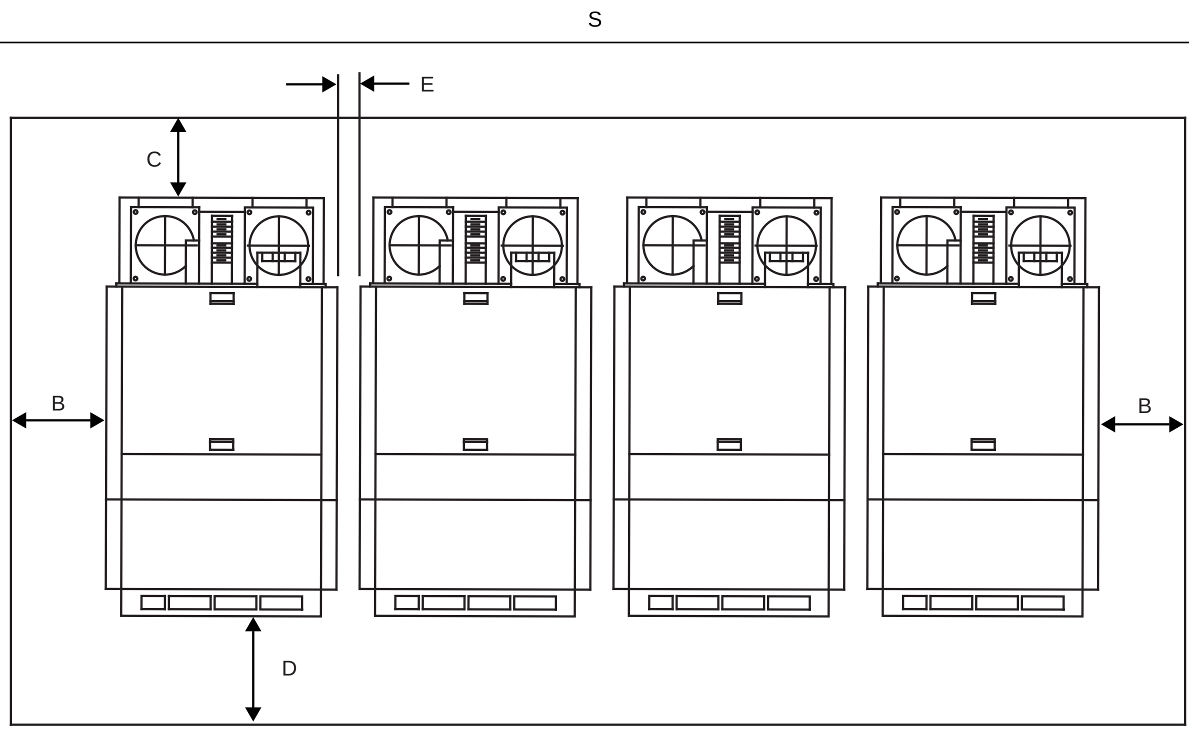
1. Packaging

The Cleaver-Brooks Model CFC boiler is shipped in three parcels. The pressure vessel assembly mounted on a skidded crate, the control panel in a box, and the outer casing with insulation in a skidded box. It is recommended that the pressure vessel be properly mounted with all piping connections attached prior to installation of the casing.

2. Boiler placement

The boiler or boilers should be mounted in a space in accordance with **Figure 2-1** below. Required front, rear, and side clearances are shown.

Note: If the boiler room is constructed with non-combustible walls, it is possible to install the units closer to the side walls, but the front and rear clearances must be maintained.



	DIM	Inches
Top Clearance	A	14
Side Clearance	B	20
Backway	C	20
Front	D	36
Between Boilers	E	3

Figure 2-1 Clearance Required

3. Casing assembly

To assemble the CFC casing, the following tools are required:

Figure 2-2

- Flat head screwdriver
- Phillips screwdriver
- Cordless screwdriver
- Utility knife
- Crescent wrench
- Machine head screw bit
- Diagonal cutters
- Fork lift or pallet jack
- Socket wrench
- 10mm socket
- 13mm socket
- 19mm socket
- 6” socket extension
- Zip-ties
- Sheet metal screws

1. Remove all packing material and open all boxes shipped with the boiler.
2. Remove all casing panels from box and group like pieces together for easy access.
3. Locate boiler legs and attaching nuts/bolts (**Figure 2-2**). Ensure all four (six on CFC 3300) leg height adjusters are at the same level before installing legs.
4. Remove the wooden skid cross beam from the front of the boiler
5. Using an appropriate jack, lift up the front of the boiler.

Note: A crane or fork lift may also be used to lift the boiler. When using a crane, observe the rigging arrangement shown in **Figure 2-3.** To install the boiler legs, first lift boiler, then remove and discard the wooden base. Install legs and position the boiler. Proceed with step 10 below.

CFC SIZE	500/750	1000	1500	1800	2500	3300
A	70.625”	82.875”	74.875”	82”	84”	92”
B	118.625”	130.875”	122.875”	130”	132”	140”
C	20.5”	33.5”	32.625”	32.625	37.375”	43.5”
D	3.15”	1.97”	2.76”	2.76	3.94”	6”
E	3.15”	1.97”	2.76”	2.76	3.94”	7”
F	20.5”	33.5”	32.625	32.625	37.375”	41.5”
G	1162 lbs	1796 lbs	2225 lbs	2504 lbs	3640 lbs	4836 lbs

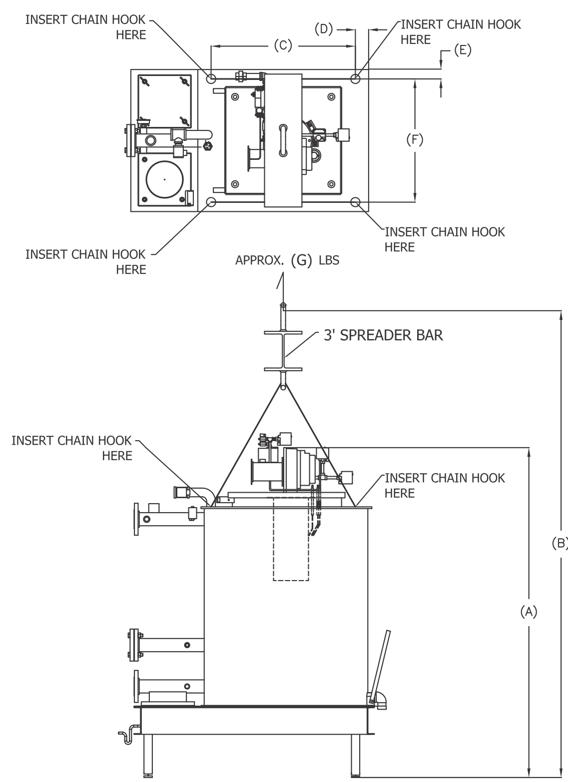


Figure 2-3 CFC Standard Rigging Arrangement

6. Attach the boiler front legs.
7. Lift up the back of the boiler using the jack and remove the wooden skid side beams.
8. Attach the rear boiler mounting legs.
9. Lifting eyes are provided for moving and positioning the boiler.
10. Before installing insulation, level the boiler using a level placed against the side of the vessel.
11. Wrap insulation blanket around pressure vessel. Ensure all pre-cut holes fit completely over boiler fittings (**Figure 2-4**) and blanket is snug to the vessel.
12. Peel backing from any excess length of insulation. Tuck excess portion under other end of blanket. Place backing over overlapping segments (**Figure 2-5**) and proceed with step 13.

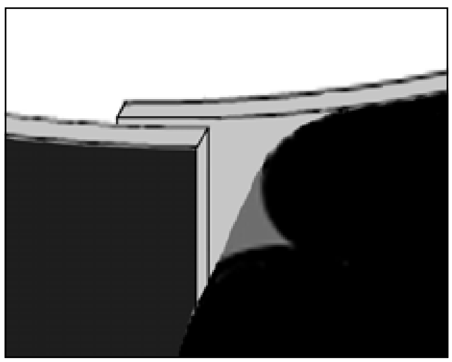


Figure 2-5

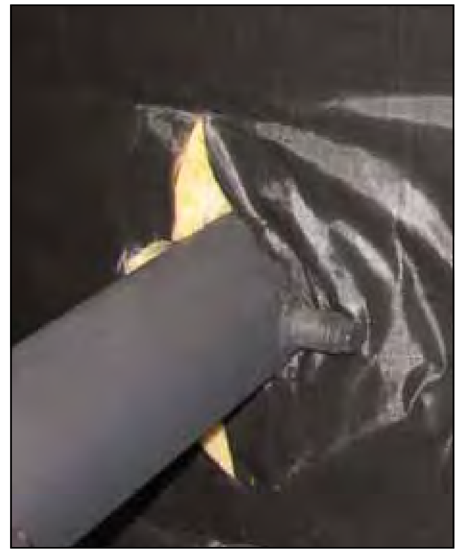


Figure 2-4

13. Use tension springs to hold edges of blanket together. Poke end of spring through the fabric of the insulation blanket (**Figure 2-6**). Place one spring at the top and one at the bottom of the blanket. Place the remaining two springs equally spaced.

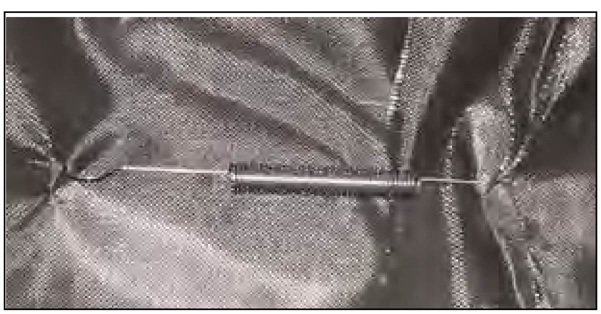


Figure 2-6

14. Fit one end of black plastic strap to the fastener (**Figure 2-7**). Wrap strap around the boiler and connect other end to fastener. Repeat with second strap. Tighten straps so blanket is snug, but do not overtighten. Do not compress insulation. Position the straps at ¼ and ¾ height.

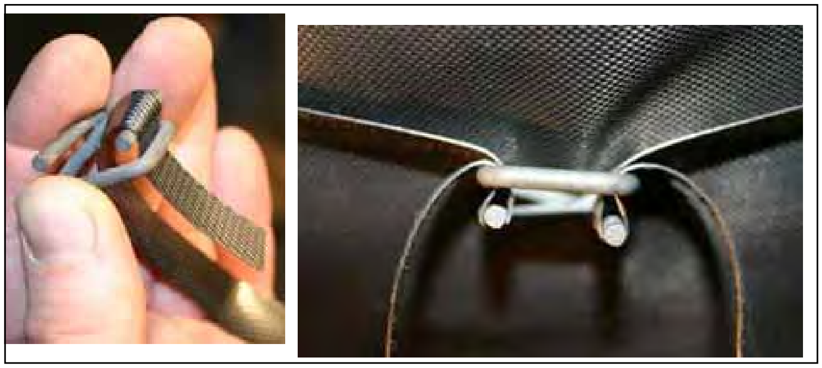


Figure 2-7

15. Using a 10mm socket, or by hand, remove 3 nuts and washers from the mounting studs extending from each side of the top plate of the boiler (**Figure 2-8**).

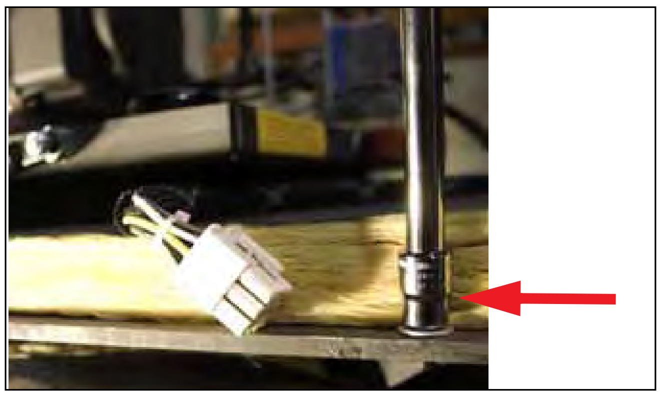


Figure 2-8

16. Attach electrical supply channels on each side (**Figure 2-9**).

Figure 2-9

17. Attach large side panels to each side, fitting on top of the electrical supply channel. Fasten loosely, using nuts and washers previously removed. Do not over tighten. You will need these panels to move slightly to fit the other pieces. See **Figure 2-10**.

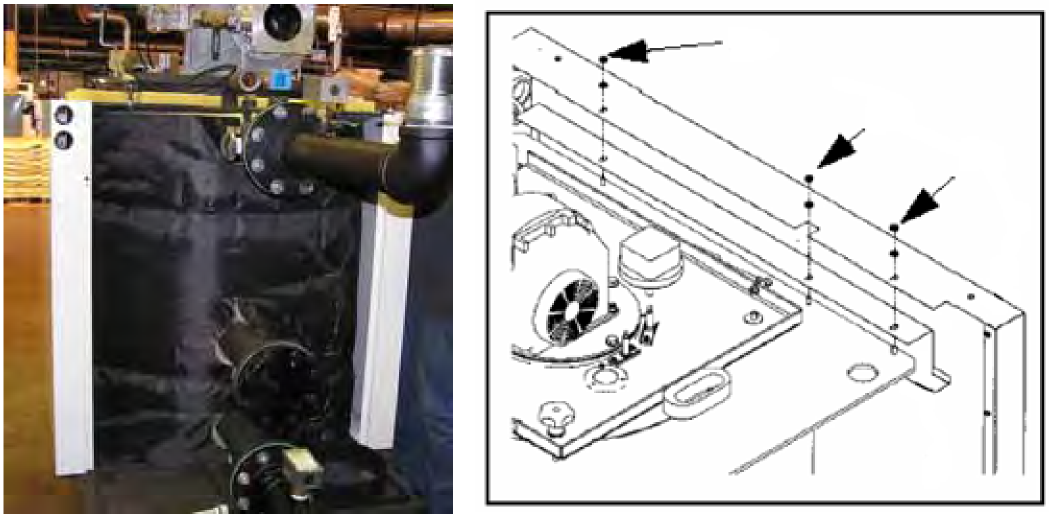


Figure 2-10

18.Remove control panel from box. Uncoil sensor wires and route wires out of left-hand side of panel.

19.Mount control panel on front of boiler (**Figure 2-11**). Make sure to route sensor wires in wiring channel on left-hand side of the boiler (see also **Figure 2-38**).

Figure 2-11

20.Connect control wiring (**Figure 2-12**):

- Connect flame rod cable (**A**) to stand alone electrode on right (includes burner ground connection). For UV scanner applications, mount the scanner to the burner assembly.
- Connect ignition cables (**B**) to dual igniter electrode. For pilot ignition applications, also connect the pilot solenoid valve cable (**C**) to the pilot valve.
- Connect remaining connectors per connection diagram (see **Figure 2-38**).

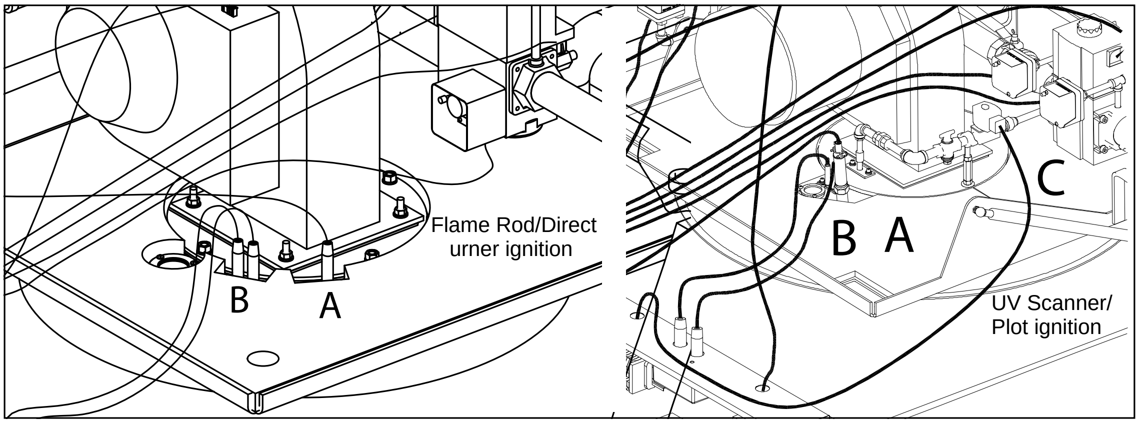


Figure 2-12

21. Route return water sensor (the 2-wire sensor) to the lower pipe on back of boiler, and install lower panel. Coat sensor with heat-conductive compound P/N 872-00631. Insert sensor into return pipe sensor well and secure with mounting clamp (**Figure 2-13**).

Figure 2-13

22. Coat outlet feed water temperature sensor (the 3-wire sensor) with heat-conductive compound P/N 872-00631. Insert sensor in sensor well behind the burner (**Figure 2-14**).

Figure 2-14

23.Install rear center panels (**Figure 2-15**).

Figure 2-15

24.Install C-clips on upper side panels, then install panels on boiler (**Figure 2-16**).

25.(CFC 3300 only) the main gas train and pilot train ship loose and should be connected before installing the casing top.

26.Install front panel and top panel.*

*Sizes 500/750 top/front is 1 piece.
*Size 3300 top is 2 pieces.

27.Attach side skirt panels to boiler legs using the supplied cap nuts (**Figure 2-17**).

Figure 2-16

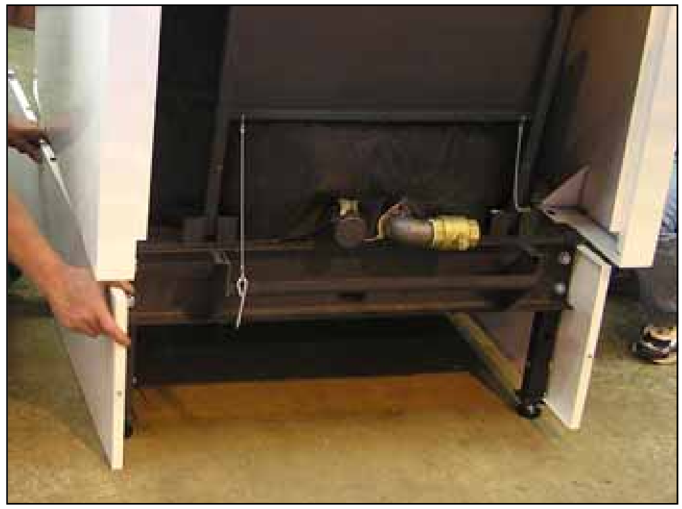


Figure 2-17

28.Attach front skirt panel to the side panels.

29.Install front panel.*

*Size 3300 front panel is 2 pieces.

Assembly is now complete.

Figure 2-18

B. FLUE GAS / COMBUSTION AIR CONNECTIONS

The flue gases from the Model CFC boiler should be removed via a gas-tight, temperature and corrosion resistant flue gas pipeline. Only flue gas systems approved and tested by the relevant region or province are to be connected to the boiler. Refer to flue piping manufacturer for proper installation and sealing instructions. See also Chapter 3 of this manual for combustion air and flue gas venting requirements.

C. WATER TREATMENT

Cleaver-Brooks ClearFire condensing boilers are suitable for heating systems without significant oxygenation capacity. Systems with continuous oxygenation capacity due to unknown or unseen leaks must be equipped with a system separation or pretreatment device.

Untreated drinking water is generally the best heating medium as filling and make-up water for a system that utilizes the Model CFC. If the water available from the main system is not suitable for use, then demineralization and/or treatment with inhibitors is necessary. Treated filling and make-up water must be checked at least once a year or more frequently if so specified in the application guidelines from the inhibitor manufacturer.

Those parts of the boiler in contact with water are manufactured with ferrous materials and corrosion-resistant stainless steel. The chloride content of the heating water must not exceed 30 mg/l and the pH level should be between 8.3 to 9.5 after six weeks of operation.

To maintain the boiler's efficiency and prevent overheating of the heating surfaces, the values in **Table 2-1** should not be exceeded. Water make-up during the lifetime of the boiler should not be greater than 3 times the system volume. A water meter should be installed on the feed line to monitor makeup water volume.

Following production of the pressure vessel, the interior surfaces are cleaned and therefore a pre-start boil out of the vessel is not needed. Should the system require boil out or cleaning after installation of the CFC, take care that no particulate matter reaches the boiler during the cleaning process. A removable filter should be used for this purpose.

Notice

Corrosion and sludge deposits in old systems must be removed prior to installation of a new boiler.

Table 2-1 Model CFC Water Chemistry

Parameter	Limit
pH	8.3 - 9.5
Chloride	30 mg/liter
Nitrates	50 mg/liter
Sulphates	50 mg/liter
Oxygen	0.1 mg/liter
Specific Conductivity	3500 umho/cm
Total Hardness	<10 ppm

Table 2-2 Model CFC Water Temperature Data (Non-Glycol)

Minimum supply temp.	33°F
Maximum operating temp.	194°F
Maximum design temp.	210°F

D. USING GLYCOL

The Model CFC boiler may be operated with a solution of glycol and water. Where glycols are added, the system must first be cleaned and flushed. Correct glycol selection and regular monitoring of the in-use concentration and its stability is essential to ensure adequate, long-term freeze protection, including protection from the effects of glycol-derived corrosion resulting from glycol degradation.

Typically, ethylene glycol is used for freeze protection, but other alternatives exist, such as propylene glycol. Glycol reduces the water-side heat capacity (lower specific heat than 100% water) and can reduce the effective heat transfer to the system. Because of this, design flow rates and pump selections should be sized with this in mind.

Generally, corrosion inhibitors are added to glycol systems. However, all glycols tend to oxidize over time in the presence of oxygen, and when heated, form aldehydes, acids, and other oxidation products. Whenever inadequate levels of water treatment buffers and corrosion inhibitors are used, the resulting water glycol mixture pH may be reduced to below 7.0 (frequently reaching 5) and acid corrosion results. Thus, when pH levels drop below 7.0 due to glycol degradation the only alternative is to drain, flush, repassivate, and refill with a new inhibited glycol solution.

The following recommendations should be adhered to in applying ClearFire model CFC boilers to hydronic systems using glycol:

1) Maximum allowable antifreeze proportion (volume %):
   50% antifreeze (glycol)
   50% water
2) The glycol concentration determines the maximum allowable firing rate and output of the boiler(s). Please refer to the firing rate limitation and corresponding high fire speed settings vs. glycol % in the charts below.
3) Maximum allowable boiler outlet/supply temperature: 185 deg F (85 deg C).
4) Minimum water circulation through the boiler:
   a) The minimum water circulation must be defined in such a way that the temperature difference between the boiler outlet/supply and inlet/return is a maximum of 40 deg F (22 deg C), defined as DT (Delta T). A DT Limit algorithm should be enabled in the boiler controller.
   b) Independent from the hydraulics of the heating system, constant water circulation through each boiler is required while the boiler is operating (requires a dedicated boiler

pump if in a primary/secondary loop arrangement). Refer to table below for minimum boiler circulation rates.

5) Minimum over-pressure at the boiler:
For outlet temperatures up to the maximum of 185 deg F (85 deg C), a minimum operating pressure of 30 psig (2.1 bar) is required.

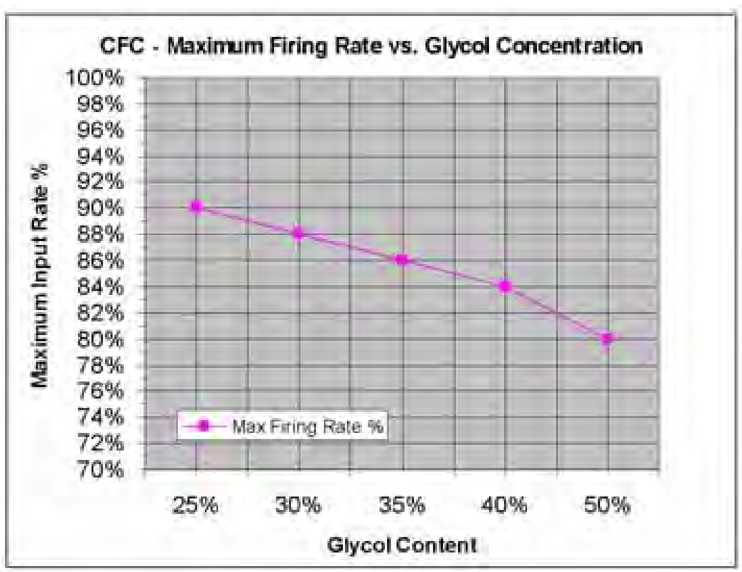
6) pH level should be maintained between 8.3 and 9.5

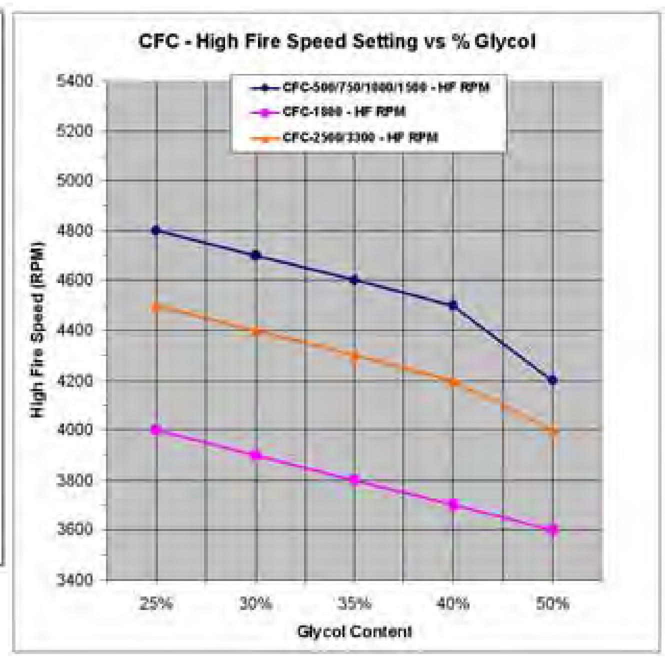
Glycol Application Guidelines — ClearFire Model CFC

Minimum required boiler circulation rate (gpm) at maximum firing rate.				
ClearFire	System ΔT (˚F)			
Model-Size	ΔT = 10˚	ΔT = 20˚	ΔT = 30˚	ΔT = 40˚
CFC-500	88	44	29	22
CFC-750	131	66	44	33
CFC-1000	175	88	58	44
CFC-1500	263	131	88	66
CFC-1800	316	158	105	79
CFC-2500	438	219	146	110
CFC-3300	578	289	193	145

Notes/Limitations:

1. Maximum firing rate determined by ClearFire CFC - Glycol Firing Rate Limitation chart (below). Maximum high fire blower speed should be set according to chart.
2. Glycol concentration limit of 25%-50%. Minimum required system operating pressure is 30 psig.
3. Maximum system operating temperature of 180 ˚F. Maximum ΔT of 40˚.
4. Circulation rates correlate with boiler output based on 92% nominal efficiency.
5. Standard altitude (<1000' ASL). Contact C-B for high altitude applications.
6. Pumps should be sized based on system design ΔT and minimum required flow rates.
7. At minimum firing rate, the minimum circulation rate should correspond to the boiler's turndown.





> **⚠ Warning**
>
> **The boiler must not be installed on carpeting.**

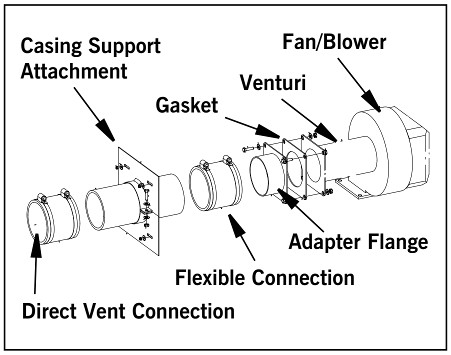


Figure 2-19 Direct Vent Combustion Air

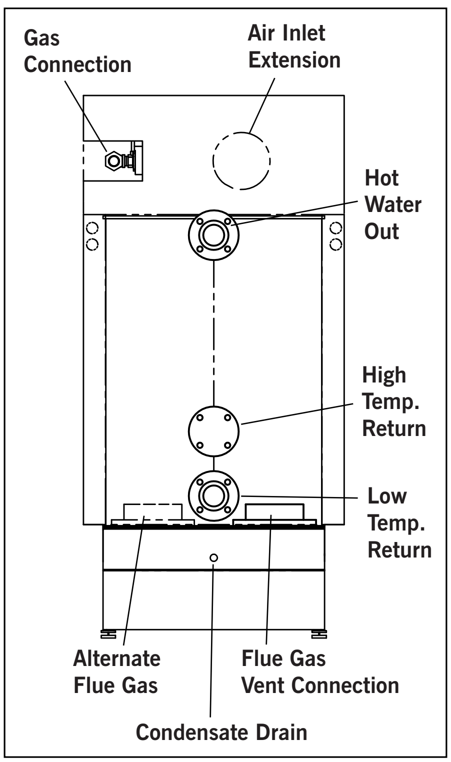


Figure 2-20 CFC Rear View

E. BOILER ROOM

The boiler room must comply with all building codes and regulations. An adequate supply of combustion air is required for safe operation. If the optional direct vent combustion air kit (**Figure 2-19**) is not used, ventilation must be provided to meet applicable regulations for air supply.

Notice

See Section 6, Parts, for part numbers for the Direct Vent Combustion Air kits available.

Clean combustion air is required for optimum efficiency and boiler operation. Dust and airborne contaminants will adversely effect burner performance. If conditions dictate, a serviceable filter must be placed in the intake piping to eliminate airborne contamination to the burner. An optional air filter is available from Cleaver-Brooks. Additionally, if a direct vent combustion air intake vent is used the intake should be directed to eliminate rain or snow from entering the intake piping. The boiler must be installed so that the gas ignition system components are protected from water (dripping, spraying, etc.) during appliance operation and service.

F. GAS CONNECTIONS

1. General

The ClearFire Model CFC gas fired condensing boilers are full modulating input units that require appropriate gas supply pressure and volume for proper operation. The gas requirements specified in this section must be satisfied to ensure efficient and stable combustion. Installation must follow these guidelines and those of any local authorities having installation jurisdiction.

2. Gas Train Components

CFC boilers are equipped with a gas train that meets the requirements of ASME CSD-1, FM and XL-GAP (formerly IRI). The gas train and its components have been designed and tested to operate for the highest combustion efficiency for the CFC units. A gas pressure regulator ships with the boiler.

3. Gas Pressure Requirements

For proper and safe operation, each CFC Series boiler requires a stable gas supply pressure. See **Table 2-3** for pressure requirements.

Table 2-3: Model CFC Gas Pressure Requirements

Boiler Model	Minimum pressure required at gas train connection (inches Water Column)		Max. pressure
	Natural Gas	LP Gas	
500	7"	11"	28" WC
750	7"	11"	
1000	7"	11"	
1500	10"	11"	
1800	7"	11"	
2500	9.5"	11"	
3300*	6.8"	11"	5 psi

*Pilot gas pressure CFC 3300: Natural gas 3-5" WC, LP gas 3-4" WC

Actual gas pressure should be measured when the burner is firing using a manometer at the upstream test port connection on the main gas valve. For a multiple unit installation, gas pressure should be set for a single unit first, then the remaining units should be staged on to ensure that gas supply pressure drop is not more than 1" w.c. and never below the required pressure. Fluctuating gas pressure readings could be indicative of a faulty supply regulator or improper gas train size to the boiler. Refer to tables 2-4 through 2-12 for gas piping recommendations.

To measure pilot gas pressure, use the test port on the pilot solenoid valve.

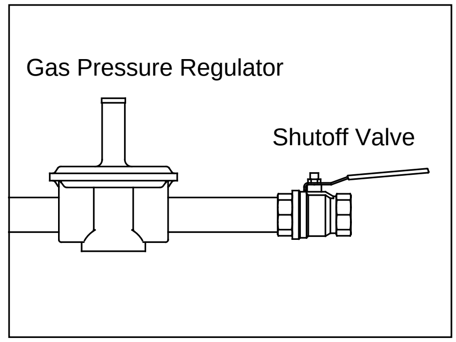


Figure 2-21 Gas Regulator and Shutoff Valve (typical)

NOTE: The pressure test port is located at the gas valve inlet flange (see **Figure 2-23**). The remaining test cocks are for leak test purposes and should not be used to measure gas pressure. Refer to **APPENDIX C - GAS VALVE INSTALLATION AND MAINTENANCE** for more information.

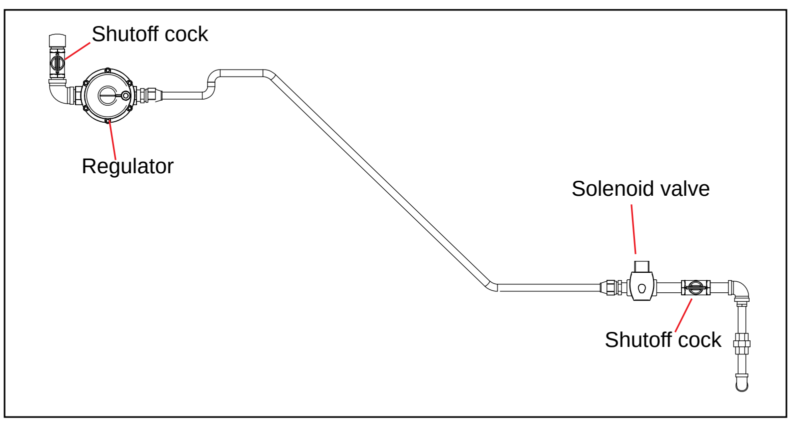


Figure 2-22 Pilot train, CFC-3300

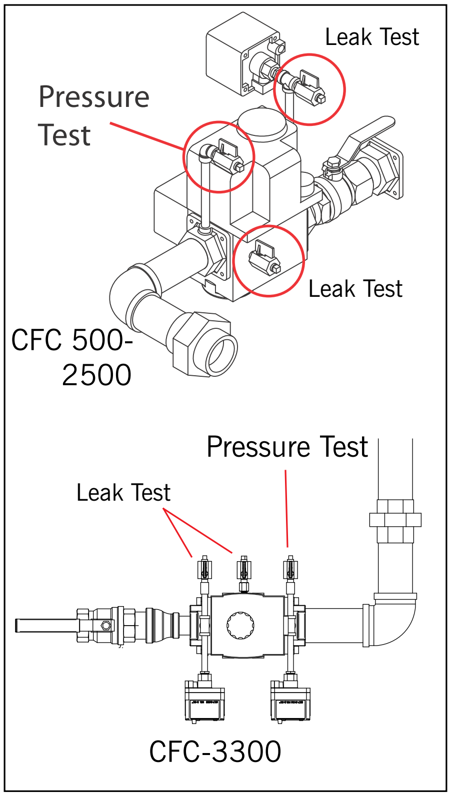


Figure 2-23 Test cocks - gas valve

4. Gas Piping

Do not use a common regulator to regulate pressure for a multiple unit installation. Use the supplied regulator for each CFC boiler. Note: Gas connection is at the rear of the boiler, left hand side as you face the rear of the boiler.

If local code permits, a flexible connection can be used between the gas line and gas valve. This will enable the burner door to be opened without disconnecting the gas line.

The regulator for each boiler must be installed outside the burner enclosure with at least 2 feet of pipe between the regulator and the boiler gas valve connection. The discharge range of the regulator must be able to maintain gas pressures as noted in **Table 2-3**.

For buildings or boiler rooms with gas supply pressure exceeding 28" w.c. (or 5 psi for CFC 3300) a "full lock-up" type regulator is required as well as overpressure protection (e.g. relief valve).

In addition to the regulator, a plug type or "butterball" type gas shutoff valve must be installed upstream of the regulator for use as a service valve. This is also required to provide positive shutoff and isolate the unit during gas piping tests.

If necessary a strainer should be installed upstream of the regulator to remove debris from the gas supply.

Drip legs are required on any vertical piping at the gas supply to each boiler so that any dirt, weld slag, or debris can deposit in the drip leg rather than into the boiler gas train. The bottom of the drip leg should removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg. Do not pipe across the top of the boiler as the burner swings up for service and must have proper clearance.

All gas piping and components to the boiler gas train connection must comply with NFPA 54, local codes, and utility requirements as a minimum. Only gas approved fittings, valves, or pipe should be used. Standard industry practice for gas piping is normally Schedule 40 black iron pipe and fittings.

Before starting the unit(s) all piping must be cleaned of all debris to prevent its entrance into the boiler gas train. Piping should be tested as noted in NFPA 54 and the boiler must be isolated during any tests.

After initial startup, the inlet screen to the gas valve should be checked and cleaned of any debris buildup that may have resulted from installation.

See **Figure 2-24** for a typical piping configuration.

5. Gas Supply Pipe Sizing

For proper operation of a single unit or a multiple unit installation, we recommend that the gas piping be sized to allow no more than 0.3" w.c. pressure drop from the source (gas header or utility meter) to the final unit location. Higher supply pressure systems may allow for a greater pressure drop. In ALL cases, minimum supply pressures must be met for proper operation of the boiler(s). The gas supplier (utility) should be consulted to confirm that sufficient volume and normal pressure are provided to the building at the discharge side of the gas meter or supply pipe.

For installations of new boilers into an existing building, gas pressure should be measured with a manometer to ensure sufficient pressure is available. A survey of all connected gas-using devices should be made. If appliances other than the boiler or boilers are connected to the gas supply line, then a determination must be made of how much flow volume (cfh) will be demanded at one time and the pressure drop requirement when all appliances are firing.

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final unit connection. As a minimum guideline, see gas piping Tables **2-4** and **2-5**. The data in these tables is from the NFPA 54 source book, 2006 edition.

To verify the input of each device that is connected to the gas piping, obtain the btu/hr input and divide this input by the calorific value of the gas that will be utilized. For instance, a unit with 750,000 btu/hr input divided by a gas calorific value of 1060 will result in a cfh flow of 707. The single boiler is approximately 20 feet from the gas supply header source. And with a measured gas supply pressure of 10" w.c. we find from **Table 2-4** that a supply pipe size of 1-1/4" should be used as a minimum.

⚠ Caution

The boiler and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of 1/2 psi (3.5 kPa).

The boiler must be isolated from the gas supply piping system by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than 1/2 psi (3.5 kPa).

Table 2-4: Gas Line Capacity - Schedule 40 Metallic Pipe

Pipe Size							
Nominal	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	1.049	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)						
10	514	1,060	1,580	3,050	4,860	8,580	17,500
20	363	726	1,090	2,090	3,340	5,900	12,000
30	284	583	873	1,680	2,680	4,740	9,660
40	243	499	747	1,440	2,290	4,050	8,290
50	215	442	662	1,280	2,030	3,590	7,330
60	195	400	600	1,160	1,840	3,260	6,640
70	179	368	552	1,060	1,690	3,000	6,110
80	167	343	514	989	1,580	2,790	5,680
90	157	322	482	928	1,480	2,610	5,330
100	148	304	455	877	1,400	2,470	5,040
125	131	269	403	777	1,240	2,190	4,460
150	119	244	366	704	1,120	1,980	4,050
175	109	209	336	648	1,030	1,820	3,720
200	102	185	313	602	960	1,700	3,460

**Fuel: Natural Gas
**Inlet Pressure: Less than 2.0 psi
**Pressure Drop: 0.30" w.c.
**Specific Gravity: 0.60

Table 2-5: Gas Line Capacity - Schedule 40 Metallic Pipe

Pipe Size							
Nominal	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)						
10	678	1,390	2,090	4,020	6,400	11,300	23,100
20	466	957	1,430	2,760	4,400	7,780	15,900
30	374	768	1,150	2,220	3,530	6,250	12,700
40	320	657	985	1,900	3,020	5,350	10,900
50	284	583	873	1,680	2,680	4,740	9,600
60	257	528	791	1,520	2,430	4,290	8,760
70	237	486	728	1,400	2,230	3,950	8,050
80	220	452	677	1,300	2,080	3,670	7,490
90	207	424	635	1,220	1,950	3,450	7,030
100	195	400	600	1,160	1,840	3,260	6,640
125	173	355	532	1,020	1,630	2,890	5,890
150	157	322	482	928	1,480	2,610	5,330
175	144	296	443	854	1,360	2,410	4,910
200	134	275	412	794	1,270	2,240	4,560
**Fuel: Natural Gas							
**Inlet Pressure: Less than 2.0 psi							
**Pressure Drop: 0.50" w.c.							
**Specific Gravity: 0.60							

6. Gas Header

Design of a single common gas header with individual takeoffs for a multiple unit installation is recommended. Boiler gas manifold piping should be sized based on the volume requirements and lengths between boilers and the fuel main header (see **Figure 2-24**).

Tables **2-6** to **2-12** indicate the proper sizing for multiple units of equal size, placed on the factory standard center with the noted take off size. For installations with a mixed sized use, determine the flow of each unit and total the input. With the total input, determine length of run from the source and determine what size header will be needed for the flow of all units firing. Pipe sizes based on **Table 2-4**.

Table 2-6: Multiple Unit Manifold, CFC 500

CFC 500 Boilers				
# of Units	1	2	3	4
Pipe Size to Boiler	1"	1"	1"	1"
Header Pipe size	1-1/4"	1-1/4"	1-1/2"	2"

Table 2-7: Multiple Unit Manifold, CFC 750

CFC 750 Boilers				
# of Units	1	2	3	4
Pipe Size to Boiler	1"	1"	1"	1"
Header Pipe size	1-1/4"	1-1/2"	2"	2-1/2"

Table 2-8: Multiple Unit Manifold, CFC 1000

CFC 1000 Boilers				
# of Units	1	2	3	4
Pipe Size to Boiler	1-1/4"	1-1/4"	1-1/4"	1-1/4"
Header Pipe size	1-1/4"	2"	2"	2-1/2"

Table 2-9: Multiple Unit Manifold, CFC 1500

CFC 1500 Boilers				
# of Units	1	2	3	4
Pipe Size to Boiler	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Header Pipe size	1-1/2"	2"	2-1/2"	3"

Table 2-10: Multiple Unit Manifold, CFC 1800

CFC 1800 Boilers				
# of Units	1	2	3	4
Pipe Size to Boiler	2"	2"	2"	2"
Header Pipe size	2"	2-1/2"	3"	3"

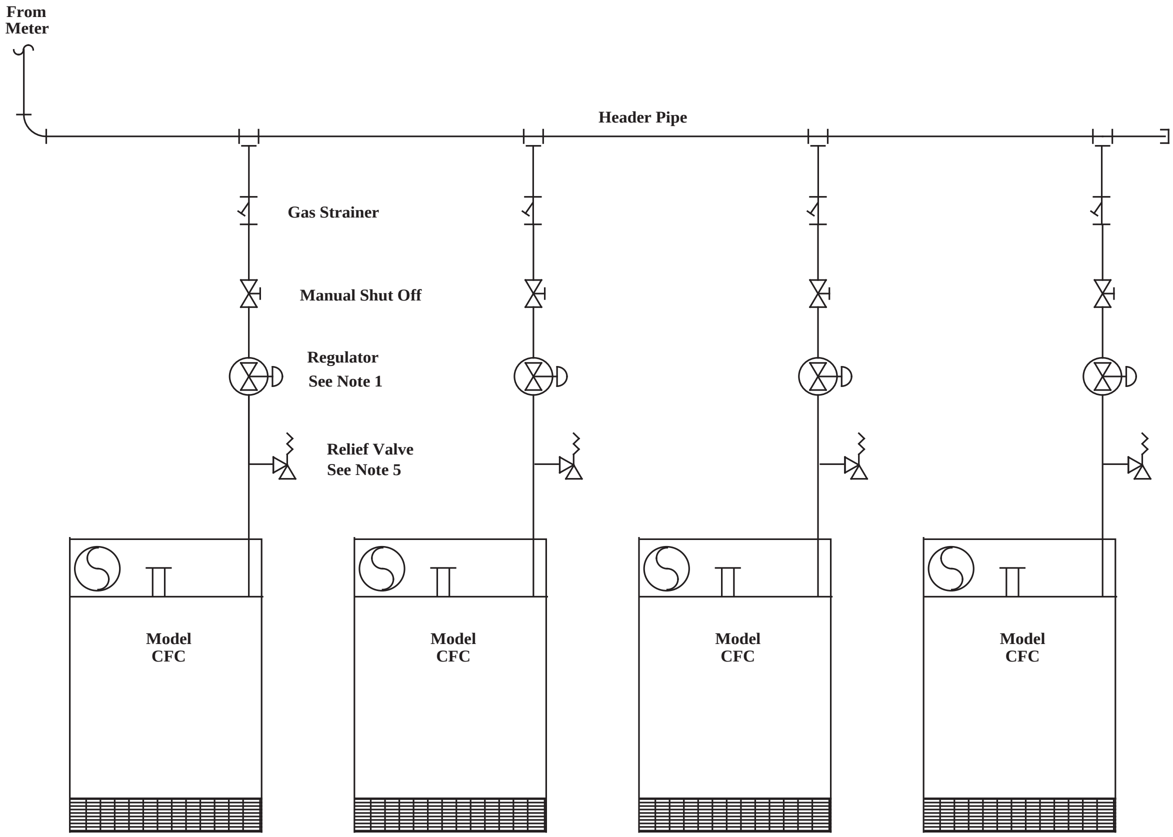
Table 2-11: Multiple Unit Manifold, CFC 2500

CFC 2500 Boilers				
# of Units	1	2	3	4
Pipe Size to Boiler	2"	2"	2"	2"
Header Pipe size	2"	3"	3"	4"

Table 2-12: Multiple Unit Manifold, CFC 3300

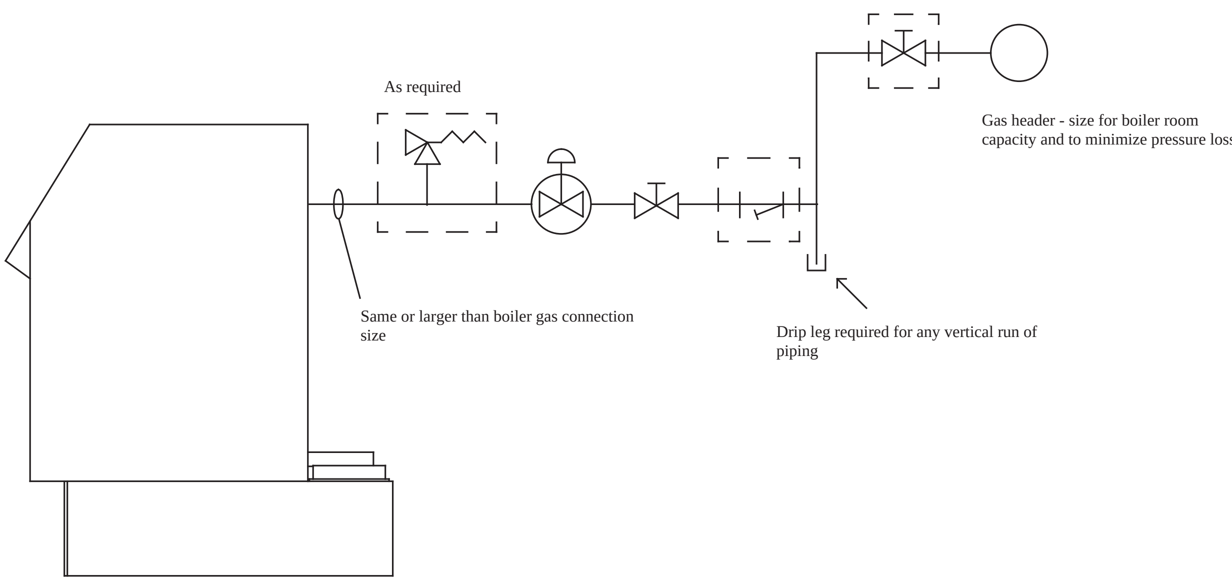
CFC 3300 Boilers				
# of Units	1	2	3	4
Pipe Size to Boiler	2"	2"	2"	2"
Header Pipe size	2"	3"	4"	4"

Figure 2-24 Gas Piping



Gas Header Piping, Typical

NOTES:
1. Dedicated gas pressure regulator required for each boiler.
2. Refer to local fuel gas codes when applicable.
3. Header to be sized for room capacity.
4. Provision required for measuring gas supply pressure at boiler.
5. Relief valve required if gas supply pressure >1 psig.



G. BOILER WATER PIPING

1. General

All boiler hot water outlet and return piping is connected at the rear of the boiler. Piping is to be installed per local codes and regulations.The pipelines for the hot water outlet and return may be connected in the usual manner without removing the cladding elements. Unused connectors must be safely blanked off.

2. Safety valve

Figure 2-25 Pressure relief valve piped to safe point of discharge

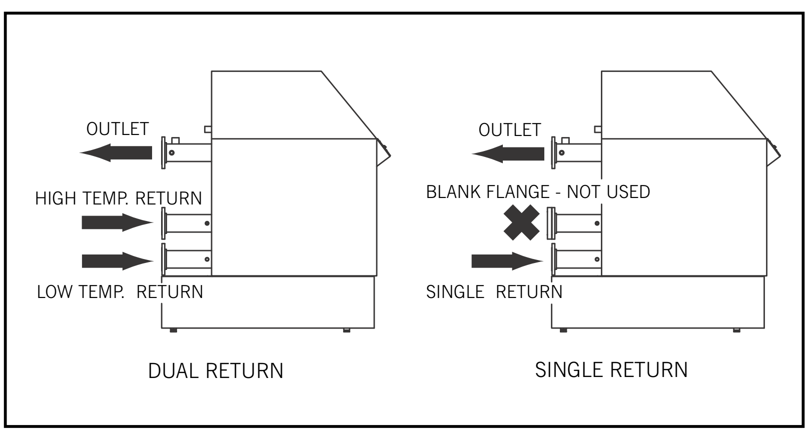
The pressure relief valve (safety valve) should be piped from the coupling on the hot water outlet pipe (see **Figure 2-25**). Use pipe sealing compound and a flat sided wrench when securing the Safety relief valve. Do not use a pipe wrench and do not over tighten the relief valve. The safety valve must be mounted in a vertical position so that discharge piping and code-required drains can be properly piped to prevent buildup of back pressure and accumulation of foreign material around the valve seat area. Apply only a moderate amount of pipe compound to male threads and avoid overtightening, which can distort the seats. Use only flat-jawed wrenches on the flats provided.

> **⚠ Warning**
>
> Only properly certified personnel such as the safety valve manufacturer's certified representative should adjust or repair the boiler safety valve. *Failure to follow this warning could result in serious personal injury or death.*

3. Dual return design

The Model CFC features separate high and low temperature return water connections, allowing for condensing performance within high temperature hydronic systems. With as little as 10% return water at or below 120 deg F, the Model CFC will achieve condensing performance, with associated gains in efficiency.

If using only a single (common) return, the lower return connection should be used.



4. Pressure drop curves

The information in **Figure 2-26** through **Figure 2-31** and in Tables **2-13** and **2-14** can help in determining pump requirements for Model CFC installations.

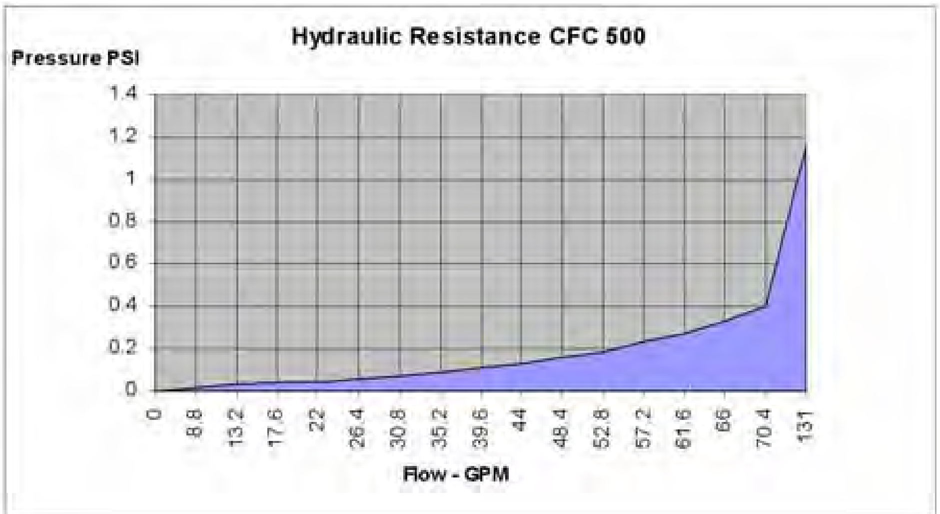


Figure 2-26 Pressure Drop Curve, CFC 500

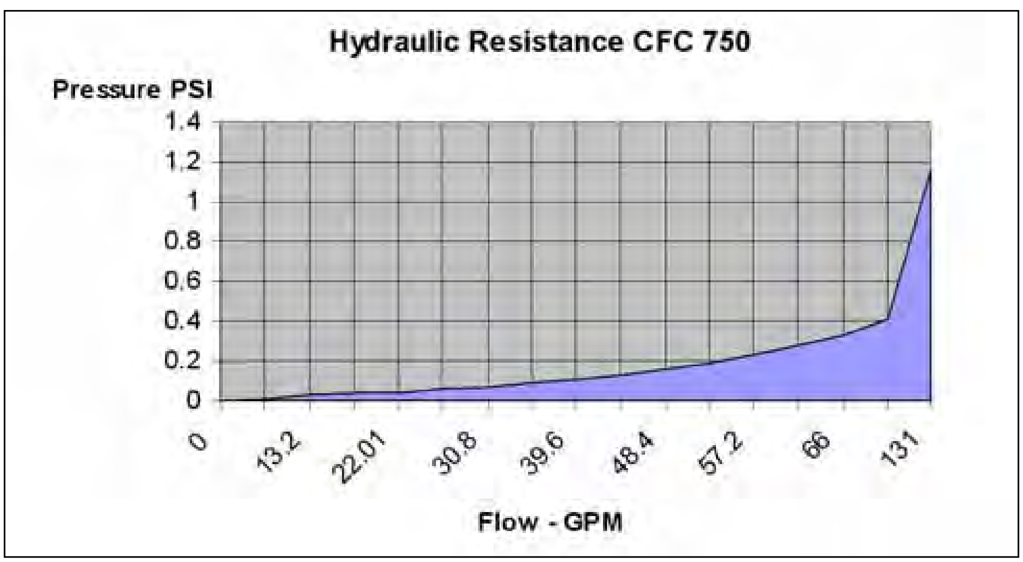


Figure 2-27 Pressure Drop Curve, CFC 750

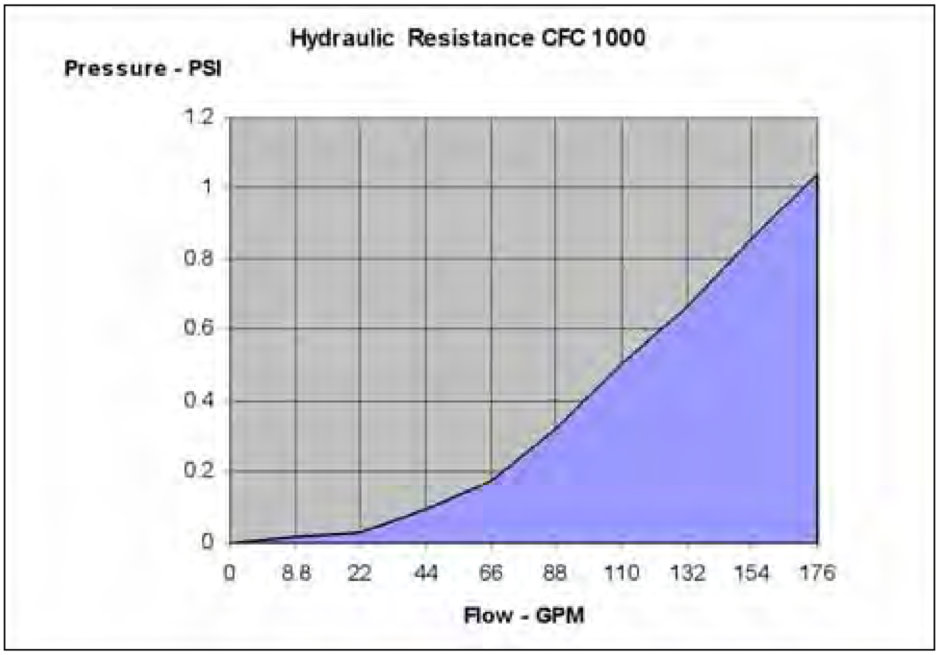


Figure 2-28 Pressure Drop Curve, CFC 1000

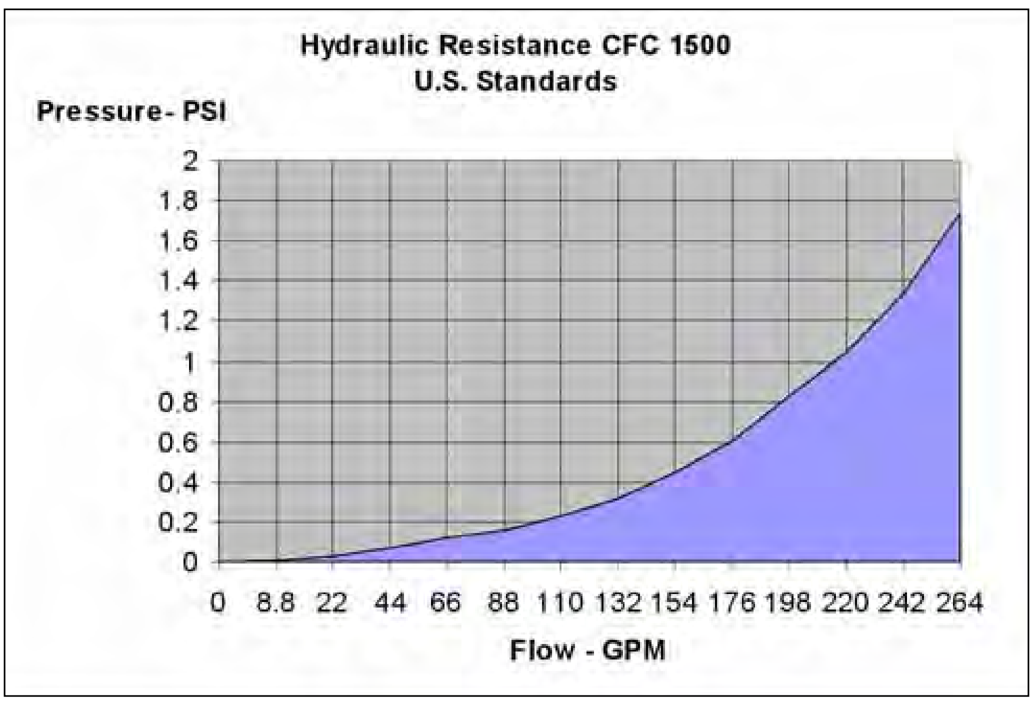


Figure 2-29 Pressure Drop Curve, CFC 1500

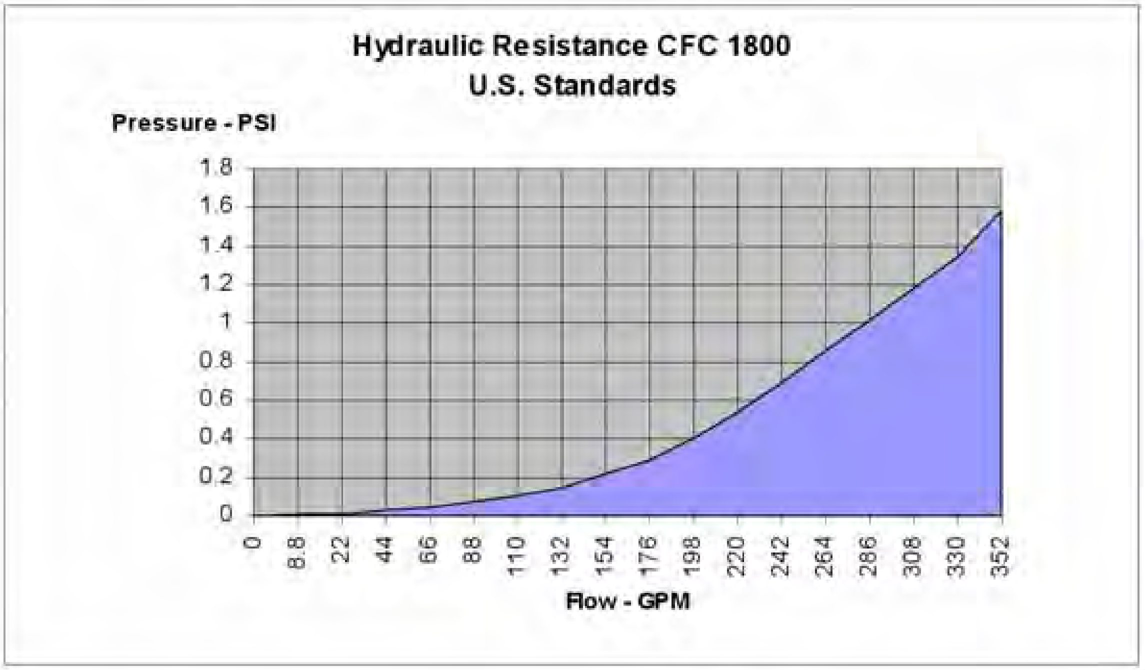


Figure 2-30 Pressure Drop Curve, CFC 1800

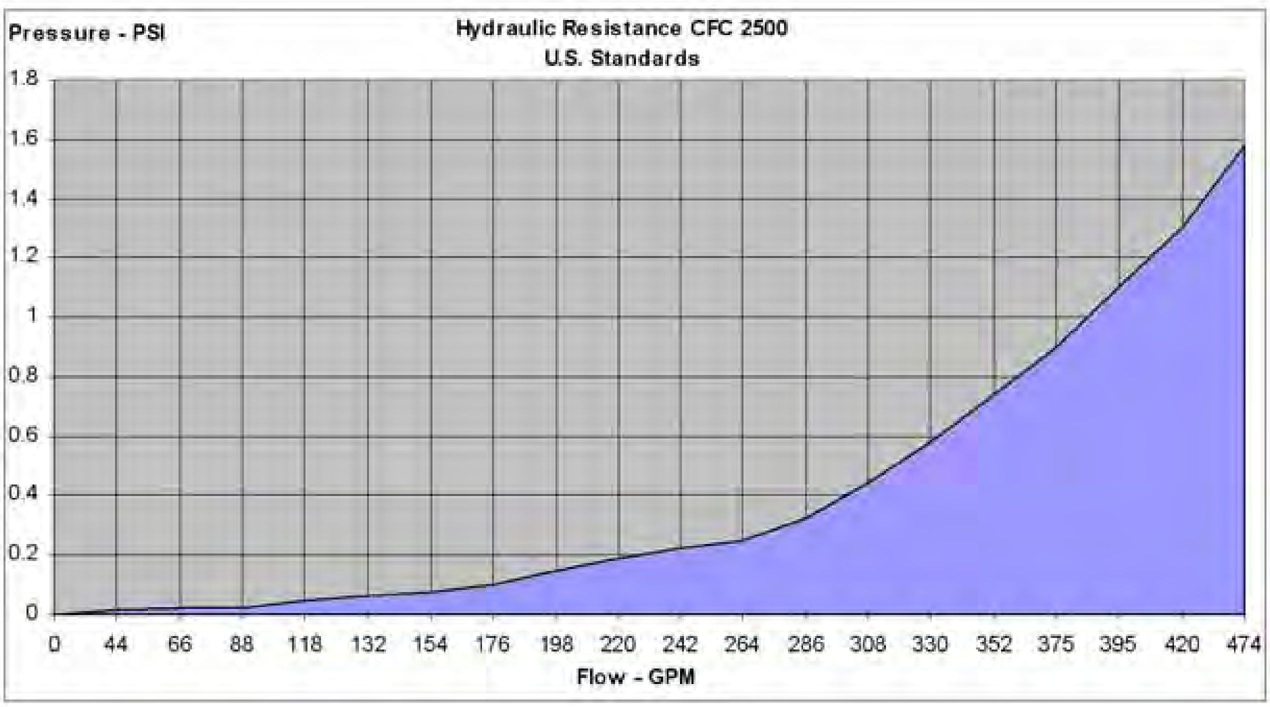


Figure 2-31 Pressure Drop Curve, CFC 2500

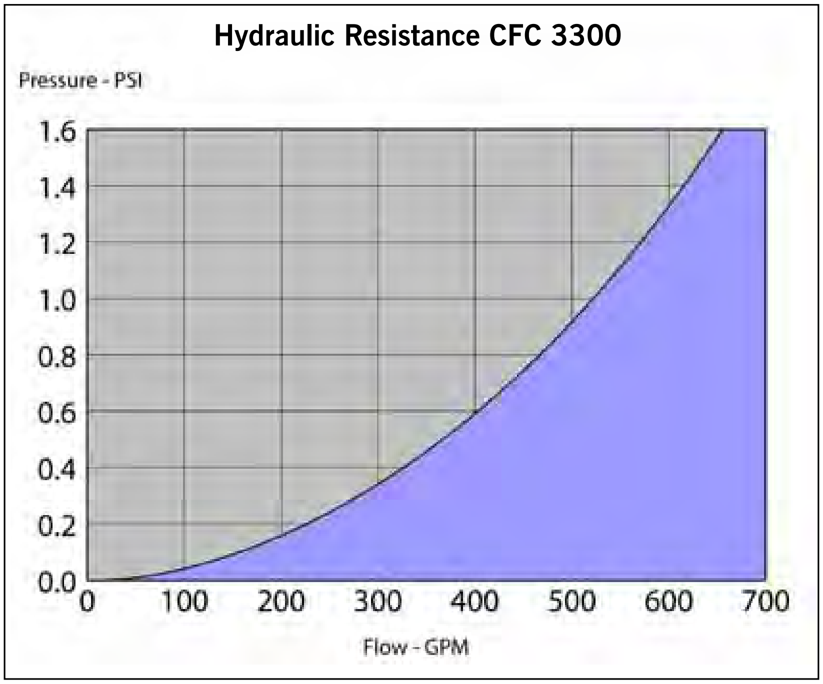


Figure 2-32 Pressure Drop Curve, CFC 3300

Table 2-13: Maximum flow rate through ClearFire boilers (U.S. flow rates)

System Temperature Drop Deg F												
	10	20	30	40	50	60	70	80	90	100	110	120
Boiler Size	Flow Rate GPM											
500	95	48	33	24	19	16	12	11	10.5	9	8	7
750	131	66	44	33	26	22	19	16	15	13	12	11
1000	176	88	59	44	35	29	25	22	20	18	16	15
1500	260	130	87	65	52	43	37	33	29	26	24	23
1800	351	176	117	88	70	59	50	44	39	35	32	30
2500	470	235	157	118	95	79	67	59	52	48	43	39
3300	620	310	207	155	124	103	89	78	69	62	56	52
Recommended flow rates relative to temperature drop so as not to exceed boiler output.												

Table 2-14: Maximum flow rate through ClearFire boilers (metric flow rates)

System Temperature Drop ^{0} C												
	5	11	17	22	27	33	38	45	50	55	61	64
Boiler Size	Flow Rate m^3 /hr.											
500	21.6	10.9	7.5	5.4	4.3	3.6	2.7	2.5	2.3	2	1.8	1.6
750	29.75	15	10	7.5	6	5	4.3	3.6	3.4	2.9	2.7	2.5
1000	40	20	14	10	8	7	6	5	4.5	4	3.6	3.4
1500	59	29.5	20	15	12	10	8.4	7.5	6.6	6	5.4	5.2
1800	80	40	27	20	16	13	11.3	10	9	8	7.3	6.8
2500	106.7	53.4	36.7	26.8	21.6	17.9	15.2	13.4	11.8	10.9	9.8	8.8
3300	141	70.4	47	35.2	28	23.4	20.2	17.7	15.7	14.1	12.7	11.8
Recommended flow rates relative to temperature drop so as not to exceed boiler output.												

H. CONDENSATE REMOVAL AND TREATMENT

The condensate generated during normal boiler operation must be removed in accordance with local codes and regulations. The condensate can be piped to a local treatment system or run into the optional condensate treatment assembly. When piping condensate direct to drain, a trap (**Figure 2-33**) must be installed on the condensate outlet to prevent discharge of flue gases from the boiler. When using the treatment tank, a drain trap is included in the tank assembly and no external trap is required.

The water trap must be filled with water prior to commissioning and checked or refilled at each required maintenance interval.

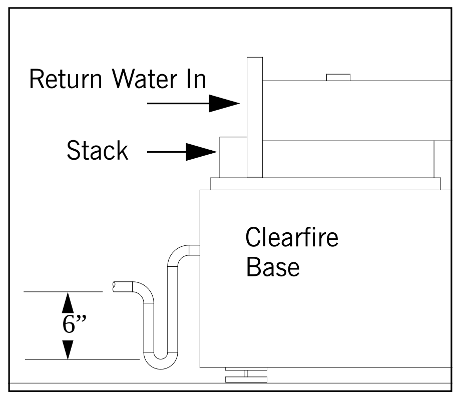


Figure 2-33 Flue Gas Trap 6 inch Minimum Water Column

Notice

The condensate occurring during operation in both the boiler and the flue gas pipeline has to be neutralized and piped to a safe drain. The conditions for the discharge of condensates into public drain systems are determined by the local authorities and municipalities.

Condensate leaving the boiler normally has a pH of 4-6. The responsible authority will inform you if a higher pH value is required for condensate piped to drain. The CFC neutralization system contains the granulate NEUTRALAT, a natural compound which acts to increase the pH of the condensate flowing through it. The neutralization system comprises the plastic neutralization tank with condensate inlet, makeup valve, drain trap, granulate chamber and condensate outlet (see **Figure 2-35**). The system is installed in the CFC lower collection area.

> **Note: To ensure compliance with regulations, it is important to contact the responsible authorities prior to the planning and execution of the boiler installation. Condensate flow of 5 to 12 GPH can be expected depending on boiler size and return water temperature.**

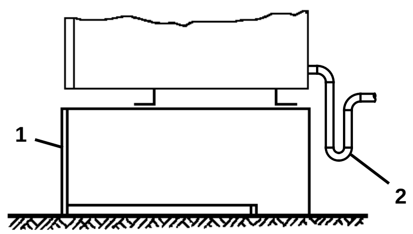


Figure 2-34 Condensate Piped Direct to Drain

1. Condensate tank setup options

The boiler is supplied with boiler legs (standard) which are sized to permit the installation of the condensate collection tank. There are two (2) condensate removal options available:

(1) Condensate direct to drain - The condensate is piped directly to a drain through the piping and water trap supplied during installation (see **Figure 2-34**).

- Piping is to be a minimum of 3/4" NPT.
- Maximum discharge pipe height from floor to be 9".
- Condensate water trap (6") required.

(2) Condensate to treatment tank - The condensate is held in a condensate tank under the boiler. The condensate is neutralized as it passes through the granular bed. The neutralized condensate is then piped to the drain.

- To install the system, assemble the tank and neutralization granulate per **Figure 2-35**. 2 bags of neutralization media are sufficient to fill the tank.
- Install the condensate tank cover and slide the complete assembly under the boiler

Pipe to the appropriate drain.

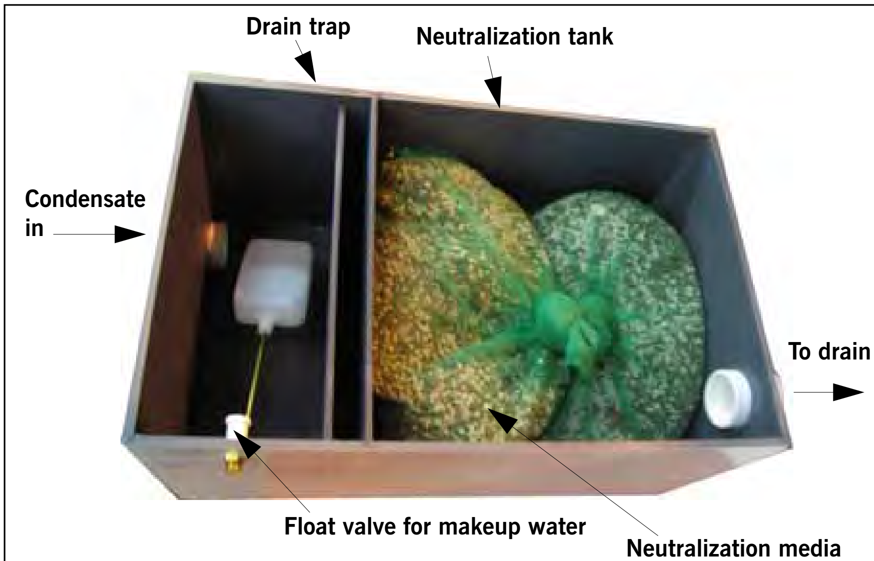


Figure 2-35 Condensate Treatment Tank

The neutralization media will require periodic replacement, to be detemined by pH analysis of condensate. If condensate is too acidic (pH is below acceptable value) the neutralization media should be replaced.

The neutralizing media should be gently agitated periodically to ensure even distribution and to avoid channeling of the condensate.

2. Condensate Piping for Multiple Boilers

The number of condensate treatment tanks required for multiple boiler installations depends on the total amount of condensate produced by the system. As a general rule, CB recommends one tank per 5-6 million BTU/hr of total boiler capacity. Model CFC capacities are as follows:

CFC Model	BTU/hr	Max. Condensation GPH	Max. Boilers per Tank
3300	3,300,000	22	2
2500	2,500,000	17	2
1800	1,800,000	12	3
1500	1,500,000	9	4
1000	1,000,000	7	5
750	750,000	5	8
500	500,000	3.5	8

See **Figure 2-36** and **Figure 2-37** for suggested piping. A drain trap is built into the condensate tank. Make-up water must be supplied at the connection shown in order to prevent flue gas from entering an idle boiler. An internal float in the condensate tank activates the make-up water valve.

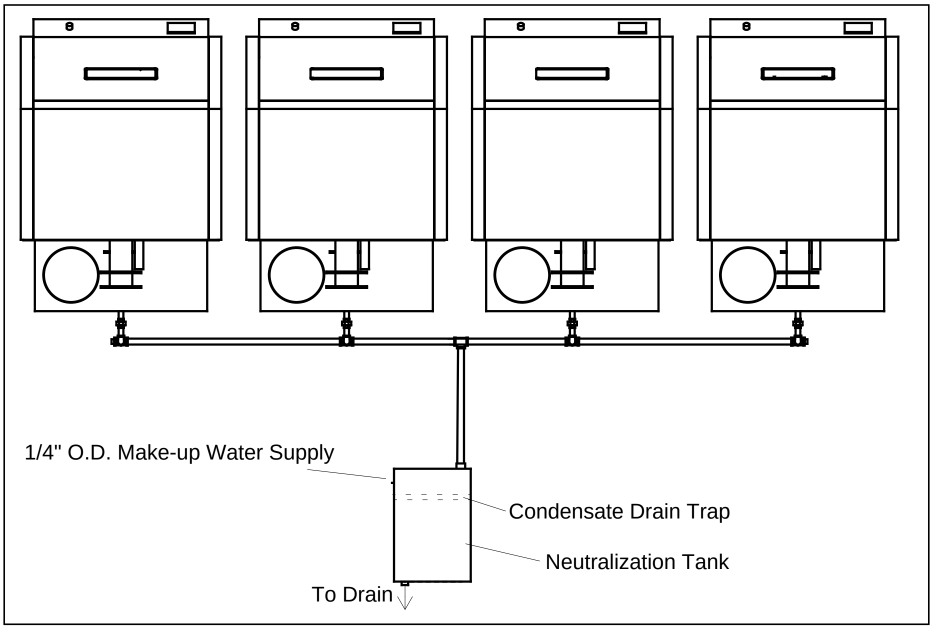


Figure 2-36 Condensate Piping for Multiple Boilers

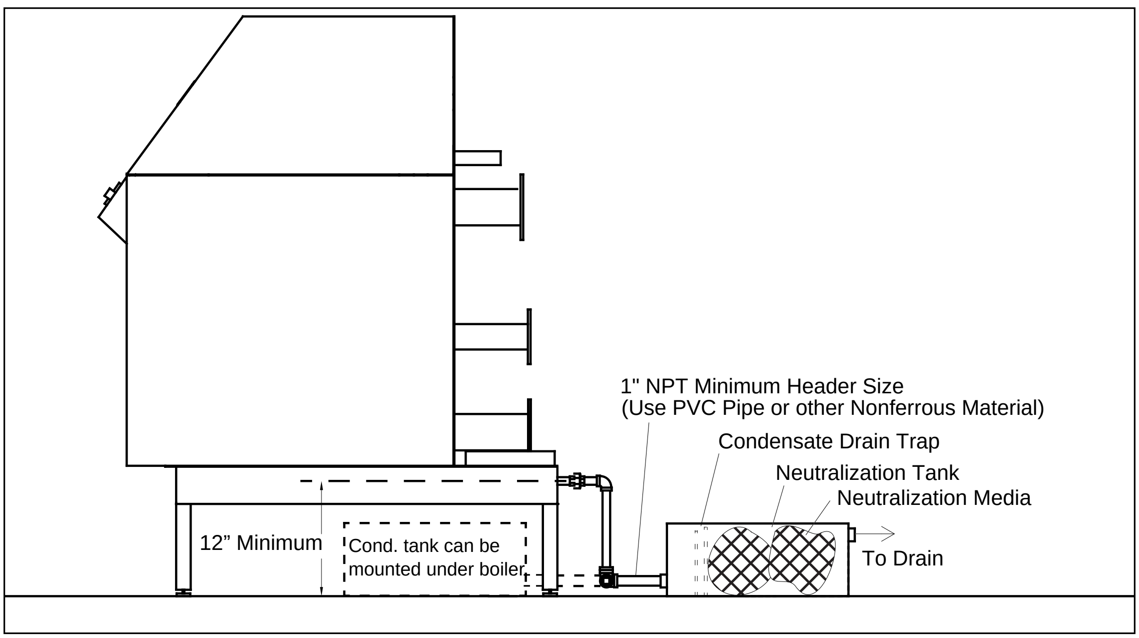


Figure 2-37 Condensate Treatment Tank for Multiple Boilers

I. ELECTRICAL CONNECTIONS

A qualified electrician or service technician must make the electrical connections to the boiler.

For typical CFC electrical component mounting see the electrical diagram mounted on the inside of the removable front panel.

For specific information on your boiler electrical system refer to the Cleaver-Brooks wiring diagram provided with the boiler.

Power is to be run from the rear of the boiler through either the left or right electrical supply channels (see **Figure 2-38**) to the control panel. AC power is to be connected to the incoming power terminals.

1. Power wiring - right side electrical supply channel.
2. Customer connections should be brought in on the right side - refer to wiring diagram.
3. Temperature sensor wiring - left side electrical supply channel.

Note: The following temperature sensor cables should be run through the left side wiring channel.

- Hot water outlet temperature sensor.
- Hot water return temperature sensor.
- Stack temperature sensor (optional).
- Outdoor temperature sensor (optional).

Warning

The blower signal wiring must be isolated from the blower power wiring and the high voltage ignition cables.

Warning

Ensure ignition cables are properly connected and not in direct contact with any sharp metal edges.

For electrical connections see **Figure 2-38.**

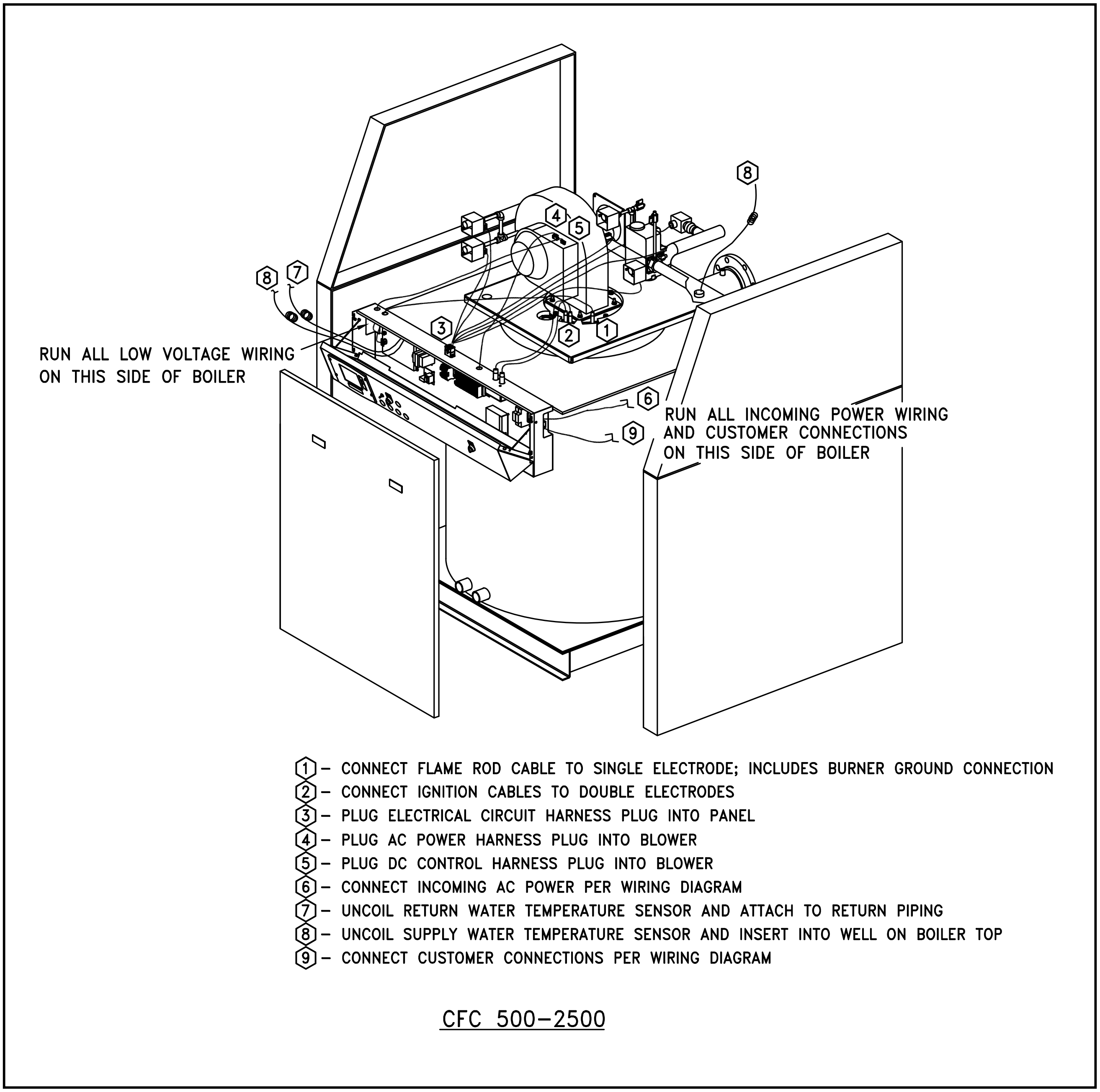


Figure 2-38 Electrical Connections CFC 500-2500

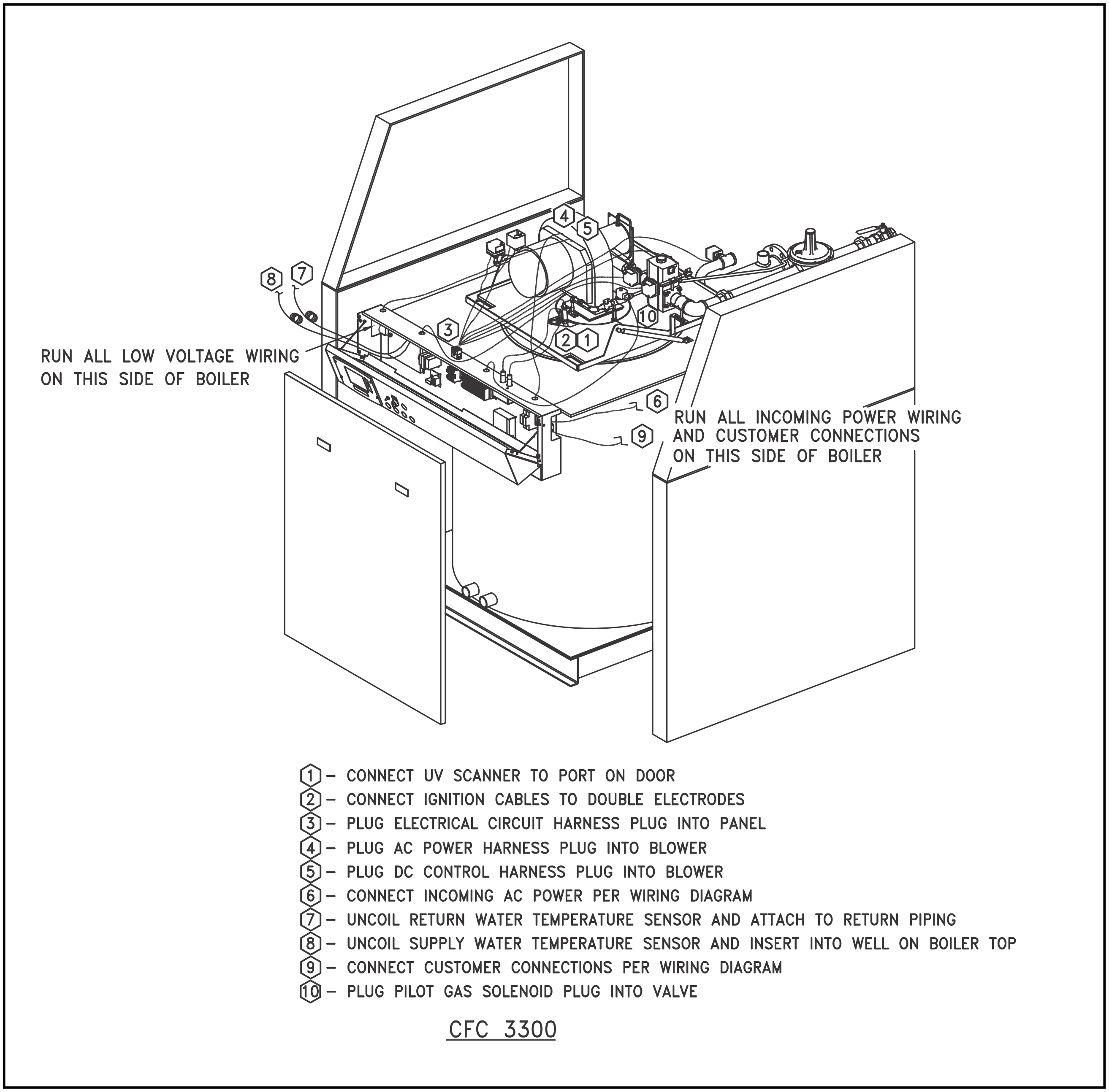
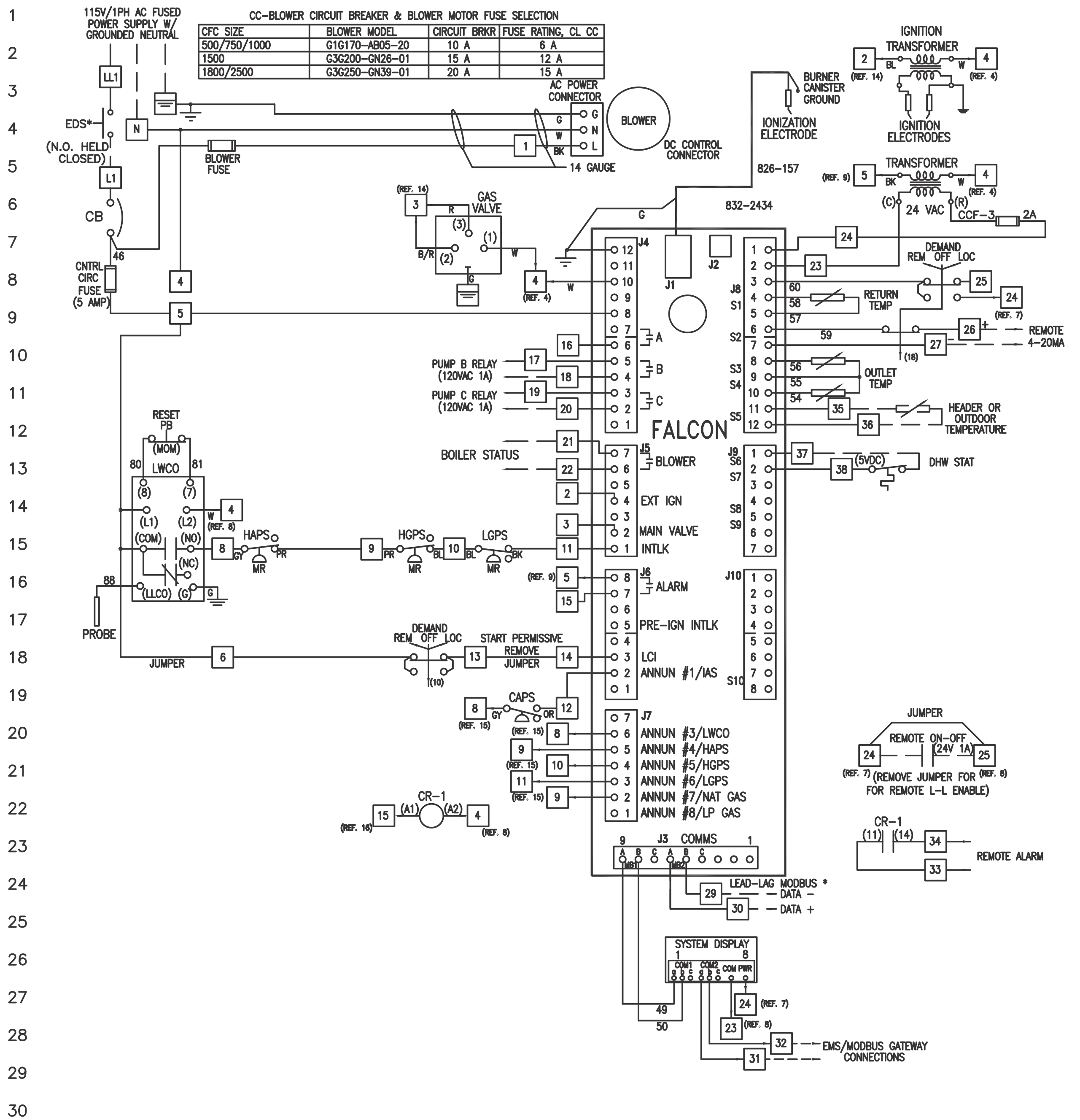


Figure 2-39 Electrical Connections CFC 3300

I. WIRING DIAGRAMS

CC–BLOWER CIRCUIT BREAKER & BLOWER MOTOR FUSE SELECTION

CFC SIZE	BLOWER MODEL	CIRCUIT BRKR	FUSE RATING, CL CC
500/750/1000	G1G170–AB05–20	10 A	6 A
1500	G3G200–GN26–01	15 A	12 A
1800/2500	G3G250–GN39–01	20 A	15 A



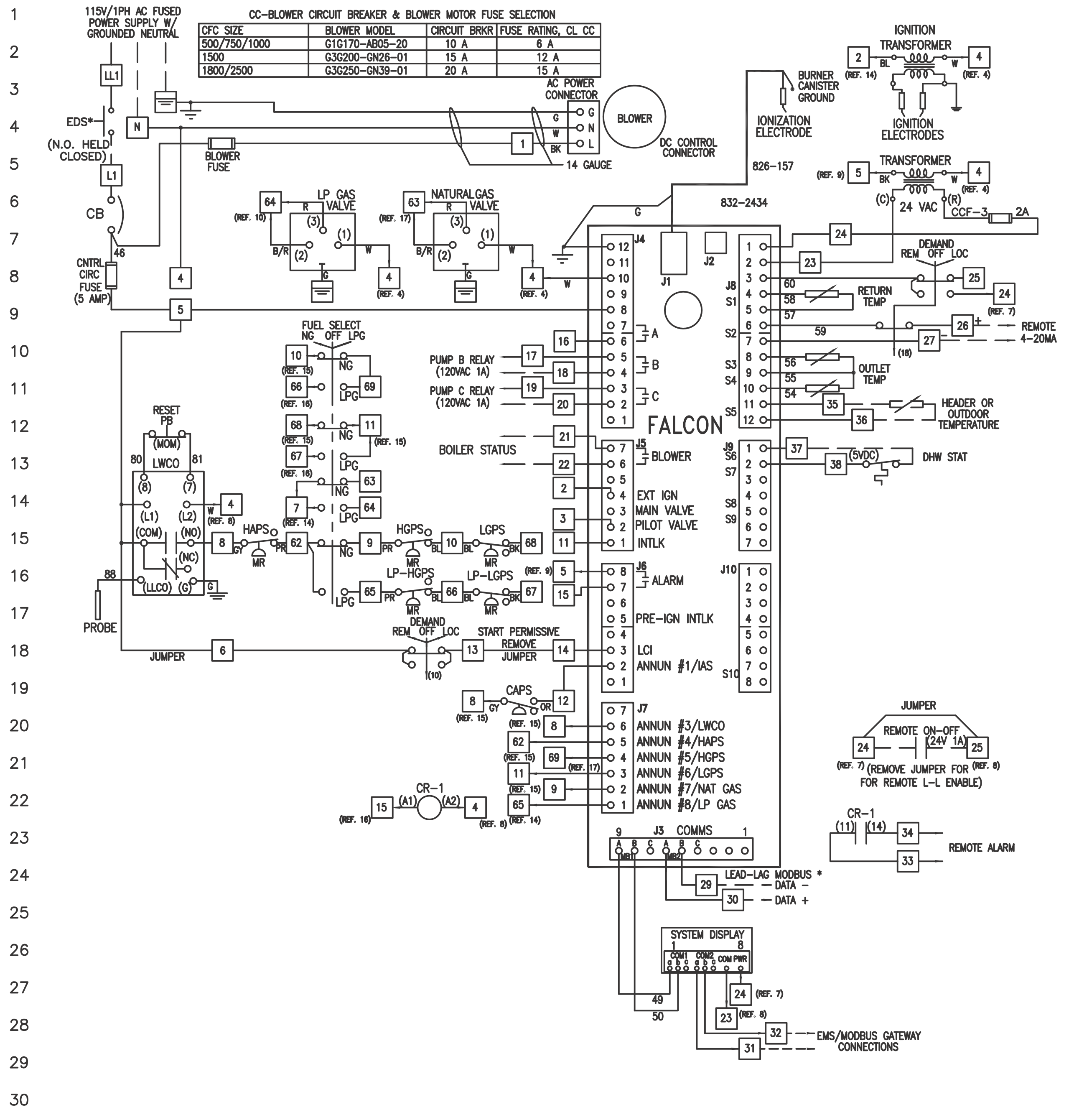
NOTES:
DASHED LINES INDICATE CUSTOMER CONNECTIONS
ALL CONTROL WIRE IS #18 AWG UNLESS OTHERWISE NOTED
COLOR DESIGNATIONS APPLY TO WIRE COLORS INSIDE CONTROL PANEL
☐ DENOTES CONTROL PANEL TERMINAL
* FALCON L–L MODBUS – CONNECT EACH BOILER IN NETWORK DAISY CHAIN

CUSTOMER CONNECTIONS:
LEAD–LAG MODBUS 29 & 30
BLDG EMS/MODBUS GATEWAY 31 & 32
REMOTE ENABLE 24 & 25
REMOTE 4–20MA INPUT 26 & 27
BOILER STATUS 21 & 22
REMOTE ALARM 33 & 34
HEADER OR OUTDOOR TEMPERATURE 35 & 36
AUX PUMP RELAYS 17 & 18, 19 & 20
DOMESTIC HOT WATER STAT 37 & 38

TERMINALS: LL1,L1,N,GR,1,2,3,4–4–4,5–5–5,6,7,8,9,10,11,12,13,14,15,16, 17,18,19,20,21,22, 23–23,24–24,25,26,27, 28,29,30,31,32,33,34,35,36, 37,38,

Figure 2-40 CFC Wiring Diagram 500-2500, single fuel

Note: Wiring diagrams shown are examples only. Installations may vary. For specific installations consult the wiring diagram provided with the boiler.



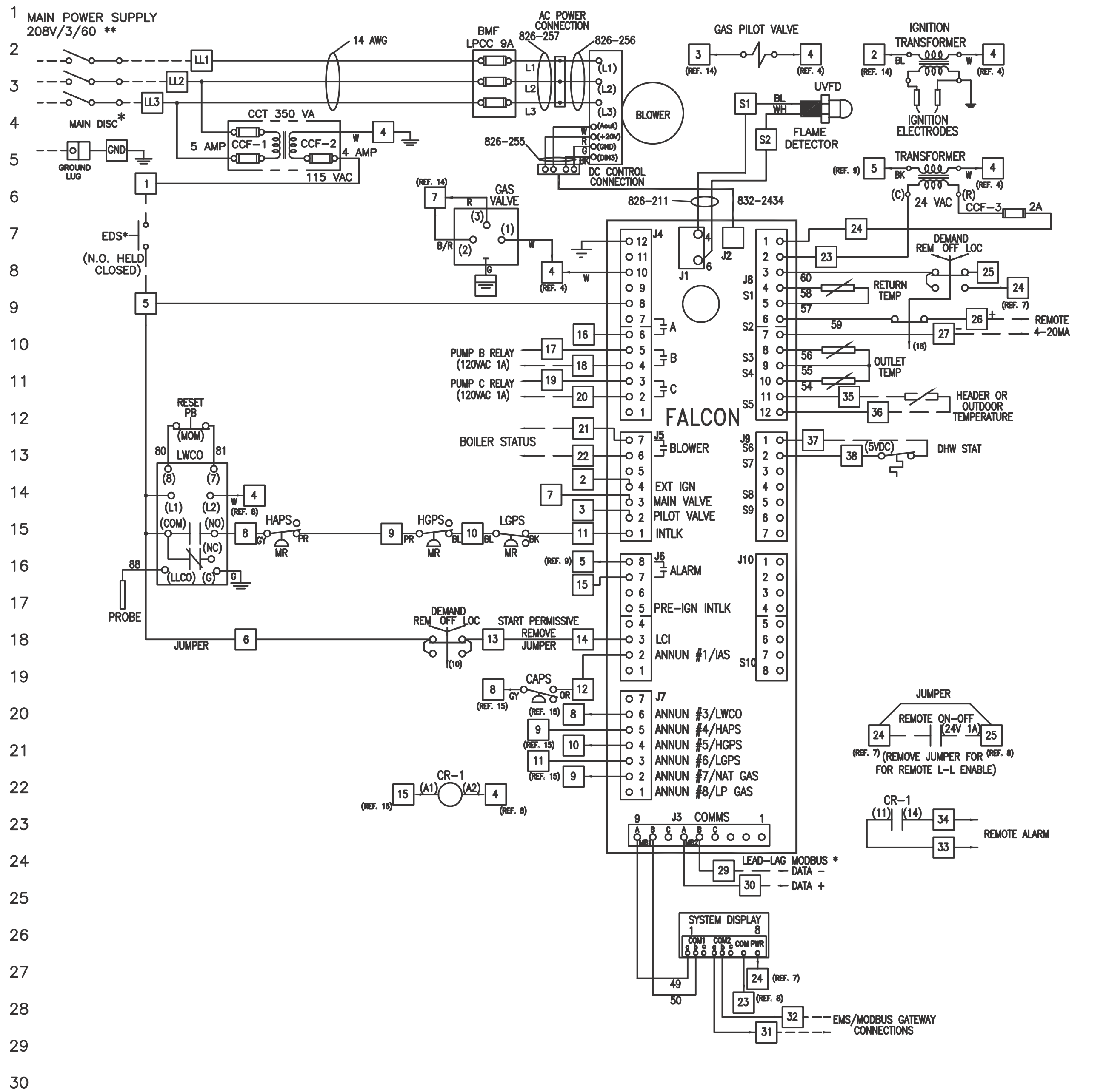
CFC SIZE	BLOWER MODEL	CIRCUIT BRKR	FUSE RATING, CL CC
500/750/1000	G1G170–AB05–20	10 A	6 A
1500	G3G200–GN26–01	15 A	12 A
1800/2500	G3G250–GN39–01	20 A	15 A

NOTES:
DASHED LINES INDICATE CUSTOMER CONNECTIONS
ALL CONTROL WIRE IS #18 AWG UNLESS OTHERWISE NOTED
COLOR DESIGNATIONS APPLY TO WIRE COLORS INSIDE CONTROL PANEL
☐ DENOTES CONTROL PANEL TERMINAL
* FALCON L–L MODBUS – CONNECT EACH BOILER IN NETWORK DAISY CHAIN

CUSTOMER CONNECTIONS:
LEAD–LAG MODBUS 29 & 30
BLDG EMS/MODBUS GATEWAY 31 & 32
REMOTE ENABLE 24 & 25
REMOTE 4–20MA INPUT 26 & 27
BOILER STATUS 21 & 22
REMOTE ALARM 33 & 34
HEADER OR OUTDOOR TEMPERATURE 35 & 36
AUX PUMP RELAYS 17 & 18, 19 & 20
DOMESTIC HOT WATER STAT 37 & 38

TERMINALS: LL1,L1,N,GR,1,2,3,4–4–4,5–5–5,6,7,8,9,10,11,12,13,14,15,16, 17,18,19,20,21,22, 23–23,24–24,25,26,27,28,29,30,31,32,33,34,35,36, 37,38, 62,63,64,65,66,67,68,69,

Figure 2-41 CFC Wiring Diagram 500-2500, dual fuel

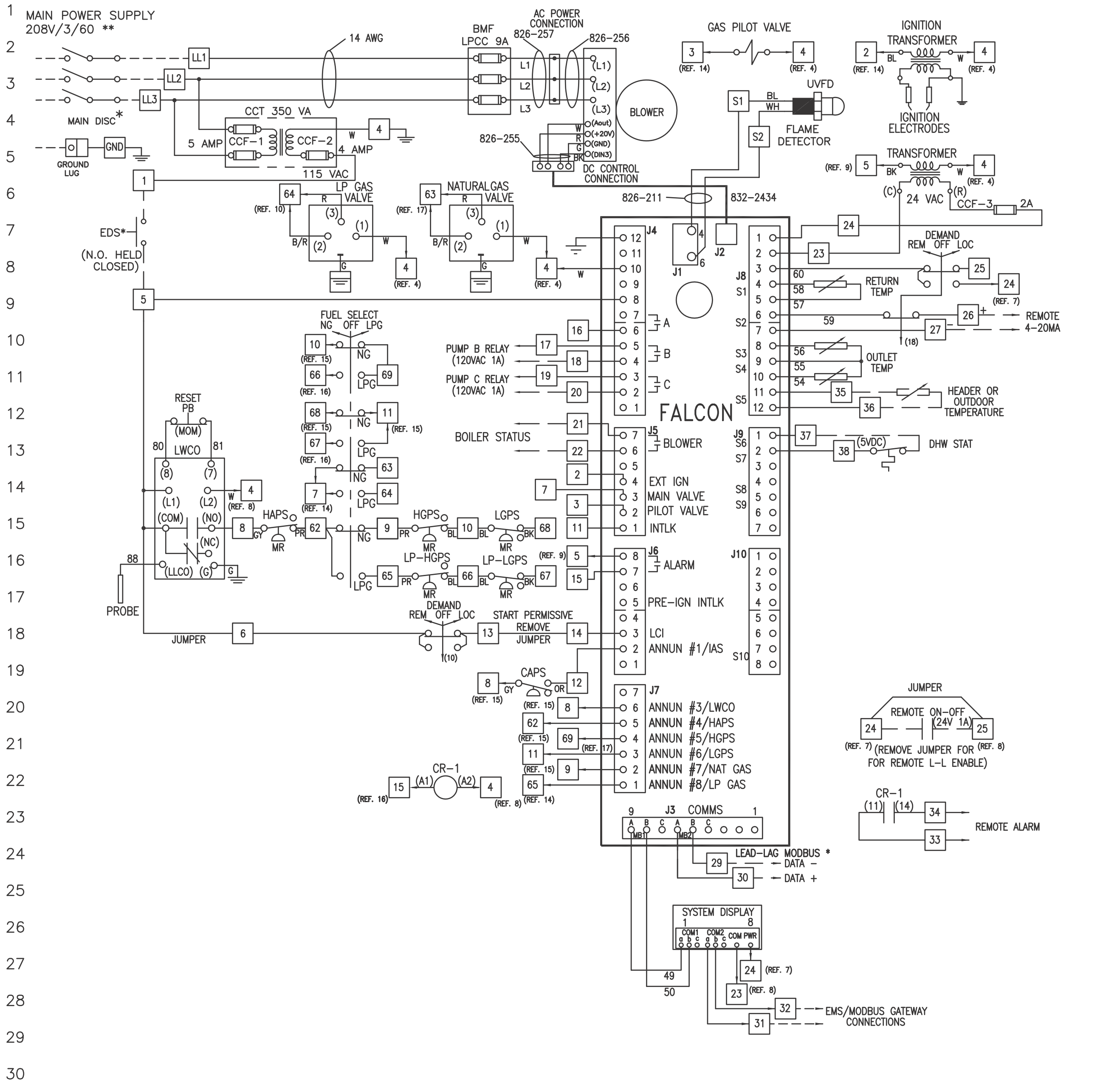


NOTES:
DASHED LINES INDICATE CUSTOMER CONNECTIONS
ALL CONTROL WIRE IS #18 AWG UNLESS OTHERWISE NOTED
COLOR DESIGNATIONS APPLY TO WIRE COLORS INSIDE CONTROL PANEL
☐ DENOTES CONTROL PANEL TERMINAL
* FALCON L-L MODBUS – CONNECT EACH BOILER IN NETWORK DAISY CHAIN
** REFER TO TRANSFORMER DETAIL BELOW TO REWIRE FOR 230V SUPPLY
CONFIRM POWER SUPPLY AND CONTROL CIRCUIT VOLTAGE BEFORE OPERATION!

CUSTOMER CONNECTIONS:
LEAD-LAG MODBUS 29 & 30
BLDG EMS/MODBUS GATEWAY 31 & 32
REMOTE ENABLE 24 & 25
REMOTE 4-20MA INPUT 26 & 27
BOILER STATUS 21 & 22
REMOTE ALARM 33 & 34
HEADER OR OUTDOOR TEMPERATURE 35 & 36
AUX PUMP RELAYS 17 & 18, 19 & 20
DOMESTIC HOT WATER STAT 37 & 38

TERMINALS: LL1,LL2,LL3,GR,1,2,3,4-4-4,5-5-5,6,7,8,9,10,11,12,13,14,15,16, 17,18,19,20,21,22, 23-23,24-24,25,26,27, 28,29,30, 31,32,33,34,35,36, 37,38, S1,S2,

Figure 2-42 CFC 3300 Wiring Diagram



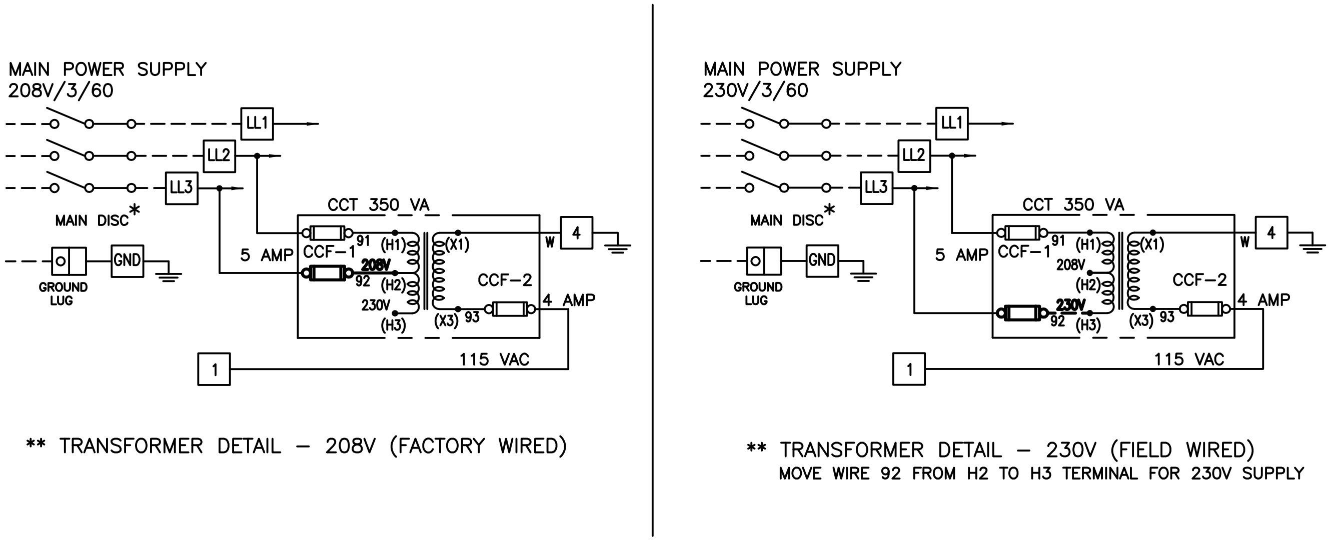
NOTES:
DASHED LINES INDICATE CUSTOMER CONNECTIONS
ALL CONTROL WIRE IS #18 AWG UNLESS OTHERWISE NOTED
COLOR DESIGNATIONS APPLY TO WIRE COLORS INSIDE CONTROL PANEL
☐ DENOTES CONTROL PANEL TERMINAL
* FALCON L-L MODBUS – CONNECT EACH BOILER IN NETWORK DAISY CHAIN
** REFER TO TRANSFORMER DETAIL BELOW TO REWIRE FOR 230V SUPPLY
CONFIRM POWER SUPPLY AND CONTROL CIRCUIT VOLTAGE BEFORE OPERATION!

CUSTOMER CONNECTIONS:
LEAD-LAG MODBUS 29 & 30
BLDG EMS/MODBUS GATEWAY 31 & 32
REMOTE ENABLE 24 & 25
REMOTE 4-20MA INPUT 26 & 27
BOILER STATUS 21 & 22
REMOTE ALARM 33 & 34
HEADER OR OUTDOOR TEMPERATURE 35 & 36
AUX PUMP RELAYS 17 & 18, 19 & 20
DOMESTIC HOT WATER STAT 37 & 38

TERMINALS: LL1,LL2,LL3,GR,1,2,3,4-4-4,5-5-5,6,7,8,9,10,11,12,13,14,15,16, 17,18,19,20,21,22, 23-23,24-24,25,26,27,28,29,30,31,32,33,34,35,36,37,38, 62,63,64,65,66,67,68,69, S1,S2,

Figure 2-43 CFC 3300 Wiring Diagram - Dual Fuel

Figure 2-44 Transformer Detail, CFC 3300



** TRANSFORMER DETAIL – 208V (FACTORY WIRED)

** TRANSFORMER DETAIL – 230V (FIELD WIRED)
MOVE WIRE 92 FROM H2 TO H3 TERMINAL FOR 230V SUPPLY

Section 3

Stack and Intake Vent Sizing and Installation

A. VENTING CONNECTIONS - GENERAL

1. Appliance Categories

Proper installation of flue gas exhaust venting is critical for the efficient and safe operation of the CFC boiler. The boiler's appliance category is a major factor determining venting system design.

Definitions:

Boilers are divided into four categories based on the pressure and temperature produced in the exhaust stack and the likelihood of condensate production in the vent.

- Category I. A boiler which operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.
- Category II. A boiler which operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.
- Category III. A boiler which operates with a positive vent pressure and with a vent gas temperature that avoids excessive condensate production in the vent.
- Category IV. A boiler which operates with a positive vent pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

Depending on the application, the Model CFC may be considered Category II, III, or IV. The specifying engineer should dictate flue venting as appropriate to the installation.

Notice

For additional information on boiler categorization, see appropriate ANSI Z21 Standard and the latest edition Standard of National Fuel Gas Code or in Canada, the latest edition of CSA Standard B149 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of local building codes.

⚠ Warning

Contact the manufacturer of the vent material if there is any question about the boiler categorization and suitability of a vent material for application on a Category II, III or IV vent system. *Using improper venting materials can result in personal injury, death or property damage*.

Notice

During winter months check the vent cap and make sure no blockage occurs from build up of snow. Condensate can freeze on the vent cap. Frozen condensate on the vent cap can result in a blocked flue condition.

2. Vent Stack

The vent should be supported to maintain proper clearances from combustible materials.

Use insulated vent pipe spacers where the vent passes through combustible roofs and walls.

Vent material should be appropriate for the Appliance Category. Application-specific information will further determine the material selected.

In some cases, PVC/CPVC material meeting ULC Type BH Class IIB specifications may be used. Use of PVC/CPVC depends on operating conditions, specific vent suppliers, and any local codes having jurisdiction. Refer to vent manufacturer's specifications for applicability.

3. Vent Terminal Location

Give special attention to the location of the vent termination to avoid possibility of property damage or personal injury.

1. Combustion gases can form a white vapor plume in the winter. The plume could obstruct a window view if the termination is installed in close proximity to windows.
2. Prevailing winds could cause freezing of condensate and water/ ice buildup on building, plants or roof.
3. The bottom of the vent terminal and the air intake shall be located at least 24 inches above grade, including normal snow line.
4. Un-insulated single-wall metal vent pipe shall not be used outside in cold climates for venting combustion gas.
5. Through-the-wall vents for Category II and IV appliances and non-categorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of other equipment. Where local experience indicates that condensate is a problem with Category III appliances, this provision shall also apply.
6. Locate and guard vent termination to prevent accidental contact by people and pets.
7. DO NOT terminate vent in window well, alcove, stairwell or other recessed area, unless previously approved by local authority.
8. DO NOT terminate above any door, window, or gravity air intake. Condensate can freeze causing ice formations.
9. Locate or guard vent to prevent condensate from damaging exterior finishes. Use a 2' x 2' rust resistant sheet metal backing plate against brick or masonry surfaces.
10. **DO NOT extend exposed stack pipe outside of building. In winter conditions condensate could freeze and block stack pipe.**

U.S. Installations- Refer to latest edition of the National Fuel Gas Code.

Vent termination requirements are as follows:

1. Vent must terminate at least four (4) feet below, four (4) feet horizontally, or one (1) foot above any door, window or gravity air inlet to the building.
2. The vent must not be less than seven (7) feet above grade when located adjacent to public walkways.
3. Terminate vent at least three (3) feet above any forced air inlet located within ten (10) feet.
4. Vent must terminate at least four (4) feet horizontally, and in no case above or below unless four (4) feet horizontal distance is maintained, from electric meters, gas meters, regulators, and relief equipment.
5. Terminate vent at least six (6) feet away from adjacent walls.
6. DO NOT terminate vent closer than five (5) feet below roof overhang.

Canada Installations- Refer to the latest edition of CAN/CSA-B149.1 and B149.2

A vent shall not terminate:

1. Directly above a paved sidewalk or driveway which is located between two single family dwellings and serves both dwellings.
2. Less than 7 ft. (2.13m) above a paved sidewalk or paved driveway located on public property.
3. Within 6 ft. (1.8m) of a mechanical air supply inlet to any building.
4. Above a meter/regulator assembly within 3 ft. (900mm) horizontally of the vertical center-line of the regulator.
5. Within 6 ft. (1.8m) if any gas service regulator vent outlet.
6. Less than 1 ft. (300mm) above grade level.
7. Within 3 ft. (1m) of a window or door which can be opened in any building, any non-mechanical air supply inlet to any building to the combustion air inlet of any other appliance.
8. Underneath a verandah, porch or deck, unless:
    - The verandah, porch or deck is fully open on a minimum of two sides beneath the floor.
    - The distance between the top of the vent termination and the underside of the verandah, porch or deck is greater than 1 ft. (30cm)

Note: For direct vent installations where the air is piped in from outside, a protective screen on the air inlet termination elbow must be used to act as an inlet screen.

⚠ Warning

Examine the venting system at least once a year. Check all joints and vent pipe connections for tightness, corrosion or deterioration.

Venting Installation Tips
Support piping: • Horizontal runs- at least every five (5) feet. • Vertical runs - use braces. • Under or near elbows

⚠ Caution

Follow items listed below to avoid personal injury or property damage.

- Cut nonmetallic vent pipe with fine-toothed hacksaw (34 teeth per inch).
- Do not use nonmetallic vent pipe or fittings that are cracked or damaged.
- Do not use nonmetallic vent fittings if they are cut or altered.
- Do not drill holes, or use screws or rivets, in nonmetallic vent pipe or fittings.

B. HORIZONTAL THRU-WALL VENTING / INSIDE COMBUSTION AIR

1. Installation

For boilers connected to gas vents or chimneys, vent installations shall be in accordance with Part 7, Venting of Equipment, of the latest edition of National Fuel Gas Code, or in Canada, the latest edition of CAN/CSA-B 149.1 and.2 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of local building codes.

These installations utilize the boiler-mounted blower to vent the combustion products to the outside. Combustion air is taken from inside the room and the vent is installed horizontally through the wall to the outside. Adequate combustion and ventilation air must be supplied to the boiler room in accordance with the National Fuel Gas Code or, in Canada, the latest edition of CAN/CSA-B 149.1 and .2 Installation Code for Gas Burning Appliances and Equipment.

The direct vent cap is not considered in the overall length of the venting system.

The vent must be installed to prevent flue gas leakage. Care must be taken during assembly to insure that all joints are sealed properly and are airtight.

The vent must be installed to prevent the potential accumulation of condensate in the vent pipes. It is recommended that:

- The vent be installed with a slope of at least 1/4” per foot of horizontal run (direction of line pitch may be back to the boiler or to the vent terminal).
- The vent be insulated through the length of the horizontal run.

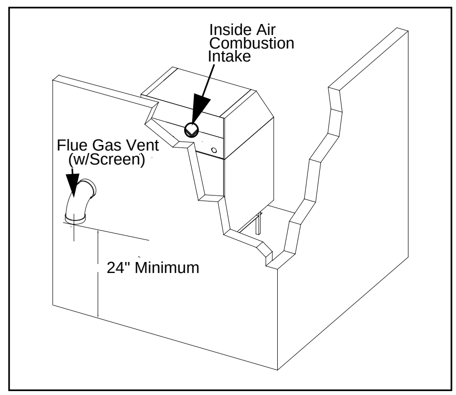


Figure 3-1 Horizontal Venting Thru-Wall Using Inside Air For Combustion

2. Horizontal Thru-Wall Stack Vent Termination

The stack vent cap MUST be mounted on the exterior of the building. The stack vent cap cannot be installed in a well or below grade. The stack vent cap must be installed at least two (2) feet above ground level and above normal snow levels.

C. HORIZONTAL THRU-WALL VENTING / DIRECT VENT COMBUSTION AIR

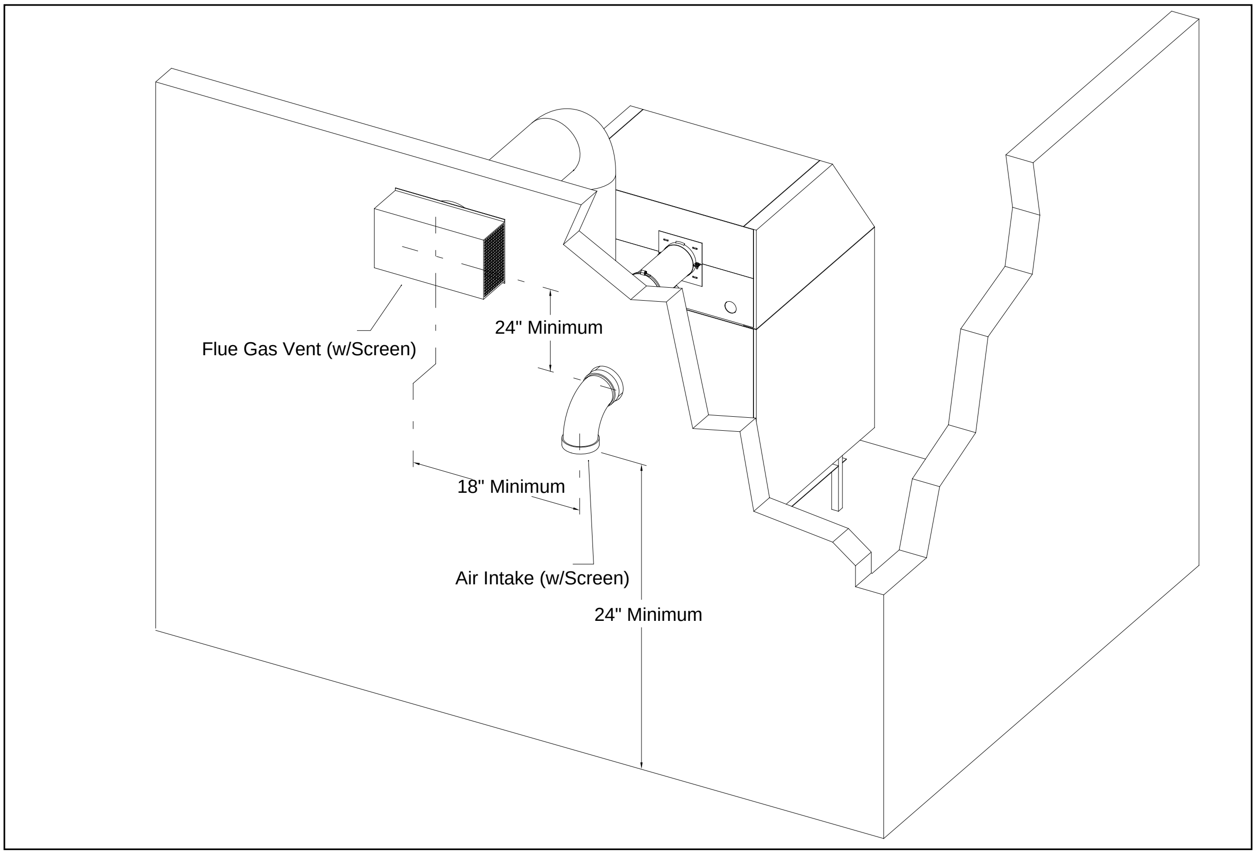


Figure 3-2 Horizontal Thru-wall Direct Venting System (Direct Vent Combustion Air/Stack Venting)

1. Installation

These installations utilize the boiler mounted blower to draw combustion air from outside and vent combustion gases to the outside.

The sealed combustion air vent cap is not considered in the overall length of the venting system.

Care must be taken during assembly that all joints are sealed properly and are airtight for both the combustion air intake and the exhaust stack piping system.

The stack vent must be installed to prevent the potential accumulation of condensate in the stack pipes. It is recommended that:

- The vent be installed with a slope of at least 1/4” per foot of horizontal run (direction of line pitch may be back to the boiler or to the vent terminal).
- The vent be insulated through the length of the horizontal run.

2. Horizontal Thru-Wall Stack Vent Termination

The stack vent cap MUST be mounted on the exterior of the building. The stack vent cap cannot be installed in a well or below grade. The stack vent cap must be installed at least one (l) foot above ground level and above normal snow levels.

Multiple stack vent caps should be installed in the same horizontal plane with a three (3) foot clearance from the side of one stack cap to the side of the adjacent stack vent cap(s).

Combustion air supplied from outside must be free of particulate and chemical contaminants. To avoid a blocked flue condition, keep all the vent caps clear of snow, ice, leaves, debris, etc.

If the boiler is vented directly out through the sidewall with no elbows and less than 10 feet of vent pipe, a restricted direct vent termination should be utilized. A well designed direct vent termination should minimize the effect of adverse wind conditions

⚠ Caution

Multiple direct stack vent caps MUST NOT be installed with one combustion air inlet directly above a stack vent cap. This vertical spacing would allow the flue products from the stack vent cap to be pulled into the combustion air intake installed above. This type of installation can cause non warrantable problems with components and poor operation of the unit due to the recirculation of flue products.

D. VERTICAL VENTING / INSIDE COMBUSTION AIR

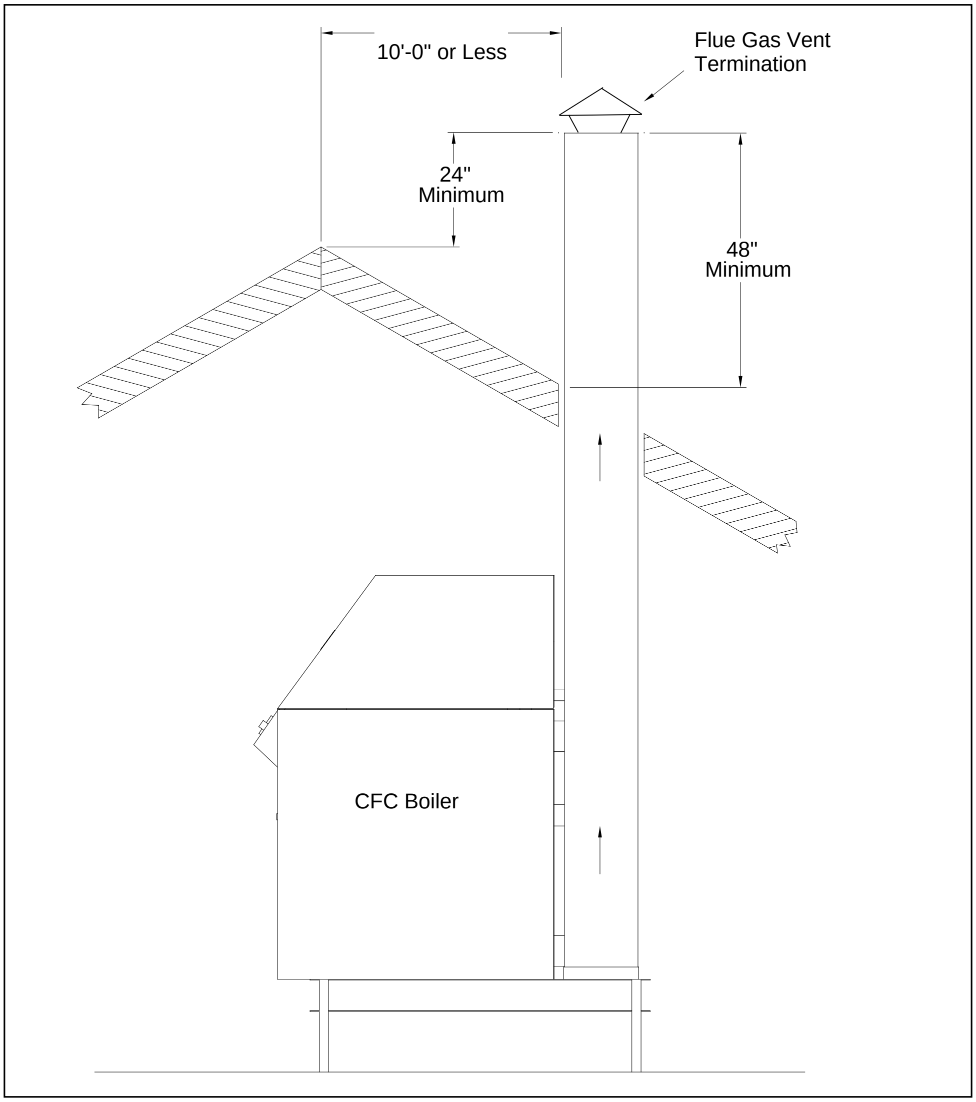


Figure 3-3 Vertical Stack with Inside Combustion Air

These installations utilize the boiler-mounted blower to vent the combustion products to the outside. Combustion air is taken from inside the room and the vent is installed vertically through the roof to the outside. Adequate combustion and ventilation air must be supplied to the boiler room in accordance with the National Fuel Gas Code or, in Canada, the latest edition of CAN/CSA-B 149.1 and 149.2 Installation Code for Gas Burning Appliances and Equipment.

To prevent accumulation of condensation in the vent, it is required to install the horizontal portion of vent with a slight slope of at least 1/4” per foot of horizontal run, pitched either back to the boiler or to a low point equipped with suitable condensate trap and drain.

Warning

No substitutions of flue pipe or vent cap material are allowed. Such substitutions would jeopardize the safety and health of inhabitants.

The Stainless Steel non-restricted direct vent cap must be furnished in accordance with AGA/CSA requirements.

E. VERTICAL VENTING / DIRECT VENT COMBUSTION AIR

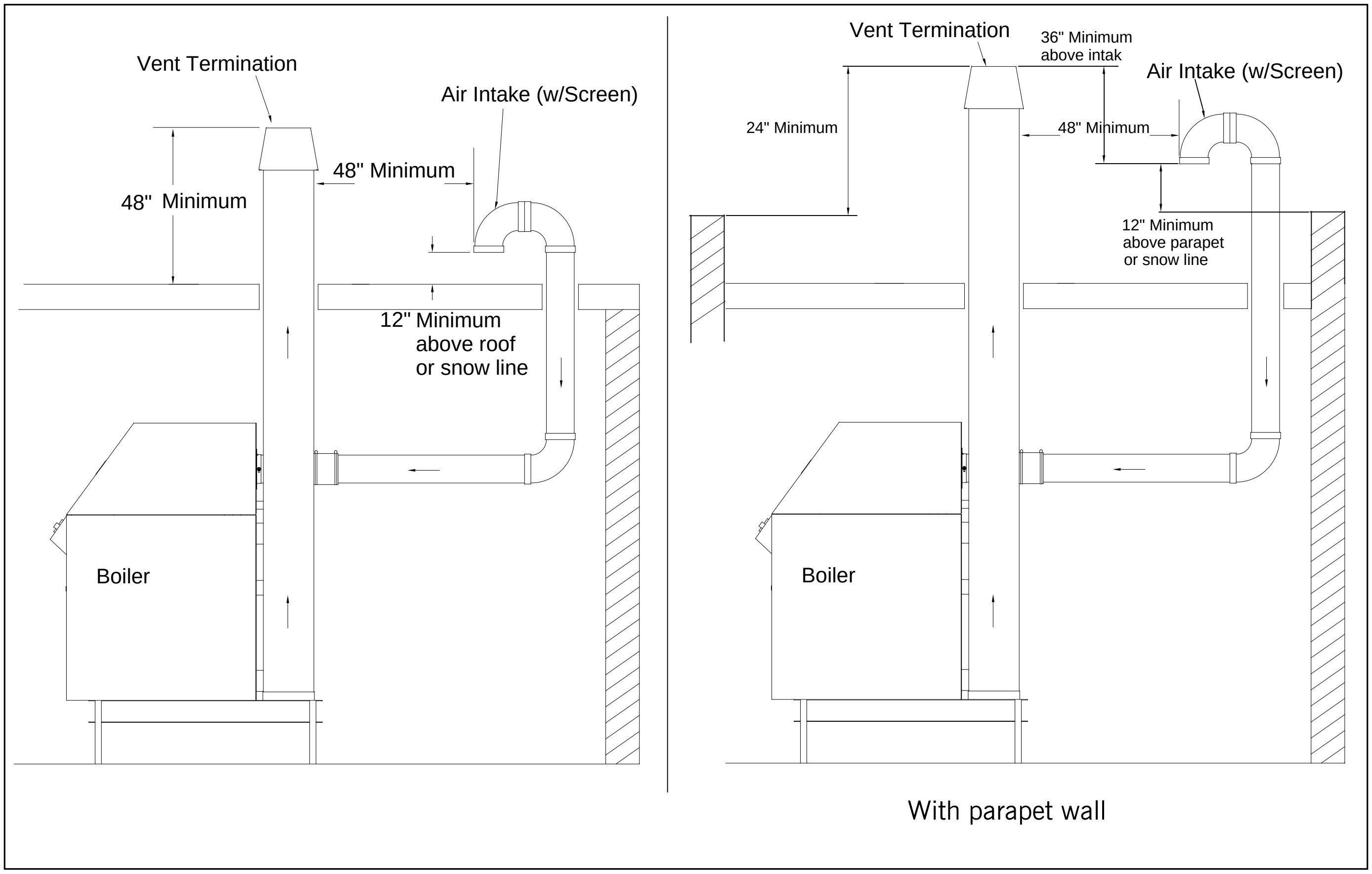


Figure 3-4 Vertical Stack with Direct Vent Combustion Air

These installations utilize the boiler-mounted blower to draw combustion air from outside and vent combustion products to the outside.

To prevent accumulation of condensation in the vent, it is required to install the horizontal portion of vent with a slight slope of at least 1/4” per foot of horizontal run, pitched either back to the boiler or to a low point equipped with suitable condensate trap and drain.

F. STACK SIZING

1. Stack design using room air for combustion

Table 3-1 STACK DESIGN (SINGLE BOILER) USING ROOM AIR

Boiler	Boiler Stack/Flue Connection	Boiler Flue/Stack Size	Maximum length of Flue Gas Vent in Feet*	Flue Connection Part No.	Room Combustion Air Required (CFM)	Air Filter Kit No. (optional)
CFC 500	**6" Standard**	**6"**	**80**	**039-01704**	125	880-01858
CFC 750	**6" Standard**	**6"**	**60**	**039-01704**	190	880-01858
CFC1000	6" Option	6"	80	039-01646	250	880-01858
CFC1000	**8" Standard**	**8"**	**140**	**039-01647**	250	880-01858
CFC1000	10" Option	10"	200	039-01705	250	880-01858
CFC1500	8" Option	8"	60	039-01645	375	880-02005
CFC1500	**10" Standard**	**10"**	**80**	**039-01644**	375	880-02005
CFC1500	12" Option	12"	120	039-01688	375	880-02005
CFC1800	10" Option	10"	60	039-01644	450	880-02005
CFC1800	**12" Standard**	**12"**	**100**	**039-01688**	450	880-02005
CFC 2500	**12" Standard**	**12"**	**110**	**039-01688**	625	880-02005
CFC3300	**12" Standard**	**12"**	**60**	**039-01761**	800	880-02502
CFC3300	14" Option	14"	110	039-01762	800	880-02502

* Each additional 90 elbow equals 5 equivalent feet of ductwork. Flue terminations may add 5-10 feet to the equivalent length and should also be included in the equivalent length calculation.
** Increasing the diameter of the air intake will reduce the overall pressure drop and thereby allow longer total vent lengths.

Draft tolerance at boiler flue connection during operation is +/- 0.25” WC.

2. Stack design using direct vent combustion

Table 3-2 STACK SIZING USING OUTSIDE AIR FOR COMBUSTION (DIRECT VENT COMBUSTION)

Boiler	Boiler Stack/Flue Connection	Combustion Air Intake Duct & Connection	Boiler Flue/Stack Size	Maximum length of Flue Gas Vent in Feet*	Maximum length of Air Intake Duct in Feet**	Direct Vent Combustion Air Kit	Flue Connection Part No.
CFC 500	6" Standard	4"	6"	75	75	880-01312	039-01704
CFC 500	6" Standard	6"	6"	80	80	880-03736	039-01704
CFC750	6" Standard	4"	6"	40	40	880-01312	039-01704
CFC 750	6" Standard	6"	6"	50	50	880-03736	039-01704
CFC1000	6" Option	4"	6"	30	30	880-01312	039-01646
CFC1000	6" Option	6"	6"	40	40	880-03736	039-01646
CFC1000	8" Standard	4"	8"	50	50	880-01312	039-01647
CFC1000	8" Standard	6"	8"	60	60	880-03736	039-01647
CFC1000	10" Option	4"	10"	70	70	880-01312	039-01705
CFC1000	10" Option	6"	10"	80	80	880-03736	039-01705
CFC1500	8" Option	6"	8"	30	30	880-01313	039-01645
CFC1500	8" Option	8"	8"	40	40	880-02451	039-01645
CFC1500	10" Standard	6"	10"	40	40	880-01313	039-01644
CFC1500	10" Standard	8"	10"	60	60	880-02451	039-01644
CFC1500	12" Option	6"	12"	60	60	880-01313	039-01688
CFC1500	12" Option	8"	12"	80	80	880-02451	039-01688
CFC1800	10" Option	6"	10"	40	40	880-01313	039-01644
CFC1800	10" Option	8"	10"	55	55	880-02451	039-01644
CFC1800	12" Standard	6"	12"	50	50	880-01313	039-01688
CFC1800	12" Standard	8"	12"	80	80	880-02451	039-01688
CFC 2500	12" Standard	8"	12"	100	100	880-02451	039-01688
CFC3300	12" Standard	8"	12"	55	55	880-02501	039-01761
CFC3300	14" Option	8"	14"	100	100	880-02501	039-01762

* Each additional 90 elbow equals 5 equivalent feet of ductwork. Flue terminations may add 5-10 feet to the equivalent length and should also be included in the equivalent length calculation.
** Increasing the diameter of the air intake will reduce the overall pressure drop and thereby allow longer total vent lengths.

Draft tolerance at boiler flue connection during operation is +/- 0.25” WC.

G. VENTING FOR MULTIPLE UNITS

Cleaver-Brooks recommends that each Model CFC in a multiple boiler installation be vented individually. If it becomes necessary to connect multiple boilers to a common breeching, measures should be taken to ensure an unrestricted flow of flue gas from each boiler.

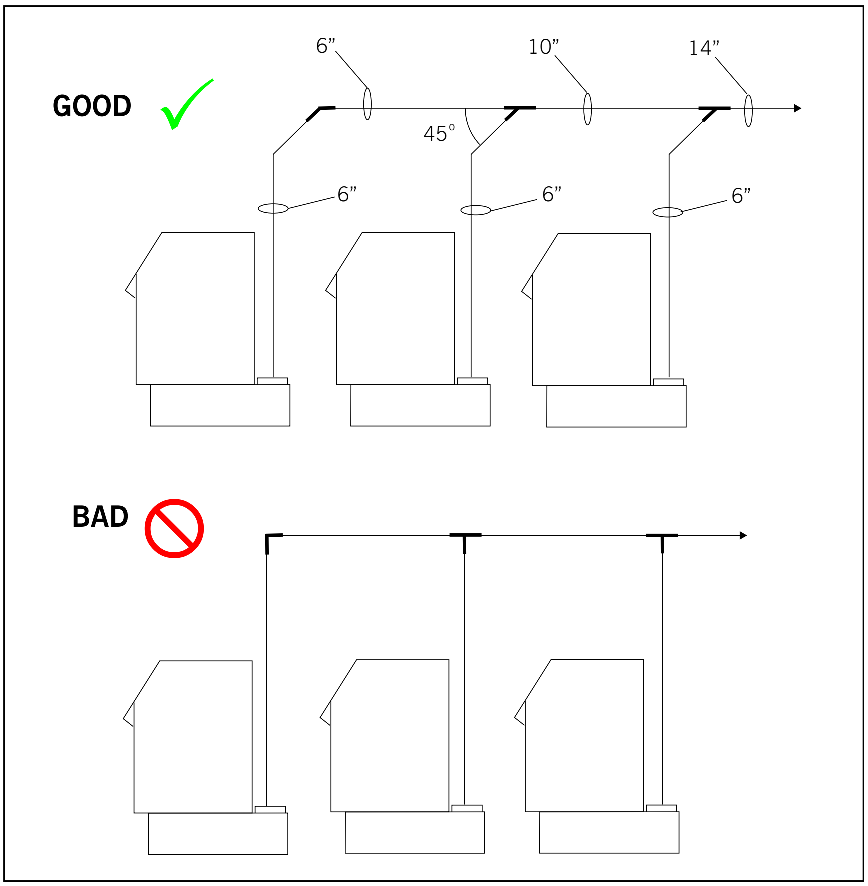
An active draft inducer is recommended when venting multiple boilers. In the absence of a draft inducer, ductwork sizing and connections require special attention.

Use ‘wye’ connections (not ‘tees’) to connect each boiler to the common breeching (see Examples 1 and 2 below).

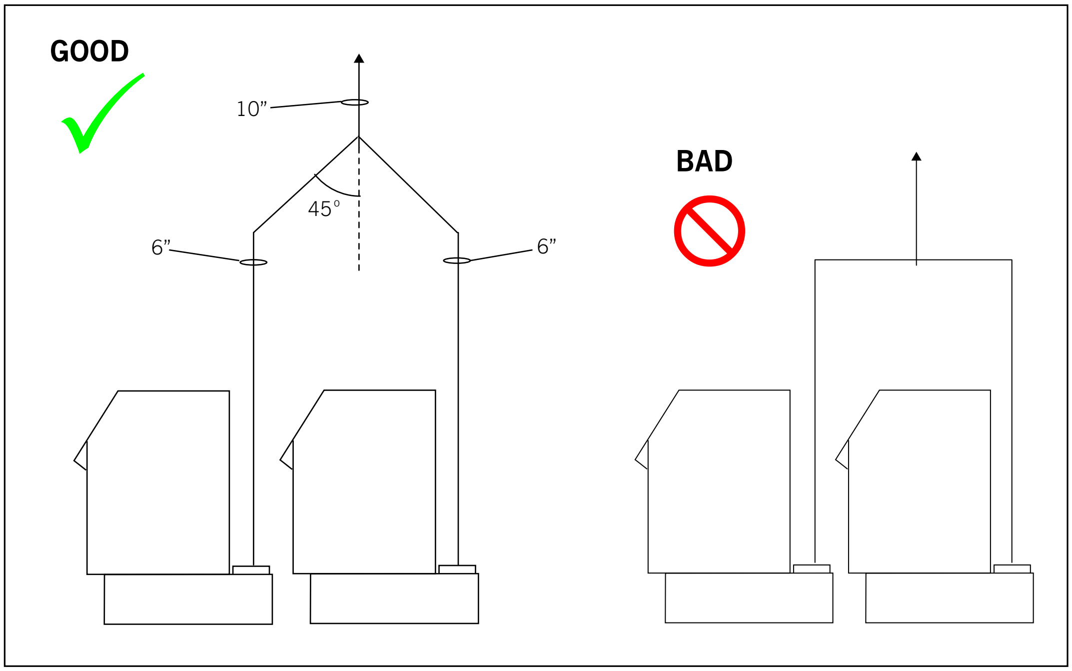
Breeching should be sized upward when necessary to accommodate additional boilers (see Example 3). As a rule of thumb, the cross-sectional area of any ductwork downstream of a wye connection should be equal to or greater than the combined area of the incoming vent sections.

When multiple boilers are connected in a CB Falcon-controlled lead/lag network, a ‘Fan rate during off cycle’ feature is available. When a boiler goes off line and completes a post purge, the fan will continue to run at a user-selectable rate. This feature provides a further measure to prevent flue gas from flowing back into the boiler.

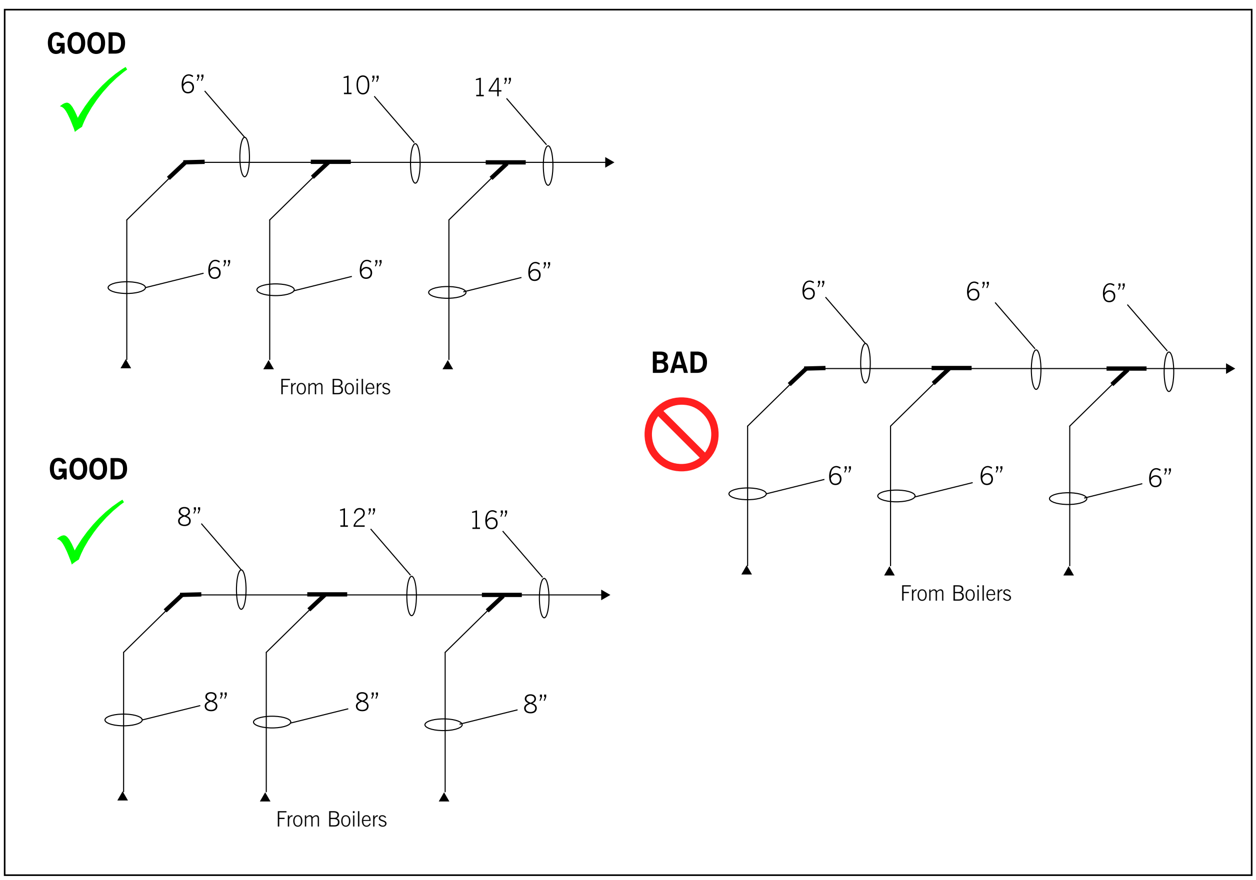
EXAMPLE 1



EXAMPLE 2



EXAMPLE 3



H. COMBUSTION AIR/BOILER ROOM VENTILATION REQUIREMENTS

The boiler(s) must be supplied with adequate quantities of uncontaminated air to support proper combustion and equipment ventilation. Air shall be free of chlorides, halogens, fluorocarbons, construction dust or other contaminants that are detrimental to the burner/boiler. If these contaminants are present, we recommend the use of direct vent combustion provided the outside air source is uncontaminated.

Combustion air can be supplied by means of conventional venting, where combustion air is drawn from the area immediately surrounding the boiler (boiler room must be positive pressure), or with direct vent (direct vent combustion) where air is drawn directly from the outside. All installations must comply with local Codes and with NFPA 54 (the National Fuel Gas Code - NFGC) for the U.S. and for Canada, CAN/CGA B 149.1 and B 149.2.

Note: A boiler room exhaust fan is not recommended as this type of device can cause a negative pressure in the boiler room if using a conventional air intake.

In accordance with NFPA54, the required volume of indoor air shall be determined in accordance with the "Standard Method" or "Known Air Infiltration Rate Method. Where the air infiltration rate is known to be less than 0.40 Air Changes per Hour, the Known Air Infiltration Rate Method shall be used (see Section 8.3 in the NFPA54 Handbook for additional information).

1. Air Supply - Unconfined Spaces (For U.S. Installations Only)

A. **All Air From Inside the Building** - If all combustion air is drawn from inside the building (the mechanical equipment room does not receive air from outside via louvers or vent openings and the boiler is not equipped with direct vent combustion) and the boiler is located in an unconfined space, use the following guidelines:

1. The mechanical equipment room must be provided with two permanent openings linked directly with additional room (s) of sufficient volume so that the combined volume of all spaces meet the criteria for an unconfined space. Note: An "unconfined space" is defined as a space whose volume is more than 50 cubic feet per 1,000 Btu per hour of aggregate input rating of all appliances installed in that space.
2. Each opening must have a minimum free area of one square inch per 1,000 Btu per hour of the total input rating of all gas utilizing equipment in the mechanical room.

3. One opening must terminate within twelve inches of the top, and one opening must terminate within twelve inches of the bottom of the room.
4. Refer to the NFGC, Section 8.3 for additional information.

B. **All Air From Outdoors** - If all combustion air will be received from outside the building (the mechanical room equipment is linked with the outdoors), the following methods can be used:

1. Two Opening Method - The mechanical equipment room must be provided with two permanent openings, one terminating within twelve inches from the top, and one opening terminating within twelve inches of the bottom of the room.
2. The openings must be linked directly (**Figure 3-5**) or by ducts (**Figure 3-6**) with the outdoors.
3. Each opening must have a minimum free area of one square inch per 4,000 Btu per hour of total input rating of all equipment in the room, when the opening is directly linked to the outdoors or through vertical ducts.
4. The minimum free area required for horizontal ducts is one square inch per 2,000 Btu per hour of total input rating of all the equipment in the room.

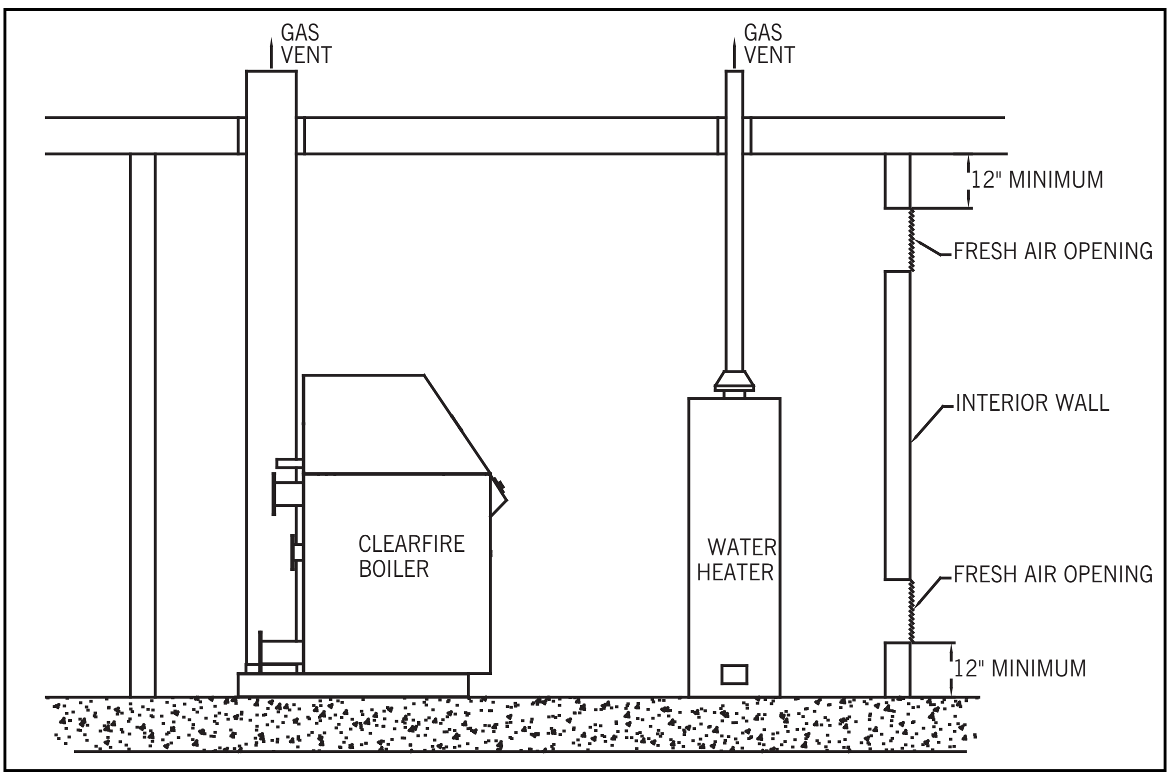


Figure 3-5 Two Opening Outside Wall Method

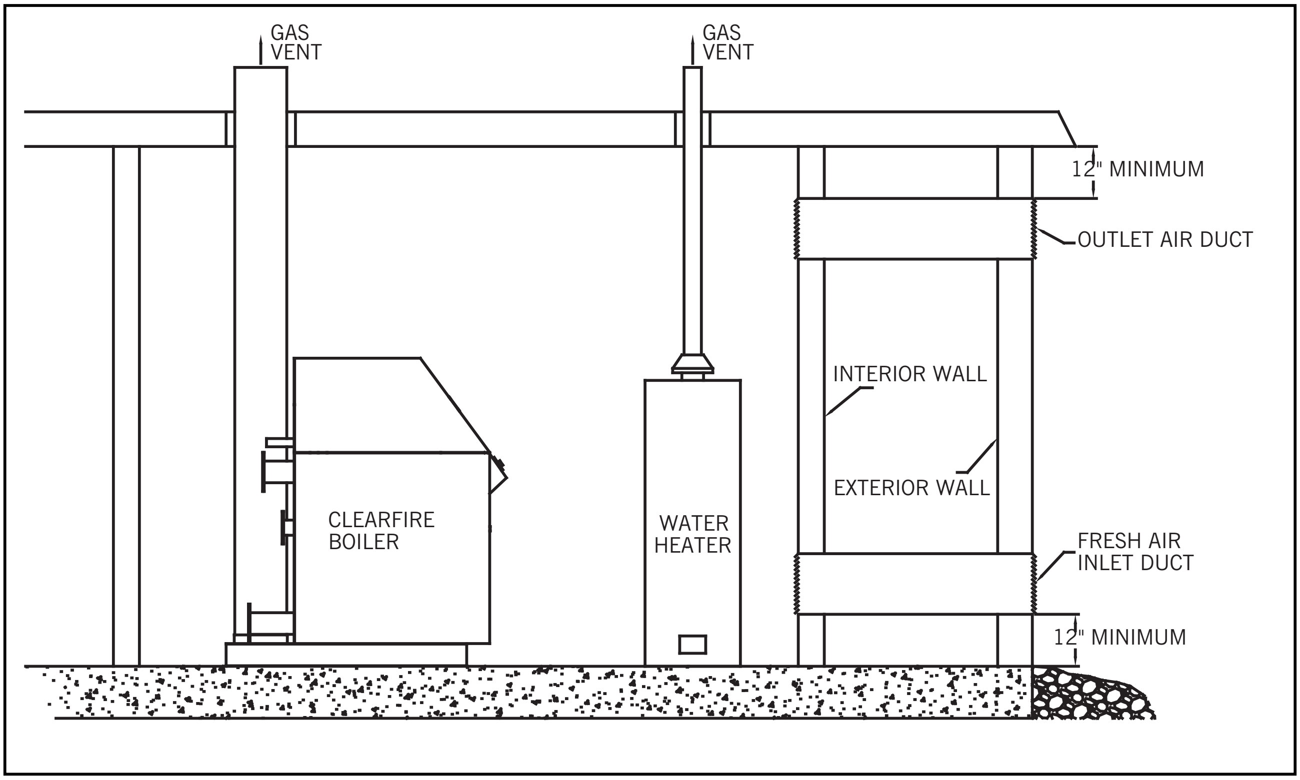


Figure 3-6. Two Opening Ducted Method

C. One Opening Method (**Figure 3-7**) - One permanent opening, commencing within 12 inches of the top of the enclosure, shall be provided.

1. The equipment shall have clearances of at least 1 inch from the sides and back and 6 inches from the front of the appliance.
2. The opening shall directly communicate with the outdoors and shall have a minimum free area of 1 square inch per 3000 BTU's per hour of the total input rating of all equipment located in the enclosure, and not less than the sum of the areas of all vent connectors in the confined space.
3. Refer to the NFGC, Section 8.3 for additional information.

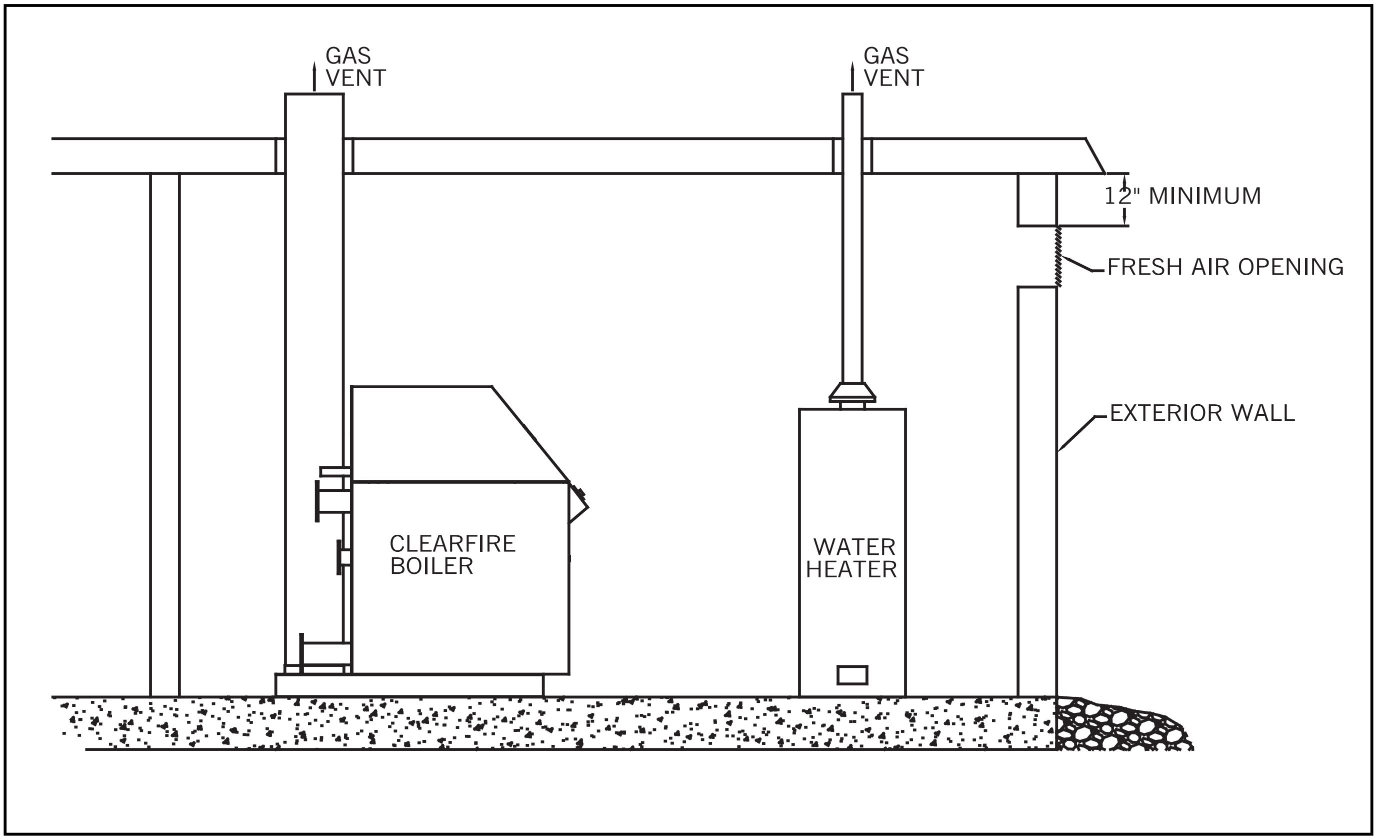


Figure 3-7. One Opening Method

2. Air Supply - Engineered Method

When determining boiler room air requirements for an unconfined space, the size of the room, airflow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in the boiler room.
   - A. Two permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler. See **Figure 3-8**.
   - B. Air supply openings can be louvered for weather protection, but they should not be covered with fine mesh wire, as this type of covering has poor air flow qualities and is subject to clogging with dirt and dust.
   - C. A vent fan in the boiler room is not recommended, as it could create a slight vacuum under certain conditions and cause variations in the quantity of combustion air. This can result in unsafe burner performance.
   - D. Under no condition should the total area of the air supply openings be less than one square foot.

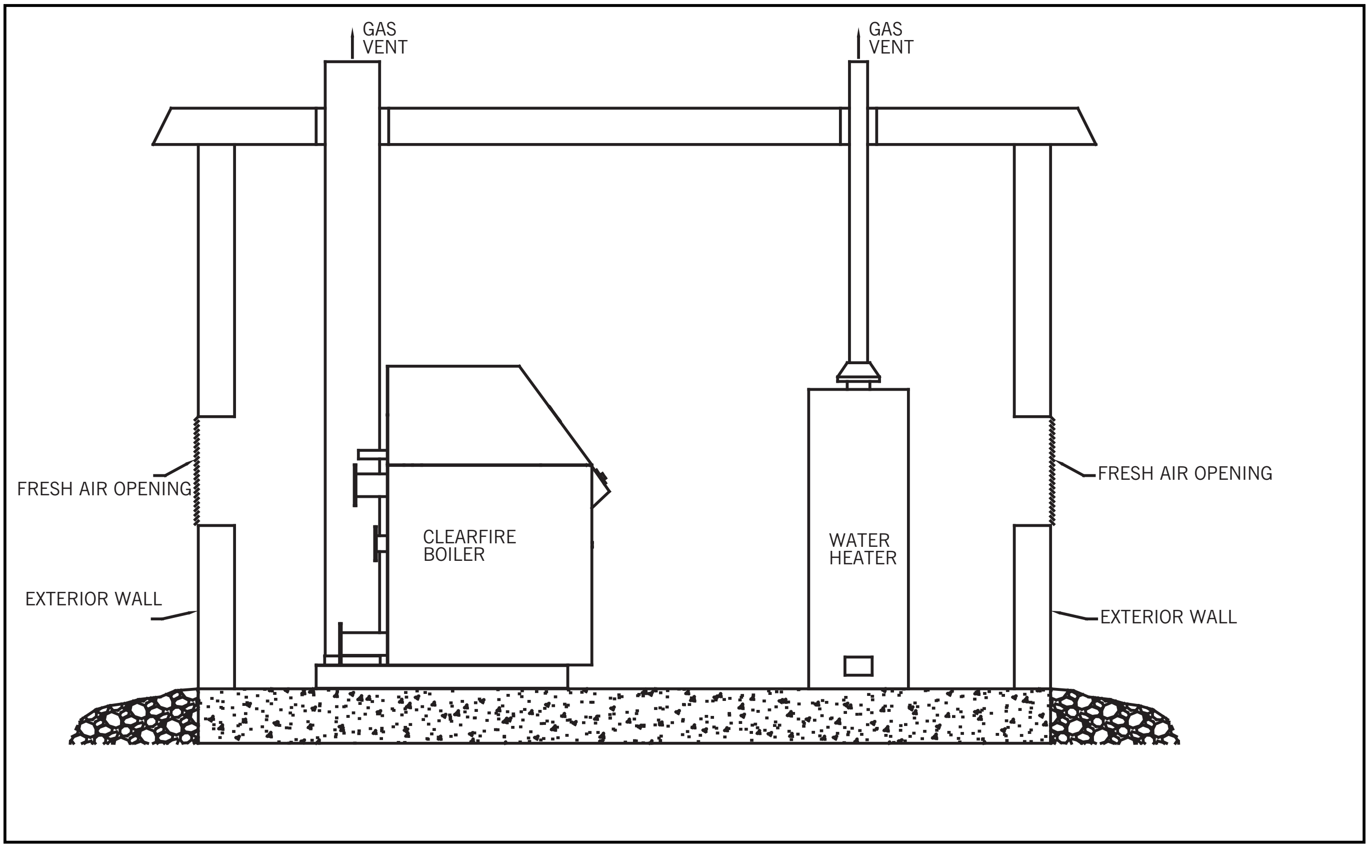


Figure 3-8. Two Opening Engineered Method

E. Size the openings by using the formula:

Area in square feet = cfm/fpm

Where cfm = cubic feet per minute of air

Where fpm = feet per minute of air

2. Amount of Air Required (cfm).
   A. Combustion Air = 0.25 cfm per kBtuh.
   B. Ventilation Air = 0.05 cfm per kBtuh.
   C. Total air = 0.3 cfm per kBtuh (up to 1000 feet elevation. Add 3% more per 1000 feet of added elevation).
3. Acceptable air velocity in the Boiler Room (fpm).
   A. From floor to 7 feet high = 250 fpm.
   B. Above 7 feet above floor = 500 fpm.

Example: Determine the area of the boiler room air supply openings for (2) Clearfire 1800 boilers at 750 feet elevation. The air openings to be 5 feet above floor level.

- Air required: 1800 x 2 = 3600 kBtuh. From 2C above, 3600 x 0.3 = 1,080 cfm.
- Air Velocity: Up to 7 feet = 250 fpm from 3 above.

- Area required: Area = cfm/fpm = 1,080/250 = 4.32 square feet total.
- Area/Opening: 4.32/2 = 2.16 sq-ft/opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

Direct Vent Combustion

If combustion air will be drawn directly from the outside by means of a duct connected to the burner air intake, use the following as a guide:

1. Install combustion air vent (direct vent combustion) in accordance with the boiler's Operating and Maintenance manual.
2. Provide for adequate ventilation of the boiler room or mechanical equipment room.
3. In cold climates, and to mitigate potential freeze-up of the intake pipe, it is highly recommended that a motorized sealed damper be used to prevent the circulation of cold air through the boiler during non-operating hours.
4. Refer to **Figure 3-2** and **Figure 3-4** for suggested piping of direct vent combustion installations. **Figure 3-9** shows the optional direct vent combustion kit providing easy adaptation of the contractor supplied air duct to boiler connection. Refer to Table 3-2 for sizing the direct vent combustion air pipe.

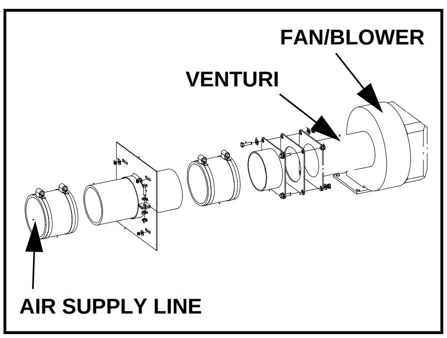


Figure 3-9. Optional Direct Vent Combustion Kit

Note: Any direct vent ductwork should be securely attached to the boiler casing. No weight should be supported by the venturi. Venting should be installed to allow easy disconnection for burner service. For best results, the Cleaver-Brooks direct vent kit is recommended. See Table 3-2 for kit part numbers.

Section 4

CFC Commissioning

⚠ Warning

The boiler and its gas connection must be leak tested before placing the boiler in operation.

A. OPERATING CONDITIONS

- The installation site should be as free as possible from vibration, dust, and corrosive media
- The controllers should be located as far as possible from sources of electromagnetic fields, such as frequency converters or high-voltage ignition transformers
- Control panel must be connected to earth ground.
- Refer to Section 3 in this manual for combustion air requirements.

Warning

When using direct vent combustion in cold climates, special care must be taken to observe combustion air temperature limits. *Failure to follow this precaution may lead to equipment damage or unsafe operation.*

Boiler room ambient conditions	
Relative humidity	≤ 85% non-condensing
Ambient temperature range	0 ºC to 50 ºC / 32ºF to 122ºF
Storage temperature range	-40 ºC to 60 ºC / -40ºF to 140ºF
Combustion air temperature	0 ºC to 50 ºC / 32ºF to 122ºF

B. FILLING BOILER

Fill the boiler and/or hydronic system. Water should be circulated through the system to allow entrapped air to escape at appropriate air venting provisions. Check to ensure that no leaks appear at any pipe connections and correct if water leaks are noticed. When no air remains in the boiler, it will be possible to reset the low water cutoff. If the low water cutoff can not be reset, it is likely that some air remains in the boiler.

C. CONTROL SETPOINTS

Preliminary settings of the burner/boiler safety controls are necessary for the initial starting of the boiler. After the burner has been properly set, minor adjustments to these controls may be necessary for the particular installation. For initial starting, set the following controls accordingly:

1. Combustion Air Proving Switch - Set the dial @ minimum.
2. Low Gas Pressure Switch - Set the dial @ minimum.
3. High Gas Pressure Switch - Set the dial @ maximum.
4. High Air Pressure Switch - Set the dial @ maximum.

Depress all manual reset buttons for all controls prior to starting.

Figure 4-1 Opening Control Panel

D. MODEL CFC BOILER / BURNER CONTROLLER

The Model CFC boiler uses the CB Falcon hydronic boiler control system. Primary controller functions include:

- Flame supervision
- Burner sequencing
- Heating/modulation control
- Hot water system pump control
- High Limit temperature control
- Thermowell-mounted NTC temperature sensors to provide measured process variable signals to the controller.

Additional features include:

- User-friendly touchscreen interface
- Modbus communication capability
- Alarm/lockout messaging with history (last 15 messages)
- Annunciation
- Outdoor reset
- Central Heating and Domestic Hot Water loop control
- Password protection of configurable parameters
- Time of Day (dual setpoint) control
- High Stack Temperature limit
- Remote reset
- Lead/Lag sequencing
- (3) configurable pump relays
- Remote modulation/remote setpoint
- Frost protection

Please review the tables within this Commissioning section to familiarize yourself with the functions and parameters of the Controller. Also see Appendices A and B for details on control configuration and operation.

