

Model CFW

ClearFire

Gas High-Efficiency Hydronic Boiler Operation and Maintenance Manual



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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 per-

formed 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 provid-

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.

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

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

The installation must conform to the requirements of the authority having jurisdiction or, in the absence of such requirements, to UL 795 Commercial-Industrial Gas Heating Equipment and/or the National Fuel Gas Code, ANSI Z223.1

CLEAVER-BROOKS

Model CFW

ClearFire Packaged Boiler

Gas High Efficiency Boiler Operation, Service, and Parts Manual



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Please direct purchase orders for replacement manuals to your local Cleaver-Brooks authorized representative.

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 eliminate certain repetitive chores, providing more time for 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.

It is essential to obtain the services of a qualified water treating company or a water consultant to recommend the proper boiler water treating practices.

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.

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Figure 1-1 Model CFW Boiler



Figure 1-2 AluFer Tube Cross Section



Figure 1-3 Hinged Burner Door

1.1-MODEL CFW FEATURES AND BENEFITS

Compact Firetube Design

The Model CFW boiler is a compact vertically fired firetube boiler (Figure 1-1). The extended heating surface tubes provide for very high levels of performance in a compact space. The Model CFW boiler is designed to fire natural gas.

High Efficiency

With the extended heating surface provided by the patented AluFer tube design (Figure 1-2) the Model CFW has a nominal fuel-to-water efficiency of up to 88% depending on operating conditions.

Advanced Construction

Constructed to ASME standards and utilizing AluFer Tube technology in a single-pass design, the Model CFW Boiler will provide many years of trouble free service. Single-pass design provides excellent thermal shock protection.

Ease of Maintenance

A hinged assembly allows access to all key burner components. A hinged door on the control panel provides access to all controls.

Quality Construction

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

ISO 9001 certified manufacturing process ensures adherence to the highest manufacturing standards.

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 Model CFW boiler utilizes "Premix" technology whereby fuel and combustion air are mixed prior to entering the firing chamber. This technology provides clean, efficient combustion with very low emission levels.

1.2-STANDARD EQUIPMENT

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.

The Burner

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

Full modulation is provided using the integral variable speed combustion air fan (up to 5:1 turndown).

Solid body radiation of the burner flame provides clean, efficient combustion and 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. At reduced firing rates, sound levels are even lower.

Provision is made for optional direct venting.

Combustion Air Proving Switch standard.



Figure 1-4 Model CFW burner

Burner Gas Train

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



Figure 1-5 Gas Train

1.3-CONTROLS

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, 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 1-6 Model CFW Electrical Panel (shown with options)

1.4-COMPONENT/CONNECTION LOCATIONS

Figure 1-7 shows the Model CFW component orientation.

Refer to Chapter 3 for recommended vent sizes and lengths for the specific boiler installation.



Figure 1-7 CFW Boiler Connections

1.5-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 CFW boiler from Cleaver-Brooks:

- A. Reusable air filter.
- B. Outside air intake for direct vent combustion.
- C. Outdoor temperature sensor for outdoor reset control.
- D. Shipped loose Auxiliary Low Water Control for field piping by others into the system piping.
- E. Alarm Horn for safety shutdown.
- F. Header temp. sensor for multiple boiler lead/lag control.
- G. Stack Thermometer.



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Provisions for combustion and ventilation air must be in accordance with UL 795, Commercial-Industrial Gas Heating Equipment, cUL, or applicable provisions of the local building codes. Failure to follow this warning could result in personal injury or death



If an external electrical source is utilized, the boiler, when installed, must be electrically bonded to ground in accordance with the requirements of the authority having jurisdiction or, in the absence of such requirements, with the National Electrical Code and/or UL 795, Commercial-Industrial Gas Heating Equipment.

▲ 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 service. Failure to follow this warning could result in equipment failure.

Milwaukee, Wisconsin

www.cleaver-brooks.com



Figure 2-1 Lifting boiler



Figure 2-2 Condensate drain



In order to avoid damage to the unit, lifting or moving the boiler should only be done by experienced personnel suitably equipped for moving heavy equipment.

2.1-LIFTING AND MOVING THE BOILER

The boiler should be lifted by the attached base rails using a suitable fork lift.

Note: The boiler should not be moved by pushing, prying, or pulling on any part of the casing.

The boiler must be installed on a non-combustible floor. If the floor is not level, piers or a raised pad slightly larger in length and width than the boiler base dimensions will make boiler installation and leveling easier.

The boiler must be installed so that all components remain accessible for inspection, cleaning, or maintenance. Field-installed piping and electrical connections must be arranged so as to avoid interfering with removal of the top cover or with the burner door.

2.2-FLUE GAS CONNECTION

The flue gases from the ClearFire boiler are 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 ClearFire boiler. Refer to flue piping manufacturer for proper installation and sealing instructions.

See Chapter 3 in this manual for more information.

2.3-CONDENSATE DRAIN

While condensing should be avoided when operating the CFW, small amounts of condensation can be expected due to cold startups and other transient conditions. A condensate drain is installed at the bottom of the stack outlet and should be piped to a drain. A drain trap with a minimum 3" water leg should be installed to prevent flue gas from entering the boiler room. See **Figure 2-2**.

Condensing should be avoided by maintaining a minimum return water temperature of 140 deg F.

2.4-WATER TREATMENT

Cleaver-Brooks ClearFire 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 CFW. 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 carbon 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.

It is recommended that the system be cleaned and flushed prior to installing the boiler. Should the system require boil out or cleaning after installation of the CFW, take care that no particulate matter reaches the boiler during the cleaning process.

Notice

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

Parameter	Limit
рН	8.3 - 9.5
Chloride	30 mg/liter
Oxygen	0.1 mg/liter
Specific Conductivity	3500 μ mho/cm
Total Hardness	<10 ppm

Table 2-1. Model CFW Water Chemistry

2.5-USING GLYCOL

The Model CFW 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 CFW boilers to hydronic systems using glycol:

- Maximum allowable antifreeze proportion (volume %): 50% antifreeze (glycol) 50% water
- 2) Glycol minimum temperature rating 300 deg F.
- 3) 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 Figure 2-3 below.
- Maximum allowable boiler outlet/supply temperature: 200 deg F (93 deg C).
- 5) 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 ΔT (Delta T). A ΔT 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. (Requires a dedicated boiler pump if in a primary/secondary loop arrangement.) Refer to Table 1 below with minimum boiler circulation rates.
- 6) Minimum over-pressure at the boiler:

For operating temperatures up to the maximum of 200 deg F (93 deg C), a minimum operating pressure of 30 psig (1.75 bar) is required.

7) pH level should be maintained between 8.3 and 9.5

Table 2-2. Glycol minimum flow

Glycol Minimum Flow Recommendations for Model CFW Boiler

Minimum required boiler circulation rate (gpm) at maximum firing rate (50% glycol/50% water).

	System Temperature Drop (°F)						
	10	10 20 30 40					
Boiler Rating		Flow Rate (gpm)					
400	66	33	22	16			
500	82	41	27	20			
750	123	61	41	31			
1000	164	82	55	41			
1500	246	123	82	61			
2000	328	164	109	82			
2400	393	197	131	98			

Notes/Limitations:

1. Maximum firing rate determined by ClearFire CFW - Glycol Firing Rate Limitation chart (below). Maximum high fire blower speed 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 200°F. Maximum ΔT of 40°F.

4. Circulation rates correlate with boiler output based on 86% 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.



Figure 2-3 Maximium firing rates and high fire settings - glycol



2.6-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 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.

2.7-GAS CONNECTIONS

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

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

2.8-GAS PRESSURE REQUIREMENTS

For proper and safe operation, each CFW Series boiler requires a stable gas pressure input. See Table 2-2 for pressure requirements.

Boiler Size	Minimum pressure required	Max. pressure
	at gas train connection	
400	7" w.c.	
500	7" w.c.	
750	7" w.c.	
1000	7" w.c.	28" w.c.
1500	10" w.c.	
2000	10" w.c.	
2400	10" w.c.	

Table 2-3 Model CFW Gas Pressure Requirements

NOTE: The pressure test port is located at the gas valve inlet flange (see **Figure 2-4**). 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 2-4 Gas Valve

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 or directly upstream of the pressure regulator. 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 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 Section 2.9 - GAS SUPPLY PIPE SIZING.

2.9-GAS PIPING

CFW units are standardly equipped with an upstream gas pressure regulator. Do not use a common regulator to regulate pressure for a multiple unit installation. Note: Gas connection is at the top of the boiler, left hand side as you face the front 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.

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

If necessary a strainer should be installed upstream of the boiler gas connection 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.

See **Figure 2-6** for a typical piping configuration.



2.10-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 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.

		Pipe Size	;				
1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	
1.049	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"	
	**Maximu	im Capacity	in Cubic Fee	et of Gas per	Hour (CFH)		
514	1,060	1,580	3,050	4,860	8,580	17,500	
363	726	1,090	2,090	3,340	5,900	12,000	
284	583	873	1,680	2,680	4,740	9,660	
243	499	747	1,440	2,290	4,050	8,290	
215	442	662	1,280	2,030	3,590	7,330	
195	400	600	1,160	1,840	3,260	6,640	
179	368	552	1,060	1,690	3,000	6,110	
167	343	514	989	1,580	2,790	5,680	
157	322	482	928	1,480	2,610	5,330	
148	304	455	877	1,400	2,470	5,040	
131	269	403	777	1,240	2,190	4,460	
119	244	366	704	1,120	1,980	4,050	
109	209	336	648	1,030	1,820	3,720	
102	185	313	602	960	1,700	3,460	
atural Gas				•			
Less than	2.0 psi	1					
op: 0.30" v	W.C.						
iravity: 0.6	0	1					
	1.049 514 363 284 243 215 195 179 167 157 148 131 119 109 102 atural Gas Less than op: 0.30"	1.049 1.380" **Maximu 514 1,060 363 726 284 583 243 499 215 442 195 400 179 368 167 343 157 322 148 304 131 269 119 244 109 209 102 185	1" 1-1/4" 1-1/2" 1.049 1.380" 1.610" **Maximum Capacity 514 1,060 1,580 363 726 1,090 284 583 873 243 499 747 215 442 662 195 400 600 179 368 552 167 343 514 157 322 482 148 304 455 131 269 403 119 244 366 313 314 102 185 313 313 atural Gas Less than 2.0 psi op: 0.30" w.c. 4	1.049 1.380" 1.610" 2.067" **Maximum Capacity in Cubic Fee 514 1,060 1,580 3,050 363 726 1,090 2,090 284 583 873 1,680 243 499 747 1,440 215 442 662 1,280 195 400 600 1,160 179 368 552 1,060 167 343 514 989 157 322 482 928 148 304 455 877 131 269 403 777 119 244 366 704 109 209 336 648 102 185 313 602 atural Gas Ess than 2.0 psi op: 0.30" w.c. 0.30"	1" 1-1/4" 1-1/2" 2" 2-1/2" 1.049 1.380" 1.610" 2.067" 2.469" **Maximum Capacity in Cubic Feet of Gas per 514 1,060 1,580 3,050 4,860 363 726 1,090 2,090 3,340 284 583 873 1,680 2,680 243 499 747 1,440 2,290 215 442 662 1,280 2,030 195 400 600 1,160 1,840 179 368 552 1,060 1,690 167 343 514 989 1,580 157 322 482 928 1,480 148 304 455 877 1,400 131 269 403 777 1,240 109 209 336 648 1,030 102 185 313 602 960 <td colspa<="" td=""><td>1" 1-1/4" 1-1/2" 2" 2-1/2" 3" 1.049 1.380" 1.610" 2.067" 2.469" 3.068" **Maximum Capacity in Cubic Feet of Gas per Hour (CFH) 514 1,060 1,580 3,050 4,860 8,580 363 726 1,090 2,090 3,340 5,900 284 583 873 1,680 2,680 4,740 243 499 747 1,440 2,290 4,050 215 442 662 1,280 2,030 3,590 195 400 600 1,160 1,840 3,260 179 368 552 1,060 1,690 3,000 167 343 514 989 1,580 2,790 157 322 482 928 1,480 2,610 148 304 455 877 1,400 2,470 131 269 403 777 1,240</td></td>	<td>1" 1-1/4" 1-1/2" 2" 2-1/2" 3" 1.049 1.380" 1.610" 2.067" 2.469" 3.068" **Maximum Capacity in Cubic Feet of Gas per Hour (CFH) 514 1,060 1,580 3,050 4,860 8,580 363 726 1,090 2,090 3,340 5,900 284 583 873 1,680 2,680 4,740 243 499 747 1,440 2,290 4,050 215 442 662 1,280 2,030 3,590 195 400 600 1,160 1,840 3,260 179 368 552 1,060 1,690 3,000 167 343 514 989 1,580 2,790 157 322 482 928 1,480 2,610 148 304 455 877 1,400 2,470 131 269 403 777 1,240</td>	1" 1-1/4" 1-1/2" 2" 2-1/2" 3" 1.049 1.380" 1.610" 2.067" 2.469" 3.068" **Maximum Capacity in Cubic Feet of Gas per Hour (CFH) 514 1,060 1,580 3,050 4,860 8,580 363 726 1,090 2,090 3,340 5,900 284 583 873 1,680 2,680 4,740 243 499 747 1,440 2,290 4,050 215 442 662 1,280 2,030 3,590 195 400 600 1,160 1,840 3,260 179 368 552 1,060 1,690 3,000 167 343 514 989 1,580 2,790 157 322 482 928 1,480 2,610 148 304 455 877 1,400 2,470 131 269 403 777 1,240

Table 2-4. Gas line capacity - S	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 Fee	t of Gas pe	r Hour (CF	H)
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: N	atural Gas						
**Inlet Pressure	: Less than	2.0 psi	1				
**Pressure [Drop: 0.50" v	w.c.	1				
**Specific	Gravity: 0.6	60	1				

Gas Header - For multiple unit installations, a single common gas header is recommended with individual takeoffs for each boiler (See Figure 2-5). Boiler gas manifold piping should be sized based on volume requirements and lengths between each boiler and the fuel main header.

Table 2-6 indicates the proper sizing for multiple units of equal size, placed on the factory standard center with the indicated take off size. For installations with a mixed sized use, determine the flow of each unit and total the input. With the total input, find length of run from the source and determine what size header will be needed for the flow of all units firing. Pipe sizes are based on Table 2-3 with boiler gas line take-off at 20 feet from the header. If pipe runs are greater or if gas pressure is different, refer to Tables 2-4 and 2-5 for pipe sizing.



Figure 2-5. Typical gas header piping

5. Relief valve required if gas supply pressure >1 psig.



Table 2-6. Gas pipe sizing for multiple unit manifolds

CFW 400						
# 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"	1-1/4"	2"	2"		

CFW 750					
# 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"	2-1/2"	

CFW 1500					
# of Units	1	2	3	4	
Pipe Size To Boiler	2"	2"	2"	2"	
Header Pipe Size	2"	2-1/2"	3"	4"	

CFW 2400						
# of Units	1	2	3	4		
Pipe Size To Boiler	2-1/2"	2-1/2"	2-1/2"	2-1/2"		
Header Pipe Size	2-1/2"	3"	4"	4"		

CFW 500						
# 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"		

CFW 1000						
# 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"		

	CFW 2000						
# of Units	1	2	3	4			
Pipe Size To Boiler	2"	2"	2"	2"			
Header Pipe Size	2"	3"	3"	4"			

2.11-BOILER WATER PIPING

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 connections must be safely blanked off.

Maximum boiler flow rates are shown in **Table 2-7.**

	System Temperature Drop °F				
	10	20	30	40	50
Boiler Size		Flow Rate GPM			
400	69	34	23	17	14
500	86	43	29	21	17
750	129	64	43	32	26
1000	172	86	57	43	34
1500	258	129	86	64	52
2000	344	172	115	86	69
2400	413	206	138	103	83

Table 2-7. CFW Maximum Flow Rates

Table 2-8 CFW Water temperature data

Minimum supply temp.	140ºF
Maximum operating temp.	240ºF
Maximum design temp.	250ºF

2.12-SAFETY VALVE

The pressure relief valve (safety valve) should be piped from the hot water outlet pipe as shown in **Figure 2-7**. Use pipe sealing compound and a flat sided wrench when securing the safety valve. Do not use a pipe wrench and do not over tighten the 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.



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.*

2.13-AIR VENT

The boiler air vent (**Figure 2-8**) must be piped to an expansion tank or other suitable provision for venting air. An optional vent valve is available from CB.

