Honeywell

R7910A SOLA HC (Hydronic Control) R7911 SOLA SC (Steam Control)

PRODUCT DATA

R7910A Hydronic Control shown.
For R7911, "Steam Control" would replace "Hydronic Control" on label.

APPLICATION

The R7910A SOLA HC is a hydronic boiler control system and the R7911 SOLA SC is a Steam Control system that provide heat control, flame supervision, circulation pump control, fan control, boiler control sequencing, 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.

SOLA HC/SC System may Consist of:

R7910/R7911 Control Device
S7999B Touchscreen Display—required for setup and ModBus communication but not required for the system to operate once the R7910A/R7911 is programmed.
S7999C Local Operator Interface, which can setup and monitor the R7910/R7911.
S7910A Local Keyboard Display Module
Flame Rod or UV flame detector (C7027, C7035, or C7044)
Temperature Sensor, NTC Type 10KΩ at 77°F (25°C) or 12KΩ at 77°F (25°C)
Limit Sensor, NTC Type 10KΩ at 77°F (25°C)
Fans (VFD)
R7911 uses a Steam Sensor, 0-15 or 0-150 psi - 4-20mA source type

66-1171-03

FEATURES

Safety and Boiler Protection

R7910 Hydronic Control

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

R7911 Steam Control

- **Slow Start, Stack Limit**

Integrated Control Functions

- **Primary Flame Safeguard Control**
- **Internal or external spark generator**
- **Algorithm Prioritization**
- **Firing Rate Limiting**
  - **R7910 Hydronic Control**
    - **Anti-Condensate, Stack Limit, Boiler Delta-T,**
    - **Boiler Slow Start, Outlet Limit**
  - **R7911 Steam Control**
    - **Stack Limit**
- **PID Load Control**
  - **R7910 Hydronic Control**
    - **CH (Central Heat)**
    - **DHW (Domestic Hot Water)**
  - **R7911 Steam Control**
    - **Steam**
- **Remote Reset**
- **TOD (Time of Day)**
- **PWM for Variable Frequency Drives**
- **Auxiliary Output Control**
  - **R7910 Hydronic Control for Pumps**
    - **3 outputs, 5 different programmable features)**
  - **R7911 Steam Control**
    - **3 programmable output features**
- **Burner Demand sources**
  - **R7910 Hydronic Control**
    - **CH, DHW and Frost Protection**
  - **R7911 Steam Control**
    - **Steam sensor**
- **Loops of Control**
  - **R7910 Hydronic Control has two loops of Control**
    - **CH**
    - **DHW**
  - **R7911 Steam Control has One loop of Control**
    - **Steam**
- **High Limit and Control (Meets UL 353)**
    - **R7910 Hydronic Control**
    - **CH, DHW and Stack**
  - **R7911 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**
- **R7910: 24 or 120Vac Digital I/O models available.**
- **R7911: 120Vac Digital I/O**
- **Flame Signal test jacks (Vdc)**
- **Three Status LEDs**
  - **Power**
  - **Flame**
  - **Alarm**
- **Flame Sensing**
  - **Ultraviolet (C7027, C7035, C7044 Sensors)**
  - **Flame Rod**
    - **Single Element (Internal spark generator and flame sense using the same element)**
    - **Dual Element (separate elements for ignition spark and flame sense)**

Inputs

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

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

  - **R7910 Hydronic Control**
    - **Outlet Limit And Temperature**
    - **DHW Limit and Temperature**
    - **Stack Limit and Temperature**
    - **Inlet Temperature**
    - **Outdoor Temperature**
  - **R7911 Steam Control**
    - **Stack Limit and Temperature**
  - **Other Analog Inputs**
    - **PWM Feedback**
    - **Flame Signal from either a Flame Rod or Ultraviolet Detector**
    - **R7910 and R7911: 4-20mA Control Input, Remote Setpoint, Remote Firing Rate**
    - **R7911: 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**
    - **R7910 Hydronic Control for Pumps 3 outputs, 5 different programmable features)**
    - **R7911 Steam Control 3 programmable output features**
  - **Combustion Blower**
  - **External Ignition**
  - **Pilot Valve**
  - **Main Valve**
  - **Alarm**

Models Available:

Table 1. SOLA HC/SC Models Available.

Model	Hydronic/Steam	Digital I/O	Modulation Output	Flame Detection	HFS/LFS Inputs
R7910A1001	Hydronic	24V	PWM 4-20mA 0-10V	FR/UV	
R7910A1019	Hydronic	120V	PWM 4-20mA 0-10V	FR/UV	BOTH
R7910A1027	Hydronic	120V	PWM 4-20mA 0-10V	FR/UV	
R7910A1084*	Hydronic	24V	PWM 4-20mA 0-10V	FR	*
R7911A1000	Steam	120V	PWM 4-20mA 0-10V	FR/UV	
R7911A1026	Steam	120V	PWM 4-20mA 0-10V	FR/UV	BOTH

* Contains built in anticipation for Low Voltage Stat Input

TABLE OF CONTENTS

PREFACE

This Product Data sheet is intended to provide a general overview of the R7910 SOLA HC and R7911 SOLA SC. The chosen set of parameters for a certain boiler type needs to be functionally tested for correct operation.

This document is a textbook version of the parameters. The glossary beginning on page 91 provides an abbreviated parameter explanation along with a reference page for a more in-depth explanation.

The actual setup of the R7910 or R7911 is accomplished using the S7999B System Operator Interface, the DSP3944 Setup Tool, or the S7999C Local Operator Interface. Refer to form 66-1170 for the S7999B or 65-0303 for the S7999C operation and setup screens. This document will assist in understanding the parameters being setup.

Appendix B is a worksheet example of a R7910 device parameters and how they might be setup to provide a system function.

Note that this sheet (like the S7999B System Operator Interface and S7999C Local Operator Interface) shows most available parameters. The actual product may have parameters made invisible or read-only by the OEM, as they apply for their product.

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

FEATURES, continued

Access codes through the display 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. These would include but not limited to:
  - Read the error log from R7910A/R7911.
  - Monitor the input and output variables of the controller.
  - Read parameters from R7910A/R7911.
  - CH and DHW setpoint adjustment.

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 R7910A/R7911 will start up in either the configured or unconfigured condition. In the Configured condition it is ready to operate a burner.

The R7910A/R7911 is in the unconfigured condition whenever a safety parameter requires editing (Commissioning). The R7910A/R7911 remains unconfigured and will not operate a burner until all safety parameters have been reviewed and confirmed.

Safety Lockout

The R7910A/R7911 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 R7910A/R7911 to reinitialize and restart.

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

Fault Handling

The R7910A/R7911 implements two kinds of faults: lockouts and alerts.

Lockout messages are stored in the R7910/R7911 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 R7910A/R7911 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 R7910A/R7911 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 R7910/R7911 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. See Product Data Sheet 65-0310 for software interface specifications (ModBus).

⚠ WARNING

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

The S7999B1026 System Operator Interface or S7999C Local Operator Interface used to change Safety Configuration Parameters is to be done **only by experienced and/or licensed burner/boiler operators and mechanics**.

Response to Writing:

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

Required Components (not supplied)

Dual Element Sensor contains Sensor plus Limit (10kohm, Beta = 3950). Note: 12kohm sensors with Beta of 3750 may be used as sensors, but not as safety limits.

- 50001464-006 6” with Molex splice connector
- 50001464-007 42” without connector

Single Element Sensor only (10 kohm, Beta = 3950)

- 198799Z 42" leads without connector
- 32003971-002 6" leads with Molex Splice Connector
- 32003971-003 CONTAINS:
  (1) 198799Z sensor with 42" leads
  (2) 118826 ANCHORS;
  (3) 199624AB MTG. SCREWS;
  (2) 121958 WIRE NUTS;
  (1) 32002217-002 SENSOR CLIP;
  (2) 291125 TIE STRAP
- UV Flame Sensor - C7027, C7035, or C7044
- Flame Rods - C7007, 8, 9
- Pilot Burner Assemblies - Q179A, C, C7005
- External Ignition Transformer - Q624A1014, Q652B1006
- Gas Valves - Solenoid V8295 (24Vac),
  V4295/7 (120Vac)
  Fluid Power V4055 (120 Vac) with V5055 or V5097
  V4730/V4734/V8730 Premix valves with Venturi
- Modulation Motor - M7294 (4-20 ma or 0-10Vdc)

- Transformer (for powering R7910/R7911 40va minimum) - AT72D (40VA) AT88 (75VA)
- R7911 - Pressure Sensor (15 or 150) 4-20mA source type
- 50032893 - 001 Bag of connectors

Required but purchased outside Honeywell:

- Circulating Pumps 24 or 120 Vac
- Blower Motor, on/off or VFD

Connectors for field wiring: May be obtained separately outside Honeywell. See list below.

ICP Device		Mates with …					
Plug #	**Description**	**Manf.**	**Part Number**				
J1	Flame Detection Interface	Molex	0050841060 (Shell), 0002081002 (Pin, 14-20 AWG)				
J2	PWM Combustion Blower Interface	Molex	0039012040 (Shell), 0039000059 (Pin, 18-24 AWG)				
J3	Comm. Interface	OST	EDZ1100/9 (SCREW)				
J4	Line Voltage I/O	Lumberg	3623 06 K129	(IDC, Pins 1 - 6)	3615-1 06 K129	(SCREW, Pins 1 - 6)	
			3623 06 K130	(IDC, Pins 7 - 12)	3615-1 06 K130	(SCREW, Pins 7 - 12)	
J5	Line Voltage I/O	Lumberg	3623 07 K01	(IDC)	3615-1 07 K01	(SCREW)	
J6	Line Voltage I/O	Lumberg	3623 08 K43	(IDC)	3615-1 04 K185	(SCREW, Pins 1- 4)	
					3615-1 04 K188	(SCREW, Pins 5- 8)	
J7	Line Voltage I/O	Lumberg	3623 07 K48	(IDC)	3615-1 07 K48	(SCREW)	
J8	Low Voltage I/O	Lumberg	3623 06 K127	(IDC, Pins 1 - 6)	3615-1 06 K127	(SCREW, Pins 1 - 6)	
			3623 06 K128	(IDC, Pins 7 - 12)	3615-1 06 K128	(SCREW, Pins 7 - 12)	
J9	Low Voltage I/O	Lumberg	3623 07 K59	(IDC)	3615-1 07 K59	(SCREW)	
J10	High Voltage I/O	Lumberg	3623 08 K64	(IDC)	3615-1 04 K187	(SCREW, Pins 1- 4)	
					3615-1 04 K186	(SCREW, Pins 5- 8)	
J11	High Voltage I/O	Lumberg	3623 07 K30	(IDC)	3615-1 07 K30	(SCREW)	

Accessories:

- S7910A Local Keyboard Display Module
- S7999B System Operator Interface
- DSP3944 System Display for system Setup when S7999B or S7999C not required.
- PM7910 Program Module - Storage module for the R7910 non-safety setup parameters, may be written to for storage or used for configuration of replacement controls or multiple systems, Commands given from any display interface through the R7910.
- S7999C1008 Local Operator Interface
- 50031353-001 Software Configuration Tool

OVERVIEW

Functions provided by the R7910A/R7911 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 R7910 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 (R7910 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

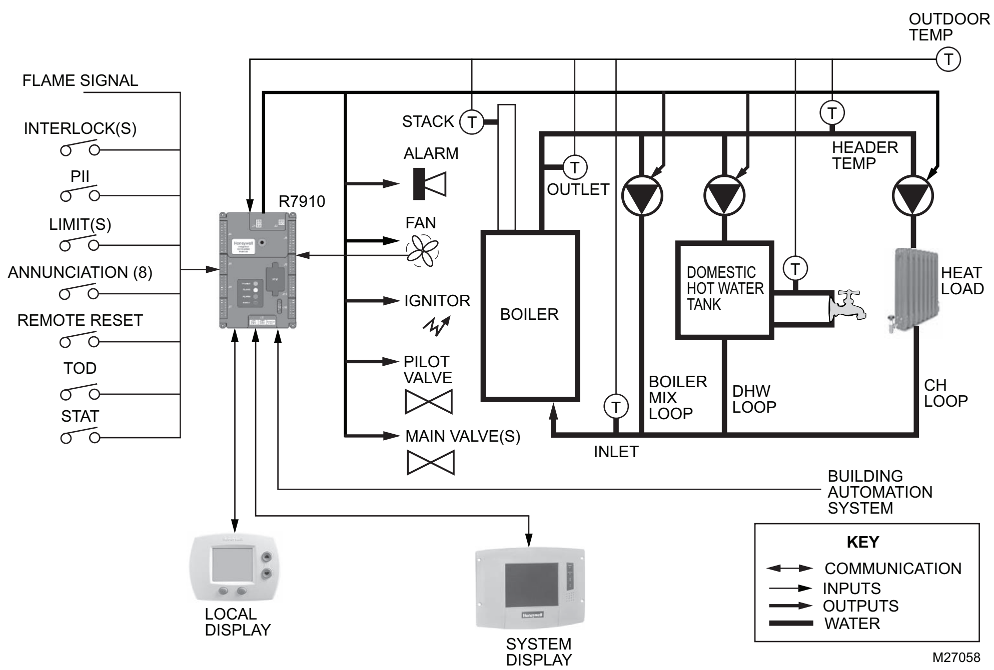


Fig. 1. General R7910 hydronic boiler schematic.

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 R7910A. 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

Three modes of communications are available to the R7910.

- ECOM is used for the S7910 Local Keyboard display for R7910/R7911 monitoring and changing setpoints. Some equipment setup and checkout is available using the S7910 along with remote reset of a lockout on the R7910/R7911.
- The R7910/R7911 has two RS485 communication ports for ModBus that allows for interfacing to one or all R7910/ R7911s of a system and presents them individually to the user. The S7999B System Operator interface and S7999C Local Operator interface are color touchscreen displays used for configuration and monitoring of the R7910A/ R7911. Control Operation and display status in both test and graphical modes can be shown along with the ability to setup. The R7910/R7911 can also be remotely reset through the S7999B/C display.

- Either ModBus RS485 communication port can be used to allow configuration and status data to be read and written to the R7910/R7911. Support a Master S7999B or a Building Automation master to control the R7910 or R7911 to respond to a single ModBus address to service the requests of the ModBus master in a Lead/Lag arrangement.

The local S7910 Keyboard display, the S7999B System Operator interface, and the S7999C Local Operator Interface are optional components.

The S7999B (or the DSP3944 which is a portable S7999B) or the S7999C is required configuration of the parameters of the R7910/R7911 but is not needed for the operation of the system once configured.

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:
R7910A/R7911 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. (UL)(cUL): Component Recognized: File No. MP268 (MCCZ)
R7910 and R7911 are certified as UL372 Primary Safety Controls.
The R7910 is certified as UL353 Limit Rated device when using part number 50001464 dual element limit rated NTC sensors.
CSD-1 Acceptable.
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.

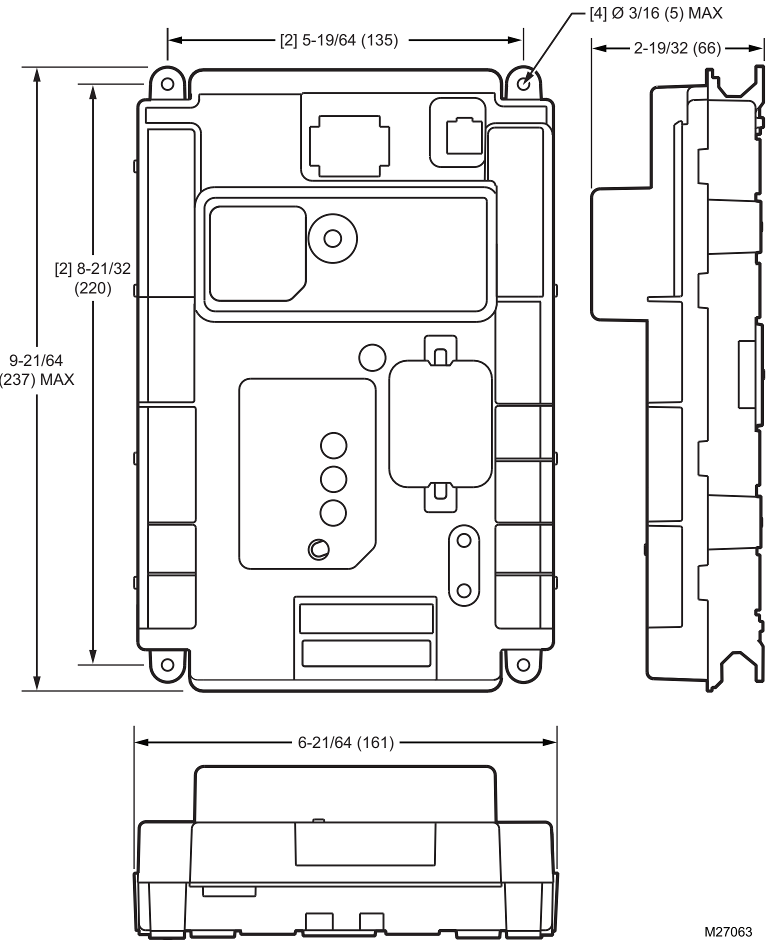


Fig. 2. R7910A/R7911 dimensions in in. (mm).

Table 2. NTC Sensors (temperature versus resistance).

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

* All sensors attached to the R7910 MUST be all 12K or 10K sensors (don't mix and match).

INSTALLATION

⚠ WARNING

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

⚠ WARNING

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

When Installing This Product…

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

Vibration

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

Weather

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

Mounting The R7910/R7911

1. Select a location on a wall, burner or electrical panel. The R7910/R7911 can be mounted directly in the control cabinet. Be sure to allow adequate clearance for servicing.
2. Use the R7910/R7911 as a template to mark the four screw locations. Drill the pilot holes.
3. Securely mount the R7910/R7911 using four no. 6 screws.

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

WIRING

⚠ WARNING

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

Ground Connection

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

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

Electrical Connections

1. Refer to Table 5 for terminal contact ratings.
2. Use 18 AWG or larger wires.
3. Wire according to specifications, following all local ordinances and requirements.

Device Power Supply, 24Vac

1. 24Vac Supply to connector J8 terminal 1.
2. 24Vac Return to connector J8 terminal 2.
3. Ground to central ground terminal, not to Ground on J4 terminal 12.

Limit String and Annunciator inputs and Safety Load Outputs

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

Dry Contacts available for:

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

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

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

High Voltage Cable

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

- Be sure that there is a good electrical return path between the R7910A/R7911 and sparking electrode (ground connection).
- A short ignition wire normally leads to lower levels of radiated electromagnetic fields.
- Use a Spark cable (32004766 or R1298020) or equivalent.
- Heat-resistant up to 248°F (120°C).
- Isolation voltage up to 25 kV DC.

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

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

Communications: Connector J3

1. Connect the S7910A Keyboard Display only to the ECOM port, connectors J3 terminal 1, J3 terminal 2, J3 terminal 3. **Do not connect the S7999 display to these connectors.**
2. Connect the S7999B/C 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

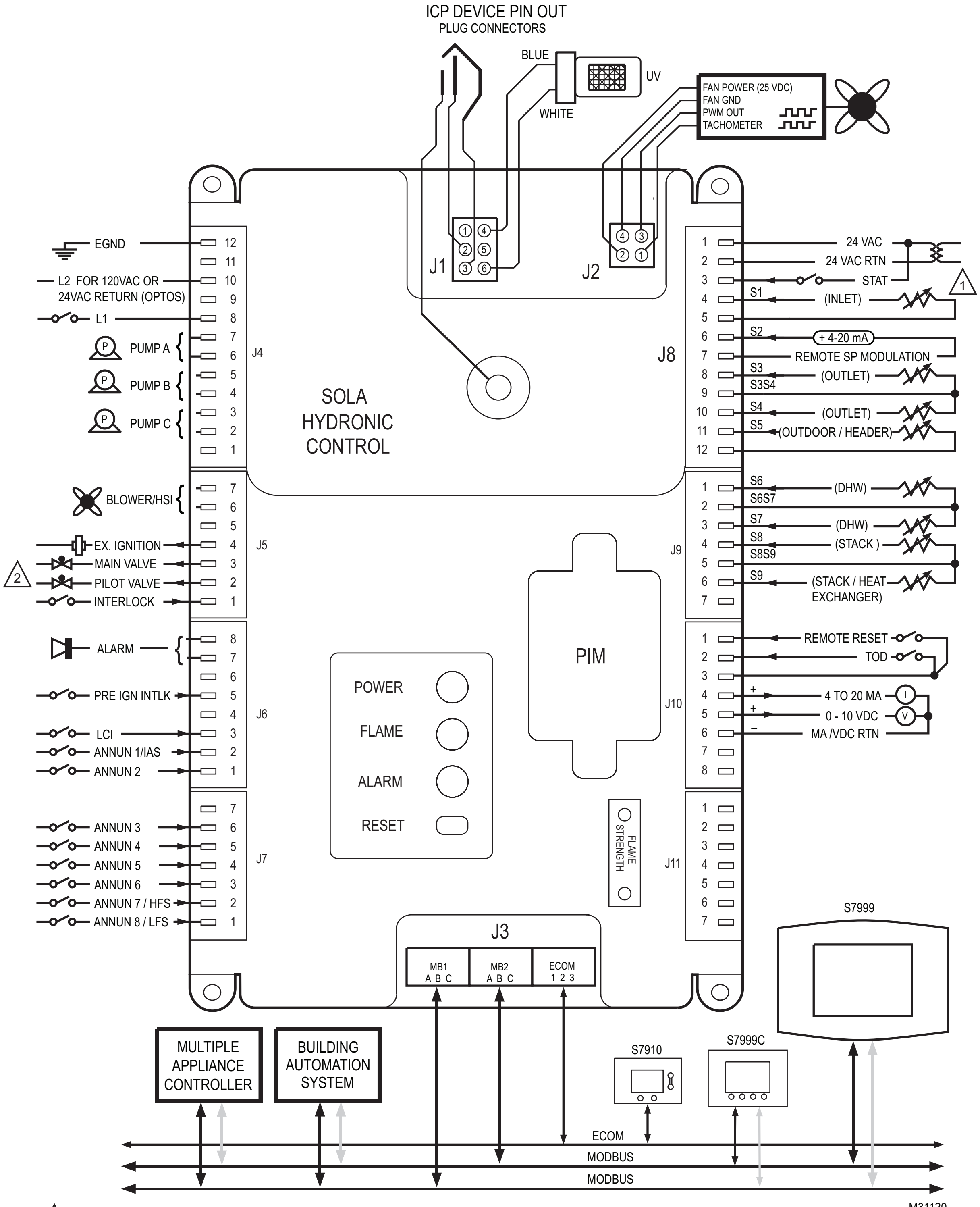
1. Check the power supply circuit. The voltage and frequency tolerance must match those of the R7910A/R7911. A separate power supply circuit may be required for the R7910A/R7911. Add the required disconnect means and overload protection.
2. Check all wiring circuits.
3. Install all electrical connectors.
4. Restore power to the panel.

The R7910A/R7911 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 5 on page 16.

Table 3. Wire Sizes.

Application	Recommended Wire Size	Recommended Part Number(s)	Maximum Leadwire Distance (in feet)
Line Voltage Terminals	14, 16, 18 AWG Copper conductor, 600 volt insulations, moisture-resistance wire	TTW60C, THW75C, THHN90C	300
Remote Reset/ TOD	18 AWG two-wire twisted pair, insulated for low voltage	Beldon 8443 or equivalent	1000
Temperature (operating) Sensors	18 AWG two-wire twisted pair, insulated for low voltage	Beldon 8443 or equivalent	50
Temperature (Limit) Sensors	18 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	14 AWG copper wire	TTW60C, THW75C, THHN90C	



1 R7910A1084 HAS AN INTERNAL LOAD RESISTOR FOR A THERMOSTAT INPUT.

2 FOR DIRECT BURNER IGNITION (DBI) THE MAIN VALVE IS WIRED TO J5 TERMINAL 2

Fig. 3. R7910A device pin out.

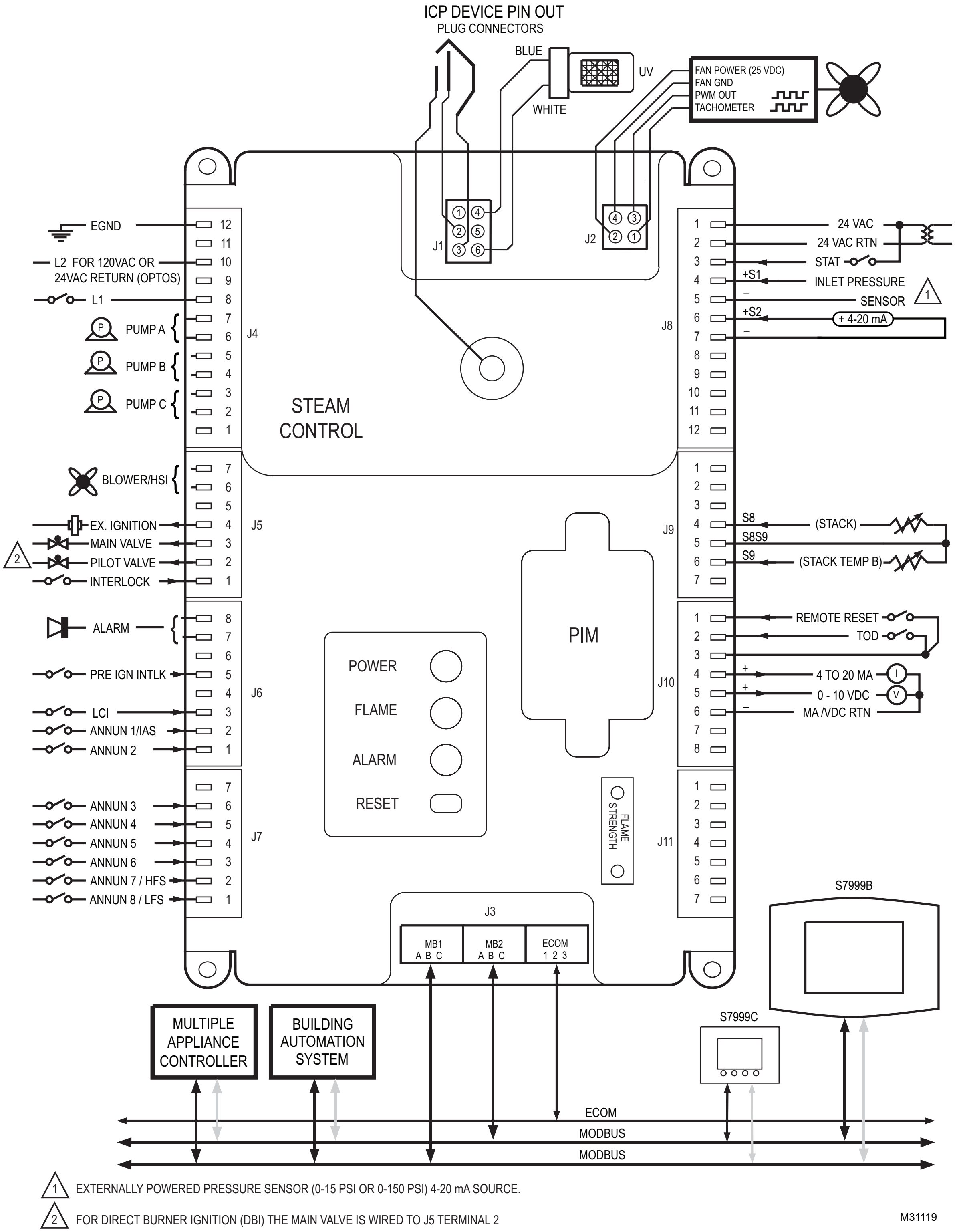


Fig. 4. R7911 device pin out.

Table 4. Recommended Grounding Practices.

Ground Type	Recommended Practice
Earth ground	**1.** Earth ground must be capable of conducting enough current to blow the 20A fuse (or breaker) in the event of an internal short circuit. **2.** Use wide straps or brackets to provide minimum length, maximum surface area ground conductors. If a leadwire must be used, use 14 AWG copper wire. **3.** Make sure that mechanically tightened joints along the ground path are free of nonconductive coatings and protected against corrosion on mating surfaces.
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 5. R7910A/R7911 Contact.

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

Table 5. R7910A/R7911 Contact. (Continued)

Connector	Term.	Function	Description and Rating (All Models)
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
J6	1	Annunc2	24VAC, 120 VAC: 2 mA maximum
J7	7	Not Used	
J7	6	Annunc3	24VAC, 120 VAC: 2 mA maximum
J7	5	Annunc4	24VAC, 120 VAC: 2 mA maximum
J7	4	Annunc5	24VAC, 120 VAC: 2 mA maximum
J7	3	Annunc6	24VAC, 120 VAC: 2 mA maximum
J7	2	Annunc7/HFS	24VAC, 120 VAC: 2 mA maximum
J7	1	Annunc8/ LFS	24VAC, 120 VAC: 2 mA maximum
J8	1	24 VAC	Device Power, 24 VAC, (20 VAC to 30 VAC)
J8	2	24 VAC	24VAC Return
J8	3	STAT	24 VAC, (20 VAC to 30 VAC)
J8	4	INLET TEMP (S1) (R7910)	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor.
J8	5	INLET TEMP Common (R7910)	Ground reference for the Inlet Temp. Sensor
J8	4	+ INPUT (R7911)	+ Supply from 4-20 mA Steam Pressure Sensor
J8	5	- INPUT (R7911)	- Supply from 4-20 mA Steam Pressure Sensor
J8	6	+ INPUT Remote SP/Mod (S2)	+ Supply from 4-20mA
J8	7	- INPUT	- Supply from 4-20mA
J8	8	OUTLET TEMP A (S3) *a,b	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J8	9	OUTLET TEMP Common (S3S4) *a,b	Ground reference for the Outlet Temp. Sensor
J8	10	OUTLET TEMP B (S4) *a	Supply for, and signal input from 10K Ohm NTC temperature sensor
J8	11	OUTDOOR/HEADER TEMP (S5) *a	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J8	12	OUTDOOR TEMP Common *a	Ground reference for the Outdoor Temp. Sensor
J9	1	DHW TEMP A (S6) *a,b	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J9	2	DHW Common (S6S7) *a,b	Ground reference for the DHW Temp. Sensor
J9	3	DHW TEMP B (S7) *a	Supply for, and signal input from 10K Ohm NTC temperature sensor
J9	4	STACK TEMP A (S8) *b	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J9	5	STACK Common (S8S9) *b	Ground reference for the Stack Temp. Sensor
J9	6	STACK TEMP/Heat Exchanger Limit (S9)	Supply for, and signal input from 10K Ohm NTC temperature sensor
J9	7	Not Used	
J10	1	REMOTE RESET	Open/Ground Input that has functionality corresponding to pushing/releasing the local reset.
J10	2	TOD (Time of Day)	Open/Ground Input which switches operating set points.