Warning

The Model CFC is factory tested. Nevertheless, all burner safety controls should be checked upon installation, prior to initial firing. **Failure to verify burner control functioning could result in severe bodily injury or death.**

Figure 4-2 CB Falcon Controller

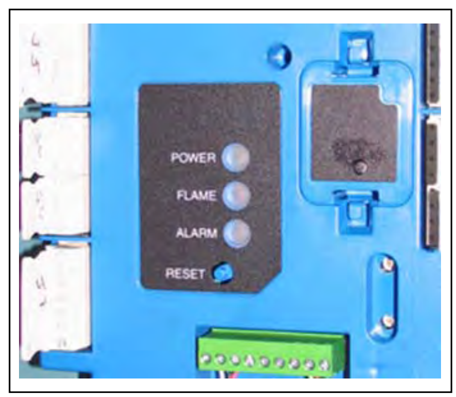


Figure 4-3 Controller status LEDs and reset button

E. CB FALCON DISPLAY/OPERATOR INTERFACE

The CB Falcon display/operator interface is mounted at the left side of the control panel for convenient access to all operating controls.

Figure 4-4 CB Falcon Display/ Operator Interface

1. Home Page

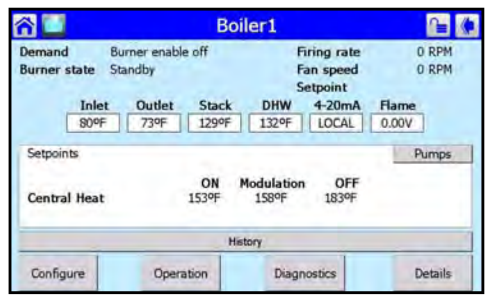
Apply power to the boiler. The Home page will appear on the CB Falcon display.

Each CB Falcon in the hydronic system is represented on the Home page by an icon and name.

2. Status Page

Pressing the Falcon icon takes the user to the Status page, which summarizes boiler status and allows navigation to the configuration, operational, and diagnostic areas of the CB Falcon interface.

Home page



Status page

The **Demand** display will show one of the following:

Burner enable off
Off (burner switch on but no demand)
Central Heat
Domestic Hot Water (if configured)

Burner state shows the currently active step in the burner operating sequence.

The central portion of the display can be toggled between the following:

Pumps shows the on/off status of boiler and system pumps.
Modulation shows fan speed RPM settings for Demand, Limited, and Override rates
Setpoints shows the ON, Modulation, and OFF temperature setpoints.

3. Operation Page

The operation page (**Figure 4-5**) displays the CB Falcon running operation, including setpoint and firing rate values. From this page the user can change setpoints, manually control the boiler's firing rate, manually turn pumps on, view annunciation information, and switch between heating loops (Central Heat and Domestic Hot Water). If a password is required to change any of the settings on this page, the user can press the Login button to enter the password.

The burner is enabled from this page by turning the <Burner switch> screen button ON.

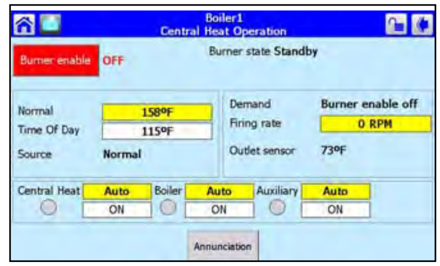


Figure 4-5 Operation Page

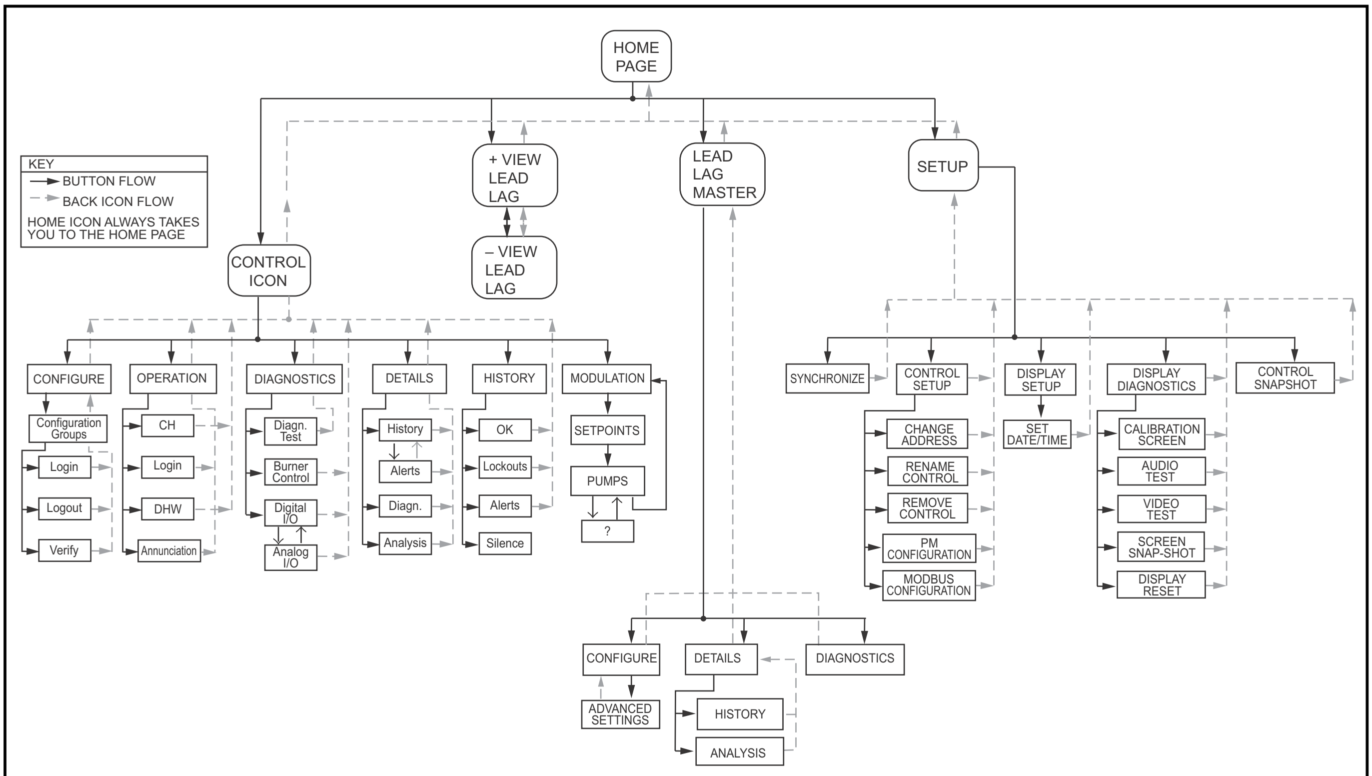


Figure 4-6 Falcon Display/Interface page flow

4. Lockouts, Holds, and Alerts

To assist in monitoring boiler operation, the CB Falcon control system employs messages of three types: **Lockouts**, **Holds**, and **Alerts**.

- **Lockouts** and **Holds** indicate interruptions in boiler operation, whether occurring as part of the normal operating sequence or due to an abnormal condition. Lockouts require a manual reset to continue operation, while Holds do not. A Hold will automatically clear when the hold condition is removed or satisfied.

The most recent Lockouts are stored in CB Falcon memory and may be accessed through the Lockout History. Holds are not logged in memory.

Note: *Before attempting to restart the boiler after a Lockout, identify and correct the Lockout condition.*

- **Alerts** indicate conditions or events which, while not preventing boiler operation, may nevertheless be of interest in evaluating boiler performance or operating conditions. Examples include certain operator actions, out-of-range configuration data, controller internal status reports (e.g. timers, counters, memory read/write activity), and recycle events. Alerts require no operator acknowledgment and are for informational purposes only.

The most recently occurring message (Lockout, Hold, or Alert) is displayed in the alarm banner on the Status screen (see **Figure 4-7**). Press this banner to access the Alert or Lockout History, where a list of the most recently occurring Alerts/Lockouts can be viewed.

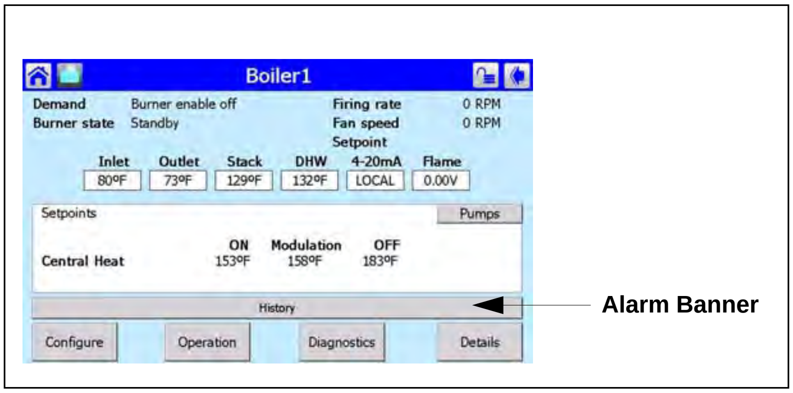


Figure 4-7 Alarm Banner

To obtain more information for a particular message, press that item in the respective history list. For Alerts, burner cycle and hours of operation at the time of occurrence will be displayed. For Lockouts, in addition to cycle and hours the screen will show on/off status of all interlocks at the time of the lockout. This information can be used to help pinpoint the cause of a particular Lockout.

See also Chapter 5, Section E - **Troubleshooting**.

F. CONTROLLER CONFIGURATION

The CB Falcon controller should be factory configured for the specific CFC boiler model. Prior to starting the boiler, verify that the factory default settings are correct for your application. Please refer to CB default settings, Table 4-1, and make any changes at this time if needed.

CB Falcon configuration is organized into the following functional groups:

- System Identification & Access
- CH - Central Heat ConfigurCation
- Outdoor Reset Configuration
- DHW - Domestic Hot Water Configuration
- Modulation Configuration
- Pump Configuration
- Statistics Configuration

- High Limits
- Stack Limit
- Other Limits
- Anti-condensation Configuration
- Frost Protection Configuration
- Annunciation Configuration
- Burner Control Interlocks
- Burner Control Timings & Rates
- Burner Control Ignition
- Burner Control Flame Failure
- System Configuration
- Fan Configuration
- Lead Lag Configuration

Table 4-1 CFC Falcon Parameters

Parameter Group	Parameter Name	Access	Min. Range	Max. Range	Parameter Units	Default Setting - CFC-500 to -2500	Default Setting - CFC-3300	Installation Setting	Modbus Register (dec)
System ID & Access	Burner name	Service				BOILER 1	BOILER 1		183
System ID & Access	Installation data	Service				SERIAL NUMBER	SERIAL NUMBER		184
System ID & Access	OEM identification	Read Only				FALCON 833-03639	FALCON 833-04086		185
System ID & Access	Installer password	Service				9220	9220		190
System ID & Access	MB1 (Modbus address)	Service				1	1		625
System ID & Access	MB2 (Modbus address)	Service				1	1		625
Central Heat Configuration	CH enable	user				Enabled	Enabled		208
Central Heat Configuration	CH demand switch	user				B:STAT terminal	B:STAT terminal		209
Central Heat Configuration	CH modulation sensor	user				A:Modulation from Outlet (S3S4) sensor	A:Modulation from Outlet (S3S4) sensor		210
Central Heat Configuration	CH setpoint	user	32	210	°F	150	150		211
Central Heat Configuration	CH TOD setpoint	user	32	194	°F	120	120		212
Central Heat Configuration	CH on hysteresis	Service	2	60	°F	5	5		213
Central Heat Configuration	CH off hysteresis	Service	2	60	°F	15	15		214
Central Heat Configuration	CH P gain	Service				25	25		216
Central Heat Configuration	CH I gain	Service				25	25		217
Central Heat Configuration	CH D gain	Service				0	0		218
Central Heat Configuration	CH hysteresis step time	Service			mmm ss	1m 0s	1m 0s		219
Central Heat Configuration	CH setpoint source	Service				A:Local setpoint is used	A:Local setpoint is used		578
Central Heat Configuration	CH modulation rate source	Service				A:Local modulation (PID) is used	A:Local modulation (PID) is used		580
Central Heat Configuration	CH has priority over LL	Service				No/False/Off	No/False/Off		582
Central Heat Configuration	CH 4 mA water temperature	Service		194	°F	60	60		583
Central Heat Configuration	CH 20 mA water temperature	Service		194	°F	180	180		584
Outdoor Reset Configuration	CH outdoor reset enable	Service				Disabled	Disabled		215

Table 4-1 CFC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access	Min. Range	Max. Range	Parameter Units	Default Setting - CFC-500 to -2500	Default Setting - CFC-3300	Installation Setting	Modbus Register (dec)
Outdoor Reset Configuration	CH ODR max outdoor temperature	Service			°F	80	80		512
Outdoor Reset Configuration	CH ODR min outdoor temperature	Service			°F	0	0		513
Outdoor Reset Configuration	CH ODR low water temperature	Service			°F	80	80		514
Outdoor Reset Configuration	CH ODR boost time	Service			mmm ss	30m 0s	30m 0s		515
Outdoor Reset Configuration	CH ODR boost maximum off point	Service				180	200		516
Outdoor Reset Configuration	CH ODR boost step	Service			°F	0	0		522
Outdoor Reset Configuration	Minimum boiler water temperature	Service			°F	80	80		526
Domestic HW Configuration	DHW enable	user				Disabled	Disabled		448
Domestic HW Configuration	DHW demand switch	user				I:Auto: DHW (S6) or sensor only	I:Auto: DHW (S6) or sensor only		449
Domestic HW Configuration	DHW has priority over CH	Service				Yes/True/On	Yes/True/On		450
Domestic HW Configuration	DHW has priority over LL	Service				Yes/True/On	Yes/True/On		451
Domestic HW Configuration	DHW priority override time	Service			mmm ss	30m 0s	30m 0s		452
Domestic HW Configuration	DHW setpoint	user	32	180	°F	130	130		453
Domestic HW Configuration	DHW TOD setpoint	Service	32	180	°F	120	120		454
Domestic HW Configuration	DHW on hysteresis	Service	2	80	°F	5	5		455
Domestic HW Configuration	DHW off hysteresis	Service	2	80	°F	15	15		456
Domestic HW Configuration	DHW P gain	Service				25	25		457
Domestic HW Configuration	DHW I gain	Service				25	25		458
Domestic HW Configuration	DHW D gain	Service				0	0		459
Domestic HW Configuration	DHW hysteresis step time	Service			mmm ss	1m 0s	1m 0s		460
Domestic HW Configuration	DHW modulation sensor	Service				F:Auto Mod from DHW (S6)or Outlet (S3S4)	F:Auto Mod from DHW (S6)or Outlet (S3S4)		461
Domestic HW Configuration	DHW priority source	Service				B:DHW heat demand	B:DHW heat demand		463
Domestic HW Configuration	DHW storage enable	Service				Disabled	Disabled		504
Domestic HW Configuration	DHW storage time	Service			mmm ss	NoValue	NoValue		505
Domestic HW Configuration	DHW storage setpoint	Service	32		°F	NoValue	NoValue		506
Domestic HW Configuration	DHW storage on hysteresis	Service			°F	NoValue	NoValue		507
Domestic HW Configuration	DHW storage off hysteresis	Service			°F	NoValue	NoValue		508
Domestic HW Configuration	DHW priority method	Service				B:Drop DHW after priority time expires	B:Drop DHW after priority time expires		509
Modulation Configuration	CH maximum modulation rate	Service	2000rpm	9000rpm	RPM	5000	5000		193
Modulation Configuration	DHW maximum modulation rate	Service	2000rpm	6500rpm	RPM	5000	5000		194
Modulation Configuration	Minimum modulation rate	Service	800rpm	3000rpm	RPM	1100	1000		195
Modulation Configuration	CH forced rate	Service	1000rpm	6500rpm	RPM	2000	2000		199

Table 4-1 CFC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access	Min. Range	Max. Range	Paramet er Units	Default Setting - CFC-500 to -2500	Default Setting - CFC-3300	Installation Setting	Modbus Register (dec)
Modulation Configura-tion	CH forced rate time	Service			mmm ss	1m 0s	1m 0s		200
Modulation Configura-tion	DHW forced rate	Service	1000rpm	6500rpm	RPM	2000	1500		201
Modulation Configura-tion	DHW forced rate time	Service			mmm ss	0m 0s	0m 0s		202
Modulation Configura-tion	Firing rate control	user				A: Automatic	A: Automatic		204
Modulation Configura-tion	Manual firing rate	user	800rpm	9000rpm	RPM	2000	1500		205
Modulation Configura-tion	Analog output hysteresis	Hidden			1 per 0.1C err	5	5		206
Modulation Configura-tion	CH slow start enable	Service				Enabled	Enabled		477
Modulation Configura-tion	DHW slow start enable	Service				Disabled	Disabled		478
Modulation Configura-tion	Slow start ramp	Service	100rpm	5000rpm	RPM per min.	500rpm	500rpm		479
Modulation Configura-tion	Slow start degrees	Service	0		°F	20	20		480
Modulation Configura-tion	Analog input hys-teresis	Service	0		mA	.2	.2		543
Pump Configuration	CH pump output	Service				No pump assign-ment	No pump assign-ment		272
Pump Configuration	CH pump control	Service				Automatic pump control	Automatic pump control		273
Pump Configuration	CH pump start delay	Service			mmm ss	0m 10s	0m 10s		292
Pump Configuration	CH pump overrun time	Service			mmm ss	5m 0s	5m 0s		274
Pump Configuration	Boiler pump out-put	Service				Pump assigned to relay B	Pump assigned to relay B		281
Pump Configuration	Boiler pump con-trol	Service				Automatic pump control	Automatic pump control		282
Pump Configuration	Boiler pump start delay	Service			mmm ss	0m 10s	0m 10s		293
Pump Configuration	Boiler pump overrun time	Service			mmm ss	5m 0s	5m 0s		283
Pump Configuration	DHW pump out-put	Service				No pump assign-ment	No pump assign-ment		276
Pump Configuration	DHW pump con-trol	Service				Automatic pump control	Automatic pump control		277
Pump Configuration	DHW pump start delay	Service			mmm ss	1m 0s	1m 0s		280
Pump Configuration	DHW pump over-run time	Service			mmm ss	1m 0s	1m 0s		278
Pump Configuration	System pump out-put	Service				No pump assign-ment	No pump assign-ment		287
Pump Configuration	System pump control	Service				Automatic pump control	Automatic pump control		288
Pump Configuration	System pump start delay	Service			mmm ss	0m 0s	0m 0s		294
Pump Configuration	System pump overrun time	Service			mmm ss	15m 0s	15m 0s		289
Pump Configuration	Auxiliary 1 pump output	Service				Pump assigned to relay C	Pump assigned to relay C		284
Pump Configuration	Auxiliary 1 pump control	Service				Automatic pump control (iso valve)	Automatic pump control (iso valve)		285
Pump Configuration	Auxiliary 1 pump start delay	Service			mmm ss	0m 0s	0m 0s		295
Pump Configuration	Auxiliary 1 pump overrun time	Service			mmm ss	5m 30s	5m 30s		752
Pump Configuration	Auxiliary 2 pump output	Service				Pump assigned to terminal A	Pump assigned to terminal A		755
Pump Configuration	Auxiliary 2 pump control	Service				Automatic pump control (start inter-lock)	Automatic pump control (start inter-lock)		756
Pump Configuration	Auxiliary 2 pump start delay	Service			mmm ss	0m 0s	0m 0s		757

Table 4-1 CFC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access	Min. Range	Max. Range	Parameter Units	Default Setting - CFC-500 to -2500	Default Setting - CFC-3300	Installation Setting	Modbus Register (dec)
Pump Configuration	Auxiliary 2 pump overrun time	Service			mmm ss	3m 0s	3m 0s		758
Pump Configuration	Pump exercise interval	Service			Days	0	0		290
Pump Configuration	Pump exercise time	Service			mmm ss	0m 0s	0m 0s		291
Pump Configuration	CH pump options 1	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		296
Pump Configuration	CH pump options 2	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		297
Pump Configuration	DHW pump options 1	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		298
Pump Configuration	DHW pump options 2	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		299
Pump Configuration	Boiler pump options 1	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		300
Pump Configuration	Boiler pump options 2	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		301
Pump Configuration	System pump options 1	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		302
Pump Configuration	System pump options 2	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		303
Pump Configuration	Auxiliary 1 pump options 1	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		753
Pump Configuration	Auxiliary 1 pump options 2	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		754
Pump Configuration	Auxiliary 2 pump options 1	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		759
Pump Configuration	Auxiliary 2 pump options 2	Service				Refer to Falcon L-L appendix	Refer to Falcon L-L appendix		760
Statistics Configuration	Burner cycle count	Read Only			Cycles	0	0		128
Statistics Configuration	Burner run time	Read Only			Hours	0	0		130
Statistics Configuration	CH pump cycle count	Read Only			Cycles	0	0		132
Statistics Configuration	DHW pump cycle count	Read Only			Cycles	0	0		134
Statistics Configuration	System pump cycle count	Read Only			Cycles	0	0		136
Statistics Configuration	Boiler pump cycle count	Read Only			Cycles	0	0		138
Statistics Configuration	Auxiliary 1 pump cycle count	Read Only			Cycles	0	0		140
Statistics Configuration	Auxiliary 2 pump cycle count	Read Only			Cycles	0	0		146
High Limits	Outlet high limit setpoint	Service	32°F (0°C)	210°F (98.9°C)	°F	180	180		464
High Limits	Outlet high limit response	Read Only				A:Lockout	A:Lockout		465
High Limits	DHW high limit enable	Service				A:No high limit	A:No high limit		474
High Limits	DHW high limit setpoint	Service	32°F (0°C)	210°F (98.9°C)	°F	NoValue	NoValue		475
High Limits	DHW high limit response	Service				B:Recycle && hold	B:Recycle && hold		476
High Limits	Outlet high limit enable	Read Only				B:Dual sensor safety high limit	B:Dual sensor safety high limit		484
Stack Limit	Stack limit enable	Service				A:No stack high limit	A:No stack high limit		466
Stack Limit	Stack limit set-point	Service	32°F (0°C)	266°F (130°C)	°F	250°F (121.1°C)	250°F (121.1°C)		467
Stack Limit	Stack limit response	Service				A:Lockout	A:Lockout		468
Stack Limit	Stack limit delay	Service			mmm ss	5m 0s	5m 0s		469

Table 4-1 CFC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access	Min. Range	Max. Range	Parameter Units	Default Setting - CFC-500 to -2500	Default Setting - CFC-3300	Installation Setting	Modbus Register (dec)
Delta-T Limits	Delta-T inlet/outlet enable	Service				Delta-T and Inversion Detection	Delta-T and Inversion Detection		470
Delta-T Limits	Delta-T inlet/outlet degrees	Service			°F	50	50		471
Delta-T Limits	Delta-T response	Service				C:Recycle && delay with retry limit	C:Recycle && delay with retry limit		472
Delta-T Limits	Delta-T delay	Service			mmm ss	5m 0s	5m 0s		473
Delta-T Limits	Delta-T retry limit	Service		100		3	3		485
Delta-T Limits	Delta-T rate limit enable	Service				Enabled	Enabled		486
Delta-T Limits	Delta-T inverse limit time	Service		30m 0s	mmm ss	5m 0s	5m 0s		487
Delta-T Limits	Delta-T inverse limit response	Service				C:Recycle && delay with retry limit	C:Recycle && delay with retry limit		488
T-rise Limit	Outlet T-rise enable	Service				Disabled	Disabled		481
T-rise Limit	T-rise degrees	Service			°F	10	10		482
T-rise Limit	T-rise delay	Service			mmm ss	5m 0s	5m 0s		483
T-rise Limit	Exchanger T-rise enable	Service				Disabled	Disabled		491
T-rise Limit	T-rise response	Service				C:Recycle && delay with retry limit	C:Recycle && delay with retry limit		492
T-rise Limit	T-rise retry limit	Service				10	10		493
Anticondensation	CH anticondensation enable	Service				Disabled	Disabled		496
Anticondensation	CH anticondensation setpoint	Service	32	194	°F	140	140		497
Anticondensation	DHW anticondensation enable	Service				Disabled	Disabled		499
Anticondensation	DHW anticondensation setpoint	Service	32	194	°F	140	140		500
Anticondensation	Anticondensation priority	Service							502
Anticondensation	Anticondensation > Stack limit	user				No/False/Off	No/False/Off		502
Anticondensation	Anticondensation > Slow start	user				Yes/True/On	Yes/True/On		502
Anticondensation	Anticondensation > Outlet limit	user				No/False/Off	No/False/Off		502
Anticondensation	Anticondensation > Delta-T	user				No/False/Off	No/False/Off		502
Anticondensation	Anticondensation > Forced rate	user				Yes/True/On	Yes/True/On		502
Anticondensation	Frost protect anti-condensation enable	user				Disabled	Disabled		503
Frost Protection	CH frost protection enable	Service				Disabled	Disabled		528
Frost Protection	CH pump frost protection overrun time	Service			mmm ss	60m 0s	60m 0s		275
Frost Protection	DHW frost protection enable	Service				Disabled	Disabled		529
Frost Protection	DHW pump frost protection overrun time	Service			mmm ss	60m 0s	60m 0s		279
Frost Protection	Outdoor frost protection setpoint	Service				32	32		530
Annunciation Configuration	Annunciation enable	Read Only				Enabled	Enabled		304
Annunciation Configuration	Annunciator 1 location	OEM				E:Other annunciation	E:Other annunciation		306

Table 4-1 CFC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access	Min. Range	Max. Range	Parameter Units	Default Setting - CFC-500 to -2500	Default Setting - CFC-3300	Installation Setting	Modbus Register (dec)
Annunciation Configuration	Annunciator1 short name	OEM			3 chars	A1	A1		307
Annunciation Configuration	Annunciator 1 long name	OEM			20 chars	AIR SWITCH	AIR SWITCH		309
Annunciation Configuration	Annunciator 2 location	Service				A:No annunciation for this terminal	A:No annunciation for this terminal		319
Annunciation Configuration	Annunciator2 short name	Service			3 chars	A2	A2		320
Annunciation Configuration	Annunciator 2 long name	Service			20 chars	AUX LOW WATER	AUX LOW WATER		322
Annunciation Configuration	Annunciator 3 location	OEM				D:Interlock circuit	D:Interlock circuit		332
Annunciation Configuration	Annunciator3 short name	OEM			3 chars	A3	A3		333
Annunciation Configuration	Annunciator 3 long name	OEM			20 chars	LOW WATER	LOW WATER		335
Annunciation Configuration	Annunciator 4 location	OEM				D:Interlock circuit	D:Interlock circuit		345
Annunciation Configuration	Annunciator4 short name	OEM			3 chars	A4	A4		346
Annunciation Configuration	Annunciator 4 long name	OEM			20 chars	HIGH AIR PRESSURE	HIGH AIR PRESSURE		348
Annunciation Configuration	Annunciator 5 location	OEM				D:Interlock circuit	D:Interlock circuit		358
Annunciation Configuration	Annunciator5 short name	OEM			3 chars	A5	A5		359
Annunciation Configuration	Annunciator 5 long name	OEM			20 chars	HIGH GAS PRESSURE	HIGH GAS PRESSURE		361
Annunciation Configuration	Annunciator 6 location	OEM				D:Interlock circuit	D:Interlock circuit		371
Annunciation Configuration	Annunciator6 short name	OEM			3 chars	A6	A6		372
Annunciation Configuration	Annunciator 6 long name	OEM			20 chars	LOW GAS PRESSURE	LOW GAS PRESSURE		374
Annunciation Configuration	Annunciator 7 location	Service				D:Interlock circuit	D:Interlock circuit		384
Annunciation Configuration	Annunciator7 short name	Service			3 chars	A7	A7		385
Annunciation Configuration	Annunciator 7 long name	Service			20 chars	NATURAL GAS	NATURAL GAS		387
Annunciation Configuration	Annunciator 8 location	Service				D:Interlock circuit	D:Interlock circuit		397
Annunciation Configuration	Annunciator8 short name	Service			3 chars	A8	A8		398
Annunciation Configuration	Annunciator 8 long name	Service			20 chars	LP GAS	LP GAS		400
Annunciation Configuration	PII short name	OEM			3 chars	PII	PII		410
Annunciation Configuration	PII long name	OEM			20 chars	Pre-Ignition ILK	Pre-Ignition ILK		412
Annunciation Configuration	LCI short name	OEM			3 chars	LCI	LCI		422
Annunciation Configuration	LCI long name	OEM			20 chars	Limit Circuit Input	Limit Circuit Input		424
Annunciation Configuration	ILK short name	OEM			3 chars	ILK	ILK		434
Annunciation Configuration	ILK long name	OEM			20 chars	Lockout Interlocks	Lockout Interlocks		436
Burner Control Interlocks	PII enable	Service				Disabled	Disabled		249
Burner Control Interlocks	LCI enable	Read Only				Enabled	Enabled		248
Burner Control Interlocks	Interlock open response	Read Only				A:Lockout	A:Lockout		238
Burner Control Interlocks	ILK bounce detection enable	Service				Enabled	Enabled		253
Burner Control Interlocks	Purge rate proving	OEM				C:Prove via fan RPM feedback	C:Prove via fan RPM feedback		229

Table 4-1 CFC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access	Min. Range	Max. Range	Parameter Units	Default Setting - CFC-500 to -2500	Default Setting - CFC-3300	Installation Setting	Modbus Register (dec)
Burner Control Interlocks	Lightoff rate proving	Service				D:Prove fan RPM except during ignition	D:Prove fan RPM except during ignition		230
Burner Control Interlocks	Interrupted air switch enable	Service				B:Enable IAS during purge	B:Enable IAS during purge		246
Burner Control Safety Timing	Prepurge rate	Service	4000rpm	6500rpm	RPM	4000	4000		196
Burner Control Safety Timing	Postpurge rate	Service	1000rpm	6500rpm	RPM	2000	2000		198
Burner Control Safety Timing	Standby rate	Service	1000rpm	3000rpm	RPM	1000	1000		207
Burner Control Safety Timing	Prepurge time	Service	0m 15s		mmm ss	0m 15s	0m 15s		231
Burner Control Safety Timing	Run stabilization time	Service	0		mmm ss	0m 10s	0m 10s		235
Burner Control Safety Timing	Postpurge time	Service	0m 15s		mmm ss	0m 15s	0m 15s		236
Burner Control Safety Timing	Forced recycle interval time	Service	0		mmm ss	0m 0s	0m 0s		254
Burner Control Ignition	Pilot test hold	Service				OFF	OFF		227
Burner Control Ignition	Ignition source	Service				External ignition	External ignition		224
Burner Control Ignition	Pilot type	Read Only				Direct Burner Ignition	Interrupted (off during Run)		227
Burner Control Ignition	Lightoff rate	Service	1000rpm	3000rpm	RPM	1800	1400		197
Burner Control Ignition	Preignition time	Service		0m 45s	mmm ss	0m 0s	0m 0s		232
Burner Control Ignition	PFEP	Service				4 seconds	10 seconds		233
Burner Control Ignition	Igniter on during	OEM				On throughout PFEP	On in first half of PFEP		226
Burner Control Ignition	MFEP	Service				NA	5 seconds		234
Burner Control Ignition	Flame threshold	OEM		5	10ths (V or uA)	.8	.8		250
Burner Control Flame Failure	Ignite failure response	OEM				Lockout	Lockout		239
Burner Control Flame Failure	Ignite failure retries	OEM				Retry 1 time	Retry 1 time		240
Burner Control Flame Failure	Ignite failure delay	Service		60m 0s	mmm ss	0m 30s	0m 30s		241
Burner Control Flame Failure	MFEP flame failure response	OEM				NA	Lockout		242
Burner Control Flame Failure	Run flame failure response	Read Only				Lockout	Lockout		243
Burner Control Flame Failure	Fan speed error response	Service				Lockout	Lockout		255
System Configuration	Flame sensor type	Service				Flame Rod	UV power tube, ignore ignitor UV		228
System Configuration	Modulation output	Read Only				Fan PWM	Fan PWM		192
System Configuration	BLR HSI function	Read Only				Blower motor	Blower motor		225
System Configuration	Temperature units	Service				Fahrenheit	Fahrenheit		178
System Configuration	Antishort cycle time	Service			mmm ss	0m 0s	0m 0s		179
System Configuration	Alarm silence time	Service			mmm ss	0m 0s	0m 0s		
System Configuration	Power up with lockout	Read Only				Do not clear lockout	Do not clear lockout		181
System Configuration	Burner switch	user				No/False/Off	No/False/Off		203
System Configuration	Line frequency	Service			mmm ss	Auto Detect (50 or 60Hz)	Auto Detect (50 or 60Hz)		630
System Configuration	Options	Service			mmm ss	Ignore FR faults when UV is configured	Ignore FR faults when UV is configured		631

Table 4-1 CFC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access	Min. Range	Max. Range	Parameter Units	Default Setting - CFC-500 to -2500	Default Setting - CFC-3300	Installation Setting	Modbus Register (dec)
Sensor Configuration	S1 (J8-4) Inlet sensor	Read Only				10K single non-safety	10K single non-safety		608
Sensor Configuration	S2 (J8-6) sensor - 4-20mA input	OEM				4_20_MA	4_20_MA		609
Sensor Configuration	S3S4 (J8-8,10) Outlet sensor	Read Only				10K dual safety	10K dual safety		610
Sensor Configuration	S5 (J8-11) sensor - Header or Outdoor	Service				10K single non-safety	10K single non-safety		611
Sensor Configuration	S6S7 (J9-1,3) DHW sensor	Service				10K single non-safety	10K single non-safety		612
Sensor Configuration	S8S9 (J9-4,6) Stack sensor	Service				Unconfigured	Unconfigured		613
Sensor Configuration	Outdoor temperature source	Service				Unconfigured	Unconfigured		626
Fan Configuration	Absolute max fan speed	OEM	2000	6500	RPM	6000	6000		256
Fan Configuration	Absolute min fan speed	OEM	800	3000	RPM	800	1000		257
Fan Configuration	PWM frequency	OEM				3000 Hz	4000 Hz		258
Fan Configuration	Pulses per revolution	OEM	2	5		3	4		259
Fan Configuration	Fan speed up ramp	Service			RPM/sec	500	500		260
Fan Configuration	Fan slow down ramp	Service			RPM/sec	500	500		261
Fan Configuration	Fan gain up	Service				30	30		262
Fan Configuration	Fan gain down	Service				30	30		263
Fan Configuration	Fan min duty cycle	Service			0-100%	10%	5%		264
Lead Lag Master Configuration	Lead lag master enable	Service				Disabled	Disabled		545
Lead Lag Master Configuration	Lead lag CH setpoint	user		230	°F	150	150		546
Lead Lag Master Configuration	Lead lag CH TOD setpoint	user		230	°F	120	120		547
Lead Lag Master Configuration	Lead lag Modbus port	OEM				MB2	MB2		569
Lead Lag Master Configuration	Lead lag operation enable	user				Off	Off		555
Lead Lag Master Configuration	Lead lag modulation backup sensor	Service				Lead Outlet sensor	Lead Outlet sensor		559
Lead Lag Master Configuration	Lead lag on hysteresis	Service			°F	5	5		549
Lead Lag Master Configuration	Lead lag off hysteresis	Service			°F	15	15		550
Lead Lag Master Configuration	Lead lag hysteresis step time	Service			mmm ss	0m 0s	0m 0s		551
Lead Lag Master Configuration	Lead lag P gain	Service				10	10		552
Lead Lag Master Configuration	Lead lag I gain	Service				15	15		553
Lead Lag Master Configuration	Lead lag D gain	Service				0	0		554
Lead Lag Master Configuration	Lead lag CH demand switch	user				STAT terminal	B:STAT terminal		556
Lead Lag Master Configuration	Lead lag CH setpoint source	Service				Local setpoint is used	A:Local setpoint is used		557
Lead Lag Master Configuration	Lead lag CH setpoint	user		230	°F	150	150		546
Lead Lag Master Configuration	Lead lag CH TOD setpoint	user		230	°F	120	120		547
Lead Lag Master Configuration	Lead lag CH 4 mA water temperature	Service			°F	80	80		560
Lead Lag Master Configuration	Lead lag CH 20 mA water temperature	Service			°F	180	180		561

1. Changing Parameter Settings

To access the CB Falcon configuration menu, press <Configure> on the Status page.

Some parameters require a password entry before allowing changes. The <Login> button will appear when any password-protected parameter is displayed on the screen. Default service level password is 9220.

Press <Login> to display the alphanumeric keyboard. Enter password and press <OK>

Change parameter settings by selecting the parameter on the page. A dialog box appears with controls allowing the user to change the selected value. Press <Clear> to clear the current value. Enter the new value and press <OK> (press <Cancel> to leave the parameter unchanged).

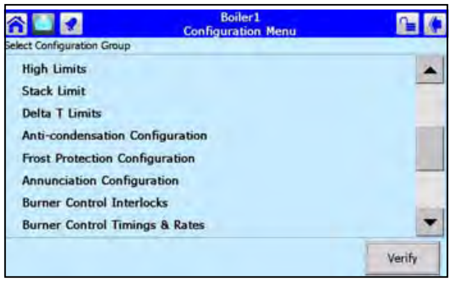


Figure 4-1 Configuration Menu

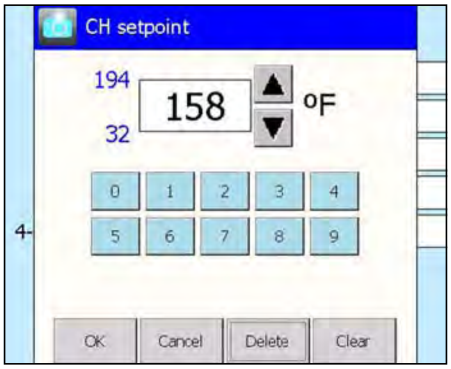


Figure 4-2 Parameter change dialog

Safety Parameters

When configuring safety parameters an additional verification step is required to confirm the changes.

1. When a safety parameter is changed, the Safety Parameter Verification page will appear. Press <Begin> to continue.
2. The affected parameter group will be displayed, showing current parameter values and a prompt, "Are these parameters set to proper values?". Press <Yes> to continue.
3. The screen will indicate RESET DEVICE NOW. Open the control panel and press the RESET button on the CB Falcon controller (press and hold for 3 seconds).

RESET must be pressed within 30 seconds to save changes.

Note: When changing multiple safety parameters, the verification steps do not need to be completed immediately.

Confirming Safety Parameter changes

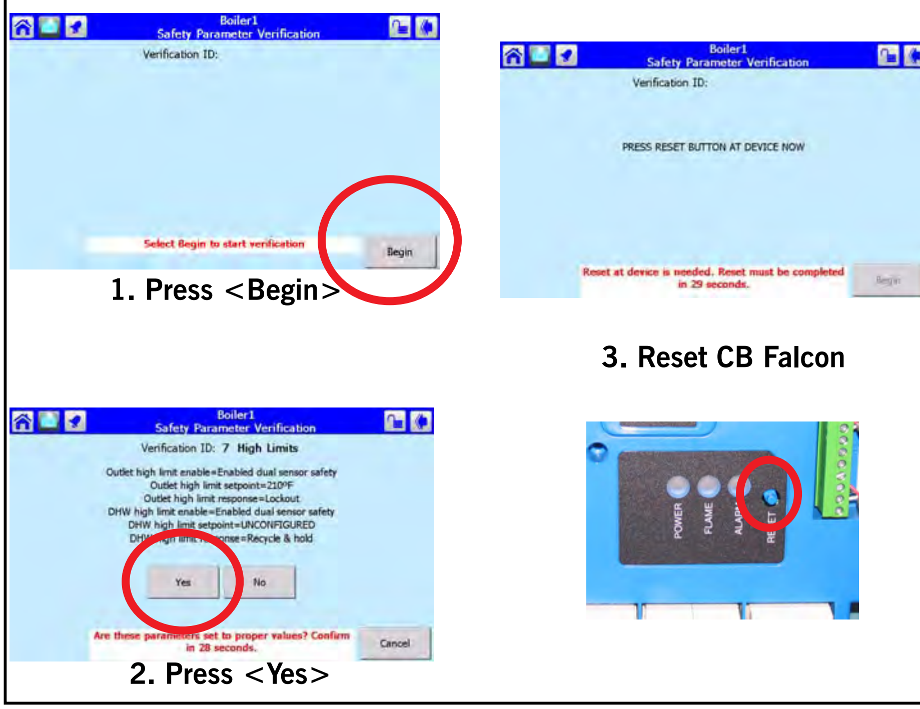


Figure 4-3 Falcon Program Module

2. Program Module

CB Falcon parameter information (non-safety parameters only) can be uploaded/downloaded using the optional Program Module. When the Program Module is installed, its features are accessible from the Falcon Setup page. Starting from the Home page, press <SETUP>, then <PROGRAM MODULE>.

G. BURNER SEQUENCE

In addition to providing modulation control, the CB Falcon is responsible for flame supervision and burner sequencing.

The CFC boiler uses direct spark ignition (gas pilot on 3300) to light the main flame. Flame sensing is accomplished with a flame rod, or ionization electrode (UV scanner on 3300).

Basic burner sequencing (Central Heat):

1. Heat request detected (Setpoint minus On Hysteresis); LCI limits and demand detected (terminals J6 3 and J8 3).
2. The CH pump is switched on.
3. After a system Safe Start Check, the Blower (fan) is switched on after a dynamic ILK switch test (if enabled).

4. After the ILK input is energized, 10 sec. allowed for IAS input (combustion air proving) to energize, and purge rate proving fan RPM is achieved - prepurge time is started.
5. When 30 sec. purge time is complete, the purge fan RPM is changed to the lightoff speed.
6. As soon as the fan-rpm is equal to the light-off RPM , the Trial for Ignition (4 sec.) or Pre-Ignition Time is started (depending on configuration).
7. Pre-Ignition Time will energize the ignitor and check for flame.
8. Trial for Ignition.
9. The ignition and the gas valve are switched on.
10. The ignition is turned off at the end of the direct burner ignition period (5 seconds into pilot ignition, CFC 3300).
11. The fan is kept at the lightoff rate during the stabilization timer, if any.
12. Before the release to modulation, the fan is switched to minimum RPM for the CH Forced Rate and Slow Start Enable, if the water is colder than the threshold.
13. Release to modulation.
14. At the end of the CH-heat request the burner is switched off and the fan stays on until post purge is complete.
15. A new CH-request is blocked for the forced off time set by the Anti Short Cycle (if enabled).
16. The pump stays on during the pump overrun time (if enabled).
17. At the end of the pump overrun time the pump will be switched off.

H. FAN SPEED SETTINGS

Because the input is determined by the fan speed, fan speed settings may have to be modified for the particular application, for high altitudes, or when using direct vent combustion. **Table 4-2** provides the default fan speed settings in typical applications for the various boiler sizes. To allow safe modulation through the firing range, these parameters should be initially set to the recommended speeds. Please contact your authorized Cleaver-Brooks representative for proper settings in high altitude and direct vent combustion applications.

Table 4-2 Fan Speed Settings

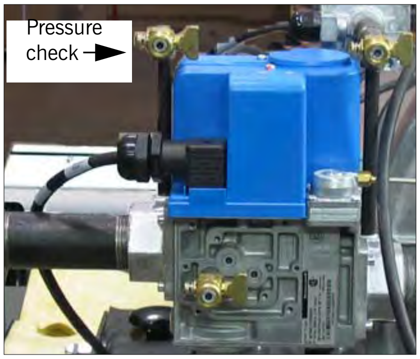
NATURAL GAS							
Setting	CFC-500	CFC-750	CFC-1000	CFC-1500	CFC-1800	CFC-2500	CFC-3300
Max. Speed (RPM) CH	5500	5300	5300	5300	4600	5000	5000
Max. Speed (RPM) DHW	5500	5300	5300	5300	4600	5000	5000
Min. Speed (RPM)	1300	1200	1100	1200	900	1100	1000
Ignition Fan Speed (Lightoff Rate)	2200	2000	1800	1800	1500	1800	1400
LP GAS/DUAL FUEL							
Max. Speed (RPM) CH	5200	5000	5000	5000	4400	4800	5000
Max. Speed (RPM) DHW	5200	5000	5000	5000	4400	4800	5000
Min. Speed (RPM)	1700	1600	1600	1700	1400	1400	1400
Ignition Fan Speed (Lightoff Rate)	2400	2200	2200	2000	1800	2000	1400

I. INITIAL START-UP PROCEDURE

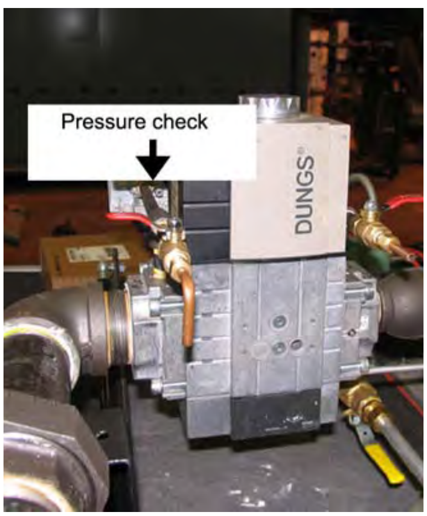
NOTE: For LP gas-fired units or boilers with optional dual-fuel gas train, see section **K - Procedures for LP gas.**

> **⚠ Warning**
>
> Before initial startup, check for blockages in the flue venting or vent terminations. Inspect the burner and furnace for any contamination or blockages.

Note: To measure supply pressure at the CFC gas valve, use the test port on the valve inlet flange (see below). Do not use the leak test cocks to measure gas pressure.



CFC 500-2500



CFC 3300

1. Gas Train and Piping

The ClearFire burner is equipped with a combination servo-regulated gas valve and venturi mixing unit. The gas valve consists of a single body with dual solenoid shut off valves, filter screen, and a built-in constant pressure gas/air servo controller. The blower speed is controlled by the CB Falcon with airflow directly proportional to the speed of the fan. The airflow creates a drop in pressure due to the venturi effect. The modulating controller of the valve actuator senses air pressure change and accordingly brings about a change in the gas flow proportional to the air pressure. The gas follows the airflow in a set ratio, so that fuel always matches the air as the burner firing rate increases or decreases.

1. Check the gas delivery system to be sure it is properly piped and wired.
2. Review available gas supply pressure to ensure that it is compatible with the ClearFire's gas train and regulator. Refer to **Table 4-4** for minimum required supply pressure and maximum allowable supply pressure.

Note: CFC 500-2500 maximum allowable inlet pressure to the CFC gas train is 1 psig. An upstream regulator and overpressure protection are required if building supply gas pressure is greater than 1 psig (cUL/CSA Canadian regulations may limit the maximum allowable gas supply pressure to 1/2 psig).

CFC 3300 maximum allowable gas supply pressure to its gas train is 5 psig.

3. To bleed air from the supply pipe, open the manual gas shut off valve upstream of the burner gas train and bleed air from the piping by loosening the union in the upstream piping.
4. The burner and its gas connection must be leak tested before placing the boiler into operation.
5. Gas Pressure Regulator - Using the adjusting screw on the main gas regulator, adjust the gas valve inlet pressure to within the recommended levels in Table 4-3.

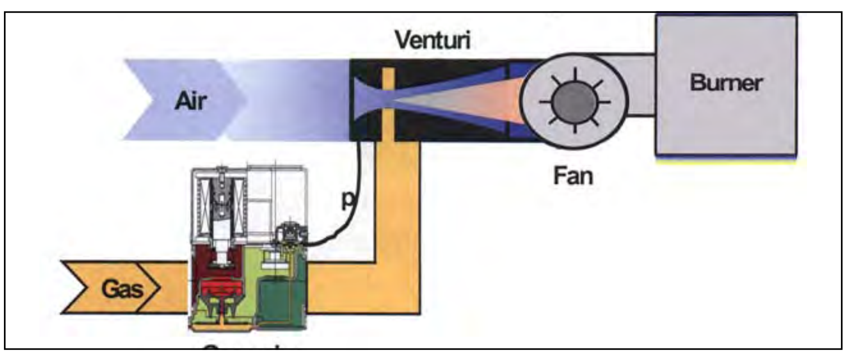


Figure 4-4 Premix Burner Technology - Full Modulation

Table 4-3 CFC Gas Pressure Requirements

Boiler Model	Minimum pressure required at gas train connection (inches Water Column)		Max. pressure
	Natural Gas	LP Gas	
500	7"	11"	28" WC
750	7"	11"	
1000	7"	11"	
1500	10"	11"	
1800	7"	11"	
2500	9.5"	11"	
3300*	6.8"	11"	5 psi

*Pilot gas pressure CFC 3300: Natural gas 3-5" WC, LP gas 3-4" WC

2. Power-Up

1. Ensure the boiler is properly wired for the available power supply. Refer to the wiring diagram provided with the boiler or to the appropriate wiring diagram in **Section 2 - Installation**.
2. Verify the voltage (control voltage is 115V-1Ph) to ensure it is within specifications.

3. Operation Check: Gas Valve, Gas Pressure Switches, Combustion Air Proving Switch, Ignition Fail

Before initial firing of the burner, the gas valve, Low Gas Pressure Switch (LGPS), High Gas Pressure Switch (HGPS), and Combustion Air Proving Switch (CAPS) should be checked for proper operation.

- Before proceeding, review **Section C - Control Setpoints** for initial LGPS, HGPS, and CAPS settings.

Note: Close the downstream manual gas shut-off valve before checking pressure switches and CAPS.

While performing the following safety checks, use the CB Falcon Annunciation screen to monitor the status of the circuits involved. Press <Annunciation> on the Operation page to access this screen.

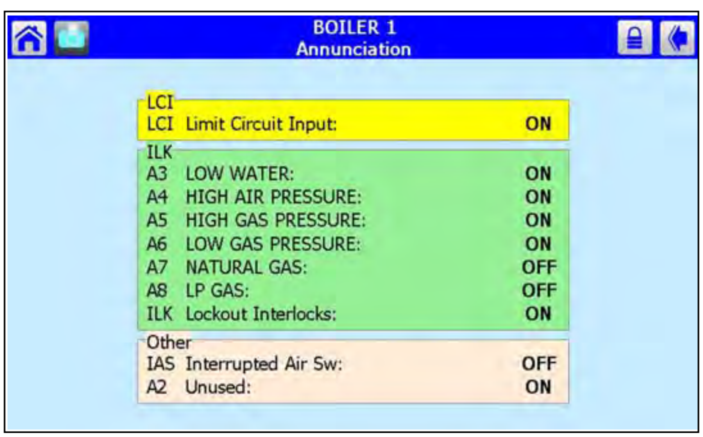


Figure 4-5 Annunciation Screen

LGPS

1. To check the Low Gas Pressure Switch, first close the upstream manual shutoff valve (both manual shutoff valves should now be closed).
2. Start the burner and wait 10 seconds during purge for CAPS to be made.
3. Turn the LGPS setting to maximum.
4. Open the test cock to bleed the gas line.
5. The controller should lock out. The screen will indicate **Lockout 67 ILK OFF**.
6. Reset the controller and change the LGPS setting back to minimum to proceed.

CAPS

1. Initiate burner sequence.
2. During purge cycle, set Combustion Air Proving Switch to its maximum setting.
3. The CB Falcon should lock out on an airflow failure. The display will show **Lockout 65 Interrupted Airflow Switch OFF**.

Note: If the CAPS fails to open even when set to maximum, test by disconnecting the low-pressure line to the switch and initiating burner sequence. The switch should now break during the purge cycle. Reconnect low-pressure side after a successful CAPS check.

4. Following a successful CAPS check, dial the CAPS back to its minimum setting and reset the CB Falcon.

HGPS and GAS VALVE

1. Open the upstream manual shutoff valve and wait a few moments for gas pressure to rise.
2. Lower the switch setting to minimum.
3. Initiate burner sequence. During the main flame establishing period, verify gas valve LEDs energize, indicating both safety shutoff valves open.
4. The CB Falcon should lock out on an interlock failure (Lockout 67).
5. Reset CB Falcon.
6. Open the downstream manual shutoff valve to clear the lockout condition.
7. Dial the HGPS back to its maximum setting and reset.

IGNITION FAILURE CHECK

1. A test of the flame rod circuit can also be performed at this time. Disconnect the flame rod cable and attempt to start the burner. The CB Falcon should lock out, indicating **Lockout 109 Ignition Failure**.
2. Replace flame rod electrode and grounding tab.

After verifying proper operation of LGPS, HGPS, CAPS, and Gas Valve, re-open the downstream manual shut-off valve.

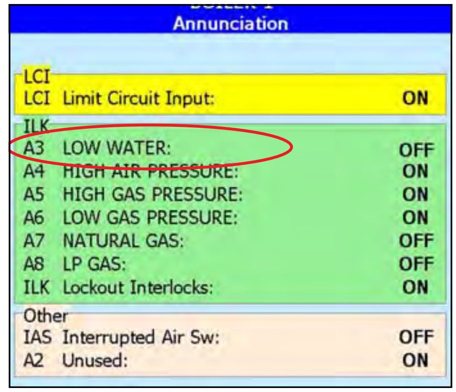


Figure 4-6 Low Water Cutoff test

4. PILOT TESTS (CFC 3300 ONLY)

PILOT FAIL CHECK

Close the gas pilot shutoff valve. Also shut off main fuel supply. Attempt to start the burner. There should be an ignition spark, but no pilot flame. The Falcon will lock out, indicating pilot failure.

Reset the Falcon, open the pilot shutoff valve, and re-establish fuel supply before continuing.

PILOT HOLD TEST

On the Falcon display, go to Configure>Ignition and turn <Pilot Hold> to ON. Open the manual valve on the pilot gas train, keeping the downstream main gas valve closed. Initiate the burner sequence. The burner will go through prepurge and will go to trial for pilot ignition. Once the pilot is lit, check for flame signal on the Falcon display and visually inspect the pilot flame through the sight port on top of the boiler. Once a good pilot flame has been established, open the downstream main gas shutoff valve and turn the Pilot Hold setting to OFF. The Falcon will proceed to main flame trial for ignition.

5. LOW WATER CUTOFF Check

1. Hold down the LOW WATER RESET-TEST switch for 3 seconds.
2. Check Annunciation screen. The ILK section (Interlock circuit) should show **A3 LOW WATER: OFF** (**Figure 4-6**).
3. Press RESET-TEST switch once to reset.

6. Low and High Fire Adjustments

All CFC boilers are factory tested firing natural gas at an altitude of 1000 ft ASL. Operating under different conditions may require re-adjustment of the gas valve.

CFC 500-2500

Adjustments are made using a TORX® T40 (low fire adjustment) and 3 mm hex wrench (main gas choke). The adjustment screws should initially be set to half way through each setting's range. The low fire adjustment screw is accessed by removing the slotted cap on the gas regulator using a blade screwdriver (see **Figure 4-7**). The high fire adjustment screw is accessed by removing the blue plastic cap from the valve cover (**Figure 4-8**).

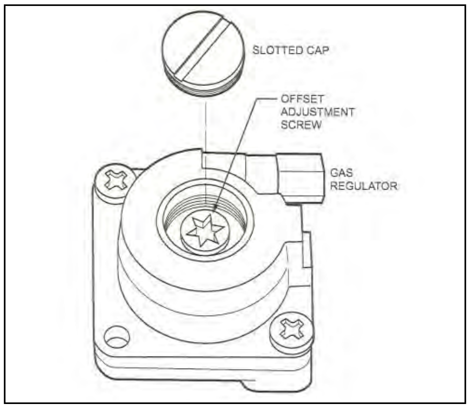


Figure 4-7 Regulating Adjusting Screw - Low Fire Offset

Turn the adjustment screw completely clockwise, counting the turns until the screw will no longer turn. Then, turn the adjustment screw counterclockwise half the number of turns counted when turning clockwise.

NOTE: When adjusting low fire offset, clockwise adjustments *increase* gas flow, and counterclockwise adjustments *decrease* gas flow.

When adjusting the main gas choke, clockwise adjustments *decrease* gas flow, and counterclockwise adjustments *increase* gas flow.

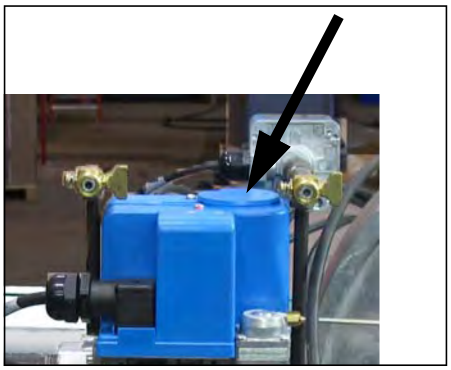


Figure 4-8 Main Gas Choke - High Fire Adjustment

Refer to Appendix A for further information on gas valve setup, operation, and testing.

CFC 3300

See figure below for low and high fire adjustments on the CFC 3300. Both low and high fire adjustments are CLOCKWISE to INCREASE gas flow.

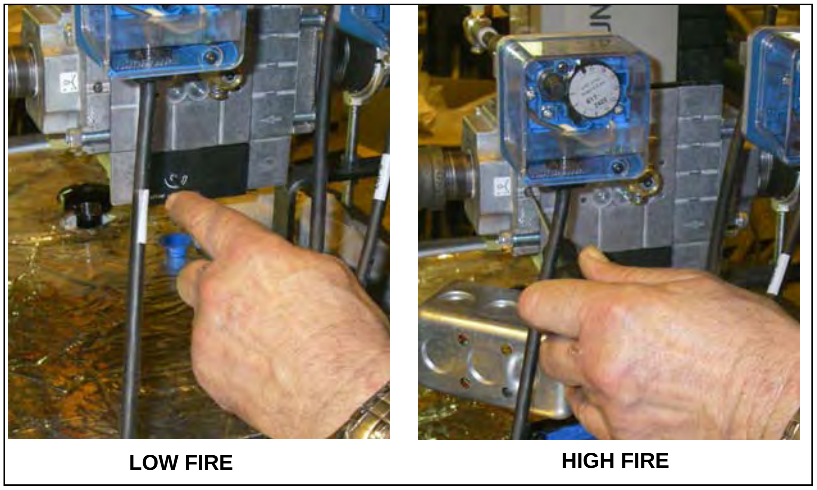


Figure 4-9 Low/High fire adjustments - CFC 3300

7. Modulation OFF point

Prior to setting combustion, the Modulation OFF point should be adjusted upward to avoid nuisance shutdowns while the burner is under manual control.

8. Setting Combustion

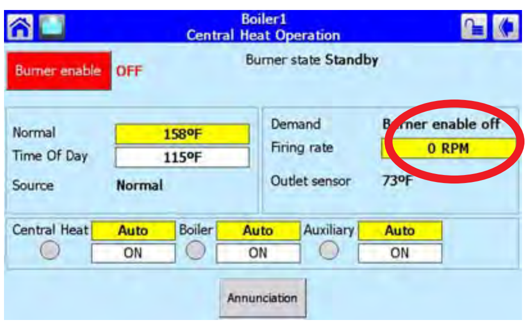
Note: A Combustion Analyzer is required to properly set up the Model CFC burner. Do not attempt to fire and adjust the burner without this equipment.

Note: Ensure boiler is filled with water prior to burner startup.

NOTE: Install the combustion analyzer probe as close as possible to the boiler vent connection. Sampling too far from the boiler vent can produce false readings due to air diluting the flue gas.

The burner does not have need of linkages for fuel/air adjustment, nor is a separate manual-auto switch provided for burner positioning. All firing rate adjustments are accomplished via the CB Falcon Control. Setting combustion will require manually modulating the burner via the CB Falcon from low fire to high fire two or more times to ensure a consistent air/fuel ratio.

Manual Modulation - use the procedure below to change the burner firing rate manually.



1. On the CB Falcon **Operation** screen, press the **Firing rate** display.

2. A numeric keypad will appear, showing the current firing rate.

3. Press <Clear> to clear the current value.

4. Enter the desired RPM setting using the numeric keypad (refer to **Table 4-2**, Fan Speed Settings).

5. Press <OK>. The display will return to the Operation screen and the burner will modulate to the chosen firing rate.

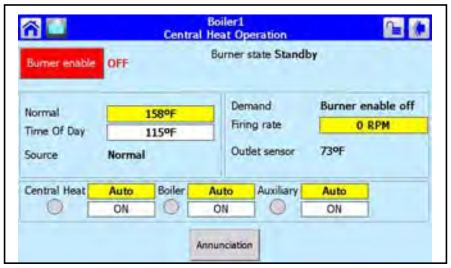


Figure 4-10 Operation screen

To set combustion:

1. Check inlet gas pressure and reset low gas pressure switch.
2. At Operation screen set firing rate to low fire. Review burner sequence before proceeding.
3. Turn LOCAL/REMOTE switch to LOCAL.
4. Initiate burner firing sequence. The burner switch is accessed via the CB Falcon Operation page (**Figure 4-10**). If the burner does not ignite, adjust choke counterclockwise slightly until you can see a slight yellow flame at the burner during ignition. Clockwise adjustments to the low-fire offset screw may also be tried. Check that gas pressure to gas valve inlet is sufficient to fire burner (see Table 4-3 for gas pressure requirements).
5. After burner lights, maintain in low fire position. At low fire, using main choke on gas valve and a combustion analyzer set O2 level within 3-8% O2.
6. Manually modulate the burner to high fire. Adjust the gas choke if necessary to obtain desired O2% (6% - 7%).
7. Modulate to low fire and fine tune offset screw to obtain desired O2% (6% - 7%).

Verify adjustments by modulating back and forth between low and high fire.

While setting combustion observe gas pressure at low fire and at high fire. Ensure pressure is within limits shown in Table 4-3.

9. High Air Pressure Switch settings

The High Air Pressure witch (HAPS) is used to safely shut down the boiler in case of a blocked flue or blocked condensate condition.

The HAPS switch setting for each model CFC can be found below:

Table 4-4 HAPS Settings

Model	Setting
CFC-500	3.5" W.C.
CFC-750	3.5" W.C.
CFC-1000	3.5" W.C.
CFC-1500	4.5" W.C.
CFC-1800	4.5" W.C.
CFC-2500	5.25" W.C.
CFC-3300	5.75" W.C.

The HAPS has a manual reset, similar to the High/Low gas pressure switches.

Note: In the event of a HAPS lockout, investigate possible causes before attempting to restart boiler.

10. Limit Controls Check

The Modulation Off (operating limit) and High Limit functions can be tested while the boiler is operating by adjusting the respective setting downward and allowing the boiler outlet temperature to rise. The Modulation Off point is the sum of the Modulating setpoint and the Hysteresis Off value. The Modulation On point is the setpoint minus the Hysteresis On value.

When the boiler's outlet temperature exceeds either of these settings, the boiler will shut down. When the operating limit is exceeded, the boiler will automatically recycle upon the outlet temperature dropping below the on point. When the High Limit is exceeded, a lockout should result requiring a manual reset of the control after the temperature has dropped below the high limit setting.

Before testing the High Limit, temporarily set the Modulation OFF point higher than the High Limit setting.

Restore Modulation OFF and High Limit to operational settings after testing.

Specific settings are determined by application. Maximum High Limit for Model CFC is 210 deg F.

The High Limit setting is considered a safety parameter. Any changes made will require a password login and reset of the CB Falcon.

J. POST START-UP CHECKOUT PROCEDURE

1. Ensure proper air venting to expansion tank.
2. Set high gas pressure switch to 50% higher than operating gas pressure at low fire. Set low gas pressure switch to 50% lower than operating gas pressure at low fire.
3. Check the draft on the outlet stack on each boiler, compare to acceptable limits (-.25 to +.25" W.C.) and record in start up form. Operating outside of acceptable limits could result in light off and flame failure problems.
4. Switch to automatic operation and monitor flue gas to ensure consistent excess air.
5. Reassemble all panels and covers that were removed and replace any plugs that were removed to check gas pressure.
6. Verify HAPS switch operation by simulating a blocked flue condition.
7. Verify gas pressures remain within limits shown in Table 4-3.
8. Provide instructions to owner and operators on operation, safety and maintenance of the equipment.
9. Provide instructions to owner and operators on proper water treatment guidelines and procedures.

K. PROCEDURES FOR LP (PROPANE) GAS

- Minimum LP gas pressure required is 11" W.C. at 700' ASL. Pressure correction required for high altitudes.
- Maximum gas pressure rating of the gas train is 1 psig.

Warning

Ensure that proper LP gas piping standards and practices are followed and that the LP gas is properly vaporized. **Failure to do so can result in serious injury or damage to the boiler.**

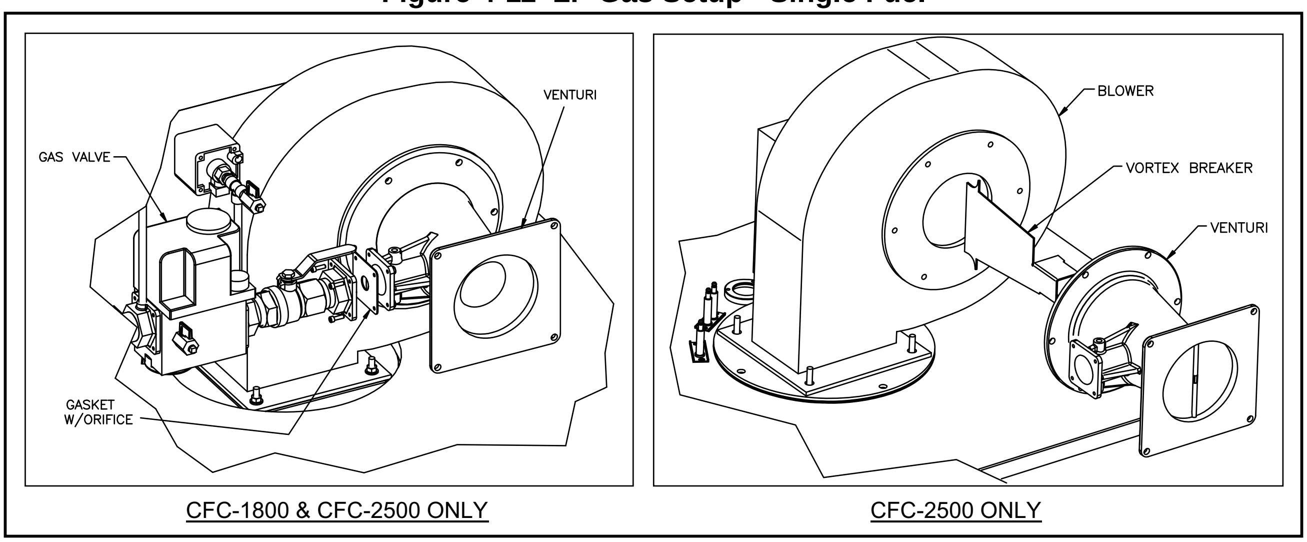
Notice

When changing fuels, ensure the CB Falcon has been configured with the proper fan speed settings for the fuel being used. See **Table 4-1**.

1. Single fuel units

1. Close upstream manual gas shut-off valve. Disconnect power from the boiler.
2. Install orifice gasket provided by replacing the existing venturi-gas train connection gasket with appropriate orifice (see **Table 4-4**). Install the vortex breaker (CFC-2500 only) between venturi and blower with the main body of the vortex breaker in the vertical position. Ensure gas train-venturi connection is secure and gas tight. Ensure venturi-blower connection is tight.

Figure 4-11 LP Gas Setup - Single Fuel



3. Connect power to the boiler. Power up the controls.
4. Access boiler control Configuration menu. Press <Login>. Enter service level password: 9220. Press <OK>.

5. Select Modulation configuration. Adjust CH and DHW maximum modulation rates according to **Table 4-1**. Adjust minimum modulation rate according to **Table 4-1**. Return to Configuration menu.
6. Select Burner Control Ignition configuration. Adjust ignition, or lightoff, rate according to **Table 4-1**. A warning will appear noting that you are changing a safety parameter. After changing the speed, return to Configuration menu.
7. Press <Verify> to check safety parameter change(s). Press <Begin> and check that all changes are correct. Press <Yes> if correct. If incorrect press <No> and return to appropriate parameter configuration menu to correct. After all safety parameter changes are checked, the controller requires a manual reset. Open the panel and reset the control.
8. Follow normal startup and commissioning procedures in this manual beginning with Section **I - Initial Startup Procedure**. Proper combustion settings for LP gas on ClearFire boilers are between 6.5 - 7.5% O2.

Table 4-5 Parts for LP Gas

	Gasket Orifice P/N	Dia. (in.)	Vortex Breaker
CFC-1800	853-01309	0.625"	N/A
CFC-2500	853-01294	0.750"	197-00311

Notice

When changing a single fuel unit from LP gas to natural gas, the orifice gasket must be removed. The vortex breaker may remain in place if desired. If the vortex breaker remains installed, fan speed settings will need to be adjusted upward from the normal natural gas settings.

2. Units with optional dual-fuel gas train

Notice

When commissioning dual-fuel units, natural gas combustion setup should be performed *first*.

1. Shut down boiler.
2. Close the natural gas supply and open propane supply.
3. Turn fuel selector switch to ‘LP Gas’. The Falcon annunciator should show natural gas OFF and LP gas ON.
4. Turn gas selector valve to the LP gas position (see **Figure 4-12**).
5. Depress gas pressure switches to reset.
6. Measure gas pressure at inlet to LP gas valve - should be 11” W.C. minimum.

7. Access boiler control Configuration menu. Press <Login>. Enter service level password: 9220. Press <OK>.
8. Select Modulation configuration. Adjust CH and DHW maximum modulation rates according to **Table 4-1**. Adjust minimum modulation rate according to **Table 4-1**. Return to Configuration menu.
9. Select Burner Control Ignition configuration. Adjust ignition, or lightoff, rate according to **Table 4-1**. A warning will appear noting that you are changing a safety parameter. After changing the speed, return to Configuration menu.
10. Press <Verify> to check safety parameter change(s). Press <Begin> and check that all changes are correct. Press <Yes> if correct. If incorrect press <No> and return to appropriate parameter configuration menu to correct. After all safety parameter changes are checked, the controller requires a manual reset. Open the panel and reset the control.
11. Follow normal startup and commissioning procedures in this manual beginning with Section **I - Initial Startup Procedure**. Proper combustion settings for LP gas on ClearFire boilers are between 6.5 - 7.5% O2.

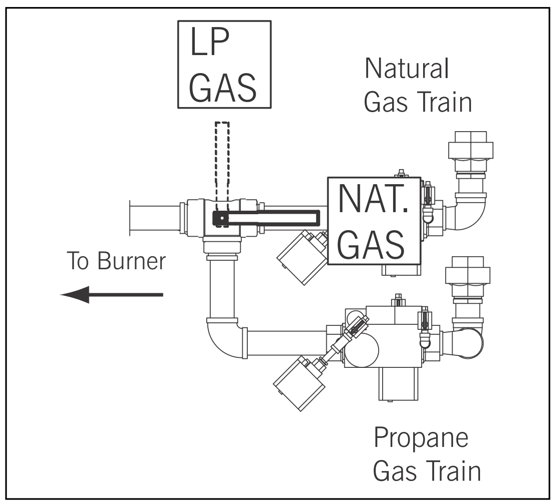


Figure 4-12 Gas selector valve

L. FALCON CONTROL FUNCTIONS AND CUSTOMER INTERFACE

Following is a brief overview of the Falcon control features on ClearFire boilers. Please refer to the Falcon Control operating instructions in Appendix A for more detailed explanations.

- Set Point
- Time-of-Day (TOD) Set Point
- Hysteresis On and Hysteresis Off
- PID modulation control
- Remote Enable and Remote 4-20mA Input
- Remote Modulation
- Remote Set Point
- Rate Limiting/Override
- Configurable pump/auxiliary relay contacts
- Annunciator
- Diagnostics
- Lockout/Alarm History
- Trend Analysis
- Modbus communications
- Lead/Lag Control for up to 8 boilers
- DHW demand priority

Set Point, TOD Set Point, Hysteresis On, Hysteresis Off, and PID load control

The set point is the value that the boiler's PID load control attempts to maintain in order to meet system demand. The modulating set point can be adjusted at the Operation page or under the Central Heat Configuration parameter group. No password is required to change the set point. To change the set point at the Operation page, press the set point value next to "Normal". Clear the current value and enter the new value. Press <OK> to establish the new set point.

The Time-of-Day (TOD), or setback, set point is an alternative set point that is enabled when a remote contact connected to terminals J10-2 & J10-3 is closed (Refer to Figure 2-10 CFC wiring diagram). When the circuit is open, the boiler control reverts back to the normal set point. The TOD set point can be adjusted at either the Operation page or under the Central Heat Configuration parameter group. Service level password login may be required to change this parameter.

The hysteresis on and hysteresis off points can only be changed under the Central Heat Configuration parameter group and require a login with the Service level password. Hysteresis on is the differential below the current set point at which the boiler will restart following an off cycle. Hysteresis off is the differential above the current set point at which the boiler will cycle off – effectively the boiler's operating limit. These two parameters apply to both the normal and TOD set points. To minimize the frequency of cycling the boiler on and off, the values of either, or both, of these settings may be increased. Default settings for Hysteresis on and off are 5 deg F and 15 deg F, respectively.

The PID (Proportional-Integral-Derivative) load control operates on the demand source's modulation rate. Under Central Heat configuration, the PID gain values can be adjusted to match the desired modulation response. The default gain value settings of P=25, I=25 & D=0 have proven to work well with typical single boiler heating applications.

Decreasing the PID gain values slows down the controller's response to a change in load demand. Increasing the gain values causes more aggressive control, though setting the values too high can lead to 'overshoot' and unnecessary cycling.

Remote Enable and Remote 4-20mA Input

Remote enable and Remote 4-20mA input allow the boiler to be sequenced and/or controlled from a separate boiler room controller or building management system. The 3-position Demand switch at the front of the control panel determines whether the boiler is off, in local, or under remote control. When in the "LOC" (local) position, the boiler operates on its own set point and ignores any remote signal connections. When in the "REM" (remote) position, the boiler can be enabled and modulated by remote discrete and analog (4-20mA) inputs, respectively. When in the "OFF" position, the boiler will not operate.

Refer to Figure 2-10 in this manual or to your specific boiler wiring diagram for remote enable and remote 4-20mA input connections. For simple remote on-off sequencing, only terminals 24 and 25 (Falcon J8-1 & J8-3) need to be connected to dry enable contacts at the remote controller. When terminal 25 (demand input) is energized, the demand is enabled. The boiler then operates on its local set point and PID modulating control settings.

For **remote modulation** (firing rate) control, both the remote enable and remote 4-20mA input connections must be made. The default setting for the 4-20mA remote input is "Local". This setting should be verified under the Falcon control's Central Heat configuration group, "Central Heat>Modulation>Modulation Rate Source". For remote modulation this parameter should be set to "S2 (J8-6) 4-20 mA with sensor on-off.

To avoid nuisance operating limit shut downs of the boiler, the Falcon's normal operating set point should be adjusted to a value that is greater than the system header set point.

With demand present and completion of a successful trial for ignition sequence, the boiler will modulate according to the 4-20mA input signal provided: 4mA = minimum modulation rate (low fire); 20mA = maximum modulation rate (high fire). The boiler will continue to modulate until the demand is removed, the operating limit is reached, LCI is opened (e.g. low water condition), or a Falcon lockout alarm occurs (e.g. ILK opens on a High Limit trip).

To configure the boiler for **remote set point** control, navigate to the Falcon control's Central Heat configuration group. Change the setting of "Central Heat Configuration>Set Point>Set Point Source" to “S2 (J8-6) 4-20mA”. Next, the span of the 4-20mA needs to be established. The “20mA water temperature” parameter determines the value for 20mA; “4mA water temperature” determines the value for 4mA.

Depending on the quality of the remote input signal, the modulation rate or operating set point may fluctuate slightly because of small changes in the measured current signal or because of induced noise. Under the Modulation configuration group, the “4-20mA input Hysteresis” setting may need to be adjusted to avoid undesired fluctuations in the either the modulation rate or operating set point. The default setting is 0.2mA and can be increased to essentially filter out small fluctuations of the input signal. It may take some trial and error to establish the optimum input hysteresis setting for a particular system.

If at any time the remote 4-20mA input signal is disconnected, the Falcon control will indicate “OPEN” or “LOCAL” under the 4-20mA input value at the operation screen. The boiler will then operate on its local set point and PID modulation control. Once the 4-20mA signal is reestablished, the boiler will resume operation under remote control.

Rate Limiting/Override

For safety reasons or to accommodate special operating conditions, the CB Falcon incorporates a number of control functions that either limit the modulation range or set the firing rate to a specific value. These functions include **Delta T** limiting, **Slow Start**, and **Forced Rate**. See Appendix A for a complete listing of control functions with detailed descriptions and parametrization instructions.

Delta T limiting is designed to reduce the firing rate in case of an excessive difference between the inlet and outlet temperatures caused by a mismatch between water flow rate and boiler firing rate. Sensor connections to the CB Falcon are at J8-4 and -5 (inlet temperature) and J8-8,-9, and -10 (outlet temperature). Delta T limiting includes an **Inversion Detection** mode which when enabled becomes active in case the inlet temperature is higher than the outlet temperature (indicating reverse water flow through the boiler).

Forced Rate limiting causes the burner to stay at a fixed firing rate for a fixed time period immediately after lightoff, following the Run Stabilization period (if any). The forced rate period is optionally followed by a Slow Start function that limits the ramp-up speed of the firing rate whenever the water is colder than a user-specifiable threshold. Slow Start can help reduce set point overshoot, high limit trips, and frequent cycling.

Configurable Pump/Aux Relay Contacts

The CB Falcon Pump/Aux Relay outputs are configurable by means of six preconfigured Pump Control Blocks. Each control block is configured for a specific application:

1. Central Heat Pump
2. Boiler Pump (for primary/secondary pumping)
3. DHW pump
4. System Pump
5. “Aux 1 Pump” - used for a boiler isolation valve
6. “Aux 2 Pump” - used for a boiler Start Permissive Interlock

Each pump control block has seven parameters (for details see Falcon Lead Lag appendix):

Pump Options (2 parameter blocks) - determine pump on/off conditions

Start Delay - if burner is just starting up, timer will delay pump turning on

Overrun Time - keeps the pump running for a short time after the input turns off or demand is satisfied

Output Connection - selects Pump A, B, or C (refer to WD, Figure 2-10)

Cycle Count - one cycle counter for each pump output; can be reset if a pump is replaced

Pump Control - selects Auto or Manual control

A Pump Exercise routine helps to prevent pumps from freezing up due to long periods of inactivity. Configurable parameters are Pump Exercise Interval (days) and Pump Exercise Time (minutes). Any pump that remains off for the Pump Exercise Interval will be turned on for the duration given by Pump Exercise Time.

The relays may be configured for various other functions, including freeze protection, isolation valves, damper interlocks, operating status, etc.

Annunciator

The Annunciator monitors the Falcon control circuit to provide fault and status messages, and also provides first out annunciation for interlock lockouts. Eight inputs are available in addition to the Interlock, Load Control, and Pre-Ignition Interlock inputs, totalling 11 monitored points. Annunciator points can be accessed from the Falcon display Operation screen.

Lead/Lag Control (up to eight boilers)

Multiple CB Falcon units can be connected in a lead/lag system. Controllers in a lead/lag configuration communicate over the Falcon’s MB2 Modbus network.

One CB Falcon in the lead/lag network hosts the Lead Lag Master function, which coordinates the activities of the Slave units (individual Falcons, including the one hosting the Master) via Modbus. The Master uses its host controller’s header sensor to receive control input information and to maintain the optimum setpoint. An outdoor temperature sensor can also be connected for Lead Lag outdoor reset control.

Boiler sequencing, on/off staging, and firing rate allocation are user-configurable. The Falcon's default lead lag parameter settings have been optimized specifically for ClearFire-C condensing boiler operation.

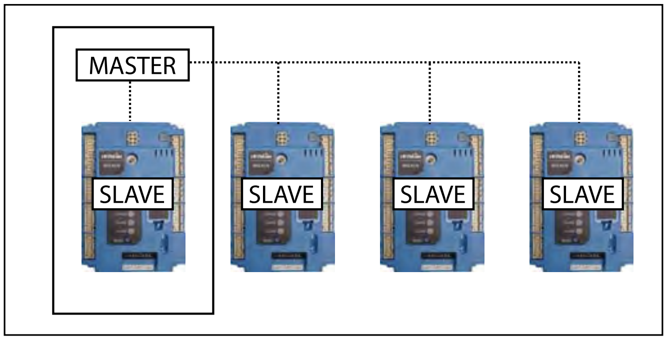


Figure 4-13 Falcon Lead/Lag

Refer to Falcon appendix or to the Falcon Lead/Lag appendix in this manual for additional information.

Modbus Communication

For remote enable / remote setpoint (see above) and for remote monitoring through a building EMS, the Falcon uses the Modbus communication protocol. For more information on Modbus setup and implementation, see the Falcon Modbus appendix in this manual.

Section 5

Service and Maintenance

⚠ Caution

Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation.Failure to do so may result in equipment failure.

⚠ Caution

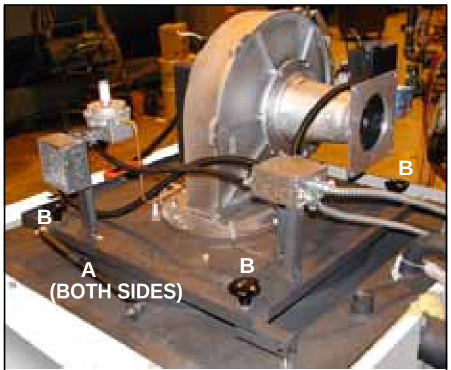
Verify proper operation after servicing. Failure to do so may result in equipment failure.

On an annual basis the boiler vessel and burner combustion system must be checked and cleaned. This work is to be carried out by an authorized Cleaver-Brooks Service Technician.

A. CLEANING PROCEDURE / DISASSEMBLY

1. Close off the gas supply to the boiler and disconnect electrical power at the primary switch box.
2. Remove the top cover of the boiler.
3. Disconnect the gas piping to the burner head.
4. Disconnect the electrical connections to the blower assembly.
5. Remove air combustion piping if supplied.
6. Unscrew the four- (4) hold down nuts securing the burner door to the pressure vessel.
7. The burner door, burner head, blower motor and assembly will lift on the provided gas struts (see **Figure 5-2**).
8. The blower motor and gas valve assembly assembly can be removed from the boiler.
9. The burner head can be separated from the head assembly by removing 4 bolts and washers.

Check the burner head for any damage, burn marks or perforations. If damage is determined replace the damaged parts. If the canister is in good condition clean out any dirt and contaminates with a vacuum cleaner inside and out alternating with compressed air to dislodge any debris of combustion.



A. Gas Assist lift cylinders (2)
B. Burner head hold down nuts

Figure 5-1 Burner Head (in place)

1. With the burner head and blower removed the combustion chamber can be accessed for all service requirements.
2. Check ignition and ionization electrodes for deposits and proper gap. Clean or replace as needed.
3. Inspect the pressure vessel and combustion chamber area for any damage or contamination. If dirt or contaminates are found it is recommended that the tubes be washed with a high-pressure power washer.

Figure 5-2 Burner Door

⚠ Caution

Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation. Verify proper operation after servicing.

B. REASSEMBLY

1. Assembly is the reverse of the above instructions.
2. A new rope gasket should be installed on the burner door; see recommended spare parts list.

C. IGNITION AND FLAME DETECTION SYSTEMS

Electrode and Flame Rod (CFC 500-2500)

The ignition and ionization electrodes should be replaced annually, or more frequently if conditions require. Inspect the electrodes periodically for signs of fouling, displacement, or other damage.

Electrodes should be replaced with the electrode turned towards the burner mantle after it is inserted into the burner head. Observe the dimensions below when replacing:

1/2” gap between ionization electrode and the surface of the burner canister.

1/8” gap between ignitor electrode and ground electrode.

7/8” from ignitor electrode to the burner canister.

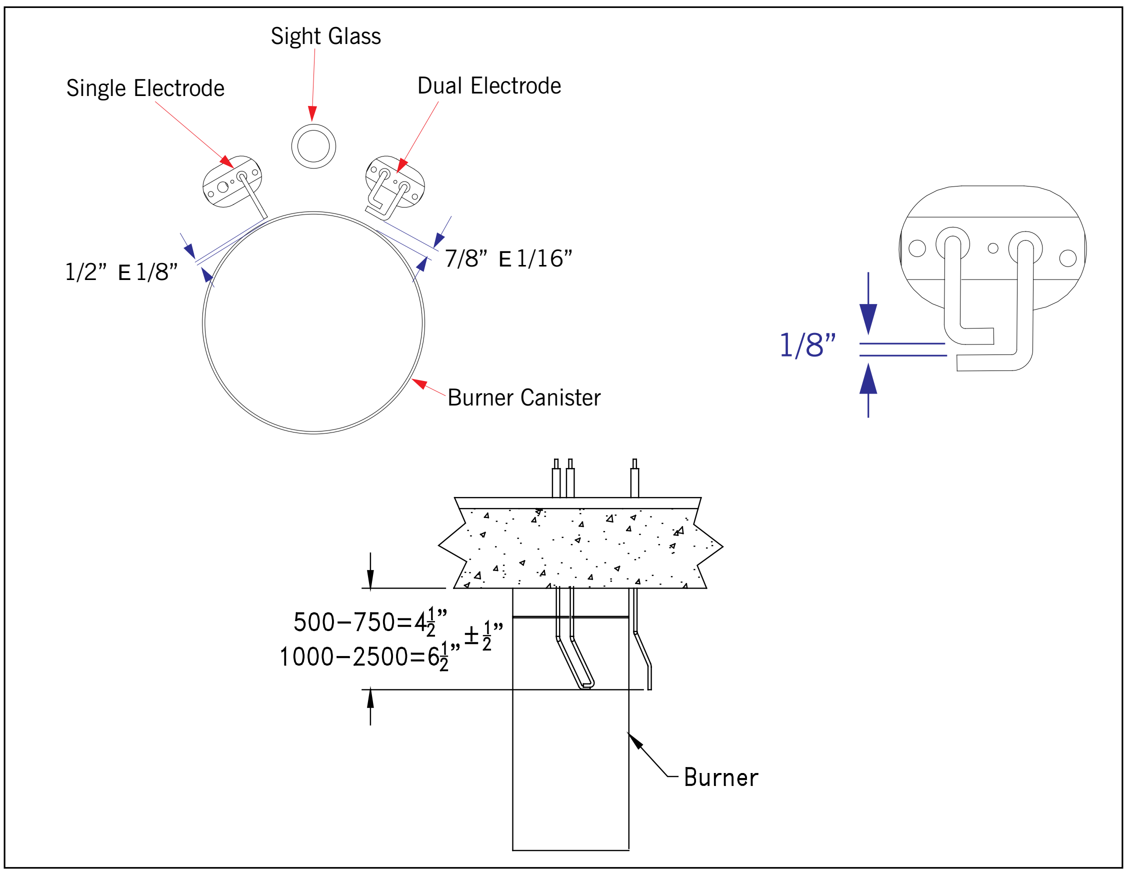


Figure 5-3 Electrode spacing CFC 500-2500

When replacing the adjustable flame rod:

- While holding the flame rod in position, tighten the bracket nut until you cannot twist the flame rod. This can be done by slightly wiggling the flame rod back and forth when tightening. You should also begin to feel tension in the nut while tightening. Suggested torque is 60-75 in-lbs.

Figure 5-4 Tightening Flame Rod

- Once the flame rod is secure, double check the measurements for the proper positioning of the flame rod end.
- Close burner door if opened and re-attach wiring connections.
- Reconnect power to boiler. Turn on boiler and check for a good flame signal.
- A low-fire flame signal of 5-15 and above is considered good. If the flame signal is lower, try rotating the flame rod slightly or adjusting the axial position to obtain a stronger signal. If an acceptable flame signal can not be produced, open the boiler door and check the flame rod settings with respect to the boiler drawings.

To avoid proximity of the flame rod to the ignition electrodes, any rotational adjustments should be made on the side opposite the ignitor.

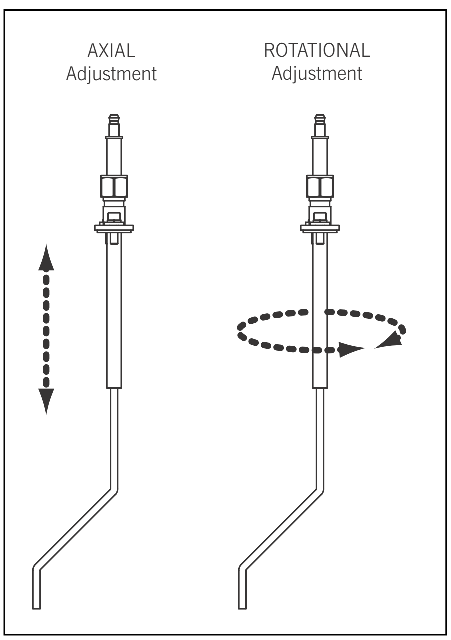


Figure 5-5 Flame Rod Adjustment

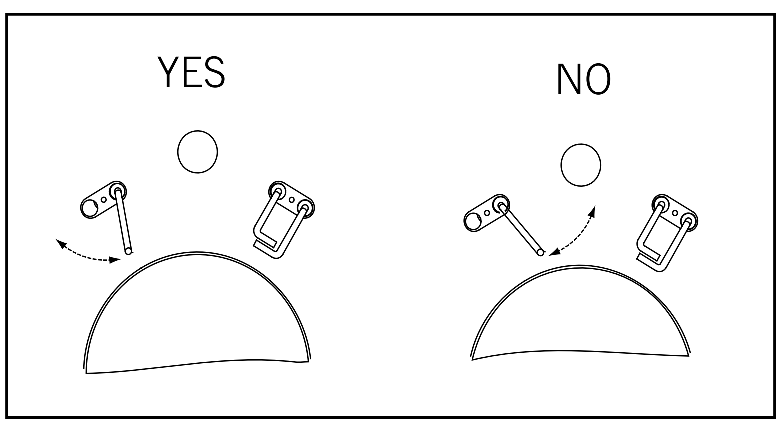


Figure 5-6 Rotating Flame Rod (view from inside furnace)

Pilot and UV Scanner (CFC 3300)

Maintenance of the UV scanner consists of periodic inspection and cleaning. To inspect, unscrew the UV flame detector from the bracket. Check to ensure that the flame viewing lens is clear and free of dust or debris. Wipe with a clean rag if necessary.

When replacing the scanner, verify an unobstructed line of sight through the scanner bracket to the burner canister.

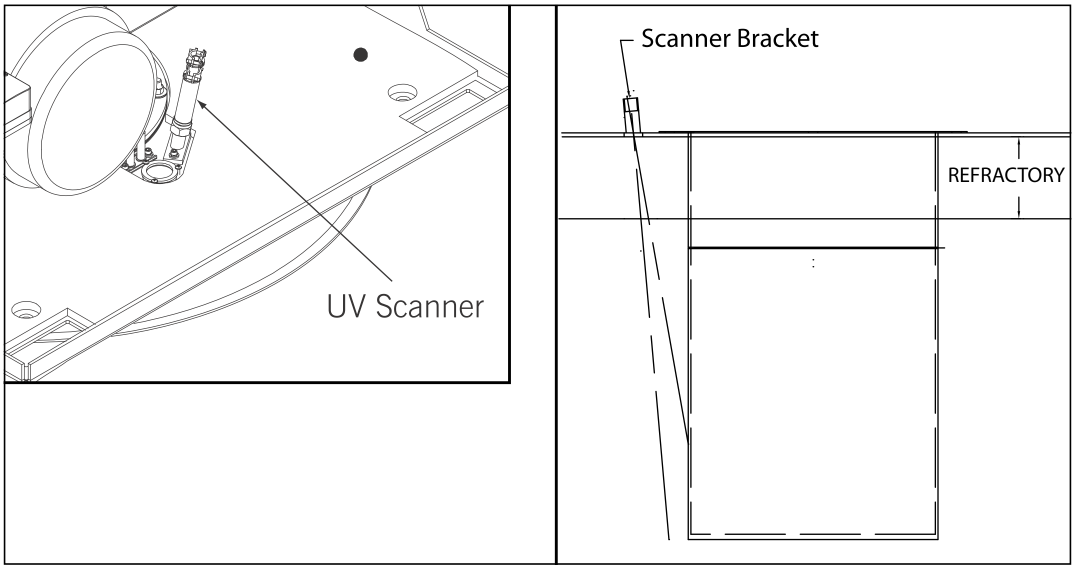


Figure 5-7

The CFC 3300 uses an interrupted gas pilot in lieu of direct spark ignition. The dual ignition electrode is the same component used in direct spark models; it should be inspected regularly and cleaned or replaced as needed. The spacing of the ignitor to the burner canister should be 1/2” (see below).

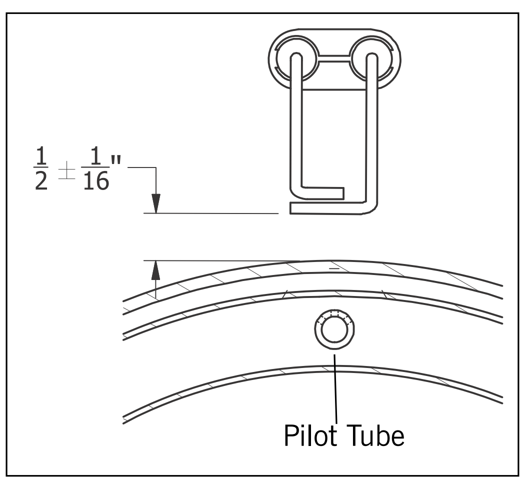


Figure 5-8

D. TROUBLESHOOTING

Lockout Conditions

1. Observe lockout code and description - refer to CB Falcon appendix if necessary.
2. After determining lockout condition, investigate possible causes.
3. When cause is diagnosed, remedy condition.
4. Reset control. Boiler should be able to start normally.
5. If lockout recurs, further investigation is required. Repeat steps 1 through 4 as needed. If necessary, contact your CB service representative for technical support.

EXAMPLE: Lockout 79 Outlet Temperature High Limit

1. Before resetting control to clear lockout, check for sufficient water flow through boiler. Possible sources of insufficient flow include closed water valves, insufficient pump speed, air trapped in boiler (inadequate air venting), or modulation set point and off point close to outlet high limit setting.

   The CB Falcon system display/interface provides extensive boiler diagnostic data at the time of lockout that can help in determining the source of a problem. This information is accessed through the Lockout History.
2. Remedy condition that caused lockout to occur.
3. Reset control by pressing <Clear Lockout> from the Lockout History screen.

Light-off Problems

Check electrode positioning according to Section C above. The flame rod can be adjusted as described.

The dimensions on the ignition electrodes are not easily adjustable - bending the rods can cause damage to the insulation material. In addition, a bent electrode will return to its original shape when heated. If an ignitor or flame rod is out of specification, replacement is generally required. Clean or replace as necessary.

Also see **Troubleshooting Chart** below.

Troubleshooting Chart

Symptom/Fault Indication	Possible Causes
Erratic display/controller behavior	Faulty electrical ground - Check ground terminals in control panel. System should be grounded firmly to metal casing. External ground wiring may be necessary.
Touch screen not working properly	Screen out of calibration - from Falcon home page, go to Setup/Advanced Setup/Diagnostics. Under "Touch Screen" press <Calibrate> and follow instructions on screen.
Burner can failure; High Gas Pressure lockouts	Incorrect gas pressure: • Check regulated gas pressure and ensure it agrees with Table 4-3. Check other equipment connected to gas main - regulator and gas supply piping sizings should be based on all appliances being ON. • A dedicated, properly sized gas pressure regulator is required for each boiler. • Customer connection should reduce to boiler gas train.
Lightoff problems	• Wrong gas pressure. Check regulated gas pressure and ensure it agrees with Table 4-3. Check other equipment connected to gas main - regulator and gas supply piping sizings should be based on all appliances being ON. • Incorrect fan speed settings - increase fan speed by 100 RPM increments until successful lightoff occurs. • Bad cable connections (ignition or flame rod) • Electrodes fouled or improperly spaced - electrodes should be cleaned or replaced and spacing adjusted. • Debris on burner canister. To clean the unit, remove the burner can and blow compressed air from the outside in. Vacuum up the residue. • Electrical ground problem
Outlet Temperature High Limit lockout	• Insufficient water flow through boiler - closed water valves, insufficient pump speed • Air trapped in boiler • Modulation set point and off point too close to outlet high limit setting
Interrupted Air Switch lockout	• Blower not running • Blocked blower inlet • CAPS switch defective or improperly wired
Loss of flame	• Debris on burner • Blocked condensate drain • Combustion improperly set • Flame rod fouled or out of position

Section 6

Parts

Table 6-1. Recommended Spare Parts List Model CFC

	Boiler Size						
Item	**500**	**750**	**1000**	**1500**	**1800**	**2500**	**3300**
Falcon Controller, Hydronic	833-3639	833-3639	833-3639	833-3639	833-3639	833-3639	833-4086
Display/Operator Interface, Falcon System	833-5105	833-5105	833-5105	833-5105	833-5105	833-5105	833-5105
Kit, Flame Rod	880-3762	880-3762	880-3762	880-3762	880-3762	880-3762	—
UV Scanner	—	—	—	—	—	—	817-1743
Dual Electrode, Sparking	380-1061	380-1061	380-1061	380-1061	380-1061	380-1061	380-1061
Electrode Gasket (qty 3)	380-1032	380-1032	380-1032	380-1032	380-1032	380-1032	380-1032
Burner Canister	380-1045	380-1045	380-1029	380-1030	380-1030	380-1074	380-1117
Water Side Gaskets (qty 3)	853-340	853-340	853-340	853-543	853-241	853-350	853-350
Transformer, 115V/25V	832-235	832-235	832-235	832-235	832-235	832-235	832-235
Fuse (5A), Control Circuit	832-1811	832-1811	832-1811	832-1811	832-1811	832-1811	—
Fuse (4A), Control Circuit	—	—	—	—	—	—	832-1810
Fuse (2A), 24VAC Secondary	832-2051	832-2051	832-2051	832-2051	832-2051	832-2051	832-2051
Relay, DPDT, 115VAC Coil	833-3532	833-3532	833-3532	833-3532	833-3532	833-3532	833-3532
Gasket, Burner Canister (2)	380-1053	380-1053	380-1033	380-1034	380-1034	380-1034	380-1115
Gasket, Adapter to Blower	380-1037	380-1037	380-1037	380-1076	380-1038	380-1038	380-1038
Cable, Blower Signal	832-2434	832-2434	832-2434	832-2434	832-2434	832-2434	832-2434
Cable, Blower Motor Sensing Adapter	—	—	—	—	—	—	826-255
Ignition Cable (2)	826-156	826-156	826-156	826-156	826-156	826-156	826-156
Blower Power Cord	832-2101	832-2101	832-2101	832-2101	832-2101	832-2101	826-256
Burner Sight Glass	851-26	851-26	851-26	851-26	851-26	851-26	851-26
Retainer, Sight Glass	65-879	65-879	65-879	65-879	65-879	65-879	65-879
Gasket, Sight Glass (2)	853-213	853-213	853-213	853-213	853-213	853-213	853-213

	Boiler Size/Fuse Rating						
	500/6A	750/6A	1000/6A	1500/12A	1800/15A	2500/15A	3300/9A
Blower Fuse	832-01881	832-01881	832-01881	832-01887	832-01888	832-01888	832-01885

Figure 6-1. Boiler Mechanical Assembly CFC 500-2500

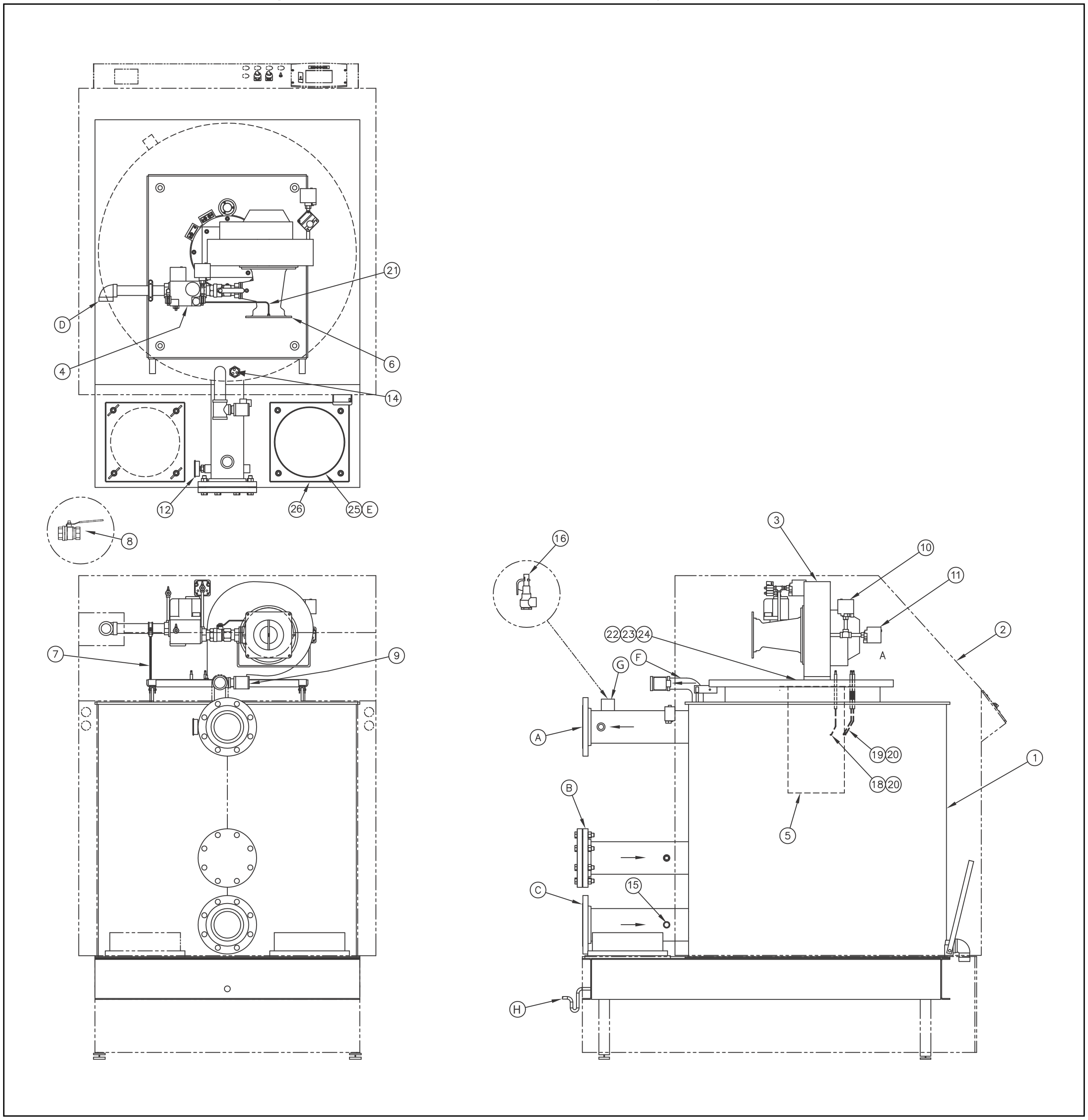


Table 6-2. Boiler Mechanical Assembly CFC 500-2500

		BOILER SIZE						
ITEM	REQ.	500	750	1000	1500	1800	2500	DESCRIPTION
1	1	380 01104	380 01104	380 01105	380 01106	380 01099	380 01100	PRESSURE VESSEL
2	1	880 02525	880 02525	880 02526	880 02527	880 02528	880 02529	CASING ASSEMBLY (CASING, LEGS & INSULATION)
3	1	894 04076	894 04076	894 04076	894 04111	894 04075	894 04075	BLOWER UNIT, 115/1/60
4	1	SEE TABLE	SEE TABLE	SEE TABLE	SEE TABLE	SEE TABLE	SEE TABLE	GAS TRAIN
5	1	380 01045	380 01045	380 01029	380 01030	380 01030	380 01074	BURNER CAN UNIT
6	1	048 00659	048 00655	048 00655	048 00656	048 00656	048 00662	VENTURI
7	1	008 03540	008 03540	008 03540	008 03541	008 03541	008 03648	GAS TRAIN SUPPORT BRACKET
8	1	SEE TABLE	SEE TABLE	SEE TABLE	SEE TABLE	SEE TABLE	SEE TABLE	MANUAL GAS SHUTOFF VALVE
9	1	817 03984	817 03984	817 03984	817 03984	817 03984	817 03984	PROBE HOLDER
10	1	817 03468	817 03468	817 03468	817 03468	817 03468	817 03468	AIR SWITCH (CAPS)
11	1	817 02420	817 02420	817 02420	817 02420	817 02420	817 02420	HIGH AIR PRESSURE SWITCH (HAPS)
12	1	850 01163	850 01163	850 01163	850 01163	850 01163	850 01163	GAUGE, PRESSURE & TEMP., 2.5"ø, 0–100 PSI, 60°–260°F
13	1	826B00158	826B00158	826B00158	826B00158	826B00158	826B00158	CABLE HARNESS (GAS VALVE, HGPS, LGPS, HAPS, CAPS, LWCO)
14	1	817 04403	817 04403	817 04403	817 04403	817 04403	817 04403	SENSOR, HW SUPPLY/OUTLET TEMPERATURE
15	1	817 04404	817 04404	817 04404	817 04404	817 04404	817 04404	SENSOR, RETURN/INLET TEMPERATURE
16	1	940 00691	940 00691	940 00691	940 00691	940 00811	940 00811	OPTIONAL SAFETY VALVE (60#) (SHIPPED LOOSE)
	1	940 00478	940 00478	940 00478	940 00478	940 00480	940 00480	OPTIONAL SAFETY VALVE (30#) (SHIPPED LOOSE)
	1	940-00584	940-00584	940-00584	940-00584	940-00584	940-00584	STD SAFETY VALVE (125#)(SHIPPED LOOSE)
18	1	380A01062	380A01062	380A01060	380A01060	380A01060	380A01060	SINGLE ELECTRODE
19	1	380A01061	380A01061	380A01061	380A01061	380A01061	380A01061	DUAL ELECTRODE
20	2	380A01032	380A01032	380A01032	380A01032	380A01032	380A01032	GASKET, DUAL ELECTRODE
21	1	380 01048	380 01048	380 01048	380 01049	380 01049	380 01049	SENSING LINE
22	2	380A01053	380A01053	380A01033	380A01034	380A01034	380A01034	GASKET, BURNER TO ADAPTER PLATE
23	1	380A01052	380A01052	380A01035	380A01082	380A01036	380A01036	ADAPTER PLATE ASSEMBLY
24	1	380A01037	380A01037	380A01037	380A01076	380A01038	380A01038	GASKET, ADAPTER PLATE TO BLOWER
25	1	039B01704	039B01704	039B01647	039 01644	039 01688	039 01688	VENT, FLUE GAS OUTLET, 12" STACK
26	1	380 01090	380 01090	380 01089	380 01088	380 01088	380 01088	GASKET, FLUE GAS OUTLET

Gas Train

	BOILER SIZE						
	500	750	1000	1500	1800	2500	3300
SINGLE FUEL	507-08324	507-08323	507-08321	507-08320	507-08319	507-08188	185-01140
DUAL FUEL	185-00703	185-00702	185-00701	185-00700	185-00699	185-00698	185-01142

Table 6-3. Connection Sizes

		BOILER SIZE						
		500	750	1000	1500	1800	2500	3300
”A”	HW SUPPLY SIZE	2–1/2”–150# R.F.FLG.			3”–150# R.F.FLG.	4”–150# R.F.FLG.	5”–150# R.F.FLG.	
”B”	HIGH TEMP. RETURN SIZE	2–1/2”–150# R.F.FLG.			3”–150# R.F.FLG.	4”–150# R.F.FLG.	5”–150# R.F.FLG.	
”C”	LOW TEMP. RETURN SIZE	2–1/2”–150# R.F.FLG.			3”–150# R.F.FLG.	4”–150# R.F.FLG.	5”–150# R.F.FLG.	
”D”	GAS SUPPLY LINE	1” NPT.	1” NPT.	1” NPT.	1–1/2” NPT.	1–1/2” NPT.	1–1/2” NPT.	2” NPT.
”E”	STACK INS. DIA.	5.875”	5.875”	7.875”	9.875”	11.875”	11.875”	11.875”
”F”	VENT SIZE	1–1/2” NPT.	1–1/2” NPT.	1–1/2” NPT.	1–1/2” NPT.	1–1/2” NPT.	1–1/2” NPT.	1–1/2” NPT.
“G”	SAFETY VALVE COUPLING	1 - 1/4”	1 - 1/4”	1 - 1/4”	1 - 1/4”	1 - 1/4”	1 - 1/4”	
“H”	CONDENSATE DRAIN	3/4” NPT.	3/4” NPT.	3/4” NPT.	3/4” NPT.	3/4” NPT.	1” NPT.	

Figure 6-2. Boiler Mechanical Assembly CFC 3300

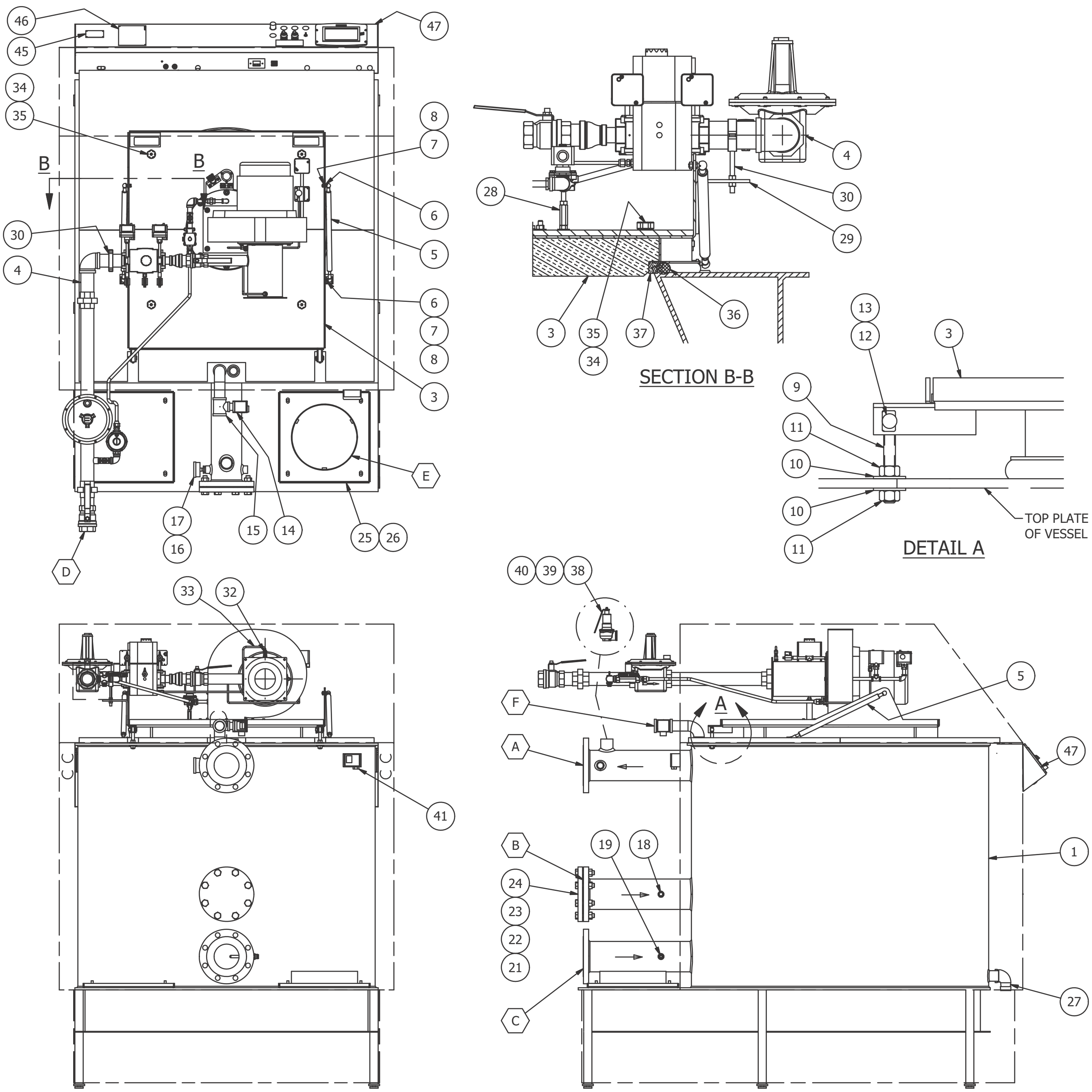
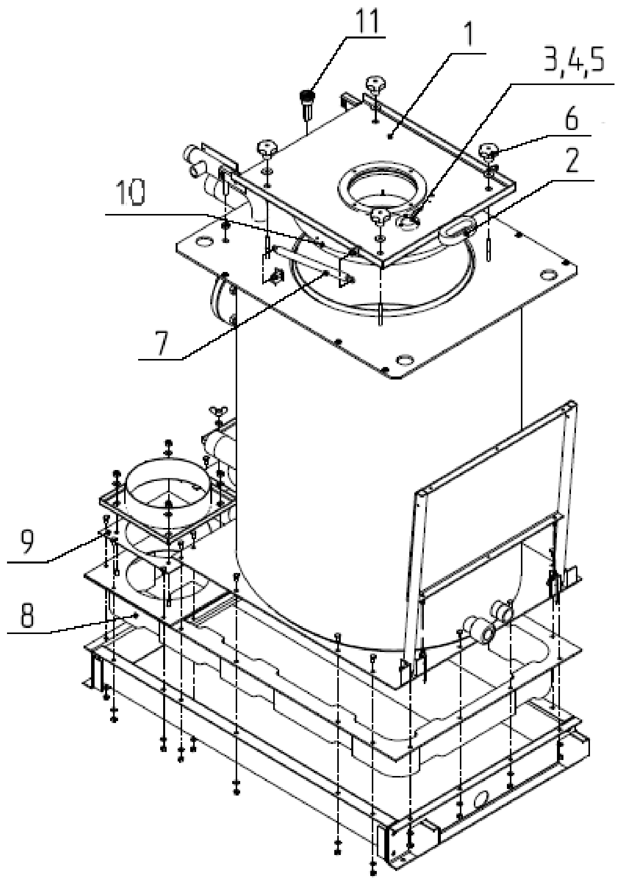


Table 6-4. Boiler Mechanical Assembly CFC 3300

NOTES	ITEM	QTY	PART NO	DESCRIPTION
	1	1	380-01116-000	VESSEL, PRESSURE, CFC-3300
SHIP LOOSE	2	1	880-02708-000	KIT, CASING ASSEMBLY (CASING, LEGS AND INSULATION)
	3	1	429-01783-000	BURNER & DOOR ASSEMBLY
	4	1	185-01140-000	GAS TRAIN, MAIN GAS AND PILOT
	5	2	961-00089-000	GAS SPRING, PUSH TYPE, 10.2" x 150# W/BALL JOINT ENDS
	6	4	868-01635-000	FASTENER, BALL STUD, 13MM DIA. x 5/16"-18 MALE THREAD
	7	4	952-00114-000	LOCK WASHER, 5/16" DIA. STEEL
	8	4	869-00036-000	HEX NUT, 5/16-18 UNC ASTM A307 GR. A
	9	2	068-00060-000	ROD END, 1/2" BORE DIA, 1/2"-13 UNC MALE THREAD
	10	4	952-00286-000	WASHER, FLAT, 1/2", PLAIN STEEL
	11	4	869-00015-000	NUT, HEX HD. 1/2-13 UNC ASTM A563 GR. A
	12	2	056-00361-000	CLEVIS PIN, 1/2" DIA x 1-1/4" LG.
	13	2	903-00064-000	PIN, COTTER, EXTENDED PRONG, 1/8" X 3/4" LG.
	14	1	817-03984-000	LWCO PROBE HOLDER
	15	1	847-00303-000	TEE, REDUCING, 1-1/2" X 1-1/2" X 1" NPT, 150# M.I.
	16	1	847-00422-000	BUSHING, HEX HD., 3/4" NPT X 1/4" NPT
	17	1	850-02481-000	GAUGE, TRIDICATOR, 2-1/2" ROUND DIAL , 0-250 PSI, 60-260°F
	18	1	858-00103-000	PLUG, 1/2" NPT.
	19	1	817-00405-000	WELL, SEPARABLE, HONEYWELL, 1/2" NPT. W/CLAMP
	20	1	826-00158-000	CABLE HARNESS (GAS VALVE, HGPS, LGPS, HAPS, CAPS, LWCO)
	21	8	868-00199-000	CAPSCREW, HEX HD, 3/4-10 UNC X 3" LG. A307 GR. A
	22	8	869-00018-000	HEX NUT,3/4-10 UNC A563 GR. A
	23	1	853-00350-000	GASKET, RING, 5"-150#
	24	1	849-00641-000	FLANGE, BLIND, RAISED FACE, 150#, 5" NPS
STANDARD, SEE NOTE 2	25	1	039-01761-000	VENT, FLUE GAS OUTLET, 12"
OPTIONAL, SEE NOTE 2	26	1	039-01762-000	VENT, FLUE GAS OUTLET, 14"
	27	1	859-00110-000	ELBOW, STREET, 1-1/2" NPT, 90 DEGREE, 150# M.I., B16.3
	28	1	008-04160-000	BRACKET, PILOT GAS TRAIN, BOLT-ON, 3/8" NPT.
	29	1	008-03540-000	BRACKET, GAS TRAIN
	30	1	008-04153-000	BRACKET, MAIN GAS TRAIN, BOLT-ON, 2" NPT.
	31	3	800-00103-000	ADAPTER, 1/8 BSPT (MALE) x 1/8" NPT (FEMALE)
	32	2	845-00468-000	CONNECTOR, .125" MPT. x .25" ODC
	33	1	939-00642-000	TUBING, ALUMINUM, 1/4" O.D. x .035" WALL x 34" LG.
	34	4	952-00255-000	WASHER, FLAT, PLAIN WROUGHT STEEL, 1-1/4"OD x 1/2"ID
	35	4	865-00082-000	KNOB, METRIC THREAD, M10 (COMES WITH ITEM 1)
	36	1	853-00999-000	GASKET, ROPE, 1" DIA. x 113" LG.
	37	1	872-01060-000	BULK INSULATION BLANKET, 1" THICK x 2" x 110" LG.
STANDARD, SHIP LOOSE	38	1	940-00584-000	SAFETY VALVE, 125 PSI, 3/4" X 1"
OPTIONAL, SHIP LOOSE	39	1	940-00566-000	SAFETY VALVE, 60 PSI, 1-1/2" X 2"
OPTIONAL, SHIP LOOSE	40	1	940-00480-000	SAFETY VALVE, 30 PSI, 1-1/2" X 2"
OPTIONAL, SHIP LOOSE	41	1	817-04099-000	AUXILIARY HIGH LIMIT CONTROL
OPTIONAL, NOT SHOWN	42	1	TBD	LP GAS CONVERSION PACKAGE
NOT SHOWN, SHIP LOOSE	43	1	880-04121-000	NAMEPLATE PACKAGE FOR CFC BOILERS
NOT SHOWN	44	1	750-00263-000	MANUAL, CFC BOILERS
	45	1	118-00331-000	NAMEPLATE, UL GAS FIRED BOILER (118A00331)
	46	1	118-03937-000	DATA PLATE, CLEARFIRE BOILERS (118A03937)
SEE NOTE 1, SHIP LOOSE	47	1	283-03644-000	CONTROL PANEL AND CABLE HARNESS (283C03644)
	48	1	826-00255-000	CABLE, BLOWER MOTOR SENSING ADAPTER
	49	1	826-00256-000	CABLE, BLOWER MOTOR POWER
	50	1	826-00262-000	CABLE, GAS PILOT SOLENOID
OPTIONAL, SHIP LOOSE	51	1	880-02451-000	KIT, SEALED COMBUSTION AIR
OPTIONAL, SHIP LOOSE	52	1	880-02502-000	KIT, AIR FILTER, 7-1/2" DIA. x 12" HIGH
OPTIONAL, NOT SHOWN	53	1	185-01142-000	GAS TRAIN, DUAL FUEL, MAIN GAS AND PILOT
OPTIONAL, NOT SHOWN	54	1	845-00489-000	CONNECTOR, TUBING, TEE, 1/4" ODT
OPTIONAL, NOT SHOWN	55	1	939-00642-000	TUBING, ALUMINUM, 1/4" O.D. x .035" WALL x 6-5/8" LG.

NOTE: ITEMS 54 & 55 ARE ONLY USED WITH ITEM 53. WHEN DUAL TRAIN IS USED, (2) OF ITEMS 29 & 30 ARE REQUIRED, (3) OF ITEM 32 IS REQUIRED AND ITEM 4 IS NOT NEEDED.

Figure 6-3. Vessel



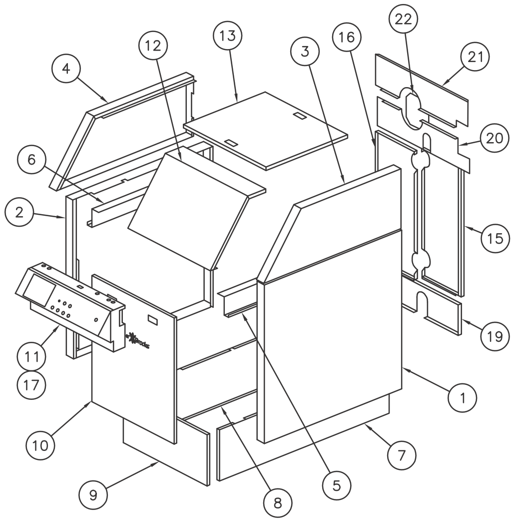
	CFC 750	CFC 1000	CFC 1500	CFC 1800	CFC 2500	CFC3300			
	607–8602	607–8603	607–8604	607–8605	607–8606		ITEM	QTY	DESCRIPTION
#	132–02637	132–02282	132–02384	132–02384	132–02385	132-02800	1	1	BURNER FLANGE COMPLETE
*	865–00080	865–00080	865–00080	865–00080	865–00080	SEE BURNER DRAWER ASSY.	2	1	GRASP
*	865–00081	865–00081	865–00081	865–00081	865–00081		3	1	HOOD FOR GLASS
*	851–00506	851–00506	851–00506	851–00506	851–00506		4	1	GLASS
*	853–01282	853–01282	853–01282	853–01282	853–01282		5	1	GASKET FOR GLASS
	865–00082	865–00082	865–00082	865–00082	865–00082		6	1	STAR GRASP
	530–00662	530–00662	530–00662	530–00662	530–00662		7	1	GAS–FILLED SUPPORT
	961–00080	961–00081	961–00082	961–00082	961–00083		8	1	CONDENSATE BOX
	853–01283	853–01284	853–01285	853–01285	853–01285		9	1	GASKET
*	853–01286	853–01286	853–01286	853–01286	853–01286	SEE BURNER DRAWER	10	1	ROPE GASKET, 3/4"
	096–00073	096–00073	096–00073	096–00073	096–00073	096–00073	11	1	3–HOLE–WELL 1" NPT X 95
	872-01247	872-01248	872-01249	872-01249	872-01250	872-01551	12	1	INSULATION BLANKET, TOP
	872-01237	872-01238	872-01239	872-01239	872-01241	872-01242	13	1	INSULATION BLANKET, SHELL
	872-01234	872-01234	872-01235	872-01235	872-01236	872-01236	14		STRAP
	872-01233	872-01233	872-01233	872-01233	872-01233	872-01233	15		BUCKLES

* NOTE: Item 1 contains items 2,3,4,5 & 10.

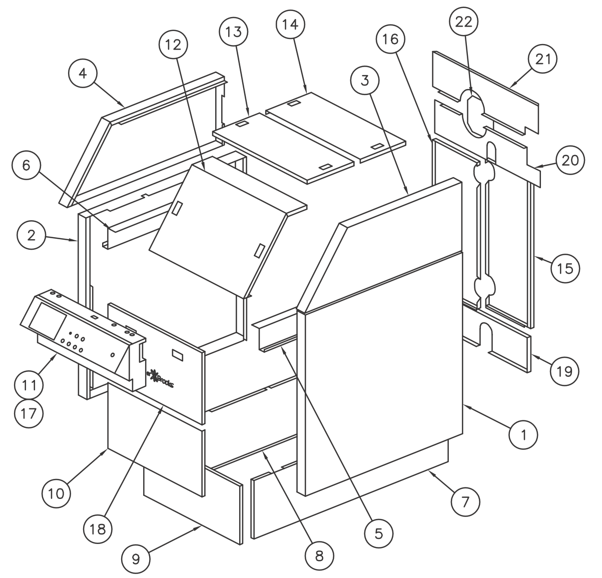
FOR BURNER FLANGE REFRACTORY REPAIR KIT USE:
880–02530 – 750 CFC BOILER
880–02531 – 1000 CFC BOILER
880–02532 – 1500/2500 CFC BOILER

Figure 6-4. Casing

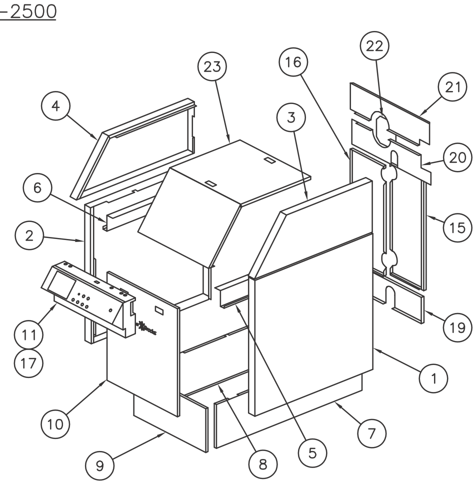
CFC 500/750	CFC 1000	CFC 1500	CFC 1800	CFC 2500	CFC 3300			
880-02525-000	880-02526-000	880-02527-000	880-02528-000	880-02529-000	880-02708-000	ITEM	QTY.	DESCRIPTION
107-08441-000	107-08442-000	107-08442-000	107-08442-000	107-08444-000	107-08599-000	1	1	SIDE PANEL, RIGHT
107-08445-000	107-08446-000	107-08446-000	107-08446-000	107-08448-000	107-08600-000	2	1	SIDE PANEL, LEFT
107-08449-000	107-08450-000	107-08451-000	107-08451-000	107-08453-000	107-08601-000	3	1	SIDE PANEL, RIGHT, UPPER
107-08454-000	107-08455-000	107-08456-000	107-08456-000	107-08458-000	107-08602-000	4	1	SIDE PANEL, LEFT, UPPER
107-08459-000	107-08474-000	107-08474-000	107-08474-000	107-08513-000	107-08603-000	5	1	WIRE TROUGH, RIGHT SIDE
107-08460-000	107-08475-000	107-08475-000	107-08475-000	107-08514-000	107-08604-000	6	1	WIRE TROUGH, LEFT SIDE
107-08461-000	107-08476-000	107-08491-000	107-08491-000	107-08515-000	107-08605-000	7	1	SIDE PANEL, RIGHT, SKIRT
107-08462-000	107-08477-000	107-08492-000	107-08492-000	107-08516-000	107-08606-000	8	1	SIDE PANEL, LEFT, SKIRT
107-08463-000	107-08478-000	107-08493-000	107-08493-000	107-08517-000	107-08607-000	9	1	FRONT PANEL, SKIRT
107-08464-000	107-08479-000	107-08494-000	107-08494-000	107-08518-000	107-08608-000	10	1	FRONT PANEL
107-08465-000	107-08480-000	107-08495-000	107-08495-000	107-08519-000	107-08609-000	11	1	CONTROL PANEL
–	107-08481-000	107-08496-000	107-08496-000	107-08520-000	107-08610-000	12	1	COVER, FRONT
–	107-08482-000	107-08497-000	107-08497-000	107-08521-000	107-08611-000	13	1	COVER, TOP
–	–	–	–	–	107-08612-000	14	1	COVER, TOP, REAR
107-08466-000	107-08483-000	107-08498-000	107-08510-000	107-08522-000	107-08613-000	15	1	REAR PANEL, RIGHT
107-08467-000	107-08484-000	107-08499-000	107-08511-000	107-08523-000	107-08614-000	16	1	REAR PANEL, LEFT
107-08468-000	107-08485-000	107-08500-000	107-08500-000	107-08524-000	107-08615-000	17	1	CONTROL PANEL, BASE
–	–	–	–	–	107-08616-000	18	1	FRONT PANEL, HALF
107-08469-000	107-08486-000	107-08501-000	107-08512-000	107-08525-000	107-08617-000	19	1	REAR PANEL, SKIRT
107-08470-000	107-08487-000	107-08502-000	107-08502-000	107-08526-000	107-08618-000	20	1	REAR PANEL, UPPER II
107-08471-000	107-08488-000	107-08503-000	107-08503-000	107-08527-000	107-08619-000	21	1	REAR PANEL, UPPER I
107-08472-000	107-08472-000	107-08472-000	107-08472-000	107-08528-000	107-08620-000	22	1	SCREEN
107-08473-000	–	–	–	–	–	23	1	COVER, COMPLETE



CFC 1000–2500

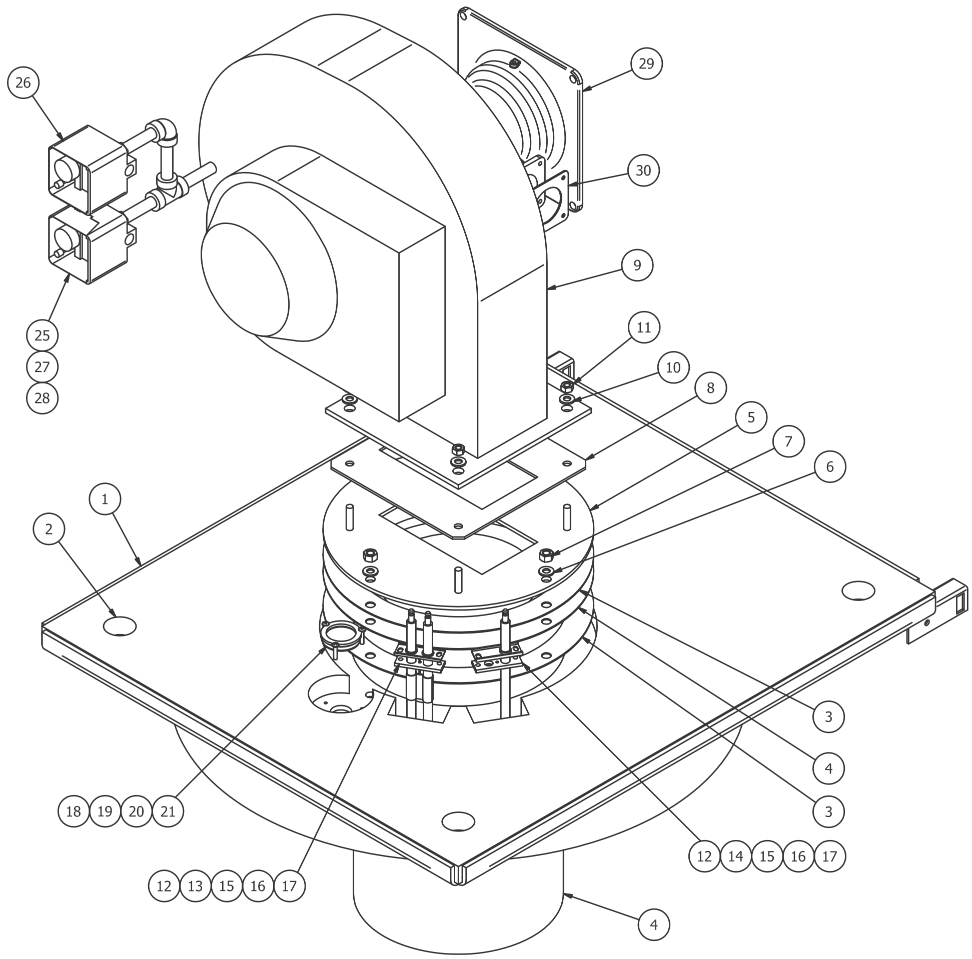


CFC 3300



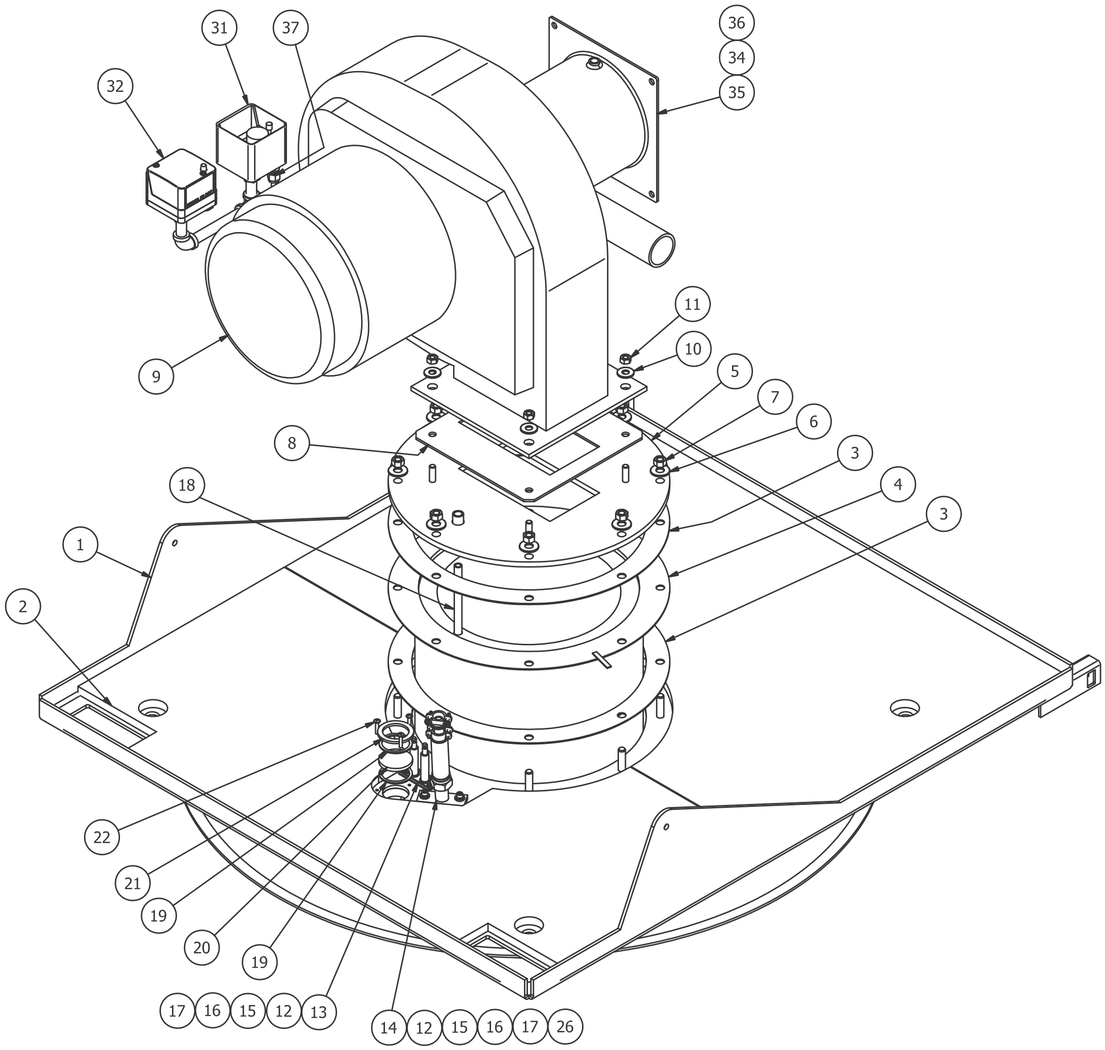
CFC 500–750

Figure 6-5. Burner Door Assembly CFC 500-2500



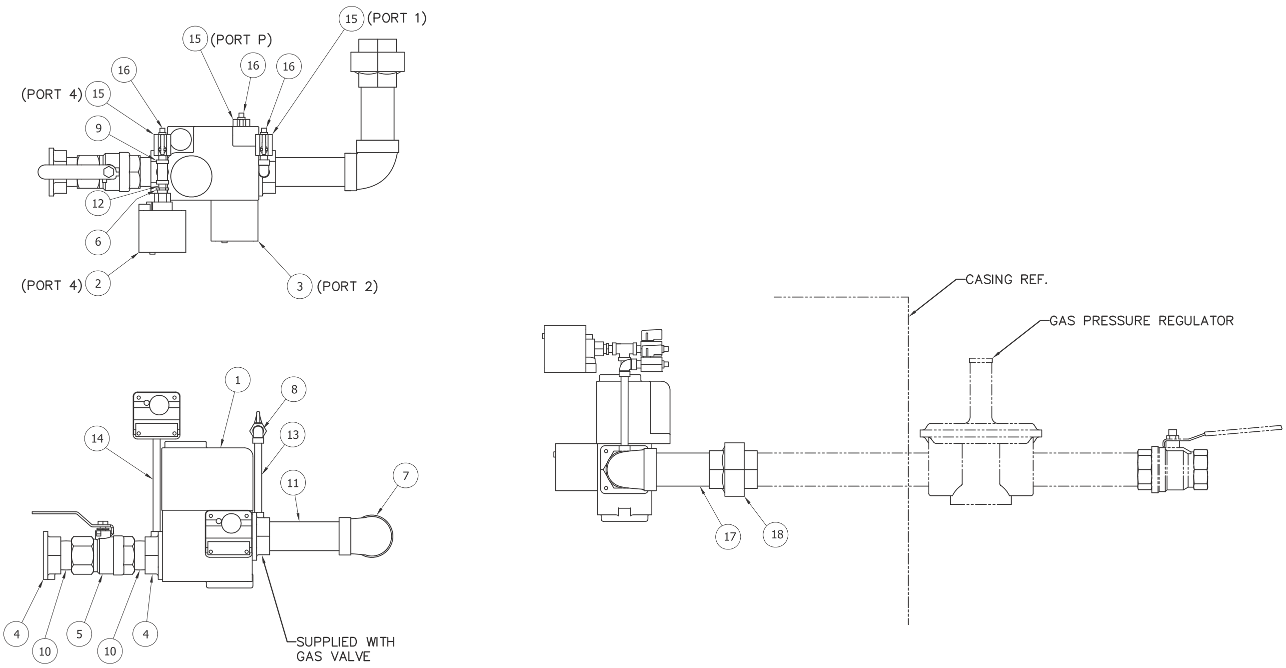
ITEM	QTY	PART NO						DESCRIPTION
		500	750	1000	1500	1800	2500	
1	1	132-02637	132-02637	132-02282	132-02384	132-02384	132-02385	DOOR ASSEMBLY
2	1	872-01252	872-01252	872-01253	872-01254	872-01254	872-01255	INSULATION BOARD WITH FACE
3	2	380 01053	380 01053	380 01033	380-01034-000	380-01034-000	380-01034-000	GASKET, ADAPTER PLATE TO DOOR
4	1	380 01045	380 01045	380 01029	380 01030	380 01030	380 01074	BURNER CAN
5	1	380-01052	380-01052	380-01035	380-01082	380-01036-000	380-01036-000	ADAPTER PLATE
6	4	952-00298-000	952-00298-000	952-00298-000	952-00298-000	952-00298-000	952-00298-000	WASHER, FLAT, PLAIN
7	4	869-00030-000	869-00030-000	869-00030-000	869-00030-000	869-00030-000	869-00030-000	NUT, HEX. 3/8"-16 UNC
8	1	380-01037	380-01037	380-01037	380-01076	380-01038-000	380-01038-000	GASKET, ADAPTER PLATE TO BLOWER
9	1	894 04076	894 04076	894 04076	894 04111	894 04075	894 04075	BLOWER UNIT
10	1	952-00297-000	952-00297-000	952-00297-000	952-00297-000	952-00297-000	952-00297-000	WASHER, FLAT, PLAIN
11	4	869-00198-000	869-00198-000	869-00198-000	869-00198-000	869-00198-000	869-00198-000	NUT, HEX, 5/16"-18 UNC
12	2	380-01032-000	380-01032-000	380-01032-000	380-01032-000	380-01032-000	380-01032-000	GASKET, ELECTRODE
13	1	380-01061-000	380-01061-000	380-01061-000	380-01061-000	380-01061-000	380-01061-000	ELECTRODE, DUAL, CLEARFIRE IGNITION
14	1	380-01062-000	380-01062-000	380-01060-000	380-01060-000	380-01060-000	380-01060-000	ELECTRODE, SINGLE, CLEARFIRE FLAME ROD
15	4	952-00144-000	952-00144-000	952-00144-000	952-00144-000	952-00144-000	952-00144-000	WASHER, FLAT
16	4	952-00117-000	952-00117-000	952-00117-000	952-00117-000	952-00117-000	952-00117-000	LOCK WASHER, #10
17	4	868-00533-000	868-00533-000	868-00533-000	868-00533-000	868-00533-000	868-00533-000	CAPSCREW, SOCKET HD, #10-32 UNF
18	2	853-00213-000	853-00213-000	853-00213-000	853-00213-000	853-00213-000	853-00213-000	SIGHT GLASS GASKET
19	1	851-00026-000	851-00026-000	851-00026-000	851-00026-000	851-00026-000	851-00026-000	SIGHT GLASS, PYREX
20	1	952-00498-000	952-00498-000	952-00498-000	952-00498-000	952-00498-000	952-00498-000	SIGHT GLASS WASHER
21	3	860-00097-000	860-00097-000	860-00097-000	860-00097-000	860-00097-000	860-00097-000	MACHINE SCREWS, #8-32 UNC
25	1	817-03468-000	817-03468-000	817-03468-000	817-03468-000	817-03468-000	817-03468-000	COMBUSTION AIR PROVING SWITCH
26	1	817-02420-000	817-02420-000	817-02420-000	817-02420-000	817-02420-000	817-02420-000	HIGH AIR PRESSURE SWITCH
27	2	845-00468-000	845-00468-000	845-00468-000	845-00468-000	845-00468-000	845-00468-000	CONNECTOR, 1/8" MPT x 1/4" ODC
28	1	845-00468-000	845-00468-000	845-00468-000	845-00468-000	845-00468-000	939-00661-000	TUBING, ALUMINUM, 1/4" O.D.
29	1	048 00659	048 00655	048 00655	048 00656	048 00656	048-00662-000	VENTURI, COMBUSTION AIR/GAS
30	1	800-00098-000	800-00098-000	800-00098-000	800-00098-000	800-00098-000	800-00098-000	GASKET, VENTURI TO GAS TRAIN

Figure 6-6. Burner Door Assembly CFC 3300



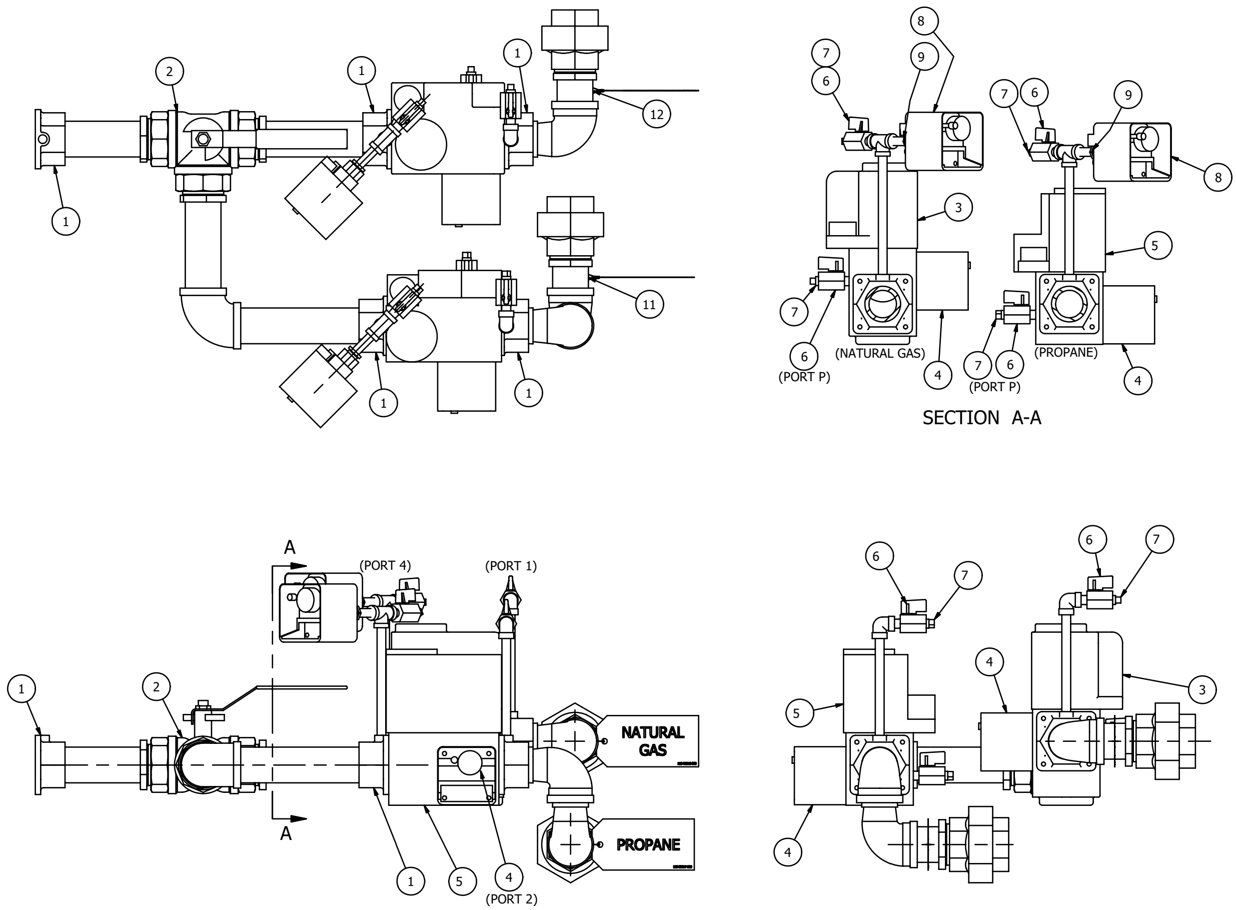
ITEM	QTY	PART NO	DESCRIPTION
1	1	132-02800-000	DOOR ASSEMBLY
2	1	094-01030-000	INSULATION BOARD WITH FACE
3	2	380-01115-000	GASKET, ADAPTER PLATE TO DOOR
4	1	380-01117-000	BURNER CAN
5	1	380-01114-000	ADAPTER PLATE
6	8	952-00298-000	WASHER, FLAT, PLAIN
7	8	869-00030-000	NUT, HEX, 3/8-16 UNC
8	1	380-01038-000	GASKET, ADAPTER PLATE TO BLOWER
9	1	894-05311-000	BLOWER UNIT
10	4	952-00297-000	WASHER, FLAT, PLAIN
11	4	869-00198-000	HEX NUT, 5/16-18 UNC
12	2	380-01032-000	GASKET, ELECTRODE
13	1	380-01061-000	ELECTRODE, DUAL, CLEARFIRE IGNITION
14	1	008-04052-000	BRACKET, MOUNTING, UV SCANNER
15	4	952-00144-000	WASHER, FLAT
16	4	952-00117-000	LOCK WASHER, #10
17	4	868-00533-000	CAPSCREW, SOCKET HD, #10-32 UNF
18	1	090-04464-000	TUBE, GAS PILOT
19	2	853-00213-000	SIGHT GLASS GASKET
20	1	851-00026-000	SIGHT GLASS, PYREX
21	1	952-00498-000	SIGHT GLASS WASHER
22	3	860-00097-000	MACHINE SCREW, #8-32 UNC
26	1	817-01743-000	SCANNER ASSEMBLY - UV
31	1	817-03468-000	COMBUSTION AIR PROVING SWITCH
32	1	817-02420-000	HIGH AIR PRESSURE SWITCH
33	2	845-00468-000	CONNECTOR, 1/8" MPT x 1/4" ODC
34	1	853-01476-000	O-RING, BUNA-N
35	1	048-00811-000	VENTURI, COMBUSTION AIR/GAS
36	6	868-01430-000	CAPSCREW, HEX HD, M8
37	1	939-00661-000	TUBING, ALUMINUM, 1/4" O.D.

Figure 6-7 Gas train - single fuel 500-2500



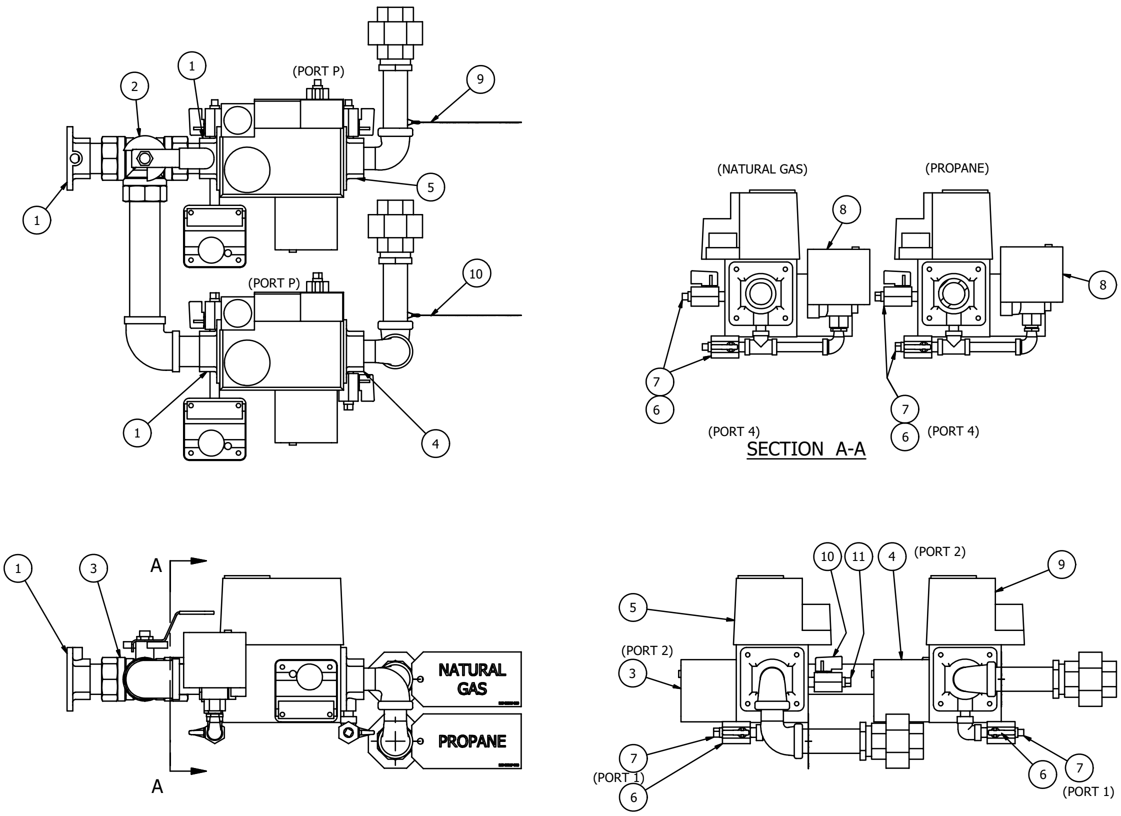
ITEM	QTY	BOILER SIZE 500	750	1000	1500	1800	2500	DESCRIPTION
1	1	940 07162	940 07163	940 07164	940 07165	940 07235	940 07235	GAS VALVE, C/W ADAPTER
2	1	817 02420	817 02420	817 02420	817 02420	817 02420	817 02420	HIGH GAS PRESSURE SWITCH (HGPS)
3	1	817 02414	817 02414	817 02414	817 02414	817 02414	817 02414	LOW GAS PRESSURE SWITCH (LGPS)
4	2	800 00092	800 00092	800 00092	800 00093	800 00093	800 00093	ADAPTER, PIPE, GAS VALVE, C/W O-RING, BOLTS & NUTS
5	1	941 01944	941 01944	941 01944	941 01945	941 01945	941 01945	BUTTERBALL VALVE,
6	1	847 01172	847 01172	847 01172	847 01172	847 01172	847 01172	BUSHING, REDUCING, HEX HEAD
7	1	847 00551	847 00552	859 00082	847 00557	847 00557	847 00557	ELBOW, REDUCING, 90°
8	1	859 00077	859 00077	859 00077	859 00077	859 00077	859 00077	ELBOW, 90°
9	1	859 00021	859 00021	859 00021	859 00021	859 00021	859 00021	TEE
10	2	857 00673	857 00673	857 00673	857 00709	857 00709	857 00709	NIPPLE
11	1	857 00652	857 00708	857 00673	857 00757	857 00757	857 01607	NIPPLE
12	1	857 00719	857 00719	857 00719	857 00719	857 00719	857 00719	NIPPLE
13	1	857 02199	857 02199	857 02199	857 02199	857 02199	857 02199	NIPPLE
14	1	857 01642	857 01642	857 01642	857 01642	857 01642	857 01642	NIPPLE
15	3	825 00239	825 00239	825 00239	825 00239	825 00239	825 00239	LEAKAGE TEST COCK
16	3	858 00088	858 00088	858 00088	858 00088	858 00088	858 00088	PLUG PIPE, SQUARE HEAD
17	1	857 00644	857 00644	857 00644	857 00669	857 00669	857 00669	NIPPLE,
18	1	858 00166	858 00166	858 00166	858 00168	858 00168	858 00168	UNION, FEMALE, 150# M.I.