2.14-ELECTRICAL CONNECTIONS

Refer to **Figure 2-9** for CFW wiring and cable connections.



Figure 2-7 Pressure relief valve piped to safe point of discharge



Figure 2-8 Air Vent

A qualified electrician or service technician must make the electrical connections to the boiler; all local electrical and building codes should be adhered to.

Main power and any remote wiring should be brought to the left side of the control panel and terminated at the appropriate terminals provided.





Notice

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

2.15-WIRING DIAGRAM

Figure 2-10 shows a basic wiring diagram for the model CFW.

Note: *Wiring diagram shown is an example only*. Installations may vary. Refer to the Cleaver-Brooks wiring diagram provided with the boiler for information specific to your installation.



Figure 2-10 CFW Wiring Diagram, basic

TERMINALS:LL1, L1N,C,12,3,4-4-4,5-5-5,6,7,8,9,10,11,12,13,14,15,16,17,18, 19,20,21,22, 23,24,25,26,27, 28,29,30, 31,32,33,34, 35,36, 37,38, 39,40,41,42,



Chapter 3 Stack and Intake Vent Sizing and Installation

VENTING CONNECTIONS — GENERAL
VENT STACK
VENT TERMINAL LOCATION
HORIZONTAL THRU-WALL VENTING, INDOOR AIR
HORIZONTAL THRU-WALL DIRECT VENTING
HORIZONTAL THRU-WALL STACK VENT TERMINATION
VERTICAL VENTING, INDOOR COMBUSTION AIR
VERTICAL VENTING DIRECT SEALED COMBUSTION AIR 3-9
STACK AND COMB. AIR DUCT DESIGN - DIRECT VENT 3-10
VENTING FOR MULTIPLE UNITS

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3.1-Venting Connections — General

Proper installation of flue gas exhaust venting is critical for the efficient and safe operation of the ClearFire boiler.

Definition of Appliance Categories

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.

The Model CFW can be considered a Category III or IV boiler. Depending on the application, the specifying engineer may dictate alternative category flue venting as deemed appropriate. *The CFW should not be operated in a way that allows condensation to occur in the boiler.* However, due to the high efficiency of the CFW condensation may occur in flue venting. Proper consideration for these conditions is the responsibility of the specifying engineer and installer.

Notice

For additional information on boiler categorization, see latest edition standard of National Fuel Gas Code or in Canada, the latest edition of CGA 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 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.

3.2-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.

3.3-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.
- 11. Multiple direct stack installations require a four (4) foot clearance between the stack caps, center to center.

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/CGA-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:
 - A. The verandah, porch or deck is fully open on a minimum of two sides beneath the floor.
 - B. 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 sealed 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.



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

Observe the following to avoid personal injury or property damage:

- To cut nonmetallic vent pipe, use a 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.

3.4-Horizontal Thru-Wall Venting, Indoor Air

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/CGA-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/CGA-B 149.1 and.2 Installation Code for Gas Burning Appliances and Equipment.

Vent termination equivalent lengths should be added to the total venting system length calculations.

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:

- 1. The vent be installed with a slight downward slope of not more than 1/4" per foot of horizontal run to the vent terminal.
- 2. The vent be insulated through the length of the horizontal run.

For appliances installed in extreme cold climate, it is recommended that:

- 1. The vent be installed with a slight upward slope of not more than 1/4" per foot of horizontal run to the vent terminal. In this case, an approved condensate trap must be installed per applicable codes.
- 2. The vent be insulated through the length of the horizontal run.



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



Figure 3-2 Horizontal Thru-wall Direct Venting Installation

3.5-Horizontal Thru-wall, Direct Venting

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

The flue and combustion air vent terminations are not considered in the overall length of the venting system. An equivalent length of each termination should be included in total vent length calculations.

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:

- 1. The vent be installed with a slight downward slope of not more than 1/4" per foot of horizontal run to the stack terminal.
- 2. The stack vent is to be insulated through the length of the horizontal run.

For appliances installed in extreme cold climate, it is recommended that:

1. The stack vent be installed with a slight upward slope of not more than 1/4" per foot of horizontal run to the vent terminal. In this case, an approved condensate trap must be installed per applicable codes.

2. The stack vent is to be insulated through the length of the horizontal run.

3.6-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 (I) 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.

\wedge	Caution
<u> </u>	

Multiple direct stack vent caps MUST NOT be installed with a 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.



3.7-Vertical Venting, Indoor Combustion Air

Figure 3-3 Vertical Stack with Indoor 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/CGA-B 149.1 AND.2. Installation Code for Gas Burning Appliances and Equipment.

To prevent condensation accumulation in the vent, it is required to install the horizontal portion of vent with a slight upward slope of not more than 1/4" per foot of horizontal run and an approved condensate trap must be installed per applicable codes.


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

3.8- Vertical Venting, Direct Vent Combustion Air

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



Figure 3-4 Vertical Stack with Direct Vent Combustion

These installations utilize the boiler mounted blower to draw combustion air from outside and vent combustion products to the outside. A positive pressure venting system is required

To prevent condensation accumulation in the vent, it is required to install the horizontal portion of vent with a slight upward slope of not more than 1/4" per foot of horizontal run; an approved condensate trap must be installed per applicable codes.

Boiler Size	Stack Connection -	Combustion Air Duct	Maximum Flue	Maximum Air Intake
	Flue Diameter (in)	Diameter (in)	Length (ft) [SEE NOTES]	Length (ft) [SEE NOTES]
400	6	4	100	100
500	6	4	80	80
750	6	4	70	70
1000	6	6	60	60
1500	8	6	40	40
2000	10	8	60	60
2400	10	8	60	60

3.9-Stack and Combustion Air Duct Design Using Direct Vent Combustion

NOTES:

1 - Each 90 deg. elbow equals 5 equivalent feet of ductwork. Subtract from the maximum or minimum length accordingly.

2 - Increasing the diameter of the air intake will reduce the pressure drop and thereby allow longer total vent lengths.

Maximum allowable pressure drop in combustion air intake duct is -0.25" w.c.

3 - Vent termination equivalent lengths should be added to the total length calculations. If unknown, use:

Each vent termination = 10 equivalent ft.

4 - Allowable combustion air temperature range is 32 deg F - 122 deg F. Combustion air at lower temperatures should be tempered to within this range. *Combustion air that is too cold or too hot can adversely affect performance and can lead to equipment damage.*

3.10-Venting for Multiple Units

Cleaver-Brooks recommends that each Model CFW 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









Chapter 4 CFW Commissioning

OPERATING CONDITIONS2
FILLING BOILER
CONTROL SETPOINTS
MODEL CFW BOILER / BURNER CONTROLLER
CB FALCON DISPLAY/OPERATOR INTERFACE
LOCKOUTS, HOLDS, AND ALERTS
CONTROLLER CONFIGURATION
BURNER SEQUENCE
FAN SPEED SETTINGS
INITIAL START-UP PROCEDURE
POST START-UP CHECKOUT PROCEDURE
FALCON CONTROL FUNCTIONS AND CUSTOMER INTERFACE

Warning

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

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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.

Table 4-1	CFW	Water	Capacity
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Boiler Size	Capacity (U.S. Gallons)
400	43
500	93
750	143
1000	164
1500	176
2000	211
2400	244

4.1-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.

Boiler room ambient conditions	
Relative humidity	\leq 85% non-condensing
Ambient temperature range	0 °C to 50 °C / 32°F to 122°F
Storage temperature range	-40 °C to 60 °C / -40°F to 140°F
Combustion air temperature	0 °C to 50 °C / 32°F to 122°F

4.2-FILLING BOILER

The boiler must be filled to capacity (see **Table 4-1**) before being placed into service. The vessel has been pressure tested at the factory; if local regulations require on-site pressure testing, tests should be performed with the air vent connection and safety valve removed and the respective fittings plugged.

4.3-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.

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



Figure 4-1 CB Falcon Controller

4.4-MODEL CFW BOILER / BURNER CONTROLLER

The Model CFW 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) ٠
- Annunciation
- Outdoor reset
- Central heating and domestic hot water loop control
- Password protection of configurable parameters
- Time of Day (dual setpoint) control Remote reset
- Lead/Lag sequencing
- (3) configurable pump relays
- Remote modulation/remote setpoint
- Frost protection
- Anti condensation

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 CFW 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.

4.5-CB FALCON DISPLAY/OPERATOR INTERFACE

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

Home Page

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

The boiler control icon should appear on this page with indication of current status of the control.

If no icon appears when the display is powered up:

- Verify that the controller is receiving power.
- Check the communication wiring between the controller and display; verify the following connections (also see **Figure 4-5**):

Falcon Controller (Terminal J3)	Display
MB1 A (RED)	Terminal 5
MB1 B (BLACK)	Terminal 4
MB1 C (WHITE)	Terminal 3

The display may need to be synchronized with the controller. Press SETUP SYSTEM CONFIGURATION SYNCHRONIZE.



Figure 4-2 Controller status LEDs and reset button



Figure 4-3 CB Falcon Display/ **Operator Interface**



Figure 4-4 Home Page



Figure 4-5 Falcon communications wiring

After powering up the system for the first time it is recommended to change the following settings under Advanced Setup>User Preferences:

- Change "Modbus upper address limit" to 10.
- Check the "Automatic Synchronization" box. This will allow the display and controller to synchronize on power-up.
- "Enable audible" enables the Falcon alarm horn.



After making changes, press <Save> and cycle power to the controller.

Status Page

Pressing the Falcon icon on the Home Page 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.







Figure 4-6 Status Page

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

Burner switch 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.

The modulation setpoints can be changed from the Status page by pressing the current displayed value. A numeric keypad will pop up, allowing entry of new values.

Operation Page

From this page the user can enable the burner, 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 (see **Figure 4-7**).



Figure 4-7 Operation Page



Figure 4-8 Falcon Display/Interface page flow

4.6-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 page (see **Figure 4-9**). Press this banner to access the Alert or Lockout History, where a list of the most recently occurring Alerts/Lockouts can be viewed.

See Tables 49 and 50 in the CB Falcon Manual (included as APPRENDIX A to this manual) for Lockout, Hold, and Alert codes.

🕕 Baile	er 1 一 🕥
Demand Central Heat	Firing rate 2000 RPM
Burner state Run	Fan speed 2018 RPM
Inlet Outlet Stack	Setpoint 150F DHW Header Outdoor
103F 102F ?	102F 100F 102F
	Modulation
-Pumps	
Central Heat	Domestic Hot Water
Central Heat O Boiler	System
Histo	ory
Configure Operation	Diagnostics Details

Figure 4-9 Alarm Banner

4.7-CONTROLLER CONFIGURATION

The CB Falcon controller should be factory configured for the specific CFW 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 4-2**, and make any changes at this time if needed.

CB Falcon configuration is grouped into the following functional groups:

- System Identification & Access
- CH Central Heat Configuration
- Outdoor Reset Configuration
- DHW Domestic Hot Water Configuration
- Modulation Configuration
- Pump Configuration
- Statistics Configuration
- High Limits
- Stack Limit
- Delta T Limit

- 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

								Modbus
Parameter Group	Parameter Name	Access	Min. Range	Default Setting	Max. Range	Parameter Units	Installation Setting	Register (dec)
System ID & Access	Boiler Name	Service		Boiler 1				0183
System ID & Access	Installation data	Service		SERIAL NUMBER				0184
System ID & Access	OEM Identification	Read Only		CB FALCON 833- 03871				0185
System ID & Access	Installer password	Service		9220				0190
	MB1 Modbus							
System ID & Access	address	Service	0	1	250			
System ID & Access	MB2 Modbus address	Service	0	1	250			
System ID & Access	Factory data	Read Only						
Central Heat Configuration	CH enable	Service		Enabled				0208
Contrainicat Configuration	CH demand	OCIVICC		Enabled				0200
Central Heat Configuration	source	Service		Stat terminal				0209
oonnan roat oonngalation	CH modulation	0011100		Modulation from				0200
Central Heat Configuration	sensor	Service		Outlet sensor (S3S4)				0210
Central Heat Configuration	CH setpoint	User	130	180	240	°F		0211
Central Heat Configuration	CH TOD setpoint	User	130	160	240	°F		0212
Central Heat Configuration	CH on hysteresis	Service	2	5	60	°F		0213
Central Heat Configuration	CH off hysteresis	Service	2	15	60	°F		0210
Central Heat Configuration	CH outdoor reset	Service	2	15	00	1		0214
Central Heat Configuration	enable	Service		Disabled				0215
Central Heat Configuration	CH P gain	Service	0	25	400			0216
Central Heat Configuration	CH I gain	Service	0	25	400			0210
Central Heat Configuration	CH D gain	Service	0	0	400			0217
Central fleat Conliguration	CH hysteresis	Service	0	0	400			0210
Central Heat Configuration	step time	Service	0	60	900	seconds		0219
Central Heat Configuration	CH setpoint source	Service		Local SP				0578
	CH modulation			Local Modulation				
Central Heat Configuration	source	Service		(PID)				0580
	CH has priority							
Central Heat Configuration	over LL	Service		No				0582
Control I loot Confirmation	CH 4mA water	Comico	<u> </u>	450	0.40			0500
Central Heat Configuration	temperature CH 20mA water	Service	60	150	240			0583
Central Heat Configuration	temperature	Service	140	230	240			0584
Outdoor Reset Configuration	CH ODR max. outdoor temperature	Service	-40	80	140	°F		0512
Culdoor Reset Configuration	CH ODR min.	Dervice	-40	00	140			0312
	outdoor							
Outdoor Reset Configuration		Service	-40	0	140	°F		0513
5	CH ODR low							
Outdoor Reset Configuration	water temperature	Service	130	150	240	°F		0514
Outdoor Doost Configuration	CH ODR maximum	Comico	100	000	0.40	۰ ۲		0540
Outdoor Reset Configuration	off point Minimum boiler	Service	130	230	240	°F		0516
Outdoor Reset Configuration		Service	130	140	240	°F		0526
Domestic HW Configuration	DHW enable	User		Disabled	_ 10			0448
Comparation	DHW demand	0001		DHW switch (S6)				0-1-10
Domestic HW Configuration	switch	Service		or sensor only				0449
	DHW priority has			·				-
Domestic HW Configuration	priority over CH	Service		Yes				0450

 Table 4-2
 CFW Falcon Parameters

		0	aioon	Falameters (oonn	lucuj	
Domestic HW Configuration	DHW priority has priority over LL	Service		Yes			0451
	DHW priority	Service		165			0451
Domestic HW Configuration	override time	Service	0	1800		seconds	0452
Domestic HW Configuration	DHW setpoint	User	32	130	180	°F	0453
-	DHW TOD						
Domestic HW Configuration	setpoint	Service	32	120	180	°F	0454
	DHW on						
Domestic HW Configuration	hysteresis	Service	2	5	80	°F	0455
	DHW off						
Domestic HW Configuration	hysteresis	Service	2	15	80	°F	0456
Domestic HW Configuration	DHW P gain	Service	0	25	400		0457
Domestic HW Configuration	DHW I gain	Service	0	25	400		0458
Domestic HW Configuration	DHW D gain	Service	0	0	400		0459
	DHW hysteresis						
Domestic HW Configuration	step time	Service	0	60	900	seconds	0460
	DHW modulation			Auto: DHW sensor			
Domestic HW Configuration	sensor	Service		(S6) or Outlet (S3S4)			0461
	DHW priority	. .		DHW heat			
Domestic HW Configuration	source	Service		demand			0463
Domestic HW Storage	DHW storage	Llaan		Disabled			0504
Configuration Domestic HW Storage	enable	User		Disabled			0504
Configuration	DHW storage time	Service	0	0		seconds	0505
Domestic HW Storage	DHW storage	Service	0	0		Seconds	0303
Configuration	setpoint	User	32	Unconfigured	240	°F	0506
Domestic HW Storage	DHW storage on	0001		encenngalea	2.0	•	
Configuration	hysteresis	Service	2	Unconfigured	80	°F	0507
Domestic HW Storage	DHW storage off			Ū.			
Configuration	hysteresis	Service	2	Unconfigured	80	°F	0508
Domestic HW Storage	DHW priority			Drop DHW after			
Configuration	method	Service		priority time expires			0509
Burner Control Ignition	Lightoff rate	Service	1000	1800	3000	RPM	0197
Burner Control Ignition	Ignition source	Read Only		External ignitor			0224
				On throughout			
Burner Control Ignition	Ignitor on during	Read Only		PFEP			0226
				Direct Burner			
Burner Control Ignition	Pilot type	Read Only		Ignition			0227
Burner Control Ignition	Preignition time	Service	0	3	900	seconds	0232
	Pilot Flame Est.						
Burner Control Ignition	Period (PFEP)	Read Only		4		seconds	0233
	Main Flame Est.	LP data a		N 10			0004
Burner Control Ignition	Period (MFEP)	Hidden		NA		seconds	0234
Burner Control Ignition	Flame threshold	OEM	0.5	0.8	5	V or µA	0250
Burner Central Flome Failure	Ignite failure	Convior		Lookout			0000
Burner Control Flame Failure	Ignite failure	Service		Lockout			0239
Burner Control Flame Failure		Service		1			0240
						aaaanda	
Burner Control Flame Failure	MFEP flame	Service		30		seconds	0241
Burner Control Flame Failure		Hidden		Lockout			0242
	Run flame failure	Thadon		Loonour			0272
Burner Control Flame Failure		Read Only		Lockout			0243
Burner Control Interlocks	Purge rate proving	OEM		Fan speed			0229
	Lightoff rate			Fan speed - except			0220
Burner Control Interlocks	proving	Service		Fan speed - except during ignition			0230