Table 5. R7910A/R7911 Contact. (Continued)

Connector	Term.	Function	Description and Rating (All Models)
J10	3	TOD/REMOTE RESET COMMON	Ground reference for time of day and remote reset inputs
J10	4	MODULATION 4 - 20mA (+) (Out)	4 to 20 mA Current modulation signal out into a 600 Ohm
J10	5	MODULATION 0 - 10 VDC (+) (Out)	0 to 10 VDC Voltage modulation signal out, 10 mA max.
J10	6	MODULATION COMMON (-)	Ground reference for voltage and current modulation signals.
J10	7	Not Used	
J10	8	Not Used	
J11	1–7	Not Used	
SPECIAL CONNECTIONS			
E1	Spark	8kV minimum open circuit voltage; 2.8mJ at the igniter	
	Plug In Module (PM7910)		
1	VCC		
2	CSO		
3	CS1		
4	SDA		
5	SCL		
6	GND		
Flame +	FS +	Testpoint for Flame signal. 0 to 10 VDC	
Flame -	FS -	Testpoint for Flame signal - Ground reference.	

[a]. Not used by R7911SC [b]. For single sensor 10K or 12K connect to TEMP A Terminals.

Table 6. 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 R7910A/R7911 is shipped in the unconfigured condition, so when power is applied, all safety loads are off and the burner status when viewed from the S7999 Display is shown as “Safety data setup needed.”

Once the Safety Data is configured, the R7910A/R7911 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 R7910A/R7911 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 R7910/R7911 is shipped, but may be changed later using the SOLA Configuration program or the S7999 system display or using the electronic configuration tool.

Parameter Control Blocks (PCB)

The R7910/R7911 Parameters are managed using control blocks. There are three parameter control blocks (PCB) that may be installed into the memory of the R7910A/R7911:

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

A parameter control block can be downloaded using a file-transfer method that operates within the Modbus protocol. The R7910A/R7911 Modbus (see form 65-0310) 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 (part number 50031353-001) 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 R7910 or R7911 through the ModBus port. An example is shown in Table 50, beginning on page 102.

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 7. (All parameters are readable via Modbus, however a Modbus error response message is sent if an attempt is made to write one that is marked read-only, or that requires a password and the appropriate password level is not in-effect.)

Table 7. Interaction of OEM Parameter Settings.

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

OEM ALERT PCB

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

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

OEM RANGE PCB

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

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

⚠ WARNING

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

The S7999B1026 System Operator Interface or S7999C 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 R7910A/R7911 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 R7910/R7911 will transition to the configured condition.

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

1. The user edits safety data in the enabled section. At any time, if “exit” is chosen, the session is ended and the R7910A/R7911 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 R7910A/R7911 to calculate the modified section of safety data. However it is not yet accepted and written into memory, nor does the R7910A/R7911 leave the unconfigured state; instead it continues with the confirmation process in the next step.
3. The R7910A/R7911 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 R7910A/R7911.
4. After all items are confirmed, the R7910A/R7911 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 R7910A/R7911 is in the configured condition, unless some other parameter section also needs setup. If some other section needs setup, the R7910A/R7911 is again at step 1.

Functional Sub Systems

There are nine functional sub systems to the R7910A/R7911. They are:

1. System Operational Settings (page 20)
2. General Configuration Settings (page 21)
3. Demand and Rate (page 23)
4. Rate Limits and Override (page 44)
5. Burner Control (page 65)
6. Modulation Output (page 51)
7. Pump Control (page 54)
8. Lead Lag (page 73)
9. Annunciation (page 62)

SYSTEM OPERATIONAL SETTINGS

System settings are those that enable or disable the R7910A/R7911 functions in general or that alter the behavior or availability of multiple configurable items. See Table 8.

Table 8. System Operation Settings.

Parameter	Comment
CH enable	Enable, Disable (R9710 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 (R7911 only) This parameter determines whether the Steam input is enabled.
DHW enable	Enable, Disable (R7910 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 8. System Operation Settings. (Continued)

Parameter	Comment
Warm Weather Shutdown Setpoint	Temperature, None
Lead Lag slave enable	Enable, Disable (R7910 only)
Lead Lag Master enable	Enable, Disable (R7910 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 R7910/ R7911 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 R7910 are active. When disabled, the R7910 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 R7910 Hydronic Control 10K NTC single non-safety 12K NTC single non-safety UNCONFIGURED For R7911 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 R7910 Hydronic Control and R7911 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 R7910 Hydronic Control and R7911 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 R7910 Hydronic Control and R7911 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 R7910 Hydronic Control 10K NTC single non-safety 12K NTC single non-safety For R7911 Steam Control - there is not an Outdoor Sensor Feature. Designates the type of analog sensor type is on connector J8 terminals 11 and 12.
DHW Priority Time ODR Enable	Disable, Enable When enabled, the DHW priority override time parameter will be derated when the outdoor temperature is below 32°F. When the outdoor temperature is 32°F and above, the programmed time will be used as-is. When the outdoor temperature is -40°F and below, the programmed override time will be derated to zero (no override). Between 32°F and -40°F, a linear interpolation will be used. For example, at the midway point of -4°F, the DHW priority override time is one half of the value provided by the parameter.

GENERAL CONFIGURATION SETTINGS

Those that alter the behavior or availability of configurable items that are not in any other category. Those that are not defined in other sections are listed in Table 9:

Table 9. General Configuration Settings.

Parameter	Comment
Temperature Units	F, C This parameter determines whether the temperature is represented in units of Fahrenheit or Celsius degrees.
Anti short cycle time	mm:ss Whenever the burner is turned off due to no demand, the anti short cycle timer is started and the burner remains in a Standby Delay condition waiting for this time to expire. The anti short cycle time does not apply, however, to recycle events such as loss of airflow or flame, it applies only to loss of demand. The anti short cycle time always inhibits a CH or LL demand. However, if a DHW demand occurs then its priority is checked. If it has the highest priority because of either: • a non-zero value in the DHW priority timer (which is loaded using the DHW priority time parameter) • due to the setting in both: DHW priority vs LL (if Lead Lag Master enable is enabled) AND DHW priority vs CH (if CH enable is enabled) • then the anti short cycle delay is ignored and the DHW demand is served.
Burner name	text The Burner Name is a text parameter stored in the R7910A/R7911 to identify the burner.
OEM ID	text The OEM ID is a text parameter stored in the R7910/R7911 intended for use by an OEM to record identification information related to the OEM's configuration and setup of the R7910/R7911.
Installation Data	text The Installation Data is a text parameter stored in the R7910/R7911. It is intended for use by the installer to record identification information about how the R7910/R7911 was setup at the installation time.

Demand and Rate

The Demand and Rate subsystem produces 3 outputs:

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

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

- Central Heating (CH) for R7910 or Steam for R7911
- Domestic Hot Water (DHW) R7910 only
- Lead Lag (LL)

These are all similar in that:

- Their inputs are a temperature sensor (pressure for R7911) 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 R7910 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 R7910A 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 R7910A 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 R7910A parameters, and the behavior of the R7910A 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:

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

Demand/Rate Selection and Limiting (example using R7910 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 65.
- Manual Rate control is in “Modulation Output” on page 51.
- Frost Protection is in “Frost Protection (Hydronic only)” on page 41.
- Various Rate Limiting inputs are in “Rate Limits and Override” on page 44.

The Demand/Rate Selection subsystem is connected internally in the R7910A as shown in Fig. 5:

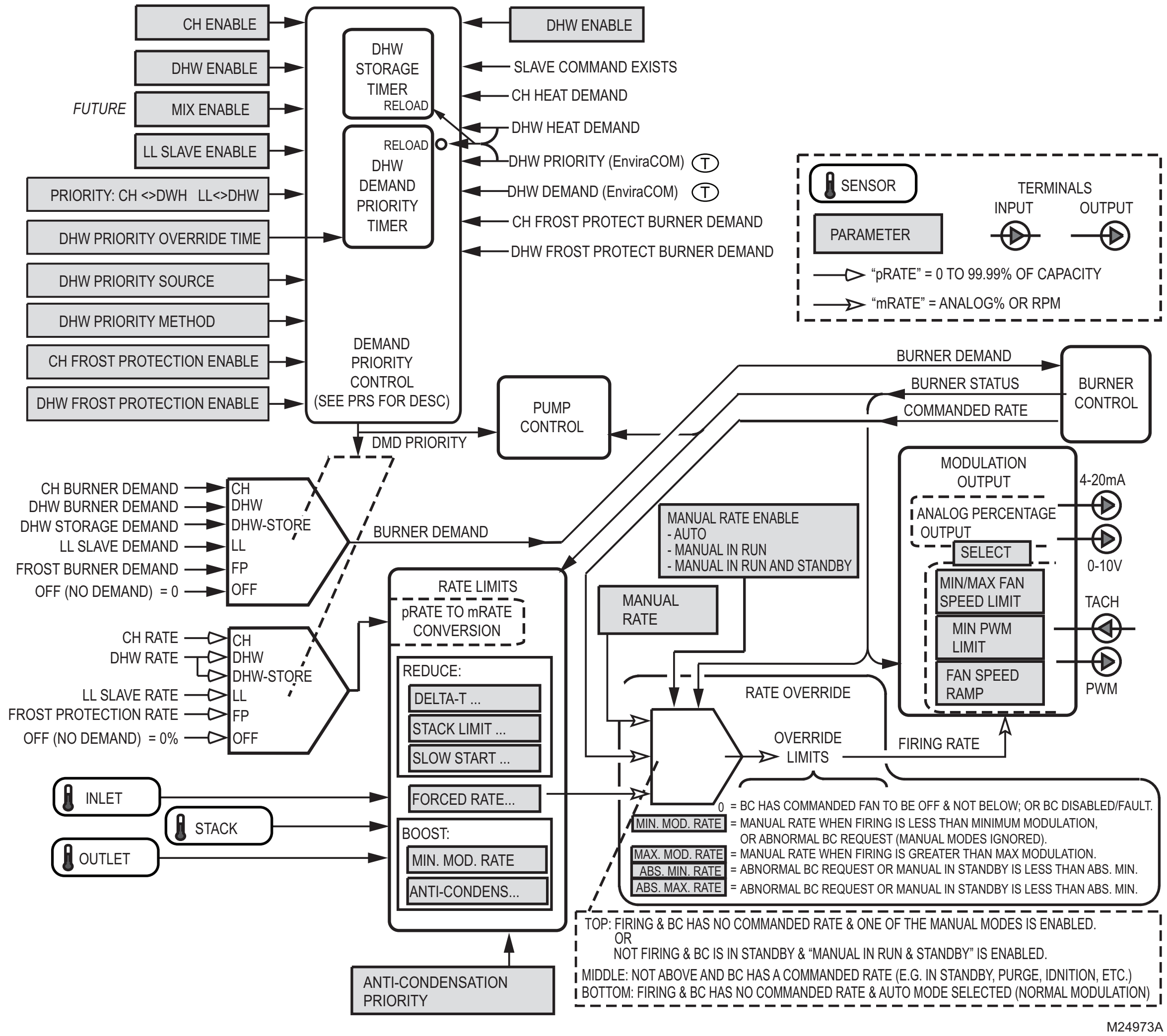


Fig. 5. Demand and rate selection diagram.

The demand priority control block shown in Fig. 5 determines which source of demand has control of the R7910A burner, according to parameters and the logic described below.

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

```
Writable Parameters are enclosed in a box

IF "DHW pump demand" is true
    Set DHW_storage_timer to [DHW storage time]
ELSE
    Decrement DHW_storage_timer (count down to zero, then stop)

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

M24971A

Fig. 6. DHW priority timer logic.

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

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

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

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

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

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


IF priority is Off
    IF DHW Storage Enable is true and DHW_storage_timer
    is greater than zero
        priority = DHW
IF priority is Off
    IF (  CH Frost Protection Enable   is true AND
         "CH Frost Protect Burner Demand" is true        )
        priority = FP
    IF (  DHW Frost Protection Enable is true AND
         "DHW Frost Protect Burner Demand" is true       )
        priority = FP
DETERMINE IF DHW DEMAND SHOULD IGNORE AN ANTI SHORT CYCLE (ASC) DELAY...
IF priority is DHW
    IF (  DHW_priority_timer is non-zero
          OR
          [ ( CH Enable is false OR DHW priority > CH priority )
                                         AND
            ( LL Enable is false OR DHW priority > LL priority )
          ] )
        ignoreASC = true
                                                                    M24972A
```

Fig. 7. Burner demand priority control.

CH Hydronic Loop Demand and Rate

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

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

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

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

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

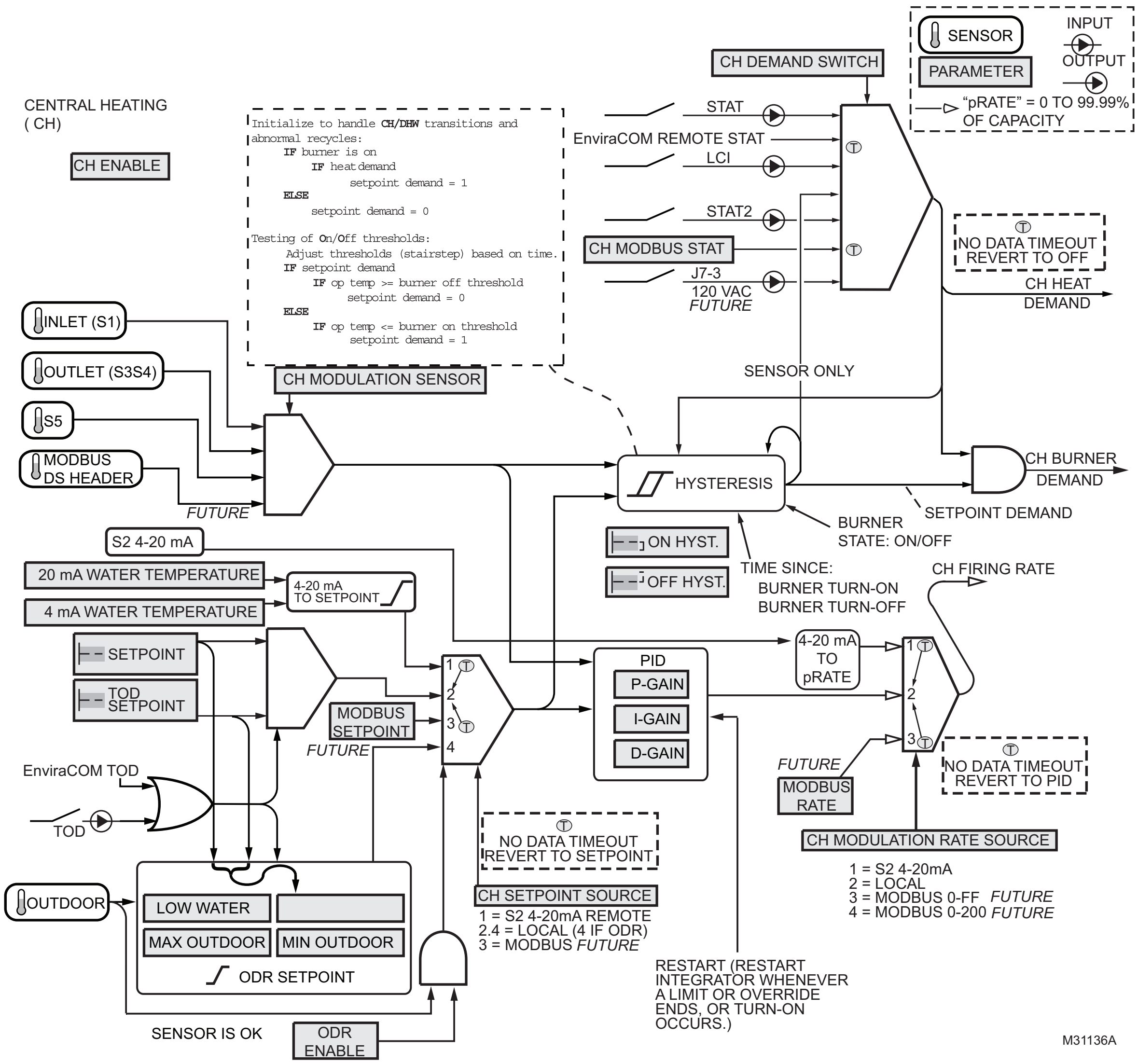


Fig. 8. Central heating hydronic diagram.

The function of each parameter and feature is given below.

Table 10. Central Heating Hydronic Parameters.

Parameter	Comment
CH demand switch	STAT, LCI, Sensor Only, EnviraCOM Remote STAT J7-3 120 Vac The CH demand switch may be selected from four options. In all cases, for burner demand to exist, the sensor must be generating a demand as determined by values. • When "Sensor Only" is chosen, no other input is considered and pump demand is derived from burner demand. • When "STAT" is chosen, the STAT input (J8 Terminal 3) in the On condition creates pump demand and it also must be on for burner demand to exist; if it is off there is no demand. • When "LCI" is chosen, the LCI input (J6 Terminal 3) in the On condition creates pump demand and it also must be on for burner demand to exist; if it is off there is no demand.
CH sensor	Outlet, Inlet The sensor used for modulation and demand may be the Outlet sensor, the 4-20 mA Header or inlet sensor.

Table 10. Central Heating Hydronic Parameters. (Continued)

Parameter	Comment
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 27.
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 27.
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 32)
CH hysteresis step time	seconds Time of each step. A step time of zero - disables this feature. (see the Setpoint and Hysteresis section, page 32)
CH P-gain CH I-gain CH D-gain	0-400 These parameters are the gains applied to the proportional, integral, and differential terms of the PID equation for the CH loop.
CH setpoint source	Local, S2 4-20mA If the setpoint source is Local, then the control’s local setpoint system is used. This setting enables the normal use of the CH setpoint, CH TOD setpoint, and the CH outdoor reset parameters and functions. If the setpoint source is S2 4-20mA, then the setpoint is determined by the 4-20mA setpoint routine. If this sensor is invalid then the control behaves as if Local were selected.
Modulation rate source	Local, S2 4-20mA • If the modulation rate source is Local, then the control’s PID algorithm determines the modulation rate. If the modulation rate source is S2 4-20mA, then the modulation rate is determined by the S2 4-20mA modulation routine that exists in prior controls. If this sensor is invalid then the control behaves as if Local were selected.
CH ODR low water temperature CH ODR maximum outdoor temperature	Degrees or None These two parameters determine the lower-right point on the graph.

Outdoor Reset and Boost

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

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

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

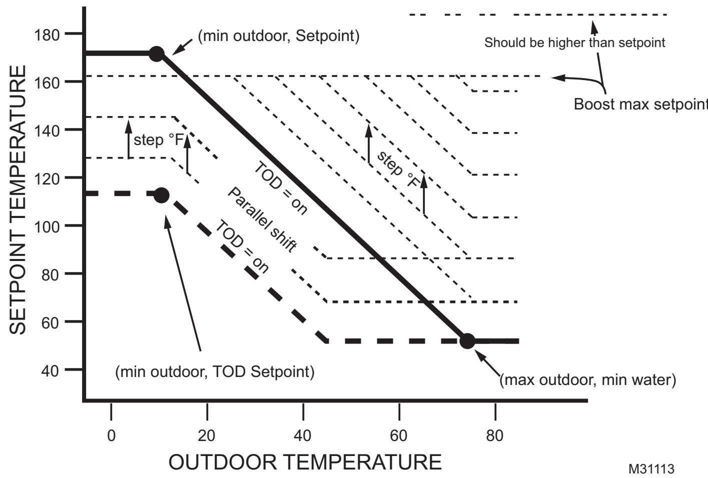


Fig. 9. Outdoor reset with TOD and boost.

Table 11. Outdoor Reset and Boost Parameters.

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

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

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

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

If the TOD switch changes state after at least one boost event has occurred, the new effective setpoint is the higher of:
- the old boosted setpoint and
- the new unboosted setpoint.

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

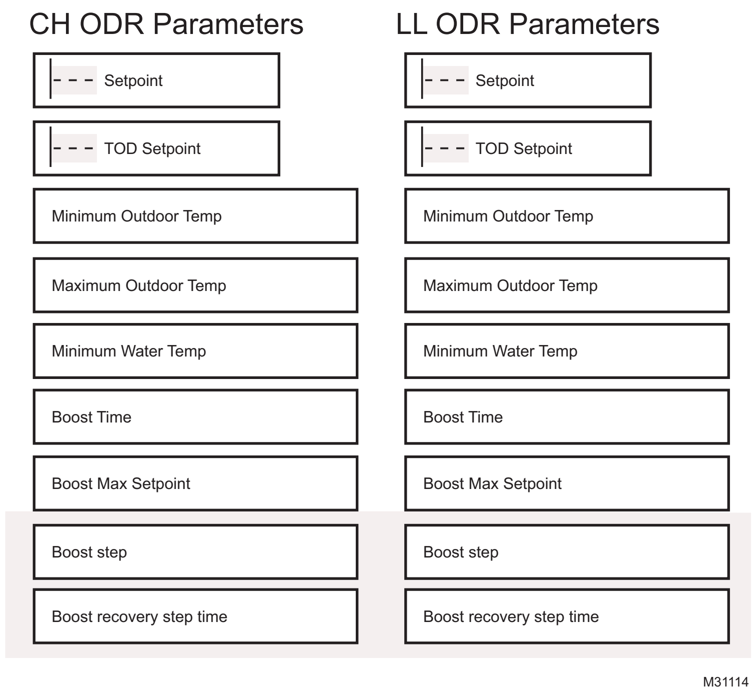


Fig. 10. Outdoor reset parameters.

Steam Loop Demand and Rate

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

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

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

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

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

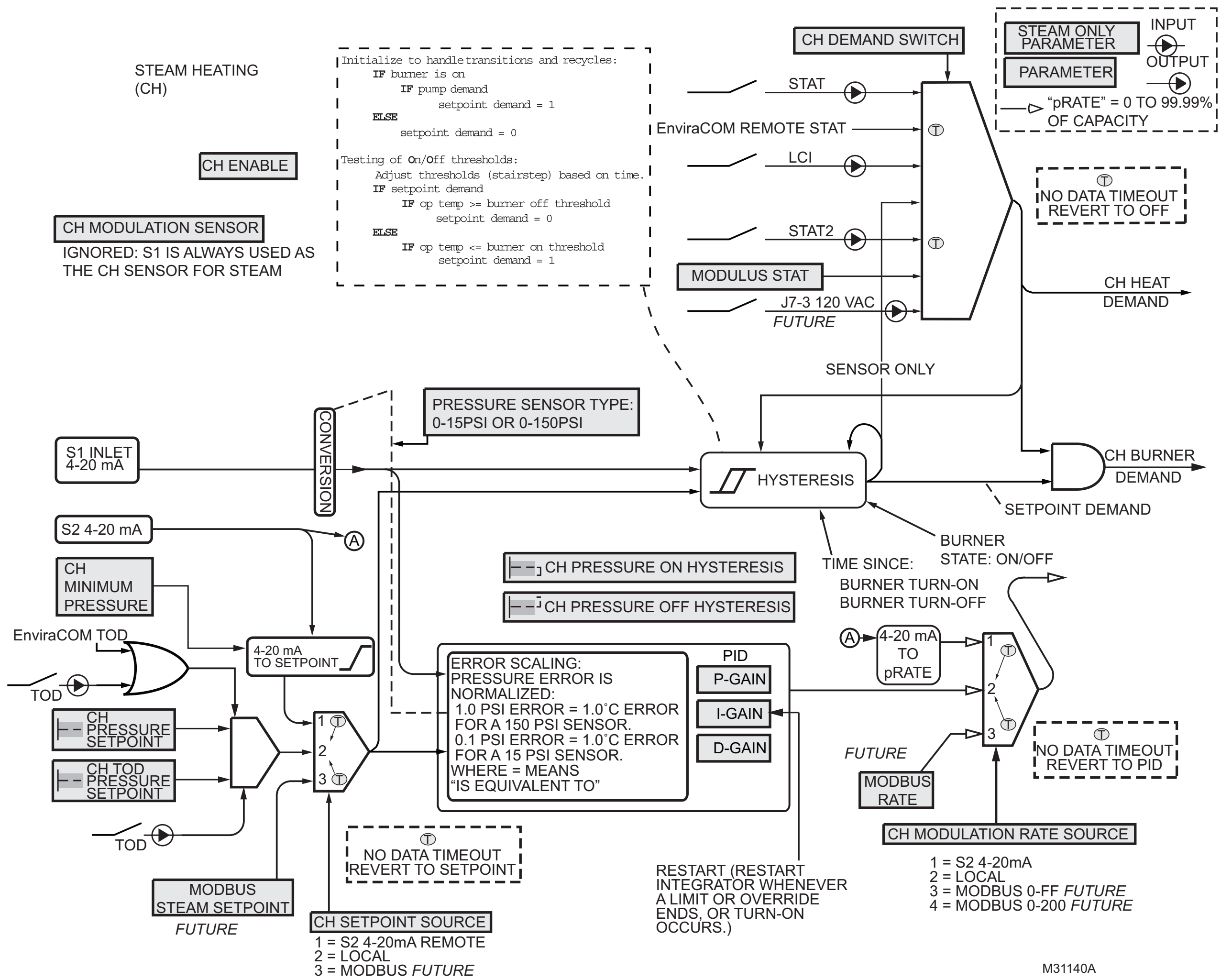


Fig. 11. Central heating steam diagram.

The function of each parameter and feature is given below.

.

Table 12. Central Heating Steam Parameters.

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

Table 12. Central Heating Steam Parameters. (Continued)

Parameter	Comment
Steam pressure setpoint	PSI or None This setpoint is used when the time-of-day input is off.
Steam time-of-day pressure setpoint	PSI or None This setpoint is used when the time-of-day input (J10 terminal 2) is on.
Steam Pressure off hysteresis Steam Pressure on hysteresis	PSI or None The off hysteresis is added to the setpoint pressure to determine the pressure at which the demand turns off. Similarly, the on hysteresis is subtracted from the setpoint to determine the pressure at which demand turns on. These may be set to None to indicate that no hysteresis has been defined. The On and Off hysteresis are adjusted at the time the burner changes from off to on, and from on to off, as shown in Fig. 12. This gives the PID algorithm some room to be more aggressive in tracking the load, which can result in overshoot (or undershoot). (see the Setpoint and Hysteresis section, page 32)
Steam hysteresis step time	seconds Time of each step. A step time of zero - disables this feature. (see the Setpoint and Hysteresis section, page 32)
Steam P-gain Steam I-gain Steam D-gain	0-100 These parameters are the gains applied to the proportional, integral, and differential terms of the PID equation for the Steam loop.
Steam 4-20mA remote control	Disable, Setpoint, Modulation **Disable:** When the value is “Disable,” the 4-20mA input via the Header is ignored and both of the remote control functions are disabled. **Modulation:** When the burner is free to modulate during the Run state, the 4-20mA input from the Header input becomes the modulation source, where 4mA corresponds to the Minimum modulation rate and 20mA corresponds to the Maximum modulation rate. All other behavior remains as it was; the setpoint and the on/off hysteresis values are still used to determine the burner-on and burner-off thresholds, and the TOD will still affect the burner-on and burner-off thresholds, if this is enabled. When the 4-20mA input is faulty (open, shorted, out of range, etc.) the control issues an alert and reverts to using PID output for modulation, as if the 4-20mA function were disabled. **Setpoint:** This parameter disables the CH outdoor reset function and the setpoint is provided using a linear interpolation of the 4-20mA input value within a range: • Either the CH pressure setpoint or the CH TOD pressure setpoint provides the setpoint for the 20mA, depending on the state of the TOD input, and the CH minimum pressure provides the setpoint for 4mA. When the 4-20mA input is faulty (open, shorted, out of range, etc.) the control issues an alert and reverts to using: • For steam either the CH pressure setpoint or the CH TOD pressure setpoint, depending on the state of the TOD input.
Steam 4-20mA remote control hysteresis	n.n mA Provides a hysteresis filter for the 4-20ma remote control input.
CH minimum pressure	PSI This parameter provides the minimum steam pressure used to calculate the 4-20mA control setpoint for 4mA.
20 mA CH pressure	PSI or None Establishes the pressures for the end points of the 4-20 mA inputs

Setpoint and Hysteresis (Hydronic)

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

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

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

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

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

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

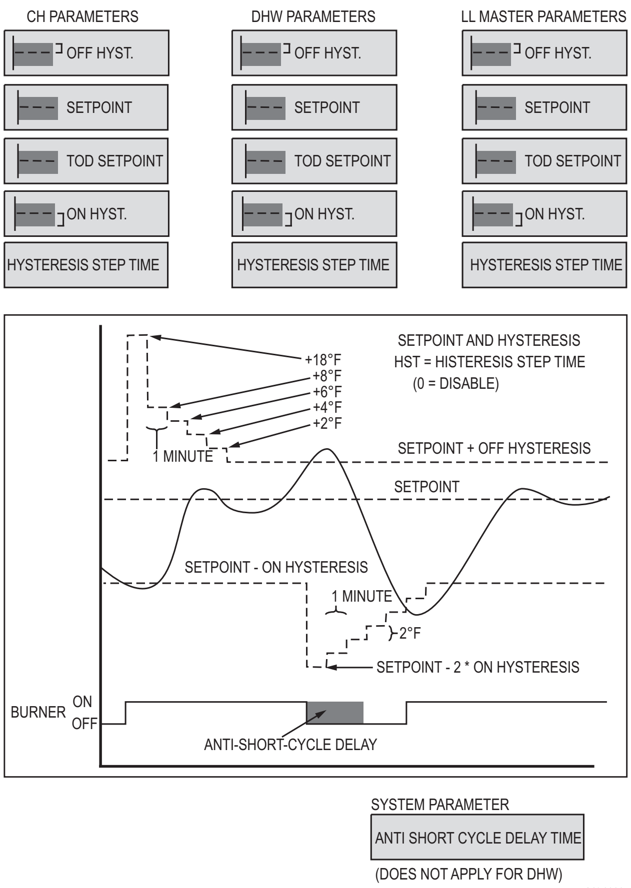


Fig. 12. Hydronic Setpoint and hysteresis.