Figure 6-8. Gas train, dual fuel: CFC 1000 - 2500



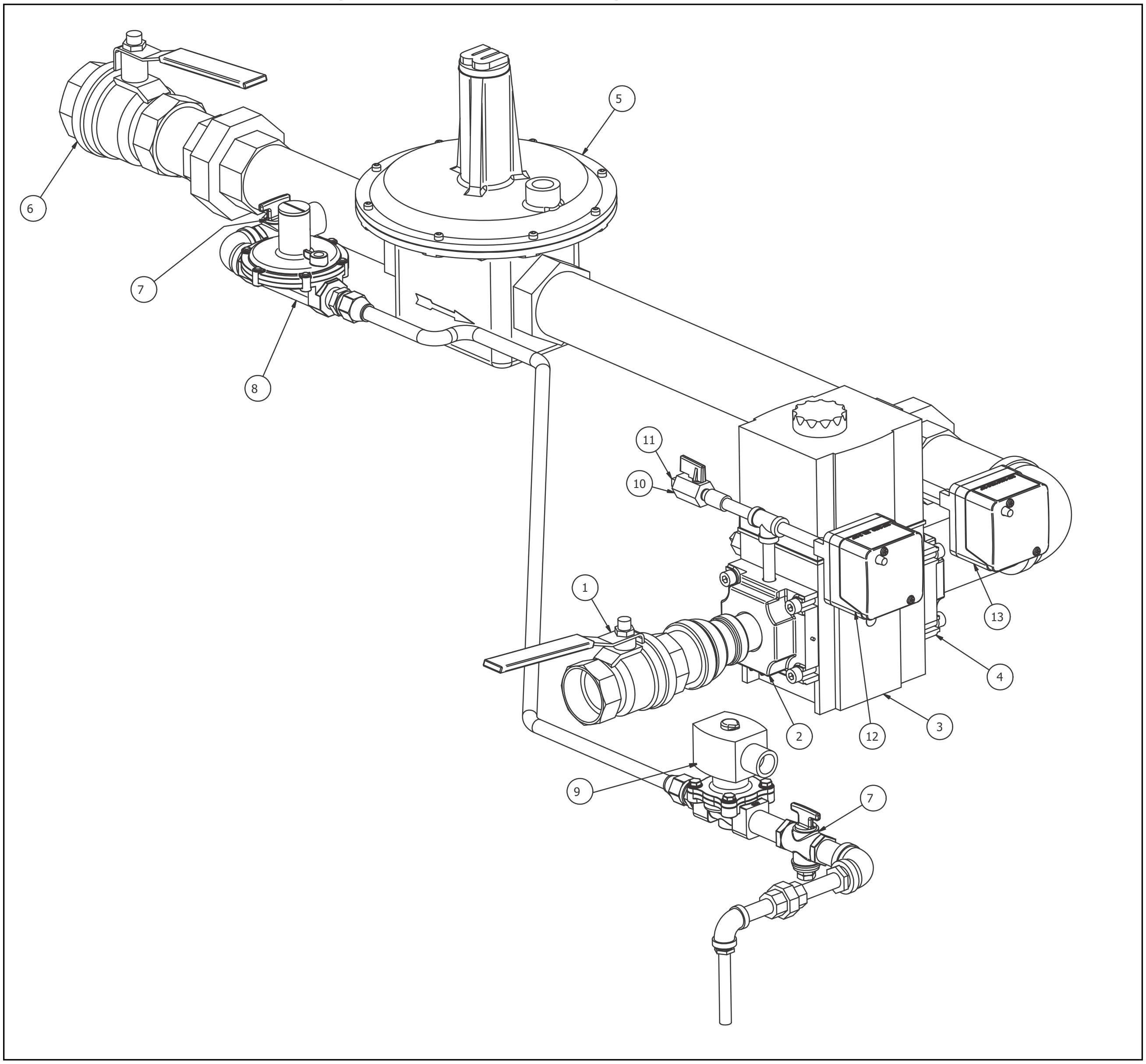
ITEM	QTY	PART NO.	DESCRIPTION	2500	1800	1500	1000
1	5	800-00093-000	ADAPTER	800-00093-000	800-00093-000	800-00093-000	800-00092-000
2	1	223-00013-000	BALL VALVE	223-00013-000	223-00013-000	223-00013-000	223-00015-000
3	1	940-07235-000	GAS VALVE	940-07235-000	940-07235-000	940-07165-000	940-07164-000
4	2	817-02414-000	LOW GAS PRESSURE SWITCH	817-02414-000	817-02414-000	817-02414-000	817-02414-000
5	1	940-07165-000	GAS VALVE	940-07165-000	940-07165-000	940-07165-000	940-07164-000
6	6	825-00239-000	Leakage Test Cock	825-00239-000	825-00239-000	825-00239-000	825-00239-000
7	6	858-00088-000	PIPE PLUG	858-00088-000	858-00088-000	858-00088-000	858-00088-000
8	2	817-02420-000	HIGH GAS PRESSURE SWITCH	817-02420-000	817-02420-000	817-02420-000	817-02420-000
9	2	847-01172-000	BUSHING	847-01172-000	847-01172-000	847-01172-000	847-01172-000
10	1	048-00686-000	ORIFICE	048-00686-000	048-00686-000	———	———
11	1	118-03817-000	NAMEPLATE, TAG, PROPANE	118-03817-000	118-03817-000	118-03817-000	118-03817-000
12	1	118-03816-000	NAMEPLATE, TAG, NATURAL GAS	118-03816-000	118-03816-000	118-03816-000	118-03816-000

Figure 6-9. Gas train, dual fuel: CFC 500 - 750



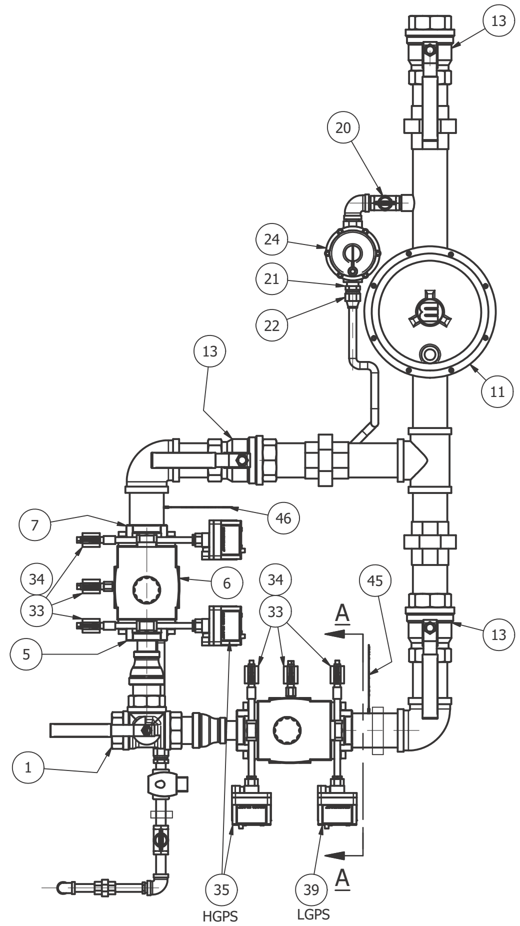
ITEM	QTY	DESCRIPTION	750	500
1	3	Adapter	800-00092-000	800-00092-000
2	1	BALL VALVE	223-00015-000	223-00015-000
3	2	LOW GAS PRESSURE SWITCH	817-02414-000	817-02414-000
4	2	ADAPTER	800-00095-000	800-00094-000
5	2	VALVE, GAS	940-07163-000	940-07162-000
6	6	Leakage Test Cock	825-00239-000	825-00239-000
7	6	PIPE PLUG	858-00088-000	858-00088-000
8	2	HIGH GAS PRESSURE SWITCH	817-02420-000	817-02420-000
9	1	NAMEPLATE, TAG, NATURAL GAS	118-03816-000	118-03816-000
10	1	NAMEPLATE, TAG, PROPANE	118-03817-000	118-03817-000

Figure 6-10. Gas train, single fuel - CFC 3300

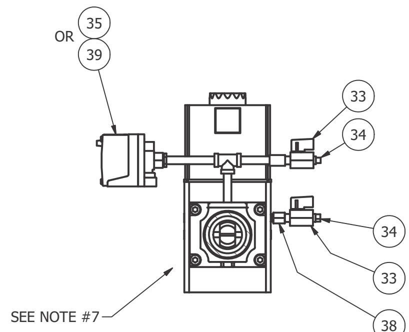


ITEM	QTY	PART NO	DESCRIPTION
1	1	941-01946-000	BALL VALVE, 1-1/2" NPT.
2	1	800-00101-000	ADAPTER, PIPE, 1" NPT. W/ SHUTTER, O-RING & SCREWS
3	1	940-07482-000	VALVE, GAS, 110VAC
4	1	800-00102-000	ADAPTER, PIPE, 2" NPT. WITHOUT SHUTTER
5	1	918-00637-000	REGULATOR, GAS PRESS., 2" NPT, 4"-12" WC (VIOLET)
6	1	941-01947-000	VALVE, BUTTERBALL, 2" NPT.
7	2	825-00030-000	COCK, GAS SERVICE, TEE HEAD, 1/2" NPT, BRONZE
8	1	918-00356-000	REGULATOR, GAS PRESSURE, 1/2" NPT, 2-6" WC
9	1	235-00282-000	VALVE, SOLENOID, GAS PILOT, 3/8"
10	3	825-00239-000	LEAKAGE TEST COCK, 1/8" NPT.
11	3	858-00088-000	PIPE PLUG, SQ. HD. 1/8" NPT 150# M.I., B16.14
12	1	817-02420-000	HGPS, 3-21"WC RANGE, MR, 1/4" NPT MOUNT
13	1	817-02416-000	LGPS, 3-21"WC RANGE, MR, 1/4" NPT MOUNT

Figure 6-11. Gas train, dual fuel - CFC 3300



ITEM	QTY	PART NO	DESCRIPTION
1	1	223-00013-000	BALL VALVE, 3-WAY, BRASS, 1-1/2" NPT.
5	2	800-00101-000	ADAPTER, PIPE, 1" NPT. WITH SHUTTER, O-RING AND SCREWS
6	2	940-07482-000	VALVE, GAS, 110VAC
7	2	800-00102-000	ADAPTER, PIPE, 2" NPT. WITHOUT SHUTTER
11	1	918-00637-000	REGULATOR, GAS PRESSURE, MAXITROL #210E, 2" NPT, 4"-12" WC (VIOLET)
13	3	941-01947-000	VALVE, BUTTERBALL, 2" NPT.
20	1	825-00030-000	COCK, GAS SERVICE, TEE HEAD, 1/2" NPT, BRONZE
24	1	918-00356-000	REGULATOR, GAS PRESSURE, 1/2" NPT, 2-6" WC
25	1	857-00697-000	NIPPLE, PIPE, SMLS, 3/8" NPS x 2" LG., SCH.80
26	1	859-00080-000	ELBOW, 90 DEG, 1/2" NPT 150# M.I.
27	1	235-00282-000	VALVE, SOLENOID, GAS PILOT, 3/8"
33	6	825-00239-000	LEAKAGE TEST COCK, 1/8" NPT.
34	6	858-00088-000	PIPE PLUG, SQ. HD. 1/8" NPT 150# M.I., B16.14
35	2	817-02420-000	HGPS, 3-21"WC RANGE, MR, 1/4" NPT MOUNT
38	2	800-00103-000	ADAPTER, 1/8 BSPT (MALE) x 1/8" NPT (FEMALE)
39	2	817-02416-000	LGPS, 3-21"WC RANGE, MR, 1/4" NPT MOUNT
45	1	118-03816-000	NAMEPLATE, TAG, NATURAL GAS
46	1	118-03817-000	NAMEPLATE, TAG, PROPANE
48	1	825-00029-000	COCK, GAS SERVICE, TEE HEAD, 3/8" NPT, BRONZE



SECTION A-A
(TYPICAL)

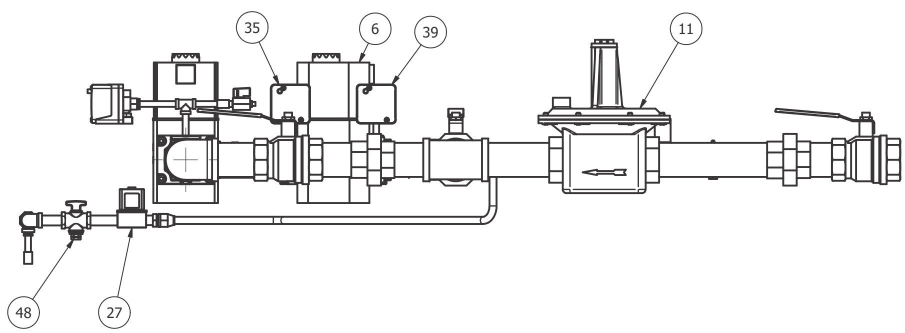


Figure 6-12. Electrical assemblies - single fuel 500-2500

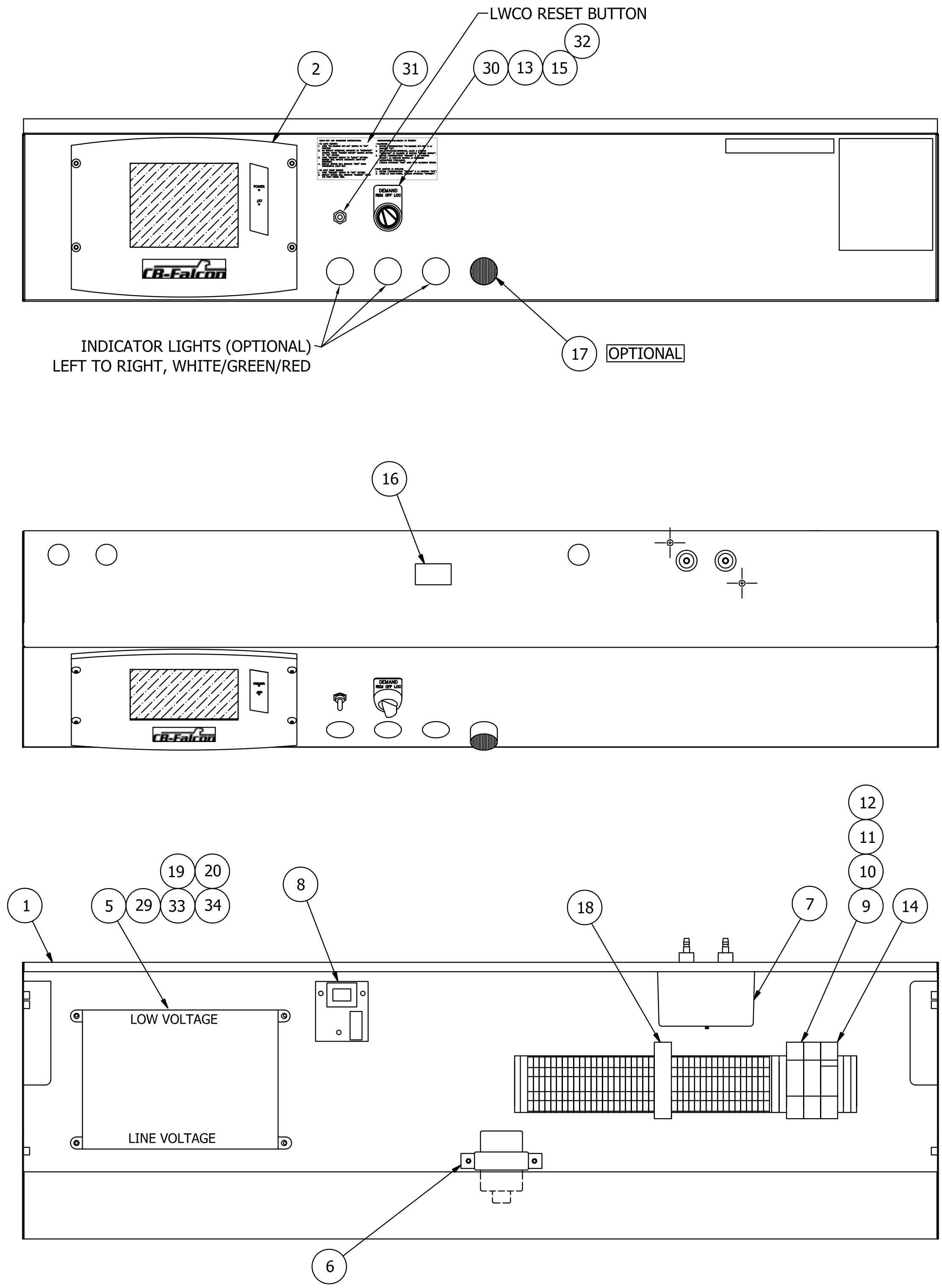


Table 6-5. Electrical assemblies single fuel 500-2500

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	SEE TABLE	CONTROL PANEL
2	1	833-05105-000	DISPLAY, TOUCHSCREEN, SYSTEM FALCON
3	-	------------	-------------------------------------
4	-	------------	-------------------------------------
5	1	833-03639-000	FALCON CONTROLLER, HYDRONIC
6	1	832-00235-000	TRANSFORMER
7	1	832-02451-000	IGNITION TRANSFORMER
8	1	833-03547-000	CONTROLLER, LWCO
9	1	434-00084-000	TERMINAL TRACK FOR ALL CFC BOILERS
10	1	SEE TABLE	FUSE, LPCC TIME DELAY, BLOWER FUSE
11	1	832-01811-000	FUSE, 5 AMP, CONTROL CIRCUIT
12	1	832-02051-000	FUSE, 2 AMP
13	5	836-01136-000	CONTACT BLOCK, N.O.
14	1	SEE TABLE	CIRCUIT BREAKER,
15	1	118-03922-000	NAME PLATE DEMAND REMOTE/OFF/LOC
16	1	059-07423-000	MOUNTING PLATE
17	0*	817-03571-000	ALARM, BUZZER, PANEL MOUNTED
18	1	833-03532-000	RELAY, DPDT, 120V COIL
19	1	826-00200-000	INLET TEMP. SENSOR CABLE
20	1	826-00201-000	OUTLET TEMP. SENSOR CABLE
21	-	------------	-------------------------------------
22	-	------------	-------------------------------------
23	-	------------	-------------------------------------
24		SEE FIGURE 6-13	
25			
26			
27			
28			
29	1	880-02343-000	PLUG CONNECTOR KIT, FALCON
30	1	836-01148-000	SWITCH SELECTOR, 3 POSITION
31	1	118-03755-000	LABEL, LIGHT OFF & SHUTDOWN
32	1	881-00348-000	LATCH, PLASTIC
33	1	817-04403-000	SENSOR, HW SUPPLY/OUTLET TEMP
34	1	817-04814-000	SENSOR, RETURN INLET TEMPERATURE

*OPTIONAL

Table 6-6. Item 1 Control Panel

Boiler Size					
500	750	1000	1500	1800	2500
119-00429	119-00429	119-00430	119-00431	119-00431	119-00426

Table 6-7. Item 10 Blower Fuse

Boiler Size/Fuse Rating					
500/6A	750/6A	1000/6A	1500/12A	1800/15A	2500/15A
832-01881	832-01881	832-01881	832-01887	832-01888	832-01888

Table 6-8. Item 14 Circuit Breaker

Boiler Size/Breaker Amp Rating					
500/10A	750/10A	1000/10A	1500/15A	1800/20A	2500/20A
983-00081	983-00081	983-00081	983-00087	983-00147	983-00147

Figure 6-13. Cables and Cable Harness - Single Fuel 500-2500

ITEM	QTY	PART NO.	DESCRIPTION
24	2	826B00156	IGNITION CABLE
25	1	826B00157	FLAME ROD CABLE
26	1	832B02434	BLOWER SIGNAL CABLE
27	1	826B00160	CABLE HARNESS
28	1	832B02101	BLOWER POWER CORD
35	1	82600158	BURNER CABLE HARNESS

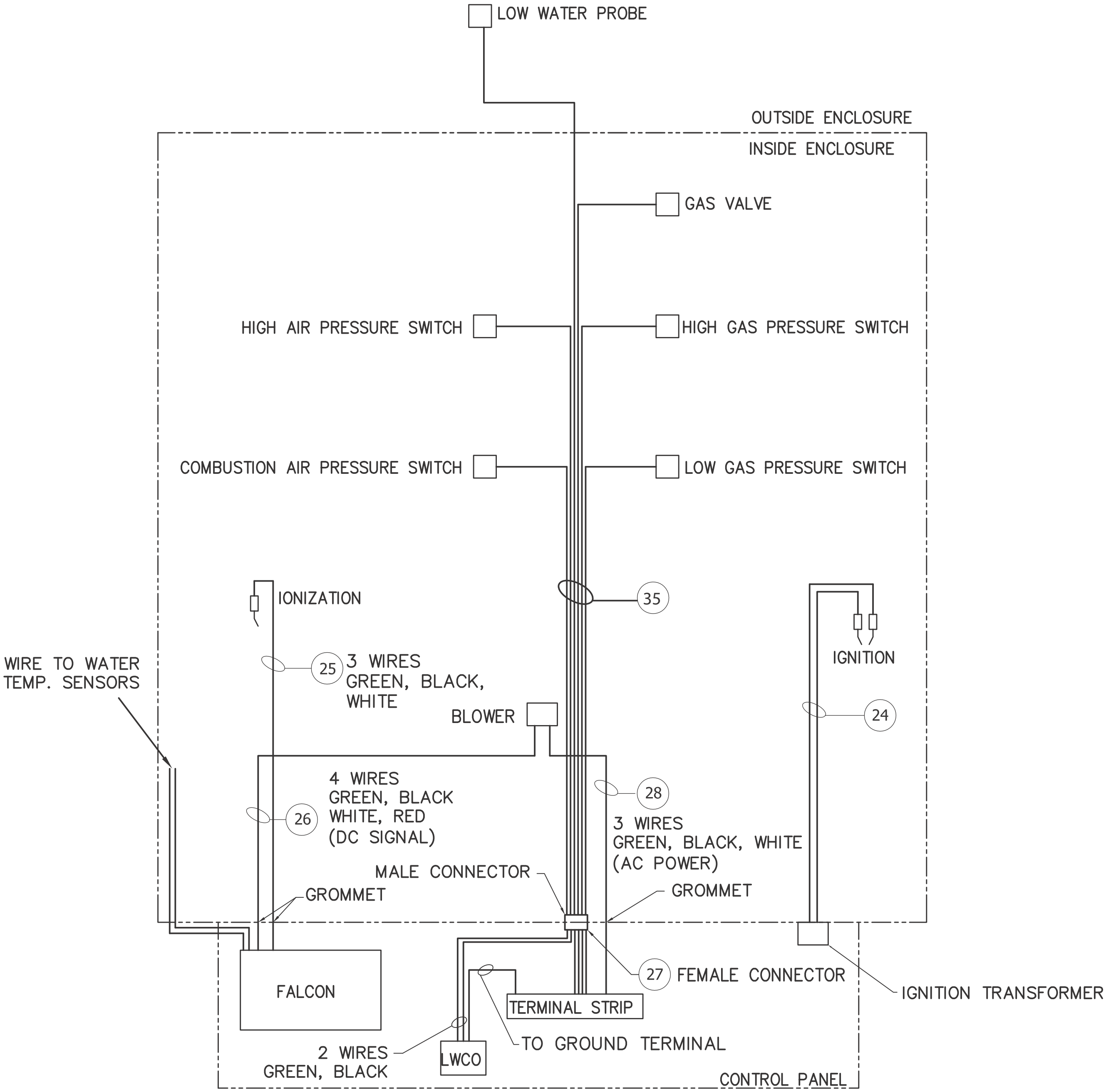
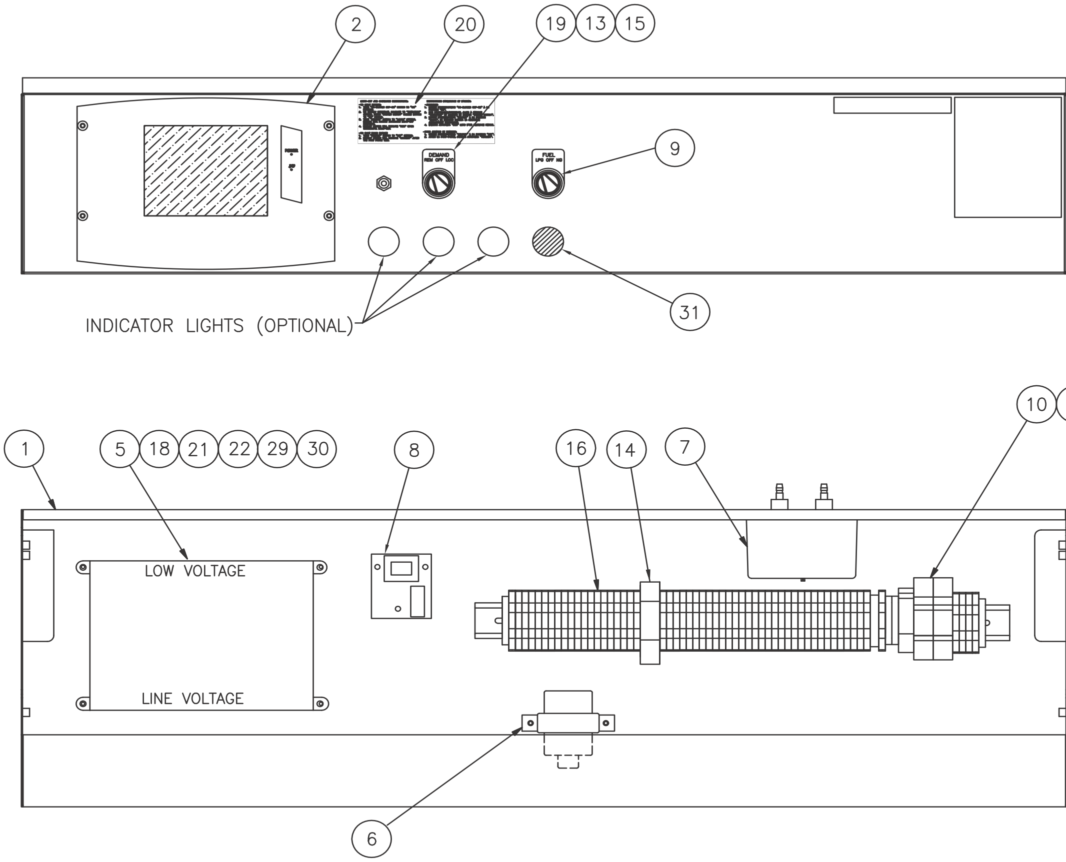


Figure 6-14. Electrical Assemblies - Dual Fuel 500-2500



ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	SEE TABLE	CONTROL PANEL
2	1	833-05105-000	DISPLAY, TOUCH SCREEN SYSTEM FOR FALCON
5	1	833-03639-000	FALCON CONTROLLER, HYDRONIC
6	1	832-00235-000	TRANSFORMER
7	1	832-02451-000	IGNITION TRANSFORMER
8	1	833-03547-000	CONTROLLER, LWCO
9	1	836-08737-000	SWITCH, ROTARY CAM 8 CONTACT
10	1	SEE TABLE	FUSE, LPCC TIME DELAY, BLOWER FUSE
11	1	832-01811-000	FUSE, 5 AMP, CONTROL CIRCUIT
12	1	832-02051-000	FUSE, 2 AMP
13	5	836-01136-000	CONTACT BLOCK, N.O.
14	1	SEE TABLE	CIRCUIT BREAKER
15	1	118-03922-000	NAME PLATE DEMAND REMOTE/OFF/LOC
16	1	434-00085-000	TERMINAL TRACK FOR CFC, 1500-2500 DUAL FUEL

ITEM	QTY	PART NUMBER	DESCRIPTION
18	1	880-02343-000	PLUG CONNECTOR KIT, FALCON
19	1	836-01148-000	SWITCH SELECTOR, 3 POSITION
20	1	118-03755-000	LABEL, LIGHT OFF & SHUTDOWN
21	1	817-04403-000	SENSOR, HW SUPPLY/OUTLET TEMPERATURE
22	1	817-04814-000	SENSOR, RETURN INLET TEMPERATURE
23	SEE FIGURE 6-15		
24			
25			
26			
27			
28			
29	1	826-00200-000	INLET TEMP. SENSOR CABLE
30	1	826-00201-000	OUTLET TEMP. SENSOR CABLE
31	1	817-03571-000	ALARM, BUZZER, PANEL MOUNTED (OPTIONAL)
32	1	881-00348-000	LATCH, PLASTIC

ITEM 1 CONTROL PANEL						
BOILER SIZE	500	750	1000	1500	1800	2500
PART #	119-00429	119-00429	119-00430	119-00431	119-00431	119-00426

ITEM 10 BLOWER FUSE						
BOILER SIZE/ FUSE RATING	500/6 AMP	750/6 AMP	1000/6 AMP	1500/12 AMP	1800/15 AMP	2500/15 AMP
PART #	832-01881	832-01881	832-01881	832-01887	832-01888	832-01888

ITEM 14 CIRCUIT BREAKER			
BOILER SIZE/ AMP RATING	1500/15 AMP	1800/20 AMP	2500/20 AMP
PART #	983-00087	983-00147	983-00147

Figure 6-15. Cables and Cable Harness - Dual Fuel 500-2500

24	2	826-00156-000	IGNITION CABLE
25	1	826-00157-000	FLAME ROD CABLE
26	1	832-02434-000	BLOWER SIGNAL CABLE
27	1	826-00160-000	CABLE HARNESS, PANEL
28	1	832-02101-000	BLOWER POWER CORD
36	1	826-00163-000	CABLE HARNESS FOR PROPANE
37	1	826-00158-000	CABLE HARNESS, BURNER
38	1	826-00162-000	CABLE HARNESS FOR PROPANE GAS TRAIN

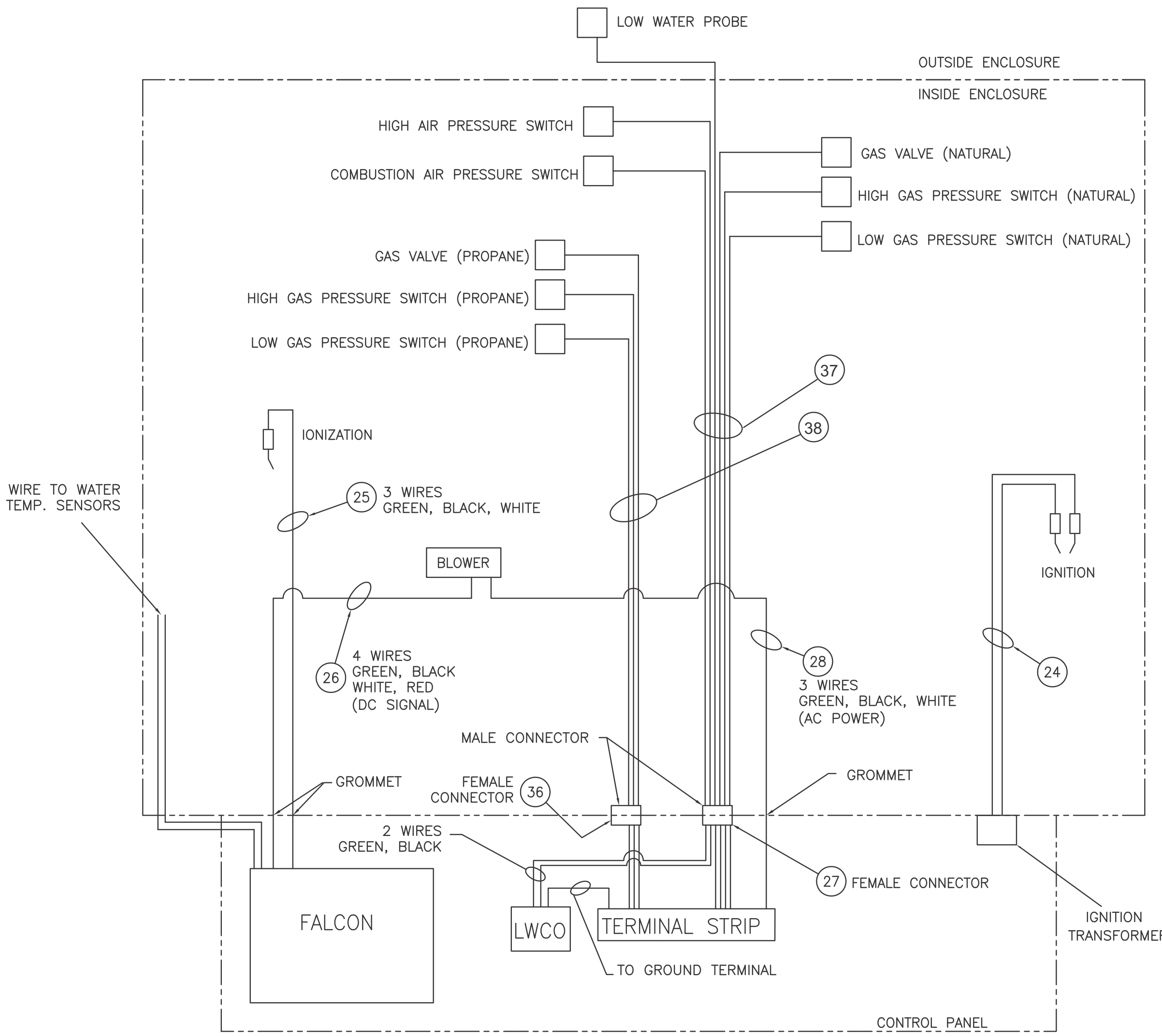


Figure 6-16. Electrical Assemblies - CFC 3300

ITEM	QTY	PART NO	DESCRIPTION
1	1	119-00435-000	CONTROL PANEL (119C00435)
2	1	833-05105-000	DISPLAY, SYSTEM
3	1		N/A
4	1	833-04086-000	FALCON CONTROLLER, HYDRONIC
5	1	832-00235-000	TRANSFORMER, 115v/25v
6	1	832-02451-000	IGNITION TRANSFORMER
7	1	880-02343-000	PLUG, CONNECTOR KIT, FALCON
8	1	833-03547-000	CONTROLLER, LWCO
9	1	434-00086-000	TERMINAL TRACK, CFC-3300 BOILERS
10	1		N/A
11	5	836-01136-000	CONTACT BLOCK, N.O.
12	3	832-01885-000	FUSE, 9 AMP, LPCC TIME DELAY (BLOWER)
13	1	836-01148-000	SWITCH, SELECTOR, 3 POSITION
14	1	118-03922-000	NAME PLATE, DEMAND REM/OFF/LOC
15	1	118-03755-000	LABEL, LIGHT OFF AND SHUTDOWN (118A03755)
16	1	178-00049-000	TRANSFORMER, 460/230/208V PRI, 350VA, FUSED TOP
17	2	832-01811-000	FUSE, 5.0 AMP (PRIMARY, FOR 208V & 230V)
18	1	832-01810-000	FUSE, 4.0 AMP (SECONDARY)
19	1	059-07423-000	PLATE, CONNECTOR MOUNTING
20	1	817-03571-000	ALARM, BUZZER, PANEL MOUNTED (OPTIONAL)
21	1	833-03532-000	ELECTRICAL-RELAY, DPDT,115VAC COIL
22	1	826-00200-000	CABLE, INLET TEMP. SENSOR (826B00200)
23	1	826-00201-000	CABLE, OUTLET TEMP. SENSOR (826B00201)
24	1	817-04403-000	SENSOR, HW SUPPLY/OUTLET TEMPERATURE
25	1	817-04814-000	SENSOR, RETURN/INLET TEMPERATURE
26	1	832-02051-000	FUSE, 2 AMP, 5x20mm
27	1	881-00348-000	LATCH, PLASTIC

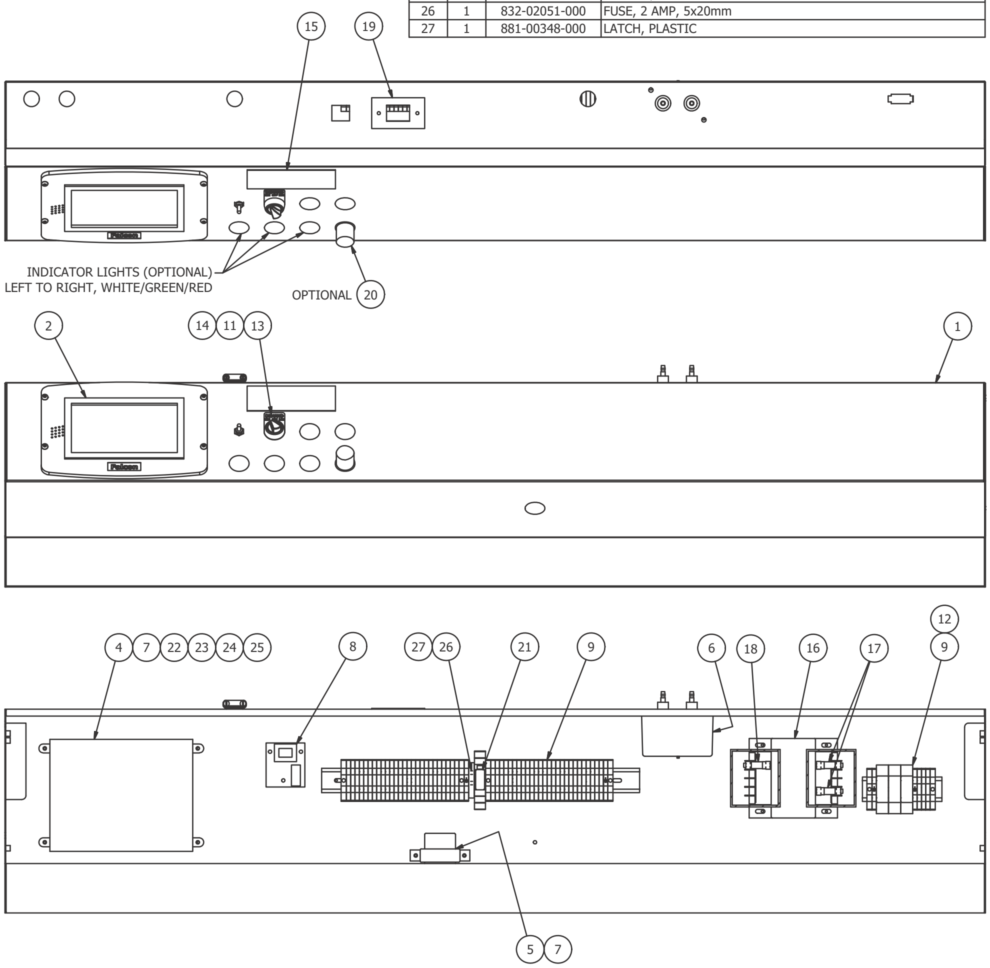
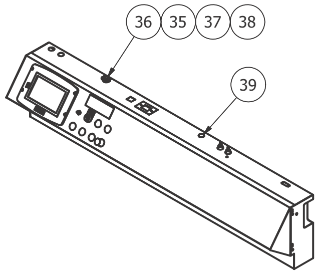
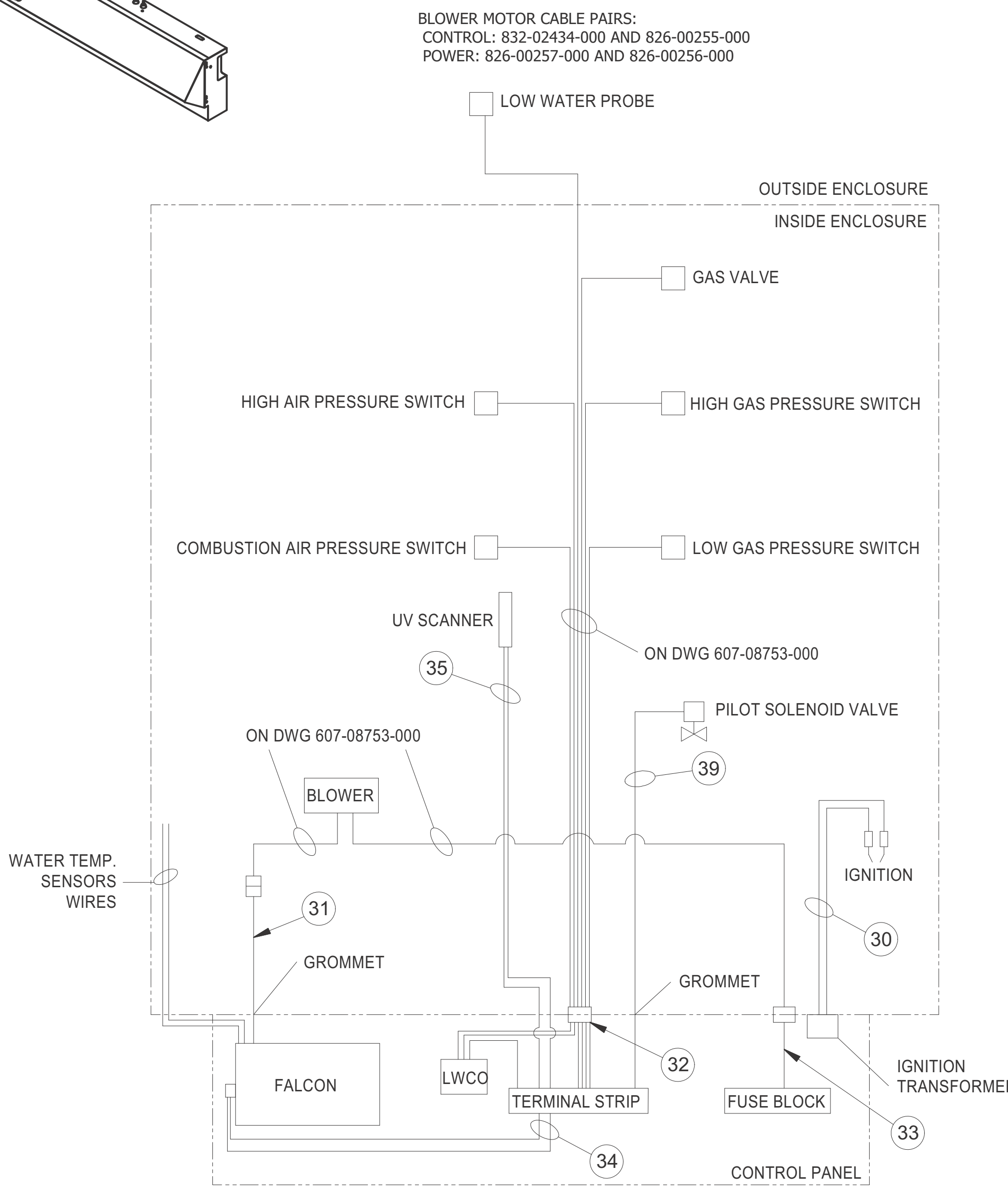


Figure 6-17. Cables and Cable Harness - CFC 3300

ITEM	QTY	PART NO	DESCRIPTION
30	2	826-00156-000	CABLE, IGNITION
31	1	832-02434-000	CABLE, BLOWER SIGNAL
32	1	826-00160-000	CABLE HARNESS, FEMALE END
33	1	826-00257-000	CABLE, BLOWER POWER
34	1	826-00211-000	CABLE, UV SCANNER TO FALCON J1
35	1	817-01743-000	SCANNER ASSEMBLY - UV
36	1	848-00003-000	CONNECTOR, STRAIGHT, 3/8"
37	2	848-00100-000	BUSHING, ANTI-SHORT, GREENFIELD, 3/8"
38	1	827-00006-000	CONDUIT, FLEX, GREENFIELD, 3/8" x 36" LG.
39	1	826-00262-000	CABLE, GAS PILOT SOLENOID





OPTIONAL PARTS

Table 6-9. Air Filter

BOILER SIZE	VENTURI CONNECTION SIZE	DESCRIPTION	PART NO.
500	4”	AIR FILTER KIT*	880-01858
750	4”	AIR FILTER KIT*	880-01858
1000	4”	AIR FILTER KIT*	880-01858
1500	6”	AIR FILTER KIT*	880-02005
1800	6”	AIR FILTER KIT*	880-02005
2500	6”	AIR FILTER KIT*	880-02005
3300	6”	AIR FILTER KIT*	880-02502
All		AIR FILTER CLEANING KIT	332-00035

*AIR FILTER KIT INCLUDES VENTURI MTG FLANGE, GASKET, AND HARDWARE

Table 6-10. Direct Vent Kits

BOILER SIZE	VENTURI CONNECTION SIZE	CUSTOMER AIR DUCT CONNECTION SIZE	DIRECT VENT KIT
500	4” 4”	4” 6”	880-01312 880-03736*
750	4” 4”	4” 6”	880-01312 880-03736*
1000	4” 4”	4” 6”	880-01312 880-03736*
1500	6” 6”	6” 8”	880-01313 880-02451**
1800	6” 6”	6” 8”	880-01313 880-02451**
2500	6”	8”	880-02451**
3300	6”	8”	880-02451**

*Includes 6x4 reducer
**Includes 8x6 reducer

Direct Vent Kit

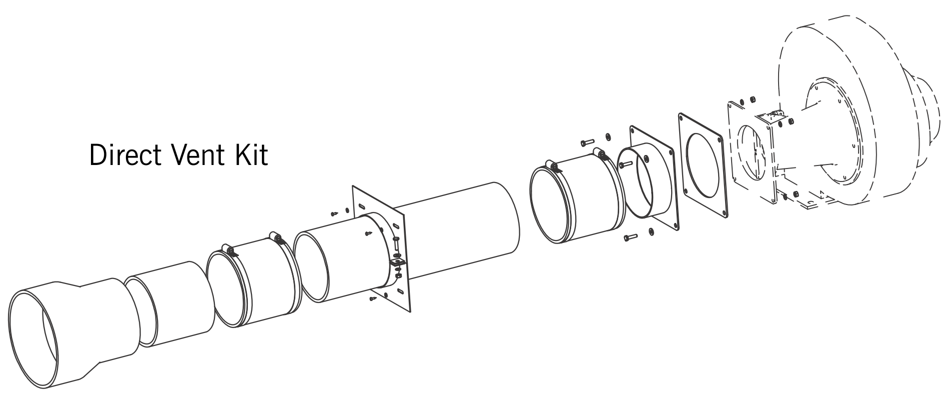


Table 6-11. MIsc. Optional Parts

DESCRIPTION	PART NO.
CONDENSATE TREATMENT SYSTEM / DRAIN TRAP INCL. MEDIA	195-04036
FLUE GAS CONDENSATE NEUTRALIZING MEDIA (6# BAG)	947-00007
STACK TEMPERATURE SENSOR	817-4403
AQUASTAT, DHW TANK OR HEAT EXCH. TEMPERATURE	817-4370
INLET TEMPERATURE SENSOR	817-4404
AUX. LOW WATER CUTOFF - PROBE TYPE, MANUAL RESET	817-3390
ALARM HORN	817-3571
BOILER AIR VENT VALVE	940-7358
EXTERNAL HIGH LIMIT TEMPERATURE CONTROL	817-4099
FALCON LEAD LAG KIT - INCLUDES ODT SENSOR, HEADER TEMP. SENSOR, THERMOWELL, & PIM	880-3670
OUTDOOR TEMP. SENSOR W/WEATHERPROOF ENCLOSURE	817-4517
HEADER TEMPERATURE SENSOR (FOR LEAD LAG)	817-4468
THERMOWELL, 1/2" NPT W/CLAMP	817-00405
PLUG-IN MODULE (PIM) - FOR CLONING AND BACKUP	833-3640

Table 6-12. Vent (Flue) Connections

	Model CFC						
Connection Size	500	750	1000	1500	1800	2500	3300
6"	039-1704	039-1704	039-1646	NA	NA	NA	
8"	NA	NA	039-1647	039-1645	NA	NA	
10"	NA	NA	039-1705	039-1644	039-1644	NA	
12"	NA	NA	NA	039-1688	039-1688	039-1688	039-1761
14"	NA	NA	NA	NA	NA	NA	039-1762

STANDARD
OPTIONAL

Appendix A — CB Falcon Hydronic Control

CB Falcon Boiler Control System

833-3578 Steam

833-3639 & 833-3871 Hydronic

INSTALLATION AND OPERATION

APPLICATION

The CB Falcon is a boiler control system available for steam or hydronic applications. The Falcon is able to provide heat control, flame supervision, circulation pump control, fan control, boiler control, and electric ignition function. It will also provide boiler status and error reporting.

Multiple boilers can be joined together to heat a system instead of a single, larger burner or boiler. Using boilers in parallel is more efficient, costs less, reduces emissions, improves load control, and is more flexible than the traditional large boiler.

CB Falcon system may consist of:

833-3639/3871 or 833-3578 Control Device
Touchscreen Display—required for setup and Modbus communication.
Flame Rod or UV flame sensor
Temperature Sensor, NTC Type
Limit Sensor, NTC Type, dual element
833-3578 uses a Steam Pressure Sensor, 0-15 or 0-150 psi - 4-20mA source type

Models Available:

Table 1. CB Falcon Models Available.

Model	Hydronic/Steam	Digital I/O	Modulation Output	Flame Sense/Burner Type
833-3578	Steam (CB Boiler Models CFH, CFV)	120V	PWM	FR - DSI
833-3639	Hydronic (CB Model CFC)	120V	PWM	FR - DSI
833-3871	Hydronic (CB Model CFW)	120V	PWM	FR - DSI

FR = Flame Rod
DSI = Direct Spark Ignition

TABLE OF CONTENTS

This manual is intended to provide a general overview of the CB Falcon hydronic and steam controls. The chosen set of parameters for a certain boiler type needs to be functionally tested for correct operation. Certain controllers are factory configured for specific boiler models.

This document is a textbook version of the parameters. The glossary beginning on page 89 provides an abbreviated parameter explanation along with a reference page for a more in-depth explanation.

The actual setup of the hydronic or steam control is accomplished using the 833-3577 System Operator Interface. Refer to manual 750-241 for the operation and setup screens. This document will assist in understanding the parameters being set up. The manual contains a worksheet example of Falcon device parameters and how they might be set up to provide a functioning system.

Note that while the worksheet shows most parameters as being available, the actual product may have parameters made invisible or read-only by the OEM, as applicable to specific boiler models.

The chosen set of parameters for a certain boiler type MUST be functionally tested for correct operation.

Access codes allow for different levels of setup:

— The OEM level allows for equipment to operate within guidelines that they feel necessary for safe and efficient operation of their equipment. The OEM makes available the parameters that the installing contractor needs for installation adjustments of the equipment.

— The installer setup information is customized by the OEM. The access code for the installer level must be obtained from the OEM.

— The User level allows for non critical adjustments for the individual piece of equipment. User-permitted actions include but are not limited to:

- Read the error log.
- Monitor the input and output variables of the controller.
- Read parameters.
- CH and DHW setpoint adjustment.

FEATURES

Safety and Boiler Protection

Hydronic Control

- Frost Protection, Slow Start, Anti-condensate, Boiler Delta-T, Stack Limit, Boiler Limit, DHW Limit, Outlet T-Rise Limit

Steam Control

- Slow Start, Stack Limit

Integrated Control Functions

- Primary Flame Safeguard Control
- Internal or external spark generator
- Algorithm Prioritization
- Firing Rate Limiting
    - Hydronic Control
        - Anti-Condensate, Stack Limit, Boiler Delta-T,
        - Boiler Slow Start, Outlet Limit
    - Steam Control
        - Stack Limit
- PID Load Control
    - Hydronic Control
        - CH (Central Heat)
        - DHW (Domestic Hot Water)
    - Steam Control
        - Steam
- Remote Reset
- TOD (Time of Day)
- PWM for Variable Frequency Drives
- Auxiliary Output Control
    - Hydronic Control for Pumps
        - 3 outputs, 5 different programmable features)
    - Steam Control
        - 3 programmable output features
- Burner Demand sources
    - Hydronic Control
        - CH, DHW and Frost Protection
    - Steam Control
        - Steam sensor
- Loops of Control
    - Hydronic Control has two loops of Control
        - CH
        - DHW
    - Steam Control has One loop of Control
        - Steam
- High Limit and Control (Meets UL 353)
        - Hydronic Control
        - CH, DHW and Stack
    - Steam Control
        - Stack
- Fifteen Item Fault Code History including equipment status at time of lockout
- Fifteen Item Alert Code Status including equipment status at time of internal alerts
- 24Vac Device Power
- Hydronic: 24 or 120Vac Digital I/O models available.
- Steam: 120Vac Digital I/O
- Flame Signal test jacks (Vdc)
- Three Status LEDs
    - Power
    - **Flame**
    - Alarm
- Flame Sensing
    - Ultraviolet (C7027, C7035, C7044 Sensors)
    - Flame Rod
        - Single Element (Internal spark generator and flame sense using the same element)
        - Dual Element (separate elements for ignition spark and flame sense)

Inputs

- Analog Inputs
    - NTC Sensor Inputs (10kohm or 12kohm)

    NOTE:12kohm and 10kohm single sensors cannot be used for Limit Application functions (10kohm dual sensors only).

    - Hydronic Control
        - Outlet Limit And Temperature
        - DHW Limit and Temperature
        - Stack Limit and Temperature
        - Inlet Temperature
        - Outdoor Temperature
    - Steam Control
        - Stack Limit and Temperature
    - Other Analog Inputs
        - PWM Feedback
        - Flame Signal from either a Flame Rod or Ultraviolet Detector
        - 4-20mA Control Input, Remote Setpoint, Remote Firing Rate
        - 4-20mA Steam Input Pressure (15 or 150 psi)
- Digital Inputs
    - Pre Ignition Interlock (Programmable)
    - LCI (Load [or Limit] Control Input) (Programmable)
    - Interlock (Programmable)
    - Annunciation (8 Programmable) (6 Programmable plus High Fire and Low Fire Switch Interlocks—model specific)
    - Remote Reset
    - TOD (Time of Day)

Outputs

- Analog Outputs
    - Modulation
        - 4-20mA
        - 0-10 Vdc
        - PWM for Variable Frequency Drives
- Digital Outputs
    - Auxiliary Output Control
        - Hydronic Control for Pumps
          3 outputs, 5 different programmable features)
        - Steam Control
          3 programmable output features
    - Combustion Blower
    - External Ignition
    - Pilot Valve
    - Main Valve
    - Alarm

OPERATIONAL FEATURES

Self Test

The Safety Processor performs Dynamic Self Checks that supervise microcomputer performance to ensure proper operation. The microcomputer tests itself and its associated hardware with comprehensive safety routines. Any malfunction will be detected by the microcomputer to cause a safety shutdown and cause the Dynamic Safety Relay to de-energize all safety-critical loads.

Initialization

The CB Falcon will start up in either the configured or unconfigured condition. In the Configured condition it is ready to operate a burner.

The Falcon is in the unconfigured condition whenever a safety parameter requires editing (Commissioning). The Falcon remains unconfigured and will not operate a burner until all safety parameters have been reviewed and confirmed.

Safety Lockout

The Falcon can be set up to maintain a lockout condition on power interruption or to reset the lockout on a power interruption.

Reset

Pressing and releasing the reset button (or the remote reset input) causes a lockout condition to be cleared, and the microcomputer that operates the burner control part of the Falcon to reinitialize and restart.

A safety lockout can also be reset through a writable parameter from the system display through Modbus.

Fault Handling

The Falcon implements two kinds of faults: lockouts and alerts.

Lockout messages are stored in the Falcon non-volatile memory (File and lockout remain with power interruption) and Alerts are stored in the volatile memory (file clears on power interruption).

- **Lockout** causes the burner control to shutdown and requires manual or remote reset to clear the lockout.
    - It always causes the alarm contact to close.
    - Gets logged into the 15 item lockout history.
- **Alerts** include every other kind of problem that does not shut the burner down. Examples of alerts are faults from non–safety functions or abnormal events that are relevant to an operator or end user.
    - Alerts never require manual intervention to reset them (an alert is not a condition, it is an event).
    - Whether the alarm contact closes or not is programmable by the OEM for each alert.
    - Alerts are logged in the 15 item alert history and sorted in chronological order. Only one instance of each alert fault code occurs in the history, corresponding to the most recent occurrence of the alert.

Sensor Select

Inputs for Header or Outdoor temperature sensors might be available from various sources, so parameters are provided to select the input source. These parameters determine:
- how temperatures are obtained;
- if/where temperature information is stored;
- where a control loop gets its data.

Sensor Signal Conditioning

The analog sensors signal includes filtering to reduce the effect of noise and spurious read events. This filter includes averaging to smooth sensor output and reject occasional spurious values to prevent them from affecting the average.

Sensors won’t cause a fault condition unless the value is requested for control purposes. Thus it is not a fault for a sensor to be absent or otherwise non-operational unless it is used for something (i.e. outdoor temperature).

If its value is requested and a sensor fault exists, then an alert condition is triggered by the requestor in response to the fault status, unless this is either a normal operating condition (e.g., the DHW sensor used as a switch) or causes a lockout (e.g., a failed high limit sensor).

Safety sensors include the comparison of redundant sensors. If a safety sensor mismatch occurs this is reported to the caller as a fault (which will cause the operator to take an appropriate action).

Sensor faults will include:

- **out-of-range: low**
- **out-of-range: high**—distinguishing low vs. high is important when sensor inputs are being used as digital on/off inputs; in this case these out-of-range values are not faults.
- **mismatch**—applies to safety sensors, where two sensors are compared.

Non-Volatile Memory

The Falcon will store the following items in non-volatile memory (Information remains in control on power interruption):

- Factory configuration data
- Parameter Control Blocks (for example, Read only and Password Settings)
- All configuration parameters
- The 15 item lockout history
- Cycle and Time history

Lockout History

The lockout history contains 15 records. Each record is a snapshot of the following values as they existed at the time of the lockout.

- **Burner Lockout/Hold** identifies the cause of the lockout.
- **Burner State** identifies the state of the burner control (e.g. standby, purge, run).
- **Burner Displayed Time: mm:ss** is the displayed timer used by the Burner Control at the time of lockout (e.g. prepurge time, ignition time, etc.).
- **Annunciator First-out** is the first-out code for the lockout.
- **Burner Run Time** is the elapsed time of burner operation.
- **Burner Cycle Count** is the number of burner cycles (based on the main valve being turned on).
- All analog sensor values (Inlet, Header, Outlet, Outdoor, DHW, Stack, or Steam)

Cycle and Time History

The non-volatile memory contains the following parameters and status values related to cycle counts and elapsed operation time:

- Burner Run Time: hhhhhh:mm
- Burner cycle count: 0-999,999
- CH cycle count: 0-999,999
- DHW cycle count: 0-999,999
- Boiler pump cycle count: 0-999,999
- Auxiliary pump cycle count: 0-999,999
- System pump cycle count: 0-999,999

These are writable parameters so they may be altered if the Falcon is moved, the burner is replaced or some component is replaced.

There are also two non-writable counters:

- Controller Run Time: hhhhhh:mm
- Control cycle count: 0-999,999

Flame Signal Processing

The flame signal processing will monitor either a flame rod or a UV flame sensor. The flame signal voltage at the test jacks or on the bar graph on the display is the measured voltage in the range from 0V to 15V. The display could show stronger numerical data.

The incoming flame signals are filtered to eliminate transient and spurious events.

The Flame failure response time (FFRT) is 4 seconds.

Flame sensitivity is set by the Flame Threshold parameter, which will provide the ON/OFF threshold specified in volts or microamps (1 volt is equivalent to 1 microamp).

Temperature Settings

All parameters that provide a temperature have a possible value of “None.”

This value is a special code that is not a legal temperature. If the Falcon control is configured with a “none” temperature, then this setting must be set up by the installer before the control will operate.

Modbus/ECOM Event Handling

The Modbus and ECOM communication system responds to queries and can write new values to the parameters.

⚠ WARNING

Explosion Hazard.
Improper configuration can cause fuel buildup and explosion.
Improper user operation may result in property loss, physical injury, or death.

Safety Configuration Parameters should be changed **only by experienced and/or licensed burner/boiler operators and mechanics**.

Response to Writing:

- Safety parameters will cause a lockout and must be reviewed and verified before the control will operate again.
- Non-safety parameters may be written at any time and will become effective within a short time; however, any behavior that is seeded by the parameter value and is currently in-progress (e.g. a delay time) may not respond to the change until the next time this behavior is initiated.

Required Components (not supplied)

- Dual Element Temperature Sensor - contains Sensor plus Limit (NTC, 10kohm, Beta = 3950).
- Single Element Sensor only (NTC, 10kohm, Beta = 3950)
- UV Flame Sensor
- Flame Rods
- External Ignition Transformer
- Gas Valves - Solenoid (24Vac)
  Fluid Power (120 Vac)
  Premix valves with Venturi
- Modulation Motor (4-20 ma or 0-10Vdc)
- Transformer (for powering Falcon; 40VA minimum) - 40VA or 75VA
- Pressure Sensor (15 or 150psi)
- 880-2343 connector kit (see below)
- Flame Rod cable harness
- Combustion air blower (VSD-PWM) signal cable harness
- Transformer (for powering Falcon 40va minimum) - AT72D (40VA) AT88 (75VA)
- Steam - Pressure Sensor (15 or 150) 4-20mA source type
- 50032893 - 001 Bag of connectors

880-2343 Connector Kit

Device		Mates with …					
Plug #	Description	Manf.	Part Number				
J1	Flame Detection Interface	Molex	0050841060 (Shell), 0002082004 (Pin, 14-20 AWG)				
J2	PWM Combustion Blower Interface	Molex	0039012040 (Shell), 0039000059 (Pin, 18-24 AWG)				
J3	Comm. Interface	OST	EDZ1100/9 (SCREW)				
J4	Line Voltage I/O	Lumberg	3623 06 K129	(IDC, Pins 1 - 6)	3615-1 06 K129	(SCREW, Pins 1 - 6)
			3623 06 K130	(IDC, Pins 7 - 12)	3615-1 06 K130	(SCREW, Pins 7 - 12)
J5	Line Voltage I/O	Lumberg	3623 07 K01	(IDC)	3615-1 07 K01	(SCREW)
J6	Line Voltage I/O	Lumberg	3623 08 K43	(IDC)	3615-1 04 K185	(SCREW, Pins 1- 4)
					3615-1 04 K188	(SCREW, Pins 5- 8)
J7	Line Voltage I/O	Lumberg	3623 07 K48	(IDC)	3615-1 07 K48	(SCREW)
J8	Low Voltage I/O	Lumberg	3623 06 K127	(IDC, Pins 1 - 6)	3615-1 06 K127	(SCREW, Pins 1 - 6)
			3623 06 K128	(IDC, Pins 7 - 12)	3615-1 06 K128	(SCREW, Pins 7 - 12)
J9	Low Voltage I/O	Lumberg	3623 07 K59	(IDC)	3615-1 07 K59	(SCREW)
J10	High Voltage I/O	Lumberg	3623 08 K64	(IDC)	3615-1 04 K187	(SCREW, Pins 1- 4)
					3615-1 04 K186	(SCREW, Pins 5- 8)
J11	High Voltage I/O	Lumberg	3623 07 K30	(IDC)	3615-1 07 K30	(SCREW)

OVERVIEW

Functions provided by the Falcon include automatic boiler sequencing, flame supervision, system status indication, firing rate control, load control, CH/DHW control, limit control, system or self-diagnostics and troubleshooting.

The maximum version of the controller offers:

- NTC-temperature sensor for:
  - Outlet Limit And Temperature
  - DHW (Domestic Hot Water) Limit and Temperature
  - Stack Temperature Limit and Temperature
  - Inlet Temperature
  - Outdoor Temperature (hydronic only)
- Modulating output PWM-driven rotation speed controlled DC-fan for optimal modulation control.
- Three Pump Outputs with 5 selectable operation modes
- 24Vac or 120Vac (model specific) offer:
  - Output control of gas valve (Pilot and Main) and External Ignition Transformer
  - Digital inputs for room limit control, high limit control, Air pressure switch, Gas pressure switch, low water cutoff, valve proof of closure switch.
- Optional switches:
  - Time of Day switch
  - Burner switch
  - Remote Reset
- Easy modification of the parameters on three levels:
  - End-user
  - Installer / Service engineer
  - Manufacturer
- Integrated spark transformer
- Optional external spark transformer
- Optional combined ignition and flame sensing
- Test jacks for flame signal measurement from either a flame rod or UV flame sensor.
- Alarm Output

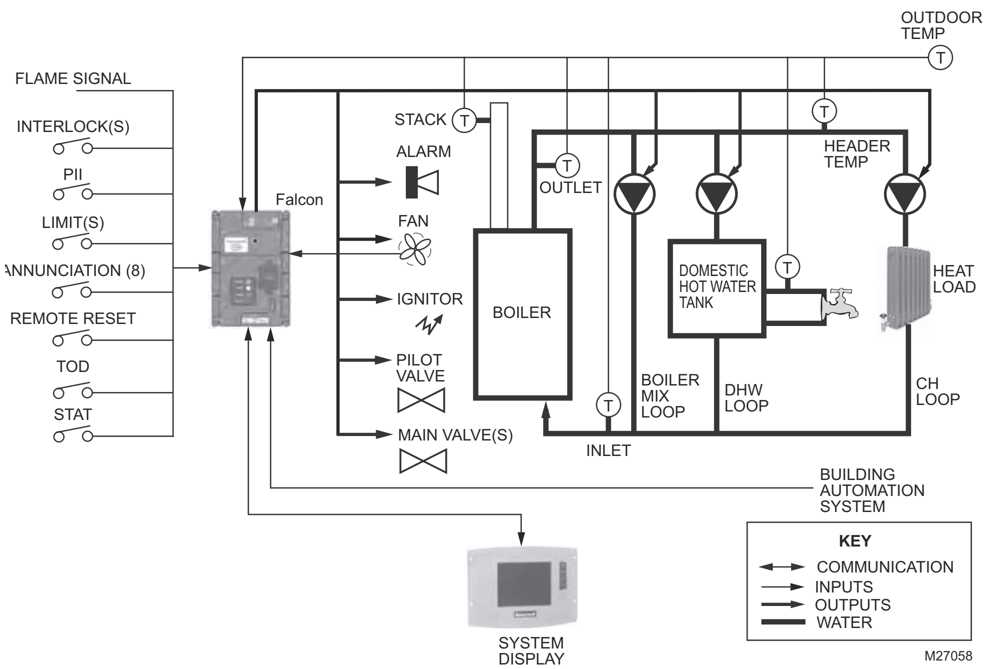


Fig. 1. General Falcon hydronic boiler schematic.

Fig. 1 shows two loops of heat control: Central Heating (CH), and an optional second loop for Domestic Hot Water (DHW) can be configured on each Falcon. The DHW loop transfers heat from the boiler outlet to hot water appliances in conjunction with the primary system heat loop. Priority assignment to each heat loop can be configured to specify which loop gets serviced first.

COMMUNICATIONS AND DISPLAYS

- The Falcon has two RS485 communication ports for Modbus that allows for interfacing to one or all Falcons in a system and presents them individually to the user. The System Operator interface is used for configuration and monitoring of the CB Falcon. Control operation and display status in both test and graphical modes can be shown. The Falcon can also be remotely reset through the display.
- Either Modbus RS485 communication port can be used to allow configuration and status data to be read and written to the controller. A Building Automation master can control the Falcon to respond to requests in a Lead/Lag arrangement.

SPECIFICATIONS

Electrical Ratings:
Operating voltage
24Vac (20 to 30 Vac, 60 Hz ±5%)
Connected Load for Valve and annunciator functions:
24Vac, 60Hz
120Vac (+10%/-15%), 60Hz (±5%)
Model Specific

Corrosion:
Falcon should not be used in a corrosive environment.

Operating Temperature: -4°F to 150°F (-20°C to 66°C)

Storage/Shipping Temperature: -40°F to 150°F (-40°C to 66°C).

Humidity:
Up to 95% Relative Humidity, noncondensing at 104°F for 14 days. Condensing moisture may cause safety shutdown.

Vibration: 0.0 to 0.5g Continuous (V2 level)

Enclosure: Nema 1/IP40.

Approvals:
Underwriters Laboratories, Inc. Component Recognized: File No. MP268 (MCCZ). 833-3639 and 833-3578 are certified as UL372 Primary Safety Controls. 833-3639 is rated as a UL353 limit-rated device when using the dual element limit-rated NTC sensors.

CSD-1:
Meets CSD-1 section CF-300 requirements as a Primary Safety Control.
Meets CSD-1 section CW-400 requirements as a Temperature Operation control.
Meets CSD-1 section CW-400 requirements as a Temperature High Limit Control when configured for use with 10kohm NTC sensors.
Federal Communications Commission, Part 15,
Class B.Emissions.

Dimensions: See Fig. 2.

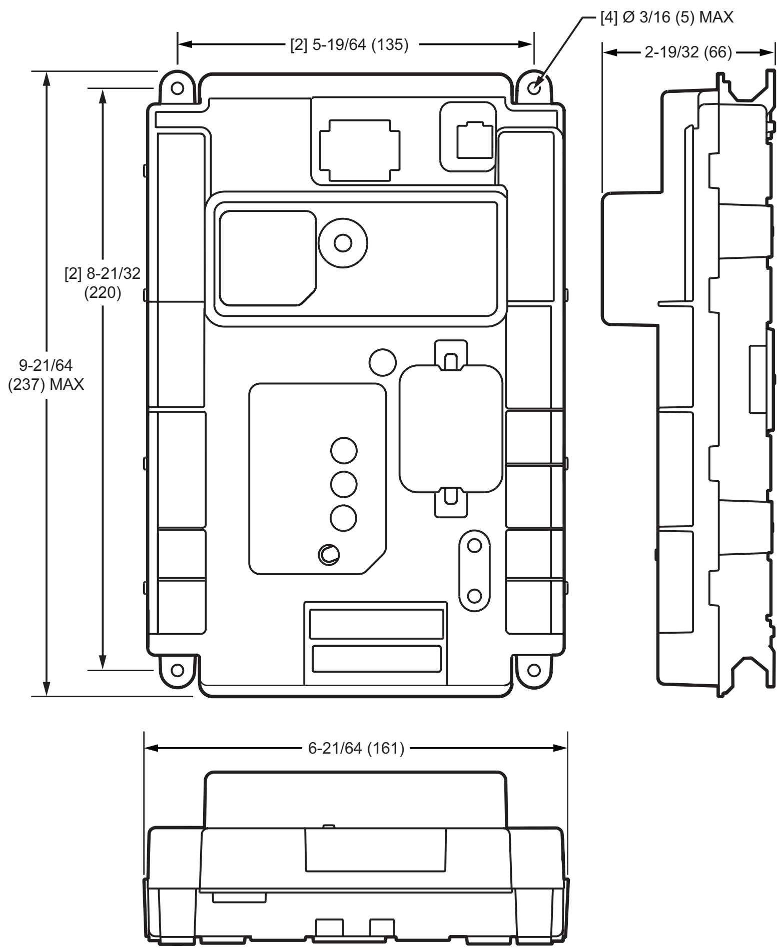


Fig. 2. Falcon dimensions in in. (mm).

Table 1. NTC Sensors (temperature versus resistance).

Temp C (F)	12K NTC (kOhm)* Beta of 3750	10K NTC (kOhm)* Beta of 3950
-30 (-22)	171.70	176.08
-20 (-4)	98.82	96.81
-10 (14)	58.82	55.25
0 (32)	36.10	32.64
10 (50)	22.79	19.90
20 (68)	14.77	12.49
25 (77)	12.00	10.00
30 (86)	9.81	8.06
40 (104)	6.65	5.32
50 (122)	4.61	3.60
60 (140)	3.25	2.49
70 (158)	2.34	1.75
80 (176)	1.71	1.26
90 (194)	1.27	0.92
100 (212)	0.95	0.68
110 (230)	0.73	0.51
120 (248)	0.56	0.39

*Sensors attached to the Falcon MUST be all 12K or 10K sensors (don't mix and match).

INSTALLATION

⚠ WARNING

Fire or Explosion Hazard.
Can cause property damage, severe injury, or death.
To prevent possible hazardous boiler operation, verify safety requirements each time a control is installed on a boiler.

⚠ WARNING

Electrical Shock Hazard.
Can cause severe injury, death or property damage.
Disconnect the power supply before beginning installation to prevent electrical shock and equipment damage. More than one power supply disconnect can be involved.

When Installing This Product…

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Refer to the wiring diagram provided as part of the appliance or refer to Fig. 3.
3. Check the ratings given in the instructions and on the product to make sure that the product is suitable for your application.
4. Installer must be a trained, experienced combustion service technician.
5. Disconnect the power supply before beginning installation to prevent electrical shock and equipment damage. More than one disconnect may be involved.
6. All wiring must comply with applicable local electrical codes, ordinances and regulations.
7. After installation is complete, check out product operation as provided in these instructions.

Vibration

Do not install the relay module where it could be subjected to vibration in excess of 0.5G continuous maximum vibration.

Weather

The relay module is not designed to be weather-tight. When installed outdoors, protect the relay module using an approved weather-tight enclosure.

Mounting The Falcon

1. Select a location on a wall, burner or electrical panel. The Falcon can be mounted directly in the control cabinet. Be sure to allow adequate clearance for servicing.
2. Use the Falcon as a template to mark the four screw locations. Drill the pilot holes.
3. Securely mount the Falcon using four no. 6 screws.

NOTE: The device can be removed and replaced in the field without rewiring.

WIRING

⚠ WARNING

Electrical Shock Hazard.
Can cause serious injury, death or property damage.
Disconnect power supply before beginning wiring to prevent electrical shock and equipment damage. More than one disconnect may be involved.

Ground Connection

The ground connection on the controller must not be used as a central ground connection for the 120 Vac connections.

1. Use the common ground terminal next to the controller, close to connector J4 terminal 12.
2. Connect the central ground terminal with the connection contact of the controller (connector J4 terminal 12).
3. Connect the ground wire of the main power connector, the CH pump, the DHW pump (if present) and the ignition wire to the central ground terminal.

Electrical Connections

1. Refer to Table 4 for terminal contact ratings.
2. Use 18 AWG or larger wires.
3. Wire according to specifications, following all local ordinances and requirements.

Device Power Supply, 24Vac

1. 24Vac Supply to connector J8 terminal 1.
2. 24Vac Return to connector J8 terminal 2.

3. Ground to central ground terminal, not to Ground on J4 terminal 12.

Limit String and Annunciator inputs and Safety Load Outputs

1. Wiring to connectors J4, J5, J6 and J7.
2. Line Voltage (120Vac) or Low Voltage (24Vac) by model number.

Dry Contacts available for:

1. Pump A: Connector J4 terminal 6 & 7.
2. Pump B: Connector J4 terminal 4 & 5.
3. Pump C: Connector J4 terminal 2 & 3.
4. Blower: Connector J5 terminal 6 & 7.
5. Alarm: Connector J6 terminal 7 & 8.

Wiring Connectors J2, J8, J9, and J10 Low Voltage Connections (includes NTC Sensor Inputs, 4 to 20 mA Input, PWM Combustion Blower Motor output, combustion blower speed (tachometer) input, Remote and TOD reset, current and voltage outputs)

1. Wire according to specifications, following all local ordinances and requirements.
2. Do not bundle the low voltage wires with the ignition cable, 120 Vac wires, CH Pump or DHW Pump.
3. Bundle the wires for the fan and join them with the other 24V low-voltage wires.
4. Bundle the wires for the NTC sensors and the PWM combustion blower control separately.

High Voltage Cable

1. Always use a grommet when placing the high voltage cable through a sheet metal panel.
2. Never join the high voltage cable with other wires.

- Be sure that there is a good electrical return path between the Falcon and sparking electrode (ground connection).
- A short ignition wire normally leads to lower levels of radiated electromagnetic fields.
- Use a Spark cable (32004766 or R1298020) or equivalent.
- Heat-resistant up to 248°F (120°C).
- Isolation voltage up to 25 kV DC.

Note that the high voltage ignition spark, the high voltage ignition lead and the return path of the current that flows during sparking is an important source of electromagnetic interference.

A ground return wire is required in the appliance to reduce the high frequency components of the actual return current.

Communications: Connector J3

1. The ECOM port - connectors J3 terminal 1, J3 terminal 2, J3 terminal 3 - is not used in CB Falcon aplications **Do not connect the display to these connectors.**
2. Connect the 833-3577/3725 Display to either J3 Modbus port (MB1 or MB2), connectors a, b, c.

Flame Signal: Connector J1

1. Flame Rod: Single Element
   a. Connect the Flame rod for both ignition spark and flame sense to the ignition transformer terminal.
   b. Connect the Flame rod ground to connector J1 terminal 3.
   c. Install a jumper between connector J1 terminal 1 and terminal 2.
2. Flame Rod: Dual Element (separate elements for ignition spark and flame sense)
   a. Connect the Flame rod sense lead to connector J1 terminal 2.
   b. Connect the Flame rod ground to connector J1 terminal 3.
   c. Do not route the Flame rod sense lead wire or ground wire near the ignition spark high-voltage cable or other line voltage wiring.

UV Flame Detection

1. Connect the UV Flame detector sense lead (blue wire) to connector J1 terminal 4.
2. Connect the UV Flame detector ground lead (white wire) to connector J1 terminal 6.
3. Do not route the UV Flame detector wiring near the ignition spark high-voltage cable or other line voltage wiring.

Final Wiring Check

1. Check the power supply circuit. The voltage and frequency tolerance must match those of the Falcon. A separate power supply circuit may be required for the Falcon. Add the required disconnect means and overload protection.
2. Check all wiring circuits.
3. Install all electrical connectors.
4. Restore power to the panel.

The Falcon can be removed and replaced in the field without requiring re-wiring.

The lengths of the wires and electrical ratings for each terminal are specified in Table 4 on page 15.

Table 2. Wire Sizes.

Application	Recommended Wire Size	Recommended Part Number(s)	Maximum Leadwire Distance (in feet)
Line Voltage Terminals	14, 16, 18 AWG Copper conductor, 600 volt insulations, moisture-resistance wire	TTW60C, THW75C, THHN90C	300
Remote Reset/ TOD	22 AWG two-wire twisted pair, insulated for low voltage	Beldon 8443 or equivalent	1000

Table 2. Wire Sizes. (Continued)

Application	Recommended Wire Size	Recommended Part Number(s)	Maximum Leadwire Distance (in feet)
Modulating Output Signal	22 AWG two-wire twisted pair, insulated for low voltage	Beldon 8443 or equivalent	50
Modbus communication	22 AWG two-wire twisted pair, insulated for low voltage	22 AWG two-wire twisted pair, insulated for low voltage	
Temperature (operating) Sensors	22 AWG two-wire twisted pair, insulated for low voltage	Beldon 8443 or equivalent	50
Temperature (Limit) Sensors	22 AWG two-wire twisted pair with ground.	Beldon 8723 shielded cable or equivalent	50
Flame Sensor (Flame Rod/UV)	14, 16, 18 AWG Copper conductor, 600 volt insulations, moisture-resistance wire	TTW60C, THW75C, THHN90C	30
Ignition	Ignition Cable rated for 25kV at 482F(250C)	32004766-001 (2') or -003 (per foot)	3
Grounding	Earth ground	**1.** Earth ground must be capable of conducting enough current to blow the 20A fuse (or breaker) in the event of an internal short circuit. **2.** Use wide straps or brackets to provide minimum length, maximum surface area ground conductors. If a leadwire must be used, use 14 AWG copper wire. **3.** Make sure that mechanically tightened joints along the ground path are free of nonconductive coatings and protected against corrosion on mating surfaces.	
Grounding	Signal ground	Use the shield of the signal wire to ground the device to the signal ground terminals [3(c)] of each device. Connect the shield at both ends of the chain to earth ground.	

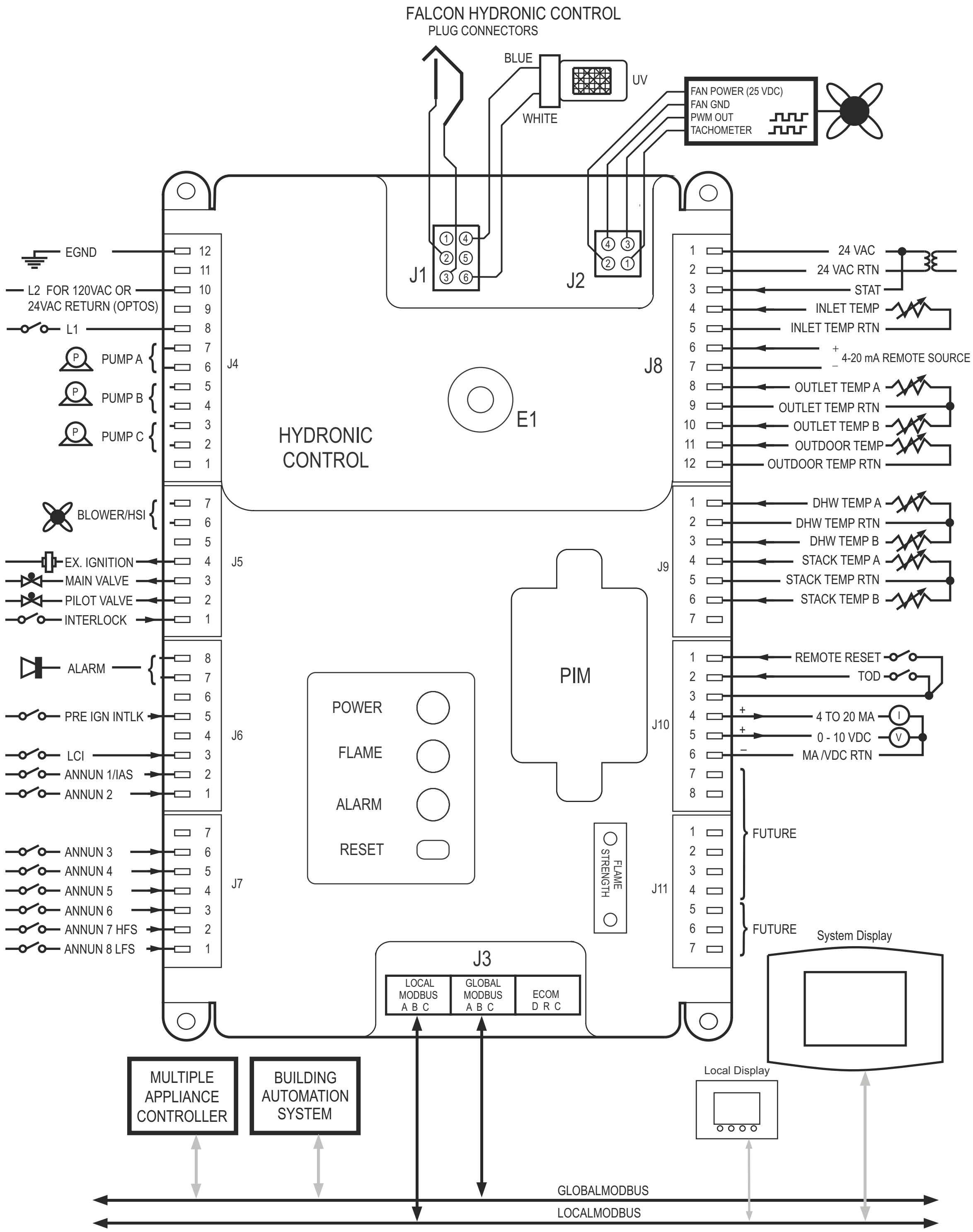


Fig. 3. Falcon device pin out (hydronic)

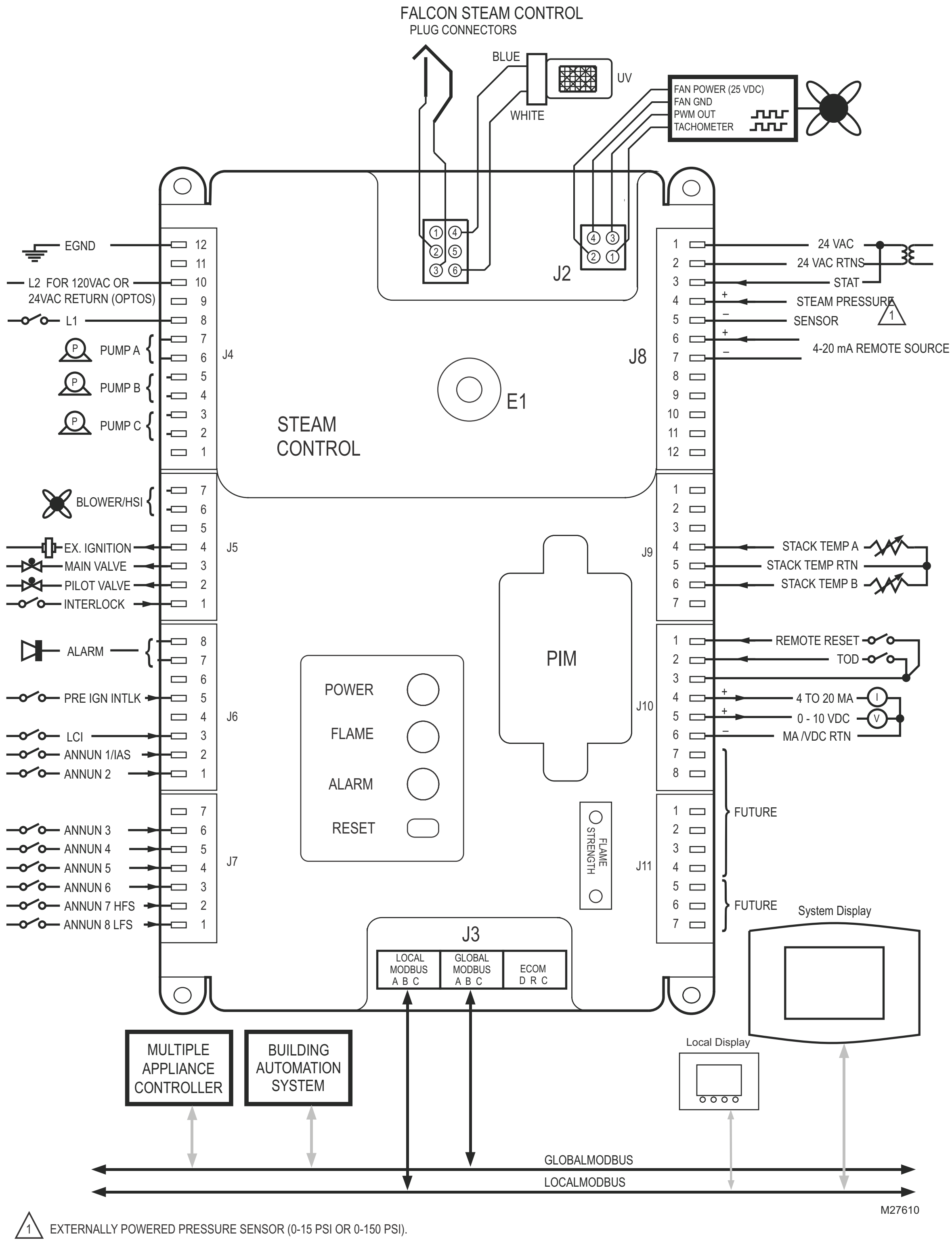


Fig. 4. Falcon device pin out (steam)

Table 3. Falcon Contact.

Connector	Term.	Function	Description and Rating (All Models)
J1	1		
	2	FLAME ROD INPUT	
	3	FLAME ROD COMMON	
	4	UV	
	5		
	6	UV COMMON	
J2	1	TACH	Tachometer Input (Tach) Tachometer input.
	2	25V	Electronic Blower Motor Power (25 VDC)
	3	PWM	Digital modulation (PWM) Output Digital modulation signal out.
	4	GND	Ground pin for Fan interface and power
J3	a	a	Modbus MB1 RS-485 +
	b	b	Modbus MB1 RS-485 -
	c	c	Modbus MB1 Ground (G)
	a	a	Modbus MB2 RS-485 +
	b	b	Modbus MB2 RS-485 -
	c	c	Modbus MB2 RS-485 Ground (G)
	1	1	ECOM Data (1)
	2	2	ECOM Receive (2)
	3	3	ECOM (3)
J4	12	EARTH GROUND	Earth ground
Not Used		Not Used	
J4	10	L2	Power Supply Neutral
Not Used		Not Used	
J4	8	L1	120 VAC (+ 10/15%, 50 or 60 HZ) to power UV
J4	7	PUMP A Input	120 VAC: 44.4 ALR, 7.4 Amps run
J4	6	PUMP A Output	120 VAC: 44.4 ALR, 7.4 Amps run
J4	5	PUMP B Input	120 VAC: 44.4 ALR, 7.4 Amps run
J4	4	PUMP B Output	120 VAC: 44.4 ALR, 7.4 Amps run
J4	3	PUMP C Input	120 VAC: 44.4 ALR, 7.4 Amps run
J4	2	PUMP C Output	120 VAC: 44.4 ALR, 7.4 Amps run
J4	1	Not Used	
J5	7	BLOWER/HSI Input	24VAC, 120 VAC: 44.4 ALR, 7.4 Amps run
J5	6	BLOWER/HSI Output	24VAC, 120 VAC: 44.4 ALR, 7.4 Amps run
J5	5	Not Used	
J5	4	EXT. IGNITION	See Table 6
J5	3	MAIN VALVE	See Table 6
J5	2	PILOT VALVE	See Table 6
J5	1	INTERLOCK	Per Model Input Rating
J6	8	ALARM Input	24VAC, 120 VAC: 6.3 ALR, 0.63 Amps full load
J6	7	ALARM Output	24VAC, 120 VAC: 6.3 ALR, 0.63 Amps full load
J6	6	Not Used	
J6	5	Pre-Ignition Interlock (PII)	24VAC, 120 VAC: 2 mA maximum
J6	4	Not Used	
J6	3	Load/Limit Control Input (LCI)	24VAC, 120 VAC: 2 mA maximum
J6	2	Annunc1 / IAS	24VAC, 120 VAC: 2 mA maximum

Table 3. Falcon Contact. (Continued)

Connector	Term.	Function	Description and Rating (All Models)
J6	1	Annunc2	24VAC, 120 VAC: 2 mA maximum
J7	7	Not Used	
J7	6	Annunc3	24VAC, 120 VAC: 2 mA maximum
J7	5	Annunc4	24VAC, 120 VAC: 2 mA maximum
J7	4	Annunc5	24VAC, 120 VAC: 2 mA maximum
J7	3	Annunc6	24VAC, 120 VAC: 2 mA maximum
J7	2	Annunc7/HFS	24VAC, 120 VAC: 2 mA maximum
J7	1	Annunc8/ LFS	24VAC, 120 VAC: 2 mA maximum
J8	1	24 VAC	Device Power, 24 VAC, (20 VAC to 30 VAC)
J8	2	24 VAC	24VAC Return
J8	3	STAT	24 VAC, (20 VAC to 30 VAC)
J8	4	INLET TEMP (S1) (hydronic)	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor.
J8	5	INLET TEMP Common (hydronic)	Ground reference for the Inlet Temp. Sensor
J8	4	+ INPUT (steam)	+ Supply from 4-20 mA Steam Pressure Sensor
J8	5	- INPUT (steam)	- Supply from 4-20 mA Steam Pressure Sensor
J8	6	+ INPUT Remote SP/Mod (S2)	+ Supply from 4-20mA
J8	7	- INPUT	- Supply from 4-20mA
J8	8	OUTLET TEMP A (S3) *a,b	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J8	9	OUTLET TEMP Common (S3S4) *a,b	Ground reference for the Outlet Temp. Sensor
J8	10	OUTLET TEMP B (S4) *a	Supply for, and signal input from 10K Ohm NTC temperature sensor
J8	11	OUTDOOR/HEADER TEMP (S5) *a	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J8	12	OUTDOOR TEMP Common *a	Ground reference for the Outdoor Temp. Sensor
J9	1	DHW TEMP A (S6) *a,b	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J9	2	DHW Common (S6S7) *a,b	Ground reference for the DHW Temp. Sensor
J9	3	DHW TEMP B (S7) *a	Supply for, and signal input from 10K Ohm NTC temperature sensor
J9	4	STACK TEMP A (S8) *b	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J9	5	STACK Common (S8S9) *b	Ground reference for the Stack Temp. Sensor
J9	6	STACK TEMP/Heat Exchanger Limit (S9)	Supply for, and signal input from 10K Ohm NTC temperature sensor
J9	7	Not Used	
J10	1	REMOTE RESET	Open/Ground Input that has functionality corresponding to pushing/releasing the local reset.
J10	2	TOD (Time of Day)	Open/Ground Input which switches operating set points.
J10	3	TOD/REMOTE RESET COMMON	Ground reference for time of day and remote reset inputs
J10	4	MODULATION 4 - 20mA (+) (Out)	4 to 20 mA Current modulation signal out into a 600 Ohm
J10	5	MODULATION 0 - 10 VDC (+) (Out)	0 to 10 VDC Voltage modulation signal out, 10 mA max.
J10	6	MODULATION COMMON (-)	Ground reference for voltage and current modulation signals.
J10	7	Not Used	
J10	8	Not Used	
J11	1–7	Not Used	
SPECIAL CONNECTIONS			

Table 3. Falcon Contact. (Continued)

Connector	Term.	Function	Description and Rating (All Models)
E1	Spark	8kV minimum open circuit voltage; 2.8mJ at the igniter	
	Plug In Module (PM7910)		
1	VCC		
2	CSO		
3	CS1		
4	SDA		
5	SCL		
6	GND		
Flame +	FS +	Testpoint for Flame signal. 0 to 10 VDC	
Flame -	FS -	Testpoint for Flame signal - Ground reference.	

[a] Not used by Falcon steam control [b] For single sensor 10K or 12K connect to TEMP A Terminals.

Table 4. Valve Load Ratings.

Combination #	Ignition	Pilot Valve[a]	Main Valve[a]
1	No Load	180 VA Ignition + motorized valves with 660 VA inrush, 360 VA opening, 250 VA holding	65VA pilot duty + motorized valves with 3850 VA inrush, 700 VA opening, 250 VA holding
2	No Load	50VA Pilot Duty + 4.5A Ignition	65VA pilot duty + motorized valves with 3850 VA inrush, 700 VA opening, 250 VA holding
3	4.5A Ignition	65VA pilot duty + motorized valves with 3850 VA inrush, 700 VA opening, 250 VA holding	65VA pilot duty + motorized valves with 3850 VA inrush, 700 VA opening, 250 VA holding
4	4.5A Ignition	2A Pilot Duty	65VA pilot duty + motorized valves with 3850 VA inrush, 700 VA opening, 250 VA holding
5	4.5A Ignition	2A Pilot Duty	2A Pilot Duty

[a] For Direct Burner Ignition (DBI) the main valve gets connected to J5 terminal 2.

STARTUP

The Falcon is shipped in the unconfigured condition, so when power is applied, all safety loads are off and the burner status when viewed from the display is shown as “Safety data setup needed.”

Once the Safety Data is configured, the Falcon is ready to operate a boiler.

Commissioning

Passwords

A password level of protection may be assigned to any parameter. Three levels are shown in decreasing order of privilege:

1. **OEM password required**—allows access to all parameters
2. **Installer password required**—allows access to some parameters
3. **End User (no password)**—allows access to non-password parameters

Whenever a valid password has been provided, the Falcon remains in the access level of that password until either 10 minutes of inactivity (no more edits) has occurred or the command is received to exit to the normal no-password state.

The OEM and Installer passwords are given a default value when the Falcon is shipped, but may be changed later using the Configuration program, the system display, or the electronic configuration tool.

Parameter Control Blocks (PCB)

The Falcon Parameters are managed using control blocks. There are three parameter control blocks (PCB) that may be installed into the memory of the Falcon:

1. **OEM Parameter PCB**—makes any parameter hidden and/or unalterable and assigns the password level
2. **OEM Alert PCB**—determines which alerts are enabled and, for those that are enabled, if the alert causes the alarm contacts to close.
3. **OEM Range PCB**—limits the range of any parameter.

A parameter control block can be downloaded using a file-transfer method that operates within the Modbus protocol. The Falcon Modbus defines the format of parameter control block data and the download procedure. All of the OEM PCBs require the OEM password before they can be downloaded.

The Software Configuration Tool allows all available parameters to be viewed, modified, and downloaded. This tool allows for building a device working from a spreadsheet. Customizing can be done on this, along with choosing to have the parameter Hidden, Read Only, or Level of Password protection. When complete this sheet can be saved and/or directly downloaded into the Falcon through the Modbus port. An example is shown in Table 49, beginning on page 100.

OEM PARAMETER PCB:

Providing the OEM password allows downloading of a parameter control block for OEM protected data. This block assigns the value of these attributes for each parameter:

- **Range Limit**—If provided the parameter's value will be limited.
- **Hidden**—This attribute prevents the parameter from showing in the display - it is hidden.
- **Read-only**—This attribute prevents the parameter from being changed.
- **Password**—The password attribute defines the level of password needed to alter the item: OEM, Installer, or none.

The interaction and behavior of these settings is shown in Table 6. (All parameters are readable via Modbus, however a Modbus error response message is sent if an attempt is made to write one that is marked read-only, or that requires a password and the appropriate password level is not in-effect.)

Table 5. Interaction of OEM Parameter Settings.

Hidden	Read-only	Password	System Display		Modbus register I/O	
			Shown	Write	Read	Write
0	0	0	Yes	Anytime	Yes	Yes
0	0	1	Yes	Need Password	Yes	Need Password
0	1	x	Yes	No	Yes	No
1	0	0	No	No	Yes	Yes
1	0	1	No	No	Yes	Need Password
1	1	x	No	No	Yes	No

OEM ALERT PCB

Providing the OEM password allows downloading of a parameter control block for alerts.

- Each item in this block enables/disables the alert - a disabled alert is never shown.
- An enabled alert has the option of closing the alarm contacts, whenever this alert occurs.

OEM RANGE PCB

Providing the OEM password allows downloading of a parameter control block for range limits.

- This block specifies the minimum and maximum values for any writable parameter that accepts a numeric range, and for parameters that are enumerated lists, it can suppress one or more of the items in the list. If a parameter is not listed in this PCB, then it is restricted by the factory installed limits.

WARNING

Explosion Hazard.
Improper configuration can cause fuel buildup and explosion.
Improper user operation may result in property loss, physical injury, or death.

The 833-3577 System Operator Interface or 833-3725 Local Operator Interface used to change Safety Configuration Parameters is to be done **only by experienced and/or licensed burner/boiler operators and mechanics**.

Programming Safety Parameters

All safety parameters require either the OEM or installer password before they can be changed.

The password level assigned by the OEM Parameter PCB controls the minimum password level of all safety items.

However if the parameter control block indicates that no password is required for a safety item, the Installer password will be enforced.

The Falcon may be in one of two conditions, configured, and unconfigured. It will run only in the configured condition. In the unconfigured condition, the setup of safety data is required following the procedure below before it will run. In the unconfigured condition, all safety loads are off and the burner is locked out, showing “Safety data setup needed.”

To modify and confirm the safety data requires the following steps: When complete, the Falcon will transition to the configured condition.

To begin, the user needs to provide a valid password.

1. The user edits safety data in the enabled section. At any time, if “exit” is chosen, the session is ended and the Falcon remains in an unconfigured state. In this case the burner control status indicates “Safety data setup needed.”
2. When the edits are complete and the user accepts (rather than exit) the parameters the display will show “edits done.” This causes the Falcon to calculate the modified section of safety data. However it is not yet accepted and written into memory, nor does the Falcon leave the unconfigured state; instead it continues with the confirmation process in the next step.
3. The Falcon provides a parameter state and expects the user has either confirmed the data or rejected it. If the user rejects the data then the process returns to step 2 and when editing again is done the confirmation process begins again. Once started, the confirmation process is successful only if each safety data item has been confirmed, in the order provided by the Falcon.
4. After all items are confirmed, the Falcon requests the user to press and hold the Reset button on the device for 3 seconds. The user must accomplish this within 30 seconds.
5. If the reset button is pressed and held for 3 seconds (an optional equivalent: a Reset is entered on the local display) to confirm that the programmed device is physically the one that the operator intended to program then the safety data and its confirmation is accepted and burned into memory. When this is done, the Falcon is in the configured condition, unless some other parameter section also needs setup. If some other section needs setup, the Falcon is again at step 1.

Functional Sub Systems

There are nine functional sub systems to the Falcon. They are:

1. System Operational Settings (page 19)
2. General Configuration Settings (page 20)
3. Demand and Rate (page 22)
4. Rate Limits and Override (page 43)
5. Burner Control (page 64)
6. Modulation Output (page 50)
7. Pump Control (page 53)
8. Lead Lag (page 72)
9. Annunciation (page 61)

SYSTEM OPERATIONAL SETTINGS

System settings are those that enable or disable the Falcon functions in general or that alter the behavior or availability of multiple configurable items. See Table 7.

Table 6. System Operation Settings.

Parameter	Comment
CH enable	Enable, Disable (hydronic only) This parameter determines whether the CH loop is enabled or disabled. It may be disabled to turn it off temporarily, or because the application does not use this feature.
CH Priority vs. Lead Lag	CH > LL, CH < LL
Steam enable	Enable, Disable (steam only) This parameter determines whether the Steam input is enabled.
DHW enable	Enable, Disable (hydronic only) This parameter determines whether the DHW loop is enabled or disabled. It may be disabled to turn it off temporarily, or because the application does not use this feature.
DHW Priority Source	Disabled, DHW heat demand
DHW Priority Method	Boost during priority time, drop after priority time
Warm Weather Shutdown	Enable, Disable, Shutdown after demands have ended, Shutdown immediately

Table 6. System Operation Settings. (Continued)

Parameter	Comment
Warm Weather Shutdown Setpoint	Temperature, None
Lead Lag slave enable	Enable, Disable (hydronic only)
Lead Lag Master enable	Enable, Disable (hydronic only)
DHW priority vs LL DHW priority vs CH	These parameters determine the priority of DHW versus other sources of calls-for-heat, when more than one source is enabled. The LL source has a fixed priority versus the CH source: if an Falcon is set up as a LL slave, and a LL master is controlling it, then the CH source is ignored.
DHW priority override time	mm:ss This parameter determines whether a DHW demand can temporarily override the priority defined by the DHW priority parameters. If it is non zero, then a DHW demand will take priority over both the LL demand and the CH demand, for the specified time. If the DHW demand persists for longer than the specified time then this override priority will expire and control will revert to the normal priority. The override timer is reset when demand from the DHW source turns off. If normal DHW priority is already higher than the one or both of the competing priorities, then this parameter has no effect versus the competing priority.
Annunciation enable (Model Specific)	Enable, Disable This parameter determines whether the Annunciator feature of the Falcon are active. When disabled, the Falcon will ignore the Annunciator inputs. It may be disabled to turn it off temporarily, but more typically this will be turned off because the application does not use this feature.
Burner Switch	On, Off This parameter enables or disables the burner control. When it is off, the burner will not fire.
Inlet Connector Type	For Falcon Hydronic Control 10K NTC single non-safety 12K NTC single non-safety UNCONFIGURED For Steam Control 15 PSI, 150 PSI, or UNCONFIGURED Designates the type of analog sensor on connector J8 terminals 4 and 5.
Outlet Connector Type	For Falcon Hydronic Control and Steam Control 10K NTC dual safety-connector J8 terminals 8, 9, and 10 10K or 12K NTC single non-safety-connector J8 terminals 8 and 9 Designates the type of analog sensor used. NOTE: the 10K NTC is a dual sensor used for safety limits and requires safety verification during setup.
DHW Connector Type	For Falcon Hydronic Control and Steam Control 10K NTC dual safety-connector J9 terminals 1, 2, and 3 10K or 12K NTC single non-safety-connector J9 terminals 1 and 2 Designates the type of analog sensor type used. NOTE: the 10K NTC is a dual sensor used for safety limits and requires safety verification during setup.
Stack Connector Type	For Falcon Hydronic Control and Steam Control 10K NTC dual safety-connector J9 terminals 4, 5 and 6 10K or 12K NTC single non-safety-connector J9 terminals 4 and 5 Designates the type of analog sensor type used. NOTE: the 10K NTC is a dual sensor used for safety limits and requires safety verification during setup.
Outdoor Connector Type	For Falcon Hydronic Control 10K NTC single non-safety 12K NTC single non-safety For Steam Control - there is not an Outdoor Sensor Feature. Designates the type of analog sensor type is on connector J8 terminals 11 and 12.
DHW Priority Time ODR Enable	Disable, Enable When enabled, the DHW priority override time parameter will be derated when the outdoor temperature is below 32°F. When the outdoor temperature is 32°F and above, the programmed time will be used as-is. When the outdoor temperature is -40°F and below, the programmed override time will be derated to zero (no override). Between 32°F and -40°F, a linear interpolation will be used. For example, at the midway point of -4°F, the DHW priority override time is one half of the value provided by the parameter.

GENERAL CONFIGURATION SETTINGS

Those that alter the behavior or availability of configurable items that are not in any other category. Those that are not defined in other sections are listed in Table 8:

Table 7. General Configuration Settings.

Parameter	Comment
Temperature Units	F, C This parameter determines whether the temperature is represented in units of Fahrenheit or Celsius degrees.
Anti short cycle time	mm:ss Whenever the burner is turned off due to no demand, the anti short cycle timer is started and the burner remains in a Standby Delay condition waiting for this time to expire. The anti short cycle time does not apply, however, to recycle events such as loss of airflow or flame, it applies only to loss of demand. The anti short cycle time always inhibits a CH or LL demand. However, if a DHW demand occurs then its priority is checked. If it has the highest priority because of either: • a non-zero value in the DHW priority timer (which is loaded using the DHW priority time parameter) • due to the setting in both: DHW priority vs LL (if Lead Lag Master enable is enabled) AND DHW priority vs CH (if CH enable is enabled) • then the anti short cycle delay is ignored and the DHW demand is served.
Burner name	text The Burner Name is a text parameter stored in the Falcon to identify the burner.
OEM ID	text The OEM ID is a text parameter stored in the Falcon intended for use by an OEM to record identification information related to the OEM's configuration and setup of the Falcon.
Installation Data	text The Installation Data is a text parameter stored in the Falcon. It is intended for use by the installer to record identification information about how the Falcon was set up at the installation time.

Demand and Rate

The Demand and Rate subsystem produces 3 outputs:

- **Pump demand**
- **Burner demand**, which tells the burner control it should fire, and
- the modulation **rate**, which is the burner's firing rate.

There are three normal sources that share use of the burner:

- Central Heating (CH) or Steam
- Domestic Hot Water (DHW) hydronic only
- Lead Lag (LL)

These are all similar in that:

- Their inputs are a temperature sensor (pressure for steam) and a setpoint value.
- Their outputs are:
    a. On/off pump demand
    b. An on/off demand indication that is on if the subsystem wants the burner to fire.
    c. A modulation rate which is a percentage value between 0% and 100% that the subsystem wants as the burners firing rate.
- They use a PID calculation to set the modulation rate.

Each of these sources has its own separate parameters.

Additionally the Falcon hydronic has two sources that can call for burner firing, but do not use a PID calculation or modulate to a setpoint: CH Frost Protection and DHW frost protection, which always fire at the minimum modulation rate.

PID Requirements as a replacement for MCBA Control:

The internal gain scalers for P, I, and D can be calibrated so that the gains for a legacy MCBA control can be copied to the Falcon without conversion at one specific maximum fan speed.

The chosen fan speed for calibrating these scalers is 5000 RPM, that is, when both the MCBA and the Falcon have a maximum fan speed of 5000 RPM, the user-programmable P, I, and D gains used by the MCBA can be directly copied to the corresponding Falcon parameters, and the behavior of the Falcon control will then be similar to the MCBA.

At other values of maximum fan speed, the parameters to provide similar behavior can be calculated as:

$GAIN_{FALCON} = GAIN_{MCBA}$ * Max_fan_speed / 5000

Demand/Rate Selection and Limiting (example using Falcon Hydronic Control)

These sources of demand and modulation rate are processed by a priority selector that determines which of the sources (Central Heating [CH], Domestic Hot Water [DHW], or Lead Lag Master [LL]) actually has control of the burner.

The frost protection source has control only if none of the others want the burner to fire.

Additionally, the modulation rate requested by the source can be modified by rate limiting, which adjusts the burner firing rate during special conditions and it can be overridden by manual control or burner control (e.g. prepurge and lightoff).

The descriptions of the parameters shown in Fig. 5 occur elsewhere in this document:

- The enables and the DHW priority timeout are in “Burner Control Operation” on page 64.
- Manual Rate control is in “Modulation Output” on page 50.
- Frost Protection is in “Frost Protection (Hydronic only)” on page 40.
- Various Rate Limiting inputs are in “Rate Limits and Override” on page 43.

The Demand/Rate Selection subsystem is connected internally in the Falcon as shown in Fig. 5:

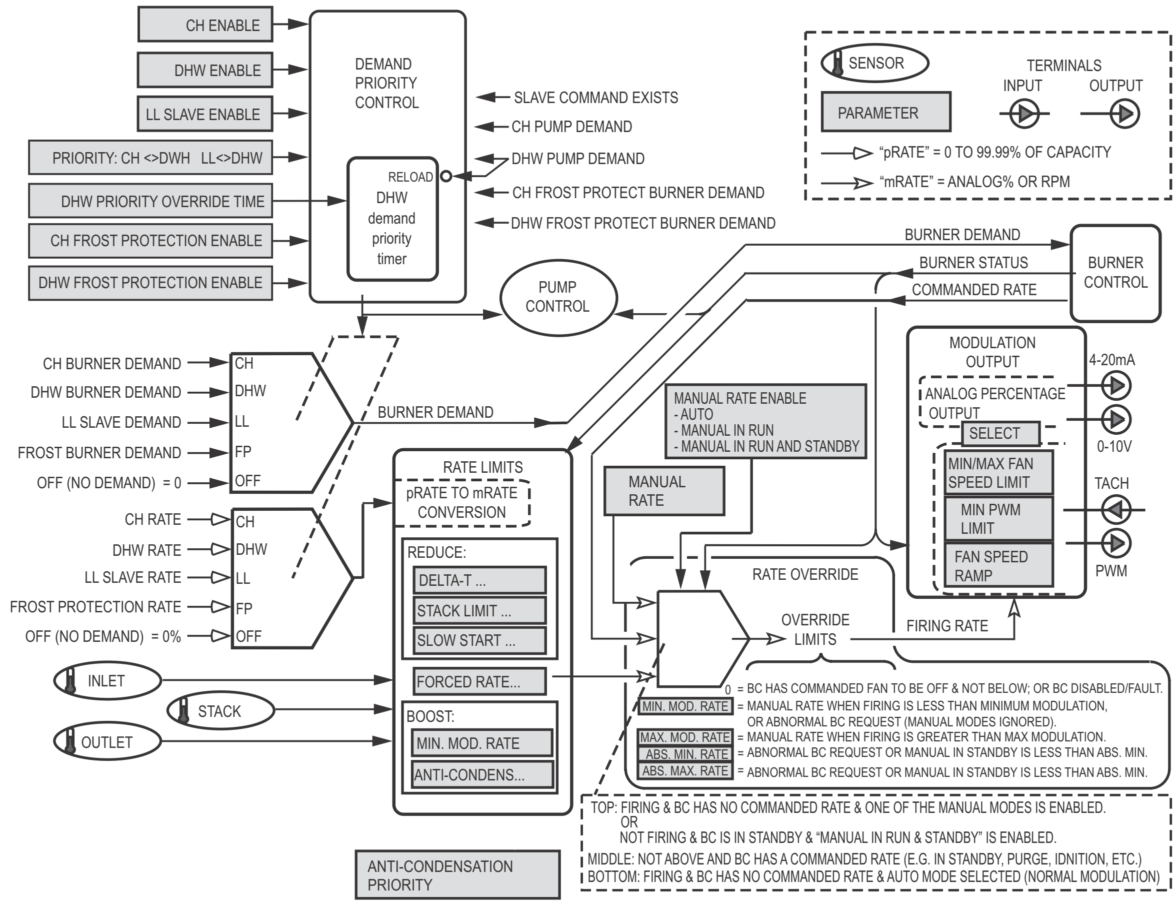


Fig. 5. Demand and rate selection diagram.

The demand priority control block shown in Fig. 5 determines which source of demand has control of the burner, according to parameters and the logic described below.

The DHW priority timer within this block operates according to the logic:

```
                    Writable Parameters are enclosed in a box
IF "DHW pump demand" is true
    Set DHW_storage_timer to DHW storage time
ELSE
    Decrement DHW_storage_timer (count down to zero, then stop)

IF "DHW pump demand" is false
    Set DHW_priority_timer to DHW priority override time
ELSE
    Decrement DHW_priority_timer (count down to zero, then stop)
```

Fig. 6. DHW priority timer logic.

The burner demand priority control block implements a priority scheme according to the descriptions of the parameters shown as providing input to this block. The implementation is:

```
                                          Writable Parameters are enclosed in a box
priority = Off  (assume this)
ignoreASC = false  (assume that Anti Short Cycle should not be ignored)

IF  DHW Enable is true AND "DHW Pump Demand" is true
    IF DHW_priority_timer is greater than zero
        priority = DHW

IF priority is Off
    IF  CH Enable  is true AND "CH Pump Demand" is true
        priority = CH

    IF  LL Slave Enable  is true AND "Slave Command Exists" is true
        priority = LL  (LL is always > CH)

    IF  DHW Enable  is true AND "DHW Pump Demand" is true
        IF priority is CH
              IF DHW priority is > CH priority THEN priority = DHW
        ELSE IF priority is LL
              IF DHW priority is > LL priority THEN priority = DHW
        ELSE
            priority = DHW


IF priority is Off
    IF DHW Storage Enable is true and DHW_storage_timer
    is greater than zero
        priority = DHW
IF priority is Off
    IF (  CH Frost Protection Enable  is true AND
         "CH Frost Protect Burner Demand" is true        )
        priority = FP
    IF (  DHW Frost Protection Enable is true AND
         "DHW Frost Protect Burner Demand" is true       )
        priority = FP
DETERMINE IF DHW DEMAND SHOULD IGNORE AN ANTI SHORT CYCLE (ASC) DELAY...
IF priority is DHW
    IF (  DHW_priority_timer is non-zero
          OR
          [ ( CH Enable is false OR DHW priority > CH priority )
                                     AND
            ( LL Enable is false OR DHW priority > LL priority )
          ] )
        ignoreASC = true
```

Fig. 7. Burner demand priority control.

CH Hydronic Loop Demand and Rate

The CH (Central Heating) Hydronic Demand and Rate source compares a selected input sensor to a setpoint.

Burner demand will exist if the sensor temperature falls below the setpoint minus a hysteresis value. Once the burner demand signal is on, it remains on until the sensor temperature is above the setpoint plus a hysteresis value, or until the other selected demand source input (e.g., Stat, Remote Stat) if any, turns off.

Pump demand may be driven by the selected demand source input (Stat input, a remote stat, or by the sensor alone).

A Proportional-Integral-Differential (PID) controller operates to generate the demand source's requested modulation rate.

The Hydronic Central Heating function is implemented as shown in Fig. 8.

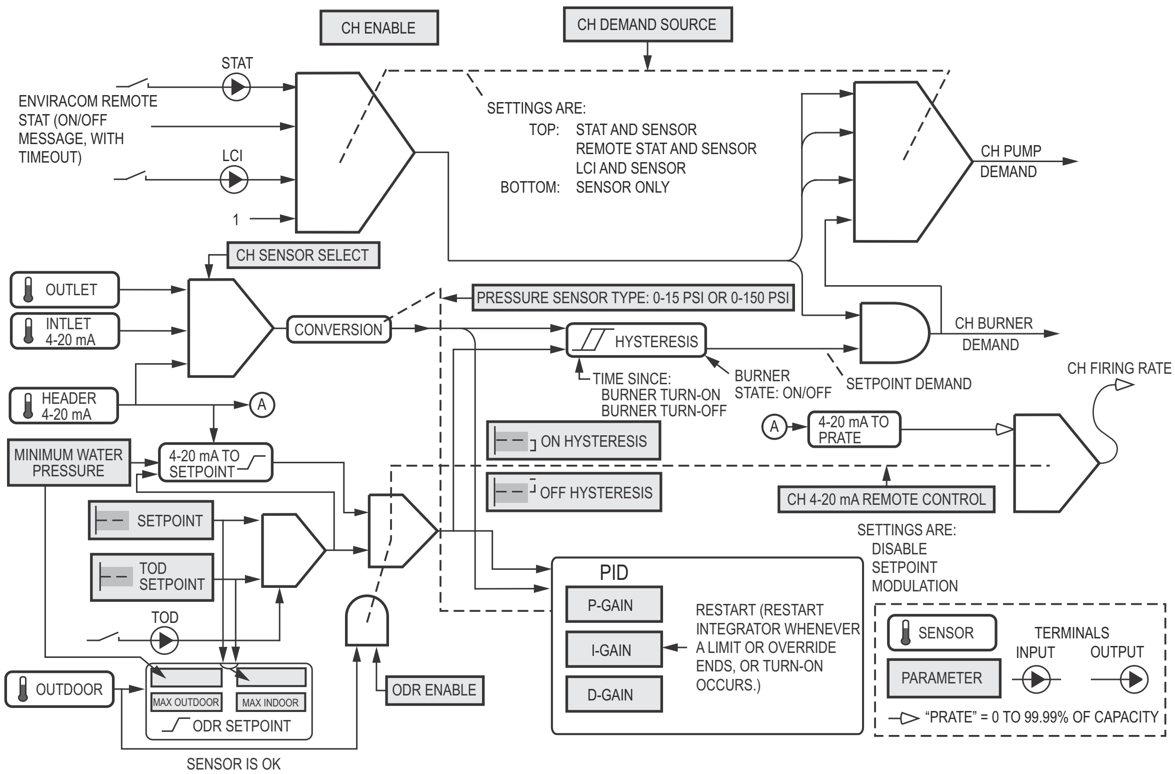


Fig. 8. Central heating hydronic diagram.

The function of each parameter and feature is given below.

Table 8. Central Heating Hydronic Parameters.

Parameter	Comment
CH demand switch	STAT, LCI, Sensor Only, EnviraCOM Remote STAT J7-3 120 Vac The CH demand switch may be selected from four options. In all cases, for burner demand to exist, the sensor must be generating a demand as determined by values. • When "Sensor Only" is chosen, no other input is considered and pump demand is derived from burner demand. • When "STAT" is chosen, the STAT input (J8 Terminal 3) in the On condition creates pump demand and it also must be on for burner demand to exist; if it is off there is no demand. • When "LCI" is chosen, the LCI input (J6 Terminal 3) in the On condition creates pump demand and it also must be on for burner demand to exist; if it is off there is no demand.
CH sensor	Outlet, Inlet The sensor used for modulation and demand may be the Outlet sensor, the 4-20 mA Header or inlet sensor.
CH setpoint	Degrees or None This setpoint is used when the time-of-day input is off. If the ODR function is inactive, the setpoint is used as-is. If the ODR function is active (input on J10-2), this setpoint provides one coordinate for the outdoor reset curve, as described in "Outdoor Reset and Boost" on page 26.

Table 8. Central Heating Hydronic Parameters. (Continued)

Parameter	Comment
Modulation sensor	Inlet (S1), Outlet (S3, S4), S5 The selected input provides the temperature for modulation control. As a startup check, if the CH Loop is enabled for a hydronic system, then if the select sensor is not a temperature input (i.e. S1 is a 4-20 ma input for Steam), then this causes an alert and causes the CH loop to suspend.
CH Demand source	Local, Modbus, 4-20 mA
4 mA water temperature	Degrees Establishes temperature for 4 mA input
20 mA water temperature	Degrees Establishes temperature for 20 mA input
CH time-of-day setpoint	Degrees or None This setpoint is used when the time-of-day input (J10-2) is on. If the ODR function is inactive then the setpoint is used as-is. If the ODR function is active then this setpoint provides one coordinate for the shifted (because TOD is on) outdoor reset curve, as described in “Outdoor Reset and Boost” on page 26.
CH off hysteresis CH on hysteresis	Degrees or None The off hysteresis is added to the setpoint temperature to determine the temperature at which the demand turns off. Similarly, the on hysteresis is subtracted from the setpoint to determine the temperature at which demand turns on. These may be set to None to indicate that no hysteresis has been defined. The On and Off hysteresis are adjusted at the time the burner changes from off to on, and from on to off, as shown in Fig. 12. This gives the PID algorithm some room to be more aggressive in tracking the load, which can result in overshoot (or undershoot). (see the Setpoint and Hysteresis section, page 31)
CH hysteresis step time	seconds Time of each step. A step time of zero - disables this feature. (see the Setpoint and Hysteresis section, page 31)
CH P-gain CH I-gain CH D-gain	0-400 These parameters are the gains applied to the proportional, integral, and differential terms of the PID equation for the CH loop.
CH setpoint source	Local, S2 4-20mA If the setpoint source is Local, then the control’s local setpoint system is used. This setting enables the normal use of the CH setpoint, CH TOD setpoint, and the CH outdoor reset parameters and functions. If the setpoint source is S2 4-20mA, then the setpoint is determined by the 4-20mA setpoint routine. If this sensor is invalid then the control behaves as if Local were selected.
Modulation rate source	Local, S2 4-20mA • If the modulation rate source is Local, then the control’s PID algorithm determines the modulation rate. If the modulation rate source is S2 4-20mA, then the modulation rate is determined by the S2 4-20mA modulation routine that exists in prior controls. If this sensor is invalid then the control behaves as if Local were selected.
CH ODR low water temperature CH ODR maximum outdoor temperature	Degrees or None These two parameters determine the lower-right point on the graph.

Outdoor Reset and Boost

The outdoor reset function is symmetrical for each of the control loops that use it, although they each have their own parameters.

If the outdoor reset feature is enabled and the sensor is functioning, the current outdoor temperature is used to determine the setpoint by interpolation. The lookup function uses two X, Y points to determine a line on the graph, as shown in Fig. 9. The Y coordinate of the top-right point depends on the time-of-day input; if TOD is off, then CH setpoint is used. If TOD is on, the CH TOD setpoint provides the Y coordinate and the and the lower-left point is recalculated to shift the graph in a parallel way.

- For outdoor temperatures lower than the minimum, the water temperature provided by the appropriate setpoint is used.
- For outdoor temperatures higher than the maximum, the minimum water temperature is used.
- For outdoor temperatures between the minimum and the maximum, a linear interpolation is used to find the setpoint.

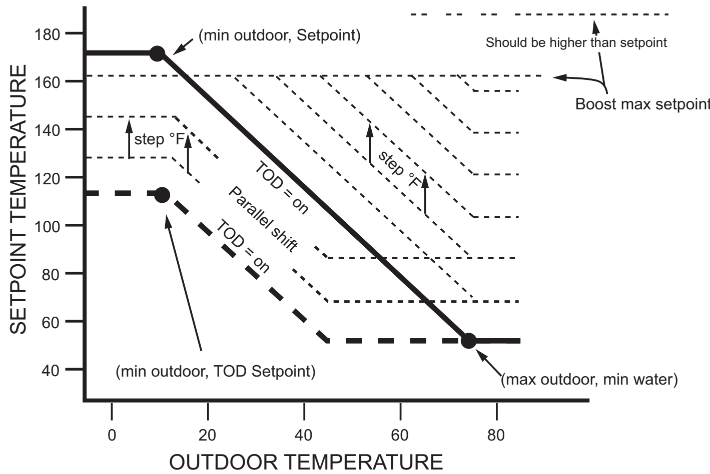


Fig. 9. Outdoor reset with TOD and boost.

Table 9. Outdoor Reset and Boost Parameters.

Parameter	Comment
CH ODR low outdoor temperature	Degrees or None This parameter determines the X coordinate of one point on the ODR graph. At that outdoor temperature, the setpoint will be the CH setpoint (or the CH TOD setpoint, if TOD Is on).
CH ODR boost time CH ODR boost max burner off point	mm:ss Degrees or None If CH outdoor reset is not active or if the CH ODR boost time parameter is zero, then the boost function is inactive. Otherwise, the boost time provides a time interval. Each time this interval elapses and demand is not satisfied, the setpoint is increased by 18°F, up to the maximum provided by the CH ODR boost max burner off point. However, if the latter is not valid, then the boost function is inactive and an alert is issued.
CH ODR low water temperature CH ODR maximum outdoor temperature	Degrees or None These two parameters determine one point on the ODR graph. At the maximum outdoor temperature, the setpoint will be the low water temperature.
CH ODR boost step	Degrees or None
CH ODR boost recovery step time	mm:ss
Minimum boiler water temperature	Degrees or None Defines the minimum outdoor reset setpoint for the stand-alone CH loop if this is invalid or none, then outdoor reset is inhibited and will not run. If enabled an alert is issued.

If CH outdoor reset is not active or if the CH ODR boost time parameter is zero, then the boost function is inactive. Otherwise, the boost time provides a time interval and the other parameters must be valid—if they are not, the boost function is inactive and an alert is issued.

Each time the boost time interval elapses and CH demand is not satisfied, the effective CH setpoint is increased by the amount specified in CH ODR boost step. However, CH ODR boost max setpoint limits this action: it is never exceeded.

Once the demand is satisfied the boosted setpoint remains active and slowly returns to its non-boosted level according to the CH ODR boost recovery step time. Whenever this interval elapses, the setpoint is adjusted back toward its normal value by 0.5°C (0.9°F).

If the TOD switch changes state after at least one boost event has occurred, the new effective setpoint is the higher of:

- the old boosted setpoint and
- the new unboosted setpoint.

However, if the first boost event has not yet occurred, then the new setpoint is adopted immediately. In either case, the boost timer—which began when the demand started and continues to measure the boost time interval—is not reset when TOD changes state.

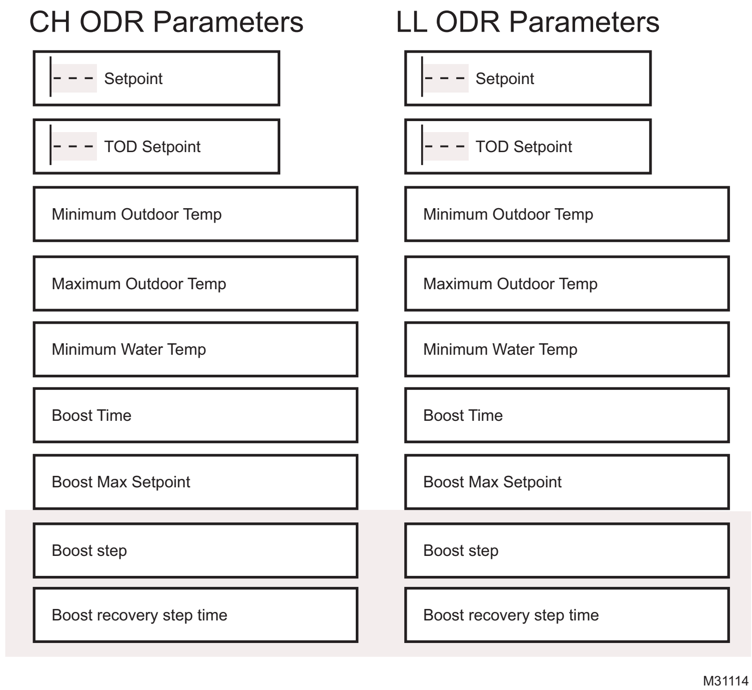


Fig. 10. Outdoor reset parameters.

Steam Loop Demand and Rate

The CH (Central Heating) Steam Demand and Rate source compares a selected input sensor to a setpoint.

Burner demand will exist if the sensor pressure falls below the setpoint minus a hysteresis value. Once the burner demand signal is on, it remains on until the sensor pressure is above the setpoint plus a hysteresis value, or until the other selected demand source input (e.g., Stat, Remote Stat) if any, turns off.

Pump (or output) demand may be driven by the selected demand source input (Stat input, a remote stat, or by the sensor alone).

A Proportional-Integral-Differential (PID) controller operates to generate the demand source's requested modulation rate.

The Steam Central Heating function is implemented as shown in Fig. 11.

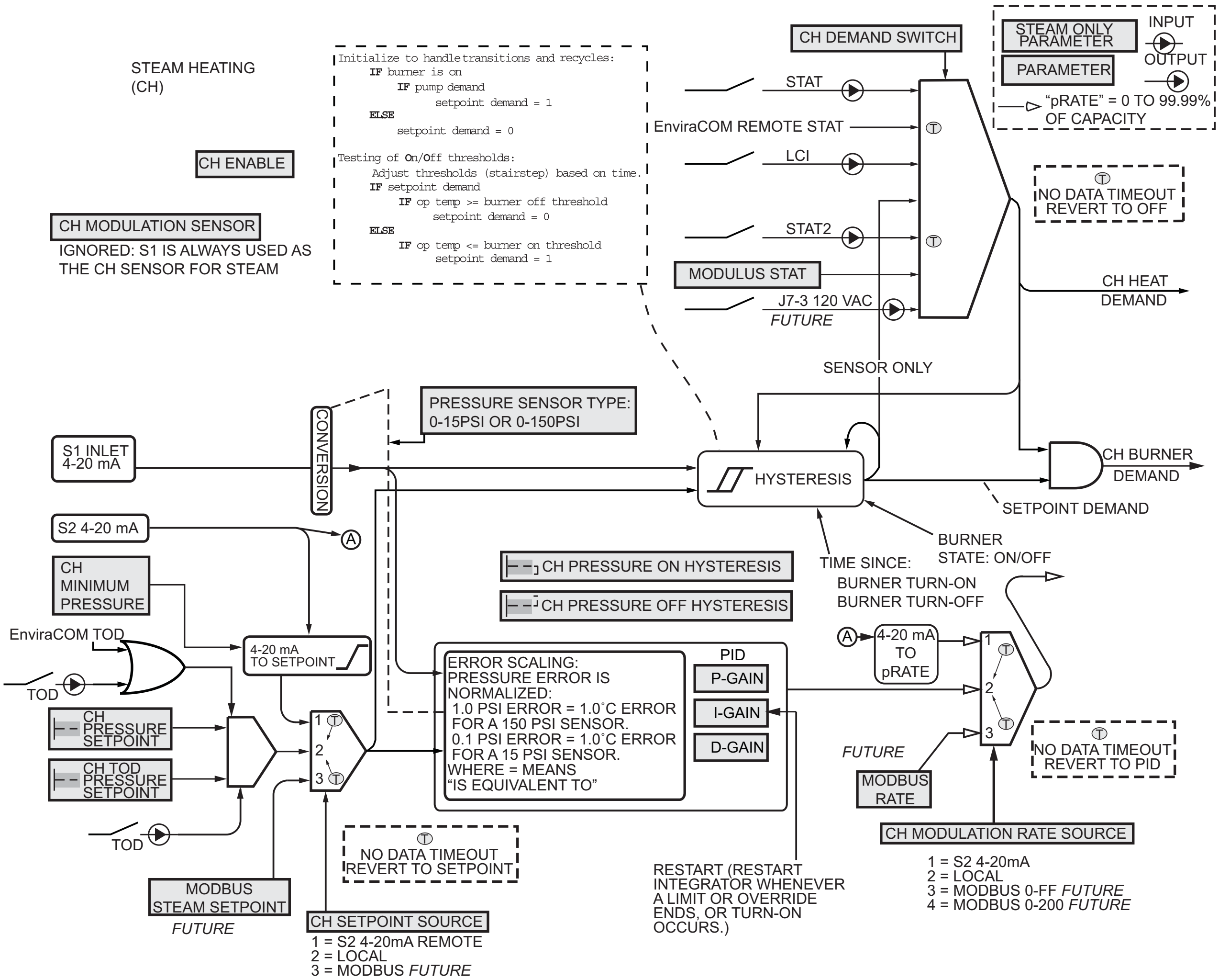


Fig. 11. Central heating steam diagram.

The function of each parameter and feature is given below.

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Table 10. Central Heating Steam Parameters.

Parameter	Comment
Steam enable	Disable, Enable Disable/enable steam feature.
Steam demand source	STAT and Sensor, Remote Stat and Sensor, LCI and Sensor, Sensor Only The CH demand source may be selected from four options. In all cases, for burner demand to exist, the sensor must be generating a demand as determined by setpoint and hysteresis values. • When "Sensor Only" is chosen, no other input is considered and pump demand is derived from burner demand. • When "STAT and Sensor" is chosen, the STAT input in the On condition creates pump demand and it also must be on for burner demand to exist; if it is off there is no demand. • When "Remote Stat and Sensor" is chosen, a message indicating the remote stat is on creates pump demand and it also must be on for burner demand to exist; if the message indicates this stat is off or if no message has been received within the message timeout time (3–4 minutes), there is no demand. • When "LCI and Sensor" is chosen, the LCI input in the On condition creates pump demand and it also must be on for burner demand to exist; if it is off there is no demand.
Steam sensor	Inlet The sensor used for modulation and demand may be either the Outlet sensor, the 4-20mA Inlet sensor.

Table 10. Central Heating Steam Parameters. (Continued)

Parameter	Comment
Steam pressure setpoint	PSI or None This setpoint is used when the time-of-day input is off.
Steam time-of-day pressure setpoint	PSI or None This setpoint is used when the time-of-day input (J10 terminal 2) is on.
Steam Pressure off hysteresis Steam Pressure on hysteresis	PSI or None The off hysteresis is added to the setpoint pressure to determine the pressure at which the demand turns off. Similarly, the on hysteresis is subtracted from the setpoint to determine the pressure at which demand turns on. These may be set to None to indicate that no hysteresis has been defined. The On and Off hysteresis are adjusted at the time the burner changes from off to on, and from on to off, as shown in Fig. 12. This gives the PID algorithm some room to be more aggressive in tracking the load, which can result in overshoot (or undershoot). (see the Setpoint and Hysteresis section, page 31)
Steam hysteresis step time	seconds Time of each step. A step time of zero - disables this feature. (see the Setpoint and Hysteresis section, page 31)
Steam P-gain Steam I-gain Steam D-gain	0-100 These parameters are the gains applied to the proportional, integral, and differential terms of the PID equation for the Steam loop.
Steam 4-20mA remote control	Disable, Setpoint, Modulation **Disable:** When the value is “Disable,” the 4-20mA input via the Header is ignored and both of the remote control functions are disabled. **Modulation:** When the burner is free to modulate during the Run state, the 4-20mA input from the Header input becomes the modulation source, where 4mA corresponds to the Minimum modulation rate and 20mA corresponds to the Maximum modulation rate. All other behavior remains as it was; the setpoint and the on/off hysteresis values are still used to determine the burner-on and burner-off thresholds, and the TOD will still affect the burner-on and burner-off thresholds, if this is enabled. When the 4-20mA input is faulty (open, shorted, out of range, etc.) the control issues an alert and reverts to using PID output for modulation, as if the 4-20mA function were disabled. **Setpoint:** This parameter disables the CH outdoor reset function and the setpoint is provided using a linear interpolation of the 4-20mA input value within a range: • Either the CH pressure setpoint or the CH TOD pressure setpoint provides the setpoint for the 20mA, depending on the state of the TOD input, and the CH minimum pressure provides the setpoint for 4mA. When the 4-20mA input is faulty (open, shorted, out of range, etc.) the control issues an alert and reverts to using: • For steam either the CH pressure setpoint or the CH TOD pressure setpoint, depending on the state of the TOD input.
Steam 4-20mA remote control hysteresis	n.n mA Provides a hysteresis filter for the 4-20ma remote control input.
CH minimum pressure	PSI This parameter provides the minimum steam pressure used to calculate the 4-20mA control setpoint for 4mA.
20 mA CH pressure	PSI or None Establishes the pressures for the end points of the 4-20 mA inputs

Setpoint and Hysteresis (Hydronic)

The CH, DHW and LL master each have similar setpoint and hysteresis functions. The parameters for each are separate and independent.

Whenever the burner turns on, the turn-off threshold is raised by 18°F,and then it is decreased in steps. The time of each step is provided by the hysteresis step time parameter. If the time (T) is not-zero, then the following schedule is followed until the off threshold reaches its original value:

Step	Time since turn-on	Hydronic Turn-off threshold
1	0 <= time <1T	Setpoint + Off hysteresis + 18°F
2	1T <=time <2T	Setpoint + Off hysteresis + 8°F
3	2T <= time <3T	Setpoint + Off hysteresis + 6°F
4	3T <=time <4T	Setpoint + Off hysteresis + 4°F
5	4T <=time <5T	Setpoint + Off hysteresis + 2°F
6	5 <= time	Setpoint

Whenever the burner turns off, the turn-on threshold is lowered by doubling the on hysteresis, and then increasing it by 2 degrees F per step until it reaches its original value.

The time of each step is provided by the hysteresis step time parameter. The number of steps required to reach the original on hysteresis is the on hysteresis value divided by 2 degrees F.

Step	Time since turn-on	Hydronic Turn-on threshold
1	0<=timer <1T	Setpoint - 2 * On hysteresis
2	1T<=time <2T	Setpoint - 2 * On hysteresis + 1*2°F
3	2T<=time <3T	Setpoint - 2 * On hysteresis + 2* 2°F
4	nT<=time <(n+1)T	Setpoint -2 * On hysteresis + n * 2°F
5	(on hysteresis/ 2F*T<=time	Setpoint

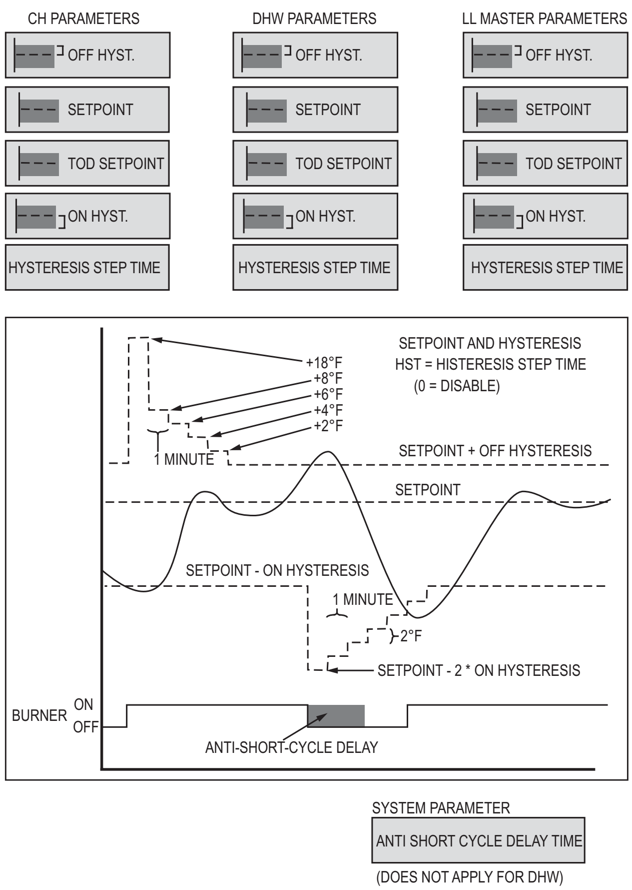


Fig. 12. Hydronic Setpoint and hysteresis.

Setpoint and Hysteresis (Steam Control)

The Steam and LL master each have similar setpoint and hysteresis functions. The parameters for each are separate and independent.

Whenever the burner turns on, the turn-off threshold is raised by 10psi (1.0 for 0-15 psi), and then it is decreased in steps. The time of each step is provided by the hysteresis step time parameter. If the time (T) is not-zero, then the following schedule is followed until the off threshold reaches its original value:

Steam Turn-off Threshold		
Step	150psi Sensor	15psi Sensor
1	10	1.0
2	8	0.8
3	6	0.6
4	4	0.4
5	2	0.2
6	Setpoint	Setpoint

Whenever the burner turns off, the turn-on threshold is lowered by doubling the on hysteresis, and then increasing it by 2 psi (.2 psi for 0-15 psi) per step until it reaches its original value.

The time of each step is provided by the hysteresis step time parameter. The number of steps required to reach the original on hysteresis is the on hysteresis value divided by 2 psi per step for (0–150 PSI .2 psi per step for; 0–15 PSI).

Steam Turn-on Threshold		
Step	150psi Sensor	15psi Sensor
1	0<=timer<1T	Setpoint - 2* On hysteresis
2	1T<=time<2T	Setpoint - 2 * On hysteresis + .2psi
3	2T<=time<3T	Setpoint - 2 * On hysteresis + .2psi
4	nT<=time<(n+1)T	Setpoint - 2 * On hysteresis + .2psi
5	(on hysteresis/ 2psi<=time)	Setpoint

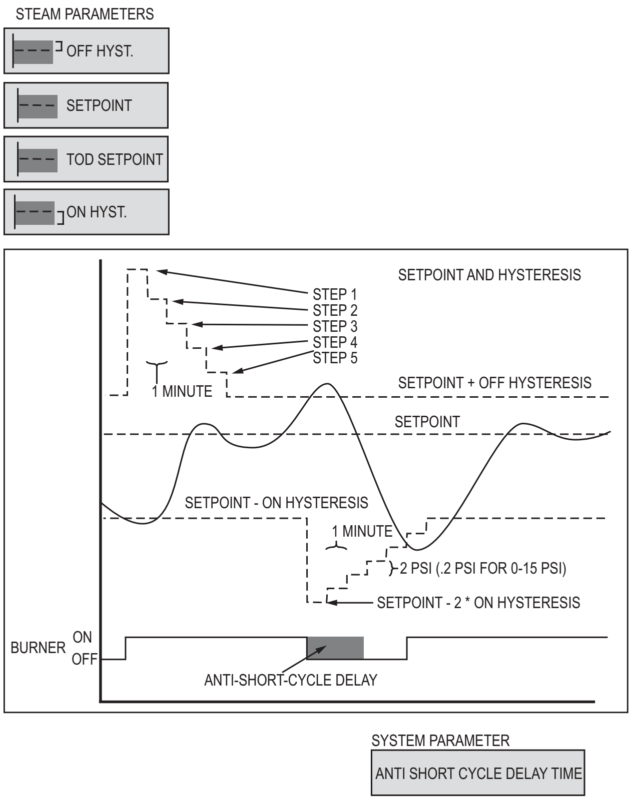


Fig. 13. Steam Setpoint and hysteresis.

DHW Loop Demand and Rate (Hydronic only)

The Domestic Hot Water (DHW) Demand and Rate source compares a sensor to a setpoint.

A Burner demand will exist if the sensor temperature falls below the setpoint minus a hysteresis value. Once the burner demand signal is on, it remains on until the sensor temperature is above the setpoint plus a hysteresis value, or until the other selected demand source input (i.e. Remote Stat or DHW Switch), if any, turns off.

Pump demand may be driven by the a remote stat, or by the sensor alone.

A Proportional-Integral-Differential controller operates to generate the source's requested modulation rate.

The DHW function is implemented as shown in Fig. 14.

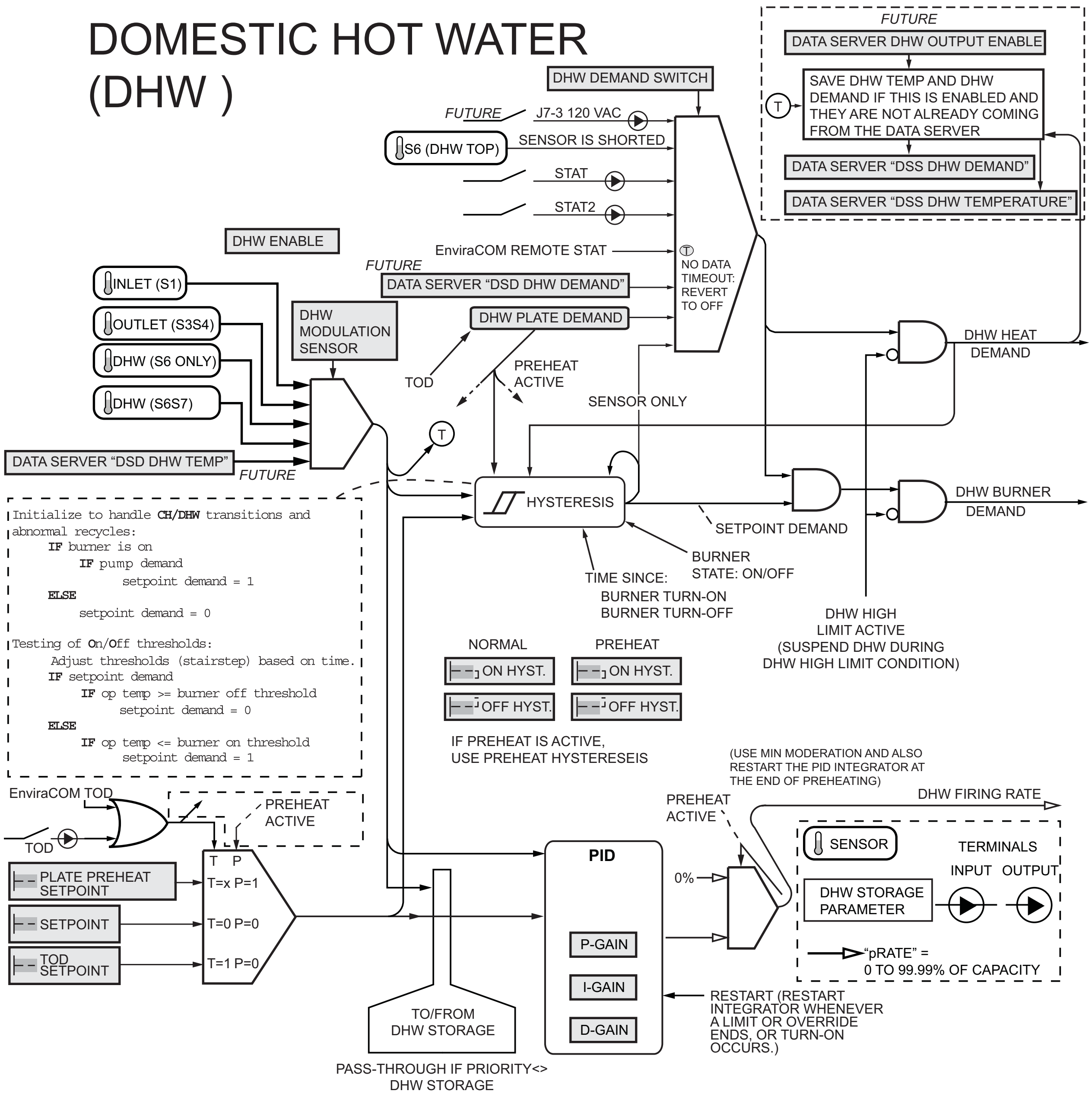


Fig. 14. Domestic hot water function.

The DHW loop's ability to override the normal demand priority is described in the System Operation Settings section. Otherwise the behavior of each parameter and feature is given below.

Table 11. Domestic Hot Water Parameters.

Parameter	Comment

DHW demand switch	DHW Sensor Only, DHW Switch, Auto-Sensor Only, EnviraCOM DHW Request, STAT, Auto and EnviraCOM DHW, Plate Heat Exchanger, J7-3 120 Vac
	This parameter selects the source of demand for the DHW system.
	• If **Sensor Only** is selected, the burner on/off hysteresis levels also provide “pump demand” or heat demand; there is no other switch-like input.
	• If **DHW Switch** is selected, the S6 sensor (one half of the DHW sensor, which is S6S7) acts as a switch. If it is shorted then there is DHW heat demand; if it is open then there is no DHW heat demand.
	• If either **Auto DHW (S6) and EnviraCOM DHW Remote Stat** or **Auto: Sensor Only** is selected, the S6 sensor (one half of the DHW sensor, which is S6S7) is used for automatic detection. In this case:
	  • **DHW high limit enable** must be set to Disable (because it is not being used as a safety sensor).
	  • **DHW connector type** must be set to either “10K single nonsafety NTC” or “12K single non-safety NTC”
	  • **DHW modulation sensor** must be set to either “Auto DHW (S6) or Inlet,” or “Auto DHW (S6) or Outlet.”
	• If these are not as specified then a lockout occurs.
	The behavior of the auto-detection is:
	• If DHW (S6) is shorted or open then:
	• DHW (S6) provides heat demand input and modulation is controlled by the input (Inlet or Outlet) specified by the DHW modulation sensor parameter.
	• ELSE (when DHW (S6) is providing a valid temperature) Modulation is controlled by the DHW (S6) sensor, and if this DHW demand switch parameter selects:
	  • **Auto: DHW(S6) or Sensor Only** then: The DHW sensor provides heat demand, as if the “Sensor Only” option had been chosen.
	  • **Plate Heat Exchanger** then the DHW heat demand operates as specified in the Plate Heat Exchanger section.
	  • **STAT** then the J8 terminal 3 input is the DHW heat demand signal.
	  • J7 terminal 3 120 Vac

DHW setpoint	Degrees or None This setpoint is used whenever the time-of-day switch is off or not connected (unused).
DHW TOD setpoint	Degrees or None This setpoint is used when the time-of-day switch (J10 terminal 2) is on.
DHW off hysteresis DHW on hysteresis	Degrees or None The off hysteresis is added to the setpoint temperature to determine the temperature at which the demand turns off. Similarly, the on hysteresis is subtracted from the setpoint to determine the temperature at which demand turns on. However, these are adjusted at the time the burner changes from on to off, and from off to on to give the PID algorithm some room to be more aggressive in tracking the load, which can result in overshoot (undershoot). This adjustment is identical to that described for the CH demand and rate source, except it is controlled by the DHW hysteresis step time. (see the Setpoint and Hysteresis section, page 31)
DHW hysteresis step time	seconds The time for each step. A step time of zero disables this feature. (see the Setpoint and Hysteresis section, page 31)
DHW P-gain DHW I-gain DHW D-gain	0-400 These parameters are the gains applied to the proportional, integral, and differential terms of the PID equation for the DHW loop.
DHW priority time ODR enable	Disable, Enable When enabled, the DHW priority override time parameter will be derated when the outdoor temperature is below 32°F. When the outdoor temperature is 32°F and above, the programmed time will be used as-is. When the outdoor temperature is -40°F and below, the programmed override time will be derated to zero (no override). Between 32°F and -40°F, a linear interpolation will be used. For example, at the midway point of -4°F, the DHW priority override time is one half of the value provided by the parameter.

Table 11. Domestic Hot Water Parameters. (Continued)

Parameter	Comment

DHW modulation sensor	Inlet (S1), Outlet (S3S4), DHW (S6S7), Auto DHW (S6) or Inlet(S1), Auto DHW (S6) or Outlet
	This parameter selects the source of modulation control for the DHW system. If the selected input is not a temperature (e.g. S1 is steam pressure for a steam control) then an alert occurs and the DHW control subsystem is suspended.
	• If **Inlet** is selected then the sensor on J8 terminal 4 provides DHW temperature.
	• If **Outlet** is selected then this sensor controls DHW modulation.
	• If DHW **(S6S7)** is selected then this sensor controls DHW modulation.
	• If one of the two **Auto: DHW(S6) or Inlet(S1) or DHW(S6) or Outlet** options is selected, then the modulation sensor is determined by the automatic detection function described for the DHW demand switch parameter.
	  • If **Auto DHW (S6) or Inlet** is selected then the Inlet sensor is used if DHW (S6) is a heat demand switch input.
	  • If **Auto: DHW (S6) or Outlet** is selected then the Outlet sensor is used if DHW (S6) is a heat demand switch input.

Plate Heat Exchanger

Plate heat exchanger demand for DHW comes from one of two sources:

- **Tap Demand** - detected primarily as a temperature decrease rate when hot water is “tapped”, e.g. when a tap is turned on.
- **Preheat demand** - used to keep a plate exchanger preheated so it is warm enough to be ready to provide hot water, and also so that Tap demand can be detected (it has to be warm if a temperature drop rate is to be detected).

One of the selections for the DHW demand switch parameter is “Plate Heat Exchanger”. This selection acts as an enable for the Tap Demand and Preheat Demand subsystems. If this choice is selected then the logic described in Fig. 15 and Table 13 is used to generate DHW demand; however if this is not selected, then the logic is inactive and does not apply.

Tap Demand

For a plate-type heat exchanger, a set of parameters is used to detect demand when the DHW system is tapped (as in turning on a tap). This tapping is detected either as a drop in DHW temperature that exceeds a certain rate, or as a temperature threshold that is exceeded (on the low side) for a period of time. When either of these events occurs, tap demand becomes True. Once tap demand is True, it remains on for a minimum time. At the end of this time tap demand will end when one of two criteria occurs, based upon comparing the Inlet temperature to the DHW and Outlet temperatures.

Because tap demand has two criteria for starting, and two other criteria for stopping, it is modeled as a Set/Clr block driven by two OR gates, which in turn are connected to the four criteria sources. The tap demand is also modeled to have a “force” input, which forces it to recognize a “Set” event: this is used when Preheat has had control and is now relinquishing this control to Tap demand.

The plate heat exchanger subsystem will operate as shown in Fig. 15

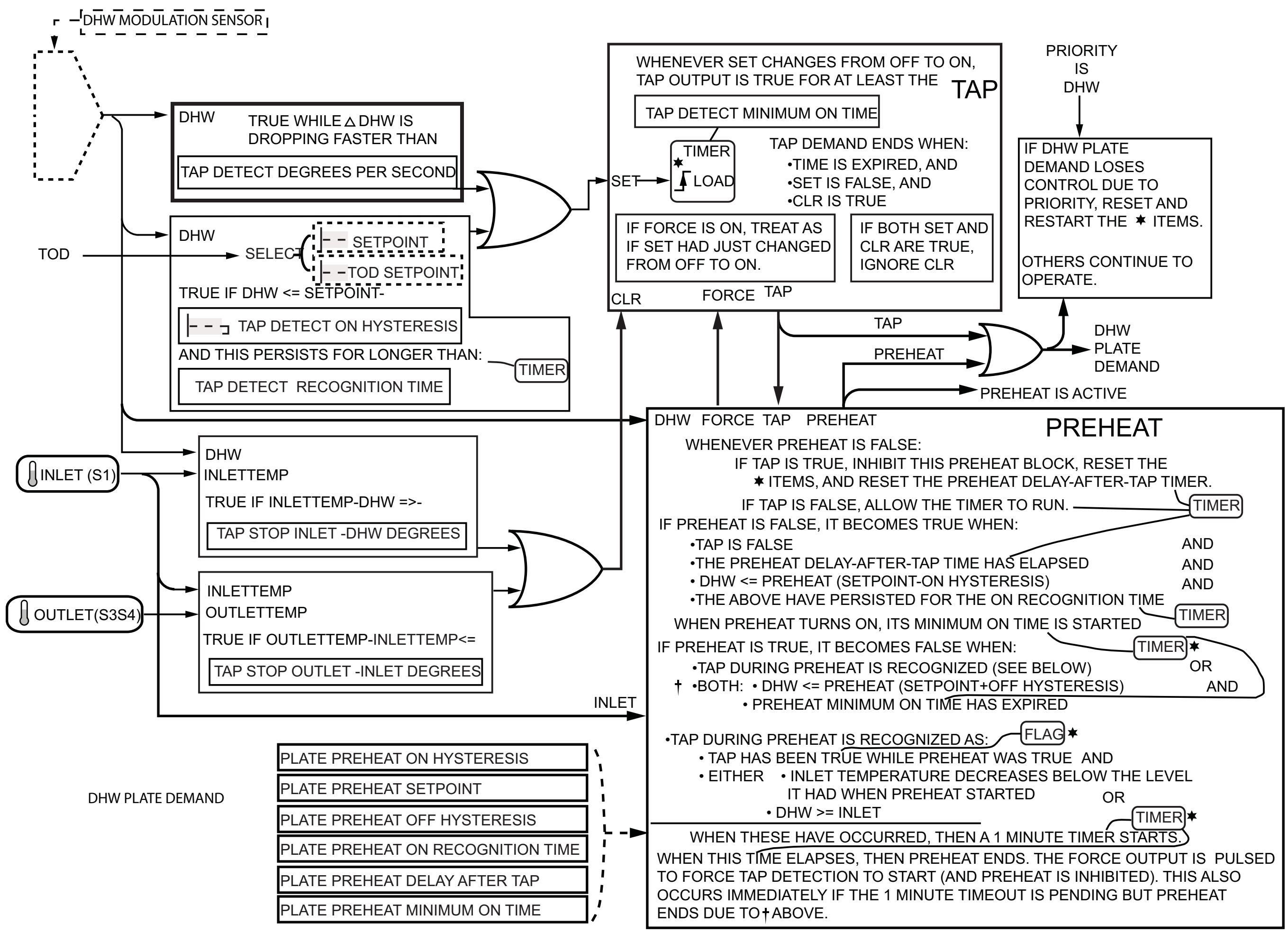


Fig. 15. Plate heat exchanger subsystem.

Table 12. Plate Heat Exchanger Parameters.

Parameter	Comment
Tap detect degrees per second	Degrees or None This tap demand “set” criteria depends on rate of change of the DHW sensor. The rate of change of this temperature is monitored. If it falls at a rate faster than specified degrees per second then the Tap demand block is “Set” (Tap demand becomes true and the minimum on timer is started).
Tap detect on hysteresis	Degrees or None The second tap demand “set” criteria depends on the value of the DHW sensor. If the temperature is less than or equal to the threshold given by subtracting this parameter from the normal DHW setpoint, and if this condition has persisted for the time specified by the Tap detect recognition time parameter, the Tap demand block is “Set” (Tap demand becomes true and the minimum on timer is started). The timer that measures the Tap detect recognition time resets if the temperature rises above the threshold and a new Tap detect event will not occur again until the threshold has again been met or exceeded (on the low side) for the recognition time.
Tap detect on recognition time	hr:mm:ss or None This provides the time for a Tap detect event due to the Tap detect on hysteresis, as described just above.
Tap detect on threshold	-17 °C to 82 °C (-0 °F to 180 °F)

Table 12. Plate Heat Exchanger Parameters. (Continued)

Parameter	Comment
Tap detect minimum on time	hr:mm:ss or None Once a tap detect event has occurred, and the Tap demand block is Set, it remains true for at least the time provided by this parameter. If DHW loses control due to priority, the timer is restarted, so that when Tap demand again gains control of the burner it remains in this condition for the full minimum on time. After the minimum on time has elapsed, tap demand may will end due to either of the “Clr” criteria described below, for the Tap stop Inlet-DHW degrees parameter or the Tap stop Outlet-Inlet degrees parameter. The “Clr” input to the tap demand block will be effective, however, only if the minimum on time has elapsed AND the “Set” condition is false; otherwise the Clr input may persist but it will be ignored until those two requirements are also met.
Tap stop Inlet-DHW degrees	Degrees or None One criteria for asserting “Clr” is based on the difference between the DHW and the Inlet temperature, calculated as: Inlet - DHW. When this value is positive and is greater than or equal to the degrees given by this parameter, tap demand’s “Clr” input is asserted.
Tap stop Outlet-Inlet degrees	Degrees or None The other criteria for asserting “Clr” is based on the difference between the Outlet and the Inlet temperature, calculated as: Outlet - Inlet. When this value is negative or is less than or equal to the degrees given by this parameter, tap demand’s “Clr” input is asserted.

Plate preheat off hysteresis	Degrees or None
	The preheat off threshold is calculated as:
	T_{OFF} = Plate preheat setpoint + Plate preheat off hysteresis
	If the preheat block is True, then it becomes False when:
	• Tap during Preheat is recognized (see below) OR
	• Both
	  • DHW sensor temperature >= T_{OFF}, AND
	  • The preheat minimum on time has elapsed.

Preheat Demand

To ensure that the plate heat exchanger is ready, it maintains a preheat temperature. This temperature is determined by a setpoint, hysteresis on, and hysteresis off parameters. Thus at its core it also is a Set/Clr block. Preheat is made somewhat more complex because is has its own minimum on time and because tap demand may occur while preheat is in-progress. Therefore various rules specify when Preheat lets go and turns control over to Tap Demand.

Table 13. Preheat Demand Parameters.

Parameter	Comment

Plate preheat delay after tap	mm:ss or None
	Whenever the Preheat block is false, it monitors the Tap demand block's output and operates a timer that ensures preheat will not begin too soon after a tap demand has recently ended.
	Whenever the preheat block is false:
	• If Tap demand is true:
	  Reset the timer that measures the preheat delay after tap to measure the time specified by this parameter, but do not allow the timer to run.
	• Else, when Tap demand is false:
	  Allow the timer to run.
	In either case, if the preheat delay time has not elapsed then inhibit the Preheat demand block so that it cannot become true.

Plate preheat setpoint	Temperature or None This parameter provides the DHW setpoint used when firing for preheat. It also is used as the basis for detecting the need to preheat.
Plate preheat on recognition time	mm:ss or None This parameter provides the time duration for recognizing that preheat demand exists.

Table 13. Preheat Demand Parameters. (Continued)

Parameter	Comment
Plate preheat on hysteresis	Degrees or None The preheat on threshold is calculated as: T_{ON} = Plate preheat setpoint - Plate preheat on hysteresis If the preheat block is False, then it is Set (becomes True) when: **1.** Tap demand is false, AND **2.** The preheat delay-after-tap time has elapsed, AND **3.** DHW sensor temperature <= T_{ON}, AND **4.** The above have remained true for the time specified by: Plate preheat on recognition time That is, whenever conditions 1, 2, or 3 are not true, a preheat recognition timer is reset. Whenever they are all true then the timer is allowed to run. If the time elapses then the preheat block becomes true (preheat is active, and this causes the plate demand to be true). Whenever preheat first becomes active, the Inlet temperature is sampled and saved, a Tap during Preheat flag is cleared, and a 1 minute timer is marked as inactive. (All of these are used by the Tap during Preheat logic.) Whenever preheat demand becomes true, a minimum on timer is started to measure the time specified by the Plate preheat minimum on time parameter. Preheat demand will remain true until this time elapses (except that it may convert to Tap demand under the conditions described for “Tap during Preheat”). If preheat loses control of the burner due to priority, the minimum on timer will be restarted so that it provides the full minimum on time, when priority returns to preheat.
Plate preheat minimum on time	mm:ss or None This parameter provides the minimum on time for preheating.

Plate preheat off hysteresis	Degrees or None
	The preheat off threshold is calculated as:
	T_{OFF} = Plate preheat setpoint + Plate preheat off hysteresis
	If the preheat block is True, then it becomes False when:
	• Tap during Preheat is recognized (see below) OR
	• Both
	  • DHW sensor temperature >= T_{OFF}, AND
	  • The preheat minimum on time has elapsed.

Tap During Preheat

Although preheat cannot become True while Tap demand is true, it is possible that Tap demand may occur after Preheat has started. If the conditions for Tap demand are met, that is, if tap demand does become true during preheat, this is noted by setting the Tap during Preheat flag (which was cleared initially when preheat began).

If this flag is set:

- If the Inlet temperature is less than the temperature it had when preheat started, and the 1 minute timer is not already running, then, a 1 minute timer is started.
- If any of these occur:
  - The 1 minute timer is running, and it elapses, OR
  - The DHW temperature equals or exceeds the Inlet temperature, OR
  - Both:
    DHW sensor temperature >= TOFF, AND
    The preheat minimum on time has expired
- Then:
  - Tap demand is forced on, that is, a “Set” event is generated for it, which starts its minimum on timer.
  - Preheat becomes false (inactive).

Preheat Modulation control

Preheat provides its own setpoint and hysteresis values. These are used by the burner on/off hysteresis logic in place of the normal DHW values, as shown in Table 15.

Table 14. Preheat Modulation Values.

	Preheat Inactive	Preheat is active
Setpoint	DHW setpoint	Plate preheat setpoint
Hysteresis On	DHW off hysteresis	Plate preheat on hysteresis
Hysteresis Off	DHW off hysteresis	Plate preheat on hysteresis

However, the preheat function does not modulate and does not use the PID function. Whenever preheat is active, the minimum modulation rate is used. (As usual, a modulation rate of 0% may be used as an output because this value always will be clipped to the minimum modulation rate by the rate limit section.)

When preheat ends the DHW PID integrator will be restarted since it may have accumulated a value during the preheat time which is not relevant because it was not in control. (This is done in the same way as for the end of an override: preheat is essentially a rate override.)

DHW Storage

DHW Storage provides a source of demand for the DHW system that will keep the DHW pump on and maintain the water temperature for a programmable period of time after the normal DHW demand has been satisfied. The DHW storage feature has its own setpoint and hysteresis values, so they can differ from the values used during normal DHW demand.

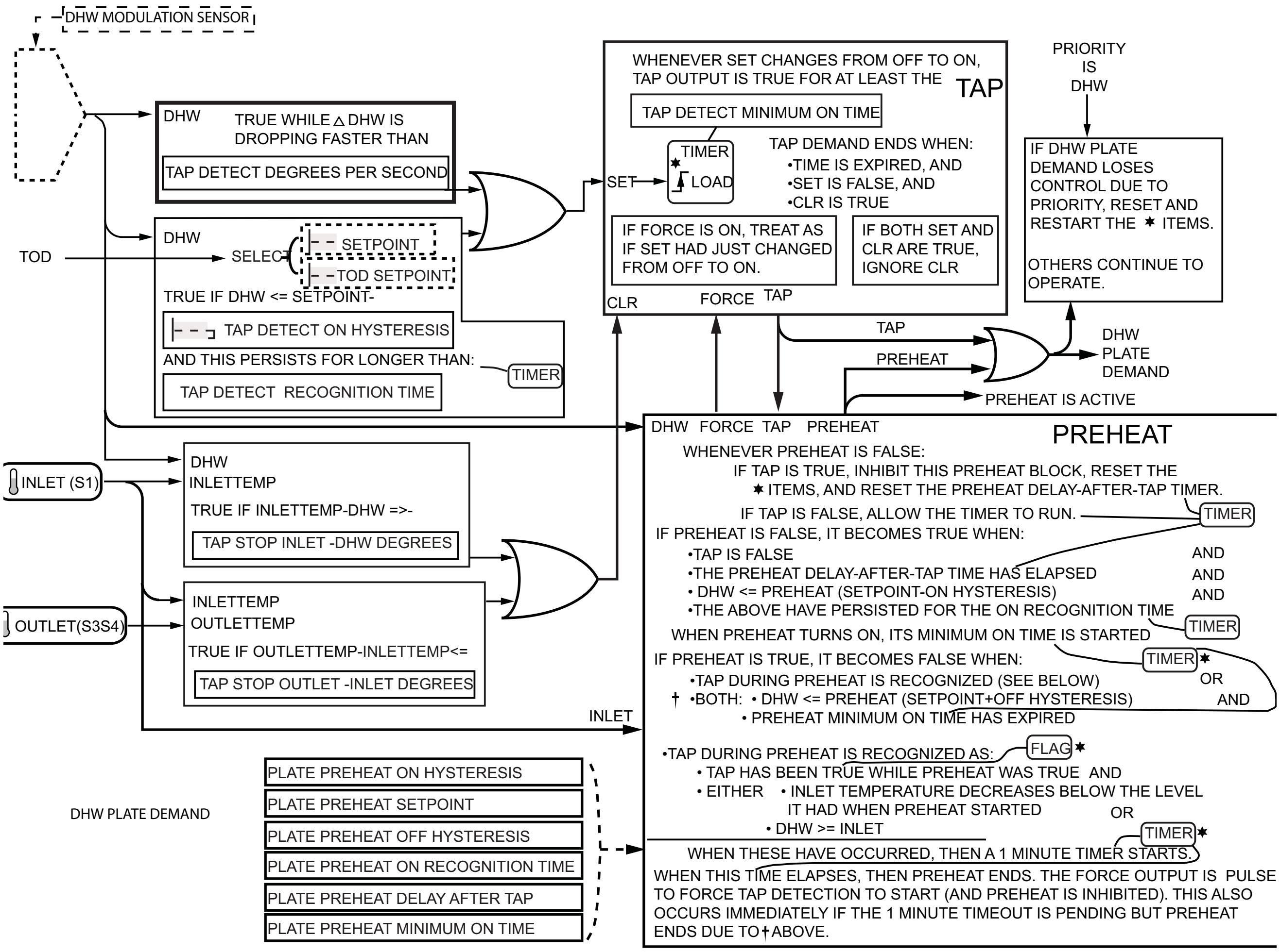


Fig. 16. DHW storage.

Table 15. DHW Storage Demand Parameters.

Parameter	Comment
DHW storage enable	Enable, Disable This parameter enables or disables the DHW storage feature. If it is disabled then the other parameters below are ignored.
DHW storage time	mm:ss The time DHW storage temperature is maintained.
DHW storage setpoint	degrees or None The temperature setpoint that the boiler maintains during the DHW storage time.
DHW storage on hysteresis	degrees or None This provides the on hysteresis as an offset that is applied to the DHW storage setpoint, used during DHW storage demand.
DHW storage off hysteresis	degrees or None This provides the off hysteresis as an offset that is applied to the DHW storage setpoint, used during DHW storage demand.

DHW Storage Operation

When the DHW storage feature is enabled, whenever any normal DHW call-for-heat is satisfied (i.e. pump demand turns off) the DHW storage demand begins and persists for the time given by the DHW storage time parameter. During this time the DHW pump is turned on, and the burner fires as needed to maintain the DHW storage setpoint. DHW storage demand is lower in priority than:

- CH demand,
- DHW normal demand, and
- LL slave demand.

DHW storage demand is higher in priority than:

- CH frost protection demand, and
- DHW frost protection demand

If another DHW normal demand occurs during the DHW storage time, the storage timer is reset and DHW storage demand begins anew when the DHW normal demand is satisfied. If a CH or LL demand occurs during the DHW storage demand, these take control of the burner; however, the DHW storage timer continues to run. When the higher priority demand is satisfied, then if the DHW storage demand is still active (the time has not yet elapsed) then the boiler again serves the remainder of the DHW storage demand. When the storage time has expired then DHW storage demand ends and does not recur until a normal DHW demand has recurred and ends. The DHW setpoint and hysteresis are used in the same way as existing setpoints and hysteresis values. This includes use of the DHW hysteresis step time behavior, which modifies the burner on/off thresholds over time.

The gains used by DHW storage are the normal DHW PID gains. This occurs because the DHW PID block is shared by the two demand sources.

- The DHW storage feature, when active, uses the demand source selected by the normal DHW demand source.
- The DHW storage feature, when active, provides setpoint information to the normal DHW PID block, which is used to provide the firing rate when DHW storage is active (i.e. it is shared).

DHW Storage uses the same pump as DHW demand.

The DHW storage feature is shown in Fig. 16.

Frost Protection (Hydronic only)

Frost protection, like other sources, generates pump demand and rate.

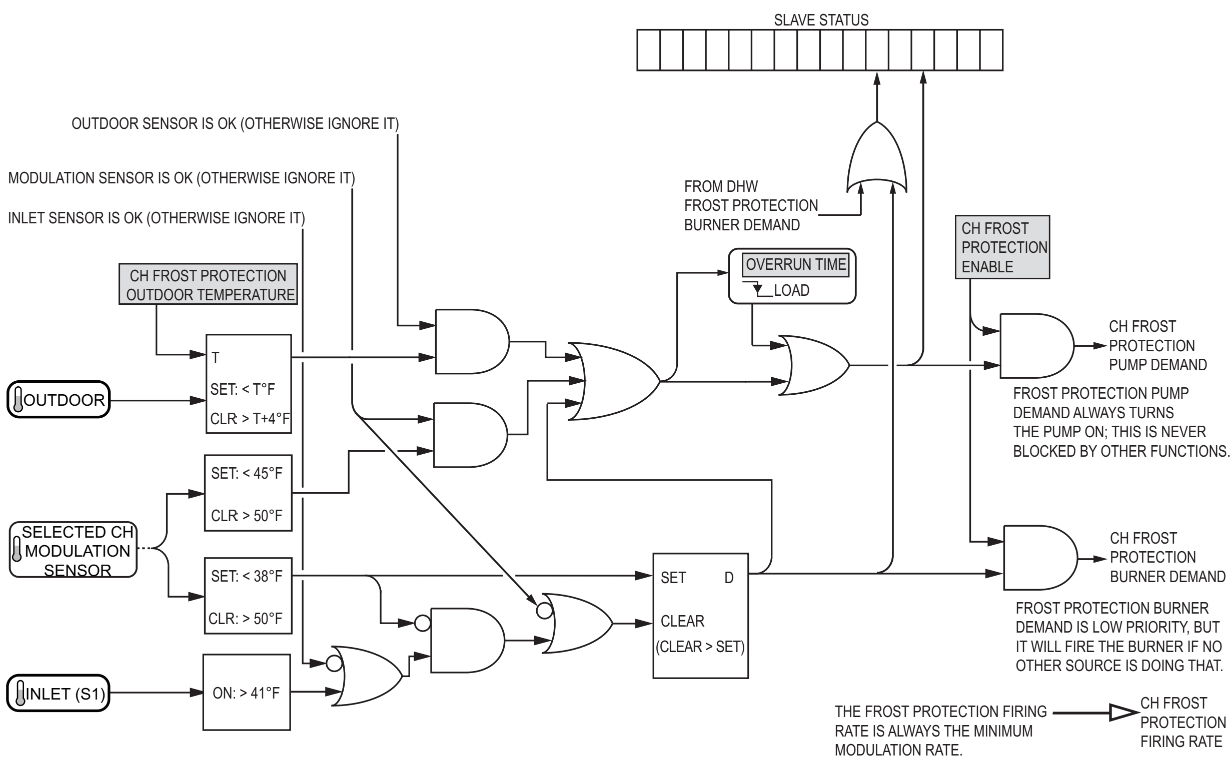


Fig. 17. CH Frost protection.

The behavior of each parameter and feature is given below.

Table 16. CH Frost Protection Parameters.

Parameter	Comment
CH Frost protection enable	Enable, Disable When enabled, regardless of whether the boiler is firing or not or whether CH is in control or not: • The CH pump is turned on if the CH control temperature is below 45ºF, using the active CH sensor: Header or Outlet OR • The CH pump is turned on if the outdoor sensor is valid and the temperature is below a programmed frost protection level provided by the CH frost protection outdoor setpoint parameter. Once turned on, the CH pump remains on until: 1) the outdoor temperature is above the programmed frost protection level + 4ºF, and 2) the outlet temperature exceeds 50ºF. When both of these have occurred, then a CH frost protection overrun timer is started. After the timer expires, the pump reverts to normal operation. This source of pump control has the highest priority and cannot be overridden by any subsystem (e.g. anticondensation) that wants to turn off the CH pump. Additionally, if the burner has no demand from any other source, then the frost protection source generates a burner demand if the outlet temperature is below 38ºF and it requests a minimum modulation firing rate. It maintains this demand until some other source of demand takes over—frost protection is the lowest priority burner demand source—or CH Frost protection burner demand ends. CH Frost protection burner demand ends when both of these occur: 1) the outlet temperature exceeds 50ºF. 2) the inlet temperature is greater than 41ºF. If the CH control sensor (Outlet or Header) is invalid (e.g. disconnected) then it is ignored by CH frost protection. If the Inlet sensor is invalid (e.g. disconnected) then frost protection ignores that sensor and operates only on the CH control sensor. If the Outdoor sensor is invalid it is ignored without issuing an alert.
CH Frost Protection outdoor setpoint	Degrees or None CH Pump is turned on when the temperature is below the programmed frost protection level.
CH frost overrun time	hr:mm:ss This time indicates how long the CH pump demand should continue to run after CH frost protection pump demand ends.

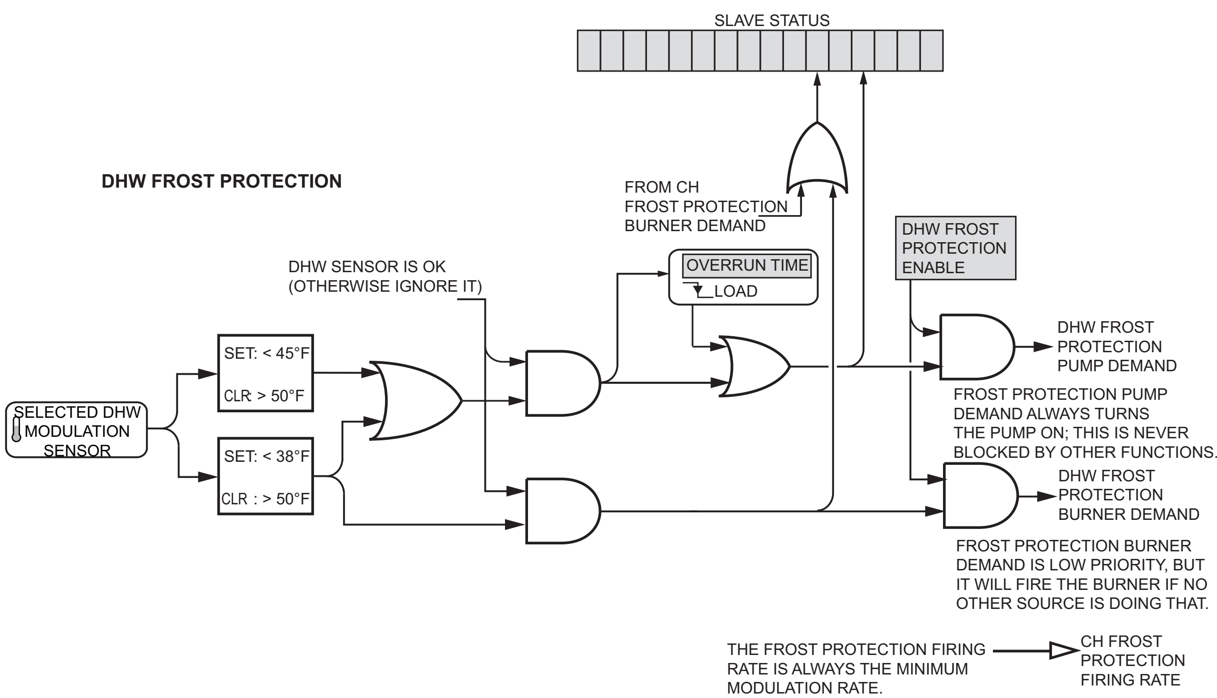


Fig. 18. DHW frost protection.

Table 17. DHW Frost Protection Parameters.

Parameter	Comment
DHW frost protection enable	Enable, Disable The DHW frost protection feature is enabled or disabled by this parameter. See Fig. 18. DHW frost protection will use the DHW sensor, if the DHW demand source parameter selects a switch instead of a sensor. When enabled, regardless of whether the boiler is firing or not or whether DHW is in control or not: • The DHW pump is turned on if the DHW temperature is below 45ºF • Once turned on, the DHW pump remains on until the DHW temperature exceeds 50ºF. When this occurs then the DHW overrun timer is started. After the timer expires, the DHW pump reverts to normal operation. This source of pump control has the highest priority and cannot be overridden by any subsystem (e.g. anticondensation) that wants to turn off the DHW pump. Additionally, if the burner has no demand from any other source, then the frost protection source generates a burner demand if the DHW temperature is below 38ºF and it requests a minimum modulation firing rate. It maintains this demand until some other source of demand takes over—frost protection is the lowest priority burner demand source—or DHW Frost protection ends. DHW Frost protection ends when the DHW temperature exceeds 50ºF. If the DHW sensor is invalid (e.g. disconnected) then it is ignored by DHW frost protection.
DHW frost overrun time	hr:mm:ss This time indicates how long the DHW pump demand should continue to run after DHW frost protection pump demand ends.
Frost protection method	Min modulation continuous, Mid modulation at 5 min/hour Determines what happens when Frost Protection (from any source) becomes active. • **Min modulation continuous** Burner demand, if/when it occurs as part of frost protection, is continuous until the Frost Protection condition no longer exists. • **Mid modulation at 5 min/hour** Burner demand occurs for 5 minutes when Frost Protection burner demand first becomes active, then thereafter it remains off for 55 minutes, then of for 5, off for 55, etc.

Rate Limits and Override

The Limit and Override subsystem consists of three separate concepts:

- Safety limit functions that cause a burner control to lockout or recycle if safety-critical limits are reached.
- Rate limit functions that limit the range of modulation due to special or abnormal operating conditions. It is common for a rate limit to become effective whenever conditions approach a safety limit, to try to prevent the consequence of reaching the safety limit.
- Rate override functions set the firing rate to a specific value without regard to firing rate due to modulation requests or rate limits.

Rate Limit Priorities

There are two kinds of rate limit:

— Rate reducers, those that act to limit the maximum firing rate:
  - Delta-T limit - Hydronic
  - Stack limit
  - Slow start
  - Outlet limit - Hydronic
  - Forced rate (Forced rate might actually specify any rate, but for priority purposes it is considered to be a reducer.)

— Rate increasers, that act to increase the firing rate. There is only one of these:
  - Anticondensation - Hydronic

Anticondensation has a programmable priority vs. the other rate limits (Hydronic only):

Anticondensation versus Delta-T
Anticondensation versus Stack limit
Anticondensation versus Slow start
Anticondensation versus Forced Rate
Anticondensation versus Outlet limit

So the rate limit priority scheme uses the following steps, where “active” means that the rate override is both enabled and requesting its rate:

1. If Anticondensation is active and all rate reducers are inactive, then Anticondensation determines the rate.
2. If Anticondensation is active and one or more rate reducers are also active, then the priority of Anticondensation is compared to each active rate reducer. Of those active rate reducers that have higher priority than Anticondensation, the lowest rate requested by any of these determines the rate. However, if Anticondensation has higher priority than any active rate reducers, then Anticondensation determines the rate.
3. If Anticondensation is inactive, then the lowest rate requested by any active rate reducer determines the firing rate.

When an “abnormal” rate limit occurs an alert is issued. The rate limits that are abnormal are: Delta-T, Stack, Outlet, and Anticondensation. The other two limits, Slow Start and Forced Rate, are considered to be normal in that they always occur if they are enabled.

Delta-T Limit (Rate Limit Only/Hydronic only)

The Delta-T limit is designed to reduce the firing rate in case the difference between the following is excessive:
- The Inlet and the Outlet temperature
- The Inlet and the exchanger temperature
- The exchanger and the Outlet temperature

Each will operate identically and will use either similar parameters or shared parameters. The left name is typically at a lower temperature than the one on the right (except when the temperature is inverted due to a reversed flow, or some other abnormal condition).

The “inlet temperature” is provided by S1 (J8 terminal 4), the “exch” exchanger temperature is provided by S9 (J9 terminal 6), and the “outlet” temperature is S3S4 (J8 terminal 8, 9 and 10) dual sensor.

Table 18. Delta-T Limit Parameters.