Table 4-2 CFW Falcon Parameters (Continued)

						,	
Burner Control Interlocks	Interlock start check enable	Hidden		No ILK Check			0237
Burner Control Interlocks	Interlock open	Thuten		NO IER CHECK			 0237
Burner Control Interlocks	response	Read Only		Lockout			0238
	Interrupted air	-					
	switch (IAS)			Enable during			
Burner Control Interlocks	enable	Service		purge & ignition			0246
Burner Control Interlocks	LCI enable	Read Only		Enabled			0248
Burner Control Interlocks	PII enable	Service		Disabled			0249
	ILK bounce						
Burner Control Interlocks	detection enable	Service		Enabled			0253
Burner Control Timings &							
Rates	Prepurge rate	OEM	4000	4000	6500	RPM	0196
Burner Control Timings &	Destruires rote	Comico	1000	2000	6500	лом	0100
Rates Burner Control Timings &	Postpurge rate	Service	1000	2000	6500	RPM	0198
Rates	Standby rate	Service	1000	1000	6500	RPM	0207
Burner Control Timings &		0011100		1000	0000		0207
Rates	Prepurge time	Service	15	15	900	seconds	0231
Burner Control Timings &	Run stabilization						
Rates	time	Service	0	10	900	seconds	0235
Burner Control Timings &							
Rates	Postpurge time	Service	15	15	900	seconds	0236
Modulation (System)							
Configuration	Modulation Output			VSD Fan PWM			0192
Modulation Configuration	CH max. mod. rate	Service	2000	4800	6500	RPM	0193
	DHW max. mod.	. .		1000	0500	5514	
Modulation Configuration	rate	Service	2000	4800	6500	RPM	 0194
Modulation Configuration	Minimum mod. rate	Service	800	1200	3000	RPM	0195
Modulation Configuration	CH forced rate	Service	1000	2000	6500	RPM	0199
Modulation Configuration	CH forced rate	Service	1000	2000	0000	RPIVI	0199
Modulation Configuration	time	Service	0	0	14400	seconds	0200
Modulation Configuration	DHW forced rate	Service	1000	2000	6500	RPM	0200
Woodaalon Conngeration	DHW forced rate	OCIVICE	1000	2000	0000		0201
Modulation Configuration	time	Service	0	0	14400	seconds	0202
	CH slow start						
Modulation Configuration	enable	Service		Enabled			0477
	DHW slow start						
Modulation Configuration	enable	Service		Disabled			0478
			465			RPM/	0.4=0
Modulation Configuration	Slow start ramp	Service	100	500	5000	minute	0479
Modulation Configuration	Slow start cotocist	Service	0	20	180	deg (below SP)	0480
Modulation Configuration	Slow start setpoint Analog output	Service	U	20	100	steps	0400
Modulation Configuration	hysteresis	Hidden	0	5	400	(5=0.1 mA)	0206
guiadon	Analog input		5			steps	-200
Modulation Configuration	hysteresis	Service	0	2	200	(1=0.1mA)	0543
Modulation Configuration	Firing rate control	User		Auto		,	0204
Modulation Configuration	Manual firing rate	User	800	2000	6500	RPM	0205
Pump Configuration	CH pump output	Service		No assignment			0272
Pump Configuration	CH pump control	Service		Auto			0272
	CH pump control	Service		Λιιυ			0213
Pump Configuration	time	Service	0	300	28800	seconds	0274
	1		~				

Table 4-2 CFW Falcon Parameters (Continued)

						,		
	CH pump frost							
	protection overrun							
Pump Configuration	time	Service	0	3600	28800	seconds		0275
Pump Configuration	DHW pump output	Service		Pump B				0276
	DHW pump							
Pump Configuration	control	Service		Auto				0277
	DHW pump							
Pump Configuration	overrun time	Service	0	60	28800	seconds		0278
	DHW pump frost							
	protection overrun	- · ·						
Pump Configuration	time	Service	0	3600	28800	seconds		0279
	DHW pump start	. .						
Pump Configuration	delay	Service	0	0	28800	seconds		0280
Duran Configuration	Boiler pump	Comico		Nie eesterment				0004
Pump Configuration	output Deiler sums	Service		No assignment				0281
Dump Configuration	Boiler pump control	Comico		Auto				0282
Pump Configuration	Boiler pump	Service		Auto				0282
Pump Configuration	overrun time	Service	0	300	28800	seconds		0283
Fump Configuration		Service	0	300	20000	Seconds		0203
Pump Configuration	Auxiliary 1 pump output	Service		Pump A				0284
Fullip Colliguation	Auxiliary 1 pump	Service		Fullip A				0204
Pump Configuration	control	Service		Auto				0285
r ump conngulation	Auxiliary 1 pump	OCIVICC		Local burner	-			0200
Pump Configuration	on when	Service		demand				0286
	System pump	Cervice		demand				0200
Pump Configuration	output	Service		No assignment				0287
·	System pump							
Pump Configuration	control	Service		Auto				0288
Pump Configuration	System pump	Service	0	900	28800	seconds		0289
r unp coniguration	Pump exercise	Gervice	0	300	20000	3600103		0203
Pump Configuration	interval	Service	0	0	28800	seconds		0290
	Pump exercise	OCIVICC	0	0	20000	30001103		0230
Pump Configuration	time	Service	0	0	28800	seconds		0291
	CH pump start	0011100	, ,	•	20000	00001140		0201
Pump Configuration	delay	Service	0	0	28800	seconds		0292
1 0	Boiler pump start							
Pump Configuration	delay	Service	0	0	28800	seconds		0293
	System pump start							
Pump Configuration	delay	Service	0	0	28800	seconds		0294
	Auxiliary 1 pump							
Pump Configuration	start delay	Service	0	0	28800	seconds		0295
	CH pump options							
Pump Configuration	1	Service		0XE327				0296
	CH pump options							
Pump Configuration	2	Service		0xC04E				0297
	DHW pump							
Pump Configuration	options 1	Service		0xE04A				0298
	DHW pump		7					
Pump Configuration	options 2	Service		0xC016				0299
	Boiler pump		1				I T	
Pump Configuration	options 1	Service		0xE30F				0300
	Boiler pump	_						
Pump Configuration	options 2	Service		0xC0DF				0301
	System pump	. .						0000
Pump Configuration	options 1	Service		0xE36C				0302

 Table 4-2
 CFW Falcon Parameters (Continued)

		0.11.		i alameters (•••		
Pump Configuration	System pump options 2	Service		0x801D			0303
	Auxiliary 1 pump	0011100		0,0015			0000
Pump Configuration	overrun time	Service	0	300	28800	seconds	0752
	Auxiliary 1 pump						
Pump Configuration	options 1	Service		0x0003			0753
	Auxiliary 1 pump						
Pump Configuration	options 2	Service		0x4002			0754
	Auxiliary 2 pump						
Pump Configuration	output	Service		Pump C			0755
Pump Configuration	Auxiliary 2 pump control	Sonioo		Auto			0756
Fump Configuration	Auxiliary 2 pump	Service		Auto			0756
Pump Configuration	start delay	Service	0	0	28800	seconds	0757
r amp oornigaration	Auxiliary 2 pump	0011100	•	•	20000		0101
Pump Configuration	overrun time	Service	0	0	28800	seconds	0758
	Auxiliary 2 pump						
Pump Configuration	options 1	Service		0x0000			0759
	Auxiliary 2 pump						
Pump Configuration	options 2	Service		0x4001			0760
					999,99		
Statistics Configuration	Burner cycle count	Read Only	0		9		0128
					999,99		0.400
Statistics Configuration	Burner run time	Read Only	0		9		0130
Statistics Configuration	CH pump cycle count	Read Only	0		999,99 9		0132
Statistics Configuration	DHW pump cycle	Reau Only	0		9999,99		0132
Statistics Configuration	count	Read Only	0		9		0134
g	System pump		-		999,99		
Statistics Configuration	cycle count	Read Only	0		9		0136
	Boiler pump cycle				999,99		
Statistics Configuration	count	Read Only	0		9		0138
Statistics Configuration	Auxiliary 1 pump	Read Only	0		999,99		0140
Statistics Configuration	Auxiliary 2 pump	Read Only	0		999,99		0146
System Configuration	Temperature units	Service		Fahrenheit			0178
, 0	Antishort cycle						
System Configuration	time	Service	0	60	28800	seconds	0179
System Configuration	Alarm silence time	Service	0	0	3600	seconds	0180
	Power-up with			Do NOT clear			
System Configuration	lockout	Read Only		lockout			0181
System Configuration	Burner switch	User		Off			0203
	Blower/HSI						
System Configuration	function	Read Only		Blower			0225
System Configuration	Flame sensor type	Service		Flame rod			0228
	Forced recycle						
System Configuration	interval time	Service		24		hours	0254
Custom Configuration	Fan speed error	Cor in		l a al su d			0055
System Configuration	response	Service		Lockout			0255
System (Sensor) Configuration	Inlet sensor type	Read Only		10k NTC single non-safety			0608
Comguration	S2 (remote 4-	Read Only		non-salety			0000
System (Sensor)	20mA or header)						
Configuration	sensor type	OEM		4-20mA			0609
System (Sensor)				10k NTC dual			
Configuration	Outlet sensor type	Read Only		safety			0610

						,	
System (Sensor)	S5 (outdoor)	Comico		10k NTC single			0044
Configuration	sensor type	Service		non-safety			0611
System (Sensor)				10k NTC single			
Configuration	DHW sensor type	Service		non-safety			0612
System (Sensor)							
Configuration	Stack sensor type	Service		Unconfigured			0613
	Outdoor						
System (Sensor)	temperature						
Configuration	source	Service		Unconfigured			0626
	Warm weather			Warm weather			
System Configuration	shutdown enable	Service		shutdown disabled			0627
	Warm weather						
System Configuration	shutdown setpoint	Service		100		°F	0628
	Use STAT with						
	EnviraCOM						
System Configuration	remote stat	Hidden		Disable			0629
, 0	Absolute max. fan						
Fan Configuration	speed	OEM	2000	6500	6500	RPM	0256
	Absolute min. fan	0	2000				0200
Fan Configuration	speed	OEM	800	800	3000	RPM	0257
_	· ·						
Fan Configuration	PWM frequency	OEM	1000	3000	4000	Hz	0258
	Pulses per				0		0050
Fan Configuration	revolution	Read Only	2	3	3		0259
	Fan speed up						
Fan Configuration	ramp	Service	0	0	1000	RPM/sec	0260
	Fan speed down						
Fan Configuration	ramp	Service	0	0	1000	RPM/sec	0261
Fan Configuration	Fan gain up	Service	0	30	100		0262
Fan Configuration	Fan gain down	Service	0	30	100		0263
·	Fan min. duty		-				
Fan Configuration	cycle	Service	5	10	100	%	0264
l'an comiguation	Outlet high limit	CONTRO		10	100	/0	0201
High Limits	enable	Read Only		Enabled			0484
	Outlet high limit	Read Only		Enabled			0-0-
High Limits	setpoint	Service	140	210	240	°F	0464
	Outlet high limit	Service	140	210	240	F	0404
High Limits	-	Read Only		Lockout			0465
	response	Read Only		LUCKUUL			0405
L Park I Cartos	DHW high limit	Question		Disabled			0474
High Limits	enable	Service		Disabled			0474
Llink Lincite	DHW high limit	Contine	4.40	Neurstan	0.40	0 -	0475
High Limits	setpoint	Service	140	No value	240	°F	0475
115-1-1-5-2	DHW high limit	o .					0.170
High Limits	response	Service		Recycle & hold			0476
Stack Limit	Stack limit enable	Service		Disabled			0466
Stack Limit	Stack limit setpoint	Service	32	250	266	°F	0467
	Stack limit						
Stack Limit	response	Service		Lockout			0468
Stack Limit	Stack limit delay	Service	0	300	900	seconds	0469
	Delta-T enable -	CONTROL	0	Enabled ΔT and	000	00001103	0-100
Delta T Limits	Inlet to outlet flow	Service		inversion detect			0470
		Service		inversion detect			0470
Dolto T Limito	Delta-T degrees -	Somilar	0	00	100	°F	0474
Delta T Limits	Inlet to outlet flow	Service	0	80 Basyala & Dalay	160	F	0471
Dalka Tilizzitz	Dalta Taur	0		Recycle & Delay			0.470
Delta T Limits	Delta-T response	Service		w/ retry limit			0472
Delta T Limits	Delta-T delay	Service	0	5	480	minutes	0473

Table 4-2	CFW Falcon	Parameters	(Continued)	١
		i arameters		,

						•		
		. .			400	retries (b4		0.405
Delta T Limits	Delta-T retry limit	Service	0	3	100	lockout)		0485
	Delta-T rate limit	o .						0.400
Delta T Limits	enable Dalta Tiawaraa	Service		Enabled				0486
Dolto T Limito	Delta-T inverse	Comico		5	20	minutoo		0407
Delta T Limits	limit time Delta-T inverse	Service		5 Recycle & Delay	30	minutes		0487
Delta T Limits		Sonico		w/ retry limit				0488
	limit response Delta-T enable -	Service		w/ retry infin				0400
	Exchanger to							
Delta T Limits	outlet flow	Service		Disabled				0489
	Delta-T degrees -	Service		Disabled				0403
	Exchanger to							
Delta T Limits	outlet flow	Service	0	80	160	°F		0490
	Delta-T enable -	0011100	Ŭ		100	•		0400
	Inlet to Exchanger							
Delta T Limits	flow	Service		Disabled				0494
	Delta-T degrees -			21000100				0.01
	Inlet to Exchanger							
Delta T Limits	flow	Service	14	80	160	°F		0495
	Outlet T-rise							
T-rise Limit	enable	Service		Disabled				0481
T-rise Limit	T-rise degrees	Service		10		°F		0482
T-rise Limit	T-rise delay	Service		5		minutes		0483
	Exchanger T-rise	Service		5		minutes		0403
T-rise Limit	enable	Service		Disabled				0491
		Service		Recycle & Delay				0431
T-rise Limit	T-rise response	Service		w/ retry limit				0492
T-rise Limit	T-rise retry limit	Service		10				0493
	Heat exchanger	Service		10				0493
Heat Exchanger High Limit	high limit enable	Service		Disabled				0592
	Heat exchanger	Service		Disabled				0332
Heat Exchanger High Limit	high limit setpoint	Service	32	200	266	°F		0593
	Heat exchanger	OCIVICC	52	Recycle & Delay	200	•		0000
Heat Exchanger High Limit	high limit response	Service		w/ retry limit				0594
	Heat exchanger							
Heat Exchanger High Limit	high limit delay	Service	0	5	900	minutes		0595
······································	Heat exchanger		-					
Heat Exchanger High Limit	retry limit	Service		Lockout				0596
	Plate preheat							
Plate HX Preheat	delay after tap	Service		90		seconds		0688
	Plate preheat							
Plate HX Preheat	setpoint	Service		120		°F		0689
	Plate preheat on							
Plate HX Preheat	recognition time	Service		10		seconds		0690
	Plate preheat ON							
Plate HX Preheat	hysteresis	Service		5		°F		0691
	Plate preheat OFF							
Plate HX Preheat	hysteresis	Service		5		°F		0692
	Plate preheat							
Plate HX Preheat	minimum on time	Service		60		seconds		0693
	Tap detect							
	degrees per							
Plate HX Preheat	second	Service		2		°F		0694
	Tap detect ON							
Plate HX Preheat	hysteresis	Service		20		°F		0695