Setpoint and Hysteresis (Steam Control)

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

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

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

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

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

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

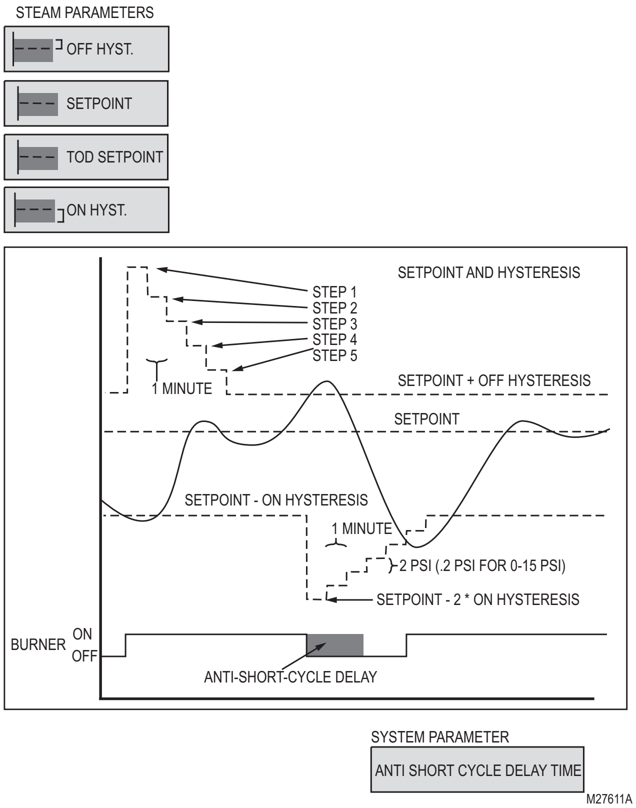


Fig. 13. Steam Setpoint and hysteresis.

DHW Loop Demand and Rate (Hydronic only)

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

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

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

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

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

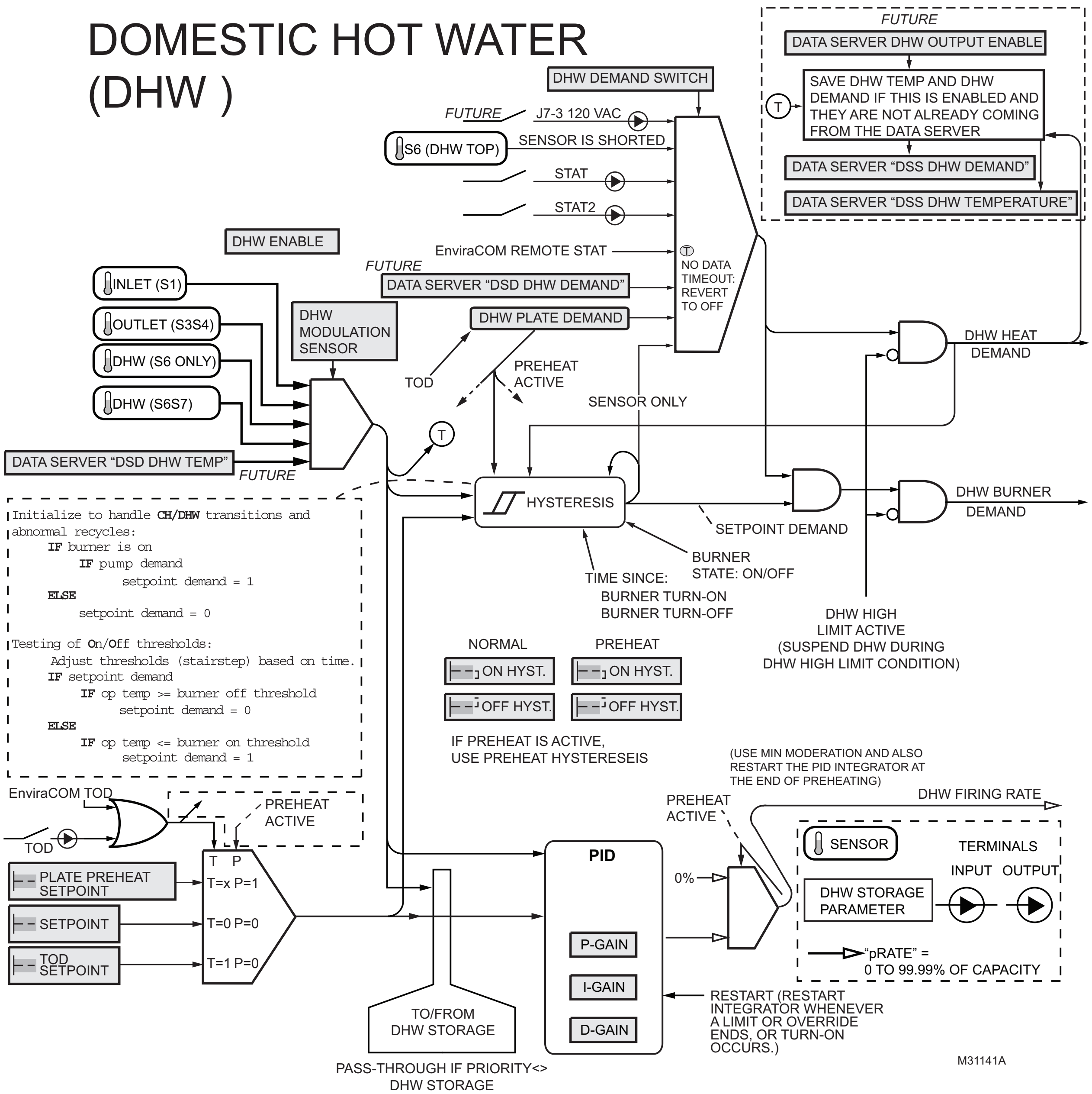


Fig. 14. Domestic hot water function.

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

Table 13. Domestic Hot Water Parameters.

Parameter	Comment

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

DHW setpoint	Degrees or None This setpoint is used whenever the time-of-day switch is off or not connected (unused).
DHW TOD setpoint	Degrees or None This setpoint is used when the time-of-day switch (J10 terminal 2) is on.
DHW off hysteresis DHW on hysteresis	Degrees or None The off hysteresis is added to the setpoint temperature to determine the temperature at which the demand turns off. Similarly, the on hysteresis is subtracted from the setpoint to determine the temperature at which demand turns on. However, these are adjusted at the time the burner changes from on to off, and from off to on to give the PID algorithm some room to be more aggressive in tracking the load, which can result in overshoot (undershoot). This adjustment is identical to that described for the CH demand and rate source, except it is controlled by the DHW hysteresis step time. (see the Setpoint and Hysteresis section, page 32)
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 32)
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 13. Domestic Hot Water Parameters. (Continued)

Parameter	Comment

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

Plate Heat Exchanger

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

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

One of the selections for the DHW demand switch parameter is “Plate Heat Exchanger”. This selection acts as an enable for the Tap Demand and Preheat Demand subsystems. If this choice is selected then the logic described in Fig. 15 and Table 14 is used to generate DHW demand; however if this is not selected, then the logic is inactive and does not apply.

Tap Demand

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

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

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

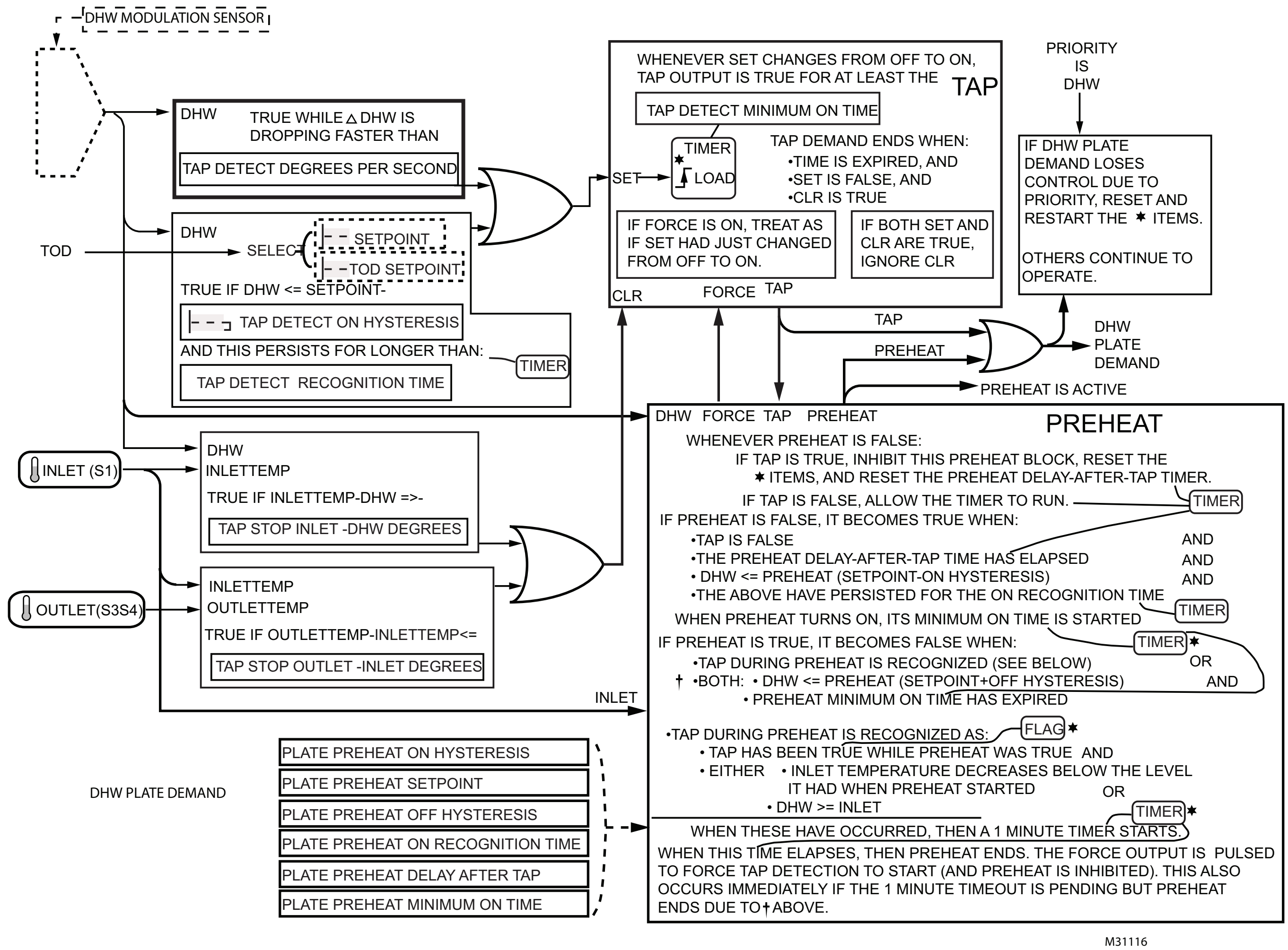


Fig. 15. Plate heat exchanger subsystem.

Table 14. Plate Heat Exchanger Parameters.

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

Table 14. Plate Heat Exchanger Parameters. (Continued)

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

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

Preheat Demand

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

Table 15. Preheat Demand Parameters.

Parameter	Comment

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

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

Table 15. Preheat Demand Parameters. (Continued)

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

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

Tap During Preheat

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

If this flag is set:

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

Preheat Modulation control

Preheat provides its own setpoint and hysteresis values. These are used by the burner on/off hysteresis logic in place of the normal DHW values, as shown in Table 16.

Table 16. 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.

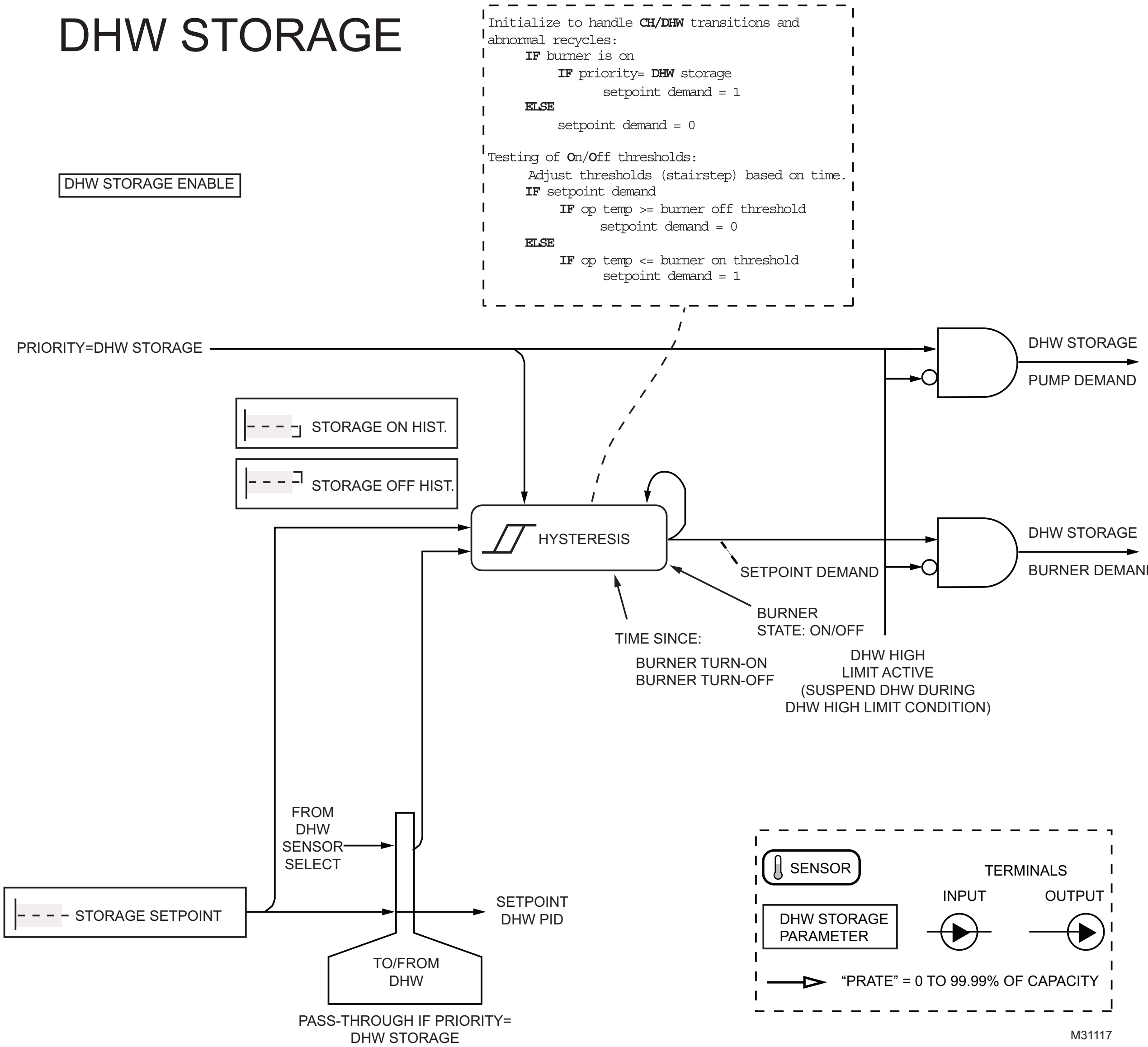


Fig. 16. DHW storage.

Table 17. DHW Storage Demand Parameters.

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

DHW Storage Operation

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

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

DHW storage demand is higher in priority than:

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

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

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

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

DHW Storage uses the same pump as DHW demand.

The DHW storage feature is shown in Fig. 16.

Frost Protection (Hydronic only)

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

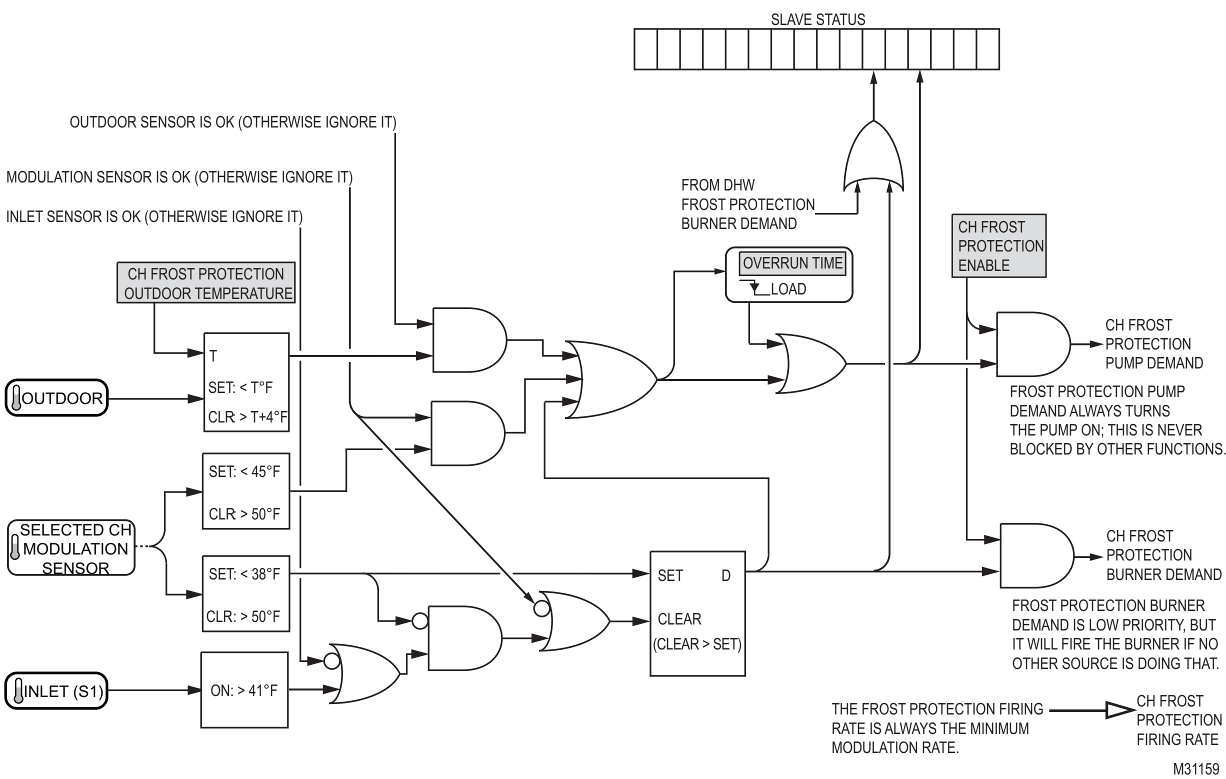


Fig. 17. CH Frost protection.

The behavior of each parameter and feature is given below.

Table 18. CH Frost Protection Parameters.

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

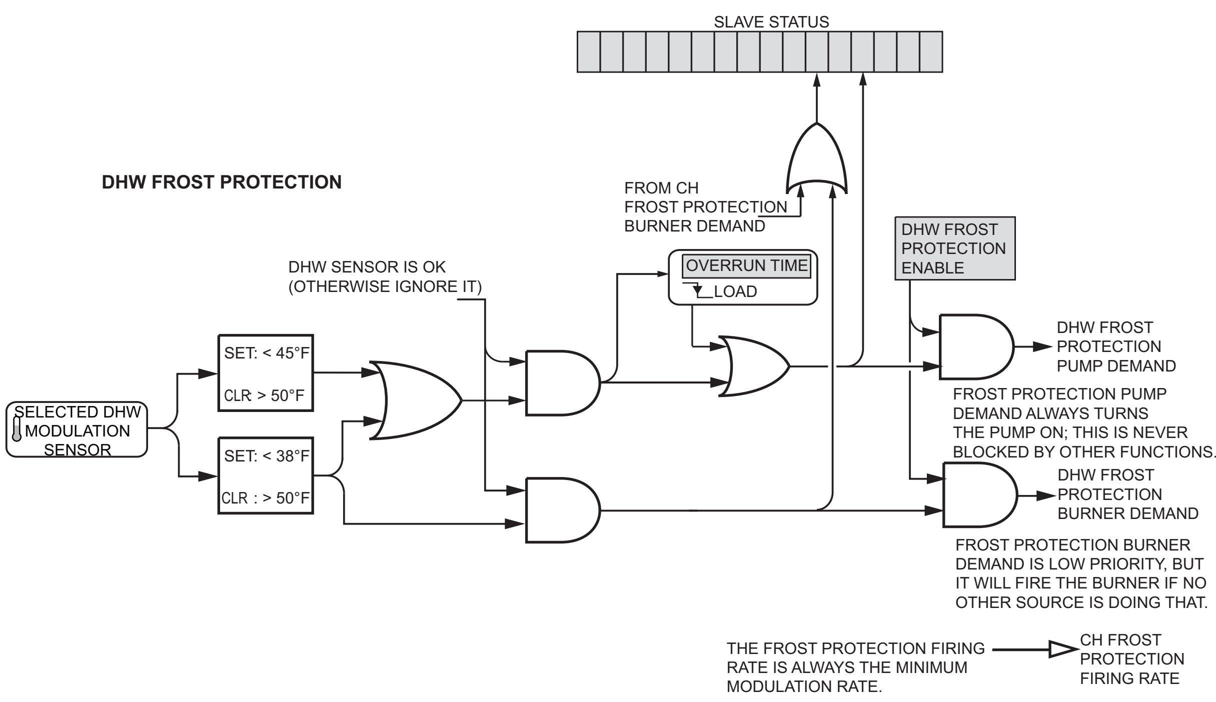


Fig. 18. DHW frost protection.

Table 19. DHW Frost Protection Parameters.

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

Rate Limits and Override

The Limit and Override subsystem consists of three separate concepts:

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

Rate Limit Priorities

There are two kinds of rate limit:

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

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

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

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

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

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

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

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

The Delta-T limit is designed to reduce the firing rate in case the difference between the following is excessive:

- The Inlet and the Outlet temperature
- The Inlet and the exchanger temperature
- The exchanger and the Outlet temperature

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

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

Table 20. Delta-T Limit Parameters.

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

Table 20. Delta-T Limit Parameters. (Continued)

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

T-Rise

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

Table 21. T-Rise Parameters.

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

Table 21. T-Rise Parameters. (Continued)

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

Heat Exchanger High Limit

A temperature limit may be imposed on the exchanger temperature.

Table 22. Heat Exchanger High Limit Parameters.

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

Stack limit (Safety limit and Rate limit)

Table 23. Limits and Rate Override: Stack Limit Parameters.

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

STACK RATE LIMIT

If the stack limit is enabled, as the temperature approaches the stack limit temperature, the Stepped Modulation rate limit function (see “Stepped modulation rate limit” on page 47) is active.

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

Table 24. 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 47) is active.

Stepped modulation rate limit

The Delta-T, Stack, and Outlet limit functions all use the same stepped modulation limiting, which reduces the maximum allowed modulation rate in five steps as the monitored temperature approaches the limit.

The limiting performs as follows:

A range is determined by calculating:

range= Maximum modulation rate
 - Minimum modulation rate

NOTE: The DHW maximum modulation rate is used when firing for DHW, and for other sources the CH maximum modulation rate is used.

A step size is determined by dividing this range by 5:

stepsize=range/5

Thus there are 5 steps in the modulation limiting:

step 0: unlimited (max is 100%)
step 1: max is 80% of range
step 2: max is 60% of range
step 3: max is 40% of range
step 4: max is 20% of range
step 5: limited to minimum modulation rate

If the monitored temperature is not within 12°F of the limit, then no rate limiting occurs. The stepped rate limit behaves as illustrated below:

Assuming that rate limiting has not been in effect, when the monitored temperature crosses a threshold that is 10°F away from the limit, then the maximum allowed firing rate is reduced by one stepsize (to 80%) and thereafter it is reduced by one stepsize every two °F until it is reduced to the minimum modulation rate when the 2°F threshold is crossed. Assuming that rate limiting has been in-effect then the thresholds for returning to a less restrictive step are shifted by 2°F to provide hysteresis. I.e. to go from step 4 to step 5 the threshold occurs at 2°F, but to go the other way, from step 5 to step 4, the threshold is 4°F.

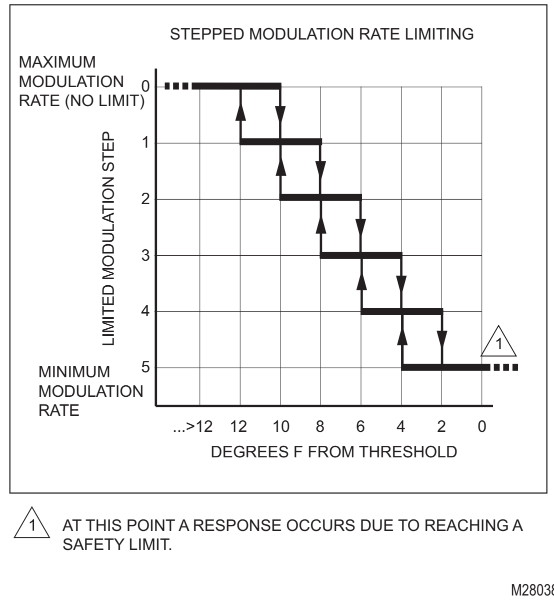


Fig. 19. Stepped modulation rate limiting.

Slow Start and Forced Rate limits (Hydronic Control)

The Forced Rate limit causes the burner to stay at a fixed firing rate immediately after lightoff, just after the end of the Run Stabilization time (if any). This is optionally followed by a slow start function that limits the ramp-up speed of the firing rate when the water is colder than a threshold, as shown in the following diagram.

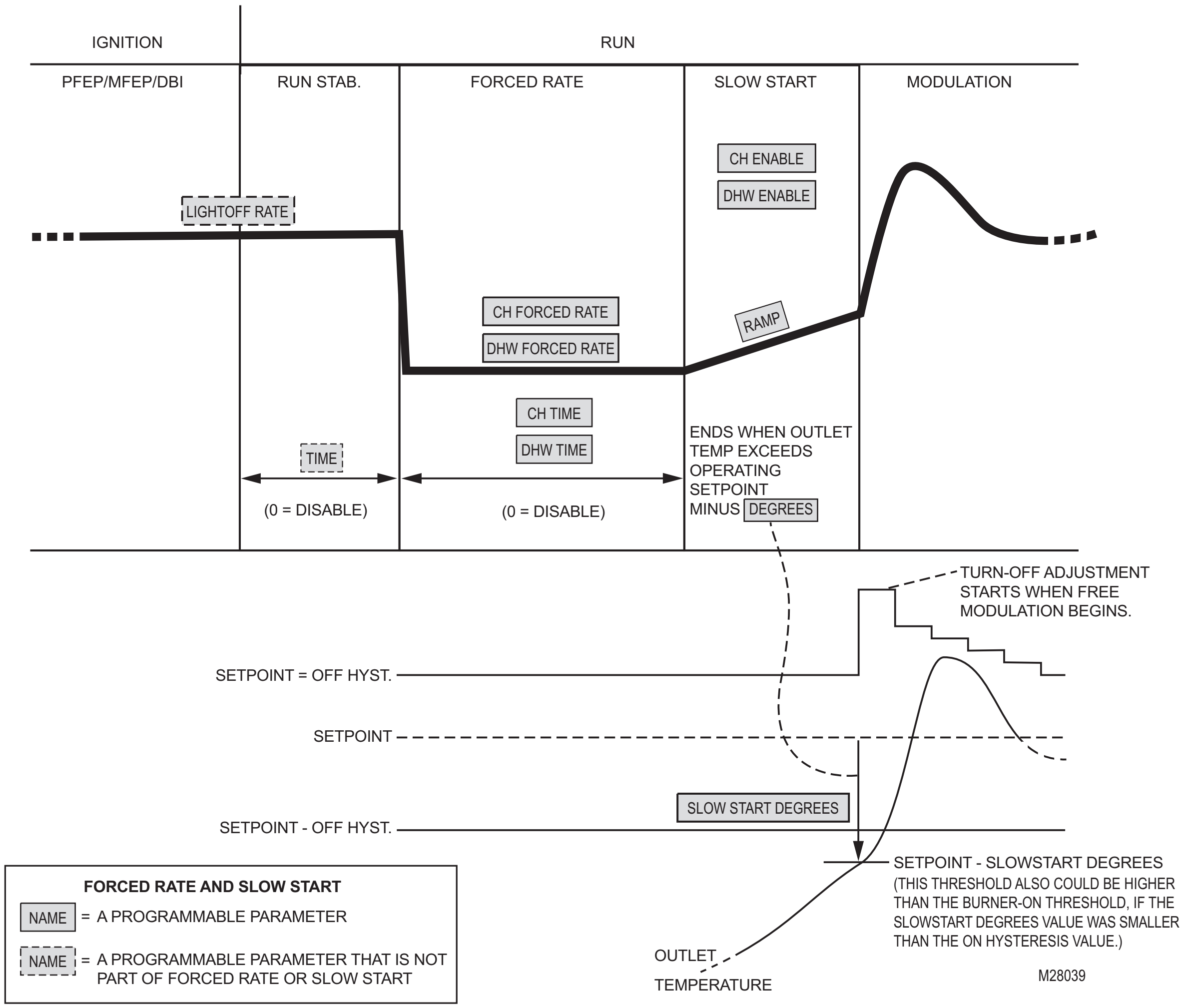


Fig. 20. Slow Start and Forced Rate limits.

Table 25. Limits and Rate Override: Slow Start Limit Parameters.

Parameter	Comment
CH forced rate time	MM:SS This parameter determines the duration of the forced rate period, when firing for CH or LL demand. If it is set to zero then this forced rate period is disabled.
CH forced rate	RPM or % This parameter provides the firing rate during the CH forced rate time. It is also the initial rate for the CH slow start period (even if the forced rate time is zero).
DHW forced rate time	MM:SS This parameter determines the duration of the forced rate period, when firing for DHW demand. If it is set to zero then this forced rate period is disabled.
DHW forced rate	RPM or % This parameter provides the firing rate during the DHW forced rate time. It is also the initial rate for the DHW slow start period (even if the DHW forced rate time is zero).

Table 25. Limits and Rate Override: Slow Start Limit Parameters. (Continued)

Parameter	Comment
CH slow start enable	Enable, Disable This parameter enables or disables the slow start limit function for CH and LL demand sources. It uses the CH forced rate parameter as the starting point for the slow start. If the forced rate parameter is invalid or zero and slow start is enabled, then the slow start function does not occur and an alert is issued.
DHW slow start enable	Enable, Disable This parameter enables or disables the slow start limit function for DHW demand source. It uses the DHW forced rate parameter as the starting point for the slow start. If this forced rate parameter is invalid or zero and slow start is enabled, then the slow start function does not occur and an alert is issued.
Slow start setpoint	Degrees or None If slow start limiting is enabled and the outlet temperature is less than the temperature provided by subtracting this number of degrees from the setpoint, then slow start rate limiting is effective. Whenever the outlet temperature is above this value, slow start limiting has no effect.
Slow start ramp	RPM or % Per Minute When slow start limiting is effective, the modulation rate will increase no more than the amount per minute given by this parameter. Although provided as a per-minute value, the R7910A will calculate and apply this as a stepped function using a step duration of 10 seconds.

DHW High Limit (Hydronic Control)

If DHW high limit enable is enabled then whenever the DHW high limit has been reached the DHW pump will be forced off. It will remain off until the DHW input temperature is lower than the DHW high limit temperature minus 5°F. The DHW high limit pump inhibit function is not a safety function.

Table 26. Limits and Rate Override: Outlet High Limit.