Parameter	Comment
Delta-T inlet/outlet enable	Disable, Enable Delta-T, Enable Inversion Detection, Enable Delta-T and Inversion Detection.
Delta-T inlet/exch enable	Disable, Enable Delta-T, Enable Inversion Detection, Enable Delta-T and Inversion Detection.
Delta-T exch/outlet enable	Disable, Enable Delta-T, Enable Inversion Detection, Enable Delta-T and Inversion Detection. If either of the heat exchanger delta-Ts is enabled, the Stack Connector Type must be either “10K single non-safety NTC” or “12K single non-safety NTC.” If this condition is not met then a lockout occurs because the exchanger input requires using the Stack sensor as two separate sensors. Stack being S8 (J9 terminal 4) and heat exchanger being S9 (J9 terminal 6). If this value is “disable” then all behavior associated with the Delta-T function is disabled. If the Enable Delta-T, or Enable Delta-T and Inversion Detection options are chosen to enable the Delta-T behavior, then the temperature gap between the temperature of “lo” and “hi” is limited by the number of degrees given by the Delta-T degrees parameter. If the Enable Inversion Detection or Enable Delta-T and Inversion Detection options are chosen, the Inversion detection is active. This is implemented as a time limit on how long the inverse of the normal temperature relationship will be tolerated. Temperature inversion is the condition where the “lo” temperature is higher than the “hi” temperature. If the inversion persists for longer that Delta-T inverse limit timer, then the response given by Delta-T inverse limit response occurs.
Delta-T inlet/outlet degrees	Degrees, none

Table 18. Delta-T Limit Parameters. (Continued)

Parameter	Comment
Delta-T inlet/exch degrees	Degrees, none
Delta-T exch/outlet degrees	Degrees, none This is the temperature at which a Delta-T response occurs, measured as the signed value (hi-lo) if the result is negative then it is treated as zero (inversion detection may be enabled to handle this, but that is a different function which does not use this parameter).
All of the Delta-T functions will share the following parameters:	
Delta-T response	Lockout, Recycle & Delay, Recycle & delay with retry limit This specifies the type of response that occurs when the Delta-T degrees threshold is met. The Recycle & delay with retry limit will limit the number of retries as specified by the Delta-T retry limit.
Delta-T delay	mm:ss, none Specifies the delay time that occurs whenever a recycle occurs due to a Delta-T or Delta-T inverse event occurs and the specified response includes “Recycle...” The burner will remain in the Standby Hold condition until the delay expires.
Delta-T retry limit	number of tries If either the Delta-T response or the Delta-T inverse limit response specify a retry limit, then any recycles due to reaching the corresponding response threshold are counted. If this count ever exceeds the “n” value, then a lockout occurs. A single counter is used for Delta-T and Inversion Detections, so it could be that different causes occurred to make the counter exceed its final retry limit count of “n” Only the final event that causes the count to exceed the retry limit is annunciated as the cause of the lockout, although each of the reasons for recycling abnormally always generates an alert, as usual, so the presence of other events will be visible in that log. The retry counter is cleared when a normal recycle (burner turn-off) occurs due to satisfying all of the demands. A limit of zero is equivalent to selecting “lockout.”
Delta-T rate limit enable	Disable, Enable Disable then no modulation limiting occurs as the delta-T threshold is approached. Enable, then the Stepped Modulation Limiting feature is active for Delta-T.
Delta-T inverse limit time	mm:ss or None This provides the time limit during which inverted temperature is tolerated when one of the two inverse detection option is enabled.
Delta-T inverse limit response	Lockout, Recycle & Delay, Recycle & delay with retry limit If temperature inversion detection is enabled and it persists for the time given by the Delta-T inverse limit time, then the response described by this parameter occurs. The delay time used is the time specified by the Delta-T delay and the retry limit is the count specified by the Delta-T retry limit.

T-Rise

A limit may be imposed on the rate of temperature rise for either the outlet or exchanger temperature, or both.

Table 19. T-Rise Parameters.

Parameter	Comment
Outlet T-Rise enable	Disable, Enable This enables/disables temperature rise detection for the outlet sensor S3 (J8 terminal 8).
Exchanger T-Rise enable	Disable, Enable This enables/disables temperature rise detection for the heat exchanger sensor S9 (J9 terminal 6). If this selection is “Enable” then the Stack Connector Type must be either “10K single non-safety NTC” or “12K single non-safety NTC.” If this condition is not met then a lockout occurs because the exchanger input requires using the Stack sensor as two separate sensors. Stack being S8 (J9 terminal 4) and heat exchanger being S9 (J9 terminal 6).

Table 19. T-Rise Parameters. (Continued)

Parameter	Comment
T-Rise degrees per second limit	Degrees or None For any input that has T-rise detection enabled, this parameter provides the maximum rate of temperature increase that will be allowed. If the temperature increases at a rate greater than this, and this rate of increase persists for 4 seconds then the response specified by T-rise response occurs.
T-Rise response	Lockout, recycle & delay, Recycle & delay with retry limit Specifies response should “T-Rise degrees per second limit” is exceeded.
T-rise delay	mm:ss or None Specifies the delay time that occurs whenever a recycle occurs due to a T-rise event and the specified response includes “Recycle...” The burner will remain in the Standby Hold condition until the delay expires.
T-rise retry limit	n If the “T-rise response” specifies a retry limit, then any recycles due to reaching the corresponding response threshold are counted. If this count ever exceeds the “n” value, then a lockout occurs.

Heat Exchanger High Limit

A temperature limit may be imposed on the exchanger temperature.

Table 20. Heat Exchanger High Limit Parameters.

Parameter	Comment
Heat exchanger high limit	Disable, Enable This enables/disables temperature rise detection for the heat exchanger sensor S9 (J9 terminal 6). If this selection is “Enable” then the Stack Connector Type must be either “10K single non-safety NTC” or “12K single non-safety NTC.” If this condition is not met then a lockout occurs because the exchanger input requires using the Stack sensor as two separate sensors. Stack being S8 (J9 terminal 4) and heat exchanger being S9 (J9 terminal 6).
Heat exchanger high limit setpoint	Temperature or none Provides the setpoint at which a response occurs if “Heat exchanger high limit” function is enabled.
Heat exchanger high limit response	Lockout, recycle & delay, Recycle & delay with retry limit Specifies response should “Heat exchanger high limit setpoint” threshold is reached.
Heat exchanger high limit delay	mm:ss or None Specifies the delay time that occurs whenever a recycle occurs due to a Heat exchanger high limit event and the specified response includes “Recycle...” The burner will remain in the Standby Hold condition until the delay expires.
Heat exchanger retry limit	n If the “Heat exchanger high limit response” specifies a retry limit, then any recycles due to reaching the heat exchanger high limit threshold are counted. If this count ever exceeds the “n” value, then a lockout occurs.
Heat exchanger T-rise enable	Enabled, Disabled

Stack limit (Safety limit and Rate limit)

Table 21. Limits and Rate Override: Stack Limit Parameters.

Parameter	Comment
Stack limit enable	Disable, Enable, Enable single-non-safety This parameter enables or disables the entire stack temperature limit function. Disable turns off the Limit function. Enable turns on the Limit function and requires a 10k dual safety NTC sensor. Enable single-non-safety allows for 10kohm or 12kohm NTC sensor to provide limit (non-safety) function.
Stack limit setpoint	Degrees or None If the stack temperature reaches or exceeds the safety limit temperature given by this parameter then the response defined below will occur.
Stack limit response	Lockout, Recycle & delay If the stack temperature exceeds the stack setpoint, then a response will occur. If the selected response is a lockout, then the burner control locks out. However, if the selected response is Recycle & Delay, the burner control recycles and holds while waiting for a delay (see below) to expire, and after the delay it tries again (assuming that demand is still present).
Stack limit delay	MM:SS This parameter provides the delay time for the Stack limit.

STACK RATE LIMIT

If the stack limit is enabled, as the temperature approaches the stack limit temperature, the Stepped Modulation rate limit function (see “Stepped modulation rate limit” on page 46) is active.

Outlet high limit (Safety limit and Rate Limit/Hydronic only)

Table 22. Limits and Rate Override: Outlet High Limit Parameters.

Parameter	Comment
Outlet high limit enable	Enable, Disable Enable function requires the outlet high limit sensor to be a safety check dual redundant type. Disable allows for single sensor input to allow steam to use outlet as non-safety.
Outlet high limit setpoint	degrees or None If the outlet temperature reaches the value given by this parameter then a response will occur
Outlet high limit response	Lockout, Recycle & hold This parameter selects the response. If lockout is selected, the burner control locks out. If Recycle & hold is selected, the burner control recycles and waits for the outlet temperature to fall. It will remain in this holding condition until the outlet temperature is lower than the outlet high limit setpoint minus 5°F.

OUTLET HIGH LIMIT CH PUMP CONTROL (HYDRONIC ONLY)

Whenever the outlet high limit has been reached the CH pump will be turned on. It will remain on until the outlet temperature is lower than the outlet high limit setpoint minus 5°F.

OUTLET RATE LIMIT (HYDRONIC ONLY)

Whenever the outlet sensor is not used as the modulation sensor, the outlet rate limit function is active. (This will occur when modulating via the DHW sensor, the Header sensor, or as a LL slave.) In these cases, as the outlet temperature approaches the outlet high limit setpoint, the Stepped Modulation rate limit function (see “Stepped modulation rate limit” on page 46) is active.

Stepped modulation rate limit

The Delta-T, Stack, and Outlet limit functions all use the same stepped modulation limiting, which reduces the maximum allowed modulation rate in five steps as the monitored temperature approaches the limit.

The limiting performs as follows:

A range is determined by calculating:

range= Maximum modulation rate
 - Minimum modulation rate

NOTE: The DHW maximum modulation rate is used when firing for DHW, and for other sources the CH maximum modulation rate is used.

A step size is determined by dividing this range by 5:

stepsize=range/5

Thus there are 5 steps in the modulation limiting:

step 0: unlimited (max is 100%)
step 1: max is 80% of range
step 2: max is 60% of range
step 3: max is 40% of range
step 4: max is 20% of range
step 5: limited to minimum modulation rate

If the monitored temperature is not within 12°F of the limit, then no rate limiting occurs. The stepped rate limit behaves as illustrated below:

Assuming that rate limiting has not been in effect, when the monitored temperature crosses a threshold that is 10°F away from the limit, then the maximum allowed firing rate is reduced by one stepsize (to 80%) and thereafter it is reduced by one stepsize every two °F until it is reduced to the minimum modulation rate when the 2°F threshold is crossed. Assuming that rate limiting has been in-effect then the thresholds for returning to a less restrictive step are shifted by 2°F to provide hysteresis. I.e. to go from step 4 to step 5 the threshold occurs at 2°F, but to go the other way, from step 5 to step 4, the threshold is 4°F.

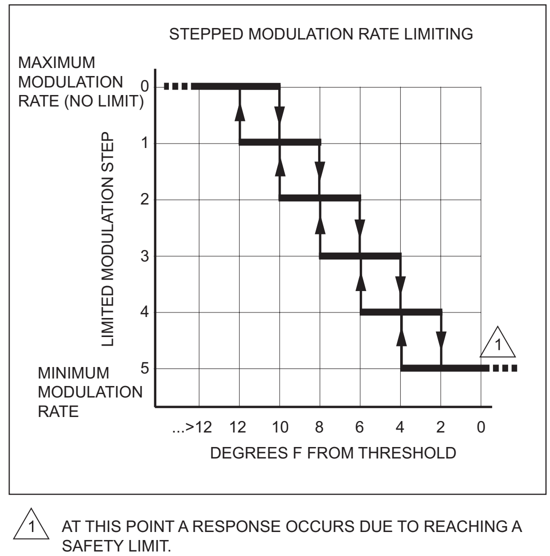


Fig. 19. Stepped modulation rate limiting.

Slow Start and Forced Rate limits (Hydronic Control)

The Forced Rate limit causes the burner to stay at a fixed firing rate immediately after lightoff, just after the end of the Run Stabilization time (if any). This is optionally followed by a slow start function that limits the ramp-up speed of the firing rate when the water is colder than a threshold, as shown in the following diagram.

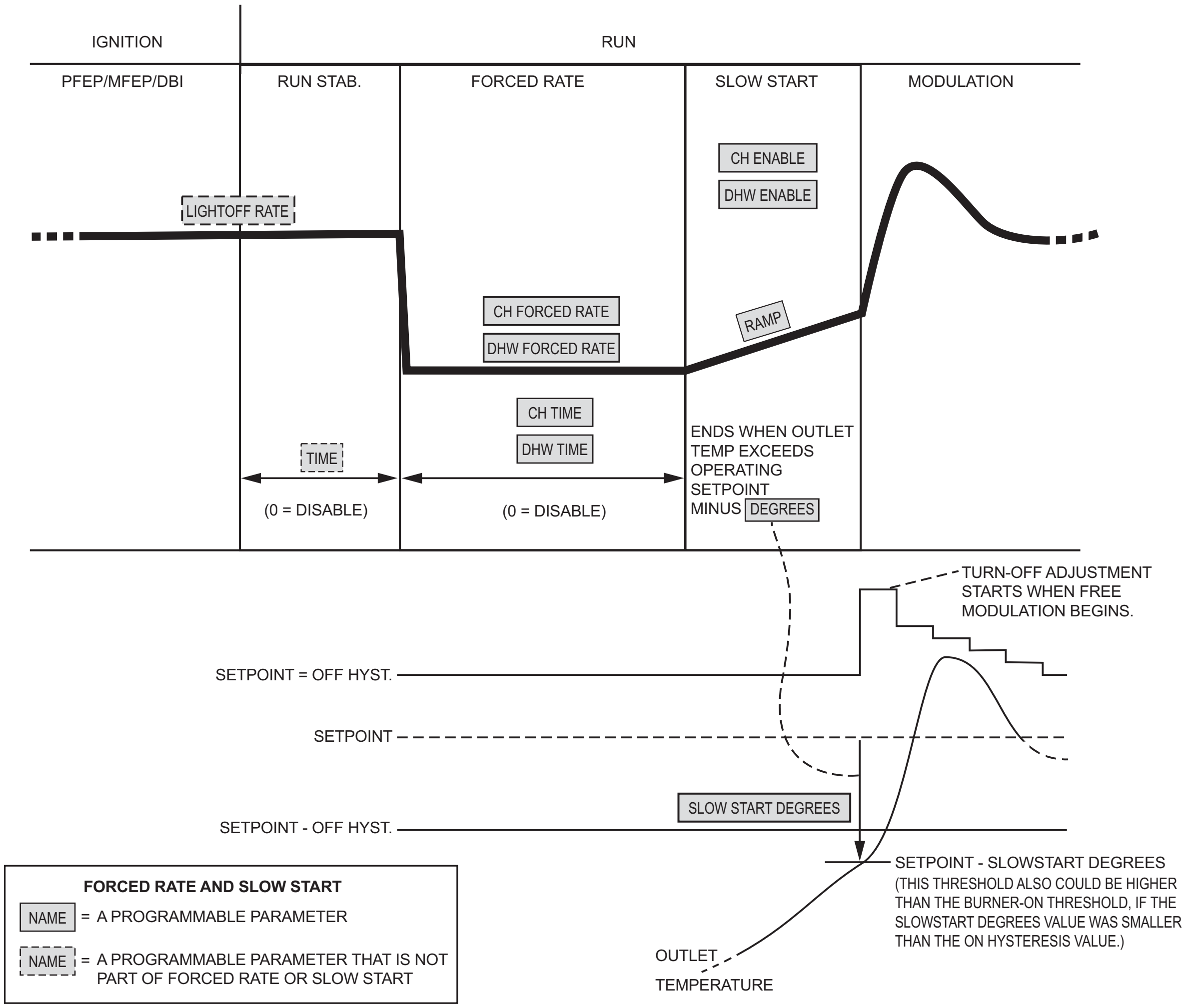


Fig. 20. Slow Start and Forced Rate limits.

Table 23. Limits and Rate Override: Slow Start Limit Parameters.

Parameter	Comment
CH forced rate time	MM:SS This parameter determines the duration of the forced rate period, when firing for CH or LL demand. If it is set to zero then this forced rate period is disabled.
CH forced rate	RPM or % This parameter provides the firing rate during the CH forced rate time. It is also the initial rate for the CH slow start period (even if the forced rate time is zero).
DHW forced rate time	MM:SS This parameter determines the duration of the forced rate period, when firing for DHW demand. If it is set to zero then this forced rate period is disabled.
DHW forced rate	RPM or % This parameter provides the firing rate during the DHW forced rate time. It is also the initial rate for the DHW slow start period (even if the DHW forced rate time is zero).

Table 23. Limits and Rate Override: Slow Start Limit Parameters. (Continued)

Parameter	Comment
CH slow start enable	Enable, Disable This parameter enables or disables the slow start limit function for CH and LL demand sources. It uses the CH forced rate parameter as the starting point for the slow start. If the forced rate parameter is invalid or zero and slow start is enabled, then the slow start function does not occur and an alert is issued.
DHW slow start enable	Enable, Disable This parameter enables or disables the slow start limit function for DHW demand source. It uses the DHW forced rate parameter as the starting point for the slow start. If this forced rate parameter is invalid or zero and slow start is enabled, then the slow start function does not occur and an alert is issued.
Slow start setpoint	Degrees or None If slow start limiting is enabled and the outlet temperature is less than the temperature provided by subtracting this number of degrees from the setpoint, then slow start rate limiting is effective. Whenever the outlet temperature is above this value, slow start limiting has no effect.
Slow start ramp	RPM or % Per Minute When slow start limiting is effective, the modulation rate will increase no more than the amount per minute given by this parameter. Although provided as a per-minute value, the Falcon will calculate and apply this as a stepped function using a step duration of 10 seconds.

DHW High Limit (Hydronic Control)

If DHW high limit enable is enabled then whenever the DHW high limit has been reached the DHW pump will be forced off. It will remain off until the DHW input temperature is lower than the DHW high limit temperature minus 5°F. The DHW high limit pump inhibit function is not a safety function.

Table 24. Limits and Rate Override: Outlet High Limit.

Parameter	Comment
DHW high limit enable	Enable, Disable This parameter enables or disables the DHW high limit function. It must be disabled when the DHW input is used as a switch to indicate DHW demand. If set to “Enable,” the DHW connector type must be 10K dual safety NTC.
DHW high limit setpoint	Degrees or None If DHW high limit enable is enabled and the DHW temperature reaches the value given by this parameter, then a response will occur.
DHW high limit response	Lockout, Recycle & Hold This parameter selects the response. If lockout is selected then the burner control locks out. If Recycle & Hold is selected then the burner control recycles and holds until the DHW temperature falls below the DHW high limit temperature minus 5°F.

Anticondensation (Hydronic Control)

The anticondensation function reduces condensation effects when the temperature is below a threshold by increasing the firing rate and optionally shutting off the pump.

Anticondensation operates only when the burner is firing, and is active only if enabled for the demand source (i.e. CH, DHW) currently controlling the burner.

The pump corresponding to that source will usually be on; however, to warm the heat exchanger more quickly, that pump may be forced off when anticondensation is active.

The anticondensation parameters are as follows:

Table 25. Anticondensation Parameters.

Parameter	Comment
CH anticondensation enable	Enable, Disable This parameter enables or disables anticondensation for CH and LL demand.
CH anticondensation setpoint	Degrees or None If CH demand anticondensation is enabled, and if CH demand or LL slave demand is in control of the burner, and the burner is firing, and if the temperature of the outlet sensor is below the temperature given by this parameter: then the anticondensation subsystem requests the burner's firing rate to be set to the rate given by the CH maximum modulation rate. Whether this succeeds or not depends on the priority of anticondensation compared to other rate-reducing limits (as described at the beginning of "Rate Limits and Override" on page 43). When the CH source sensor temperature reaches or exceeds the temperature given by this parameter plus a fixed hysteresis value or 4°F then this rate limit ends.
DHW anticondensation enable	Enable, Disable This parameter enables or disables anticondensation for the outlet sensor when the DHW loop is in control.
DHW anticondensation setpoint	Degrees or None If DHW demand anticondensation is enabled, and if DHW demand is in control of the burner, and the burner is firing, and if the temperature of the outlet sensor is below the temperature given by this parameter: • Then the anticondensation subsystem requests the burner's firing rate to be set to the rate given by DHW maximum modulation rate. Whether this succeeds or not depends on the priority of anticondensation compared to other rate-reducing limits (as described at the beginning of "Rate Limits and Override" on page 43). • When the outlet sensor temperature reaches or exceeds the temperature given by this parameter plus a fixed hysteresis value or 4°F then this rate limit ends.
Frost protection anticondensation enable	Enabled, Disabled When Frost Protection is in control, either the CH or DWH anticondensation function is enabled.
Anticondensation Priority	Anticondensation is more important than (check those that apply): Stack limit Delta T limit Slow start Forced rate Outlet high limit

Modulation Output

The modulation output subsystem uses as its input either the modulation rate provided by the Internal Demand/Rate Selector, which possibly is limited by a Rate Limit function, or it uses a fixed modulation rate indicated by the burner control, such as during prepurge or lightoff, or it uses a manual rate.

Fig. 5 in "Demand and Rate" on page 22 shows these sources. The modulation output subsystem sends a rate to one of three outputs: a fan speed control that uses a PWM output and tachometer feedback, a 4-20 mA analog signal, or a 0-10 V analog signal.

When the installer selects a fan speed system, rate parameters will be specified in RPM without regard to the burner capacity represented by a particular RPM. When one of the analog outputs is chosen, rate parameters will be specified as percentages, and in this case, the installer typically is thinking of this as a percent of burner capacity.

Common Modulation Parameters

These parameters are needed whenever any type of modulation is used.

Table 26. Modulation Output Parameters.

Parameter	Comment
Modulation output	Fan Speed, 4-20mA, 0-10V This parameter selects the type of modulation output. The Falcon software responds by driving the appropriate circuit to provide modulation of firing rate. This parameter also affects the interpretation or the type of all parameters which specify rates. These may be provided either as motor RPM or as percentage values, depending on the type of modulation output selected. A programmed value is valid only as a fan speed, or as a percent, but not both. Thus if a system is set up using fan speed values, and then the modulation output parameter is changed to select one of the analog outputs, then all of the fan speeds become “Invalid”. Similarly, parameters that were set up as percentages are invalid when interpreted as fan speeds.
Standby rate	RPM or % This parameter specifies the analog output or fan speed used during Standby. If the control is receiving commands via the LL slave module to operate at a given rate, that parameter has higher priority and this parameter is ignored. For a PWM fan system: This rate command will not run the motor. For an analog rate output system: • the output rate is 4mA or 0V Else when Standby rate is non-zero then: • the output rate is determined by the analog output mapping and the mA or V rate analog is applied to the motor.
Prepurge rate	RPM or % This parameter specifies the analog output or fan speed used during prepurge.
Lightoff rate	RPM or % This parameter specifies the analog output or fan speed used during ignition.
Firing rate control	Auto, Manual in Run, Manual in Run and Standby If this parameter is set to either of the manual options, then the burner’s firing rate during modulation in the Run state is the rate given by the Manual firing rate parameter. If the Manual in Run and Standby option is chosen, the firing rate output is also controlled by the manual firing rate parameter during the Standby condition; however this applies only to the normal, idle Standby condition and not to a Standby Hold condition, wherein the burner is preparing to fire but cannot leave standby because of something abnormal. In the latter case the rate is driven by the burner control sequencer. A manual rate does not generate demand—to fire at this rate demand must be present from another source. When set to “Auto” the manual firing rate parameter is ignored.
Manual firing rate	RPM or % This parameter specifies the analog output or fan speed during burner modulation or standby, when firing rate control specifies manual mode.
CH Maximum modulation rate DHW Maximum modulation rate Minimum modulation rate	RPM or % These parameters provide the limits of analog output or fan speed during modulation. The minimum modulation rate is the same for both CH and DHW.
Postpurge rate	RPM or % This parameter specifies the analog output or fan speed used during postpurge.

Fan Speed Modulation Parameters

These parameters are used only when fan speed is selected as the modulation output.

Table 27. Fan Speed Modulation Parameters.

Parameter	Comment
Absolute maximum fan speed	RPM The fan will never operate above the RPM provided by this parameter, regardless of the rate request. The maximum speed is 12000 RPM.
Absolute minimum fan speed	RPM The fan will never operate below the RPM provided by this parameter, regardless of the rate request, except by commanding it to turn off. The minimum speed is 500 RPM.

Table 27. Fan Speed Modulation Parameters. (Continued)

Parameter	Comment
PWM frequency	1000Hz, 2000Hz, 3000Hz, 4000Hz, This parameter provides the frequency used by the PWM output to control the fan.
Pulses per revolution	0-10 Typically is the number of sensors that the fan contains.
Fan gain up	0-100 This is the gain for speeding up the fan.
Fan gain down	0-100 This is the gain for slowing down the fan.
Speed up ramp	RPM per second Whenever the burner is firing, the fan will be commanded to increase its RPM no faster than the rate provided by this parameter.
Slow down ramp	RPM per second Whenever the burner is firing, the fan will be commanded to decrease its RPM no faster than the rate provided by this parameter.
Fan min duty cycle	duty% The fan modulation output will never send a duty cycle lower than this threshold, except for a 0% duty cycle to turn the fan off. This can be used to limit the minimum PWM to a level that prevents stalling of the fan.

Analog Modulation Parameters

These parameters are used only when 4-20mA or 0-10V is selected for modulation output.

Table 28. Fan Speed Modulation Parameters.

Parameter	Comment
Analog output hysteresis	n This parameter adjusts the amount of hysteresis applied to the PID output when a non-PWM modulation is selected. The “n” value determines how much the PID is required to change in a new direction before the output will change. This is somewhat experimental, although simulation shows this technique provides better response and also better control of motor reversals than a deadband. A typical range is 0 (disabled) to 10, although higher values are allowed. The amount of PID change required to change direction is computed as: n/10 * Pgain * P scaler Background: The granularity of temperature measurement in the Falcon is 0.1C, which is represented internally as an integer (e.g. C * 10). Thus if the temperature changes by the smallest measurable amount (e.g. 1 count), the P term of the PID output will contribute a change of 1*Pgain * P scaler, to the total PID output. The parameter thus allows some fraction of this change to be the threshold for changing direction, e.g. “n” = 5 means0.5 or half of this amount of change would be needed to change direction. If the Igain is zero then using any value of “n” less than 10 makes no difference; however when Igain is non-zero it also contributes to the PID output, so smaller amounts of hysteresis make sense. Experimentally, values of between 5 to 10 seem to work well.

PUMP CONTROL

There are six identical pump control blocks. Each has a different name but are entirely equal in features and capabilities. For example, if the block named CH Pump were configured to control the DHW pump and vice versa, and the pumps were hooked up that way, both pumps would work normally. Each can be configured for any purpose without regard to the pump name. See Fig. 21.

The pump names are:
- Boiler
- CH
- DHW
- Aux1
- Aux2
- System

Pump control blocks can operate for a local Falcon, a LL Master, or both. Some pump demands are always from the local controller, some from the LL Master and some may come from either source.

The pump overrun timers for frost protection are part of the frost protection block, instead of the pump control block.

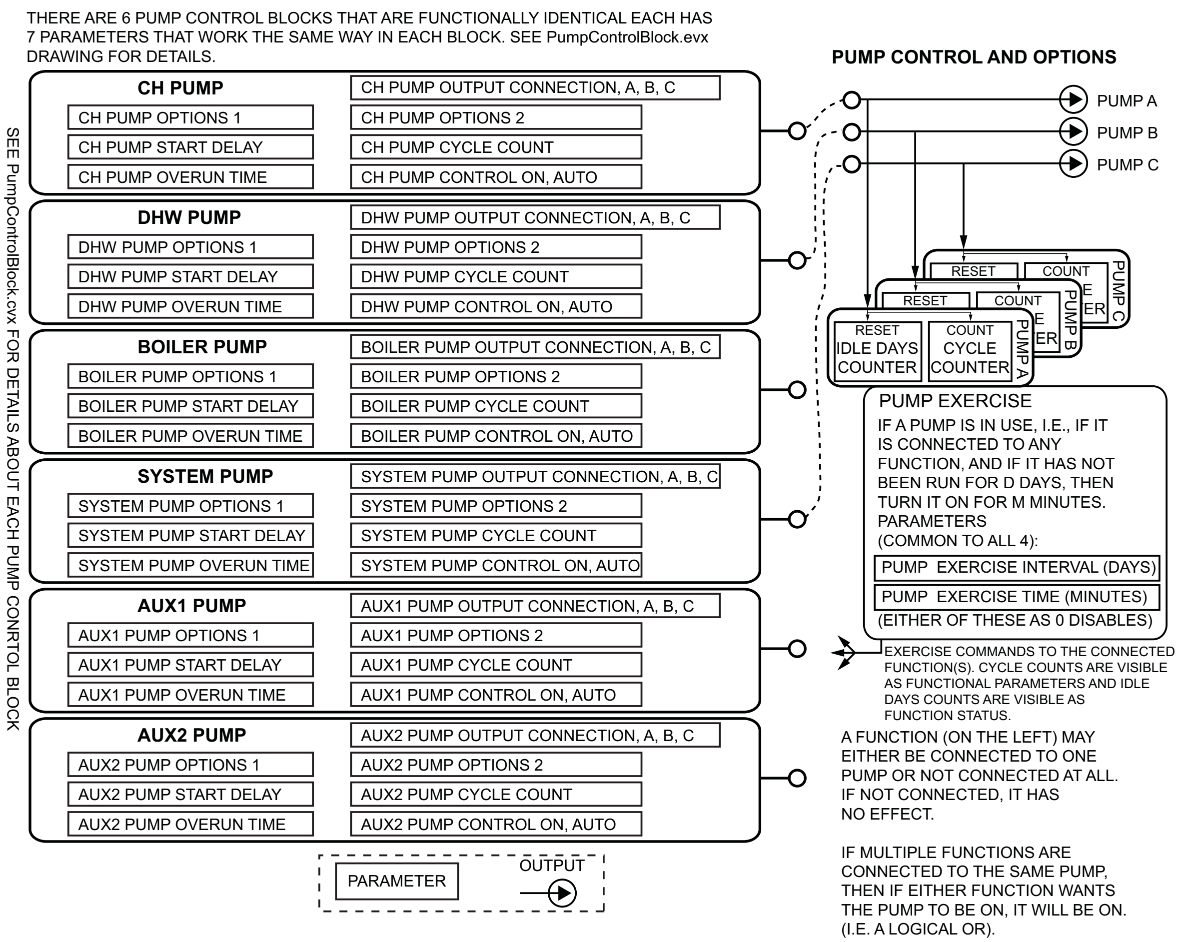


Fig. 21. Pump control blocks.

Pump Control Block Parameters

Each pump control block implements the parameters described in Table 30, where “XX” is a placeholder for any of the six pump names (CH, DHW, Boiler, System, Aux1, or Aux2).

- **Normal pump demand:** These bits are in the lower left of Fig. 22, and each of them enable or disable pump demand that flows through the start delay and overrun time, to the “On” connection of the physical device as shown in Fig. 22. This form of pump demand may be inhibited by Force Off.
- **Frost pump demand:** These bits enable or disable frost protection pump behavior, and these also flow to the “On connection and thus may be inhibited by Force Off.
- **Force Off conditions:** These bits enable or disable reasons why the pump may be forced off. The force Off conditions flow to the “Force Off” connection to the pump output block, and this signal inhibits the normal pump demand and frost pump demand, but not the Force On conditions.

- **Force On conditions:** These bits enable or disable reasons why the pump may be forced on. A force on condition flows to the "Force On" connection to the pump output block, and is not inhibited by Force Off.
- **General controls:** Two of the bits enable or disable general behavior that is not connected to the pump output block.

Fig. 22 shows how a pump control block works when connected to a pump output. The Pump On Options determine the sources that normally turn the pump on. These may be modified by an optional Start Delay and an optional Overrun Time. However, this normal pump on demand may be inhibited by the Force Off options. No matter what the normal Pump On Demand, or the Force Off conditions are requesting, there are Force On options that always turn the pump on.

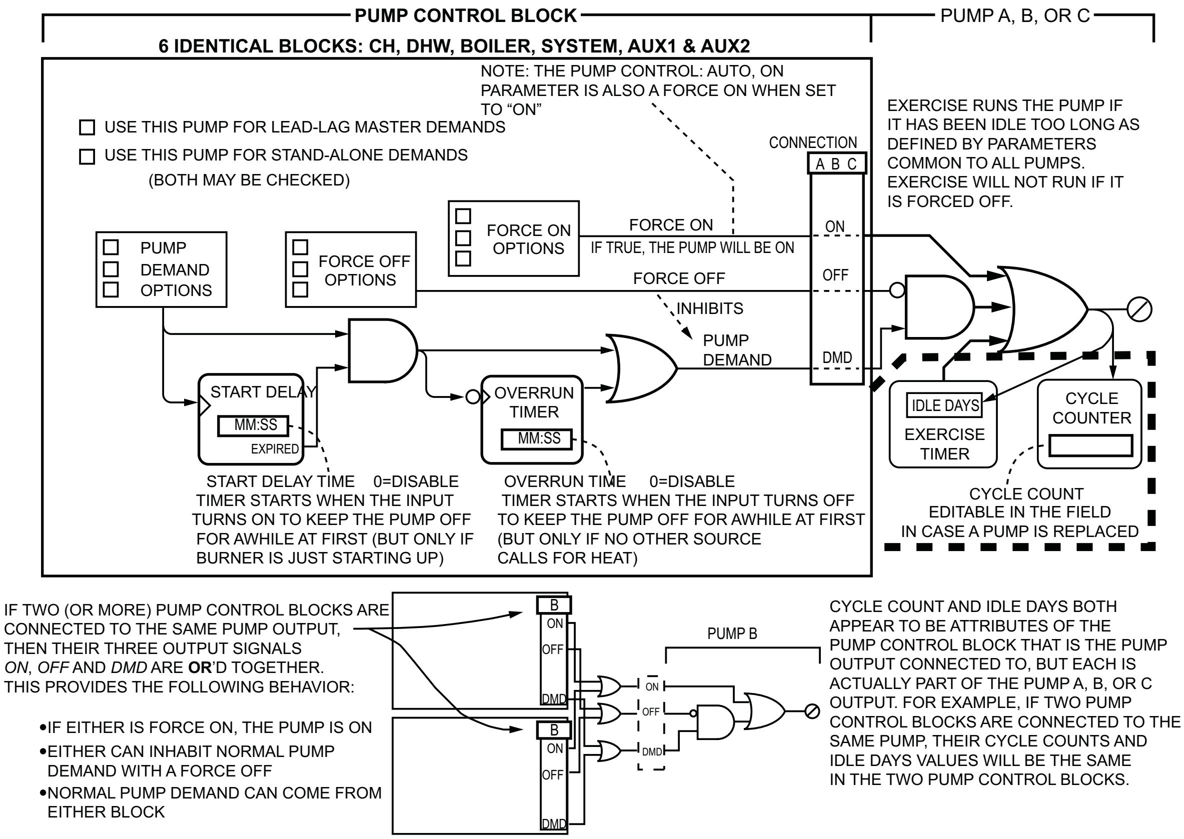


Fig. 22. Pump control block.

Table 29. Pump Control Block Parameters.

Parameter	Comment
XX pump output	None, Pump A, Pump B, Pump C This allows the XX pump function to be disconnected or to be attached to any of the pump outputs. If two pump blocks are connected to the same pump output then their signals are effectively OR'd together as shown in Fig. 22.
XX pump control	On, Auto The XX pump can be turned on manually, or it can be set to operate automatically. If it is turned on then it remains on until changed back to Auto.

Table 29. Pump Control Block Parameters. (Continued)

Parameter	Comment
XX pump start delay	mm:ss When the pump demand changes from off to on, this delay time is used to delay the start of the pump. The pump then starts after the delay expires, assuming that the demand is still present. A delay time of zero disables the delay. For a stand-alone (non-slave) Falcon, this delay is skipped and does not occur if it is already firing when the pump demand off-to-on event occurs. For a Falcon in slave mode, this delay is skipped and does not occur if the “Master Service Status” (defined in the LL specification and noted in the drawing) informs the slave unit that some slave burner in the system is already firing, when the pump demand off-to-on event occurs.
XX pump overrun time	mm:ss This time indicates how long the pump should remain on after pump demand ends. A time of zero disables the overrun. However, a pump should overrun to use up the last of the heat only if it is the last pump running. Therefore: For a stand-alone Falcon if any local service is active then this status cancels any overrun that is in-progress. For a slave Falcon if any master service is active at this time this status cancels any overrun that is in-progress.
XX pump cycles	0–999,999 The XX pump cycle counters are mapped to the physical cycle counters; there is one counter for each of the three physical pump outputs and this counter is visible via this parameter, for whichever pump block (or blocks) are connected to it via the block's XX pump output parameter. It is possible for two (or more) pump functions to be assigned to the same physical pump. In this case, that physical pump's cycle counter is visible in each pump control block. A pump cycle counter has the range 0 through 999,999 and it can be restarted if a pump is replaced.

Pump Exercising

Each of the pumps (A, B, and C) will have an exercise timer that helps to ensure that pumps do not “freeze up” due to long periods of no use. However, this is active only if the pump is attached to some function: a pump output that is not attached is not exercised.

For pumps that are attached, whenever the pump is off, a timer will measure the pump-off time. When the day counter reaches the value provided by the Pump Exercise Interval (Days) parameter, then the pump will be turned on for the time given by the Pump Exercise Time parameter.

Whenever the pump is on, for any reason, the counter is set to zero to begin a new measurement.

Table 30. Pump Exercising Parameters.

Parameter	Comment
Pump Exercise Interval (Days)	0, or N If set to zero, the exercise function is disabled. Otherwise this parameter provides the interval time between exercising the pumps. It is common to all three pump outputs (A, B, and C).
Pump Exercise Time	MM:SS If the time is zero then the exercise function is disabled. Otherwise this parameter provides the time that a pump should be on when it is exercised. It is common to all three pump outputs (A, B, and C).

Frost Protection Requests

The frost protection requests are set or cleared to match the status generated by the frost protection detection functions for each Falcon.

Firing For Local Frost Protection

This tells the LL master that although the burner is firing independently, it is doing so for frost protection and thus is still available as a lead/lag slave. This will be when 1) frost protection is controlling the Falcon per the priority scheme (which occurs only if frost protection is enabled), and 2) burner demand is true and the burner is currently firing or preparing to fire to serve that demand. Otherwise it will be clear.

Pump X, Y, and Z

The pumps of the Slave can be used by the Master control. The pump X, Y, and Z utilize the pump connections A, B, C of a specified slave.

The Burner Control Uses:

Inputs

All digital inputs are conditioned to eliminate response to spurious noise and transient events while preserving the required response.

FLAME

The flame signal includes signal conditioning, flame-on timing, and flame-off (FFRT) timing. The control responds to loss of flame and the abnormal presence of flame as defined by the equipment setup.

LOAD (OR LIMIT) CONTROL INPUT (LCI) (J6 TERMINAL 3)

The LCI typically includes all of the limits that cause a burner to hold or recycle. For burner control sequences that use it, a burner will not fire if the LCI input is off. If the LCI turns off during a burner run cycle, the system will return to standby.

INTERLOCK (ILK) (J5 TERMINAL 1)

The ILK input typically includes all of the limits that cause a burner to lock out if it turns off during a run cycle, must turn on within some seconds after demand is present during purge. An example is an airflow switch. The equipment setup will define the response to this signal.

INTERRUPTED AIR SWITCH (IAS) (J6 TERMINAL 2)

The IAS input can be used to connect an airflow switch that normally opens during the Run state at low modulation rates, and thus cannot be in the interlock circuit. The equipment setup will define the response to this signal.

PRE-IGNITION INTERLOCK (PII) (J6 TERMINAL 5)

The Pre-ignition interlock typically includes a proof of closure switch from the main valve. If it is on, then the valve is closed. The equipment setup will define the response to this signal.

HIGH FIRE PROVING SWITCH (HFS) (J7 TERMINAL 2) (DEVICE SPECIFIC)

A control may use an HFS, such as during Prepurge to prove that a damper is in the proper position or that airflow is sufficient. The equipment setup will define the response to the HFS signal.

LOW FIRE PROVING SWITCH (LFS) (J7 TERMINAL 1) (DEVICE SPECIFIC)

A control may use an LFS, such as during ignition to prove that a damper is in the proper position. The equipment setup will define the response to the LFS signal.

STAT (J8 TERMINAL 3), REMOTE STAT, AND LCI AS DEMAND INPUTS (J6 TERMINAL 3)

The presence of demand may be configured to be:

- the on condition of the Stat input
- a message from a Remote Stat
- the on condition of the LCI input
- or may be driven by the sensor status alone

The presence of demand causes pump turn-on as a primary effect, and will cause the burner control to fire only if a setpoint demand signal is also received from the subsystem, which is monitoring temperature. If burner demand exists, then the burner control will attempt to light the burner and if this succeeds, release control to the modulation source. However if a hold condition exists, then the burner control will remain in the hold condition until that condition reverts to normal. The equipment setup will define the response to demand signals.

Outputs

MODULATION OVERRIDE

The burner control will control the modulation output when the burner is off and during burner startup and shutdown by driving the modulation rate directly, overriding the normal source for modulation control, according to this table:

During	The firing rate will be set to
Standby	Lightoff rate
Prepurge	Prepurge rate
Ignition (PFEP, MFEP, DSI)	Lightoff rate
Run stabilization	Lightoff rate
Postpurge	Postpurge rate
Lockout	Lightoff rate

BLOWER MOTOR (J5 TERMINAL 6,7)

The blower output will be operated to control a blower motor: the terminal will be energized at the start of prepurge and remain on through the end of postpurge, to establish airflow for those systems that require this function.

However, when the Hot Surface Ignitor function is enabled, the terminal will be operated as an Ignition Output.

EXTERNAL IGNITION TRANSFORMER (J5 TERMINAL 4) PILOT VALVE (J5 TERMINAL 2) /MAIN VALVE (J5 TERMINAL 3) AND INTERNAL SAFETY RELAY (EXT. IGN/ PV / MV/ SR)

The burner control operates these relays and monitors their feedback to ensure that they are in the correct state. These relays provide the electrical power to energize the External Ignition Transformer, Pilot Valve and Main Valve terminals. If an output is not in its proper state, the system will respond with a lockout or recycle.

FLAME VOLTAGE (TEST JACKS)

This voltage will represent the flame strength using a 0 to 15V range, where 0.8 volts indicates the presence of flame.

Burner Control Safety Parameters (Established by the OEM)

The following parameters may be modified only by using the process for safety data described in “Commissioning” on page 18.

The parameters occur here in their order of use in a typical burner sequence.

Table 31. Burner Control Safety Parameters.

Parameter	Comment
NTC sensor type	10K dual safety, 12K single non-safety, 10K single non-safety This parameter determines whether 10K or 12K sensors are used for the Inlet, Outlet, DHW header, Stack, and Outdoor analog sensor inputs. Falcon Steam Control has Stack sensor option only. This parameter also determines whether dual sensors are used with a cross-check for the Outlet, Stack, and DHW sensors. If “10K dual safety” is chosen, these three sensors are each dual 10K sensors, and if they do not track within 6°F then recycle and hold occurs, until the sensors are tracking again.
LCI enable	Enable, Disable If the LCI input is enabled, then the control will check the LCI as a recycle limit. It must be on before the burner control will exit the Standby condition and LCI will cause a recycle if it turns off at other times. If this input is off and demand is present, the burner control will indicate that it is waiting for LCI so the Annunciator can provide a corresponding value in the Annunciator Hold parameter, for use by a display.
PII enable	Enable, Disable If the PII input is enabled, then the control will check the PII as a preignition interlock limit. (As defined by the equipment setup, it typically must be on before the burner control will exit the Standby condition.) If this input is off and the burner control is in a hold condition waiting for it to turn on, then the burner control will indicate that it is waiting for PII so that the Annunciator can provide a corresponding value in the Annunciator Hold parameter, for use by a display.
Interlock start check	Enable, Disable If the Interlock start check is enabled and the fan is off (in some cases it can be on during Standby), then the control will check the ILK input as it exits the Standby condition, in response to demand. If this input is on then the burner control will hold for 120 seconds waiting for it to turn off. If this hold time expires and the ILK is still on, then a lockout occurs.
IAS start check enable	Enable, Disable If the Interrupted Air Switch Enable parameter is set to “Disable” then this parameter is ignored. Otherwise, if the IAS start check is enabled and the fan is off (in some cases it can be on during Standby), then the control will check the IAS input as it exits the Standby condition, in response to demand. If this input is on then the burner control will hold for 120 seconds waiting for it to turn off. If this hold time expires and the IAS is still on, then a lockout occurs.
ILK/IAS open response	Lockout, Recycle During prepurge after a delay to establish airflow, and during Ignition, MFEP, and Run, the burner control requires the ILK to remain on. If it opens during Ignition, MFEP, or Run then this parameter determines the response: either a lockout or a recycle back to the Safe Start check. If recycle is selected and ILK is open during prepurge: the purge timer is set to zero and the prepurge state holds at time zero, waiting for the ILK to reclose which will resume purge timing. If this hold persists for 30 seconds then the control will go to a Standby Delay condition for 5 minutes, then try again. If the burner control is in a hold condition (but not a Standby Delay) waiting for ILK to turn on, then the burner control will indicate that it is waiting for ILK so that the Annunciator can provide a corresponding value in the Annunciator Hold parameter, for use by a display.
ILK bounce detection enable	Enable, Disable
Interrupted air switch (IAS) enable	Disable, Purge Only, Purge & Ignition This parameter determines when the IAS input is tested. If set to “Disable” then the IAS input is ignored by the burner control, and may be used as an Annunciator input. If set to “Purge Only” then IAS is monitored in the same way as the ILK input, with the same responses, during the Prepurge state. If set to “Purge & Ignition” then IAS is monitored in the same way as the ILK input, with the same responses, during the Prepurge and Ignition states. The IAS in not monitored during Run.
Prepurge time	MM:SS This parameter sets the burner control’s prepurge time. Setting this parameter to zero disables prepurge.

Table 31. Burner Control Safety Parameters. (Continued)

Parameter	Comment
Purge rate proving	None, High Fire Switch, Fan Speed This parameter determines the input used to confirm the purge rate has been reached. It is unused and ignored if the Prepurge time is set to zero. If set to None, the purge rate is commanded during prepurge but purge timing begins immediately without waiting for any feedback. If set to High Fire Switch then the HFS input must be on to prove the purge rate. Additionally, if this is selected and HFS is already on upon exit from Standby then an additional 30 second prepurge delay (indicating HFS jumpered) is enforced before the measured Prepurge time begins. If the HFS opens during purge, the burner control will react as specified by the equipment setup (typically by restarting or holding Prepurge). If set to Fan Speed then the measured fan speed must be within the specified prepurge rate, +/- 3% for 3 seconds before the rate is proven and the measured prepurge time begins. If the fan speed later goes outside of the prepurge rate +/- 10% during purge, the burner control will react as specified by the equipment setup (typically by restarting or holding Prepurge).
Lightoff rate proving	None, Low Fire Switch, Fan Speed This parameter determines the input used to confirm the rate has been reached for lighting the burner. If set to None, the lightoff rate is commanded during ignition but is not checked. If set to Low Fire Switch then the LFS input must be on to prove the lightoff rate. Additionally, if this is selected and LFS is already on upon exit from prepurge then an additional 30 second delay (indicating LFS jumpered) is enforced before the Ignition time begins. If the LFS opens during ignition, the burner control will react as specified by the equipment setup (typically by locking out). If set to Fan Speed then the measured fan speed must be within the specified lightoff rate, +/ - 3% for 3 seconds before the rate is proven and Ignition begins. If the fan speed later goes outside of the prepurge rate +/- 10% during ignition or MFEP, the burner control will react as specified by the equipment setup (typically by locking out).
Pilot type	Interrupted, Intermittent, DBI, Direct Burner Ignition Pulsed An interrupted pilot turns off at the end of the main flame establishing period (MFEP), whereas an intermittent pilot remains on during the run period and thus there is no MFEP. The third choice, DBI (direct burner ignition) indicates that there is no pilot and that the main flame is lit directly using the igniter. The ignition time is fixed at 4 seconds whenever direct burner ignition is selected.
DBI time	None, 4 sec, 10 sec, 15 sec
Flame sensor type	Flame Rod, UV, UV with Spark Interference
Forced recycle interval time	Time, None After scheduled time of continuous run, system is recycled, specifically if UV detector is used to provide Safe Start.

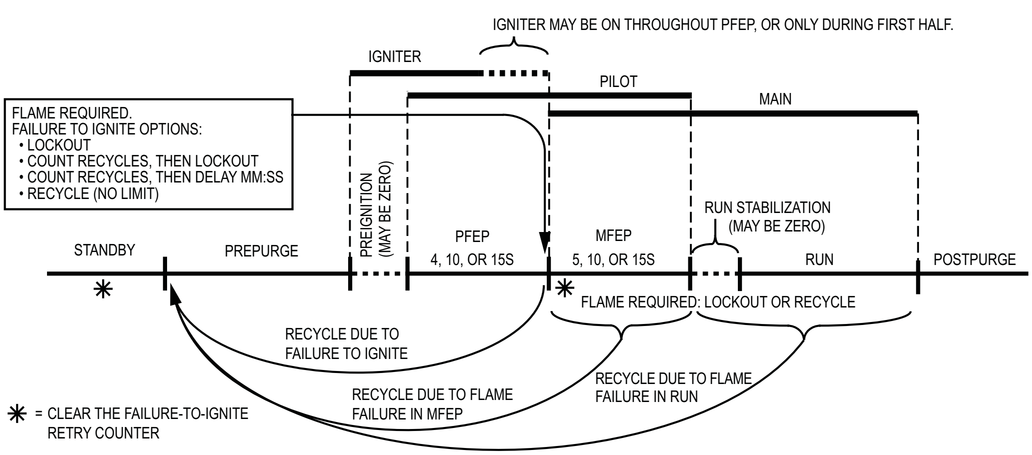


Fig. 23. Interrupted pilot.

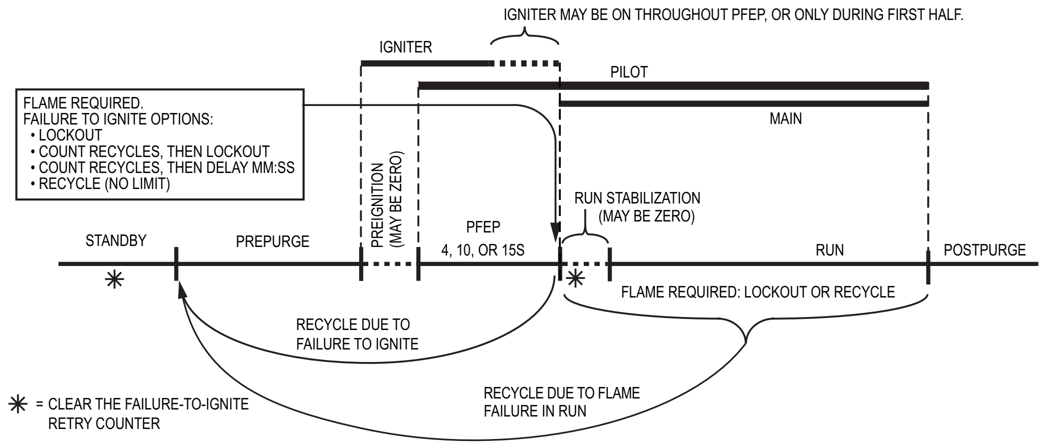


Fig. 24. Intermittent pilot.

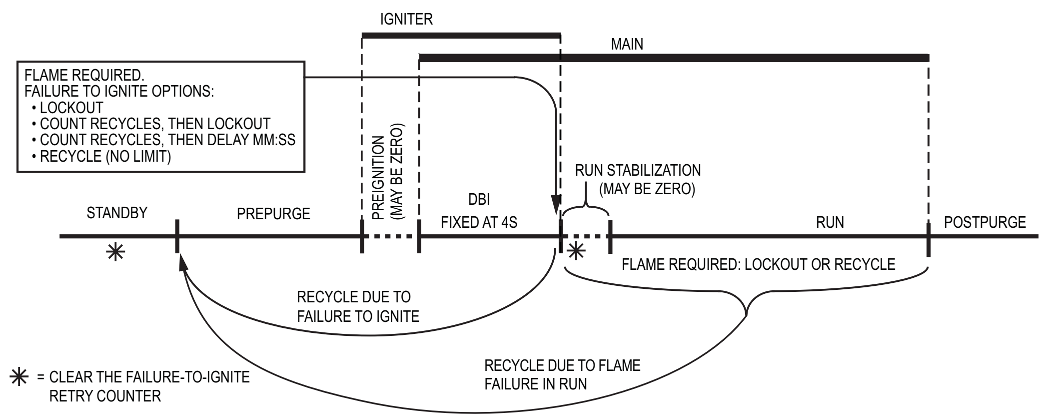


Fig. 25. Direct burner ignition

Table 31. Burner Control Safety Parameters. (Continued)

Parameter	Comment
Igniter on during	Pilot Flame Establishing Period or First half of PFEP This parameter is not needed and ignored if DBI (Direct Burner Ignition) is selected. Otherwise the igniter may be on throughout the PFEP, or only during the first half of it: • 2 seconds for a 4 second PFEP time, • 5 seconds for a 10 second PFEP time, • 7 seconds for a 15 second PFEP time. When the igniter is external, it is on continuously during the defined period. However when the igniter is selected as the internal spark generator then, during its on time as defined by this parameter, it actually is intermittently on, then off, then on, then off, with each state lasting 1/4 second. (This is done because flame cannot be sensed while the igniter is on, due to hardware limitations, so flame sense and igniter spark are done alternatetly at a 1/4 second rate.)
Pilot type	Interrupted, Intermittent, DBI, Direct Burner Ignition Pulsed
Preignition time	hr:mm:ss
Pilot flame establishing period (PFEP)	4, 10, or 15 seconds This parameter is ignored if DBI is selected. Otherwise there are three choices for the duration of PFEP: 4, 10, or 15 seconds. Flame must be on at the end of this period or a response occurs (see “Ignite failure response” on page 60).

Table 31. Burner Control Safety Parameters. (Continued)

Parameter	Comment
Main flame establishing period (MFEP)	5, 10, or 15 Seconds This parameter only appears if Pilot type is Interrupted. Three choices of the MFEP time are provided: 5, 10, or 15 seconds. Flame must remain on throughout the MFEP, otherwise a response occurs (see "MFEP flame failure response" on page 60).
Ignite failure response	Lockout, Recycle & Hold After Retries, Recycle & Lockout After Retries, Continuous Recycle If a failure to ignite is detected at the end of the Ignition period, then there are four possible responses: • Lockout • Recycle & hold after retries—the burner control recycles to the beginning of purge and counts how many times this has occurred. If the retry count has been reached, a hold occurs with the system purging. After the hold, the retry count is cleared and the burner tries (and retries) again. • Recycle & lockout after retries—the burner control recycles to the beginning of purge and counts how many times this has occurred. If the retry count has been reached, a lockout occurs. • Continuous recycle—the burner control recycles without limit. The retry counter is cleared during Standby (no demand), during the hold imposed by the retry counter, or if flame is achieved.
Ignite failure retries	3, 5 This parameter provides the number of retries, either 3 or 5.
Ignite failure delay	MM:SS When Recycle & hold after retries is selected, this parameter provides the delay time for the hold.
MFEP flame failure response	Lockout, Recycle During the MFEP state, if the flame fails there is a choice for the response. If lockout is selected, a flame failure during MFEP causes a lockout. However, if recycle is selected, the burner control shuts off the fuel and recycles back to the beginning of prepurge, then continues with the normal burner startup process (prepurge, ignition, then run) to attempt to light the burner again.
Run flame failure response	Lockout, Recycle During the Run state if flame fails then there is a choice for the response. If lockout is selected for flame failure during Run. However, if recycle is selected, the burner control shuts off the fuel and recycles back to the beginning of prepurge, then continues with the normal burner startup process (prepurge, ignition, then run) to light the burner again.
Fan speed error response	Lockout, Recycle If fan fails in Run and recycle is selected then the burner control recycles back to the beginning of Prepurge, then continues with the normal burner startup process to attempt to bring the fan up to speed again.
Pilot test hold	Enable, Disable This parameter is provided to support the pilot turndown test required by burner standards for Intermittent and Interrupted pilots. It is ignored if Pilot Type is DBI. If the Pilot type is Interrupted or Intermittent and this parameter is enabled, the burner control sequence will hold (forever) at 1 second into the Ignition state. During Pilot Test Hold, a flame-out timer always starts at zero when the Ignition state is entered, then counts up toward 15 seconds while flame is off and down toward zero when flame is on. This timer has a possible effect only during the pilot test: if it ever reaches 15 seconds of accumulated flame out time then a lockout occurs. The pilot test hold should be enabled prior to entering Ignition, since changes to parameters may require some seconds to take effect. Similarly, when the hold is disabled the burner control may remain in the hold condition for a short time.
Ignition source	Internal, External, Hot Surface Ignitor The Falcon can use either an internal spark generator, an external ignition source driven via relay contacts that are interlocked with the main valve and powered through the ILK input terminal or Hot Surface Ignitor using connector J5 (terminal 6 and 7).
Run stabilization time	MM:SS During run stabilization the modulation rate is held at the light-off rate and is released for modulation only after the hold time given by this parameter has expired. If this parameter is zero then there is no stabilization time.

Table 31. Burner Control Safety Parameters. (Continued)

Parameter	Comment
Postpurge time	0 seconds to 5 minutes (MM:SS) This parameter sets the burner control's postpurge time. Setting this parameter to zero disables postpurge.

ANNUNCIATOR

The Annunciator section monitors the status of a series string of limits, control, and interlock contacts to enhance fault and status messages.

The Annunciator's 8 inputs (A1–A8) along with the Interlock (ILK), Load (Limit) Control Input (LCI), and Pre Ignition Interlock (PII) inputs, provide a total of 11 monitored contact components.

The Annunciator function is defined by a specific model number.

Each Annunciator input has three parameters:

- **Long Name:** 20 characters long; name is displayed when viewing the Annunciator status from a system display like the 833-3577.
- **Short Name:** 3 characters long; used for status viewing by more limited local displays, like the 833-3725. The short name can also be used as part of a lockout or hold message.
- **Location:** Each Annunciator terminal location may be designated:
    - **LCI:** Monitors a series of wired devices for load/limit control.
    - **ILK:** Monitors a series of wired devices in the interlock string.
    - **PII:** Typically a closed indicator switch (pre-ignition interlock or also called a proof of closure switch) located on a gas valve (but may include other devices).
    - **Unused:** not used
    - **Other:** Used to Monitor a circuit, not related to any of the above.

The input terminal names (Interlock [ILK], Load [Limit] Control Input [LCI], Pre Ignition Interlock [PII]) can be renamed with a long (20 character) and short (3 character) name that better describes their purpose.

Three Annunciator terminals may already be assigned functions based on the system parameter setup:

- **A1:** Will be Interrupted Air Switch (IAS) if the parameter is enabled.
- **A7:** Will be High Fire Switch (HFS) if the parameter for Purge Rate Proving parameter is enabled
- **A8:** Will be Low Fire Switch (LFS) if Lightoff Rate Proving parameter is enabled.

CHECKOUT

Open equipment Control, Limits, and/or Interlock inputs. Check that the Falcon reacts as programmed and annunciates the point status properly.

Important: Restore ALL Controls, Limits, and Interlock inputs altered above to proper operation.

DO NOT place jumpers wires across the installation controls, limits and interlocks.

Annunciator Example

Fig. 26 is an example of wiring to the Annunciator terminals and names that have been assigned for this example.

Note that the assigned terminals (LCI, ILK, and PII) are the last interlocks in their category.

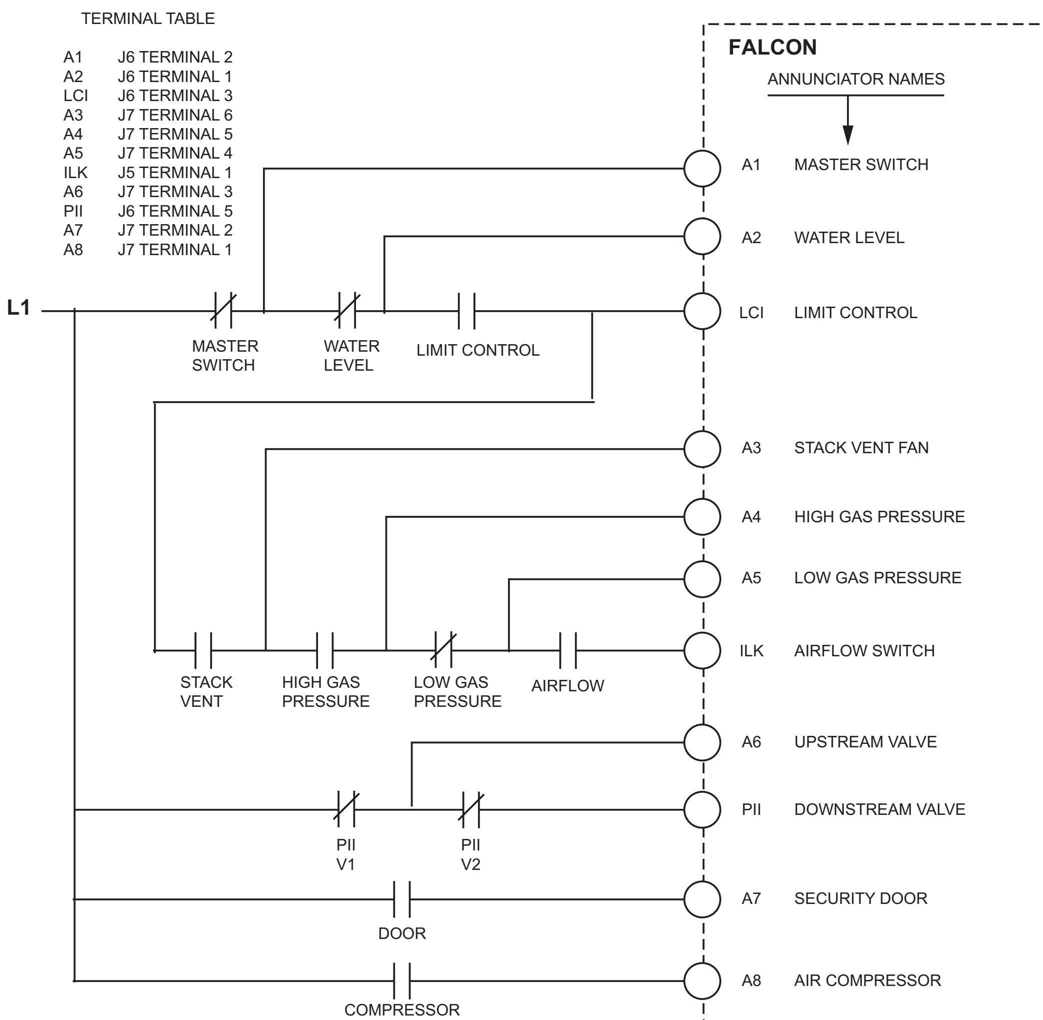


Fig. 26. Example of annunciator inputs and terminal names.

Sorting

Annunciator items are sorted first by their category assignment. The category order is:

LCI, ILK, PII, Other (Unused items appearing in the Other category)

Within the category, inputs are sorted by the input identifier (A1–A8), with the additional rule that LCI (if enabled) is last in the LCI category, ILK last in the ILK category, and PII (if enabled) is last in the PII category.

Viewing the System Display using the “programmable” annunciator display in this case would resemble Fig. 27.

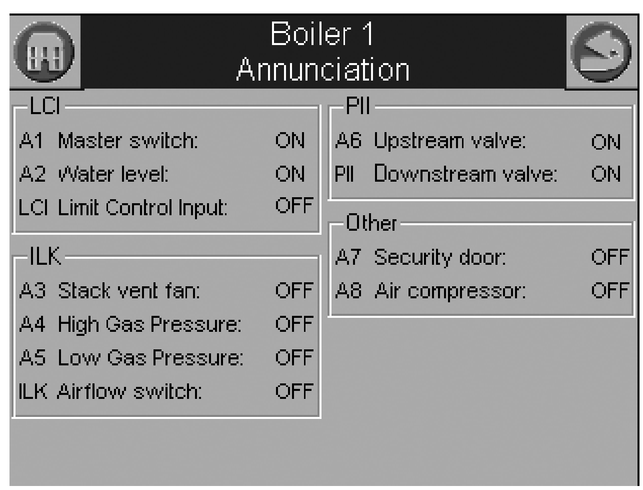


Fig. 27. Annunciator display.

If A7 is defined as a HFS input, then the parameter that calls it a “Security door” would be ignored and the automatic value (High Fire Switch) is used instead (the same would be true for the A8 LFS and A1 IAS).

FAULT HANDLING

Lockouts and Alerts

The Falcon implements two kinds of faults: lockouts and alerts.

A list of fault codes with possible troubleshooting tips is provided in Table 50 on page 105.

A list of alerts is provided in Table 51 on page 113.

LOCKOUT

- A lockout causes the boiler control to shutdown and requires manual or remote reset to clear the lockout.
- Always causes alarm contacts to close.
- Logged in lockout history.

ALERT

- Every other kind of problem that isn't a lockout is an alert. Examples include boiler control abnormal holds, LL master problems, faults from non-safety functions, etc.
- Alerts never require manual intervention to reset them; that is, if the alert clears up, then normal operation will continue. An alert is not a condition, it is an event. The cause of the alert may be a condition, e.g. something that is causing an abnormal hold, but the alert itself in this case is a momentary event generated upon entry to that condition.
- Whether the alarm contact closes or not is programmable for each alert by the OEM.
- Alerts are logged in a 15-item volatile alert history sorted in chronological order. Only one instance of each alert code occurs in the history, corresponding to the most recent occurrence of that alert.

Alarms for Alerts

The Alarm Parameter Control Block (see the section above) determines which alerts will cause an alarm (by closing the alarm contacts) and which will be reported silently.

Thus an alarm might be on because of a lockout or an alert. If the cause is a lockout then the alarm contacts remain close until the lockout is cleared. However, for alarms due to alerts (which may recur) the alarm may be silenced for a period of time (0–600 minutes) by specifying it in the Alarm Silence Time parameter.

BURNER CONTROL OPERATION

Safety Shutdown of Burner Control Functions

Safety Shutdown (Lockout) occurs if any of the following occur during the indicated period:

1. INITIATE Period:
   a. A/C line power errors occurred.
   b. Four minute INITIATE period has been exceeded.
2. STANDBY Period:
   a. Flame signal is present after 240 seconds.
   b. Preignition Interlock is open an accumulative time of 30 seconds.
   c. Interlock Start check feature is enabled and the Interlock String (including Airflow Switch) is closed for 120 seconds with the controller closed. (jumpered or welded Interlock).
   d. Pilot Valve Terminal is energized.
   e. Main Valve Terminal is energized.
   f. Internal system fault occurred.
3. PREPURGE Period:
   a. Preignition Interlock opens anytime during PREPURGE period.
   b. Flame signal is detected for 10 seconds accumulated time during PREPURGE.
   c. Purge Rate Fan RPM or High Fire Switch fails to close within four minutes and fifteen seconds after the firing rate motor is commanded to drive to the high fire position at the start of PREPURGE.
   d. Light off Rate Fan RPM or Low Fire Switch fails to close within four minutes and fifteen seconds after the firing rate motor is commanded to drive to the low fire position at the end of PREPURGE.
   e. Lockout Interlock (if programmed) does not close within 10 seconds.
   f. Lockout Interlock opens during PREPURGE.
   g. Pilot Valve terminal is energized.
   h. Main Valve terminal is energized.
   i. Internal system fault occurred.
4. PRE-IGNITION TIME
   a. Lockout Interlock opens.
   b. IAS Purge and Ignition enabled and the Interlock opens.
   c. Preignition Interlock opens.
   d. Pilot Valve terminal is energized.
   e. Main Valve terminal is energized.
5. PILOT FLAME ESTABLISHING PERIOD (PFEP)
   a. Low Fire Switch opens (if enabled).
   b. Lockout Interlock opens (if enabled).
   c. Pilot Valve terminal is not energized.
   d. No flame is present at the end of the PFEP, or after programmed number of retry attempts.
   e. Main valve terminal is energized.
   f. Internal system fault occurred.
6. MAIN FLAME ESTABLISHING PERIOD (MFEP).
   a. Low Fire Switch opens (if enabled).
   b. Lockout Interlock opens (if enabled).
   c. Pilot valve terminal is not energized.
   d. Main valve terminal is not energized.
   e. No flame present at the end of MFEP.
   f. Internal system fault occurred.
7. RUN Period:
   a. No flame is present, or flame is lost (if enabled-lockout).
   b. Lockout Interlock opens) if enabled).
   c. IAS Purge and Ignition enabled and the Interlock opens.
   d. Pilot terminal energized (if programmed as Interrupted Pilot).
   e. Main valve terminal is not energized.
   f. Internal system fault occurred.
8. POSTPURGE Period.
   a. Preignition Interlock does not close in five seconds.
   b. Pilot Valve terminal is energized.
   c. Main Valve terminal is energized.
   d. Internal system fault occurred.
   e. Flame sensed 240 seconds accumulated time after the RUN period.

Safety Shutdown

1. If the lockout interlocks open or a sensor designated as a safety limit are read as defective, Falcon will lockout and the blower motor will be de-energized.

   If these open during the firing period, all fuel valves will be de-energized, the system will complete postpurge, and will lockout indicated by an alarm.
2. If the pilot flame is not detected by the end of the last (X number recycle attempt), pilot trial for ignition period, the pilot valve, and ignition transformer will be de-energized, the system will complete post purge and will lockout indicated by an alarm.
3. If the main flame is not detected at the end of the last recycle attempt of the main flame establishing period, all fuel valves will be de-energized, the device will complete postpurge, and will lockout indicated by an alarm.
4. If the flame sensing signal is lost during the run period (if lockout is selected), all fuel valves will be de-energized within 4 seconds after the loss of the flame signal, the device will complete postpurge, and will lockout indicate by an alarm.
5. Manual reset is required following any safety shutdown. Manual reset may be accomplished by pressing the push button on the device, pressing the remote reset wired into connector J10, or through an attached display.

   Interrupting power to Falcon will cause electrical resets, but does not reset a lockout condition.

Operational Sequence

Initiate

The Falcon enters the Initiate sequence on Initial Power up or:
- Voltage fluctuations vary less than 20Vac or greater than 30Vac.
- Frequency fluctuations vary +/-5% (57 to 63 Hz).
- If Demand, LCI, or Stat interrupt (open) during the Prepurge Period.
- After the reset button is pressed or fault is cleared at the displays.

The Initiate sequence also delays the burner motor from being energized and de-energized from an intermittent AC line input or control input.

If an AC problem exists for more than 240 seconds a lockout will occur.

Central Heating

Start-up sequence central heating request (system in standby):

1. Heat request detected (On Setpoint - On Hysteresis).
2. The CH pump is switched on.
3. After a system Safe Start Check, the Blower (fan) is switched on after a dynamic ILK switch test (if enabled).
4. After the ILK switch is closed and the purge rate proving fan RPM is achieved (or High Fire Switch is closed) - prepurge time is started.
5. When the purge time is complete, the purge fan RPM is changed to the Lightoff Rate or if used, the damper motor is driven to the Low Fire Position.
6. As soon as the fan-rpm is equal to the light-off rpm (or the Low Fire Switch closes), the Trial for Ignition or Pre-Ignition Time is started (depending on configuration).
7. Pre-Ignition Time will energize the ignitor and check for flame.
8. Trial for Ignition. Fig. 23–25 on page 59 shows three ignition options. Specifics for timings and device actions are defined by the OEM or installer.
9. The ignition and the gas valve are switched on.
10. The ignition is turned off at the end of the direct burner ignition period, or for a system that does use a pilot, at the end (or optionally at the middle) of the Pilot Flame Establishing Period (PFEP). For an interrupted pilot system this is followed by a Main Flame Establishing Period (MFEP) where the pilot ignites the main burner. For an intermittent pilot there is no MFEP.
11. The fan is kept at the lightoff rate during the stabilization timer, if any.
12. Before the release to modulation, the fan is switched to minimum RPM for the CH Forced Rate and Slow Start Enable, if the water is colder than the threshold.
13. At the end of the CH-heat request the burner is switched off and the fan stays on until post purge is complete.
14. A new CH-request is blocked for the forced off time set by the Anti Short Cycle (if enabled).
15. The pump stays on during the pump overrun time (if enabled).
16. At the end of the pump overrun time the pump will be switched off.

Domestic Hot Water

Start-up sequence DHW-request (system in standby):

1. Heat request detected (either DHW Sensor Only, DHW Sensor and Remote Command or DHW Switch and Inlet Sensor, whichever applies).
2. The pump is switched on (after the DHW Pump Start Delay).
3. After a system Safe Start Check, the Blower (fan) is switched on after a dynamic ILK switch test (if enabled).
4. After the ILK switch is closed and the purge rate proving fan RPM is achieved (or High Fire Switch is closed) - prepurge time is started.
5. When the purge time is complete, the purge fan RPM is changed to the Lightoff Rate or if used, the damper motor is driven to the Low Fire Position.
6. As soon as the fan-rpm is equal to the light-off rpm (or the Low Fire Switch closes), the Trial for Ignition or Pre-Ignition Time is started (depending on configuration).
7. Pre-Ignition Time will energize the ignitor and check for flame.
8. Trial for Ignition. Fig. 23–25 on page 59 shows three ignition options. Specifics for timings and device actions are defined by the OEM or installer.
9. The ignition and the gas valve are switched on.
10. The ignition is turned off at the end of the direct burner ignition period, or for a system that does use a pilot, at the end (or optionally at the middle) of the Pilot Flame Establishing Period (PFEP). For an interrupted pilot system this is followed by a Main Flame Establishing Period (MFEP) where the pilot ignites the main burner. For an intermittent pilot there is no MFEP.
11. The fan is kept at the lightoff rate during the stabilization timer, if any.
12. Before the release to modulation, the fan is switched to minimum RPM for the DHW Forced Rate and Slow Start Enable, if the water is colder than the threshold.
13. At the end of the DHW-heat request the burner is switched off and the fan stays on until post purge is complete.
14. A new DHW-request is blocked for the forced off time set by the Anti Short Cycle (if enabled).
15. The pump stays on during the pump overrun time (if enabled).
16. At the end of the pump overrun time the pump will be switched off.

SYSTEM CHECKOUT

This section provides general checkout and troubleshooting procedures for the Primary Safety function of Falcon devices.

⚠ WARNING

Explosion Hazard.
Can cause serious injury or death.
Do not allow fuel to accumulate in the combustion chamber for longer than a few seconds without igniting, to prevent danger of forming explosive mixture. Close manual fuel shutoff valve(s) if flame is not burning at end of specified time.

⚠ WARNING

Electric Shock Hazard.
Can cause serious injury or death.
Use extreme care while testing system. Line voltage is present on most terminal connections when power is on.

Open master switch before removing or installing the Falcon device or Display Module connector.

Make sure all manual fuel shutoff valves are closed before starting initial lightoff check and Pilot Turndown tests.

Do not put the system in service until you have satisfactorily completed all applicable tests in this section and any others recommended by the original equipment manufacturer.

Limit trial for pilot to 10 seconds. Limit the attempt to light main burner to 2 seconds after the fuel reaches burner nozzle. Do not exceed manufacturer’s nominal lightoff time.

⚠ CAUTION

Equipment Malfunction or Damage Hazard.
Each device type is unique. Using existing wiring on a module change can cause equipment damage. Make wiring changes when a module is replaced with a different Falcon device to sequence burner.

IMPORTANT

1. If the system fails to perform properly, note the fault code, fault message, equipment status, and sequence time on the display. Then refer to the Fault Code section in this manual.

2. Repeat all required Checkout tests after all adjustments are made. All tests must be satisfied with the flame detector(s) in their final position.

Equipment Recommended

- 833-3577 Display/Operator Interface Module.
- Volt-ohmmeter (1M ohm/volt minimum sensitivity) with: 0-300 Vac capability. 0-6000 ohm capability. 0-10 Vdc capability.

Checkout Summary

Table 1 provides an overview of checkout steps performed for each applicable system.

See the product data sheet for location of component parts terminal locations.

Table 32. Checkout steps and applicable systems.

Checkout Step	Piloted Systems	DSI Systems	Flame Rod Systems	Ultraviolet Flame Detectors
Preliminary Inspection	X	X	X	X
Flame Signal Measurement	X	X	X	X
Initial Lightoff Check for Proved Pilot	X			
Initial Lightoff Check for Direct Spark Ignition		X		
Pilot Turndown Test	X			
Ignition Interference Test			X	
Hot Refractory Hold-in Test				X
Ignition Spark Pickup				X
Response to Other Ultraviolet Sources				X
Flame Signal with Hot Combustion Chamber	X	X	X	X
Safety Shutdown Tests	X	X	X	X

Preliminary Inspection

Perform the following inspections to avoid common problems. Make certain that:

1. Wiring connections are correct and all screws are tight.
2. Flame detector(s) is clean, installed and positioned properly. Consult the applicable Instructions.
3. Combination connector J1 wiring and flame detector(s) are correctly used. See product data sheet for wiring.
4. Burner is completely installed and ready to fire; consult equipment manufacturer's instructions. Fuel lines are purged of air.
5. Combustion chamber and flues are clear of fuel and fuel vapor.
6. Power is connected to the system disconnect switch (master switch).
7. Lockout is reset (reset button) only if the Falcon unit is powered.
8. System is in STANDBY condition. STANDBY message is displayed on the 833-3577 Falcon Display.
9. All limits and interlocks are reset.

Flame Signal Measurement

Install a DC voltmeter in the Falcon test jacks. Observe polarity when connecting meter leads.

INITIAL LIGHTOFF CHECKS

Proved Pilot Systems

Perform this check on all installations that use a pilot. It should immediately follow the preliminary inspection.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this check.

1. Open the master switch.
2. Make sure that the manual main fuel shutoff valve(s) is closed. Open the manual pilot shutoff valve. If the pilot takeoff is downstream from the manual main fuel shutoff valve(s), slightly open the manual main valve to supply pilot gas flow. Make sure the main fuel is shut off just upstream from the burner inlet, or disconnect power from the automatic main fuel valve(s).
3. Close the master switch and start the system with a call for heat by raising the setpoint of the operating controller; see the operating sequence. The Falcon should start the INITIATE sequence.
4. Let the sequence advance to PILOT IGN (status is displayed on the 833-3577 Display/Operator Interface, if used). The PILOT valve energizes, ignition spark should occur, and the pilot flame should light. If the pilot ignites, the FLAME LED is energized. Go to step 7.
5. If the pilot flame is not established during the PFEP (pilot flame establishing period), safety shutdown occurs. Let the sequence complete its cycle.
6. Push the reset pushbutton and let the system recycle once. If the pilot flame still does not ignite, make the following ignition/pilot adjustments:

EXTERNAL IGNITION SOURCE

a. Open the master switch and remove the Falcon connector J5.
b. Ensure that both the manual pilot shutoff valve and the manual main shutoff valves are closed.
c. On connector J5, jumper power to the ignition terminal J5 terminal 4. Disconnect the leadwire to the pilot valve if it is connected to the same terminal.
d. Close the master switch to energize only the ignition transformer.
e. If the ignition spark is not strong and continuous, open the master switch and adjust the ignition electrode spark gap setting to the manufacturer's recommendation.
f. Make sure the ignition electrodes are clean.
g. Close the master switch and observe the spark.
h. After a continuous spark is obtained, open the master switch and add a jumper on the Connector J5 terminal 2 or reconnect the pilot valve lead wire if it was disconnected in step b.
i. Open the manual pilot shutoff valve.
j. Close the master switch to energize both the ignition transformer and the pilot valve.

k. If the pilot flame does not ignite and if the ignition spark is still continuous, adjust the pilot gas pressure regulator until a pilot flame is established.
l. When the pilot flame ignites properly and stays ignited, open the master switch and remove the jumper(s) from the J5 terminals.
m. Check for adequate bleeding of the fuel line.
n. Reinstall the J5 connector onto the Falcon module, close the master switch and return to step 4.

INTERNAL IGNITION SOURCE

To check the internal ignition, the Falcon controller will need to be cycled:

a. Open the master switch and remove connector J5.
b. Ensure both the manual pilot shutoff valve and the manual main fuel shutoff valves are closed.
c. Cycle the Falcon controller and observe the ignition spark. (To provide a longer ignition period, additional time can be added to the pre-ignition time parameter.)
d. If the ignition spark is not strong and continuous, open the master switch and adjust the ignition electrodes spark gap setting to the manufacturer's recommendation
e. Make sure that the ignition electrodes are clean.
f. Close the master switch and cycle the controller and observe the spark.
g. After obtaining a strong spark, open the master switch, remove the main valve wire from connector J5 terminal 3 and re-install connector J5 to the controller.
h. Open the manual pilot shutoff valve.
i. Close the master switch and change the pre-ignition time parameter back to the original value if you changed it in step C.
j. Cycle the controller to energize both the ignition transformer and the pilot valve.
k. If the pilot flame does not ignite and if the ignition spark is still continuous, adjust the pilot gas pressure regulator until a pilot flame is established.
l. When the pilot flame ignites properly and stays ignited, open the master switch and reconnect the main valve to the connector J5 terminal 3 (if removed in step g).
m. Close the master switch and return to Step 4.

7. When the pilot flame ignites, measure the flame signal. If the pilot flame signal is unsteady or approaching the flame threshold value (see flame threshold parameter), adjust the pilot flame size or detector sighting to provide a maximum and steady flame signal.
8. Recycle the system to recheck lightoff and pilot flame signal.
9. When the MAIN Valve energizes, make sure the automatic main fuel valve is open; then smoothly open the manual main fuel shutoff valve(s) and watch for main burner flame ignition. When the main burner flame is established, go to step 16.
10. If the main burner flame is not established within 5 seconds or the normal lightoff time specified by the equipment manufacturer, close the manual main fuel shutoff valve(s).
11. Recycle the system to recheck the lightoff and pilot flame signal.
12. Smoothly open the manual fuel shutoff valve(s) and try lightoff again. (The first attempt may have been required to purge the lines and bring sufficient fuel to the burner.)
13. If the main burner flame is not established within 5 seconds or the normal lightoff time specified by the equipment manufacturer, close the manual main fuel shutoff valve(s). Check all burner adjustments.
14. If the main burner flame is not established after two attempts:
   a. Check for improper pilot flame size.
   b. Check for excess combustion air at low fire.
   c. Check for adequate low fire fuel flow.
   d. Check for proper gas supply pressure.
   e. Check for proper valve operation.
   f. Check for proper pilot flame positioning.
15. Repeat steps 8 and 9 to establish the main burner flame; then go to step 16.
16. With the sequence in RUN, make burner adjustments for flame stability and Btu input rating.
17. Shut down the system by opening the burner switch or by lowering the setpoint of the operating controller. Make sure the main flame goes out. There may be a delay due to gas trapped between the valve(s) and burner. Make sure all automatic fuel valve(s) close.
18. Restart the system by closing the burner switch and/or raising the setpoint of the operating controller. Observe that the pilot flame is established during PILOT IGN and the main burner flame is established during MAIN IGN within the normal lightoff time.
19. Measure the flame signal. Continue to check for the proper flame signal through the RUN period. Check the flame signal at both High and Low Firing Rate positions and while modulating, if applicable.
20. Run the burner through another sequence, observing the flame signal for:
   a. Pilot flame alone.
   b. Pilot and main flame together.
   c. Main flame alone (unless monitoring an intermittent pilot). Also observe the time it takes to light the main flame. Ignition of main flame should be smooth.
21. Make sure all readings are in the required ranges before proceeding.
22. Return the system to normal operation.

NOTE: After completing these tests, open the master switch and remove all test jumpers from the connector terminals, limits/controls or switches.

Direct Burner Ignition (DBI) Systems

This check applies to gas and oil burners not using a pilot. It should immediately follow the preliminary inspection. Refer to the appropriate sample block diagram of field wiring for the ignition transformer and fuel valve(s) hookup.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this check.

1. Open the master switch.
2. Complete the normal ready-to-fire checkout of the fuel supply and equipment as recommended by the equipment manufacturer.
3. Close all manual main fuel shutoff valve(s). Check that the automatic fuel valve(s) is closed. Make sure fuel is not entering the combustion chamber.
4. Close the master switch and start the system with a call for heat by raising the setpoint of the operating controller; see Falcon module sequencing. The program sequence should start the INITIATE sequence.
5. Let the sequence advance through PREPURGE (if applicable). Ignition spark should turn on during the ignition trial period. Listen for the click of the fuel solenoid valve(s). The Falcon module locks out and the ALARM LED turns on.
6. Let the Falcon module complete its cycle.
7. Open the manual fuel shutoff valve(s).
8. Push the reset button and the module recycles the program sequence through PREPURGE (if applicable).

9. When the fuel valve turns on during the ignition period, make sure that the main burner flame is established. If it is, go to step 14.
10. If the main burner flame is not established within 4 seconds or within the normal lightoff time specified by the equipment manufacturer, close the manual fuel shutoff valve(s), and open the master switch.
11. Wait about three minutes. Close the master switch, open the manual fuel shutoff valve(s), and try to lightoff the burner again. The first attempt may be required to purge the lines and bring sufficient fuel to the burner. If it is not established on the second attempt, proceed to step 13.
12. Check all burner adjustments.
13. Make the following ignition and main burner adjustments:

INTERNAL IGNITION SOURCE

To check the internal ignition, the controller will need to be cycled:

a. Open the master switch and remove connector J5.
b. Ensure both the manual main valve shutoff valve and the manual main fuel shutoff valves are closed.
c. Cycle the controller and observe the ignition spark. (To provide a longer ignition period, additional time can be added to the pre-ignition time parameter.)
d. If the ignition spark is not strong and continuous, open the master switch and adjust the ignition electrodes spark gap setting to the manufacturer's recommendation.
e. Make sure the ignition electrodes are clean.
f. Close the master switch and cycle the controller and observe the spark.
g. After obtaining a strong spark, open the master switch, re-install connector J5 to the controller.
h. Open the manual main valve shutoff valve.
i. Close the master switch and change the pre-ignition time parameter back to the original value if you changed it in step C.
j. Cycle the controller to energize both the ignition transformer and the main fuel valve.
k. If the main flame does not ignite and if the ignition spark is still continuous, adjust the main burner gas pressure regulator until a main flame is established.
l. Check the main flame signal and ensure it is above the threshold level and within the manufacturer's recommendation.
m. Return to Step 8.

EXTERNAL IGNITION SOURCE

a. Open the master switch and remove the Falcon module connector J5.
b. Ensure that the manual main burner fuel shutoff valve is closed.
c. On connector J5, jumper power to the ignition terminal, J5 terminal 4.
d. Close the master switch to energize only the ignition source.
e. If the ignition spark is not strong and continuous, open the master switch and adjust the ignition electrode spark gap to the manufacturer's recommendation.
f. Make sure electrodes are clean.
g. Close the master switch and observe the spark.
h. After obtaining a strong and continuous spark, open the master switch; remove the jumper between power and J5 terminal 4. Re-install the connector J5 to the controller.
i. Open the manual main burner fuel shutoff valve.
j. Close the master switch.
k. Cycle the controller to energize both the ignition source and the main fuel valve.
l. If the main flame does not ignite and if the ignition spark is still continuous, adjust the main burner gas pressure regulator until a main flame is established.
m. Check the main flame signal and insure it is above the threshold level and within the manufacture's recommendations.
n. Return to step 8.

14. When the main burner flame is established, the sequence advances to RUN. Make burner adjustments for flame stability and input rating.
15. Shut down the system by opening the burner switch or by lowering the setpoint of the operating controller. Make sure the burner flame goes out and all automatic fuel valves close.
16. If used, remove the bypass jumpers from the low fuel pressure limit.
17. Restart the system by closing the burner switch and/or raising the setpoint of the operating controller. Observe that the main burner flame is established during Main Ignition, within the normal lightoff time specified by the equipment manufacturer.
18. Measure the flame signal. Continue to check for the proper signal through the RUN period. Check the signal at both high and low firing rate positions and while modulating. Any pulsating or unsteady readings require further attention.
19. Make sure all readings are in the required ranges before proceeding.

NOTE: On completing these tests, open the master switch and remove all test jumpers, limits/controls or switches.

20. Return the system to normal operation.

PILOT TURNDOWN TEST (ALL INSTALLATIONS USING A PILOT)

Perform this check on all installations that use a pilot. The purpose of this test is to verify that the main burner can be lit by the smallest pilot flame that can hold in the flame amplifier and energize the FLAME LED. Clean the flame detector(s) to make sure that it detects the smallest acceptable pilot flame.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this test.

1. Open the master switch.
2. Close the manual main fuel shutoff valve(s).
3. Connect a manometer (or pressure gauge) to measure pilot gas pressure during the turndown test.
4. Open the manual pilot shutoff valve(s).
5. Close the master switch
   — Go to the 833-3577 Display/Operator Interface.
   — Select Diagnostics Test button at the bottom of the display.
   — Select Diagnostics test button at the bottom of this new screen.
   — Select Pilot Test at the bottom of this new screen.
   — Select Start Test at the bottom of this screen.
6. Start the system with a call for heat. Raise the setpoint of the operating controller. The Falcon sequence should start, and PREPURGE (if applicable) should begin. The sequence will hold in the pilot flame establishing period and the FLAME LED comes on when the pilot flame ignites.

NOTE: If the sequence does not stop, reset the system and make sure that you selected the Pilot Test.

7. Turn down the pilot gas pressure very slowly, reading the manometer (or pressure gauge) as it drops. Stop instantly when the FLAME LED goes out. Note the pressure reading. The pilot flame is at the minimum turndown position. Immediately turn up the pilot pressure until the FLAME LED comes on again or the flame signal increases to above the flame threshold value. (See flame threshold parameter).

NOTE: If there is no flame for 15 seconds in the TEST position, the Falcon module locks out.

8. Repeat step 7 to verify the pilot gas pressure reading at the exact point the FLAME LED light goes out.
9. Increase the pilot gas pressure immediately until the FLAME LED comes on, and then turn it down slowly to obtain a pressure reading just above the dropout point or until the flame signal increases to above the flame threshold value (See flame threshold parameter).
10. Turn the pilot hold test OFF and allow the controller to start a burner cycle. During the Main Flame Establishing Period, make sure the automatic main fuel valve(s) opens; then smoothly open the manual main fuel shutoff valve(s) (or any other manually-opened safety shutoff valve(s), if used) and watch for main burner ignition. If the lightoff is not rough and the main burner flame is established, go to step 18.

NOTE: This step requires two people, one to open the manual valve(s) and one to watch for ignition.

11. If the main burner flame is not established within 5 seconds, or within the normal lightoff time specified by the equipment manufacturer, close the manual main fuel shutoff valve(s) and open the master switch. If the lightoff is rough, the pilot flame size is too small.
12. Close the master switch and perform another pilot hold test (see step 5).
13. Increase the pilot flame size by increasing its fuel flow until a smooth main flame lightoff is accomplished.
14. Reposition the flame rod or the flame scanner sight tube or use orifices until the pilot flame signal voltage is in the range of 0.7 Vdc above the flame threshold value.
15. When the main burner lights reliably with the pilot at turndown, disconnect the manometer (or pressure gauge) and turn up the pilot gas flow to that recommended by the equipment manufacturer.
16. If used, remove the bypass jumpers from the terminals, limits/controls, or switches.
17. Run the system through another cycle to check for normal operation.
18. Return the system to normal operation.

IGNITION INTERFERENCE TEST (FLAME RODS)

Ignition interference can subtract from (decrease) or add to (increase) the flame signal. If it decreases the flame signal enough, it causes a safety shutdown. If it increases the flame signal, it could cause the FLAME LED to come on when the true flame signal is below the minimum acceptable value.

Start the burner and measure the flame signal with both ignition and pilot (or main burner) on, and then with only the pilot (or main burner) on. Any significant difference (greater than 0.5 Vdc) indicates ignition interference.

To Eliminate Ignition Interference

1. Make sure there is enough ground area.
2. Be sure the ignition electrode and the flame rod are on opposite sides of the ground area.
3. Check for correct spacing on the ignition electrode. (See manufacturer's recommendation.)
4. Make sure the leadwires from the flame rod and ignition electrode are not too close together.
5. Replace any deteriorated leadwires.
6. If the problem cannot be eliminated, consider changing the system to an ultraviolet flame detection system.

HOT REFRACTORY HOLD-IN TEST (ULTRAVIOLET DETECTORS)

This condition can delay response to flame failure and also can prevent a system restart if hot refractory is detected.

The ultraviolet detector can respond to hot refractory above 2300 F (1371 C).

1. When the maximum refractory temperature is reached, close all manual fuel shutoff valves, or open the electrical circuits of all automatic fuel valves.
2. Visually observe when the burner flame or FLAME LED goes out. If this takes more than 3 seconds, the detector is sensing hot refractory.
3. Immediately terminate the firing cycle. Lower the setpoint to the operating controller, or set the Fuel Selector Switch to OFF. Do not open the master switch.

NOTE: Some burners continue to purge oil lines between the valves and nozzles even though the fuel valves are closed. Terminating the firing cycle (instead of opening the master switch) allows purging of the combustion chamber. This reduces buildup of fuel vapors in the combustion chamber caused by oil line purging.

4. If the detector is sensing hot refractory, correct the condition by one or more of the following procedures:
   a. Add an orifice plate in front of the cell to restrict the viewing area of the detector.
   b. Resight the detector at a cooler, more distant part of the combustion chamber. Make sure the detector properly sights the flame.
   c. Try lengthening the sight pipe or decreasing the pipe size (diameter).

For details, refer to the detector Instructions and the equipment Operating Manual. Continue adjustments until hot refractory hold-in is eliminated.

IGNITION SPARK RESPONSE TEST (ULTRAVIOLET DETECTORS)

Test to make certain that the ignition spark is not actuating the FLAME LED:

1. Open the master switch.
2. Close the pilot and main burner manual fuel shut-off valve(s).
3. Close the master switch
   — Go to the 833-3577 Display/Operator Interface.
   — Select Diagnostics Test button at the bottom of the display.
   — Select Diagnostics test button at the bottom of this new screen.
   — Select Pilot Test at the bottom of this new screen.
   — Select Start Test at the bottom of this screen.
4. Start the system with a call for heat. Raise the setpoint of the operating controller. The Falcon sequence should start and prepurge (if applicable) should begin. The sequence will hold in pilot flame establishing period with only the ignition on. Ignition spark should occur but the flame signal should not be more than 0.5 Vdc.
5. If the flame signal is higher than 0.5 Vdc and the FLAME LED does come on, consult the equipment operating manual and resight the detector farther out from the spark, or away from possible reflection. It may be necessary to construct a barrier to block the ignition spark from the detector view. Continue adjustments until the flame signal due to ignition spark is less than 0.5 Vdc.

NOTE: For controllers with software revision xxxx.2292 or higher, if the above procedures have been attempted and flame signal is still above 0.5 Vdc, use the following procedure:

FOR DIRECT BURNER IGNITION SYSTEMS

a. Using the 833-3577 Display/Operator Interface, select the Configure button (lower left corner of the Status page).
b. Using the left scroll down function, scroll down to select the System Configuration Parameter page (you will need to be logged in with a password).
c. Select Flame Sensor Type parameter.
d. Select UV Power Tube with Spark Interference.
e. Changing the Flame Sensor Type will require parameter verification.
f. Page back one level (upper right screen corner back arrow button).
g. Select the Verify button.
h. Select Begin.
i. Follow the prompts on the Operator Interface.

FOR PILOT SYSTEMS

a. Using the 833-3577 Display/Operator Interface, select the Configure button (lower left corner of the Status page).
b. Using the left scroll down function, scroll down to select the System Configuration Parameter page (you will need to be logged in with a password).
c. Select Flame Sensor Type parameter.
d. Select UV Power Tube with Spark Interference.
e. Select the Burner Control Ignition Page.
f. Select Ignitor On During parameter.
g. Select 1st half of PFEP.
h. Changing these two parameters will require parameter verification.
i. Page back one level (upper right screen corner back arrow button).
j. Select the Verify button.
k. Select Begin.
l. Follow the prompts on the Operator Interface.

Response to Other Ultraviolet Sources

Some sources of artificial light (such as incandescent or fluorescent bulbs, and mercury sodium vapor lamps) and daylight produce small amounts of ultraviolet radiation. Under certain conditions, an ultraviolet detector responds to these sources as if it is sensing a flame. To check for proper detector operation, check the Flame Failure Response Time (FFRT) and conduct Safety Shutdown Tests under all operating conditions.

Flame Signal With Hot Combustion Chamber (All Installations)

1. With all initial start-up tests and burner adjustments completed, operate the burner until the combustion chamber is at the maximum expected temperature.
2. Observe the equipment manufacturer's warm-up instructions.
3. Recycle the burner under these hot conditions and measure the flame signal. Check the pilot alone, the main burner flame alone, and both together (unless monitoring only the pilot flame when using an intermittent pilot, or only the main burner flame when using DBI). Check the signal at both High and Low Firing Rate positions and while modulating, if applicable.
4. Lower the setpoint of the operating controller and observe the time it takes for the burner flame to go out. This should be within four seconds FFRT of the controller.
5. If the flame signal is too low or unsteady, check the flame detector temperature. Relocate the detector if the temperature is too high.
6. If necessary, realign the sighting to obtain the proper signal and response time.
7. If the response time is still too slow, replace the controller.
8. If the detector is relocated or resighted, or the controller is replaced, repeat all required Checkout tests.

SAFETY SHUTDOWN TESTS (ALL INSTALLATIONS)

Perform these tests at the end of Checkout, after all other tests are completed. If used, the external alarm should turn on. Press the RESET pushbutton on the Falcon module to restart the system.

1. Open a Pre-Ignition Interlock (if PII parameter is enabled) during the STANDBY or PREPURGE period.
   a. *Pre-Ignition ILK* fault is displayed on the Operator Interface Module.
   b. Safety shutdown occurs.
2. Opening a Lockout Interlock during PREPURGE, PILOT IGN, MAIN IGN or RUN period.
   a. *Lockout ILK* fault is displayed on the Operator Interface Module.
   b. Safety shutdown occurs.
3. Detection of flame 240 seconds after entry to STANDBY from RUN. Detection of flame from 10 seconds up to 30 seconds into PREPURGE time.
   a. Simulate a flame to cause the flame signal voltage level to rise above the flame threshold value for 240 seconds after entry to STANDBY from RUN and also

simulate a flame signal for 10 seconds to 30 seconds for PREPURGE.
   b. *Flame Detected out of sequence* fault is displayed on the Operator Interface Module.
   c. Safety shutdown occurs.

4. Failure to ignite pilot or Main Burner (DBI setup).
   a. Close pilot and main fuel manual shutoff valve(s).
   b. Cycle burner on.
   c. Automatic pilot valve(s) or main valves (DBI) should be energized but the pilot or main burner (DBI) cannot ignite.
   d. *Ignition Failure* fault is displayed on the Operator Interface to indicate the fault.
   e. Safety shutdown occurs.

5. Failure to ignite main (only interrupted pilot application).
   a. Open the manual pilot valve(s); leave the main fuel manual shutoff valve(s) closed.
   b. Depress the RESET button.
   c. Start the system.
   d. The pilot should ignite and the flame signal should be above the flame threshold value but the main burner cannot light.
   e. The flame signal should drop below the flame threshold value within the FFRT after the interrupted pilot goes out.
   f. *Ignition Failure* fault is displayed on the Operator Interface Module.
   g. Safety shutdown occurs.

6. Loss of flame during RUN.
   a. Open the main fuel manual shutoff valve(s) and open manual pilot shutoff valve(s).
   b. Depress the RESET button.
   c. Start the system. Start-up should be normal and the main burner should light normally.
   d. After the sequence is in the normal RUN period for at least 10 seconds with the main burner firing, close the manual main fuel shutoff valve(s) to extinguish the main burner flame. (On intermittent pilot applications, also, close the pilot manual shutoff valve.)
   e. The flame signal should drop below the flame threshold value within the FFRT of the Falcon module after the main flame and/or pilot goes out.
   f. *Main Flame Fail* fault is displayed on the Operator Interface Module.
   g. Safety shutdown or recycle, then lock out on failure to light the pilot depending on the configuration the Falcon module.

7. Open a Pre-Ignition Interlock after the first 5 seconds of POSTPURGE.
   a. Open the main fuel manual shutoff valve(s) and open manual pilot shutoff valve(s).
   b. Depress the RESET button.
   c. *Pre-Ignition ILK* fault is displayed on the Operator Interface Module.
   d. Safety shutdown occurs.

IMPORTANT

If the Falcon module fails to shut down on any of these tests, take corrective action; refer to Troubleshooting and the Falcon module diagnostics and return to the beginning of all checkout tests.

When all checkout tests are completed, reset all switches to the original status. Remove any jumpers that you may have installed for testing.

TROUBLESHOOTING

System Diagnostics

Troubleshooting control system equipment failures is easier with the Falcon's self-diagnostics and first-out annunciation. In addition to an isolated spst alarm relay (audible annunciation), the Falcon module provides visual annunciation by displaying a fault code and fault or hold message at the 833-3577 Display/Operator Interface. The Falcon modules provide many diagnostic and alert messages for troubleshooting the system.

Self-diagnostics of the Falcon modules enables them to detect and annunciate both external and internal system problems. Fault messages, such as interlock failures, flame failures and false flame signals are displayed at the Operator Interface Module and annunciated at the Falcon by the ALARM LED.

The Operator Interface displays a sequence status message indicating: STANDBY, PURGE, PILOT IGN, MAIN IGN, RUN and POSTPURGE. The selectable messages also provide visual indication of current status and historical status of the equipment such as: Flame Signal, Total Cycles, Total Hours, Fault History, Diagnostic Information and Expanded Annunciator terminal status (if used). With this information, most problems can be diagnosed without extensive trial and error testing.

Diagnostic Information Lockout and Alert History Data are available to assist in troubleshooting the Falcon module.

The module provides diagnostic information to aid the service mechanic in obtaining information when trouble-shooting the system.

Diagnostic Information Index

The Falcon modules monitor digital and analog input/output (I/O) terminals and can display the status of the terminal at the Operator Interface Module. The display shows the actual status of the terminal. If voltage is detected at a digital I/O terminal, the LED turns green next to the terminal energized, but if no voltage is detected at the terminal, the LED will be red. Actual analog I/O values are displayed on the operator interface module.

Historical Information Index

The Falcon modules have nonvolatile memory that allows them to retain historical information for the fifteen most recent lockouts. Each of the fifteen lockout files retains the cycle when the fault occurred, the hour of operation when the fault occurred, a fault code, a fault message and burner status when the fault occurred. In addition to the lockout files, the Falcon modules retain fifteen alert files.

SERVICE NOTES:

1. Reset the device module by pressing the RESET pushbutton on the device or pressing a remote reset pushbutton wired into connector J10 or through the display. A power-up reset causes an electrical reset of the module but does not reset a lockout condition.
2. Use the connector screw terminals to check input or output voltage.

LEAD LAG

Falcon devices contain the ability to be a stand-alone control, operate as a Lead Lag Master control (which also uses the Falcon control function as one of the slaves), or to operate solely as a slave to the lead lag system.

Falcon devices utilize two Modbus ports (MB1 and MB2) for communications. One port is designated to support a system display and the other port supports communications from the LL Master with its slaves. Fig. 28 shows a simplified wiring diagram connecting the system display with a 4 system Lead Lag arrangement.

The Lead Lag master is a software service that is hosted by a Falcon control. It is not a part of that control, but is an entity that is “above” all of the individual Falcon controls (including the one that hosts it). The Lead Lag master sees the controls as a set of Modbus devices, each having certain registers, and in this regard it is entirely a communications bus device, talking to the slave Falcon controls via Modbus.

The LL master uses a few of the host Falcon's sensors (header temperature and outdoor temperature) and also the STAT electrical inputs in a configurable way, to provide control information.

Lead Lag (LL) Master General Operation

The LL master coordinates the firing of its slave units. To do this it adds and drops stages to meet changes in load, and it sends firing rate commands to those that are firing.

The LL master turns the first stage on and eventually turns the last stage off using the same criteria as for any modulation control loop:

- When the operating point reaches the Setpoint minus the On hysteresis, then the first Falcon is turned on.
- When the operating point reaches the Setpoint plus the Off hysteresis then the last slave Falcon (or all slave units) are turned off.

The LL master PID operates using a percent rate: 0% is a request for no heat at all, and 100% means firing at the maximum modulation rate.

The LL master may be aware of slave’s minimum firing rate and use this information for some of its algorithms, but when apportioning rate it may also assign rates that are less than this. In fact, the add-stage and drop-stage algorithms may assume this and be defined in terms of theoretical rates that are possibly lower than the actual minimum rate of the Falcon control. A unit that is firing and is being commanded to fire at less than its minimum modulation rate will operate at its minimum rate: this is a standard behavior for a Falcon control in stand-alone (non-slave) mode.

If any slave under LL Master control is in a Run-Limited condition, then for some algorithms the LL master can apportion to that stage the rate that it is actually firing at.

Additionally when a slave imposes its own Run-limited rate, this may trigger the LL Master to add a stage, if it needs more capacity, or drop a stage if the run-limiting is providing too much heat (for example if a stage is running at a higher-than commanded rate due to anti-condensation).

By adjusting the parameters in an extreme way it is possible to define add-stage and drop-stage conditions that overlap or even cross over each other. Certainly it is incorrect to do this, and it would take a very deliberate and non-accidental act to accomplish it. But there are two points in this:

1. LL master does not prevent it, and more important;
2. it will not confuse the LL master because it is implemented as a state machine that is in only one state at a time;

for example:

— if its add-stage action has been triggered, it will remain in this condition until either a stage has been added,

or

— the criteria for its being in an add-stage condition is no longer met; only then will it take another look around to see what state it should go to next.

Assumptions

Modulating stage The modulating stage is the Falcon that is receiving varying firing rate requests to track the load.

First stage This is the Falcon that was turned on first, when no slaves were firing.

Previous stage The Falcon that was added to those stages that are firing Just prior to the adding of the Falcon that is under discussion.

Next stage The Falcon that will or might be added as the next one to fire.

Last stage The Falcon that is firing and that was added the most recently to the group of slaves that are firing. Typically this is also the modulating stage, however as the load decreases then the last-added stage will be at its minimum rate and the previous stage will be modulating.

Lead boiler The Lead boiler is the Falcon that is the first stage to fire among those stages which are in the equalize runtime (Lead/Lag) group. If a boiler is in the “Use first” group it may fire before the Lead boiler fires.

First boiler A Falcon may be assigned to any of three groups: “Use First”, “Equalize Runtime”, or “Use Last”. If one or more Falcons are in the “Use First” category, then one of these (the one with the lowest sequence number) will always be the first boiler to fire. If there is no Falcon in the “Use First” category and one or more are in the “Equalize Runtime” category, then the First boiler is also the Lead boiler.

Add-stage method, Add-stage detection timing, Add-stage request

An Add-stage method implements the criteria for adding another stage. Criteria that may apply are the firing rate of a stage or stages vs. a threshold, the amount of operating point versus setpoint error seen by the master, the rate at which setpoint error is developing, and the rate at which a stage or stages are approaching their maximum or baseload firing rate.

Typically these use Add-stage detection timing to determine how long these things have persisted. When all criteria have been met for a sufficient time, then an Addstage request is active.

Drop-stage method, Drop-stage detection timing, Drop-stage request

A Drop-stage method implements the criteria for dropping a stage. Criteria that may apply are the firing rate of a stage (or stages) vs. a threshold, the amount of operating point versus setpoint error seen by the master, the rate at which setpoint error is developing, and the rate at which a stage or stages are approaching their minimum firing rate. Typically these use Drop-stage detection timing to determine how long these things have persisted. When all criteria have been met for a sufficient time, then an Drop-stage request is active.

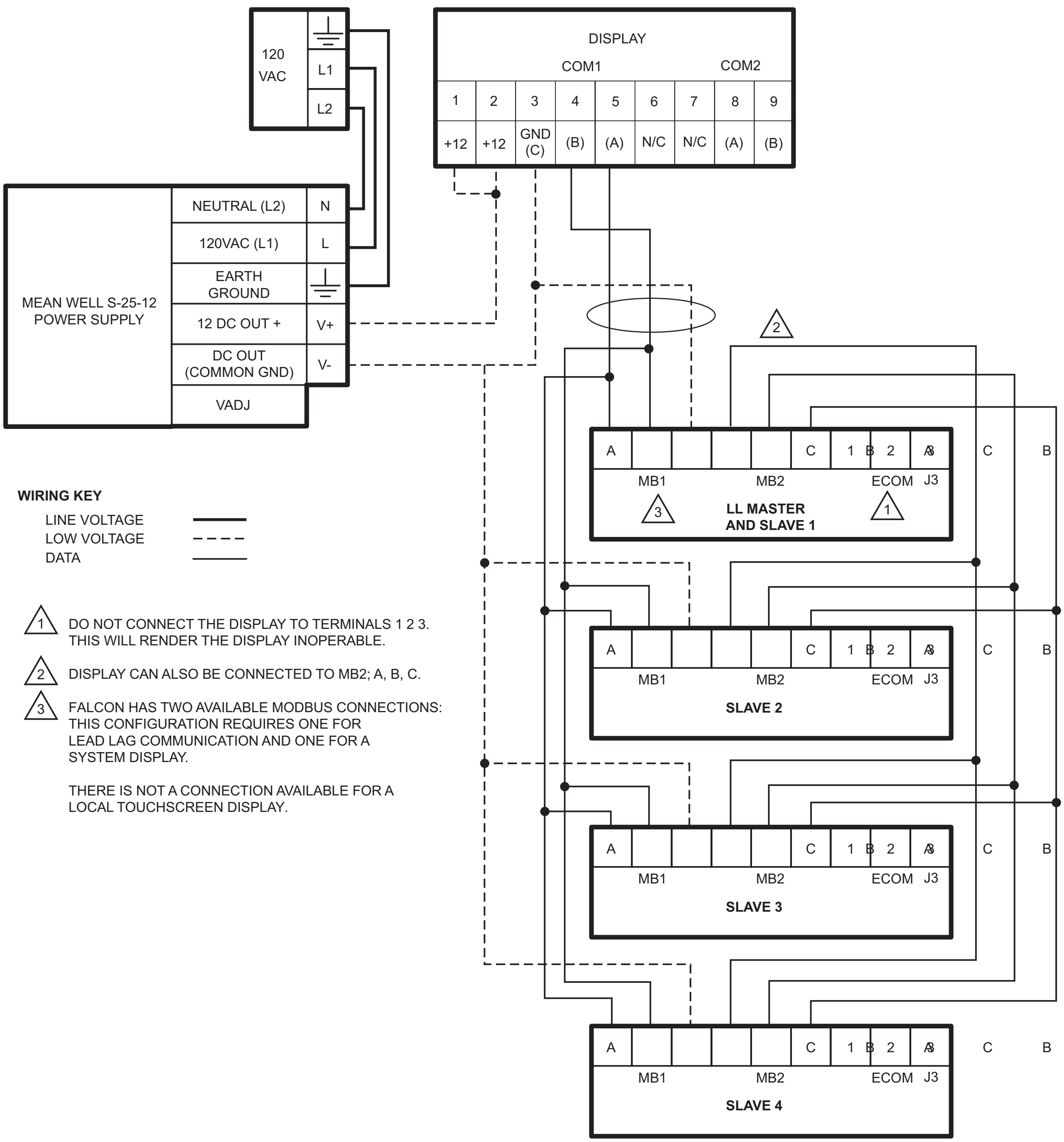


Fig. 28. Lead lag wiring diagram.

Lead-Lag Operation

OEM Configurable parameters may be adjusted as part of the OEM factory configuration and in the field using the System Display with appropriate password permissions (see “Passwords” on page 18). Specific parameters may also be configured in the field by the local display.

Field Installation Configuration

1. The master and slave controllers are enabled via the system display.
2. All Falcon controllers are programmed with a default address of 1.

Assuming the Master Falcon controller remains address 1, the address of the slave controllers in the system must have a unique address (1–8) via the local display.

Basic Operation

1. Firing rate determination – Parallel common-base limited
   a. All boilers have a single assignable base load firing rate.
   b. Allocation
      (1) As load increases:
         (a) Until all stages are firing - No stage is requested to exceed the common base load rate.
         (b) After all stages are firing - There is no restriction on the slave's commanded firing rate.
      (2) As load decreases:
         (a) As long as all available stages are firing - There is no restriction on the slave's commanded firing rate.
         (b) When at least one stage has been dropped - No stage is requested to exceed the common base load rate.
2. Rotation
   a. The lead boiler is rotated based sequence order. The lead boiler rotation time is a configurable OEM parameter. Rotation is sequential by address (1-2-3-4; 2-3-4-1; etc.).
   b. Rotation trigger occurs at the start of each new heat cycle.
3. Source of heat for call – The call for heat originates at the master boiler. This source can be configured to be an external thermostat or via EnviraCOM Remote Stat.
4. Slave boiler lockout – If any slave is in lockout the master boiler will cause it to be skipped and all system load setting calculation settings will be based only on available boilers.
5. Master boiler lockout – If the master boiler is in lock-out then its burner control function will be skipped in the rotation the same as the slave controllers. However, the master boiler function will continue to operate.

System Component Failure Responses

1. If the system header sensor becomes disconnected from the master boiler then the master boiler will control off of one of the following OEM configurable actions
   a. Disable - No backup will be used.
   b. Lead Outlet - Outlet temperature of the lead boiler will be used as the backup during firing.
   c. Slave Outlet Average - Average of the outlet temperatures of all slave boilers that are firing will be used as a backup.
2. If the sensor chosen by the above parameter is faulty then the backup sensor provided may be used. When burner demand is off and no burners are firing, then, for either “Lead Outlet” or “Slave Outlet Average”, the lead boiler's outlet temperature is used to monitor for burner demand.

Local Display Configuration and Operation

1. The configuration parameters available on the local display are edited in the Service Mode.
2. Access to the Service Mode is accomplished by pressing both up/down buttons for 3 seconds.
3. Status and Operation
   a. Slave status
      (1) “Rmt” and “Adr” icons are on to show slave (follower) has been enabled.
      (2) Current burner status is shown.
      (3) To show slave CFH.
         (a) Alternate “%” firing rate and actual (slave) Outlet temp to indicate slave CFH otherwise show the Home screen.
   b. Master status
      (1) Rmt icon is on, Adr icon is off to show Master (Leader) has been enabled.
      (2) Current burner status is shown.
      (3) Actual temperature LL (Header) temperature is shown as described in number 5 on page 75 below.
      (4) Pressing the up/down buttons allows setpoint adjustment for LL-CH only (not LL-DHW or LL-Mix or others).
         (a) All pump configurations must be done using the PC Configuration tool in the OEM factories.
      (5) To show Master CFH
         (a) Alternate “CH” or “LL” or “Hdr” in numbers field with the actual temperature to indicate LL CH CFH.
4. Configuration
   a. Continue scrolling through set-up screens until “Remote Firing Control” screen is reached.
   b. Rmt On/Off selection chooses to navigate the user through the Master/Slave configuration as existing today.
   c. Set master/slave remote address as is done on currently on the local display.
   d. The following parameters are mapped to Modbus addresses.
      (1) “LL” = LL Operation (3 user selections available)
         (a) “Ldr”
            • Master Enable
            • Slave Enable
         (b) “SLA”
            • Slave Only Enable
            • Master Disable
         (c) “OFF”
            • Master Disable
            • Slave Disable
      (2) HS = On/Off Hysteresis (One value used for all LL boilers)
         (a) “HS” for on and off hysteresis values.
            • Only allow 1 setting for both on and off hysteresis values.
            • Must adhere to the strictest of either the HS On or Off limits:
              Highest value of the “low” range limit in Falcon control
              Lowest value of the “high” range limit in Falcon control

- See Falcon Modbus specification for details. Typical values: 2-15

(3) BL = Baseload common
(a)“BL” for baseload
(b)User selection 0 – 100 %
(4) Use existing timeout, Done button, and Next button functionality to enter these parameters.
(5) User selections will be selected by MMI.
(a)The local display does not adhere to the PCB (OEM parameter selections used by system display).

5. In normal display operation the display allows a user to scroll through a list of temperatures with associated icons (CH, Inlet, Delta, DHW, Stack, Outdoor) using the Next button. With LL active the display will show the header temperature at the end of the list of temperatures as follows:
a. The characters “LL” are displayed in the number field.
b. When the next button is pressed again the temperature is displayed.
c. If the Up or Down buttons are pressed then the LL set-point is changed.

System Display Configuration

The following parameters are available for OEM configuration and may be adjusted through a System Display or programmed at the OEM production facility.

Table 33. OEM Configuration Parameters

Master Falcon	Slave Falcon
LL frost protection enable	Slave mode
LL frost protection rate	Base load rate
Base load rate	Slave sequence order
LL CH demand switch	LL Demand to firing delay
LL CH set point source	
LL Modulation sensor	
LL Base load common	
LL Modulation backup sensor	
LL CH 4mA water temperature	
LL Lead selection method	
LL CH 20mA water temperature	
LL Lag selection method	
LL Add stage method 1	
LL Add stage detection time 1	
LL Add stage error threshold	
LL Add stage rate offset	
LL Add stage inter-stage delay	
LL Drop stage method 1	
LL Drop stage detection time 1	
LL Drop stage error threshold	
LL Drop stage rate offset	
LL Lead rotation time	
LL Force lead rotation time	
LL Drop stage inter-stage delay	

Slave Operation and Setup

Slave Data Supporting Lead Lag

This data is provided by each slave control to support operation when a LL master exists. Fig. 29 summarizes the slave's registers and data:

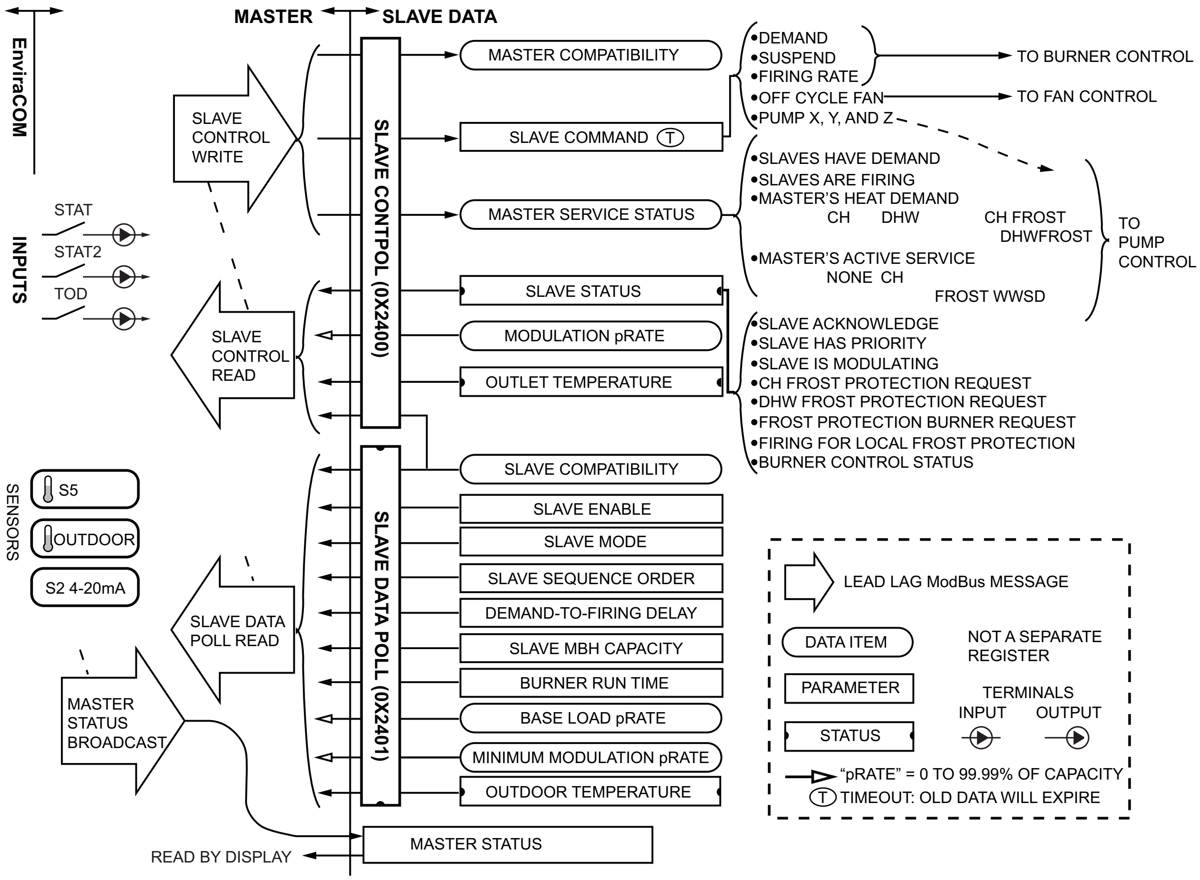


Fig. 29. Master/Slave data transmission.

Table 34. Slave Data Supporting Lead Lag Parameters.

Parameter	Comment
LL - Slave enable	Disable, Enable via Modbus, Enable for Master It enables or disables the "LL Slave" Demand and Rate module. If the slave mode is set to Disable then: none of the slave functions are active, LL - Slave Status register is zero, the LL – Master Service Status register is not writable and is held at zero (this is important for pump control which might otherwise use values in this location). The LL - Slave Command register is writable but it is mostly ignored, however the Aux pump X, Y, and Z are effective for any setting of the LL - Slave enable parameter. The Enable for Falcon Master option LL - Slave write and LL - Slave read parameters; if "Enable for Master" is not selected, then these parameters are disabled.
LL - Slave write	data This allows the slave to accept command messages from a master.
LL - Slave read	data This provides the slave status message to be read by a Master. It includes all of the data that is read from a slave.
LL - Slave mode	Use First, Equalize Runtime, Use Last If set to Use First, then this slave will be used prior to using other slave units with other values. If this parameter is set to Equalize Runtime, then this slave will be staged according to a run time equalization. (Any units set to Use First will precede any that are set to Equalize Runtime.) If this parameter is set to Use Last, then this slave will be used only after all Use First and Equalize Runtime units have been brought online.

Table 34. Slave Data Supporting Lead Lag Parameters. (Continued)

Parameter	Comment
LL - Slave priority sequence order	0-255 Slave sequence order is used to determine the order in which the slaves will be used (staged on) for those Falcons with the same Slave mode setting. Numbers may be skipped, that is 3 will be first if there is no 1 or 2. Note: For Equalize Runtime purposes, 1 does not mean the unit will be used first every time; that will vary over time based on the master's run time equalization scheme. In this case the sequence number determines the relative order in which Falcon controls will be used in a round-robin scheme. If the slave sequence number value is zero, then the slave unit's modbus address will be used instead. If two Falcons are set to the same mode and both have the same sequence number then an alert will occur and the order in which they are used will be arbitrary and is not guaranteed to be repeatable.
LL - Demand-to-firing delay	mm:ss or None This delay time is needed by the LL master to determine the length of time to wait between requesting a slave to fire and detecting that it has failed to start. It should be set to the total time normally needed for the burner to transition from Standby to Run, including such things as transition to purge rate, prepurge time, transition to lightoff rate, all ignition timings, and include some extra margin.
LL - Base load rate	rpm or % This specifies the preferred firing rate of a burner, which is used for some types of control.
LL - Fan during off-cycle rate	rpm or % (0=disable) This determines if or where the fan is to be operating during the standby period.

LL Master Operation and Setup

LL master operation is subdivided into the following functions:

Overall control - The LL master has parameters that enable and disable its operation.

Periodic data polling - The LL master uses polling to discover new slave Falcon devices and to periodically refresh the information it has about known slave devices.

Slave control - The LL master sends each active slave a command and also performs a slave status read for each known slave device at a high rate. It also sends a Master status broadcast that is heard by all slaves.

Slave status manager - The LL master operates a state machine that keeps track of slave status for each Falcon that is enabled as a slave device.

Demand and priority - Different sources of demand can cause the LL master to operate in different ways. These sources have a priority relationship.

Rate control - Each demand source has one or more setpoints that may be active and an operation sensor. These are used to detect turn-on and turn-off conditions. The difference between operating point and setpoint is sent to a PID block to determines the LL master's firing rate.

Rate allocation - The PID block's output is used to determine the firing rate of each slave using various rate allocation techniques.

Stager - The stager determines when slaves should turn on as the need for heat increases, and when they should turn off as it decreases.

Add-stage methods - Various methods can be used to determine when a new stage should be added.

Drop-stage methods - Various methods can be used to determine when a stage should be dropped

Sequencer - The sequencer determines which Falcon will be the next one to turn on or turn off.

Table 35. Overall Control Parameters.

Parameter	Comment
LL master enable	Disable, Enable
LL master Modbus port	MB1, MB2 The LL master may be disabled, enabled. If Disable is selected then all LL master functions are inactive. If Enable is selected then it acts as the active bus master at all times on the modbus port it is assigned to use by the LL Master Modbus port parameter.
LL operation switch	Off, On This controls the LL master in the same way that the Burner switch controls a stand-alone Falcon. If “On” then the LL master is enabled to operate. If this parameter is “Off” then the LL master turns off all slaves and enters an idle condition.

Periodic Data Polling Messages

The LL master will poll to discover all the slave devices when it starts up. Thereafter it polls the known devices to make sure they are still present and to obtain updated status information. It also periodically polls the entire slave address range to discover any new slave devices.

A polled slave unit is read to determine the values of the following data items:

a. The slave's type (compatibility) as indicated by the LL - Slave type
b. The slave enable status LL - Slave enable
c. The slave mode as set in LL - Slave mode
d. The slave sequence order as set in LL - Slave sequence order
e. LL - Demand-to-firing delay: mm:ss or None See Table 37.
f. CT - Burner run time. See Table 37.

Table 36. Data Polling Parameters.

Parameter	Comment
LL - Demand-to-firing delay	mm:ss or None This delay time is needed by the LL master to determine the length of time to wait between requesting a slave to fire and detecting that it has failed to start. It should be set to the total time normally needed for the burner to transition from Standby to Run, including such things as transition to purge rate, prepurge time, transition to lightoff rate, all ignition timings, and some extra margin.
CT - Burner run	This parameter will be needed if measured run-time equalization is being used.

Slave Control Messages

After a slave device has been discovered, the LL master sends each slave unit a command message.

There are 5 commands that might be sent:

- DnFnM0: Demand=no, Run off-cycle fan=no, Modulation=0%.
  The LL master sends this message to all LL slaves when none of these are firing. All slaves are commanded to turn off and remain off.
- DnFyM0: Demand=no, Run off-cycle fan=yes, Modulation=0%.
  The LL master sends this message to slaves that are off, whenever any slave is firing (due to either LL master control or independent operation).
- DsFnM0 or DsFyM0: Demand=suspend, Run off-cycle fan=y/n, Modulation=0%
  The LL master sends this message to request a burner to recycle and remain in Standby if it has not yet opened its main valve (e.g. it is in Prepurge or PFEP) but to keep firing if it has reached MFEP or Run.

This message is used to abort the startup of a slave that is not yet firing (because demand went away just before it was firing), but to keep it on if it actually is firing (the LL master will discover what happened in a subsequent status response).

The LL master also sends this message to a slave that is OnLeave. (This ensures that if the slave is firing when it returns to LL master control, it will stay that way until the master has decided whether to use it; or conversely, if the slave stops firing for some reason that it will not start up again until the LL master has requested this.

In either case, the command will be DsFyM0 to turn on the off cycle fan if any other slave burners are firing, or DsFnM0 to turn the fan off if the slave is the only slave that might (or might not) be firing.

- DyFnM0-100: Demand=yes, Run off-cycle fan=no, Modulation=0-100%
  The LL master sends this message to turn the burner on and to assign the burner's firing rate.

If the commanded modulation rate is less than the burner's minimum modulation rate, then the burner should always operate at its minimum rate.

SlaveState States

Recovering A slave that is recovering is checked once per second. If any of the following are true:
DataPollFaultCounter non-zero
StatusReadFaultCounter non-zero
AbnormalFaultCounter non-zero

then the slave's RecoveryTimer is cleared (it has not yet begun to recover). If the RecoveryTimer reaches the RecoveryTime then the slave has recovered and the SlaveState is changed to Available. Each time it is checked (once per second) the slave's RecoveryLimitTimer is also incremented and if the slave has not yet recovered when this timer reaches the RecoveryTimeLimit then:

If the slave is not enabled for the LL master or if its DataPollFaultCounter or StatusReadFaultCounter is non-zero, its SlaveState is Set to Unknown (which logically removes it from the slave table). Otherwise the RecoveryLimitTimer is cleared which starts a new recovery measurement and the slave remains in recovery (indefinitely).

Available A slave in the Available state remains that way until the Stager moves it into the AddStage state or the ProcessSlaveStatus action moves it to some other state.

AddStage A slave in the AddStage state remains that way until the ProcessSlaveStatus moves it to Firing or some other state, or the Stager times out and moves it into the Recovering state if it fails to fire.

SuspendStage A slave in the SuspendStage state remains that way until the ProcessSlaveStatus moves it to some other state, or the Stager times out and moves it into either the Firing or the Available state.

Firing A slave in the Firing state remains that way until the ProcessSlaveStatus moves it to some other state, or the Stager drops the stage and moves it into the Available state.

OnLeave A slave in the OnLeave state remains that way until the ProcessSlaveStatus moves it to some other state.

Disabled A slave in the Disabled state remains that way until the ProcessSlaveStatus moves it to Recovering.

Demand and Priority

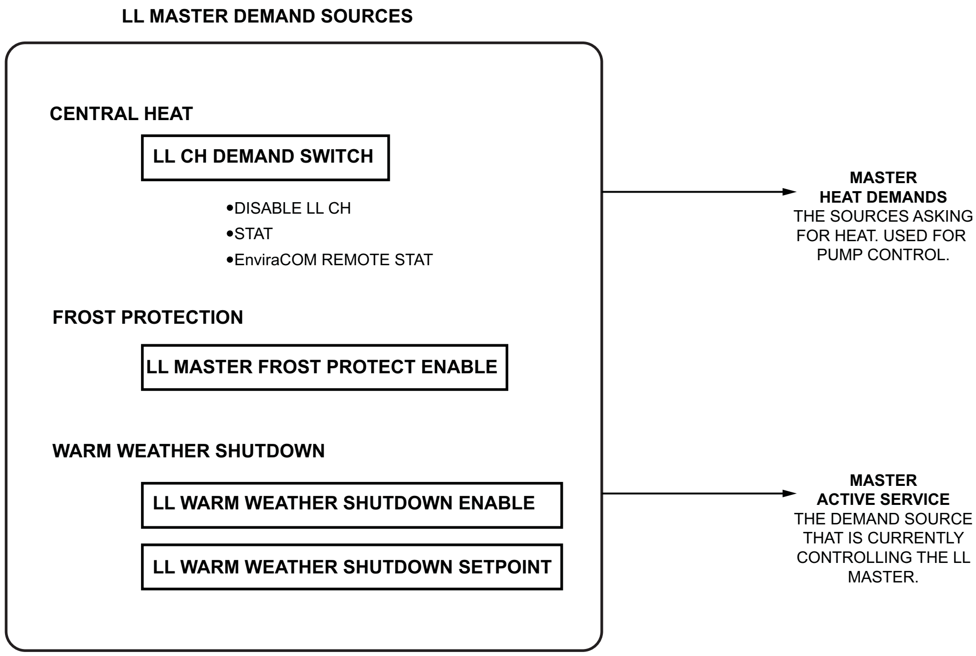


Fig. 30. LL Master demand sources.

CH DEMAND

Table 37. CH Demand Parameters.

Parameter	Comment
LL CH demand switch	Disable, STAT, EnviraCOM Remote Stat The inputs that can function as the CH demand switch are: STAT, EnvironCOM Remote Stat. If the CH demand switch value is Disable, the LL master does not respond to CH demand.

WARM WEATHER SHUTDOWN (WW-SD)

Table 38. Warm Weather Shutdown (WW-SD) Parameters.

Parameter	Comment
Warm weather shutdown enable	Disable, Shutdown after demands have ended, Shutdown immediately

Table 38. Warm Weather Shutdown (WW-SD) Parameters. (Continued)

Parameter	Comment
Warm weather shutdown setpoint	Temperature or None When warm weather shutdown is Disabled then it has no effect (i.e. the Warm Weather Shutdown (WW-SD)) status shown on the priority diagram is false). These two parameters are shared by the stand-alone Falcon control and the LL master and have the same effect for either control. If it is enabled then it uses a 4°F (2.2°C) hysteresis: If WW-SD) is false, then when the Outdoor temperature is above the value provided by **Warm weather shutdown setpoint** then: If **Shutdown after demands have ended** is selected then any current CH demand that is present prevents WW-SD) from becoming true; that is if CH demand is false then WW-SD) becomes true. Otherwise if **Shutdown immediately** is selected then WW-SD) becomes true, it immediately causes CH demand to end. If WW-SD) is true, then when the Outdoor temperature is below the value provided by **Warm weather shutdown setpoint** minus 4°F then WW-SD) becomes false. When warm weather shutdown is true then: New occurrences of CH demand is inhibited. DHW demand is not affected.

Frost Protection

LL master frost protection is enabled with the LL - Frost protection enable parameter.

The need for frost protection is actually detected independently by each slave, which notifies the master whether frost detection occurred in CH frost detection, and/or its DHW frost detection, and whether it is severe enough to require burner firing as well as pump operation. This is done via its BC - Slave status parameter.

If LL - Frost protection enable is Enable, then the master's LL - Slave write message, will indicate CH or DHW frost protection or both as read from each slave's BC - Slave Status. This will cause any slave pumps which are enabled to follow this status to turn on without any other action required from the master.

If any slave is indicating CH or DHW frost protection, and additionally that slave's BC - Slave status register indicates burner firing is requested then the LL master's frost protection burner demand will be true.

If the priority scheme allows the master to honor this demand, then it will fire a single burner (the current lead burner as specified by the sequencer) at the rate indicated by LL - Frost protection rate: 0-100%. (100% represents 100% firing of this boiler, and where 0% or any value less than the boiler's minimum firing rate represents the minimum firing rate).

Modulation

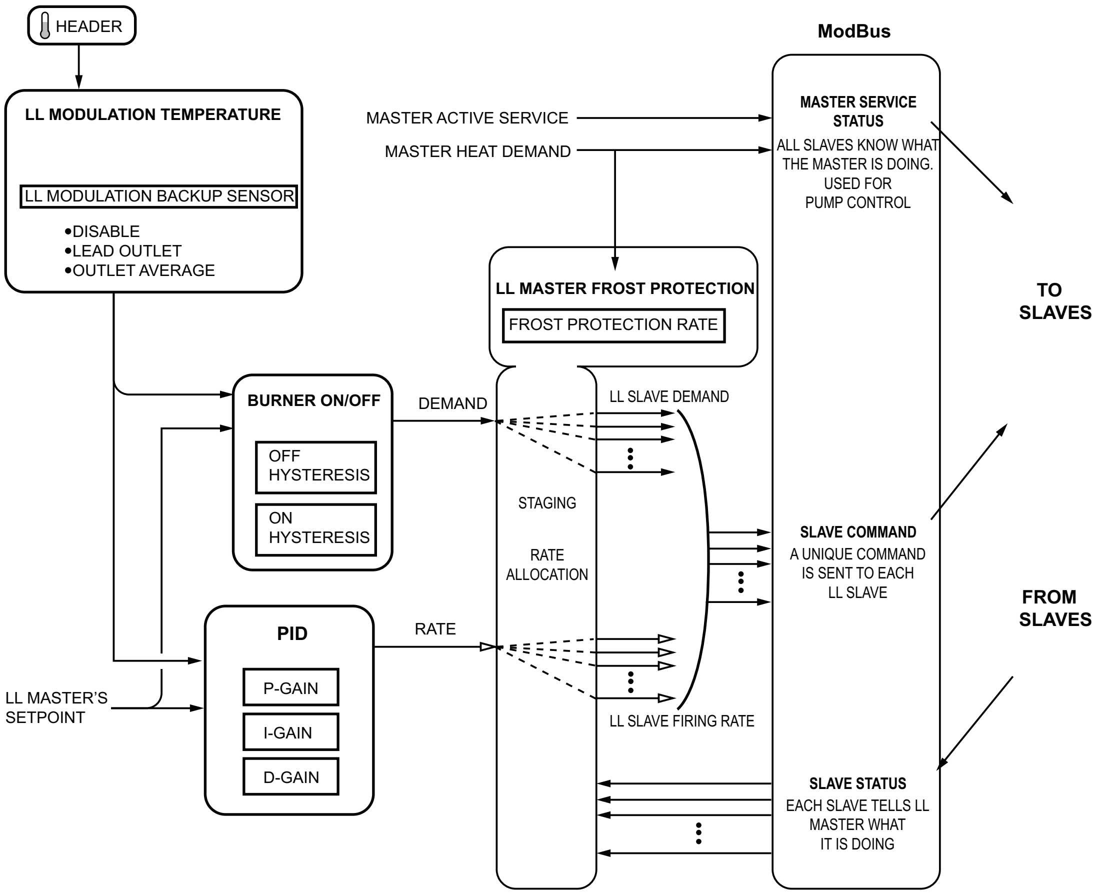


Fig. 31. Modulation.

Modulation Sensor

Table 39. Modulation Sensor Parameters.

Parameter	Comment
LL Modulation sensor	S10 The LL master's modulation sensor uses the S10 sensor wired at J10 terminal 7 and 8. If the LL master is enabled and its sensor is faulty then an alert will be issued.
LL Modulation backup sensor	Disable, Lead Outlet, Slave Outlet Average If the sensor chosen by the LL Modulation sensor is faulty then the backup sensor provided here may be used. If **Disable** is selected then no backup will be used. If **Lead Outlet** is selected then the outlet temperature of the lead boiler will be used as the backup during firing. If **Slave Outlet Average** is selected then average of the outlet temperatures of all slave boilers that are firing will be used as a backup.

When the burner demand is off and no burners are firing then, for either Lead Outlet or Slave Outlet Average, the lead boiler's outlet temperature is used to monitor for burner demand.

Setpoints

Table 40. Setpoint Parameters.

Parameter	Comment
LL CH Setpoint source	Local, S2 4-20mA If the setpoint source is Local then the Falcon control's local setpoint system is used. This setting enables the normal use of the CH setpoint, CH TOD setpoint, and the CH outdoor reset parameters and functions. If the setpoint source is S2 4-20mA then the setpoint is determined by the 4-20mA input on S2, and the two parameters described below. If the 4-20mA signal goes out of range or is invalid, and this persists for a specified time, then the setpoint source reverts to “Local”. In this case once it has gone to “Local”, it remains that way until the 4-20mA signal is stable again.
LL CH 20mA Water Temperature CH 4mA Water Temperature	Temperature or None These provided the 20mA and 4mA temperatures for the interpolation curve. If either of these have the None value, are invalid, are out of range, or are too close for interpolation, an alert is issued and the setpoint reverts to “Local” when it is selected as 4-20mA.
LL CH setpoint	Degrees or None This setpoint is used when the time-of-day input is off. If the ODR function is inactive then the setpoint is used as-is. If the ODR function is active then this setpoint provides one coordinate for the outdoor reset curve.
LL CH TOD setpoint	Degrees or None This setpoint is used when the time-of-day input is on. If the ODR function is inactive then the setpoint is used as-is. If the ODR function is active then this setpoint provides one coordinate for the shifted (because TOD is on) outdoor reset curve.
LL CH ODR minimum water temperature	Degrees or None This specifies the minimum outdoor reset setpoint for the LL master. If the outdoor reset function calculates a temperature that is below the temperature specified here, then this parameter's temperature will be used. If this parameter is invalid or None then the outdoor reset function will be inhibited and will not run: if it is enabled then an alert is issued.

TIME OF DAY

The Time of Day has one sources of control: a switch contact. Closed TOD is an on condition; open, then TOD is off.

OUTDOOR RESET

The outdoor reset for the LL CH functions are implemented as described for a stand-alone CH loop.

Each of the loops which implements outdoor reset and boost has its own parameters. The parameters used by the LL master are:

- LL setpoint
- LL CH TOD setpoint
- LL CH ODR minimum outdoor temperature: degrees or None
- LL CH ODR maximum outdoor temperature: degrees or None
- LL CH ODR low water temperature: degrees or None

Demand and Rate

ON/OFF HYSTERESIS

Includes hysteresis shifting at turn-on, turn-off.

Table 41. On/Off Hysteresis Parameters.

Parameter	Comment
LL off hysteresis LL on hysteresis	Degrees or None The LL hysteresis values apply to all setpoint sources. The behavior of the hysteresis function is identical to the behavior of the stand-alone CH hysteresis function, except: • where stand-alone CH hysteresis uses the on/off status of a single burner, the LL hysteresis uses the on/off status of all slave burners: this status is true if any slave burner is on, and false only if all are off. • where stand-alone CH hysteresis uses time of turn-on and turn-off of a single burner, the LL hysteresis uses the turn-on of the first slave burners and the turn-off of the last slave burner.

LEAD LAG PID

The behavior of the Lead Lag PID function is identical to the behavior of the stand-alone CH PID function. The same gain scalers and algorithms are used.

RATE ADJUSTMENT

When the LL - Slave dropout/return compensation parameter specifies a rate adjustment and a rate compensation event occurs (a slave leaves while firing, or a slave returns) then rate adjustment will alter the integrator value so that the commanded rate compensates for the added or lost capacity.

INTEGRATOR COMPENSATION

A stand-alone Falcon includes a feature to smooth the response when a rate override has occurred (such as delta-T rate limit) causing the PID output to be ignored.

Whenever an override has occurred then, at the moment the override ends, the integrator is loaded with a value that causes the PID output to match the current rate, whenever this is possible within the integrator's limits. The Lead Lag PID will implement similar behavior: The rate allocator will provide a trigger that causes the integrator's value to be recomputed and this trigger will activate whenever a rate allocation limit is released; that is, this event will occur any time the system transitions from the condition in which it is not free to increase the total modulation rate, to the condition where this rate may increase.

Implementation:
The examples below are ways in which this may occur, but in implementation what is necessary, first of all, is to use a rate allocator that assigns rate to each slave and can detect when all of the assigned rate is absorbed, or if there is excess requested rate that the firing stages could not absorb.

Then:

1. Whenever the system is rate limited, that is, when A) all firing stages are commanded to their respective maximums and also B) the PID is asking for more heat than that, note that this has occurred by setting a flag and also record total rate that the system absorbed (the total of the commanded maximums, not the PID's requested rate which might include excess).
2. Whenever the rate allocator completes an execution pass and detects that both conditions of step 1 are no longer true (demand has decreased) then it clears the flag.
3. Whenever the rate allocator completes an execution pass and detects both conditions of step 1 are true, and it also detects that the total rate potentially absorbed by the system (the commands have not yet been sent) has increased from the value that was saved when the flag was set, then it re-computes the integrator value based on the old commanded maximum, clears the flag, and actually allocates the old rate that was saved when the flag was set.

Examples include:

- The rate allocator has encountered a limit such as base load (for a "limited" rate allocation scheme) and this limit is released.
- All stages are at their maximum (base load, or max modulation) and one or more stages are rate-limited (such as due to slow-start or stepped modulation limiting due to high stack temperature, etc.) and the rate limited stage recovers, changing from rate-limited to free to modulate. (This is indicated by the Slave Status "slave is modulating" bit: the changing of this bit from false to true is not, itself, a trigger, but while it is true the rate allocator can assign to the slave only the firing rate that it is reporting; thus the release of this might allow more rate to be absorbed by the system. It also might not do this, if for example the slave was in anticondensation and thus the rate limit was maximum modulation rate.)
- All firing stages are at their maximum (base load, or max modulation) and a stage which was OnLeave returns in the firing state and is available for modulation.
- An add-stage is in-progress and all firing burners are at their limits (max modulation rate or base load) and then the new stage becomes available.

This also applies when the system is first starting up, that is, all firing burners are at their limits (zero) because non are firing, and thus when the add-stage is finished the system transitions from no modulation at all, to modulating the first stage.

LEAD LAG BURNER DEMAND

Lead Lag burner demand will be present when Frost protection burner demand is true, as described the section on Frost protection. For the CH, and DHW demand sources, Lead Lag burner demand will be true when one of these is true and also setpoint demand from the hysteresis block is true.

Rate Allocation

The rate allocator first generates the LL - Slave Command. Except for the Firing state, the value ultimately depends only upon the SlaveState. The values are:

- Available
- AddStage
- SuspendStage depending on whether any other slave stage is firing, no matter what SlaveState it is in.
- Firing
- OnLeave - same as SuspendStage This ensures that when a slave returns and is already firing, it will remain firing until the master decides what to do about that, or if it is not firing it will remain off.
- Disabled - same as Available
- Recovering - same as Available

The rate allocator next fills in the modulation rate for all Firing boilers.

The rate allocator also provides functions to return identification of the modulating stage and the last stage, for use by the Add-stage and Drop-stage methods.

Table 42. Rate Allocation Parameters.

Parameter	Comment
LL - Base load common	0-100% If set to zero, this parameter is disabled. For any non-zero value, it uses the individual base load rates of each slave to be ignored by the LL master's routines and this common value to be used instead. It is an easy way to set all base loads to the same value, without having to set each slave. Some rate allocation algorithms may specify the use of this parameter, and that the slave base load settings are ignored.
LL - Rate allocation method	Parallel common-base limited This selects the rate allocation method. This performs three purposes: 1) it determines how the LL master allocates firing rate to each active stage, 2) the modulating stage and last stage are determined for the Add-stage and Drop-stage methods, 3) it determines the overflow rate and underflow rate and can provide this to staging algorithms.

OVERFLOW RATE AND UNDERFLOW RATE

The rate allocator knows the rate assigned to each stage, and the requested rate, and thus can determine the difference between these.

This difference has two forms: overflow (used by Add-stage methods), underflow (used by Drop-stage methods).

When asked for rate overflow the threshold that is used is the upper limit of the modulating stage per the current rate allocation rules. Additionally this threshold may be shifted if the Add-stage method is using a dRate/dt behavior. Rate overflow is a positive or negative percentage offset from the threshold. For example:

> If the modulating stage is at the staging threshold position but the LL master is not asking for more heat than this, then the overflow rate is 0%. If it is at this location (limited) or above this location (unlimited) and the LL master is asking for 10% more than the threshold value, then the overflow rate is 10%. If it is below the staging threshold position by 5%, then the overflow rate is -5%.

When asked for rate underflow the threshold that is used is the minimum modulation rate of the last stage. Additionally this threshold may be shifted if the Drop-stage method is using a dRate/dt behavior.

Rate underflow is a positive or negative percentage offset from the threshold. For example:

> If the last stage is at the threshold position but the LL master is not asking for less heat than this, then the underflow rate is 0%. If it is at this location and the LL master is asking for 10% less than the threshold value, then the underflow rate is -10%. If the last stage is 5% above the threshold then the underflow rate is 5%.

Rate Allocation Method (PARALLEL COMMON-BASE LIMITED)

Allocation All stages that are Firing receive the same firing rate. Only the LL - Base load common parameter is used for base loading, the individual slave's base load values are ignored.

As load increases:
Until all stages are Firing: No stage is requested to exceed the common base load rate.

After all stages are Firing: There is no restriction on the slave's commanded firing rate.

As load decreases:
As long as all available stages are Firing, there is no restriction on the slave's commanded firing rate.

When at least one stage has been dropped: No stage is requested to exceed the common base load rate.

Modulating stage Since all Firing stages receive the same rate, any stage can be considered to be the modulating stage. The one with the highest StagingOrder number is considered to be the modulating stage.

Last stage The stage with the highest StagingOrder number is the last stage.

Overflow and Underflow For the Parallel common-base limited the LL - Base load common parameter provides the overflow threshold.

For the Parallel common-base limited the minimum modulation rate provides the underflow threshold.

Stager

The Stager is an internal program that manages the lead lag functions. In all cases:

- The first burner turns on due to the combination of heat demand (call for heat from a source) and setpoint demand (operating point falls below the setpoint minus the on hysteresis).
- The last burner (or all burners) turn off due to the loss of burner demand which is caused by either the loss of heat demand (no call for heat from any source) or the loss of setpoint demand (the operating point climbs above the setpoint plus the off hysteresis).
- In between those two extremes the Add-stage and Drop-stage methods determine when staging occurs.

Table 43. Stager Parameters.

Parameter	Comment
LL - Add-stage interstage delay	mm:ss This specifies the minimum time that the Stager waits after adding one stage before adding another stage or dropping a stage.
LL -Drop-stage interstage delay	mm:ss This parameter specifies the minimum time that the Stager waits after dropping one stage before dropping another stage or adding a stage.

Adding Stages

The internal algorithms that generate AddStageRequests are called Add-stage methods. All methods work by observing various criteria such as the Firing stages, the commanded rate, or setpoint error.

Table 44. Adding Stages Parameters.

Parameter	Comment
LL - Add-Stage detection time1	mm:ss This provides time thresholds.
LL - Add-Stage method1	Disable, Error threshold, Rate threshold, dError/dt and threshold, dRate/dt and threshold In the descriptions below, the relevant AddStageDetectTimer is referred to as AddStageDetectTimerN.
LL - Add-stage error threshold	degrees This provides the error threshold as defined by the methods below.
LL - Add-stage rate offset	-100% to +100% This provides the rate offset threshold as defined by the methods below.

Add-stage Methods

Error threshold For error threshold staging, a stage is added when the error becomes excessive based on degrees away from setpoint, and time.

Add-stage condition:

- The modulating burner(s) is at its (their) maximum position per the rate allocation rules,
- The operating point is below the setpoint by an amount greater than or equal to LL - Add-stage error threshold

When the Add-stage condition is false then AddStageDetectTimerN is set to zero. (If the condition is true then AddStageDetectTimerN is not zeroed and thus allowed to run.) If this timer reaches or exceeds LL- Add-stage detection timeN then AddStageRequestN is true.

Rate threshold For rate based staging, a stage is added based on the rate of the modulating stage.

Add-stage condition The modulating burner is at a rate that is at or above the rate which is calculated by adding the LL - Add-stage rate offset to the maximum position per the rate allocation rules.

Examples:

rate offset = 20% The add-stage condition will occur if the modulating stage is 20% above base load for unlimited allocations, or, if limited, when there is 20% more rate to distribute than can be absorbed by firing the stages at base load.

rate offset = -20% The add-stage condition will be as described just above, but the threshold is now 20% below the modulating stage's base load rate.

To support this, the current Rate Allocation method asks for the current “Overflow rate” - see the Rate Allocator section.

Dropping Stages

The internal algorithms that generate DropStageRequests are called Drop-stage methods. One or two methods may be active at any time. If two are active then their requests are OR'd together. All methods work by observing various criteria such as the Firing stages, the commanded rate, or Setpoint.

Dropping Stages Parameters:

Table 45. Dropping Stages Parameters.

Parameter	Comment
LL - Drop-Stage detection time	mm:ss This provides time thresholds. They differ only in that: LL - Drop-Stage detection time is used with DropStageDetectTimer In the descriptions below, the relevant parameter is referred to as LL – Drop Stage detection timeN.
LL - Drop-Stage method	Disable, Error threshold, Rate threshold, dError/dt and threshold, dRate/dt and threshold

Table 45. Dropping Stages Parameters. (Continued)

Parameter	Comment
LL - Drop-stage error threshold	degrees This provides the error threshold as defined by the methods below.
LL - Drop-stage rate offset	-100% to +100% This provides the rate offset threshold as defined by the methods below.

Drop-stage Methods

Error threshold For error threshold staging, a stage is dropped when the error becomes excessive based on degrees away from setpoint and time.

Drop-stage condition:
- The modulating burner(s) is at its (their) minimum position per the rate allocation rules,
- The operating point is above the setpoint by an amount greater than or equal to LL - Drop-stage error threshold

When the Drop-stage condition is false then **DropStageDetectTimerN** is set to zero. (If the condition is true then **DropStageDetectTimerN** is not zeroed and thus allowed to run.) If this timer reaches or exceeds **LL - Drop-stage detection timeN** then **DropStageRequestN** is true.

Rate threshold For rate based staging, a stage is dropped based on the rate of the last stage.

Drop-stage condition
The modulating burner(s) is at a rate that is at or below the minimum modulation rate plus a rate offset.

Examples:

rate offset = 20% The Drop-stage condition will occur when the last stage is less than a threshold that is the minimum modulation rate plus another 20%.

rate offset = 0% The Drop-stage condition will occur when the last stage is at the minimum modulation rate.

rate offset = -20% The Drop-stage condition will occur if the last stage is at minimum modulation and there is 20% less rate to distribute than can be absorbed; that is, the rate allocator would like the minimum modulation rate to be lower than it is.

To support this, the current Rate Allocation method asks for the current “Underflow rate” - see “Rate Allocation Methods” on page 84.

Sequencer

The sequencer determines which Falcon is next whenever an Add-stage event occurs. It maintains the following variables:

LeadBoilerSeqNum - sequence number of the current lead boiler in the Slave Status table.

Lead BoilerRunTime - the cumulative time that the current lead boiler has been running

In all cases, if a boiler sequence number is needed and LL - Slave sequence order is 0, then the boiler's modbus address is used as its sequence number.

In all cases, if two boilers being compared have the same effective sequence number, then the one that is selected is undefined (either may prevail).

Table 46. Sequencer Parameters.

Parameter	Comment
LL - Lead selection method	Rotate in sequence order, Measured run time This determines the selection method for lead selection and sequencing, as described below.
LL - Lag selection method	Sequence order, Measured run time This determines the selection method for lag selection and sequencing, as described below.
LL - Lead rotation time	hh:mm or None This determines the lead rotation time as defined below.
LL - Force lead rotation time	hh:mm or None If this parameter is a non-zero time, then it is used to force the rotation of the lead boiler if it stays on longer than the time specified.

Sequencer Add Boiler Selection

The sequencer selects the next boiler to be added according to a sorted order. This description assumes this is implemented by assigning an ordering number and that the lowest numbers are the first to be added.

- Any Available slaves that have a mode of Use First will have the lowest ordering numbers. If two or more Use First boilers exist, they are numbered according to their assigned LL - Slave sequence order or Modbus address if this value is zero, as described above.
- Next are slaves that have the mode of Equalize Runtime. When the add boiler routine gets to this group it first invokes the Voluntary Lead Rotation routine (to make sure this is done, but only once) and then selects an Available boiler, if any, ordered according to:
    - The first is the lead boiler per the LeadBoilerSeqNum parameter.
    - The rest are the other slaves ordered according to the LL –Lag selection method} parameter:
- If this parameter is “Rotate in sequence order”, then they are ordered according to their LL – Slave sequence order or Modbus address if this value is zero, as described above.

- If this parameter is "Measured run time" then they are ordered according to their reported run time. If two have the same measured run time, then either may be selected.
- Last are any Available slaves that have a mode of Use Last. These will have the highest numbers. If two or more Use Last boilers exist, they are numbered according to their assigned LL - Slave sequence order or Modbus address if this value is zero, as described above.

Voluntary Lead Rotation

The current lead boiler is identified by the LeadBoilerSeqNum value. This value will change when the stager has asked the sequencer for a boiler to add and either:

- the boiler identified by LeadBoilerSeqNum is neither Available nor Firing (i.e. it has a fault or is OnLeave), or
- the LeadBoilerRunTime value exceeds LL - Lead rotation time.

In either of these cases, the algorithm performed is:

If the **LL - Lead selection method** is "Rotate in sequence order", then
LeadBoilerSeqNum is incremented, and then new lead boiler is the one that is a slave in Equalize Runtime mode that is responding to the LL master (i.e. not OnLeave or Recovering, but it might be Firing), and:

- has a sequence number equal to LeadBoilerSeqNum, or
- If no boiler has this then the closest one with a sequence number greater than this number is used, or
- If no boiler has a greater sequence number, then the one that has the smallest sequence number is used (wrap around).

Otherwise when the LL - Lead selection method is "Measured run time", then the lead boiler is the one having the lowest Measured run time value. If two have the same measured run time, then either may be selected.

The LeadBoilerRunTime value is then set to zero to give the new lead boiler a fresh allotment.

NOTE: if the old lead boiler is the only one, then this process may end up redesignating this as the "new" lead with a fresh time allotment.

Forced Lead Rotation

When the boiler identified by LeadBoilerSeqNum is firing and also LeadBoilerRunTime reaches the LL - Force lead rotation time parameter time then:

1. The current lead boiler is noted.
2. Lead rotation occurs as described above under Voluntary Lead Rotation (this changes the designation, but does not change the actual firing status).

SLAVE WRITE: DATA

This allows the slave to accept command messages from a Falcon master.

SLAVE READ: DATA

This provides the slave status message to be read by a master. It includes all of the data that is read from a slave.

SLAVE MODE: USE FIRST, EQUALIZE RUNTIME, USE LAST

- If set to Use First, then this slave will be used prior to using other slave slaves with other values.
- If this parameter is set to Equalize Runtime, then this slave will be staged according to a run time equalization. (Any slaves set to Use First will precede any that are set to Equalize Runtime.)
- If this parameter is set to Use Last, then this slave will be used only after all Use First and Equalize Runtime slaves have been brought online.

SLAVE PRIORITY SEQUENCE ORDER: 0-255

Slave sequence order is used to determine the order in which the slaves will be used (staged on) for those slaves with the same Slave mode setting. Numbers may be skipped, that is 3 will be first if there is no 1 or 2.

NOTE: For Equalize Runtime purposes, 1 does not mean the slave will be used first every time; that will vary over time based on the master's run time equalization scheme. In this case the sequence number determines the relative order in which slave controls will be used in a round-robin scheme.

If the slave sequence number value is zero, then the slave's Modbus address will be used instead.

If two slaves are set to the same mode and both have the same sequence number then an alert will occur and the order in which they are used will be arbitrary and is not guaranteed to be repeatable.

Sequencer Ordering Function

Part of the sequencer is called by the stager just before the stager runs, to give the sequencer a chance to assign order numbers to stages that very recently turned on, and to maintain these in a sequence. It uses the StagingOrder item in the Slave Status table for this purpose.

The sequencer ordering function examines all slaves and sets to zero the StagingOrder of any stage that is not Firing.

This ensures that any stage that has left the Firing condition recently is no longer in the number sequence.

Next, skipping all of those that have 0 values in StagingOrder it finds the lowest numbered StagingOrder and gives it the value 1, the next receive 2, etc.

Thus if gaps have developed due to a slave dropping out these are filled in.

Finally, the ordering function continues on, giving the next numbers to and Firing stages which have a 0 StagingOrder values (i.e. they recently were added, or they recently returned from OnLeave).

Example:

	Before	After
Notfiring	3	0
Notfiring	0	0
Firing	2	
Firing	5	
Firing	0	
Firing	4	

Sequencer Drop Lag Boiler Selection

When the stager asks the sequencer for a lag boiler to drop the sequencer looks at the StagingOrder numbers of all Firing boilers. If only one Firing boiler is found, or none are found, then this selection function returns a value that indicates no boiler may be dropped. Otherwise it returns an identifier for the boiler having the highest StagingOrder number.

Sequencer 1 Minute Event

Part of the sequencer is called by the timing service at a 1 minute rate to implement lead rotation.

The 1 minute event checks the boiler identified by LeadBoilerSeqNum. If it is Firing then the LeadBoilerRunTime is incremented.

Alert and Fault message information is shown in APPENDIX C.