Table 4-2 CFW Falcon Parameters (Continued	Table 4-2	CFW Falcon P	arameters	(Continued)
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	Tap detect on recognition time	Service		5	sec	onds	0696
	Tap stop Inlet-	Cervice		0	500	onuo	0000
Plate HX Preheat	DHW degrees	Service		5	c	°F	0697
	Tap stop Outlet- DHW degrees	Service		10	c	°F	0698
	Tap detect						
	minimum on time	Service		60	sec	onds	0699
-	Tap detect on						
	threshold Plate preheat	Service		No value		`F	0700
	detect on						
	threshold	Service		No value		°F	0701
	Plate preheat	Service		NO value		Г	0701
	detect off						
	threshold	Service		No value		'F	0702
	Annunciation	Service		NU value		1	0702
	enable	Hidden		Enabled			0304
-	Annunciator 1	Thuuen		Linableu			0304
	location	OEM		Other			0306
	Annunciator 1	OLIM		Other			0000
	short name	OEM		A1			0307
	Annunciator 1 long	02.00		,,,,			0001
	name	OEM		AIR SWITCH			0309
-	Annunciator 2	02.00					0000
	location	Service		Unused (or LCI)			0319
_	Annunciator 2						
Annunciation Configuration	short name	Service		A2			0320
_	Annunciator 2 long			AUX LOW			
Annunciation Configuration	name	Service		WATER			0322
-	Annunciator 3						
Annunciation Configuration	location	OEM		ILK			0332
	Annunciator 3						
Annunciation Configuration	short name	OEM		A3			0333
/	Annunciator 3 long						
Annunciation Configuration	name	OEM		LOW WATER			0335
	Annunciator 4						
3	location	OEM		ILK			0345
	Annunciator 4						
Annunciation Configuration	short name	OEM		A4			0346
	Annunciator 4 long						
0	name	OEM		AUX LIMIT			0348
	Annunciator 5						
0	location	OEM		ILK			0358
	Annunciator 5	05.1		. –			00-5
5	short name	OEM		A5			0359
	Annunciator 5 long	0511		HIGH GAS			0001
,		OEM		PRESSURE			0361
	Annunciator 6	0514					0074
5	location	OEM		ILK			0371
	Annunciator 6			40			0070
5	short name	OEM		A6 LOW GAS			 0372
	Annunciator 6 long			PRESSURE			0274
0	name Annunciator 7	OEM		FRESSURE			0374
	location	Service		Unused			0384
		0011100		0110000	II		0004

			aicon		J OIIII	lucuj	
Annunciation Configuration	Annunciator 7 short name	Service		A7			0385
Annunciation Conliguration		Service		A/			0365
Annunciation Configuration	Annunciator 7 long name	Service		NATURAL GAS			0387
Annunciation Configuration	Annunciator 8 location	Service		Unused			0397
Annunciation Configuration	Annunciator 8 short name	Service		A8			0398
	Annunciator 8 long						
Annunciation Configuration	name	Service		LP GAS			0400
Annunciation Configuration	PII short name	OEM		PII			0410
Annunciation Configuration	PII long name	OEM		Pre-Ignition ILK			0412
Annunciation Configuration	LCI short name	OEM		LCI			0422
Annunciation Configuration	LCI long name	OEM		Load Control Input			0424
Annunciation Configuration	ILK short name	OEM		ILK			0434
Annunciation Configuration	ILK long name	OEM		Interlock			0436
Anti-condensation	-	OLIW		Interiock			0430
Configuration	CH anti- condensation enable	Service		Enabled			0496
	CH anti-						
Anti-condensation	condensation	Convice	32	140	230	°F	0497
Configuration	setpoint CH anti-	Service	32	140	230	F	0497
Anti-condensation	condensation pump						
Configuration	force off	Service		Disabled			0498
Anti-condensation	DHW anti-						
Configuration	condensation enable	Service		Enabled			0499
Anti-condensation	DHW anti- condensation						
Configuration	setpoint	Service	32	140	230	°F	0500
Anti condenantion	DHW anti-						
Anti-condensation Configuration	condensation pump force off	Service		Disabled			0501
Anti-condensation	Anti-condensation	Service		Disableu			0301
Configuration	> Outlet limit	Service		No			0502
Anti-condensation	Anti-condensation	0011100		110			0002
Configuration	> Delta-T	Service		Yes			0502
Anti-condensation	Anti-condensation						
Configuration	> Stack limit	Service		No			0502
Anti-condensation	Anti-condensation						
Configuration	> Slow start	Service		Yes			0502
Anti-condensation	Anti-condensation						
Configuration	> Forced rate	Service		Yes			0502
Anti-condensation	Frost protect anticondensation						
Configuration	enable	Service		Yes			0503
Frost Protection	CH frost protection						
Configuration	enable	Service		Disabled			0528
Frost Protection	DHW frost						
Configuration	protection enable	Service		Disabled			0529
Frost Protection	Outdoor frost						
Configuration	protection setpoint	Service	-40	32	120	°F	0530
Frost Protection	LL frost protection	0		Disation			0500
Configuration	enable	Service		Disabled			 0532
Frost Protection	LL frost protection	Condisa	_	200/	100		0522
Configuration	rate	Service	0	20%	100		0533
Lead Lag Configuration	Lead Lag slave enable	Service		Disabled			0544
	Lead Lag master	0011100		Disabieu			0044
Lead Lag Configuration	enable	Service		Disabled			0545
			1	000.00			5010

Table 4-2	CFW Falcon	Parameters	(Continued)
			(••••••••••••••••••••••••••••••••••••••

			alcon	Falameters (Somm	lueuj	
	Lead Lag CH	. .		100			
Lead Lag Configuration	setpoint	Service	130	180	230	°F	0546
	Lead Lag CH TOD	. .	400	100		. –	05.47
Lead Lag Configuration	setpoint	Service	130	160	230	°F	0547
Lead Lea Configuration	Lead Lag on	Comilao		5		°F	0540
Lead Lag Configuration	hysteresis	Service		5		۴	0549
Lood Log Configuration	Lead Lag off hysteresis	Service		15		°F	0550
Lead Lag Configuration	Lead Lag	Service		15		Г —	0550
	hysteresis step						
Lead Lag Configuration	time	Service		60		seconds	0551
Lead Lag Configuration	Lead Lag P gain	Service	0	10	400	30001103	0552
			-	-			
Lead Lag Configuration	Lead Lag I gain	Service	0	25	400		0553
Lead Lag Configuration	Lead Lag D gain	Service	0	0	400		0554
	Lead Lag	. .					
Lead Lag Configuration	operation switch	Service		Yes/True/On			0555
	Lead Lag CH	0					0550
Lead Lag Configuration	demand switch	Service		STAT terminal			0556
Lood Lon Configuration	Lead Lag CH	Comilao		Land			0557
Lead Lag Configuration	setpoint source Lead Lag modulation	Service		Local Use average of all		-	0557
Lead Lag Configuration	backup sensor	Service		slave outlet sensors			0559
	Lead Lag CH 4mA						
Lead Lag Configuration	water temperature	Service		130		°F	0560
Load Log Configuration	Lead Lag CH 20mA	Comico		230		°F	0564
Lead Lag Configuration	water temperature	Service				F	0561
Lead Lag Configuration	Slave mode	Service		Equalize run time			0564
Lead Lag Configuration	Base load rate	Service	800	3000	6000	RPM	0566
	Fan rate during off	. .					
Lead Lag Configuration	cycle	Service	0	0	6000	RPM	0567
Lood Lon Configuration	Slave sequence	Comilao		0			0500
Lead Lag Configuration	order	Service		0		-	0568
Load Log Configuration	Lead Lag Modbus	Comico		MDO			0560
Lead Lag Configuration	port Lead Lag slave	Service		MB2			0569
	demand to firing						
Lead Lag Configuration	delay	Service	60	300		seconds	0570
	Base load						
Lead Lag Configuration	common	Service	0	45%	100	RPM	0572
	Lead selection			Lowest measured			
Lead Lag Configuration	method	Service		run time			0574
	Lag selection			Rotate in			
Lead Lag Configuration	method	Service		sequence order			0575
	Lead Lag add			Firing rate			
Lead Lag Configuration	stage method 1	Service		threshold			0714
Lead Lag Configuration	Lead Lag add stage detection time 1	Service	60	300		seconds	0716
Loud Lag Configuration	Lead Lag add stage	0011100	00	000		30001103	0/10
Lead Lag Configuration	error threshold	Service		5		°F	0718
	Lead Lag add						
Lead Lag Configuration	stage rate offset	Service	-100	20%	100		0719
Lood Log Configuration	Lead Lag add stage	Contine	100	000		00007-1-	0700
Lead Lag Configuration	interstage delay	Service	180	900 Firing roto		seconds	0722
Lood Log Configuration	Lead Lag drop	Sorias		Firing rate			0700
Lead Lag Configuration	stage method 1 Lead Lag drop stage	Service		threshold			 0723
Lead Lag Configuration	detection time 1	Service	60	300		seconds	0725
	Lead Lag drop stage						
Lead Lag Configuration	error threshold	Service		10		°F	0727

 Table 4-2
 CFW Falcon Parameters (Continued)

	Lead Lag drop					_				
Lead Lag Configuration	stage rate offset	Service	-100	-3%	100			0728		
	Lead Lag drop stage	0011100	100	070	100			0720		
Lead Lag Configuration	interstage delay	Service	180	900		seconds		0731		
Lead Lag Configuration	Lead rotation time	Service	1	24		hours		0733		
	Force lead rotation									
Lead Lag Configuration	time	Service	1	168		hours		0734		
				All Boilers Off						
Lead Lag Configuration	Boiler off options	Service		option disabled				0736		
	All boilers off									
Lead Lag Configuration	threshold	Service		25		°F		0737		
	Lead Lag CH ODR									
Lood Loo Configuration	max. outdoor	Comilao	40	00	110	°F		0540		
Lead Lag Configuration	temperature	Service	-40	80	140	-15		0518		
	Lead Lag CH ODR min. outdoor									
Lead Lag Configuration	temperature	Service	-40	0	140	°F		0518		
	Lead Lag CH ODR									
	low water	- ·								
Lead Lag Configuration	temperature	Service		130	230	°F		0519		
Lead Lag Configuration	Lead Lag CH ODR maximum off point	Service	130	230	230	°F		0521		
	Lead Lag CH ODR	0011100	100	200	200			0021		
	min. water									
Lead Lag Configuration	temperature	Service		130	230	°F		0527		
	Lead Lag CH outdoor									
Lead Lag Configuration	reset enable	Service		Disabled				0548		
** Shaded parameters are S		d require Ve	erification	and manual reset o	f the con	trol prior to o	peration. Please re	efer to		
Section 4.7.1, "Changing pa	Section 4.7.1, "Changing parameter settings".									

Table 4-2 CFW Falcon Parameters (Continued)	Table 4-2	CFW Falcon	Parameters	(Continued)
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4.7.1-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. The default service level password is 9220.

Press $<\!\text{Login}\!>$ to display the alphanumeric keyboard. Enter password and press $<\!\text{OK}\!>$

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 4-11 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. See Appendix for complete instructions on using the CB Falcon Display/Interface.



Figure 4-10 Configuration Menu





4.7.2-Program Module



Figure 4-13 Program module

CB Falcon parameter information can be uploaded/downloaded using the optional Program Module. When the Program Module is installed, its features are accessible from the Falcon Setup page. See Appendix C for more information.

4.8-BURNER SEQUENCE

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

The CFW boiler uses direct spark ignition (no gas pilot) to light the main flame. Flame sensing is accomplished with a flame rod, or ionization electrode.

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 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.
- 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).
- At the end of the pump overrun time the pump will be switched off.

4.9-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 4-3** 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.

					CFW Size			
Configuration Group	Parameter	400	500	750	1000	1500	2000	2400
Modulation	Max. Speed - High Fire	5300	5200	4400	5600	5000	4500	4500
Modulation	Min. Speed - Low Fire	1800	1300	1200	1500	1200	1000	1000
Burner Control Ignition	Ignition Fan Speed (Lightoff Rate)	2400	2000	2000	2200	1800	1800	1800

Table 4-3 Fan Speed Settings - Natural Gas

4.10-INITIAL START-UP PROCEDURE

4.10.1-Gas Train and Piping

The ClearFire burner is equipped with a combination servoregulated 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 brings about a change in the gas flow proportional to the air flow. The gas follows



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



Figure 4-14

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.
- Review available gas pressure to assure it is compatible with the main gas regulators upstream of the Model CFW gas train. Note: The maximum rated inlet pressure to the CFW gas train is 1 psig (28" WC). An upstream regulator and overpressure protection are required if building supply gas pressure is greater than 1 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 or opening the inlet gas test cock.
- 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 outlet pressure to the recommended levels in **Table 4-4**.

Boiler Size	Minimum pressure required	Max. pressure
	at gas train connection	
400	7" w.c.	
500	7" w.c.	
750	7" w.c.	
1000	7" w.c.	28" w.c.
1500	10" w.c.	
2000	10" w.c.	
2400	10" w.c.	

Table 4-4 Model CFW Gas Pressure Requirements

4.10.2-Power-Up

- 1. Ensure blower motor is properly wired for the available power supply.
- 2. Verify the voltage (control voltage is 115V-1Ph.-60Hz) to ensure it is within specifications.

4.10.3-Operation Check: Gas Valve, Gas Pressure Switches, and Combustion Air Proving Switch

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 4.3** - **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.

CFW- 2400 Annunciation				
LCI		Other		
LCI Limit Circuit Input	ON	A1 Interrupted Air Sw: A2 Unused	OFF	
	OFF			
A7 NATURAL GAS: A8 LP GAS: ILK Lockout Interlocks	ON OFF OFF			

Figure 4-15 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 (Interrupted Airflow Switch)

- 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.

Note: The CAPS is ignored when the boiler is in "Run" state. A CAPS test must be performed during Purge or Trial for Ignition.

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.

4.10.4-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 4-16).

Press RESET-TEST switch once to reset.

	0001	CFW- 2400 Annunciation				
	LCI		Other			
	LCI Limit Circuit Input	ON	A1 Interrupted Air Sw: A2 Unused			
<	A3 LOW WATER: A4 LOW GAS PRESSURE: A5 HIGH GAS PRESSURE: A6 HIGH AIR PRESSURE: A7 NATURAL GAS: A8 LP GAS: ILK Lockout Interlocks	OFF	>			

Figure 4-16 Low Water Cutoff test

4.10.5-Low and High Fire Adjustments

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

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 4-17**). The high fire adjustment screw is accessed by removing the blue plastic cap from the valve cover (see **Figure 4-18**).

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.

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



Figure 4-17 Regulating Adjusting Screw - Low Fire Offset



Figure 4-18 Main Gas Choke - High Fire Adjustment

4.10.6-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.

4.10.7-Setting Combustion

- Note: A Combustion Analyzer is required to properly set up the Model CFW burner. Do not attempt to fire and adjust the burner without this equipment.
- Note: Ensure boiler is filled with water prior to burner startup.

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 to ensure a consistent air/fuel ratio. 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 leakage diluting the flue gas. To enable the burner, go to the Operation screen and press the <Burner switch> button at the upper left. *The burner will not operate* if this button is in the "OFF" state.

Manual Modulation - use the procedure below Boiler 1 Central Heat Burner switch Normal Time Of Day Source Normal Pumps Central Heat ON Central Heat Con Central Heat ON Central Heat Central Heat Con Central Heat Con Central Heat Central Login Annunciation Central Heat Central Heat Central Heat Central Heat Central Heat Central Heat Central Central Heat Central Heat Central Heat Central Heat Central Central Heat Central Heat Central Central Heat Central Heat Central Heat Central Heat Central Heat Central Central Central Heat Central Central Centr	CFW-2400 Firing Rate Firing rate control Automatic Manual firing rate Manual in Run Manual in Run <td< th=""></td<>
 Firing rate display in the Modulation section 3. Press <clear> to clear the current value</clear> 4. Enter the desired RPM setting using the keypad (refer to Table 4-3, Fan Speed Setti 5. Press <ok>. The display will return to tion screen and the burner will modulate to sen firing rate.</ok> 	e. numeric ings). the Opera-

Note: The <Burner switch> screen button enables the burner, but will not by itself start the lightoff sequence. In order for the burner to start, the following must be true:

- <Burner switch> screen button is ON
- All control circuit interlocks are satisfied
- A demand for heat exists (DEMAND switch is in the appropriate position and water temperature is below setpoint)

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. 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 4-4** 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% (5% 6%).
- 7. Modulate to low fire and fine tune offset screw to obtain desired 02% (5% 6%).