Parameter	Comment
DHW high limit enable	Enable, Disable This parameter enables or disables the DHW high limit function. It must be disabled when the DHW input is used as a switch to indicate DHW demand. If set to “Enable,” the DHW connector type must be 10K dual safety NTC.
DHW high limit setpoint	Degrees or None If DHW high limit enable is enabled and the DHW temperature reaches the value given by this parameter, then a response will occur.
DHW high limit response	Lockout, Recycle & Hold This parameter selects the response. If lockout is selected then the burner control locks out. If Recycle & Hold is selected then the burner control recycles and holds until the DHW temperature falls below the DHW high limit temperature minus 5°F.

Anticondensation (Hydronic Control)

The anticondensation function reduces condensation effects when the temperature is below a threshold by increasing the firing rate and optionally shutting off the pump.

Anticondensation operates only when the burner is firing, and is active only if enabled for the demand source (i.e. CH, DHW) currently controlling the burner.

The pump corresponding to that source will usually be on; however, to warm the heat exchanger more quickly, that pump may be forced off when anticondensation is active.

The anticondensation parameters are as follows:

Table 27. Anticondensation Parameters.

Parameter	Comment
CH anticondensation enable	Enable, Disable This parameter enables or disables anticondensation for CH and LL demand.
CH anticondensation setpoint	Degrees or None If CH demand anticondensation is enabled, and if CH demand or LL slave demand is in control of the burner, and the burner is firing, and if the temperature of the outlet sensor is below the temperature given by this parameter: then the anticondensation subsystem requests the burner's firing rate to be set to the rate given by the CH maximum modulation rate. Whether this succeeds or not depends on the priority of anticondensation compared to other rate-reducing limits (as described at the beginning of "Rate Limits and Override" on page 44). 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 44). • When the outlet sensor temperature reaches or exceeds the temperature given by this parameter plus a fixed hysteresis value or 4°F then this rate limit ends.
Frost protection anticondensation enable	Enabled, Disabled When Frost Protection is in control, either the CH or DWH anticondensation function is enabled.
Anticondensation Priority	Anticondensation is more important than (check those that apply): Stack limit Delta T limit Slow start Forced rate Outlet high limit

Modulation Output

The modulation output subsystem uses as its input either the modulation rate provided by the Internal Demand/Rate Selector, which possibly is limited by a Rate Limit function, or it uses a fixed modulation rate indicated by the burner control, such as during prepurge or lightoff, or it uses a manual rate.

Fig. 5 in "Demand and Rate" on page 23 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 28. Modulation Output Parameters.

Parameter	Comment
Modulation output	Fan Speed, 4-20mA, 0-10V This parameter selects the type of modulation output. The R7910A 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 29. Fan Speed Modulation Parameters.

Parameter	Comment
Absolute maximum fan speed	RPM The fan will never operate above the RPM provided by this parameter, regardless of the rate request. The maximum speed is 12000 RPM.
Absolute minimum fan speed	RPM The fan will never operate below the RPM provided by this parameter, regardless of the rate request, except by commanding it to turn off. The minimum speed is 500 RPM.

Table 29. Fan Speed Modulation Parameters. (Continued)

Parameter	Comment
PWM frequency	1000Hz, 2000Hz, 3000Hz, 4000Hz, This parameter provides the frequency used by the PWM output to control the fan.
Pulses per revolution	0-10 Typically is the number of sensors that the fan contains.
Fan gain up	0-100 This is the gain for speeding up the fan.
Fan gain down	0-100 This is the gain for slowing down the fan.
Speed up ramp	RPM per second Whenever the burner is firing, the fan will be commanded to increase its RPM no faster than the rate provided by this parameter.
Slow down ramp	RPM per second Whenever the burner is firing, the fan will be commanded to decrease its RPM no faster than the rate provided by this parameter.
Fan min duty cycle	duty% The fan modulation output will never send a duty cycle lower than this threshold, except for a 0% duty cycle to turn the fan off. This can be used to limit the minimum PWM to a level that prevents stalling of the fan.

Analog Modulation Parameters

These parameters are used only when 4-20mA or 0-10V is selected for modulation output.

Table 30. 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 R7910 is 0.1C, which is represented internally as an integer (e.g. C * 10). Thus if the temperature changes by the smallest measurable amount (e.g. 1 count), the P term of the PID output will contribute a change of 1*Pgain * P scaler, to the total PID output. The parameter thus allows some fraction of this change to be the threshold for changing direction, e.g. “n” = 5 means0.5 or half of this amount of change would be needed to change direction. If the Igain is zero then using any value of “n” less than 10 makes no difference; however when Igain is non-zero it also contributes to the PID output, so smaller amounts of hysteresis make sense. Experimentally, values of between 5 to 10 seem to work well.

PUMP CONTROL

There are six identical pump control blocks. Each has a different name but are entirely equal in features and capabilities. For example, if the block named CH Pump were configured to control the DHW pump and vice versa, and the pumps were hooked up that way, both pumps would work normally. Each can be configured for any purpose without regard to the pump name. See Fig. 21.

The pump names are:
- Boiler
- CH
- DHW
- Aux1
- Aux2
- System

Pump control blocks can operate for a Local SOLA, a SOLA LL Master, or both. Some pump demands are always from the local SOLA, some from the LL SOLA Master and some may come from either source.

The pump overrun timers for frost protection are part of the frost protection block, instead of the pump control block.

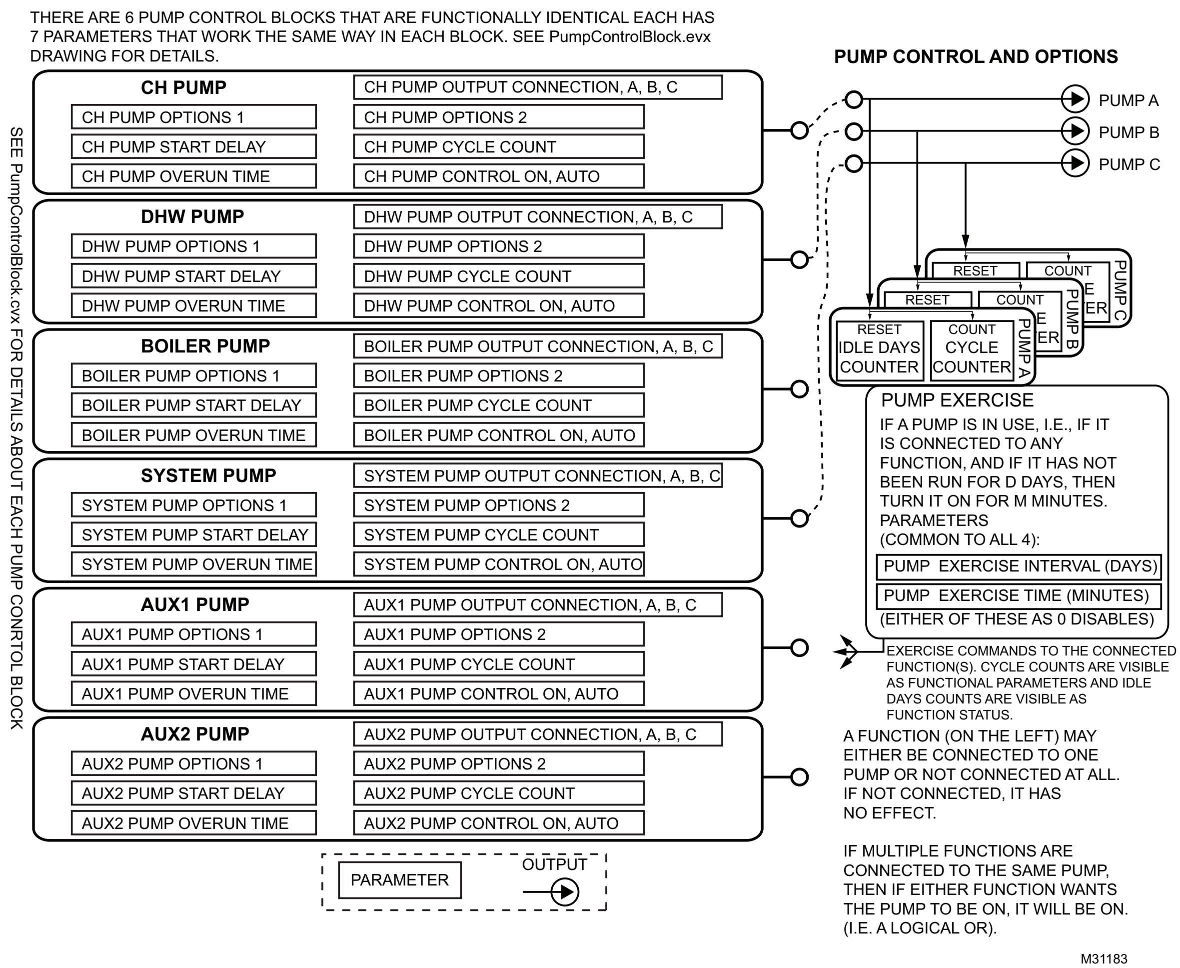


Fig. 21. Pump control blocks.

Pump Control Block Parameters

Each pump control block implements the parameters described in Table 31, 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.

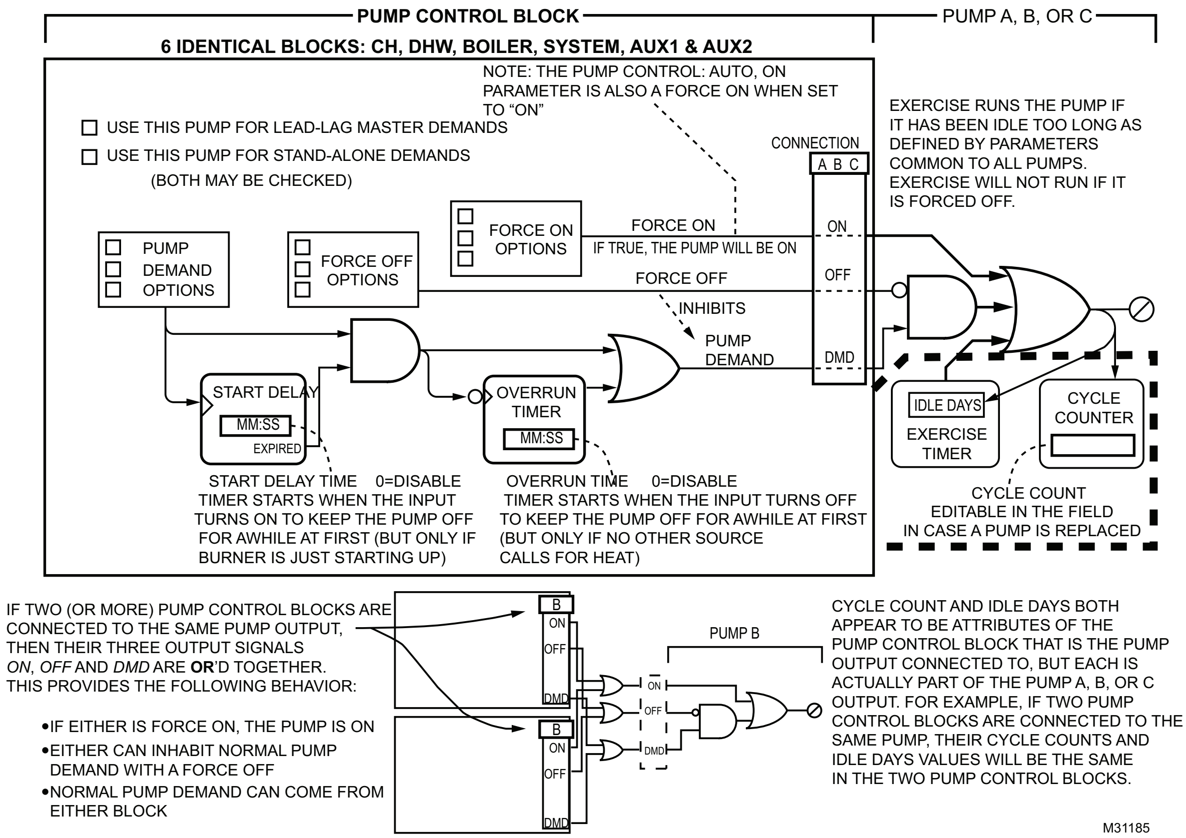


Fig. 22. Pump control block.

Table 31. Pump Control Block Parameters.

Parameter	Comment
XX pump output	None, Pump A, Pump B, Pump C This allows the XX pump function to be disconnected or to be attached to any of the pump outputs. If two pump blocks are connected to the same pump output then their signals are effectively OR'd together as shown in Fig. 22.
XX pump control	On, Auto The XX pump can be turned on manually, or it can be set to operate automatically. If it is turned on then it remains on until changed back to Auto.

Table 31. Pump Control Block Parameters. (Continued)

Parameter	Comment
XX pump start delay	mm:ss When the pump demand changes from off to on, this delay time is used to delay the start of the pump. The pump then starts after the delay expires, assuming that the demand is still present. A delay time of zero disables the delay. For a stand-alone (non-slave) SOLA, this delay is skipped and does not occur if it is already firing when the pump demand off-to-on event occurs. For a SOLA 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 SOLA 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 SOLA if any local service is active then this status cancels any overrun that is in-progress. For a slave SOLA if any master service is active at this time this status cancels any overrun that is in-progress.
XX pump cycles	0–999,999 The XX pump cycle counters are mapped to the physical cycle counters; there is one counter for each of the three physical pump outputs and this counter is visible via this parameter, for whichever pump block (or blocks) are connected to it via the block's XX pump output parameter. It is possible for two (or more) pump functions to be assigned to the same physical pump. In this case, that physical pump's cycle counter is visible in each pump control block. A pump cycle counter has the range 0 through 999,999 and it can be restarted if a pump is replaced.

Pump Exercising

Each of the pumps (A, B, and C) will have an exercise timer that helps to ensure that pumps do not “freeze up” due to long periods of no use. However, this is active only if the pump is attached to some function: a pump output that is not attached is not exercised.

For pumps that are attached, whenever the pump is off, a timer will measure the pump-off time. When the day counter reaches the value provided by the Pump Exercise Interval (Days) parameter, then the pump will be turned on for the time given by the Pump Exercise Time parameter.

Whenever the pump is on, for any reason, the counter is set to zero to begin a new measurement.

Table 32. Pump Exercising Parameters.

Parameter	Comment
Pump Exercise Interval (Days)	0, or N If set to zero, the exercise function is disabled. Otherwise this parameter provides the interval time between exercising the pumps. It is common to all three pump outputs (A, B, and C).
Pump Exercise Time	MM:SS If the time is zero then the exercise function is disabled. Otherwise this parameter provides the time that a pump should be on when it is exercised. It is common to all three pump outputs (A, B, and C).

Frost Protection Requests

The frost protection requests are set or cleared to match the status generated by the frost protection detection functions for each SOLA.

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 SOLA 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 19.

The parameters occur here in their order of use in a typical burner sequence.

Table 33. 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. R7911 Steam Control has Stack sensor option only. This parameter also determines whether dual sensors are used with a cross-check for the Outlet, Stack, and DHW sensors. If “10K dual safety” is chosen, these three sensors are each dual 10K sensors, and if they do not track within 6°F then recycle and hold occurs, until the sensors are tracking again.
LCI enable	Enable, Disable If the LCI input is enabled, then the control will check the LCI as a recycle limit. It must be on before the burner control will exit the Standby condition and LCI will cause a recycle if it turns off at other times. If this input is off and demand is present, the burner control will indicate that it is waiting for LCI so the Annunciator can provide a corresponding value in the Annunciator Hold parameter, for use by a display.
PII enable	Enable, Disable If the PII input is enabled, then the control will check the PII as a preignition interlock limit. (As defined by the equipment setup, it typically must be on before the burner control will exit the Standby condition.) If this input is off and the burner control is in a hold condition waiting for it to turn on, then the burner control will indicate that it is waiting for PII so that the Annunciator can provide a corresponding value in the Annunciator Hold parameter, for use by a display.
Interlock start check	Enable, Disable If the Interlock start check is enabled and the fan is off (in some cases it can be on during Standby), then the control will check the ILK input as it exits the Standby condition, in response to demand. If this input is on then the burner control will hold for 120 seconds waiting for it to turn off. If this hold time expires and the ILK is still on, then a lockout occurs.
IAS start check enable	Enable, Disable If the Interrupted Air Switch Enable parameter is set to “Disable” then this parameter is ignored. Otherwise, if the IAS start check is enabled and the fan is off (in some cases it can be on during Standby), then the control will check the IAS input as it exits the Standby condition, in response to demand. If this input is on then the burner control will hold for 120 seconds waiting for it to turn off. If this hold time expires and the IAS is still on, then a lockout occurs.
ILK/IAS open response	Lockout, Recycle During prepurge after a delay to establish airflow, and during Ignition, MFEP, and Run, the burner control requires the ILK to remain on. If it opens during Ignition, MFEP, or Run then this parameter determines the response: either a lockout or a recycle back to the Safe Start check. If recycle is selected and ILK is open during prepurge: the purge timer is set to zero and the prepurge state holds at time zero, waiting for the ILK to reclose which will resume purge timing. If this hold persists for 30 seconds then the control will go to a Standby Delay condition for 5 minutes, then try again. If the burner control is in a hold condition (but not a Standby Delay) waiting for ILK to turn on, then the burner control will indicate that it is waiting for ILK so that the Annunciator can provide a corresponding value in the Annunciator Hold parameter, for use by a display.
ILK bounce detection enable	Enable, Disable
Interrupted air switch (IAS) enable	Disable, Purge Only, Purge & Ignition This parameter determines when the IAS input is tested. If set to “Disable” then the IAS input is ignored by the burner control, and may be used as an Annunciator input. If set to “Purge Only” then IAS is monitored in the same way as the ILK input, with the same responses, during the Prepurge state. If set to “Purge & Ignition” then IAS is monitored in the same way as the ILK input, with the same responses, during the Prepurge and Ignition states. The IAS in not monitored during Run.
Prepurge time	MM:SS This parameter sets the burner control’s prepurge time. Setting this parameter to zero disables prepurge.

Table 33. Burner Control Safety Parameters. (Continued)

Parameter	Comment
Purge rate proving	None, High Fire Switch, Fan Speed This parameter determines the input used to confirm the purge rate has been reached. It is unused and ignored if the Prepurge time is set to zero. If set to None, the purge rate is commanded during prepurge but purge timing begins immediately without waiting for any feedback. If set to High Fire Switch then the HFS input must be on to prove the purge rate. Additionally, if this is selected and HFS is already on upon exit from Standby then an additional 30 second prepurge delay (indicating HFS jumpered) is enforced before the measured Prepurge time begins. If the HFS opens during purge, the burner control will react as specified by the equipment setup (typically by restarting or holding Prepurge). If set to Fan Speed then the measured fan speed must be within the specified prepurge rate, +/- 3% for 3 seconds before the rate is proven and the measured prepurge time begins. If the fan speed later goes outside of the prepurge rate +/- 10% during purge, the burner control will react as specified by the equipment setup (typically by restarting or holding Prepurge).
Lightoff rate proving	None, Low Fire Switch, Fan Speed This parameter determines the input used to confirm the rate has been reached for lighting the burner. If set to None, the lightoff rate is commanded during ignition but is not checked. If set to Low Fire Switch then the LFS input must be on to prove the lightoff rate. Additionally, if this is selected and LFS is already on upon exit from prepurge then an additional 30 second delay (indicating LFS jumpered) is enforced before the Ignition time begins. If the LFS opens during ignition, the burner control will react as specified by the equipment setup (typically by locking out). If set to Fan Speed then the measured fan speed must be within the specified lightoff rate, +/- 3% for 3 seconds before the rate is proven and Ignition begins. If the fan speed later goes outside of the prepurge rate +/- 10% during ignition or MFEP, the burner control will react as specified by the equipment setup (typically by locking out).
Pilot type	Interrupted, Intermittent, DBI, Direct Burner Ignition Pulsed An interrupted pilot turns off at the end of the main flame establishing period (MFEP), whereas an intermittent pilot remains on during the run period and thus there is no MFEP. The third choice, DBI (direct burner ignition) indicates that there is no pilot and that the main flame is lit directly using the igniter. The ignition time is fixed at 4 seconds whenever direct burner ignition is selected.
DBI time	None, 4 sec, 10 sec, 15 sec
Flame sensor type	Flame Rod, UV, UV with Spark Interference
Forced recycle interval time	Time, None After scheduled time of continuous run, system is recycled, specifically if UV detector is used to provide Safe Start.

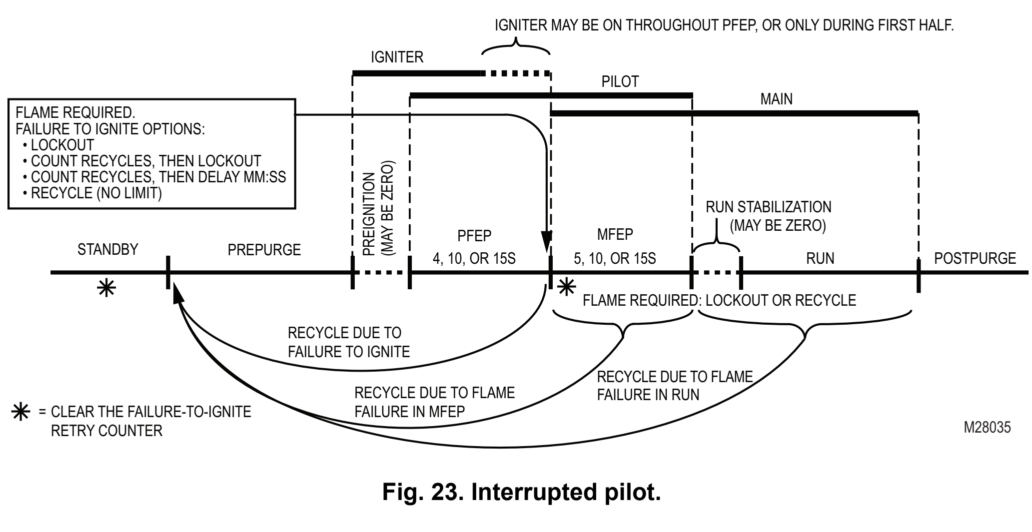


Fig. 23. Interrupted pilot.

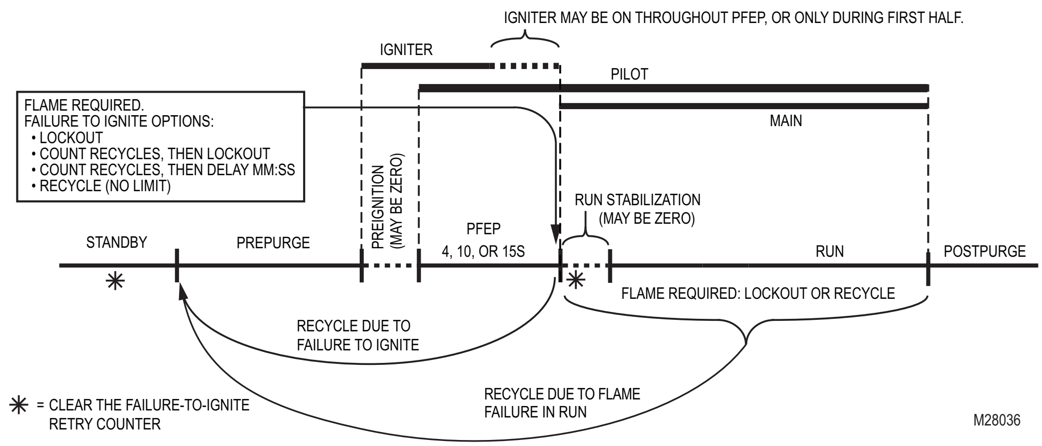


Fig. 24. Intermittent pilot.

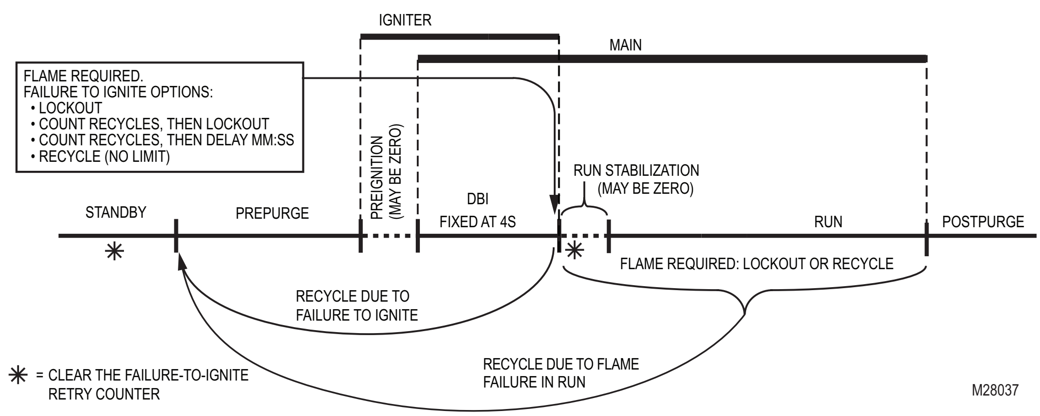


Fig. 25. Direct burner ignition

Table 33. Burner Control Safety Parameters. (Continued)

Parameter	Comment
Igniter on during	Pilot Flame Establishing Period or First half of PFEP This parameter is not needed and ignored if DBI (Direct Burner Ignition) is selected. Otherwise the igniter may be on throughout the PFEP, or only during the first half of it: • 2 seconds for a 4 second PFEP time, • 5 seconds for a 10 second PFEP time, • 7 seconds for a 15 second PFEP time. When the igniter is external, it is on continuously during the defined period. However when the igniter is selected as the internal spark generator then, during its on time as defined by this parameter, it actually is intermittently on, then off, then on, then off, with each state lasting 1/4 second. (This is done because flame cannot be sensed while the igniter is on, due to hardware limitations, so flame sense and igniter spark are done alternatetly at a 1/4 second rate.)
Pilot type	Interrupted, Intermittent, DBI, Direct Burner Ignition Pulsed
Preignition time	hr:mm:ss
Pilot flame establishing period (PFEP)	4, 10, or 15 seconds This parameter is ignored if DBI is selected. Otherwise there are three choices for the duration of PFEP: 4, 10, or 15 seconds. Flame must be on at the end of this period or a response occurs (see “Ignite failure response” on page 61).

Table 33. Burner Control Safety Parameters. (Continued)

Parameter	Comment
Main flame establishing period (MFEP)	5, 10, or 15 Seconds This parameter only appears if Pilot type is Interrupted. Three choices of the MFEP time are provided: 5, 10, or 15 seconds. Flame must remain on throughout the MFEP, otherwise a response occurs (see "MFEP flame failure response" on page 61).
Ignite failure response	Lockout, Recycle & Hold After Retries, Recycle & Lockout After Retries, Continuous Recycle If a failure to ignite is detected at the end of the Ignition period, then there are four possible responses: • Lockout • Recycle & hold after retries—the burner control recycles to the beginning of purge and counts how many times this has occurred. If the retry count has been reached, a hold occurs with the system purging. After the hold, the retry count is cleared and the burner tries (and retries) again. • Recycle & lockout after retries—the burner control recycles to the beginning of purge and counts how many times this has occurred. If the retry count has been reached, a lockout occurs. • Continuous recycle—the burner control recycles without limit. The retry counter is cleared during Standby (no demand), during the hold imposed by the retry counter, or if flame is achieved.
Ignite failure retries	3, 5 This parameter provides the number of retries, either 3 or 5.
Ignite failure delay	MM:SS When Recycle & hold after retries is selected, this parameter provides the delay time for the hold.
MFEP flame failure response	Lockout, Recycle During the MFEP state, if the flame fails there is a choice for the response. If lockout is selected, a flame failure during MFEP causes a lockout. However, if recycle is selected, the burner control shuts off the fuel and recycles back to the beginning of prepurge, then continues with the normal burner startup process (prepurge, ignition, then run) to attempt to light the burner again.
Run flame failure response	Lockout, Recycle During the Run state if flame fails then there is a choice for the response. If lockout is selected for flame failure during Run. However, if recycle is selected, the burner control shuts off the fuel and recycles back to the beginning of prepurge, then continues with the normal burner startup process (prepurge, ignition, then run) to light the burner again.
Fan speed error response	Lockout, Recycle If fan fails in Run and recycle is selected then the burner control recycles back to the beginning of Prepurge, then continues with the normal burner startup process to attempt to bring the fan up to speed again.
Pilot test hold	Enable, Disable This parameter is provided to support the pilot turndown test required by burner standards for Intermittent and Interrupted pilots. It is ignored if Pilot Type is DBI. If the Pilot type is Interrupted or Intermittent and this parameter is enabled, the burner control sequence will hold (forever) at 1 second into the Ignition state. During Pilot Test Hold, a flame-out timer always starts at zero when the Ignition state is entered, then counts up toward 15 seconds while flame is off and down toward zero when flame is on. This timer has a possible effect only during the pilot test: if it ever reaches 15 seconds of accumulated flame out time then a lockout occurs. The pilot test hold should be enabled prior to entering Ignition, since changes to parameters may require some seconds to take effect. Similarly, when the hold is disabled the burner control may remain in the hold condition for a short time.
Ignition source	Internal, External, Hot Surface Ignitor The R7910A 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 33. 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 S7999B.
- **Short Name:** 3 characters long; used for status viewing by more limited local displays, like the S7910. 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 R7910 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.