APPENDIX A: PARAMETER GLOSSAR

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
20 mA CH pressure	PSI or None Establishes the pressures for the end points of the 4-20 mA inputs	30
4 mA water temperature	Degrees Establishes temperature for 4 mA input	26
20 mA water temperature	Degrees Establishes temperature for 20 mA input	26
Absolute max fan speed	The fan will never be commanded to operate above the RPM provided by this parameter, regardless of the rate request.	51
Absolute min fan speed	The fan will never be commanded to operate below the RPM provided by this parameter, regardless of the rate request, except by commanding it to turn off.	51
Alarm silence time	Alarms can be silenced for the amount of time given by this parameter.	63
Analog output hysteresis	When modulating via 0-10V or 4-20mA, changes in the direction of PID output can be limited by a small amount of hysteresis, to decrease the occurrence of actual control reversals.	52
Annunciation enable	This parameter determines whether the Annunciator features of the Falcon are active. When disabled, the Falcon will ignore the Annunciator inputs (because the application does not use this feature).	20
Annunciator 1 location	The location of the contacts monitored by the A1 annunciator input.	61
Annunciator 1 long name	The long name (up to 20 characters) of the A1 annunciator input.	61
Annunciator 2 location	The location of the contacts monitored by the A2 annunciator input.	61
Annunciator 2 long name	The long name (up to 20 characters) of the A2 annunciator input.	61
Annunciator 3 location	The location of the contacts monitored by the A3 annunciator input.	61
Annunciator 3 long name	The long name (up to 20 characters) of the A3 annunciator input.	61
Annunciator 4 location	The location of the contacts monitored by the A4 annunciator input.	61
Annunciator 4 long name	The long name (up to 20 characters) of the A4 annunciator input.	61
Annunciator 5 location	The location of the contacts monitored by the A5 annunciator input.	61
Annunciator 5 long name	The long name (up to 20 characters) of the A5 annunciator input.	61
Annunciator 6 location	The location of the contacts monitored by the A6 annunciator input.	61
Annunciator 6 long name	The long name (up to 20 characters) of the A6 annunciator input.	61
Annunciator 7 location	The location of the contacts monitored by the A7 annunciator input.	61
Annunciator 7 long name	The long name (up to 20 characters) of the A7 annunciator input.	61
Annunciator 8 location	The location of the contacts monitored by the A8 annunciator input.	61
Annunciator 8 long name	The long name (up to 20 characters) of the A8 annunciator input.	61
Annunciator mode	The annunciator may be fixed, in which the labels and locations of the inputs is pre-assigned, or programmable in which these things may be altered.	61

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Annunciator 1 short name	The short (3 letter) name of the contacts monitored by the A1 annunciator input.	61
Annunciator 2 short name	The short (3 letter) name of the contacts monitored by the A2 annunciator input.	61
Annunciator 3 short name	The short (3 letter) name of the contacts monitored by the A3 annunciator input.	61
Annunciator 4 short name	The short (3 letter) name of the contacts monitored by the A4 annunciator input.	61
Annunciator 5 short name	The short (3 letter) name of the contacts monitored by the A5 annunciator input.	61
Annunciator 6 short name	The short (3 letter) name of the contacts monitored by the A6 annunciator input.	61
Annunciator 7 short name	The short (3 letter) name of the contacts monitored by the A7 annunciator input.	61
Annunciator 8 short name	The short (3 letter) name of the contacts monitored by the A8 annunciator input.	61
Anticondensation > Delta-T	Anti-condensation (rate increase) may have a higher or lower priority than Delta-T (rate decrease), when both of these are active and competing.	50
Anticondensation > Forced rate	Anti-condensation (rate increase) may have a higher or lower priority than forced rate (a specific firing rate), when both of these are active and competing.	50
Anticondensation > Outlet limit	Anti-condensation (rate increase) may have a higher or lower priority than Outlet high limit (rate decrease), when both of these are active and competing.	50
Anticondensation Priority	Anticondensation is more important than (check those that apply): Stack limit, Delta T limit, Slow start, Forced rate, Outlet high limit	50
Anticondensation > Slow start	Anti-condensation (rate increase) may have a higher or lower priority than slow start (a specific firing rate slope), when both of these are active and competing.	50
Anticondensation > Stack limit	Anti-condensation (rate increase) may have a higher or lower priority than Stack high limit (rate decrease), when both of these are active and competing.	50
Anti short cycle time	Whenever the burner is turned off due to no demand the anti-short-cycle timer is started and the burner remains in a Standby Delay condition waiting for this time to expire. Does not apply, however, to recycle events or DHW demand.	21
BLR function	This parameter selects the function for the output terminal—J5 Terminal 5 and 6.	56
Burner name	This parameter allows each control to have a unique name.	20
Boiler pump cycles	Can be written to a new value (e.g. if the pump or controller is replaced).	6
Burner cycles	Burner cycle count. Incremented upon each entry to Run. Can be written to a new value (e.g. if the burner or controller is replaced).	6
Burner run time	Burner run time. Measures the time spent in the Run state. Can be written to a new value (e.g. if the burner or controller is replaced).	6
Burner switch	This parameter enables or disables the burner control. When it is off, the burner will not fire.	19
CH anticondensation enable	This parameter enables or disables anti-condensation for CH and LL demand.	50
CH anticondensation pump	If CH anti-condensation is in control of the burner and this parameter is Forced off, then the CH pump is turned off to warm up the heat exchanger more quickly.	50
CH anticondensation setpoint	If CH anti-condensation is enabled, has priority, CH or LL slave is firing the burner, and the outlet temperature is below this parameter then the firing rate set to the Maximum modulation rate until the temperature exceeds this by 4 degrees F.	50
CH D gain	This gain applied to the Differential term of the PID equation for the CH loop.	26
CH Demand source	Local, Modbus, 4-20 mA	26
CH demand switch	The source of CH loop control can be specified to use different inputs.	25
CH enable	This parameter determines whether the CH loop is enabled or disabled. It may be disabled to turn it off temporarily, or because the application does not use this feature.	19

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
CH forced rate	For CH demand, if the CH forced rate time is non-zero, then the firing rate will be held at the rate specified here during that time. This parameter is also needed as the starting point for Slow State, even if the forced rate time is zero.	48
CH forced rate time	For CH demand, if this time is non-zero then, upon entry to Run, the firing rate will be held at the CH forced rate.	48
CH frost protection enable	The CH frost protection feature can be enabled to turn the CH pump and possibly fire the burner whenever the CH input sensor is too cold.	41
CH has Priority over Lead Lag	Yes, No, Cancel	19
CH hysteresis step time	The time needed for one step of hysteresis shift, when the off hysteresis threshold or on hysteresis threshold is shifted due to a burner-on or burner-off event, respectively. Zero disables this function.	26
CH I gain	This gain applied to the Integral term of the PID equation for the CH loop.	26
CH maximum modulation rate	Provides the upper limit of analog output or fan speed during modulation when firing for CH.	51
CH maximum outdoor temperature	This parameter determines the maximum outdoor temperature for the CH outdoor reset graph. At the maximum outdoor temperature the setpoint will be the minimum water temperature.	27
CH minimum outdoor temperature	This parameter determines the X coordinate of one point on the ODR graph. At this outdoor temperature the setpoint will be the CH setpoint (or the CH TOD setpoint, if TOD is on).	27
CH minimum pressure	Provides the minimum Steam Pressure used to calculate the 4-20mA remote controlled setpoint.	30
CH minimum water temperature	This parameter provides the CH setpoint when the outdoor reset temperature is at its defined maximum.	27
CH ODR boost setup	Degrees or None	27
CH ODR boost recovery setup time	mm:ss	27
CH ODR maximum water temperature	This parameter determines one point on the ODR graph. At the maximum outdoor temperature, the setpoint will be the minimum water temperature.	27
CH ODR minimum outdoor temperature	This parameter determines the X coordinate of one point on the ODR graph. At that outdoor temperature, the setpoint will be the CH setpoint (or the CH TOD setpoint, if TOD Is on).	27
CH ODR minimum water temperature	This parameter determines one point on the ODR graph. At the maximum outdoor temperature, the setpoint will be the minimum water temperature.	27
CH off hysteresis	The off hysteresis is added to the CH setpoint to determine the temperature at which this demand turns off	26
CH on hysteresis	The on hysteresis is subtracted from the Setpoint to determine the temperature at which demand turns on.	26
CH outdoor reset	If outdoor reset is enabled then the current outdoor temperature is used to determine the Setpoint by interpolation using CH Setpoint (or CH Time-Of-Day Setpoint if TOD is on), the min water temperature, and the min and max outdoor temperatures.	26
CH P gain	This gain applied to the proportional term of the PID equation for the CH loop.	26
CH pump cycles	Can be written to a new value (e.g. if the pump or controller is replaced).	6
CH frost overrun time	This time indicates how long the CH pump should remain on after frost protection demand ends. That is, whenever the pump has been on due to frost protection and then this demand ends, it always continues to run for the time given by this parameter.	41
CH sensor or Inlet	The sensor used for modulation and demand may be either the Outlet sensor or a 4-20mA Header sensor input.	25
CH setpoint	This Setpoint is used when the time-of-day input is off. If the ODR function is active, this Setpoint provides one coordinate for the outdoor reset curve, as described for the CH Outdoor Reset parameter.	25
CH setpoint source	Local S2 (J8-6) 4-20mA	26
CH slow start enable	This parameter enables or disables the slow start limit function for CH (or LL slave) demand.	49

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
CH TOD setpoint	This Setpoint is used when the time-of-day input is on. If the ODR function is active, this Setpoint provides one coordinate for the shifted (because TOD is on) outdoor reset curve, as described for the CH Outdoor Reset parameter.	26
DBI time	None, 4 sec, 10 sec, 15 sec	58
Delta-T degrees	If the outlet is hotter than the inlet temperature by the amount given by this parameter, the response defined for the Delta-T Limit Response will occur. Stepped Modulation Limiting will occur as the temperature approaches this limit.	44
Delta-T delay	This parameter provides the delay time for the Delta-T limit.	44
Delta-T enable	This parameter enables or disables the entire delta-T limit function.	43
Delta-T exch/outlet enable	Disable, Enable Delta-T, Enable Inversion Detection, Enable Delta-T and Inversion Detection.	43
Delta-T inlet/exch enable	Disable, Enable Delta-T, Enable Inversion Detection, Enable Delta-T and Inversion Detection.	43
Delta-T inlet/outlet enable	Disable, Enable Delta-T, Enable Inversion Detection, Enable Delta-T and Inversion Detection.	43
Delta-T inverse limit time	This provides the time limit during which inverted temperature is tolerated when one of the two inverse detection option is enabled.	44
Delta-T inverse limit response	If temperature inversion detection is enabled and it persists for the time given by the Delta-T inverse limit time, then the response described by this parameter occurs. The delay time used is the time specified by the Delta-T delay and the retry limit is the count specified by the Delta-T retry limit.	44
Delta-T rate limit enable	Disable then no modulation limiting occurs as the delta-T threshold is approached. Enable, then the Stepped Modulation Limiting feature is active for Delta-T.	44
Delta-T response	If the temperature difference exceeds the limit and Recycle && delay is selected then the burner control recycles and holds while waiting for a delay (see the Delta-T Limit Delay parameter) to expire.	44
Delta-T retry limit	If either the Delta-T response or the Delta-T inverse limit response specify a retry limit, then any recycles due to reaching the corresponding response threshold are counted. If this count ever exceeds the “n” value, then a lockout occurs.	44
DHW anticondensation enable	This parameter enables or disables anti-condensation for the DHW sensor.	50
DHW anticondensation setpoint	If DHW anti-condensation is enabled, has priority, DHW is firing the burner, and the outlet is below the temperature given by this parameter then the firing rate set to the Maximum modulation rate until the temperature exceeds this by 4 degrees F.	50
DHW Connector Type	Designates the Sensor type connected to the control for proper reading.	20
DHW D gain	This gain applied to the Differential term of the PID equation for the DHW loop.	34
DHW demand switch	The source of DHW loop control can be specified to use different inputs.	34
DHW enable	This parameter determines whether the DHW loop is enabled or disabled. It may be disabled to turn it off temporarily or because the application does not use this feature.	19
DHW forced rate	For DHW demand, if the DHW forced rate time is non-zero, then the firing rate will be held at the rate specified here during that time. This parameter is also needed as the starting point for Slow State, even if the forced rate time is zero.	48
DHW forced rate time	For DHW demand, if this time is non-zero then, upon entry to Run, the firing rate will be held at the DHW forced rate.	48
DHW frost overrun time	This time indicates how long the DHW pump should continue to run after DHW frost protection pump demand ends.	42
DHW frost protection enable	The DHW frost protection feature can be enabled to turn the DHW pump and possibly fire the burner whenever the DHW input sensor is too cold.	42
DHW high limit	This parameter enables or disables the DHW high limit function. It must be disabled when the DHW input is used as a switch to indicate DHW demand.	49

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
DHW high limit response	If Recycle && hold is selected, the burner control recycles and waits for the DHW temperature to fall. It will remain in this holding condition until the DHW temperature is lower than the DHW high limit temperature minus 5 degrees F.	49
DHW high limit setpoint	If the DHW temperature reaches the value given by this parameter then a response will occur.	49
DHW hysteresis step time	The time needed for one step of hysteresis shift, when the off hysteresis threshold or on hysteresis threshold is shifted due to a burner-on or burner-off event, respectively. Zero disables this function.	34
DHW I gain	This gain applied to the Integral term of the PID equation for the DHW loop.	34
DHW maximum modulation rate	Provides the upper limit of analog output or fan speed during modulation when firing for DHW.	51
DHW modulation sensor	This parameter selects the source of modulation control for the DHW system. If the selected input is not a temperature (e.g. S1 is steam pressure for a steam control) then an alert occurs and the DHW control subsystem is suspended.	35
DHW off hysteresis	The off hysteresis is added to the DHW Setpoint to determine the temperature at which DHW demand turns off	34
DHW on hysteresis	The on hysteresis is subtracted from the DHW Setpoint to determine the temperature at which DHW demand turns on.	34
DHW P gain	This gain applied to the Proportional term of the PID equation for the DHW loop.	34
DHW priority source	Disabled, DHW heat demand	19
DHW priority method	Boost during priority time, drop after priority time	19
DHW Priority Time ODR Enable	When enabled, the DHW Priority Override Time is derated when the outdoor temperature is below 32°F. When the outdoor temperature is at or above 32°F, the programmed time is used as-is. For temperatures at or below -40°F, the programmed override time is derated to zero (no override). Between 32°F and -40°F, a linear interpolation is used. For example, at -4°F, DWH priority override time is half the value provided by the parameter.	34
DHW priority versus CH	This parameters determines the priority of DHW versus the CH call-for-heat, when both of these are enabled and active. (If DHW has a lower priority, it may be boosted to the highest priority temporarily via the DHW Priority Override Time parameter.)	20
DHW priority versus LL	This parameters determines the priority of DHW versus the LL slave call-for-heat, when more than one source is enabled. (If DHW has a lower priority, it may be boosted to the highest priority temporarily via the DHW Priority Time parameter.)	20
DHW priority override time	If this parameter is non-zero then a DHW demand will take priority over other demand sources for the specified time. If this persists for longer than this time the priority will expire. The timer is reset when demand from the DHW source turns off.	20
DHW pump cycles	Can be written to a new value (e.g. if the pump or controller is replaced).	6
DHW pump frost protection overrun time	This time indicates how long the DHW pump should remain on after frost protection demand ends. That is, whenever the pump has been on due to frost protection and then this demand ends, it always continues to run for the time given by this parameter.	42
DHW setpoint	This Setpoint is used whenever the time-of-day switch is off or not connected (unused).	34
DHW slow start enable	This parameter enables or disables the slow start limit function for DHW demand.	49
DHW storage enable	This parameter enables or disables the DHW storage feature. If it is disabled then the other parameters below are ignored.	39
DHW storage off hysteresis	This provides the off hysteresis as an offset that is applied to the DHW storage setpoint, used during DHW storage demand.	39
DHW storage on hysteresis	This provides the on hysteresis as an offset that is applied to the DHW storage setpoint, used during DHW storage demand.	39
DHW storage setpoint	The temperature setpoint that the boiler maintains during the DHW storage time.	39
DHW storage time	The time DHW storage temperature is maintained.	39
DHW time of day setpoint	This Setpoint is used when the time-of-day switch is on.	34

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Exchanger T-Rise enable	This enables/disables temperature rise detection for the heat exchanger sensor S9 (J9 terminal 6).	44
Fan during off cycle rate	If this parameter is non-zero for a control that is enabled as a LL slave, then it provides the modulation rate (e.g. fan speed) that should be used when the LL master indicates this burner should be off but should run its fan at the off cycle rate.	
Fan gain down	This parameter determines how aggressively the fan controller changes the fan duty cycle when the fan should slow down. It is the gain of a first-order filter (e.g. it is the I gain of a PID control in which the P and D gains are always zero).	52
Fan gain up	This parameter determines how aggressively the fan controller changes the fan duty cycle when the fan should speed up. It is the gain of a first-order filter (e.g. it is the I gain of a PID control in which the P and D gains are always zero).	52
Fan min duty cycle	Whenever a variable speed fan is on it will never receive a duty cycle less than this parameter's value. It should be set to the duty cycle at which the fan is guaranteed to keep spinning (after it has started) so that it will never stall.	52
Fan speed error response	If fan fails in Run and recycle is selected then the burner control recycles back to the beginning of Prepurge, then continues with the normal burner startup process to attempt to bring the fan up to speed again.	60
Firing rate control	If one of the manual modes is chosen then the Manual Rate parameter controls the firing rate during the specified states.	51
Flame sensor type	Different kinds of flame detectors may be used. This parameter tells the control what type of sensor is installed.	58
Flame threshold	The flame threshold can be adjusted to match various kinds of flame detectors and equipment. It is specified in tenths of volts, where 0.1V = 0.1 microamp for a flame rod.	
Forced recycle interval time	After scheduled time of continuous run, system is recycled, specifically if inversion detection is used to provide Safe Start.	58
Frost protection anticondensation enable	When Frost Protection is in control, either the CH or DWH anticondensation function is enabled.	50
Frost protection method	Determines what happens when Frost Protection (from any source) becomes active.	42
Heat exchanger high limit	This enables/disables temperature rise detection for the heat exchanger sensor S9 (J9 terminal 6).	45
Heat exchanger high limit delay	Specifies the delay time that occurs whenever a recycle occurs due to a Heat exchanger high limit event and the specified response includes “Recycle...” The burner will remain in the Standby Hold condition until the delay expires.	45
Heat exchanger high limit response	Specifies response should “Heat exchanger high limit setpoint” threshold is reached.	45
Heat exchanger high limit setpoint	Provides the setpoint at which a response occurs if “Heat exchanger high limit” function is enabled.	45
Heat exchanger retry limit	If the “Heat exchanger high limit response” specifies a retry limit, then any recycles due to reaching the heat exchanger high limit threshold are counted. If this count ever exceeds the “n” value, then a lockout occurs.	45
Heat exchanger T-rise enable	Enabled, Disabled	45
IAS start check enable	This parameter enables a start check for the Interrupted Air Switch input. If enabled, this input must be off before leaving Standby, to prove that it is not shorted.	57
Ignite failure delay	When Recycle && hold after retries is selected as the response for an ignition failure, this parameter provides the delay time for the hold.	60
Ignite failure response	If ignition fails then several responses are possible. This parameter selects one of these responses.	60
Ignite failure retries	This parameter provides the number of retries for an ignition failure, if the response to failure of ignition includes retries.	60
Igniter on during	The igniter may be on throughout the pilot establishing period, or only during the first half of it (early ignition termination). Ignored if DBI is selected.	59
Ignition source	Several outputs may be selected as the ignition source. This parameter selects one of these.	60

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
ILK bounce detection enable	Enable, Disable	57
ILK long name	The long name (up to 20 characters) of the ILK annunciator input.	61
ILK short name	The short (3 letter) name of the contacts monitored by the ILK annunciator input.	61
Inlet Connector Type	Designates the sensor type connected to the control for proper reading.	20
Installation data	The installer may edit this parameter to provide installation information.	21
ILK/IAS open response	During prepurge after a delay to establish airflow and during Ignition, MFEP, and Run, the burner control requires the ILK to remain on. If it opens during these times, this parameter determines the response: either a lockout or a recycle.	57
Interlock (ILK) start check enable	If enabled, the control will check the ILK input as it exits the Standby condition in response to demand. If on, the burner control will hold waiting for it to turn off. If this hold time expires and the ILK is still on, a lockout occurs.	57
Interrupted air switch (IAS) enable	This parameter enables the Interrupted Air Switch input. If enabled it is tested in the same way and during the same states as the ILK input.	57
LCI enable	The LCI input may be enabled as a recycle interlock, or this may be disabled. (It is normal to disable the LCI here if it is to be used as a demand input for the CH control loop.)	57
LCI long name	The long name (up to 20 characters) of the LCI annunciator input.	61
LCI short name	The short (3 letter) name of the contacts monitored by the LCI annunciator input.	61
Lead Lag frost protection enable	Enabled, Disabled	80
Lead Lag frost protection rate	Set the protection rate as a percentage. 100% represents 100% firing of this boiler, and where 0% or any value less than the boiler's minimum firing rate represents the minimum firing rate.	80
Lead lag time of day setpoint	This Setpoint is used when the time-of-day input is on. If the ODR function is active, this Setpoint provides one coordinate for the shifted (because TOD is on) outdoor reset curve, as described for the LL Outdoor Reset parameter.	Not available at this time.
Lightoff rate	This parameter specifies the analog output or fan speed used during Ignition.	51
Lightoff rate proving	This parameter specifies the input used to confirm the Prepurge rate has been reached.	58
LL - Base load rate	This specifies the preferred firing rate of a burner, which is used for some types of control.	77
LL - Demand-to-firing delay	This delay time is needed by the LL master to determine the length of time to wait between requesting a slave unit to fire and detecting that it has failed to start. It should be set to the total time normally needed for the burner to transition from Standby to Run, including such things as transition to purge rate, prepurge time, transition to lightoff rate, all ignition timings, and include some extra margin.	77
LL - Fan during off-cycle rate	This determines if or where the fan is to be operating during the standby period.	77
LL master enable	Disable, Enable	77
LL master Modbus port	The LL master may be disabled, enabled. If Disable is selected then all LL master functions are inactive. If Enable is selected then it acts as the active bus master at all times on the Modbus port it is assigned to use by the LL Master Modbus port parameter.	77
LL operation switch	This controls the LL master in the same way that the Burner switch controls a stand-alone unit. If “On” then the LL master is enabled to operate. If this parameter is “Off” then the LL master turns off all slaves and enters an idle condition.	77
LL - Slave enable	It enables or disables the “LL Slave” Demand and Rate module.	76
LL - Slave mode	If set to Use First, then this slave will be used prior to using other slave units with other values. If this parameter is set to Equalize Runtime, then this slave will be staged according to a run time equalization. (Any units set to Use First will precede any that are set to Equalize Runtime.) If this parameter is set to Use Last, then this slave will be used only after all Use First and Equalize Runtime units have been brought online.	76
LL - Slave priority sequence order	Slave sequence order is used to determine the order in which the slave units will be used (staged on) for those units with the same Slave mode setting. Numbers may be skipped, that is 3 will be first if there is no 1 or 2.	77
LL - Slave read	This provides the slave status message to be read by a Master. It includes all of the data that is read from a slave.	76

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
LL - Slave write	This allows the slave to accept command messages from a master.	76
Manual firing rate	This parameter specifies the analog output or fan speed during burner modulation, when the Firing rate control parameter specifies Manual mode.	51
MFEP	This parameter provides choices for the duration of the MFEP (main flame establishing period) time. Flame must remain on throughout the MFEP or a response occurs. Not needed and ignored unless the Pilot type is Interrupted.	60
MFEP flame failure response	If flame fails in the Main Flame Establishing Period and recycle is selected then the burner control recycles back to the beginning of Prepurge, then continues with the normal burner startup process to attempt to light the burner again.	60
Minimum modulation rate	Provides the lower limit of analog output or fan speed during modulation (this is for both CH and DHW).	51
Modulation output	This parameter selects the modulation output. The Falcon software responds by driving the appropriate circuit to provide modulation of firing rate.	51
Modulation rate source	If the modulation rate source is Local, then the control's PID algorithm determines the modulation rate. If the modulation rate source is S2 4-20mA, then the modulation rate is determined by the S2 4-20mA modulation routine that exists in prior controls. If this sensor is invalid then the control behaves as if Local were selected.	26
Modulation sensor	The selected input provides the temperature clearance for modulation control. As a startup check, if the CH Loop is enabled for a hydronic system, and if the select sensor is not a temperature input, then this causes an alert and forces the CH loop to suspend.	26
NTC sensor type	The sensors used may all be the 10K NTC type in which safety sensors are redundant, or all be a 12K NTC type in which no sensors are redundant and external temperature limit devices are required. The latter is for MCBA retrofit compatibility.	57
OEM identification	The OEM may provide identification information here.	21
Outdoor Connector Type	Designates the Sensor type connected to the control for proper reading.	20
Outdoor frost protection setpoint	This parameter provides the setpoint for frost protection based on outdoor temperature. When the outdoor temperature falls below this threshold then frost protection will be active.	
Outlet Connector Type	Designates the Sensor type connected to the control for proper reading.	20
Outlet high limit enable	Used to set the Outlet high limit on or off.	46
Outlet high limit response	If Recycle && hold is selected, the burner control recycles and waits for the outlet temperature to fall. It will remain in this holding condition until the outlet temperature is lower than the outlet high limit temperature minus 5 degrees F.	46
Outlet high limit setpoint	If the outlet temperature reaches the value given by this parameter, a response will occur.	46
Outlet T-Rise enable	This enables/disables temperature rise detection for the outlet sensor S3 (J8 terminal 8).	44
PFEP	This parameter provides choices for the duration of the pilot flame establishing period. Flame must be on at the end of this period. This parameter is ignored if DBI (Direct Burner Ignition) is selected.	59
PII enable	This parameter enables the Pre-Ignition Interlock input. If disabled the PII input is ignored.	57
PII long name	The long name (up to 20 characters) of the PII annunciator input.	61
PII short name	The short (3 letter) name of the contacts monitored by the PII annunciator input.	61
Pilot test hold	If the Pilot type is Interrupted or Intermittent and this parameter is enabled then the burner control sequence will hold (forever) at 1 second into the Ignition state, while monitoring the flame via a 15 second timer.	57
Pilot type	Interrupted pilot turns off after MFEP (main flame establishing period). Intermittent pilot remains on during the Run period (no MFEP). DBI (direct burner ignition) indicates the main flame is lit directly using a 4 second ignition period.	58
Plate preheat delay after tap	Whenever the Preheat block is false, it monitors the Tap demand block's output and operates a timer that ensures preheat will not begin too soon after a tap demand has recently ended.	37

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page

Plate preheat off hysteresis	The preheat off threshold is calculated as:
	T_{OFF} = Plate preheat setpoint + Plate preheat off hysteresis
	If the preheat block is True, then it becomes False when:
	• Tap during Preheat is recognized (see below) OR
	• Both
	  • DHW sensor temperature >= T_{OFF}, AND
	  • The preheat minimum on time has elapsed.
		37

Plate preheat minimum on time	This parameter provides the minimum on time for preheating.	38
Plate preheat on hysteresis	The preheat on threshold is calculated as: T_{ON} = Plate preheat setpoint - Plate preheat on hysteresis If the preheat block is False, then it is Set (becomes True) when: **1.** Tap demand is false, AND **2.** The preheat delay-after-tap time has elapsed, AND **3.** DHW sensor temperature <= T_{ON}, AND **4.** The above have remained true for the time specified by: Plate preheat on recognition time That is, whenever conditions 1, 2, or 3 are not true, a preheat recognition timer is reset. Whenever they are all true then the timer is allowed to run. If the time elapses then the preheat block becomes true (preheat is active, and this causes the plate demand to be true).	38
Plate preheat on recognition time	This parameter provides the time duration for recognizing that preheat demand exists.	37
Plate preheat setpoint	This parameter provides the DHW setpoint used when firing for preheat. It also is used as the basis for detecting the need to preheat.	37
Postpurge rate	This parameter specifies the analog output or fan speed used during Postpurge.	51
Postpurge time	This parameter sets the burner control's postpurge time. Setting this parameter to zero disables prepurge.	57
Preignition time	hr:mm:ss	59
Prepurge rate	This parameter specifies the analog output or fan speed used during Prepurge.	51
Prepurge time	This parameter sets the burner control's prepurge time. Setting this parameter to zero disables prepurge.	57
Pulses per revolution	The number of pulses per revolution of the fan is provided by this parameter. (Typically it is the number of Hall-effect sensors that the fan contains.)	52
Pump exercise interval	This parameter specifies the maximum number of days that a pump can be off. If this limit is reached then the pump is turned on for the specified exercise time. If the interval is zero then this exercise function is disabled.	55
Pump exercise time	This parameter specifies the amount of time that a pump remains on, when it has been turned on due to the exercise interval. If this time is zero then the exercise function is disabled.	55
Purge rate proving	This parameter specifies the input used to confirm the Prepurge rate has been reached.	58
PWM frequency	This parameter provides the frequency of the pulse-width modulation for variable speed fan control.	52
Run flame failure response	If flame fails in Run and recycle is selected then the burner control recycles back to the beginning of Prepurge, then continues with the normal burner startup process to attempt to light the burner again.	60
Run stabilization time	During run stabilization the modulation rate is held at the Lightoff Rate parameter setting and is released for modulation only after the hold time given by this parameter has expired. If this parameter is zero then there is no stabilization time.	57
Slow down ramp	Whenever the burner is firing it will be commanded to decrease its RPM no faster than the rate provided by this parameter.	52
Slow start ramp	When slow start limiting is effective, the modulation rate will increase no more than the amount per minute given by this parameter.	49
Slow start setpoint	If slow start limiting is enabled and the outlet temperature is less than the temperature provided by this parameter, slow start rate limiting is effective, whereas whenever the outlet temperature is above this value, slow start limiting has no effect.	49
Spark Voltage	Spark voltage configuration for Safety uC	

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Speed up ramp	Whenever the burner is firing it will be commanded to increase its RPM no faster than the rate provided by this parameter.	52
Stack Connector Type	Designates the Sensor type connected to the control for proper reading.	20
Stack limit delay	This parameter provides the delay time for the Stack limit.	46
Stack limit enable	This parameter enables or disables the entire stack temperature limit function.	46
Stack limit response	For Recycle and Delay, the burner control recycles and holds while waiting for a delay (see the Stack Limit Delay parameter) to expire, and after the delay it tries again.	46
Stack limit setpoint	If the stack temperature exceeds the temperature given by this parameter then the response defined for the Stack Limit Response parameter will occur. As the temperature approaches this limit, the Stepped Modulation Limiting function is active.	46
Standby Rate	Specifies the analog output of fan speed used during standby or demand off time.	51
Steam 4-20mA remote	Allows modulation from source other than pressure sensor.	30
Steam D gain	Gain applied to the differential	30
Steam enable	Disable/enable steam feature.	29
Steam demand source	The source of Steam loop control can be specified to use different inputs.	29
Steam hysteresis step time	Time for each step.	30
Steam I gain	Gain applied to the Integral.	30
Steam min. pressure	Provides minimum pressure used to calculate the 4-20ma setpoint for 4ma.	30
Steam P gain	Gain applied to the Proportional.	30
Steam pressure off hysteresis, on hysteresis	On or Off hysteresis adjusted to the setpoint at which this demand turns off or on.	30
Steam pressure setpoint	Pressure Control setpoint	30
Steam sensor	The sensor used for modulation and demand - typically a 4-20ma source.	29
Steam time of day setpoint	Provides the steam pressure setpoint when TOD is on.	30
System pump cycles	Can be written to a new value (e.g. if the pump or controller is replaced).	6
T-Rise degrees per second limit	For any input that has T-rise detection enabled, this parameter provides the maximum rate of temperature increase that will be allowed. If the temperature increases at a rate greater than this, and this rate of increase persists for 4 seconds then the response specified by T-rise response occurs.	45
T-Rise response	Specifies response should “T-Rise degrees per second limit” is exceeded.	45
T-rise delay	Specifies the delay time that occurs whenever a recycle occurs due to a T-rise event and the specified response includes “Recycle...” The burner will remain in the Standby Hold condition until the delay expires.	45
T-rise retry limit	If the “T-rise response” specifies a retry limit, then any recycles due to reaching the corresponding response threshold are counted.	45
Tap detect degrees per second	This tap demand “set” criteria depends on rate of change of the DHW sensor. The rate of change of this temperature is monitored.	36
Tap detect minimum on time	Once a tap detect event has occurred, and the Tap demand block is Set, it remains true for at least the time provided by this parameter. If DHW loses control due to priority, the timer is restarted, so that when Tap demand again gains control of the burner it remains in this condition for the full minimum on time.	37
Tap detect on threshold	-17 °C to 82 °C (-0 °F to 180 °F)	36

Table 47. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Tap detect on hysteresis	The second tap demand “set” criteria depends on the value of the DHW sensor. If the temperature is less than or equal to the threshold given by subtracting this parameter from the normal DHW setpoint, and if this condition has persisted for the time specified by the Tap detect recognition time parameter, the Tap demand block is “Set” (Tap demand becomes true and the minimum on timer is started).	36
Tap detect on recognition time	This parameter provides the time for a Tap detect event due to the Tap detect on hysteresis parameter, as described just above.	36
Tap stop Inlet-DHW degrees	One criteria for asserting “Clr” is based on the difference between the DHW and the Inlet temperature, calculated as: Inlet - DHW. When this value is positive and is greater than or equal to the degrees given by this parameter, tap demand’s “Clr” input is asserted.	37
Tap stop Outlet-Inlet degrees	The other criteria for asserting “Clr” is based on the difference between the Outlet and the Inlet temperature, calculated as: Outlet - Inlet. When this value is negative or is less than or equal to the degrees given by this parameter, tap demand’s “Clr” input is asserted.	37
Temperature units	This parameter determines whether temperature is represented in units of Fahrenheit or Celsius degrees.	21
Warm Weather Shutdown	Enable, Disable, Shutdown after demands have ended, Shutdown immediately	19
Warm Weather Shutdown Setpoint	Temperature, None	20
XX pump output	This allows the XX pump function to be disconnected or to be attached to any of the pump outputs. If two pump blocks are connected to the same pump output then their signals are effectively OR'd together as shown in Fig. 22.	54
XX pump control	The XX pump can be turned on manually, or it can be set to operate automatically. If it is turned on then it remains on until changed back to Auto.	54
XX pump start delay	When the pump demand changes from off to on, this delay time is used to delay the start of the pump. The pump then starts after the delay expires, assuming that the demand is still present. A delay time of zero disables the delay. For a stand-alone (non-slave) Falcon, this delay is skipped and does not occur if it is already firing when the pump demand off-to-on event occurs. For a Falcon in slave mode, this delay is skipped and does not occur if the “Master Service Status” (defined in the LL specification and noted in the drawing) informs the slave unit that some slave burner in the system is already firing, when the pump demand off-to-on event occurs.	55
XX pump overrun time	This time indicates how long the pump should remain on after pump demand ends. A time of zero disables the overrun. However, a pump should overrun to use up the last of the heat only if it is the last pump running. Therefore: For a stand-alone Falcon if any local service is active then this status cancels any overrun that is in-progress. For a slave Falcon if any master service is active at this time this status cancels any overrun that is in-progress.	55
XX pump cycles	The XX pump cycle counters are mapped to the physical cycle counters; there is one counter for each of the three physical pump outputs and this counter is visible via this parameter, for whichever pump block (or blocks) are connected to it via the block's XX pump output parameter. It is possible for two (or more) pump functions to be assigned to the same physical pump. In this case, that physical pump's cycle counter is visible in each pump control block. A pump cycle counter has the range 0 through 999,999 and it can be restarted if a pump is replaced.	55

APPENDIX B: HYDRONIC DEVICE PARAMETER WORKSHEET EXAMPLE

Table 48. Example of a Completed Device Parameter Worksheet.

Parameter Name	Customer Choice - Hidden, Read Only or Password protected	Minimum Range	Default Setting	Maximum Range	Parameter Units
Burner cycle count	Read Only		0		Cycles
Burner run time	Read Only		0		Hours
CH pump cycles	Read Only		0		Cycles
DHW pump cycles	Read Only		0		Cycles
System pump cycles	Read Only		0		Cycles
Boiler pump cycles	Read Only		0		Cycles
Auxiliary pump cycles	Read Only		0		Cycles
Temperature units	Read Only		A:Fahrenheit		
Antishort cycle time	Read Only		1m 0s		mmm:ss
Alarm silence time	Read Only		5m 0s		mmm:ss
Burner name	Read Only				20 chars
Installation data	Read Only				20 chars
OEM identification	Read Only				20 chars
Modulation output	Hidden		B:Demand rate is in % units		
CH maximum modulation rate	Read Only		100%		% | RPM
DHW maximum modulation rate	Read Only		100%		% | RPM
Minimum modulation rate	Read Only		0%		% | RPM
Prepurge rate	Read Only		100%		% | RPM
Lightoff rate	Read Only		25%		% | RPM
Postpurge rate	Read Only		25%		% | RPM
CH forced rate	Read Only		25%		% | RPM
CH forced rate time	Read Only		1m 0s		mmm:ss
DHW forced rate	Read Only		25%		% | RPM
DHW forced rate time	Read Only		120m 0s		mmm:ss
Burner switch	Read Only		Yes/True/On		
Firing rate control	Read Only		A:Automatic firing		
Manual firing rate	Read Only		25%		% | RPM
Analog output hysteresis	Read Only		0	20	1 to 10
CH enable	Read Only		Enabled		
CH demand source	Read Only		D:Sensor & LCI		
CH sensor	Read Only		A:Outlet sensor		
CH setpoint	Read Only	32°F 0°C	180°F 82°C	240°F 116°C	
CH tod setpoint	Read Only	32°F 0°C	160°F 71°C	240°F 116°C	
CH on hysteresis	Read Only	2°F 1°C	15°F 8°C	100°F 56°C	
CH off hysteresis	Read Only	2°F 1°C	15°F 8°C	100°F 56°C	
CH outdoor reset enable	Read Only		Disabled		

Table 48. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Choice - Hidden, Read Only or Password protected	Minimum Range	Default Setting	Maximum Range	Parameter Units
CH P gain	Read Only		50	400	
CH I gain	Read Only		50	400	
CH D gain	Read Only		0	400	
CH hysteresis step time	Read Only		1m 0s		mmm:ss
Ignition source	Read Only		A:Internal ignition (spark)		
BLR HSI function	Read Only		A:Blower motor		
Igniter on during	Read Only		A:On throughout PFEP		
Pilot type	Read Only		A:Interrupted (off during Run)		
Flame sensor type	Read Only		A:No flame sensor		
Purge rate proving	Read Only		B:Prove via HFS terminal		
Lightoff rate proving	Read Only		B:Prove via LFS terminal		
Prepurge time	Read Only		0m 30s		mmm:ss
Preignition time	Read Only		0m 0s		mmm:ss
PFEP	Read Only		C:10 seconds		
MFEP	Read Only		C:10 seconds		
Run stabilization time	Read Only		0m 10s		mmm:ss
Postpurge time	Read Only		0m 15s		mmm:ss
Interlock start check enable	Read Only		Disabled		
Interlock open response	Read Only		A:Lockout		
Ignite failure response	Read Only		A:Lockout		
Ignite failure retries	Read Only		A:Number of retries not set		
Ignite failure delay	Read Only		5m 0s		mmm:ss
MFEP flame failure response	Read Only		A:Lockout		
Run flame failure response	Read Only		A:Lockout		
Pilot test hold	Hidden		Disabled		
NTC sensor type	Read Only		A:10K dual safety		
Interrupted air switch enable	Read Only		A:no IAS		
IAS start check enable	Hidden		Enabled		
LCI enable	Read Only		Enabled		
PII enable	Read Only		Enabled		
Flame threshold	Read Only	2	8	140	.1 Volts/uA
Absolute max fan speed	Read Only	500	5000	7000	RPM
Absolute min fan speed	Read Only	500	800	5000	RPM
PWM frequency	Read Only		D:3000 Hz		
Pulses per revolution	Read Only	1	3	10	
Fan speed up ramp	Read Only		0		RPM/sec
Fan slow down ramp	Read Only		0		RPM/sec
Fan gain up	Read Only		50	100	
Fan gain down	Read Only		50	100	

Table 48. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Choice - Hidden, Read Only or Password protected	Minimum Range	Default Setting	Maximum Range	Parameter Units
Fan min duty cycle	Read Only		10	100	0-100%
CH pump output	Read Only		A:No pump assignment		
CH pump control	Read Only		A:Automatic pump control		
CH pump overrun time	Read Only		1m 0s		mmm:ss
CH pump frost protection overrun time	Read Only		1m 0s		mmm:ss
DHW pump output	Read Only		A:No pump assignment		
DHW pump control	Read Only		A:Automatic pump control		
DHW pump overrun time	Read Only		1m 0s		mmm:ss
DHW pump frost protection overrun time	Read Only		1m 0s		mmm:ss
DHW pump start delay	Read Only		0m 0s		mmm:ss
Boiler pump output	Read Only		A:No pump assignment		
Boiler pump control	Read Only		A:Automatic pump control		
Boiler pump overrun time	Read Only		1m 0s		mmm:ss
Auxiliary pump output	Read Only		A:No pump assignment		
Auxiliary pump control	Read Only		A:Automatic pump control		
Auxiliary pump on when	Read Only		A:Auxiliary ON when CH pump is ON		
System pump output	Read Only		A:No pump assignment		
System pump control	Read Only		A:Automatic pump control		
System pump overrun time	Read Only		1m 0s		mmm:ss
Pump exercise interval	Read Only		0		Days
Pump exercise time	Read Only		0m 0s		mmm:ss
Annunciation enable	Read Only		Enabled		
Annunciator 1 location	Read Only		E:No annunciation for this terminal		
Annunciator1 short name	Read Only		A1		3 chars
Annunciator 1 long name	Read Only		Annunciator 1		20 chars
Annunciator 2 location	Read Only		E:No annunciation for this terminal		
Annunciator2 short name	Read Only		A2		3 chars
Annunciator 2 long name	Read Only		Annunciator2		20 chars
Annunciator 3 location	Read Only		E:No annunciation for this terminal		
Annunciator3 short name	Read Only		A3		3 chars
Annunciator 3 long name	Read Only		Annunciator3		20 chars

Table 48. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Choice - Hidden, Read Only or Password protected	Minimum Range	Default Setting	Maximum Range	Parameter Units
Annunciator 4 location	Read Only		A:No annunciation for this terminal		
Annunciator4 short name	Read Only		A4		3 chars
Annunciator 4 long name	Read Only		Annunciator4		20 chars
Annunciator 5 location	Read Only		E:No annunciation for this terminal		
Annunciator5 short name	Read Only		A5		3 chars
Annunciator 5 long name	Read Only		Annunciator5		20 chars
Annunciator 6 location	Read Only		E:No annunciation for this terminal		
Annunciator6 short name	Read Only		A6		3 chars
Annunciator 6 long name	Read Only		Annunciator6		20 chars
Annunciator 7 location	Read Only		E:No annunciation for this terminal		
Annunciator7 short name	Read Only		A7		3 chars
Annunciator 7 long name	Read Only		Annunciator7		20 chars
Annunciator 8 location	Read Only		E:No annunciation for this terminal		
Annunciator8 short name	Read Only		A8		3 chars
Annunciator 8 long name	Read Only		Annunciator8		20 chars
PII short name	Read Only		PII		3 chars
PII long name	Read Only		Pre-Ignition ILK		20 chars
LCI short name	Read Only		LCI		3 chars
LCI long name	Read Only		Load Control Input		20 chars
ILK short name	Read Only		ILK		3 chars
ILK long name	Read Only		Interlock		20 chars
DHW enable	Read Only		Disabled		
DHW demand source	Read Only		A:DHW sensor only		
DHW has priority over CH	Read Only		No/False/Off		
DHW has priority over LL	Read Only		No/False/Off		
DHW priority time	Read Only		30m 0s		mmm:ss
DHW setpoint	Read Only	32°F 0°C	140°F 60°C	240°F 116°C	
DHW tod setpoint	Read Only	32°F 0°C	120°F 49°C	240°F 116°C	
DHW on hysteresis	Read Only	2°F 1°C	5°F 3°C	100°F 56°C	
DHW off hysteresis	Read Only	2°F 1°C	5°F 3°C	100°F 56°C	
DHW P gain	Read Only	0	50	400	
DHW I gain	Read Only	0	50	400	
DHW D gain	Read Only	0	50	400	
DHW hysteresis step time	Read Only		0m 0s		mmm:ss
Outlet high limit setpoint	Read Only	32°F 0°C	220°F 104°C	240°F 116°C	
Outlet high limit response	Read Only	[A B #c #d]	A:Lockout		
Stack limit enable	Read Only		Disabled		
Stack limit setpoint	Read Only	32°F 0°C	200°F 93°C	500°F 260°C	
Stack limit response	Read Only	[A #b C #d]	A:Lockout		

Table 48. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Choice - Hidden, Read Only or Password protected	Minimum Range	Default Setting	Maximum Range	Parameter Units
Stack limit delay	Read Only		5m 0s		mmm:ss
Delta-T enable	Read Only		Disabled		
Delta-T degrees	Read Only		30°F 17°C		
Delta-T response	Read Only	[A #b C #d]	A:Lockout		
Delta-T delay	Read Only		5m 0s		mmm:ss
DHW high limit enable	Read Only		Enabled		
DHW high limit setpoint	Read Only	32°F 0°C	150°F 66°C	240°F 116°C	
DHW high limit response	Read Only	[A B #c D]	D:Suspend DHW		
CH slow start enable	Read Only		Disabled		
DHW slow start enable	Read Only		Disabled		
Slow start ramp	Read Only		10%		% | RPM per minute
Slow start setpoint	Read Only	0°F -18°C	20°F -7°C	180°F 82°C	
CH anticondensation enable	Read Only		Disabled		
CH anticondensation setpoint	Read Only	32°F 0°C	135°F 57°C	240°F 116°C	
CH anticondensation pump Force Off	Read Only		Disabled		
DHW anticondensation enable	Read Only		Disabled		
DHW anticondensation setpoint	Read Only	32°F 0°C	135°F 57°C	240°F 116°C	
DHW anticondensation pump force off	Read Only		Disabled		
Anticondensation > Outlet limit	Read Only		No/False/Off		
Anticondensation > Delta-T	Read Only		No/False/Off		
Anticondensation > Stack limit	Read Only		No/False/Off		
Anticondensation > Slow start	Read Only		Yes/True/On		
Anticondensation > Forced rate	Read Only		Yes/True/On		
CH ODR max outdoor temperature	Read Only		80°F 27°C		
CH ODR min outdoor temperature	Read Only		0°F -18°C		
CH ODR min water temperature	Read Only	32°F 0°C	50°F 10°C	240°F 116°C	
CH frost protection enable	Read Only		Disabled		
DHW frost protection enable	Read Only		Disabled		
Outdoor frost protection setpoint	Read Only		32°F 0°C		

APPENDIX C: LOCKOUT AND HOLD CODES

To support the recommended Troubleshooting, the Falcon has an Alert File. Review the Alert history for possible trends that may have been occurring prior to the actual Lockout.

Note Column: H= Hold message; L=Lockout message; H or L= either Hold or Lockout depending on Parameter Configuration

Table 49. Falcon Lockout and Hold Codes.

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
	Safety Data Faults		
1	Unconfigured safety data	1. New Device, complete device configuration and safety verification. 2. If fault repeats, replace module.	L
2	Waiting for safety data verification	1. Device in Configuration mode and safety parameters need verification and a device needs reset to complete verification. 2. Configuration ended without verification, re enter configuration, verify safety parameters and reset device to complete verification. 3. If fault repeats, replace module.	L
	Internal Operation Errors		

Table 49. Falcon Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
3	Internal fault: Hardware fault	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	H
4	Internal fault: Safety Relay key feedback error		H
5	Internal fault: Unstable power (DCDC) output		H
6	Internal fault: Invalid processor clock		H
7	Internal fault: Safety relay drive error		H
8	Internal fault: Zero crossing not detected		H
9	Internal fault: Flame bias out of range		H
10	Internal fault: Invalid Burner control state		L
11	Internal fault: Invalid Burner control state flag		L
12	Internal fault: Safety relay drive cap short		H
13	Internal fault: PII shorted to ILK		H or L
14	Internal fault: HFS shorted to LCI		H or L
15	Internal fault: Safety relay test failed due to feedback ON		L
16	Internal fault: Safety relay test failed due to safety relay OFF		L
17	Internal fault: Safety relay test failed due to safety relay not OFF		L
18	Internal fault: Safety relay test failed due to feedback not ON		L
19	Internal fault: Safety RAM write		L
20	Internal fault: Flame ripple and overflow		H
21	Internal fault: Flame number of sample mismatch		H
22	Internal fault: Flame bias out of range		H
23	Internal fault: Bias changed since heating cycle starts		H
24	Internal fault: Spark voltage stuck low or high		H
25	Internal fault: Spark voltage changed too much during flame sensing time		H
26	Internal fault: Static flame ripple		H
27	Internal fault: Flame rod shorted to ground detected		H
28	Internal fault: A/D linearity test fails		H
29	Internal fault: Flame bias cannot be set in range		H
30	Internal fault: Flame bias shorted to adjacent pin		H
31	Internal fault: SLO electronics unknown error		H
32-46	Internal fault: Safety Key 0 through 14		L
	System Errors		
47	Flame Rod to ground leakage		H
48	Static flame (not flickering)		H
49	24VAC voltage low/high	1. Check the Module and display connections. 2. Check the Module power supply and make sure that both frequency, voltage and VA meet the specifications.	H

Table 49. Falcon Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
50	Modulation fault	Internal sub-system fault. 1. Review alert messages for possible trends. 2. Correct possible problems. 3. If fault persists, replace module.	H
51	Pump fault		H
52	Motor tachometer fault		H
53	AC inputs phase reversed	1. Check the Module and display connections. 2. Check the Module power supply and make sure that both frequency and voltage meet the specifications. 3. On 24Vac applications, assure that J4-10 and J8-2 are connected together.	L
54	Safety GVT model ID doesn't match application's model ID		L
55	Application configuration data block CRC errors		L
56-57	RESERVED		
58	Internal fault: HFS shorted to IAS	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	L
59	Internal Fault: Mux pin shorted		L
	Normal Event Status		
60	Internal Fault: HFS shorted to LFS		L
61	Anti short cycle	Will not be a lockout fault. Hold Only.	H
62	Fan speed not proved		H
63	LCI OFF	1. Check wiring and correct any faults. 2. Check Interlocks connected to the LCI to assure proper function. 3. Reset and sequence the module; monitor the LCI status. 4. If code persists, replace the module.	H
64	PII OFF	1. Check wiring and correct any faults. 2. Check Preignition Interlock switches to assure proper functioning. 3. Check the valve operation. 4. Reset and sequence the module; monitor the PII status. 5. If code persists, replace the module.	H or L
65	Interrupted Airflow Switch OFF	1. Check wiring and correct any possible shorts. 2. Check airflow switches to assure proper functioning. 3. Check the fan/blower operation. 4. Reset and sequence the module; monitor the airflow status. 5. If code persists, replace the module.	H or L
66	Interrupted Airflow Switch ON		H or L
67	ILK OFF	1. Check wiring and correct any possible shorts. 2. Check Interlock (ILK) switches to assure proper function. 3. Verify voltage through the interlock string to the interlock input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the	H or L
68	ILK ON		H or L
69	Pilot test hold	1. Verify Run/Test is changed to Run. 2. Reset Module. 3. If fault repeats, replace module.	H
70	Wait for leakage test completion	1. Internal Fault. Reset Module. 2. If fault repeats, replace module.	H
71-77	RESERVED		
78	Demand Lost in Run	1. Check wiring and correct any possible errors. 2. If previous steps are correct and fault persists, replace the module.	H
79	Outlet high limit	1. Check wiring and correct any possible errors. 2. Replace the Outlet high limit. 3. If previous steps are correct and fault persists, replace the module.	H or L

Table 49. Falcon Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
80	DHW high limit	1. Check wiring and correct any possible errors. 2. Replace the DHW high limit. 3. If previous steps are correct and fault persists, replace the module.	H or L
81	Delta T limit	1. Check Inlet and Outlet sensors and pump circuits for proper operation. 2. Recheck the Delta T Limit to confirm proper setting. 3. If previous steps are correct and fault persists, replace the module.	H or L
82	Stack limit	1. Check wiring and correct any possible errors. 2. Replace the Stack high limit. 3. If previous steps are correct and fault persists, replace the module.	H or L
83	Delta T exchanger/outlet limit		H or L
84	Delta T inlet/exchanger limit		H or L
85	Inlet/outlet inversion limit		H or L
86	Exchanger/outlet inversion limit		H or L
87	Inlet/exchanger inversion limit		H or L
88	Outlet T-rise limit		H or L
89	Exchanger T-rise limit		H or L
90	Heat exchanger high limit		H or L
	Sensor Faults		
91	Inlet sensor fault	1. Check wiring and correct any possible errors. 2. Replace the Inlet sensor. 3. If previous steps are correct and fault persists, replace the module.	H
92	Outlet sensor fault	1. Check wiring and correct any possible errors. 2. Replace the Outlet sensor. 3. If previous steps are correct and fault persists, replace the module.	H
93	DHW sensor fault	1. Check wiring and correct any possible errors. 2. Replace the DHW sensor. 3. If previous steps are correct and fault persists, replace the module.	H
94	Header sensor fault	1. Check wiring and correct any possible errors. 2. Replace the header sensor. 3. If previous steps are correct and fault persists, replace the module.	H
95	Stack sensor fault	1. Check wiring and correct any possible errors. 2. Replace the stack sensor. 3. If previous steps are correct and fault persists, replace the module.	H
96	Outdoor sensor fault	1. Check wiring and correct any possible errors. 2. Replace the outdoor sensor. 3. If previous steps are correct and fault persists, replace the module.	H
97	Internal Fault: A2D mismatch.	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	L
98	Internal Fault: Exceeded VSNSR voltage		L
99	Internal Fault: Exceeded 28V voltage tolerance		L
100	Pressure Sensor Fault	1. Verify the Pressure Sensor is a 4-20ma source. 2. Check wiring and correct any possible errors. 3. Test Pressure Sensor for correct operation. 4. Replace the Pressure sensor. 5. If previous steps are correct and fault persists, replace the module.	H

Table 49. Falcon Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
101-104	RESERVED		
	Flame Operation Faults		
105	Flame detected out of sequence	1. Check that flame is not present in the combustion chamber. Correct any errors. 2. Make sure that the flame detector is wired to the correct terminal. 3. Make sure the F & G wires are protected from stray noise pickup. 4. Reset and sequence the module, if code reappears, replace the flame detector. 5. Reset and sequence the module, if code reappears, replace the module.	H or L
106	Flame lost in MFEP	1. Check pilot valve (Main Valve for DSI) wiring and operation - correct any errors. 2. Check the fuel supply. 3. Check fuel pressure and repeat turndown tests. 4. Check ignition transformer electrode, flame detector, flame detector siting or flame rod position. 5. If steps 1 through 4 are correct and the fault persists, replace the module.	L
107	Flame lost early in run		L
108	Flame lost in run		L
109	Ignition failed		L
110	Ignition failure occurred	Hold time of recycle and hold option. Will not be a lockout fault. Hold Only.	H
111	Flame current lower than WEAK threshold	Internal hardware test. Not a lockout,	H
112	Pilot test flame timeout	Interrupted Pilot or DSI application and flame lost when system in “test” mode. 1. Reset the module to restart.	L
113	Flame circuit timeout	Flame sensed during Initiate or off cycle, hold 240 seconds, if present after 240 seconds, lockout.	L
114-121	RESERVED		
	Rate Proving Faults		
122	Lightoff rate proving failed	1. Check wiring and correct any potential wiring errors. 2. Check VFDs ability to change speeds. 3. Change the VFD 4. If the fault persists, replace the module.	L
123	Purge rate proving failed		L
124	High fire switch OFF	1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function (not welded or jumpered). 3. Manually drive the motor to the High Fire position and adjust the HF switch while in this position and verify voltage through the switch to the HFS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
125	High fire switch stuck ON		H
126	Low fire switch OFF	1. Check wiring and correct any potential wiring errors. 2. Check Low Fire Switch to assure proper function (not welded or jumpered). 3. Manually drive the motor to the High Fire position and adjust the LF switch while in this position and verify voltage through the switch to the LFS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
127	Low fire switch stuck ON		H or L
128	Fan speed failed during prepurge	1. Check wiring and correct any potential wiring errors. 2. Check VFDs ability to change speeds. 3. Change the VFD 4. If the fault persists, replace the module.	H or L
129	Fan speed failed during preignition		H or L
130	Fan speed failed during ignition		H or L
131	Fan movement detected during standby		H
132	Fan speed failed during run		H
133-135	RESERVED		
	Start Check Faults		

Table 49. Falcon Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
136	Interrupted Airflow Switch failed to close	1. Check wiring and correct any possible wiring errors. 2. Check Interrupted Airflow switch(es) to assure proper function. 3. Verify voltage through the airflow switch to the IAS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
137	ILK failed to close	1. Check wiring and correct any possible shorts. 2. Check Interlock (ILK) switches to assure proper function. 3. Verify voltage through the interlock string to the interlock input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
138-142	RESERVED		
	FAULT CODES 149 THROUGH 165 ARE OEM SPECIFIC FAULT CODES.		
143	Internal fault: Flame bias out of range 1		L
144	Internal fault: Flame bias out of range 2		L
145	Internal fault: Flame bias out of range 3		L
146	Internal fault: Flame bias out of range 4		L
147	Internal fault: Flame bias out of range 5		L
148	Internal fault: Flame bias out of range 6		L
149	Flame detected	OEM Specific 1. Holds if flame detected during Safe Start check up to Flame Establishing period.	H or L
150	Flame not detected	OEM Specific 1. Sequence returns to standby and restarts sequence at the beginning of Purge after the HF switch opens. if flame detected during Safe Start check up to Flame Establishing period.	H
151	High fire switch ON	OEM Specific 1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function (not welded or jumpered). 3. Manually drive the motor to the High Fire position and adjust the HF switch while in this position and verify voltage through the switch to the HFS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H or L
152	Combustion pressure ON	OEM Specific 1. Check wiring and correct any errors. 2. Inspect the Combustion Pressure Switch to make sure it is working correctly. 3. Reset and sequence the relay module. 4. During STANDBY and PREPURGE, measure the voltage between Terminal J6-5 and L2 (N). Supply voltage should be present. If not, the lockout switch is defective and needs replacing. 5. If the fault persists, replace the relay module.	H or L
153	Combustion Pressure Off		H or L
154	Purge Fan switch On	OEM Specific 1. Purge fan switch is on when it should be off.	H or L
155	Purge Fan switch Off		H
155	Purge fan switch OFF		H or L

Table 49. Falcon Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
156	Combustion pressure and Flame ON	OEM Specific 1. Check that flame is not present in the combustion chamber. Correct any errors. 2. Make sure that the flame detector is wired to the correct terminal. 3. Make sure the F & G wires are protected from stray noise pickup. 4. Reset and sequence the module, if code reappears, replace the flame detector.	H or L
157	Combustion pressure and Flame OFF		L
158	Main valve ON	OEM Specific 1. Check Main Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.	L
159	Main valve OFF		L
160	Ignition ON	OEM Specific 1. Check Ignition terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.	L
161	Ignition OFF		L
162	Pilot valve ON	OEM Specific 1. Check Pilot Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.	L
163	Pilot valve OFF		L
164	Block intake ON	OEM Specific 1. Check wiring and correct any errors. 2. Inspect the Block Intake Switch to make sure it is working correctly. 3. Reset and sequence the module. 4. During Standby and Purge, measure the voltage across the switch. Supply voltage should be present. If not, the Block Intake Switch is defective and needs replacing. 5. If the fault persists, replace the relay module.	L
165	Block intake OFF		L
166-171	RESERVED		
	Feedback		
172	Main relay feedback incorrect	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	L
173	Pilot relay feedback incorrect		L
174	Safety relay feedback incorrect		L
175	Safety relay open		L
176	Main relay ON at safe start check		L
177	Pilot relay ON at safe start check		L
178	Safety relay ON at safe start check		L
179-183	RESERVED		
	Parameter Faults		
184	Invalid BLOWER/HSI output setting	1. Return to Configuration mode and recheck selected parameters, reverify and reset module. 2. If fault repeats, verify electrical grounding. 3. If fault repeats, replace module.	L
185	Invalid Delta T limit enable setting		L
186	Invalid Delta T limit response setting		L
187	Invalid DHW high limit enable setting		L
188	Invalid DHW high limit response setting		L
189	Invalid Flame sensor type setting		L
190	Invalid interrupted air switch enable setting		L
191	Invalid interrupted air switch start check enable setting		L
192	Invalid igniter on during setting		L
193	Invalid ignite failure delay setting		L

Table 49. Falcon Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
194	Invalid ignite failure response setting	1. Return to Configuration mode and recheck selected parameters, reverify and reset module. 2. If fault repeats, verify electrical grounding. 3. If fault repeats, replace module.	L
195	Invalid ignite failure retries setting		L
196	Invalid ignition source setting		L
197	Invalid interlock open response setting		L
198	Invalid interlock start check setting		L
199	Invalid LCI enable setting		L
200	Invalid lightoff rate setting		L
201	Invalid lightoff rate proving setting		L
202	Invalid Main Flame Establishing Period time		L
203	Invalid MFEP flame failure response setting		L
204	Invalid NTC sensor type setting		L
205	Invalid Outlet high limit response setting		L
206	Invalid Pilot Flame Establishing Period setting		L
207	Invalid PII enable setting		L
208	Invalid pilot test hold setting		L
209	Invalid Pilot type setting		L
210	Invalid Postpurge time setting		L
211	Invalid Power up with lockout setting		L
212	Invalid Preignition time setting		L
213	Invalid Prepurge rate setting		L
214	Invalid Prepurge time setting		L
215	Invalid Purge rate proving setting		L
216	Invalid Run flame failure response setting		L
217	Invalid Run stabilization time setting		L
218	Invalid Stack limit enable setting		L
219	Invalid Stack limit response setting		L
220	Unconfigured Delta T limit setpoint setting		L
221	Unconfigured DHW high limit setpoint setting		L
222	Unconfigured Outlet high limit setpoint setting		L
223	Unconfigured Stack limit setpoint setting		L
224	Invalid DHW demand source setting		L
225	Invalid Flame threshold setting		L
226	Invalid Outlet high limit setpoint setting		L
227	Invalid DHW high limit setpoint setting		L
228	Invalid Stack limit setpoint setting		L
229	Invalid Modulation output setting		L
230	Invalid CH demand source setting		L
231	Invalid Delta T limit delay setting		L
232	Invalid Pressure sensor type setting		L
233	Invalid IAS closed response setting		L
234	Invalid Outlet high limit enable setting		L
235	Invalid Outlet connector type setting		L
236	Invalid Inlet connector type setting		L
237	Invalid DHW connector type setting		L
238	Invalid Stack connector type setting		L

Table 49. Falcon Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
239	Invalid S2 (J8-6) connector type setting		L
240	Invalid S5 (J8-11) connector type setting		L
241	Exchanger sensor not allowed with stack connector setting		L
242	Invalid DHW auto detect configuration		L
243	Invalid UV with spark interference not compatible with Ignitor on throughout PFEP		L
244	Internal fault: Safety relay test invalid state		L
245	Invalid Outlet connector type setting for T-rise		L
246	4-20mA cannot be used for both modulation and setpoint control		L
247	Invalid ILK bounce detection enable		L
248	Invalid forced recycle interval		L
249	STAT cannot be demand source when Remote Stat is enabled		L
250	Invalid Fan speed error response		L
251-255	RESERVED		

Table 50. Alerts.

Code	Description
	EE Management Faults
0	None (No alert)
1	Alert PCB was restored from factory defaults
2	Safety configuration parameters were restored
3	Configuration parameters were restored from
4	Invalid Factory Invisibility PCB was detected
5	Invalid Factory Range PCB was detected
6	Invalid range PCB record has been dropped
7	EEPROM lockout history was initialized
8	Switched application annunciation data blocks
9	Switched application configuration data blocks
10	Configuration was restored from factory defaults
11	Backup configuration settings was restored from
12	Annunciation configuration was restored from
13	Annunciation configuration was restored from
14	Safety group verification table was restored from
15	Safety group verification table was updated
16	Invalid Parameter PCB was detected
17	Invalid Range PCB was detected
	System Parameter Errors
18	Alarm silence time exceeded maximum
19	Invalid safety group verification table was
20	Backdoor Password could not be determined.
21	Invalid safety group verification table was

Table 50. Alerts. (Continued)

Code	Description
22	CRC errors were found in application
23	Backup Alert PCB was restored from active one
24	RESERVED
25	Lead Lag operation switch was turned OFF
26	Lead Lag operation switch was turned ON
27	Safety processor was reset
28	Application processor was reset
29	Burner switch was turned OFF
30	Burner switch was turned ON
31	Program Module (PM) was inserted into socket
32	Program Module (PM) was removed from socket
33	Alert PCB was configured
34	Parameter PCB was configured
35	Range PCB was configured
36	Program Module (PM) incompatible with product
37	Program Module application parameter revision
38	Program Module safety parameter revision
39	PCB incompatible with product contained in
40	Parameter PCB in Program Module is too large
41	Range PCB in Program Module was too large for
42	Alert PCB in Program Module was too large for
43	IAS start check was forced on due to IAS
	System Operation Faults
44	Low voltage was detected in safety processor
45	High line frequency occurred

Table 50. Alerts. (Continued)

Code	Description
46	Low line frequency occurred
47	Invalid subsystem reset request occurred
48	Write large enumerated Modbus register value
49	Maximum cycle count was reached
50	Maximum hours count was reached
51	Illegal Modbus write was attempted
52	Modbus write attempt was rejected (NOT
53	Illegal Modbus read was attempted
54	Safety processor brown-out reset occurred
55	Application processor watchdog reset occurred
56	Application processor brown-out reset occurred
57	Safety processor watchdog reset occurred
58	Alarm was reset by the user at the control
	Demand/Rate Command Faults
59	Burner control firing rate was > absolute max
60	Burner control firing rate was < absolute min rate
61	Burner control firing rate was invalid, % vs. RPM
62	Burner control was firing with no fan request
63	Burner control rate (nonfiring) was > absolute
64	Burner control rate (nonfiring) was < absolute
65	Burner control rate (nonfiring) was absent
66	Burner control rate (nonfiring) was invalid, % vs.
67	Fan off cycle rate was invalid, % vs. RPM
68	Setpoint was overridden due to sensor fault
69	Modulation was overridden due to sensor fault
70	No demand source was set due to demand
71-73	RESERVED
	Fan Parameter Errors
74	Periodic Forced Recycle
75	Absolute max fan speed was out of range
76	Absolute min fan speed was out of range
77	Fan gain down was invalid
78	Fan gain up was invalid
79	Fan minimum duty cycle was invalid
80	Fan pulses per revolution was invalid
81	Fan PWM frequency was invalid
82-83	RESERVED
	Modulation Parameter Errors
84	Lead Lag CH 4-20mA water temperature setting
85	No Lead Lag add stage error threshold was
86	No Lead Lag add stage detection time was
87	No Lead Lag drop stage error threshold was
88	No Lead Lag drop stage detection time was

Table 50. Alerts. (Continued)

Code	Description
89	RESERVED
90	Modulation output type was invalid
91	Firing rate control parameter was invalid
92	Forced rate was out of range vs. min/max
93	Forced rate was invalid, % vs. RPM
94	Slow start ramp value was invalid
95	Slow start degrees value was invalid
96	Slow start was ended due to outlet sensor fault
97	Slow start was end due to reference setpoint
98	CH max modulation rate was invalid, % vs. RPM
99	CH max modulation rate was > absolute max
100	CH modulation range (max minus min) was too
101	DHW max modulation rate was invalid, % vs.
102	DHW max modulation rate was > absolute max
103	DHW modulation range (max minus min) was too
104	Min modulation rate was < absolute min rate
105	Min modulation rate was invalid, % vs. RPM
106	Manual rate was invalid, % vs. RPM
107	Slow start enabled, but forced rate was invalid
108	Analog output hysteresis was invalid
109	Analog modulation output type was invalid
110	IAS open rate differential was invalid
111	IAS open step rate was invalid
112	MIX max modulation rate was invalid, % vs. RPM
113	MIX max modulation rate was >absolute max or
114	MIX modulation range (max minus min) was too
	Modulation Operation Faults
115	Fan was limited to its minimum duty cycle
116	Manual rate was > CH max modulation rate
117	Manual rate was > DHW max modulation rate
118	Manual rate was < min modulation rate
119	Manual rate in Standby was > absolute max rate
120	Modulation commanded rate was > CH max
121	Modulation commanded rate was > DHW max
122	Modulation commanded rate was < min
123	Modulation rate was limited due to outlet limit
124	Modulation rate was limited due to Delta-T limit
125	Modulation rate was limited due to stack limit
126	Modulation rate was limited due to
127	Fan Speed out of range in RUN
128	Modulation rate was limited due to IAS was open
129	Slow start ramp setting of zero will result in no
130	No forced rate was configured for slow start

Table 50. Alerts. (Continued)

Code	Description
	CH parameter Errors
131	CH demand source was invalid
132	CH P-gain was invalid
133	CH I-gain was invalid
134	CH D-gain was invalid
135	CH OFF hysteresis was invalid
136	CH ON hysteresis was invalid
137	CH sensor type was invalid
138	CH hysteresis step time was invalid
139	CH remote control parameter was invalid
140	CH ODR not allowed with remote control
141	Steam P-gain was invalid
142	Steam I-gain was invalid
143	Steam D-gain was invalid
144	Steam OFF hysteresis was invalid
145	Steam ON hysteresis was invalid
	CH Operation Faults
146	CH control was suspended due to fault
147	CH header temperature was invalid
148	CH outlet temperature was invalid
149	CH steam pressure was invalid
	CH Parameter errors (continued)
150	Steam setpoint source parameter was invalid
151	Minimum water temperature parameter was
152	Minimum water temperature parameter was
153	Minimum pressure parameter was greater than
154	Minimum pressure parameter was greater than
155	CH modulation rate source parameter was
156	Steam modulation rate source parameter was
	DHW Parameter Errors
157	DHW demand source was invalid
158	DHW P-gain was invalid
159	DHW I-gain was invalid
160	DHW D-gain was invalid
161	DHW OFF hysteresis was invalid
162	DHW ON hysteresis was invalid
163	DHW hysteresis step time was invalid
164	DHW sensor type was invalid
165	Inlet sensor type was invalid for DHW
166	Outlet sensor type was invalid for DHW
167	DHW Storage OFF hysteresis was invalid
168	DHW Storage ON hysteresis was invalid
169	DHW modulation sensor type was invalid

Table 50. Alerts. (Continued)

Code	Description
170	DHW modulation sensor was not compatible for
	DHW Operation Faults
171	DHW control was suspended due to fault
172	DHW temperature was invalid
173	DHW inlet temperature was invalid
174	DHW outlet temperature was invalid
175	DHW high limit must be disabled for AUTO mode
176	DHW sensortype was not compatible for AUTO
177	DHW priority source setting was invalid
178	DHW priority method setting was invalid
	CH Operation Faults (continued)
179	CH S5 (J8 terminal 11) sensor was invalid
180	CH inlet temperature was invalid
181	CH S10 (J10 terminal 7) sensor was invalid
182	Lead Lag CH setpoint source was invalid
	Lead Lag Parameter errors
183	Lead Lag P-gain was invalid
184	Lead Lag I-gain was invalid
185	Lead Lag D-gain was invalid
186	Lead Lag OFF hysteresis was invalid
187	Lead Lag ON hysteresis was invalid
188	Lead Lag slave enable was invalid
189	Lead Lag hysteresis step time was invalid
190	No Lead lag Modbus port was assigned
191	Lead Lag base load common setting was invalid
192	Lead Lag DHW demand switch setting was
193	Lead Lag Mix demand switch setting was invalid
194	Lead Lag modulation sensor setting was invalid
195	Lead Lag backup modulation sensor setting was
196	Lead Lag slave mode setting was invalid
197	Lead Lag rate allocation setting was invalid
198	Lead selection setting was invalid
199	Lag selection setting was invalid
200	Lead Lag slave return setting was invalid
201	Lead Lag add stage method setting was invalid
202	STAT may not be a Lead Lag CH demand source
203	Lead Lag base load rate setting was invalid
	Lead Lag Operation Faults
204	Lead Lag master was suspended due to fault
205	Lead Lag slave was suspended due to fault
206	Lead Lag header temperature was invalid
207	Lead Lag was suspended due to no enabled
208	Lead Lag slave session has timed out

Table 50. Alerts. (Continued)

Code	Description
209	Too many Lead Lag slaves were detected
210	Lead Lag slave was discovered
211	Incompatible Lead Lag slave was discovered
212	No base load rate was set for Lead Lag slave
213	Lead Lag slave unable to fire before demand to
214	Adding Lead Lag slave aborted due to add
215	No Lead Lag slaves available to service demand
216	No Lead Lag active service was set due to
217	No Lead Lag add stage method was specified
218	No Lead Lag drop stage method was specified
219	Using backup lead lag header sensor due to
	Frost Protection Faults
220	Lead Lag frost protection rate was invalid
221	Lead Lag drop stage method setting was invalid
222	CH frost protection temperature was invalid
223	CH frost protection inlet temperature was invalid
224	DHW frost protection temperature was invalid
225-226	RESERVED
227	DHW priority override time was not derated due
228	Warm weather shutdown was not checked due
229	Lead Lag slave communication timeout
230	RESERVED
231	Lead Lag CH setpoint was invalid
232	Lead Lag CH time of day setpoint was invalid
233	LL outdoor temperature was invalid
234	Lead Lag ODR time of day setpoint was invalid
235	Lead Lag ODR time of day setpoint exceeded
236	Lead Lag ODR max outdoor temperature was
237	Lead Lag ODR min outdoor temperature was
238	Lead Lag ODR low water temperature was
239	Lead Lag ODR outdoor temperature range was
240	Lead Lag ODR water temperature range was too
241	Lead Lag DHW setpoint was invalid
242	Lead Lag Mix setpoint was invalid
243	Lead Lag CH demand switch was invalid
244	Lead Lag CH setpoint source was invalid
245	RESERVED
246	CH setpoint was invalid
247	CH time of day setpoint was invalid
248	CH outdoor temperature was invalid
249	CH ODR time of day setpoint was invalid
250	CH ODR time of day setpoint exceeds normal
251	CH max outdoor setpoint was invalid

Table 50. Alerts. (Continued)

Code	Description
252	CH min outdoor setpoint was invalid
253	CH min water setpoint was invalid
254	CH outdoor temperature range was too small
255	CH water temperature range was too small
256	Steam setpoint was invalid
257	Steam time of day setpoint was invalid
258	Steam minimum pressure was invalid
259	CH ODR min water temperature was invalid
260	RESERVED
261	DHW setpoint was invalid
262	DHW time of day setpoint was invalid
263	DHW storage setpoint was invalid
264	STAT may not be a DHW demand source when
265-266	RESERVED
267	STAT may not be a CH demand source when
268	CH 4mA water temperature setting was invalid
269	CH 20mA water temperature setting was invalid
270	Steam 4mA water temperature setting was
271	Steam 20mA water temperature setting was
272	Abnormal Recycle: Pressure sensor fault
273	Abnormal Recycle: Safety relay drive test failed
274	Abnormal Recycle: Demand off during Pilot
275	Abnormal Recycle: LCI off during Drive to Purge
276	Abnormal Recycle: LCI off during Measured
277	Abnormal Recycle: LCI off during Drive to
278	Abnormal Recycle: LCI off during Pre-Ignition
279	Abnormal Recycle: LCI off during Pre-Ignition
280	Abnormal Recycle: LCI off during Main Flame
281	Abnormal Recycle: LCI off during Ignition period
282	Abnormal Recycle: Demand off during Drive to
283	Abnormal Recycle: Demand off during Measured
284	Abnormal Recycle: Demand off during Drive to
285	Abnormal Recycle: Demand off during Pre-
286	Abnormal Recycle: Demand off during Pre-
287	Abnormal Recycle: Flame was on during Safe
288	Abnormal Recycle: Flame was on during Drive to
289	Abnormal Recycle: Flame was on during
290	Abnormal Recycle: Flame was on during Drive to
291	Abnormal Recycle: Flame was not on at end of
292	Abnormal Recycle: Flame was lost during Main
293	Abnormal Recycle: Flame was lost early in Run
294	Abnormal Recycle: Flame was lost during Run
295	Abnormal Recycle: Leakage test failed

Table 50. Alerts. (Continued)

Code	Description
296	Abnormal Recycle: Interrupted air flow switch
297	Abnormal Recycle: Interrupted air flow switch
298	Abnormal Recycle: Interrupted air flow switch
299	Abnormal Recycle: Interrupted air flow switch
300	Abnormal Recycle: Interrupted air flow switch
301	Abnormal Recycle: Interrupted air flow switch
302	Abnormal Recycle: Ignition failed due to
303	Abnormal Recycle: ILK off during Drive to Purge
304	Abnormal Recycle: ILK off during Measured
305	Abnormal Recycle: ILK off during Drive to
306	Abnormal Recycle: ILK off during Pre-Ignition
307	Abnormal Recycle: ILK off during Pre-Ignition
308	Abnormal Recycle: ILK off during Main Flame
309	Abnormal Recycle: ILK off during Ignition period
310	Run was terminated due to ILK was off
311	Run was terminated due to interrupted air flow
312	Stuck reset switch
313	Run was terminated due to fan failure
314	Abnormal Recycle: Fan failed during Drive to
315	Abnormal Recycle: Fan failed during Measured
316	Abnormal Recycle: Fan failed during Drive to
317	Abnormal Recycle: Fan failed during Pre-Ignition
318	Abnormal Recycle: Fan failed during Pre-Ignition
319	Abnormal Recycle: Fan failed during Ignition
320	Abnormal Recycle: Fan failed during Main Flame
321	Abnormal Recycle: Main Valve off after 10
322	Abnormal Recycle: Pilot Valve off after 10
323	Abnormal Recycle: Safety Relay off after 10
324	Abnormal Recycle: Hardware flame bias
325	Abnormal Recycle: Hardware static flame
326	Abnormal Recycle: Hardware flame current
327	Abnormal Recycle: Hardware flame rod short
328	Abnormal Recycle: Hardware invalid power
329	Abnormal Recycle: Hardware invalid AC line
330	Abnormal Recycle: Hardware SLO flame ripple
331	Abnormal Recycle: Hardware SLO flame sample
332	Abnormal Recycle: Hardware SLO flame bias
333	Abnormal Recycle: Hardware SLO flame bias
334	Abnormal Recycle: Hardware SLO spark stuck
335	Abnormal Recycle: Hardware SLO spark
336	Abnormal Recycle: Hardware SLO static flame
337	Abnormal Recycle: Hardware SLO rod shorted
338	Abnormal Recycle: Hardware SLO AD linearity

Table 50. Alerts. (Continued)

Code	Description
339	Abnormal Recycle: Hardware SLO bias not set
340	Abnormal Recycle: Hardware SLO bias shorted
341	Abnormal Recycle: Hardware SLO electronics
342	Abnormal Recycle: Hardware processor clock
343	Abnormal Recycle: Hardware AC phase
344	Abnormal Recycle: Hardware A2D mismatch
345	Abnormal Recycle: Hardware VSNSR A2D
346	Abnormal Recycle: Hardware 28V A2D
347	Abnormal Recycle: Hardware HFS IAS shorted
348	Abnormal Recycle: Hardware PII INTLK shorted
349	Abnormal Recycle: Hardware HFS LCI shorted
350	Abnormal Recycle: Hardware HFS LFS shorted
351	Abnormal Recycle: Invalid zero crossing
352	Abnormal Recycle: fault stack sensor
353	Abnormal Recycle: stack limit
354	Abnormal Recycle: delta T limit
355	Abnormal Recycle: fault outlet sensor
356	Abnormal Recycle: outlet high limit
357	Abnormal Recycle: fault DHW sensor
358	Abnormal Recycle: DHW high limit
359	Abnormal Recycle: fault inlet sensor
360	Abnormal Recycle: Check Parameters Failed
	Internal Errors
361	Internal error: No factory parameters were
362	Internal error: PID iteration frequency was invalid
363	Internal error: Demand-Rate interval time was
364	Internal error: Factory calibration parameter for
365	Internal error: CH PID P-scaler was invalid
366	Internal error: CH PID I-scaler was invalid
367	Internal error: CH PID D-scaler was invalid
368	Internal error: DHW PID P-scaler was invalid
369	Internal error: DHW PID I-scaler was invalid
370	Internal error: DHW PID D-scaler was invalid
371	Internal error: Lead Lag master PID P-scaler was
372	Internal error: Lead Lag master PID I-scaler was
373	Internal error: Lead Lag master PID D-scaler was
374	Abnormal Recycle: Hardware flame bias high
375	Abnormal Recycle: Hardware flame bias low
376	Abnormal Recycle: Hardware flame bias delta
377	Abnormal Recycle: Hardware flame bias delta
378	Abnormal Recycle: Hardware flame bias
379	Abnormal Recycle: Hardware flame bias
380	Abnormal Recycle: Fan Speed Not Proven

Table 50. Alerts. (Continued)

Code	Description
381	Abnormal Recycle: Fan Speed Range Low
382	Abnormal Recycle: Fan Speed Range High
383-450	RESERVED
	Circulator Errors
451	Circulator control was invalid
452	Circulator P-gain was invalid
453	Circulator I-gain was invalid
454	Circulator temperature was invalid
455	Circulator outlet temperature was invalid
456	Circulator inlet temperature was invalid
457	Circulator outdoor temperature was invalid
458	Circulator sensor choice was invalid
459	Circulator PID setpoint was invalid
	Debug Faults
460	LCI lost in run
461	Abnormal Recycle: Demand lost in run from
462	Abnormal Recycle: Demand lost in run due to
463	Abnormal Recycle: Demand lost in run due to no
464	LCI lost in Combustion Pressure Establishing
465	LCI lost in Combustion Pressure Stabilization
466	RESERVED
	Internal Data Faults
467	Internal error: EEPROM write was attempted
468	Internal error: EEPROM cycle count address
469	Internal error: EEPROM days count address was
470	Internal error: EEPROM hours count address
471	Internal error: Lockout record EEPROM index
472	Internal error: Request to write PM status was
473	Internal error: PM parameter address was invalid
474	Internal error: PM safety parameter address was
475	Internal error: Invalid record in lockout history
476	Internal error: EEPROM write buffer was full
477	Internal error: Data too large was not written to
478	Internal error: Safety key bit 0 was incorrect
479	Internal error: Safety key bit 1 was incorrect
480	Internal error: Safety key bit 2 was incorrect
481	Internal error: Safety key bit 3 was incorrect
482	Internal error: Safety key bit 4 was incorrect
483	Internal error: Safety key bit 5 was incorrect
484	Internal error: Safety key bit 6 was incorrect
485	Internal error: Safety key bit 7 was incorrect
486	Internal error: Safety key bit 8 was incorrect
487	Internal error: Safety key bit 9 was incorrect

Table 50. Alerts. (Continued)

Code	Description
488	Internal error: Safety key bit 10 was incorrect
489	Internal error: Safety key bit 11 was incorrect
490	Internal error: Safety key bit 12 was incorrect
491	Internal error: Safety key bit 13 was incorrect
492	Internal error: Safety key bit 14 was incorrect
493	Internal error: Safety key bit 15 was incorrect
494	Internal error: Safety relay timeout
495	Internal error: Safety relay commanded off
496	Internal error: Unknown safety error occurred
497	Internal error: Safety timer was corrupt
498	Internal error: Safety timer was expired
499	Internal error: Safety timings
500	Internal error: Safety shutdown
501	RESERVED
	MIX Errors
502	Mix setpoint was invalid
503	Mix time of day setpoint was invalid
504	Mix outdoor temperature was invalid
505	Mix ODR time of day setpoint was invalid
506	Mix ODR time of day setpoint exceeds normal setpoint
507	Mix ODR max outdoor temperature was invalid
508	Mix ODR min outdoor temperature was invalid
509	Mix ODR low water temperature was invalid
510	Mix ODR outdoor temperature range was invalid
511	Mix ODR water temperature range was invalid
512	Mix demand switch was invalid
513	Mix ON hysteresis was invalid
514	Mix OFF hysteresis was invalid
515	Mix ODR min water temperature was invalid
516	Mix hysteresis step time was invalid
517	Mix P-gain was invalid
518	Mix I-gain was invalid
519	Mix D-gain was invalid
520	Mix control was suspended due to fault
521	Mix S10 (J10-7) temperature was invalid
522	Mix outlet temperature was invalid
523	Mix inlet temperature was invalid
524	Mix S5 (J8-11) temperature was invalid
525	Mix modulation sensor type was invalid
526	Mix ODR min water temperature setpoint was invalid
527	Mix circulator sensor was invalid
528	Mix flow control was invalid
529	Mix temperature was invalid
530	Mix sensor was invalid

Table 50. Alerts. (Continued)

Code	Description
531	Mix PID setpoint was invalid
532	STAT may not be a Mix demand source when Remote Stat is enabled
533-539	RESERVED
540	Delta T inlet/outlet enable was invalid
541	Delta T exchanger/outlet enable was invalid
542	Delta T inlet/exchanger enable was invalid
543	Delta T inlet/outlet degrees was out of range
544	Delta T exchanger/outlet degrees was out of range
545	Delta T inlet/exchanger degrees was out of range
546	Delta T response was invalid
547	Delta T inversion limit response was invalid
548	Delta T rate limit enable was invalid
549	Delta T exchanger/outlet wasn't allowed due to stack limit setting
550	Delta T inlet/outlet limit was exceeded
551	Delta T exchanger/outlet limit was exceeded
552	Delta T inlet/exchanger limit was exceeded
553	Inlet/outlet inversion occurred
554	Exchanger/outlet inversion occurred
555	Inlet/exchanger inversion occurred
556	Delta T exchanger/outlet wasn't allowed due to stack connector setting
557	Delta T inlet/exchanger wasn't allowed due to stack limit setting
558	Delta T inlet/exchanger wasn't allowed due to stack connector setting
559	Delta T delay was not configured for recycle response
	T Rise Errors
560	Outlet T-rise enable was invalid
561	Heat exchanger T-rise enable was invalid
562	T-rise degrees was out of range
563	T-rise response was invalid
564	Outlet T-rise limit was exceeded
565	Heat exchanger T-rise limit was exceeded
566	Heat exchanger T-rise wasn't allowed due to stack limit setting
567	Heat exchanger T-rise wasn't allowed due to stack connector setting
568	Outlet T-rise wasn't allowed due to outlet connector setting
569	T-rise delay was not configured for recycle response
	Heat Exchanger High Limit Errors
570	Heat exchanger high limit setpoint was out of range
571	Heat exchanger high limit response was invalid

Table 50. Alerts. (Continued)

Code	Description
572	Heat exchanger high limit was exceeded
573	Heat exchanger high limit wasn't allowed due to stack limit setting
574	Heat exchanger high limit wasn't allowed due to stack connector setting
575	Heat exchanger high limit delay was not configured for recycle response
	Pump Errors
576	CH pump output was invalid
577	DHW pump output was invalid
578	Boiler pump output was invalid
579	Auxiliary pump output was invalid
580	System pump output was invalid
581	Mix pump output was invalid
582-589	RESERVED
	DHW Plate Heat Exchanger Errors
590	DHW plate preheat setpoint was invalid
591	DHW plate preheat ON hysteresis was invalid
592	DHW plate preheat OFF hysteresis was invalid
593	Tap detect degrees was out of range
594	Tap detect ON hysteresis was invalid
595	Inlet - DHW tap stop degrees was out of range
596	Outlet - Inlet tap stop degrees was out of range
597	DHW tap detect on threshold was invalid
598	DHW plate preheat detect on threshold was invalid
599	DHW plate preheat detect off threshold was invalid

Appendix B — CB Falcon Display/Operator Interface

Falcon
System Display 833-05105

PRODUCT DATA

APPLICATION

The 833-5105 is a microprocessor-based color touch-screen Operator Interface (OI) display that provides an operator interface for monitoring and configuring parameters in the Falcon hydronic control and steam control systems.

The 833-5105 can be used to monitor an individual boiler but is also used for multiple boiler applications in a lead/lag arrangement. It consists of 2 RS485 ports (COM 1 & COM 2) and USB port. The 833-5105 display can be flush front or behind mounted into a panel cutout. Wiring connections to the display are through a removable 8-pin wiring header.

The 833-5105 is a multiple language display (English, French and Spanish selectable).

FEATURES

- **Individual boiler status, configuration, history and diagnostics**
- **Allows configuration and monitoring of the Falcon controls (Hydronic or Steam) burner control sequence, flame signal, diagnostics, historical files, and faults**
- **Allows switching view between multiple boilers and lead-lag master/slaves**
- **Real-time data trending analysis and transferring saved trend data to Excel spreadsheet**
- **7” 800 x 480, 24 bit high resolution color LCD touch screen for clarity**
- **Full AC97 audio with integral speaker for sound output. It supports Audio File Formats**
- **Adjustable backlight control**
- **Real time clock with coin-cell battery back up**
- **Contrast and volume controls**
- **Screen Capture function to capture screen images**
- **USB port for file transfers and software updates**
- **2 RS-485 (COM1 & 2) ports for communication protocol, such as Modbus™**
- **Windows® CE 6.0 Operating System**
- **8-pin connector, back-up battery and mounting hardware are provided**

PREFACE

This User Guide is intended to provide a general overview of the 833-5105 Operator Interface (OI) Displays. It is intended to guide you through the features and operation of the OI Display as you interface with the Falcon control and establish the parameter points of the system.

Note that this sheet shows all parameters. The actual product may have parameters made invisible or Read Only as they may not apply to the product.

SPECIFICATIONS

Electrical Ratings:
Input Voltage: 18 – 30 Vac (24Vac nominal), 50/60 Hz
Input Current: 500 mA max
Power consumption: 12W max

Operating Temperature: -4 to 158 ºF (-20 to 70 ºC)

Storage/Shipping Temperature: -22 to 176 ºF (-30 to 80 ºC)

Humidity: 90% RH, non condensing

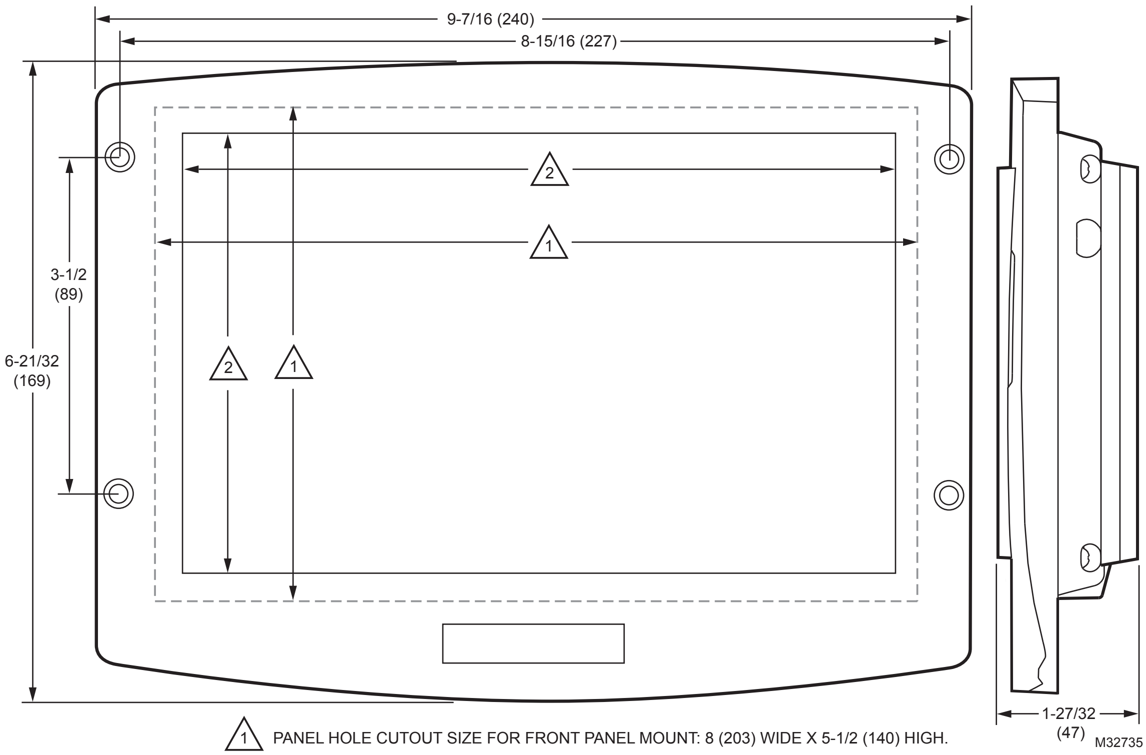
Enclosure rating: IP10 / NEMA 1

Approvals:
FCC Part 15, Class A Digital Device
Underwriter’s Laboratories, Inc. (UL) (cUL) Component Recognized (for non-continuous operation): File Number MH20613 (MCCZ).
Canada: ICES-003

Dimension: See Fig. 1

Replacement Parts

5006382-001 Bag assembly includes:
- 8-pin connector
- CR2032 coin battery
- Mounting hardware



1 PANEL HOLE CUTOUT SIZE FOR FRONT PANEL MOUNT: 8 (203) WIDE X 5-1/2 (140) HIGH.

2 PANEL HOLE CUTOUT SIZE FOR REAR PANEL MOUNT: 7-1/8 (181) WIDE X 4-11/16 (119) HIGH.

Fig. 1. Display dimensions in inches (mm).

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generateds, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment is a residential area is likely to cause harmful interference in which case the use will be required to correct the interference at his own expense.

The Class A digital apparatus complies with Canadian ICES-003

SAFETY FEATURES

The OI Display contains software that incorporates many features that are designed to guide you safely through the commissioning process. Safety, however, is your responsibility.

Read all documentation carefully and respond appropriately to all error messages

WARNING

Explosion Hazard.
Improper configuration can cause fuel buildup and explosion.
Improper user operation may result in PROPERTY LOSS, PHYSICAL INJURY or DEATH.

Using the OI Displays to change parameters, must be attempted by **only experienced and/or licensed burner/boiler operators and mechanics**.

INSTALLATION INSTRUCTIONS

The OI Display can be mounted on the door panel of an electrical enclosure.

1. Select the location on the door panel to mount the display; note that the device will extend into the enclosure at least one inch past the mounting surface.
2. Provide an opening in the panel door 8" wide X 5 1/2" high (for front panel mount) or 7 1/8" wide X 4 11/16" high (for rear panel mount). See Fig. 1 or use cutout templates provided in Fig. 96 and Fig. 97.
3. Place the OI Display in the opening and use it as a template to mark the location of the four mounting screw holes. Remove the device.
4. Using pilot holes as guides, drill 1/4 in. holes through the door panel.
5. Place the display in the opening, aligning the mounting holes in the device with the drilled holes in the panel.

6. Secure the display to the panel with four #6-32 screws and nuts provided.
7. Wire the 24 Vac power supply and the RS-485 cables using the wiring diagram in Fig. 2.
8. Ensure the 8-pin connector plug is aligned with the header pins when inserting the 8-pin connector plug back onto the Display. Secure firmly.

WIRING

The S7999D OI Display must be appropriately wired for both power and communications.

The communication is done over two RS-485 bus ports:

- COM1: connected directly to the SOLA device J3 connector to either Modbus (MB1 or MB2)
- COM2: A bus to the Building Automation System

Table 1. 8-pin Connector Terminals.

Pin #	Function
1	COM1 A
2	COM1 B
3	COM1 C*
4	COM2 A
5	COM2 B
6	COM2 C*
7	24 Vac Common *
8	24 Vac Power

* These 3 terminals are connected internally and can be connected to earth ground

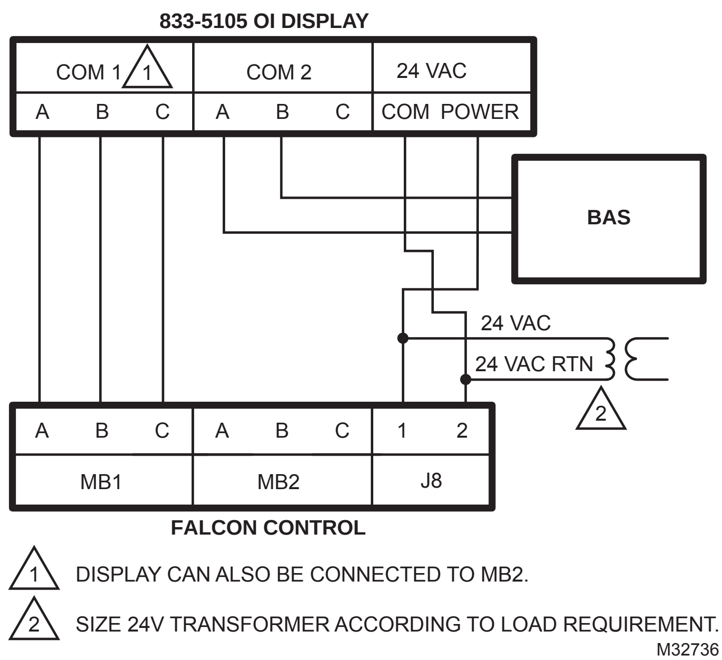
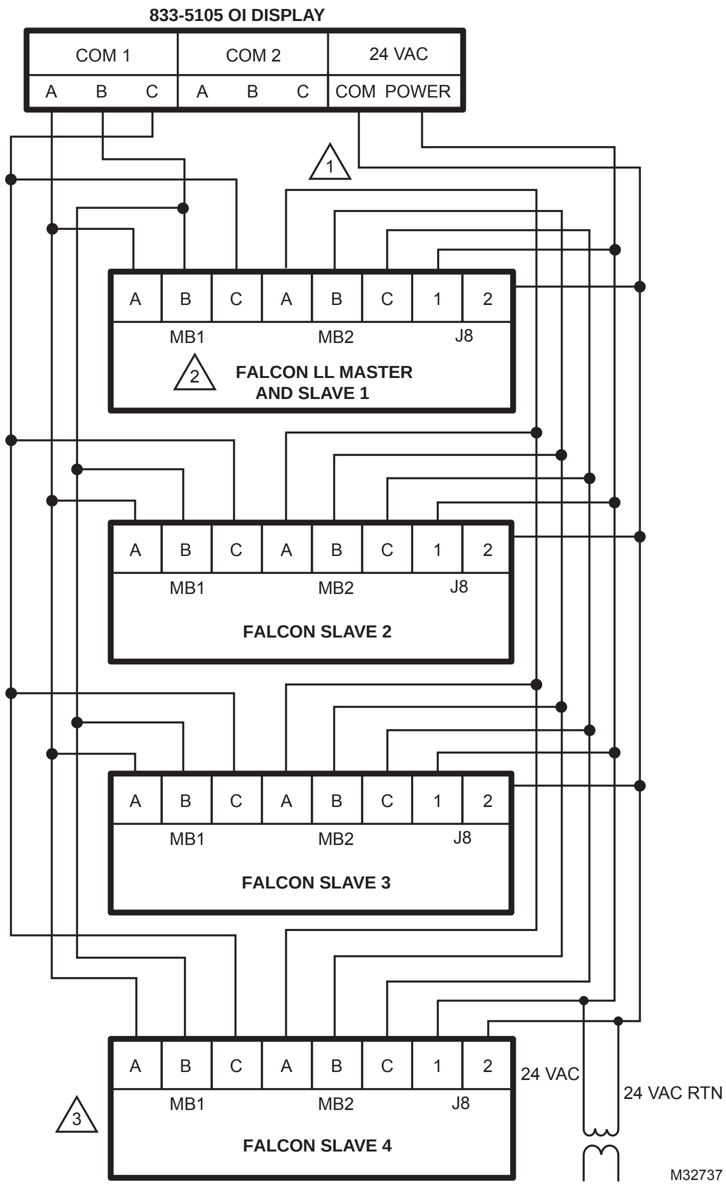


Fig. 2. 833-5105 wiring diagram.



1. DISPLAY CAN ALSO BE CONNECTED TO MB2; A, B, C AND THE SLAVES NEED TO BE WIRED TO MB1.
2. CONTROLLER HAS TWO AVAILABLE MODBUS CONNECTIONS: THIS CONFIGURATION REQUIRES ONE FOR CONTROL LEAD LAG COMMUNICATION AND ONE FOR A 833-5105 SYSTEM DISPLAY.
3. UP TO A MAXIMUM OF 8 FALCON SLAVES IN A LEAD LAG NETWORK.
4. SIZE 24V TRANSFORMER ACCORDING TO LOAD REQUIREMENT.

Fig. 3. Wiring diagram for lead lag.

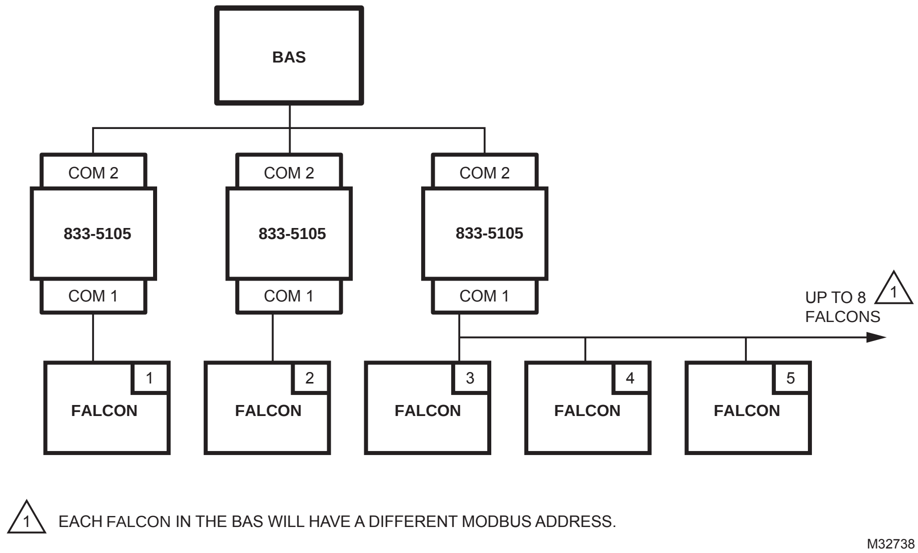


Fig. 4. 833-5105 in a Building Automation System.

BUILDING AUTOMATION SYSTEM (BAS) CONFIGURATION

Connect the BAS Modbus wiring to COM2 of the 833-5105 and ensure all devices have unique Modbus addresses as defined in Fig. 4.

BAS Modbus message timeout should be set to 1.0 seconds or higher. This means it could take up to 1.0 seconds (max) for the System Display to reply to a BAS message.

Retries: BAS must setup retries upon timeout to ensure the Modbus request is accepted.

BAS Modbus poll rate should be set to 1.0 seconds. This means that the BAS should wait for a minimum of 1.0 seconds after receiving a Modbus message from Sola before sending a new Modbus message.

QUICK SETUP

1. Make sure the 833-5105 8-pin connector is properly aligned and pressed firmly in place.
2. Make sure the wires between the 8-pin connector and the controller are properly wired and secured.
3. Make sure the power supply is connected securely to the power source.

⚠ WARNING

Electrical Shock Hazard.
Can cause severe injury, death or equipment damage.
Line voltage is present at the 120 Vac power supply.

STARTING THE S7999D OI DISPLAY

Power-up Validation

The Home page will appear when the device is properly powered. Select the Setup button to adjust contrast and sound as desired. It the screen is dim, check Pin 7 and 8 wiring connections.

A "camera" icon on the left top corner is for screen snapshot use. Up to 16 snapshots can be stored in the display and can be copied to an USB memory stick.

Fig. 5. Home page (Boiler 1 in normal operation).

Home page

Make sure a screen similar to Fig. 5 appears after the OI Display has completely powered up.

On System applications, each Falcon Control is represented on the Home page by an icon and name. Pressing the icon allows the user to zoom in on that boiler and see its specific details.

These details are provided on a new page, which can include additional buttons that display detail and operation information, which itself leads to other pages. The pages are traversed in a tree structure method, as shown in Fig. 6.

The Falcon icons will appear in one of four colors indicating the boiler status.

- **Blue**: Normal operation
- **Red**: Lockout operation
- **Yellow**: Standby mode (burner switch off)
- **Gray**: Communication error (disconnected or power off)

Up to 8 systems can be displayed on the Home page. The name of each boiler is displayed next to the Falcon icon button. When Lead Lag is enabled, the system header temperature and firing rate are displayed for each System. When the burner is in standby or not firing the firing rate is not displayed.

NOTE: The boiler name may be cut off on the Home page when all icons are present.

The Home page also includes a System Analysis button that allows the user to view status information on a system-wide (i.e. multiple boiler) basis. The user can choose which status information to compare from the Falcon Controls in the system.

Pressing the Setup button on the Home page displays miscellaneous setup and diagnostic functions It also contains the setup configuration for BAS applications.

Press the Falcon icon to open that control's status page. Go to "Configuration Button" to continue.

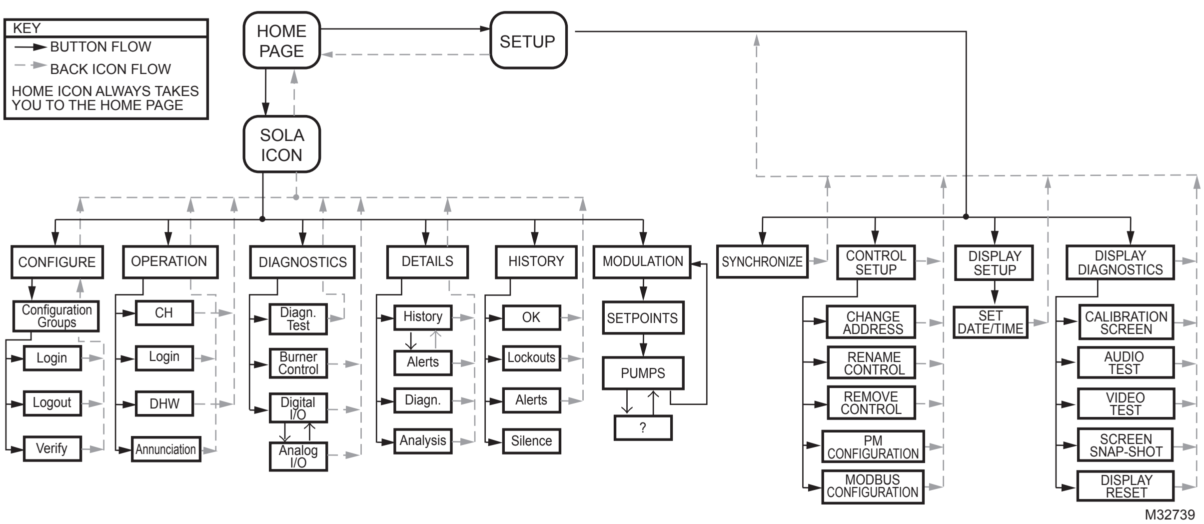


Fig. 6. 833-5105 display page flow.

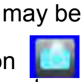
PAGE NAVIGATION

The Falcon OI Displays present information and options in a paged manner. Pages are displayed in a tree structure in which the user navigates up and down to arrive at the desired Function (see Fig. 6). The page descriptions are provided below so that you can understand the purpose of each and view the selections, parameters and information that is available or required on each.

Common OI Display Page Symbols

Most pages have a Home button  on the top-left corner of the screen and a Back button  on the top-right corner of the screen. The Home button returns the user to the Home page and terminates any operation in progress. The Back button returns the user to the previous page.

Two other icons may be noticed on the top menu bar:

A Camera button  is for screen snapshot use. Up to 16 snapshots can be stored in the display and can be copied to an USB memory stick.

A Padlock  indicates a password is needed to change the parameter. An unlocked padlock indicates the password has been entered.

Status page

This status page appears on the 833-5105 when the Sola control icon is pressed on the "Home" page. The status page displays the current condition of the burner control and displays some of the more important configuration settings.

The boiler name associated with the burner control is displayed in the title on the status page.

NOTE: When the burner control has no boiler name defined, Modbus address is used to identify the boiler.

The initial status page displayed contains summary status information as shown in Fig. 7. Any status information not applicable for the installation is grayed/blanked out on the screen.

Buttons on this screen include:

- **Configure**: used to configure the burner control (see "Configure Button" for more details).
- **Operation**: used to perform daily or frequent functions with the burner control, such as setpoint adjustment, etc. (see "Operation Button" for details).
- **Diagnostic**: used to view burner control diagnostic information (see "Diagnostics Button" for more details).
- **Details**: used to view burner control detail status information (see "Details Button" for more details).

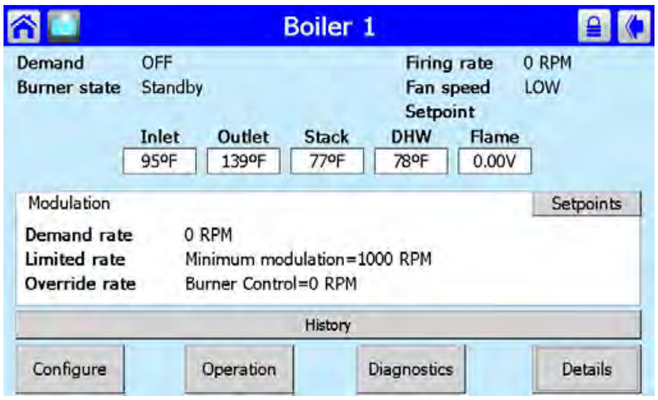


Fig. 7. Status page.

Configure Button

The configuration page allows the user to view and set parameters that define how the connected Falcon functions in the (hydronic or steam) heating system.

The configuration page contains a menu of parameters grouped into functional areas that the user selects for configuration (see Fig. 8). See Table 59 for all parameters available for configuration (some parameters may not be visible).

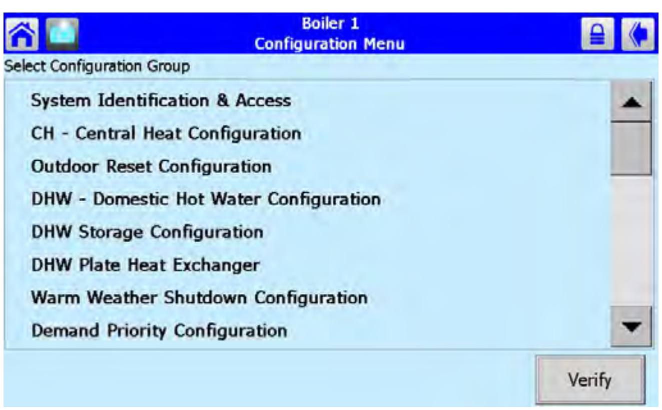


Fig. 8. Configuration menu page.

No specific order for configuration is required. All parameters are enabled for editing, though some may not be applicable (e.g., a configuration parameter may disable a control feature). Selecting a parameter group from the menu displays parameters exclusively applicable for the functional group on the page (see Fig. 9). These parameters can be edited, and when the user is finished, control returns back to the configuration menu page.

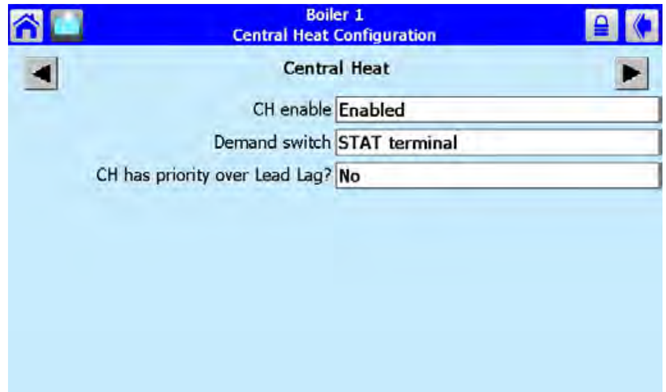


Fig. 9. Sample configuration page for the Falcon Hydronic control.

Each parameter is displayed in its group. If there are more parameters than will fit on the screen, a vertical scroll bar allows the user to scroll up and down to view all parameters. The parameter name is displayed on the left and the current setting is displayed in the text box on the right.

Configuration Password

Some parameters require a valid configuration password be entered by the user before the parameter can be changed. The password need only be entered once while the user remains on the configuration pages. Leaving the configuration pages ends the scope of the password.

Three levels of access to Falcon Control parameters are permitted. Each access level has defined rights when interfacing with configuration and status parameters within the controls.

- **End user:** The end user can read or view the control parameters and be allowed to change some operating parameters, CH setpoint as an example.
- **Installer:** The installer can read all control parameters and change allowed parameters. This access level is used to customize the control for a particular installation.
- **OEM:** The OEM can read and change all parameters, change sensor limits and burner control safety parameters.

Different passwords exist in the Falcon Control for each access level. The end user level requires no password, but the installer and OEM levels have unique passwords defined for them.

The installer and OEM passwords can be changed in the Falcon Control after logging in with the current password. When the password is changed, it is saved for all future logins.

NOTE: Each boiler in a multi-boiler configuration has its own set of installer and OEM passwords. To avoid user confusion, the passwords should be changed to the same password in each control, but there is no requirement to do so. **Make sure to record your password.**

The user is notified that a new password is needed to change a parameter (or until a password is entered successfully)—see Fig. 10. The user can continue viewing the configuration parameters regardless of whether a password is entered successfully.

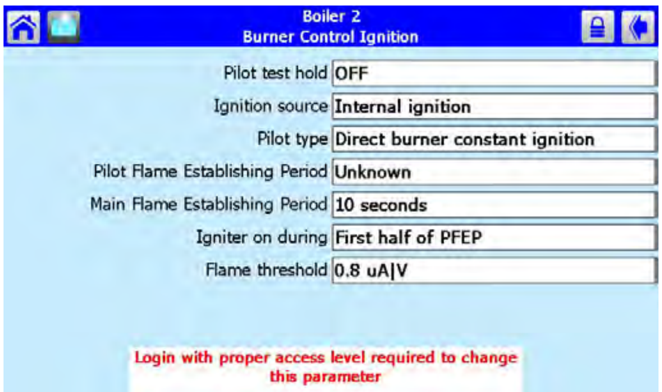


Fig. 10. Login required.

The Falcon Controls maintain a password time-out that limits the scope of the password entry. Once a password is successfully entered, the control starts an internal timer that expires after 10 minutes of inactivity. After the timer expires, the user is required to re-enter a password before a parameter can be changed.

The user is not required to enter a configuration password for a parameter that has a lower access level than the access level achieved by an earlier password entry for any configuration group (as long as the user stays in the configuration pages). The user only needs to enter a password once until a parameter that has a higher access level is selected.

Keyboard

Some pages request user entry of characters. When this type of input is required, a keyboard page appears, as shown in Fig. 11. The text box at the top of the screen displays the current (or default) setting of the user input. The user can add to this text, clear it, or change it.

The Shift key on the left side of the screen shifts between upper and lowercase characters. Pressing the Shift key toggles the keyboard from one mode to the other (continuous pressing of the Shift button is not required). The OK button should be pressed when the user is done entering the text input. The Cancel button on the bottom of the screen allows the user to ignore any text changes that have been made and keep the original text value. Pressing the OK or Cancel buttons returns the user to the page displayed prior to the keyboard page.

Login

Pressing the Login button allows entering the password from a keyboard as shown in Fig. 11. After the password is entered, the OK button is selected. The Cancel button aborts the password login.

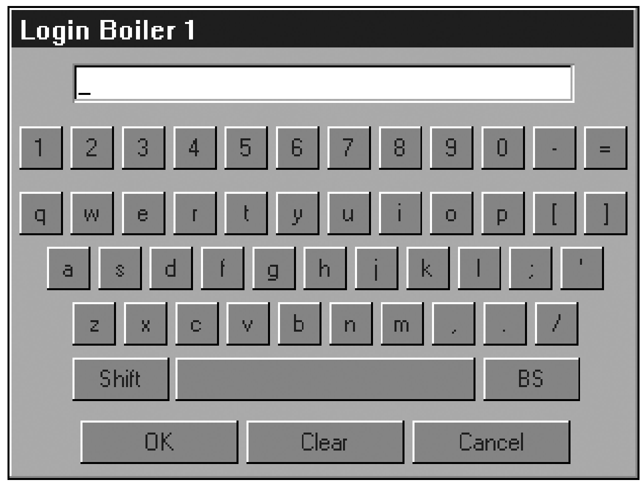


Fig. 11. Device login screen.

WARNING

Explosion Hazard.
Improper configuration can cause fuel buildup and explosion.
Improper user operation may result in PROPERTY LOSS, PHYSICAL INJURY or DEATH.

Using the OI Displays to change parameters must be attempted by **only experienced and/or licensed burner/boiler operators and mechanics**.

Change Parameter Settings

Change parameter settings by selecting the parameter on the page. A dialog box displays for the parameter with controls allowing the user to change the value (see Fig. 12). After changing the setting to a new value, press the OK button. Pressing the Cancel button leaves the parameter unchanged.

The changed setting is reflected on the screen and sent to the control when the OK button is pressed.

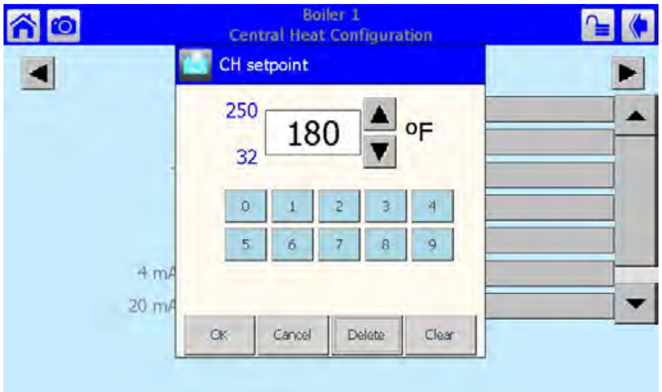


Fig. 12. Change configuration parameter page example of a Hydronic Control.

Verify

Pressing the Verify button displays safety configuration parameters for an additional verification step to commit the changes.

Safety parameters are grouped into blocks that include only safety parameters, not a mixture of safety data and non-safety data. All parameters within the safety group undergo a verification process. A safety parameter group is identified on the display to indicate when the configuration parameters are safety-related. Each safety parameter group is verified one at a time until all have been verified. See Fig. 13.

Fig. 13. Safety verification.

Like operating parameters, safety parameters can be viewed without the need to enter a password.

Safety parameter blocks that have been changed require verification. The verification steps do not have to be completed immediately; the installer can move between and change parameter groups before the verification is done. A Verify button is enabled that allows the installer to conduct verification sessions (the example of the Verify button in Fig. 8 is not yet enabled because the installer hasn't logged in).

NOTE: When the installer proceeds with the safety parameter configuration, the control unlocks the safety parameters in this group and marks them unusable. Failure to complete the entire safety configuration procedure leaves the control in an un-runnable state (lockout 2).

All safety configuration parameters in the group should have the same access level. If this condition isn't so, the user is asked to enter another password when a higher access level is needed.

Successful login is noted by the lock icon, which changes to "unlocked" on the page. The installer may begin to change safety parameters (or any other parameters) at that time. (See Fig. 14.) If the Sola Control is in an unconfigured (or new) state, then this warning doesn't appear. All parameters that need changes should be changed during the login.

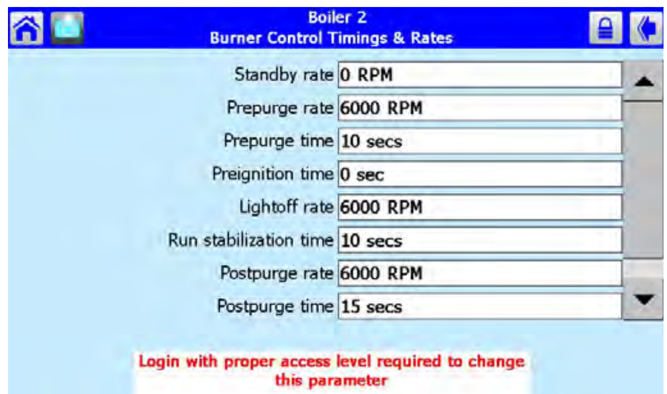


Fig. 14. Edit safety data (requires login).

If the safety configuration session is terminated after it has started (in the Edit or Verify stages), the Sola Control is left in an unconfigured (unrunnable) state.

The installer can terminate the session by pressing the Menu button or by attempting to leave the Verification page with the Home or Back buttons (top-left and -right screen corners, respectively). However, leaving the session at this point leaves the control in an unrunnable state and confirms whether the installer still wants to do so.

The settings of all parameters in each safety block must be verified to save them in the control.

When the installer is done changing safety parameters, pressing the Verify button on the configuration screen begins the Verification process. The settings for all safety parameters in each changed block are presented and Verified by the installer (see Fig. 15).

Fig. 15. Safety parameter confirmation.

Fault/Alarm Handling

Each Falcon control reports to the OI display when a safety lockout or an Alert occurs.

Safety lockouts are indicated on each configuration page as an alarm bell symbol. At the status page, the History button turns red (see Fig. 16). If the 833-5105 is displaying the system status icons, the control in alarm will turn red (see Fig. 17).

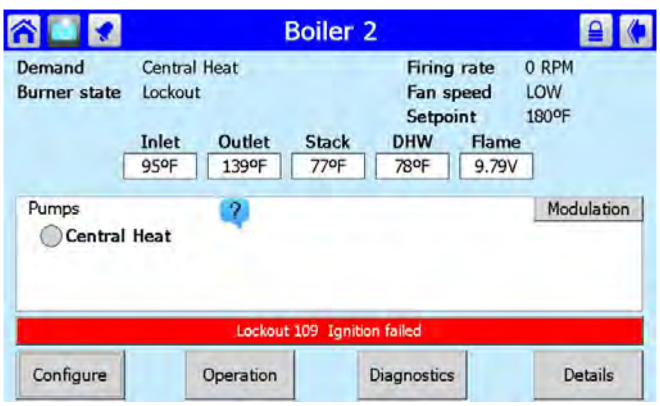


Fig. 16. Lockout condition - Status page.

Fig. 17. Lockout condition - Home page.

The lockout history can be displayed by pressing on the History button. The state information about each lockout is displayed along with the date/time that the lockout occurred (see Table 2). Current date/time stamp is a display setup feature.

Table 2. Sola Control Lockout History.

Data	Comment
Lockout time	Set by display
Fault code	Unique code defining which lockout occurred.
Annunciator first out	First interlock in limit string results in a shutdown.
Description	Fault description
Burner Lockout/Hold	Source/reason for lockout/ hold
Burner control state	
Sequence time	Burner control state timer at time of fault
Cycle	Burner control cycle
Run Hours	Burner control hours
I/O	All digital I/O status at time of fault
Annunciator 1-8 states	All annunciator I/O status at time of fault
Fault data	Fault dependent data

An alert log can be displayed for each control by pressing the Alert button on the bottom of the history status page. A description of the alert is displayed along with the time when the alert occurred (see Table 3).

Table 3. Falcon Control Alert Log.

Data	Comment
Alert time	Set by display
Alert code	Unique code defining which fault occurred.
Description	Alert description

History Button

The History button on the Home page serves not only as a button, but also displays Falcon Control lockouts, holds, and alerts as they occur. The History button can be selected at any time, regardless of which type of information is displayed, to view history information. Pressing the History button displays a dialog box (see Fig. 18) that allows the user to select the type of history to view. The user can also silence an audible alarm generated by the control during a lockout or alert by alarm condition.

This History dialog box provides an exploded view of the status information displayed in the History button (the font is larger). One of the four buttons (OK, Lockouts, Alerts, or Silence) can be selected. If none of these buttons are selected the dialog box closes after 30 seconds.

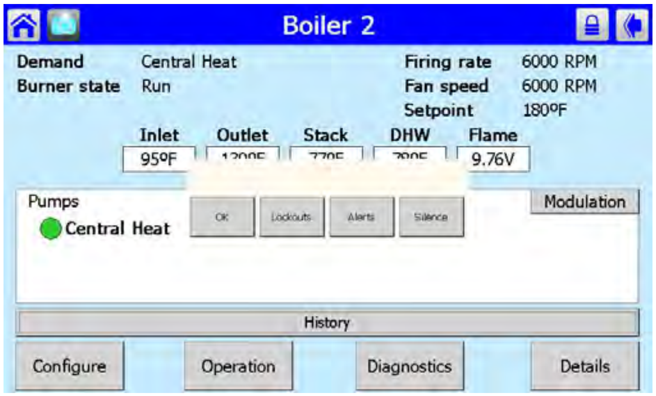


Fig. 18. Hydronic history example shown—exploded view.

Two types of historical data can be displayed on the history page: lockout history and alert log.

The entire 15 fault code history is displayed in a scrollable list with the most recent fault displayed first followed by the next most recent fault (see Fig. 19). Summary information is displayed for each fault entry, including the burner cycle count, fault code, and fault number with description. Detailed information for a specific fault entry that also includes burner control sequence state, burner run-time hours, annunciation status, etc., is viewed by selecting (touching the History line) the lockout entry in the list (see "Fault/Alarm Handling" on page 10 for details).

Fig. 19. Lockout history example shown.

The date and time that each fault occurred is displayed in the lockout history. The lockout timestamp displays in both the lockout summary and detail information.

The Falcon Control does not maintain date or time of day information. The date and time stamp is assigned by the OI display. When the OI display first obtains the lockout and alert history from the control (during the display data synchronization), no timestamps are assigned since the times that the lockouts occurred are unknown. All new lockouts that occur after the synchronization are assigned timestamps.

NOTE: The system time can be set in the OI display to ensure that correct timestamps are given to the controls' lockouts and alerts.

The Clear Lockout button allows the user to acknowledge and clear (reset) the lockout when in lockout state, much the same as pressing the reset button on the front of the Sola Control.

The user can toggle between displaying the controls' lockout history and alert log by pressing the Alerts or Lockouts button on the bottom of the pages.

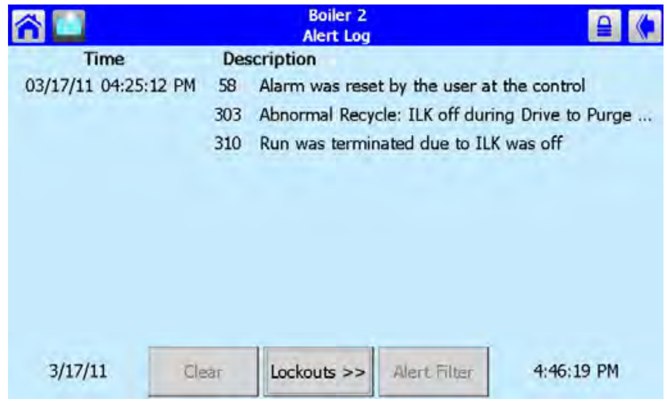


Fig. 20. Alert log example shown.

To see additional detail about a lockout or alert, touching on the lockout or alert in the list expands the view of that lockout or alert, as shown in Fig. 21 and Fig. 22.

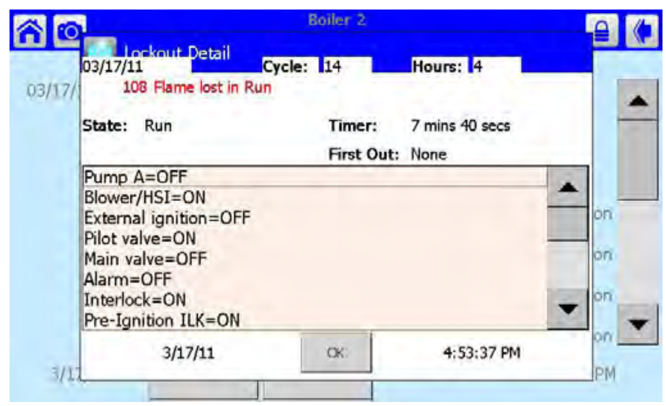


Fig. 21. Control expanded lockout detail.

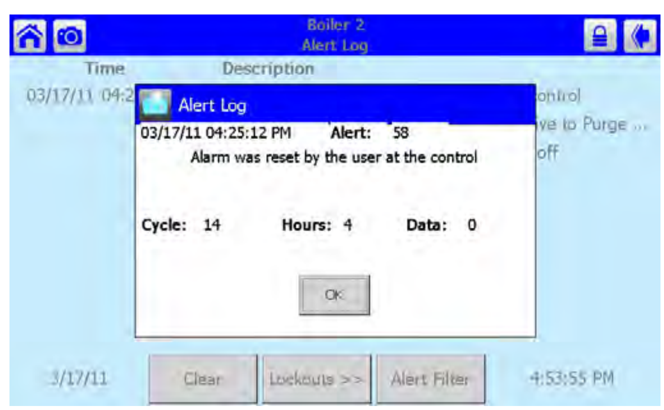


Fig. 22. Control expanded alert detail.

Operation Button

The operation button displays the Falcon Control running operation, including setpoint and firing rate values. From this page the user can change setpoints, manually control the boiler's firing rate, manually turn pumps on, view annunciation information, and switch between hydronic heating loops (Central Heat and Domestic Hot Water). If a password is required to change any of the settings on this page, the user can press the Login button to enter the password.

Annunciation information is shown in Fig. 23 and Fig. 24.

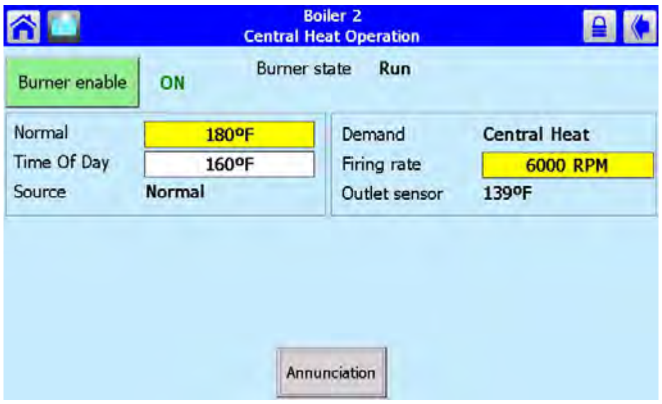


Fig. 23. Hydronic operation page shown.

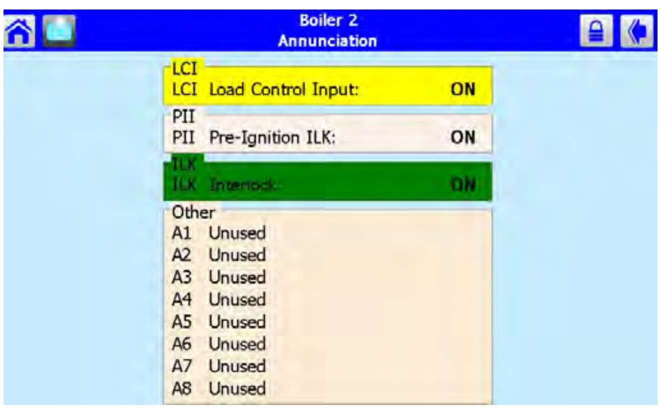


Fig. 24. Programmable annunciation.

Diagnostics Button

The Diagnostics button displays analog and digital I/O status of the Falcon Control. A snapshot of the diagnostic status is displayed and updated once per second as it changes in the control. See "R7910A or R7911 Diagnostics" for more information about this status.

The digital I/O data is displayed as LEDs that are either on (green) or off (gray) (see Fig. 25). Not all digital I/O can be displayed at the same time on the page, so a horizontal scroll bar is used to move the view left and right to show all digital I/O data.

Fig. 25. Diagnostic page (digital I/O).

The control analog I/O can also be viewed on the OI Display. A snapshot of the diagnostic status is displayed and updated as it changes in the control.

The analog I/O data is displayed as bar charts with I/O level represented in the I/O range (see Fig. 26) Analog I/O that is not enabled for the installation displays a blank I/O level. Not all analog I/O can be displayed at the same time on the page, so a horizontal scroll bar is used to move the view left and right to show all analog I/O status.

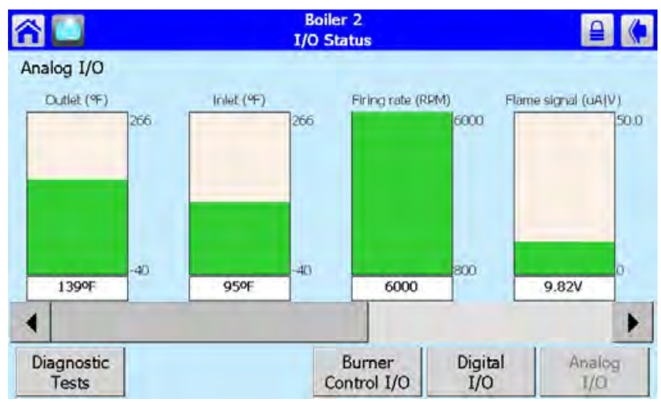


Fig. 26. Diagnostics page (analog I/O).

System Configuration

The OI Display has some functions related to general configuration for the control in the end user installation.

Pressing the Display Refresh button invokes a search procedure. A new R7910A Hydronic Control or R7911 Steam Control is identified by "Unknown" status next to its name in the boiler system list (see Fig. 27). "Unknown" indicates that configuration data has not been retrieved from the control yet.

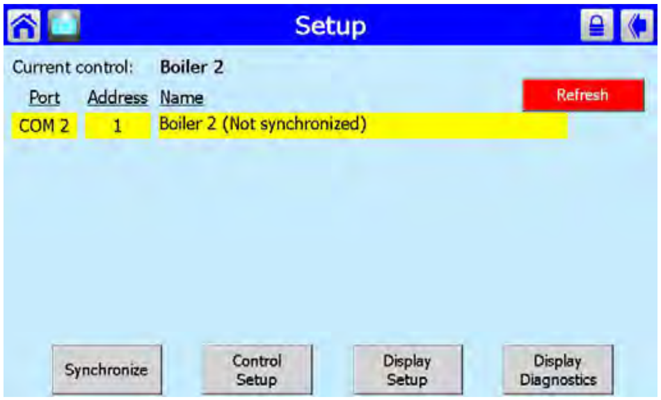


Fig. 27. System refresh and synchronize screen.

The control connected to the Modbus network is indicated to the user after the search procedure has concluded.

Once the control is located it must be synchronized with the OI Display before it can be displayed. New controls are not displayed on the Home page until this synchronization (see below) is performed.

System Synchronization

The user can manually synchronize configuration data from the connected controls at any time.

A new control is visible when configuration and status data is gathered from it. This collection procedure takes a few minutes. The control is marked as “Unknown” when no configuration information exists. Normally, control configuration data collection only needs to be performed when the control is initially installed. However, a re synchronization is necessary after the OI Display is reset.

The user presses the Synchronize button to begin synchronization with the control. See Fig. 27.

Configuration

The SOLA Control can be configured from the OI Display. The control configuration is grouped into the functional groups seen in Table 4.

Table 4. Functional Configuration Groups.

Hydronic Control	Steam Control
System Identification and Access	Steam Identification and Access
CH - Central Heat	Steam Configuration
Outdoor Reset	Modulation Configuration
DHW - Domestic Hot Water	Pump Configuration
DHW Storage	
DHW Plate	
Warm Weather Shutdown	
Demand Priority	
Modulation Configuration	Statistics Configuration
Pump Configuration	Stack Limit
Statistics Configuration	Annunciation Configuration
High Limit	Burner Control Interlocks
Stack Limit	Burner control Timings and Rates
Delta T Limits	
T-Rise Limit	
Heat Exchanger High Limit	
Anti-condensation	Burner Control Flame Failure
Frost Protection Configuration	System Configuration
Annunciation Configuration	Fan Configuration
Burner Control Interlocks	Lead Lag Configuration
Burner Control Timings and Rates	
Burner Control Ignition	
Burner Control Flame Failure	
System Configuration	
Fan Configuration	
Sensor Configuration	
Lead Lag Slave Configuration	
Lead Lag Master Configuration	

Table 4. Functional Configuration Groups.

Most of this configuration is performed by either the contractor/installer or at Honeywell. Each functional group is displayed on the Configuration menu page.

Parameters in functional groups that are not applicable for the installation can be ignored. In some cases, features in a functional group are disabled by default and are enabled when needed for the installation.

R7910A HYDRONIC CONTROL, R7911 STEAM CONTROL CONFIGURATION PARAMETERS

The following pages list the configuration parameters available for the R7910A or R7911 installed.

NOTE: Individual Configuration pages may differ from this text as features are added or amended by Honeywell.

A password is required to make changes to the Configuration Parameters. The SOLA Control will be in a Lockout 2 “waiting for safety data verification” as received or will go to a Lockout 2 when changes are made to the safety data.

⚠ WARNING

Explosion Hazard.
Improper configuration can cause fuel buildup and explosion.
Improper user operation may result in PROPERTY LOSS, PHYSICAL INJURY or DEATH.

The OI Display used to change parameters, must be attempted by **only experienced and/or licensed burner/boiler operators and mechanics**.

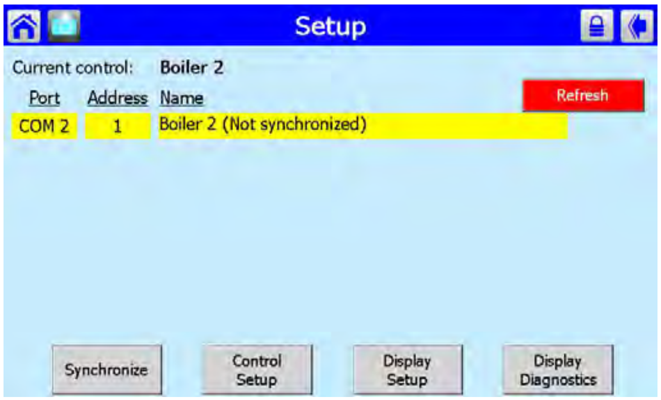


Fig. 28. System identification and access configuration (Hydronic Screen Shown).

Table 5 displays System Identification and Access parameters.

Table 5. System Identification and Access Parameters.

Parameter	Comment
Boiler Name	Name to identify boiler (up to 20 characters)
Installation	Notes regarding installation (up to 20 characters)
Installer password	Change installer password setting
OEM password	Change OEM password setting
Factory Data	OEM name to associate with boiler (up to 20 characters)

When the burner name is changed, the name is saved in the Falcon and displayed in the title of all pages that zoom into the control.

Default installer password is "9220".

Table 6. System Identification Information.

Status	Comment
Product Type	Type of product that the burner is
OS Number	Model number associated with burner
Software Version	Version of software running in the Falcon
Date Code	Date when Falcon was assembled
Application Revision	Version of application data in the Falcon
Safety Revision	Revision of safety data in the Falcon

Central Heat Parameters (Hydronic Control Only)

Table 7 displays Central Heat Hydronic Control configuration parameters.

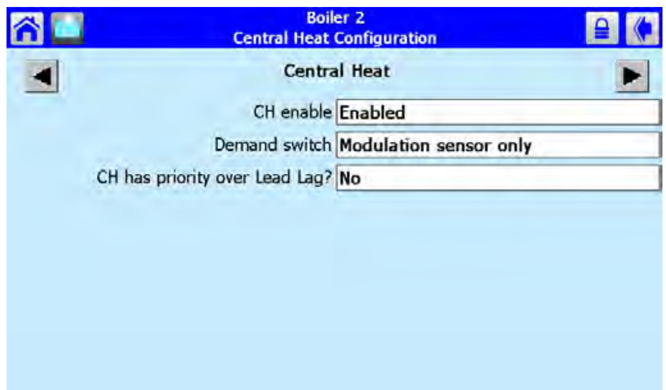


Fig. 29. Central Heat hydronic configuration.

Table 7. Central Heat Hydronic Configuration Parameters.

Parameter	Comment
CH enable	Disable or Enable Central Heating Loop
Demand switch	Sensor for Central Heat demand: Sensor only Sensor & STAT terminal Sensor & Remote Stat LCI & Sensor
Outdoor reset	Enabled Disabled
CH has priority over Lead Lag	Yes, No, Cancel
Setpoint source	Local S2 (J8-6) 4-20mA
Setpoint	Setpoint for normal Central Heat modulation: -40 °F to 266 °F (-40 °C to 130 °C)

Table 7. Central Heat Hydronic Configuration Parameters. (Continued)

Parameter	Comment
Time of day setpoint	Setpoint when Time Of Day switch is on. -40 °F to 266 °F (-40 °C to 130 °C)
Off hysteresis	Differential above setpoint when boiler is turned off. 32 °F to 266 °F (0 °C to 130 °C)
On hysteresis	Differential from setpoint when boiler is turned on. 32 °F to 266 °F (0 °C to 130 °C)
4 mA water temperature	-40 °F to 266 °F (-40 °C to 130 °C)
20 mA water temperature	-40 °F to 266 °F (-40 °C to 130 °C)
Modulation sensor	Outlet sensor, Inlet sensor, S5 (J8-11)
Modulation Rate Sensor	Local
P-gain	Gain applied for the P portion of the PID equation 0-400
I-gain	Gain applied for the I portion of the PID equation 0-400
D-gain	Gain applied for the D portion of the PID equation 0-400
Hysteresis step time	Time between hysteresis step changes: 0-600 seconds (0=Disable hysteresis stepping)

Table 8. Steam Configuration Parameters

Parameter	Comment
Steam enable	Disable/enable steam feature
Steam demand source	Sensor and LCI Sensor and Remote Stat Sensor and Stat Terminal Sensor Only
Steam pressure setpoint	Setpoint for normal modulation Adjustable 0 to 15 or 0 to 150 (sensor dependant)
Steam time of day setpoint	Setpoint when TOD switch on Adjustable 0 to 15 or 0 to 150 (sensor dependant)
Minimum steam pressure	Establishes setpoint for the 4ma. input. Adjustable 0 to 15 or 0 to 150 (sensor dependant)
Steam pressure off hysteresis	Differential below setpoint when boiler is turned off Adjustable 0 to 15 or 0 to 150 (sensor dependant)
Steam pressure on hysteresis	Differential from setpoint when boiler is turned on. Adjustable 0 to 15 or 0 to 150 (sensor dependant)
Steam hysteresis step time	Time between hysteresis changes 0 to 600 seconds (0=disable)

Table 8. Steam Configuration Parameters

Parameter	Comment
Steam P Gain	Gain applied for the P portion of the PID equation 0-400
Steam I Gain	Gain applied for the I portion of the PID Equation - 0-400
Steam D Gain	Gain applied for the D portion of the PID equation 0-400
Steam 4-20 ma remote control	uses 4-20ma remote control function to control either the setpoint or modulation for Steam Disable, setpoint, modulation

Outdoor Reset Parameters (Hydronic Control Only)

Table 9 displays Outdoor Reset configuration parameters. Pressing the left or right arrow displays Lead Lag, which lists the same parameters.

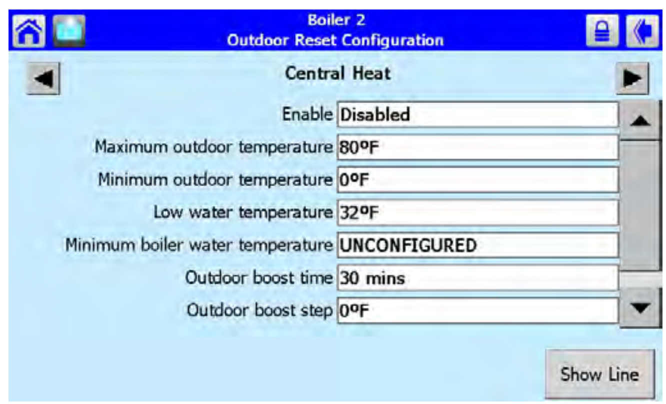


Fig. 30. Outdoor reset configuration.

Table 9. Outdoor Reset Configuration Parameters.

Parameter	Comment
Maximum outdoor temperature	-40 °F to 266 °F (-40 °C to 130 °C)
Minimum outdoor temperature	-40 °F to 266 °F (-40 °C to 130 °C)
Low water temperature	-40 °F to 266 °F (-40 °C to 130 °C)
Minimum water temperature	-40 °F to 266 °F (-40 °C to 130 °C)
Maximum off point	-40 °F to 266 °F (-40 °C to 130 °C)

Domestic Hot Water (DHW) Configuration Parameters (Hydronic Control Only)

Table 10 displays Domestic Hot Water (DHW) configuration parameters.

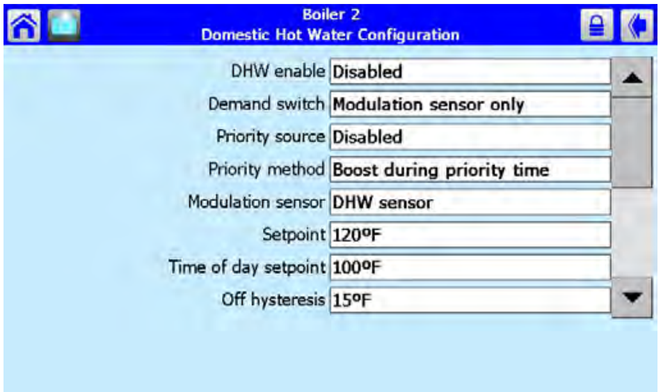


Fig. 31. Domestic Hot Water (DHW) configuration.

Table 10. Domestic Hot Water (DHW) Configuration Parameters.

Parameter	Comment
Enable	Disable or Enable Domestic Hot Water Loop
Demand switch	Sensor for Central Heat demand: DHW sensor only, DHW sensor & Remote Stat, DHW switch & inlet sensor, or DHW switch & outlet sensor
Priority source	Which system has priority: Disabled or Heat Demand
Priority method	Boost during priority time Drop after priority time
Modulation sensor	DHW Sensor Outlet Sensor Inlet Sensor Auto: DHW (S6) or Inlet Sensor Auto: DHW (S6) or Outlet Sensor
Setpoint	-40 °F to 240 °F (-40 °C to 115 °C)
Time of day setpoint	Setpoint when Time Of Day switch is on. -40 °F to 240 °F (-40 °C to 115 °C)
Off hysteresis	Differential above setpoint when boiler is turned off. -40 °F to 240 °F (-40 °C to 115 °C)
On hysteresis	Differential from setpoint when boiler is turned on. 2 °F to 234 °F (-16 °C to 112 °C)
DHW priority override time	___hour ___min ___sec
Hysteresis step time	___hour ___min ___sec
DHW priority vs CH	Which system has priority: Central Heat over Domestic Hot Water, or Domestic Hot Water over Central Heat

Table 10. Domestic Hot Water (DHW) Configuration Parameters. (Continued)

Parameter	Comment
DHW priority vs Lead Lag	Which system has priority: Lead Lag over Domestic Hot Water, Domestic Hot Water over Lead Lag
DHW P-gain	Gain applied for the P portion of the PID equation 0-400
DHW I-gain	Gain applied for the I portion of the PID equation 0-400
DHW D-gain	Gain applied for the D portion of the PID equation 0-400

DHW Storage Configuration

Table 11 displays DHW Storage configuration parameters.

Table 11. DHW Storage Configuration Parameters.

Parameter	Comment
DHW storage enable	Enabled, Disabled
Storage time	___hour ___min ___sec
Setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
Off hysteresis	-0 °F to 180 °F (-17 °C to 82 °C)
On hysteresis	-0 °F to 180 °F (-17 °C to 82 °C)

DHW Plate Heat Exchanger Configuration

Table 12 displays DHW Plate Heat Exchanger configuration parameters.

Table 12. DHW Plate Heat Exchanger Configuration Parameters.

Parameter	Comment
Tap detect degrees	-0 °F to 180 °F (-17 °C to 82 °C)
Tap detect on recognition time	___hour ___min ___sec
Tap detect on threshold	-0 °F to 180 °F (-17 °C to 82 °C)
Tap detect minimum on time	___hour ___min ___sec
Tap stop inlet-DHW degrees	-0 °F to 180 °F (-17 °C to 82 °C)
Tap stop outlet-Inlet degrees	-0 °F to 180 °F (-17 °C to 82 °C)
Plate preheat setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
Plate preheat on recognition time	___hour ___min ___sec

Table 12. DHW Plate Heat Exchanger Configuration Parameters. (Continued)

Parameter	Comment
Plate preheat on hysteresis	-0 °F to 180 °F (-17 °C to 82 °C)
Plate preheat off hysteresis	-0 °F to 180 °F (-17 °C to 82 °C)
Plate preheat detect on threshold	-0 °F to 180 °F (-17 °C to 82 °C)
Plate preheat detect off threshold	-0 °F to 180 °F (-17 °C to 82 °C)
Plate preheat minimum on time	___hour ___min ___sec
Plate preheat delay after tap	___hour ___min ___sec

Warm Weather Shutdown Configuration

Table 13 displays Warm Weather Setpoint configuration parameters.

Table 13. Warm Weather Setpoint Configuration Parameters.

Parameter	Comment
Enable	Enabled, disabled
Setpoint	-40 °F to 266 °F (-40 °C to 130 °C)

Demand Priority Configuration Parameters

Fig. 32 displays R7910A Hydronic Control Demand Priority configuration options. Press the arrows to change the priority order.

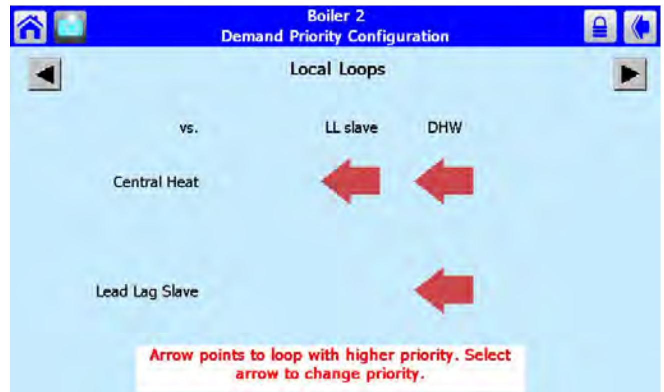


Fig. 32. Demand priority configuration.

Modulation Configuration Parameters

Table 14 displays Hydronic Control Modulation configuration parameters.

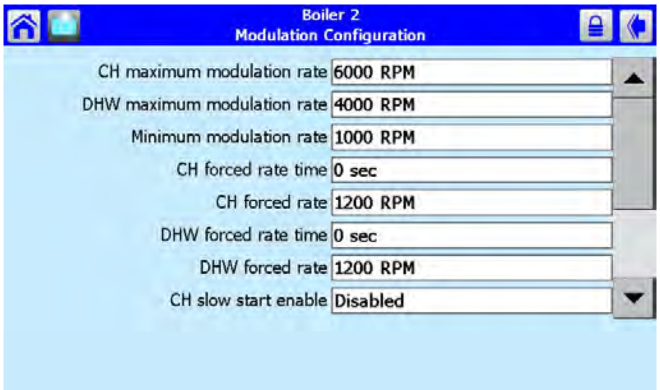


Fig. 33. Modulation configuration.

Table 14. R7910A Hydronic Control Modulation Configuration Parameters.

Parameter	Comment
CH maximum modulation rate	RPM or %
DHW maximum modulation rate	RPM or %
Minimum modulation rate	RPM or %
CH forced rate time	0-600 seconds
CH forced rate	RPM or %

Table 14. R7910A Hydronic Control Modulation Configuration Parameters. (Continued)

Parameter	Comment
DHW forced rate time	0-600 seconds
DHW forced rate	RPM or %
CH slow start enable	Enabled Disabled
DHW slow start enable	Enabled Disabled
Slow start degrees	-40 °F to 266 °F (-40 °C to 130 °C)
Slow start ramp	RPM /minute or %/minute
0-10/4-20 mA Output hysteresis	

Steam Modulation Configuration Parameters

Table 15 displays Steam Modulation Configuration parameters.

Table 15. R7911 Steam Modulation Configuration Parameters.

Parameter	Comment
CH maximum modulation rate	RPM or %
Minimum modulation rate	RPM or %
CH forced rate time	0-600 seconds
CH forced rate	RPM or %
0-10/4-20 mA Output hysteresis	

Pump Configuration Parameters

Table 16 displays Pump configuration parameters. Use the left and right arrows to switch between Central Heat, Boiler, DHW, System, Auxiliary 1, and Auxiliary 2 pumps. The parameters are the same for all pumps.

Pressing the Advanced Settings button brings up a number of other advanced configuration options for each pump. Press the Control Settings button to return to the screen shown in Fig. 34.

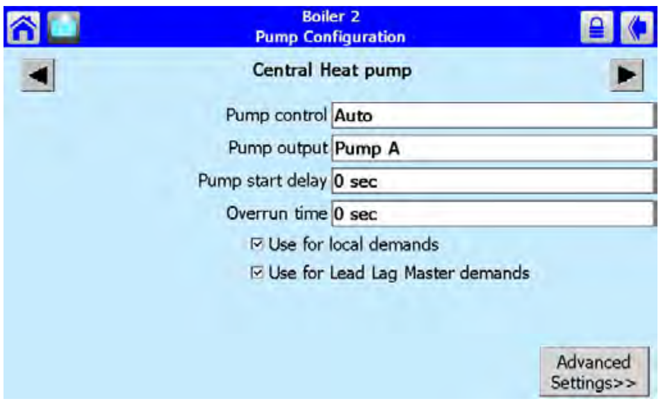


Fig. 34. Pump configuration.

Table 16. Pump Configuration Parameters for Falcon Hydronic System.

Parameter	Comment
Pump control	Auto On
Pump output	Pump A Pump B Pump C None
Pump start delay	___hour ___min ___sec
Overrun time	___hour ___min ___sec

*Table 60 on page 42 has more parameters listed.

NOTE: The Falcon Steam Control does not have pumps, but the outputs are available to operate air dampers or accessories. CH Pump, Boiler Pump and System Pump are used for these output options.

Table 16a. Pump Configuration Parameters for Steam Modulation Configuration Parameters.

Parameter	Comment
Auxiliary pump control	Auto On
Auxiliary pump is on when	CH pump is ON Slave command
Auxiliary pump output	Pump A Pump B Pump C None
Boiler pump control	Auto On
Boiler pump output	Pump A Pump B Pump C None
Boiler pump overrun time	0-600 seconds 0 = Not configured
CH pump control	Auto On
CH pump output	Pump A Pump B Pump C None
CH pump overrun time	0-600 seconds 0 = Not configured
System pump control	Auto On
System pump output	Pump A Pump B Pump C None
System pump ourrun time	0-600 seconds 0 = Not configured
Pump exercise time	0-600 seconds 0= Not configured

Statistics Configuration Parameters

Table 17 displays Statistics configuration parameters.

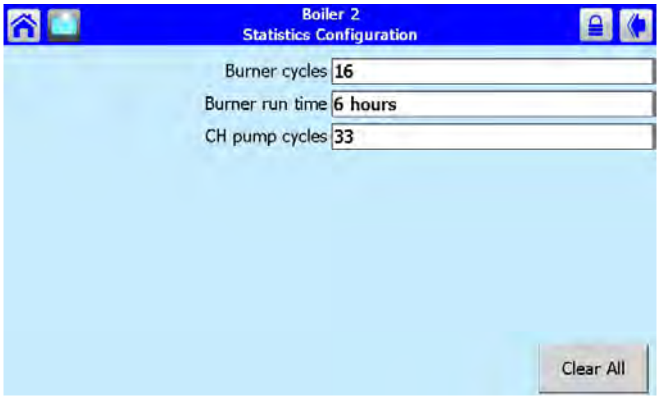


Fig. 35. Statistics configuration.

Table 17. Statistics Configuration Parameters.

Parameter	Comment
Auxiliary pump cycles	0-999,999
Boiler pump cycles	0-999,999
Burner cycles	0-999,999
Burner run time	0-999,999
CH pump cycles	0-999,999
DHW pump cycles	0-999,999
System pump cycles	0-999,999
Auxiliary 2 pump cycles	0-999,999

High Limit Configuration Parameters (Hydronic Control Only)

Table 18 displays outlet high limit configuration parameters.

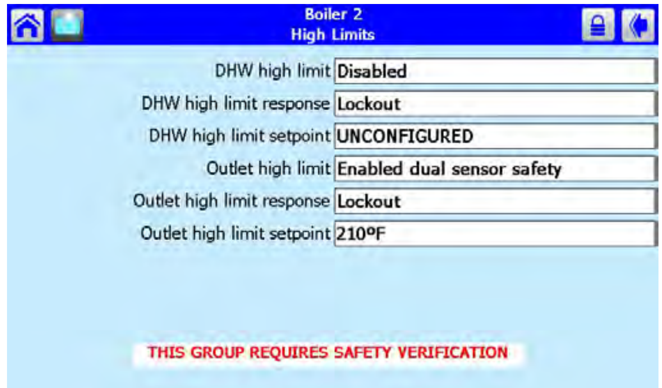


Fig. 36. High Limits configuration.

Table 18. High Limit Configuration Parameters.

Parameter	Comment
DHW high limit	Enabled Disabled
DHW high limit response	Recycle & hold Lockout
DWH high limit setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
Outlet high limit	Enabled Disabled
Outlet high limit response	Recycle & hold Lockout
Outlet high limit setpoint	-40 °F to 266 °F (-40 °C to 130 °C)

Stack Limit Configuration Parameters

Table 19 displays stack limit configuration parameters.

Fig. 37. Stack Limit configuration.

Table 19. Stack Limit Configuration Parameters.

Parameter	Comment
Stack limit	Enabled dual sensor safety Enabled single sensor non safety Disabled
Stack limit delay	___hour ___min ___sec
Stack limit response	Lockout Recycle & delay
Stack limit setpoint	32 °F to 266 °F (0 °C to 130 °C)

Delta T Limit Configuration Parameters (Hydronic Control Only)

Table 20 displays other limit parameters. Use the left and right arrows to switch between Inlet to Outlet Flow and Exchanger to Outlet Flow. The parameters are the same for all pumps.

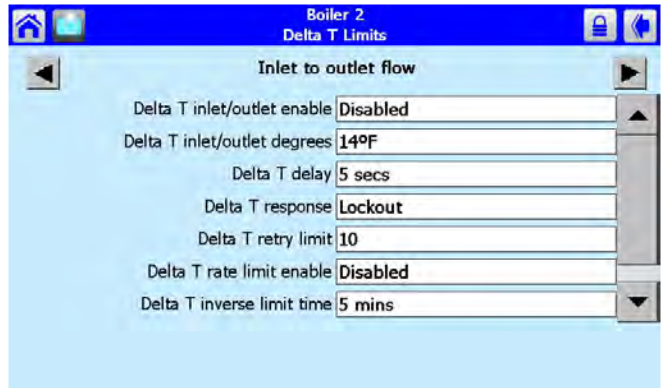


Fig. 38. Delta T Limit configuration.

Table 20. Delta T Limit Configuration Parameters.

Parameter	Comment
Delta T enable	Enabled Disabled
Delta T degrees	0 °F to 234 °F (-17 °C to 112 °C)
Delta T delay	___hour ___min ___sec
Delta T response	Recycle & delay Recycle & Delay with retry limit Lockout
Delta T retry limit	0–100
Delta T rate limit enable	Enabled Disabled
Delta T inverse limit time	___hour ___min ___sec
Delta T inverse limit response	Recycle & delay Recycle & delay with retry limit Lockout

T-Rise Limit Configuration Parameters

Table 21 displays T-Rise limit parameters.

Table 21. T-Rise Limit Configuration Parameters.

Parameter	Comment
Outlet T-rise enable	Enabled Disabled
Heat exchanger T-rise enable	Enabled Disabled
T-rise degrees	0 °F to 234 °F (-17 °C to 112 °C)/sec
T-rise response	Recycle & delay Recycle & delay with retry limit Lockout
T-rise retry limit	0 to 100
T-rise delay	___hour ___min ___sec

Heat Exchanger High Limit Configuration Parameters

Table 22 displays T-Rise limit parameters.

Table 22. Heat Exchanger High Limit Configuration Parameters.

Parameter	Comment
Heat exchanger high limit enable	Enabled Disabled
Heat exchanger high limit setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
Heat exchanger high limit response	Recycle & delay Recycle & delay with retry limit Lockout
Heat exchanger retry limit	0 to 100
Heat exchanger high limit delay	___hour ___min ___sec

Anti-Condensation Configuration Parameters (Hydronic Control Only)

Table 23 displays anti-condensation parameters. Use the left and right arrows to switch between Central Heat, Domestic Hot Water, Frost Protection, and Priority parameters.

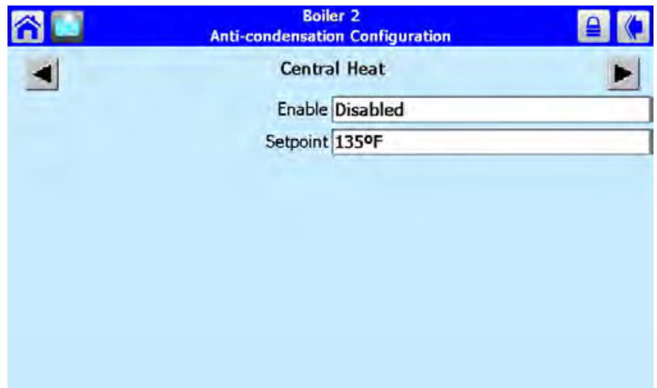


Fig. 39. Anti-condensation configuration.

Table 23. Anti-Condensation Configuration Parameters.

Parameter	Comment
CH Enable	Enabled Disabled
CH Setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
DHW Enable	Enabled Disabled
DHW Setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
Frost Protection Enable	Enabled Disabled
Anticondensation Priority	Anticondensation is more important than (check those that apply): Stack limit Delta T limit Slow start Forced rate Outlet high limit

Frost Protection Parameters (Hydronic Control Only)

Table 24 displays frost protection parameters.

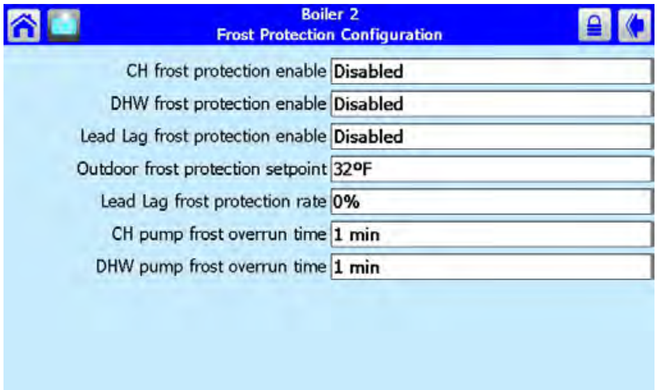


Fig. 40. Frost Protection configuration.

Table 24. Frost Protection Configuration Parameters.

Parameter	Comment
CH frost protection enable	Enabled Disabled
DHW frost protection enable	Enabled Disabled
Lead Lag frost protection enable	Enabled Disabled
Outdoor frost protection setpoint	-40 °F to 266 °F (-40 °C to 130 °C) (applicable for CH only)
Lead Lag frost protection rate	___%
CH pump frost overrun time	___hour ___min ___sec
DHW pump frost overrun time	___hour ___min ___sec

Annunciation Configuration Parameters

Table 25 displays annunciation configuration parameters.

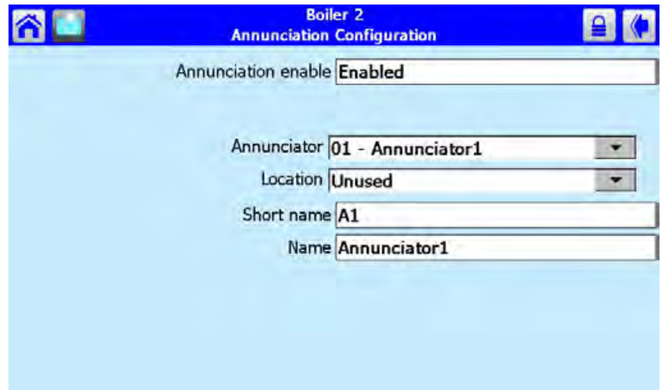


Fig. 41. Annunciation configuration example.

Table 25. Annunciation Configuration Parameters.

Parameter	Comment
Annunciation enable	Enabled Disabled
Annunciator (1–8) location	01 - Annunciator 1 02 - Annunciator 2 03 - Annunciator 3 04 - Annunciator 4 05 - Annunciator 5 06 - Annunciator 6 07 - Annunciator 7 08 - Annunciator 8 PII - Pre-Ignition ILK LCI - Load Control Input ILK - Interlock
Annunciator (1–8) short name	Up to 3 characters
Annunciator (1–8) name	Up to 20 characters

Safety Configuration Parameters

Table 26 through 29 display safety parameters.

NOTE: Login is required to change Safety Parameters and the Falcon Control will go to a Lockout 2 “waiting for safety data verification” when a change is made.

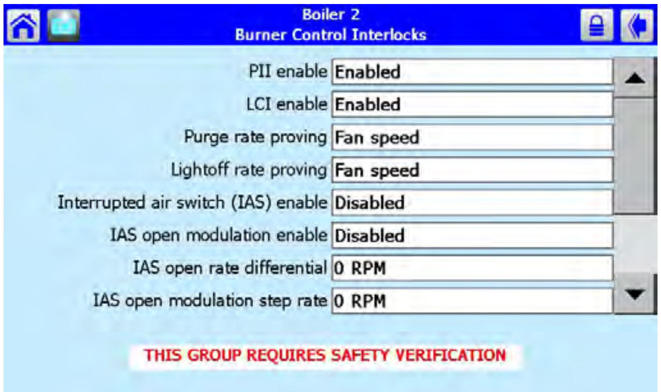


Fig. 42. Burner Control Interlocks control.

Table 26. Burner Control Interlocks Configuration.

Parameter	Comment
PII enable	Enabled Disabled
LCI enable	Enabled Disabled
Interrupted air switch (IAS) enable	Enable during purge and ignition Disabled Enable during purge
Interlock (ILK) start check enable	No ILK check ILK check
ILK/IAS open response	Recycle Lockout
ILK bounce detection enable	Enabled Disabled
Purge rate proving	Fan Speed High Fire Switch None
Lightoff rate proving	Fan Speed Low Fire Switch None

Fig. 43. Burner Control Timings and Rates configuration.

Table 27. Burner Control Timings and Rates Configuration.

Parameter	Comment
Prepurge rate	RPM or %
Prepurge time	___hour ___min ___sec
Run stabilization time	___hour ___min ___sec
Standby Rate	RPM or %
Postpurge rate	RPM or %
Postpurge time	___hour ___min ___sec
Forced recycle interval time	___day ___hour ___min

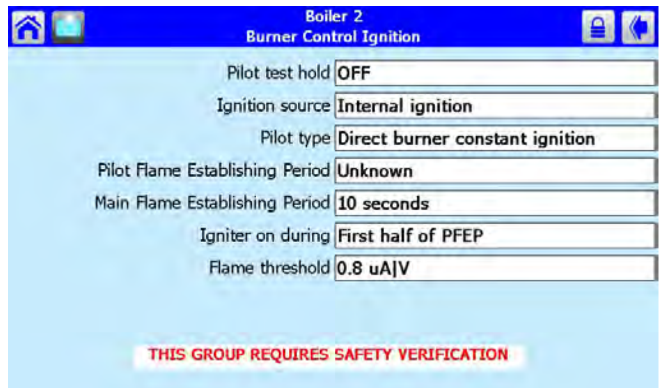


Fig. 44. Burner Control Ignition configuration.

Table 28. Burner Control Ignition Configuration.

Parameter	Comment
Pilot test hold	On Off
Ignition source	Hot Surface Igniter External ignition Internal ignition
Pilot type	Direct burner constant ignition Direct burner pulsed ignition Intermittent Interrupted
Lightoff rate	RPM or %
Preignition time	___hour ___min ___sec
Pilot Flame Establishing Period	15 secs 10 secs 4 secs
Igniter on during	1st half of PFEP Pilot Flame Establishing Period
Main Flame Establishing Period	15 secs 10 secs 5 secs
Flame Threshold	µA/V

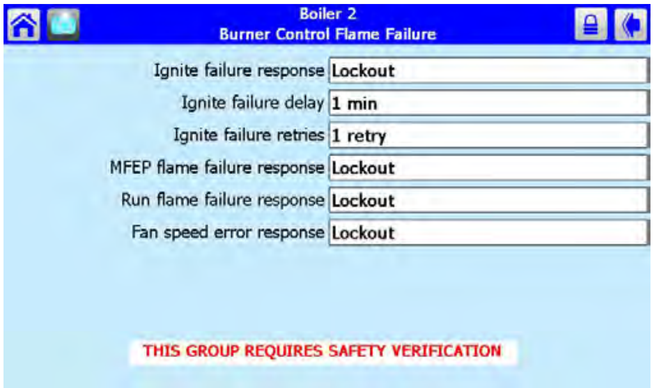


Fig. 45. Burner Control Flame Failure configuration.

Table 29. Burner Control Flame Failure Configuration.

Parameter	Comment
Ignite failure response	Lockout Recycle Recycle & hold Recycle & lockout
Ignite failure delay	___hour ___min ___sec
Ignite failure retries	1, 3, or 5
MFEP flame failure response	Recycle Lockout
Run flame failure response	Recycle Lockout
Fan speed error response	Recycle Lockout

Safety Parameter Verification

When any of the safety configuration parameters are changed, the safety parameter verification procedure must be performed before the control will resume burner control. The control enters a lockout state, if not already in one, and remains locked out until this verification procedure is performed.

Safety parameter verification lockout occurs when safety parameter setting is changed. See Fig. 46.

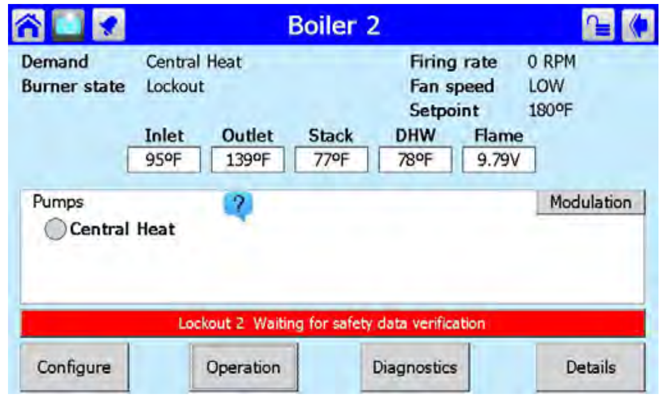


Fig. 46. Safety verification lockout.

The user must log in before verification can be completed, as shown in Fig. 47.

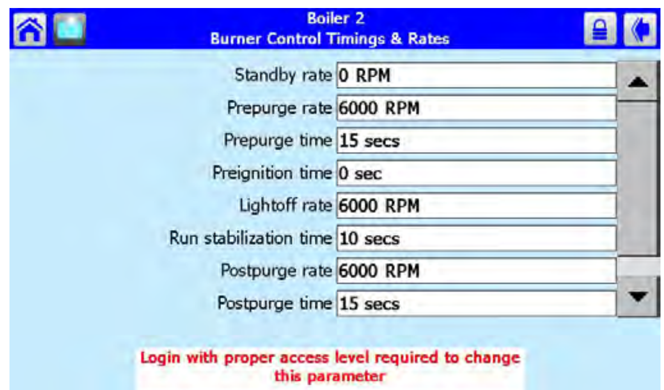


Fig. 47. Safety verification login.

After successful login, the user presses the Begin button to start safety parameter verification. See Fig. 48.

Fig. 48. Begin safety verification.

The first group of safety configuration parameters that needs verification is displayed. The user is asked to confirm that the settings are correct, as shown in Fig. 49.

Fig. 49. Confirm safety parameter settings.

After the first safety parameter group has been confirmed by the user (by pressing the Yes button), the next safety parameter group waits for verification as shown in Fig. 50.

Fig. 50. Safety parameter settings confirmed; next group waiting for confirmation.

The user has 30 secs to confirm each safety configuration group's settings. If the user takes too long to confirm the settings, an error message is displayed, as shown in Fig. 51.

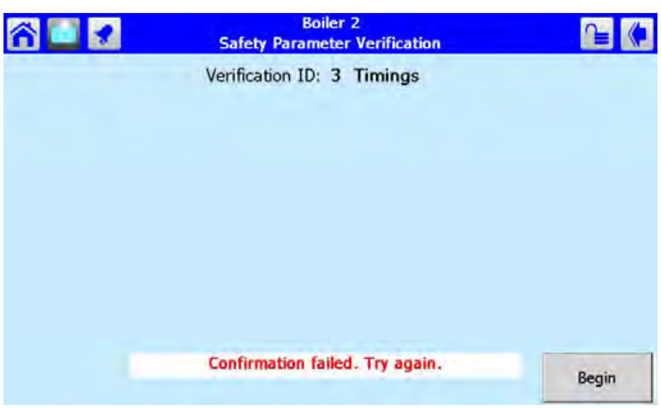


Fig. 51. Confirmation timed out.

After all safety parameter groups have been verified, the user must press the Reset button on the control within 30 seconds to confirm the correct device. See Fig. 52.

Fig. 52. Reset Falcon.

When the user has pressed the Reset button on the control, completing verification procedure, a Verification Complete screen is displayed, as shown in as shown in Fig. 53.

Fig. 53. Safety parameter configuration complete.

If for some reason the user does not press the Reset button on the control within 30 seconds, the configuration is cancelled, as shown in Fig. 54.

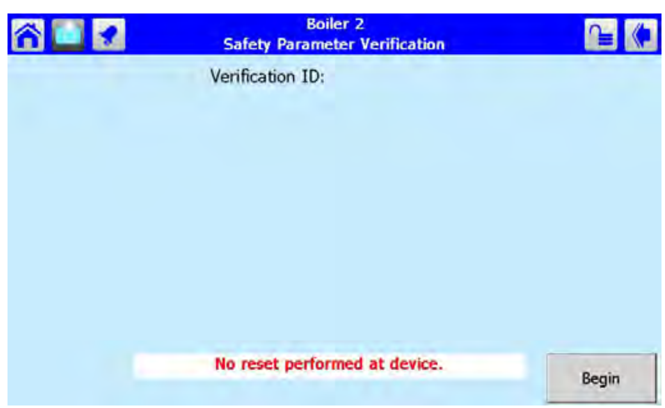


Fig. 54. Control reset timed out.

Individual Configuration Parameters

Table 30 and Table 31 displays system configuration parameters for individual controls.

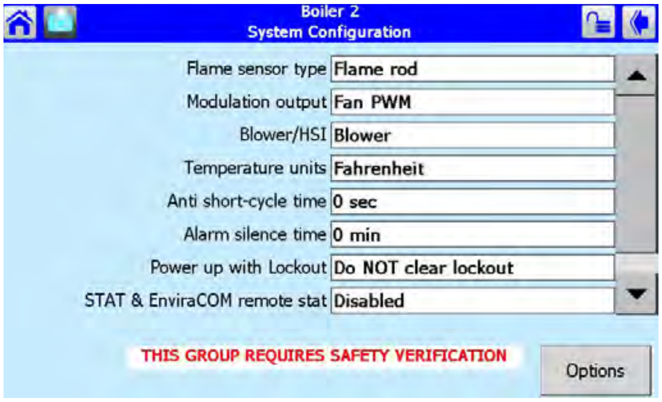


Fig. 55. System configuration (hydronic shown).

Table 30. Hydronic System Configuration Parameters.

Parameter	Comment
Flame sensor type	Flame rod UV power tube UV power tube with spark interference None
Modulation output	4-20mA 0-10V Fan PWM
Blower/HSI	Blower Hot surface ignition
Temperature units	Fahrenheit Celsius
Anti short-cycle time	___hour ___min ___sec
Alarm silence time	___hour ___min ___sec
Power up with Lockout	Clear lockout Do NOT clear lockout
STAT & EnviraCOM remote stat	Enabled Disabled

Table 31. R7911 System Configuration Parameters.

Parameter	Comment
Flame sensor type	Flame rod UV
Modulation output	4-20ma 0-10V Fan PWM
Blower/HSI	Blower Hot surface ignitor
Temperature units	Fahrenheit Celsius

Table 31. System Configuration Parameters. (Continued)

Parameter	Comment
Anti short cycle time	___hour ___min ___sec
Alarm silence time	___day ___hour ___min
Power up with lockout	Clear lockout Do NOT clear lockout
Inlet connector type	0-15 psi 0-150 psi UNCONFIGURED
Stack connector type	10k NTC dual safety 10k NTC single non-safety 12k NTC single non-safety UNCONFIGURED
Header	4-20ma UNCONFIGURED

Fan Parameters

Table 32 displays fan parameters.

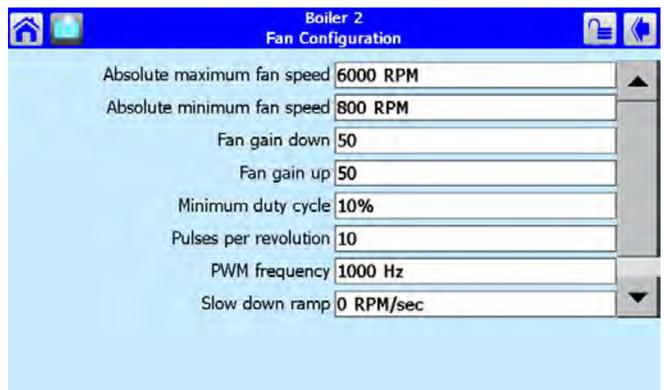


Fig. 56. Fan configuration.

Table 32. Fan Configuration Parameters.

Parameter	Comment
Absolute maximum fan speed	500–12000 RPM
Absolute minimum fan speed	500–12000 RPM
Fan gain down	0-100
Fan gain up	0-100
Minimum duty cycle	1-100%
Pulses per revolution	1-10
PWM frequency	1000 2000 3000 4000
Slow down ramp	0-12000 RPM/sec
Speed up ramp	0-12000 RPM/sec

Lead Lag Slave Configuration Parameters (Hydronic Control Only)

Table 33 displays Lead Lag Slave Configuration parameters.

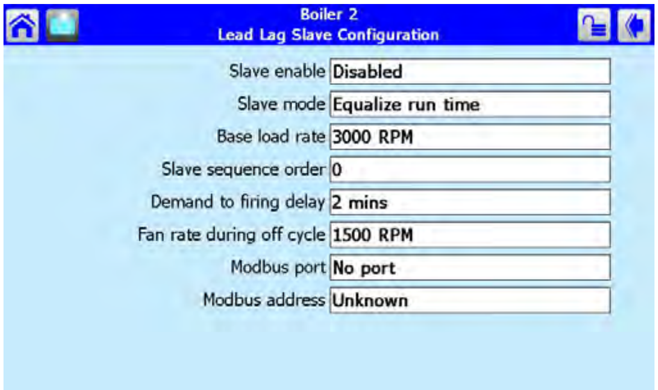


Fig. 57. Lead Lag slave configuration.