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 4-4**.

4.10.8-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 CFW is 240 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.

4.11-POST START-UP CHECKOUT PROCEDURE

- 1. 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.
- 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.
- 3. Switch to automatic operation and monitor flue gas to ensure consistent excess air.
- 4. Reassemble all panels and covers that were removed and replace any plugs that were removed to check gas pressure.
- 5. Verify gas pressures remain within limits shown in **Table 4-4**.
- 6. Provide instructions to owner and operators on operation, safety and maintenance of the equipment.
- 7. Provide instructions to owner and operators on proper water treatment guidelines and procedures.

4.12-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
- PÍD modulation control
- Remote Enable and Remote 4-20mA Input
- Remote Modulation
- Remote Set Point
- Rate Limiting/Override
- Anticondensation
- Configurable pump/auxiliary relay contacts
- Annunciator
- Diagnostics
- Lockout/Alarm History
- Trend Analysis
- Modbus communications
- Lead/Lag Control

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 CFW 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 is 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 0 and 3 psi, respectively.

The PID (Proportional-Integral-Derivative) load control operates to generate 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 applications.

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 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 active set point determines the value for 20mA; "minimum 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.

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.

Anticondensation

The Anticondensation function increases the firing rate (and optionally shuts off the pump) when the temperature is below a configurable setpoint. Anticondensation can be programmed to take priority over other rate limits as needed.

NOTE: The high temperature limit control always has priority over rate limiting and anti-condensation.

Configurable Pump/Aux Relay Contacts

The CB Falcon Pump/Aux Relay outputs are configurable by means of six identical Pump Control Blocks. Each control block has seven parameters:

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

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 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.

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 Lead/Lag Modbus network.

One CB Falcon in the lead/lag network hosts the 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 and outdoor temperature sensors to receive control input information and to maintain the optimum setpoint

Boiler sequencing, on/off staging, and firing rate allocation are user-configurable.



Figure 4-19 Falcon Lead/Lag

Various methods can be used to determine when a new stage should be added to or dropped from the lead/lag sequence. All methods work by observing various criteria such as the firing stages, the commanded rate, or setpoint error.

For **error threshold** staging, a stage is added/dropped when the error becomes excessive based on degrees away from setpoint and time.

For **rate based** staging, a stage is added/dropped based on the rate of the modulating stage.

Refer to CB Falcon manual (Appendix A in this manual) for additional information.


Section 5 Service and Maintenance

CLEANING PROCEDURE / DISASSEMBLY	5-2
REASSEMBLY	5-3
IGNITION ELECTRODE AND FLAME ROD	5-3
TROUBLESHOOTING	5-3

ACaution

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.

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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.

5.1-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 combustion air 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 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 damage, burn marks or perforations. Replace any 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.

- 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.





Figure 5-1 Burner Head (in place)



Figure 5-2 Burner Door

5.2-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.



Figure 5-3 Combustion Chamber and Tube Sheet

5.3-IGNITION ELECTRODE AND FLAME ROD 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 as shown in **Figure 5-4** with the electrode turned towards the burner mantle after it is inserted into the burner head. Observe the dimensions below when replacing (also see **Figure 5-5**):

 $3/8^{\prime\prime}$ 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.

5.4-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

Figure 5-4 Electrode Setup

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

If frequent light-off problems occur, check the condition and positioning of the flame rod and ignition electrodes.

The distance between the flame rod and the burner (mantle) should be 3/8". The dimensions on both the booster ignitors and the flame rod 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 electrode or flame rod is out of specification, replacement is generally required. Clean or replace as necessary.

Also see Troubleshooting Chart below.

Electrode spacing for the booster ignitor should be 1/8".

The distance of the nearest booster ignitor electrode to the mantle is approximately 7/8".



Figure 5-5 Electrode spacing

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.</calibrate>			
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 agree with Table 4-4. 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 			



Chapter 6 Model CFW Parts

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1. Recommended Spare Parts List

ITEM	QTY	400 PART NO.	500 PART NO.	750 PART NO.	1000 PART NO.	1500 PART NO.	2000 PART NO.	2400 PART NO.	DESCRIPTION
1	1		380.010)37.000		380.01076.000	380.010)38·000	GASKET, ADAPTER PLATE TO BLOWER
2	2		380.01053.000		380.01033.000		380.01034.000		GASKET, ADAPTER PLATE TO DOOR
3	1		380.01045.000		380.01029.000	380.01030.000	380.010)74.000	BURNER CANISTER
4	1				880-03669-000				KIT, FLAME ROD
5	1	380.01061.000							ELECTRODE, DUAL, IGNITION
6	2				380.01032.000				GASKET, ELECTRODE
7	1				800.00098.000				GASKET, VENTURI
8	2				826.00156.000				CABLE, IGNITION
9	1				851.00026.000				SIGHT GLASS, PYREX
10	2				853.00213.000				GASKET, SIGHT GLASS
11	4	853·00934·000							GASKET, HANDHOLE
12	1		982∙000 ' LG.		982∙000 '' LG.	853·00982·000 85" LG.	853-009 98"		GASKET, ROPE, DRY OVEN



7

13	4	940-00584-000	SAFETY VALVE, 125 PSI (STANDARD)
	1	940-00476-000	SAFETY VALVE, 30 PSI (OPTIONAL)
14 1		817-03984-000	LWCO PROBE HOLDER
17	1	850-02481-000	TRIDICATOR

2. Vessel & Panel Assembly

ITEM	DESCRIPTION	400	500	750	1000	1500	2000	2400
15	VESSEL / SMOKEBOX	607-08645-000	607-08647-000	607-08638-000	607-08642-000	607-08636-000	607-08641-000	607-08644-000
16	INSULATION / LAGGING	465-02699-000	465-02700-000	465-02671-000	465-02694-000	465-02670-000	465-02692-000	465-02695-000

		All sizes
18	CONTROL PANEL ASS'Y	283-03600-000

3. Burner Assembly





ITEM	QTY	400 PART NO.	500 PART NO.	750 PART NO.	1000 PART NO.	1500 PART NO.	2000 PART NO.	2400 PART NO.	DESCRIPTION
1	1	132-026	665-000	132-02655- 000	132-02664- 000	132-02653- 000	132-02	659-000	DOOR, BURNER, INSULATED
2	2		380-01053-000		380-01033- 000		380-01034-000		GASKET, ADAPTER PLATE TO DOOR
3	1		380-01045-000		380-01029- 000	380-01030- 000	380-01	074-000	BURNER CANNISTER
4	1	380-01084- 000	380-010	081-000	380-01035- 000	380-01098- 000	380-01	036-000	ADAPTER PLATE, BLOWER TO DRY OVEN
5	1		380-010	037-000		380-01076- 000	380-01038-000		GASKET, ADAPTER PLATE TO BLOWER
6	1		894-040	076-000		894-04111- 000	894-04075-000		BLOWER UNIT
7	1	048-006	659-000	048-00	655-000	048-000	656-000	048-00662- 000	VENTURI
8	2				853-00213-000				SIGHT GLASS GASKET
9	1				851-00026-000				SIGHT GLASS
10	1				952-00498-000				WASHER
11	1	817-03468-000							COMBUSTION AIR PROVING SWITCH
12	2				380-01032-000				GASKET, ELECTRODE
13	1		380-01062-000			380-010	060-000		ELECTRODE, SINGLE (FLAME ROD)
14	1		380-01061-000						ELECTRODE, DUAL (IGNITION)
15	1				853-00982-000				GASKET, ROPE

4. Gas Train

TTEM	OTV	PART NO.					DECODIDITION	
ITEM	QTY	400	500	750	1000	1500	2000-2400	DESCRIPTION
1	2	941-01944-000	941-01944-000	941-01944-000	941-01944-000	941-01945-000	941-01945-000	VALVE, BUTTERBALL, BRONZE
2	1	940-07162-000	940-07162-000	940-07164-000	940-07164-000	940-07165-000	940-07235-000	VALVE, GAS, COMBO, 120V
3	1	817-02414-000	817-02414-000	817-02414-000	817-02414-000	817-02414-000	817-02414-000	LOW GAS PRESSURE SWITCH
4	1	817-02420-000	817-02420-000	817-02420-000	817-02420-000	817-02420-000	817-02420-000	HIGH GAS PRESSURE SWITCH
5	3	825-00239-000	825-00239-000	825-00239-000	825-00239-000	825-00239-000	825-00239-000	LEAKAGE TEST COCK
6	3	858-00088-000	858-00088-000	858-00088-000	858-00088-000	858-00088-000	858-00088-000	PIPE PLUG, SQ. HD
7	1	918-00032-000	918-00032-000	918-00032-000	918-00032-000	918-00730-000	918-00730-000	GAS PRESSURE REGULATOR
8	1	941-01944-000	941-01944-000	941-01944-000	941-01944-000	941-01946-000	941-01946-000	VALVE, BUTTERBALL, BRONZE



5. Control Panel

						-		
ITEM	QTY		DESCRIPTION	ITEM	QTY	_		DESCRIPTION
1	1	119-00420-000	CABINET, ELECTRICAL W/SUB BASE (119C00420)	24	1	836	-01147-000	SWITCH, SELECTOR, 2 POSITION
2	2	826-00156-000	IGNITION CABLE (826B00156)	25	1	836-	-01148-000	SWITCH, SELECTOR, 3 POSITION
3	1	826-00157-000	FLAME ROD CABLE (826B00157)	26	1	848	-01321-000	FUSE BLOCK, SINGLE POLE
4	1	826-00163-000	CABLE HARNESS (826B00163)	27	2	848	-01491-000	FUSE BLOCK, SINGLE POLE
5	1	832-00235-000	TRANSFORMER	28	1	879-	-00995-000	NAME PLATE, DEMAND REM-OFF-LOC
6	1	832-01811-000	FUSE, 5AMP, CONTROL CIRCUIT	29	1	879	-00995-000	NAME PLATE, CC-BLOWER OFF-ON
7	1	832-01951-000	DIN RAIL, 12" LG.	30	1	880-	-02343-000	PLUG CONNECTOR KIT FALCON
8	1	832-02045-000	FUSE, 1 AMP	31	2	881	-00348-000	LATCH, PLASTIC
9	1	832-02101-000	BLOWER POWER CORD (832B02101)	32	1	884	-00078-000	TERMINAL, SCRULUG, #14 THRU #4 AWG
10	2	832-02248-000	TERMINAL END RETAINING ANCHOR	33	1	SE	E TABLE	FUSE, AMP, LPCC TIME DELAY, BLOWER FUSE
11	1	832-02249-000	JUMPER, 2 POLE					
12	2	832-02250-000	JUMPER, 3 POLE	1 [LIGH	IT PACKAGE OPTION
13	20	832-02326-000	TERMINAL BLOCK	1	ITEM	QTY	PART NO	
14	20	832-02327-000	TERMINAL LABEL CLIP	1 [34	1		000 NAME PLATE, FUEL VALVE
15	1	832-02328-000	TERMINAL, GROUNDING	1 [35	1	881-00352	000 PILOT LIGHT, GREEN
16	1	832-02410-000	POWER SUPPLY (INCLUDED W/SYSTEM & LOCAL DISPLAY)	1 [36	1	881-00349	000 LED LIGHT MODULE, GREEN
17	1	832-02434-000	BLOWER CABLE, SIGNAL	1 [37	1		000 NAME PLATE, ALARM
18	1	832-02451-000	IGNITION TRANSFORMER	1 [38	1	881-00350	000 PILOT LIGHT, RED
19	1	833-03547-000	CONTROLLER, LWCO	1 [39	1	881-00351	000 LED LIGHT MODULE, RED
20	1	833-03725-000	DISPLAY, TOUCHSCREEN, LOCAL INTERFACE FOR FALCON CONTROL	1 [40	1	879-00995	000 NAME PLATE, DEMAND
21	1	833-03871-000	CONTROLLER, BOILER, HYDRONIC, FALCON	1 [41	1		000 PILOT LIGHT, WHITE
22	5		CONTACT BLOCK	1 [42	1	881-00358	000 LED LIGHT MODULE, WHITE
23	1	836-01142-000	RESET PUSH BUTTON (SUPPLIED W/ITEM 20)	1				
			· · · · · ·	-			HOR	N PACKAGE OPTION

37 38 39

	FUSE TABLE	
MODEL	P/N	RATING
400-1000	832-01881-000	6A
1500	832-01887-000	12A
2000-2400	832-01888-000	15A

66

6

FRONT VIEW

Φ

(23)

Б



NOTE: ITEMS 2 & 30 ARE NOT SHOWN

PANEL LAYOUT

(43)

(20)

(31)(24)(22)(29)

31 25 22 28

(42)(41)(40)

36 35 34

Boiler Size	Connection Size	Part Number
400	4"	880-03418
500	4"	880-03418
750	4"	880-02674
1000	4" x 6"	880-02670
1500	6"	880-03534
2000	6" x 8"	880-02671
2400	6" x 8"	880-02671

6. Direct Vent Combustion Kits (optional)



7. Falcon Lead/Lag Kits (optional)

KIT P/N 880-03670 INCLUDES:

Description	Part Number
HEADER TEMPERATURE SENSOR	817-04468
THERMOWELL	817-00405
OUTDOOR TEMPERATURE SENSOR	817-04517
FALCON PLUG-IN MODULE (PIM)	833-03640

8. Optional Parts misc.

Description	Part Number
AIR FILTER KIT, CFW 400, 500, 750, 1000	880-01858
AIR FILTER KIT, CFW 1500, 2000, 2400	880-02005
AIR FILTER CLEANING KIT	332-00035
SAFETY VALVE 30 PSI	940-00476
SAFETY VALVE 60 PSI	940-00691
ALARM HORN	817-03571
AUX. LOW WATER CUTOFF	817-03390
AIR VENT VALVE	940-07358
EXTERNAL HIGH LIMIT TEMP. CONTROL 240 DEG F MAX	817-04098
FALCON PLUG-IN MODULE (PIM) for parameter cloning & backup	833-03640
DHW TEMPERATURE SENSOR	817-04814
INLET TEMPERATURE SENSOR	817-04814
THERMOWELL	817-00405

APPENDIX A - CB FALCON CONTROLLER



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

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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.

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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

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- 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 ValveAlarm

4

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.



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 inprogress (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	۱	
Plug #	Description	Manf.	Part Number			
J1	Flame Detection Interface	Molex	0050841060 (Shell), 0002082004 (Pin, 14-20 AWG)			
J2	PWM Combustion Blower Interface	Molex	0039012040 (Sh	ell), 0039000059 (Pin,	18-24 AWG)	
J3	Comm. Interface	OST	EDZ1100/9 (SCR	REW)		
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 limitrated 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).

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

Table 1. NTC Sensors (temperature versus resistance).

*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...

- Read these instructions carefully. Failure to follow them 1. could damage the product or cause a hazardous condition.
- Refer to the wiring diagram provided as part of the appli-2. ance 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.
- Use the Falcon as a template to mark the four screw 2. 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.
- Connect the central ground terminal with the connection 2. 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.
- Wire according to specifications, following all local ordi-3. nances 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

- 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.

5.

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

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	 Earth ground must be capable of conducting enough current to blow the 20A fuse (or breaker) in the event of an internal short circuit. 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. 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.	

Table 2. Wire Sizes. (Continued)



Fig. 3. Falcon device pin out (hydronic)



Fig. 4. Falcon device pin out (steam)

Table 3. Falcon Contact.

Connecto	r 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	ТАСН	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	а	a	Modbus MB1 RS-485 +
	b	b	Modbus MB1 RS-485 -
	с	с	Modbus MB1 Ground (G)
	а	а	Modbus MB2 RS-485 +
	b	b	Modbus MB2 RS-485 -
	с	с	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)

J7 (J7 (J7 (J7 (J7 (J7 (1 7 6 5 4 3	Annunc2 Not Used Annunc3	24VAC, 120 VAC: 2 mA maximum
J7 (J7 (J7 2 J7 2 J7 3	6 5 4	Annunc3	
J7 5 J7 4 J7 5	5 4		
J7 4 J7 ;	4		24VAC, 120 VAC: 2 mA maximum
J7 C		Annunc4	24VAC, 120 VAC: 2 mA maximum
	3	Annunc5	24VAC, 120 VAC: 2 mA maximum
J7 2	-	Annunc6	24VAC, 120 VAC: 2 mA maximum
	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	2	24 VAC	24VAC Return
J8 (3	STAT	24 VAC, (20 VAC to 30 VAC)
J8 4	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	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	8	OUTLET TEMP A (S3) *a,b	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J8 9	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
, Jð	1	DHW TEMP A (S6) *a,b	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J9 2	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	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	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	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	6	MODULATION COMMON (-)	Ground reference for voltage and current modulation signals
J10	7	Not Used	
J10 8	8	Not Used	
J11	1–7	Not Used	+
SPECIAL CO			

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 I	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 filetransfer 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.)