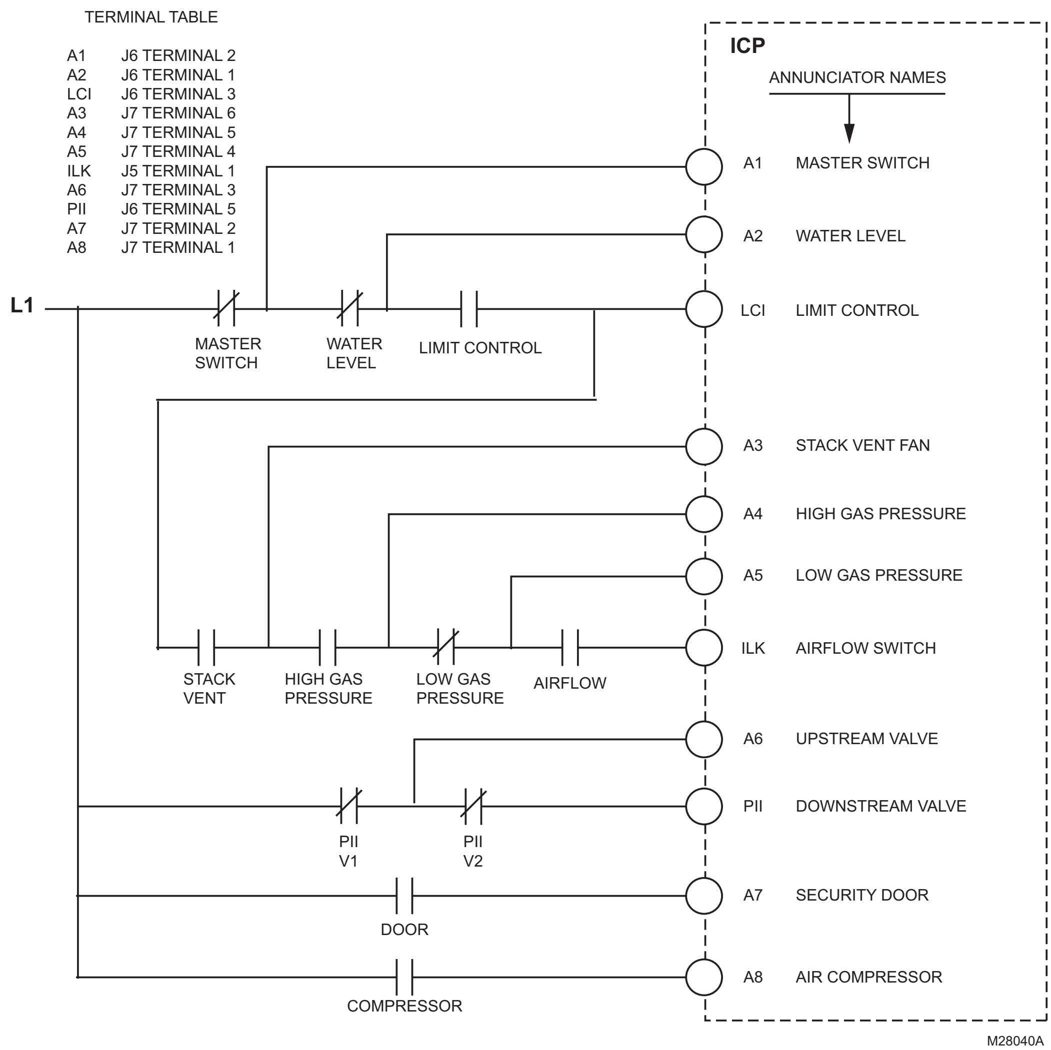


Fig. 26. Example of annunciator inputs and terminal names.

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 S7999B System Display using the “programmable” annunciator display in this case would resemble Fig. 27.

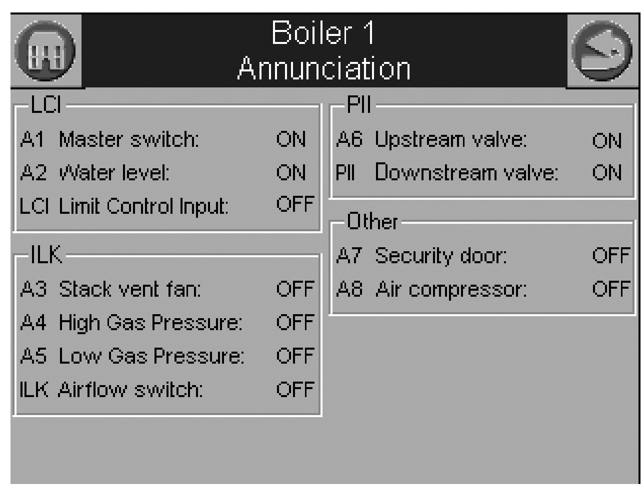


Fig. 27. Annunciator display.

If A7 is defined as a HFS input, then the parameter that calls it a “Security door” would be ignored and the automatic value (High Fire Switch) is used instead (the same would be true for the A8 LFS and A1 IAS).

FAULT HANDLING

Lockouts and Alerts

The R7910A implements two kinds of faults: lockouts and alerts.

A list of fault codes with possible troubleshooting tips is provided in Table 51 on page 107.

A list of alerts is provided in Table 52 on page 115.

LOCKOUT

- A lockout causes the boiler control to shutdown and requires manual or remote reset to clear the lockout.
- Always causes alarm contacts to close.
- Logged in lockout history.

ALERT

- Every other kind of problem that isn't a lockout is an alert. Examples include boiler control abnormal holds, LL master problems, faults from non-safety functions, etc.
- Alerts never require manual intervention to reset them; that is, if the alert clears up, then normal operation will continue. An alert is not a condition, it is an event. The cause of the alert may be a condition, e.g. something that is causing an abnormal hold, but the alert itself in this case is a momentary event generated upon entry to that condition.
- Whether the alarm contact closes or not is programmable for each alert by the OEM.
- Alerts are logged in a 15-item volatile alert history sorted in chronological order. Only one instance of each alert code occurs in the history, corresponding to the most recent occurrence of that alert.

Alarms for Alerts

The Alarm Parameter Control Block (see the section above) determines which alerts will cause an alarm (by closing the alarm contacts) and which will be reported silently.

Thus an alarm might be on because of a lockout or an alert. If the cause is a lockout then the alarm contacts remain close until the lockout is cleared. However, for alarms due to alerts (which may recur) the alarm may be silenced for a period of time (0–600 minutes) by specifying it in the Alarm Silence Time parameter.

BURNER CONTROL OPERATION

Safety Shutdown of Burner Control Functions

Safety Shutdown (Lockout) occurs if any of the following occur during the indicated period:

1. INITIATE Period:
   a. A/C line power errors occurred.
   b. Four minute INITIATE period has been exceeded.
2. STANDBY Period:
   a. Flame signal is present after 240 seconds.
   b. Preignition Interlock is open an accumulative time of 30 seconds.
   c. Interlock Start check feature is enabled and the Interlock String (including Airflow Switch) is closed for 120 seconds with the controller closed. (jumpered or welded Interlock).
   d. Pilot Valve Terminal is energized.
   e. Main Valve Terminal is energized.
   f. Internal system fault occurred.
3. PREPURGE Period:
   a. Preignition Interlock opens anytime during PREPURGE period.
   b. Flame signal is detected for 10 seconds accumulated time during PREPURGE.
   c. Purge Rate Fan RPM or High Fire Switch fails to close within four minutes and fifteen seconds after the firing rate motor is commanded to drive to the high fire position at the start of PREPURGE.
   d. Light off Rate Fan RPM or Low Fire Switch fails to close within four minutes and fifteen seconds after the firing rate motor is commanded to drive to the low fire position at the end of PREPURGE.
   e. Lockout Interlock (if programmed) does not close within 10 seconds.
   f. Lockout Interlock opens during PREPURGE.
   g. Pilot Valve terminal is energized.
   h. Main Valve terminal is energized.
   i. Internal system fault occurred.
4. PRE-IGNITION TIME
   a. Lockout Interlock opens.
   b. IAS Purge and Ignition enabled and the Interlock opens.
   c. Preignition Interlock opens.
   d. Pilot Valve terminal is energized.
   e. Main Valve terminal is energized.
5. PILOT FLAME ESTABLISHING PERIOD (PFEP)
   a. Low Fire Switch opens (if enabled).
   b. Lockout Interlock opens (if enabled).
   c. Pilot Valve terminal is not energized.
   d. No flame is present at the end of the PFEP, or after programmed number of retry attempts.
   e. Main valve terminal is energized.
   f. Internal system fault occurred.
6. MAIN FLAME ESTABLISHING PERIOD (MFEP).
   a. Low Fire Switch opens (if enabled).
   b. Lockout Interlock opens (if enabled).
   c. Pilot valve terminal is not energized.
   d. Main valve terminal is not energized.
   e. No flame present at the end of MFEP.
   f. Internal system fault occurred.
7. RUN Period:
   a. No flame is present, or flame is lost (if enabled-lockout).
   b. Lockout Interlock opens) if enabled).
   c. IAS Purge and Ignition enabled and the Interlock opens.
   d. Pilot terminal energized (if programmed as Interrupted Pilot).
   e. Main valve terminal is not energized.
   f. Internal system fault occurred.
8. POSTPURGE Period.
   a. Preignition Interlock does not close in five seconds.
   b. Pilot Valve terminal is energized.
   c. Main Valve terminal is energized.
   d. Internal system fault occurred.
   e. Flame sensed 240 seconds accumulated time after the RUN period.

Safety Shutdown

1. If the lockout interlocks open or a sensor designated as a safety limit are read as defective, SOLA 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 SOLA will cause electrical resets, but does not reset a lockout condition.

Operational Sequence

Initiate

The R7910 enters the Initiate sequence on Initial Power up or:

- Voltage fluctuations vary less than 20Vac or greater than 30Vac.
- Frequency fluctuations vary +/-5% (57 to 63 Hz).
- If Demand, LCI, or Stat interrupt (open) during the Prepurge Period.
- After the reset button is pressed or fault is cleared at the displays.

The Initiate sequence also delays the burner motor from being energized and de-energized from an intermittent AC line input or control input.

If an AC problem exists for more than 240 seconds a lockout will occur.

Central Heating

Start-up sequence central heating request (system in standby):

1. Heat request detected (On Setpoint - On Hysteresis).
2. The CH pump is switched on.
3. After a system Safe Start Check, the Blower (fan) is switched on after a dynamic ILK switch test (if enabled).
4. After the ILK switch is closed and the purge rate proving fan RPM is achieved (or High Fire Switch is closed) - prepurge time is started.
5. When the purge time is complete, the purge fan RPM is changed to the Lightoff Rate or if used, the damper motor is driven to the Low Fire Position.
6. As soon as the fan-rpm is equal to the light-off rpm (or the Low Fire Switch closes), the Trial for Ignition or Pre-Ignition Time is started (depending on configuration).
7. Pre-Ignition Time will energize the ignitor and check for flame.
8. Trial for Ignition. Fig. 23–25 on page 60 shows three ignition options. Specifics for timings and device actions are defined by the OEM or installer.
9. The ignition and the gas valve are switched on.
10. The ignition is turned off at the end of the direct burner ignition period, or for a system that does use a pilot, at the end (or optionally at the middle) of the Pilot Flame Establishing Period (PFEP). For an interrupted pilot system this is followed by a Main Flame Establishing Period (MFEP) where the pilot ignites the main burner. For an intermittent pilot there is no MFEP.
11. The fan is kept at the lightoff rate during the stabilization timer, if any.
12. Before the release to modulation, the fan is switched to minimum RPM for the CH Forced Rate and Slow Start Enable, if the water is colder than the threshold.
13. At the end of the CH-heat request the burner is switched off and the fan stays on until post purge is complete.
14. A new CH-request is blocked for the forced off time set by the Anti Short Cycle (if enabled).
15. The pump stays on during the pump overrun time (if enabled).
16. At the end of the pump overrun time the pump will be switched off.

Domestic Hot Water

Start-up sequence DHW-request (system in standby):

1. Heat request detected (either DHW Sensor Only, DHW Sensor and Remote Command or DHW Switch and Inlet Sensor, whichever applies).
2. The pump is switched on (after the DHW Pump Start Delay).
3. After a system Safe Start Check, the Blower (fan) is switched on after a dynamic ILK switch test (if enabled).
4. After the ILK switch is closed and the purge rate proving fan RPM is achieved (or High Fire Switch is closed) - prepurge time is started.
5. When the purge time is complete, the purge fan RPM is changed to the Lightoff Rate or if used, the damper motor is driven to the Low Fire Position.
6. As soon as the fan-rpm is equal to the light-off rpm (or the Low Fire Switch closes), the Trial for Ignition or Pre-Ignition Time is started (depending on configuration).
7. Pre-Ignition Time will energize the ignitor and check for flame.
8. Trial for Ignition. Fig. 23–25 on page 60 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 R7910 and R7911 SOLA devices.

⚠ WARNING

Explosion Hazard.
Can cause serious injury or death.
Do not allow fuel to accumulate in the combustion chamber for longer than a few seconds without igniting, to prevent danger of forming explosive mixture. Close manual fuel shutoff valve(s) if flame is not burning at end of specified time.

⚠ WARNING

Electric Shock Hazard.
Can cause serious injury or death.
Use extreme care while testing system. Line voltage is present on most terminal connections when power is on.

Open master switch before removing or installing the R7910 or R7911 SOLA device or Display Module connector.

Make sure all manual fuel shutoff valves are closed before starting initial lightoff check and Pilot Turndown tests.

Do not put the system in service until you have satisfactorily completed all applicable tests in this section and any others recommended by the original equipment manufacturer.

Limit trial for pilot to 10 seconds. Limit the attempt to light main burner to 2 seconds after the fuel reaches burner nozzle. Do not exceed manufacturer’s nominal lightoff time.

⚠ CAUTION

Equipment Malfunction or Damage Hazard.
Each device type is unique. Using existing wiring on a module change can cause equipment damage. Make wiring changes when a module is replaced with a different R7910 or R7911 SOLA device to sequence burner.

IMPORTANT

1. If the system fails to perform properly, note the fault code, fault message, equipment status, and sequence time on the display. Then refer to the Fault Code section in the R7910 and R7911 Product Data Sheet form 66-1171.
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

- S7999 Operator Interface Module.
- Volt-ohmmeter (1M ohm/volt minimum sensitivity) with: 0-300 Vac capability. 0-6000 ohm capability. 0-10 Vdc capability.

Checkout Summary

Table 1 provides an overview of checkout steps performed for each applicable system.

See the product data sheet for location of component parts terminal locations.

Table 34. Checkout steps and applicable systems.

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

Preliminary Inspection

Perform the following inspections to avoid common problems. Make certain that:

1. Wiring connections are correct and all screws are tight.
2. Flame detector(s) is clean, installed and positioned properly. Consult the applicable Instructions.
3. Combination connector J1 wiring and flame detector(s) are correctly used. See product data sheet for wiring.
4. Burner is completely installed and ready to fire; consult equipment manufacturer's instructions. Fuel lines are purged of air.
5. Combustion chamber and flues are clear of fuel and fuel vapor.
6. Power is connected to the system disconnect switch (master switch).
7. Lockout is reset (reset button) only if the R7910 or R7911 SOLA Module is powered.
8. System is in STANDBY condition. STANDBY message is displayed in the S7999 Operator Interface Module.
9. All limits and interlocks are reset.

Flame Signal Measurement

Install a DC voltmeter in the SOLA 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 R7910 and R7911 SOLA Module sequence. The R7910 or R7911 SOLA Module should start the INITIATE sequence.
4. Let the sequence advance to PILOT IGN (status is displayed on the S7999 Operator Interface Module, 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 R7910 and R7911 SOLA Module connector J5.
   b. Ensure that both the manual pilot shutoff valve and the manual main shutoff valves are closed.

c. On connector J5, jumper power to the ignition terminal J5 terminal 4. Disconnect the leadwire to the pilot valve if it is connected to the same terminal.
d. Close the master switch to energize only the ignition transformer.
e. If the ignition spark is not strong and continuous, open the master switch and adjust the ignition electrode spark gap setting to the manufacturer's recommendation.
f. Make sure the ignition electrodes are clean.
g. Close the master switch and observe the spark.
h. After a continuous spark is obtained, open the master switch and add a jumper on the Connector J5 terminal 2 or reconnect the pilot valve lead wire if it was disconnected in step b.
i. Open the manual pilot shutoff valve.
j. Close the master switch to energize both the ignition transformer and the pilot valve.
k. If the pilot flame does not ignite and if the ignition spark is still continuous, adjust the pilot gas pressure regulator until a pilot flame is established.
l. When the pilot flame ignites properly and stays ignited, open the master switch and remove the jumper(s) from the J5 terminals.
m. Check for adequate bleeding of the fuel line.
n. Reinstall the J5 connector onto the R7910 or R7911 SOLA Module, close the master switch and return to step 4.

INTERNAL IGNITION SOURCE

To check the internal ignition, the R7910 or R7911 controller will need to be cycled:

a. Open the master switch and remove connector J5.
b. Ensure both the manual pilot shutoff valve and the manual main fuel shutoff valves are closed.
c. Cycle the R7910 or R7911 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 R7910 or R7911 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 R7910 or R7911 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 R7910 or R7911 controller to energize both the ignition transformer and the pilot valve.
k. If the pilot flame does not ignite and if the ignition spark is still continuous, adjust the pilot gas pressure regulator until a pilot flame is established.
l. When the pilot flame ignites properly and stays ignited, open the master switch and reconnect the main valve to the connector J5 terminal 3 (if removed in step g).
m. Close the master switch and return to Step 4.

7. When the pilot flame ignites, measure the flame signal. If the pilot flame signal is unsteady or approaching the flame threshold value (see flame threshold parameter), adjust the pilot flame size or detector sighting to provide a maximum and steady flame signal.

8. Recycle the system to recheck lightoff and pilot flame signal.

9. When the MAIN Valve energizes, make sure the automatic main fuel valve is open; then smoothly open the manual main fuel shutoff valve(s) and watch for main burner flame ignition. When the main burner flame is established, go to step 16.

10. If the main burner flame is not established within 5 seconds or the normal lightoff time specified by the equipment manufacturer, close the manual main fuel shutoff valve(s).

11. Recycle the system to recheck the lightoff and pilot flame signal.

12. Smoothly open the manual fuel shutoff valve(s) and try lightoff again. (The first attempt may have been required to purge the lines and bring sufficient fuel to the burner.)

13. If the main burner flame is not established within 5 seconds or the normal lightoff time specified by the equipment manufacturer, close the manual main fuel shutoff valve(s). Check all burner adjustments.

14. If the main burner flame is not established after two attempts:
   a. Check for improper pilot flame size.
   b. Check for excess combustion air at low fire.
   c. Check for adequate low fire fuel flow.
   d. Check for proper gas supply pressure.
   e. Check for proper valve operation.
   f. Check for proper pilot flame positioning.

15. Repeat steps 8 and 9 to establish the main burner flame; then go to step 16.

16. With the sequence in RUN, make burner adjustments for flame stability and Btu input rating.

17. Shut down the system by opening the burner switch or by lowering the setpoint of the operating controller. Make sure the main flame goes out. There may be a delay due to gas trapped between the valve(s) and burner. Make sure all automatic fuel valve(s) close.

18. Restart the system by closing the burner switch and/or raising the setpoint of the operating controller. Observe that the pilot flame is established during PILOT IGN and the main burner flame is established during MAIN IGN within the normal lightoff time.

19. Measure the flame signal. Continue to check for the proper flame signal through the RUN period. Check the flame signal at both High and Low Firing Rate positions and while modulating, if applicable.

20. Run the burner through another sequence, observing the flame signal for:
   a. Pilot flame alone.
   b. Pilot and main flame together.
   c. Main flame alone (unless monitoring an intermittent pilot). Also observe the time it takes to light the main flame. Ignition of main flame should be smooth.

21. Make sure all readings are in the required ranges before proceeding.

22. Return the system to normal operation.

NOTE: After completing these tests, open the master switch and remove all test jumpers from the connector terminals, limits/controls or switches.

Direct Burner Ignition (DBI) Systems

This check applies to gas and oil burners not using a pilot. It should immediately follow the preliminary inspection. Refer to the appropriate sample block diagram of field wiring for the ignition transformer and fuel valve(s) hookup.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this check.

1. Open the master switch.
2. Complete the normal ready-to-fire checkout of the fuel supply and equipment as recommended by the equipment manufacturer.
3. Close all manual main fuel shutoff valve(s). Check that the automatic fuel valve(s) is closed. Make sure fuel is not entering the combustion chamber.
4. Close the master switch and start the system with a call for heat by raising the setpoint of the operating controller; see R7910 and R7911 SOLA 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 R7910 or R7911 SOLA Module locks out and the ALARM LED turns on.
6. Let the R7910 or R7911Sola Module complete its cycle.
7. Open the manual fuel shutoff valve(s).
8. Push the reset button and the module recycles the program sequence through PREPURGE (if applicable).
9. When the fuel valve turns on during the ignition period, make sure that the main burner flame is established. If it is, go to step 14.
10. If the main burner flame is not established within 4 seconds or within the normal lightoff time specified by the equipment manufacturer, close the manual fuel shutoff valve(s), and open the master switch.
11. Wait about three minutes. Close the master switch, open the manual fuel shutoff valve(s), and try to lightoff the burner again. The first attempt may be required to purge the lines and bring sufficient fuel to the burner. If it is not established on the second attempt, proceed to step 13.
12. Check all burner adjustments.
13. Make the following ignition and main burner adjustments:

INTERNAL IGNITION SOURCE

To check the internal ignition, the R7910 or R7911 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 R7910 or R7911 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 R7910 or R7911 controller and observe the spark.
g. After obtaining a strong spark, open the master switch, re-install connector J5 to the R7910 or R7911 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 R7910 or R7911 controller to energize both the ignition transformer and the main fuel valve.
k. If the main flame does not ignite and if the ignition spark is still continuous, adjust the main burner gas pressure regulator until a main flame is established.
l. Check the main flame signal and ensure it is above the threshold level and within the manufacturer's recommendation.
m. Return to Step 8.

EXTERNAL IGNITION SOURCE

a. Open the master switch and remove the R7910 or R7911 SOLA module connector J5.
b. Ensure that the manual main burner fuel shutoff valve is closed.
c. On connector J5, jumper power to the ignition terminal, J5 terminal 4.
d. Close the master switch to energize only the ignition source.
e. If the ignition spark is not strong and continuous, open the master switch and adjust the ignition electrode spark gap to the manufacturer's recommendation.
f. Make sure electrodes are clean.
g. Close the master switch and observe the spark.
h. After obtaining a strong and continuous spark, open the master switch; remove the jumper between power and J5 terminal 4. Re-install the connector J5 to the R7910 or R7911 controller.
i. Open the manual main burner fuel shutoff valve.
j. Close the master switch.
k. Cycle the R7910 or R7911 controller to energize both the ignition source and the main fuel valve.
l. If the main flame does not ignite and if the ignition spark is still continuous, adjust the main burner gas pressure regulator until a main flame is established.
m. Check the main flame signal and insure it is above the threshold level and within the manufacture's recommendations.
n. Return to step 8.

14. When the main burner flame is established, the sequence advances to RUN. Make burner adjustments for flame stability and input rating.
15. Shut down the system by opening the burner switch or by lowering the setpoint of the operating controller. Make sure the burner flame goes out and all automatic fuel valves close.
16. If used, remove the bypass jumpers from the low fuel pressure limit.
17. Restart the system by closing the burner switch and/or raising the setpoint of the operating controller. Observe that the main burner flame is established during Main Ignition, within the normal lightoff time specified by the equipment manufacturer.
18. Measure the flame signal. Continue to check for the proper signal through the RUN period. Check the signal at both high and low firing rate positions and while modulating. Any pulsating or unsteady readings require further attention.
19. Make sure all readings are in the required ranges before proceeding.

NOTE: On completing these tests, open the master switch and remove all test jumpers, limits/controls or switches.

20. Return the system to normal operation.

PILOT TURNDOWN TEST (ALL INSTALLATIONS USING A PILOT)

Perform this check on all installations that use a pilot. The purpose of this test is to verify that the main burner can be lit by the smallest pilot flame that can hold in the flame amplifier and energize the FLAME LED. Clean the flame detector(s) to make sure that it detects the smallest acceptable pilot flame.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this test.

1. Open the master switch.
2. Close the manual main fuel shutoff valve(s).
3. Connect a manometer (or pressure gauge) to measure pilot gas pressure during the turndown test.
4. Open the manual pilot shutoff valve(s).
5. Close the master switch
   - Go to the S7999 Operator Interface Module.
   - 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 R7910 or R7911 SOLA 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 R7910 or R7911 SOLA 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 R7910 or R7911 controller to start a burner cycle. During the Main Flame Establishing Period, make sure the automatic main fuel valve(s) opens; then smoothly open the manual main fuel shutoff valve(s) (or any other manually-opened safety shutoff valve(s), if used) and watch for main burner ignition. If the lightoff is not rough and the main burner flame is established, go to step 18.

NOTE: This step requires two people, one to open the manual valve(s) and one to watch for ignition.

11. If the main burner flame is not established within 5 seconds, or within the normal lightoff time specified by the equipment manufacturer, close the manual main fuel shutoff valve(s) and open the master switch. If the lightoff is rough, the pilot flame size is too small.
12. Close the master switch and perform another pilot hold test (see step 5).
13. Increase the pilot flame size by increasing its fuel flow until a smooth main flame lightoff is accomplished.
14. Reposition the flame rod or the flame scanner sight tube or use orifices until the pilot flame signal voltage is in the range of 0.7 Vdc above the flame threshold value.
15. When the main burner lights reliably with the pilot at turndown, disconnect the manometer (or pressure gauge) and turn up the pilot gas flow to that recommended by the equipment manufacturer.
16. If used, remove the bypass jumpers from the terminals, limits/controls, or switches.
17. Run the system through another cycle to check for normal operation.
18. Return the system to normal operation.

IGNITION INTERFERENCE TEST (FLAME RODS)

Ignition interference can subtract from (decrease) or add to (increase) the flame signal. If it decreases the flame signal enough, it causes a safety shutdown. If it increases the flame signal, it could cause the FLAME LED to come on when the true flame signal is below the minimum acceptable value.

Start the burner and measure the flame signal with both ignition and pilot (or main burner) on, and then with only the pilot (or main burner) on. Any significant difference (greater than 0.5 Vdc) indicates ignition interference.

To Eliminate Ignition Interference

1. Make sure there is enough ground area.
2. Be sure the ignition electrode and the flame rod are on opposite sides of the ground area.
3. Check for correct spacing on the ignition electrode. (See manufacturer's recommendation.)
4. Make sure the leadwires from the flame rod and ignition electrode are not too close together.
5. Replace any deteriorated leadwires.
6. If the problem cannot be eliminated, consider changing the system to an ultraviolet flame detection system.

HOT REFRACTORY HOLD-IN TEST (ULTRAVIOLET DETECTORS)

This condition can delay response to flame failure and also can prevent a system restart if hot refractory is detected.

The ultraviolet detector can respond to hot refractory above 2300 F (1371 C).

1. When the maximum refractory temperature is reached, close all manual fuel shutoff valves, or open the electrical circuits of all automatic fuel valves.
2. Visually observe when the burner flame or FLAME LED goes out. If this takes more than 3 seconds, the detector is sensing hot refractory.
3. Immediately terminate the firing cycle. Lower the setpoint to the operating controller, or set the Fuel Selector Switch to OFF. Do not open the master switch.

NOTE: Some burners continue to purge oil lines between the valves and nozzles even though the fuel valves are closed. Terminating the firing cycle (instead of opening the master switch) allows purging of the combustion chamber. This reduces buildup of fuel vapors in the combustion chamber caused by oil line purging.

4. If the detector is sensing hot refractory, correct the condition by one or more of the following procedures:

a. Add an orifice plate in front of the cell to restrict the viewing area of the detector.
b. Resight the detector at a cooler, more distant part of the combustion chamber. Make sure the detector properly sights the flame.
c. Try lengthening the sight pipe or decreasing the pipe size (diameter).

For details, refer to the detector Instructions and the equipment Operating Manual. Continue adjustments until hot refractory hold-in is eliminated.

IGNITION SPARK RESPONSE TEST (ULTRAVIOLET DETECTORS)

Test to make certain that the ignition spark is not actuating the FLAME LED:

1. Open the master switch.
2. Close the pilot and main burner manual fuel shut-off valve(s).
3. Close the master switch
   - — Go to the S7999 Operator Interface Module.
   - — 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 R7910 or R7911 SOLA 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 R7910 or R7911 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 S7999 Operator Interface Module, 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 S7999 Operator Interface Module, select the Configure button (lower left corner of the Status page).
b. Using the left scroll down function, scroll down to select the System Configuration Parameter page (you will need to be logged in with a password).
c. Select Flame Sensor Type parameter.
d. Select UV Power Tube with Spark Interference.
e. Select the Burner Control Ignition Page.
f. Select Ignitor On During parameter.
g. Select 1st half of PFEP.
h. Changing these two parameters will require parameter verification.
i. Page back one level (upper right screen corner back arrow button).
j. Select the Verify button.
k. Select Begin.
l. Follow the prompts on the Operator Interface.

Response to Other Ultraviolet Sources

Some sources of artificial light (such as incandescent or fluorescent bulbs, and mercury sodium vapor lamps) and daylight produce small amounts of ultraviolet radiation. Under certain conditions, an ultraviolet detector responds to these sources as if it is sensing a flame. To check for proper detector operation, check the Flame Failure Response Time (FFRT) and conduct Safety Shutdown Tests under all operating conditions.

Flame Signal With Hot Combustion Chamber (All Installations)

1. With all initial start-up tests and burner adjustments completed, operate the burner until the combustion chamber is at the maximum expected temperature.
2. Observe the equipment manufacturer's warm-up instructions.
3. Recycle the burner under these hot conditions and measure the flame signal. Check the pilot alone, the main burner flame alone, and both together (unless monitoring only the pilot flame when using an intermittent pilot, or only the main burner flame when using DBI). Check the signal at both High and Low Firing Rate positions and while modulating, if applicable.
4. Lower the setpoint of the operating controller and observe the time it takes for the burner flame to go out. This should be within four seconds FFRT of the R7910 or R7911 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 R7910 or R7911 controller.
8. If the detector is relocated or resighted, or the R7910 or R7911 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 R7910 or R7911 SOLA Module to restart the system.

1. Open a Pre-Ignition Interlock (if PII parameter is enabled) during the STANDBY or PREPURGE period.
   a. *Pre-Ignition ILK* fault is displayed on the Operator Interface Module.
   b. Safety shutdown occurs.
2. Opening a Lockout Interlock during PREPURGE, PILOT IGN, MAIN IGN or RUN period.
   a. *Lockout ILK* fault is displayed on the Operator Interface Module.
   b. Safety shutdown occurs.
3. Detection of flame 240 seconds after entry to STANDBY from RUN. Detection of flame from 10 seconds up to 30 seconds into PREPURGE time.
   a. Simulate a flame to cause the flame signal voltage level to rise above the flame threshold value for 240 seconds after entry to STANDBY from RUN and also simulate a flame signal for 10 seconds to 30 seconds for PREPURGE.
   b. *Flame Detected out of sequence* fault is displayed on the Operator Interface Module.
   c. Safety shutdown occurs.
4. Failure to ignite pilot or Main Burner (DBI setup).
   a. Close pilot and main fuel manual shutoff valve(s).
   b. Cycle burner on.
   c. Automatic pilot valve(s) or main valves (DBI) should be energized but the pilot or main burner (DBI) cannot ignite.
   d. *Ignition Failure* fault is displayed on the Operator Interface to indicate the fault.
   e. Safety shutdown occurs.
5. Failure to ignite main (only interrupted pilot application).
   a. Open the manual pilot valve(s); leave the main fuel manual shutoff valve(s) closed.
   b. Depress the RESET button.
   c. Start the system.
   d. The pilot should ignite and the flame signal should be above the flame threshold value but the main burner cannot light.
   e. The flame signal should drop below the flame threshold value within the FFRT after the interrupted pilot goes out.
   f. *Ignition Failure* fault is displayed on the Operator Interface Module.
   g. Safety shutdown occurs.
6. Loss of flame during RUN.
   a. Open the main fuel manual shutoff valve(s) and open manual pilot shutoff valve(s).
   b. Depress the RESET button.
   c. Start the system. Start-up should be normal and the main burner should light normally.
   d. After the sequence is in the normal RUN period for at least 10 seconds with the main burner firing, close the manual main fuel shutoff valve(s) to extinguish the main burner flame. (On intermittent pilot applications, also, close the pilot manual shutoff valve.)
   e. The flame signal should drop below the flame threshold value within the FFRT of the R7910 or R7911 SOLA 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 R7910 or R7911 SOLA 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 R7910 or R7911 SOLA Module fails to shut down on any of these tests, take corrective action; refer to Troubleshooting and the SOLA 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 R7910 or R7911 SOLA Module self-diagnostics and first-out annunciation. In addition to an isolated spst alarm relay (audible annunciation), the R7910 or R7911 SOLA Module provides visual annunciation by displaying a fault code and fault or hold message at the S7999 Operator Interface Module. The R7910 and R7911 SOLA Modules provide many diagnostic and alert messages for troubleshooting the system.