Table 33. Lead Lag Slave Configuration Parameters.

Parameter	Comment
Slave enable	Slave ModBUS slave Disabled
Slave mode	Use first Use last Equalize run time
Base load rate	0–6000 rpm
Slave sequence order	0–8
Demand to firing delay	___hour ___min ___sec
Fan rate during off cycle	0–12000 rpm
ModBus port	MB1 MB2 No port
ModBus address	0–250

Lead Lag Master Configuration Parameters (Hydronic Control Only)

Table 34 displays Lead Lag Master Configuration parameters.

Click the Advanced Settings button to see available advanced parameters as shown in Table 34–43.

Use the left and right arrows to switch between Modulation, CH, DHW, Frost Protection, Warm Weather Shutdown, Algorithms, Rate Allocation, Add stage and Drop stage parameters.

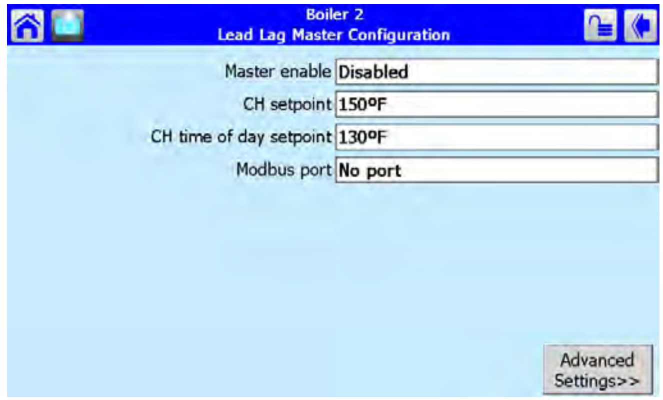


Fig. 58. Lead Lag master configuration and Advanced Settings button.

Table 34. Lead Lag Master Configuration Parameters.

Parameter	Comment
Master enable	Enabled Disabled
CH setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
CH time of day setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
ModBus port	MB1 MB2 No port
ModBus address	1–250

Table 35. Lead Lag Master Configuration Advanced Settings: Modulation Parameters.

Parameter	Comment
Modulation backup sensor	Lead outlet sensor Slave outlet sensor average Disabled
Off hysteresis	0 °F to 234 °F (-17 °C to 112 °C)
On hysteresis	0 °F to 234 °F (-17 °C to 112 °C)
Hysteresis step time	___Hour ____Minute _____Second
P gain	0 - 400
I gain	0 - 400
D gain	0 - 400

Table 36. Lead Lag Master Configuration Advanced Settings: Central Heat Parameters.

Parameter	Comment
Demand switch	Stat Remote Stat ModBus Stat Disabled
Setpoint source	Local ModBus 4-20 ma
Setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
Time of day setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
4 ma water temperature	-40 °F to 266 °F (-40 °C to 130 °C)
20 ma water temperature	-40 °F to 266 °F (-40 °C to 130 °C)
Outdoor reset	Enabled Disabled

Table 37. Lead Lag Master Configuration Advanced Settings: DHW Parameters.

Parameter	Comment
Priority source	DHW heat demand Disabled
Priority method	Boost during priority time Drop after priority time
DHW priority override time	___Hour ____Minute _____Second

Table 38. Lead Lag Master Configuration Advanced Settings: Frost Protection Parameters.

Parameter	Comment
Enable	Enabled Disabled
Outdoor setpoint	-40 °F to 266 °F (-40 °C to 130 °C)
Frost protection rate	____%

Table 39. Lead Lag Master Configuration Advanced Settings: Warm Weather Shutdown Parameters.

Parameter	Comment
Enable	Enabled Disabled
Setpoint	-40 °F to 266 °F (-40 °C to 130 °C)

Table 40. Lead Lag Master Configuration Advanced Settings: Algorithms Parameters.

Parameter	Comment
Lead selection method	Sequence order Measured run time
Lag selection method	Sequence order Measured run time
Lead rotation time	___day ____hour _____min
Force lead rotation time	___day ____hour _____min

Table 41. Lead Lag Master Configuration Advanced Settings: Rate Allocation Parameters.

Parameter	Comment
Base load common	? %

Table 42. Lead Lag Master Configuration Advanced Settings: Add Stage Parameters.

Parameter	Comment
Method	Error threshold Firing rate threshold Disabled
Detection time	___Hour ____Minute _____Second
Error threshold	0 °F to 234 °F (-17 °C to 112 °C)
Rate offset	± ________ %
Interstage delay	___Hour ____Minute _____Second

Table 43. Lead Lag Master Configuration Advanced Settings: Drop Stage Parameters.

Parameter	Comment
Method	Error threshold Firing rate threshold
Detection time	___Hour ____Minute _____Second
Error threshold	0 °F to 234 °F (-17 °C to 112 °C)
Rate offset	± ________ %
Interstage delay	___Hour ____Minute _____Second

DETAILS

Details of the hydronic or steam system is accomplished through the detail status pages. The detail status page is shown below.

Screens will appear only if they are configured for your system.

Information shown is current status. For example: firing rate is the current fan speed or motor position; timing shown is current time Sola is at.

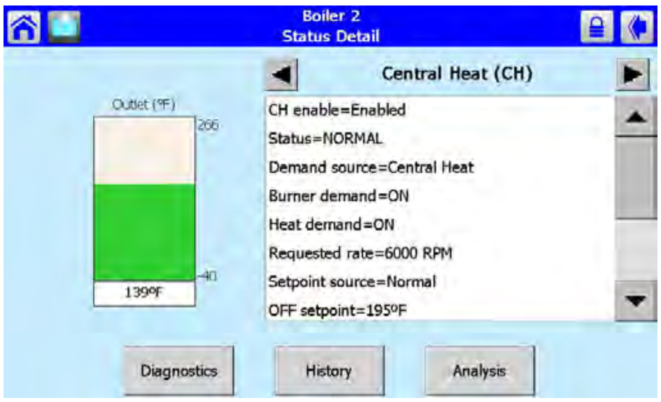


Fig. 59. Hydronic CH detail status page.

Status information on the detail status page is organized into groups and displayed on the page one group at a time. The user moves from one group to another using the left and right arrow buttons.

Status data on the detail status page is displayed in a menu for the group that is currently displayed. If more status items exist in the group than will fit on the screen, a vertical scroll bar allows the user to see all status data. If the user selects a line of status data in the menu, it will expand in bigger, more easily readable text, as show in Fig. 60. Additional information about Status data and groups that are displayed are provided in the R7910A or R7911 Status section of this document.

Fig. 60. Hydronic "expanded" detail status.

Status

Data in Tables 44–Table 55 are displayed on the Hydronic or Steam status pages. A complete list of Status tables can be found in Table 59 on page 41.

The CH status data shown in Table 44 displays first when the CH Hydronic heating loop is selected on the Home page.

Table 44. CH Hydronic Status.

Data	Comment
CH enable	Enabled, Disabled
CH burner demand	On or Off
CH pump	On or Off
CH pump demand	On or Off
CH pump overrun time	Running overtime for CH pump (seconds)
CH requested rate	RPM or %
CH OFF setpoint	Setpoint plus hysteresis
CH setpoint	Temp setting between -40 °F to 266 °F (-40 °C to 130 °C)
CH ON setpoint	Setpoint minus hysteresis
CH setpoint source	Normal, TOD, Outdoor reset, Remote control
CH status	Disabled, Normal, Suspended
Demand source	Sensor only, Sensor and Stat terminal, Sensor and Remote Stat, LCI and sensor
Outlet high limit	Yes or No
Outlet high limit setpoint	Temp setting between -40 °F to 266 °F (-40 °C to 130 °C)
Outlet sensor state	None, Normal, Open, Shorted, Outside high range, Outside low range, Not reliable (None = no outlet sensor)
Outlet temperature	Outlet temperature (same as bar graph)

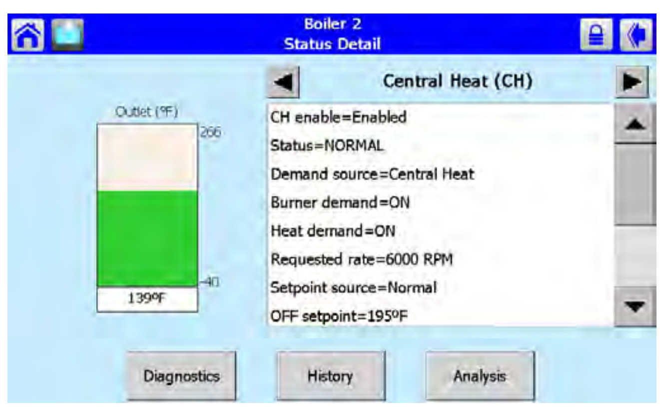


Fig. 61. CH Hydronic Status menu (top).

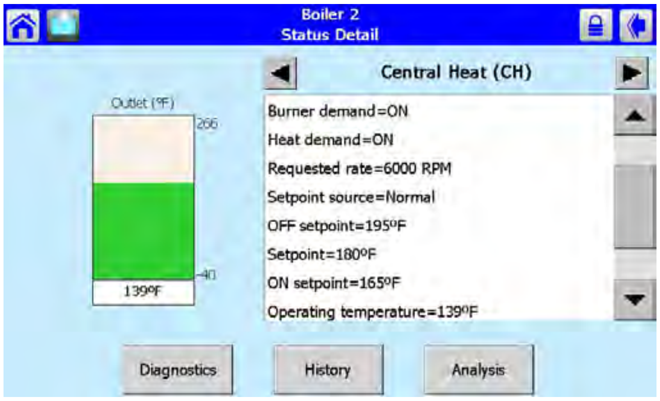


Fig. 62. CH Hydronic Status menu (middle).

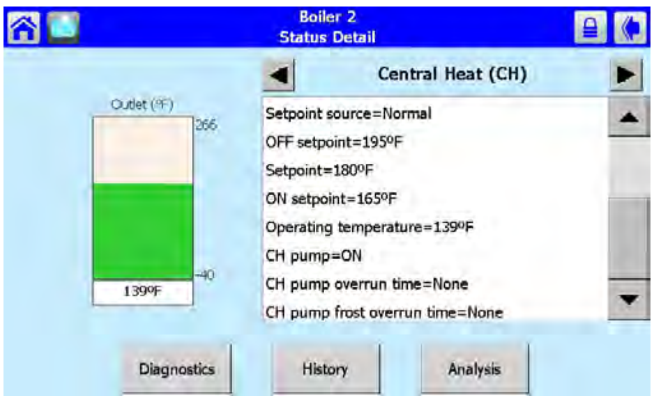


Fig. 63. CH Hydronic Status menu (bottom).

The status data in Table 45 displays first when the DHW Hydronic heating loop is selected on the Home page. Scrolling through the status groups eventually shows both.

Table 45. DHW Hydronic Status.

Data	Comment
DHW enable	Enabled, Disabled
Demand source	Unknown, No source demand, CH, DHW, Lead Lag, CH frost protection, DHW frost protection, No demand due to burner switch
DHW burner demand	On or Off
DHW high limit	Temp setting between -40 °F to 266 °F (-40 °C to 130 °C)
DHW high limit setpoint	Temp setting between -40 °F to 266 °F (-40 °C to 130 °C)
DHW priority override time	0-600 seconds
DHW pump	On or Off
DHW pump demand	On or Off
DHW pump overrun time	Running overrun time for DHW pump (seconds)

Table 45. DHW Hydronic Status. (Continued)

Data	Comment
DHW requested rate	RPM or %
DHW sensor state	None, Normal, Open, Shorted, Outside high range, Outside low range, Not reliable (None = no outlet sensor)
DHW OFF setpoint	Setpoint plus hysteresis
DHW setpoint	Temp setting between -40 °F to 266 °F (-40 °C to 130 °C)
DHW ON setpoint	Setpoint minus hysteresis
DHW setpoint source	Normal, TOD, Outdoor reset
DHW status	Disabled, Normal, Suspended
DHW temperature	DHW temperature (same as bar graph)

The bar graph displayed for the CH control loop (hydronic) is the outlet sensor temperature; for the DHW control loop it is the DHW sensor temperature. When no analog DHW sensor is installed (digital switch instead), the inlet sensor temperature is displayed.

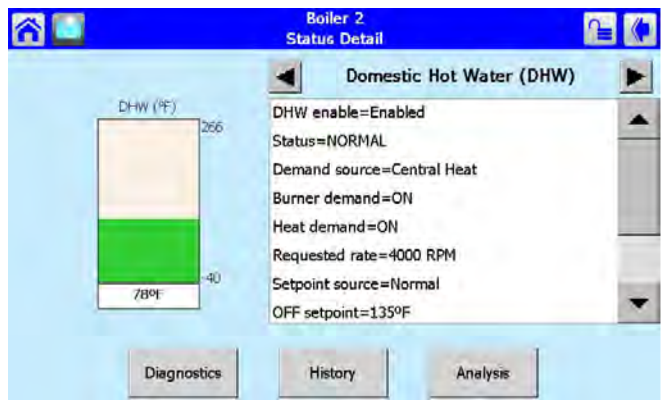


Fig. 64. DHW Hydronic Status menu (top).

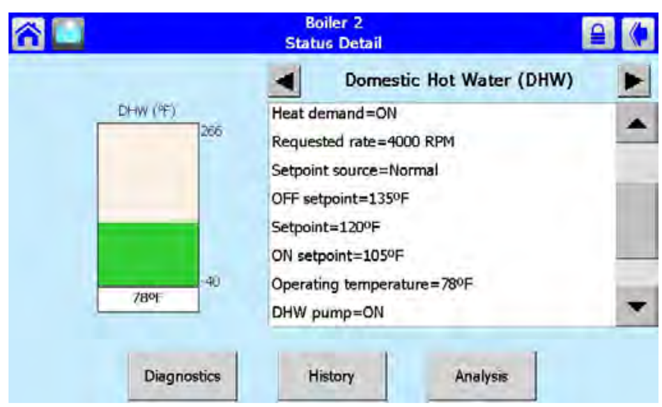


Fig. 65. DHW Hydronic Status menu (middle).

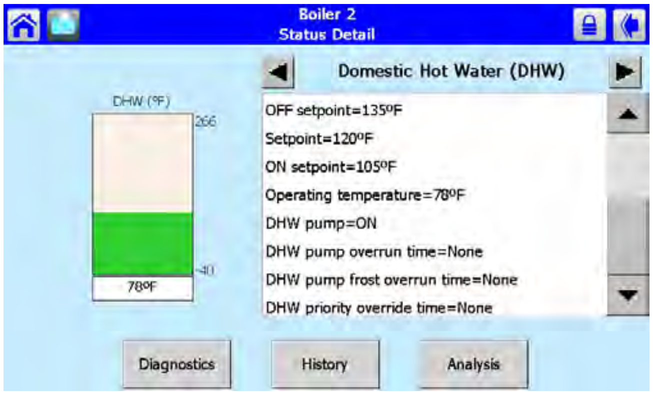


Fig. 66. DHW Hydronic Status menu (bottom).

Burner Control Status

The Burner Control status page will display the status data shown in Table 46.

Table 46. Burner Control Status.

Data	Comment
Alarm reason	Description for alarm being on (maybe lockout or a hold message)
Annunciator first out	First annunciator input related to lockout
Annunciator hold	First annunciator input related to hold
Burner state	Disabled, Locked out, Anti-short cycle, Unconfigured safety data, Standby Hold, Standby, Delay, Normal Standby, Preparing, Firing, Postpurge
Sequence time	Running time for timed burner control operation (seconds)
Delay time	Running display of delay time when burner control in delay state.
Firing rate	% or RPM. Adjustable when firing rate control set to Manual.
Firing rate control	Auto or Manual
Flame signal	Flame signal strength
Hold code	Description of hold message if locked out
Lockout	Description of lockout message if locked out
Pilot test hold	Off or Hold
Remote STAT	On or Off
Note: Steam will show Steam psi as the bar graph	

The bar graph displayed for this status is the outlet sensor temperature.

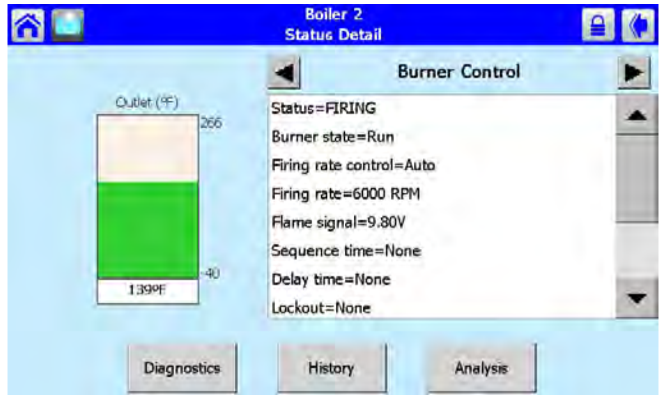


Fig. 67. Burner Control Status menu (top).

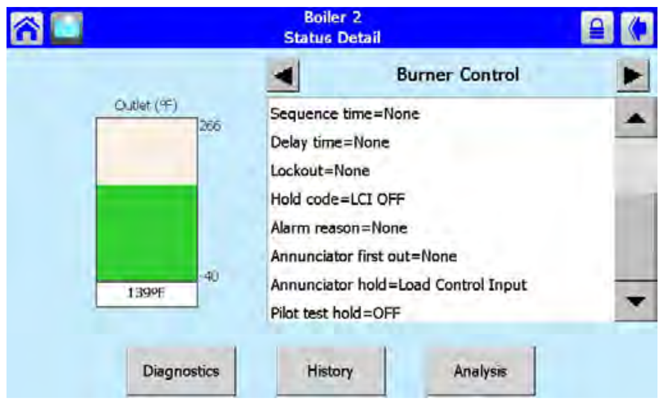


Fig. 68. Burner Control Status menu (bottom).

Burner control can be turned on and off in the hydronic or steam Falcon by the user.

Hydronic Demand and Modulation Status

Table 47 displays the status page data for the hydronic Falcon.

Table 47. Hydronic Demand and Modulation Status.

Data	Comment
Demand source	CH, DHW, Lead Lag, or Frost Protection (parameter that has current priority)
Firing rate	% or RPM. Adjustable when firing rate control set to Manual.
Demand rate	% or RPM.
Rate limiter	None, Outlet high limit, Delta T limit, Stack limit, Slow start limit, Anti-condensation, Minimum modulation, Forced rate
Limited rate	% or RPM
Rate override	Burner control default, Burner control, manual firing rate off, None
Override rate	% or RPM

The bar graph displayed for this status is the outlet sensor temperature.

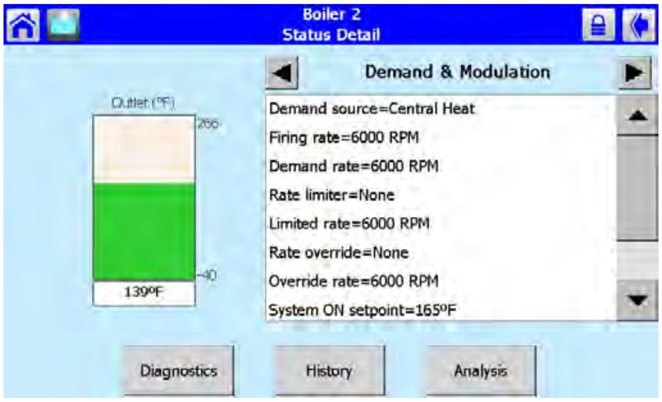


Fig. 69. Demand and Modulation Status menu (top).

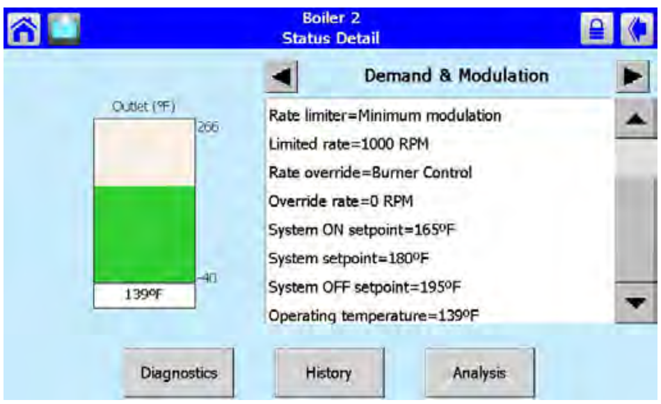


Fig. 70. Demand and Modulation Status menu (bottom).

Inlet Temperature Status

Table 48 displays the status page data for inlet temperature.

Table 48. Inlet High Limit Status.

Data	Comment
Inlet sensor state	None, Normal, Open, Shorted, Outside high range, Outside low range, Not reliable (None=no outlet sensor)
Inlet temperature	Inlet sensor temperature (same as bar graph)

The bar graph displayed for this status is the inlet sensor temperature.

Fan Status

Table 49 displays the status page data for the fan in the control.

Table 49. Control Fan Status.

Data	Comment
Fan speed	% or RPM (current fan speed)
Maximum fan speed	Setpoint of maximum fan speed (% or RPM)
Minimum fan speed	Setpoint of minimum fan speed (% or RPM)

The bar graph displayed for this status is the fan speed.

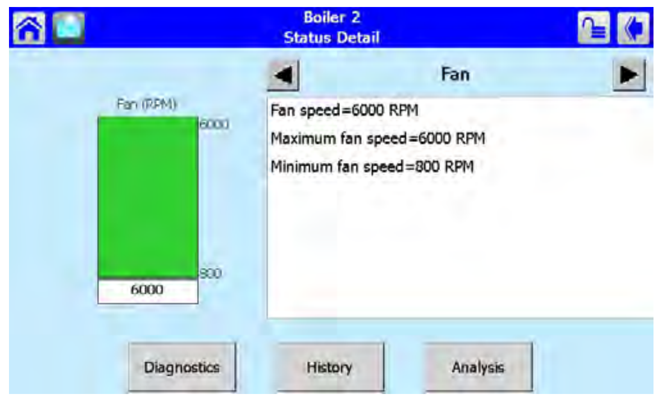


Fig. 71. Control Fan Status menu.

Hydronic Pump Status

Table 50 displays the status page data for this example, Central Heat pump in the hydronic Falcon. Screens available for DHW, Boiler, System, Aux1 and Aux2 will be the same if that pump is configured.

Table 50. Hydronic CH Pump Status.

Data	Comment
CH Pump	On or Off
Controlling Pump Terminal	Pump A, B, or C
Status	On, Off, or Not Used
Delay time	Duration of delay time
Overrun time	Duration of overrun time
Frost overrun time	Duration of frost overrun time
Idle days	Number of days idle
Cycle count	Number of cycles

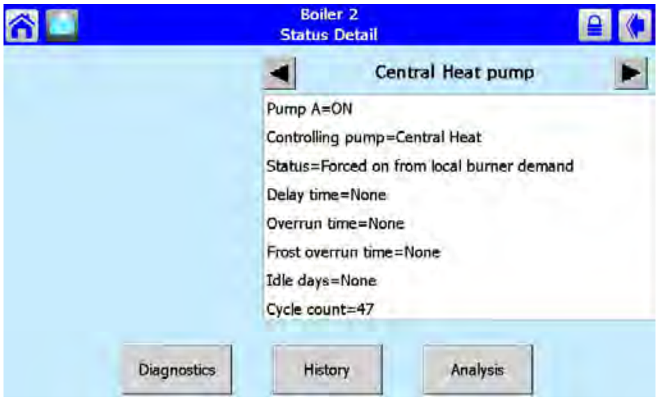


Fig. 72. Hydronic CH pump status menu.

Flame Detection Status

The status data shown in Table 51 is displayed for flame detection.

Table 51. Flame Detection Status.

Data	Comment
Flame detected	Yes or No
Flame signal	Flame signal strength (same as bar graph)
Pilot test hold	Off or hold

The bar graph displayed for this status is the flame signal.

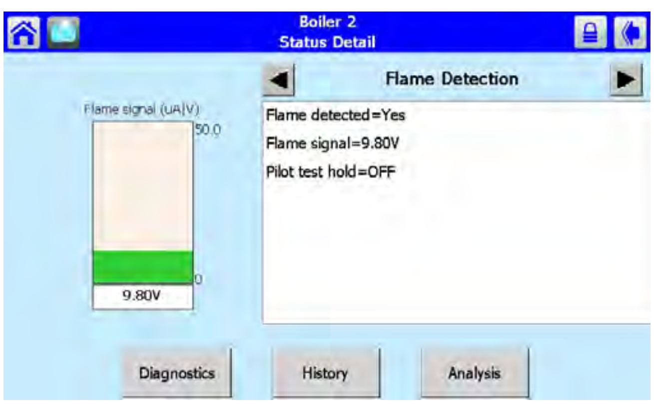


Fig. 73. Flame Detection Status menu.

NOTE: This same status is also displayed for burner control status. A separate status group is defined to provide a bar graph of the flame signal.

Statistics Status

Table 52 displays the statistics status page data. Though the Steam control will not have a pump, the output can be used to run some other auxiliary equipment.

Table 52. Control Statistics Status.

Data	Comment
Burner cycles	Number of cycles
Burner run time	Duration of run time
CH pump cycles	Number of cycles
System pump cycles	Number of cycles
Controller cycles	Number of cycles
Controller run time	Duration of run time

The bar graph displayed for this status is the outlet sensor temperature.

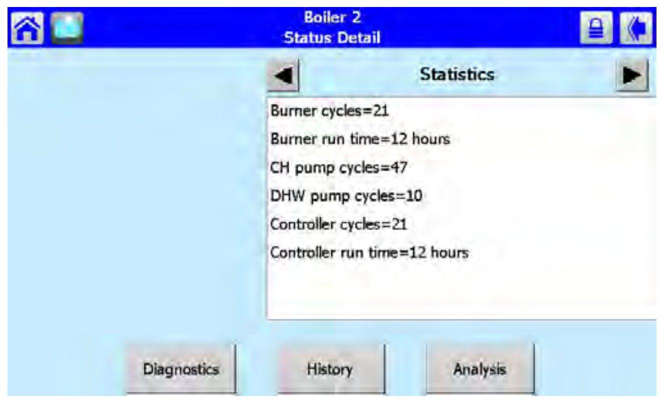


Fig. 74. Control Statistics Status menu (top).

Stack Limit Status

Table 53 shows the status page data for the control Stack Limit.

Table 53. Stack Limit Status.

Data	Comment
Stack limit enable	Enabled or Disabled
Stack limit	Temp setting between -40 °F to 266 °F (-40 °C to 130 °C)
Stack limit setpoint	Temp setting between -40 °F to 266 °F (-40 °C to 130 °C)
Stack sensor state	None, Normal, Open, Shorted, Outside high range, Outside low range, Not reliable (None=no stack temp sensor)
Stack temperature	Stack sensor temperature (same as bar graph)

The bar graph displayed for this status is the stack sensor temperature.

Lead Lag Slave Status - Hydronic Only

Table 54 shows the status page data for Lead Lag Slave.

Table 54. Lead Lag Slave.

Data	Comment
Type	Slave
Command Received	Yes/No
Demand	Off
Request Rate	RPM
Burner Control	Standby
Modulating	No
Priority	

Lead Lag Master Status - Hydronic Only

Table 55 shows the status page data for Lead Lag Master.

Table 55. Lead Lag Master.

Data	Comment
Master enabled	Enabled
Status	normal
Demand source	Lead lag slave
Active Service	None
Off setpoint	160 °F (71 °C)
Setpoint	150 °F (66 °C)
On setpoint	145 °F (63 °C)
operating temperature	150 °F (66 °C)
Sensor state	normal
Sensor temperature	150 °F (66 °C)
Slave firing	no
Stager state	idle
Stager timer	
CH demand	
CH frost demand	no
DHW frost demand	no

DIAGNOSTICS

The diagnostic page displays analog and digital I/O status of the control. The digital I/O data is displayed as LEDs that are either on (green) or off (gray) (see Fig. 75). Not all digital I/O can be displayed at the same time on the page, so a horizontal scroll bar is used to move the view left and right to show all digital I/O data.

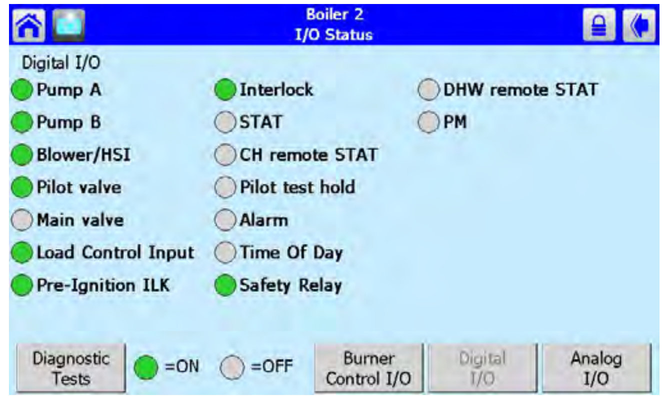


Fig. 75. Diagnostic digital I/O page.

Temperature sensors or pressure sensors also display the current sensor state, (i.e., whether there is a fault condition or the sensor is in a normal monitoring state). The user can toggle between displaying the control digital and analog I/O (the initial display is the digital I/O). The Digital or Analog button on the bottom of the diagnostic page changes the I/O displayed to the type indicated by the button.

The following data is displayed on the control diagnostics page.

Table 56. Control Digital I/O Data.

Data	Comment
Pump A	On/Off
Pump B	On/Off
Pump C	On/Off
Blower/HSI	On/Off
Pilot valve	On/Off
Main valve	On/Off
Load Control Input	On/Off
STAT	On/Off
Pre-ignition interlock	On/Off
Interlock	On/Off
External ignition	On/Off
Alarm	On/Off
Pilot test hold	On/Off
Time Of Day	On/Off
Safety relay	On/Off
Low Gas	On/Off
High Gas	On/Off
Annunciator 3	On/Off
Annunciator 4	On/Off
PM	On/Off
Annunciator 5	On/Off
Annunciator 6	On/Off
Annunciator 7	On/Off
Annunciator 8	On/Off
PM Lead/Lag	On/Off

"On" status is indicated by a green LED and "Off" status is indicated by a gray LED.

Table 57. Control Analog I/O Data.

Data	Comment
Outlet	
Inlet	If enabled
Firing rate	% or RPM
Flame signal	V
Fan speed	RPM (if applicable). Should match with firing rate.
Domestic Hot Water	If enabled
Stack	If enabled
Outdoor	If enabled
Header	If enabled

Analog I/O data is displayed as bar charts depicting the I/O level (see Fig. 76). Analog I/O that is not enabled for the installation displays a blank I/O level. To see all analog I/O, use the horizontal scroll bar to move the view left and right.

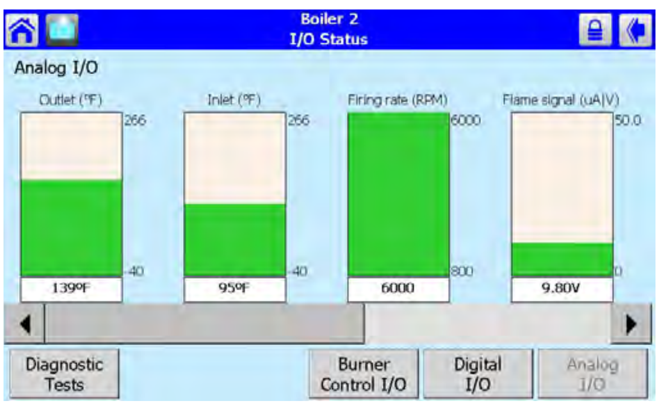


Fig. 76. Diagnostics analog I/O page.

INSTALLER CHECKOUT

Diagnostics Tests

Pressing the Diagnostics Test button launches the diagnostic tests. The first test displayed on the right side of the screen is the last selected test shown, as seen in Fig. 77.

This screen enables the user to perform the following tests:
Modulation Test: enables the user to verify that the burner is firing at the correct rate. (See Fig. 77.)
Pilot Test: enables the user to verify that the pilot valve is functioning properly. The user can also perform burner adjustments for the pilot flame. (See Fig. 78.)
Pump Test: enables the user to verify that the correct pump is on or off. The Start Test button will test all pumps; pressing an individual pump tests that pump only. (See Fig. 79.)
Burner Switch: this button turns the burner on or off.
Start Test: runs the test for 5 minutes.

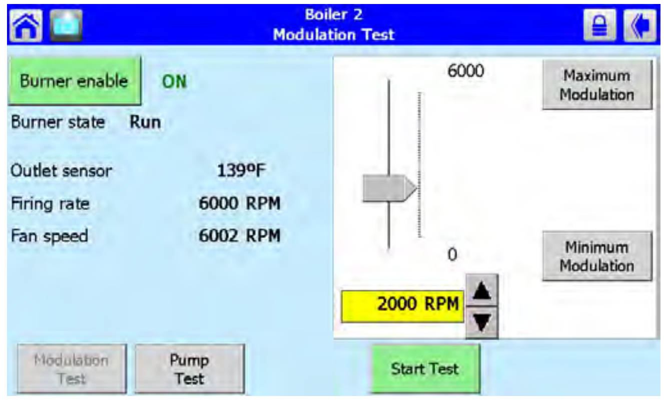


Fig. 77. Modulation test.

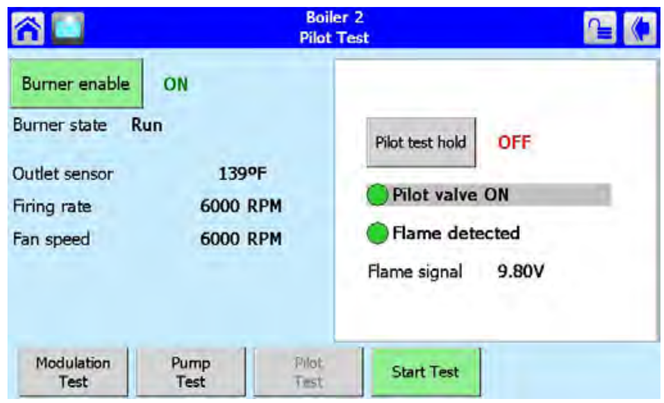


Fig. 78. Pilot test.

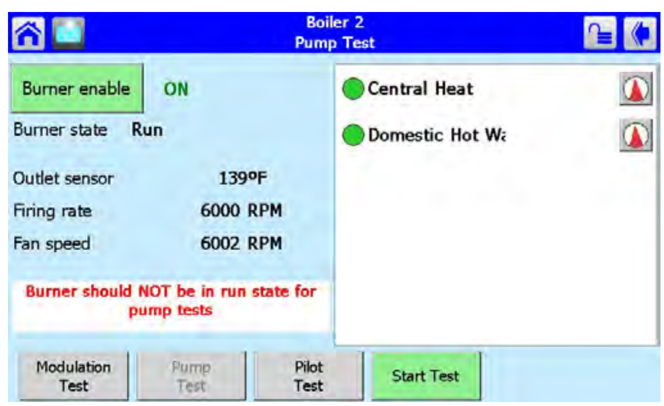


Fig. 79. Pump test.

DISPLAY SETUP AND DIAGNOSTICS

The Setup page allows the user to configure some display settings. Pressing the Setup button on the Home page (see Fig. 5) will bring up the Setup page and Display Diagnostics page (see Fig. 80).

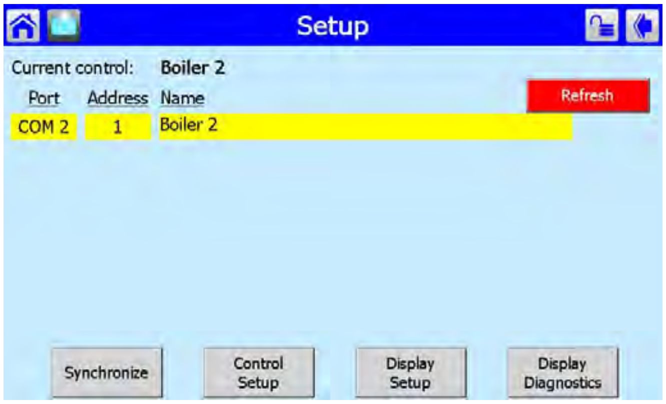


Fig. 80. Setup page.

Press the Display Setup page to display various options that can be set by the user (see Fig. 81 to Fig. 85)

The General tab (Fig. 81) contains the following settings:

- **Display alerts on Status Summary Bar?** This determines whether non-safety alerts will be shown on the summary bar of the home page
- **Display empty parameter groups?** This cleans up the home page by hiding unused parameter groups
- **Sound audio alarm for faults?** This uses the display speaker to sound an alarm on shutdown for Falcon faults

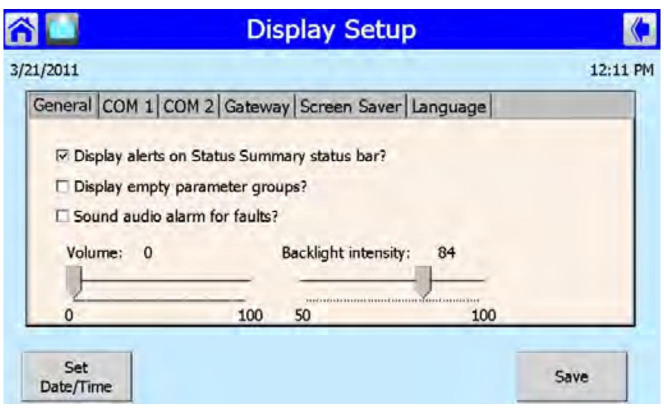


Fig. 81. Setup page - General setup.

The COM1 tab (see Fig. 82) contains the following setting:

- **Enable COM1 port:** This box must be selected to enables the COM1 interface
- **Modbus address range 1-N:** Sets the Modbus address for the connected device (range is 1 to 250).
- **Modbus baud rate:** Select the baud rate (38400, 19200 or 9600 bps)

The COM2 is Modbus gateway for Building Automation System (BAS) networking:

- **Enable COM2 port:** This box must be selected to enables the COM2 BAS interface
- **Modbus address range 1-N:** Sets the Modbus address for the connected device (range is 1 to 250).
- **Modbus baud rate:** Select the baud rate (38400, 19200 or 9600 bps)

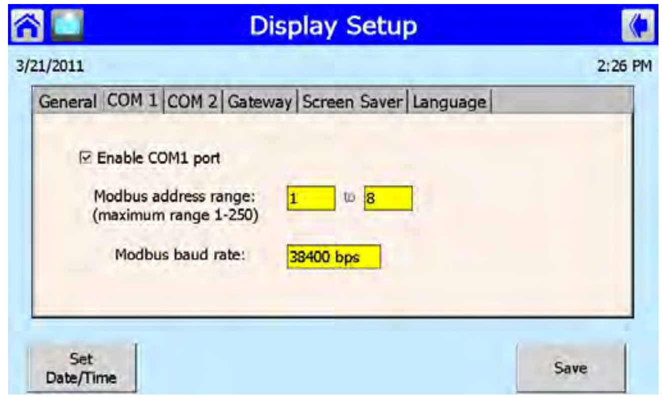


Fig. 82. Setup page - Com ports setup.

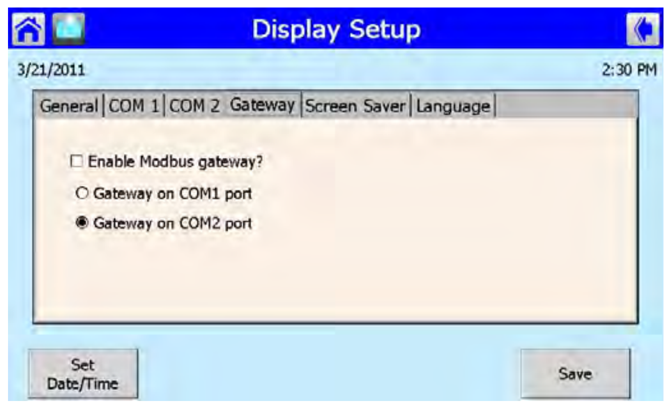


Fig. 83. Setup page - Gateway setup.

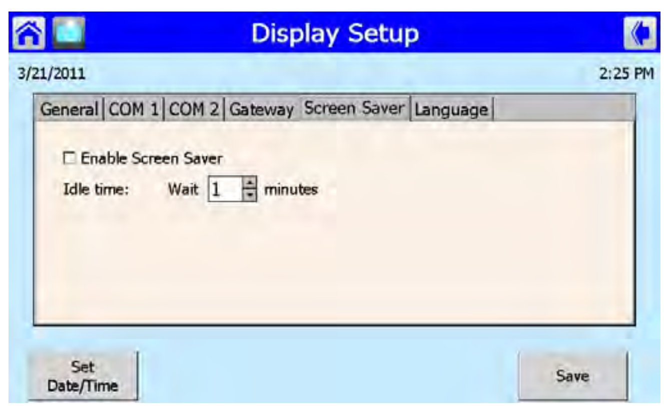


Fig. 84. Setup page - Screen setup.

Fig. 85. Setup page - Language setup.

Trend Analysis Page

Trend analysis of FAlcon status data can be viewed on the display. A graph displays a historical view of status data over varying time periods.

Pressing the device icon, then the “Details” button, will bring up the “Status Details” screen (see Fig. 59). Press the “Analysis” button to access trend variables (see Fig. 87 and Fig. 88).

A 2-dimensional graph with status data values shown on the Y axis over time specified on the X axis is displayed. Status for the most recent time is represented on the left side of the graph with older status running towards the right side of the graph.

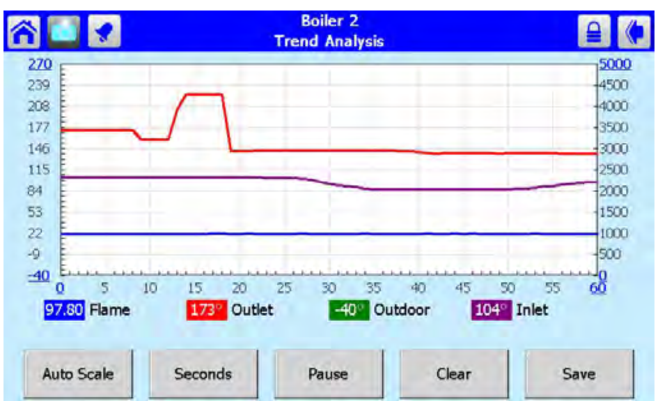


Fig. 86. Trend analysis page.

Up to 4 status variables can be viewed at the same time on one trend analysis graph. Select the status variables for the graph on the menu page (see Fig. 87). This menu displays when the Trend Analysis button is selected on the status page.

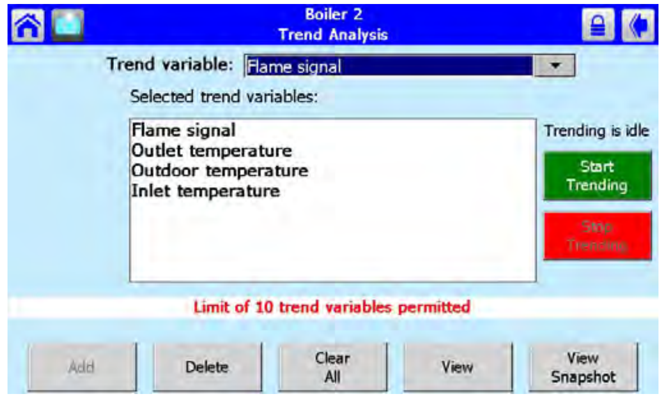


Fig. 87. Trend analysis menu page.

The status variable with the largest range (minimum to maximum) is used as the Y-axis range in the graph.

As the status variables are selected they are listed in a trend variables list box. The user chooses the status variables from a drop down menu and then presses the Add button to add each status variable to the trend variable list.

Each status variable displayed in the trend analysis is represented by a different colored line, as follows:

1. First status variable = green
2. Second status variable = yellow
3. Third status variable = red
4. Fourth status variable = blue

No more than two different measurement units (such as degrees), are allowed for the status variables selected in the trend analysis graph. Attempts to add a status variable with a third measurement unit are rejected.

A second Y axis is displayed on the right side of the graph to represent the scale for the second measurement unit. This can result in minor clipping of the curves on the right side, as shown in Fig. 88 and 89.

Fig. 88. Trend analysis page with firing rate.

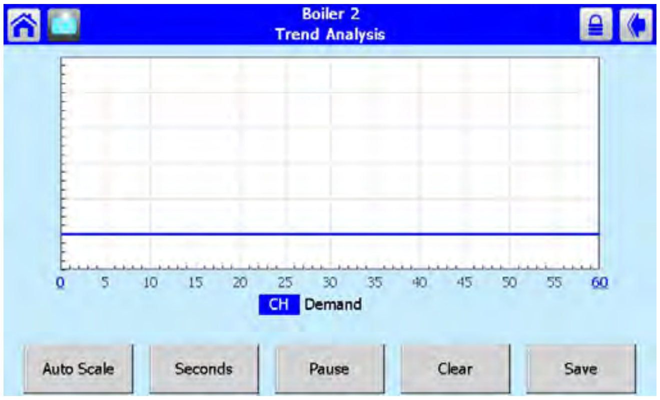


Fig. 89. Trend analysis page with demand source.

If any of the status variables has degrees as a unit of measurement, degrees is used for the main Y axis (on the left of the graph). The status variables selected are saved and are displayed by default when the trend analysis menu page is first displayed. Status data is updated on the graph with new status at the same rate as the sample time period selected. The current sample time period is displayed in a button on the page (in Fig. 88 and 89, the button is “Seconds”).

Status older than the sample time period is dropped from the right end of the curve as newer status appears on the left end of the curve.

Trend data can be viewed in one-second (most recent 60 second time period), 15-second (most recent 15-minute time period), and hour (most recent 24 hour time period) intervals.

NOTE: Full graphs require that the display has been monitoring the Falcon for the complete time period. Partial graphs display if this is not the case.

The buttons at the bottom can be used to change the view of the graph. The user can change the sample rates of the display by pressing the Seconds, Minutes, Hours, or Days button (the button changes depending on what sample rate is currently displayed). The + and - buttons zoom in and out of the graph so the Y axis depicts different degrees of detail for the data range. The viewing window can be moved up and down the graph to see the complete range when zoomed in.

The smallest measurement interval is a single whole digit (no fractional precision) when the entire range exceeds 10 units, e.g., 20–30 degrees.

Pressing the Stop button will pause trend data updates of the graph. The graph “freezes” the view when stopped. However, trend data sampling from the Falcon continues regardless whether the graph update is stopped or not. Restarting the updates causes the graph to be refreshed with the latest data samples.

Pressing the Clear button will clear the trend sample data for a Falcon. All trend data for the Falcon is cleared including status variables that are not included in the graph. The user is asked to confirm this action before proceeding.

NOTE: For system trend analysis graphs the Clear button isn’t present, so no status variables can be cleared.

A snapshot of the trend analysis graph can be taken and saved to the display. The user is asked to confirm the save before it occurs.

NOTE: While this snapshot is saved, trend data sampling for all Falcons is temporarily halted. Gaps or static level values occur in the trend data as a result.

The date and time that the snapshot is taken is stored with the snapshot. Only the status variables displayed in the graph are stored in the snapshot. All raw sample data for the status variables are stored so that any sample rate can be viewed offline.

Sample data stored in snapshot is either the real-time status at the time that the Save button is pressed or it is the sample data at the time that the graph is stopped.

Special case trend analysis graphs for PID tuning can be viewed for CH, DHW, and Lead Lag demands.

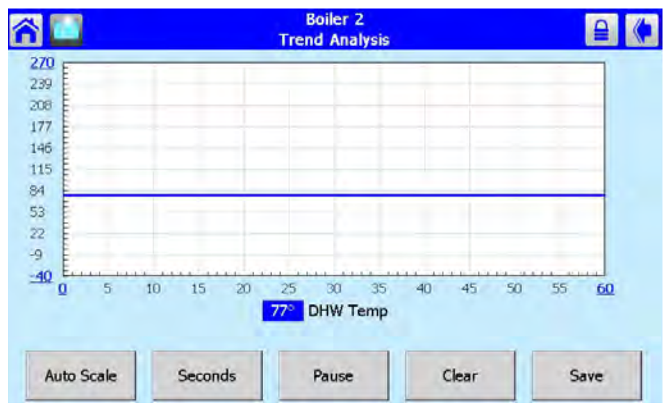


Fig. 90. PID Trend analysis page.

Data included in the PID analysis graph are:

- Sensor temperature (outlet for CH, DHW for DHW, and header for Lead Lag)
- Setpoint (for corresponding demand source)
- Burner firing rate
- Hysteresis on (for corresponding demand source)
- Hysteresis off (for corresponding demand source)

The Clear button is disabled for the PID analysis (doesn’t apply to hysteresis).

The default sample rate is 15 sec periods (a tick mark on the X axis for every 15 second period, with minutes displayed every 4 tick marks).

Special case trend analysis graph for vessel heat exchange can be selected.

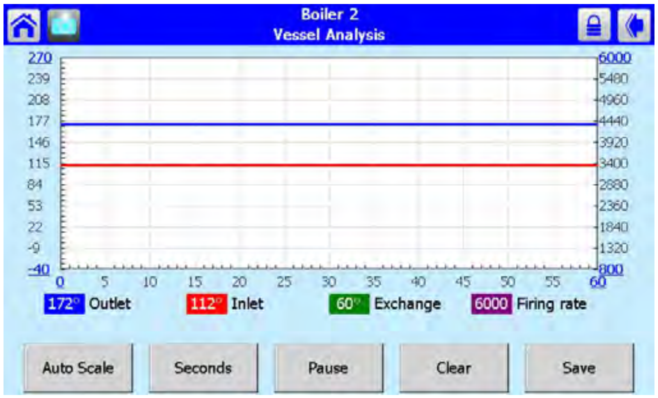


Fig. 91. Vessel analysis page.

Data included in the vessel analysis graph are:

- Outlet temperature
- Inlet temperature
- Heat exchange (outlet – inlet)
- Burner firing rate

Automatic sampling of trend data takes place when the trend analysis report is displayed. No user intervention is necessary to invoke sampling.

NOTE: Sample data is collected and stored in the 833-5105. The Falcon control does not collect any historical data for trending purposes. For this reason any display reset causes all sampling to start over with no data.

Trend analysis of the following data from each Falcon control is possible:

Table 58. Trend Analysis Data.

Data	Comment
Demand source	CH, DHW, LL (Lead Lag), or FP (Frost Protection) Steam Sensor
Outlet temperature (hydronic only)	
Firing rate	% or RPM
Fan speed	PWM feedback
Flame signal strength	V
Inlet temperature (hydronic only)	If enabled
DHW temperature (hydronic only)	If enabled
Outdoor temperature	If enabled
Stack temperature	If enabled
Header temperature (hydronic only)	If enabled
CH setpoint	Actual CH setpoint based on time of day (TOD).

Table 58. R7910/R7911 Trend Analysis Data. (Continued)

Data	Comment
DHW setpoint (R7910 only)	Actual DHW setpoint based on TOD.
Central Heat Operation Analysis	
Domestic Hot Water Operation Analysis (R7910 only)	
Vessel Analysis	

Trend Analysis Snapshot

The trend analysis snapshot file is stored in Comma Separated Value (CSV) format in the 833-5105 so it can be imported into a spreadsheet program such as Microsoft Excel.

The trend analysis snapshot file can be viewed in graph form on the display. It can also be copied to a USB device.

Diagnostics

Pressing the Diagnostics button permits some display hardware diagnostics (see Fig. 92). **Normally, these diagnostics are applicable only for factory testing purposes, but conditions may arise that warrant this testing.**

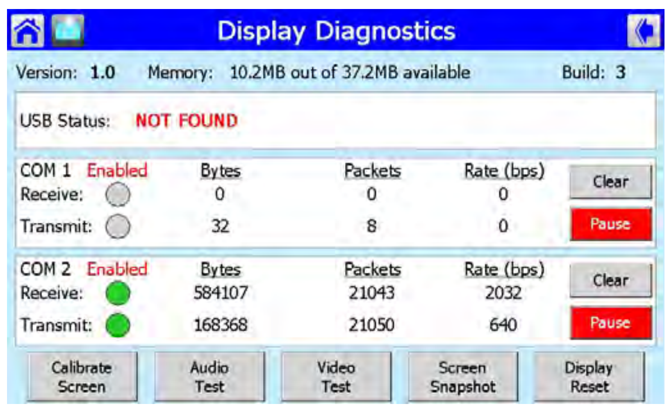


Fig. 92. Display diagnostics.

NOTE: COM 1 Communication test is a factory-only test. Performing this text when not connected to a factory test fixture will always yield a "Failed" result.

Each test is invoked by pressing the Test button next to the diagnostic. The results of the diagnostic test ("PASS" or "FAIL") display in the text box next to the Test button.

Date and Time

Display time can be configured in the 833-5105 and applied to the Falcon. A date and time is entered by the user at the display and any data that is timestamped is marked with the current time and date in the display.

The Display clock is set by selecting the "Set Date/Time" button on the Display Setup page (see Fig. 84).

NOTE: **It's important that the time be set in the Display so correct timestamps are given to Falcon lockouts. The display's time and date need to be set should power be interrupted to the display.**

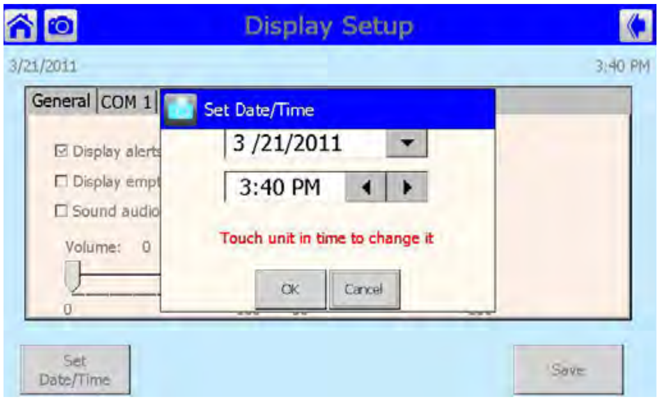


Fig. 93. Display Date and Time.

Edit the date and time and press the OK button to set the new settings. Press the Cancel button to exit without changing the time or date.

Version

Pressing the Version button on the Advanced Setup page displays manufacturer and software version information (Fig. 94).

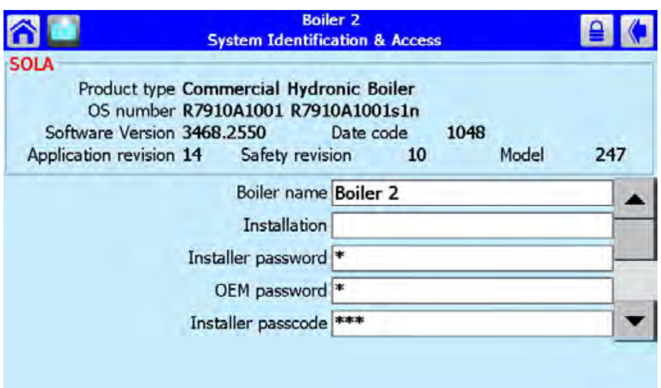


Fig. 94. Code version.

Display Reset

The user can reset the display and force a power-up by pressing the Display Reset button. A pop-up dialog box confirming the reset request displays (Fig. 95) before the reset proceeds.

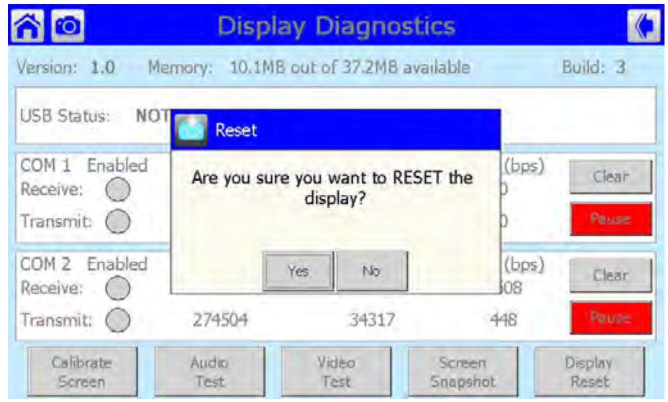


Fig. 95. Processor Reset.

When the Display is reset, the display will reboot and automatically seek out the Modbus™ device connected to it. When the search is complete, the display will return to the home page.

Table 59. Status Tables.

Name	Table #	Page #
CH	44	30
DHW	45	31
Burner Control	46	32
Demand and Modulation	47	32
Inlet High Limit	48	33
Fan	49	33
Pump	50	33
Flame Detection	51	34
Statistics	52	34
Stack Limit	53	34
Lead Lag Slave	54	35
Lead Lag Master	55	35

Parameters

A complete list of configurable parameters is shown in Table 60.

Table 60. Configurable Parameters.

Parameter	Comment	Table #	Page #
Boiler Name	Name to identify boiler (up to 20 characters)	5	14
Installation	Notes regarding installation (up to 20 characters)		
Installer password	Change installer password setting		
OEM password	Change OEM password setting		
Factory Data	OEM name to associate with boiler (up to 20 characters)		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
CH enable	Disable or Enable Central Heating Loop	7	14
CH demand switch	Sensor for Central Heat demand: Sensor only Sensor & STAT terminal Sensor & Remote Stat LCI & Sensor		
CH Outdoor reset	Enabled Disabled		
CH has priority over Lead Lag	Yes, No, Cancel		
CH Setpoint source	Local S2 (J8-6) 4-20mA		
CH Setpoint	Setpoint for normal Central Heat modulation: -40 °F to 266 °F (-40 °C to 130 °C)		
CH time of day setpoint	Setpoint when Time Of Day switch is on. -40 °F to 266 °F (-40 °C to 130 °C)		
CH off hysteresis	Differential above setpoint when boiler is turned off. -40 °F to 266 °F (-40 °C to 130 °C)		
CH on hysteresis	Differential from setpoint when boiler is turned on.-40 °F to 266 °F (-40 °C to 130 °C)		
4 mA water temperature	-40 °F to 266 °F (-40 °C to 130 °C)		
20 mA water temperature	-40 °F to 266 °F (-40 °C to 130 °C)		
Modulation sensor	Outlet sensor, Inlet sensor, S5 (J8-11)		
Modulation Rate Sensor	Local		
CH P-gain	Time between hysteresis step changes: 0-400		
CH I-gain	Time between hysteresis step changes: 0-400		
CH D-gain	Time between hysteresis step changes: 0-400		
Hysteresis step time	Time between hysteresis step changes: 0-600 seconds (0=Disable hysteresis stepping)		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
Steam enable	Disable/enable steam feature	8	15
Steam demand source	Sensor and LCI Sensor and Remote Stat Sensor and Stat Terminal Sensor Only		
Steam pressure setpoint	Setpoint for normal modulation Adjustable 0 to 15 or 0 to 150 (sensor dependant)		
Steam time of day setpoint	Setpoint when TOD switch on Adjustable 0 to 15 or 0 to 150 (sensor dependant)		
Minimum steam pressure	Establishes setpoint for the 4ma. input. Adjustable 0 to 15 or 0 to 150 (sensor dependant)		
Steam pressure off hysteresis	Differential below setpoint when boiler is turned off Adjustable 0 to 15 or 0 to 150 (sensor dependant)		
Steam pressure on hysteresis	Differential from setpoint when boiler is turned on. Adjustable 0 to 15 or 0 to 150 (sensor dependant)		
Steam hysteresis step time	Time between hysteresis changes 0 to 600 seconds (0=disable)		
Steam P Gain	Gain applied for the P portion of the PID equation 0-400		
Steam I Gain	Gain applied for the I portion of the PID Equation - 0-400		
Steam D Gain	Gain applied for the D portion of the PID equation 0-400		
Steam 4-20 ma remote control	uses 4-20ma remote control function to control either the setpoint or modulation for Steam Disable, setpoint, modulation		
CH maximum outdoor temperature	-40 °F to 266 °F (-40 °C to 130 °C)	9	15
CH minimum outdoor temperature	-40 °F to 266 °F (-40 °C to 130 °C)		
Low water temperature	-40 °F to 266 °F (-40 °C to 130 °C)		
Minimum water temperature	-40 °F to 266 °F (-40 °C to 130 °C)		
Maximum off point	-40 °F to 266 °F (-40 °C to 130 °C)		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
DHW enable	Disable or Enable Domestic Hot Water Loop	10	16
DHW demand switch	Sensor for Central Heat demand: DHW sensor only, DHW sensor & Remote Stat, DHW switch & inlet sensor, or DHW switch & outlet sensor		
DHW Priority source	Which system has priority: Disabled or Heat Demand		
DHW Priority method	Boost during priority time Drop after priority time		
DHW Modulation sensor	DHW Sensor Outlet Sensor Inlet Sensor Auto: DHW (S6) or Inlet Sensor Auto: DHW (S6) or Outlet Sensor		
DHW setpoint	-40 °F to 240 °F (-40 °C to 115 °C)		
DHW time of day setpoint	Setpoint when Time Of Day switch is on. -40 °F to 240 °F (-40 °C to 115 °C)		
DHW off hysteresis	Differential above setpoint when boiler is turned off. -40 °F to 240 °F (-40 °C to 115 °C)		
DHW on hysteresis	Differential from setpoint when boiler is turned on. 2 °F to 234 °F (-16 °C to 112 °C)		
DHW priority override time	___hour ___min ___sec		
DHW hysteresis step time	Time between hysteresis step changes: 0-600 seconds (0=Disable hysteresis stepping)		
DHW priority vs CH	Which system has priority: Central Heat over Domestic Hot Water, or Domestic Hot Water over Central Heat		
DHW priority vs LL	Which system has priority: Lead Lag over Domestic Hot Water, Domestic Hot Water over Lead Lag		
DHW P-gain	Time between hysteresis step changes: 0-400		
DHW I-gain	Time between hysteresis step changes: 0-400		
DHW D-gain	Time between hysteresis step changes: 0-400		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
DHW storage enable	Enabled, Disabled	11	16
Storage time	___hour ___min ___sec		
Setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
Off hysteresis	-0 °F to 180 °F (-17 °C to 82 °C)		
On hysteresis	-0 °F to 180 °F (-17 °C to 82 °C)		
Tap detect degrees	-0 °F to 180 °F (-17 °C to 82 °C)	12	16
Tap detect on recognition time	___hour ___min ___sec		
Tap detect on threshold	-0 °F to 180 °F (-17 °C to 82 °C)		
Tap detect minimum on time	___hour ___min ___sec		
Tap stop inlet-DHW degrees	-0 °F to 180 °F (-17 °C to 82 °C)		
Tap stop outlet-Inlet degrees	-0 °F to 180 °F (-17 °C to 82 °C)		
Plate preheat setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
Plate preheat on recognition time	___hour ___min ___sec		
Plate preheat on hysteresis	-0 °F to 180 °F (-17 °C to 82 °C)		
Plate preheat off hysteresis	-0 °F to 180 °F (-17 °C to 82 °C)		
Plate preheat detect on threshold	-0 °F to 180 °F (-17 °C to 82 °C)		
Plate preheat detect off threshold	-0 °F to 180 °F (-17 °C to 82 °C)		
Plate preheat minimum on time	___hour ___min ___sec		
Plate preheat delay after tap	___hour ___min ___sec		
Warm Weather Setpoint Enable	Enabled, disabled	13	17
Warm Weather Setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
CH maximum modulation rate	RPM or %	14	18
DHW maximum modulation rate	RPM or %		
Minimum modulation rate	RPM or %		
CH forced rate time	0-600 seconds		
CH forced rate	RPM or %		
DHW forced rate time	0-600 seconds		
DHW forced rate	RPM or %		
CH slow start enable	Enabled Disabled		
DHW slow start enable	Enabled Disabled		
Slow start degrees	-40 °F to 266 °F (-40 °C to 130 °C)		
Slow start ramp	RPM /minute or %/minute 0-10/4-20 mA Output hysteresis		
0-10/4-20 mA Output hysteresis			
4-20 mA input hysteresis			
Pump control	Auto On	16	19
Pump output	Pump A Pump B Pump C None		
Pump start delay	___hour ___min ___sec		
Overrun time	___hour ___min ___sec		
Boiler pump output	Pump A Pump B Pump C None		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
Auxiliary pump control	Auto On	16	19
Auxiliary pump is on when	CH pump is ON Slave command		
Auxiliary pump output	Pump A Pump B Pump C None		
Boiler pump control	Auto On		
Boiler pump output	Pump A Pump B Pump C None		
Boiler pump overrun time	0-600 seconds 0 = Not configured		
CH pump control	Auto On		
CH pump output	Pump A Pump B Pump C None		
CH pump overrun time	0-600 seconds 0 = Not configured		
System pump control	Auto On		
System pump output	Pump A Pump B Pump C None		
System pump ourrun time	0-600 seconds 0 = Not configured		
Pump exercise time	0-600 seconds 0= Not configured		
Auxiliary pump cycles	0-999,999	17	20
Boiler pump cycles	0-999,999		
Burner cycles	0-999,999		
Burner run time	0-999,999		
CH pump cycles	0-999,999		
DHW pump cycles	0-999,999		
System pump cycles	0-999,999		
Auxiliary 2 pump cycles	0-999,999		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
DHW high limit	Enabled Disabled	18	20
DHW high limit response	Suspend DHW Recycle & hold Lockout		
DHW high limit setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
Outlet high limit response	Recycle & hold Lockout		
Outlet high limit setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
Stack limit	Enabled Disabled	19	21
Stack limit delay	0-600 seconds		
Stack limit response	Lockout Recycle & delay		
Stack limit setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
Delta T enable	Enabled Disabled	20	21
Delta T degrees	-40 °F to 266 °F (-40 °C to 130 °C)		
Delta T delay	0-600 seconds		
Delta T response	Recycle & delay Lockout		
Delta T retry limit			
Delta T rate limit enable	Enabled Disabled		
Delta T inverse limit time	___hour ___min ___sec		
Delta T inverse limit response	Recycle & delay Recycle & delay with retry limit Lockout		
Outlet T-rise enable	Enabled Disabled	21	22
Heat exchanger T-rise enable	Enabled Disabled		
T-rise degrees	0 °F to 234 °F (-17 °C to 112 °C)		
T-rise response	Recycle & delay Recycle & delay with retry limit Lockout		
T-rise retry limit	0 to 100		
T-rise delay	___hour ___min ___sec		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
Heat exchanger high limit enable	Enabled Disabled	22	22
Heat exchanger high limit setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
Heat exchanger high limit response	Recycle & delay Recycle & delay with retry limit Lockout		
Heat exchanger retry limit	0 to 100		
Heat exchanger high limit delay	___hour ___min ___sec		
CH anticon-densation enable	Enabled Disabled	23	22
CH anticon-densation pump	Normal (no change) CH pump forced off		
CH anticon-densation setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
DHW anti-condensa-tion enable	Enabled Disabled		
DHW anti-condensa-tion pump	Normal (no change) DHW pump forced off		
DHW anti-condensa-tion setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
Anticondensa tion Priority	Anticondensation is more important than (check those that apply): Stack limit Delta T limit Slow start Forced rate Outlet high limit		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
CH frost protection enable	Enabled Disabled	24	23
DHW frost protection enable	Enabled Disabled		
Lead Lag frost protection enable	Enabled Disabled		
Outdoor frost protection setpoint	-40 °F to 266 °F (-40 °C to 130 °C) (applicable for CH only)		
Lead Lag frost protection rate	___%		
CH pump frost overrun time	___hour ___min ___sec		
DHW pump frost overrun time	___hour ___min ___sec		
Annunciation enable	Enabled Disabled	25	23
Annunciator (1–8) location	01 - Annunciator 1 02 - Annunciator 2 03 - Annunciator 3 04 - Annunciator 4 05 - Annunciator 5 06 - Annunciator 6 07 - Annunciator 7 08 - Annunciator 8 PII - Pre-Ignition ILK LCI - Load Control Input ILK - Interlock		
Annunciator (1–8) short name	Up to 3 characters		
Annunciator (1–8) name	Up to 20 characters		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
PII enable	Enabled Disabled	26	24
LCI enable	Enabled Disabled		
Interrupted air switch (IAS) enable	Enable during purge and ignition Disabled Enable during purge		
Interlock (ILK) start check enable	No ILK check ILK check		
ILK/IAS open response	Recycle Lockout		
ILK bounce detection enable	Enabled Disabled		
Purge rate proving	Fan Speed High Fire Switch None		
Lightoff rate proving	Fan Speed Low Fire Switch None		
Prepurge rate	RPM or %	27	24
Prepurge time	0-600 seconds 0 = Not configured		
Run stabilization time	0-600 seconds 0 = Not configured		
Standby Rate	RPM or %		
Postpurge rate	RPM or %		
Postpurge time	0-600 seconds 0 = Not configured		
Forced recycle interval time	___hour ___min ___sec		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
Pilot test hold	On Off	28	24
Ignition source	Hot Surface Igniter External ignition Internal ignition		
Pilot type	Direct burner constant ignition Direct burner pulsed ignition Intermittent Interrupted		
Lightoff rate	RPM or %		
Preignition time	0-600 seconds 0 = Not configured		
Pilot Flame Establishing Period	15 secs 10 secs 4 secs		
Igniter on during	1st half of PFEP Pilot Flame Establishing Period		
Main Flame Establishing Period	15 secs 10 secs 5 secs		
Flame Threshold	μA/V		
Ignite failure response	Lockout Recycle Recycle & hold Recycle & lockout	29	25
Ignite failure delay	0-600 seconds 0 = Not configured		
Ignite failure retries	1, 3, or 5		
MFEP flame failure response	Recycle Lockout		
Run flame failure response	Recycle Lockout		
Fan speed error response	Recycle Lockout		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
Flame sensor type	Flame rod UV power tube UV power tube with spark interference None	30	27
Modulation output	4-20mA 0-10V Fan PWM*		
Blower/HSI	Blower Hot surface ignition		
Temperature units	Fahrenheit Celsius		
Anti short-cycle time	0-600 seconds 0 = Not configured		
Alarm silence time	0-600 minutes 0 = Not configured		
Power up with Lockout	Clear lockout Do NOT clear lockout		
STAT & EnviraCOM remote stat	Enabled Disabled		
Flame sensor type	Flame rod UV	31	27
Modulation output	4-20ma 0-10V Fan PWM		
Blower/HSI	Blower Hot surface ignitor		
Temperature units	Fahrenheit Celsius		
Anti short cycle time	0-600 minutes		
Alarm silence time	0-600 minutes		
Power up with lockout	Clear lockout Do NOT clear lockout		
Inlet connector type	0-15 psi 0-150 psi UNCONFIGURED		
Stack connector type	10k NTC dual safety 10k NTC single non-safety 12k NTC single non-safety UNCONFIGURED		
Header	4-20ma UNCONFIGURED		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
Absolute maximum fan speed	RPM	32	27
Absolute minimum fan speed	RPM		
Fan gain down	0-100		
Fan gain up	0-100		
Minimum duty cycle	1-100%		
Pulses per revolution	1-10		
PWM frequency	1000 2000 3000 4000		
Slow down ramp	0-12000 RPM/sec		
Speed up ramp	0-12000 RPM/sec		
Slave enable	Slave ModBUS slave Disabled	33	28
Slave mode	Use first Use last Equalize run time		
Base load rate	0–6000 rpm		
Slave sequence order	0–8		
Demand to firing delay	___hour ___min ___sec		
Fan rate during off cycle	0–12000 rpm		
ModBus port	MB1 MB2 No port		
ModBus address	0–250		
Master enable	Enabled Disabled	34	28
CH setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
CH time of day setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
ModBus port	MB1 MB2 No port		
ModBus address	0–250		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
Modulation backup sensor	Lead outlet sensor Slave outlet sensor average Disabled	35	28
Off hysteresis	0 °F to 234 °F (-17 °C to 112 °C)		
On hysteresis	0 °F to 234 °F (-17 °C to 112 °C)		
Hysteresis step time	___Hour ____Minute _____Second		
P gain	0 - 400		
I gain	0 - 400		
D gain	0 - 400		
Demand switch	Stat Remote Stat ModBus Stat Disabled	36	29
Setpoint source	Local ModBus 4-20 ma		
Setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
Time of day setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
4 ma water temperature	-40 °F to 266 °F (-40 °C to 130 °C)		
20 ma water temperature	-40 °F to 266 °F (-40 °C to 130 °C)		
Outdoor reset	Enabled Disabled		
Priority source	DHW heat demand Disabled	37	29
Priority method	Boost during priority time Drop after priority time		
DHW priority override time	___Hour ____Minute _____Second		
Enable	Enabled Disabled	38	29
Outdoor setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		
Frost protection rate	____%		
Enable	Enabled Disabled	39	29
Setpoint	-40 °F to 266 °F (-40 °C to 130 °C)		

Table 60. Configurable Parameters. (Continued)

Parameter	Comment	Table #	Page #
Lead selection method	Sequence order Measured run time	40	29
Lag selection method	Sequence order Measured run time		
Lead rotation time	___day ____hour _____min		
Force lead rotation time	___day ____hour _____min		
Base load common	? %	41	29
Method	Error threshold Firing rate threshold Disabled	42	29
Detection time	___Hour ____Minute _____Second		
Error threshold	0 °F to 234 °F (-17 °C to 112 °C)		
Rate offset	± _________ %		
Interstage delay	___Hour ____Minute _____Second		
Method	Error threshold Firing rate threshold Disabled	43	29
Detection time	___Hour ____Minute _____Second		
Error threshold	0 °F to 234 °F (-17 °C to 112 °C)		
Rate offset	± _________ %		
Interstage delay	___Hour ____Minute _____Second		

Table 61. Other Tables.

Parameter	Table #	Page #
8-pin Connector Terminals	1	3
Lockout History	2	10
Alert Log	3	10
Digital I/O Data	56	35
Analog I/O Data	57	36

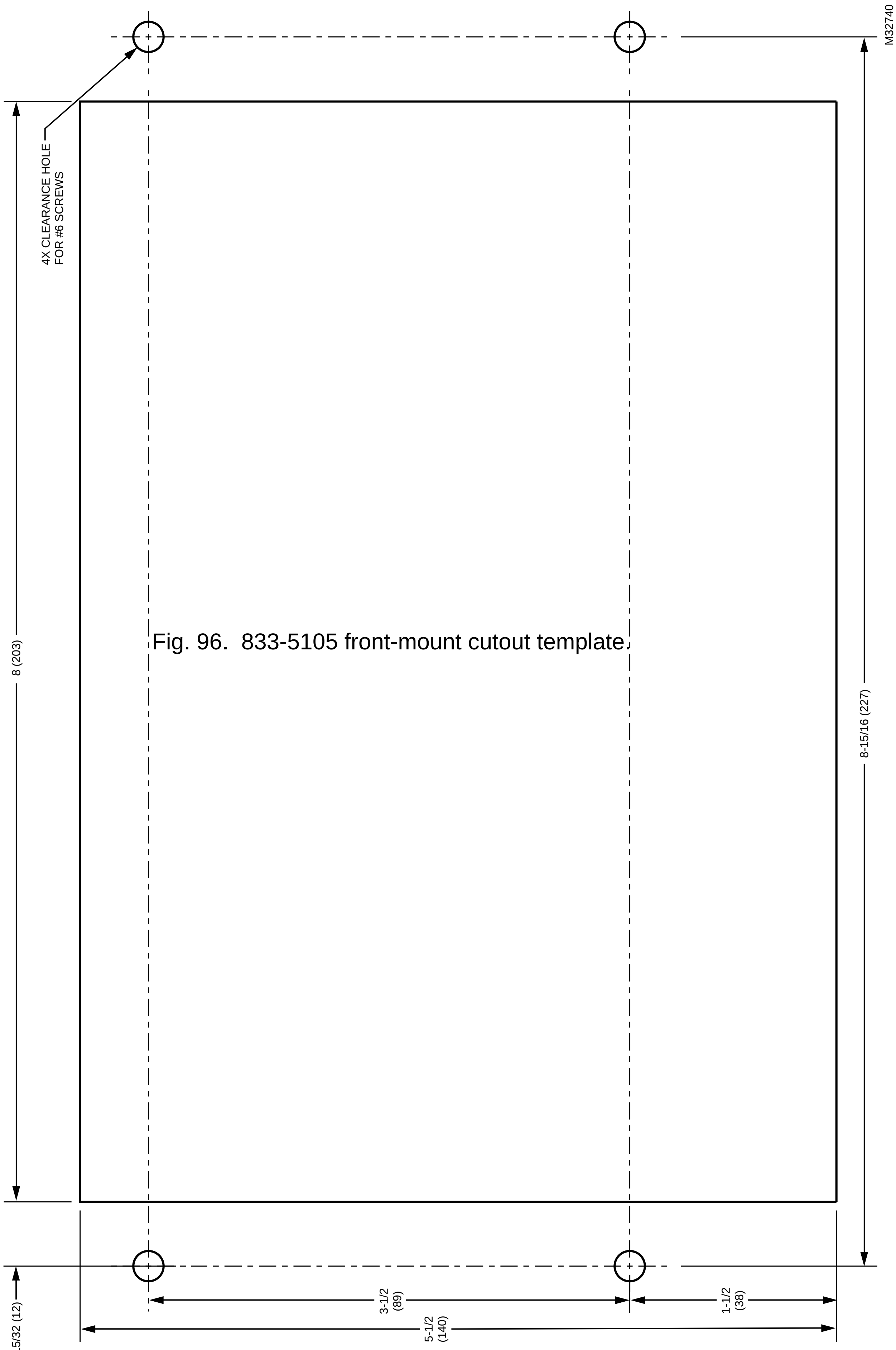


Fig. 96. 833-5105 front-mount cutout template.

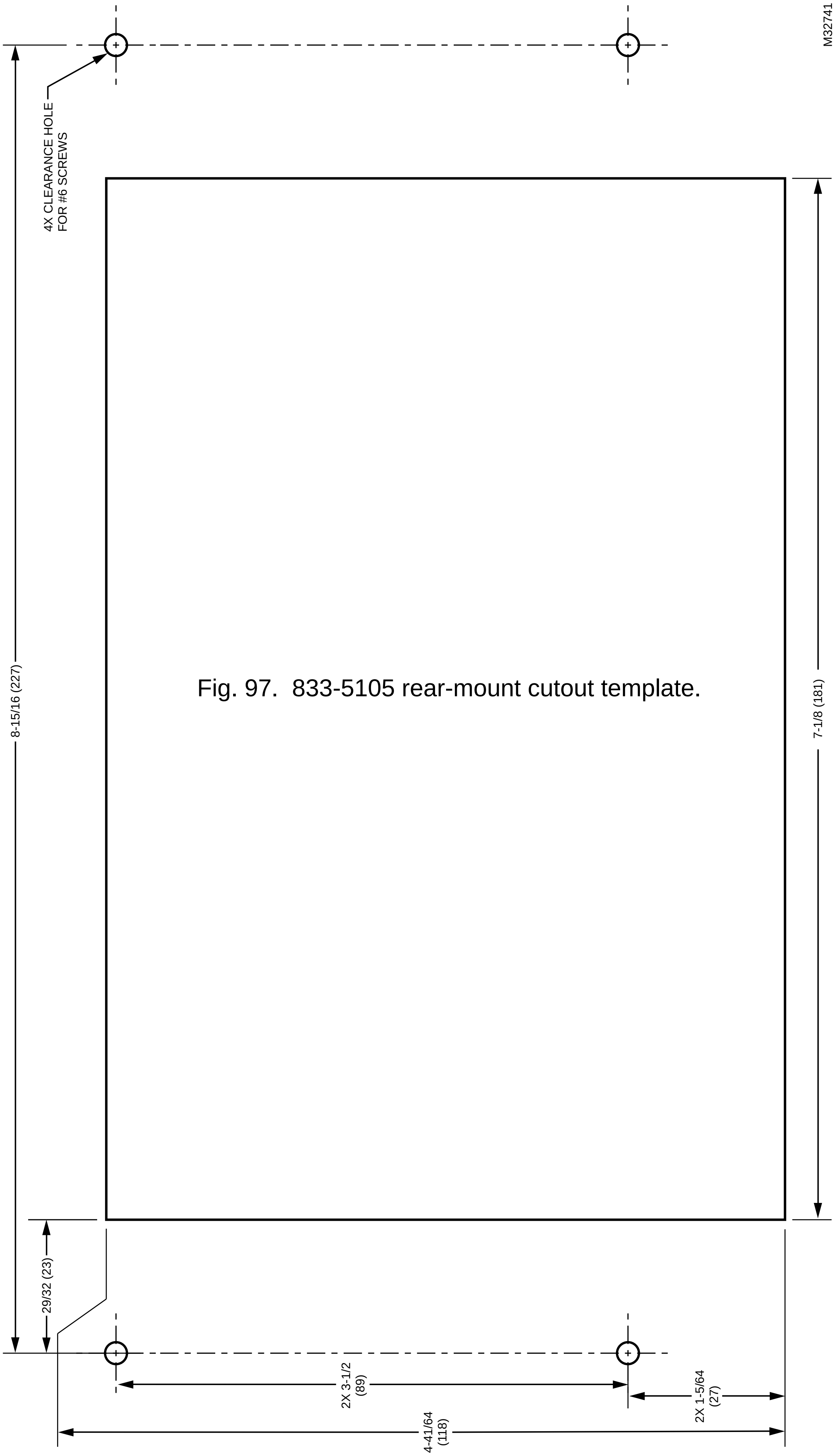


Fig. 97. 833-5105 rear-mount cutout template.

Appendix C — CB Falcon Plug-In Module

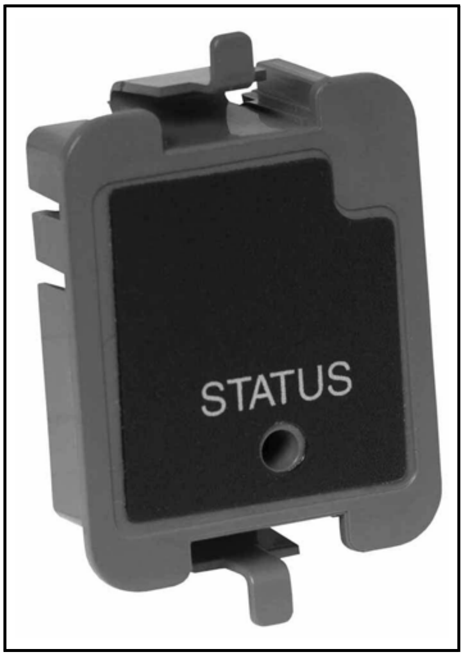
CleaverBrooks

833-3640 Program Module for the

833-3639 / 833-3871 Hydronic Control or

833-3578 Steam Control

PRODUCT DATA



APPLICATION

The 833-3640 Program Module is an optional plug-in device for the CB-Falcon Hydronic and Steam Controls. From the system level the 833-3577 System Operator Interface can direct the CB Falcon to transfer or retrieve parameter information with the Program Module.

FEATURES

- **Can be removed or installed while the CB Falcon is powered.**
- **Facilitate multiple controller setups.**
- **Back up and restore the CB Falcon non- safety parameter values.**

SPECIFICATIONS

Supply Voltage: Power is supplied by the 833-3639/3871 or 833-3578

Ambient Storage Temperature: -40 to 150°F (-40 to 65°C)

Ambient Operating Temperature: -40 to 150°F (-40 to 65°C)

Indicator LEDs: One (Status LED) Blinking LED indicated the Program Module is properly seated and powered from the CB Falcon..

The 833-3639/3871 CB Falcon Hydronic Control and 833-3578 CB Falcon Steam Control have a backup region that will allow the CB Falcon's programmable data to be backed up and restored. This supports both replacement of a controller that has failed and setup of a new controller. This process is described below.

All operations that read and write 833-3640 data are password-protected.

Back up parameters to PROGRAM MODULE

The CB Falcon will copy the following data to the PROGRAM MODULE's backup region.

- A backup control header
- All non-safety parameter values

Restore parameters from the 833-3640

The CB Falcon will copy the parameter data described above from the PROGRAM MODULE back into a Falcon unit. The Falcon will check the backup control header. If it indicates compatibility then restoring is allowed.

The PROGRAM MODULE restore process disables other CB Falcon processing (except display I/O), and finally the PROGRAM MODULE data is loaded into the CB Falcon from the backup region.

OPERATION

1. Remove the dust cover from the CB Falcon Hydronic or CB Falcon Steam Control and install the 833-3640 Program Module.
2. The CB Falcon may be powered while installing (or removing) the PM.
3. When the PM and the CB Falcon make connection,the status LED will blink on the PM.
4. Once the PM is installed, and the LED is blinking, the Backup or Restore functions are available. Go to the Falcon operator interface Home screen (see Fig. 1).

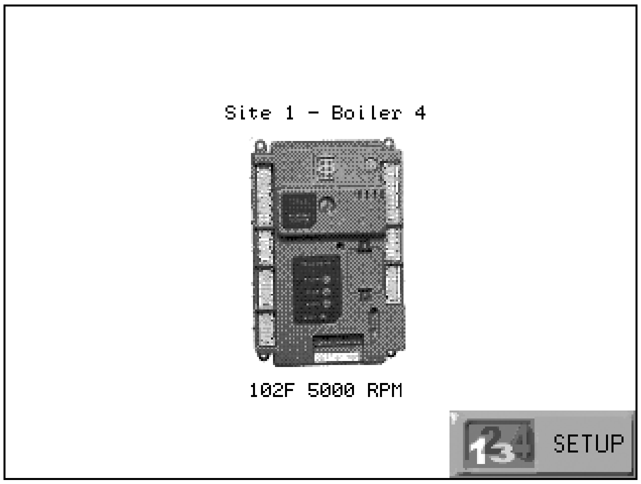


Fig. 1. Home page.

5. Press the Setup button. The screen shown in Fig. 2 will appear.

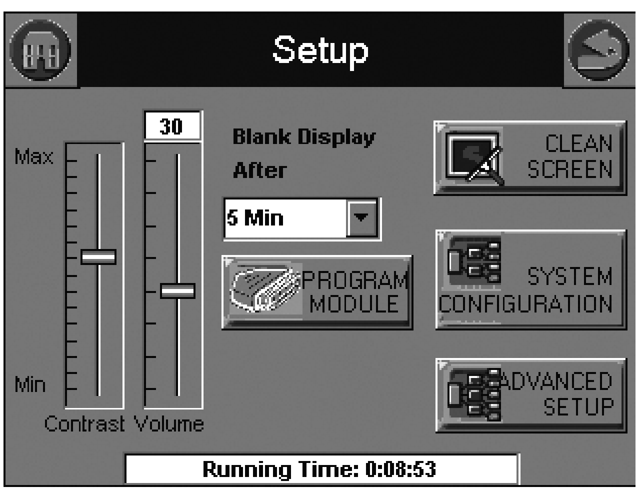


Fig. 2. Setup page.

6. Press the Program Module button on the Setup screen, as shown in Fig. 2.
7. Select the burner that contains the Program Module you will be working with, as shown in Fig. 3.

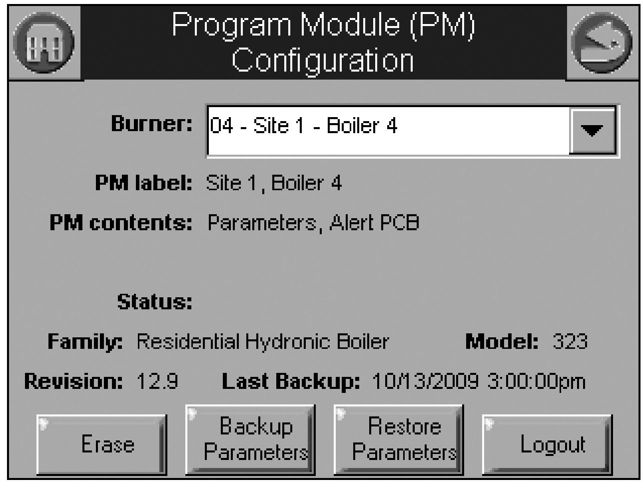


Fig. 3. Program Module Configuration page.

Button Actions

NOTE: An installer password will be required to perform the below functions:

- **Erase**—will erase the contents of the installed Program Module for the selected Burner.
- **Backup**—will copy non-safety parameter values and Backup Control Header data from the CB Falcon installed in the Burner location noted and save the data to the Program Module.
- **Restore**—will transfer all “Backup” non-safety parameter data from the Program Module to the CB Falcon installed in the selected Burner.

When completed, the Program Module may be removed and installed in another CB Falcon for configuration of non-safety parameters or removed and stored for Backup should the original CB Falcon need to be replaced for any reason.

Install the Dust Cover into the CB Falcon to keep foreign material from getting into the Program Module Connector.

Backup Data

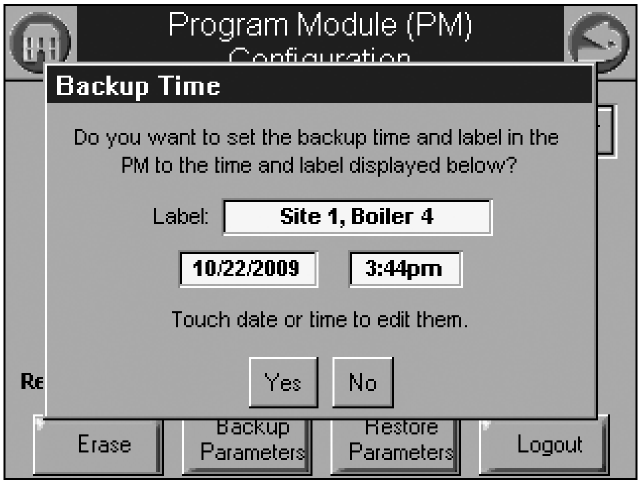


Fig. 4. Backup Data settings.

A 20 character label, date, and time can be entered in the Label field. This name appears when the Backup Parameters button is pressed.

If “Yes” is pressed, then a label will be written in the PM memory that will be shown on the 833-3639 Program Module page when the PM is inserted.

If “No” is pressed then no label will be written in the PM memory.

Appendix D — Gas Valve

Honeywell

V4730C/V8730C/V4734C

1:1 Gas/Air Servo Regulated Gas Valves

Product data

Note: Photo shows valve with manual safety shutoff valve and venturi installed.

CONTENTS

APPLICATION

The V4730C/V8730C/V4734C 1:1 Gas/Air Servo Regulated Gas Valves, with the addition of the Venturi Mixing Unit (VMU) and dc fan, are used for modulating premix appliances such as gas burners, gas boilers, rooftop units, makeup air units and process applications.

FEATURES

- Wide modulation range (14% to 100% of burner load).
- 24 Vac and 120 Vac models.
- Main valve body with two shutoff seats (double block valve).
- Closing time less than one second.
- Mesh screen (strainer) between inlet flange and main body.
- Various pressure tap points available at main body when no additional valves or pressure switches are used.
- DIN 43650 Plug Connector with 36-in. (914 mm) leadwires included.
- Flexible mounting positions of venturi manifold to fan.
- Replaceable pipe flange adapters available.
- Position indication lamp for each valve stage

SPECIFICATIONS

The specifications in this section are related to the Venturi Mixing Unit (VMU) and Combination Gas Valve.

Models: See Table 1

Table 1: Model Information

Model Number	Size (in.)	Voltage/Frequency	V1 + V2 Total Current	Capacity (Natural Gas 0.64sp.gr)
V4730C1006	1/2	120 Vac, 50/60 Hz	0.32 A	22-150 kW (73-512 kBtuh)
V4730C1014	3/4			43-300 kW (146-1024 kBtuh)
V4730C1022	1		0.5 A	
V4730C1030	1-1/4			55-382 kW (185-1300 kBtuh)[a]/71 - 500 kW (245-1710 kBtuh)
V4734C1002	1-1/4	120 Vac, 50/60 Hz	2.6 A at start 1.04 A during operation	97-680 kW (326-2287 kButh) when used with VMU680 unit
V8730C1007	1/2	24 Vac, 50/60 Hz	1.56 A	22-150 kW (73-512 kBtuh)
V8730C1015	3/4			43-300 kW (146-1024 kBtuh)
V8730C1023	1		1.72 A	
V8730C1031	1-1/4			55-382 KW (185-1300 kBtuh)[a]/71 - 500 KW (245-1710 kBtuh)

[a] When used with VMU335 Venturi UnitAnwendung

Maximum Operating Pressure (UL):

1.45 psi (100 mBar), except for 1-1/4 in. size:
(24V): 1 psi (70 mBar).
(120V): 1.45 psi (100mBar)
CSA Approved: 0.5 psi (34 mBar).
Note: CSA Certification to 1/2 psi.

Connections:

1/8 in. (3 mm) NPT pressure taps at inlet and outlet flanges. Eight flange connections are provided at the main body to mount either a pressure switch (high or low) or a ValveProving System (VPS).

Torsion and Bending Stress:

Pipe connections meet EN151, Group 2, requirements.

Electrical Equipment:

Standard DIN plug connector with 36-in. (914 mm) leadwires.

Valve Position Indicator Lamps:

Inboard (closest to the valve body) - V1.
Outboard - V2.

Ambient Temperature Range:

5°F to 140°F (-15°C to +60°C).

Coil Insulation Solenoid Valves:

Class H insulation system.

Body Material:

Aluminum alloy, die-cast

Strainer:

Fine mesh screen (0.135 in. [0.34 mm] diameter). AISI 303 steel, serviceable after removing inlet flange screws. Meets EN161 requirements for strainers

Seals and Gaskets:

Hydrocarbon-resistant NBR and Viton rubber types.

Flange Kit:

Consists of one flange with sealing plug, one O-ring and four screws. See Table 2.
Note: Valve comes with one kit only.

Table 2: Flange Kits.

Part Number	Size NPT in in. (mm)
32006652-001	1/2 (13)
32006652-002	3/4 (19)
32006652-003	1 (25)
32006652-004	1-1/4 (32)

Manual Shut-Off Valve Kits:

50002653-001 for use with 1 in. NPT or smaller valves.
50002653-002 for use with 1-1/4 in. NPT valves.

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number. If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Honeywell Automation and Control Products Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care

1885 Douglas Drive North

Minneapolis, Minnesota 55422-4386

In Canada - Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Scarborough, Ontario M1V 4Z9.

International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

Opening Time:

Dead time maximum: 1 second.

First valve opening: less than 1 second.

Second valve opening: reaches 50% of the adjustable outlet pressure within 5 seconds.

Maximum Allowable Leakage:

Outerwall: 3 cu. in./hr (50 cm3/h) at test pressure of 0.87 psi (6 mBar) and 7.83 psi (540 mBar).

First Valve: 2.5 cu. in./hr (40 cm3/h) at test pressure of 0.87 psi (6 mBar) and 7.83 psi (540 mBar).

Second Valve: 2.4 cu. in./hr (40 cm3/h) at test pressure of 0.87 psi (6 mBar) and 7.83 psi (540 mBar).

High Pressure Test:

In the OFF condition, the valve will withstand 21.75 psi (1.5 Bar) inlet pressure without damage.

Accessories:

FL020008 Mesh Screen.
Flange Kits (see Table 2).
DIN43650 Connector
32006653-001 Venturi O-rings/screws.

Operational Voltage Range:

The combination gas valve will function satisfactorily between 85% and 110% of the rated voltage.

Gas Valve Connection to Venturi (Field-Assembled):

Four screws and an O-ring are used to connect the gas valve to the venturi/manual shutoff valve.
The metal tube provided with the venturi must be connected between the venturi and the gas valve regulator.

Fan Connection:

The venturi is connected to the fan using six bolts (wich are included with VMU).

Minimum Load:

The minimum load for which the system can be used is 14-17% of the reference load, which equals a minimum pressure differential of 0.2 in. wc (50 Pa) of the 1:1 venturi/servo regulator gas control.

Approvals:

Gas Appliance Directive 90.396/EEC

ANSI: Z21.21

CSA: 6.5

Capacity Curves:

See Fig. 9 to 14.

Dimensions:

See Fig. 1 to 5

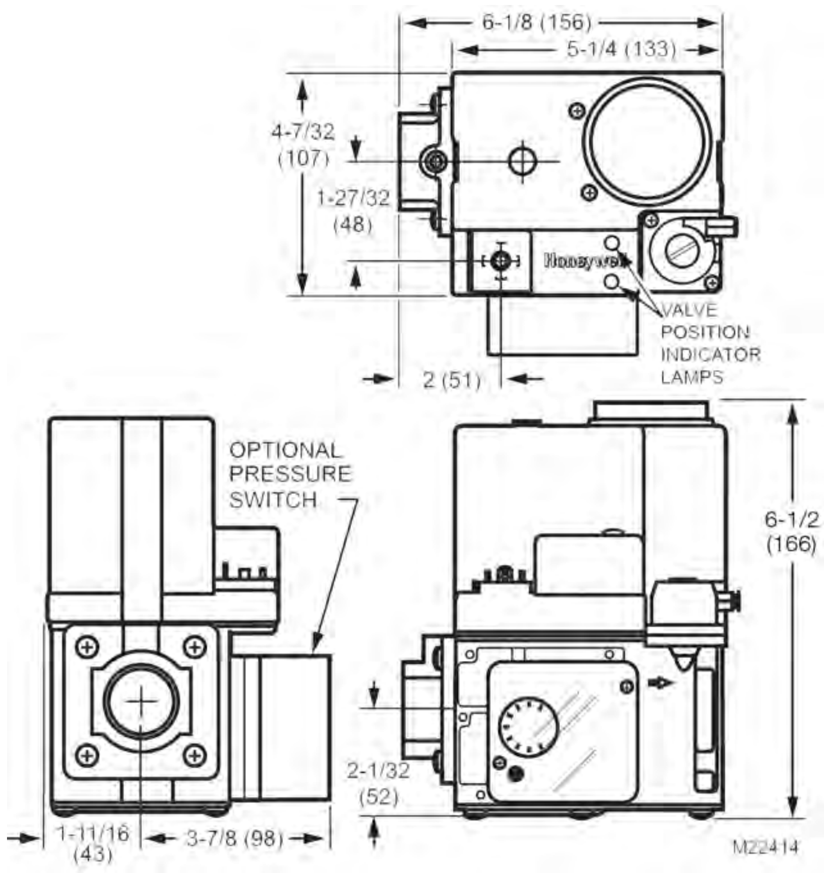


Fig. 1: V4730C/V8730C Gas Valves, 1/2 in. (13 mm) and 3/4 in. (19 mm) size, dimensions in in. (mm).

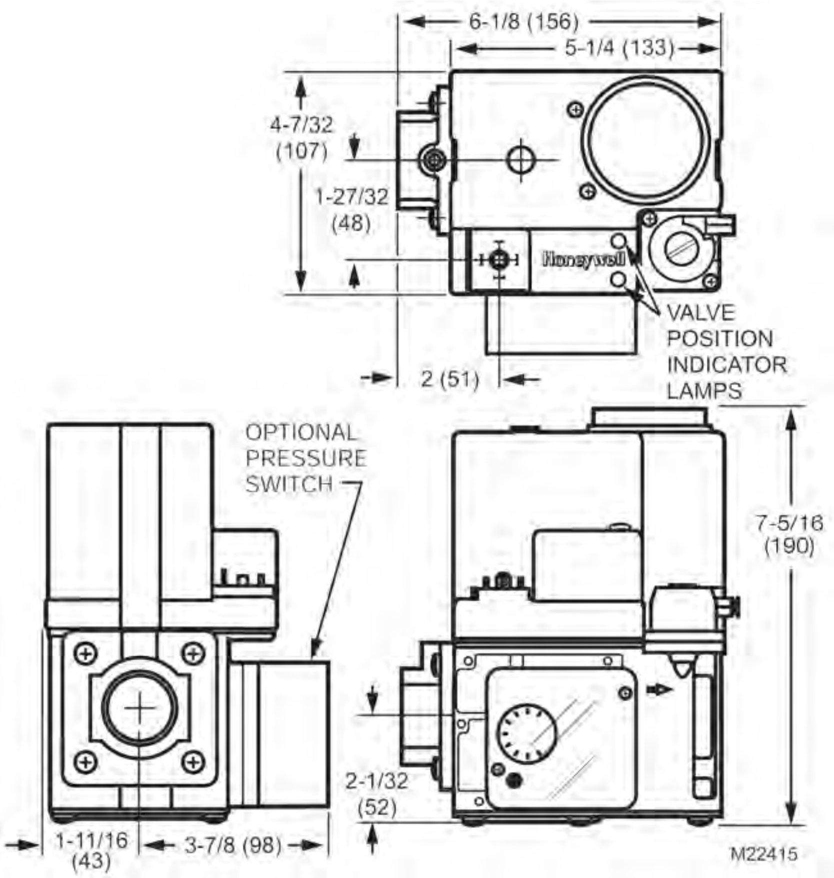


Fig. 2: V4730C/V8730C Gas Valves, 1 in. (25 mm) size, dimensions in in. (mm).

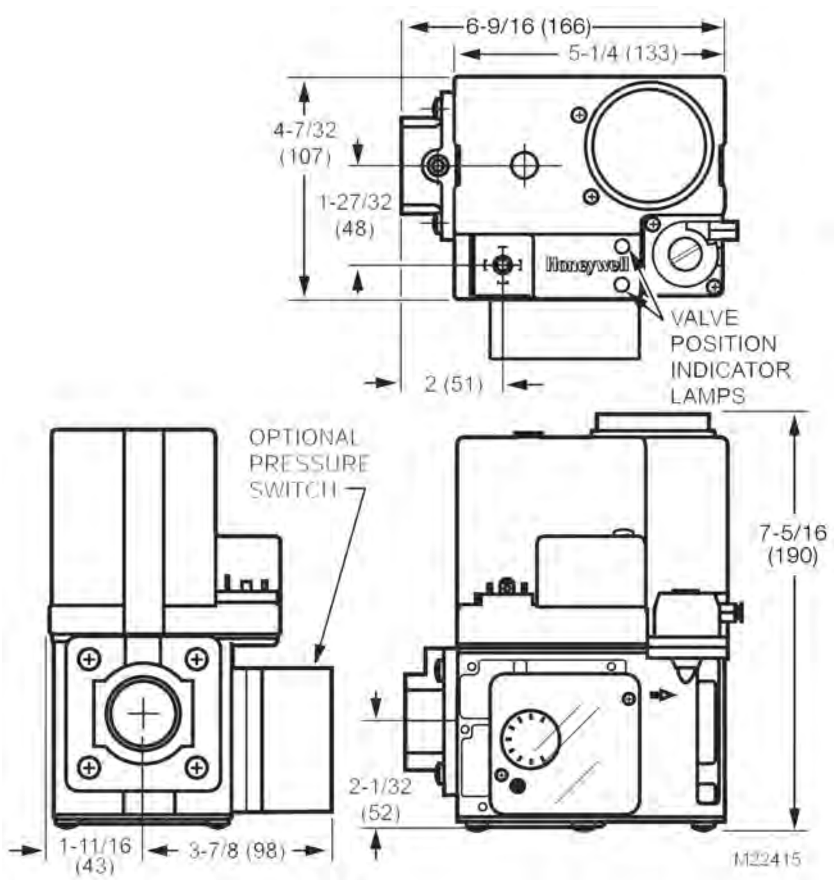


Fig. 3: V4730C/V8730C Gas Valves, 1-1/4 in. (32mm) size, dimensions in in. (mm).

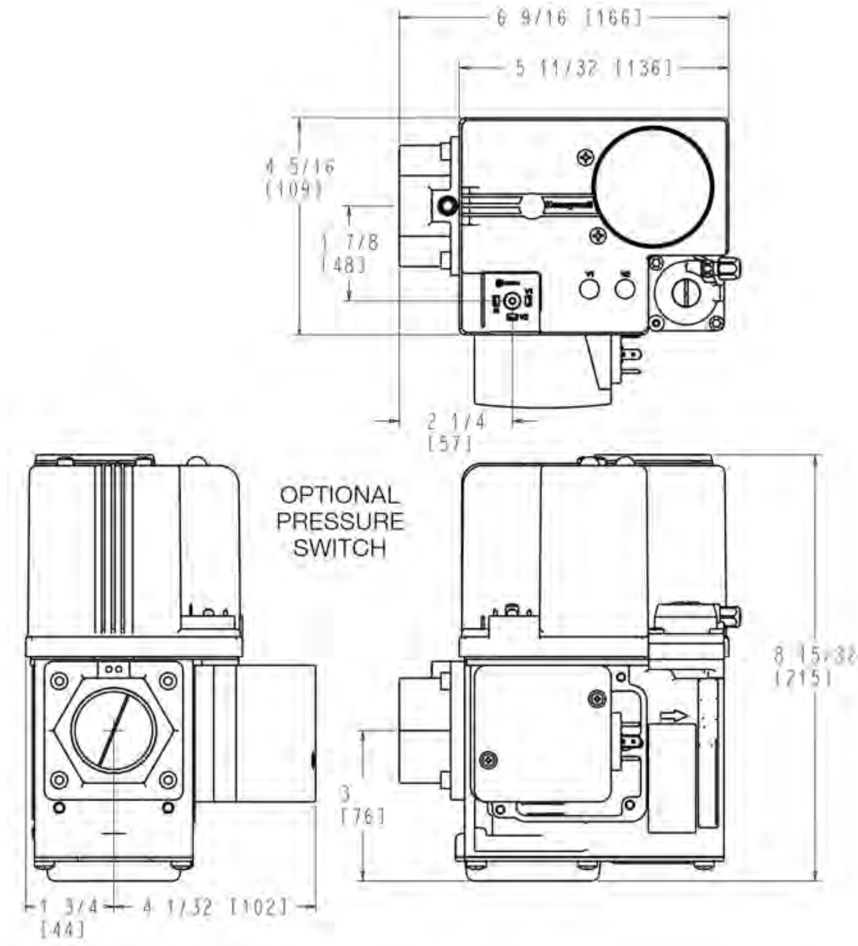


Fig. 4: V4734C Gas Valves 1-1/4 in. (32mm) size, dimensions in in. (mm).

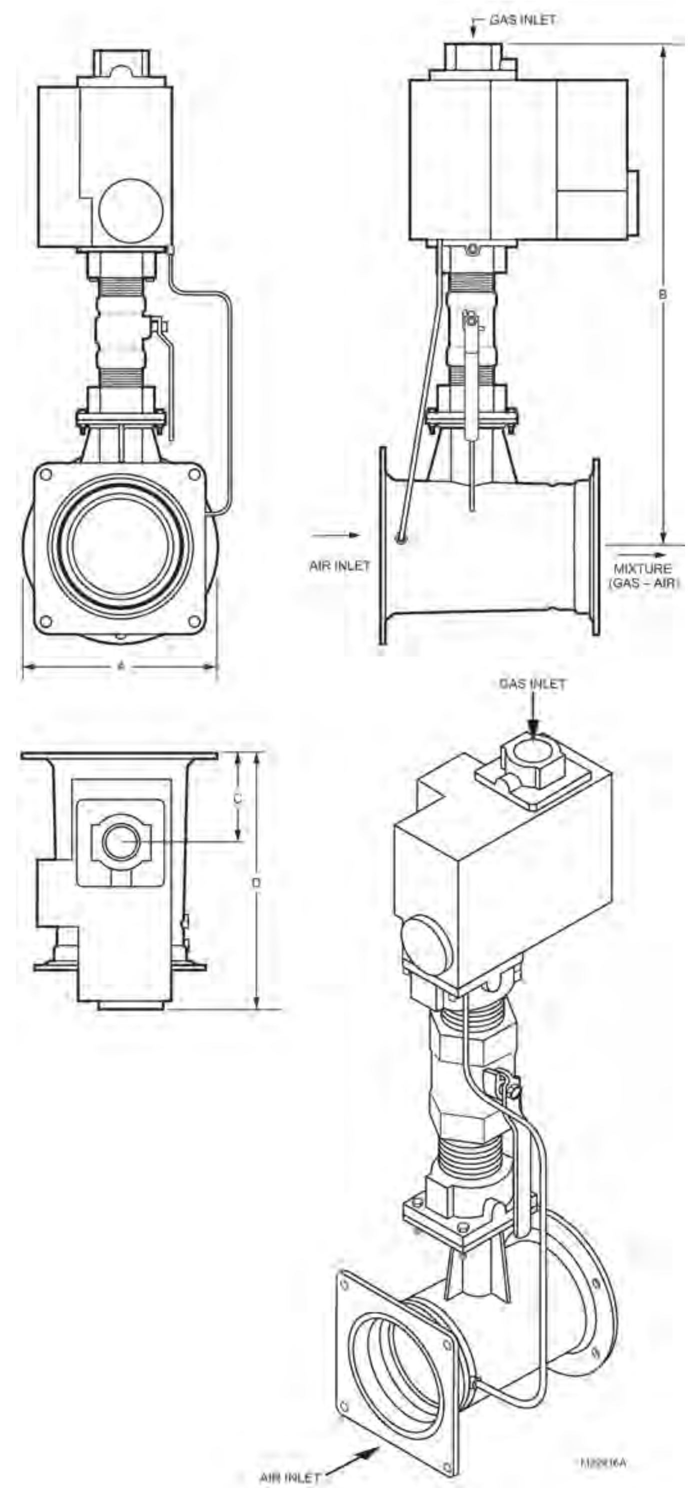


Fig. 5: Venturi 150-335 kW, with 1/2 in. to 1 in. gas valves and valve shutoff kit installed dimensions in in. (mm). See Table 3 for dimensions

Table 3: Dimensions in inches (millimeters)

Valve Size in inches	A	B	C	D
1/2, 3/4	6 - 1/4 (159)	15 - 15/16 (405)	2 - 15/16 (75)	7 -7 1/2 (191)
1				8 - 5/16 (211)

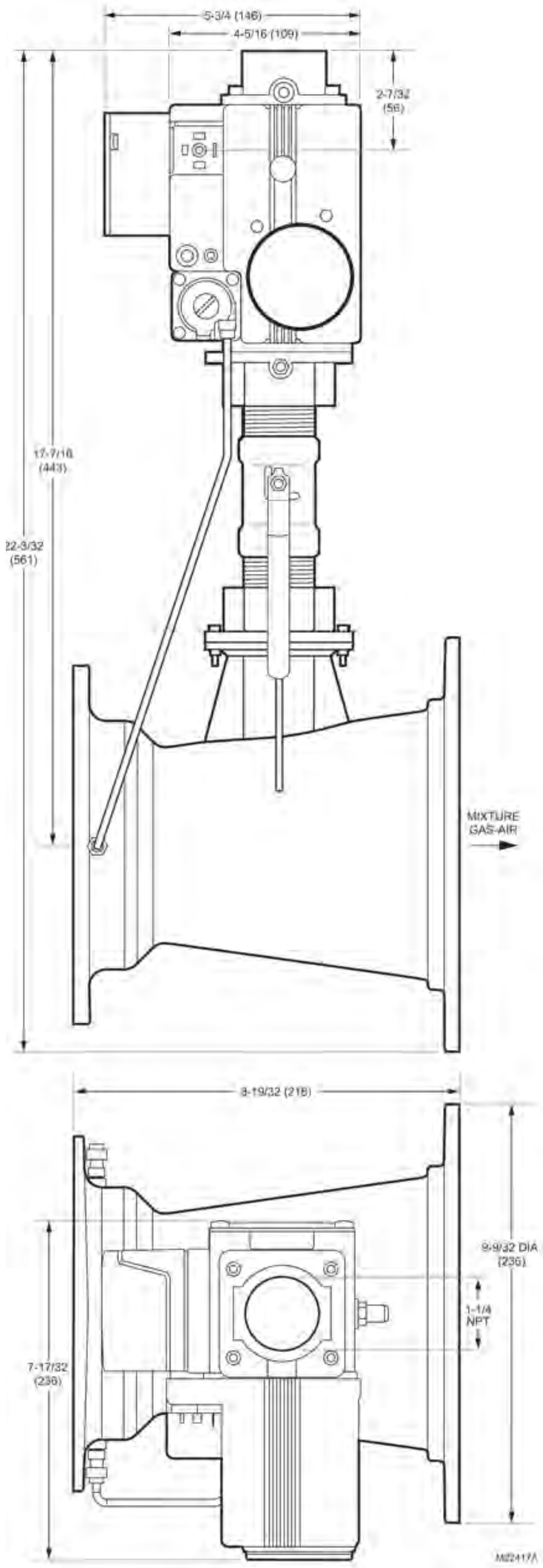


Fig. 6: Venturi 500kW, with V4730 gas vlave and valve shutoff kit installed, dimensions in in. (mm), part 1.

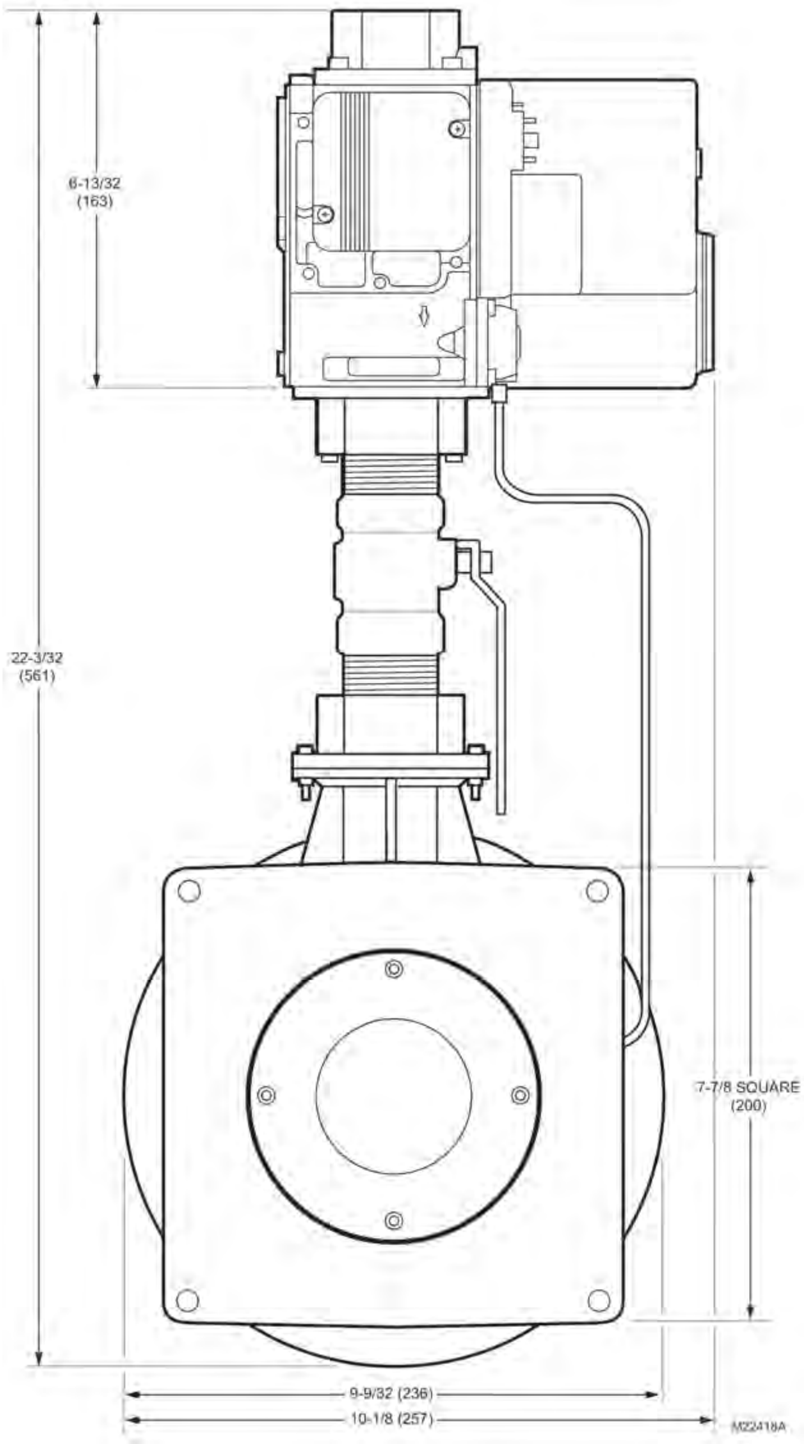


Fig. 7: Venturi, 500 kW, with V4730 gas valve and valve shutoff kit installed, dimensions in in. (mm), part 2

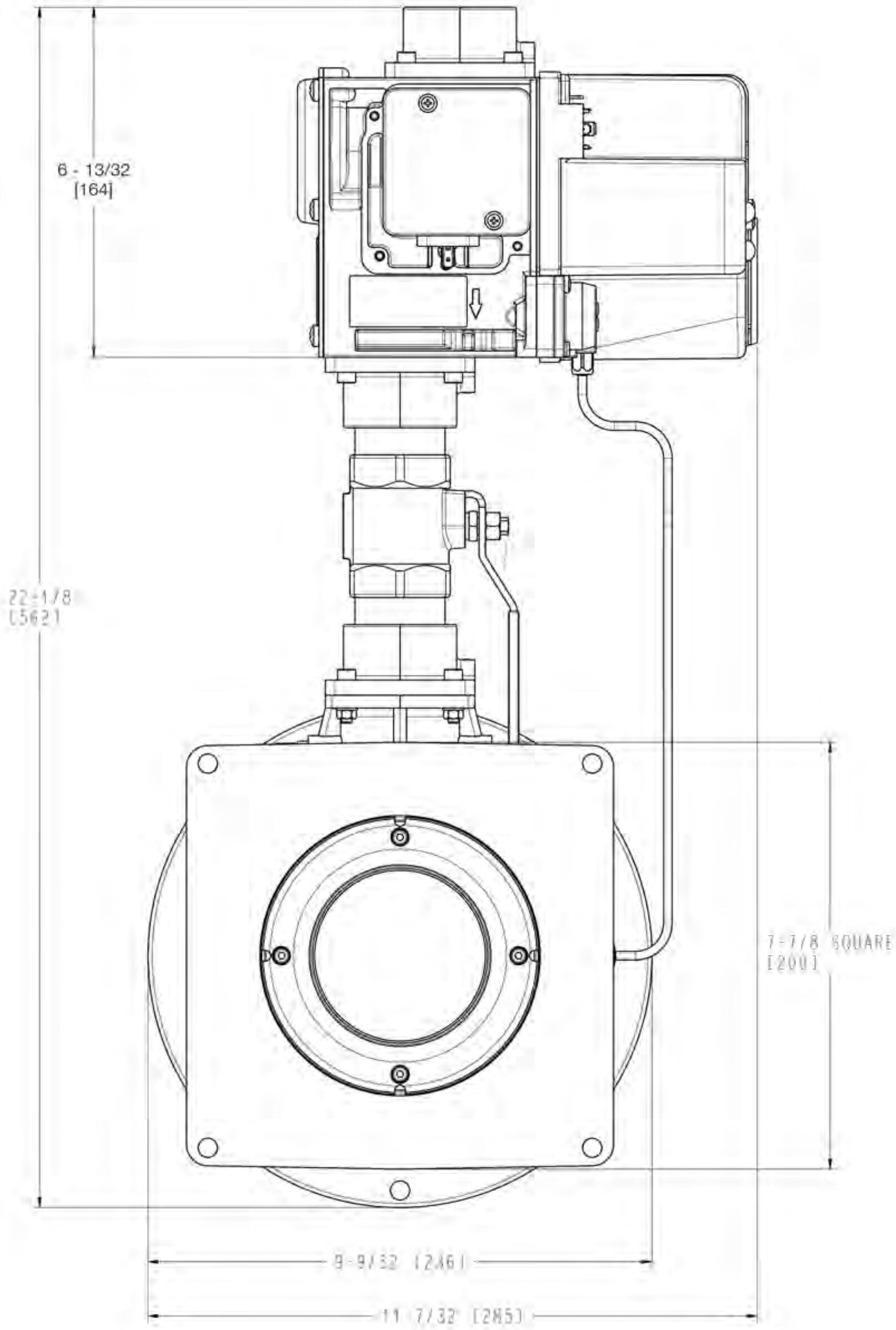


Fig. 8: V4734 + VMU 500/680

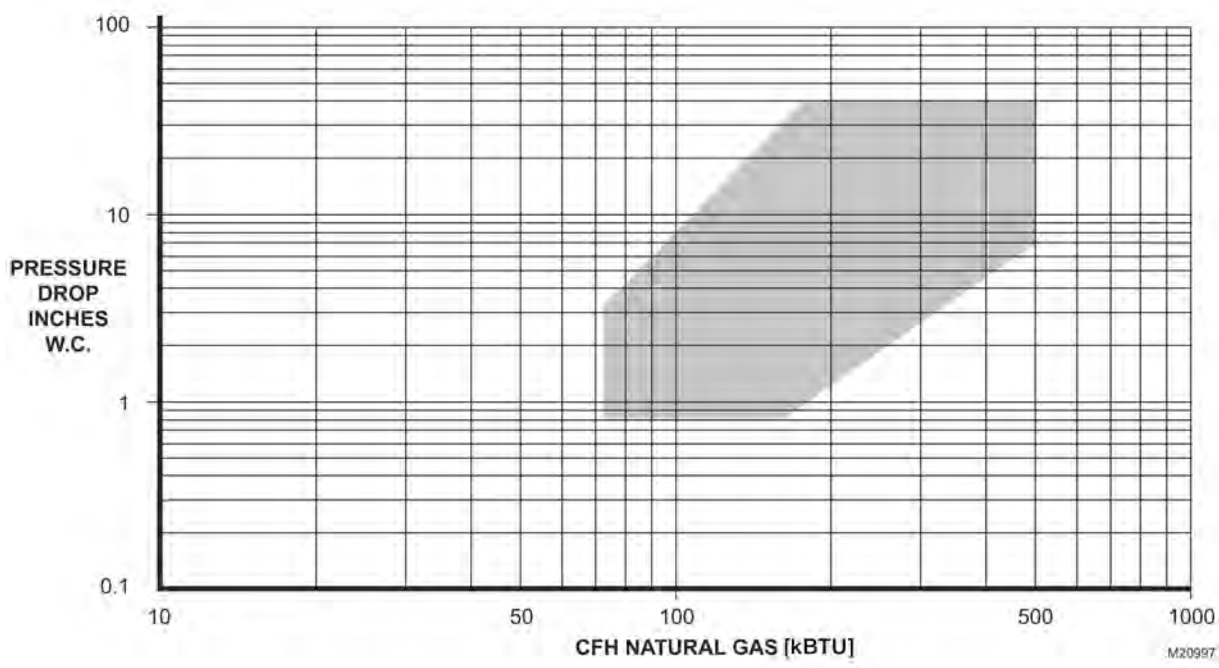


Fig. 9: Capacity curves for V4730C/V8730C and VMU 150 Venturi, 1/2 in. size.

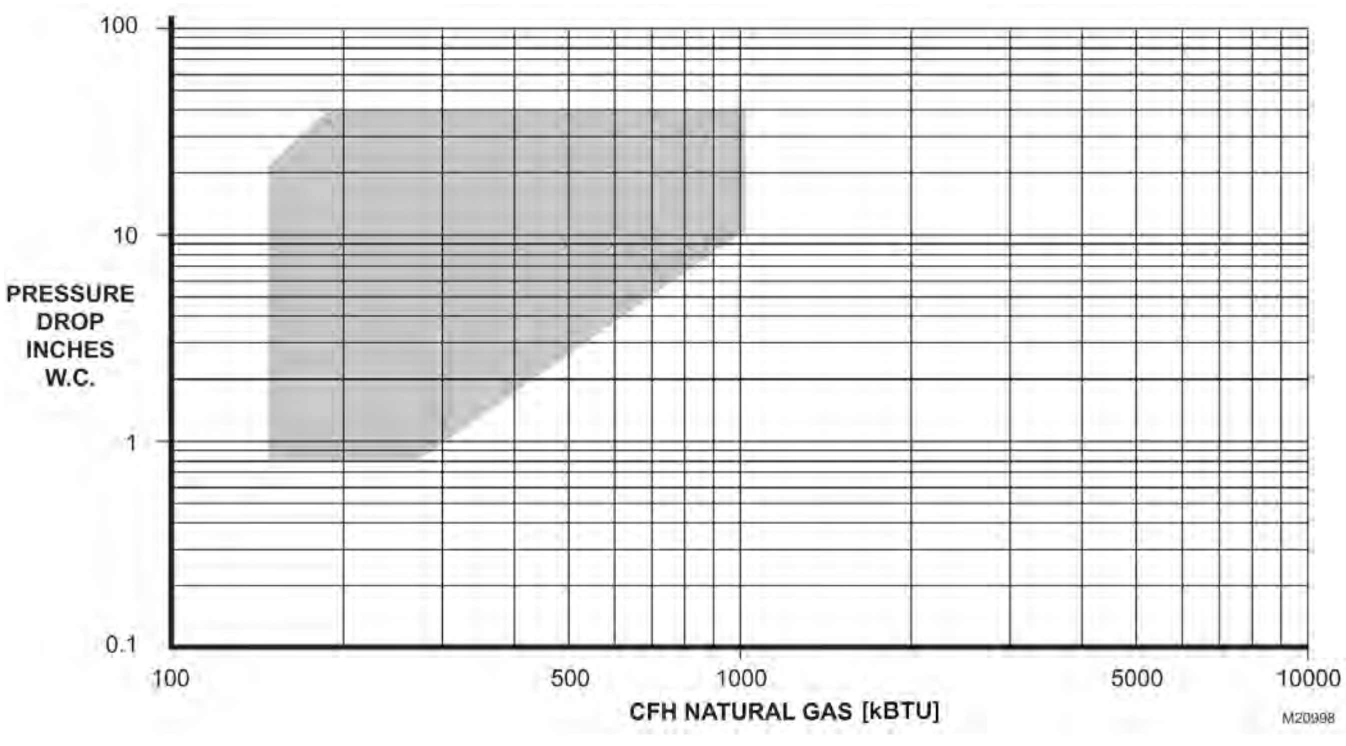


Fig. 10: Capacity curves for V4730C/V8730C and VMU 300 Venturi, 3/4 in. size

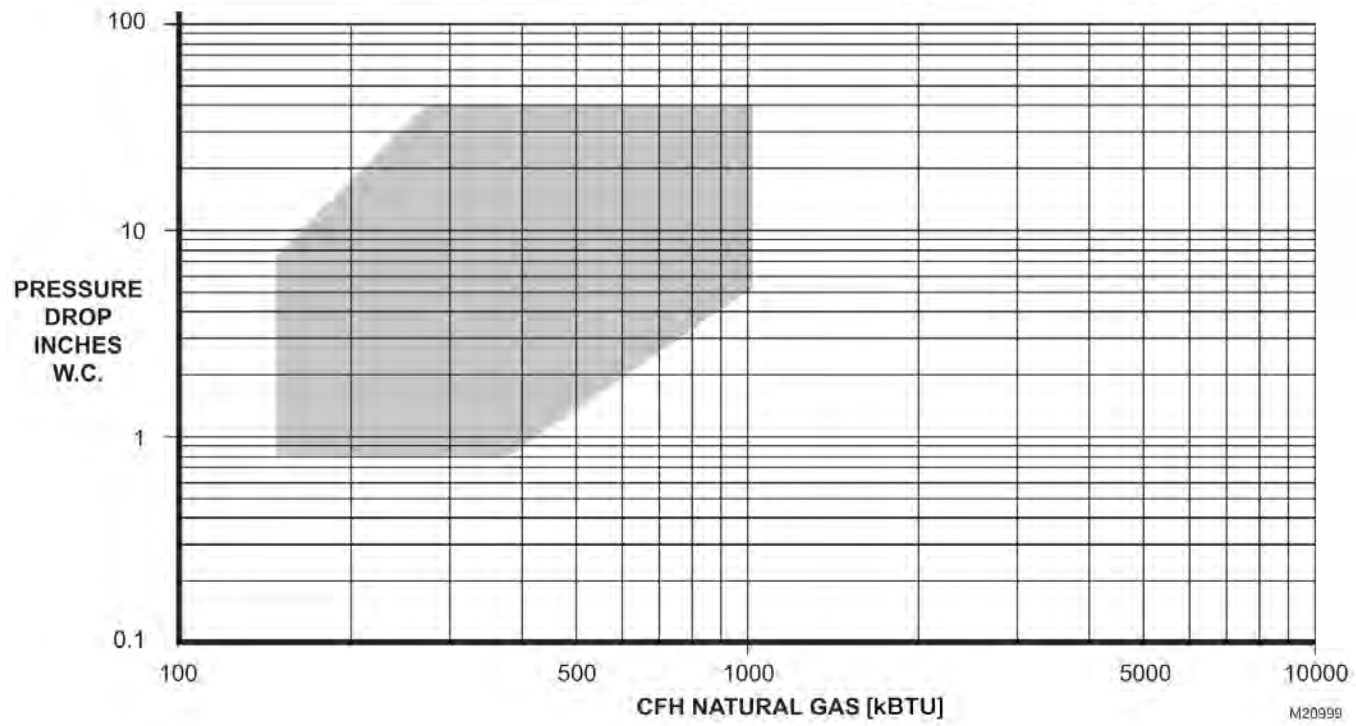


Fig. 11: Capacity curves for V4730C/V8730C and VMU 300 Venturi, 1 in. size.

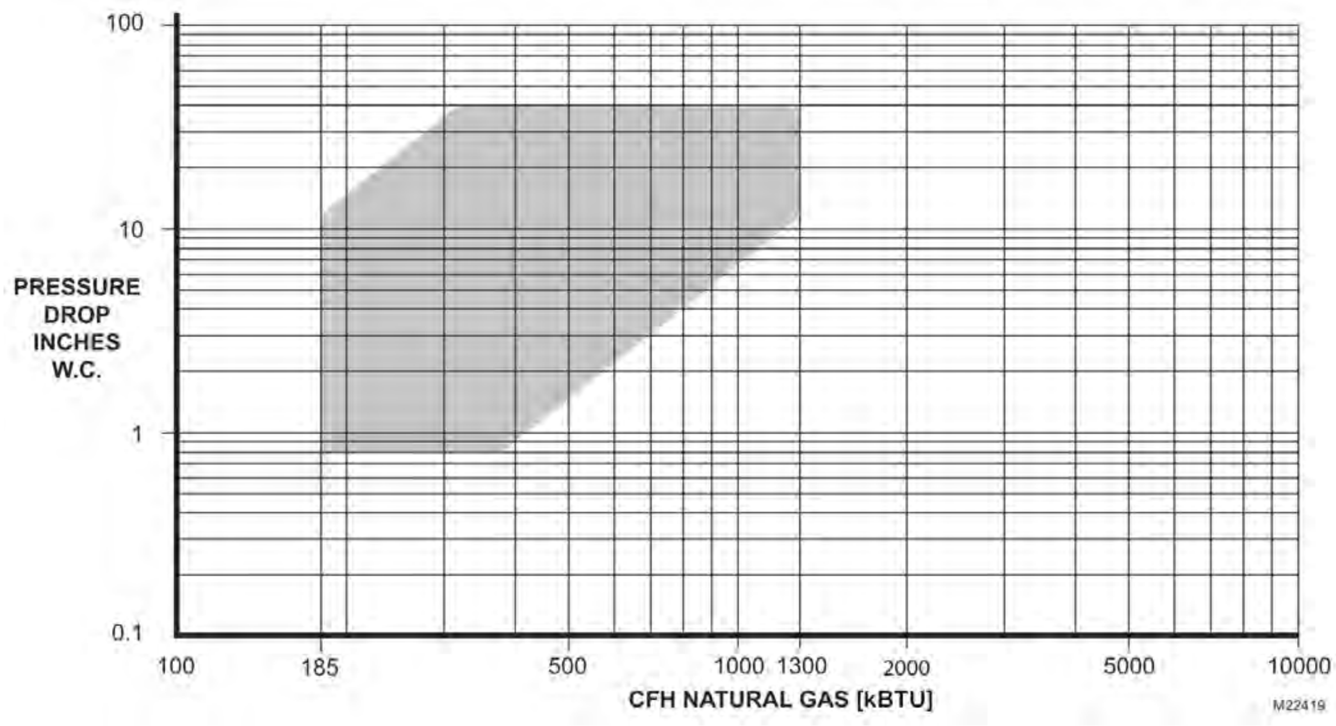


Fig. 12: Capacity curves for V4730C/V8730C and VMU 335 Venturi, 1-1/4 in. size.

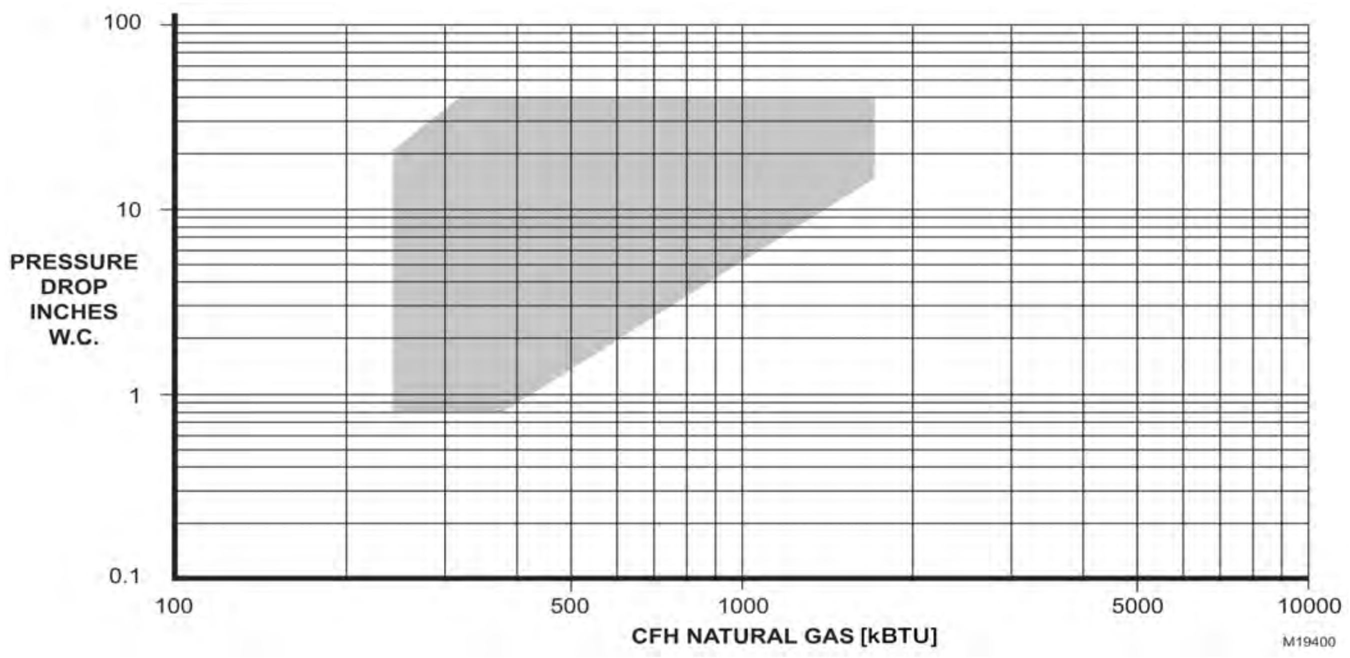


Fig. 13: Capacity curves for V4730C/V8730C and VMU 500 Venturi, 1-1/4 in. size.

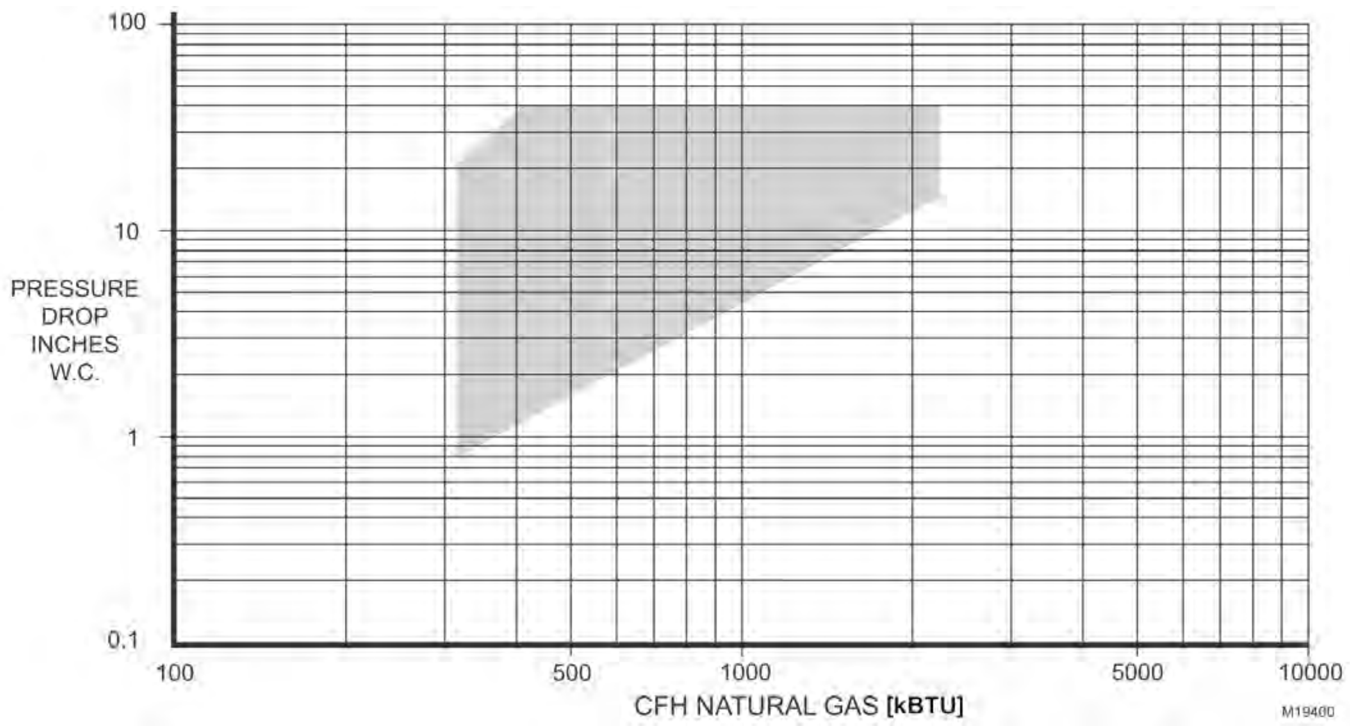


Fig. 14: Capacity curves for V4734C/V8734C and VMU 680 Venturi, 1-1/4 in. size.

INSTALLATION

When Installing This Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. The installer must be a trained, experienced, flame safeguard technician.
4. After installation is complete, check out product operation as provided in these instructions

WARNING

Fire or Explosion Hazard. Can cause severe injury, death or property damage

1. Turn off the gas supply before beginning installation
2. Disconnect power to the valve actuator before beginning installation to prevent electrical shock and damage to the equipment.
3. Do not remove the seal over the valve inlet and outlet until ready to connect piping.
4. The valve must be installed so that the arrow on the valve points in the direction of the gas flow, so that gas pressure helps to close the valve

Mounting Position

The valve/venturi is factory-calibrated in the upright position for the most accurate metering of the gas flow.This is with the air flow through the venturi in a horizontal direction and the gas flow into the valve in a horizontal direction. The valve can be mounted up to ±90 degrees from this position without affecting the fuel/air metering at medium and high firing rates (3000 to 5000 rpm of the blower), but at lower firing rates (1000 rpm) the fuel might be reduced up to 10% when the valve is not mounted upright. To counter this, the low fire gas flow may be carefully field adjusted for non-upright mounting as follows:

1. With the valve in the final mounting position, adjust the venturi fan for the lowest burner firing rate.
2. Remove the slotted cap on the gas regulator using a slotted screwdriver. This will expose the offset adjustment screw (see Fig. 11).
3. Using a TORX® T40 or a 5 mm hex wrench, carefully adjust the low fire gas setting for proper combustion.
4. After proper low fire offset adjustment has been made, reinstall the slotted cap on the regulator.
5. Before commissioning the burner, check for proper lightoff and verify correct fuel/air mix and combustion quality through out the entire firing range (from lowest to highest fan speeds used).

Mounting Locations

The distance between the gas valve and the wall/ground must be a minimum of 11-5/16 in. (30 cm).

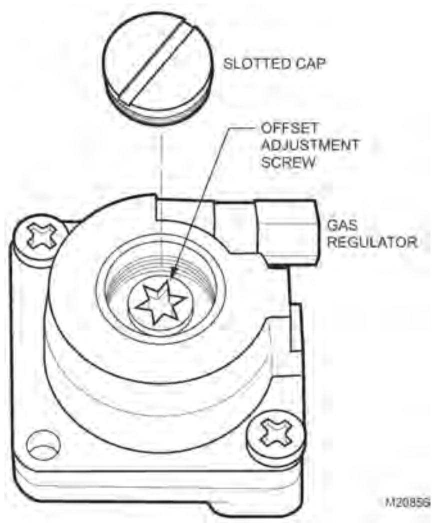


Fig. 15: Regulating adjusting screw

Main Gas Connection

1. Take care that dirt does not enter the gas valve during handling.
2. Remove the flanges from the valves.
3. Use new, properly reamed, pipe, free from chips.
4. Apply a moderate amount of good quality pipe dope, resistant to the action of liquefied petroleum (LP) gas, only on the pipe threads.
5. Screw the flanges onto the pipes.
6. Do not thread the pipe too far into the flange. Valve distortion or malfunction can result from excess pipe in the flange.
7. Make sure O-ring sealing surfaces are clean.
8. Using general purpose lithium grease, grease the O-ring.
9. Install the O-ring into the O-ring groove provided on the valve body (one O-ring per groove).
10. Mount the gas valve to the flanges, using the screws removed earlier.
11. Complete the electrical connections as instructed in the Electrical Connections section.

WARNING

Fire or Explosion Hazard. Can cause severe injury, death or property damage.

Perform a soap-and-water solution gas leak test any time work is done on a gas system.

ELECTRICAL CONNECTIONS

WARNING

Electrical Shock Hazard. Can cause severe injury or death.

Disconnect the power supply before beginning wiring to prevent electrical shock. More than one disconnect may be involved.

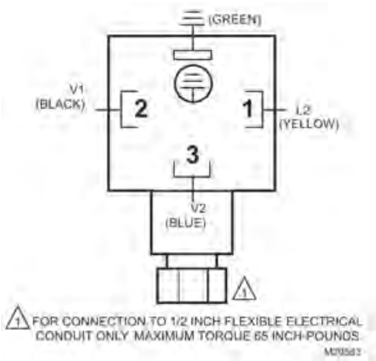


Fig. 16: Four-pin electrical plug connector

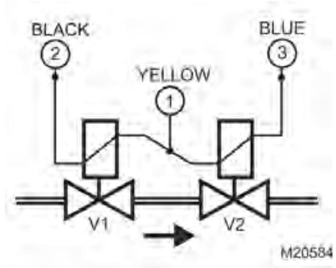


Fig. 17: Electrical connection diagram

Wiring

1. Use 14, 16 or 18 AWG copper conductor, 600 volt insulation, moisture-resistant wire for line voltage connections. Recommended wire types are TTW60C, THW75C or THHN90C.
2. Follow the instructions below for wiring the gas valve. See Fig. 16 and 17 for reference.
   2.a T1 (yellow) will be L2 (120 Vac or 24 Vac).
   2.b T2 (black) will be L1 (120 Vac or 24 Vac) to Valve 1.
   2.c T3 (blue) will be L1 (120 Vac or 24 Vac) to Valve 2.
   2.d Ground (green) will be earth ground.

ADJUSTMENTS AND FINAL CHECKOUT

The following procedures are related to the adjustments on the main gas valve. For adjustments of the other devices (i.e., pressure switches), refer to the instructions supplied with the applicable device.

WARNING

Fire or Explosion Hazard.

Can cause severe injury, death or property damage.

Only fully qualified, experienced, flame safeguard technicians should make adjustments on the valve.

Pressure Tap Points (Fig. 18)

The V4730C/V8730C/V4734C Valves have a number of connection points (1/8 in. [3 mm] NPT plugs) for measuring pressure and/or mounting a pressure switch. The pressure tap points are:

1 inlet pressure at first SSOV flange tap.
2 inlet pressure at first SSOV.
P outlet pressure at first SSOV.
3 inlet pressure at second SSOV.
4 outlet pressure at second SSOV flange tap.

The following pressures can be measured:

1. Inlet pressure-tap on inlet flange (1).
2. Pressure after inlet screen (2).
3. Unregulated intermediate pressure-pressure between the two shutoff seats (P).
4. Regulated intermediate pressure-pressure between the shutoff valves (3).
5. Outlet pressure-tap from flange (4).

The corresponding numbers (2, P, 3) can be found on the side of the valve.

Note: To mount the C6097 Pressure Switch, refer to instructions in form number 65-0237, furnished with the switch. The pressure switch can be mounted to 2, P, or 3 on either side of the valve.

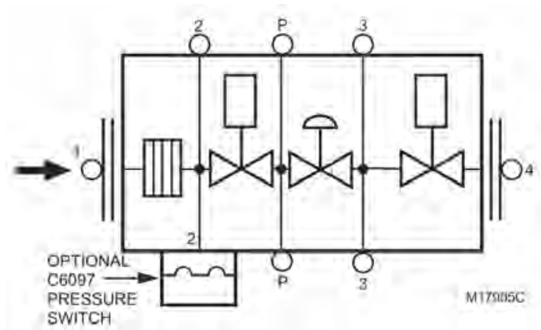


Fig. 18: Pressure tap points

Second Valve, Fast Opening

Flow rate is adjusted from 0% to 100% of full rated flow. To adjust the flow rate:

1. Remove the flat, round, blue plastic cap from the cover. Using a 3 mm (7/64 in.) hex wrench, turn the adjustment screw counterclockwise to increase or clockwise to decrease the flow rate.
2. Snap the flat, round, blue plastic cap back onto the cover.

Final Checkout of the Installation

Set the system in operation after any adjustment is completed and observe several complete cycles to ensure that all burner components function correctly.

OPERATION

The V4730C/V8730C/V4734C are normally closed valves. The valves open when energized and close when power is removed.

WARNING

Explosion and Electrical Shock Hazard. Can cause severe injury, death or property damage.

1. Do not put the system into service until you have satisfactorily completed the Valve Leak Test, all applicable tests described in the Checkout section of the instructions for the flame safeguard control, and any other tests required by the burner manufacturer.
2. All tests must be performed by a trained, experienced, flame safeguard technician.
3. Close all manual fuel shutoff valves immediately if trouble occurs.

After the installation is complete, cycle the valve several times with the manual fuel shutoff valve cock closed. Make sure the valve functions properly. Also, perform the Valve Leak Test before putting the valve into service.

Valve Leak Test (Fig. 19)

This is a test for checking the closure tightness of the gas shutoff valve. It should be performed only by trained, experienced, flame safeguard technicians during the initial startup of the burner system or whenever the valve is replaced. It is recommended that this test should also be included in the scheduled inspection and maintenance procedures. For a periodic inspection test, follow steps 1, 3, 4, 5, 8, 9, 10, 12, 13, 17, and 18.

WARNING

Electrical Shock Hazard. Can cause severe injury or death.

Remove the power from the system before beginning the valve leak test to prevent electrical shock. More than one disconnect may be involved.

1. De-energize the control system to make sure no power goes to the valves.
2. Close the upstream manual gas cock (A).
3. Make sure the manual test petcock (F) is closed in the leak test tap assembly.
4. To test the first SSOV, remove the 1/8 in. (3mm) NPT plug from pressure tap point P.
5. Install the leak test tap into pressure tap point P on the valve body.
6. Open the upstream manual gas cock (A) to repressurize the first SSOV.
7. Immerse the 1/4 in. (6 mm) tube vertically 1/2 in. (13 mm) in a jar of water.
8. Slowly open the manual test petcock (F).
9. When the rate of bubbles coming through the water stabilizes, count the number of bubbles appearing during a ten-second period. Each bubble appearing represents a flow rate of 0.001 cfh (28 cch). See Table 4.
10. Close the upstream manual gas cock (A).
11. Remove the leak test tap from the valve body.
12. Using a small amount of pipe sealant on the 1/8 in. (3 mm) NPT plug, reinstall the plug in pressure tap point P
13. To test the second SSOV, remove the 1/8 in. (3 mm) NPT plug from the flange pressure tap point 4.
14. Install the leak test tap into pressure tap point 4.
15. Close the downstream manual gas cock (E).
16. Energize the first SSOV

Table 4: max. bubbles per pipe size

Pipe Size (in. NPT)	Maximum Seat Leakage (UL)	Maximum Number of Bubbles in 10 seconds
1/2 - 3/4	235 cch	6
1	275 cch	7
1 - 1/4	340 cch	8

17. Immerse the 1/4 in. (6 mm) tube vertically 1/2 in. (13mm) into a jar of water.
18. Slowly open the manual test petcock (F).
19. When the rate of bubbles coming through the water stabilizes, count the number of bubbles appearing during a ten-second period. Each bubble appearing during a 10-second period represents a flow rate of 0.001 cfh (28 cch). See Table 4.
20. De-energize First SSOV
21. Remove the leak test tap from the valve body.
22. Using a small amount of pipe sealant on the 1/8 in. (3 mm) NPT plug, reinstall the plug in pressure tap point 4.

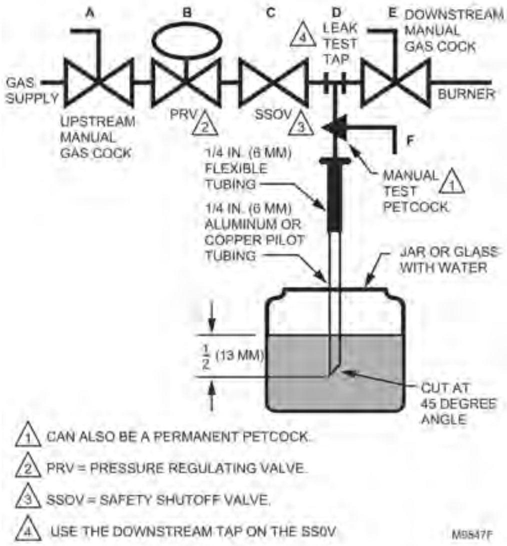


Fig. 19: Valve leak test

After the Test

1. . Make sure the downstream manual gas cock (E) is closed.
2. Open the upstream manual gas cock (A) and energize the valve through the safety system.
3. Test with rich soap and water solution to make sure there is no leak at the test tap (D) or any pipe adapter/valve mating surfaces.
4. De-energize the valve (C).
5. Open the downstream manual gas cock (E).
6. Restore the system to normal operation.

TROUBLESHOOTING

WARNING

Electrical Shock Hazard. Can cause severe injury, death or property damage.

Use extreme caution when troubleshooting; line voltage is present.

IMPORTANT

Do not replace the valve until all other sources of trouble are eliminated.

Troubleshooting Procedure

If the valve does not open when the thermostat or controller calls for heat:

1. Check for voltage at the valve leadwires or terminal block.
2. If there is no voltage at the valve leadwires or terminal block, make sure:
   2.a voltage is connected to the master switch.
   2.b master switch is closed and overload protection (circuit breaker, fuse, or similar device) has notopened the power line.
3. If there is still no voltage at the valve leadwires or terminal block, make sure all appropriate contacts in the thermostat or controller, limits and flame safeguard control are closed. If one or more are open, determine the cause(s); correct the trouble and proceed.
4. If there is proper voltage at the valve but the valve still does not open, check for normal gas pressure.
5. If the valve still does not open, replace the valve.

If the valve does not close when one or more of the appropriate contacts in the thermostat, controller, limits or flame safeguard control is open:

1. Make sure the valve is wired in the correct circuit.
2. Open the master switch to remove power from the valve.
3. If the valve closes now, check the wiring for the valve and correct the wiring as necessary.
4. Check for a short in the electrical circuit and repair it as necessary.

SERVICE INFORMATION

WARNING

Explosion Hazard and Electrical Shock Hazard. Can cause severe injury, death or property damage.

Turn off gas supply and disconnect all electrical power to the valve before servicing.

IMPORTANT

Only trained, experienced, flame safeguard technicians should attempt to service or repair flame safeguard controls and burner assemblies.

Scheduled Inspection and Maintenance

Set up and follow a schedule for periodic inspection and maintenance, including the burner, all other controls and the valves. It is recommended that the valve leak test in the Checkout section be included in this schedule. Refer to the instructions for the primary safety control (s) 0 for more inspection and maintenance information.

Screen/Strainer Replacement

1. Make sure the gas supply is turned off and all electrical power has been removed.
2. Remove bolts/nuts from flange/valve.
3. Remove flange from gas supply pipe.
4. Remove old screen/strainer.
5. Clean the strainer by using compressed air, or replace the strainer.
6. Install the cleaned strainer or new strainer.
7. Make sure O-ring sealing surface is clean on the flange.
8. Using general purpose lithium grease, grease the O-ring.
9. Apply a moderate amount of good quality pipe dope, resistant to the action of LP gas, only on the pipe threads.
10. Install the O-ring in the O-ring groove provided on the flange/valve body (one O-ring per groove).
11. Screw the flange onto the pipe.
12. Mount the gas valve to the flange, using the bolts and nuts for each flange.
13. Apply power to the valve.
14. Turn on the main gas supply.
15. Complete the valve leak test.
16. Return the valve to service.

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EN0H-0281NL05-R1006
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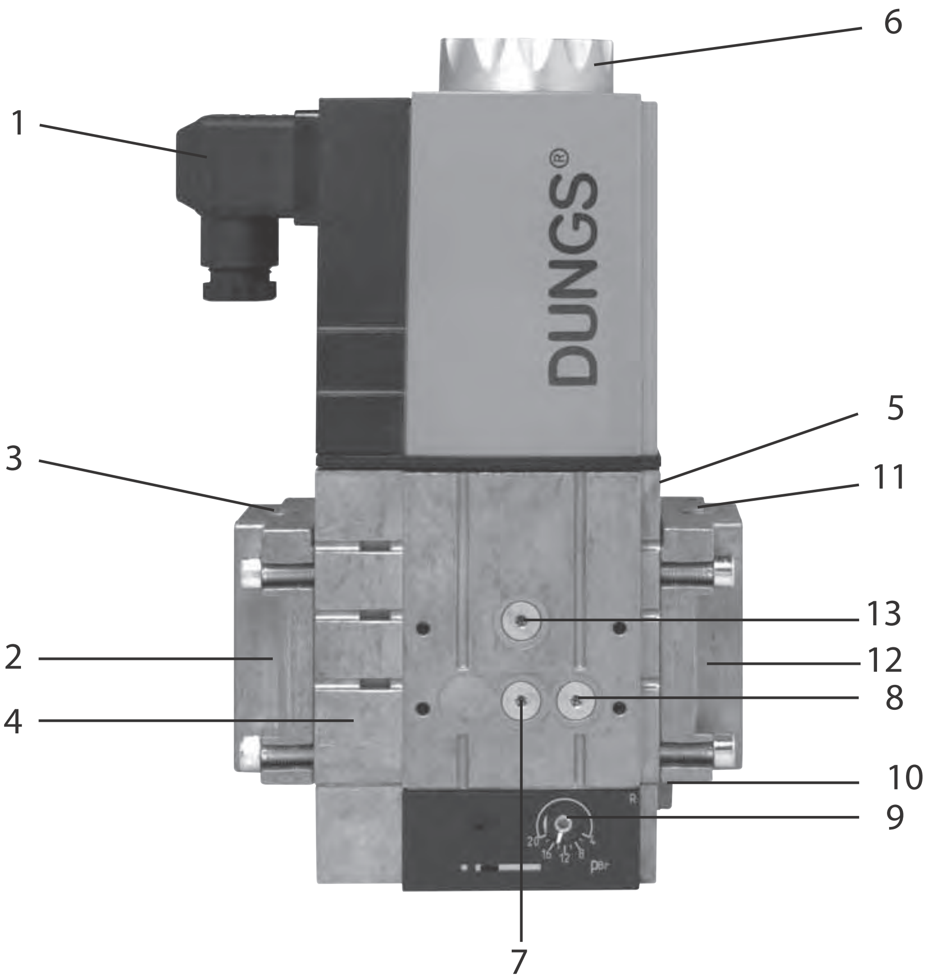
Honeywell

DUNGS Gas Valve (CFC 3300)



1 Electrical DIN connection for valves

2 Input flange

3 Pressure connection upstream of filter

4 Filter

5 Type plate

6 Cover

7 Test point connection upstream of V1, possible on both sides

8 Test point connection downstream of V2 possible on both sides

9 Setting screw for p_{Br} burner pressure

10 Vent nozzle

11 Pressure connection Burner pressure p_{Br}

12 Output flange

13 Test point connection upstream of V1, possible on both sides

Setting the pressure controller

⚠ Pressure controller is provisionally set at the factory. The setting values must be locally adapted to machine conditions. Important: Follow the instructions of the burner manufacturer!

1. Open protective slide.
2. Start burner. Adjustment of setting value only possible in operation, Fig. 1
3. Check ignition reliability of burner.
4. If necessary, repeat settings. Check intermediate values.
5. Seal setting screw, see below.

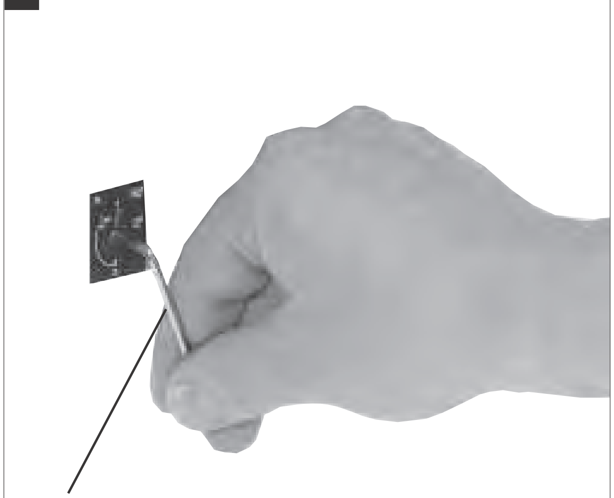
⚠ Ensure optimum combustion and ignition reliability!

Lead seal

After setting the required pressure setpoint:

1. Close protective slide.
2. Secure protective slide closed position with a screw (Fig. 3)

1



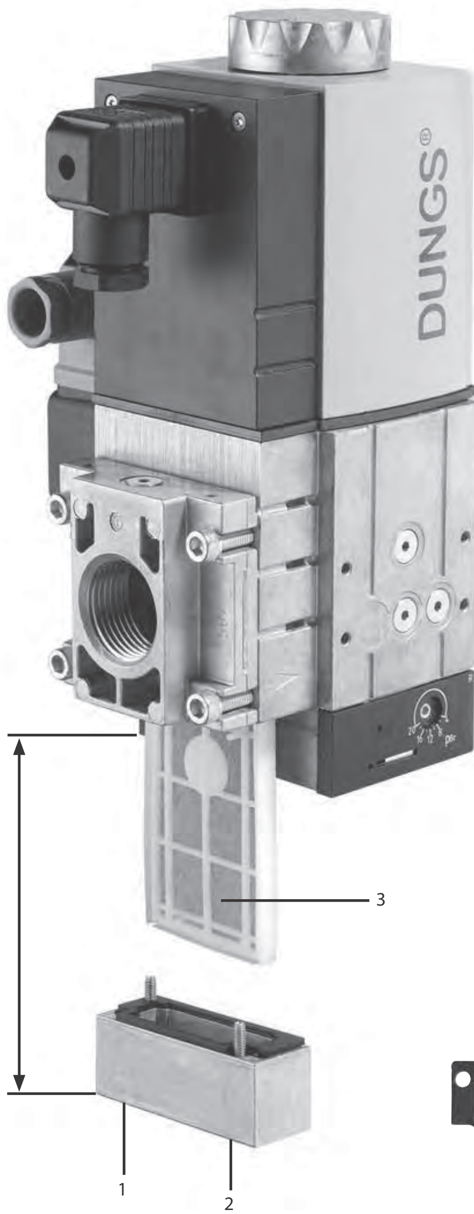
Allen key no. 2.5

2

open

3

closed

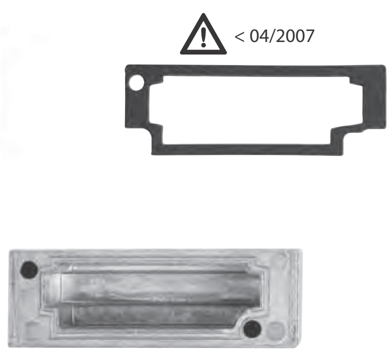


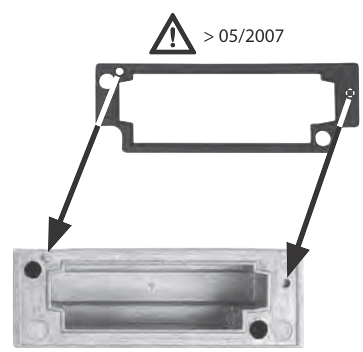
Inspect the filter at least once a year.
Change the filter, if Δp between pressure connections 1 and 2 > 10 mbar.
Change the filter, if Δp between pressure connections 1 and 2 is twice as high compared to the last inspection.

1. Interrupt gas supply: close ball valve
2. Remove screws 1-2
3. Change filter insert 3
4. Screw in screws 1-2 without using any force and fasten.
5. Perform leakage and function test, p_{max} = 360 mbar (5.22 psi)

Space requirements for fitting filter:

MBC-300-...:	150 mm
MBC-700-...:	170 mm
MBC-1200-...:	230 mm





Dungs Gas Valve

Appendix E — CB Falcon Lead Lag Operation

Falcon Lead Lag control provides sequencing and staging for up to 8 boilers using Falcon controllers linked over the Falcon Lead Lag Modbus network. This manual includes:

- **Installation and Startup** instructions for ClearFire boiler lead lag applications.
- **Lead Lag Operation** reference manual containing operation details and in-depth descriptions of Falcon lead lag control algorithms and parameters.
- **Modbus** reference with details on Falcon Modbus setup and implementation, included lead lag network setup, building EMS communications, and Modbus register maps

Before a lead lag control network can be established, individual boilers must be properly installed and commissioned. For information refer to the latest revision of the appropriate boiler manual:

750-263 Model CFC ClearFire Condensing Boiler
750-296 Model CFW ClearFire Hydronic Boiler
750-295 Model CFH Steam Boiler
750-269 Model CFV Vertical Steam Boiler

Review especially the sections pertaining to multiple boiler installations.

See also the latest revisions of:

750-265 Falcon Boiler Control
750-241 Falcon Display/Operator Interface
750-308 Falcon Modbus
750-244 Falcon Program Module (PIM)

INSTALLATION AND STARTUP

1- INTRODUCTION

The Falcon boiler control in conjunction with Cleaver-Brooks' ClearFire line of commercial boilers provides a reliable and efficient solution for facilities requiring a modular, multiple-boiler system. The Falcon is uniquely capable of taking advantage of the ClearFire's characteristic combustion and thermal performance profiles, apportioning the load to individual boilers so as to maximize overall system efficiency.

Figure 1 shows efficiency data for the ClearFire CFC condensing boiler. Note that the CFC operates most efficiently at low fire (20% firing rate). While different model ClearFire boilers will differ somewhat in their operational characteristics, all share a tendency to reach peak efficiencies at lower firing rates. The Falcon lead lag routine uses a modulation scheme based on a user-selectable common base load rate, which when properly configured will provide optimum load response and efficiency for any Model ClearFire lead lag network.

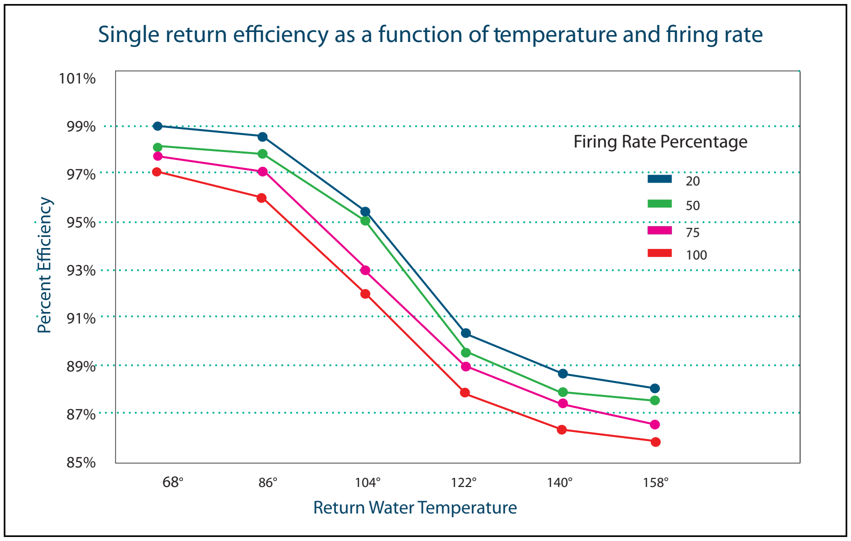


Figure 1 - CFC Efficiencies

2- SYSTEM REQUIREMENTS

Hydronic Systems

- 2-8 boilers equipped with 833-03639 Falcon hydronic controls. *All Falcon controllers in a Lead/ Lag network must have compatible software versions.** To check the software version on a particular Falcon controller, use the touchscreen display and go to Configure>System Identification and Access.
- Modbus network connecting all Falcon boiler controllers in the system.
- System header temperature sensor (required for lead lag operation).
- An outdoor temperature sensor may be connected to an available Falcon sensor input for outdoor reset control (optional).
- 833-03577 display for each boiler.**

A Falcon lead lag kit 880-3670 is available from Cleaver-Brooks and includes a system header temperature sensor with thermowell, outdoor air temperature sensor, and Falcon Program Module for copying parameter settings from one Falcon to another.

* Software version 1987.2432 or later required.
** Software version 1.3.1 or later required (1.4.0 or later for building EMS communication).

Steam Systems

- 2-8 boilers equipped with 833-03578 Falcon steam controls. *All Falcon controllers in a Lead/ Lag network must have compatible software versions.** To check the software version on a particular Falcon controller, use the touchscreen display and go to Configure>System Identification and Access.
- Modbus network connecting all Falcon boiler controllers in the system.
- System header pressure sensor (required for lead lag operation).
- 833-03577 display for each boiler.**

A Falcon lead lag kit (880-3755 for 15# steam or 880-3756 for 150# steam) is available from Cleaver-Brooks and includes a system header pressure transmitter and Falcon Program Module for copying parameter settings from one Falcon to another.

* Software version 3468.2550 or later required.

** Software version 1.4.2 or later required.

3- SPECIFICATIONS

- Maximum length of Modbus network (18 AWG 2-conductor shielded or twisted pair cable): approx. 600 ft (200 m). **NOTE** - terminating resistors may be necessary for long cable runs.
- Lead lag Modbus baud rate: 38400
- EMS Modbus baud rate: user selectable (9600, 19200, 38400)

Refer to appropriate manual for control component environmental specifications.

For more on the Modbus protocol, visit www.modbus-ida.org.

4- FEATURES

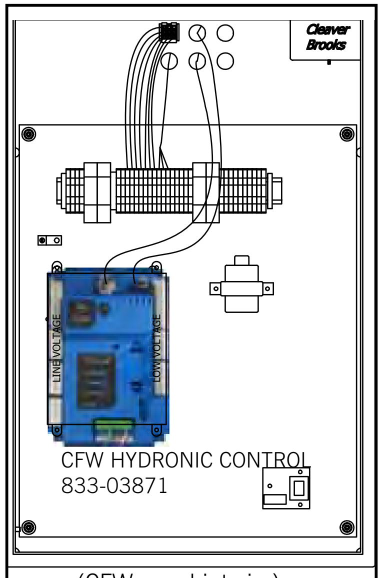
Falcon controllers connected in a lead lag network use the Modbus communication bus to communicate in a ‘Master-Slave’ configuration. The ‘Master’ is a software management service and is ‘hosted’ by one of the Falcon units in the network. *The lead lag Master is not a separate controller* and no additional control panels or devices are required to configure and operate a Falcon lead lag network. The Master is responsible for all high-level system functions including boiler sequencing and staging, pump/valve control, and system PID setpoint control.