			System Display		Modbus register I/O	
Hidden	Read-only	Password	Shown	Write	Read	Write
0	0	0	Yes	Anytime	Yes	Yes
0	0	1	Yes	Need Password	Yes	Need Password
0	1	х	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.

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.

- 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.
- 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.

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.

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.		

Table 6. System Operation Settings. (Continued)

Those that alter the behavior or availability of configurable defined in oth

items that are not in any other category. Those that are not defined in other sections are listed in Table 8:

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.	

Table 7. General Configuration Settings.

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:



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)
     ТΕ
        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 )
           1)
         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.

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.

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.



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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.

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.

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

Table 10. Central Heating Steam Parameters. (Continued)

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







(DOES NOT APPLY FOR DHW)

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 To	urn-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

CB FALCON



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.

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) 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 a 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.

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.

Table 11. Domestic Hot Water Parameters. (Continued)

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.

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)

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 "CIr" 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 "CIr" 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.

Table 12. Plate Heat Exchanger Parameters. (Continued)

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.
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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)
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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 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.
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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.
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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 45°F, 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:
	 the outdoor temperature is above the programmed frost protection level + 4°F, and the outlet temperature exceeds 50°F. 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 38°F 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 50°F.
	 2) the inlet temperature is greater than 41°F. 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.

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 45°F Once turned on, the DHW pump remains on until the DHW temperature exceeds 50°F. 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 38°F 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 50°F. 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.

Table 17. DHW Frost Protection Parameters.

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-1 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.

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 s	hare 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.

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

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.
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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).

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.

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

Table 20. Heat Exchanger High Limit Parameters.

Stack limit (Safety limit and Rate limit)

Table 21. Limits and Rate Override: Stack Limit Pa	rameters.
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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.

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).	

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.

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.

Table 24. Limits and Rate Override: Outlet High Limit.

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:

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	

Table 25. Anticondensation Parameters.

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.
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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.

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.

Table 27. Fan Speed Modulation Parameters. (Continued)

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
- Aux2
 Sustan
- 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.

THERE ARE 6 PUMP CONTROL BLOCKS THAT ARE FUNCTIONALLY IDENTICAL EACH HAS 7 PARAMETERS THAT WORK THE SAME WAY IN EACH BLOCK. SEE PumpControlBlock.evx DRAWING FOR DETAILS.





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.
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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.

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.

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).

Table 30. Pump Exercising Parameters.

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.

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)
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Parameter	Comment
Igniter on duringPilot Flame Establishing Period or First half of PFEP This parameter is not needed and ignored if DBI (Direct Burner Ignition) is sel Otherwise the igniter may be on throughout the PFEP, or only during the first I • 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. He the igniter is selected as the internal spark generator then, during its on time a this parameter, it actually is intermittently on, then off, then on, then off, with e lasting 1/4 second. (This is done because flame cannot be sensed while the ig to hardware limitations, so flame sense and igniter spark are done alternatetly 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).

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 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)

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.

\odot
valve: ON
am valve: ON
oor: OFF
essor: OFF

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.
 - 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 PRE-PURGE 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).
- 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).
- 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.
- 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.

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.

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

- 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.

Checkout Step	Piloted Systems	DSI Systems	Flame Rod Systems	Ultraviolet Flame Detectors
Preliminary Inspection	Х	Х	Х	Х
Flame Signal Measurement	Х	Х	Х	Х
Initial Lightoff Check for Proved Pilot	Х			
Initial Lightoff Check for Direct Spark Ignition		Х		
Pilot Turndown Test	Х			
Ignition Interference Test			Х	
Hot Refractory Hold-in Test				Х
Ignition Spark Pickup				Х
Response to Other Ultraviolet Sources				Х
Flame Signal with Hot Combustion Chamber	Х	Х	Х	Х
Safety Shutdown Tests	Х	Х	Х	Х

Table 32. Checkout steps and applicable systems.

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.
- 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.
- 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.

- 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.
- 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.
- 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.
- 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.
- I. 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.
 - d. Check for proper gas supply pressure.e. Check for proper valve operation.
 - f. Check for proper pilot flame positioning.
- 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).
- 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.
- 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.
- 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.

- I. 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.
 - 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.
- I. 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.
 - 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:

- 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.
- 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
 - 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.
- 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.
- 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.
 - 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.

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	

Table 33. OEM Configuration Parameters

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:

75



Fig. 29. Master/Slave data transmission.

Table 34. Slave Da	ata Supporting Lead	Lag Parameters.
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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.

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.

Table 34. Slave Data Supporting Lead Lag Parameters. (Continued)

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.

Devenator

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

Comment

Sequencer - The sequencer determines which Falcon will be the next one to turn on or turn off.

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.

Table 35. Overall Control Parameters.

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

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.

Table 38. Warm Weather Shutdown (WW-SD) Parameters. (Continued)

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.
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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.
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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 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.

LL setpoint

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:

- 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 Dropstage 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 - Addstage 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:

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.

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 LeadBoilerSegNum 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.
- 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

Parameter Name Short Description Ref. Page 20 mA CH pressure PSI or None 30 Establishes the pressures for the end points of the 4-20 mA inputs 4 mA water Dearees 26 temperature Establishes temperature for 4 mA input 20 mA water Dearees 26 Establishes temperature for 20 mA input temperature 51 Absolute max fan The fan will never be commanded to operate above the RPM provided by this parameter, speed regardless of the rate request. Absolute min fan The fan will never be commanded to operate below the RPM provided by this parameter, 51 regardless of the rate request, except by commanding it to turn off. speed Alarm silence time Alarms can be silenced for the amount of time given by this parameter. 63 Analog output When modulating via 0-10V or 4-20mA, changes in the direction of PID output can be 52 hvsteresis limited by a small amount of hysteresis, to decrease the occurrence of actual control reversals. Annunciation enable This parameter determines whether the Annunciator features of the Falcon are active. 20 When disabled, the Falcon will ignore the Annunciator inputs (because the application does not use this feature). Annunciator 1 The location of the contacts monitored by the A1 annunciator input. 61 location Annunciator 1 long The long name (up to 20 characters) of the A1 annunciator input. 61 name Annunciator 2 The location of the contacts monitored by the A2 annunciator input. 61 location Annunciator 2 long The long name (up to 20 characters) of the A2 annunciator input. 61 name Annunciator 3 The location of the contacts monitored by the A3 annunciator input. 61 location Annunciator 3 long The long name (up to 20 characters) of the A3 annunciator input. 61 name Annunciator 4 The location of the contacts monitored by the A4 annunciator input. 61 location Annunciator 4 long The long name (up to 20 characters) of the A4 annunciator input. 61 name Annunciator 5 The location of the contacts monitored by the A5 annunciator input. 61 location 61 Annunciator 5 long The long name (up to 20 characters) of the A5 annunciator input. name Annunciator 6 The location of the contacts monitored by the A6 annunciator input. 61 location Annunciator 6 long The long name (up to 20 characters) of the A6 annunciator input. 61 name Annunciator 7 The location of the contacts monitored by the A7 annunciator input. 61 location Annunciator 7 long The long name (up to 20 characters) of the A7 annunciator input. 61 name Annunciator 8 The location of the contacts monitored by the A8 annunciator input. 61 location Annunciator 8 long The long name (up to 20 characters) of the A8 annunciator input. 61 name The annunciator may be fixed, in which the labels and locations of the inputs is pre-Annunciator mode 61 assigned, or programmable in which these things may be altered.

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

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	mm:ss	27
recovery setup time 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		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

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

Table 4	47. Para	ameter	Glossary.
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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

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.
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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

Parameter Name Short Description Ref. Page LL - Slave write 76 This allows the slave to accept command messages from a master. Manual firing rate This parameter specifies the analog output or fan speed during burner modulation, when 51 the Firing rate control parameter specifies Manual mode. This parameter provides choices for the duration of the MFEP (main flame establishing MFEP 60 period) time. Flame must remain on throughout the MFEP or a response occurs. Not needed and ignored unless the Pilot type is Interrupted. If flame fails in the Main Flame Establishing Period and recycle is selected then the burner MFEP flame failure 60 control recycles back to the beginning of Prepurge, then continues with the normal burner response startup process to attempt to light the burner again. Provides the lower limit of analog output or fan speed during modulation (this is for both CH 51 Minimum and DHW). modulation rate This parameter selects the modulation output. The Falcon software responds by driving the 51 Modulation output appropriate circuit to provide modulation of firing rate. If the modulation rate source is Local, then the control's PID algorithm determines the Modulation rate 26 modulation rate. source 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. Modulation sensor The selected input provides the temperature clearance for modulation control. 26 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. The sensors used may all be the 10K NTC type in which safety sensors are redundant, or NTC sensor type 57 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. OEM identification The OEM may provide identification information here. 21 Outdoor Connector 20 Designates the Sensor type connected to the control for proper reading. Туре Outdoor frost This parameter provides the setpoint for frost protection based on outdoor temperature. protection setpoint When the outdoor temperature falls below this threshold then frost protection will be active. **Outlet Connector** Designates the Sensor type connected to the control for proper reading. 20 Туре Outlet high limit Used to set the Outlet high limit on or off. 46 enable Outlet high limit If Recycle && hold is selected, the burner control recycles and waits for the outlet 46 response 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. Outlet high limit If the outlet temperature reaches the value given by this parameter, a response will occur. 46 setpoint **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. 59 Flame must be on at the end of this period. This parameter is ignored if DBI (Direct Burner Ignition) is selected. PII enable This parameter enables the Pre-Ignition Interlock input. If disabled the PII input is ignored. 57 The long name (up to 20 characters) of the PII annunciator input. PII long name 61 PII short name The short (3 letter) name of the contacts monitored by the PII annunciator input. 61 If the Pilot type is Interrupted or Intermittent and this parameter is enabled then the burner Pilot test hold 57 control sequence will hold (forever) at 1 second into the Ignition state, while monitoring the flame via a 15 second timer. Interrupted pilot turns off after MFEP (main flame establishing period). Intermittent pilot 58 Pilot type 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. Whenever the Preheat block is false, it monitors the Tap demand block's output and 37 Plate preheat delay

Table 47. Parameter Glossary.

after tap

recently ended.

operates a timer that ensures preheat will not begin too soon after a tap demand has

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.			
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: Tap demand is false, AND The preheat delay-after-tap time has elapsed, AND DHW sensor temperature <= T_{ON}, AND 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.			
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			

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.				
Stack Connector Type	Designates the Sensor type connected to the control for proper reading. 2				
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.				
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.				
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					
Tap detect on threshold	-17 °C to 82 °C (-0 °F to 180 °F)	36			

Table 47. Parameter Glossary.

Parameter Name	Short Description				
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).				
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

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.

Customer					
Parameter Name	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)

Desembles Norse	Customer Choice - Hidden, Read Only or Password	Minimum Daw	Default Catting	Movimum Dom-	Deremeter Units
Parameter Name Annunciator 4 location	Protected Read Only	Minimum Range	Default Setting A:No annunciation	Maximum Range	Parameter Units
Annunciator 4 location	Read Only		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	

A:Lockout

[A #b C #d]

Read Only

Stack limit response

	Customer Choice - Hidden, Read Only or Password				
Parameter Name	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		

Table 48. Example of a Completed Device Parameter Worksheet. (Continued)

APPENDIX C: LOCKOUT AND HOLD CODES

Note Column: H= Hold message; L=Lockout message; H or L= either Hold or Lockout depending on Parameter Configuration

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.

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
	Safety Data Faults		
1	Unconfigured safety data	 New Device, complete device configuration and safety verification. If fault repeats, replace module. 	L
2	Waiting for safety data verification	 Device in Configuration mode and safety parameters need verification and a device needs reset to complete verification. Configuration ended without verification, re enter configuration, verify safety parameters and reset device to complete verification. If fault repeats, replace module. 	L
	Internal Operation Errors		

Table 49. Falcon Lockout and Hold Codes.

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
3	Internal fault: Hardware fault	Internal Fault.	Н
4	Internal fault: Safety Relay key feedback error	 Reset Module. If fault repeats, replace module. 	Н
5	Internal fault: Unstable power (DCDC) output		Н
6	Internal fault: Invalid processor clock		Н
7	Internal fault: Safety relay drive error		Н
8	Internal fault: Zero crossing not detected		Н
9	Internal fault: Flame bias out of range		Н
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		Н
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		Н
21	Internal fault: Flame number of sample mismatch		Н
22	Internal fault: Flame bias out of range		Н
23	Internal fault: Bias changed since heating cycle starts		Н
24	Internal fault: Spark voltage stuck low or high		Н
25	Internal fault: Spark voltage changed too much during flame sensing time		Н
26	Internal fault: Static flame ripple		Н
27	Internal fault: Flame rod shorted to ground detected		Н
28	Internal fault: A/D linearity test fails		Н
29	Internal fault: Flame bias cannot be set in range		Н
30	Internal fault: Flame bias shorted to adjacent pin		Н
31	Internal fault: SLO electronics unknown error		н
32-46	Internal fault: Safety Key 0 through 14		L
	System Errors		
47	Flame Rod to ground leakage		Н
48	Static flame (not flickering)		Н
49	24VAC voltage low/high	 Check the Module and display connections. Check the Module power supply and make sure that both frequency, voltage and VA meet the specifications. 	Н

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
50	Modulation fault	Internal sub-system fault.	Н
51	Pump fault	 1. Review alert messages for possible trends. 2. Correct possible problems. 	Н
52	Motor tachometer fault	3. If fault persists, replace module.	Н
53	AC inputs phase reversed	 Check the Module and display connections. Check the Module power supply and make sure that both frequency and voltage meet the specifications. 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.	L
59	Internal Fault: Mux pin shorted	1. Reset Module. 2. If fault repeats, replace module.	L
	Normal Event Status		
60	Internal Fault: HFS shorted to LFS		L
61	Anti short cycle	Will not be a lockout fault. Hold Only.	Н
62	Fan speed not proved		Н
63	LCI OFF	 Check wiring and correct any faults. Check Interlocks connected to the LCI to assure proper function. Reset and sequence the module; monitor the LCI status. If code persists, replace the module. 	Η
64	PII OFF	 Check wiring and correct any faults. Check Preignition Interlock switches to assure proper functioning. Check the valve operation. Reset and sequence the module; monitor the PII status. If code persists, replace the module. 	H or L
65	Interrupted Airflow Switch OFF	1. Check wiring and correct any possible shorts.	H or L
66	Interrupted Airflow Switch ON	 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
67	ILK OFF	1. Check wiring and correct any possible shorts.	H or L
68	ILK ON	 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
69	Pilot test hold	 Verify Run/Test is changed to Run. Reset Module. If fault repeats, replace module. 	Н
70	Wait for leakage test completion	 Internal Fault. Reset Module. If fault repeats, replace module. 	Н
71-77	RESERVED		
78	Demand Lost in Run	 Check wiring and correct any possible errors. If previous steps are correct and fault persists, replace the module. 	Н
79	Outlet high limit	 Check wiring and correct any possible errors. Replace the Outlet high limit. If previous steps are correct and fault persists, replace the module. 	H or L