Self-diagnostics of the R7910 and R7911 SOLA 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 R7910 or R7911 SOLA Module 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 SOLA Module.

The module provides diagnostic information to aid the service mechanic in obtaining information when trouble-shooting the system.

Diagnostic Information Index

The R7910 and R7911 SOLA 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 R7910 and R7911 SOLA 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 R7910 and R7911 SOLA modules retain fifteen alert files.

SERVICE NOTES:

1. Reset the device module by pressing the RESET push-button on the device or pressing a remote reset pushbutton wired into connector J10 or through the display. A power-up reset causes an electrical reset of the module but does not reset a lockout condition.
2. Use the connector screw terminals to check input or output voltage.

LEAD LAG

SOLA devices contain the ability to be a stand-alone control, operate as a Lead Lag Master control (which also uses the SOLA control function as one of the slaves), or to operate solely as a slave to the lead lag system.

SOLA devices utilize two ModBus™ ports (MB1 and MB2) for communications. One port is designated to support a system S7999B 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 SOLA control. It is not a part of that control, but is an entity that is “above” all of the individual SOLA 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 SOLA controls via Modbus.

The LL master uses a few of the host SOLA'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 Solas. 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 SOLA is turned on.
- When the operating point reaches the Setpoint plus the Off hysteresis then the last slave SOLA (or all slave SOLAs) 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.

This firing rate is sent to the slaves as a percentage, but this is apportioned to the slave Solas according to the rate allocation algorithm selected by the Rate allocation method parameter.

For some algorithms, this rate might be common to all slave Solas that are firing. For others it might represent the total system capacity and be allocated proportionally.

For example, if there are 4 slaves and the LL master's percent rate is 30%, then it might satisfy this by firing all four slaves at 30%, or by operating the first slave at 80% (20% of the system’s capacity) and a second slave at 40% (10% of the system’s capacity).

The LL master may be aware of slave SOLA’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 SOLA control. A SOLA 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 SOLA 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 SOLA that is receiving varying firing rate requests to track the load.

First stage This is the SOLA that was turned on first, when no slave Solas were firing.

Previous stage The SOLA that was added to those stages that are firing Just prior to the adding of the SOLA that is under discussion.

Next stage The SOLA that will or might be added as the next SOLA to fire.

Last stage The SOLA 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 SOLA 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 SOLA may be assigned to any of three groups: “Use First”, “Equalize Runtime”, or “Use Last”. If one or more Solas 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 SOLA 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.

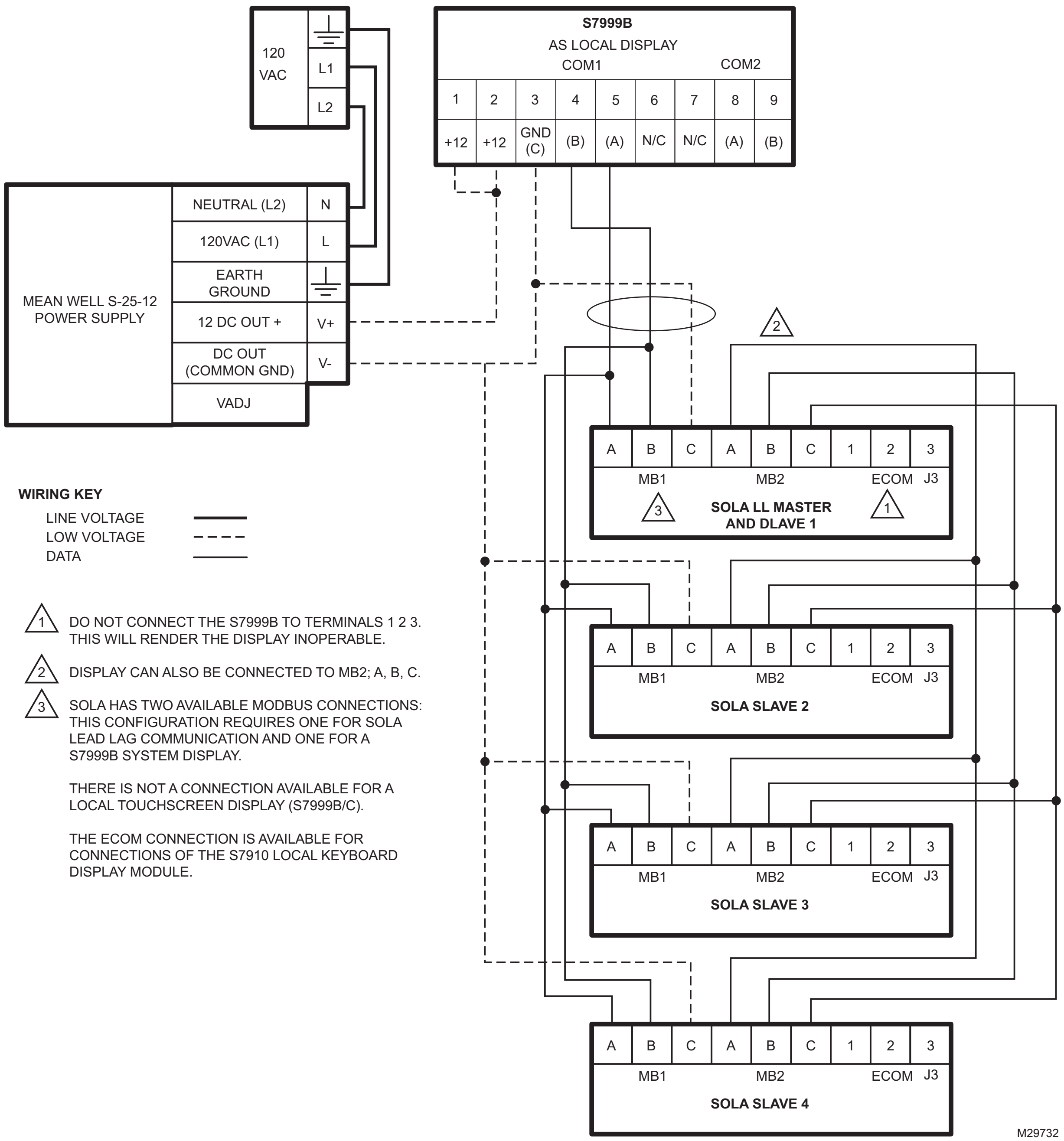


Fig. 28. S7999B system and lead lag wiring diagram.

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 19). 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 S7910 or S7999 display.
2. All SOLA controllers are programmed with a default address of 1.

Assuming the Master SOLA controller remains address 1, the address of the slave controllers in the system must have a unique address (1–8) via the local display.

Basic Operation

1. Firing rate determination – Parallel common-base limited
   a. All boilers have a single assignable base load firing rate.
   b. Allocation

(1) As load increases:
(a)Until all stages are firing - No stage is requested to exceed the common base load rate.
(b)After all stages are firing - There is no restriction on the slave's commanded firing rate.
(2) As load decreases:
(a)As long as all available stages are firing - There is no restriction on the slave's commanded firing rate.
(b)When at least one stage has been dropped - No stage is requested to exceed the common base load rate.

2. Rotation
a. The lead boiler is rotated based sequence order. The lead boiler rotation time is a configurable OEM parameter. Rotation is sequential by address (1-2-3-4; 2-3-4-1; etc.).
b. Rotation trigger occurs at the start of each new heat cycle.

3. Source of heat for call – The call for heat originates at the master boiler. This source can be configured to be an external thermostat or via EnviraCOM Remote Stat.

4. Slave boiler lockout – If any slave is in lockout the master boiler will cause it to be skipped and all system load setting calculation settings will be based only on available boilers.

5. Master boiler lockout – If the master boiler is in lock-out then its burner control function will be skipped in the rotation the same as the slave controllers. However, the master boiler function will continue to operate.

System Component Failure Responses

1. If the system header sensor becomes disconnected from the master boiler then the master boiler will control off of one of the following OEM configurable actions
a. Disable - No backup will be used.
b. Lead Outlet - Outlet temperature of the lead boiler will be used as the backup during firing.
c. Slave Outlet Average - Average of the outlet temperatures of all slave boilers that are firing will be used as a backup.

2. If the sensor chosen by the above parameter is faulty then the backup sensor provided may be used. When burner demand is off and no burners are firing, then, for either “Lead Outlet” or “Slave Outlet Average”, the lead boiler's outlet temperature is used to monitor for burner demand.

Local Display Configuration and Operation

1. The configuration parameters available on the local display are edited in the Service Mode.

2. Access to the Service Mode is accomplished by pressing both up/down buttons for 3 seconds.

3. Status and Operation
a. Slave status
(1) “Rmt” and “Adr” icons are on to show slave (follower) has been enabled.
(2) Current burner status is shown.
(3) To show slave CFH.
(a)Alternate “%” firing rate and actual (slave) Outlet temp to indicate slave CFH otherwise show the Home screen.
b. Master status
(1) Rmt icon is on, Adr icon is off to show Master (Leader) has been enabled.
(2) Current burner status is shown.
(3) Actual temperature LL (Header) temperature is shown as described in number 5 on page 76 below.
(4) Pressing the up/down buttons allows setpoint adjustment for LL-CH only (not LL-DHW or LL-Mix or others).
(a)All pump configurations must be done using the PC Configuration tool in the OEM factories.
(5) To show Master CFH
(a)Alternate “CH” or “LL” or “Hdr” in numbers field with the actual temperature to indicate LL CH CFH.

4. Configuration
a. Continue scrolling through set-up screens until “Remote Firing Control” screen is reached.
b. Rmt On/Off selection chooses to navigate the user through the Master/Slave configuration as existing today.
c. Set master/slave remote address as is done on currently on the local display.
d. The following parameters are mapped to Modbus addresses.
(1) “LL” = LL Operation (3 user selections available)
(a)“Ldr”
- Master Enable
- Slave Enable

(b)“SLA”
- Slave Only Enable
- Master Disable

(c)“OFF”
- Master Disable
- Slave Disable

(2) HS = On/Off Hysteresis (One value used for all LL boilers)
(a)“HS” for on and off hysteresis values.
- Only allow 1 setting for both on and off hysteresis values.
- Must adhere to the strictest of either the HS On or Off limits:
  Highest value of the “low” range limit in SOLA control
  Lowest value of the “high” range limit in SOLA control
- See SOLA 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 S7999).

5. In normal display operation the display allows a user to scroll through a list of temperatures with associated icons (CH, Inlet, Delta, DHW, Stack, Outdoor) using the Next button. With LL active the display will show the header temperature at the end of the list of temperatures as follows:
a. The characters “LL” are displayed in the number field.
b. When the next button is pressed again the temperature is displayed.
c. If the Up or Down buttons are pressed then the LL set-point is changed.

System Display Configuration

The following parameters are available for OEM configuration and may be adjusted through a System Display or programmed at the OEM production facility.

Table 35. OEM Configuration Parameters

Master SOLA	Slave SOLA
LL frost protection enable	Slave mode
LL frost protection rate	Base load rate
Base load rate	Slave sequence order
LL CH demand switch	LL Demand to firing delay
LL CH set point source	
LL Modulation sensor	
LL Base load common	
LL Modulation backup sensor	
LL CH 4mA water temperature	
LL Lead selection method	
LL CH 20mA water temperature	
LL Lag selection method	
LL Add stage method 1	
LL Add stage detection time 1	
LL Add stage error threshold	
LL Add stage rate offset	
LL Add stage inter-stage delay	
LL Drop stage method 1	
LL Drop stage detection time 1	
LL Drop stage error threshold	
LL Drop stage rate offset	
LL Lead rotation time	
LL Force lead rotation time	
LL Drop stage inter-stage delay	

Slave Operation and Setup

Slave Data Supporting Lead Lag

This data is provided by each slave SOLA control to support operation when a LL master exists. Fig. 29 summarizes the slave's registers and data:

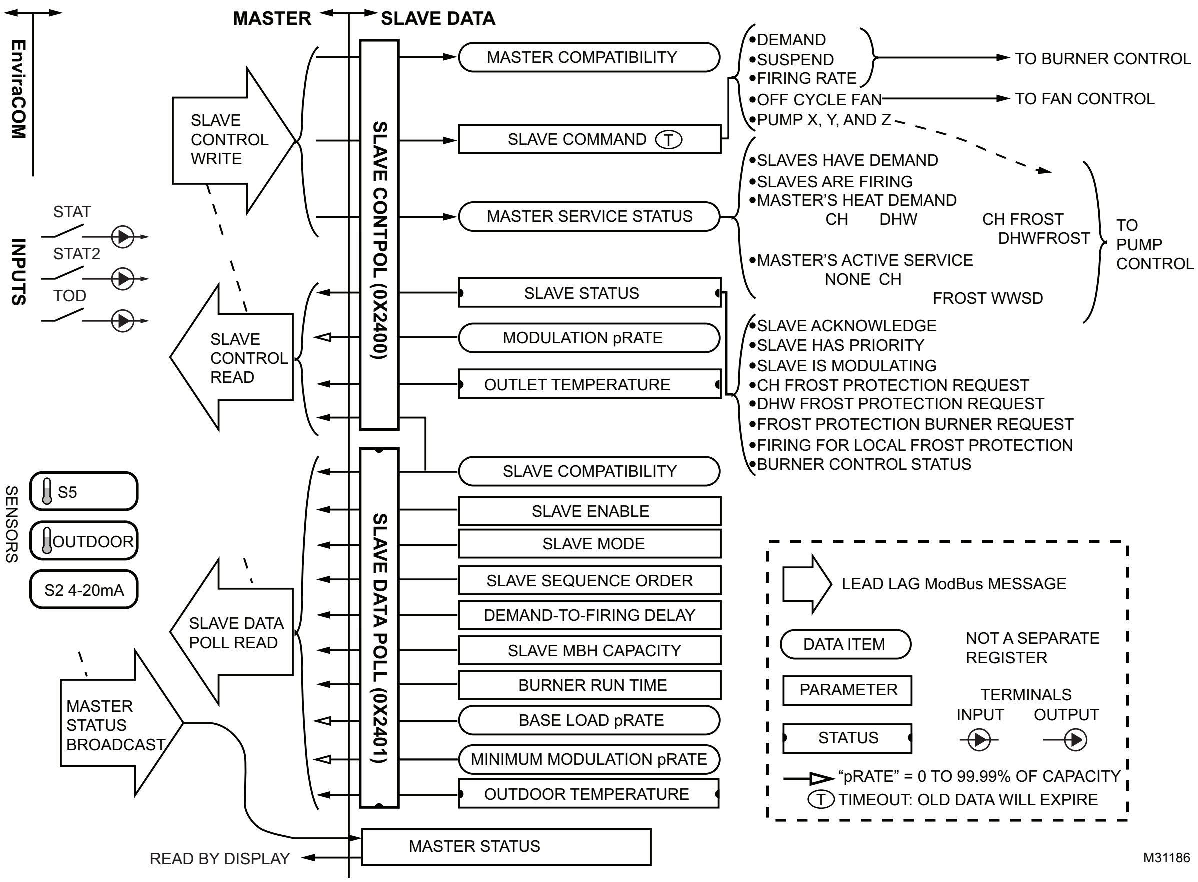


Fig. 29. Master/Slave data transmission.

Table 36. Slave Data Supporting Lead Lag Parameters.

Parameter	Comment
LL - Slave enable	Disable, Enable via Modbus, Enable for SOLA 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 SOLA Master option LL - Slave write and LL - Slave read parameters; if "Enable for SOLA Master" is not selected, then these parameters are disabled.
LL - Slave write	data This allows the slave to accept command messages from a SOLA master.
LL - Slave read	data This provides the slave status message to be read by a SOLA 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 SOLA will be used prior to using other slave Solas with other values. If this parameter is set to Equalize Runtime, then this slave SOLA will be staged according to a run time equalization. (Any Solas set to Use First will precede any that are set to Equalize Runtime.) If this parameter is set to Use Last, then this slave SOLA will be used only after all Use First and Equalize Runtime Solas have been brought online.

Table 36. Slave Data Supporting Lead Lag Parameters. (Continued)

Parameter	Comment
LL - Slave priority sequence order	0-255 Slave sequence order is used to determine the order in which the slave Solas will be used (staged on) for those Solas 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 SOLA 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 SOLA controls will be used in a round-robin scheme. If the slave sequence number value is zero, then the slave SOLA's modbus address will be used instead. If two Solas are set 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 SOLA to fire and detecting that it has failed to start. It should be set to the total time normally needed for the burner to transition from Standby to Run, including such things as transition to purge rate, prepurge time, transition to lightoff rate, all ignition timings, and include some extra margin.
LL - Base load rate	rpm or % This specifies the preferred firing rate of a burner, which is used for some types of control.
LL - Fan during off-cycle rate	rpm or % (0=disable) This determines if or where the fan is to be operating during the standby period.

LL Master Operation and Setup

LL master operation is subdivided into the following functions:

Overall control - The LL master has parameters that enable and disable its operation.

Periodic data polling - The LL master uses polling to discover new slave SOLA devices and to periodically refresh the information it has about a known slave SOLA 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 SOLA that is enabled as a slave device.

Demand and priority - Different sources of demand can cause the LL master to operate in different ways. These sources have a priority relationship.

Rate control - Each demand source has one or more setpoints that may be active and an operation sensor. These are used to detect turn-on and turn-off conditions. The difference between operating point and setpoint is sent to a PID block to determines the LL master's firing rate.

Rate allocation - The PID block's output is used to determine the firing rate of each slave SOLA using various rate allocation techniques.

Stager - The stager determines when slave Solas should turn on as the need for heat increases, and when they should turn off as it decreases.

Add-stage methods - Various methods can be used to determine when a new stage should be added.

Drop-stage methods - Various methods can be used to determine when a stage should be dropped

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

Table 37. Overall Control Parameters.

Parameter	Comment
LL master enable	Disable, Enable
LL master Modbus port	MB1, MB2 The LL master may be disabled, enabled. If Disable is selected then all LL master functions are inactive. If Enable is selected then it acts as the active bus master at all times on the modbus port it is assigned to use by the LL Master Modbus port parameter.
LL operation switch	Off, On This controls the LL master in the same way that the Burner switch controls a stand-alone SOLA. If “On” then the LL master is enabled to operate. If this parameter is “Off” then the LL master turns off all slaves and enters an idle condition.

Periodic Data Polling Messages

The LL master will poll to discover all the slave devices when it starts up. Thereafter it polls the known devices to make sure they are still present and to obtain updated status information. It also periodically polls the entire slave address range to discover any new slave devices.

A polled SOLA 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 38.
f. CT - Burner run time. See Table 38.

Table 38. 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 SOLA 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 SOLA 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 Solas 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 SOLA 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

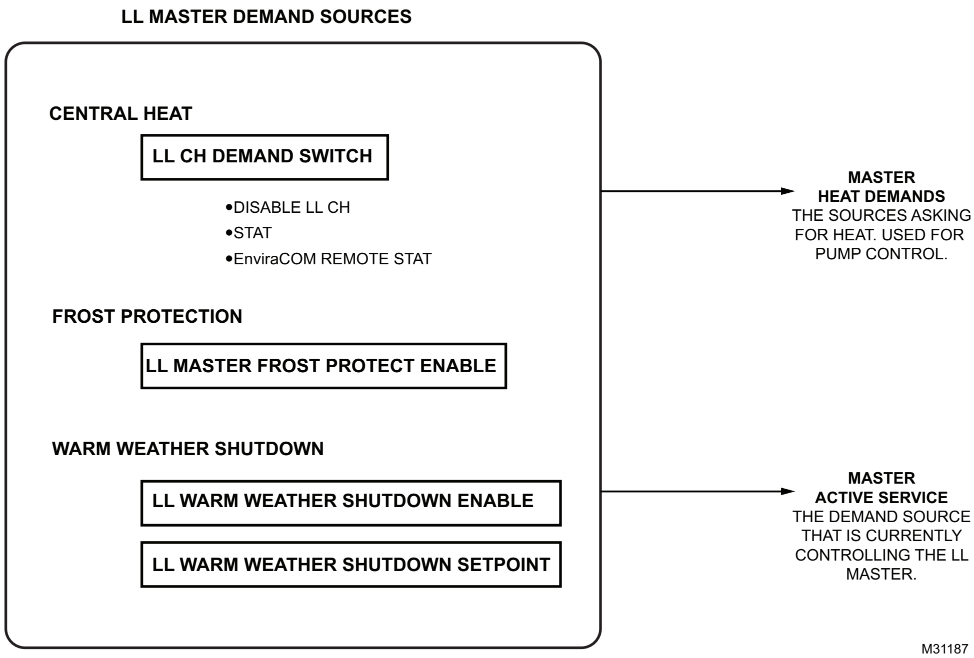


Fig. 30. LL Master demand sources.

CH DEMAND

Table 39. 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 40. Warm Weather Shutdown (WW-SD) Parameters.

Parameter	Comment
Warm weather shutdown enable	Disable, Shutdown after demands have ended, Shutdown immediately

Table 40. Warm Weather Shutdown (WW-SD) Parameters. (Continued)

Parameter	Comment
Warm weather shutdown setpoint	Temperature or None When warm weather shutdown is Disabled then it has no effect (i.e. the Warm Weather Shutdown (WW-SD)) status shown on the priority diagram is false). These two parameters are shared by the stand-alone SOLA control and the LL master and have the same effect for either control. If it is enabled then it uses a 4°F (2.2°C) hysteresis: If WW-SD) is false, then when the Outdoor temperature is above the value provided by **Warm weather shutdown setpoint** then: If **Shutdown after demands have ended** is selected then any current CH demand that is present prevents WW-SD) from becoming true; that is if CH demand is false then WW-SD) becomes true. Otherwise if **Shutdown immediately** is selected then WW-SD) becomes true, it immediately causes CH demand to end. If WW-SD) is true, then when the Outdoor temperature is below the value provided by **Warm weather shutdown setpoint** minus 4°F then WW-SD) becomes false. When warm weather shutdown is true then: New occurrences of CH demand is inhibited. DHW demand is not affected.

Frost Protection

LL master frost protection is enabled with the LL - Frost protection enable parameter.

The need for frost protection is actually detected independently by each slave, which notifies the master whether frost detection occurred in CH frost detection, and/or its DHW frost detection, and whether it is severe enough to require burner firing as well as pump operation. This is done via its BC - Slave status parameter.

If LL - Frost protection enable is Enable, then the master's LL - Slave write message, will indicate CH or DHW frost protection or both as read from each slave's BC - Slave Status. This will cause any slave pumps which are enabled to follow this status to turn on without any other action required from the master.

If any slave is indicating CH or DHW frost protection, and additionally that slave's BC - Slave status register indicates burner firing is requested then the LL master's frost protection burner demand will be true.

If the priority scheme allows the master to honor this demand, then it will fire a single burner (the current lead burner as specified by the sequencer) at the rate indicated by LL - Frost protection rate: 0-100%. (100% represents 100% firing of this boiler, and where 0% or any value less than the boiler's minimum firing rate represents the minimum firing rate).

Modulation

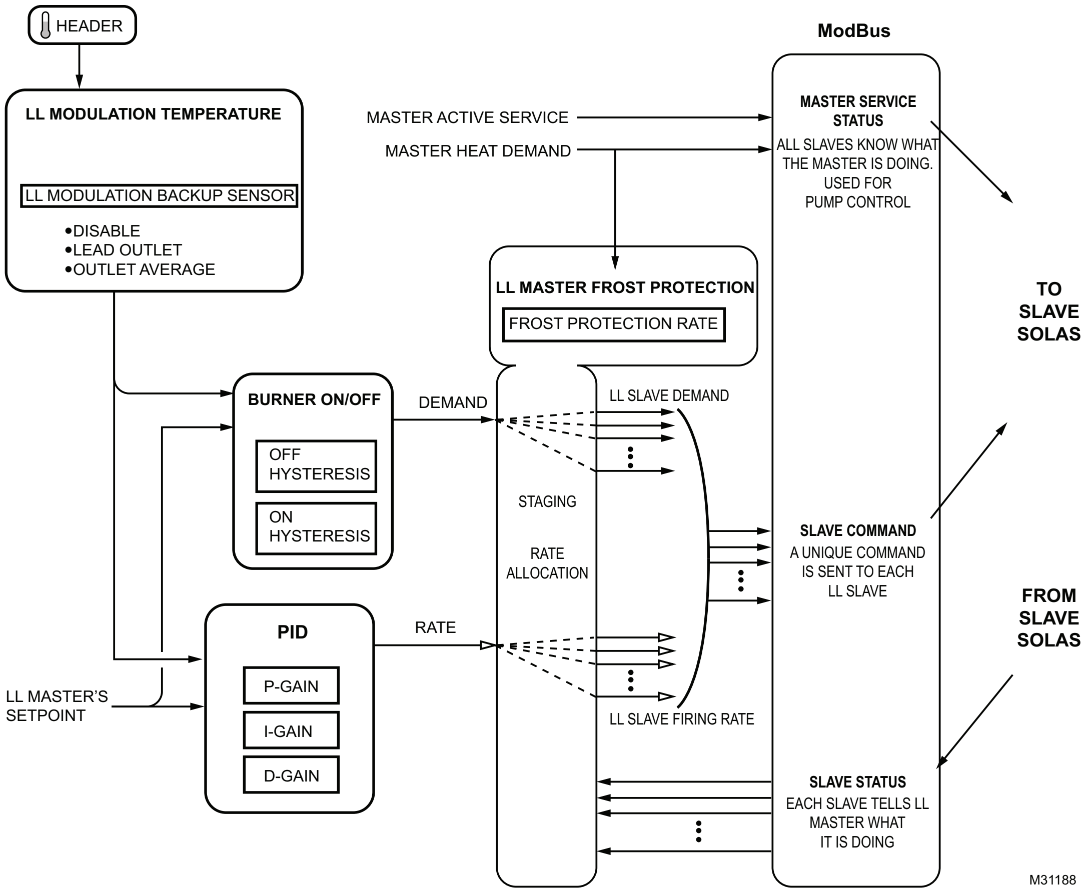


Fig. 31. Modulation.

Modulation Sensor

Table 41. Modulation Sensor Parameters.

Parameter	Comment
LL Modulation sensor	S10 The LL master's modulation sensor uses the S10 sensor wired at J10 terminal 7 and 8. If the LL master is enabled and its sensor is faulty then an alert will be issued.
LL Modulation backup sensor	Disable, Lead Outlet, Slave Outlet Average If the sensor chosen by the LL Modulation sensor is faulty then the backup sensor provided here may be used. If **Disable** is selected then no backup will be used. If **Lead Outlet** is selected then the outlet temperature of the lead boiler will be used as the backup during firing. If **Slave Outlet Average** is selected then average of the outlet temperatures of all slave boilers that are firing will be used as a backup.

When the burner demand is off and no burners are firing then, for either Lead Outlet or Slave Outlet Average, the lead boiler's outlet temperature is used to monitor for burner demand.

Setpoints

Table 42. Setpoint Parameters.

Parameter	Comment
LL CH Setpoint source	Local, S2 4-20mA If the setpoint source is Local then the SOLA control's local setpoint system is used. This setting enables the normal use of the CH setpoint, CH TOD setpoint, and the CH outdoor reset parameters and functions. If the setpoint source is S2 4-20mA then the setpoint is determined by the 4-20mA input on S2, and the two parameters described below. If the 4-20mA signal goes out of range or is invalid, and this persists for a specified time, then the setpoint source reverts to “Local”. In this case once it has gone to “Local”, it remains that way until the 4-20mA signal is stable again.
LL CH 20mA Water Temperature CH 4mA Water Temperature	Temperature or None These provided the 20mA and 4mA temperatures for the interpolation curve. If either of these have the None value, are invalid, are out of range, or are too close for interpolation, an alert is issued and the setpoint reverts to “Local” when it is selected as 4-20mA.
LL CH setpoint	Degrees or None This setpoint is used when the time-of-day input is off. If the ODR function is inactive then the setpoint is used as-is. If the ODR function is active then this setpoint provides one coordinate for the outdoor reset curve.
LL CH TOD setpoint	Degrees or None This setpoint is used when the time-of-day input is on. If the ODR function is inactive then the setpoint is used as-is. If the ODR function is active then this setpoint provides one coordinate for the shifted (because TOD is on) outdoor reset curve.
LL CH ODR minimum water temperature	Degrees or None This specifies the minimum outdoor reset setpoint for the LL master. If the outdoor reset function calculates a temperature that is below the temperature specified here, then this parameter's temperature will be used. If this parameter is invalid or None then the outdoor reset function will be inhibited and will not run: if it is enabled then an alert is issued.

TIME OF DAY

The Time of Day has one sources of control: a switch contact. Closed TOD is an on condition; open, then TOD is off.

OUTDOOR RESET

The outdoor reset for the LL CH functions are implemented as described for a stand-alone CH loop.

Each of the loops which implements outdoor reset and boost has its own parameters. The parameters used by the LL master are:

- LL setpoint
- LL CH TOD setpoint
- LL CH ODR minimum outdoor temperature: degrees or None
- LL CH ODR maximum outdoor temperature: degrees or None
- LL CH ODR low water temperature: degrees or None

Demand and Rate

ON/OFF HYSTERESIS

Includes hysteresis shifting at turn-on, turn-off.

Table 43. 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 SOLA includes a feature to smooth the response when a rate override has occurred (such as delta-T rate limit) causing the PID output to be ignored.

Whenever an override has occurred then, at the moment the override ends, the integrator is loaded with a value that causes the PID output to match the current rate, whenever this is possible within the integrator's limits. The Lead Lag PID will implement similar behavior: The rate allocator will provide a trigger that causes the integrator's value to be recomputed and this trigger will activate whenever a rate allocation limit is released; that is, this event will occur any time the system transitions from the condition in which it is not free to increase the total modulation rate, to the condition where this rate may increase.