- **PID setpoint control** - The lead lag Master uses a proportional-integral-derivative algorithm to maintain system header temperature at a setpoint. Individual boilers are turned on and off as necessary according to the configured sequence and add/drop-stage methods. PID gain settings are user-configurable.
- **Outdoor reset** (hot water systems) - Adjusts the setpoint according to outdoor temperature. Uses an outdoor temperature sensor wired to one of the lead lag slaves’ sensor inputs.
- **Time of day** setpoint (night setback).
- **Remote enable -** system can be enabled from a separate boiler room controller or building energy management system (EMS).
- **Remote setpoint** (hot water)
- **Warm weather shutdown** (hot water) - uses the outdoor temperature and shuts down the lead lag system at a setpoint (plus a 4 deg F hysteresis). Can be programmed to shut down immediately or when current demand for central heat ends.
- **Frost Protection** (hot water) - when an individual slave requires frost protection it notifies the lead lag Master, which will then activate a pump or if necessary fire a burner.
- **Pump control** (hot water) - 3 configurable relays on each Falcon controller can be controlled in conjunction with the lead lag Master.

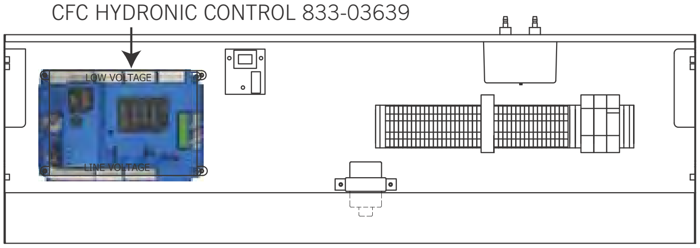
5- PARTS

Controls

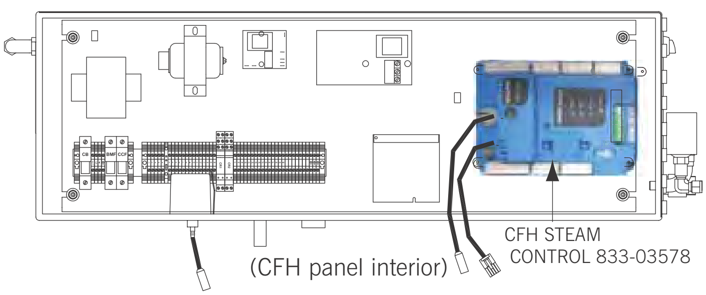
PART NUMBER	DESCRIPTION	
833-03639	FALCON HYDRONIC CONTROL	Model CFC 500-2500
833-04086	FALCON HYDRONIC CONTROL	Model CFC 3300
833-03871	FALCON HYDRONIC CONTROL	Model CFW
833-03578	FALCON STEAM CONTROL	Models CFH/CFV



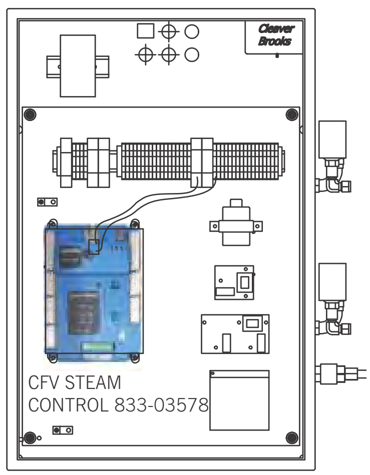
(CFW panel interior)



(CFC control panel interior)



(CFH panel interior)



(CFV Panel Interior)

Display

PART NUMBER	DESCRIPTION
833-05105	FALCON SYSTEM DISPLAY / OPERATOR INTERFACE

Lead Lag Kits

Hydronic (kit number 880-03670):

PART NUMBER	DESCRIPTION
817-04468	TEMPERATURE SENSOR, HEADER SUPPLY, 10K NTC THERMISTOR
817-00405	THERMOWELL
817-04517	OUTDOOR TEMP. SENSOR
833-03640	FALCON PROGRAM MODULE

15# Steam (kit number 880-3755)

PART NUMBER	DESCRIPTION
817-04385	PRESSURE TRANSMITTER*, HEADER SUPPLY, 4-20mA, 2-WIRE, 0-15#
833-03640	FALCON PROGRAM MODULE
854-00011	SIPHON COIL

150# Steam (kit number 880-3756)

PART NUMBER	DESCRIPTION
817-04386	PRESSURE TRANSMITTER*, HEADER SUPPLY, 4-20mA, 2-WIRE, 0-150#
833-03640	FALCON PROGRAM MODULE
854-00011	SIPHON COIL

*1/4” process connection

6- SYSTEM SETUP

Figure 2 shows a basic Falcon lead lag system consisting of a 4-boiler network with remote enable and outdoor air temperature reset.

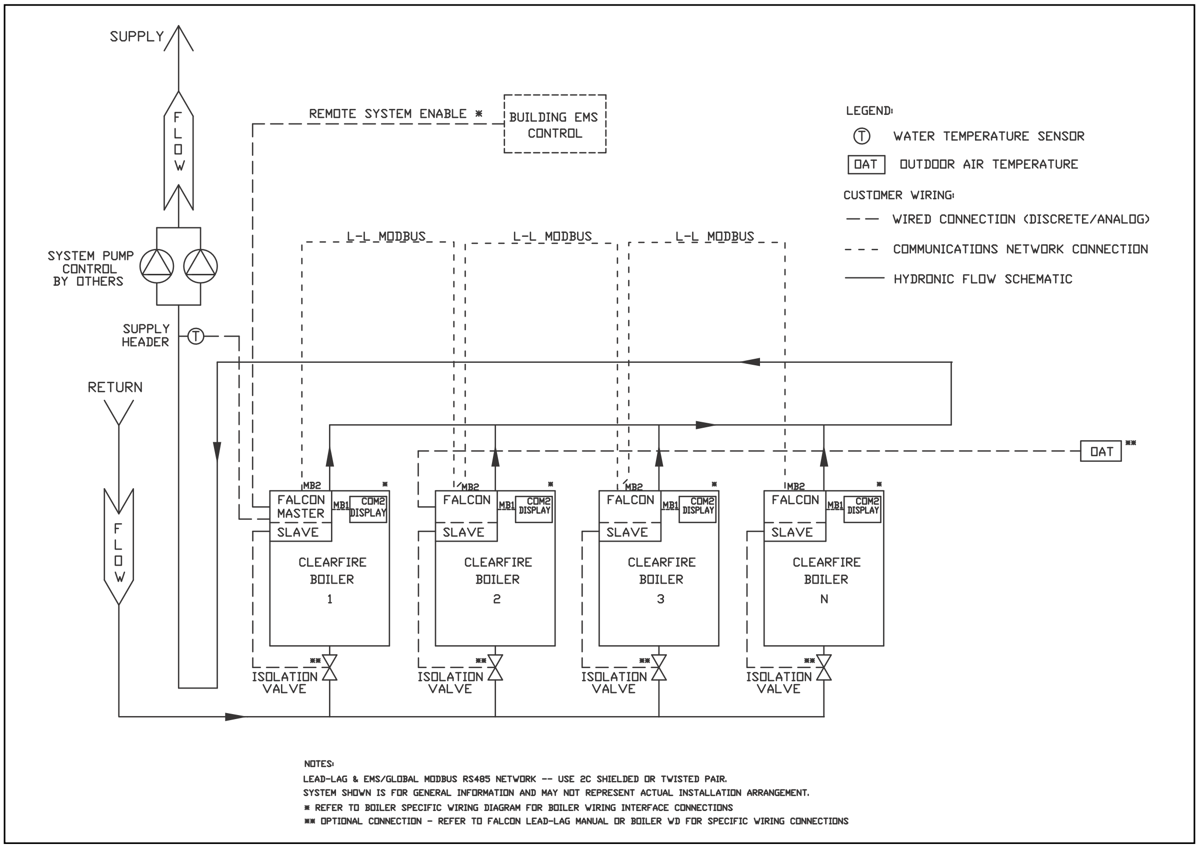


Figure 2 - Four Boiler Lead Lag System

6.1 - Lead Lag Modbus Network

Falcon controllers should be connected in a ‘daisy-chain’ manner (see **Figure 2**) over the **MB2** bus using 18 AWG 2-conductor shielded or twisted pair cable. Connections are made at control panel terminals 39 and 40 (see **Figure 3**) or can be directly landed on the Falcon controller’s MB2 A and B terminals.

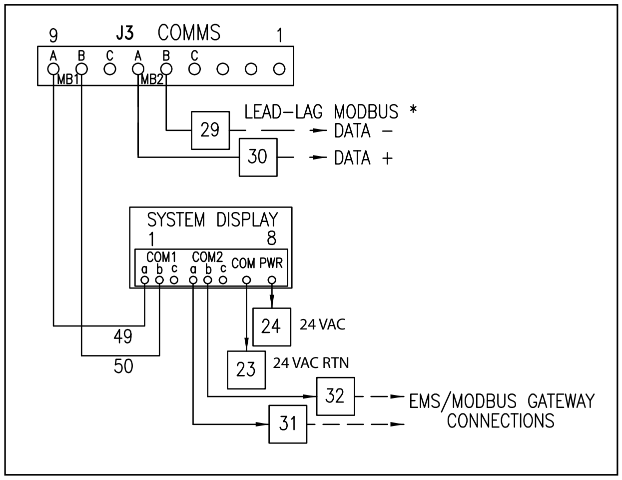


Figure 3 - Falcon communication wiring

6.2 - Header Temperature Sensor (hot water systems)

Determine which boiler will be the lead lag Master host and connect the header temperature sensor to this boiler at the appropriate control panel terminals.

Temperature sensor (hot water): Terminals 35 and 36 (Falcon terminals J8-11 and J8-12; sensor input S5). See **Figure 4a**.

NOTE: refer to specific boiler wiring diagram for proper terminal numbers.

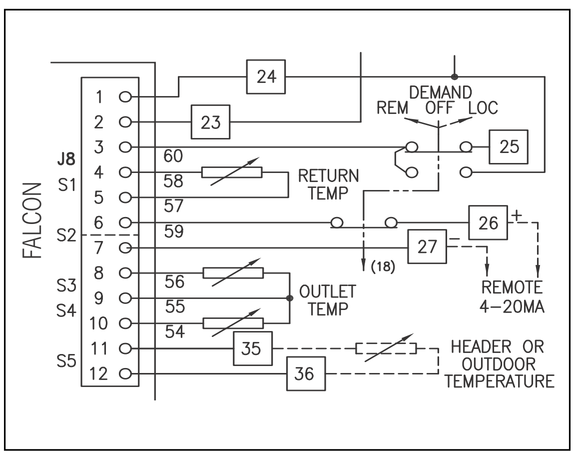


Figure 4a - Header temp. sensor (hydronic)

6.3 - Header Pressure Transmitter (steam systems)

Determine which boiler will be the lead lag Master host and connect the header pressure transmitter to this boiler at the appropriate control panel terminals.

Pressure transmitter (steam) - 2-wire, 4-20mA: Terminals 26 and 28 (Falcon terminals J8-6 and power supply VDC+; J8-7 is jumpered to VDC- see **Figure 4b**).

NOTE: refer to specific boiler wiring diagram for proper terminal numbers.

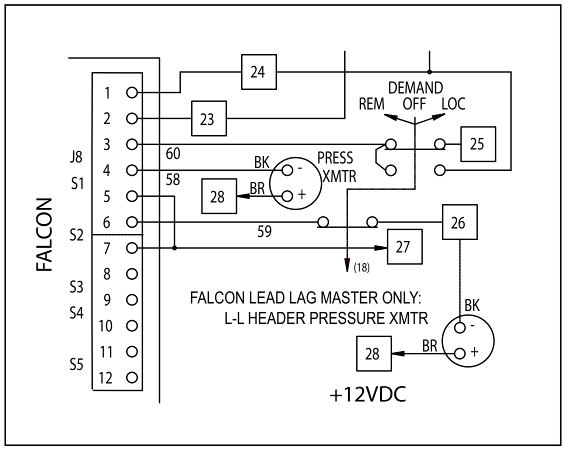
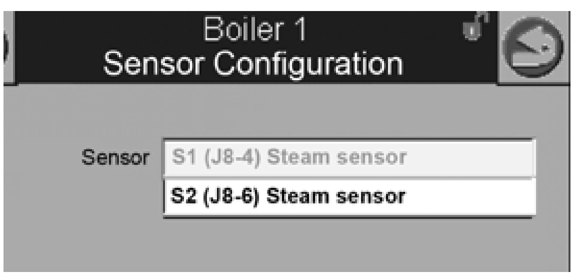
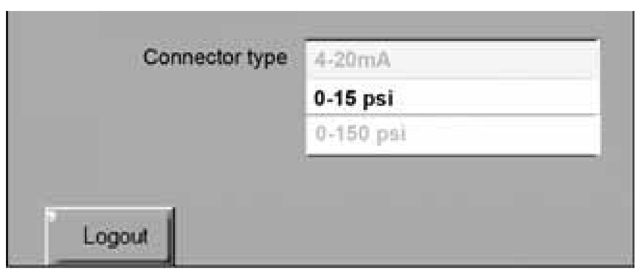


Figure 4b - Header press. transmitter (steam)

Sensor Configuration (steam)

For steam systems the header pressure transmitter input needs to be configured at the Master host. Go to CONFIGURE>Sensor Configuration and from the pull-down menu select **S2 (J8-6)**. For “Connector type” select 0-15 psi or 0-150 psi according to the design pressure of your system. Do *not* use the 4-20mA selection. ***The remote 4-20mA input is unavailable on Falcon steam lead lag systems.***





6.3 - Outdoor Temperature Sensor (optional; hot water only)

The outdoor temperature sensor, if used, may be connected to control panel terminals 35 and 36 on any available boiler in the network (other than the boiler hosting the Master). Once configured, the sensor will be recognized by the lead lag Master.

Sensor Configuration (hot water)

The Outdoor Reset, Warm Weather Shutdown, and Frost Protection routines all make use of the outdoor temperature. To configure the outdoor temperature sensor, go to the boiler that has the sensor connected (see **6.3** above for sensor connection).

1. Starting from the display home page, go to VIEW INDIVIDUAL>CONFIGURE>Sensor Configuration.
2. Under **Outdoor temperature source** Select 'S5 (J8-11) Sensor'.

Once configured, the sensor will be recognized by the lead lag Master over the Modbus network.

6.4 - Connecting to a Building Energy Management System (EMS)

A Falcon lead lag network may be connected to a building EMS by several means:

- **Discrete contact** for remote enable - allows a building EMS to send a remote lead lag system enable signal to the Falcon lead lag Master. To use, connect the signal source to terminals 24 and 25 on the Master host and remove the jumper there. Jumpers may stay in place on the remaining slave boilers.
- **Analog 4-20mA input** for remote setpoint (hot water only) - For remote setpoint operation, connect a 4-20mA set point signal at terminals 26 and 27 on the Master host. Go to lead lag configuration parameters (advanced settings) and under Central Heat parameters change 'Setpoint Source' to S2. Set the Master host boiler's demand switch to REMOTE.
- **Modbus -** The Falcon's Modbus communication capabilities allow the transfer of information between the lead lag network and a building EMS for purposes of remote system monitoring or data acquisition. Connection to the lead lag Modbus network is made at control panel terminals 41 and 42 on each boiler (connected to the Falcon display's COM2 terminals). Refer to specific boiler wiring diagram.

  An additional use of Modbus is for remote enable/remote setpoint operation. These features can be implemented via Modbus as an alternative to using the hard contacts as described above.

  See the appendix to this document for Modbus registers and additional information.

  Also see manual **750-308** Falcon Modbus Communication (included as an appendix to the ClearFire boiler manual) for a complete description of Modbus features.

7- COMMISSIONING

Before commissioning the system, ensure all network wiring and sensor connections have been made according to the above instructions.

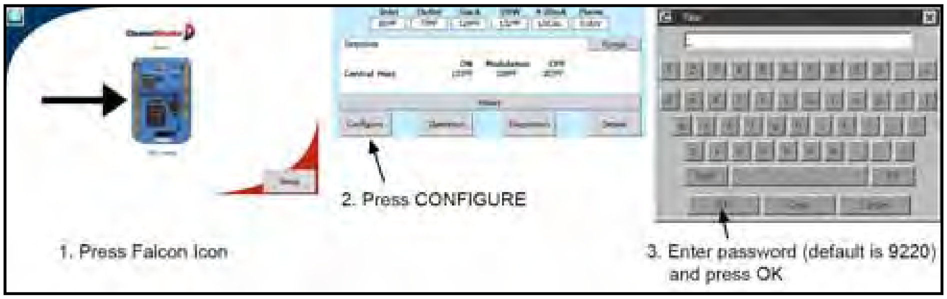
Begin with all boilers' demand switches in the OFF position.

All CC-Blower power switches should be ON.

7.1 - Lead Lag Master Configuration

1. Log in at the Service level on the boiler hosting the lead lag Master (default password is 9220).

Logging in:



2. Go to Lead Lag Master Configuration and make any necessary parameter changes. The first set of parameters shown will be the following:

Master Enable should be left at Disabled for now.

CH (steam) setpoint is the system header temperature (pressure) that the lead lag system will attempt to maintain.

CH (steam) time of day is the setpoint used by the TOD/Night Setback routine, if utilized.

Modbus port should be set to MB2**.** This is the port used by the Falcon Lead Lag Modbus network.

Table 1a - Lead Lag Master Configuration Parameters (Hydronic)

Parameter	Range	CB Default Setting	Installation Setting
Master enable	Enabled Disabled	Disabled	
CH setpoint	-40 to 266 deg F (-40 to 130 deg C)	150 deg F	
CH time of day setpoint	-40 to 266 deg F (-40 to 130 deg C)	120 deg F	
Modbus port	MB1 MB2 No port	MB2	

Table 1b - Lead Lag Master Configuration Parameters (Steam)

Parameter	Range	CB Default Setting	Installation Setting
Master enable	Enabled Disabled	Disabled	
Steam setpoint	0-135 psi	10 psi	
Steam time of day setpoint	0-135 psi	0 psi	
Modbus port	MB1 MB2 No port	MB2	

Remaining lead lag Master parameters are accessed by pressing <ADVANCED SETTINGS> and are shown in Tables 2a (hydronic) and 2b (steam). Use the left and right arrow buttons near the top of the screen to navigate through the parameter menus. Use the scroll bar on the right hand side of the scren to scroll through the parameter lists.

Table 2a - Lead Lag Master Configuration Parameters - Advanced Settings, Hydronic

Parameter	Range	CB Default Setting	Installation Setting
Modulation Parameters			
Modulation backup sensor	Lead outlet sensor Slave outlet sensor average Disabled	Slave outlet sensor average	
Off hysteresis	0 deg F to 234 deg F (-17 deg C to 112 deg C)	15	
On hysteresis	0 deg F to 234 deg F (-17 deg C to 112 deg C)	5	
Hysteresis step time	hr min sec	0 min	
P gain	0-400	10	
I gain	0-400	15	
D gain	0-400	0	
Central Heat Parameters			
Demand switch	Stat Terminal Remote Stat Disabled	Stat Terminal	
Setpoint source	Local 4-20mA	Local	
Setpoint	-40 deg F to 266 deg F (-40 deg C to 130 deg C)	150	
Time of day setpoint	-40 deg F to 266 deg F (-40 deg C to 130 deg C)	120	
4mA water temperature	-40 deg F to 266 deg F (-40 deg C to 130 deg C)	80	
20mA water temperature	-40 deg F to 266 deg F (-40 deg C to 130 deg C)	180	
Outdoor reset	Enabled Disabled	Disabled	
Frost Protection Parameters			
Frost protection enable	Enabled Disabled	Disabled	
Outdoor frost protection setpoint	-40 deg F to 266 deg F (-40 deg C to 130 deg C)	32 deg F	
Frost protection rate	%	20%	
Warm Weather Shutdown Parameters			
Warm weather shutdown enable	Enabled	Disabled	
Warm weather shutdown setpoint	-40 deg F to 266 deg F (-40 deg C to 130 deg C)	100 deg F	
Algorithms Parameters			
Lead selection method	Sequence order Measured run time	Sequence order	
Lag selection method	Sequence order Measured run time	Sequence order	
Lead rotation time	day hr min	120 hrs	
Force lead rotation time	day hr min	168 hrs	
Rate Allocation Parameters			
Base load common	0-100%	45%	
Add Stage Parameters			
Add stage method	Error threshold Firing rate threshold Disabled	Firing rate threshold	
Add stage detection time	hr min sec	3 min	
Error threshold	0 deg F to 234 deg F (-17 deg C to 112 deg C)	5 deg F	
Rate offset	E%	0%	
Add Stage interstage delay	hr min sec	10 min	
Drop Stage Parameters			
Drop stage method	Error threshold Firing rate threshold	Firing rate threshold	
Drop stage detection time	hr min sec	3 min	
Error threshold	0 deg F to 234 deg F (-17 deg C to 112 deg C)	10 deg F	
Rate offset	E%	-3%	
Drop stage interstage delay	hr min sec	10 min	

Table 2a - Lead Lag Master Configuration Parameters - Advanced Settings, Hydronic (Continued)

Boiler off options		Disabled	
All boilers off threshold	deg F	210	

Table 2b - Lead Lag Master Configuration Parameters - Advanced Settings, Steam

Parameter	Range	CB Default Setting	Installation Setting
Modulation Parameters			
Modulation sensor	S1 (J8-4) Steam Sensor S2 (J8-6) Steam Sensor	S2 (J8-6) Steam Sensor	
Off hysteresis	psi	5	
On hysteresis	psi	0	
Hysteresis step time	hr min sec	0 sec	
P gain	0-400	10	
I gain	0-400	25	
D gain	0-400	0	
Steam Parameters			
Demand switch	Stat Terminal Mod Sensor Disabled	Stat Terminal	
Setpoint source	Local 4-20mA - ***Not compatible with Falcon steam lead lag.***	Local	
Setpoint	0-135 psi	10	
Time of day setpoint	0-135 psi	0	
Algorithms Parameters			
Lead selection method	Sequence order Measured run time	Sequence order	
Lag selection method	Sequence order Measured run time	Sequence order	
Lead rotation time	day hr min	120 hrs	
Force lead rotation time	day hr min	168 hrs	
Rate Allocation Parameters			
Base load common	0-100%	75%	
Add Stage Parameters			
Add stage method	Error threshold Firing rate threshold Disabled	Firing rate threshold	
Add stage detection time	hr min sec	3 min	
Error threshold	0 deg F to 234 deg F (-17 deg C to 112 deg C)	5 deg F	
Rate offset	E%	0%	
Add Stage interstage delay	hr min sec	10 min	
Drop Stage Parameters			
Drop stage method	Error threshold Firing rate threshold	Firing rate threshold	
Drop stage detection time	hr min sec	2 min	
Error threshold	psi	3 psi	
Rate offset	E%	-3%	
Interstage delay	hr min sec	5 min	

Modulation backup sensor (hot water) - this parameter determines the setpoint source ('backup sensor') in the event of a header temperature sensor failure. If **Disable** is selected then no backup will be used. If **Lead Outlet** is selected then the outlet temperature of the lead boiler will be used as the backup during firing. If

Slave Outlet Average is selected then average of the outlet temperatures of all slave boilers that are firing will be used as a backup.

Modulation sensor (steam) - choices are **S1 (J8-4)** and **S2 (J8-6).** Default is **S2**, the system header pressure transmitter. In the event of a header pressure transmitter failure, the local transmitter (**S1**) can be configured as the lead lag modulation sensor.

Note that in steam systems the modulation backup source must be manually configured. In hydronic systems this selection will be made automatically based on the settings in **Modulation backup sensor** above.

On, Off hysteresis - The LL hysteresis values apply to all setpoint sources. The behavior of the hysteresis function is identical to the behavior of the stand-alone hysteresis function, except:

- Where stand-alone hysteresis uses the on/off status of a single boiler, the LL hysteresis uses the on/off status of all slave boilers: this status is true if any slave boiler is on, and false only if all are off.
- Where stand-alone hysteresis uses time of turn-on and turn-off of a single boiler, the LL hysteresis uses the turn-on of the first slave boiler and the turn-off of the last slave boiler.

PID gain - The behavior of the lead lag PID function is identical to the behavior of the stand-alone PID function. The same gain scalers and algorithms are used.

Demand Switch - Selects the input for CH (steam) demand. If set to **Disable**, the LL master does not respond to a demand.

Setpoint Source - Selectable between **Local** and **S2 4-20mA** for remote setpoint operation (hot water only; see **6.4** above).

4mA/20mA Water Temperature (hot water only) - Defines the temperature range if **S2 4-20mA** selected as setpoint source.

Outdoor Reset (hot water only) if enabled uses the current outdoor temperature to determine setpoint (outdoor temperature sensor required; see **7.5** and **7.6** below).

Frost Protection (hot water only) is active when enabled and outdoor temperature is below the **Outdoor frost protection setpoint.** If any slave indicates frost protection required, the Master will turn on any pumps that are enabled for frost protection, and may additionally fire the current lead burner at the **Frost protection rate**.

Lead lag selection method and **rotation time** together determine the sequence order of boilers.

Base load common - This is the firing rate threshold used for adding stages. If set to zero, this parameter is disabled.

As demand increases, until all boilers are firing none will be requested to exceed the base load common rate. Similarly, as demand decreases no boilers will be dropped until the load can be met by remaining boilers firing at or below the base load rate.

The staging parameters (**Add/Drop stage method**, **detection time**, and **interstage delay**; **error threshold, rate offset**) together determine, based on demand, when a boiler in the sequence will be requested to turn on or off.

7.3 - Lead Lag Slave Configuration

It will be convenient to remain at the Master host boiler to configure the unit as a Slave (recall that the lead lag Master is a communication function and not a separate controller - the Falcon hosting the Master must also be configured as a Slave in order to be available to the lead lag network).

1. Go to CONFIGURE>Lead Lag Slave Configuration.

2. Available parameters are shown in Table 3. Make any necessary changes at this time.

Table 3 - Lead Lag Slave Configuration Parameters

Parameter	Range	CB Default Setting	Installation Setting
Slave enable	Enable slave for built-in Lead Lag master Enable slave for third party Lead Lag master Disabled	Disabled	
Slave mode	Use first Use last Equalize run time	Equalize run time	
Base load rate	ignored		
Slave sequence order	0-8	0 (= use Modbus address)	
Demand to firing delay	hr min sec	3 min	
Fan rate during off cycle	0-6500 RPM	0	
Modbus port	MB1 MB2 No port	MB2	
Modbus address	1-8	1	

Slave enable should be set to 'Enable slave for built-in Lead Lag master'. The 'Enable slave for third party' setting is for use with external (non-Falcon) control.

Some Falcon versions may indicate 'Slave' and 'Modbus Slave' as the choices for this parameter. In this case select 'Slave' (NOT 'Modbus Slave').

Slave mode - If set to **Use First**, this boiler will be used prior to any with other values. If set to **Equalize Runtime**, then this boiler will be staged according to a run time equalization algorithm (any boilers set to Use First will precede any that are set to Equalize Run Time). If set to **Use Last**, then this boiler will be used only after all Use First and Equalize Runtime boilers have been brought online.

Slave sequence order - if set to 0 will use this Slave's Modbus address.

Demand to firing delay - This delay time is needed by the LL master to determine the length of time to wait between requesting a Slave to fire and detecting that it has failed to start. It should be set to the total time normally needed for the burner to transition from Standby to Run, including such timers as transition to purge rate, prepurge time, transition to lightoff rate, all ignition timings, and some extra margin.

Fan rate during off cycle - This determines if or at what rate the fan is to operate during the standby period. It may be advisable in some installations to set this parameter so as to prevent flue gas from entering the boiler room through an idle boiler.

Modbus port is MB2.

Modbus address This will eventually need to be set to a unique address on each slave boiler. This can be done after copying parameters to all slaves (see **7.4** below).

7.4 - Copying parameters to remaining slaves

The procedure below will copy the first slave's parameter set to remaining slaves. See also 750-244 PIM manual.

1. Remove the Program Module slot cover from the Master host controller and insert a Falcon 833-3640 Program Module ('PIM' or 'PM'). See **Figure 1**.

Figure 1 - Loading a PIM

2. From the Home page go to SETUP> PROGRAM MODULE.
3. Press <Backup Parameters>. The display will indicate when uploading is complete. When finished, remove the PIM and replace the cover.
4. Insert the PIM in the next boiler to be configured.
5. Go to the boiler’s Program Module Configuration screen (SETUP> PROGRAM MODULE).
6. Press <Restore Parameters>. A warning will be displayed:

> WARNING! This operation replaces all NON-SAFETY configuration parameters in the control with those from the PM. SAFETY PARAMETER SETTINGS ARE NOT CHANGED BY THIS RESTORE. Are you sure you wish to continue?

7. Press <Yes> to continue. The **Status** line on the PIM configuration screen will indicate when parameter writing is complete. If the parameter set being downloaded is from a different Falcon firmware version, it is possible that not all available parameters will be restored. This is normal. When finished, remove the PIM and replace the cover.
8. Repeat steps 4-7 with the remaining boilers.
9. **IMPORTANT** - after parameterizing all boilers, remember to give each one a unique Modbus address. **Each boiler’s MB1 and MB2 addresses must be the same.** To change the Modbus address:

   Starting from the Home page, go to VIEW INDIVIDUAL>Configure>System Identification and Access. Scroll down to Modbus addresses. If two addresses are displayed (MB1 and MB2) ensure that BOTH are set to the desired address for this boiler. If only one Modbus address is shown, set it to the desired address.

Note: Each boiler in a Falcon lead lag network must have a unique Modbus address.

Note: The MB1 and MB2 addresses for each individual boiler must be the same.

Caution

After cloning parameters with the PIM: If using boilers of different sizes/models, it will be necessary to reset the min/max modulation speed settings.

Once the lead lag Master host has been configured and enabled, an additional pushbutton <VIEW LEAD LAG>/<VIEW INDIVIDUAL> will appear on the touchscreen home page of the Master and any configured slaves. On the Master host boiler, this button toggles between two display menu paths: one for the individual boiler and one for the lead lag system. On remaining slave boilers, <VIEW LEAD LAG> shows that boiler's lead lag status and the active service only.

7.6 - Enable Master

When all slaves have been enabled and configured, go to the Master host and under Lead Lag Master Configuration change **Master Enable** to 'Enabled'.

7.7 - Outdoor Reset Configuration (hot water only)

Before the Outdoor Reset feature can be used, the outdoor temperature sensor must be connected to a slave boiler on the lead lag network and configured.

Outdoor reset parameters are configured on the **lead lag Master host**. Starting from the Home page on the Falcon Master host, go to the Lead Lag Master configuration group, then go to <Advanced Settings>.

The example below shows how a given set of parameter values determines an outdoor reset curve. In the example:

Minimum outdoor temperature = 0 deg F
CH setpoint = 180 deg F
Maximum outdoor temperature = 80 deg F
Low water temperature = 70 deg F

The end points (x_1, y_1) and (x_2, y_2) of the ODR curve are defined by (x_1= MIn. OD Temp., y_1 = Setpoint) and (x_2 = Max. OD Temp., y_2 =Low Water Temp,)

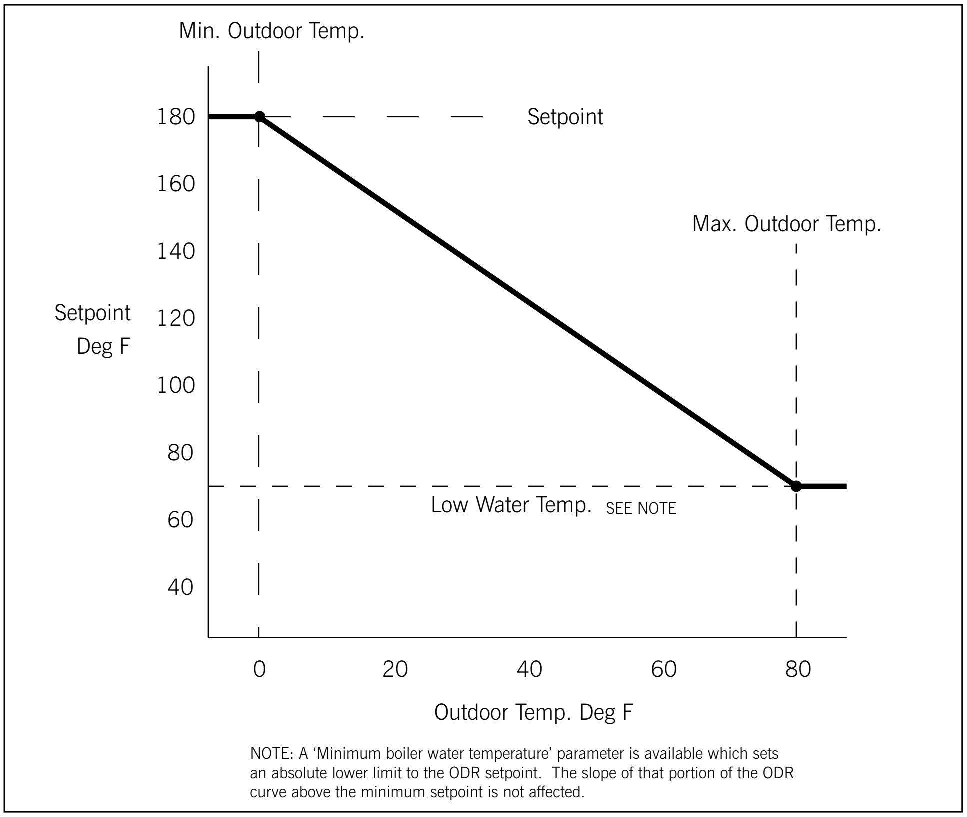


Figure 2 - ODR Curve

To view the currently programmed ODR curve, press <Show Line> on the ODR configuration screen.

Additional parameters are available for Time of Day setpoint and boost; see Lead Lag Operation reference manual for a full description.

8- STARTUP

To start the lead lag system:

1. Turn all boiler demand switches to LOCAL.
2. On the Master host boiler home page press VIEW LEAD LAG>Lead Lag Master to access the Lead Lag Operation screen. Turn the <Lead Lag Operation> screen switch ON.

The system should now start when a demand is present.

9- MONITORING SYSTEM PERFORMANCE

Press <VIEW LEAD LAG> to view the lead lag Home page.

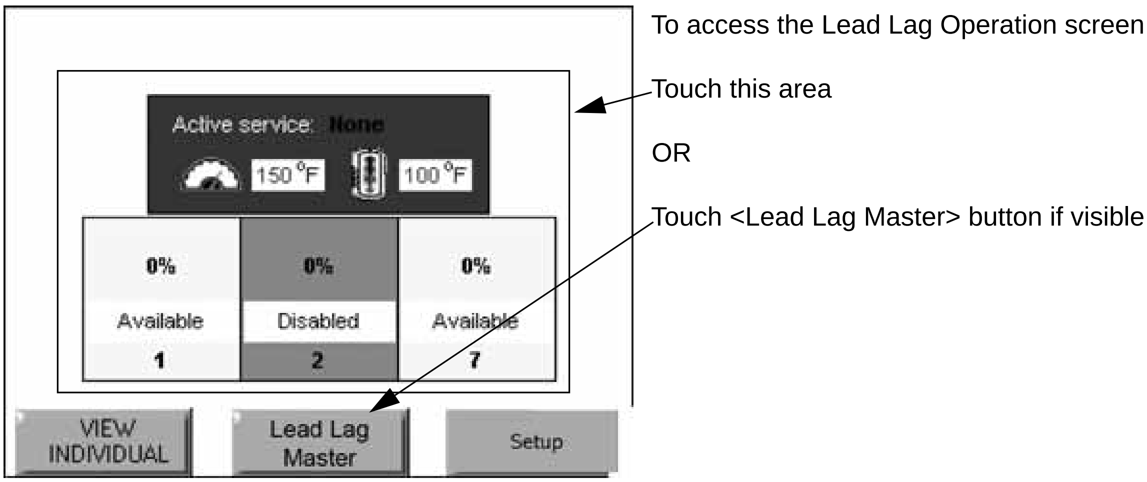


Figure 3 - Lead Lag Home Page

This page shows the system setpoint, actual header temperature, and status of each slave boiler.

The possible Slave states are:

- **Available** - boiler is ready to use but is not currently firing.
- **AddStage** - stage is getting ready to fire.
- **SuspendStage** - stage was getting ready but is not needed.
- **Firing** - boiler is currently firing.
- **OnLeave** - boiler is operating for some other demand source having higher priority than LL Slave.
- **Disabled** - boiler is locked out or disabled in some way.
- **Recovering** - slave is in time delay before becoming available.

If the state of any slave is **Unknown** it will be removed from the display.

Note: If during operation an alert 'NO SLAVES AVAILABLE FOR LEAD LAG' occurs:

While not a lockout condition, **this alert will close the alarm contact in the Master host.** The alarm can only be reset at the Master host controller by opening the panel and pressing the RESET button on the Falcon controller.

The Falcon has extensive diagnostic features for monitoring individual boiler and system lead lag performance, including alert/lockout history and real-time data trending. Refer to the boiler manual and to the Falcon controller and display manuals for additional information.

10-EXAMPLE SYSTEMS

Figure 4 through **Figure 8** show piping and network wiring for some typical lead lag network configurations. *Systems shown are examples only.* Actual installations may vary.

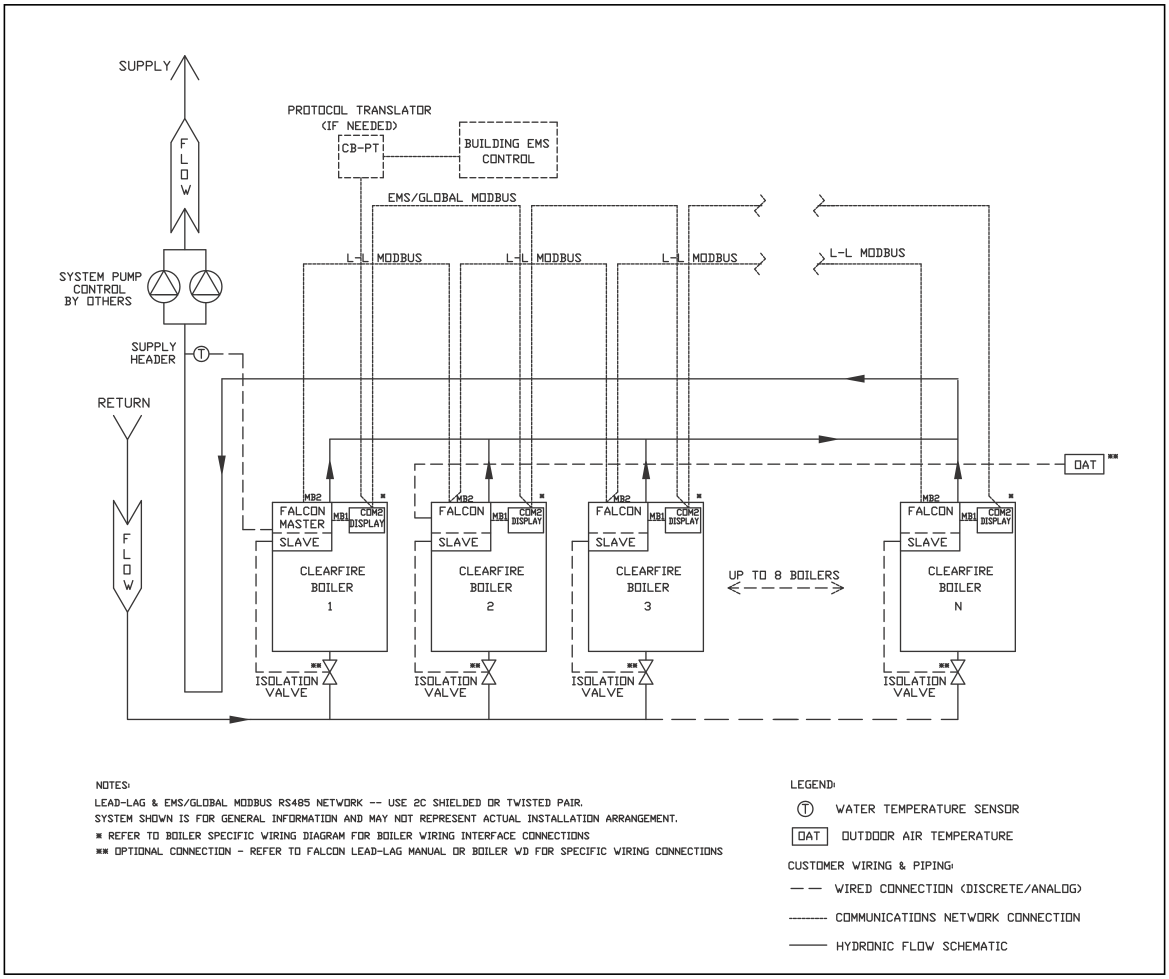


Figure 4 - Falcon Lead Lag with outdoor reset and EMS for remote comms/monitoring

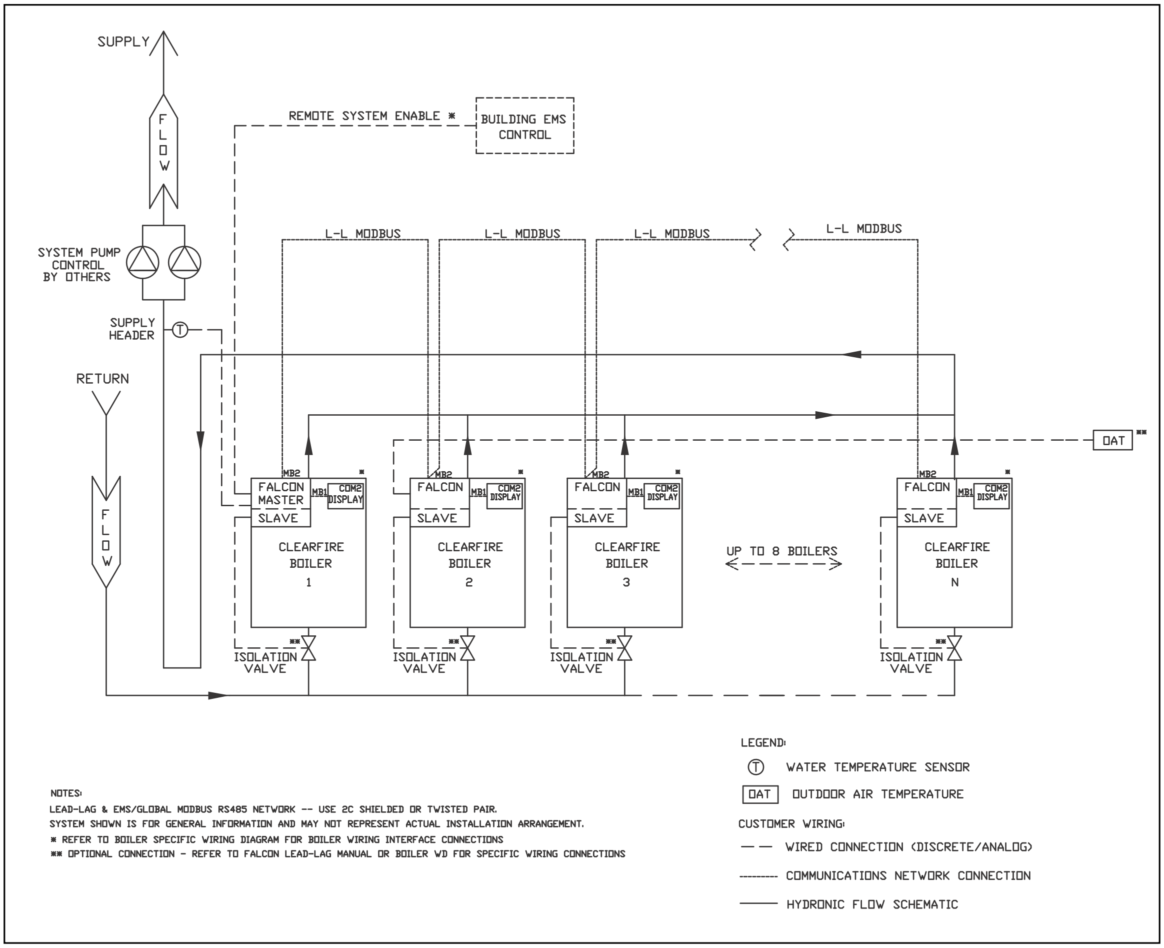


Figure 5 - Falcon Lead Lag with outdoor reset and EMS for remote enable

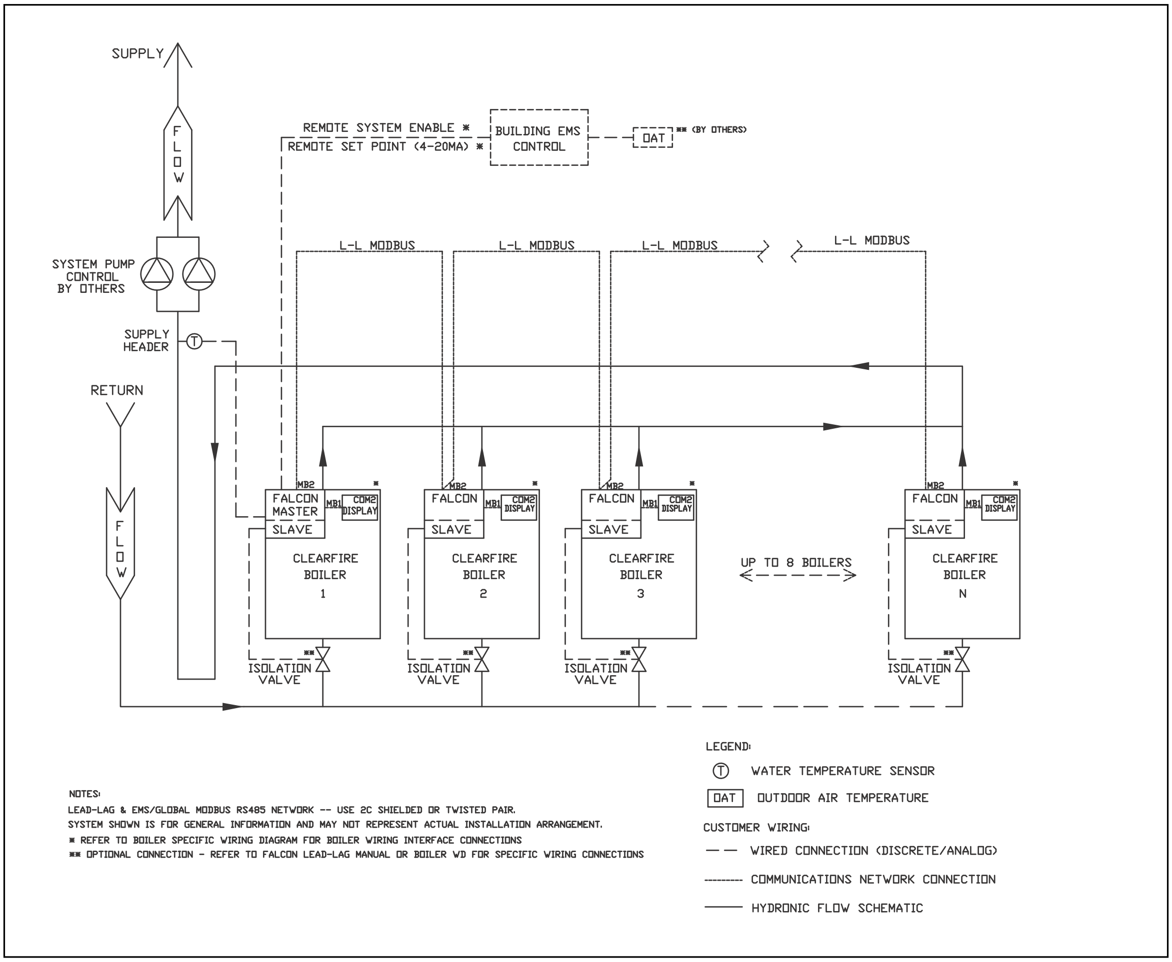


Figure 6 - Falcon LL with EMS for remote enable/remote setpoint

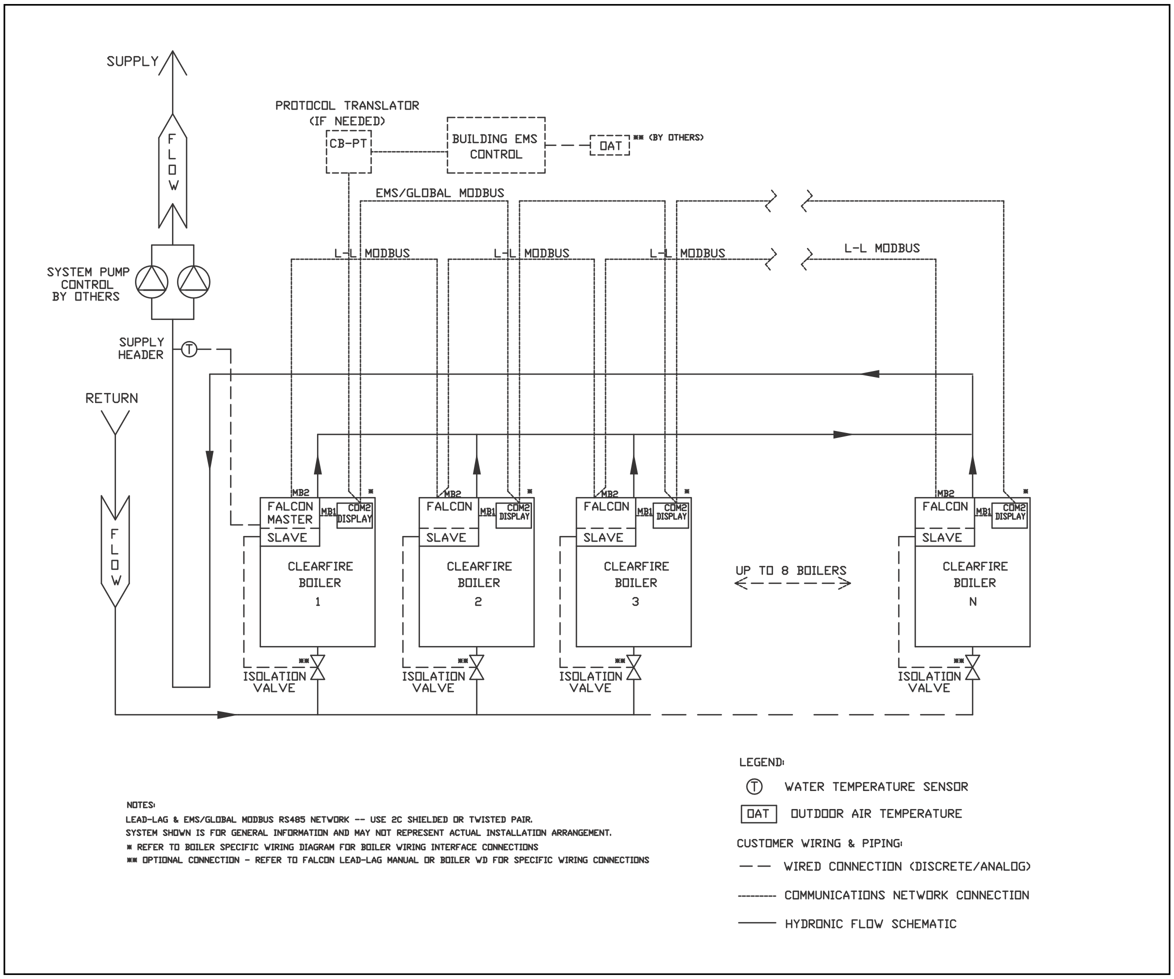


Figure 7 - Falcon Lead Lag with EMS for remote comms/monitoring

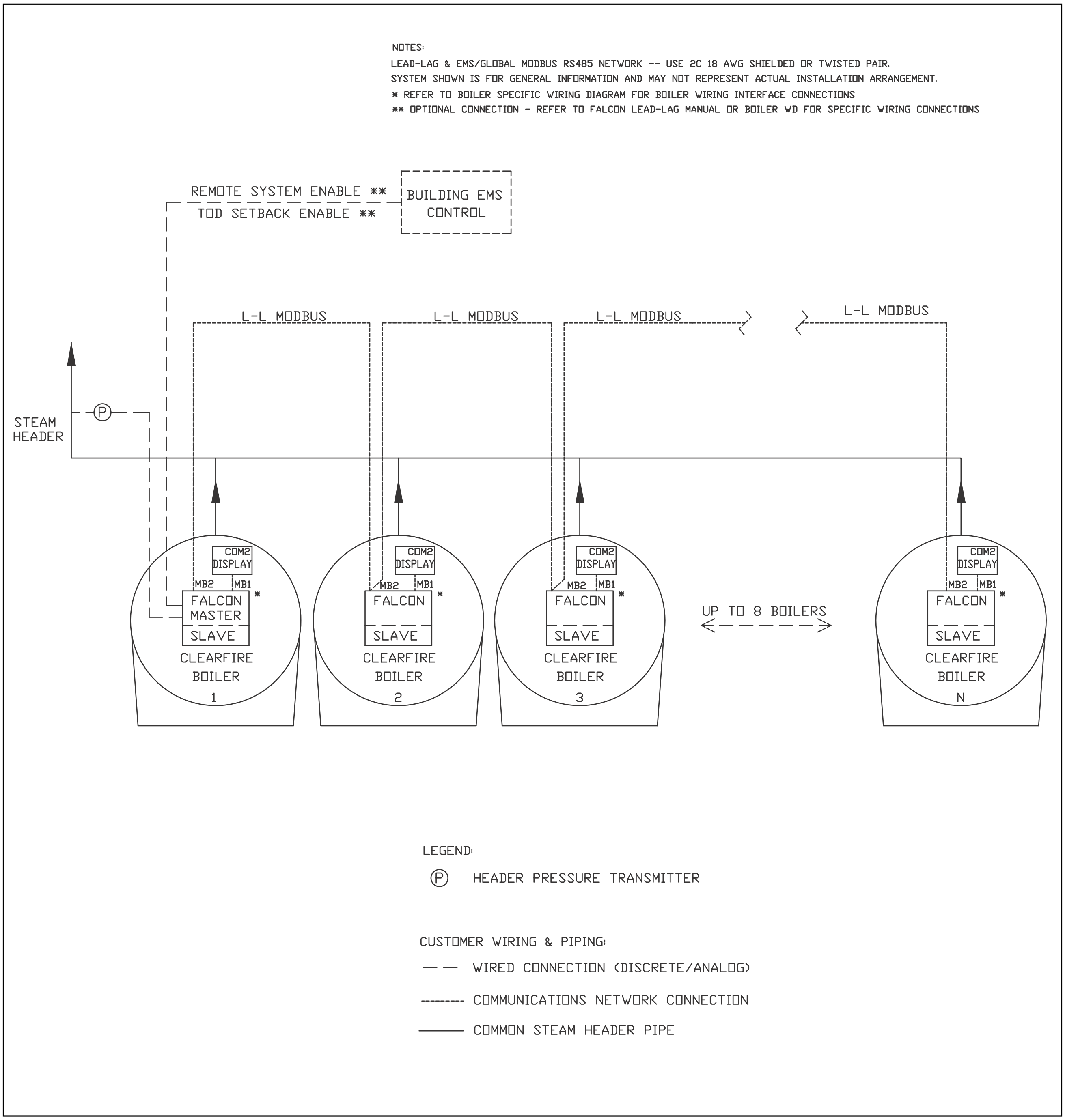


Figure 8 - Typical Steam System

11-EXAMPLE HYDRONIC PIPING DIAGRAMS

Figure 9 through **Figure 12** below show some typical hydronic systems. Examples of Pump Control Block (PCB) parameters for these and other systems can be found in **Figure 13** through **Figure 18**.

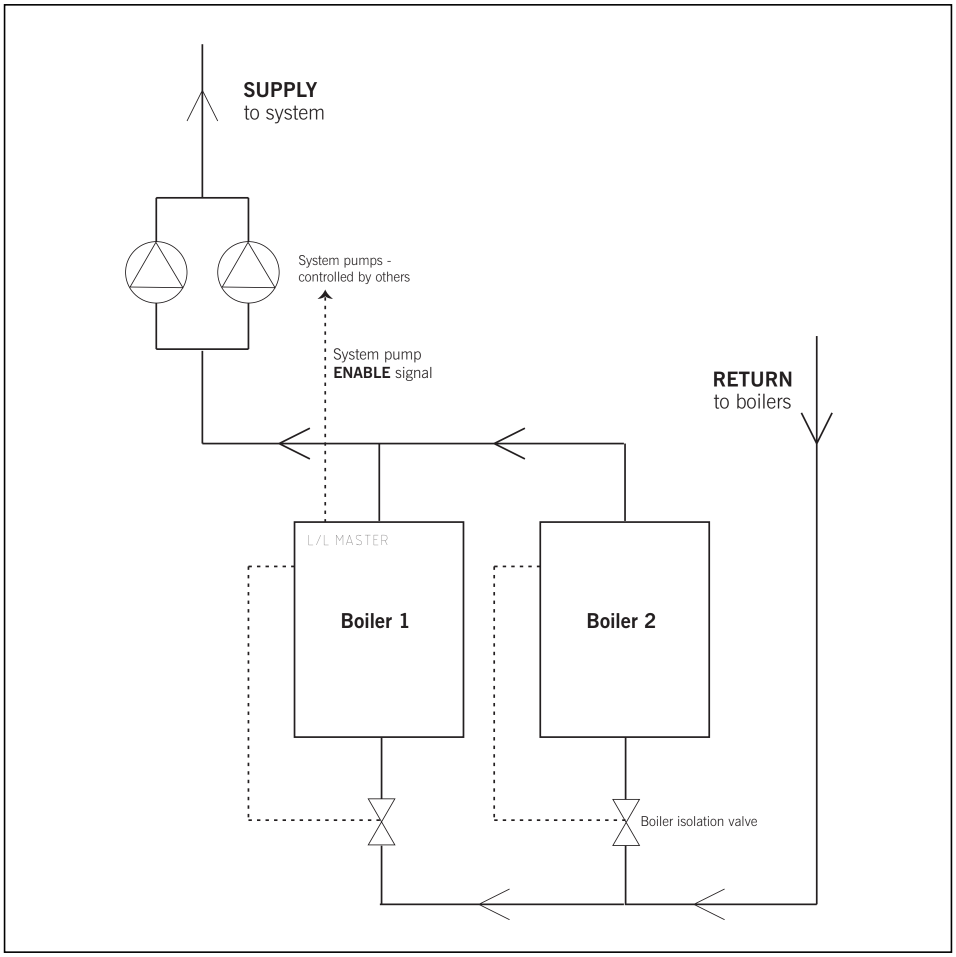


Figure 9 - Primary Pumping

Isolation Valve Control

At each Slave use Aux 1 Pump control block for isolation valve control (see **Figure 17**). Assign to Pump B relay. Also assign Boiler Pump control block (see **Figure 14)** to Pump B relay. Wire isolation valve open/close to Falcon Pump B relay terminals.*

System Pump Enable (optional)

At Master, use System Pump enable (**Figure 13**).** Assign Pump C. Wire pump enable to Falcon Pump C relay terminals.

*This configuration will ensure that as long as Falcon Lead Lag is enabled, the lead boiler isolation valve will remain open. When Lead Lag is disabled, any programmed overrun times will continue for their full duration.

**Falcon Lead/Lag control sends *only* an Enable signal to the system pumps. Any system pump operational control (pump lead lag, standby, rotation, etc.) is by others.

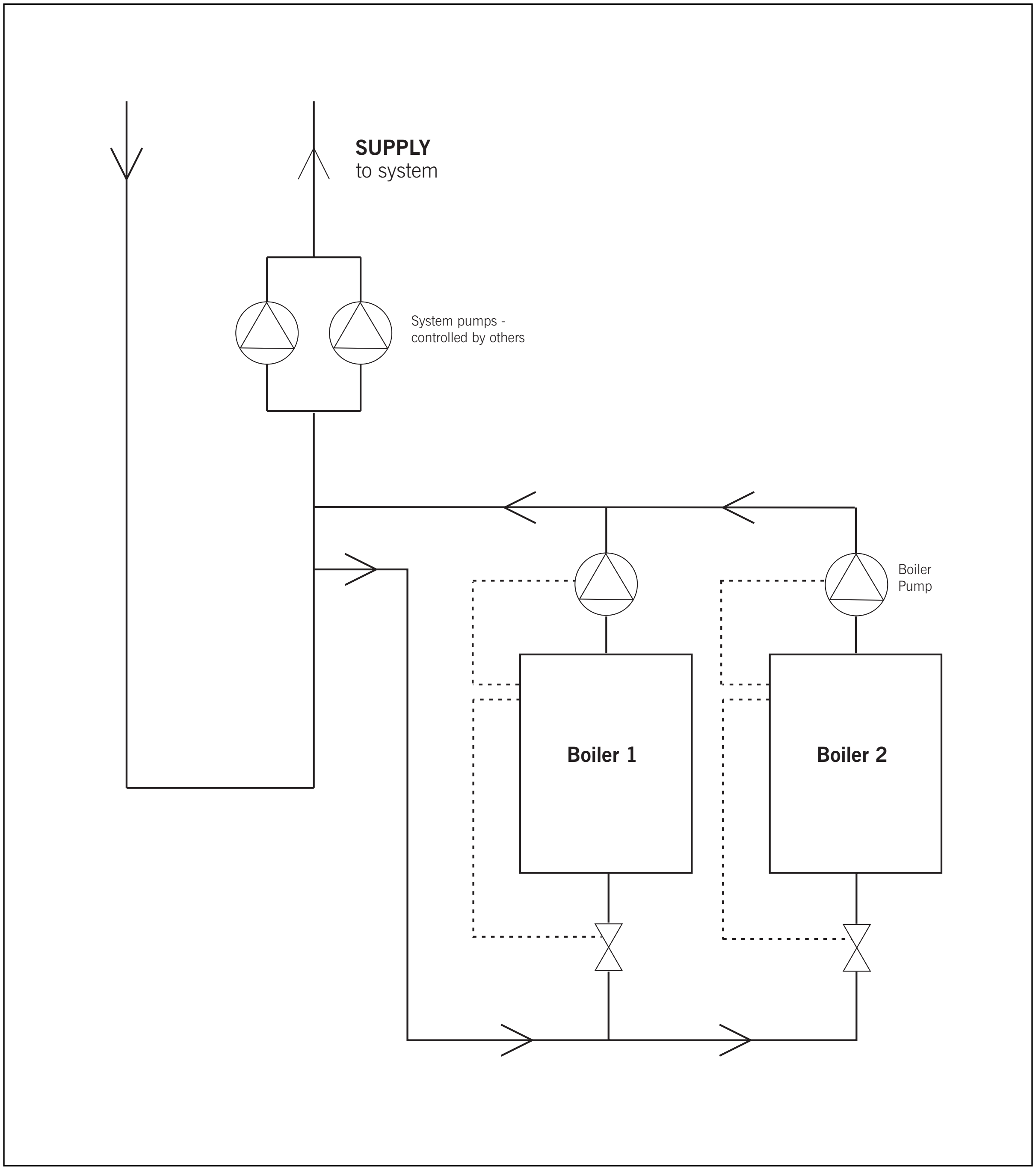


Figure 10 - Primary/Secondary Piping

At each slave:

Use Boiler Pump control block (**Figure 14**) - assign to Pump B relay.

Use Aux 1 Pump (**Figure 17**) - assign to Pump C relay.

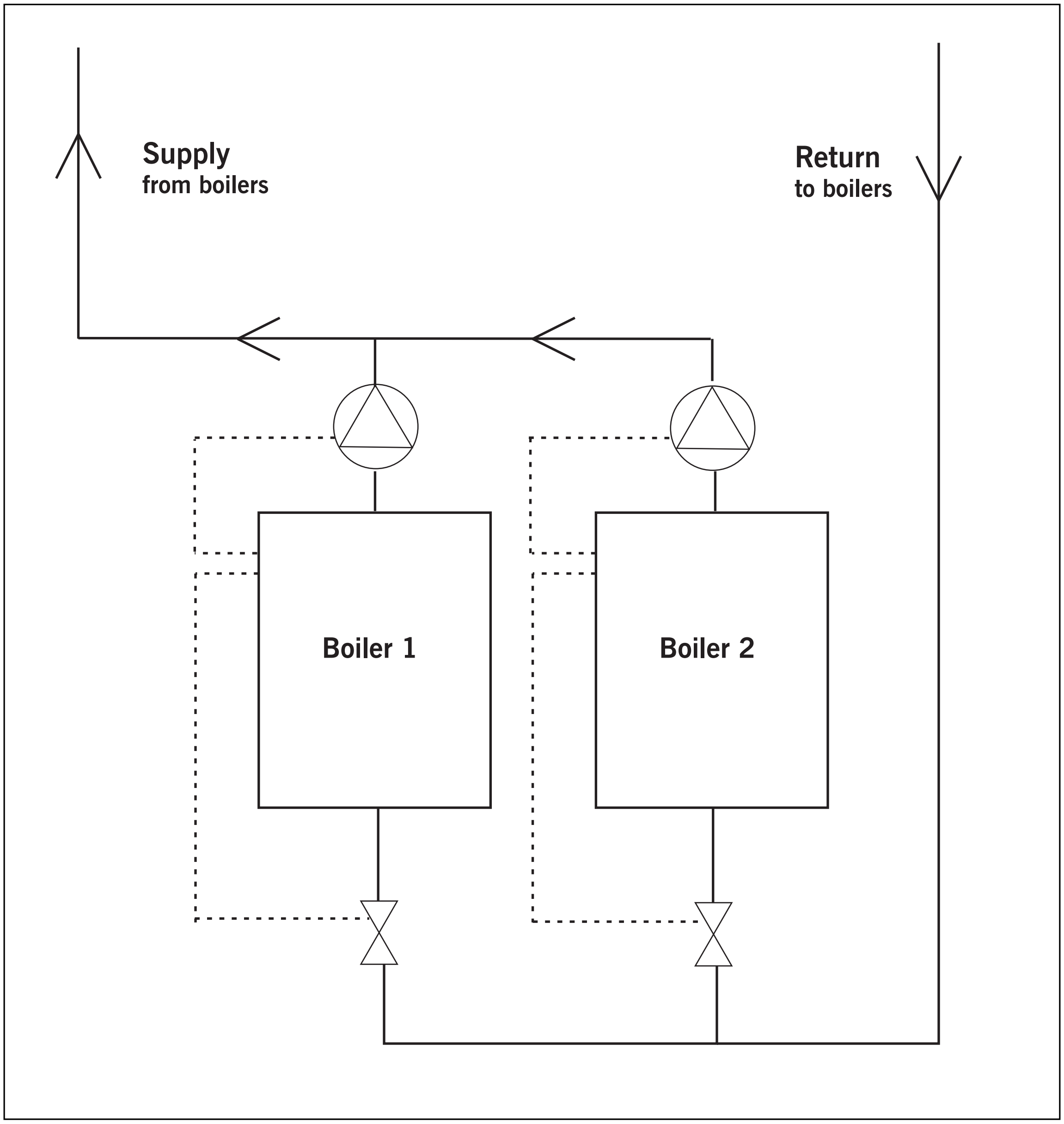


Figure 11 - Primary with dedicated system/boiler pumps

PCB configuration - same as **Figure 10**.

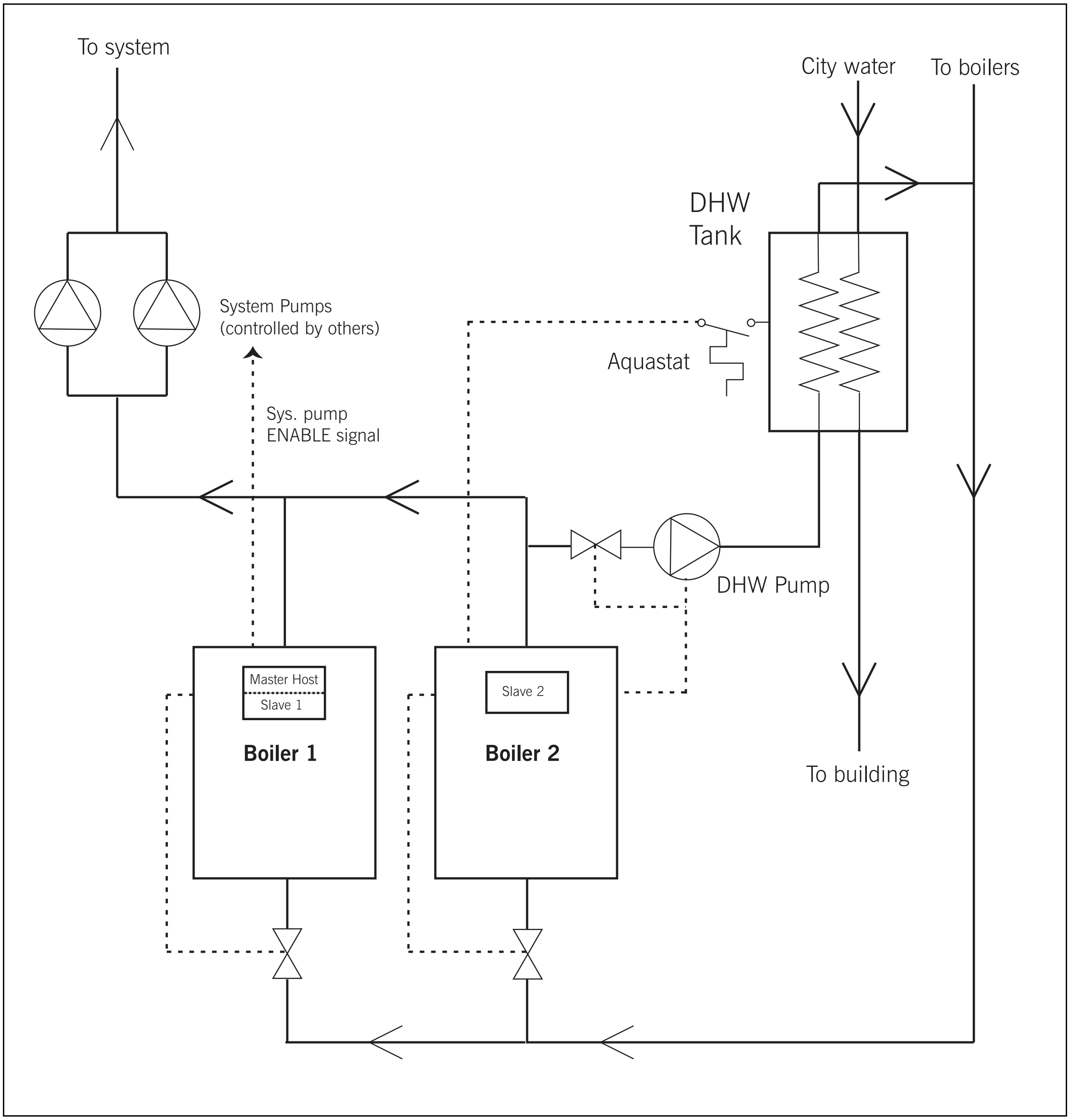


Figure 12 - Domestic Hot Water priority on slave

In this example one boiler (NOT the lead lag Master host) has been enabled for Domestic Hot Water service. When this boiler receives a DHW demand signal via the connected aquastat, it will be released from the lead lag network and will operate on its local DHW setpoint. The boiler's status will show as "On Leave" on the Master host's lead lag Home page. When DHW demand is satisfied the boiler will again be available to the lead lag network.

At each Slave, use Aux 1 Pump (**Figure 17**) for isolation valve - assign Pump B.

At Master host, use System Pump (**Figure 13**) for system pump enable - assign Pump C.

At DHW boiler, use DHW Pump (**Figure 15**) for DHW pump and/or valve - assign pump C.

12-PUMP CONTROL BLOCK (PCB) EXAMPLES

Examples shown are the system defaults and are the settings referred to in figures 9-12 above. For information on programming the Pump Control Blocks see the Falcon manual 750-265.

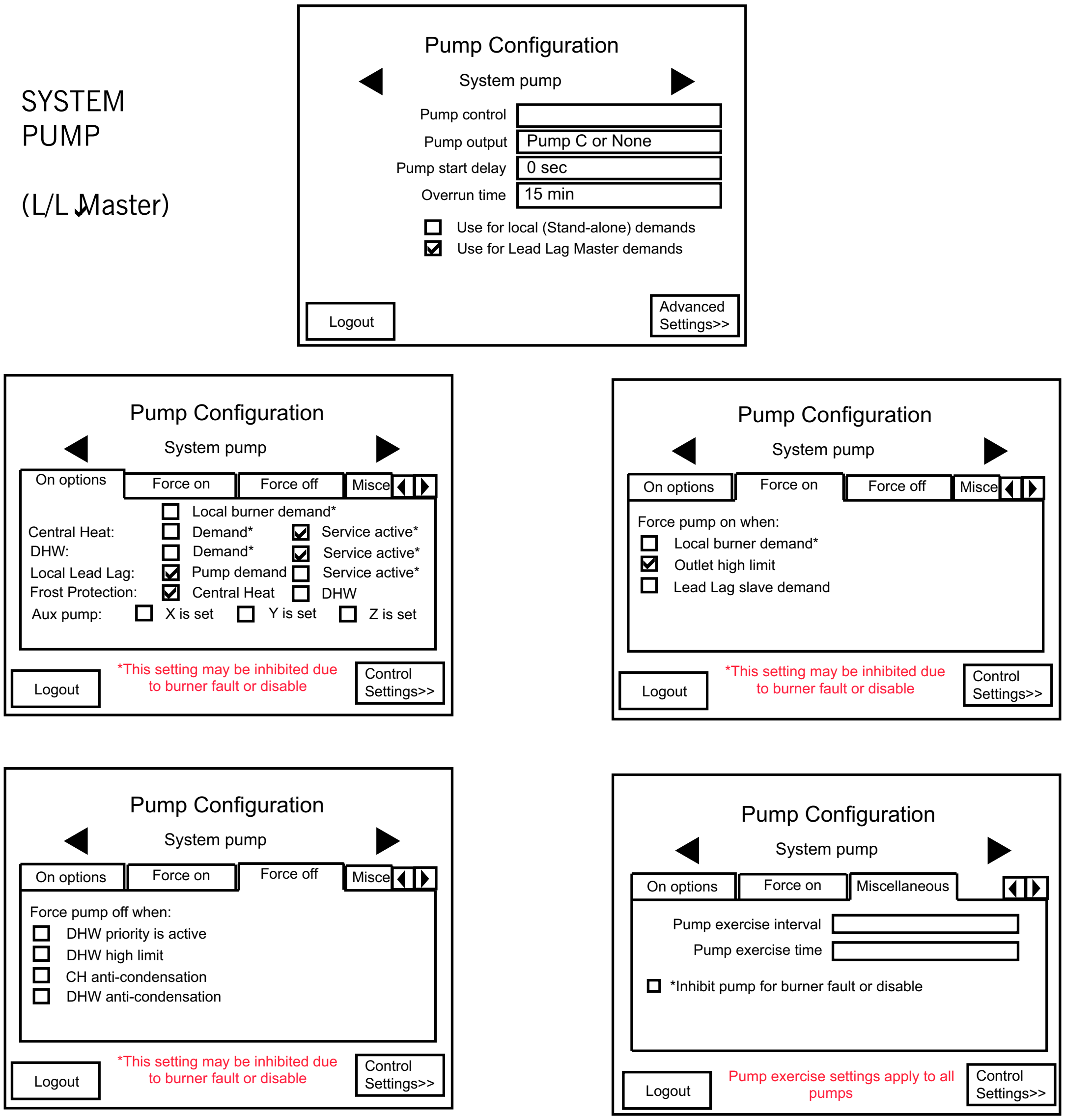


Figure 13 - System Pump

BOILER
PUMP

(L/L Slave)

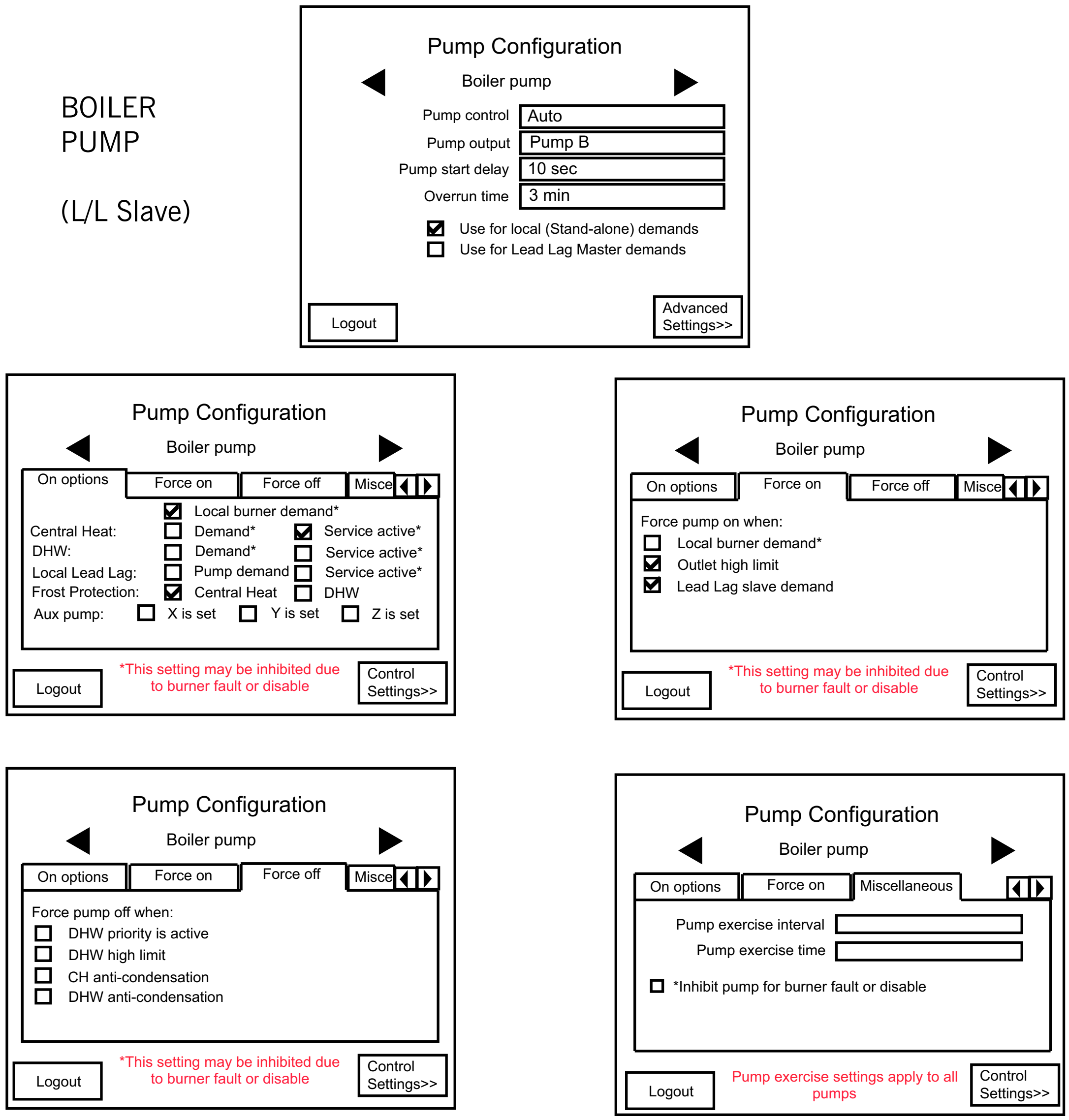


Figure 14 - Boiler Pump

DHW
PUMP

(L/L Slave)

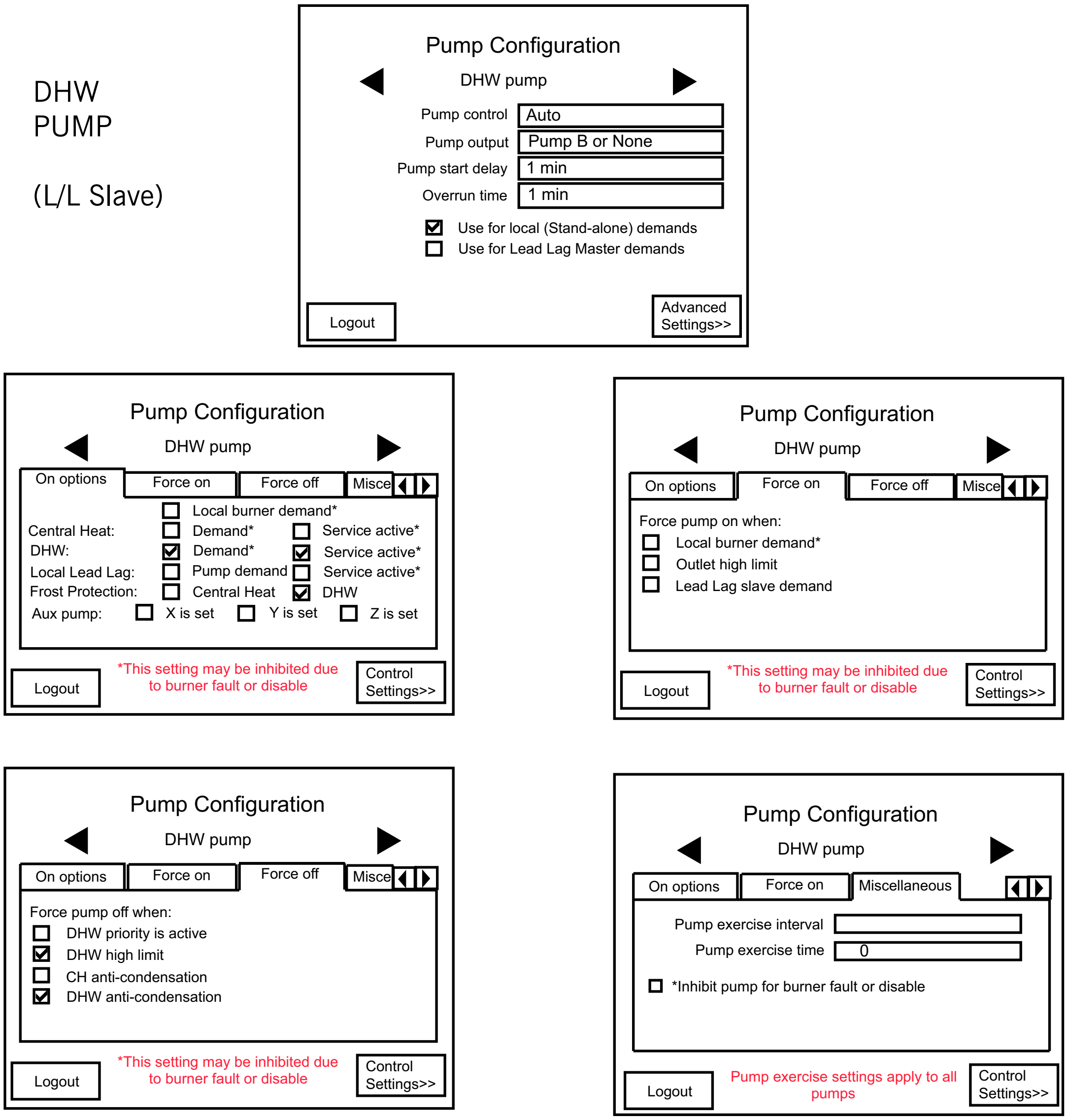


Figure 15 - DHW Pump

CH PUMP

(L/L Slave
or L/L Master)

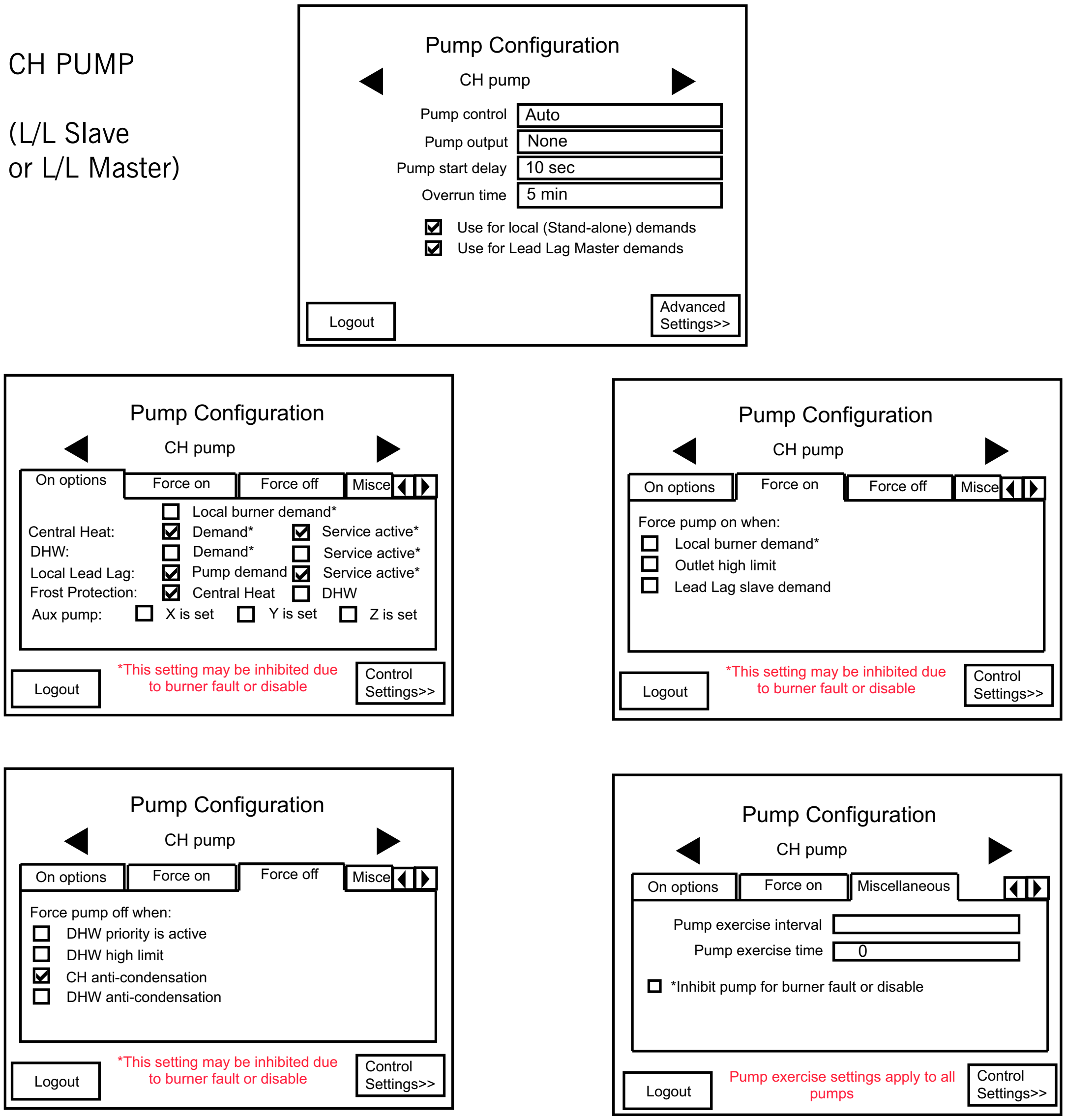


Figure 16 - Central Heat Pump

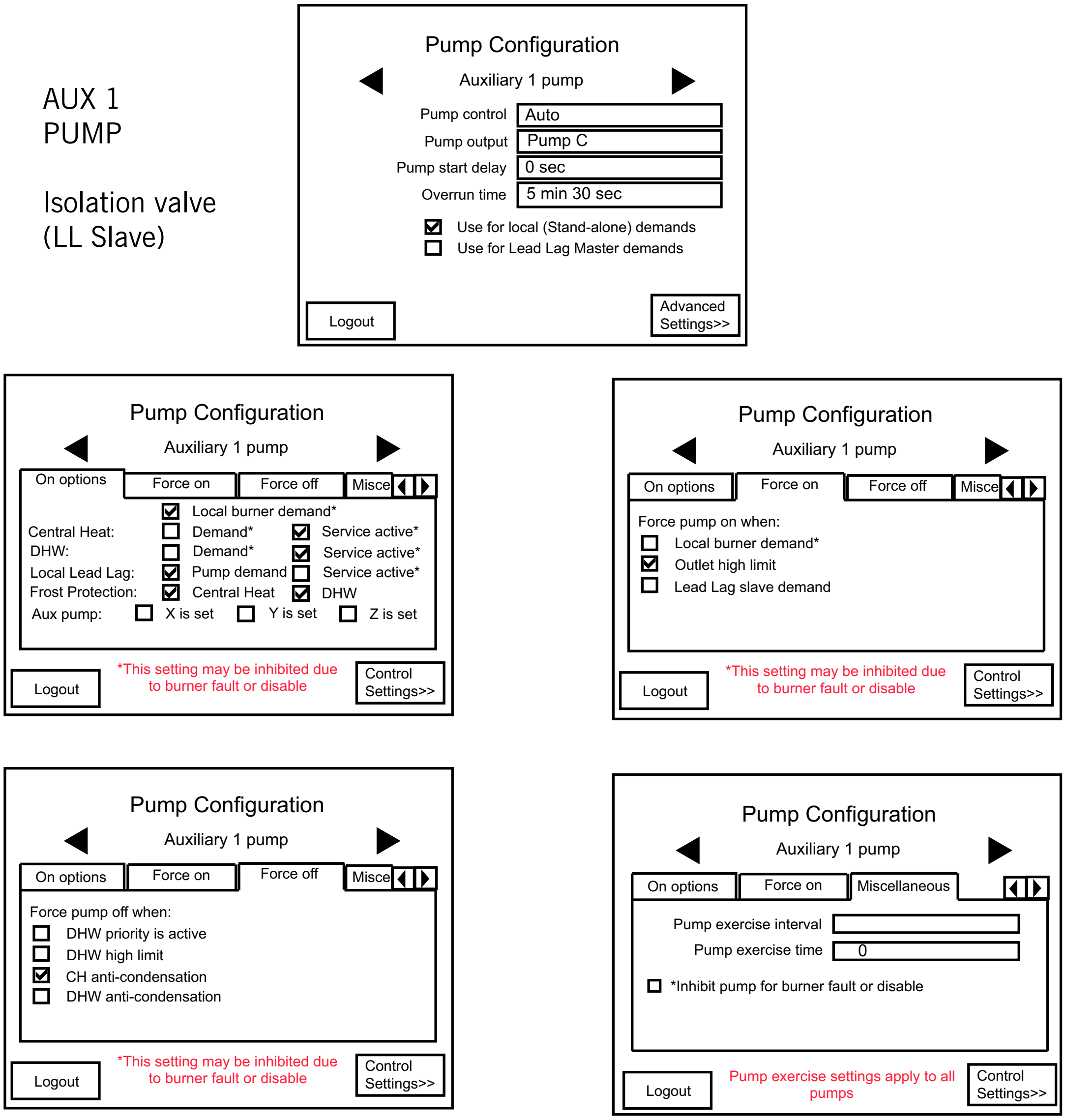


Figure 17 - Aux 1 Pump

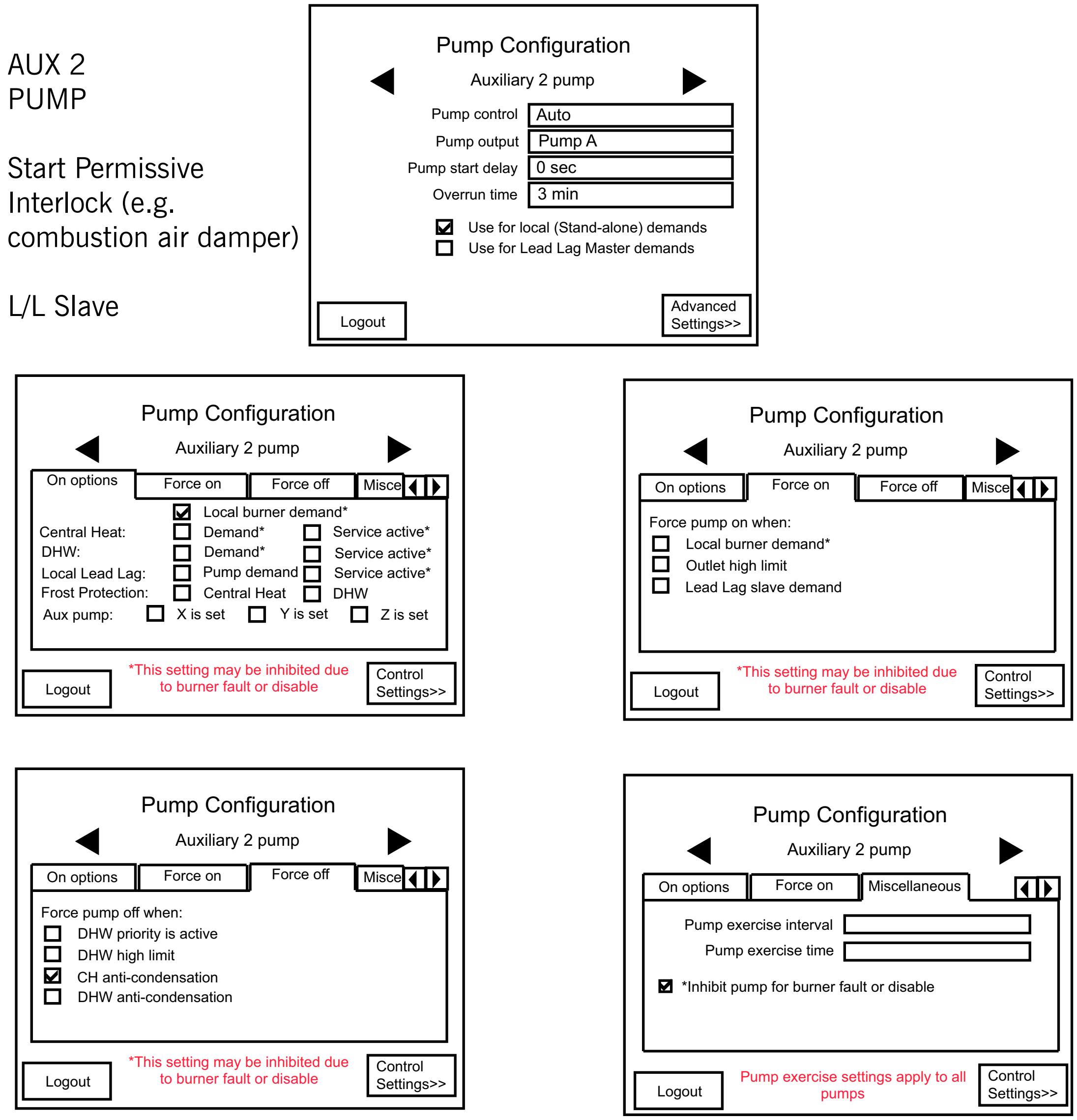


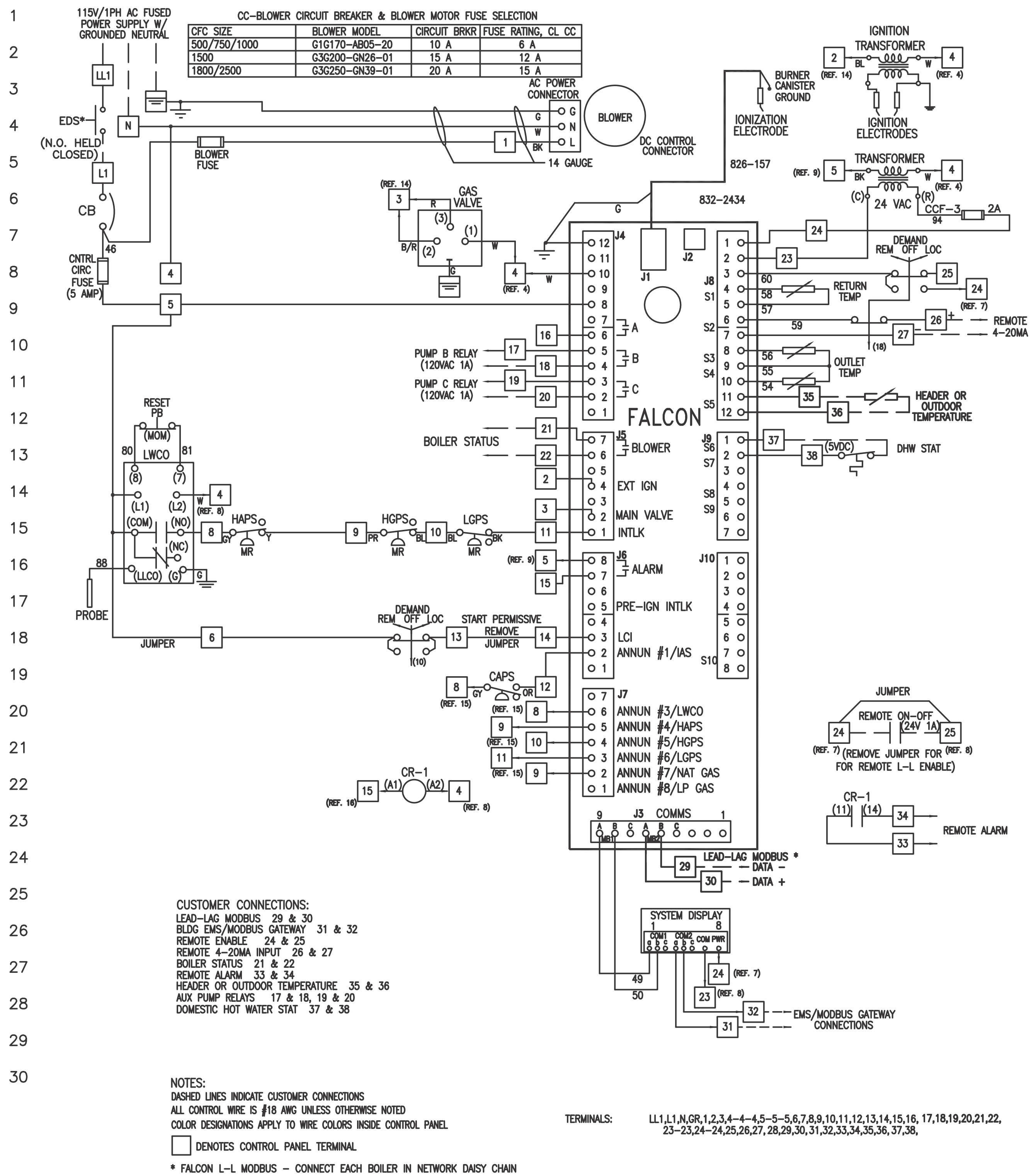
Figure 18 - Aux 2 Pump

13-Boiler Wiring Diagrams

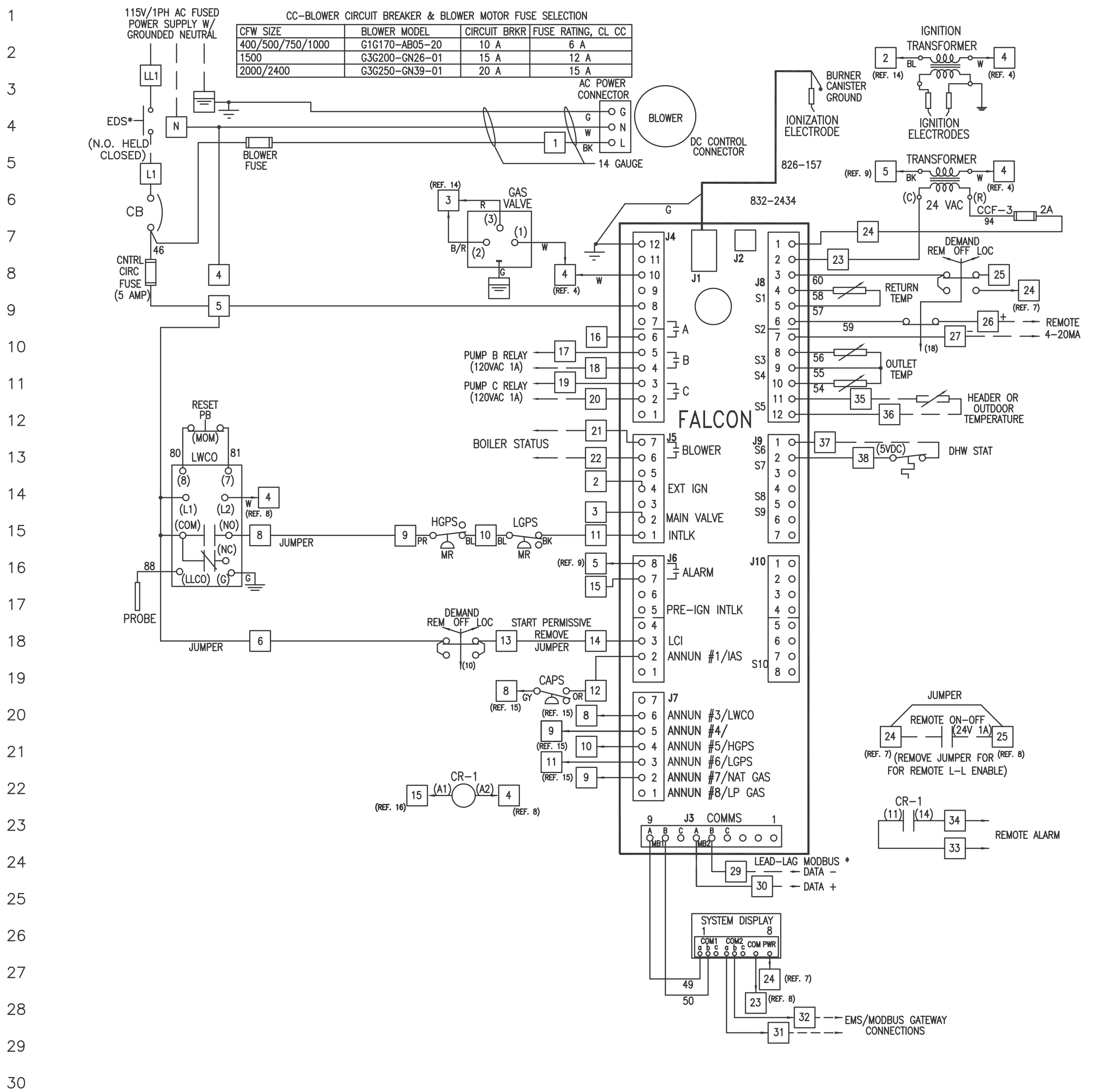
Model CFC ClearFire condensing boiler

CC-BLOWER CIRCUIT BREAKER & BLOWER MOTOR FUSE SELECTION

CFC SIZE	BLOWER MODEL	CIRCUIT BRKR	FUSE RATING, CL CC
500/750/1000	G1G170-AB05-20	10 A	6 A
1500	G3G200-GN26-01	15 A	12 A
1800/2500	G3G250-GN39-01	20 A	15 A



Model CFW ClearFire hydronic boiler



CC-BLOWER CIRCUIT BREAKER & BLOWER MOTOR FUSE SELECTION

CFW SIZE	BLOWER MODEL	CIRCUIT BRKR	FUSE RATING, CL CC
400/500/750/1000	G1G170-AB05-20	10 A	6 A
1500	G3G200-GN26-01	15 A	12 A
2000/2400	G3G250-GN39-01	20 A	15 A

NOTES:
DASHED LINES INDICATE CUSTOMER CONNECTIONS
ALL CONTROL WIRE IS #18 AWG UNLESS OTHERWISE NOTED
COLOR DESIGNATIONS APPLY TO WIRE COLORS INSIDE CONTROL PANEL
☐ DENOTES CONTROL PANEL TERMINAL
* FALCON L-L MODBUS – CONNECT EACH BOILER IN NETWORK DAISY CHAIN

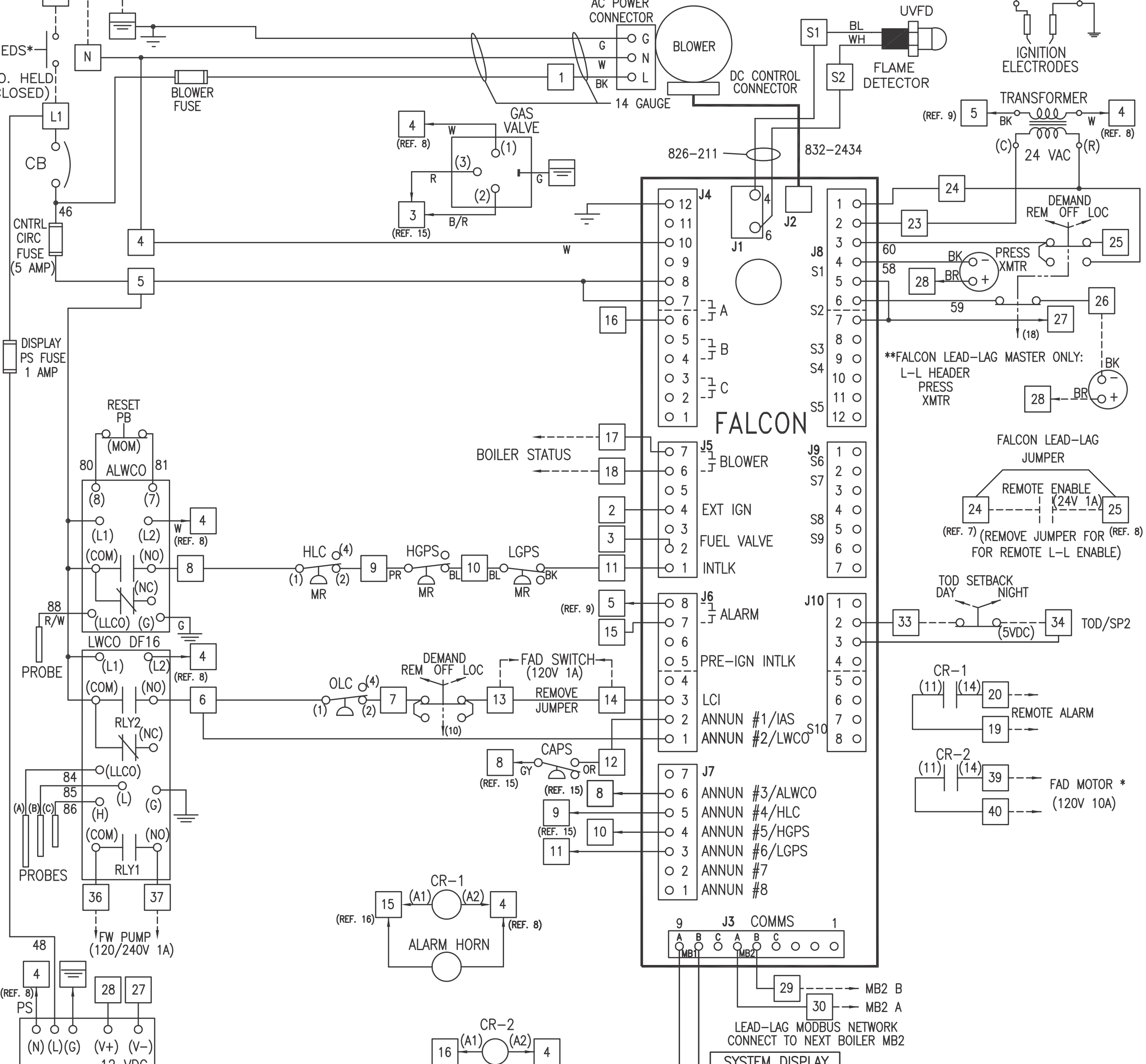
CUSTOMER CONNECTIONS:
LEAD-LAG MODBUS 29 & 30
BLDG EMS/MODBUS GATEWAY 31 & 32
REMOTE ENABLE 24 & 25
REMOTE 4-20MA INPUT 26 & 27
BOILER STATUS 21 & 22
REMOTE ALARM 33 & 34
HEADER OR OUTDOOR TEMPERATURE 35 & 36
AUX PUMP RELAYS 17 & 18, 19 & 20
DOMESTIC HOT WATER STAT 37 & 38

TERMINALS: LL1,L1,N,GR,1,2,3,4-4-4,5-5-5,6,7,8,9,10,11,12,13,14,15,16, 17,18,19,20,21,22, 23-23,24-24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,

Model CFV/CFH ClearFire steam boiler

CC-BLOWER CIRCUIT BREAKER & BLOWER MOTOR FUSE SELECTION

BOILER SIZE	BLOWER MODEL	CIRCUIT BRKR	FUSE RATING, CL CC
10/15/20/25/30 HP	G1G170-AB05-20	10 A	6 A
40 HP	G3G200-GN26-01	15 A	12 A
50/60 HP	G3G250-GN39-01	20 A	15 A



NOTES:
DASHED LINES INDICATE CUSTOMER CONNECTIONS
ALL CONTROL WIRE IS #18 AWG UNLESS OTHERWISE NOTED
COLOR DESIGNATIONS APPLY TO WIRE COLORS INSIDE CONTROL PANEL
☐ DENOTES CONTROL PANEL TERMINAL
**FALCON L-L MASTER – HEADER PRESSURE TRANSMITTER

CUSTOMER CONNECTIONS:
FALCON LEAD-LAG MODBUS 29 & 30
REMOTE L-L ENABLE 24 & 25
LEAD-LAG HEADER PRESSURE 26 & 28
BOILER STATUS 17 & 18
REMOTE ALARM 19 & 20
FW PUMP ON/OFF 36 & 37
TIME OF DAY (TOD/SETBACK) 33 & 34
FRESH AIR DAMPER INTERLOCK 13,14,39,40

EMS INTERFACE MODBUS 31 & 32

TERMINALS: LL1,L1,N,G,1,2,3,4-4-4,5-5-5,6,7,8,9,10,11,12,13,14,15,16,17,18, 19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,S1,S2,

LEAD LAG OPERATION

Reference Manual

Contents

Many of the descriptions used herein refer to functions or tables internal to the Falcon. Only those functions specifically identified as 'parameters' are user-configurable.

GENERAL DESCRIPTION OF THE LEAD LAG APPLICATION

Falcon devices contain the ability to be a stand alone control, operate as a Lead Lag Master control which also uses the falcon control function as one of the slaves or to operate solely as a slave to the lead lag system. Conceptually it is not a part of that specific control, but is an entity that is "above" all of the individual Falcon controls (including the one that hosts it). The master sees each slave (including the one that hosts it) as a set of Modbus devices, each having certain registers, and in this regard it is entirely a communications bus device, talking to the slave Falcon controls via Modbus. Falcon devices utilize two 'ModBus™' ports (MB1 and MB2) for communications. One port will be designated to support a system display and the other port will support communications from the LL Master with its slaves. The diagram on page 4 shows a simplified wiring diagram with a 4 system Lead Lag arrangement.

The Lead Lag master is a software service that is hosted by a falcon control.

The LL master uses a few of the host unit's sensors (header temperature and outdoor temperature) and also the STAT electrical inputs in a configurable way, to provide control information.

LEAD LAG (LL) MASTER GENERAL OPERATION

The LL master coordinates the firing of its slave falcons. To do this it must add stages and drop them to meet changes in load, and it sends firing rate commands to those that are firing.

The LL master turns the first stage on and eventually turns the last stage off using the same criteria as for any modulation control loop:

- When the operating point reaches the Setpoint minus the On hysteresis, then the first Falcon is turned on.
- When the operating point reaches the Setpoint plus the Off hysteresis then the last slave Falcon (or all slave units) are turned off.

The LL master PID operates using a percent rate that is, 0% is a request for no heat at all, and 100% means firing at the maximum modulation rate.

The firing rate is sent to the slaves as a percentage apportioned according to the rate allocation algorithm selected by the **Rate allocation method** parameter.

For some algorithms this rate might be common to all slave units that are firing. For others it might represent the total system capacity and be allocated proportionally.

> For example, if there are 4 slaves and the LL master's percent rate is 30%, then it might satisfy this by:
>
> firing all four slaves at 30%,
>
> or
>
> by operating the first slave at 80% (20% of the system's capacity) and a second slave at 40% (10% of the system's capacity).

The LL master may be aware of slave falcons minimum firing rate and use this information for some of its algorithms, but when apportioning rate it may also assign rates that are less than this. In fact the add-stage and drop-stage algorithms may assume this and be defined in terms of theoretical rates that are possibly lower than the actual minimum rate of the falcon control. In any case a falcon that is firing and is being commanded to fire at less than its minimum modulation rate will operate at its minimum rate: this is a standard behavior for a falcon control in stand-alone (non-slave) mode.

If any slave under LL Master control is in a Run-Limited condition, then for some algorithms the LL master can apportion to that stage the rate that it is actually firing at.

Additionally when a slave imposes its own Run-limited rate this may trigger the LL

Master to add a stage, if it needs more capacity, or drop a stage if the run-limiting is providing too much heat (for example if a stage is running at a higher-than commanded rate due to anti-condensation).

By adjusting the parameters in an extreme way it is possible to define add-stage and drop-stage conditions that overlap or even cross over each other. Certainly it is incorrect to do this, and it would take a very deliberate and non-accidental act to accomplish it. But there are two points in this:

1. LL master does not prevent it, and more important;
2. it will not confuse the LL master because it is implemented as a state machine that is in only one state at a time; for example:

- if its add-stage action has been triggered, it will remain in this condition until either a stage has been added,

or

- the criteria for its being in an add-stage condition is no longer met; only then will it take another look around to see what state it should go to next.

Assumptions:

Modulating stage The modulating stage is the falcon that is receiving varying firing rate requests to track the load.

First stage This is the falcon that was turned on first, when no slaves were firing.

Previous stage The falcon that was added to those stages that are firing. Just prior to the adding of the unit that is under discussion.

Next stage The falcon that will or might be added as the next unit to fire.

Last stage The falcon that is firing and that was added the most recently to the group of slaves that are firing. Typically this is also the modulating stage, however as the load decreases then the last-added stage will be at its minimum rate and the previous stage will be modulating.

Lead boiler The Lead boiler is the falcon that is the first stage to fire among those stages which are in the equalize runtime (Lead/Lag) group. If a boiler is in the "Use first" group it may fire before the Lead boiler fires.

First boiler A falcon may be assigned to any of three groups: "Use First", "Equalize Runtime", or "Use Last". If one or more units are in the "Use First" category, then one of these (the one with the lowest sequence number) will always be the first boiler to fire. If there is no falcon in the "Use First" category and one or more are in the "Equalize Runtime" category, then the First boiler is also the Lead boiler.

Add-stage method

Add-stage detection timing

Add-stage request An **Add-stage method** implements the criteria for adding another stage. Criteria that may apply are the firing rate of a stage or stages vs. a threshold, the amount of operating point versus setpoint error seen by the master, the rate at which setpoint error is developing, and the rate at which a stage or stages are approaching their maximum or baseload firing rate.

Typically these use **Add-stage detection timing** to determine how long these things have persisted. When all criteria have been met for a sufficient time, then an **Add-stage request** is active.

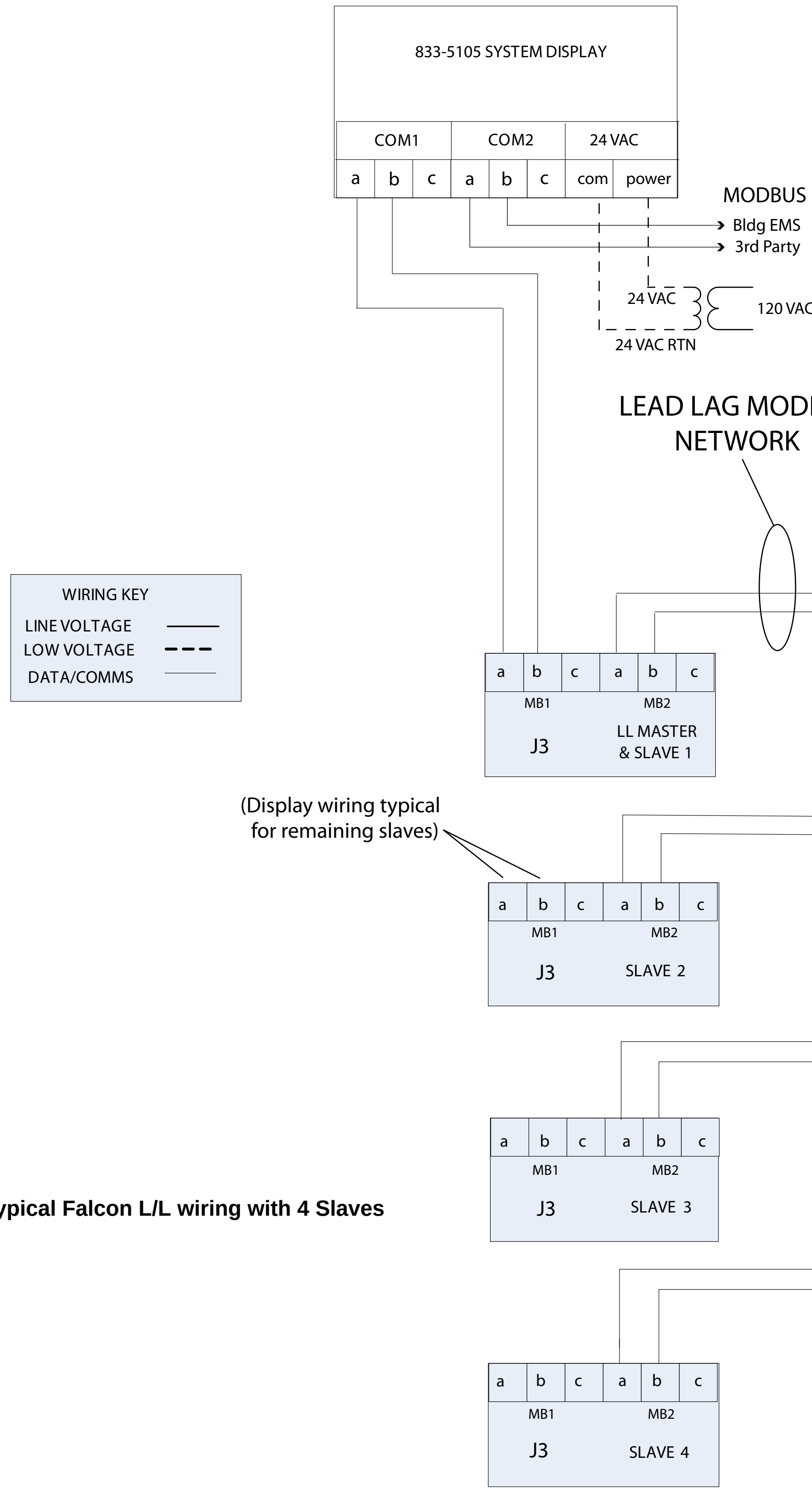
Drop-stage method

Drop-stage detection timing

Drop-stage request A **Drop-stage method** implements the criteria for dropping a stage. Criteria that may apply are the firing rate of a stage (or stages) vs. a threshold, the amount of operating point versus setpoint error seen by the master, the rate at which setpoint error is developing, and the rate at which a stage or stages are approaching their minimum firing rate.

Typically these use **Drop-stage detection timing** to determine how long these things have persisted. When all criteria have been met for a sufficient time, then an **Drop-stage request** is active.

SYSTEM WIRING HOOKUP



Typical Falcon L/L wiring with 4 Slaves

LEAD-LAG OPERATION

This is a summary of the functional capability of the embedded lead-lag on the falcon control. OEM configurable parameters may be adjusted as part of the OEM factory configuration and in the field using the System Display with appropriate password permissions.

1. Field Installation Configuration
   a. The master and slave controllers are enabled via the Falcon display.
   b. All falcon controllers are programmed with a default address of 1. Assuming the Master controller remains address 1, the address of the slave controllers in the system must have a unique address (1..8).

2. Basic Operation
   a. Firing rate determination – Parallel common-base limited
      (1) All boilers have a single assignable base load firing rate.
      (2) Allocation
         (a) As load increases:
            (i) Until all stages are Firing - No stage is requested to exceed the common base load rate.
            (ii) After all stages are Firing - There is no restriction on the slave's commanded firing rate.
         (b) As load decreases:
            (i) As long as all available stages are firing - There is no restriction on the slave's commanded firing rate.
            (ii) When at least one stage has been dropped - No stage is requested to exceed the common base load rate.
   b. Rotation
      (1) The lead boiler is rotated based sequence order. The lead boiler rotation time is a configurable OEM assigned parameter. Rotation is sequential by address (1-2-3-4; 2-3-4-1; etc.)
      (2) Rotation trigger occurs at the start of each new heat cycle.
   c. Source of heat for call – The call for heat originates at the master boiler. This source may be configured to be an external thermostat or via EnviraCOM Remote Stat.
   d. Slave boiler lockout – If any slave is in lockout the master boiler will cause it to be skipped and all system load setting calculation settings will be based only on available boilers.
   e. Master boiler lockout – If the master boiler is in lockout then its burner control function will be skipped in the rotation the same as the slave controllers. However, the master boiler function will continue to operate.

3. System Component Failure Responses
   a. If the system header sensor becomes disconnected from the master boiler then the master boiler will control off of one of the following OEM configurable actions
      (1) Disable - No backup will be used
         (a) Lead Outlet - Outlet temperature of the lead boiler will be used as the backup during firing
            (i) Slave Outlet Average - Average of the outlet temperatures of all slave boilers that are firing will be used as a backup
         (b) If the sensor chosen by the above parameter is faulty then the backup sensor provided may be used. When burner demand is off and no burners are firing then, for either "Lead Outlet" or "Slave Outlet Average", the lead boiler's outlet temperature is used to monitor for burner demand.

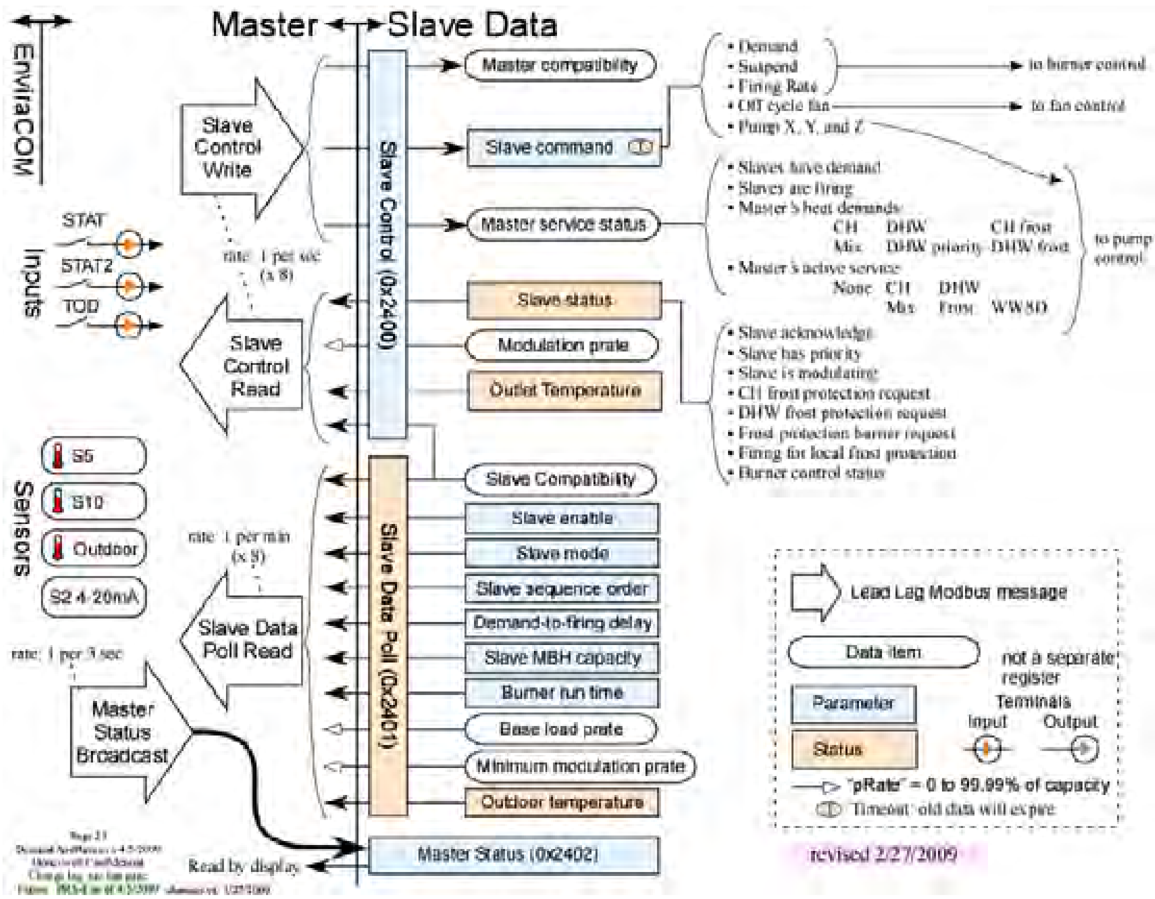
4. System Display Configuration – The following parameters are available for OEM configuration and may be adjusted through a System Display or programmed at the OEM production facility.

Master falcon	**Slave falcon**
LL frost protection enable	Slave mode
LL frost protection rate	Base load rate
Base load rate	Slave sequence order
LL CH demand switch	LL Demand to firing delay
LL CH set point source	
LL Modulation sensor	
LL Base load common	
LL Modulation backup sensor	
LL CH 4mA water temperature	
LL Lead selection method	
LL CH 20mA water temperature	
LL Lag selection method	
LL Add stage method 1	
LL Add stage detection time 1	
LL Add stage error threshold	
LL Add stage rate offset	
LL Add stage inter-stage delay	
LL Drop stage method 1	
LL Drop stage detection time 1	
LL Drop stage error threshold	
LL Drop stage rate offset	
LL Lead rotation time	
LL Force lead rotation time	
LL Drop stage inter-stage delay	

SLAVE OPERATION AND SETUP

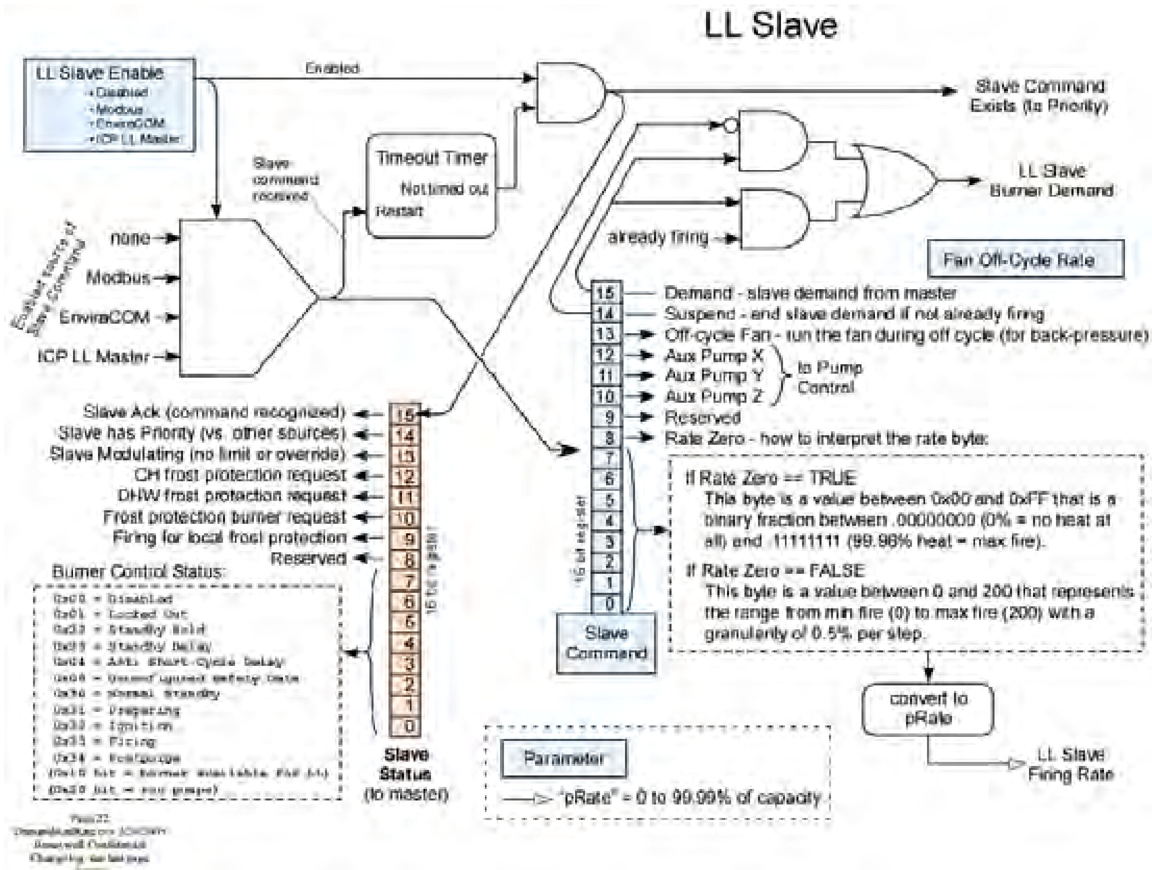
Slave Data Supporting Lead Lag

This data is provided by each slave falcon control to support operation when a LL master exists. The illustration below summarizes the slave's registers and data:



LL Slave

Some slave changes relate to pump control, frost protection, and also are available to 3rd party (non falcon) LL master devices. The generic LL slave is updated to operate as shown by the diagram below:



Frost protection requests

The frost protection in this status register will be set or cleared to match the status generated by the frost protection detection functions.

Firing for local frost protection

This provides indication to the LL master that although the burner is firing independently, it is doing so for frost protection and thus is still available as a lead/lag slave. This is set when 1) frost protection is controlling the falcon per the priority scheme (which occurs only if frost protection is enabled), and 2) burner demand is true and the burner is currently firing or preparing to fire to serve that demand. Otherwise it will be clear.

Aux Pump X, Y, and Z

The pump control in the Slave can be used by previously-existing command devices to create the same behavior. However before these bits controlled actions is specific pump blocks, they are now more general. The pump X, Y, and Z bits control actions in any pump block defined to handle them (see the pump control block definition).

SLAVE PARAMETERS

SLAVE ENABLE: DISABLE, ENABLE VIA MODBUS, ENABLE FOR FALCON MASTER

It enables or disables the "LL Slave" Demand and Rate module.

If the slave mode is set to Disable then:
none of the slave functions are active, **Slave Status** register is zero, the **LL – Master Service Status** register is not writable and is held at zero (this is important for pump control which might otherwise use values in this location).

The **Slave Command** register is writable but it is mostly ignored, however the Aux pump X, Y, and Z are effective for any setting of the **Slave enable** parameter.

The **Enable for falcon Master** option **Slave write** and **Slave read** parameters; if "Enable for falcon Master" is not selected, then these parameters are disabled.

SLAVE MODE: USE FIRST, EQUALIZE RUNTIME, USE LAST

If set to Use First, then this falcon will be used prior to using other falcons with other values.

If set to Equalize Runtime, then this falcon will be staged according to a run time equalization algorithm. (Any falcon set to Use First will precede any that are set to Equalize Run time.)

If set to Use Last, then this burner will be used only after all Use First and Equalize Runtime falcons have been brought online.

SLAVE SEQUENCE ORDER: 0-255

Slave sequence order is used to determine the order in which falcons will be used (staged on) for those falcons which the same Slave mode setting. Numbers may be skipped, that is 3 will be first if there is no 1 or 2.

Note: For Equalize Runtime purposes, 1 does not mean the falcon will be used first every time; that will vary over time based on the master's run time equalization scheme. In this case the sequence number determines the relative order in which

falcon controls will be used in a round-robin scheme.

If the slave sequence number value is zero, then the slave falcon's ModBus address will be used instead.

If two falcons which are set the same mode both have the same sequence number then an alert will occur and the order in which they are used will be arbitrary and is not guaranteed to be repeatable.

DEMAND-TO-FIRING DELAY: MM:SS OR NONE

This delay time is needed by the LL master to determine the length of time to wait between requesting a slave falcon to fire and detecting that it has failed to start. It should be set to the total time normally needed for the burner to transition from Standby to Run, including such things as transition to purge rate, prepurge time, transition to lightoff rate, all ignition timings, and some extra margin.

BASE LOAD RATE: RPM OR %

This specifies the preferred firing rate of a burner, which is used for some types of control algorithms.

FAN DURING OFF-CYCLE RATE: RPM OR % (0=DISABLE)

This determines if or where the fan is to be operating during the standby period.

LL MASTER OPERATION AND SETUP

LL master operation is subdivided into the following functions:

- **Overall control** - The LL master has parameters that enable and disable its operation.
- **Periodic data polling** - The LL master uses polling to discover new slave falcon devices and to periodically refresh the information it has about a known slave falcon devices.
- **Slave control** - the LL master sends each active slave a command and also performs a slave status read for each known slave device. It also sends a Master status broadcast that is heard by all slaves.
- **Slave status manager** - The LL master keeps track of slave status for each falcon that is enabled as a slave device.
- **Demand and priority** - different sources of demand can cause the LL master to operate in different ways. These sources have a priority relationship.
- **Modulation** - each demand source has one or more setpoints that may be active and an operation sensor. These are used to detect turn-on and turn-off conditions. The difference between operating point and setpoint determines the LL master's firing rate.
- **Stager** - the stager determines when slave falcons should turn on as the need for heat increases, and when they should turn off as the need for heat decreases.**Rate allocation** - the PID block's output is used to determine the firing rate of each slave unit using various rate allocation techniques.
- **Add-stage methods** - various methods can be used to determine when a new stage should be added.
- **Drop-stage methods** - various methods can be used to determine when a stage should be dropped
- **Sequencer** - the sequencer determines which unit will be the next one to turn on or turn off.

Overall Control

LL MASTER ENABLE: DISABLE, ENABLE,

LL MASTER MODBUS PORT: MB1, MB2

If Disable is selected then all LL master functions are inactive. If Enable is selected then it acts as the active bus master on the ModBus port it is assigned.

LL OPERATION SWITCH: OFF, ON

This controls the LL master in the same way that the Burner switch controls a stand-alone unit. If "On" then the LL master is enabled to operate. If this parameter is "Off" then the LL master turns off all slaves and enters an idle or standby condition.

Periodic Data Polling messages

The LL master uses polling to discover new slave devices and to periodically refresh the information it has about known slave Falcon devices.

Thereafter it polls the known devices to make sure they are still present and to obtain updated status information. It also periodically polls the entire slave address range to discover any new slave devices.

A polled device is read to determine the values of the following data items:

a. The slave's type (compatibility) as indicated by the **Slave type**
b. The slave enable status **Slave enable**
c. The slave mode as set in **Slave mode**
d. The slave sequence order as set in **Slave sequence order**
e. **Demand-to-firing delay: mm:ss or None**
   This delay time is needed by the LL master to determine the length of time to wait between requesting a slave to fire and detecting that it has failed to start. It should be set to the total time normally needed for the burner to transition from Standby to Run, including such things as transition to purge rate, prepurge time, transition to lightoff rate, all ignition timings, and some extra margin.
f. **CT - Burner run time**

This parameter will be needed if measured run-time equalization is being used.

Slave Control

The LL master sends each active slave a command and also performs a slave status read for each known slave device. It also sends a Master status broadcast that is heard by all slaves.

There are 5 commands that might be sent:

- All slaves are commanded to turn off and remain off.
- The LL master sends message to slaves that are off, to turn their fans on.
- The LL master suspends operation which request a burner to recycle and remain in Standby if it has not yet opened its main valve (e.g. it is in Prepurge or PFEP) but to keep firing if it has reached MFEP or Run. This suspend may be for the fan to be on or off in standby.

  This message is used to abort the startup of a slave that is not yet firing (because demand went away just before it was firing), but to keep it on if it actually is firing (the LL master will discover what happened in a subsequent status response).

  The LL master also sends this message to a slave that is OnLeave. (This ensures that if the slave is firing when it returns to LL master control, it will stay that way until the master has decided whether to use it; or conversely, if the slave stops firing for some reason that it will not start up again until the LL master has requested this.

  In either case, the command will be to turn on the off cycle fan if any other slave burners are firing, or to turn the fan off if the slave is the only slave that might (or might not) be firing.

- The LL master sends message to turn the burner on and to assign the burner's firing rate.

  If the commanded modulation rate is less than the burner's minimum modulation rate, then the burner should always operate at its minimum rate.

Slave Status Manager

The LL master keeps track of slave status for each unit that is enabled as a slave device. The slave status manager operates internally for each slave device (up to 8).

There is a table entry for each device containing the following data:

- **SlaveState**:
  - — Unknown - indicates the table entry is unused and empty
  - — Available - indicates the slave is OK and ready to use, but is not
  - — currently firing as a slave
  - — AddStage - stage is getting ready to fire
  - — SuspendStage - stage was getting ready but is not needed
  - — Firing - indicates the slave is currently firing
  - — OnLeave - indicates the slave is operating for some other demand source within it that has higher priority than slave demand.
  - — Disabled - indicates the slave is locked out or disabled in some way
  - — Recovering - indicates the slave is in a time delay to ensure that it is
    OK before it is again considered to be available.
- **RecoveryTime**: Saves how long the slave must be OK to recover.
- **RecoveryTimer**: Used to measure the slaves recovery time
- **RecoveryLimitTimer**: Enforces a maximum slave recovery time
- **DataPollFaultCounter**: Used to tolerate momentary communication problems and to act on these if they are excessive.
- **StatusReadFaultCounter**: Used to tolerate momentary communication problems and to act on these if they are excessive.
- **AbnormalFaultCounter**: Used to tolerate momentary abnormality
- **StagingOrder**: Used to record the stage-on order, for use by the sequencer when it needs to drop a stage.
- Storage for each item described in the Periodic data polling section
- Storage for each item described in the Slave status read response section
- Slave Command - the command word from the master to the slave.

Features common to all states

- Whenever a slave device is not in an expected condition then a recovery function is used to set up timers to give a faulty slave:
  - — minimum time that it must appear to be OK, and
  - — limit how long a slave has to recover from any error.
- If the slave status read was bad then the slave's **FaultCounter** is incremented and if it to reaches the fault value tries, then a recovery action is invoked.
  This action does nothing else if the status read was Bad.

  If the slave status read was OK then the status function puts the slave read response data in a slave status table.

  If a transition to another state is indicated then the **SlaveState** is simply set to the indicated state.

Data poll response handling

VALID RESPONSE MESSAGE

When a slave responds with a properly formatted message it is examined to see if **Slave enable** value is "Enable for Master".

- If the "Enable for Master" value is not present then the slave status table is checked and if the slave is not in the table then the message is ignored (this is normal). However if the slave is in the table then the message is stored as usual and the slave will invoke the action as a disabled slave and cause recovery action to occur.
- If the "Enable for Master" value is present then the slave status table is checked and if the slave is not in the table then the slave data is stored in an empty position in the table. However if the slave is in the table then the message is stored as usual (this is the normal case).

INVALID RESPONSE OR NO RESPONSE

When a CB Falcon responds to a data poll with an improperly formatted message or it does not respond then the slave status table is checked and:

If the polled slave device is in the table then the **Data Poll Fault** is noted. If this causes a fault counter to exceed the fault value then the SetRecovering handling is invoked.

SlaveState states

Recovering A slave that is recovering is checked once per second.

If the slave has recovered the **SlaveState** table is changed to Available.

If the slave has not yet recovered when its recovery timer reaches the **RecoveryTimeLimit** then:

If the slave is not enabled for the LL master its **SlaveState** table is Set to Unknown (which logically removes it from the slave table). Otherwise the **RecoveryLimitTimer** is cleared which starts a new recovery measurement and the slave remains in recovery (indefinitely).

Available A slave in the Available state remains that way until the Stager moves it into the AddStage state or the ProcessSlaveStatus action moves it to some other state.

AddStage A slave in the AddStage state remains that way until the ProcessSlaveStatus moves it to Firing or some other state, or the Stager times out and moves it into the Recovering state if it fails to fire.

SuspendStage A slave in the SuspendStage state remains that way until the ProcessSlaveStatus moves it to some other state, or the Stager times out and moves it into either the Firing or the Available state.

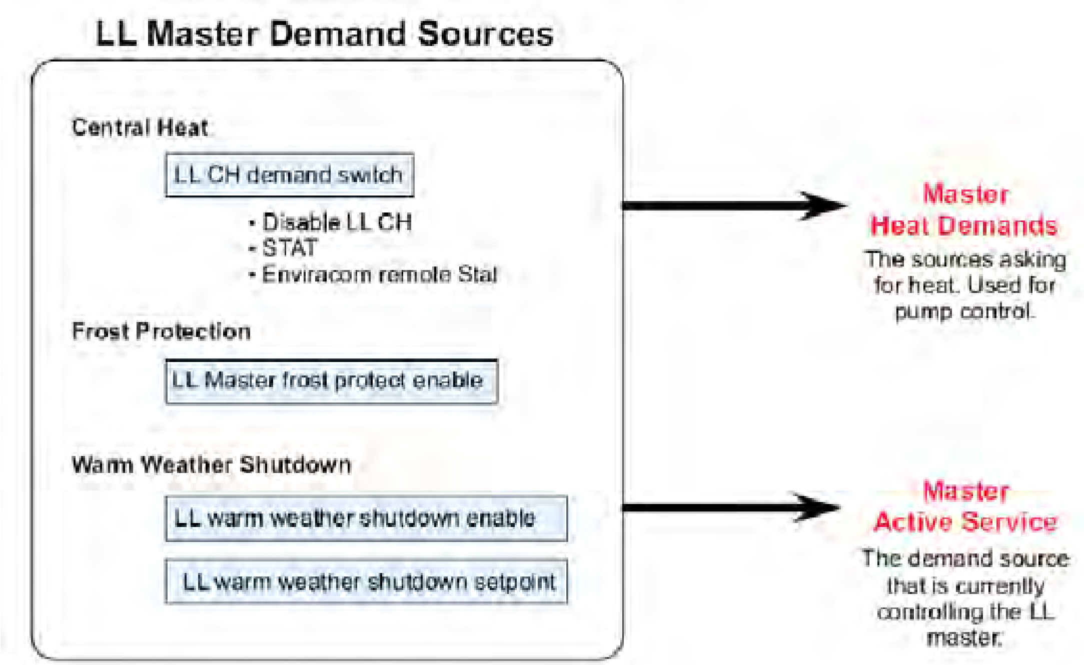
Firing A slave in the Firing state remains that way until the ProcessSlaveStatus moves it to some other state, or the Stager drops the stage and moves it into the Available state.

OnLeave A slave in the OnLeave state remains that way until the ProcessSlaveStatus moves it to some other state.

Disabled A slave in the Disabled state remains that way until the ProcessSlaveStatus moves it to Recovering.

Demand and Priority

Different sources of demand can cause the LL master to operate in different ways. These sources have a priority relationship.



CH Demand

LL CH DEMAND SWITCH: DISABLE, STAT, ENVIRONCOM REMOTE STAT

The inputs that can function as the CH demand switch are: STAT, EnvironCOM Remote Stat. If the CH demand switch value is Disable, the LL master does not respond to CH demand.

Warm Weather Shutdown

WARM WEATHER SHUTDOWN ENABLE: DISABLE, SHUTDOWN AFTER DEMANDS HAVE ENDED, SHUTDOWN IMMEDIATELY

WARM WEATHER SHUTDOWN SETPOINT: TEMPERATURE OR NONE

When warm weather shutdown is Disabled then it has no effect (i.e. the Warm Weather Shutdown (WWSD) status shown on the priority diagram is false).

These two parameters are shared by the stand-alone control and the LL master and have the same effect for either control.

This function requires the outdoor temperature. This temperature may be obtained from either a local sensor or a LL slave. If WWSD is enabled but the outdoor temperature is invalid and unknown, then the WWSD function acts as if it is disabled and has no effect and an alert is issued indicating an invalid outdoor temperature.

If it is enabled then it uses a 4°F (2.2°C) hysteresis:

If WWSD is false, then when the Outdoor temperature is above the value provided by **Warm weather shutdown setpoint** then:

If "**Shutdown after demands have ended**" is selected then any current CH demand that is present prevents WWSD from becoming true; that is if CH demand is false then WWSD becomes true.

Otherwise if "**Shutdown immediately**" is selected then WWSD becomes true, it immediatetly causes CH demand to end.

If WWSD is true, then when the Outdoor temperature is below the value provided by **Warm weather shutdown setpoint** minus 4°F (2.2°C) then WWSD becomes false.

When warm weather shutdown is true then:
New occurrences of CH demand is inhibited.
DHW demand is not affected.

Frost protection

LL master frost protection is enabled with **Frost protection enable: Disable, Enable**

The need for frost protection is actually detected independently by each slave which notifies the master whether frost detection occurred in CH frost detection, and/or its DHW frost detection, and whether it is severe enough to require burner firing as well as pump operation. This is done via its **Slave status** parameter.

If **Frost protection enable** is Enable then the master's **Slave write** message, will indicate CH or DHW frost protection or both as read from each slave's **Slave Status**. This will cause any slave pumps which are enabled to follow this status to turn on without any other action required from the master.

If any slave is indicating CH or DHW frost protection, and additionally that slave's **Slave status** register indicates burner firing is requested then the LL master's frost protection burner demand will be true.

If the priority scheme allows the master to honor this demand, then it will fire a single burner (the current lead burner as specified by the sequencer) at the rate indicated by **Frost protection rate: 0-100%.** (100% represents 100% firing of this boiler, and where 0% or any value less than the boiler's minimum firing rate represents the minimum firing rate).

Priority Control

CH heat demand is a simple signal such as STAT, EnviroCOM remote stat, or Warm Weather Shutdown.

Frost protection input to the priority logic is not a heat demand, it is a burner demand (because frost protection always turns on pumps without regard to the priority control - it is a priority item only if it also wants to fire).

Master Status

MASTER HEAT DEMAND

Is a data item which contains the status for the following sources of demand. All sources that are currently calling for heat will be true (multiple items may be true at the same time) except when WWSD is active, then CH demand is inhibited.

CH Demand
CH Frost demand – true if any slave is calling for CH frost protection and **Frost protection enable** is true.

MASTER ACTIVE SERVICE

Is a data item which contains the identity of a single source of demand that the LL Master is currently serving according to its priority:

- None – no active service, LL master is idle
- CH
- Frost – burner demand is true for frost protection
- WWSD – no high priority demand is active, and WWSD is inhibiting CH demand (if any).

MASTER SERVICE STATUS

Is a data item used by pump control logic that combines the Master Heat Demand and Master Active Service data. It is implemented as described by the Pump Control Block diagram.

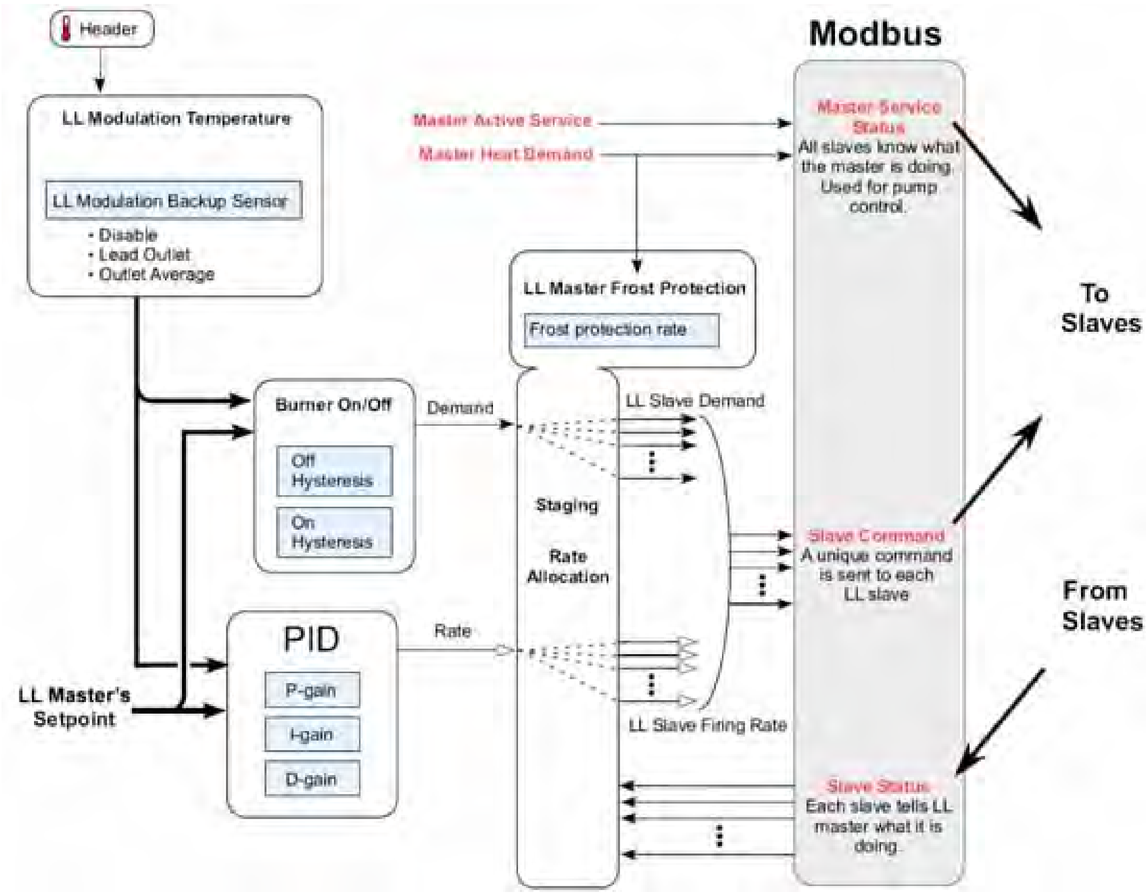
Outdoor Temperature

For a CB Falcon that hosts a LL master, the outdoor temperature may be known from either of two sources. If the host has an outdoor sensor that is reporting a valid temperature then this sensor reading is used. Otherwise, if any slave is reporting a valid temperature as part of its Data Poll message, then this temperature is used.

The resulting outdoor temperature provides all outdoor temperature needs for both stand-alone and LL master purposes. If neither source has a valid temperature then the outdoor temperature is simply invalid and unknown, and the functions which need this information handle it accordingly per their individual definitions.

Modulation

Each demand source has one or more setpoints that may be active and an operation sensor. These are used to detect turn-on and turn-off conditions. The difference between operating point and setpoint determines the LL master's firing rate



Modulation Sensor

LL MODULATION SENSOR: S5

The LL master's modulation sensor uses the S5 sensor (connector J8 terminal 11 and 12).

If the LL master is enabled and its sensor is faulty then an alert will be issued.

LL MODULATION BACKUP SENSOR: DISABLE, LEAD OUTLET, SLAVE OUTLET AVERAGE

If the sensor chosen by the **LL Modulation sensor** is faulty then the backup sensor provided here may be used.

If **Disable** is selected then no backup will be used.

If **Lead Outlet** is selected then the outlet temperature of the lead boiler will be used as the backup during firing.

If **Slave Outlet Average** is selected then average of the outlet temperatures of all slave boilers that are firing will be used as a backup.

When the burner demand is off and no burners are firing then, for either **Lead Outlet** or **Slave Outlet Average**, the lead boiler's outlet temperature is used to monitor for burner demand.

Setpoints

LL CH SETPOINT SOURCE: LOCAL, S2 4-20MA

If the setpoint source is **Local** then the control's local setpoint system is used. This setting enables the normal use of the CH setpoint, CH TOD setpoint, and the CH outdoor reset parameters and functions.

If the setpoint source is **S2 4-20mA** then the setpoint is determined by the 4-20mA input on S2, and the two parameters described below. If the 4-20mA signal goes out of range or is invalid, and this persists for a specified time, then the setpoint source reverts to "Local". In this case once it has gone to "Local", it remains that way until the 4-20mA signal is stable again.

LL CH 20MA WATER TEMPERATURE: TEMPERATURE OR NONE

CH 4MA WATER TEMPERATURE: TEMPERATURE OR NONE

These provide the 20mA and 4mA temperatures for the interpolation curve. If either of these have the None value, are invalid, are out of range, or are too close for interpolation, an alert is issued and the setpoint reverts to "Local" when it is selected as 4-20mA.

LL CH SETPOINT: DEGREES OR NONE

This setpoint is used when the time-of-day input is off. If the ODR function is inactive then the setpoint is used as-is.

If the ODR function is active then this setpoint provides one coordinate for the outdoor reset curve.

LL CH TOD SETPOINT: DEGREES OR NONE

This setpoint is used when the time-of-day input is on. If the ODR function is inactive then the setpoint is used as-is.

If the ODR function is active then this setpoint provides one coordinate for the shifted (because TOD is on) outdoor reset curve.

TIME OF DAY

The Time of Day has one sources of control: a switch contact. Closed TOD is an on condition; open, then TOD is off.

OUTDOOR RESET AND BOOST (BOOST IS FUTURE)

The outdoor reset and boost functions for the LL CH functions will be implemented as described for a stand-alone CH loop.

Each of the loops which implements outdoor reset and boost has its own parameters. The parameters used by the LL master are:

- LL setpoint
- LL CH TOD Setpoint
- LL Outdoor reset enable: Disable, enable
- LL CH ODR minimum outdoor degrees or None
- temperature:
- LL CH ODR maximum outdoor temperature: degrees or None
- LL CH ODR low water temperature: degrees or None
- LL CH ODR boost time: mm:ss or None
- LL CH ODR boost max setpoint: degrees or None
- LL CH ODR boost step: degrees or None
- LL CH ODR boost recovery step time:mm:ss or None

The outdoor reset function requires the outdoor temperature. This temperature may be obtained from either a local sensor or a LL slave as described earlier. If the outdoor temperature is invalid and unknown, then no outdoor reset action occurs and an alert is issued indicating an invalid outdoor temperature.

LL CH ODR MINIMUM WATER TEMPERATURE: DEGREES OR NONE

This specifies the minimum outdoor reset setpoint for the LL master. If the outdoor reset function calculates a temperature that is below the temperature specified here, then this parameter's temperature will be used.

If this parameter is invalid or None then the outdoor reset function will be inhibited and will not run: if it is enabled then an alert is issued.

Demand and Rate

On/Off Hysteresis Includes hysteresis shifting at turn-on, turn-off

LL OFF HYSTERESIS: DEGREES OR NONE

LL ON HYSTERESIS: DEGREES OR NONE

The LL hysteresis values apply to all setpoint sources. The behavior of the hysteresis function is identical to the behavior of the stand-alone CH hysteresis function, except:

- where stand-alone CH hysteresis uses the on/off status of a single burner, the LL hysteresis uses the on/off status of all slave burners: this status is true if any slave burner is on, and false only if all are off.
- where stand-alone CH hysteresis uses time of turn-on and turn-off of a single burner, the LL hysteresis uses the turn-on of the first slave burners and the turn-off of the last slave burner.

LEAD LAG PID

The behavior of the Lead Lag PID function is identical to the behavior of the stand-alone CH PID function. The same gain scalars and algorithms are used.
Additionally:

RATE ADJUSTMENT

When the **Slave dropout/return compensation** parameter specifies a rate adjustment and a rate compensation event occurs (a slave leaves while firing, or a slave returns) then rate adjustment will alter the integrator value so that the commanded rate compensates for the added or lost capacity.

INTEGRATOR COMPENSATION

A stand-alone CB Falcon includes a feature to smooth the response when a rate override has occurred (such as delta-T rate limit) causing the PID output to be ignored.

Whenever an override has occurred then, at the moment the override ends, the integrator is loaded with a value that causes the PID output to match the current rate, whenever this is possible within the integrator’s limits. The Lead Lag PID will implement similar behavior: The rate allocator will provide a trigger that causes the integrator's value to be recomputed and this trigger will activate whenever a rate allocation limit is released; that is, this event will occur any time the system transitions from the condition in which it is not free to increase the total modulation rate, to the condition where this rate may increase.

Implementation:

The examples below are ways in which this may occur, but in implementation what is necessary, first of all, is to use a rate allocator that assigns rate to each slave and can detect when all of the assigned rate is absorbed, or if there is excess requested rate that the firing stages could not absorb.

Then:

1. Whenever the system is rate limited, that is, when A) all firing stages are commanded to their respective maximums and also B) the PID is asking for more

heat than that, note that this has occurred by setting a flag and also record total rate that the system absorbed (the total of the commanded maximums, not the PID's requested rate which might include excess).

2. Whenever the rate allocator completes an execution pass and detects that both conditions of step 1 are no longer true (demand has decreased) then it clears the flag.

3. Whenever the rate allocator completes an execution pass and detects both conditions of step 1 are true, and it also detects that the total rate potentially absorbed by the system (the commands have not yet been sent) has increased from the value that was saved when the flag was set, then it re-computes the integrator value based on the old commanded maximum, clears the flag, and actually allocates the old rate that was saved when the flag was set.

Examples include:

- The rate allocator has encountered a limit such as base load (for a "limited" rate allocation scheme) and this limit is released.
- All stages are at their maximum (base load, or max modulation) and one or more stages are rate-limited (such as due to slow-start or stepped modulation limiting due to high stack temperature, etc.) and the rate limited stage recovers, changing from rate-limited to free to modulate.

(This is indicated by the Slave Status "slave is modulating": the changing from false to true is not, itself, a trigger, but while it is true the rate allocator can assign to the slave only the firing rate that it is reporting; thus the release of this might allow more rate to be absorbed by the system. It also might not do this, if for example the slave was in anti-condensation and thus the rate limit was maximum modulation rate.)

- All firing stages are at their maximum (base load, or max modulation) and a stage which was OnLeave returns in the firing state and is available for modulation.
- An add-stage is in-progress and all firing burners are at their limits (max modulation rate or base load) and then the new stage becomes available.

This also applies when the system is first starting up, that is, all firing burners are at their limits (zero) because non are firing, and thus when the add-stage is finished the system transitions from no modulation at all, to modulating the first stage.

Lead Lag Burner Demand

Lead Lag burner demand will be present when Frost protection burner demand is true, as described in the section on Frost protection. For the CH, and DHW demand sources, Lead Lag burner demand will be true when one of these is true and also setpoint demand from the hysteresis block is true.

Rate Allocation

The PID block's output is used to determine the firing rate of each slave using various rate allocation techniques.

Common Features

All rate allocation methods share certain features.

The rate allocator first generates the **Slave Command.** Except for the Firing state, the value ultimately depends only upon the **SlaveState**. The values are:

Available
AddStage
SuspendStage depending on whether any other slave stage is firing, no matter what SlaveState it is in.
Firing
OnLeave - same as SuspendStage
This ensures that when a slave returns and is already firing, it will remain firing until the master decides what to do about that, or if it is not firing it will remain off.
Disabled - same as Available
Recovering - same as Available

It next runs a rate allocator that depends upon the rate allocation method. This routine fills in the modulation rate for all Firing boilers.

Each rate allocation method also provides functions to return identification of the modulating stage and the last stage, for use by the Add-stage and Drop-stage methods.

Rate Allocation Parameters

BASE LOAD COMMON: 0-100%

If set to zero, this parameter is disabled. For any non-zero value, it uses the individual base load rates of each slave to be ignored by the LL master's routines and this common value to be used instead. It is an easy way to set all base loads to the same value, without having to set each slave.

Some rate allocation algorithms may specify the use of this parameter, and that the slave base load settings are ignored.

RATE ALLOCATION METHOD: PARALLEL COMMON-BASE LIMITED

This selects the rate allocation method. This performs three purposes:

1) it determines how the LL master allocates firing rate to each active stage,

2) the modulating stage and last stage are determined for the

Add-stage and Drop-stage methods,

3) it determines the overflow rate and underflow rate and can provide this to staging algorithms.

OVERFLOW RATE AND UNDERFLOW RATE

The rate allocator knows the rate assigned to each stage, and the requested rate, and thus can determine the difference between these.

This difference has two forms: overflow (used by Add-stage methods), underflow (used by Drop-stage methods).

When asked for rate overflow the threshold that is used is the upper limit of the modulating stage per the current rate allocation rules. Additionally this threshold may be shifted if the Add-stage method is using a dRate/dt behavior. Rate overflow is a positive or negative percentage offset from the threshold. For example:

If the modulating stage is at the staging threshold position but the

LL master is not asking for more heat than this, then the overflow rate is 0%. If it is at this location (limited) or above this location (unlimited) and the LL master is asking for 10% more than the threshold value, then the overflow rate is 10%. If it is below the staging threshold position by 5%, then the overflow rate is -5%.

When asked for rate underflow the threshold that is used is the minimum modulation rate of the last stage. Additionally this threshold may be shifted if the Drop-stage method is using a dRate/dt behavior.

Rate underflow is a positive or negative percentage offset from the threshold. For example:

If the last stage is at the threshold position but the LL master is not asking for less heat than this, then the underflow rate is 0%. If it is at this location and the LL master is asking for 10% less than the threshold value, then the underflow rate is -10%. If the last stage is 5% above the threshold then the underflow rate is 5%.

Rate allocation methods

PARALLEL COMMON-BASE LIMITED

Allocation

All stages that are Firing receive the same firing rate.

Only the **Base load common** parameter is used for base loading, the individual slave's base load values are ignored.

As load increases:

Until all stages are Firing:

No stage is requested to exceed the common base load rate.

After all stages are Firing:

There is no restriction on the slave's commanded firing rate.

As load decreases:

As long as all available stages are Firing There is no restriction on the slave's commanded firing rate.

When at least one stage has been dropped:

No stage is requested to exceed the common base load rate.

MODULATING STAGE

Since all Firing stages receive the same rate, any stage can be considered to be the modulating stage. The one with the highest **StagingOrder** number is considered to be the modulating stage.

Last stage

The stage with the highest **StagingOrder** number is the last stage.

OVERFLOW AND UNDERFLOW

For the **Parallel common-base limited** the **Base load common** parameter provides the overflow threshold.

For the **Parallel common-base limited** the minimum modulation rate provides the underflow threshold.

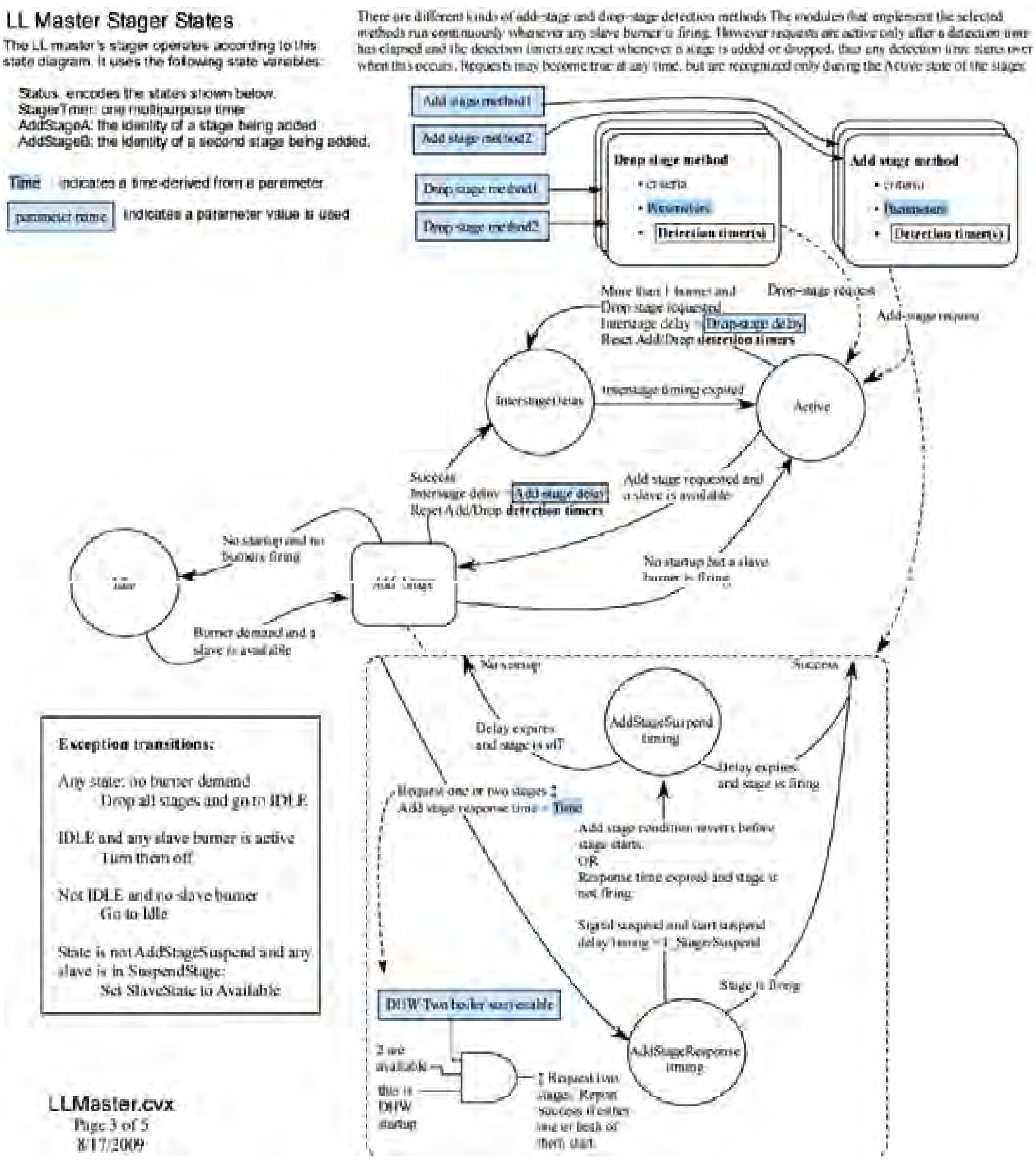
Stager

The Stager is an internal program that determines when slave CB Falcons should turn on as the need for heat increases, and when they should turn off as the need for heat decreases.

In all cases:

- The first burner turns on due to the combination of heat demand (call for heat) and setpoint demand (operating point falls below the setpoint minus the on hysteresis).
- The last burner (or all burners) turn off due to the loss of burner demand which is caused by either the loss of heat demand (no call for heat) or the loss of setpoint demand (the operating point climbs above the setpoint plus the off hysteresis).
- In between those two extremes the Add-stage and Drop-stage methods determine when staging occurs.

The stager handles burner on and burner off events. It operates according to this state transition diagram.



The stager has the following variables:

StagerState: encodes the current state of the stager.
StagerTimer: multipurpose 1 second timer used by states which measure time.
StagerTimeLimit: the timeout value for the StagerTimer
LeadStartup: flag indicating the lead boiler is starting
AddStageA: the stage being added to those already firing

Stager Parameters

ADD-STAGE INTERSTAGE DELAY: MM:SS

This specifies the minimum time that the Stager waits after adding one stage before adding another stage or dropping a stage.

DROP-STAGE INTERSTAGE DELAY: MM:SS

This parameter specifies the minimum time that the Stager waits after dropping one stage before dropping another stage or adding a stage.

Functions common to all stager states

These functions handle overall burner demand responsibility, and take care of cleaning up any anomalous conditions.

BURNER DEMAND

The stager checks the Master's LL burner demand. If this demand is off all slaves with SlaveStates of AddStage, SuspendStage, or Firing are set to Available by the Rate Allocator turning them all off and the **StagerState** is set to be Idle.

STAGERSTATE = IDLE WITH SLAVES ACTIVE

If the stager runs and its state is Idle, it checks the status of all slaves. If any of these have **SlaveState**=AddStage, SuspendStage, or Firing then these are set to Available (this will cause the Rate Allocator to turn them all off).

Stager States

The stager's operation is defined for each of its states:

STAGERSTATE = IDLE

Burner demand means that a demand source is calling for heat and there is also setpoint demand.

When there is no burner demand the stager is forced to be **Idle**.

When burner demand becomes true (Call for Heat) the stager checks the sequencer to identify the lead boiler. That boiler is given a command to start.

The stager resets (to verify it is at 0) and starts its **StagerTimer**, and sets the **StagerTimeLimit** to the value of the slave's **Demand-to-firing delay** time.

If the Stager fails to get even one boiler from the Sequencer, it issues an alert and suspends until it runs again.

STAGERSTATE = ADDSTAGERESPONSE

During this state the stager is waiting for slave to transition to Firing.

If the identified boiler has a **SlaveState**=Firing then the stager:
Resets and starts it's **StagerTimer**, sets the **StagerTimeLimit** to **Add-stage interstage delay,** and changes the **StagerState** to InterstageDelay.

If the boiler's **SlaveState** is still AddStage then:

The stager checks to see if the **StagerTimer** has reached the **StagerTimeLimit**.

If so then the stager: Changes the **SlaveState** to SuspendStage, resets and starts its **StagerTimer**, sets the **StagerTimeLimit** to T_StagerSuspend. This allows additional time for the slave to reach its firing condition.

STAGERSTATE = ADDSTAGESUSPEND

During this state the stager is waiting to see if the slave has transitioned to Firing or Available.

If the identified boiler has a **SlaveState**=Firing then the stager:

Resets and starts its **StagerTimer**, sets the **StagerTimeLimit** to **Add-stage interstage delay,** it changes the **StagerState** to InterstageDelay.