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
80	DHW high limit	 Check wiring and correct any possible errors. Replace the DHW high limit. If previous steps are correct and fault persists, replace the module. 	H or L
81	Delta T limit	 Check Inlet and Outlet sensors and pump circuits for proper operation. Recheck the Delta T Limit to confirm proper setting. If previous steps are correct and fault persists, replace the module. 	H or L
82	Stack limit	 Check wiring and correct any possible errors. Replace the Stack high limit. If previous steps are correct and fault persists, replace the module. 	H or L
83	Delta T exchanger/outlet limit		H or L
34	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	 Check wiring and correct any possible errors. Replace the Inlet sensor. If previous steps are correct and fault persists, replace the module. 	H
92	Outlet sensor fault	 Check wiring and correct any possible errors. Replace the Outlet sensor. If previous steps are correct and fault persists, replace the module. 	Н
93	DHW sensor fault	 Check wiring and correct any possible errors. Replace the DHW sensor. If previous steps are correct and fault persists, replace the module. 	Н
94	Header sensor fault	 Check wiring and correct any possible errors. Replace the header sensor. If previous steps are correct and fault persists, replace the module. 	Н
95	Stack sensor fault	 Check wiring and correct any possible errors. Replace the stack sensor. If previous steps are correct and fault persists, replace the module. 	Н
96	Outdoor sensor fault	 Check wiring and correct any possible errors. Replace the outdoor sensor. If previous steps are correct and fault persists, replace the module. 	Н
97	Internal Fault: A2D mismatch.	Internal Fault.	L
98	Internal Fault: Exceeded VSNSR voltage	1. Reset Module. 2. If fault repeats, replace module.	L
99	Internal Fault: Exceeded 28V voltage tolerance		L
100	Pressure Sensor Fault	 Verify the Pressure Sensor is a 4-20ma source. Check wiring and correct any possible errors. Test Pressure Sensor for correct operation. Replace the Pressure sensor. If previous steps are correct and fault persists, replace the module. 	Η

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
101-104	RESERVED		
	Flame Operation Faults		
105	Flame detected out of sequence	 Check that flame is not present in the combustion chamber. Correct any errors. Make sure that the flame detector is wired to the correct terminal. Make sure the F & G wires are protected from stray noise pickup. Reset and sequence the module, if code reappears, replace the flame detector. Reset and sequence the module, if code reappears, replace the flame detector. 	H or L
106	Flame lost in MFEP	1. Check pilot valve (Main Valve for DSI) wiring and	L
107	Flame lost early in run	operation - correct any errors. 2. Check the fuel supply.	L
108	Flame lost in run	3. Check fuel pressure and repeat turndown tests.	L
109	Ignition failed	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
110	Ignition failure occurred	Hold time of recycle and hold option. Will not be a lockout fault. Hold Only.	Н
111	Flame current lower than WEAK threshold	Internal hardware test. Not a lockout,	Н
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.	L
123	Purge rate proving failed	 2. Check VFDs ability to change speeds. 3. Change the VFD 4. If the fault persists, replace the module. 	L
124	High fire switch OFF	1. Check wiring and correct any potential wiring errors.	Н
125	High fire switch stuck ON	 Check High Fire Switch to assure proper function (not welded or jumpered). 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. If steps 1-3 are correct and the fault persists, replace the module. 	Н
126	Low fire switch OFF	1. Check wiring and correct any potential wiring errors.	Н
127	Low fire switch stuck ON	 Check Low Fire Switch to assure proper function (not welded or jumpered). 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. If steps 1-3 are correct and the fault persists, replace the module. 	H or L
128	Fan speed failed during prepurge	1. Check wiring and correct any potential wiring errors.	H or L
129	Fan speed failed during preignition	2. Check VFDs ability to change speeds. 3. Change the VFD	H or L
130	Fan speed failed during ignition	4. If the fault persists, replace the module.	H or L
131	Fan movement detected during standby		Н
132	Fan speed failed during run	1	Н
133-135	RESERVED		
	Start Check Faults		

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
136	Interrupted Airflow Switch failed to close	 Check wiring and correct any possible wiring errors. Check Interrupted Airflow switch(es) to assure proper function. Verify voltage through the airflow switch to the IAS input with a voltmeter. If steps 1-3 are correct and the fault persists, replace the module. 	Η
137	ILK failed to close	 Check wiring and correct any possible shorts. Check Interlock (ILK) switches to assure proper function. Verify voltage through the interlock string to the interlock input with a voltmeter. If steps 1-3 are correct and the fault persists, replace the module. 	Η
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.	Н
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	H or L
153	Combustion Pressure Off	 Check wiring and correct any errors. Inspect the Combustion Pressure Switch to make sure it is working correctly. Reset and sequence the relay module. 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. If the fault persists, replace the relay module. 	H or L
154	Purge Fan switch On	OEM Specific	H or L
155	Purge Fan switch Off	1. Purge fan switch is on when it should be off.	H
155	Purge fan switch OFF		H or L

Table 49. Falcon Lockout and Hold Codes. (Co	ntinued)
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157 C 158 N 159 N 160 Iq 161 Iq 162 F 163 F 164 E	Combustion pressure and Flame ON Combustion pressure and Flame OFF Main valve ON Main valve OFF Ignition ON Ignition OFF Pilot valve ON Pilot valve OFF Block intake 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. OEM Specific 1. Check Main Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module. OEM Specific 1. Check Ignition terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module. OEM Specific 1. Check Ignition terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module. OEM Specific 1. Check Pilot Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module. 	H or L L L L L L
158 N 159 N 160 Iq 161 Iq 162 F 163 F 164 E	Main valve ON Main valve OFF Ignition ON Ignition OFF Pilot valve ON Pilot valve OFF	 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. OEM Specific 1. Check Main Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module. OEM Specific 1. Check Ignition terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module. OEM Specific 1. Check Ignition terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module. OEM Specific 1. Check Ignition terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module. 	L L L
159 N 160 lự 161 lự 162 F 163 F 164 E	Main valve OFF Ignition ON Ignition OFF Pilot valve ON Pilot valve OFF	 Check Main Valve terminal wiring and correct any errors. Reset and sequence the module. If fault persist, replace the module. OEM Specific Check Ignition terminal wiring and correct any errors. Reset and sequence the module. If fault persist, replace the module. OEM Specific Check Pilot Valve terminal wiring and correct any errors. 	L
160 161 162 F 163 F 164 E	Ignition ON Ignition OFF Pilot valve ON Pilot valve OFF	 Reset and sequence the module. If fault persist, replace the module. OEM Specific Check Ignition terminal wiring and correct any errors. Reset and sequence the module. If fault persist, replace the module. OEM Specific Check Pilot Valve terminal wiring and correct any errors. 	L
161 lg 162 F 163 F 164 E	Ignition OFF Pilot valve ON Pilot valve OFF	 Check Ignition terminal wiring and correct any errors. Reset and sequence the module. If fault persist, replace the module. OEM Specific Check Pilot Valve terminal wiring and correct any errors. 	L
162 F 163 F 164 E	Pilot valve ON Pilot valve OFF	 Reset and sequence the module. If fault persist, replace the module. OEM Specific Check Pilot Valve terminal wiring and correct any errors. 	L
163 F 164 E	Pilot valve OFF	1. Check Pilot Valve terminal wiring and correct any errors.	
164 E			
	Block intake ON	 Check Pilot Valve terminal wiring and correct any errors. Reset and sequence the module. If fault persist, replace the module. 	L
165 E		OEM Specific	L
	Block intake OFF	 Check wiring and correct any errors. Inspect the Block Intake Switch to make sure it is working correctly. Reset and sequence the module. 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. If the fault persists, replace the relay module. 	L
166-171 F	RESERVED		
F	Feedback		
172 N	Main relay feedback incorrect	Internal Fault.	L
173 F	Pilot relay feedback incorrect	1. Reset Module. 2. If fault repeats, replace module.	L
174 S	Safety relay feedback incorrect		L
175 S	Safety relay open		L
176 N	Main relay ON at safe start check		L
177 F	Pilot relay ON at safe start check		L
	Safety relay ON at safe start check		L
	RESERVED		
	Parameter Faults		
	Invalid BLOWER/HSI output setting	 Return to Configuration mode and recheck selected parameters, reverify and reset module. 	L
	Invalid Delta T limit enable setting	2. If fault repeats, verify electrical grounding.	L
	Invalid Delta T limit response setting	3. If fault repeats, replace module.	L
	Invalid DHW high limit enable setting	-	L
	Invalid DHW high limit response setting		L
	Invalid Flame sensor type setting		L
	Invalid interrupted air switch enable setting		L
e	Invalid interrupted air switch start check enable setting		L
	Invalid igniter on during setting Invalid ignite failure delay setting	4	L

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
194	Invalid ignite failure response setting	1. Return to Configuration mode and recheck selected	L
195	Invalid ignite failure retries setting	parameters, reverify and reset module. 2. If fault repeats, verify electrical grounding.	L
196	Invalid ignition source setting	3. If fault repeats, replace module.	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	1	L
224	Invalid DHW demand source setting	1	L
225	Invalid Flame threshold setting		L
226	Invalid Outlet high limit setpoint setting	1	L
227	Invalid DHW high limit setpoint setting		L
228	Invalid Stack limit setpoint setting	1	L
229	Invalid Modulation output setting	1	L
230	Invalid CH demand source setting	1	L
231	Invalid Delta T limit delay setting	1	L
232	Invalid Pressure sensor type setting	1	L
233	Invalid IAS closed response setting	1	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)
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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

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)

Description
Low line frequency occurred
Invalid subsystem reset request occurred
Write large enumerated Modbus register value
Maximum cycle count was reached
Maximum hours count was reached
Illegal Modbus write was attempted
Modbus write attempt was rejected (NOT
Illegal Modbus read was attempted
Safety processor brown-out reset occurred
Application processor watchdog reset occurred
Application processor brown-out reset occurred
Safety processor watchdog reset occurred
Alarm was reset by the user at the control
Demand/Rate Command Faults
Burner control firing rate was > absolute max
Burner control firing rate was < absolute min rate
Burner control firing rate was invalid, % vs. RPM
Burner control was firing with no fan request
Burner control rate (nonfiring) was > absolute
Burner control rate (nonfiring) was < absolute
Burner control rate (nonfiring) was absent
Burner control rate (nonfiring) was invalid, % vs.
Fan off cycle rate was invalid, % vs. RPM
Setpoint was overridden due to sensor fault
Modulation was overridden due to sensor fault
No demand source was set due to demand
RESERVED
Fan Parameter Errors
Periodic Forced Recycle
Absolute max fan speed was out of range
Absolute min fan speed was out of range
Fan gain down was invalid
Fan gain up was invalid
Fan minimum duty cycle was invalid
Fan pulses per revolution was invalid
Fan PWM frequency was invalid
RESERVED
Modulation Parameter Errors
Lead Lag CH 4-20mA water temperature setting
No Lead Lag add stage error threshold was
No Lead Lag add stage detection time was
No Lead Lag drop stage error threshold was
Ino Lead Lay drop stage error timeshold was

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

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

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
102	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 slave enable was invalid
190	No Lead lag Modbus port was assigned
190	
191	Lead Lag base load common setting was invalid
-	Lead Lag DHW demand switch setting was
193 194	Lead Lag Mix demand switch setting was invalid
194	Lead Lag modulation sensor setting was invalid
	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

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

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
L	, <u> </u>

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		

Codo	Description		
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		
502 503			
	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		

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		

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 PLUG-IN MODULE



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.

3	Program Module (PM) Configuration)	
	D				I
	Burner:	04 - Site 1 - I	Boiler 4	-	
	PM label: Site 1, Boiler 4				
PM	PM contents: Parameters, Alert PCB				
	Status:				
Far	nily: Reside	ntial Hydronic	Boiler	Model: 323	
Revis	ion: 12.9	Last Back	up: 10/13/20	09 3:00:00pm	
*	Erase	Backup Parameters	Restore Parameters	Logout	

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 C - 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.

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.

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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

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)

Table 1: Model Information

^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	А	В	С	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. 12: Capacity curves for V4730C/V8730C and VMU 335 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



Disconnect the power supply before beginning wiring to prevent electrical shock. More than one disconnect may be involved.

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.



Fig. 16: Four-pin electrical plug connector



Fig. 17: Electrical connection diagram

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.

- 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

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.

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.

- 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.
- 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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APPENDIX D - 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, <u>http://www.Modbus-IDA.org</u>.

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	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 "Sn" 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.

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 <i>and</i> 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 <i>and</i> J9-3	DHW dual safety temperature			
S8	J9-4	Stack single non-safety temperature			
S9	J9-6	Heat exchanger temperature			
S8S9	J9-4 <i>and</i> J9-6	Stack dual safety temperature			
S10	J10-7	Outdoor or Lead Lag Header (Central Heat) temperature			

Table 3. Sensor input names

	ALERT LOG	f				
	LOCKOUT HISTORY					
	SAFETY VERIFICATION					
+	MIX FLOW CONFIGURATION	NEW IN 2.3				
	MIX CONFIGURATION	NEW IN 2.3				
	EXTENDED SYSTEM CONFIGURATION	NEW IN 2.1				
	LEAD LAG CONFIGURATION					
	STEAM CONFIGURATION	NEW IN 2.0				
	FROST PROTECTION CONFIGURATION					
	DHW STORAGE CONFIGURATION	NEW IN 2.2				
 PLUGIN	OUTDOOR RESET (ODR) CONFIGURATION					
MODULE (PIM)	ANTICONDENSATION CONFIGURATION					
PUBLIC	LIMITS CONFIGURATION					
PUBLIC	DOMESTIC HOT WATER (DHW) CONFIGURATION					
	ANNUNCIATION CONFIGURATION					
	PUMP CONFIGURATION	PUBLIC				
	FAN CONFIGURATION					
	BURNER CONTROL CONFIGURATION					
	CENTRAL HEAT (CH) CONFIGURATION					
	MODULATION CONFIGURATION	J I				
+	SYSTEM CONFIGURATION					
	LEAD LAG STATUS					
	STATISTICS					
	MIX STATUS	NEW IN 2.3				
	PUMP STATUS					
	DOMESTIC HOT WATER (DHW) STATUS					
	CENTRAL HEAT (CH) STATUS					
	DEMAND & MODULATION STATUS					
	SENSOR STATUS					
	BURNER CONTROL STATUS					
	TREND STATUS					
	SYSTEM STATUS	↓ ↓				

Fig. 1. 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. <u>Bit map</u> : 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. <u>Bit map</u> : 15=PCB configuration 14=PIM configuration 13=Reserved 12=Lead Lag configuration 10=Outdoor reset configuration 9=Anti-condensation configuration 8=Limits 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

0003	0003	Annunciation I/O	R	U16	Only applicable when Annunciation is enabled <u>Bit map</u> : 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/exchanger 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
8000	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 000C	0011 0012	Inlet (S1) sensor DHW (S6S7) or DHW limit (S6) sensor	R R	U16 U16	-40°-130° (0.1°C precision) ^a -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

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	U16U1 6	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. <u>Bit map</u> : 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). Mode 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

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,
0025	0037	Annunciator hold	R	U16	 17-Annunciator 7, 18=Annunciator 8 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,
0026	0038	Sequence time	R	U16	18=Annunciator 8 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	Bit map: 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

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			

		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, 9=Dump exercise requested, 4=On due to overrun, 2=Forced off,

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		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		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	0100	System pump idle days	R	U16	Number of days that LL pump has not run (sat idle).
		count			
006C	0108	Boiler pump status	R	U16	For application build less than 1600 see table 12. For
0005	0.1.00		_	1140	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		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	İ		
	1				

			1	1	1
		STATISTICS	5.44		0.000.000
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

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, 8=Quetation demand, 9=Dutation demand, 9=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 <u>Product ID</u> (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

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.

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

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	

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

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	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
0129	0297	CH 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
012A	0298	DHW 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

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 off when DHW frost protection,3=Force pump on when DHW frost protection,2=Force pump on when CH and 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 off when DHW frost protection, 3=Force pump on when DHW 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 off when DHW frost protection,3=Force pump on when DHW 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

		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

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
01E5	0485	Delta-T retry limit	R/W	U16	Maximum number of recycles due to Delta-T or inversion limit.
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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)? <u>Bit map</u> : 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

		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 <i>during</i> priority time, 1=Drop DHW priority <i>after</i> 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			

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)

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

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

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.