Implementation:
The examples below are ways in which this may occur, but in implementation what is necessary, first of all, is to use a rate allocator that assigns rate to each slave and can detect when all of the assigned rate is absorbed, or if there is excess requested rate that the firing stages could not absorb.

Then:

1. Whenever the system is rate limited, that is, when A) all firing stages are commanded to their respective maximums and also B) the PID is asking for more heat than that, note that this has occurred by setting a flag and also record total rate that the system absorbed (the total of the commanded maximums, not the PID's requested rate which might include excess).
2. Whenever the rate allocator completes an execution pass and detects that both conditions of step 1 are no longer true (demand has decreased) then it clears the flag.
3. Whenever the rate allocator completes an execution pass and detects both conditions of step 1 are true, and it also detects that the total rate potentially absorbed by the system (the commands have not yet been sent) has increased from the value that was saved when the flag was set, then it re-computes the integrator value based on the old commanded maximum, clears the flag, and actually allocates the old rate that was saved when the flag was set.

Examples include:

- The rate allocator has encountered a limit such as base load (for a "limited" rate allocation scheme) and this limit is released.
- All stages are at their maximum (base load, or max modulation) and one or more stages are rate-limited (such as due to slow-start or stepped modulation limiting due to high stack temperature, etc.) and the rate limited stage recovers, changing from rate-limited to free to modulate. (This is indicated by the Slave Status "slave is modulating" bit: the changing of this bit from false to true is not, itself, a trigger, but while it is true the rate allocator can assign to the slave only the firing rate that it is reporting; thus the release of this might allow more rate to be absorbed by the system. It also might not do this, if for example the slave was in anticondensation and thus the rate limit was maximum modulation rate.)
- All firing stages are at their maximum (base load, or max modulation) and a stage which was OnLeave returns in the firing state and is available for modulation.
- An add-stage is in-progress and all firing burners are at their limits (max modulation rate or base load) and then the new stage becomes available.

This also applies when the system is first starting up, that is, all firing burners are at their limits (zero) because non are firing, and thus when the add-stage is finished the system transitions from no modulation at all, to modulating the first stage.

LEAD LAG BURNER DEMAND

Lead Lag burner demand will be present when Frost protection burner demand is true, as described the section on Frost protection. For the CH, and DHW demand sources, Lead Lag burner demand will be true when one of these is true and also setpoint demand from the hysteresis block is true.

Rate Allocation

All rate allocation methods share certain features.

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

It next runs a rate allocator that depends upon the rate allocation method. This routine fills in the modulation rate for all Firing boilers.

Each rate allocation method also provides functions to return identification of the modulating stage and the last stage, for use by the Add-stage and Drop-stage methods.

Table 44. 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 Methods

PARALLEL COMMON-BASE LIMITED

Allocation All stages that are Firing receive the same firing rate. Only the LL - Base load common parameter is used for base loading, the individual slave's base load values are ignored.

As load increases:
Until all stages are Firing: No stage is requested to exceed the common base load rate.

After all stages are Firing: There is no restriction on the slave's commanded firing rate.

As load decreases:
As long as all available stages are Firing, there is no restriction on the slave's commanded firing rate.

When at least one stage has been dropped: No stage is requested to exceed the common base load rate.

Modulating stage Since all Firing stages receive the same rate, any stage can be considered to be the modulating stage. The one with the highest StagingOrder number is considered to be the modulating stage.

Last stage The stage with the highest StagingOrder number is the last stage.

Overflow and Underflow For the Parallel common-base limited the LL - Base load common parameter provides the overflow threshold.

For the Parallel common-base limited the minimum modulation rate provides the underflow threshold.

Stager

The Stager is an internal program that manages the lead lag functions. In all cases:

- The first burner turns on due to the combination of heat demand (call for heat from a source) and setpoint demand (operating point falls below the setpoint minus the on hysteresis).
- The last burner (or all burners) turn off due to the loss of burner demand which is caused by either the loss of heat demand (no call for heat from any source) or the loss of setpoint demand (the operating point climbs above the setpoint plus the off hysteresis).
- In between those two extremes the Add-stage and Drop-stage methods determine when staging occurs.

Table 45. 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 46. Adding Stages Parameters.

Parameter	Comment
LL - Add-Stage detection time1	mm:ss This provides time thresholds.
LL - Add-Stage method1	Disable, Error threshold, Rate threshold, dError/dt and threshold, dRate/dt and threshold In the descriptions below, the relevant AddStageDetectTimer is referred to as AddStageDetectTimerN.
LL - Add-stage error threshold	degrees This provides the error threshold as defined by the methods below.
LL - Add-stage rate offset	-100% to +100% This provides the rate offset threshold as defined by the methods below.

Add-stage Methods

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

Add-stage condition:

- The modulating burner(s) is at its (their) maximum position per the rate allocation rules,
- The operating point is below the setpoint by an amount greater than or equal to LL - Add-stage error threshold

When the Add-stage condition is false then AddStageDetectTimerN is set to zero. (If the condition is true then AddStageDetectTimerN is not zeroed and thus allowed to run.) If this timer reaches or exceeds LL- Add-stage detection timeN then AddStageRequestN is true.

Rate threshold For rate based staging, a stage is added based on the rate of the modulating stage.

Add-stage condition The modulating burner is at a rate that is at or above the rate which is calculated by adding the LL - Add-stage rate offset to the maximum position per the rate allocation rules.

Examples:

rate offset = 20% The add-stage condition will occur if the modulating stage is 20% above base load for unlimited allocations, or, if limited, when there is 20% more rate to distribute than can be absorbed by firing the stages at base load.

rate offset = -20% The add-stage condition will be as described just above, but the threshold is now 20% below the modulating stage's base load rate.

To support this, the current Rate Allocation method asks for the current “Overflow rate” - see the Rate Allocator section.

Dropping Stages

The internal algorithms that generate DropStageRequests are called Drop-stage methods. One or two methods may be active at any time. If two are active then their requests are OR'd together. All methods work by observing various criteria such as the Firing stages, the commanded rate, or Setpoint.

Dropping Stages Parameters:

Table 47. 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 47. Dropping Stages Parameters. (Continued)

Parameter	Comment
LL - Drop-stage error threshold	degrees This provides the error threshold as defined by the methods below.
LL - Drop-stage rate offset	-100% to +100% This provides the rate offset threshold as defined by the methods below.

Drop-stage Methods

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

Drop-stage condition:
- The modulating burner(s) is at its (their) minimum position per the rate allocation rules,
- The operating point is above the setpoint by an amount greater than or equal to LL - Drop-stage error threshold

When the Drop-stage condition is false then **DropStageDetectTimerN** is set to zero. (If the condition is true then **DropStageDetectTimerN** is not zeroed and thus allowed to run.) If this timer reaches or exceeds **LL - Drop-stage detection timeN** then **DropStageRequestN** is true.

Rate threshold For rate based staging, a stage is dropped based on the rate of the last stage.

Drop-stage condition
The modulating burner(s) is at a rate that is at or below the minimum modulation rate plus a rate offset.

Examples:

rate offset = 20% The Drop-stage condition will occur when the last stage is less than a threshold that is the minimum modulation rate plus another 20%.

rate offset = 0% The Drop-stage condition will occur when the last stage is at the minimum modulation rate.

rate offset = -20% The Drop-stage condition will occur if the last stage is at minimum modulation and there is 20% less rate to distribute than can be absorbed; that is, the rate allocator would like the minimum modulation rate to be lower than it is.

To support this, the current Rate Allocation method asks for the current “Underflow rate” - see “Rate Allocation Methods” on page 86.

Sequencer

The sequencer determines which SOLA 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 48. Sequencer Parameters.

Parameter	Comment
LL - Lead selection method	Rotate in sequence order, Measured run time This determines the selection method for lead selection and sequencing, as described below.
LL - Lag selection method	Sequence order, Measured run time This determines the selection method for lag selection and sequencing, as described below.
LL - Lead rotation time	hh:mm or None This determines the lead rotation time as defined below.
LL - Force lead rotation time	hh:mm or None If this parameter is a non-zero time, then it is used to force the rotation of the lead boiler if it stays on longer than the time specified.

Sequencer Add Boiler Selection

The sequencer selects the next boiler to be added according to a sorted order. This description assumes this is implemented by assigning an ordering number and that the lowest numbers are the first to be added.

- Any Available slaves that have a mode of Use First will have the lowest ordering numbers. If two or more Use First boilers exist, they are numbered according to their assigned LL - Slave sequence order or Modbus address if this value is zero, as described above.
- Next are slaves that have the mode of Equalize Runtime. When the add boiler routine gets to this group it first invokes the Voluntary Lead Rotation routine (to make sure this is done, but only once) and then selects an Available boiler, if any, ordered according to:
    - The first is the lead boiler per the LeadBoilerSeqNum parameter.
    - The rest are the other slaves ordered according to the LL –Lag selection method} parameter:
- If this parameter is “Rotate in sequence order”, then they are ordered according to their LL – Slave sequence order or Modbus address if this value is zero, as described above.

- If this parameter is “Measured run time” then they are ordered according to their reported run time. If two have the same measured run time, then either may be selected.
- Last are any Available slaves that have a mode of Use Last. These will have the highest numbers. If two or more Use Last boilers exist, they are numbered according to their assigned LL - Slave sequence order or Modbus address if this value is zero, as described above.

Voluntary Lead Rotation

The current lead boiler is identified by the LeadBoilerSeqNum value. This value will change when the stager has asked the sequencer for a boiler to add and either:

- the boiler identified by LeadBoilerSeqNum is neither Available nor Firing (i.e. it has a fault or is OnLeave), or
- the LeadBoilerRunTime value exceeds LL - Lead rotation time.

In either of these cases, the algorithm performed is:

If the **LL - Lead selection method** is “Rotate in sequence order”, then
LeadBoilerSeqNum is incremented, and then new lead boiler is the one that is a slave in Equalize Runtime mode that is responding to the LL master (i.e. not OnLeave or Recovering, but it might be Firing), and:

- has a sequence number equal to LeadBoilerSeqNum, or
- If no boiler has this then the closest one with a sequence number greater than this number is used, or
- If no boiler has a greater sequence number, then the one that has the smallest sequence number is used (wrap around).

Otherwise when the LL - Lead selection method is “Measured run time”, then the lead boiler is the one having the lowest Measured run time value. If two have the same measured run time, then either may be selected.

The LeadBoilerRunTime value is then set to zero to give the new lead boiler a fresh allotment.

NOTE: if the old lead boiler is the only one, then this process may end up redesignating this as the “new” lead with a fresh time allotment.

Forced Lead Rotation

When the boiler identified by LeadBoilerSeqNum is firing and also LeadBoilerRunTime reaches the LL - Force lead rotation time parameter time then:

1. The current lead boiler is noted.
2. Lead rotation occurs as described above under Voluntary Lead Rotation (this changes the designation, but does not change the actual firing status).

SLAVE WRITE: DATA

This allows the slave to accept command messages from a SOLA master.

SLAVE READ: DATA

This provides the slave status message to be read by a SOLA 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 SOLA will be used prior to using other slave Solas with other values.
- If this parameter is set to Equalize Runtime, then this slave SOLA will be staged according to a run time equalization. (Any Solas set to Use First will precede any that are set to Equalize Runtime.)
- If this parameter is set to Use Last, then this slave SOLA will be used only after all Use First and Equalize Runtime Solas have been brought online.

SLAVE PRIORITY SEQUENCE ORDER: 0-255

Slave sequence order is used to determine the order in which the slave Solas will be used (staged on) for those Solas 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 SOLA 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 SOLA controls will be used in a round-robin scheme.

If the slave sequence number value is zero, then the slave SOLA's ModBus address will be used instead.

If two Solas are set 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 the appendix of the R7910 and R7911 SOLA Modules.

APPENDIX A: PARAMETER GLOSSARY

R7910A parameter glossary can be found in Table 49.

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
20 mA CH pressure	PSI or None Establishes the pressures for the end points of the 4-20 mA inputs	31
4 mA water temperature	Degrees Establishes temperature for 4 mA input	27
20 mA water temperature	Degrees Establishes temperature for 20 mA input	27
Absolute max fan speed	The fan will never be commanded to operate above the RPM provided by this parameter, regardless of the rate request.	52
Absolute min fan speed	The fan will never be commanded to operate below the RPM provided by this parameter, regardless of the rate request, except by commanding it to turn off.	52
Alarm silence time	Alarms can be silenced for the amount of time given by this parameter.	64
Analog output hysteresis	When modulating via 0-10V or 4-20mA, changes in the direction of PID output can be limited by a small amount of hysteresis, to decrease the occurrence of actual control reversals.	53
Annunciation enable	This parameter determines whether the Annunciator features of the R7910 are active. When disabled, the R7910 will ignore the Annunciator inputs (because the application does not use this feature).	21
Annunciator 1 location	The location of the contacts monitored by the A1 annunciator input.	62
Annunciator 1 long name	The long name (up to 20 characters) of the A1 annunciator input.	62
Annunciator 2 location	The location of the contacts monitored by the A2 annunciator input.	62
Annunciator 2 long name	The long name (up to 20 characters) of the A2 annunciator input.	62
Annunciator 3 location	The location of the contacts monitored by the A3 annunciator input.	62
Annunciator 3 long name	The long name (up to 20 characters) of the A3 annunciator input.	62
Annunciator 4 location	The location of the contacts monitored by the A4 annunciator input.	62
Annunciator 4 long name	The long name (up to 20 characters) of the A4 annunciator input.	62
Annunciator 5 location	The location of the contacts monitored by the A5 annunciator input.	62
Annunciator 5 long name	The long name (up to 20 characters) of the A5 annunciator input.	62
Annunciator 6 location	The location of the contacts monitored by the A6 annunciator input.	62
Annunciator 6 long name	The long name (up to 20 characters) of the A6 annunciator input.	62
Annunciator 7 location	The location of the contacts monitored by the A7 annunciator input.	62
Annunciator 7 long name	The long name (up to 20 characters) of the A7 annunciator input.	62
Annunciator 8 location	The location of the contacts monitored by the A8 annunciator input.	62
Annunciator 8 long name	The long name (up to 20 characters) of the A8 annunciator input.	62

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Annunciator mode	The annunciator may be fixed, in which the labels and locations of the inputs is pre-assigned, or programmable in which these things may be altered.	62
Annunciator 1 short name	The short (3 letter) name of the contacts monitored by the A1 annunciator input.	62
Annunciator 2 short name	The short (3 letter) name of the contacts monitored by the A2 annunciator input.	62
Annunciator 3 short name	The short (3 letter) name of the contacts monitored by the A3 annunciator input.	62
Annunciator 4 short name	The short (3 letter) name of the contacts monitored by the A4 annunciator input.	62
Annunciator 5 short name	The short (3 letter) name of the contacts monitored by the A5 annunciator input.	62
Annunciator 6 short name	The short (3 letter) name of the contacts monitored by the A6 annunciator input.	62
Annunciator 7 short name	The short (3 letter) name of the contacts monitored by the A7 annunciator input.	62
Annunciator 8 short name	The short (3 letter) name of the contacts monitored by the A8 annunciator input.	62
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.	51
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.	51
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.	51
Anticondensation Priority	Anticondensation is more important than (check those that apply): Stack limit, Delta T limit, Slow start, Forced rate, Outlet high limit	51
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.	51
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.	51
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.	22
BLR function	This parameter selects the function for the output terminal—J5 Terminal 5 and 6.	57
Burner name	This parameter allows each control to have a unique name.	21
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.	20
CH anticondensation enable	This parameter enables or disables anti-condensation for CH and LL demand.	51
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.	51
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.	51
CH D gain	This gain applied to the Differential term of the PID equation for the CH loop.	27
CH Demand source	Local, Modbus, 4-20 mA	27
CH demand switch	The source of CH loop control can be specified to use different inputs.	26

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
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.	20
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.	49
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.	49
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.	42
CH has Priority over Lead Lag	Yes, No, Cancel	20
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.	27
CH I gain	This gain applied to the Integral term of the PID equation for the CH loop.	27
CH maximum modulation rate	Provides the upper limit of analog output or fan speed during modulation when firing for CH.	52
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.	28
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).	28
CH minimum pressure	Provides the minimum Steam Pressure used to calculate the 4-20mA remote controlled setpoint.	31
CH minimum water temperature	This parameter provides the CH setpoint when the outdoor reset temperature is at its defined maximum.	28
CH ODR boost setup	Degrees or None	28
CH ODR boost recovery setup time	mm:ss	28
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.	28
CH ODR minimum outdoor temperature	This parameter determines the X coordinate of one point on the ODR graph. At that outdoor temperature, the setpoint will be the CH setpoint (or the CH TOD setpoint, if TOD Is on).	28
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.	28
CH off hysteresis	The off hysteresis is added to the CH setpoint to determine the temperature at which this demand turns off	27
CH on hysteresis	The on hysteresis is subtracted from the Setpoint to determine the temperature at which demand turns on.	27
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.	27
CH P gain	This gain applied to the proportional term of the PID equation for the CH loop.	27
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.	42
CH sensor or Inlet	The sensor used for modulation and demand may be either the Outlet sensor or a 4-20mA Header sensor input.	26
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.	27
CH setpoint source	Local S2 (J8-6) 4-20mA	27

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
CH slow start enable	This parameter enables or disables the slow start limit function for CH (or LL slave) demand.	50
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.	27
DBI time	None, 4 sec, 10 sec, 15 sec	59
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.	45
Delta-T delay	This parameter provides the delay time for the Delta-T limit.	45
Delta-T enable	This parameter enables or disables the entire delta-T limit function.	45
Delta-T exch/outlet enable	Disable, Enable Delta-T, Enable Inversion Detection, Enable Delta-T and Inversion Detection.	45
Delta-T inlet/exch enable	Disable, Enable Delta-T, Enable Inversion Detection, Enable Delta-T and Inversion Detection.	44
Delta-T inlet/outlet enable	Disable, Enable Delta-T, Enable Inversion Detection, Enable Delta-T and Inversion Detection.	44
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.	45
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.	45
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.	45
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.	45
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.	45
DHW anticondensation enable	This parameter enables or disables anti-condensation for the DHW sensor.	51
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.	51
DHW Connector Type	Designates the Sensor type connected to the control for proper reading.	21
DHW D gain	This gain applied to the Differential term of the PID equation for the DHW loop.	35
DHW demand switch	The source of DHW loop control can be specified to use different inputs.	35
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.	20
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.	49
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.	49
DHW frost overrun time	This time indicates how long the DHW pump should continue to run after DHW frost protection pump demand ends.	43
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.	43
DHW high limit	This parameter enables or disables the DHW high limit function. It must be disabled when the DHW input is used as a switch to indicate DHW demand.	50

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
DHW high limit response	If Recycle && hold is selected, the burner control recycles and waits for the DHW temperature to fall. It will remain in this holding condition until the DHW temperature is lower than the DHW high limit temperature minus 5 degrees F.	50
DHW high limit setpoint	If the DHW temperature reaches the value given by this parameter then a response will occur.	50
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.	35
DHW I gain	This gain applied to the Integral term of the PID equation for the DHW loop.	35
DHW maximum modulation rate	Provides the upper limit of analog output or fan speed during modulation when firing for DHW.	52
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.	36
DHW off hysteresis	The off hysteresis is added to the DHW Setpoint to determine the temperature at which DHW demand turns off	35
DHW on hysteresis	The on hysteresis is subtracted from the DHW Setpoint to determine the temperature at which DHW demand turns on.	35
DHW P gain	This gain applied to the Proportional term of the PID equation for the DHW loop.	35
DHW priority source	Disabled, DHW heat demand	20
DHW priority method	Boost during priority time, drop after priority time	20
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.	35
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.)	21
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.)	21
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.	21
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.	43
DHW setpoint	This Setpoint is used whenever the time-of-day switch is off or not connected (unused).	35
DHW slow start enable	This parameter enables or disables the slow start limit function for DHW demand.	50
DHW storage enable	This parameter enables or disables the DHW storage feature. If it is disabled then the other parameters below are ignored.	40
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.	40
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.	40
DHW storage setpoint	The temperature setpoint that the boiler maintains during the DHW storage time.	40
DHW storage time	The time DHW storage temperature is maintained.	40
DHW time of day setpoint	This Setpoint is used when the time-of-day switch is on.	35

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Exchanger T-Rise enable	This enables/disables temperature rise detection for the heat exchanger sensor S9 (J9 terminal 6).	46
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).	53
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).	53
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.	53
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.	61
Firing rate control	If one of the manual modes is chosen then the Manual Rate parameter controls the firing rate during the specified states.	52
Flame sensor type	Different kinds of flame detectors may be used. This parameter tells the control what type of sensor is installed.	59
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.	59
Frost protection anticondensation enable	When Frost Protection is in control, either the CH or DWH anticondensation function is enabled.	51
Frost protection method	Determines what happens when Frost Protection (from any source) becomes active.	43
Heat exchanger high limit	This enables/disables temperature rise detection for the heat exchanger sensor S9 (J9 terminal 6).	46
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.	46
Heat exchanger high limit response	Specifies response should “Heat exchanger high limit setpoint” threshold is reached.	46
Heat exchanger high limit setpoint	Provides the setpoint at which a response occurs if “Heat exchanger high limit” function is enabled.	46
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.	46
Heat exchanger T-rise enable	Enabled, Disabled	46
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.	58
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.	61
Ignite failure response	If ignition fails then several responses are possible. This parameter selects one of these responses.	61
Ignite failure retries	This parameter provides the number of retries for an ignition failure, if the response to failure of ignition includes retries.	61
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.	60
Ignition source	Several outputs may be selected as the ignition source. This parameter selects one of these.	61

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
ILK bounce detection enable	Enable, Disable	58
ILK long name	The long name (up to 20 characters) of the ILK annunciator input.	62
ILK short name	The short (3 letter) name of the contacts monitored by the ILK annunciator input.	62
Inlet Connector Type	Designates the sensor type connected to the control for proper reading.	21
Installation data	The installer may edit this parameter to provide installation information.	22
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.	58
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.	58
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.	58
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.)	58
LCI long name	The long name (up to 20 characters) of the LCI annunciator input.	62
LCI short name	The short (3 letter) name of the contacts monitored by the LCI annunciator input.	62
Lead Lag frost protection enable	Enabled, Disabled	82
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.	82
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.	52
Lightoff rate proving	This parameter specifies the input used to confirm the Prepurge rate has been reached.	59
LL - Base load rate	This specifies the preferred firing rate of a burner, which is used for some types of control.	79
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 SOLA 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.	79
LL - Fan during off-cycle rate	This determines if or where the fan is to be operating during the standby period.	79
LL master enable	Disable, Enable	79
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.	79
LL operation switch	This controls the LL master in the same way that the Burner switch controls a stand-alone SOLA. 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.	79
LL - Slave enable	It enables or disables the “LL Slave” Demand and Rate module.	78
LL - Slave mode	If set to Use First, then this slave SOLA will be used prior to using other slave Solas with other values. If this parameter is set to Equalize Runtime, then this slave SOLA will be staged according to a run time equalization. (Any Solas set to Use First will precede any that are set to Equalize Runtime.) If this parameter is set to Use Last, then this slave SOLA will be used only after all Use First and Equalize Runtime Solas have been brought online.	78
LL - Slave priority sequence order	Slave sequence order is used to determine the order in which the slave Solas will be used (staged on) for those Solas with the same Slave mode setting. Numbers may be skipped, that is 3 will be first if there is no 1 or 2.	79
LL - Slave read	This provides the slave status message to be read by a SOLA Master. It includes all of the data that is read from a slave.	78

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
LL - Slave write	This allows the slave to accept command messages from a SOLA master.	78
Manual firing rate	This parameter specifies the analog output or fan speed during burner modulation, when the Firing rate control parameter specifies Manual mode.	52
MFEP	This parameter provides choices for the duration of the MFEP (main flame establishing period) time. Flame must remain on throughout the MFEP or a response occurs. Not needed and ignored unless the Pilot type is Interrupted.	61
MFEP flame failure response	If flame fails in the Main Flame Establishing Period and recycle is selected then the burner control recycles back to the beginning of Prepurge, then continues with the normal burner startup process to attempt to light the burner again.	61
Minimum modulation rate	Provides the lower limit of analog output or fan speed during modulation (this is for both CH and DHW).	52
Modulation output	This parameter selects the modulation output. The R7910 software responds by driving the appropriate circuit to provide modulation of firing rate.	52
Modulation rate source	If the modulation rate source is Local, then the control’s PID algorithm determines the modulation rate. If the modulation rate source is S2 4-20mA, then the modulation rate is determined by the S2 4-20mA modulation routine that exists in prior controls. If this sensor is invalid then the control behaves as if Local were selected.	27
Modulation sensor	The selected input provides the temperature clearance for modulation control. As a startup check, if the CH Loop is enabled for a hydronic system, and if the select sensor is not a temperature input, then this causes an alert and forces the CH loop to suspend.	27
NTC sensor type	The sensors used may all be the 10K NTC type in which safety sensors are redundant, or all be a 12K NTC type in which no sensors are redundant and external temperature limit devices are required. The latter is for MCBA retrofit compatibility.	58
OEM identification	The OEM may provide identification information here.	22
Outdoor Connector Type	Designates the Sensor type connected to the control for proper reading.	21
Outdoor frost protection setpoint	This parameter provides the setpoint for frost protection based on outdoor temperature. When the outdoor temperature falls below this threshold then frost protection will be active.	
Outlet Connector Type	Designates the Sensor type connected to the control for proper reading.	21
Outlet high limit enable	Used to set the Outlet high limit on or off.	47
Outlet high limit response	If Recycle && hold is selected, the burner control recycles and waits for the outlet temperature to fall. It will remain in this holding condition until the outlet temperature is lower than the outlet high limit temperature minus 5 degrees F.	47
Outlet high limit setpoint	If the outlet temperature reaches the value given by this parameter, a response will occur.	47
Outlet T-Rise enable	This enables/disables temperature rise detection for the outlet sensor S3 (J8 terminal 8).	46
PFEP	This parameter provides choices for the duration of the pilot flame establishing period. Flame must be on at the end of this period. This parameter is ignored if DBI (Direct Burner Ignition) is selected.	60
PII enable	This parameter enables the Pre-Ignition Interlock input. If disabled the PII input is ignored.	58
PII long name	The long name (up to 20 characters) of the PII annunciator input.	62
PII short name	The short (3 letter) name of the contacts monitored by the PII annunciator input.	62
Pilot test hold	If the Pilot type is Interrupted or Intermittent and this parameter is enabled then the burner control sequence will hold (forever) at 1 second into the Ignition state, while monitoring the flame via a 15 second timer.	58
Pilot type	Interrupted pilot turns off after MFEP (main flame establishing period). Intermittent pilot remains on during the Run period (no MFEP). DBI (direct burner ignition) indicates the main flame is lit directly using a 4 second ignition period.	59
Plate preheat delay after tap	Whenever the Preheat block is false, it monitors the Tap demand block's output and operates a timer that ensures preheat will not begin too soon after a tap demand has recently ended.	38

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page

Plate preheat off hysteresis	The preheat off threshold is calculated as:
	T_{OFF} = Plate preheat setpoint + Plate preheat off hysteresis
	If the preheat block is True, then it becomes False when:
	• Tap during Preheat is recognized (see below) OR
	• Both
	  • DHW sensor temperature >= T_{OFF}, AND
	  • The preheat minimum on time has elapsed.
		38

Plate preheat minimum on time	This parameter provides the minimum on time for preheating.	39
Plate preheat on hysteresis	The preheat on threshold is calculated as: T_{ON} = Plate preheat setpoint - Plate preheat on hysteresis If the preheat block is False, then it is Set (becomes True) when: **1.** Tap demand is false, AND **2.** The preheat delay-after-tap time has elapsed, AND **3.** DHW sensor temperature <= T_{ON}, AND **4.** The above have remained true for the time specified by: Plate preheat on recognition time That is, whenever conditions 1, 2, or 3 are not true, a preheat recognition timer is reset. Whenever they are all true then the timer is allowed to run. If the time elapses then the preheat block becomes true (preheat is active, and this causes the plate demand to be true).	39
Plate preheat on recognition time	This parameter provides the time duration for recognizing that preheat demand exists.	38
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.	38
Postpurge rate	This parameter specifies the analog output or fan speed used during Postpurge.	52
Postpurge time	This parameter sets the burner control's postpurge time. Setting this parameter to zero disables prepurge.	58
Preignition time	hr:mm:ss	60
Prepurge rate	This parameter specifies the analog output or fan speed used during Prepurge.	52
Prepurge time	This parameter sets the burner control's prepurge time. Setting this parameter to zero disables prepurge.	58
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.)	53
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.	56
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.	56
Purge rate proving	This parameter specifies the input used to confirm the Prepurge rate has been reached.	59
PWM frequency	This parameter provides the frequency of the pulse-width modulation for variable speed fan control.	53
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.	61
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.	58
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.	53
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.	50
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.	50
Spark Voltage	Spark voltage configuration for Safety uC	

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Speed up ramp	Whenever the burner is firing it will be commanded to increase its RPM no faster than the rate provided by this parameter.	53
Stack Connector Type	Designates the Sensor type connected to the control for proper reading.	21
Stack limit delay	This parameter provides the delay time for the Stack limit.	47
Stack limit enable	This parameter enables or disables the entire stack temperature limit function.	47
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.	47
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.	47
Standby Rate	Specifies the analog output of fan speed used during standby or demand off time.	52
Steam 4-20mA remote	Allows modulation from source other than pressure sensor.	31
Steam D gain	Gain applied to the differential	31
Steam enable	Disable/enable steam feature.	30
Steam demand source	The source of Steam loop control can be specified to use different inputs.	30
Steam hysteresis step time	Time for each step.	31
Steam I gain	Gain applied to the Integral.	31
Steam min. pressure	Provides minimum pressure used to calculate the 4-20ma setpoint for 4ma.	31
Steam P gain	Gain applied to the Proportional.	31
Steam pressure off hysteresis, on hysteresis	On or Off hysteresis adjusted to the setpoint at which this demand turns off or on.	31
Steam pressure setpoint	Pressure Control setpoint	31
Steam sensor	The sensor used for modulation and demand - typically a 4-20ma source.	30
Steam time of day setpoint	Provides the steam pressure setpoint when TOD is on.	31
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.	46
T-Rise response	Specifies response should “T-Rise degrees per second limit” is exceeded.	46
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.	46
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.	46
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.	37
Tap detect minimum on time	Once a tap detect event has occurred, and the Tap demand block is Set, it remains true for at least the time provided by this parameter. If DHW loses control due to priority, the timer is restarted, so that when Tap demand again gains control of the burner it remains in this condition for the full minimum on time.	38
Tap detect on threshold	-17 °C to 82 °C (-0 °F to 180 °F)	37

Table 49. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Tap detect on hysteresis	The second tap demand “set” criteria depends on the value of the DHW sensor. If the temperature is less than or equal to the threshold given by subtracting this parameter from the normal DHW setpoint, and if this condition has persisted for the time specified by the Tap detect recognition time parameter, the Tap demand block is “Set” (Tap demand becomes true and the minimum on timer is started).	37
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.	37
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.	38
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.	38
Temperature units	This parameter determines whether temperature is represented in units of Fahrenheit or Celsius degrees.	22
Warm Weather Shutdown	Enable, Disable, Shutdown after demands have ended, Shutdown immediately	20
Warm Weather Shutdown Setpoint	Temperature, None	21
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.	55
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.	55
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) SOLA, this delay is skipped and does not occur if it is already firing when the pump demand off-to-on event occurs. For a SOLA 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 SOLA that some slave burner in the system is already firing, when the pump demand off-to-on event occurs.	56
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 SOLA if any local service is active then this status cancels any overrun that is in-progress. For a slave SOLA if any master service is active at this time this status cancels any overrun that is in-progress.	56
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.	56

APPENDIX B: HYDRONIC DEVICE PARAMETER WORKSHEET EXAMPLE

Table 50 is an example of a completed parameter worksheet.