The stager checks to see if the **StagerTimer** has reached the **StagerTimeLimit.**

If so then:
If the boiler's **SlaveState** is set to Available.

If any slave boiler is firing then **StagerState** = Active
Otherwise **StagerState** = Idle

STAGERSTATE = ACTIVE

During this state the stager is ready to manage add-stage and drop-stage requests.

If **AddStageRequest** is true

The Stager ask the Sequencer for an available slave.

When an available slave is found the stager repeats the above steps to bring this stage to Active.

If **DropStageRequest** is true and more than 1 slave burner is firing, the stager:

Invokes **SetRecovering** for the stage identified by **DropStageRequest**. This will turn the stage off and put it into the recovering state until it has finished its post-purge (if any).

Resets and starts its **StagerTimer**, sets **StagerTimeLimit** to **Drop-stage interstage delay,** changes the **StagerState** to InterstageDelay, invokes an action to reset the Add/Drop detection timers.

When the Interstage time has elapsed, the Stager can execute an AddStage or DropStage request.

Add Stage Methods

Various methods can be used to determine when a new stage should be added. The internal algorithms that generate **AddStageRequests** are called Add-stage methods.

All methods work by observing various criteria such as the Firing stages, the commanded rate, or setpoint error.

Adding Stages Parameters:

ADD-STAGE DETECTION TIME1: MM:SS

This provides time thresholds.

In the descriptions below, the relevant parameter is referred to as **Add-Stage detection time*N***.

Add-Stage method1:
Disable,
Error threshold,
Rate threshold,
dError/dt and threshold,
dRate/dt and threshold }

In the descriptions below, the relevant AddStageDetectTimer is referred to as AddStageDetectTimer*N*.

ADD-STAGE ERROR THRESHOLD: DEGREES

This provides the error threshold as defined by the methods below.

ADD-STAGE RATE OFFSET: -100% TO +100%

This provides the rate offset threshold as defined by the methods below.

Add-stage methods

ERROR THRESHOLD

For error threshold staging, a stage is added when the error becomes excessive based on degrees away from setpoint, and time.

ADD-STAGE CONDITION:

- The modulating burner(s) is at its (their) maximum position per the rate allocation rules,
- The operating point is below the setpoint by an amount greater than or equal to **Add-stage error threshold**

When the Add-stage condition is false then **AddStage-DetectTimer*N*** is set to zero. (If the condition is true then **AddStageDetectTimer*N*** is not zeroed and thus allowed to run.) If this timer reaches or exceeds **LL-Add-stage detection time*N*** then **AddStageRequest*N*** is true.

RATE THRESHOLD

For rate based staging, a stage is added based on the rate of the modulating stage.

ADD-STAGE CONDITION:

The modulating burner is at a rate that is at or above the rate which is calculated by adding the **Add-stage rate offset** to the maximum position per the rate allocation rules.

Examples:

rate offset = 20% The add-stage condition will occur if the modulating stage is 20% above base load for unlimited allocations, or, if limited, when there is 20% more rate to distribute than can be absorbed by firing the stages at base load.

rate offset = -20% The add-stage condition will be as described just above, but the threshold is now 20% below the modulating stage's base load rate.

To support this, the current Rate Allocation method asks for the current "Overflow rate" - see the Rate Allocator section.

Drop Stage Methods

Various methods can be used to determine when a stage should be dropped. The internal algorithms that generate **DropStageRequests** are called Drop-stage methods.

One or two methods may be active at any time. If two are active then their requests are OR'd together.

All methods work by observing various criteria such as the Firing stages, the commanded rate, or Setpoint.

Dropping Stages Parameters:

DROP-STAGE DETECTION TIME: MM:SS

This provides time thresholds. They differ only in that: **Drop-Stage detection time** is used with **DropStageDetectTimer**

In the descriptions below, the relevant parameter is referred to as **LL – Drop Stage detection time*N*}**.

Drop-Stage method:
Disable,
Error threshold,
Rate threshold,
dError/dt and threshold,
dRate/dt and threshold

DROP-STAGE ERROR THRESHOLD: DEGREES

This provides the error threshold as defined by the methods below.

DROP-STAGE RATE OFFSET: -100% TO +100%

This provides the rate offset threshold as defined by the methods below.

LL boiler off options:
Options disabled,
Enable all boilers off (ABO)
Enable lead drop-stage on error (LDSE)
Enable both ABO and LDSE

This provides options for customizing the way stages are dropped, as described below.

LL ALL BOILERS OFF THRESHOLD: TEMPERATURE OR NONE

When the LL boiler off options specifies "Enable all boilers off (ABO)" or "Enable both ABO and LDSE" then this parameter provides the boiler off threshold temperature that is used. In this case, if the temperature is the None value then a parameter error lockout occurs.

Drop-stage methods:

Error threshold

For error threshold staging, a stage is dropped when the error becomes excessive based on degrees away from setpoint and time.

DROP-STAGE CONDITION:

- The modulating burner(s) is at its (their) minimum position per the rate allocation rules,
- The operating point is above the setpoint by an amount greater than or equal to **Drop-stage error threshold**

When the Drop-stage condition is false then

DropStageDetectTimer*N* is set to zero. (If the condition is true then

DropStageDetectTimer*N* is not zeroed and thus allowed to run.) If this timer reaches or exceeds **Drop-stage detection time*N*** then **DropStageRequest*N*** is true.

Rate threshold

For rate based staging, a stage is dropped based on the rate of the last stage.

DROP-STAGE CONDITION:

-The modulating burner(s) is at a rate that is at or below the minimum modulation rate plus a rate offset.

Examples:

rate offset = 20% The Drop-stage condition will occur when the last stage is less than a threshold that is the minimum modulation rate plus another 20%.

rate offset = 0% The Drop-stage condition will occur when the last stage is at the minimum modulation rate.

rate offset = -20% The Drop-stage condition will occur if the last stage is at minimum modulation and there is 20% less rate to distribute than can be absorbed; that is, the rate allocator would like the minimum modulation rate to be lower than it is.

To support this, the current Rate Alloction method asks for the current "Underflow rate" - see the Rate Allocator section.

Boiler off options

The **LL boiler off option** controls two optional behaviors. One option is to enable the use of the **LL all boilers off threshold** and is abbreviated "ABO", and the other controls whether a lead boiler is affected by a drop-stage method based upon error, and is abbreviated as "LDSE".

ALL BOILERS OFF - ABO:

The ABO temperature provides a Burner Off threshold that essentially replaces the normal Burner Off threshold as given by the **LL off hysteresis** parameter; it is processed by the same logic block using some additional rules.

If ABO is enabled then:

- When the LL master operating point reaches or exceeds the ABO threshold this turns off LL master burner demand.
- The Burner Off threshold provided by **LL off hysteresis** is ignored if one or more lag boilers are firing.
- If LDSE is enabled:
  The Burner Off threshold provided by **LL off hysteresis** is ignored also for the lead boiler when it is firing solo (i.e. when no lag boilers are firing).
- If LDSE is disabled:
  When the lead is firing solo and the operating point reaches the Burner Off threshold specified by **LL off hysteresis** turns off LL master burner demand (and thus the lead boiler).

As usual, whenever LL master burner demand is turned off by its hysteresis block, it does not recur until the operating point falls below the Burner On threshold.

Summary of the burner-off thresholds that are used:

LDSE	ABO	DSE		
enabled	**enabled**	**exists**	**LL Off Hysteresis**	**All Boilers Off Threshold**
0	0	x	OpPt > Off Hyst means all off	Ignored (disabled)
0	1	x	OpPt > Off Hyst ignored if lags exist. OpPt > Off Hyst drops lead if it is solo.	OpPt > ABO means all off
1	0	0	Illegal, param error lockout	
1	0	1	Same thresholds as "0 0 x" above.	
1	1	0	Illegal, param error lockout	
1	1	1	Ignored by both lags and lead.	OpPt > ABO means all off

LEAD DROP-STAGE ON ERROR - LDSE:

If LDSE is enabled then either **Drop-stage method1** must be enabled to provide staging based on "Error threshold"; otherwise a parameter error lockout occurs.

Normally, for a lag boiler, dropping a stage based on error involves meeting three criteria: 1) the operating point temperature must exceed an offset from setpoint, 2) this condition must persist for a period of time, and 3) the measured time starts only when the modulating boilers are firing at the minimum modulation rate. And normally when LDSE is not enabled, the lead boiler is special case that is not affected by a drop-stage event: it shuts down only when the operating point reaches the burner-off threshold (or ABO threshold, if that is enabled).

If LDSE is enabled:

- Enabling (or disabling) LDSE has no effect on the drop-stage behavior for a lag boiler; however
- When only the lead boiler is firing then an error based drop-stage event does act to drop the lead boiler, and moreover, only one of the three criteria above are considered by the method in this case: the operating point temperature. Thus dropping the lead does not depend on exceeding this temperature for a period of time, nor does it require the lead to be at minimum modulation rate. When LDSE is enabled and the lead is firing solo, then simply reaching the drop-stage threshold causes a dropstage event that causes the lead to turn off and **[rf3259]** which thus ends LL master demand until the operating point again falls to the Burner On threshold.

Sequencer

The sequencer determines which CB Falcon will be the next one to turn on or turn off whenever an Add-stage event occurs. It maintains the following variables:

LeadBoilerSeqNum - sequence number of the current lead boiler in the Slave Status table.

Lead BoilerRunTime - the cumulative time that the current lead boiler has been running

In all cases, if a boiler sequence number is needed and **Slave sequence order** is 0, then the boiler's ModBus address is used as its sequence number.

In all cases, if two boilers being compared have the same effective sequence

number, then the one that is selected is undefined (either may prevail).

Sequencer Parameters

LEAD SELECTION METHOD: ROTATE IN SEQUENCE ORDER, MEASURED RUN TIME

This determines the selection method for lead selection and sequencing, as described below.

LAG SELECTON METHOD: SEQUENCE ORDER, MEASURED RUN TIME

This determines the selection method for lag selection and sequencing, as described below.

LEAD ROTATION TIME: HH:MM OR NONE

This determines the lead rotation time as defined below.

FORCE LEAD ROTATION TIME: HH:MM OR NONE

If this parameter is a non-zero time, then it is used to force the rotation of the lead boiler if it stays on longer than the time specified.

Sequencer Add Boiler Selection

The sequencer selects the next boiler to be added according to a sorted order. This description assumes this is implemented by assigning an ordering number and that the lowest numbers are the first to be added.

- Any Available slaves that have a mode of Use First will have the lowest ordering numbers. If two or more Use First boilers exist, they are numbered according to their assigned **Slave sequence order** or Modbus address if this value is zero**,** as descibed above.
- Next are slaves that have the mode of Equalize Runtime. When the add boiler routine gets to this group it first invokes the Voluntary Lead Rotation routine (to make sure this is done, but only once) and then selects an Available boiler, if any, ordered according to:
  — The first is the lead boiler per the **LeadBoilerSeqNum** parameter.
  — The rest are the other slaves ordered according to the **LL –Lag selection method}** parameter:
- If this parameter is "Rotate in sequence order", then they are ordered according to their **LL – Slave sequence order** or Modbus address if this value is zero**,** as descibed above.
- If this parameter is "Measured run time" then they are ordered according to their reported run time. If two have the same measured run time, then either may be selected.
- Last are any Available slaves that have a mode of Use Last. These will have the highest numbers. If two or more Use Last boilers exist, they are numbered according to their assigned **Slave sequence order** or Modbus address if this value is zero**,** as described above.

Voluntary Lead Rotation

The current lead boiler is identified by the **LeadBoilerSeqNum** value. This value will change when the stager has asked the sequencer for a boiler to add and either:

- the boiler identified by **LeadBoilerSeqNum** is neither Available nor Firing (i.e. it has a fault or is OnLeave), or
- the **LeadBoilerRunTime** value exceeds **Lead rotation time**.

In either of these cases, the algorithm performed is:
If the **Lead selection method** is "Rotate in sequence order", then **LeadBoilerSeqNum** is incremented, and then new lead boiler is the one that is a slave in Equalize Runtime mode that is responding to the LL master (i.e. not OnLeave or Recovering, but it might be Firing), and:

— has a sequence number equal to **LeadBoilerSeqNum**, or.
— If no boiler has this then the closest one with a sequence number greater than this number is used, or
— If no boiler has a greater sequence number, then the one that has the smallest sequence number is used (wrap around).

Otherwise when the **Lead selection method** is "Measured run time", then the lead boiler is the one having the lowest Measured run time value. If two have the same measured run time, then either may be selected.

The **LeadBoilerRunTime** value is then set to zero to give the new lead boiler a fresh allotment.

Note: if the old lead boiler is the only one, then this process may end up re-designating this as the "new" lead with a fresh time allotment.

Sequencer ordering function

Part of the sequencer is called by the stager just before the stager runs, to give the sequencer a chance to assign order numbers to stages that very recently turned on, and to maintain these in a sequence. It uses the **StagingOrder** item in the Slave Status table for this purpose.

The sequencer ordering function examines all slaves and sets to zero the **StagingOrder** of any stage that is not Firing.

This ensures that any stage that has left the Firing condition recently is no longer in the number sequence.

Next, skipping all of those that have 0 values in **StagingOrder** it finds the lowest numbered StagingOrder and gives it the value 1, the next receive 2, etc.

Thus if gaps have developed due to a slave dropping out these are filled in.

Finally, the ordering function continues on, giving the next numbers to and Firing stages which have a 0 StagingOrder values (i.e. they recently were added, or they recently returned from OnLeave).

Example:

	Before	After
Notfiring	3	0
Notfiring	0	0
Firing	2	1
Firing	5	3
Firing	0	4
Firing	4	2

Sequencer Drop Lag boiler selection

When the stager asks the sequencer for a lag boiler to drop the sequencer looks at the StagingOrder numbers of all Firing boilers. If only one Firing boiler is found, or none are found, then this selection function returns a value that indicates no boiler may be dropped. Otherwise it returns an identifier for the boiler having the highest **StagingOrder** number**.**

SEQUENCER 1 MINUTE EVENT

Part of the sequencer is called by the timing service at a 1 minute rate to implement lead rotation.

The 1 minute event checks the boiler identified by **LeadBoilerSeqNum.** If it is Firing then the **LeadBoilerRunTime** is incremented.

FORCED LEAD ROTATION:

When the boiler identified by **LeadBoilerSeqNum** is firing and also **LeadBoilerRunTime** reaches the **Force lead rotation time** parameter time then:

1. The current lead boiler is noted.
2. Lead rotation occurs as described above under Voluntary Lead Rotation (this changes the designation, but does not change the actual firing status).

SLAVE WRITE: DATA

This allows the slave to accept command messages from a CB Falcon master

SLAVE READ: DATA

This provides the slave status message to be read by a CB Falcon Master. It includes all of the data that is read from a slave.

SLAVE MODE: USE FIRST, EQUALIZE RUNTIME, USE LAST

- If set to Use First, then this slave will be used prior to using other slaves with other values.
- If this parameter is set to Equalize Runtime, then this slave will be staged according to a run time equalization. (Any units set to Use First will precede any that are set to Equalize Runtime.)
- If this parameter is set to Use Last, then this slave will be used only after all Use First and Equalize Runtime units have been brought online.

SLAVE PRIORITY SEQUENCE ORDER: 0-255

Slave sequence order is used to determine the order in which the slaves will be used (staged on) for those with the same Slave mode setting. Numbers may be skipped, that is 3 will be first if there is no 1 or 2.

NOTE: For Equalize Runtime purposes, 1 does not mean the CB Falcon will be used first every time; that will vary over time based on the master's run time equalization scheme. In this case the sequence number determines the relative order in which CB Falcon controls will be used in a round-robin scheme.

If the slave sequence number value is zero, then the slave CB Falcon's ModBus address will be used instead.

If two CB Falcons are set to the same mode and both have the same sequence number then an alert will occur and the order in which they are used will be arbitrary and is not guaranteed to be repeatable.

MODBUS

Building Energy Management System (EMS) interface

The following is used as a reference in this document:
MODBUS Application Protocol Specification V1.1a, June 4, 2004, http://www.Modbus-IDA.org.

This appendix describes the interface to the CB Falcon boiler controller on either the MB1 or MB2 Modbus port and the Falcon display COM 2 port. These ports are RS-485 connections that use the Modbus communication protocol to allow configuration and status data to be read from and written to the Falcon.

The CB Falcon functions as a Modbus Slave on this interface. It responds to a single Modbus address to service the requests of the Modbus Master on the RS-485 network.

Definitions

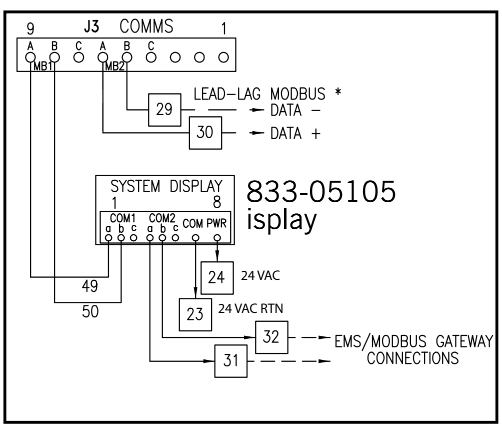
The following definitions apply in this appendix:

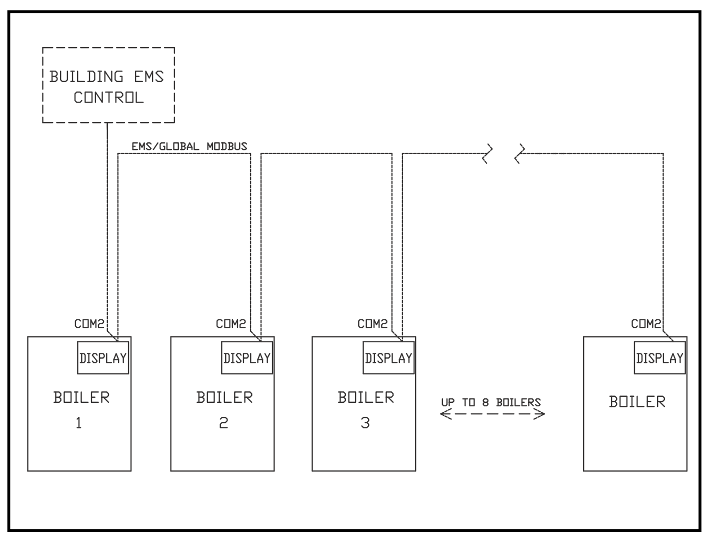
Modbus—Application layer communication protocol standard adopted by the Modbus-IDA trade association. Recognized as an industry standard protocol for RS-485 serial communication.

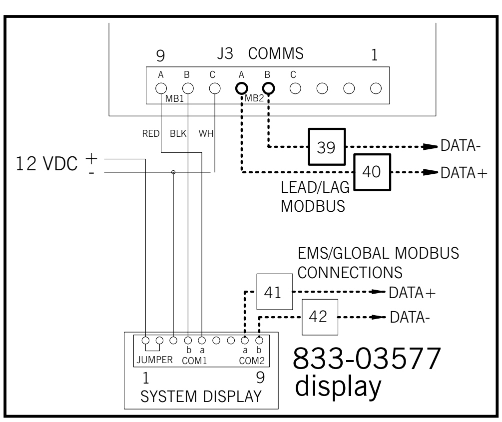
RTU—Remote Terminal Unit serial transmission mode. Mode used to encode data for Modbus where each 8-bit byte is sent as two 4-bit hexadecimal characters.

WIRING

Shown below are wiring connections at each boiler and network connections for EMS communication.







ENABLING MODBUS COMMUNICATIONS

To establish communications with a building EMS, each Falcon display in the lead lag network must have its COM 2 Modbus port enabled. Use the following steps to enable:

1. On the display Home page press <SETUP>. 

2. Go to <DISPLAY SETUP>.
3. Go to the COM 2 tab. Make sure ‘Enable Modbus Gateway?’ is checked. The Modbus baud rate can also be changed here if necessary (selectable between 38400, 19200, or 9600).

NOTE: The Modbus Gateway must be enabled at *each* boiler in the lead lag network (not just the Master host) for individual boiler status monitoring.

INTERFACE

Physical Layer

The Falcon Modbus port is a 3-pin connector that interfaces to RS-485 signals as indicated in Table 1.

Table 1: RS-485 signals

Signal	Terminal
Data + (a)	1
Data - (b)	2
Common (c)	3

The serial transmission mode on the Modbus network is the RTU mode. Message format has the characteristics shown in Table 2.

Table 2: RS-485 message format

Coding system	8-bit binary
Number of data bits per character	10 = 1 start bit 8 data bits No parity bit 1 stop bit
Bit transfer rate	38400 bps
Duplex	Half duplex
Error checking	2 byte CRC-16 polynomial
Bit transfer order	LSB first
End of message	Idle line for 3.5 or more characters

Application Layer

The Falcon Modbus interface supports the following function codes:

- 03 (0x03) Read Holding Registers
- 06 (0x06) Write Single Register
- 16 (0x10) Write Multiple Registers
- 17 (0x11) Report Slave ID

All the configuration and status data are accessed as 16-bit holding registers in this interface. Since all Falcon digital signals accessed in this interface are read only, these digital signals are mapped to bits within holding registers instead of coils or discrete inputs, to simplify the interface. Variable length data are also represented by holding registers and therefore must be accessed individually and not as part of a group. The length of the variable length data is returned in the response. All 32-bit data items are accessed as two consecutive, 16-bit holding registers, i.e., each item uses 2 register address spaces.

Except for variable length data items the registers can be accessed as a single register or up to 20 registers for writes and 125 registers for reads. Data is mapped into logical groups with room for future expansion, so some gaps exist in the register map.

Data organization is intended to allow for efficient register access. Status data is organized into register blocks by application function and a function status change indicator is used to denote when any data has changed within the register block since the last time the registers were read (See Fig. 1). The Falcon sets the status change indicator bit when at least one of the registers in the functional block has changed value since it was last read. The Modbus master can read the status change register and determine which functional register blocks have changed value since its last access and only read those register blocks. The Modbus master can ignore the status change register and poll status data as it deems fit.

MODBUS REGISTERS

Bolded registers are typical boiler/burner status monitoring points.					
Highlighted registers are allowed Modbus read/write points.					
Hex	Decimal	Parameter	R/W	Format	Description
		CONTROLLER STATUS			
0002	0002	Digital I/O	R	U16	Bit map:
					15=Safety relay
					14=Time of Day
					13=STAT (Demand)
					12=High Fire Switch (HFS)
					11=Low Fire Switch (LFS)
					10=Load Control Input(LCI)
					9=Pre-ignition interlock (PII)
					8=Interlock (ILK)
					7=Alarm
					6=Main valve (ignored on DBI burner)
					5=Pilot valve (Main fuel valve on DBI burner)
					4=Ignition
					3=Blower motor
					2=Pump C
					1=Pump B
					0=Pump A
0003	0003	Annunciation I/O	R	U16	Only applicable when Annunciation is enabled Bit map: 15-14=Reserved (always 0) 13=STAT2 12-8=Reserved (always 0)
					7=Annunciator 8 - Propane (LP) gas (dual fuel burner)
					6=Annunciator 7 - Natural Gas (dual fuel burner)
					5=Annunciator 6 - Low Gas Pressure
					4=Annunciator 5 - High Gas Pressure
					3=Annunciator 4 - High Air Pressure
					2=Annunciator 3 - Auxiliary Low Water
					1=Annunciator 2 - Low Water
					0=Annunciator 1 - Interrupted Air Switch
		TREND STATUS			
0006	0006	Demand source	R	U16	Current demand source: 0=Unknown, 1=No source demand, 2=CH, 3=DHW, 4=Lead Lag slave, 5=Lead Lag master, 6=CH frost protection, 7=DHW frost protection, 8=No demand due to burner switch (register 199) turned off, 9=DHW storage, 10=Mix
0007	0007	Outlet Limit channel	R	U16	-40°-130° (0.1°C precision)
0008	0008	Firing rate	R	U16	Actual firing rate (% or RPM).
0009	0009	Fan speed	R	U16	RPM
000A	0010	Flame signal	R	U16	0.01V or 0.01?A precision (0.00-50.00V)
000B	0011	Inlet channel	R	U16	-40°-130° (0.1°C precision)
000C	0012	DHW Limit channel	R	U16	-40°-130° (0.1°C precision)
000D	0013	Outdoor channel	R	U16	-40°-130° (0.1°C precision)
000E	0014	Stack Limit channel	R	U16	-40°-130° (0.1°C precision)
000F	0015	Header channel	R	U16	-40°-130° (0.1°C precision)
0010	0016	Active CH setpoint	R	U16	-40°-130° (0.1°C precision) Setpoint determined by CH set-point source (register 65).
0011	0017	Active DHW setpoint	R	U16	-40°-130° (0.1°C precision) Setpoint determined by DHW set-point source (register 81).
0013	0019	Register Access Status	R	U16	Register data write access status:
					0=No register writes allowed,
					1=Installer register writes allowed,
					2=OEM register writes allowed.
					3=All register writes allowed.
0015	0021	Analog remote input	R	U16	0=No signal, 4-20 mA (0.1 mA precision)
		BURNER CONTROL STATUS			
0020	0032	Burner control status	R	U16	0=Disabled, 1=Locked out, 2-3=Reserved, 4=Anti-short cycle, 5=Unconfigured safety data, 6-33=Reserved, 34=Standby Hold, 35=Standby Delay, 36-47=Reserved, 48=Normal Standby, 49=Preparing, 50=Firing, 51=Post-purge, 52-65535=Reserved

Bolded registers are typical boiler/burner status monitoring points.					
					0=Disabled
					1=Locked out
					4=Anti-short cycle
					5=Unconfigured safety data
					34=Standby Hold
					35=Standby Delay
					48=Normal Standby
					49=Preparing/Pre-purge/Ignition
					50=Firing
					51=Postpurge
0021	0033	Burner control state	R	U16	Burner control sequence (I/O) state. Different states exist between residential & commercial models (see tables 10 & 11). Model type determined by register 176.
					0=Initiate
					1=Standby Delay
					2=Standby
					3=Safe Startup
					4=Prepurge - Drive to Purge Rate
					5=Prepurge - Measured Purge Time
					6=Perpurge - Drive to Lightoff Rate
					7=Preignition Test
					8=Preignition Time
					9=Pilot Flame Establishing Period (Main Trial for Ignition with DBI)
					10=Main Flame Establishing Period (Not used with DBI)
					12=Run
					13=Postpurge
					14=Lockout
					255=Safety Processor Offline
0022	0034	Lockout code (Active)	R	U16	0=No lockout, 1-4096 (refer to Table 44, Falcon Lockout and Hold Codes)
0024	0036	Annunciator first out	R	U16	Source for annunciator first out:
					0=None or undetermined
					1=ILK
					2=PII
					11=Annunciator 1 - Interrupted Air Switch
					12=Annunciator 2 - Low Water
					13=Annunciator 3 - Auxiliary Low Water
					14=Annunciator 4 - High Air Pressure
					15=Annunciator 5 - High Gas Pressure
					16=Annunciator 6 - Low Gas Pressure
					17=Annunciator 7
					18=Annunciator 8
0025	0037	Annunciator hold	R	U16	Source for burner control hold condition (see Hold code):
					0=None or undetermined
					1=ILK
					2=PII
					3=LCI
					11=Annunciator 1 - Interrupted Air Switch
					12=Annunciator 2 - Low Water
					13=Annunciator 3 - Auxiliary Low Water
					14=Annunciator 4 - High Air Pressure
					15=Annunciator 5 - High Gas Pressure
					16=Annunciator 6 - Low Gas Pressure
					17=Annunciator 7
					18=Annunciator 8
0026	0038	Sequence time	R	U16	Running time for timed burner control operation (seconds)
0027	0039	Delay time	R	U16	Running delay time (seconds). Applicable when burner control in delayed or hold state.
0028	0040	Hold code	R	U16	Reason for burner hold (same codes as lockout, see Table 44)
0029	0041	Burner control flags	R	U16	Bit map: 15-1=Reserved (always 0) 0= Flame detected
		SENSOR STATUS			
002B	0043	Outlet OP channel (J8-10)	R	U16	-40°-130° (0.1°C precision) or other (see register 610)
002C	0044	DHW OP channel (J9-3)	R	U16	-40°-130° (0.1°C precision) or other (see register 612)

Bolded registers are typical boiler/burner status monitoring points.

002D	0045	Stack OP channel (J9-6)	R	U16	-40°-130° (0.1°C precision) or other (see register 613)
		DEMAND & MODULATION STATUS			
0038	0056	Active rate limiter	R	U16	0=None, 1=Outlet high limit, 2=Delta T limit, 3=Stack limit, 4=Slow start limit, 5=Anti-condensation, 6=Minimum modulation, 7=Forced rate
0039	0057	Limited rate	R	U16	RPM or %
003A	0058	Active rate override	R	U16	0=None, 1=Burner control default, 2=Burner control, 3=Manual firing rate, 4=Manual firing rate off
003B	0059	Override rate	R	U16	RPM or %
003C	0060	Demand rate	R	U16	RPM or %
		CENTRAL HEATING (CH) STATUS			
0040	0064	CH status	R	U16	0=Unknown, 1=Disabled, 2=Normal, 3=Suspended
0041	0065	CH setpoint source	R	U16	0=Unknown, 1=Normal setpoint, 2=TOD setpoint, 3=Outdoor reset, 4=Remote control
0042	0066	CH heat demand	R	U16	0=Off, 1=On
0043	0067	CH burner demand	R	U16	0=Off, 1=On
0044	0068	CH requested rate	R	U16	RPM or %
0045	0069	CH frost heat demand	R	U16	0=Off, 1=On
0046	0070	CH frost burner demand	R	U16	0=Off, 1=On
0047	0071	Active CH on hysteresis	R	U16	0°-130° (0.1°C precision)
0048	0072	Active CH off hysteresis	R	U16	0°-130° (0.1°C precision)
		DOMESTIC HOT WATER (DHW) STATUS			
0050	0080	DHW status	R	U16	0=Unknown, 1=Disabled, 2=Normal, 3=Suspended
0051	0081	DHW setpoint source	R	U16	0=Unknown, 1=Normal setpoint, 2=TOD setpoint, 3=Outdoor reset
0052	0082	DHW priority count	R	U16	Countdown of time when DHW has priority over CH (secs). Applicable when DHW priority time is enabled (see register 452).
0053	0083	DHW heat demand	R	U16	0=Off, 1=On
0054	0084	DHW burner demand	R	U16	0=Off, 1=On
0055	0085	DHW requested rate	R	U16	RPM or %
0056	0086	DHW frost heat demand	R	U16	0=Off, 1=On
0057	0087	DHW frost burner demand	R	U16	0=Off, 1=On
0058	0088	Active DHW on hysteresis	R	U16	0°-130° (0.1°C precision)
0059	0089	Active DHW off hysteresis	R	U16	0°-130° (0.1°C precision)
		PUMP STATUS			
0060	0096	CH pump status	R	U16	See table 41.
0061	0097	CH pump overrun time	R	U16	Running overrun time for CH pump (seconds)
0062	0098	CH FP overrun time	R	U16	Running overrun time for CH pump due to frost protection (seconds)
0063	0099	CH pump idle days count	R	U16	Number of days that CH pump has not run (sat idle).
0064	0100	DHW pump status	R	U16	See table 41.
0065	0101	DHW pump start delay time	R	U16	Count down (seconds) when DHW pump is delayed from starting.
0066	0102	DHW pump overrun time	R	U16	Running overrun time for DHW pump (seconds)
0067	0103	DHW FP overrun time	R	U16	Running overrun time for DHW pump due to frost protection (seconds)
0068	0104	DHW pump idle days count	R	U16	Number of days that DHW pump has not run (sat idle).
0069	0105	System pump status	R	U16	See table 41.
006A	0106	System pump overrun time	R	U16	Running overrun time for Lead Lag pump (seconds)
006B	0107	System pump idle days count	R	U16	Number of days that LL pump has not run (sat idle).
006C	0108	Boiler pump status	R	U16	See table 41.
006D	0109	Boiler pump overrun time	R	U16	Running overrun time for Boiler pump (seconds)
006E	0110	Boiler pump idle days count	R	U16	Number of days that boiler pump has not run (sat idle).
006F	0111	Auxiliary pump status	R	U16	See table 41.
0070	0112	Auxiliary pump idle days count	R	U16	Number of days that auxiliary pump has not run (sat idle).
		STATISTICS			
0080- 0081	0128- 0129	Burner cycle count	R	U32	0-999,999
0082- 0083	0130- 0131	Burner run time	R	U32	Hours

Bolded registers are typical boiler/burner status monitoring points.					
0084- 0085	0132- 0133	CH pump cycle count	R	U32	0-999,999
0086- 0087	0134- 0135	DHW pump cycle count	R	U32	0-999,999
0088- 0089	0136- 0137	System pump cycle count	R	U32	0-999,999
008A-008B	0138- 0139	Boiler pump cycle count	R	U32	0-999,999
008C- 008D	0140- 0141	Auxiliary pump cycle count	R	U32	0-999,999
008E-008F	0142-0143	Controller cycle count	R	U32	0-999,999
0090- 0091	0144- 0145	Controller run time	R	U32	Hours
		SYSTEM CONFIGURA-TION			
00B1	0177	Password	W		Variable length password string (up to 20 characters) requesting ICP permission to write registers.
00B2	0178	Temperature units	R	U16	Display format for temperature at user interface: 0=°F (Fahrenheit), 1=°C (Celsius)
00B3	0179	Antishort cycle time	R	U16	0-28800 seconds (8 hours), 0xFFFF=Not configured
00B4	0180	Alarm silence time	R	U16	0-600 minutes
00B6	0182	Reset and restart	W	U16	Successful login required before request is granted. Force soft reset of ICP subsystems:
					0=None,
					1=Burner control,
					2=Application,
					3=Burner control & application,
					4=Clear alert log
00B7	0183	Burner name	R		Variable length string (up to 20 characters)
00B8	0184	Installation data	R		Variable length string (up to 20 characters)
		MODULATION CONFIGU-RATION			
00C1	0193	CH maximum modulation rate	R	U16	RPM or %
00C2	0194	DHW maximum modulation rate	R	U16	RPM or %
00C3	0195	Minimum modulation rate	R	U16	RPM or %
00C4	0196	Prepurge rate	R	U16	SAFETY parameter: RPM or %
00C5	0197	Lightoff rate	R	U16	SAFETY parameter: RPM or %
00C6	0198	Postpurge rate	R	U16	SAFETY parameter: RPM or %
00C7	0199	CH forced rate	R	U16	RPM or %
00C8	0200	CH forced rate time	R	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
00C9	0201	DHW forced rate	R	U16	RPM or %
00CA	0202	DHW forced rate time	R	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
00CB	0203	Burner switch	R/W	U16	0=Off, 1=On. Used to enable/disable burner control.
00CC	0204	Firing rate control	R	U16	0=Auto, 1=Manual in Run, 2=Manual in Run&Standby
00CD	0205	Manual firing rate	R	U16	Firing rate used when control is set to manual (% or RPM)
		CH CONFIGURATION			
00D0	0208	CH enable	R/W	U16	0=Disable Central Heating, 1=Enable Central Heating
00D3	0211	CH setpoint	R/W	U16	-40°-130° (0.1°C precision)
00D4	0212	CH time of day setpoint	R	U16	-40°-130° (0.1°C precision) Setpoint when Time Of Day switch is on.
00D5	0213	CH on hysteresis	R	U16	0°-130° (0.1°C precision)
00D6	0214	CH off hysteresis	R	U16	0°-130° (0.1°C precision)
00D7	0215	CH outdoor reset enable	R	U16	0=Disable outdoor reset, 1=Enable outdoor reset
		DHW CONFIGURATION			
01C0	0448	DHW enable	R/W	U16	0=DHW disabled, 1=DHW enabled
01C5	0453	DHW setpoint	R/W	U16	-40°-130° (0.1°C precision)
01C6	0454	DHW time of day setpoint	R	U16	-40°-130° (0.1°C precision) Setpoint when Time Of Day switch is on.
01C7	0455	DHW on hysteresis	R	U16	0°-130° (0.1°C precision)
01C8	0456	DHW off hysteresis	R	U16	0°-130° (0.1°C precision)
		LIMITS CONFIGURATION			
01D0	0464	Outlet high limit setpoint	R	U16	SAFETY parameter: -40°-130° (0.1°C precision)
01D3	0467	Stack limit setpoint	R	U16	SAFETY parameter: -40°-130° (0.1°C precision)
01D7	0471	Delta-T inlet/outlet degrees	R	U16	Temperature delta between inlet & outlet sensors when Delta-T limit occurs: 0°-130° (0.1°C precision)
01DB	0475	DHW high limit setpoint	R	U16	SAFETY parameter: -40°-130° (0.1°C precision)
		OUTDOOR RESET (ODR) CONFIGURATION			

Bolded registers are typical boiler/burner status monitoring points.					
0200	0512	CH ODR maximum outdoor temperature	R	U16	-40°-130° (0.1°C precision)
0201	0513	CH ODR minimum outdoor temperature	R	U16	-40°-130° (0.1°C precision)
0202	0514	CH ODR low water temperature	R	U16	-40°-130° (0.1°C precision)
0203	0515	CH ODR boost time	R	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0204	0516	CH ODR boost maximum setpoint	R	U16	-40°-130° (0.1°C precision)
0205	0517	Lead Lag ODR maximum outdoor temperature	R	U16	-40°-130° (0.1°C precision)
0206	0518	Lead Lag ODR minimum outdoor temperature	R	U16	-40°-130° (0.1°C precision)
0207	0519	Lead Lag ODR minimum water temperature	R	U16	-40°-130° (0.1°C precision)
0208	0520	Lead Lag ODR boost time	R	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0209	0521	Lead Lag ODR boost maximum setpoint	R	U16	-40°-130° (0.1°C precision)
020A	0522	CH ODR boost step	R	U16	0°-130° (0.1°C precision)
020B	0523	CH ODR boost recovery step time	R	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
020C	0524	Lead Lag ODR boost step	R	U16	0°-130° (0.1°C precision)
		FROST PROTECTION CONFIGURATION			
0210	0528	CH frost protection enable	R	U16	0=Disable CH frost protection, 1=Enable CH frost protection
0211	0529	DHW frost protection enable	R	U16	0=Disable DHW frost protection, 1=Enable DHW frost protection
0212	0530	Outdoor frost protection setpoint	R	U16	-40°-130° (0.1°C precision) (applicable for CH only)
0213	0531	Frost protection method	R	U16	0=Continuous until condition doesn't exist, 1=Active 5 min, off 55 min cycle
		LEAD LAG CONFIGURATION			
0220	0544	Lead Lag slave enable	R	U16	0=Lead/Lag slave disabled,
					1=Lead/Lag simple slave enabled for EnviraCom master,
					2=Lead/Lag simple slave enabled for Global Modbus master,
					3=Lead/Lag full slave enabled for Global Modbus master
0221	0545	Lead Lag master enable	R	U16	0=Not a Lead/Lag master 1=Lead/Lag master
0222	0546	Lead Lag setpoint	R/W	U16	-40°-130° (0.1°C precision)
0223	0547	Lead Lag time of day setpoint	R/W	U16	-40°-130° (0.1°C precision) Setpoint when Time Of Day switch is on.
0224	0548	Lead Lag outdoor reset enable	R	U16	0=Disable outdoor reset, 1=Enable outdoor reset
0225	0549	Lead Lag on hysteresis	R	U16	0°-130° (0.1°C precision)
0226	0550	Lead Lag off hysteresis	R	U16	0°-130° (0.1°C precision)
0227	0551	Lead Lag hysteresis step time	R	U16	0°-130° (0.1°C precision)
0228	0552	Lead Lag P-gain	R	U16	0-100
0229	0553	Lead Lag I-gain	R	U16	0-100
022A	0554	Lead Lag D-gain	R	U16	0-100
022B	0555	Lead Lag master STAT input enable	R/W	U16	0=Disable STAT input, 1=Enable STAT input
022C	0556	Add stage method	R	U16	0=Rate, 1=Error
022D	0557	Add stage error threshold	R	U16	
022E	0558	Add stage rate offset	R	U16	
022F	0559	Add stage time	R	U16	Seconds
0230	0560	Drop stage rate offset	R	U16	
0231	0561	Drop stage time	R	U16	Seconds
0232	0562	Minimum stage off time	R	U16	Seconds
0233	0563	Slave mode	R	U16	0=Don't Use, 1=Use First, 2=Equalize Runtime, 3=Use Last.
0234	0564	Slave priority	R	U16	1-8
0235	0565	Slave command	R	U16	Bit map: 15=Slave demand request, 14=Slave suspend startup, 13=Slave run fan request, 12=Turn on System pump with overrun, 11=Turn on System pump with no overrun, 10=Turn on Auxiliary pump, 9=Reserved (always 0), 8=Commanded rate is binary fraction % , 7-0=Commanded rate

Bolded registers are typical boiler/burner status monitoring points.					
0236	0566	Base load rate	R	U16	RPM or % (applicable for Base Load sequencing type only)
0237	0567	Fan during off cycle rate	R	U16	RPM or %
0238	0568	Slave sequence order	R	U16	0-255
		EXTENDED CH CONFIGU-RATION			
0240	0576	CH modulation backup sensor	R	U16	Alternative modulation sensor when primary CH sensor is bad: 0=No backup sensor, 1=Header sensor
		LOCKOUT HISTORY			
0360- 0370	0864- 0880	Lockout history record 1	R	0-1 byte	Most recent lockout. See Table 4.
0371- 0381	0881- 0897	Lockout history record 2	R	0-1 byte	2nd newest lockout. See Table 4.
0382- 0392	0898- 0914	Lockout history record 3	R	0-1 byte	3rd newest lockout. See Table 4.
0393- 03A3	0915- 0931	Lockout history record 4	R	0-1 byte	4th newest lockout. See Table 4.
03A4-03B4	0932- 0948	Lockout history record 5	R	0-1 byte	5th newest lockout. See Table 4.
03B5-03C5	0949- 0965	Lockout history record 6	R	0-1 byte	6th newest lockout. See Table 4.
03C6-03D6	0966- 0982	Lockout history record 7	R	0-1 byte	7th newest lockout. See Table 4.
03D7-03E7	0983- 0999	Lockout history record 8	R	0-1 byte	8th newest lockout. See Table 4.
03E8-03F8	1000- 1016	Lockout history record 9	R	0-1 byte	9th newest lockout. See Table 4.
03F9-0409	1017- 1033	Lockout history record 10	R	0-1 byte	10th newest lockout. See Table 4.
040A-041A	1034- 1050	Lockout history record 11	R	0-1 byte	11th newest lockout. See Table 4.
041B-042B	1051- 1067	Lockout history record 12	R	0-1 byte	12th newest lockout. See Table 4.
042C- 043C	1068- 1084	Lockout history record 13	R	0-1 byte	13th newest lockout. See Table 4.
043D- 044D	1085- 1101	Lockout history record 14	R	0-1 byte	14th newest lockout. See Table 4.
044E-045E	1102- 1118	Lockout history record 15	R	0-1 byte	Oldest lockout
045F	1119	RESERVED			
		ALERT LOG			
0460- 0465	1120- 1125	Alert log record 1	R	U16	Most recent alert (see Table 8).
0466- 046B	1126- 1131	Alert log record 2	R	U16	2nd newest alert.
046C- 0471	1132- 1137	Alert log record 3	R	U16	3rd newest alert.
0472- 0477	1138- 1143	Alert log record 4	R	U16	4th newest alert.
0478- 047D	1144- 1149	Alert log record 5	R	U16	5th newest alert.
047E-0483	1150- 1155	Alert log record 6	R	U16	6th newest alert.
0484- 0489	1156- 1161	Alert log record 7	R	U16	7th newest alert.
048A-048F	1162-1167	Alert log record 8	R	U16	8th newest alert.
0490- 0495	1168- 1173	Alert log record 9	R	U16	9th newest alert.
0496- 049B	1174- 1179	Alert log record 10	R	U16	10th newest alert.
049C- 04A1	1180- 1185	Alert log record 11	R	U16	11th newest alert.
04A2-04A7	1186 1191	Alert log record 12	R	U16	12th newest alert.
04A8-04AD	1192- 1197	Alert log record 13	R	U16	13th newest alert.
04AE-04B3	1198- 1203	Alert log record 14	R	U16	14th newest alert.
04B4-04B9	1204- 1209	Alert log record 15	R	U16	Oldest alert.
04BA-0FFF	0954-4095	RESERVED			

Appendix F — CB Falcon Modbus Communication

CleaverBrooks

CB Falcon Modbus Communication

INTRODUCTION

This document describes the interface to the CB Falcon boiler controller on either the MB1 or MB2 Modbus port. These ports are RS-485 connectors that use the Modbus communication protocol to allow configuration and status data to be read from and written to the Falcon.

The CB Falcon functions as a Modbus slave (server) on this interface. It responds to a single Modbus address to service the requests of the Modbus master (client) on the RS-485 network.

This document does not describe the Modbus protocol. It only describes how this protocol is used in this interface.

Definitions

The following definitions are used in this document:

Modbus	Application layer communication protocol standard adopted by the Modbus-IDA trade association. Recognized as an industry standard protocol for RS-485 serial communication.
PCB	Parameter Control Block. Files that customize the user interface with the CB Falcon. PCBs reside in the non-volatile storage in the Falcon and are uploaded from the controller into the user interface.
PIM	Plug-In Module. Plug that can be inserted into the Falcon to enable Lead Lag and to backup & restore parameter settings in the Falcon.
RTU	Remote Terminal Unit serial transmission mode. Mode used to encode data for Modbus where each 8-bit byte is sent as two 4-bit hexadecimal characters.

Reference

The following is used as a reference in this document:

MODBUS Application Protocol Specification V1.1a, June 4, 2004, http://www.Modbus-IDA.org.

INTERFACE

Physical Layer

The Falcon Modbus port is a 3-pin connector that interfaces to RS-485 signals as indicated in Table 1.

Table 1. RS-485 signals

Signal	Terminal
Data + (a)	1
Data – (b)	2
Common (c)	3

The serial transmission mode on the Modbus network is the RTU mode. Message format has the characteristics shown in Table 2

Table 2. RS-485 message format

Coding system	8-bit binary
Number of data bits per character	10 = 1 start bit 8 data bits No parity bit 1 stop bit
Bit transfer rate	38400 bps
Duplex	Half duplex
Error checking	2 byte CRC-16 polynomial
Bit transfer order	LSB first
End of message	Idle line for 3.5 or more characters

Application Layer

The Falcon Modbus interface supports the following function codes:

- 03 (0x03) Read Holding Registers
- 06 (0x06) Write Single Register
- 16 (0x10) Write Multiple Registers
- 17 (0x11) Report Slave ID

All the configuration and status data are accessed as 16-bit holding registers in this interface. Since all Falcon digital signals accessed in this interface are read only, these digital signals are mapped to bits within holding registers instead of coils or discrete inputs, to simplify the interface. Variable length data are also represented by holding registers and therefore must be accessed individually and not as part of a group. The length of the variable length data is returned in the response. All 32-bit data items are accessed as two consecutive, 16-bit holding registers, i.e., each item uses 2 register address spaces.

The holding register map is defined in Fig. 1 and Table 4. Except for variable length data items the registers can be accessed as a single register or up to 20 registers for writes and 125 registers for reads. Data is mapped into logical groups with room for future expansion, so some gaps exist in the register map.

Data organization is intended to allow for efficient register access. Status data is organized into register blocks by application function and a function status change indicator is used to denote when any data has changed within the register block since the last time the registers were read (See Fig. 1). The Falcon sets the status change indicator bit when at least one of the registers in the functional block has changed value since it was last read. The Modbus master can read the status change register and determine which functional register blocks have changed value since its last access and only read those register blocks. The Modbus master can ignore the status change register and poll status data as it deems fit.

The Falcon has several terminals (connectors) for sensor inputs. These sensor inputs can be configured for different types of data input:

- 10K NTC dual temperature safety sensor
- 10K NTC single temperature non-safety sensor
- 12K NTC single temperature non-safety sensor
- 0-15 psi pressure sensor
- 0-50 psi pressure sensor
- 4-20 mA analog input
- Raw 0-4096 digital input

Each terminal is referenced by an "S*n*" name (where "*n*" is a number in the range of 1-10), and in some cases may be identified by a functional name that describes its purpose (See Table 3). A connector type parameter for each terminal specifies how the data input is interpreted for the terminal.

Table 3. Sensor input names

Name	Terminal	Purpose
S1	J8-4	Inlet temperature or 4-20 mA steam pressure (0-15 or 0-50 psi)
S2	J8-6	4-20 mA remote control input (setpoint or modulation)
S3	J8-8	Outlet single non-safety temperature
S4	J8-10	Undefined temperature (called Outlet operation channel)
S3S4	J8-8 *and* J8-10	Outlet dual safety temperature
S5	J8-11	Outdoor, Header (Central Heat), or Mix temperature
S6	J9-1	DHW single non-safety temperature
S7	J9-3	Undefined temperature (called DHW operation channel)
S6S7	J9-1 *and* J9-3	DHW dual safety temperature
S8	J9-4	Stack single non-safety temperature
S9	J9-6	Heat exchanger temperature
S8S9	J9-4 *and* J9-6	Stack dual safety temperature
S10	J10-7	Outdoor or Lead Lag Header (Central Heat) temperature

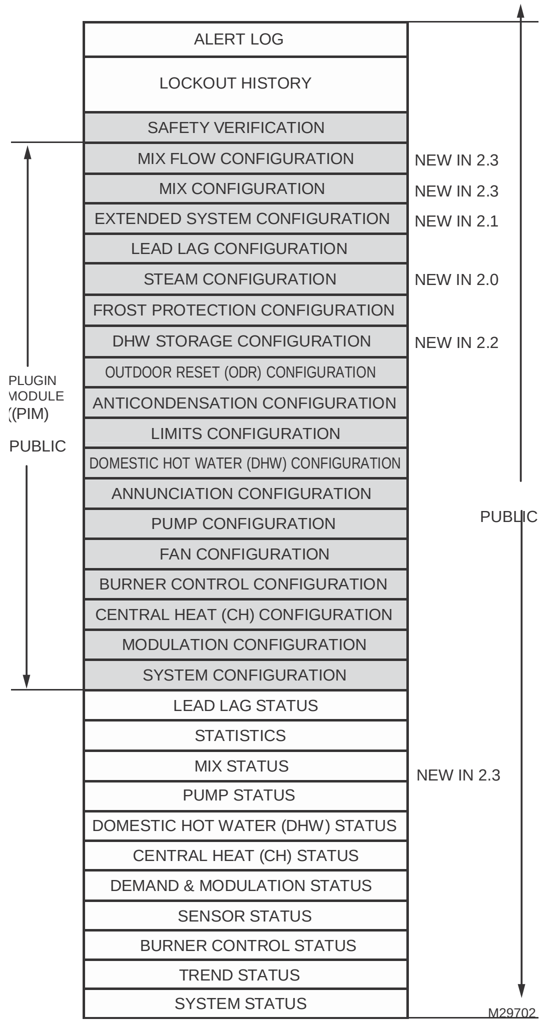


Fig. 1. Register map

Table 4. CB Falcon Modbus register map

Address (hex)	Register (dec)	Parameter	Read/ Write	Format	Note
		SYSTEM STATUS			
0000	0000	Status Change	R	U16	Register is cleared (all bits zeroed) after read. Identifies register groups that have new status in them. Bit map: 15-11=Reserved (always 1) 10=Alert log 9=Lockout history 8=Lead Lag status 7=Statistics 6=Pump status 5=DHW status 4=CH status 3=Demand&Modulation status 2=Sensor status 1=Burner control status 0=Active Lockout
0001	0001	Configuration Change	R	U16	Register is cleared (all bits zeroed) after read. Identifies register groups that have new data in them. Bit map: 15=PCB configuration 14=PIM configuration 13=Reserved 12=Lead Lag configuration 11=Frost protection configuration 10=Outdoor reset configuration 9=Anti-condensation configuration 8=Limits configuration 7=DHW configuration 6=Annunciation configuration 5=Pump configuration 4=Fan configuration 3=Burner control configuration 2=CH configuration 1=Modulation configuration 0=System configuration
0002	0002	Digital I/O	RR	U16	Bit map: 15=Safety relay 14=Time of Day 13=STAT (Demand) 12=High Fire Switch (HFS) 11=Low Fire Switch (LFS) 10=Load Control Input(LCI) 9=Pre-ignition interlock (PII) 8=Interlock (ILK) 7=Alarm 6=Main valve 5=Pilot valve 4=External ignition 3=Blower motor/HSI 2=Pump C 1=Pump B 0=Pump A

Table 4. CB Falcon Modbus register map

0003	0003	Annunciation I/O	R	U16	Only applicable when Annunciation is enabled Bit map: 15-8=Reserved (always 0) 7=Annunciator 8/LFS 6=Annunciator 7/HFS 5=Annunciator 6 4=Annunciator 5 3=Annunciator 4 2=Annunciator 3 1=Annunciator 2 0=Annunciator 1/IAS
0004	0004	Limits	R	U16	Bitmap: 15-12=Reserved (always 0) 11=Heat exchanger high limit 10=Exchanger T-rise limit 9=Outlet T-rise limit 8=Inversion inlet/exchanger limit 7=Inversion exchanger/outlet limit 6=Inversion inlet/outlet limit 5=Delta T inlet/exchanger limit 4=Delta T exchanger/outlet limit 3=Delta T inlet/outlet limit 2=Stack limit 1=DHW high limit 0=Outlet high limit
0005	0005	Plug-In Module (PIM) status	R	U16	Bit map: 15-11=Reserved, 10=OEM alert PCB stored in PIM, 9=OEM range PCB stored in PIM, 8=OEM parameter PCB stored in PIM, 7-3=Reserved (always 0), 2=Valid copyright, 1=Lead/Lag enabled, 0= PIM installed
		TREND STATUS			
0006	0006	Demand source	R	U16	Current demand source: 0=Unknown, 1=No source demand, 2=CH, 3=DHW, 4=Lead Lag slave, 5=Lead Lag master, 6=CH frost protection, 7=DHW frost protection, 8=No demand due to burner switch (register 199) turned off, 9=DHW storage, 10=Reserved, 11=Warm weather shutdown
0007	0007	Outlet (S3S4) or Outlet limit (S3) sensor	R	U16	-40°-130° (0.1°C precision)[a]
0008	0008	Firing rate	R	U16	Actual firing rate (%[b] or RPM[c]).
0009	0009	Fan speed	R	U16	RPM
000A	0010	Flame signal	R	U16	0.01V or 0.01A precision (0.00-50.00V)
000B	0011	Inlet (S1) sensor	R	U16	-40°-130° (0.1°C precision)[a]
000C	0012	DHW (S6S7) or DHW limit (S6) sensor	R	U16	-40°-130° (0.1°C precision)[a]
000D	0013	S5 sensor	R	U16	-40°-130° (0.1°C precision)[a]
000E	0014	Stack (S8S9) or Stack limit (S8) sensor	R	U16	-40°-130° (0.1°C precision)[a]

Table 4. CB Falcon Modbus register map

000F	0015	4-20 mA remote control input (S2) terminal	R	U16	4-20 mA (0.1 mA precision) or other (see register 609)
0010	0016	Active CH setpoint	R	U16	-40°-130° (0.1°C precision)[a] Setpoint determined by CH setpoint source (register 65).
0011	0017	Active DHW setpoint	R	U16	-40°-130° (0.1°C precision)[a] Setpoint determined by DHW setpoint source (register 81).
0012	0018	Active LL setpoint	R	U16	-40°-130° (0.1°C precision)[a] Setpoint determined by LL setpoint source (register 161).
0013	0019	Register Access Status	RR	U16U16	Register data write access status: 0=No register writes allowed, 1=Installer register writes allowed, 2=OEM register writes allowed. 3=All register writes allowed.
0014	0020	Steam pressure	R	U16	0-150 psi (0.1 psi precision)
0015	0021	Analog modulation input	R	U16	0=No signal, otherwise 4-20 mA (0.1 mA precision) Duplicate of register 15 when S2 terminal is 4-20 mA.
0016	0022	Active CH pressure setpoint	R	U16	0-150psi (0.1psi precision)
0017	0023	Extended Status Change	R	U16	Register is cleared (all bits zeroed) after read. Identifies register groups that have new status or configuration data in them. Bit map: 15-5=Reserved 4= DHW plate heat exchanger configuration 3=DHW plate heat exchanger status 2-0=Reserved
0018-001F	0024-0031	RESERVED			
		BURNER CONTROL STATUS			
0020	0032	Burner control status	R	U16	0=Disabled, 1=Locked out, 2-3=Reserved, 4=Anti-short cycle, 5=Unconfigured safety data, 6-33=Reserved, 34=Standby Hold, 35=Standby Delay, 36-47=Reserved, 48=Normal Standby, 49=Preparing, 50=Ignition, 51=Firing, 52=Postpurge, 53-65535=Reserved
0021	0033	Burner control state	R	U16	Burner control sequence (I/O) state (see table 11). Model type determined by register 176.
0022	0034	Lockout code	R	U16	0=No lockout, 1-4096 (see Table 8)
0023	0035	Alarm reason	R	U16	0=None, 1=Lockout (see Lockout code, register 34), 2=Alert (see Table 10), 3=Other

Table 4. CB Falcon Modbus register map

0024	0036	Annunciator first out	R	U16	Source for annunciator first out: 0=None or undetermined, 1=ILK, 2=PII, 11=Annunciator 1, 12=Annunciator 2, 13=Annunciator 3, 14=Annunciator 4, 15=Annunciator 5, 16=Annunciator 6, 17=Annunciator 7, 18=Annunciator 8
0025	0037	Annunciator hold	R	U16	Source for burner control hold condition (see Hold code): 0=None or undetermined, 1=ILK, 2=PII, 3=LCI 11=Annunciator 1, 12=Annunciator 2, 13=Annunciator 3, 14=Annunciator 4, 15=Annunciator 5, 16=Annunciator 6, 17=Annunciator 7, 18=Annunciator 8
0026	0038	Sequence time	R	U16	Running time for timed burner control operation (seconds)
0027	0039	Delay time	R	U16	Running delay time (seconds). Applicable when burner control in delayed or hold state.
0028	0040	Hold code	R	U16	Reason for burner hold (same codes as lockout, see table 7)
0029	0041	Burner control flags	R	U16	<u>Bit map</u>: 15-1=Reserved (always 0) 0= Flame detected
002A	0042	Remote Stat	R/W	U16	0=No remote STAT demand, 1=remote STAT demand indicated
		SENSOR STATUS			
002B	0043	Outlet operation (S4=J8-10) terminal	R	U16	-40°-130° (0.1°C precision)[d] or other (see register 610)
002C	0044	DHW operation (S7=J9-3) terminal	R	U16	-40°-130° (0.1°C precision)[e] or other (see register 612)
002D	0045	Stack or Heat exchanger operation (S9=J9-6) terminal	R	U16	-40°-130° (0.1°C precision)[e] or other (see register 613)
002E	0046	Outlet operation sensor (S4=J8-10) state	R	U16	0=None, 1=Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
002F	0047	DHW operation sensor (S7=J9-3) state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0030	0048	Outlet limit sensor (S3=J8-8) state	R	U16	0=None, 1=Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0031	0049	Inlet sensor (S1=J8-4) state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0032	0050	DHW limit sensor (S7=J9-1) state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0033	0051	Stack limit sensor (S8=J9-4) state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0034	0052	S5 (J8-11) sensor state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable

Table 4. CB Falcon Modbus register map

0035	0053	4-20mA remote control input(S2=J8-6) state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0036	0054	Pressure sensor (S1=J8-4) state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0037	0055	Stack operation or Heat exchanger sensor (S9=J9-6) state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
		DEMAND AND MODULATION STATUS			
0038	0056	Active rate limiter	R	U16	0=None, 1=Outlet high limit, 2=Delta T limit, 3=Stack limit, 4=Slow start limit, 5=Anti-condensation, 6=Minimum modulation, 7=Forced rate, 8= IAS is open
0039	0057	Limited rate	R	U16	RPM or %[c]
003A	0058	Active rate override	R	U16	0=None, 1=Burner control default, 2=Burner control, 3=Manual firing rate, 4=Manual firing rate off, 5=Fan on during off cycle
003B	0059	Override rate	R	U16	RPM or %[c]
003C	0060	Demand rate	R	U16	RPM or %[c]
003D-003F	0061-0063	RESERVED			
		CENTRAL HEATING (CH) STATUS			
0040	0064	CH status	R	U16	0=Unknown, 1=Disabled, 2=Normal, 3=Suspended
0041	0065	CH setpoint source	R	U16	0=Unknown, 1=Normal setpoint, 2=TOD setpoint, 3=Outdoor reset, 4=Remote control
0042	0066	CH heat demand	R	U16	0=Off, 1=On
0043	0067	CH burner demand	R	U16	0=Off, 1=On
0044	0068	CH requested rate	R	U16	RPM or %[c]
0045	0069	CH frost heat demand	R	U16	0=Off, 1=On
0046	0070	CH frost burner demand	R	U16	0=Off, 1=On
0047	0071	Active CH on hysteresis	R	U16	0°-130° (0.1°C precision)[a]
0048	0072	Active CH off hysteresis	R	U16	0°-130° (0.1°C precision)[a]
0049	0073	Active CH pressure on hysteresis	R	U16	0-150psi (0.1psi precision)
004A	0074	Active CH pressure off hysteresis	R	U16	0-150psi (0.1psi precision)
004B-004F	0075-0079	RESERVED			

Table 4. CB Falcon Modbus register map

		DOMESTIC HOT WATER (DHW) STATUS			
0050	0080	DHW status	R	U16	0=Unknown, 1=Disabled, 2=Normal, 3=Suspended
0051	0081	DHW setpoint source	R	U16	0=Unknown, 1=Normal setpoint, 2=TOD setpoint, 5=DHW tap setpoint, 6=DHW preheat setpoint
0052	0082	DHW priority count	R	U16	Countdown of time when DHW has priority over CH (secs). Applicable when DHW priority time is enabled (see register 452).
0053	0083	DHW heat demand	R	U16	0=Off, 1=On
0054	0084	DHW burner demand	R	U16	0=Off, 1=On
0055	0085	DHW requested rate	R	U16	RPM or %[c]
0056	0086	DHW frost heat demand	R	U16	0=Off, 1=On
0057	0087	DHW frost burner demand	R	U16	0=Off, 1=On
0058	0088	Active DHW on hysteresis	R	U16	0°-130° (0.1°C precision)[a]
0059	0089	Active DHW off hysteresis	R	U16	0°-130° (0.1°C precision)[a]
005A	0090	DHW storage time	R	U16	Elapsed DHW storage time (secs)
005B	0091	DHW storage heat demand	R	U16	0=Off, 1=On
005C	0092	DHW storage burner demand	R	U16	0=Off, 1=On
		PUMP STATUS			
005D	0093	Pump A status	R	U16	Bit map: Demand: 15-14=Reserved, 13=Auxiliary 2 pump demand, 12=Auxiliary 1 pump demand, 11=System pump demand, 10=Boiler pump demand, 9=DHW pump demand, 8=CH pump demand Reason: 7=Reserved, 6=Pump assigned to logical pump, 5=Pump exercise requested, 4=On due to exercise, 3=On due to overrun, 2=Forced off, 1=Forced on, 0=On due to normal demand

Table 4. CB Falcon Modbus register map

005E	0094	Pump B status	R	U16	Bit map: Demand: 15-14=Reserved, 13=Auxiliary 2 pump demand, 12=Auxiliary 1 pump demand, 11=System pump demand, 10=Boiler pump demand, 9=DHW pump demand, 8=CH pump demand Reason: 7=Reserved, 6=Pump assigned to logical pump, 5=Pump exercise requested, 4=On due to exercise, 3=On due to overrun, 2=Forced off, 1=Forced on, 0=On due to normal demand
005F	0095	CH pump start delay time	R	U16	Running delay time before CH pump will be turned on.
0060	0096	CH pump status	R	U16	For application build less than 1600 see table 12. For application build 1600 or higher see table 13[e]
0061	0097	CH pump overrun time	R	U16	Running overrun time for CH pump (seconds)
0062	0098	CH FP overrun time	R	U16	Running overrun time for CH pump due to frost protection (seconds)
0063	0099	CH pump idle days count	R	U16	Number of days that CH pump has not run (sat idle).
0064	0100	DHW pump status	R	U16	For application build less than 1600 see table 12. For application build 1600 or higher see table 13[e].
0065	0101	DHW pump start delay time	R	U16	Count down (seconds) when DHW pump is delayed from starting.
0066	0102	DHW pump overrun time	R	U16	Running overrun time for DHW pump (seconds)
0067	0103	DHW FP overrun time	R	U16	Running overrun time for DHW pump due to frost protection (seconds)
0068	0104	DHW pump idle days count	R	U16	Number of days that DHW pump has not run (sat idle).
0069	0105	System pump status	R	U16	For application build less than 1600 see table 12. For application build 1600 or higher see table 13[e].
006A	0106	System pump overrun time	R	U16	Running overrun time for Lead Lag pump (seconds)
006B	0107	System pump idle days count	R	U16	Number of days that LL pump has not run (sat idle).
006C	0108	Boiler pump status	R	U16	For application build less than 1600 see table 12. For application build 1600 or higher see table 13[e].
006D	0109	Boiler pump overrun time	R	U16	Running overrun time for Boiler pump (seconds)
006E	0110	Boiler pump idle days count	R	U16	Number of days that boiler pump has not run (sat idle).
006F	0111	Auxiliary 1 pump status	R	U16	For application build less than 1600 see table 12. For application build 1600 or higher see table 13[e].
0070	0112	Auxiliary 1 pump idle days count	R	U16	Number of days that auxiliary 1 pump has not run (sat idle).
0071	0113	Auxiliary 2 pump status	R	U16	See table 13.
0072	0114	Auxiliary 2 pump overrun time	R	U16	Running overrun time for auxiliary 2 pump (seconds)
0073	0115	Auxiliary 2 pump idle days count	R	U16	Number of days that auxiliary 2 pump has not run (sat idle).
0074-0076	0116-0118	RESERVED			
0077	0119	Auxiliary 1 pump overrun time	R	U16	Running overrun time for auxiliary 1 pump (seconds)
0078-007F	0120-0127	RESERVED			

Table 4. CB Falcon Modbus register map

		STATISTICS			
0080-0081	0128-0129	Burner cycle count	R/W	U32	0-999,999
0082-0083	0130-0131	Burner run time	R/W	U32	Hours
0084-0085	0132-0133	CH pump cycle count	R/W	U32	0-999,999
0086-0087	0134-0135	DHW pump cycle count	R/W	U32	0-999,999
0088-0089	0136-0137	System pump cycle count	R/W	U32	0-999,999
008A-008B	0138-0139	Boiler pump cycle count	R/W	U32	0-999,999
008C-008D	0140-0141	Auxiliary pump cycle count	R/W	U32	0-999,999
008E-008F	0142-0143	Controller cycle count	R	U32	0-999,999
0090-0091	0144-0145	Controller run time	R	U32	Hours
0092-0093	0146-0147	Auxiliary 2 pump cycle count	R/W	U32	0-999,999
		EXTENDED PUMP STATUS			
0094	0148	Auxiliary 2 pump start delay time	R	U16	Running delay time before auxiliary 2 pump will be turned on.
0095	0149	Boiler pump start delay time	R	U16	Running delay time before boiler pump will be turned on.
0096	0150	System pump start delay time	R	U16	Running delay time before system pump will be turned on.
0097	0151	Auxiliary 1 pump start delay time	R	U16	Running delay time before auxiliary 1 pump will be turned on.
		DHW PLATE HEAT EXCHANGER STATUS			
0098	0152	DHW tap heat demand	R	U16	0=Off, 1=On
0099	0153	DHW preheat demand	R	U16	0=Off, 1=On
009A	0154	DHW change rate	R	U16	DHW plate heat exchanger temperature change rate (degrees/second, 0.1°C precision)
009B	0155	DHW tap on recognition time	R	U16	Persistent time that DHW tap demand has been recognized (seconds)
009C	0156	DHW tap on time	R	U16	Running time of DHW tap heat demand (seconds)
009D	0157	DHW preheat delay after tap time	R	U16	Preheat delay countdown time (seconds)
009E	0158	DHW preheat on recognition time	R	U16	Persistent time that DHW preheat demand has been recognized (seconds)
009F	0159	DHW preheat on time	R	U16	Running time of DHW preheat heat demand (seconds)
		LEAD LAG STATUS			
00A0	0160	Lead Lag master status	R	U16	0=Unknown, 1=Disabled, 2=Normal, 3=Suspended
00A1	0161	Lead Lag slave status	R	U16	Bit map: 15=Slave command received, 14=Slave mode has priority over CH & DHW, 13=Slave is modulating, 12=CH frost protection request, 11=DHW frost protection request, 10=Frost protection burner request, 9=Local frost protection request, 8=Reserved (always 0), 7-0=Burner control status (see register 32)
00A2	0162	Lead Lag master setpoint source	R	U16	0=Unknown, 1=Normal setpoint, 2=TOD setpoint, 3=Outdoor reset

Table 4. CB Falcon Modbus register map

00A3	0163	Lead Lag master heat demand	R	U16	0=Off, 1=On
00A4	0164	Lead Lag slave burner demand	R	U16	0=Off, 1=On
00A5	0165	Lead Lag slave requested rate	R	U16	RPM or %[c]
		EXTENDED PUMP STATUS			
00A8	0168	Pump C status	R	U16	Bit map: Demand: 15-14=Reserved, 13=Auxiliary 2 pump demand, 12=Auxiliary 1 pump demand, 11=System pump demand, 10=Boiler pump demand, 9=DHW pump demand, 8=CH pump demand Reason: 7=Reserved, 6=Pump assigned to logical pump, 5=Pump exercise requested, 4=On due to exercise, 3=On due to overrun, 2=Forced off, 1=Forced on, 0=On due to normal demand
00A9	0169	RESERVED			
		EXTENDED SENSOR STATUS			
00AA	0170	Outdoor temperature	R	U16	-40°-130° (0.1°C precision)[b]
00AB	0171	Outdoor sensor state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
00AC	0172	Outlet T-rise rate	R	U16	Outlet temperature change rate (degrees/second, 0.1°C precision)
00AD	0173	Exchanger T-rise rate	R	U16	Heat exchanger temperature change rate (degrees/ second, 0.1°C precision)
00AE	0174	S10 sensor reading	R	U16	-40°-130° (0.1°C precision)[a]
00AF	0175	S10 sensor state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
		SYSTEM CONFIGURATION			
00B0	0176	Product type	R	U16	Product family (MSB): 0=Unknown product, 1=Hydronic boiler control, 2=Steam boiler control, 3=Reserved, 4=Fulton pulse hydronic boiler control, 5=Fulton pulse steam boiler control, 6=Cleaver Brooks hydronic boiler control, 7=Cleaver Brooks steam boiler control Product ID (LSB): 0=Residential control, 1=Commercial control
00B1	0177	Password	W		Variable length password string (up to 20 characters) requesting Falcon permission to write registers.
00B2	0178	Temperature units	R/W	U16	Display format for temperature at user interface: 0=°F (Fahrenheit), 1=°C (Celsius)
00B3	0179	Antishort cycle time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured

Table 4. CB Falcon Modbus register map

00B4	0180	Alarm silence time	R/W	U16	0-600 minutes
00B5	0181	Power up with lockout	R/W	U16	**SAFETY** parameter[f]: 0=Clear lockout on power-up (reset), 1=Do not clear lockout on power-up (preserve)
00B6	01820182	Reset and restart	W	U16	Force soft reset of Falcon subsystems: 0=None, 1=Burner control, 2=Application, 3=Burner control & application, 4=Clear alert log Successful login required before request is granted.
00B7	0183	Burner name	R/W		Variable length string (up to 20 characters)
00B8	0184	Installation data	R/W		Variable length string (up to 20 characters)
00B9	0185	OEM ID	R/W		Variable length string (up to 20 characters)
00BA	0186	OS number	R		Variable length string (up to 16 characters)
00BB	0187	Date code	R		Variable length string (up to 10 characters)
00BC	0188	Safety Processor build	R	U16	
00BD	0189	Application Processor build	R	U16	
00BE	0190	Installer password	W		To set new installer password (up to 20 characters). Requires register access status (register 177) set to Installer or higher.
00BF	0191	OEM password	W		To set new OEM password (up to 20 characters). Requires register access status (register 177) set to OEM or higher.
		MODULATION CONFIGURATION			
00C0	0192	Modulation output	R/W	U16	**SAFETY** parameter[f]: 0=Fan PWM, 1=0-10V, 2=4-20mA
00C1	0193	CH maximum modulation rate	R/W	U16	RPM or %[c]
00C2	0194	DHW maximum modulation rate	R/W	U16	RPM or %[c]
00C3	0195	Minimum modulation rate	R/W	U16	RPM or %[c]
00C4	0196	Prepurge rate	R/W	U16	**SAFETY** parameter[f]: RPM or %[c]
00C5	0197	Lightoff rate	R/W	U16	**SAFETY** parameter[f]: RPM or %[c]
00C6	0198	Postpurge rate	R/W	U16	**SAFETY** parameter[f]: RPM or %[c]
00C7	0199	CH forced rate	R/W	U16	RPM or %[c]
00C8	0200	CH forced rate time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
00C9	0201	DHW forced rate	R/W	U16	RPM or %[c]
00CA	0202	DHW forced rate time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
00CB	0203	Burner switch	R/W	U16	0=Off, 1=On. Used to enable/disable burner control.
00CC	0204	Firing rate control	R/W	U16	0=Auto, 1=Manual in Run, 2=Manual in Run & Standby
00CD	0205	Manual firing rate	R/W	U16	Firing rate used when control is set to manual (% or RPM[c])
00CE	0206	Analog output hysteresis	R/W	U16	0-10V/4-20mA modulation output hysteresis. Setting of 0-10.

Table 4. CB Falcon Modbus register map

00CF	0207	Standby rate	R/W	U16	**SAFETY** parameter[f]: RPM or %[c]
		CH CONFIGURATION			
00D0	0208	CH enable	R/W	U16	0=Disable Central Heating, 1=Enable Central Heating
00D1	0209	CH demand switch	R/W	U16	Source for CH demand: 0=Modulation sensor only, 1=STAT terminal, 2=EnviraCOM remote Stat, 3=LCI, 4=Reserved, 5=Modbus STAT
00D2	0210	CH modulation sensor	R/W	U16	Sensor used for CH modulation: 0=Outlet sensor, 2=Inlet sensor, 3=S5 sensor, 4=S10 sensor
00D3	0211	CH setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
00D4	0212	CH time of day setpoint	R/W	U16	-40°-130° (0.1°C precision)[a] Setpoint when Time Of Day switch is on.
00D5	0213	CH on hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
00D6	0214	CH off hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
00D7	0215	CH outdoor reset enable	R/W	U16	0=Disable outdoor reset, 1=Enable outdoor reset
00D8	0216	CH P-gain	R/W	U16	0-1000
00D9	0217	CH I-gain	R/W	U16	0-1000
00DA	0218	CH D-gain	R/W	U16	0-1000
00DB	0219	CH hysteresis step time	R/W	U16	0-64800 seconds (0=Disable hysteresis stepping)
00DC	0220	CH pressure setpoint	R/W	U16	0-150psi (0.1psi precision)
00DD	0221	CH pressure on hysteresis	R/W	U16	0-150psi (0.1psi precision)
00DE	0222	CH pressure off hysteresis	R/W	U16	0-150psi (0.1psi precision)
00DF	0223	RESERVED			
		BURNER CONTROL CONFIGURATION			
00E0	0224	Ignition source	R/W	U16	**SAFETY** parameter[f]: 0=Internal ignition, 1=External ignition, 2=Hot Surface Igniter (HSI)
00E1	0225	BLR/HSI function	R/W	U16	**SAFETY** parameter[f]: BLR/HSI terminal function: 0=blower motor, 1=Hot Surface Igniter (HSI)
00E2	0226	Igniter on during	R/W	U16	**SAFETY** parameter[f]: 0=All Pilot Flame Establishing Period (PFEP), 1=First ½ of PFEP
00E3	0227	Pilot type	R/W	U16	**SAFETY** parameter[f] 0=Interrupted, 1=Intermittent, 2=Direct burner ignition (constant ignition), 3=Direct burner ignition (pulsed ignition)
00E4	0228	Flame sensor type	R/W	U16	**SAFETY** parameter[f]: 0=None (no sensor) 1=Flame rod, 2=UV power tube, 3=UV power tube, ignore flame during ignition

Table 4. CB Falcon Modbus register map

00E5	0229	Purge rate proving	R/W	U16	**SAFETY** parameter[f]: 0=None, 1=High Fire Switch (HFS), 2=Fan speed
00E6	0230	Lightoff rate proving	R/W	U16	**SAFETY** parameter[f]: 0=None, 1=(Low Fire Switch) LFS, 2=Fan speed, 3=Fan speed, except during ignition
00E7	0231	Prepurge time	R/W	U16	**SAFETY** parameter[f]: 0-64800 seconds (18 hours), 0xFFFF=Not configured
00E8	0232	Pre-ignition time	R/W	U16	**SAFETY** parameter[f]: 0-64800 seconds (18 hours), 0xFFFF=Not configured
00E9	0233	Pilot flame establishing period (PFEP)	R/W	U16	**SAFETY** parameter[f]: 0=None, 1=4 seconds, 2=10 seconds, 3=15 seconds, 0xFFFF=Not configured
00EA	0234	Main flame establishing period (MFEP)	R/W	U16	**SAFETY** parameter[f]: 0=None, 1=5 seconds, 2=10 seconds, 3=15 seconds, 0xFFFF=Not configured
00EB	0235	Run stabilization time	R/W	U16	**SAFETY** parameter[f]: 0-64800 seconds (18 hours), 0xFFFF=Not configured
00EC	0236	Postpurge time	R/W	U16	**SAFETY** parameter[f]: 0-64800 seconds (18 hours), 0xFFFF=Not configured
00ED	0237	Interlock start check enable	R/W	U16	**SAFETY** parameter[f]: 0=No ILK check, 1=ILK check
00EE	0238	Interlock open response	R/W	U16	**SAFETY** parameter[f] 0=Lockout, 1=Recycle
00EF	0239	Ignite failure response	R/W	U16	**SAFETY** parameter[e]: 0=Lockout, 1=Continuous recycle, 2=Retry, recycle & hold, 3=Retry, recycle & lockout
00F0	0240	Ignite failure retries	R/W	U16	**SAFETY** parameter[f]: 0=None, 1=3 times, 2=5 times, 3=1 time, 0xFFFF=Not configured
00F1	0241	Ignite failure delay	R/W	U16	**SAFETY** parameter[f]: 0-64800 seconds (18 hours), 0xFFFF=Not configured
00F2	0242	MFEP flame failure response	R/W	U16	**SAFETY** parameter[f]: 0=Lockout, 1=Recycle
00F3	0243	Run flame failure response	R/W	U16	**SAFETY** parameter[f]: 0=Lockout, 1=Recycle
00F4	0244	Pilot test hold	R/W	U16	0=Disable, 1=Enable
00F5	0245	RESERVED	R/W	U16	

Table 4. CB Falcon Modbus register map

00F6	0246	Interrupted air switch (IAS) enable	R/W	U16	**SAFETY** parameter[f]: 0=Disable, 1=Enable during purge, 2=Enable during purge & ignition, 3=Enable during all states
00F7	0247	IAS start check enable	R/W	U16	**SAFETY** parameter[f]: 0=Disable, 1=Enable
00F8	0248	LCI enable	R/W	U16	**SAFETY** parameter[f]:: 0=Disable, 1=Enable
00F9	0249	PII enable	R/W	U16	**SAFETY** parameter[f]: 0=Disable, 1=Enable
00FA	0250	Flame threshold	R/W	U16	**SAFETY** parameter[f]: Minimum microamps needed to declare flame presence (0.1A precision). Default value is 0.8 A (8).
00FB-00FC	0251-0252	RESERVED			
00FD	0253	ILK bounce detection	R/W	U16	**SAFETY** parameter[f]: 0=Do not check for ILK bounce, 1=Check for ILK bounce
00FE	0254	Forced recycle interval time	R/W	U16	**SAFETY** parameter[f]: 0=No forced recycle, 1-64800 minutes (1080 hours), 0xFFFF=Not configured
00FF	0255	RESERVED			
		FAN CONFIGURATION			
0100	0256	Absolute maximum fan speed	R/W	U16	RPM
0101	0257	Absolute minimum fan speed	R/W	U16	RPM
0102	0258	Fan PWM frequency	R/W	U16	0=Unknown, 1=1000 Hz, 2=2000 Hz, 3=3000 Hz, 4=4000 Hz, 0xFFFF=Not configured
0103	0259	Fan pulses per revolution	R/W	U16	1-10
0104	0260	Fan speed-up ramp	R/W	U16	0-7000 RPM/sec
0105	0261	Fan slow-down ramp	R/W	U16	0-7000 RPM/sec
0106	0262	Fan gain up	R/W	U16	0-65535
0107	0263	Fan gain down	R/W	U16	0-65535
0108	0264	Fan minimum duty cycle	R/W	U16	1-100%[b]
0109-010F	0265-0271	RESERVED			
		PUMP CONFIGURATION			
0110	0272	CH pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
0111	0273	CH pump control	R/W	U16	0=Auto, 1=On
0112	0274	CH pump overrun time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0113	0275	CH FP pump overrun time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0114	0276	DHW pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
0115	0277	DHW pump control	R/W	U16	0=Auto, 1=On
0116	0278	DHW pump overrun time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0117	0279	DHW FP pump overrun time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0118	0280	DHW pump start delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0119	0281	Boiler pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
011A	0282	Boiler pump control	R/W	U16	0=Auto, 1=On

Table 4. CB Falcon Modbus register map

011B	0283	Boiler pump overrun time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
011C	0284	Auxiliary 1 pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
011D	0285	Auxiliary 1 pump control	R/W	U16	0=Auto, 1=On
011E	0286	RESERVED			
011F	0287	System pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
0120	0288	System pump control	R/W	U16	0=Auto, 1=On
0121	0289	System pump overrun time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0122	0290	Pump exercise interval	R/W	U16	Days
0123	0291	Pump exercise time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0124	0292	CH pump start delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0125	0293	Boiler pump start delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0126	0294	System pump start delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0127	0295	Auxiliary 1 pump start delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0128	0296	CH pump options 1	R/W	U16	<u>Bit map</u>: 15=Normal pump demand when auxiliary pump Z is set, 14=Normal pump demand when auxiliary pump Y is set, 13=Normal pump demand when auxiliary pump X is set, 12-7=Reserved (always 0), 6=Normal pump demand when DHW service is active, 5=Normal pump demand when CH service is active, 4=Reserved, 3=Normal pump demand when DHW demand, 2=Normal pump demand when CH demand, 1=Normal pump demand when local burner demand, 0=Local demand inhibited for faults
0129	0297	CH pump options 2	R/W	U16	<u>Bit map</u>: 15=Pump used for Lead Lag, 14=Pump used for local demand, 13-9=Reserved (always 0), 8=Force pump off when DHW high limit, 7=Force pump off when DHW anti-condensation, 6=Force pump off when CH anti-condensation, 5=Force pump off when DHW priority is active, 4=Force pump on when DHW frost protection, 3=Force pump on when CH frost protection, 2=Force pump on when Lead Lag slave demand, 1=Force pump on when local burner demand, 0=Force pump on when Outlet high limit
012A	0298	DHW pump options 1	R/W	U16	<u>Bit map</u>: 15=Normal pump demand when auxiliary pump Z is set, 14=Normal pump demand when auxiliary pump Y is set, 13=Normal pump demand when auxiliary pump X is set, 12-7=Reserved (always 0), 6=Normal pump demand when DHW service is active, 5=Normal pump demand when CH service is active, 4=Reserved, 3=Normal pump demand when DHW demand, 2=Normal pump demand when CH demand, 1=Normal pump demand when local burner demand, 0=Local demand inhibited for faults

Table 4. CB Falcon Modbus register map

012B	0299	DHW pump options 2	R/W	U16	Bit map: 15=Pump used for Lead Lag, 14=Pump used for local demand, 13-9=Reserved (always 0), 8=Force pump off when DHW high limit, 7=Force pump off when DHW anti-condensation, 6=Force pump off when CH anti-condensation, 5=Force pump off when DHW priority is active, 4=Force pump on when DHW frost protection, 3=Force pump on when CH frost protection, 2=Force pump on when Lead Lag slave demand, 1=Force pump on when local burner demand, 0=Force pump on when Outlet high limit
012C	0300	Boiler pump options 1	R/W	U16	Bit map: 15=Normal pump demand when auxiliary pump Z is set, 14=Normal pump demand when auxiliary pump Y is set, 13=Normal pump demand when auxiliary pump X is set, 12-7=Reserved (always 0), 6=Normal pump demand when DHW service is active, 5=Normal pump demand when CH service is active, 4=Reserved, 3=Normal pump demand when DHW demand, 2=Normal pump demand when CH demand, 1=Normal pump demand when local burner demand, 0=Local demand inhibited for faults
012D	0301	Boiler pump options 2	R/W	U16	Bit map: 15=Pump used for Lead Lag, 14=Pump used for local demand, 13-9=Reserved (always 0), 8=Force pump off when DHW high limit, 7=Force pump off when DHW anti-condensation, 6=Force pump off when CH anti-condensation, 5=Force pump off when DHW priority is active, 4=Force pump on when DHW frost protection, 3=Force pump on when CH frost protection, 2=Force pump on when Lead Lag slave demand, 1=Force pump on when local burner demand, 0=Force pump on when Outlet high limit
012E	0302	System pump options 1	R/W	U16	Bit map: 15=Normal pump demand when auxiliary pump Z is set, 14=Normal pump demand when auxiliary pump Y is set, 13=Normal pump demand when auxiliary pump X is set, 12-7=Reserved (always 0), 6=Normal pump demand when DHW service is active, 5=Normal pump demand when CH service is active, 4=Reserved, 3=Normal pump demand when DHW demand, 2=Normal pump demand when CH demand, 1=Normal pump demand when local burner demand, 0=Local demand inhibited for faults
012F	0303	System pump options 2	R/W	U16	Bit map: 15=Pump used for Lead Lag, 14=Pump used for local demand, 13-9=Reserved (always 0), 8=Force pump off when DHW high limit, 7=Force pump off when DHW anti-condensation, 6=Force pump off when CH anti-condensation, 5=Force pump off when DHW priority is active, 4=Force pump on when DHW frost protection, 3=Force pump on when CH frost protection, 2=Force pump on when Lead Lag slave demand, 1=Force pump on when local burner demand, 0=Force pump on when Outlet high limit

Table 4. CB Falcon Modbus register map

		ANNUNCIATION CONFIGURATION			
0130	0304	Annunciation enable	R/W	U16	0=Annunciation disabled, 1=Annunciation enabled
0131	0305	Annunciator mode	R/W	U16	0=Fixed, 1=Programmable
0132-013E	0306-0318	Annunciator 1 configuration	R/W		See table 6.
013F-014B	0319-0331	Annunciator 2 configuration	R/W		See table 6.
014C-0158	0332-0344	Annunciator 3 configuration	R/W		See table 6.
0159-0165	0345-0357	Annunciator 4 configuration	R/W		See table 6.
0166-0172	0358-0370	Annunciator 5 configuration	R/W		See table 6.
0173-017F	0371-0383	Annunciator 6 configuration	R/W		See table 6.
0180-018C	0384-0396	Annunciator 7 configuration	R/W		See table 6.
018D-0199	0397-0409	Annunciator 8 configuration	R/W		See table 6.
019A-01A5	0410-0421	PII configuration	R/W		See table 7.
01A6-01B1	0422-0433	LCI configuration	R/W		See table 7.
01B2-01BD	0434-0445	ILK configuration	R/W		See table 7.
01BE-01BF	0446-0447	RESERVED			
		DHW CONFIGURATION			
01C0	0448	DHW enable	R/W	U16	0=DHW disabled, 1=DHW enabled
01C1	0449	DHW demand switch	R/W	U16	Source of DHW demand: 0= Modulation sensor only, 1=EnviraCOM DHW request, 2=DHW switch, 3=Unused, 4=STAT terminal, 5=Reserved, 6=Modbus STAT, 7=Auto: S6 or EnviraCOM DHW request, 8=Auto: S6 or sensor only, 9=Plate heat exchanger
01C2	0450	DHW priority vs CH	R/W	U16	0=CH > DHW, 1=DHW > CH
01C3	0451	DHW priority vs LL	R/W	U16	0=LL > DHW, 1=DHW > LL
01C4	0452	DHW priority time	R/W	U16	0=No DHW priority time, >0=DHW priority time (seconds)
01C5	0453	DHW setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
01C6	0454	DHW time of day setpoint	R/W	U16	-40°-130° (0.1°C precision)[a] Setpoint when Time Of Day switch is on.
01C7	0455	DHW on hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
01C8	0456	DHW off hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
01C9	0457	DHW P-gain	R/W	U16	0-1000
01CA	0458	DHW I-gain	R/W	U16	0-1000
01CB	0459	DHW D-gain	R/W	U16	0-1000
01CC	0460	DHW hysteresis step time	R/W	U16	0-64800 seconds (0=Disable hysteresis stepping)
01CD	0461	DHW modulation sensor	R/W	U16	Sensor used for DHW modulation: 0=DHW sensor, 1=Outlet sensor, 2=Inlet sensor, 3=Modbus, 4=Auto: DHW or Inlet sensor, 5=Auto: DHW or Outlet sensor

Table 4. CB Falcon Modbus register map

01CE	0462	RESERVED			
01CF	0463	DHW priority source	R/W	U16	0=Disable DHW priority, 1=DHW priority begins when DHW heat demand starts
		LIMITS CONFIGURATION			
01D0	0464	Outlet high limit setpoint	R/W	U16	**SAFETY** parameter[f]: -40°-130° (0.1°C precision)[a]
01D1	0465	Outlet high limit response	R/W	U16	**SAFETY** parameter[f]: 0=Lockout, 1=Recycle&hold
01D2	0466	Stack limit enable	R/W	U16	**SAFETY** parameter[f]: 0=Disable stack limit, 1=Enable dual sensor safety stack limit, 2=Enable single sensor non-safety stack limit
01D3	0467	Stack limit setpoint	R/W	U16	**SAFETY** parameter[f]: -40°-130° (0.1°C precision)[a]
01D4	0468	Stack limit response	R/W	U16	**SAFETY** parameter[f]: 0=Lockout, 2=Recycle&delay
01D5	0469	Stack limit delay	R/W	U16	**SAFETY** parameter[f]: 0-64800 seconds (18 hours), 0xFFFF=Not configured
01D6	0470	Delta-T inlet/outlet enable	R/W	U16	Delta-T limit for inlet to outlet flow: 0=Disable Delta-T limit, 1=Enable Delta-T limit, 2=Enable Inversion detection, 3=Enable Delta-T limit and Inversion detection
01D7	0471	Delta-T inlet/outlet degrees	R/W	U16	Temperature delta between inlet & outlet sensors when Delta-T limit occurs: 0°-130° (0.1°C precision)[a]
01D8	0472	Delta-T response	R/W	U16	0=Lockout, 1=Recycle&delay, 2=Recycle&delay with retry limit
01D9	0473	Delta-T delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
01DA	0474	DHW high limit enable	R/W	U16	**SAFETY** parameter[f]: 0=Disable DHW high limit, 1=Enable dual sensor safety DHW high limit, 2=Enable single sensor non-safety DHW high limit
01DB	0475	DHW high limit setpoint	R/W	U16	**SAFETY** parameter[f]: -40°-130° (0.1°C precision)[a]
01DC	0476	DHW high limit response	R/W	U16	**SAFETY** parameter[f]: 0=Lockout, 2=Recycle&hold, 3=Suspend DHW
01DD	0477	CH slow start enable	R/W	U16	0=Disable CH slow start limit, 1=Enable CH slow start limit
01DE	0478	DHW slow start enable	R/W	U16	0=Disable DHW slow start limit, 1=Enable DHW slow start limit
01DF	0479	Slow start ramp	R/W	U16	RPM/min or %/min[c]
01E0	0480	Slow start setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
01E1	0481	Outlet T-rise enable	R/W	U16	0=Disable outlet T-rise limit, 1=Enable outlet T-rise limit
01E2	0482	Outlet T-rise degrees	R/W	U16	Degrees/min (0.1°C precision)[a]
01E3	0483	Outlet T-rise delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
01E4	0484	Outlet high limit enable	R/W	U16	0=Disable Outlet high limit, 1=Enable dual sensor safety Outlet high limit, 2=Enable single sensor non-safety Outlet high limit

Table 4. CB Falcon Modbus register map

01E5	0485	Delta-T retry limit	R/W	U16	Maximum number of recycles due to Delta-T or inversion limit.
01E6	0486	Delta-T rate limit enable	R/W	U16	0=Do not limit modulation rate, 1=Limit modulation rate when approaching Delta-T threshold
01E7	0487	Delta-T inverse limit time	R/W	U16	Minimum toleration time for temperature inversion (0-64800 seconds)
01E8	0488	Delta-T inverse limit response	R/W	U16	0=Lockout, 1=Recycle&delay, 2=Recycle&delay with retry limit
01E9	0489	Delta-T exchanger/outlet enable	R/W	U16	Delta-T limit for exchanger to outlet flow: 0=Disable Delta-T limit, 1=Enable Delta-T limit, 2=Enable Inversion detection, 3=Enable Delta-T limit and Inversion detection
01EA	0490	Delta-T exchanger/outlet degrees	R/W	U16	Temperature delta between exchanger & outlet sensors when Delta-T limit occurs: 0°-130° (0.1°C precision)[a]
01EB	0491	Exchanger T-rise enable	R/W	U16	0=Disable exchanger T-rise limit, 1=Enable exchanger T-rise limit
01EC	0492	T-rise response	R/W	U16	0=Lockout, 1=Recycle&delay, 2=Recycle&delay with retry limit
01ED	0493	T-rise retry limit	R/W	U16	Maximum number of recycles due to T-rise limit.
01EE	0494	Delta-T inlet/exchanger enable	R/W	U16	Delta-T limit for inlet to exchanger flow: 0=Disable Delta-T limit, 1=Enable Delta-T limit, 2=Enable Inversion detection, 3=Enable Delta-T limit and Inversion detection
01EF	0495	Delta-T inlet/exchanger degrees	R/W	U16	Temperature delta between inlet & exchanger sensors when Delta-T limit occurs: 0°-130° (0.1°C precision)[a]
		ANTICONDENSATION CONFIGURATION			
01F0	0496	CH anticondensation enable	R/W	U16	0=Disable CH anticondensation, 1=Enable CH anticondensation
01F1	0497	CH anticondensation setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
01F2	0498	CH anticondensation pump force off	R/W	U16	0=Normal (no change to CH pump) 1=CH pump forced off
01F3	0499	DHW anticondensation enable	R/W	U16	0=Disable DHW anticondensation, 1=Enable DHW anticondensation
01F4	0500	DHW anticondensation setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
01F5	0501	DHW anticondensation pump force off	R/W	U16	0=Normal (no change to DHW pump) 1=DHW pump forced off
01F6	0502	Anticondensation priority	R/W	U16	Is anticondensation more important than (0=No, 1=Yes)? Bit map: 15-5=Reserved (always 0) 4=Outlet high limit 3=Forced rate 2=Slow start 1=Delta-T limit 0=Stack limit
01F7	0503	Frost protection anticondensation enable	R/W	U16	0=Disable frost protection anticondensation, 1=Enable frost protection anticondensation

Table 4. CB Falcon Modbus register map

		DHW STORAGE CONFIGURATION			
01F8	0504	DHW storage enable	R/W	U16	0=DHW storage disabled, 1=DHW storage enabled
01F9	0505	DHW storage time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
01FA	0506	DHW storage setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
01FB	0507	DHW storage on hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
01FC	0508	DHW storage off hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
01FD	0509	DHW priority method	R/W	U16	0=Boost DHW priority ***during*** priority time, 1=Drop DHW priority ***after*** priority time expires
01FE-01FF	0510-0511	RESERVED			
		OUTDOOR RESET (ODR) CONFIGURATION			
0200	0512	CH ODR maximum outdoor temperature	R/W	U16	-40°-130° (0.1°C precision)[a]
0201	0513	CH ODR minimum outdoor temperature	R/W	U16	-40°-130° (0.1°C precision)[a]
0202	0514	CH ODR low water temperature	R/W	U16	-40°-130° (0.1°C precision)[a]
0203	0515	CH ODR boost time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0204	0516	CH ODR maximum off point	R/W	U16	-40°-130° (0.1°C precision)[a]
0205	0517	Lead Lag CH ODR maximum outdoor temperature	R/W	U16	-40°-130° (0.1°C precision)[a]
0206	0518	Lead Lag CH ODR minimum outdoor temperature	R/W	U16	-40°-130° (0.1°C precision)[a]
0207	0519	Lead Lag CH ODR low water temperature	R/W	U16	-40°-130° (0.1°C precision)[a]
0208	0520	Lead Lag CH ODR boost time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0209	0521	Lead Lag CH ODR maximum off point	R/W	U16	-40°-130° (0.1°C precision)[a]
020A	0522	CH ODR boost step	R/W	U16	0°-130° (0.1°C precision)[a]
020B	0523	CH ODR boost recovery step time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
020C	0524	Lead Lag CH ODR boost step	R/W	U16	0°-130° (0.1°C precision)[a]
020D	0525	Lead Lag CH ODR boost recovery step time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
020E	0526	Minimum boiler water temperature	R/W	U16	-40°-130° (0.1°C precision)[a]
020F	0527	Lead Lag CH ODR minimum water temperature	R/W	U16	-40°-130° (0.1°C precision)[a]
		FROST PROTECTION CONFIGURATION			
0210	0528	CH frost protection enable	R/W	U16	0=Disable CH frost protection, 1=Enable CH frost protection
0211	0529	DHW frost protection enable	R/W	U16	0=Disable DHW frost protection, 1=Enable DHW frost protection
0212	0530	Outdoor frost protection setpoint	R/W	U16	-40°-130° (0.1°C precision)[a] (applicable for CH only)
0213	0531	RESERVED			

Table 4. CB Falcon Modbus register map

0214	0532	Lead Lag frost protection enable	R/W	U16	0=Disable Lead Lag frost protection, 1=Enable Lead Lag frost protection
0215	0533	Lead Lag frost protection rate	R/W	U16	0-100% (in 0.1% units)[b]
0216-0217	0534-0535	RESERVED			
		EXTENDED MODULATION CONFIGURATION			
0218	0536	IAS open modulation enable	R/W	U16	0=Disable IAS open modulation, 1=Enable IAS open modulation
0219	0537	IAS open rate differential	R/W	U16	RPM or %[c]
021A	0538	IAS open modulation step rate	R/W	U16	RPM or %[c]
021B	0539	IAS open modulation step time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
021C	0540	IAS closed response	R/W	U16	**SAFETY** parameter[f]: 0=Lockout, 1=Recycle
		EXTENDED CENTRAL HEAT CONFIGURATION			
021D	0541	CH minimum pressure	R/W	U16	0-150psi (0.1psi precision)
021E	0542	CH time of day pressure setpoint	R/W	U16	0-150psi (0.1psi precision)
021F	0543	Analog input hysteresis	R/W	U16	0-10.0mA (0.1mA precision)
		LEAD LAG CONFIGURATION			
0220	0544	Lead Lag slave enable	R/W	U16	0=Lead/Lag slave disabled, 1=Lead/Lag simple slave enabled for EnviraCom master, 2=Lead/Lag simple slave enabled for Global Modbus master, 3=Lead/Lag full slave enabled for Global Modbus master
0221	0545	Lead Lag master enable	R/W	U16	0=Not a Lead/Lag master 1=Lead/Lag master
0222	0546	Lead Lag setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
0223	0547	Lead Lag time of day setpoint	R/W	U16	-40°-130° (0.1°C precision)[a] Setpoint when Time Of Day switch is on.
0224	0548	Lead Lag outdoor reset enable	R/W	U16	0=Disable outdoor reset, 1=Enable outdoor reset
0225	0549	Lead Lag on hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
0226	0550	Lead Lag off hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
0227	0551	Lead Lag hysteresis step time	R/W	U16	0-64800 seconds (0=Disable hysteresis stepping)
0228	0552	Lead Lag P-gain	R/W	U16	0-100
0229	0553	Lead Lag I-gain	R/W	U16	0-100
022A	0554	Lead Lag D-gain	R/W	U16	0-100
022B	0555	Lead Lag operation switch	R/W	U16	0=Turn off Lead Lag operation, 1=Turn on Lead Lag operation
022C	0556	Lead Lag CH demand switch	R/W	U16	0=Disable CH loop, 1=STAT terminal, 2=Reserved, 3=EnviraCOM remote STAT, 4=Modbus STAT (register 563)

Table 4. CB Falcon Modbus register map

022D	0557	Lead Lag CH setpoint source	R/W	U16	0=Local setpoint (register 546), 1=Modbus setpoint (register 562), 2=4-20mA setpoint (register 15)
022E	0558	Lead Lag modulation sensor	R/W	U16	Sensor used for Lead Lag modulation: 0=S5 sensor, 1=S10 sensor
022F	0559	Lead Lag modulation backup sensor	R/W	U16	Backup sensor used for Lead Lag modulation: 0=No backup sensor, 1=Outlet sensor from lead boiler, 2=Average Outlet sensor from all slave boilers
0230	0560	Lead Lag CH 4 mA water temperature	R/W	U16	Temperature corresponding to 4mA signal input: -40°-130° (0.1°C precision)[a]
0231	0561	Lead Lag CH 20 mA water temperature	R/W	U16	Temperature corresponding to 20mA signal input: -40°-130° (0.1°C precision)[a]
0232	0562	Lead Lag CH Modbus setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
0233	0563	Lead Lag CH Modbus STAT	R/W	U16	0=No call for heat, 1=Call for heat
0234	0564	Slave mode	R/W	U16	0=Use first according to priority, 1=Equalize run-time, 2=Use last according to priority
0235	0565	Slave command	R/W	U16	Bit map: 15=Slave demand request, 14=Slave suspend startup, 13=Slave run fan request, 12=Turn on auxiliary pump X, 11=Turn on auxiliary pump Y, 10=Turn on auxiliary pump Z, 9=Reserved (always 0), 8=Commanded rate is binary fraction %[g], 7-0=Commanded rate[h]
0236	0566	Base load rate	R/W	U16	RPM or %[c]
0237	0567	Fan during off cycle rate	R/W	U16	RPM or %[c]
0238	0568	Slave sequence order	R/W	U16	0-255
0239	0569	Lead Lag Modbus port	R/W	U16	Modbus port for Lead Lag control: 0=No port assigned, 1=MB1 (Local Modbus) port, 2=MB2 (Global Modbus) port
023A	0570	Slave demand to firing delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
023B	0571	Slave capacity	R/W	U16	MBH (Million BTU / hour) units
023C	0572	Base load common rate	R/W	U16	0=Disabled, 1-100% (in 0.1% units)[b]
023D	0573	Rate allocation method	R/W	U16	0=Parallel common base limited
023E	0574	Lead allocation method	R/W	U16	0=Sequence order rotation, 1=Lowest measured run time
023F	0575	Lag allocation method	R/W	U16	0=Sequence order rotation, 1=Lowest measured run time
		EXTENDED CH CONFIGURATION			
0241	0577	CH Modbus STAT	R/W	U16	Modbus call for heat (see register 209): 0=No call for heat, 1=Call for heat

Table 4. CB Falcon Modbus register map

0242	0578	CH setpoint source	R/W	U16	Source for CH setpoint: 0=Local setpoint (registers 211, 212, etc.), 1=Modbus setpoint (register 579), 2=4-20mA remote control (register 15)
0243	0579	CH Modbus setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
0244	0580	CH modulation rate source	R/W	U16	0=Local modulation (sensor), 1=Modbus binary fraction[i], 2=Modbus modulation step[h] 3=4-20mA modulation (register 15)
0245	0581	CH Modbus rate	R/W	U16	Commanded CH modulation rate[h] when source is Modbus (see register 580).
0246	0582	CH priority vs. Lead Lag	R/W	U16	0= Lead Lag > CH, 1=CH > Lead Lag
0247	0583	CH 4mA water temperature	R/W	U16	Temperature corresponding to 4mA signal input: -40°-130° (0.1°C precision)[a]
0248	0584	CH 20mA water temperature	R/W	U16	Temperature corresponding to 4mA signal input: -40°-130° (0.1°C precision)[a]
0249	0585	CH 4mA steam pressure	R/W	U16	Pressure corresponding to 4mA signal input: 0-150psi (0.1psi precision)
024A	0586	CH 20mA steam pressure	R/W	U16	Pressure corresponding to 4mA signal input: 0-150psi (0.1psi precision)
024B-024F	0587-0591	RESERVED			
		EXTENDED LIMITS CONFIGURATION			
0250	0592	Heat exchanger high limit enable	R/W	U16	0=Disable Heat exchanger high limit, 1= Enable Heat exchanger high limit
0251	0593	Heat exchanger high limit setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
0252	0594	Heat exchanger high limit response	R/W	U16	0=Lockout, 1=Recycle&delay, 2=Recycle&delay with retry limit
0253	0595	Heat exchanger high limit delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
0254	0596	Heat exchanger retry limit	R/W	U16	Maximum number of recycles due to Heat exchanger high limit.
0255-025F	0597-0607	RESERVED			
		CONNECTOR CONFIGURATION			
0260	0608	S1 (J8-4) connector type (Inlet sensor)	R/W	U16	**SAFETY** parameter[f]: 0=Unconfigured, 1=Raw A2D counts, 2=10K NTC dual temperature, 3=10K NTC single temperature, 4=12K NTC single temperature, 5=0-15 psi pressure, 6 =0-150 psi pressure, 7=4-20 mA

Table 4. CB Falcon Modbus register map

0261	0609	S2 (J8-6) connector type(4-20mA remote control input)	R/W	U16	**SAFETY** parameter[f]: 0=Unconfigured, 1=Raw A2D counts, 2=10K NTC dual temperature, 3=10K NTC single temperature, 4=12K NTC single temperature, 5=0-15 psi pressure, 6 =0-150 psi pressure, 7=4-20 mA
0262	0610	S3S4 (J8-8, 10) connector type (Outlet dual sensor) (Outlet limit sensor and Outlet operation sensor)	R/W	U16	**SAFETY** parameter[f]: 0=Unconfigured, 1=Raw A2D counts, 2=10K NTC dual temperature, 3=10K NTC single temperature, 4=12K NTC single temperature, 5=0-15 psi pressure, 6 =0-150 psi pressure, 7=4-20 mA
0263	0611	S5 (J8-11) connector type	R/W	U16	**SAFETY** parameter[f]: 0=Unconfigured, 1=Raw A2D counts, 2=10K NTC dual temperature, 3=10K NTC single temperature, 4=12K NTC single temperature, 5=0-15 psi pressure, 6 =0-150 psi pressure, 7=4-20 mA
0264	0612	S6S7 (J9-1, 3) connector type (DHW dual sensor) (DHW limit sensor and DHW operation sensor)	R/W	U16	**SAFETY** parameter[f] 0=Unconfigured, 1=Raw A2D counts, 2=10K NTC dual temperature, 3=10K NTC single temperature, 4=12K NTC single temperature, 5=0-15 psi pressure, 6 =0-150 psi pressure, 7=4-20 mA
0265	0613	S8S9 (J9-4, 6) connector type (Stack dual sensor) (Stack limit sensor and Stack operation sensor) (Stack limit sensor and Heat exchanger sensor)	R/W	U16	**SAFETY** parameter[f]: 0=Unconfigured, 1=Raw A2D counts, 2=10K NTC dual temperature, 3=10K NTC single temperature, 4=12K NTC single temperature, 5=0-15 psi pressure, 6 =0-150 psi pressure, 7=4-20 mA
0266	0614	S10 (J10-7) connector type	R/W	U16	**SAFETY** parameter[f]: 0=Unconfigured, 1=Raw A2D counts, 2=10K NTC dual temperature, 3=10K NTC single temperature, 4=12K NTC single temperature, 5=0-15 psi pressure, 6 =0-150 psi pressure, 7=4-20 mA
0267-026F	0615-0623	RESERVED			
		EXTENDED SYSTEM CONFIGURATION			
0270	0624	Installer passcode	W	U16	To set new installer passcode (000-999). Requires register access status (register 177) set to Installer or higher.
0271	0625	OEM passcode	W	U16	To set new OEM passcode (000-999). Requires register access status (register 177) set to OEM or higher.

Table 4. CB Falcon Modbus register map

0272	0626	Outdoor temperature source	R/W	U16	0=Unconfigured, 1=S5 connector, 2=S10 connector, 3=Modbus, 4=EnviraCOM sensor
0273	0627	Warm weather shutdown enable	R/W	U16	0=Disable, 1=Enable
0274	0628	Warm weather shutdown setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
0275	0629	Use STAT with EnviraCOM remote stat	R/W	U16	0=Disable, 1=Enable
0276-02AF	0630-0687	RESERVED			
		DHW PLATE HEAT EXCHANGER CONFIGURATION			
02B0	0688	Plate preheat delay after tap	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02B1	0689	Plate preheat setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
02B2	0690	Plate preheat on recognition time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02B3	0691	Plate preheat on hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
02B4	0692	Plate preheat off hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
02B5	0693	Plate preheat minimum on time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02B6	0694	Tap detect degrees	R/W	U16	Rate of temperature drop in DHW sensor when tap detection is declared: 0°-130° / second (0.1°C precision)[a]
02B7	0695	Tap detect on hysteresis	R/W	U16	0°-130° (0.1°C precision)[a]
02B8	0696	Tap detect on recognition time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02B9	0697	Tap stop DHW-Inlet degrees	R/W	U16	Temperature delta between DHW & inlet sensors when tap demand is stopped (drops below this limit): 0°-130° (0.1°C precision)[a]
02BA	0698	Tap stop Outlet-Inlet degrees	R/W	U16	Temperature delta between outlet & inlet sensors when tap demand is stopped (drops below this limit): 0°-130° (0.1°C precision)[a]
02BB	0699	Tap detect minimum on time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02BC-02BF	0700-0703	RESERVED			
		EXTENDED LEAD LAG CONFIGURATION			
02C0	0704	Lead Lag DHW demand switch	R/W	U16	0=DHW loop is disabled, 1=STAT terminal, 2=Reserved, 3=EnviraCOM DHW request, 4=Unused
02C1	0705	Lead Lag DHW setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]
02C2	0706	Lead Lag DHW priority vs. CH	R/W	U16	0=CH > DHW, 1=DHW > CH
02C3-02C6	0707-0710	RESERVED			
02C7	0711	Warm weather shutdown enable	R/W	U16	0=Disable, 1=Enable
02C8	0712	Warm weather shutdown setpoint	R/W	U16	-40°-130° (0.1°C precision)[a]

Table 4. CB Falcon Modbus register map

02C9	0713	Slave dropout/return compensation	R/W	U16	0=No slave compensation, 1=Replace dropout immediately, 2=Adjust rate for remaining slaves, 3=Both replace dropout & adjust rate
02CA	0714	Add stage method	R/W	U16	0=Do not add stage, 1=Use error threshold, 2=Use firing rate threshold, 3=Use error rate change & threshold, 4=Use firing rate change & threshold
02CB	0715	RESERVED			
02CC	0716	Add stage detection time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02CD	0717	RESERVED			
02CE	0718	Add stage error threshold	R/W	U16	0°-130° (0.1°C precision)[a]
02CF	0719	Add stage rate offset	R/W	U16	-100-100%[2] (0.1% units)
02D0	0720	Add stage error gain	R/W	U16	0-100
02D1	0721	Add stage rate gain	R/W	U16	0-100
02D2	0722	Add stage inter-stage delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02D3	0723	Drop stage method	R/W	U16	0=Do not drop stage, 1=Use error threshold, 2=Use firing rate threshold, 3=Use error rate change & threshold, 4=Use firing rate change & threshold
02D4	0724	RESERVED			
02D5	0725	Drop stage detection time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02D6	0726	RESERVED			
02D7	0727	Drop stage error threshold	R/W	U16	0°-130° (0.1°C precision)[a]
02D8	0728	Drop stage rate offset	R/W	U16	-100-100%[2] (0.1% units)
02D9	0729	Drop stage error gain	R/W	U16	0-100
02DA	0730	Drop stage rate gain	R/W	U16	0-100
02DB	0731	Drop stage inter-stage delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02DC	0732	RESERVED			
02DD	0733	Lead rotation time	R/W	U16	0-64800 minutes (1080 hours), 0xFFFF=Not configured
02DE	0734	Force lead rotation time	R/W	U16	0-64800 minutes (1080 hours), 0xFFFF=Not configured
02DF-02EF	0735-0751	RESERVED			
		EXTENDED PUMP CONFIGURATION			
02F0	0752	Auxiliary 1 pump overrun time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02F1	0753	Auxiliary 1 pump options 1	R/W	U16	Bit map: 15=Normal pump demand when auxiliary pump Z is set, 14=Normal pump demand when auxiliary pump Y is set, 13=Normal pump demand when auxiliary pump X is set, 12-7=Reserved (always 0), 6=Normal pump demand when DHW service is active, 5=Normal pump demand when CH service is active, 4=Reserved, 3=Normal pump demand when DHW demand, 2=Normal pump demand when CH demand, 1=Normal pump demand when local burner demand, 0=Local demand inhibited for faults

Table 4. CB Falcon Modbus register map

02F2	0754	Auxiliary 1 pump options 2	R/W	U16	Bit map: 15=Pump used for Lead Lag, 14=Pump used for local demand, 13-9=Reserved (always 0), 8=Force pump off when DHW high limit, 7=Force pump off when DHW anti-condensation, 6=Force pump off when CH anti-condensation, 5=Force pump off when DHW priority is active, 4=Force pump on when DHW frost protection, 3=Force pump on when CH frost protection, 2=Force pump on when Lead Lag slave demand, 1=Force pump on when local burner demand, 0=Force pump on when Outlet high limit
02F3	0755	Auxiliary 2 pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
02F4	0756	Auxiliary 2 pump control	R/W	U16	0=Auto, 1=On
02F5	0757	Auxiliary 2 pump start delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02F6	0758	Auxiliary 2 pump overrun time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
02F7	0759	Auxiliary 2 pump options 1	R/W	U16	Bit map: 15=Normal pump demand when auxiliary pump Z is set, 14=Normal pump demand when auxiliary pump Y is set, 13=Normal pump demand when auxiliary pump X is set, 12-7=Reserved (always 0), 6=Normal pump demand when DHW service is active, 5=Normal pump demand when CH service is active, 4=Reserved, 3=Normal pump demand when DHW demand, 2=Normal pump demand when CH demand, 1=Normal pump demand when local burner demand, 0=Local demand inhibited for faults
02F8	07600760	Auxiliary 2 pump options 2	R/W	U16	Bit map: 15=Pump used for Lead Lag, 14=Pump used for local demand, 13-9=Reserved (always 0), 8=Force pump off when DHW high limit, 7=Force pump off when DHW anti-condensation, 6=Force pump off when CH anti-condensation, 5=Force pump off when DHW priority is active, 4=Force pump on when DHW frost protection, 3=Force pump on when CH frost protection, 2=Force pump on when Lead Lag slave demand, 1=Force pump on when local burner demand, 0=Force pump on when Outlet high limit
02F9-033F	0761-0831	RESERVED			
		SAFETY CONFIGURATION			
0340-035F	0832-0863	RESERVED			
		LOCKOUT HISTORY			
0360-0370	0864-0880	Lockout history record 1	R		Most recent lockout. See Table 5.
0371-0381	0881-0897	Lockout history record 2	R		2nd newest lockout. See Table 5.
0382-0392	0898-0914	Lockout history record 3	R		3rd newest lockout. See Table 5.
0393-03A3	0915-0931	Lockout history record 4	R		4th newest lockout. See Table 5.
03A4-03B4	0932-0948	Lockout history record 5	R		5th newest lockout. See Table 5.
03B5-03C5	0949-0965	Lockout history record 6	R		6th newest lockout. See Table 5.
03C6-03D6	0966-0982	Lockout history record 7	R		7th newest lockout. See Table 5.
03D7-03E7	0983-0999	Lockout history record 8	R		8th newest lockout. See Table 5.
03E8-03F8	1000-1016	Lockout history record 9	R		9th newest lockout. See Table 5.
03F9-0409	1017-1033	Lockout history record 10	R		10th newest lockout. See Table 5.

Table 4. CB Falcon Modbus register map

040A-041A	1034-1050	Lockout history record 11	R		11th newest lockout. See Table 5.
041B-042B	1051-1067	Lockout history record 12	R		12th newest lockout. See Table 5.
042C-043C	1068-1084	Lockout history record 13	R		13th newest lockout. See Table 5.
043D-044D	1085-1101	Lockout history record 14	R		14th newest lockout. See Table 5.
044E-045E	1102-1118	Lockout history record 15	R		Oldest lockout
045F	1119	Alarm code	R	U16	Lockout/alert code causing alarm (see register 2).
		ALERT LOG			
0460-0465	1120-1125	Alert log record 1	R	U16	Most recent alert (see Table 9).
0466-046B	1126-1131	Alert log record 2	R	U16	2nd newest alert.
046C-0471	1132-1137	Alert log record 3	R	U16	3rd newest alert.
0472-0477	1138-1143	Alert log record 4	R	U16	4th newest alert.
0478-047D	1144-1149	Alert log record 5	R	U16	5th newest alert.
047E-0483	1150-1155	Alert log record 6	R	U16	6th newest alert.
0484-0489	1156-1161	Alert log record 7	R	U16	7th newest alert.
048A-048F	1162-1167	Alert log record 8	R	U16	8th newest alert.
0490-0495	1168-1173	Alert log record 9	R	U16	9th newest alert.
0496-049B	1174-1179	Alert log record 10	R	U16	10th newest alert.
049C-04A1	1180-1185	Alert log record 11	R	U16	11th newest alert.
04A2-04A7	11861191	Alert log record 12	R	U16	12th newest alert.
04A8-04AD	1192-1197	Alert log record 13	R	U16	13th newest alert.
04AE-04B3	1198-1203	Alert log record 14	R	U16	14th newest alert.
04B4-04B9	1204-1209	Alert log record 15	R	U16	Oldest alert.
04BA-0FFF	0954-4095	RESERVED			

[a] All temperature registers are expressed in ×C regardless what Temperature units (register 179) is set to. Temperature range is -40×C to 130×C with values given in 0.1×C units (for example, 32.0×C = 320). A temperature that is NOT applicable in this Falcon, i.e., not enabled, has a value of 0x8FFF. This temperature setting is denoted as "UNCONFIGURED" at the user interface.

[b] All percentage values are given in 0.1% granularity, i.e., 0-1000 is the range for 0.0-100.0%.

c Most significant bit in value determines which units type the parameter has: 0=RPM, 1=%. If Modulation Output parameter (register 192) doesn't match with the setting of this bit, then the parameter setting is invalid.

[d] All temperature registers are expressed in ×C regardless what Temperature units (register 179) is set to. Temperature range is -40×C to 130×C with values given in 0.1×C units (for example, 32.0×C = 320). A temperature that is NOT applicable in this Falcon, i.e., not enabled, has a value of 0x8FFF. This temperature setting is denoted as "UNCONFIGURED" at the user interface. When
configured for raw a2d counts a range of 0-4095 counts is outputted with no error detection provided in the corresponding status register. When configured for 0-15 psi or 0-150 psi the value is expressed in 0.1 psi precision.

[e] Pump control changed in Falcon starting with application build 1600 (see register 189). Pump status changed as a result. Table 12 contains the status values for units prior to build 1600, and table 13 for build 1600 or later.

[f] This register is a safety configuration parameter that requires successful access login (see register 177) before the setting can be changed. Changing this parameter also requires a safety verification with the Falcon control afterwards to confirm that its new setting is consistent with the other safety parameters.

[g] Commanded rate in least significant byte of this register can be expressed in two formats: binary fraction % or multiple of 0.5% steps. Bit 8 of this register indicates which format the commanded rate is expressed in; when bit 8 is set, the commanded rate is in binary fraction % format and when bit 8 is cleared, the commanded rate is in 0.5% steps.

[h] For binary fraction % format commanded rate is a binary fraction between .00000000 (0%=no heat at all) and .11111111 (99.98% heat = maximum fire). For 0.5% step format commanded rate is a value between 0 (minimum fire) and 200 (maximum fire) that is a multiple of 0.5% (200 x 0.5% = 100%).

[i] For Modbus binary fraction mode the CH Modbus rate (register 581) is a binary fraction between .00000000 (0%=no heat at all) and .11111111 (99.98% heat = maximum fire). For Modbus modulation step mode the CH Modbus rate is a 0.5% step format with a value between 0 (minimum fire) and 200 (maximum fire) in multiples of 0.5% (200 x 0.5% = 100%).

Each lockout history record has the format described in Table 5.

Table 5. CB Falcon lockout history record

Byte Offset	Parameter	Read/Write	Format	Note
0-1	Lockout code	R	U16	See register 34 (decimal).
2-3	Annunciator first out	R	U16	See register 36 (decimal).
4-5	Burner control state	R	U16	See register 33 (decimal).
6-7	Sequence time	R	U16	See register 37 (decimal).
8-11	Cycle	R	U32	See registers 128-129 (decimal).
12-15	Hours	R	U32	See registers 130-131 (decimal).
16-17	I/O	R	U16	See register 2 (decimal).
18-19	Annunciator	R	U16	See register 3 (decimal).
20-21	Outlet temperature	R	U16	See register 7 (decimal).
22-23	Inlet temperature/Steam pressure	R	U16	See register 11 or 20 (decimal). Data type is dependent on Product type (register 176).
24-25	DHW temperature	R	U16	See register 12 (decimal).
26-27	Outdoor temperature	R	U16	See register 13 (decimal).
28-29	Stack temperature	R	U16	See register 14 (decimal).
30-31	4-20mA input	R	U16	See register 15 (decimal).
32-33	Fault data	R	U8	Fault dependent data (U8 x 2).

Each annunciator configuration record has the format described Table 6.

Table 6. Annunciator configuration

Byte Offset	Parameter	Read/ Write	Format	Note
0-1	Location	R/W	U16	0=Unused, 1=PII, 2=LCI, 3=ILK, 4=Other
2-4	Annunciator short name	R/W	U8	
5	Unused	--	U8	
6-25	Annunciator name	R/W	U8	

PII, LCI, and ILK terminals are named with configuration records that have a format described in Table 7.

Table 7. PII, LCI, ILK terminal configuration

Byte Offset	Parameter	Read/ Write	Format	Note
0-2	Interlock short name	R/W	U8	
3	Unused	--	U8	
4-23	Interlock name	R/W	U8	

The Falcon lockout and hold codes are listed in Table 8.

Table 8. Falcon lockout and hold codes

Code	Description	Note
0	None	No lockout/ hold
1	Unconfigured safety data	Lockout
2	Waiting for safety data verification	Lockout
3	Internal fault: Hardware fault	Hold
4	Internal fault: Safety Relay key feedback error	Hold
5	Internal fault: Unstable power (DCDC) output	Hold
6	Internal fault: Invalid processor clock	Hold
7	Internal fault: Safety relay drive error	Hold
8	Internal fault: Zero crossing not detected	Hold
9	Internal fault: Flame bias out of range	Hold
10	Internal fault: Invalid Burner control state	Lockout
11	Internal fault: Invalid Burner control state flag	Lockout
12	Internal fault: Safety relay drive cap short	Hold
13	Internal fault: PII shorted to ILK	Hold/ Lockout
14	Internal fault: HFS shorted to LCI	Hold/ Lockout
15	Internal fault: Safety relay test failed due to feedback ON	Lockout
16	Internal fault: Safety relay test failed due to safety relay OFF	Lockout
17	Internal fault: Safety relay test failed due to safety relay not OFF	Lockout
18	Internal fault: Safety relay test failed due to feedback not ON	Lockout
19	Internal fault: Safety RAM write	Lockout
20	Internal fault: Flame ripple and overflow	Hold
21	Internal fault: Flame number of sample mismatch	Hold
22	Internal fault: Flame bias out of range	Hold
23	Internal fault: Bias changed since heating cycle starts	Hold
24	Internal fault: Spark voltage stuck low or high	Hold
25	Internal fault: Spark voltage changed too much during flame sensing time	Hold
26	Internal fault: Static flame ripple	Hold
27	Internal fault: Flame rod shorted to ground detected	Hold
28	Internal fault: A/D linearity test fails	Hold
29	Internal fault: Flame bias cannot be set in range	Hold
30	Internal fault: Flame bias shorted to adjacent pin	Hold
31	Internal fault: SLO electronics unknown error	Hold
32	Internal fault: Safety Key 0	Lockout
33	Internal fault: Safety Key 1	Lockout
34	Internal fault: Safety Key 2	Lockout
35	Internal fault: Safety Key 3	Lockout
36	Internal fault: Safety Key 4	Lockout
37	Internal fault: Safety Key 5	Lockout
38	Internal fault: Safety Key 6	Lockout
39	Internal fault: Safety Key 7	Lockout
40	Internal fault: Safety Key 8	Lockout
41	Internal fault: Safety Key 9	Lockout
42	Internal fault: Safety Key 10	Lockout
43	Internal fault: Safety Key 11	Lockout
44	Internal fault: Safety Key 12	Lockout
45	Internal fault: Safety Key 13	Lockout
46	Internal fault: Safety Key 14	Lockout
47	Flame rod to ground leakage	Hold
48	Static flame (not flickering)	Hold
49	24VAC voltage low/high	Hold
50	Modulation fault	Hold
51	Pump fault	Hold
52	Motor tachometer fault	Hold
53	AC inputs phase reversed	Lockout
54	Safety GVT model ID doesn't match application's model ID	Lockout
55	Application configuration data block CRC errors	Lockout
56-57	RESERVED	
58	Internal fault: HFS shorted to IAS	Lockout
59	Internal fault: Mux pin shorted	Lockout
60	Internal fault: HFS shorted to LFS	Lockout
61	Anti short cycle	Hold
62	Fan speed not proved	Hold
63	LCI OFF	Hold
64	PII OFF	Hold/ Lockout
65	Interrupted Airflow Switch OFF	Hold/ Lockout
66	Interrupted Airflow Switch ON	Hold/ Lockout
67	ILK OFF	Hold/ Lockout
68	ILK ON	Hold/ Lockout
69	Pilot test hold	Hold
70	Wait for leakage test completion	Hold
71-77	RESERVED	
78	Demand lost in run	Hold
79	Outlet high limit	Hold/ Lockout
80	DHW high limit	Hold/ Lockout

Table 8. Falcon lockout and hold codes

81	Delta T inlet/outlet limit	Hold/ Lockout
82	Stack limit	Hold/ Lockout
83	Delta T exchanger/outlet limit	Hold/ Lockout
84	Delta T inlet/exchanger limit	Hold/ Lockout
85	Inlet/outlet inversion limit	Hold/ Lockout
86	Exchanger/outlet inversion limit	Hold/ Lockout
87	Inlet/exchanger inversion limit	Hold/ Lockout
88	Outlet T-rise limit	Hold/ Lockout
89	Exchanger T-rise limit	Hold/ Lockout
90	Heat exchanger high limit	Hold/ Lockout
91	Inlet sensor fault	Hold
92	Outlet sensor fault	Hold
93	DHW sensor fault	Hold
94	S2 (J8-6) sensor fault	Hold
95	Stack sensor fault	Hold
96	S5 (J8-11) sensor fault	Hold
97	Internal fault: A2D mismatch	Lockout
98	Internal fault: Exceeded VSNSR voltage tolerance	Lockout
99	Internal fault: Exceeded 28V voltage tolerance	Lockout
100	Pressure sensor fault	Hold
101-104	RESERVED	
105	Flame detected out of sequence	Hold/ Lockout
106	Flame lost in MFEP	Lockout
107	Flame lost early in run	Lockout
108	Flame lost in run	Lockout
109	Ignition failed	Lockout
110	Ignition failure occurred	Hold
111	Flame current lower than WEAK threshold	Hold
112	Pilot test flame timeout	Lockout
113	Flame circuit timeout	Lockout
114-121	RESERVED	
122	Lightoff rate proving failed	Lockout
123	Purge rate proving failed	Lockout
124	High fire switch OFF	Hold
125	High fire switch stuck ON	Hold
126	Low fire switch OFF	Hold
127	Low fire switch stuck ON	Hold

Table 8. Falcon lockout and hold codes

128	Fan speed failed during prepurge	Hold/ Lockout
129	Fan speed failed during preignition	Hold/ Lockout
130	Fan speed failed during ignition	Hold/ Lockout
131	Fan movement detected during standby	Hold
132	Fan speed failed during run	Hold
133-135	RESERVED	
136	Interrupted Airflow Switch failed to close	Hold
137	ILK failed to close	Hold
138-142	RESERVED	
143	Internal fault: Flame bias out of range 1	Lockout
144	Internal fault: Flame bias out of range 2	Lockout
145	Internal fault: Flame bias out of range 3	Lockout
146	Internal fault: Flame bias out of range 4	Lockout
147	Internal fault: Flame bias out of range 5	Lockout
148	Internal fault: Flame bias out of range 6	Lockout
149	Flame detected	Hold/ Lockout
150	Flame not detected	Hold
151	High fire switch ON	Hold/ Lockout
152	Combustion pressure ON	Hold/ Lockout
153	Combustion pressure OFF	Hold/ Lockout
154	Purge fan switch ON	Hold/ Lockout
155	Purge fan switch OFF	Hold/ Lockout
156	Combustion pressure and Flame ON	Hold/ Lockout
157	Combustion pressure and Flame OFF	Lockout
158	Main valve ON	Lockout
159	Main valve OFF	Lockout
160	Ignition ON	Lockout
161	Ignition OFF	Lockout
162	Pilot valve ON	Lockout
163	Pilot valve OFF	Lockout
164	Block intake ON	Lockout
165	Block intake OFF	Lockout
166-171	RESERVED	
172	Main relay feedback incorrect	Lockout
173	Pilot relay feedback incorrect	Lockout
174	Safety relay feedback incorrect	Lockout
175	Safety relay open	Lockout
176	Main relay ON at safe start check	Lockout
177	Pilot relay ON at safe start check	Lockout
178	Safety relay ON at safe start check	Lockout
179-183	RESERVED	

Table 8. Falcon lockout and hold codes

184	Invalid BLOWER/HSI output setting	Lockout
185	Invalid Delta T limit enable setting	Lockout
186	Invalid Delta T limit response setting	Lockout
187	Invalid DHW high limit enable setting	Lockout
188	Invalid DHW high limit response setting	Lockout
189	Invalid Flame sensor type setting	Lockout
190	Invalid interrupted air switch enable setting	Lockout
191	Invalid interrupted air switch start check enable setting	Lockout
192	Invalid Igniter on during setting	Lockout
193	Invalid Ignite failure delay setting	Lockout
194	Invalid Ignite failure response setting	Lockout
195	Invalid Ignite failure retries setting	Lockout
196	Invalid Ignition source setting	Lockout
197	Invalid Interlock open response setting	Lockout
198	Invalid Interlock start check setting	Lockout
199	Invalid LCI enable setting	Lockout
200	Invalid lightoff rate setting	Lockout
201	Invalid Lightoff rate proving setting	Lockout
202	Invalid Main Flame Establishing Period time setting	Lockout
203	Invalid MFEP flame failure response setting	Lockout
204	Invalid NTC sensor type setting	Lockout
205	Invalid Outlet high limit response setting	Lockout
206	Invalid Pilot Flame Establishing Period setting	Lockout
207	Invalid PII enable setting	Lockout
208	Invalid pilot test hold setting	Lockout
209	Invalid Pilot type setting	Lockout
210	Invalid Postpurge time setting	Lockout
211	Invalid Power up with lockout setting	Lockout
212	Invalid Preignition time setting	Lockout
213	Invalid Prepurge rate setting	Lockout
214	Invalid Prepurge time setting	Lockout
215	Invalid Purge rate proving setting	Lockout
216	Invalid Run flame failure response	Lockout
217	Invalid Run stabilization time setting	Lockout
218	Invalid Stack limit enable setting	Lockout
219	Invalid Stack limit response setting	Lockout
220	Unconfigured Delta T limit setpoint setting	Lockout
221	Unconfigured DHW high limit setpoint setting	Lockout
222	Unconfigured Outlet high limit setpoint setting	Lockout
223	Unconfigured Stack limit setpoint setting	Lockout
224	Invalid DHW demand source setting	Lockout
225	Invalid Flame threshold setting	Lockout
226	Invalid Outlet high limit setpoint setting	Lockout
227	Invalid DHW high limit setpoint setting	Lockout
228	Invalid Stack limit setpoint setting	Lockout
229	Invalid Modulation output setting	Lockout
230	Invalid CH demand source setting	Lockout
231	Invalid Delta T limit delay setting	Lockout
232	Invalid Pressure sensor type setting	Lockout
233	Invalid IAS closed response setting	Lockout
234	Invalid Outlet high limit enable setting	Lockout
235	Invalid Outlet connector type setting	Lockout
236	Invalid Inlet connector type setting	Lockout
237	Invalid DHW connector type setting	Lockout
238	Invalid Stack connector type setting	Lockout
239	Invalid S2 (J8-6) connector type setting	Lockout
240	Invalid S5 (J8-11) connector type setting	Lockout
241	Exchanger sensor not allowed with stack connector setting	Lockout
242	Invalid DHW auto detect configuration	Lockout
243	Invalid UV with spark interference not compatible with Ignitor on throughout PFEP	Lockout
244	Internal fault: Safety relay test invalid state	Lockout
245	Invalid Outlet connector type setting for T-rise	Lockout
246	4-20mA cannot be used for both modulation and setpoint	Lockout
247	Invalid ILK bounce detection enable	Lockout
248	Invalid forced recycle interval	Lockout
249	STAT cannot be demand source when Remote Stat is enabled	Lockout
250-255	RESERVED	

Each alert log record has the format described in Table 9.

Table 9. Falcon alert log record

Byte Offset	Parameter	Read/ Write	Format	Note
0-1	Alert code	R	U16	See table 10.
2-5	Cycle	R	U32	See registers 128-129 (decimal).
6-9	Hours	R	U32	See registers 130-131 (decimal).
10	-	R	U8	Unused
11	Occurrence count	R	U8	Number of occurrences of most recent alert.

The Falcon alert codes are listed in Table 10.

Table 10. Falcon alert codes

Code	Description
0	None (No alert)
1	Alert PCB was restored from factory defaults
2	Safety configuration parameters were restored from factory defaults
3	Configuration parameters were restored from factory defaults
4	Invalid Factory Invisibility PCB was detected
5	Invalid Factory Range PCB was detected
6	Invalid range PCB record has been dropped
7	EEPROM lockout history was initialized
8	Switched application annunciation data blocks
9	Switched application configuration data blocks
10	Configuration was restored from factory defaults
11	Backup configuration settings was restored from active configuration
12	Annunciation configuration was restored from factory defaults
13	Annunciation configuration was restored from backup
14	Safety group verification table was restored from factory defaults
15	Safety group verification table was updated
16	Invalid Parameter PCB was detected
17	Invalid Range PCB was detected
18	Alarm silence time exceeded maximum
19	Invalid safety group verification table was detected
20	Backdoor password could not be determined
21	Invalid safety group verification table was not accepted
22	CRC errors were found in application configuration data blocks
23	Backup Alert PCB was restored from active one
24	RESERVED
25	Lead Lag operation switch was turned OFF
26	Lead Lag operation switch was turned ON
27	Safety processor was reset
28	Application processor was reset
29	Burner switch was turned OFF
30	Burner switch was turned ON
31	Plug-In Module (PIM) was inserted into socket
32	Plug-In Module (PIM) was removed from socket
33	Alert PCB was configured
34	Parameter PCB was configured
35	Range PCB was configured
36	Plug-In Module (PIM) incompatible with product was inserted into socket
37	Program Module application parameter revision differs from application processor

Table 10. Falcon alert codes

38	Program Module safety parameter revision differs from safety processor
39	PCB incompatible with product contained in Program Module
40	Parameter PCB in Program Module is too large for product
41	Range PCB in Program Module was too large for product
42	Alert PCB in Program Module was too large for product
43	IAS start check was forced on due to IAS enabled
44	Low voltage was detected in safety processor
45	High line frequency occurred
46	Low line frequency occurred
47	Invalid subsystem reset request occurred
48	Write large enumerated Modbus register value was not allowed
49	Maximum cycle count was reached
50	Maximum hours count was reached
51	Illegal Modbus write was attempted
52	Modbus write attempt was rejected (NOT ALLOWED)
53	Illegal Modbus read was attempted
54	Safety processor brown-out reset occurred
55	Application processor watchdog reset occurred
56	Application processor brown-out reset occurred
57	Safety processor watchdog reset occurred
58	Alarm was reset by the user at the control
59	Burner control firing rate was > absolute max rate
60	Burner control firing rate was < absolute min rate
61	Burner control firing rate was invalid, % vs. RPM
62	Burner control was firing with no fan request
63	Burner control rate (nonfiring) was > absolute max rate
64	Burner control rate (nonfiring) was < absolute min rate
65	Burner control rate (nonfiring) was absent
66	Burner control rate (nonfiring) was invalid, % vs. RPM
67	Fan off cycle rate was invalid, % vs. RPM
68	Setpoint was overridden due to sensor fault
69	Modulation was overridden due to sensor fault
70	No demand source was set due to demand priority conflicts
71-73	RESERVED
74	Periodic Forced Recycle
75	Absolute max fan speed was out of range
76	Absolute min fan speed was out of range
77	Fan gain down was invalid
78	Fan gain up was invalid
79	Fan minimum duty cycle was invalid

Table 10. Falcon alert codes

80	Fan pulses per revolution was invalid
81	Fan PWM frequency was invalid
82-83	RESERVED
84	Lead Lag CH 4-20mA water temperature setting was invalid
85	No Lead Lag add stage error threshold was configured
86	No Lead Lag add stage detection time was configured
87	No Lead Lag drop stage error threshold was configured
88	No Lead Lag drop stage detection time was configured
89	RESERVED
90	Modulation output type was invalid
91	Firing rate control parameter was invalid
92	Forced rate was out of range vs. min/max modulation
93	Forced rate was invalid, % vs. RPM
94	Slow start ramp value was invalid
95	Slow start degrees value was invalid
96	Slow start was ended due to outlet sensor fault
97	Slow start was end due to reference setpoint fault
98	CH max modulation rate was invalid, % vs. RPM
99	CH max modulation rate was > absolute max rate
100	CH modulation range (max minus min) was too small (< 4% or 40 RPM)
101	DHW max modulation rate was invalid, % vs. RPM
102	DHW max modulation rate was > absolute max rate
103	DHW modulation range (max minus min) was too small (< 4% or 40 RPM)
104	Min modulation rate was < absolute min rate
105	Min modulation rate was invalid, % vs. RPM
106	Manual rate was invalid, % vs. RPM
107	Slow start enabled, but forced rate was invalid
108	Analog output hysteresis was invalid
109	Analog modulation output type was invalid
110	IAS open rate differential was invalid
111	IAS open step rate was invalid
112	Mix max modulation rate was invalid, % vs. RPM
113	Mix max modulation rate was > absolute max or < absolute min rates
114	Mix modulation range (max minus min) was too small (< 4% or 40 RPM)
115	Fan was limited to its minimum duty cycle
116	Manual rate was > CH max modulation rate
117	Manual rate was > DHW max modulation rate
118	Manual rate was < min modulation rate
119	Manual rate in Standby was > absolute max rate
120	Modulation commanded rate was > CH max modulation rate
121	Modulation commanded rate was > DHW max modulation rate
122	Modulation commanded rate was < min modulation rate
123	Modulation rate was limited due to Outlet limit
124	Modulation rate was limited due to Delta-T limit
125	Modulation rate was limited due to Stack limit
126	Modulation rate was limited due to anticondensation
127	Fan speed out of range in RUN
128	Modulation rate was limited due to IAS was open
129	Slow start ramp setting of zero will result in no modulation rate change
130	No forced rate was configured for slow start ramp
131	CH demand source was invalid
132	CH P-gain was invalid
133	CH I-gain was invalid
134	CH D-gain was invalid
135	CH OFF hysteresis was invalid
136	CH ON hysteresis was invalid
137	CH sensor type was invalid
138	CH hysteresis step time was invalid
139	CH remote control parameter was invalid
140	CH ODR not allowed with remote control
141	Steam P-gain was invalid
142	Steam I-gain was invalid
143	Steam D-gain was invalid
144	Steam OFF hysteresis was invalid
145	Steam ON hysteresis was invalid
146	CH control was suspended due to fault
147	CH header temperature was invalid
148	CH Outlet temperature was invalid
149	CH steam pressure was invalid
150	Steam setpoint source parameter was invalid
151	Minimum water temperature parameter was greater than setpoint
152	Minimum water temperature parameter was greater than time of day setpoint
153	Minimum pressure parameter was greater than setpoint
154	Minimum pressure parameter was greater than time of day setpoint
155	CH modulation rate source parameter was invalid
156	Steam modulation rate source parameter was invalid
157	DHW demand source was invalid
158	DHW P-gain was invalid
159	DHW I-gain was invalid
160	DHW D-gain was invalid
161	DHW OFF hysteresis was invalid
162	DHW ON hysteresis was invalid
163	DHW hysteresis step time was invalid

Table 10. Falcon alert codes

164	DHW sensor type was invalid
165	Inlet sensor type was invalid for DHW
166	Outlet sensor type was invalid for DHW
167	DHW storage OFF hysteresis was invalid
168	DHW storage ON hysteresis was invalid
169	DHW modulation sensor type was invalid
170	DHW modulation sensor was not compatible for Auto mode
171	DHW control was suspended due to fault
172	DHW temperature was invalid
173	DHW inlet temperature was invalid
174	DHW outlet temperature was invalid
175	DHW high limit must be disabled for Auto mode
176	DHW sensor type was not compatible for Auto mode
177	DHW priority source setting was invalid
178	DHW priority method setting was invalid
179	CH S5 (J8-11) sensor was invalid
180	CH Inlet temperature was invalid
181	CH S10 (J10-7) sensor was invalid
182	Lead Lag CH setpoint source was invalid
183	Lead Lag P-gain was invalid
184	Lead Lag I-gain was invalid
185	Lead Lag D-gain was invalid
186	Lead Lag OFF hysteresis was invalid
187	Lead Lag ON hysteresis was invalid
188	Lead Lag slave enable was invalid
189	Lead Lag hysteresis step time was invalid
190	No Lead Lag Modbus port was assigned
191	Lead Lag base load common setting was invalid
192	Lead Lag DHW demand switch setting was invalid
193	Lead Lag Mix demand switch setting was invalid
194	Lead Lag modulation sensor setting was invalid
195	Lead Lag backup modulation sensor setting was invalid
196	Lead Lag slave mode setting was invalid
197	Lead Lag rate allocation setting was invalid
198	Lead selection setting was invalid
199	Lag selection setting was invalid
200	Lead Lag slave return setting was invalid
201	Lead Lag add stage method setting was invalid
202	STAT may not be a Lead Lag CH demand source when Remote Stat is enabled
203	Lead Lag base load rate setting was invalid
204	Lead Lag master was suspended due to fault
205	Lead Lag slave was suspended due to fault
206	Lead Lag header temperature was invalid
207	Lead Lag was suspended due to no enabled Program Module installed
208	Lead Lag slave session has timed out

Table 10. Falcon alert codes

209	Too many Lead Lag slaves were detected
210	Lead Lag slave was discovered
211	Incompatible Lead Lag slave was discovered
212	No base load rate was set for Lead Lag slave
213	Lead Lag slave unable to fire before demand to fire delay expired
214	Adding Lead Lag slave aborted due to add requirement change
215	No Lead Lag slaves available to service demand
216	No Lead Lag active service was set due to demand priority conflicts
217	No Lead Lag add stage method was specified
218	No Lead Lag drop stage method was specified
219	RESERVED
220	Lead Lag frost protection rate was invalid
221	Lead Lag drop stage method setting was invalid
222	CH frost protection temperature was invalid
223	CH frost protection inlet temperature was invalid
224	DHW frost protection temperature was invalid
225-230	RESERVED
231	Lead Lag CH setpoint was invalid
232	Lead Lag CH time of day setpoint was invalid
233	Lead Lag outdoor temperature was invalid
234	Lead Lag ODR time of day setpoint was invalid
235	Lead Lag ODR time of day setpoint exceeded normal setpoint
236	Lead Lag ODR max outdoor temperature was invalid
237	Lead Lag ODR min outdoor temperature was invalid
238	Lead Lag ODR low water temperature was invalid
239	Lead Lag ODR outdoor temperature range was too small (minimum 12 C / 22 F)
240	Lead Lag ODR water temperature range was too small (minimum 12 C / 22 F)
241	Lead Lag DHW setpoint was invalid
242	Lead Lag Mix setpoint was invalid
243	Lead Lag CH demand switch was invalid
244	Lead Lag ODR min water temperature was invalid
245	RESERVED
246	CH setpoint was invalid
247	CH time of day setpoint was invalid
248	CH outdoor temperature was invalid
249	CH ODR time of day setpoint was invalid
250	CH ODR time of day setpoint exceeds normal setpoint
251	CH max outdoor setpoint was invalid
252	CH min outdoor setpoint was invalid
253	CH ODR low water temperature was invalid
254	CH ODR outdoor temperature range was too small
255	CH ODR water temperature range was too small
256	Steam setpoint was invalid

Table 10. Falcon alert codes

257	Steam time of day setpoint was invalid
258	Steam minimum pressure was invalid
259	CH ODR min water temperature was invalid
260	RESERVED
261	DHW setpoint was invalid
262	DHW time of day setpoint was invalid
263	DHW storage setpoint was invalid
264	STAT may not be a DHW demand source when Remote Stat is enabled
265-266	RESERVED
267	STAT may not be a CH demand source when Remote Stat is enabled
268	CH 4mA water temperature setting was invalid
269	CH 20mA water temperature setting was invalid
270	Steam 4mA water temperature setting was invalid
271	Steam 20mA water temperature setting was invalid
272	Abnormal Recycle: Pressure sensor fault
273	Abnormal Recycle: Safety relay drive test failed
274	Abnormal Recycle: Demand off during Pilot Flame Establishing Period
275	Abnormal Recycle: LCI off during Drive to Purge Rate
276	Abnormal Recycle: LCI off during Measured Purge Time
277	Abnormal Recycle: LCI off during Drive to Lightoff Rate
278	Abnormal Recycle: LCI off during Pre-Ignition test
279	Abnormal Recycle: LCI off during Pre-Ignition time
280	Abnormal Recycle: LCI off during Main Flame Establishing Period
281	Abnormal Recycle: LCI off during Ignition period
282	Abnormal Recycle: Demand off during Drive to Purge Rate
283	Abnormal Recycle: Demand off during Measured Purge Time
284	Abnormal Recycle: Demand off during Drive to Lightoff Rate
285	Abnormal Recycle: Demand off during Pre-Ignition test
286	Abnormal Recycle: Demand off during Pre-Ignition time
287	Abnormal Recycle: Flame was on during Safe Start check
288	Abnormal Recycle: Flame was on during Drive to Purge Rate
289	Abnormal Recycle: Flame was on during Measured Purge Time
290	Abnormal Recycle: Flame was on during Drive to Lightoff Rate
291	Abnormal Recycle: Flame was not on at end of Ignition period
292	Abnormal Recycle: Flame was lost during Main Flame Establishing Period

Table 10. Falcon alert codes

293	Abnormal Recycle: Flame was lost early in Run
294	Abnormal Recycle: Flame was lost during Run
295	Abnormal Recycle: Leakage test failed
296	Abnormal Recycle: Interrupted air flow switch was off during Drive to Purge Rate
297	Abnormal Recycle: Interrupted air flow switch was off during Measured Purge Time
298	Abnormal Recycle: Interrupted air flow switch was off during Drive to Lightoff Rate
299	Abnormal Recycle: Interrupted air flow switch was off during Pre-Ignition test
300	Abnormal Recycle: Interrupted air flow switch was off during Pre-Ignition time
301	Abnormal Recycle: Interrupted air flow switch was off during Main Flame Establishing Period
302	Abnormal Recycle: Ignition failed due to interrupted air flow switch was off
303	Abnormal Recycle: ILK off during Drive to Purge Rate
304	Abnormal Recycle: ILK off during Measured Purge Time
305	Abnormal Recycle: ILK off during Drive to Lightoff Rate
306	Abnormal Recycle: ILK off during Pre-Ignition test
307	Abnormal Recycle: ILK off during Pre-Ignition time
308	Abnormal Recycle: ILK off during Main Flame Establishing Period
309	Abnormal Recycle: ILK off during Ignition period
310	Run was terminated due to ILK was off
311	Run was terminated due to interrupted air flow switch was off
312	Stuck reset switch
313	Run was terminated due to fan failure
314	Abnormal Recycle: Fan failed during Drive to Purge Rate
315	Abnormal Recycle: Fan failed during Measured Purge Time
316	Abnormal Recycle: Fan failed during Drive to Lightoff Rate
317	Abnormal Recycle: Fan failed during Pre-Ignition test
318	Abnormal Recycle: Fan failed during Pre-Ignition time
319	Abnormal Recycle: Fan failed during Ignition period
320	Abnormal Recycle: Fan failed during Main Flame Establishing Period
321	Abnormal Recycle: Main Valve off after 10 seconds of RUN
322	Abnormal Recycle: Pilot Valve off after 10 seconds of RUN
323	Abnormal Recycle: Safety Relay off after 10 seconds of RUN
324	Abnormal Recycle: Hardware flame bias
325	Abnormal Recycle: Hardware static flame

Table 10. Falcon alert codes

326	Abnormal Recycle: Hardware flame current invalid
327	Abnormal Recycle: Hardware flame rod short
328	Abnormal Recycle: Hardware invalid power
329	Abnormal Recycle: Hardware invalid AC line
330	Abnormal Recycle: Hardware SLO flame ripple
331	Abnormal Recycle: Hardware SLO flame sample
332	Abnormal Recycle: Hardware SLO flame bias range
333	Abnormal Recycle: Hardware SLO flame bias heat
334	Abnormal Recycle: Hardware SLO spark stuck
335	Abnormal Recycle: Hardware SLO spark changed
336	Abnormal Recycle: Hardware SLO static flame
337	Abnormal Recycle: Hardware SLO rod shorted
338	Abnormal Recycle: Hardware SLO AD linearity
339	Abnormal Recycle: Hardware SLO bias not set
340	Abnormal Recycle: Hardware SLO bias shorted
341	Abnormal Recycle: Hardware SLO electronics
342	Abnormal Recycle: Hardware processor clock
343	Abnormal Recycle: Hardware AC phase
344	Abnormal Recycle: Hardware A2D mismatch
345	Abnormal Recycle: Hardware VSNSR A2D
346	Abnormal Recycle: Hardware 28V A2D
347	Abnormal Recycle: Hardware HFS IAS shorted
348	Abnormal Recycle: Hardware PII INTLK shorted
349	Abnormal Recycle: Hardware HFS LCI shorted
350	Abnormal Recycle: Hardware HFS LFS shorted
351	Abnormal Recycle: Invalid zero crossing
352	Abnormal Recycle: fault stack sensor
353	Abnormal Recycle: stack limit
354	Abnormal Recycle: delta T limit
355	Abnormal Recycle: fault outlet sensor
356	Abnormal Recycle: outlet high limit
357	Abnormal Recycle: fault DHW sensor
358	Abnormal Recycle: DHW high limit
359	Abnormal Recycle: fault inlet sensor
360	Abnormal Recycle: Check Parameters Failed
361	Internal error: No factory parameters were detected in control
362	Internal error: PID iteration frequency was invalid
363	Internal error: Demand-Rate interval time was invalid
364	Internal error: Factory calibration parameter for modulation was invalid
365	Internal error: CH PID P-scaler was invalid
366	Internal error: CH PID I-scaler was invalid
367	Internal error: CH PID D-scaler was invalid
368	Internal error: DHW PID P-scaler was invalid
369	Internal error: DHW PID I-scaler was invalid
370	Internal error: DHW PID D-scaler was invalid

Table 10. Falcon alert codes

371	Internal error: Lead Lag master PID P-scaler was invalid
372	Internal error: Lead Lag master PID I-scaler was invalid
373	Internal error: Lead Lag master PID D-scaler was invalid
374	Abnormal Recycle: Hardware flame bias 1
375	Abnormal Recycle: Hardware flame bias 2
376	Abnormal Recycle: Hardware flame bias 3
377	Abnormal Recycle: Hardware flame bias 4
378	Abnormal Recycle: Hardware flame bias 5
379	Abnormal Recycle: Hardware flame bias 6
380-450	RESERVED
451	Circulator control was invalid
452	Circulator P-gain was invalid
453	Circulator I-gain was invalid
454	Circulator temperature was invalid
455	Circulator outlet temperature was invalid
456	Circulator inlet temperature was invalid
457	Circulator outdoor temperature was invalid
458	Circulator sensor choice was invalid
459	Circulator PID setpoint was invalid
460	LCI lost in run
461	Abnormal Recycle: Demand lost in run from application
462	Abnormal Recycle: Demand lost in run due to high limit
463	Abnormal Recycle: Demand lost in run due to no flame
464	LCI lost in Combustion Pressure Establishing Period
465	LCI lost in Combustion Pressure Stabilization Period
466	RESERVED
467	Internal error: EEPROM write was attempted before EEPROM was initialized
468	Internal error: EEPROM cycle count address was invalid
469	Internal error: EEPROM days count address was invalid
470	Internal error: EEPROM hours count address was invalid
471	Internal error: Lockout record EEPROM index was invalid
472	Internal error: Request to write PM status was invalid
473	Internal error: PM parameter address was invalid
474	Internal error: PM safety parameter address was invalid
475	Internal error: Invalid record in lockout history was removed
476	Internal error: EEPROM write buffer was full
477	Internal error: Data too large was not written to EEPROM

Table 10. Falcon alert codes

478	Internal error: Safety key bit 0 was incorrect
479	Internal error: Safety key bit 1 was incorrect
480	Internal error: Safety key bit 2 was incorrect
481	Internal error: Safety key bit 3 was incorrect
482	Internal error: Safety key bit 4 was incorrect
483	Internal error: Safety key bit 5 was incorrect
484	Internal error: Safety key bit 6 was incorrect
485	Internal error: Safety key bit 7 was incorrect
486	Internal error: Safety key bit 8 was incorrect
487	Internal error: Safety key bit 9 was incorrect
488	Internal error: Safety key bit 10 was incorrect
489	Internal error: Safety key bit 11 was incorrect
490	Internal error: Safety key bit 12 was incorrect
491	Internal error: Safety key bit 13 was incorrect
492	Internal error: Safety key bit 14 was incorrect
493	Internal error: Safety key bit 15 was incorrect
494	Internal error: Safety relay timeout
495	Internal error: Safety relay commanded off
496	Internal error: Unknown safety error occurred
497	Internal error: Safety timer was corrupt
498	Internal error: Safety timer was expired
499	Internal error: Safety timings
500	Internal error: Safety shutdown
501	RESERVED
502	Mix setpoint was invalid
503	Mix time of day setpoint was invalid
504	Mix outdoor temperature was invalid
505	Mix ODR time of day setpoint was invalid
506	Mix ODR time of day setpoint exceeds normal setpoint
507	Mix ODR max outdoor temperature was invalid
508	Mix ODR min outdoor temperature was invalid
509	Mix ODR low water temperature was invalid
510	Mix ODR outdoor temperature range was invalid
511	Mix ODR water temperature range was invalid
512	Mix demand switch was invalid
513	Mix ON hysteresis was invalid
514	Mix OFF hysteresis was invalid
515	Mix ODR min water temperature was invalid
516	Mix hysteresis step time was invalid
517	Mix P-gain was invalid
518	Mix I-gain was invalid
519	Mix D-gain was invalid
520	Mix control was suspended due to fault
521	Mix S10 (J10-7) temperature was invalid
522	Mix outlet temperature was invalid
523	Mix inlet temperature was invalid
524	Mix S5 (J8-11) temperature was invalid

Table 10. Falcon alert codes

525	Mix modulation sensor type was invalid
526	Mix ODR min water temperature setpoint was invalid
527	Mix circulator sensor was invalid
528	Mix flow control was invalid
529	Mix temperature was invalid
530	Mix sensor was invalid
531	Mix PID setpoint was invalid
532	STAT may not be a Mix demand source when Remote Stat is enabled
533-539	RESERVED
540	Delta T inlet/outlet enable was invalid
541	Delta T exchanger/outlet enable was invalid
542	Delta T inlet/exchanger enable was invalid
543	Delta T inlet/outlet degrees was out of range
544	Delta T exchanger/outlet degrees was out of range
545	Delta T inlet/exchanger degrees was out of range
546	Delta T response was invalid
547	Delta T inversion limit response was invalid
548	Delta T rate limit enable was invalid
549	Delta T exchanger/outlet wasn't allowed due to stack limit setting
550	Delta T inlet/outlet limit was exceeded
551	Delta T exchanger/outlet limit was exceeded
552	Delta T inlet/exchanger limit was exceeded
553	Inlet/outlet inversion occurred
554	Exchanger/outlet inversion occurred
555	Inlet/exchanger inversion occurred
556	Delta T exchanger/outlet wasn't allowed due to stack connector setting
557	Delta T inlet/exchanger wasn't allowed due to stack limit setting
558	Delta T inlet/exchanger wasn't allowed due to stack connector setting
559	Delta T delay was not configured for recycle response
560	Outlet T-rise enable was invalid
561	Heat exchanger T-rise enable was invalid
562	T-rise degrees was out of range
563	T-rise response was invalid
564	Outlet T-rise limit was exceeded
565	Heat exchanger T-rise limit was exceeded
566	Heat exchanger T-rise wasn't allowed due to stack limit setting
567	Heat exchanger T-rise wasn't allowed due to stack connector setting
568	Outlet T-rise wasn't allowed due to outlet connector setting
569	T-rise delay was not configured for recycle response
570	Heat exchanger high limit setpoint was out of range
571	Heat exchanger high limit response was invalid

Table 10. Falcon alert codes

572	Heat exchanger high limit was exceeded
573	Heat exchanger high limit wasn't allowed due to stack limit setting
574	Heat exchanger high limit wasn't allowed due to stack connector setting
575	Heat exchanger high limit delay was not configured for recycle response
576	CH pump output was invalid
577	DHW pump output was invalid
578	Boiler pump output was invalid
579	Auxiliary pump output was invalid
580	System pump output was invalid
581	Mix pump output was invalid
582-589	RESERVED
590	DHW plate preheat setpoint was invalid
591	DHW plate preheat ON hysteresis was invalid
592	DHW plate preheat OFF hysteresis was invalid
593	Tap detect degrees was out of range
594	Tap detect ON hysteresis was invalid
595	Inlet - DHW tap stop degrees was out of range
596	Outlet - Inlet tap stop degrees was out of range

Burner control states are provided in Table 11.

Table 11. Burner control states

State	Name
0	Initiate
1	Standby Delay
2	Standby
3	Safe Startup
4	Prepurge - Drive to Purge Rate
5	Prepurge – Measured Purge Time
6	Prepurge – Drive to Lightoff Rate
7	Preignition Test
8	Preignition Time
9	Pilot Flame Establishing Period
10	Main Flame Establishing Period
11	Direct Burner Ignition
12	Run
13	Postpurge
14	Lockout
15	Prepurge (Fulton pulse)
16	Ignition (Fulton pulse)
17	Combustion Pressure Establish (Fulton pulse)
18	Combustion Pressure Stabilization (Fulton pulse)
19	Main Flame Stabilization (Fulton pulse)
255	Safety Processor Offline

The Falcon pump status codes are contained in the following two tables. Table 12 is for older units (application build less than 1600) and Table 13 is for newer units (application build 1600 or higher).

Table 12. Pump status codes (application build less than 1600)

Status	Description	Note
0	Unknown	
1	Not connected	
2	Not Lead Lag master	
3	Pump A Off	
4	Pump B Off	
5	Pump C Off	
6	Pump A Off – Anti-condensation (CH demand)	
7	Pump B Off – Anti-condensation (CH demand)	
8	Pump C Off – Anti-condensation (CH demand)	
9	Pump A Off – Anti-condensation (DHW demand)	
10	Pump B Off – Anti-condensation (DHW demand)	
11	Pump C Off – Anti-condensation (DHW demand)	
12	Pump A Off – Anti-condensation (LL demand)	
13	Pump B Off – Anti-condensation (LL demand)	
14	Pump C Off – Anti-condensation (LL demand)	
15	Pump A On – Slave overrun	
16	Pump B On – Slave overrun	
17	Pump C On – Slave overrun	
18	Pump A On – LL master overrun	
19	Pump B On – LL master overrun	
20	Pump C On – LL master overrun	
21	Pump A Off – Start delay (DHW demand)	
22	Pump B Off – Start delay (DHW demand)	
23	Pump C Off – Start delay (DHW demand)	
24	Pump A On – CH demand	
25	Pump B On – CH demand	
26	Pump C On – CH demand	
27	Pump A On – CH frost protection	
28	Pump B On – CH frost protection	
29	Pump C On – CH frost protection	
30	Pump A On – DHW demand	
31	Pump B On – DHW demand	
32	Pump C On – DHW demand	
33	Pump A On – DHW frost protection	
34	Pump B On – DHW frost protection	
35	Pump C On – DHW frost protection	
36	Pump A Off – DHW high limit	
37	Pump B Off – DHW high limit	
38	Pump C Off – DHW high limit	
39	Pump A On – Exercise	
40	Pump B On – Exercise	
41	Pump C On – Exercise	
42	Pump A On – Frost protection	
43	Pump B On – Frost protection	
44	Pump C On – Frost protection	
45	Pump A On – Lead Lag master demand	
46	Pump B On – Lead Lag master demand	
47	Pump C On – Lead Lag master demand	
48	Pump A On – Slave demand	
49	Pump B On – Slave demand	
50	Pump C On – Slave demand	
51	Pump A On – Manual	
52	Pump B On – Manual	
53	Pump C On – Manual	
54	Pump A On – Outlet high limit	
55	Pump B On – Outlet high limit	
56	Pump C On – Outlet high limit	
57	Pump A On – Overrun	
58	Pump B On – Overrun	
59	Pump C On – Overrun	
60	Pump A On – Frost protection overrun	
61	Pump B On – Frost protection overrun	
62	Pump C On – Frost protection overrun	
63	Pump A On – Mix demand	
64	Pump B On – Mix demand	
65	Pump C On – Mix demand	

Table 13. Pump status codes (application build 1600 or higher)

Status	Description	Note
92	Forced On from manual pump control	
93	Forced On due to Outlet high limit is active	
94	Forced On from burner demand	
95	Forced On due to Lead Lag slave has demand	
96	Forced Off from local DHW priority service	
97	Forced Off from Lead Lag DHW priority service	
98	Forced Off from Central Heat anti-condensation	
99	Forced Off from DHW anti-condensation	
100	Forced Off due to DHW high limit is active	
101	Forced Off from EnviraCOM DHW priority service	
102	On due to local CH frost protection is active	
103	On due to Lead Lag CH frost protection is active	
104	On due to local DHW frost protection is active	
105	On due to Lead Lag DHW frost protection is active	
106	On from local Central Heat demand	
107	On from Lead Lag Central Heat demand	
108	On from local DHW demand	
109	On from Lead Lag DHW demand	
110	On from local Mix demand	
111	On from Lead Lag Mix demand	
112	On from local Central Heat service	
113	On from Lead Lag Central Heat service	
114	On from local DHW service	
115	On from Lead Lag DHW service	
116	On from local Mix service	
117	On from Lead Lag Mix service	
118	On from Lead Lag auxiliary pump X	
119	On from Lead Lag auxiliary pump Y	
120	On from Lead Lag auxiliary pump Z	
121	On, but inhibited by pump start delay	
122	On from pump override	
123	Off, not needed	
124	On from burner demand	
125	On from exercise	

Some holding registers contain variable length data, e.g., register 186 (OS number), that bend the normal Modbus access for holding registers. Only a single register address is assigned to these parameters even though they may contain more than two bytes (16-bits) of data. These registers MUST be accessed ONLY individually so that no confusion will exist about parameter boundaries*.

Register Writes

Data registers may require an access-level password before they can be changed (written) by the Modbus master. For data registers requiring access security, a password matching the one contained in the Falcon must be provided before the Falcon can allow the data to be changed. A valid password login remains in effect for 10 minutes before another login is required (Falcon timeout for password login). See User Interface Data Attribute Table section for more information regarding how access security is determined.

Two Modbus registers are defined to manage the register data access login:

- (0x00B1) Password
- (0x0013) Register Access Status

The Modbus master writes a password into the Password register to request write access privileges to the data registers. Even though this register is a holding register and therefore should normally only accept a 16-bit value, it accepts alphanumeric text up to 20 characters. Owing to this text-length limitation, change to this register must be written individually and not as part of a group register write.

Results of the login are reported by the Falcon Modbus in the Register Access Status register. If the Modbus master writes the correct installer password, the status register indicates this result and all data with installer access level and below can be changed. If the Modbus master writes the correct OEM password, the status register indicates this result and all data with OEM access level and below can be changed.

03 (0x03) Read Holding Registers

This function is used to read one or more consecutive data registers in the Falcon Modbus. The register address of the first register (see Modbus register map in Figure 1) in the range is included in the request along with the number of registers to read. The Falcon Modbus returns a response with the starting register address, the number of bytes returned, followed by the register data contents in register address order (lowest register address first, etc.).

Normally, the number of bytes returned is 2 times the number of registers requested since each register usually contains a 16-bit value. An exception to this rule is that registers representing variable length text data return the length of the text data which can exceed 2 bytes.

06 (0x06) Write Single Register

This function is used to write data to a single register in the Falcon. The Falcon register address and 16-bit data value to write into the register are sent to the Falcon, and the Falcon returns an acknowledgement.

*The standard Modbus protocol does not support the concept of variable length data. The Falcon Modbus interface varies from the protocol in that it supports a single register definition for text data. These special registers must be accessed exclusively by themselves in order for them to be supported.

16 (0x10) Write Multiple Registers

This function is used to write data into multiple Falcon registers with a single request. The Falcon registers must be located consecutively in the register map since only a base address is provided. The Modbus master provides the starting register address, the number of registers to write, and the total number of bytes, followed by the actual data itself. The Falcon writes the data into each register and acknowledges the completion with a response echoing the number of registers written.

When writing text data to a register representing variable length text, the number of registers should be specified as one and the byte count as the number of bytes in the text data.

17 (0x11) Report Slave ID

This function is used to locate and identify the Falcons connected on the Modbus network. The Modbus master issues a Report Slave ID request for a specific Modbus address onto the Modbus network and if a Falcon with the requested Modbus address exists, it responds to the request. If none exists, the Modbus master times out and concludes that no Falcon is present with that Modbus address.

Included in the Falcon response is the following data to further identify it:

- OS number
- Burner name

The format of the Falcon response message is depicted in Table 14.

Table 14. Report slave ID response

Byte: 0	1	2	3	4	5-20	21-40	41-42
Slave Address	Function Code	Byte Count	Slave ID	Run Indicator	OS Number	Burner Name	CRC
0x01-0xF0	0x11	0x30	0x79	0x00=OFF 0xFF=ON			

The OS number (up to 16 characters) and burner name (up to 20 characters) fields are NULL filled text strings. They have a fixed field length so that the boundaries of each field are known. These same Falcon parameters can be obtained with the Read Holding Register function.

The Run Indicator status contains an OFF status when the Falcon is in a lockout or unconfigured state. In any other case the status indicates an ON condition.

NOTE: A slave ID of 0x79 is reserved for all Falcon hydronic boiler control models at this time. Future design may expand this list to include more IDs for different models.

Exception Codes

The Modbus exception codes in Table 15 may be given by the Falcon in response to function code requests.

Table 15. Modbus exception codes

Code	Name	Comment
0x01	ILLEGAL_FUNCTION	Illegal function code or action requested
0x02	ILLEGAL_DATA_ADDRESS	Register address out of bounds
0x03	ILLEGAL_DATA_VALUE	Data in register write is invalid for register
0x10	READ_MULTIPLE_NOT_OK	Exceeded maximum registers allowed in read
0x11	ACCESS_FAILURE	Invalid password access level for register
0x12	LOGIN_FAILURE	Unrecognized password given for login