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		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		1	
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

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

02F2 02F3	0754	Auxiliary 1 pump options 2 Auxiliary 2 pump output	R/W R/W	U16 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 0=None, 1=Pump A, 2=Pump B, 3=Pump C	
02F4	0756	Auxiliary 2 pump control	R/W	U16	0=Auto, 1=On	
02F4	0750	Auxiliary 2 pump control Auxiliary 2 pump start delay	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured	
02F5 02F6						
0260	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		2 nd newest lockout. See Table 5.	
0382-0392	0898-0914	Lockout history record 3	R		3 rd newest lockout. See Table 5.	
0393-03A3	0915-0931	Lockout history record 4	R		4 th newest lockout. See Table 5.	
03A4-03B4	0932-0948	Lockout history record 5	R		5 th newest lockout. See Table 5.	
03B5-03C5	0949-0965	Lockout history record 6	R		6 th newest lockout. See Table 5.	
03C6-03D6	0966-0982	Lockout history record 7	R	1	7 th newest lockout. See Table 5.	
03D7-03E7	0983-0999	Lockout history record 8	R	+	8 th newest lockout. See Table 5.	
	1000 1010	Lockout history record 9	R	+		
03E8-03F8	1000-1016	LOCKOUL HISLOLY LECOLU S	•••		9 th newest lockout. See Table 5.	

		ao regiotor map			
040A-041A	1034-1050	Lockout history record 11	R		11 th newest lockout. See Table 5.
041B-042B	1051-1067	Lockout history record 12	R		12 th newest lockout. See Table 5.
042C-043C	1068-1084	Lockout history record 13	R		13 th newest lockout. See Table 5.
043D-044D	1085-1101	Lockout history record 14	R		14 th 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	2 nd newest alert.
046C-0471	1132-1137	Alert log record 3	R	U16	3 rd newest alert.
0472-0477	1138-1143	Alert log record 4	R	U16	4 th newest alert.
0478-047D	1144-1149	Alert log record 5	R	U16	5 th newest alert.
047E-0483	1150-1155	Alert log record 6	R	U16	6 th newest alert.
0484-0489	1156-1161	Alert log record 7	R	U16	7 th newest alert.
048A-048F	1162-1167	Alert log record 8	R	U16	8 th newest alert.
0490-0495	1168-1173	Alert log record 9	R	U16	9 th newest alert.
0496-049B	1174-1179	Alert log record 10	R	U16	10 th newest alert.
049C-04A1	1180-1185	Alert log record 11	R	U16	11 th newest alert.
04A2-04A7	11861191	Alert log record 12	R	U16	12 th newest alert.
04A8-04AD	1192-1197	Alert log record 13	R	U16	13 th newest alert.
04AE-04B3	1198-1203	Alert log record 14	R	U16	14 th 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.

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.

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.

⁹ 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.

¹ For binary fraction % format commanded rate is a binary fraction between .00000000 (0%=no heat at all) and .1111111 (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%).

For Modbus binary fraction mode the C H Modbus rate (register 581) is a binary fraction between .00000000 (0%=no heat at all) and .1111111 (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.

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).

Table 5. CB Falcon lockout history record

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.

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

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/
	, č	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
120	Low fire switch stuck ON	Hold
. 21		

Table 8. Falcon lockout and hold codes

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 Hold 137 ILK failed to close Hold 138-142 RESERVED Hold 138-142 RESERVED Lockout 143 Internal fault: Flame bias out of range 1 Lockout 144 Internal fault: Flame bias out of range 3 Lockout 145 Internal fault: Flame bias out of range 4 Lockout 146 Internal fault: Flame bias out of range 4 Lockout 147 Internal fault: Flame bias out of range 4 Lockout 148 Internal fault: Flame bias out of range 4 Lockout 150 Flame not detected Hold/ Lockout Lockout 151 High fire switch ON Hold/ Lockout Lockout 152 Combustion pressure OFF Hold/ Lockout Lockout 153 Purge fan switch OFF Hold/ Lockout Lockout 156 </th <th>128</th> <th>Fan speed failed during prepurge</th> <th>Hold/ Lockout</th>	128	Fan speed failed during prepurge	Hold/ Lockout
Lockout131Fan movement detected during standbyHold132Fan speed failed during runHold133-135RESERVED136136Interrupted Airflow Switch failed to closeHold137ILK failed to closeHold138-142RESERVED143144Internal fault: Flame bias out of range 1Lockout145Internal fault: Flame bias out of range 2Lockout146Internal fault: Flame bias out of range 4Lockout147Internal fault: Flame bias out of range 5Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/150Flame not detectedHold/151High fire switch ONHold/152Combustion pressure ONHold/153Combustion pressure OFFHold/154Purge fan switch OFFHold/155Purge fan switch OFFLockout156Combustion pressure and Flame OFFLockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake OFFLockout165Block intake OFFLockout164Block intake OFFLockout165Block intake OFFLockout164Block	129	Fan speed failed during preignition	
132Fan speed failed during runHold133-135RESERVED136136Interrupted Airflow Switch failed to closeHold137ILK failed to closeHold138-142RESERVED143144Internal fault: Flame bias out of range 1Lockout145Internal fault: Flame bias out of range 3Lockout146Internal fault: Flame bias out of range 4Lockout147Internal fault: Flame bias out of range 5Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/ Lockout150Flame not detectedHold/ Lockout151High fire switch ONHold/ Lockout152Combustion pressure ONHold/ Lockout153Combustion pressure OFFHold/ Lockout154Purge fan switch ONHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame ONHold/ Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Block intake OFFLockout164Block intake OFFLockout165Block intake OFFLockout166-171RESERVED172172Main relay feedback incorrectLockout174Safety relay	130	Fan speed failed during ignition	
133-135RESERVED136Interrupted Airflow Switch failed to closeHold137ILK failed to closeHold138-142RESERVEDInternal fault: Flame bias out of range 1Lockout144Internal fault: Flame bias out of range 2Lockout145Internal fault: Flame bias out of range 3Lockout146Internal fault: Flame bias out of range 4Lockout147Internal fault: Flame bias out of range 5Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/150Flame not detectedHold/151High fire switch ONHold/152Combustion pressure ONHold/153Combustion pressure OFFHold/154Purge fan switch ONHold/155Purge fan switch OFFHold/156Combustion pressure and Flame ONHold/157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Block intake OFFLockout164Block intake OFFLockout165Block intake OFFLockout166Trielay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay OpenLockout175 <td>131</td> <td>Fan movement detected during standby</td> <td>Hold</td>	131	Fan movement detected during standby	Hold
136Interrupted Airflow Switch failed to closeHold137ILK failed to closeHold138-142RESERVEDInternal fault: Flame bias out of range 1Lockout144Internal fault: Flame bias out of range 2Lockout145Internal fault: Flame bias out of range 3Lockout146Internal fault: Flame bias out of range 4Lockout147Internal fault: Flame bias out of range 5Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/ Lockout150Flame not detectedHold/ Lockout151High fire switch ONHold/ Lockout152Combustion pressure ONHold/ Lockout153Combustion pressure OFFHold/ Lockout154Purge fan switch OFFHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame OFFLockout157Combustion pressure and Flame OFFLockout158Main valve OFLockout159Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake OFFLockout165Block intake OFFLockout166TRRESERVED172Main relay feedback incorrectLockout173Pilot relay feedback incorrect <t< td=""><td>132</td><td>Fan speed failed during run</td><td>Hold</td></t<>	132	Fan speed failed during run	Hold
137ILK failed to closeHold138-142RESERVED143144Internal fault: Flame bias out of range 1Lockout144Internal fault: Flame bias out of range 2Lockout145Internal fault: Flame bias out of range 4Lockout146Internal fault: Flame bias out of range 5Lockout147Internal fault: Flame bias out of range 6Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/ Lockout150Flame not detectedHold/ Lockout151High fire switch ONHold/ Lockout152Combustion pressure ONHold/ Lockout153Combustion pressure OFFHold/ Lockout154Purge fan switch ONHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame OFFLockout157Combustion pressure and Flame OFFLockout158Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake OFFLockout165Block intake OFFLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay OPLockout176Main relay ON at safe start checkLockout	133-135	RESERVED	
138-142RESERVED143Internal fault: Flame bias out of range 1Lockout144Internal fault: Flame bias out of range 2Lockout145Internal fault: Flame bias out of range 3Lockout146Internal fault: Flame bias out of range 4Lockout147Internal fault: Flame bias out of range 6Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/150Flame not detectedHold/151High fire switch ONHold/152Combustion pressure ONHold/153Combustion pressure OFFHold/154Purge fan switch ONHold/155Purge fan switch OFFHold/156Combustion pressure and Flame ONHold/157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake OFFLockout165Block intake OFFLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout	136	Interrupted Airflow Switch failed to close	Hold
143Internal fault: Flame bias out of range 1Lockout144Internal fault: Flame bias out of range 2Lockout145Internal fault: Flame bias out of range 3Lockout146Internal fault: Flame bias out of range 4Lockout147Internal fault: Flame bias out of range 6Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/150Flame not detectedHold/151High fire switch ONHold/152Combustion pressure ONHold/153Combustion pressure OFFHold/154Purge fan switch ONHold/155Purge fan switch OFFHold/156Combustion pressure and Flame ONHold/157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake OFFLockout165Block intake OFFLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay feedback incorrectLockout174Safety relay ON at safe start checkLockout175Safety relay ON at safe start checkLockout	137	ILK failed to close	Hold
144Internal fault: Flame bias out of range 2Lockout145Internal fault: Flame bias out of range 3Lockout146Internal fault: Flame bias out of range 4Lockout147Internal fault: Flame bias out of range 6Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/150Flame not detectedHold/151High fire switch ONHold/152Combustion pressure ONHold/153Combustion pressure OFFHold/154Purge fan switch ONHold/155Purge fan switch OFFHold/156Combustion pressure and Flame ONHold/157Combustion pressure and Flame ONHold/158Main valve OFFLockout159Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Block intake ONLockout164Block intake OFFLockout165Block intake ONLockout164Block intake OFFLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout	138-142	RESERVED	
145Internal fault: Flame bias out of range 3Lockout146Internal fault: Flame bias out of range 4Lockout147Internal fault: Flame bias out of range 5Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/150Flame not detectedHold/151High fire switch ONHold/152Combustion pressure ONHold/153Combustion pressure OFFHold/154Purge fan switch ONHold/155Purge fan switch OFFHold/156Combustion pressure and Flame ONHold/157Combustion pressure and Flame ONHold/158Main valve ONLockout159Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Block intake ONLockout164Block intake OFFLockout165Block intake ONLockout164Block intake ONLockout165Block intake OFFLockout164Block intake OFFLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout	143	Internal fault: Flame bias out of range 1	Lockout
146Internal fault: Flame bias out of range 4Lockout147Internal fault: Flame bias out of range 5Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/ Lockout150Flame not detectedHold/ Lockout151High fire switch ONHold/ Lockout152Combustion pressure ONHold/ Lockout153Combustion pressure OFFHold/ Lockout154Purge fan switch ONHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame ONHold/ Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	144	Internal fault: Flame bias out of range 2	Lockout
147Internal fault: Flame bias out of range 5Lockout148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/ Lockout150Flame not detectedHold151High fire switch ONHold/ Lockout152Combustion pressure ONHold/ Lockout153Combustion pressure OFFHold/ Lockout154Purge fan switch ONHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame ONHold/ Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition ONLockout161Ignition OFFLockout163Pilot valve OFFLockout164Block intake OFFLockout165Block intake OFFLockout172Main relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay ON at safe start checkLockout176Main relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	145	Internal fault: Flame bias out of range 3	Lockout
148Internal fault: Flame bias out of range 6Lockout149Flame detectedHold/ Lockout150Flame not detectedHold151High fire switch ONHold/ Lockout152Combustion pressure ONHold/ Lockout153Combustion pressure OFFHold/ Lockout154Purge fan switch ONHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame ONHold/ Lockout157Combustion pressure and Flame ONHold/ Lockout158Main valve ONLockout159Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout172Main relay feedback incorrectLockout174Safety relay feedback incorrectLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	146	Internal fault: Flame bias out of range 4	Lockout
149Flame detectedHold/ Lockout150Flame not detectedHold151High fire switch ONHold/ Lockout152Combustion pressure ONHold/ Lockout153Combustion pressure OFFHold/ Lockout154Purge fan switch ONHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame ONHold/ Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout172Main relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	147	Internal fault: Flame bias out of range 5	Lockout
Lockout150Flame not detectedHold151High fire switch ONHold/ Lockout152Combustion pressure ONHold/ Lockout153Combustion pressure OFFHold/ Lockout154Purge fan switch ONHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame ON LockoutHold/ Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition ON LockoutLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake ON LockoutLockout165Block intake OFFLockout172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay openLockout175Safety relay ON at safe start checkLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout	148	Internal fault: Flame bias out of range 6	Lockout
151High fire switch ONHold/ Lockout152Combustion pressure ONHold/ Lockout153Combustion pressure OFFHold/ Lockout154Purge fan switch ONHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame ONHold/ Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition OFFLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay openLockout175Safety relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	149	Flame detected	
Image: Construct of the system of the syst	150	Flame not detected	Hold
Lockout153Combustion pressure OFFHold/ Lockout154Purge fan switch ONHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame ONHold/ Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition ONLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDIntake OFF172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay openLockout175Safety relay openLockout176Main relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	151	High fire switch ON	
Lockout154Purge fan switch ONHold/ Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame ONHold/ Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition ONLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay openLockout175Safety relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	152	Combustion pressure ON	
Lockout155Purge fan switch OFFHold/ Lockout156Combustion pressure and Flame ONHold/ Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition ONLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDI172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay openLockout175Safety relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	153	Combustion pressure OFF	
Lockout156Combustion pressure and Flame ONHold/ Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition ONLockout161Ignition OFFLockout162Pilot valve OFFLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDIntake OFF172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay openLockout175Safety relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	154	Purge fan switch ON	
Lockout157Combustion pressure and Flame OFFLockout158Main valve ONLockout159Main valve OFFLockout160Ignition ONLockout161Ignition OFFLockout162Pilot valve ONLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDIntervention172Main relay feedback incorrectLockout174Safety relay openLockout175Safety relay openLockout176Main relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	155	Purge fan switch OFF	
158Main valve ONLockout159Main valve OFFLockout160Ignition ONLockout161Ignition OFFLockout162Pilot valve ONLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDIntervention172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	156		Lockout
159Main valve OFFLockout160Ignition ONLockout161Ignition OFFLockout162Pilot valve ONLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDIntervention172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	157	Combustion pressure and Flame OFF	
160Ignition ONLockout161Ignition OFFLockout162Pilot valve ONLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDIntervention172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	158		Lockout
161Ignition OFFLockout162Pilot valve ONLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDInterpret Contemporation172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	159		
162Pilot valve ONLockout163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDIntake OFF172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout	160	-	Lockout
163Pilot valve OFFLockout164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDIntake OFF172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout		0	
164Block intake ONLockout165Block intake OFFLockout166-171RESERVEDInternational State172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout			
165Block intake OFFLockout166-171RESERVED			
166-171RESERVED172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout			
172Main relay feedback incorrectLockout173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout			Lockout
173Pilot relay feedback incorrectLockout174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout			
174Safety relay feedback incorrectLockout175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout		-	
175Safety relay openLockout176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout		-	
176Main relay ON at safe start checkLockout177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout			
177Pilot relay ON at safe start checkLockout178Safety relay ON at safe start checkLockout			
178 Safety relay ON at safe start check Lockout		-	
	177	-	Lockout
179-183 RESERVED			Lockout
	179-183	RESERVED	

Table 8. Falcon lockout and hold codes

185Invalid Delta T limit enable setting186Invalid Delta T limit response setting187Invalid DHW high limit enable setting188Invalid DHW high limit response setting189Invalid Flame sensor type setting190Invalid interrupted air switch enable setting	Lockout Lockout Lockout Lockout Lockout Lockout
 187 Invalid DHW high limit enable setting 188 Invalid DHW high limit response setting 189 Invalid Flame sensor type setting 190 Invalid interrupted air switch enable setting 	Lockout Lockout Lockout
 188 Invalid DHW high limit response setting 189 Invalid Flame sensor type setting 190 Invalid interrupted air switch enable setting 	g Lockout Lockout
189Invalid Flame sensor type setting190Invalid interrupted air switch enable setting	Lockout
190 Invalid interrupted air switch enable setting	
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 settin	g 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 settin	g Lockout
224 Invalid DHW demand source setting	Lockout

Table 8. Falcon lockout and hold codes

	Table 8. Faicon lockout and hold cod	es
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 com patible 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	
	1	

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.

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

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

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

	Table TO. Faicon alert codes
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
139	CH ODR not allowed with remote control
140	
	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
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	Faicon 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			
182	Lead Lag P-gain was invalid			
184				
185	Lead Lag I-gain was invalid			
186	Lead Lag D-gain was invalid			
187	Lead Lag OFF hysteresis was invalid			
	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			
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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. Faicon 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		

able 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

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

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		
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	Table 10. Faicon 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
ļ	setting
569	T-rise delay was not configured for recycle response
569 570	

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
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Burner control states are provided in Table 11.

Table 11	Burner	control	states
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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		
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		

Table 12. Pump status codes (application build less than 1600)

	(application build less than 1600)			
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 piority 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 textlength 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.

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 14. Report slave ID response

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			





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