Table 50. Example of a Completed Device Parameter Worksheet.

Parameter Name	Customer Choice - Hidden, Read Only or Password protected	Minimum Range	Default Setting	Maximum Range	Parameter Units
Burner cycle count	Read Only		0		Cycles
Burner run time	Read Only		0		Hours
CH pump cycles	Read Only		0		Cycles
DHW pump cycles	Read Only		0		Cycles
System pump cycles	Read Only		0		Cycles
Boiler pump cycles	Read Only		0		Cycles
Auxiliary pump cycles	Read Only		0		Cycles
Temperature units	Read Only		A:Fahrenheit		
Antishort cycle time	Read Only		1m 0s		mmm:ss
Alarm silence time	Read Only		5m 0s		mmm:ss
Burner name	Read Only				20 chars
Installation data	Read Only				20 chars
OEM identification	Read Only				20 chars
Modulation output	Hidden		B:Demand rate is in % units		
CH maximum modulation rate	Read Only		100%		% | RPM
DHW maximum modulation rate	Read Only		100%		% | RPM
Minimum modulation rate	Read Only		0%		% | RPM
Prepurge rate	Read Only		100%		% | RPM
Lightoff rate	Read Only		25%		% | RPM
Postpurge rate	Read Only		25%		% | RPM
CH forced rate	Read Only		25%		% | RPM
CH forced rate time	Read Only		1m 0s		mmm:ss
DHW forced rate	Read Only		25%		% | RPM
DHW forced rate time	Read Only		120m 0s		mmm:ss
Burner switch	Read Only		Yes/True/On		
Firing rate control	Read Only		A:Automatic firing		
Manual firing rate	Read Only		25%		% | RPM
Analog output hysteresis	Read Only		0	20	1 to 10
CH enable	Read Only		Enabled		
CH demand source	Read Only		D:Sensor & LCI		
CH sensor	Read Only		A:Outlet sensor		
CH setpoint	Read Only	32°F 0°C	180°F 82°C	240°F 116°C	
CH tod setpoint	Read Only	32°F 0°C	160°F 71°C	240°F 116°C	
CH on hysteresis	Read Only	2°F 1°C	15°F 8°C	100°F 56°C	
CH off hysteresis	Read Only	2°F 1°C	15°F 8°C	100°F 56°C	
CH outdoor reset enable	Read Only		Disabled		

Table 50. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Choice - Hidden, Read Only or Password protected	Minimum Range	Default Setting	Maximum Range	Parameter Units
CH P gain	Read Only		50	400	
CH I gain	Read Only		50	400	
CH D gain	Read Only		0	400	
CH hysteresis step time	Read Only		1m 0s		mmm:ss
Ignition source	Read Only		A:Internal ignition (spark)		
BLR HSI function	Read Only		A:Blower motor		
Igniter on during	Read Only		A:On throughout PFEP		
Pilot type	Read Only		A:Interrupted (off during Run)		
Flame sensor type	Read Only		A:No flame sensor		
Purge rate proving	Read Only		B:Prove via HFS terminal		
Lightoff rate proving	Read Only		B:Prove via LFS terminal		
Prepurge time	Read Only		0m 30s		mmm:ss
Preignition time	Read Only		0m 0s		mmm:ss
PFEP	Read Only		C:10 seconds		
MFEP	Read Only		C:10 seconds		
Run stabilization time	Read Only		0m 10s		mmm:ss
Postpurge time	Read Only		0m 15s		mmm:ss
Interlock start check enable	Read Only		Disabled		
Interlock open response	Read Only		A:Lockout		
Ignite failure response	Read Only		A:Lockout		
Ignite failure retries	Read Only		A:Number of retries not set		
Ignite failure delay	Read Only		5m 0s		mmm:ss
MFEP flame failure response	Read Only		A:Lockout		
Run flame failure response	Read Only		A:Lockout		
Pilot test hold	Hidden		Disabled		
NTC sensor type	Read Only		A:10K dual safety		
Interrupted air switch enable	Read Only		A:no IAS		
IAS start check enable	Hidden		Enabled		
LCI enable	Read Only		Enabled		
PII enable	Read Only		Enabled		
Flame threshold	Read Only	2	8	140	.1 Volts/uA
Absolute max fan speed	Read Only	500	5000	7000	RPM
Absolute min fan speed	Read Only	500	800	5000	RPM
PWM frequency	Read Only		D:3000 Hz		
Pulses per revolution	Read Only	1	3	10	
Fan speed up ramp	Read Only		0		RPM/sec
Fan slow down ramp	Read Only		0		RPM/sec
Fan gain up	Read Only		50	100	
Fan gain down	Read Only		50	100	

Table 50. 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 50. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Choice - Hidden, Read Only or Password protected	Minimum Range	Default Setting	Maximum Range	Parameter Units
Annunciator 4 location	Read Only		A:No annunciation for this terminal		
Annunciator4 short name	Read Only		A4		3 chars
Annunciator 4 long name	Read Only		Annunciator4		20 chars
Annunciator 5 location	Read Only		E:No annunciation for this terminal		
Annunciator5 short name	Read Only		A5		3 chars
Annunciator 5 long name	Read Only		Annunciator5		20 chars
Annunciator 6 location	Read Only		E:No annunciation for this terminal		
Annunciator6 short name	Read Only		A6		3 chars
Annunciator 6 long name	Read Only		Annunciator6		20 chars
Annunciator 7 location	Read Only		E:No annunciation for this terminal		
Annunciator7 short name	Read Only		A7		3 chars
Annunciator 7 long name	Read Only		Annunciator7		20 chars
Annunciator 8 location	Read Only		E:No annunciation for this terminal		
Annunciator8 short name	Read Only		A8		3 chars
Annunciator 8 long name	Read Only		Annunciator8		20 chars
PII short name	Read Only		PII		3 chars
PII long name	Read Only		Pre-Ignition ILK		20 chars
LCI short name	Read Only		LCI		3 chars
LCI long name	Read Only		Load Control Input		20 chars
ILK short name	Read Only		ILK		3 chars
ILK long name	Read Only		Interlock		20 chars
DHW enable	Read Only		Disabled		
DHW demand source	Read Only		A:DHW sensor only		
DHW has priority over CH	Read Only		No/False/Off		
DHW has priority over LL	Read Only		No/False/Off		
DHW priority time	Read Only		30m 0s		mmm:ss
DHW setpoint	Read Only	32°F 0°C	140°F 60°C	240°F 116°C	
DHW tod setpoint	Read Only	32°F 0°C	120°F 49°C	240°F 116°C	
DHW on hysteresis	Read Only	2°F 1°C	5°F 3°C	100°F 56°C	
DHW off hysteresis	Read Only	2°F 1°C	5°F 3°C	100°F 56°C	
DHW P gain	Read Only	0	50	400	
DHW I gain	Read Only	0	50	400	
DHW D gain	Read Only	0	50	400	
DHW hysteresis step time	Read Only		0m 0s		mmm:ss
Outlet high limit setpoint	Read Only	32°F 0°C	220°F 104°C	240°F 116°C	
Outlet high limit response	Read Only	[A B #c #d]	A:Lockout		
Stack limit enable	Read Only		Disabled		
Stack limit setpoint	Read Only	32°F 0°C	200°F 93°C	500°F 260°C	
Stack limit response	Read Only	[A #b C #d]	A:Lockout		

Table 50. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Choice - Hidden, Read Only or Password protected	Minimum Range	Default Setting	Maximum Range	Parameter Units
Stack limit delay	Read Only		5m 0s		mmm:ss
Delta-T enable	Read Only		Disabled		
Delta-T degrees	Read Only		30°F 17°C		
Delta-T response	Read Only	[A #b C #d]	A:Lockout		
Delta-T delay	Read Only		5m 0s		mmm:ss
DHW high limit enable	Read Only		Enabled		
DHW high limit setpoint	Read Only	32°F 0°C	150°F 66°C	240°F 116°C	
DHW high limit response	Read Only	[A B #c D]	D:Suspend DHW		
CH slow start enable	Read Only		Disabled		
DHW slow start enable	Read Only		Disabled		
Slow start ramp	Read Only		10%		% | RPM per minute
Slow start setpoint	Read Only	0°F -18°C	20°F -7°C	180°F 82°C	
CH anticondensation enable	Read Only		Disabled		
CH anticondensation setpoint	Read Only	32°F 0°C	135°F 57°C	240°F 116°C	
CH anticondensation pump Force Off	Read Only		Disabled		
DHW anticondensation enable	Read Only		Disabled		
DHW anticondensation setpoint	Read Only	32°F 0°C	135°F 57°C	240°F 116°C	
DHW anticondensation pump force off	Read Only		Disabled		
Anticondensation > Outlet limit	Read Only		No/False/Off		
Anticondensation > Delta-T	Read Only		No/False/Off		
Anticondensation > Stack limit	Read Only		No/False/Off		
Anticondensation > Slow start	Read Only		Yes/True/On		
Anticondensation > Forced rate	Read Only		Yes/True/On		
CH ODR max outdoor temperature	Read Only		80°F 27°C		
CH ODR min outdoor temperature	Read Only		0°F -18°C		
CH ODR min water temperature	Read Only	32°F 0°C	50°F 10°C	240°F 116°C	
CH frost protection enable	Read Only		Disabled		
DHW frost protection enable	Read Only		Disabled		
Outdoor frost protection setpoint	Read Only		32°F 0°C		

TROUBLESHOOTING

To support the recommended Troubleshooting, the R7910 has an Alert File. Review the Alert history for possible trends that may have been occurring prior to the actual Lockout.

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

Table 51. R7910A Lockout and Hold Codes.

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
	Safety Data Faults		
1	Unconfigured safety data	1. New Device, complete device configuration and safety verification. 2. If fault repeats, replace module.	L
2	Waiting for safety data verification	1. Device in Configuration mode and safety parameters need verification and a device needs reset to complete verification. 2. Configuration ended without verification, re enter configuration, verify safety parameters and reset device to complete verification. 3. If fault repeats, replace module.	L
	Internal Operation Errors		

Table 51. R7910A Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
3	Internal fault: Hardware fault	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	H
4	Internal fault: Safety Relay key feedback error		H
5	Internal fault: Unstable power (DCDC) output		H
6	Internal fault: Invalid processor clock		H
7	Internal fault: Safety relay drive error		H
8	Internal fault: Zero crossing not detected		H
9	Internal fault: Flame bias out of range		H
10	Internal fault: Invalid Burner control state		L
11	Internal fault: Invalid Burner control state flag		L
12	Internal fault: Safety relay drive cap short		H
13	Internal fault: PII shorted to ILK		H or L
14	Internal fault: HFS shorted to LCI		H or L
15	Internal fault: Safety relay test failed due to feedback ON		L
16	Internal fault: Safety relay test failed due to safety relay OFF		L
17	Internal fault: Safety relay test failed due to safety relay not OFF		L
18	Internal fault: Safety relay test failed due to feedback not ON		L
19	Internal fault: Safety RAM write		L
20	Internal fault: Flame ripple and overflow		H
21	Internal fault: Flame number of sample mismatch		H
22	Internal fault: Flame bias out of range		H
23	Internal fault: Bias changed since heating cycle starts		H
24	Internal fault: Spark voltage stuck low or high		H
25	Internal fault: Spark voltage changed too much during flame sensing time		H
26	Internal fault: Static flame ripple		H
27	Internal fault: Flame rod shorted to ground detected		H
28	Internal fault: A/D linearity test fails		H
29	Internal fault: Flame bias cannot be set in range		H
30	Internal fault: Flame bias shorted to adjacent pin		H
31	Internal fault: SLO electronics unknown error		H
32-46	Internal fault: Safety Key 0 through 14		L
	System Errors		
47	Flame Rod to ground leakage		H
48	Static flame (not flickering)		H
49	24VAC voltage low/high	1. Check the Module and display connections. 2. Check the Module power supply and make sure that both frequency, voltage and VA meet the specifications.	H

Table 51. R7910A Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
50	Modulation fault	Internal sub-system fault. 1. Review alert messages for possible trends. 2. Correct possible problems. 3. If fault persists, replace module.	H
51	Pump fault		H
52	Motor tachometer fault		H
53	AC inputs phase reversed	1. Check the Module and display connections. 2. Check the Module power supply and make sure that both frequency and voltage meet the specifications. 3. On 24Vac applications, assure that J4-10 and J8-2 are connected together.	L
54	Safety GVT model ID doesn't match application's model ID		L
55	Application configuration data block CRC errors		L
56-57	RESERVED		
58	Internal fault: HFS shorted to IAS	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	L
59	Internal Fault: Mux pin shorted		L
	Normal Event Status		
60	Internal Fault: HFS shorted to LFS		L
61	Anti short cycle	Will not be a lockout fault. Hold Only.	H
62	Fan speed not proved		H
63	LCI OFF	1. Check wiring and correct any faults. 2. Check Interlocks connected to the LCI to assure proper function. 3. Reset and sequence the module; monitor the LCI status. 4. If code persists, replace the module.	H
64	PII OFF	1. Check wiring and correct any faults. 2. Check Preignition Interlock switches to assure proper functioning. 3. Check the valve operation. 4. Reset and sequence the module; monitor the PII status. 5. If code persists, replace the module.	H or L
65	Interrupted Airflow Switch OFF	1. Check wiring and correct any possible shorts. 2. Check airflow switches to assure proper functioning. 3. Check the fan/blower operation. 4. Reset and sequence the module; monitor the airflow status. 5. If code persists, replace the module.	H or L
66	Interrupted Airflow Switch ON		H or L
67	ILK OFF	1. Check wiring and correct any possible shorts. 2. Check Interlock (ILK) switches to assure proper function. 3. Verify voltage through the interlock string to the interlock input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the	H or L
68	ILK ON		H or L
69	Pilot test hold	1. Verify Run/Test is changed to Run. 2. Reset Module. 3. If fault repeats, replace module.	H
70	Wait for leakage test completion	1. Internal Fault. Reset Module. 2. If fault repeats, replace module.	H
71-77	RESERVED		
78	Demand Lost in Run	1. Check wiring and correct any possible errors. 2. If previous steps are correct and fault persists, replace the module.	H
79	Outlet high limit	1. Check wiring and correct any possible errors. 2. Replace the Outlet high limit. 3. If previous steps are correct and fault persists, replace the module.	H or L

Table 51. R7910A Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
80	DHW high limit	1. Check wiring and correct any possible errors. 2. Replace the DHW high limit. 3. If previous steps are correct and fault persists, replace the module.	H or L
81	Delta T limit	1. Check Inlet and Outlet sensors and pump circuits for proper operation. 2. Recheck the Delta T Limit to confirm proper setting. 3. If previous steps are correct and fault persists, replace the module.	H or L
82	Stack limit	1. Check wiring and correct any possible errors. 2. Replace the Stack high limit. 3. If previous steps are correct and fault persists, replace the module.	H or L
83	Delta T exchanger/outlet limit		H or L
84	Delta T inlet/exchanger limit		H or L
85	Inlet/outlet inversion limit		H or L
86	Exchanger/outlet inversion limit		H or L
87	Inlet/exchanger inversion limit		H or L
88	Outlet T-rise limit		H or L
89	Exchanger T-rise limit		H or L
90	Heat exchanger high limit		H or L
	Sensor Faults		
91	Inlet sensor fault	1. Check wiring and correct any possible errors. 2. Replace the Inlet sensor. 3. If previous steps are correct and fault persists, replace the module.	H
92	Outlet sensor fault	1. Check wiring and correct any possible errors. 2. Replace the Outlet sensor. 3. If previous steps are correct and fault persists, replace the module.	H
93	DHW sensor fault	1. Check wiring and correct any possible errors. 2. Replace the DHW sensor. 3. If previous steps are correct and fault persists, replace the module.	H
94	Header sensor fault	1. Check wiring and correct any possible errors. 2. Replace the header sensor. 3. If previous steps are correct and fault persists, replace the module.	H
95	Stack sensor fault	1. Check wiring and correct any possible errors. 2. Replace the stack sensor. 3. If previous steps are correct and fault persists, replace the module.	H
96	Outdoor sensor fault	1. Check wiring and correct any possible errors. 2. Replace the outdoor sensor. 3. If previous steps are correct and fault persists, replace the module.	H
97	Internal Fault: A2D mismatch.	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	L
98	Internal Fault: Exceeded VSNSR voltage		L
99	Internal Fault: Exceeded 28V voltage tolerance		L
100	Pressure Sensor Fault	1. Verify the Pressure Sensor is a 4-20ma source. 2. Check wiring and correct any possible errors. 3. Test Pressure Sensor for correct operation. 4. Replace the Pressure sensor. 5. If previous steps are correct and fault persists, replace the module.	H

Table 51. R7910A Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
101-104	RESERVED		
	Flame Operation Faults		
105	Flame detected out of sequence	1. Check that flame is not present in the combustion chamber. Correct any errors. 2. Make sure that the flame detector is wired to the correct terminal. 3. Make sure the F & G wires are protected from stray noise pickup. 4. Reset and sequence the module, if code reappears, replace the flame detector. 5. Reset and sequence the module, if code reappears, replace the module.	H or L
106	Flame lost in MFEP	1. Check pilot valve (Main Valve for DSI) wiring and operation - correct any errors. 2. Check the fuel supply. 3. Check fuel pressure and repeat turndown tests. 4. Check ignition transformer electrode, flame detector, flame detector siting or flame rod position. 5. If steps 1 through 4 are correct and the fault persists, replace the module.	L
107	Flame lost early in run		L
108	Flame lost in run		L
109	Ignition failed		L
110	Ignition failure occurred	Hold time of recycle and hold option. Will not be a lockout fault. Hold Only.	H
111	Flame current lower than WEAK threshold	Internal hardware test. Not a lockout,	H
112	Pilot test flame timeout	Interrupted Pilot or DSI application and flame lost when system in “test” mode. 1. Reset the module to restart.	L
113	Flame circuit timeout	Flame sensed during Initiate or off cycle, hold 240 seconds, if present after 240 seconds, lockout.	L
114-121	RESERVED		
	Rate Proving Faults		
122	Lightoff rate proving failed	1. Check wiring and correct any potential wiring errors. 2. Check VFDs ability to change speeds. 3. Change the VFD 4. If the fault persists, replace the module.	L
123	Purge rate proving failed		L
124	High fire switch OFF	1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function (not welded or jumpered). 3. Manually drive the motor to the High Fire position and adjust the HF switch while in this position and verify voltage through the switch to the HFS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
125	High fire switch stuck ON		H
126	Low fire switch OFF	1. Check wiring and correct any potential wiring errors. 2. Check Low Fire Switch to assure proper function (not welded or jumpered). 3. Manually drive the motor to the High Fire position and adjust the LF switch while in this position and verify voltage through the switch to the LFS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
127	Low fire switch stuck ON		H or L
128	Fan speed failed during prepurge	1. Check wiring and correct any potential wiring errors. 2. Check VFDs ability to change speeds. 3. Change the VFD 4. If the fault persists, replace the module.	H or L
129	Fan speed failed during preignition		H or L
130	Fan speed failed during ignition		H or L
131	Fan movement detected during standby		H
132	Fan speed failed during run		H
133-135	RESERVED		
	Start Check Faults		

Table 51. R7910A Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
136	Interrupted Airflow Switch failed to close	1. Check wiring and correct any possible wiring errors. 2. Check Interrupted Airflow switch(es) to assure proper function. 3. Verify voltage through the airflow switch to the IAS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
137	ILK failed to close	1. Check wiring and correct any possible shorts. 2. Check Interlock (ILK) switches to assure proper function. 3. Verify voltage through the interlock string to the interlock input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
138-142	RESERVED		
	FAULT CODES 149 THROUGH 165 ARE OEM SPECIFIC FAULT CODES.		
143	Internal fault: Flame bias out of range 1		L
144	Internal fault: Flame bias out of range 2		L
145	Internal fault: Flame bias out of range 3		L
146	Internal fault: Flame bias out of range 4		L
147	Internal fault: Flame bias out of range 5		L
148	Internal fault: Flame bias out of range 6		L
149	Flame detected	OEM Specific 1. Holds if flame detected during Safe Start check up to Flame Establishing period.	H or L
150	Flame not detected	OEM Specific 1. Sequence returns to standby and restarts sequence at the beginning of Purge after the HF switch opens. if flame detected during Safe Start check up to Flame Establishing period.	H
151	High fire switch ON	OEM Specific 1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function (not welded or jumpered). 3. Manually drive the motor to the High Fire position and adjust the HF switch while in this position and verify voltage through the switch to the HFS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H or L
152	Combustion pressure ON	OEM Specific 1. Check wiring and correct any errors. 2. Inspect the Combustion Pressure Switch to make sure it is working correctly. 3. Reset and sequence the relay module. 4. During STANDBY and PREPURGE, measure the voltage between Terminal J6-5 and L2 (N). Supply voltage should be present. If not, the lockout switch is defective and needs replacing. 5. If the fault persists, replace the relay module.	H or L
153	Combustion Pressure Off		H or L
154	Purge Fan switch On	OEM Specific 1. Purge fan switch is on when it should be off.	H or L
155	Purge Fan switch Off		H
155	Purge fan switch OFF		H or L

Table 51. R7910A Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
156	Combustion pressure and Flame ON	OEM Specific 1. Check that flame is not present in the combustion chamber. Correct any errors. 2. Make sure that the flame detector is wired to the correct terminal. 3. Make sure the F & G wires are protected from stray noise pickup. 4. Reset and sequence the module, if code reappears, replace the flame detector.	H or L
157	Combustion pressure and Flame OFF		L
158	Main valve ON	OEM Specific 1. Check Main Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.	L
159	Main valve OFF		L
160	Ignition ON	OEM Specific 1. Check Ignition terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.	L
161	Ignition OFF		L
162	Pilot valve ON	OEM Specific 1. Check Pilot Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.	L
163	Pilot valve OFF		L
164	Block intake ON	OEM Specific 1. Check wiring and correct any errors. 2. Inspect the Block Intake Switch to make sure it is working correctly. 3. Reset and sequence the module. 4. During Standby and Purge, measure the voltage across the switch. Supply voltage should be present. If not, the Block Intake Switch is defective and needs replacing. 5. If the fault persists, replace the relay module.	L
165	Block intake OFF		L
166-171	RESERVED		
	Feedback		
172	Main relay feedback incorrect	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	L
173	Pilot relay feedback incorrect		L
174	Safety relay feedback incorrect		L
175	Safety relay open		L
176	Main relay ON at safe start check		L
177	Pilot relay ON at safe start check		L
178	Safety relay ON at safe start check		L
179-183	RESERVED		
	Parameter Faults		
184	Invalid BLOWER/HSI output setting	1. Return to Configuration mode and recheck selected parameters, reverify and reset module. 2. If fault repeats, verify electrical grounding. 3. If fault repeats, replace module.	L
185	Invalid Delta T limit enable setting		L
186	Invalid Delta T limit response setting		L
187	Invalid DHW high limit enable setting		L
188	Invalid DHW high limit response setting		L
189	Invalid Flame sensor type setting		L
190	Invalid interrupted air switch enable setting		L
191	Invalid interrupted air switch start check enable setting		L
192	Invalid igniter on during setting		L
193	Invalid ignite failure delay setting		L

Table 51. R7910A Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
194	Invalid ignite failure response setting	1. Return to Configuration mode and recheck selected parameters, reverify and reset module. 2. If fault repeats, verify electrical grounding. 3. If fault repeats, replace module.	L
195	Invalid ignite failure retries setting		L
196	Invalid ignition source setting		L
197	Invalid interlock open response setting		L
198	Invalid interlock start check setting		L
199	Invalid LCI enable setting		L
200	Invalid lightoff rate setting		L
201	Invalid lightoff rate proving setting		L
202	Invalid Main Flame Establishing Period time		L
203	Invalid MFEP flame failure response setting		L
204	Invalid NTC sensor type setting		L
205	Invalid Outlet high limit response setting		L
206	Invalid Pilot Flame Establishing Period setting		L
207	Invalid PII enable setting		L
208	Invalid pilot test hold setting		L
209	Invalid Pilot type setting		L
210	Invalid Postpurge time setting		L
211	Invalid Power up with lockout setting		L
212	Invalid Preignition time setting		L
213	Invalid Prepurge rate setting		L
214	Invalid Prepurge time setting		L
215	Invalid Purge rate proving setting		L
216	Invalid Run flame failure response setting		L
217	Invalid Run stabilization time setting		L
218	Invalid Stack limit enable setting		L
219	Invalid Stack limit response setting		L
220	Unconfigured Delta T limit setpoint setting		L
221	Unconfigured DHW high limit setpoint setting		L
222	Unconfigured Outlet high limit setpoint setting		L
223	Unconfigured Stack limit setpoint setting		L
224	Invalid DHW demand source setting		L
225	Invalid Flame threshold setting		L
226	Invalid Outlet high limit setpoint setting		L
227	Invalid DHW high limit setpoint setting		L
228	Invalid Stack limit setpoint setting		L
229	Invalid Modulation output setting		L
230	Invalid CH demand source setting		L
231	Invalid Delta T limit delay setting		L
232	Invalid Pressure sensor type setting		L
233	Invalid IAS closed response setting		L
234	Invalid Outlet high limit enable setting		L
235	Invalid Outlet connector type setting		L
236	Invalid Inlet connector type setting		L
237	Invalid DHW connector type setting		L
238	Invalid Stack connector type setting		L

Table 51. R7910A Lockout and Hold Codes. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes	NOTE
239	Invalid S2 (J8-6) connector type setting		L
240	Invalid S5 (J8-11) connector type setting		L
241	Exchanger sensor not allowed with stack connector setting		L
242	Invalid DHW auto detect configuration		L
243	Invalid UV with spark interference not compatible with Ignitor on throughout PFEP		L
244	Internal fault: Safety relay test invalid state		L
245	Invalid Outlet connector type setting for T-rise		L
246	4-20mA cannot be used for both modulation and setpoint control		L
247	Invalid ILK bounce detection enable		L
248	Invalid forced recycle interval		L
249	STAT cannot be demand source when Remote Stat is enabled		L
250	Invalid Fan speed error response		L
251-255	RESERVED		

Table 52. Alerts.

Code	Description
	EE Management Faults
0	None (No alert)
1	Alert PCB was restored from factory defaults
2	Safety configuration parameters were restored
3	Configuration parameters were restored from
4	Invalid Factory Invisibility PCB was detected
5	Invalid Factory Range PCB was detected
6	Invalid range PCB record has been dropped
7	EEPROM lockout history was initialized
8	Switched application annunciation data blocks
9	Switched application configuration data blocks
10	Configuration was restored from factory defaults
11	Backup configuration settings was restored from
12	Annunciation configuration was restored from
13	Annunciation configuration was restored from
14	Safety group verification table was restored from
15	Safety group verification table was updated
16	Invalid Parameter PCB was detected
17	Invalid Range PCB was detected
	System Parameter Errors
18	Alarm silence time exceeded maximum
19	Invalid safety group verification table was
20	Backdoor Password could not be determined.
21	Invalid safety group verification table was

Table 52. Alerts. (Continued)

Code	Description
22	CRC errors were found in application
23	Backup Alert PCB was restored from active one
24	RESERVED
25	Lead Lag operation switch was turned OFF
26	Lead Lag operation switch was turned ON
27	Safety processor was reset
28	Application processor was reset
29	Burner switch was turned OFF
30	Burner switch was turned ON
31	Program Module (PM) was inserted into socket
32	Program Module (PM) was removed from socket
33	Alert PCB was configured
34	Parameter PCB was configured
35	Range PCB was configured
36	Program Module (PM) incompatible with product
37	Program Module application parameter revision
38	Program Module safety parameter revision
39	PCB incompatible with product contained in
40	Parameter PCB in Program Module is too large
41	Range PCB in Program Module was too large for
42	Alert PCB in Program Module was too large for
43	IAS start check was forced on due to IAS
	System Operation Faults
44	Low voltage was detected in safety processor
45	High line frequency occurred

Table 52. Alerts. (Continued)

Code	Description
46	Low line frequency occurred
47	Invalid subsystem reset request occurred
48	Write large enumerated Modbus register value
49	Maximum cycle count was reached
50	Maximum hours count was reached
51	Illegal Modbus write was attempted
52	Modbus write attempt was rejected (NOT
53	Illegal Modbus read was attempted
54	Safety processor brown-out reset occurred
55	Application processor watchdog reset occurred
56	Application processor brown-out reset occurred
57	Safety processor watchdog reset occurred
58	Alarm was reset by the user at the control
	Demand/Rate Command Faults
59	Burner control firing rate was > absolute max
60	Burner control firing rate was < absolute min rate
61	Burner control firing rate was invalid, % vs. RPM
62	Burner control was firing with no fan request
63	Burner control rate (nonfiring) was > absolute
64	Burner control rate (nonfiring) was < absolute
65	Burner control rate (nonfiring) was absent
66	Burner control rate (nonfiring) was invalid, % vs.
67	Fan off cycle rate was invalid, % vs. RPM
68	Setpoint was overridden due to sensor fault
69	Modulation was overridden due to sensor fault
70	No demand source was set due to demand
71-73	RESERVED
	Fan Parameter Errors
74	Periodic Forced Recycle
75	Absolute max fan speed was out of range
76	Absolute min fan speed was out of range
77	Fan gain down was invalid
78	Fan gain up was invalid
79	Fan minimum duty cycle was invalid
80	Fan pulses per revolution was invalid
81	Fan PWM frequency was invalid
82-83	RESERVED
	Modulation Parameter Errors
84	Lead Lag CH 4-20mA water temperature setting
85	No Lead Lag add stage error threshold was
86	No Lead Lag add stage detection time was
87	No Lead Lag drop stage error threshold was
88	No Lead Lag drop stage detection time was

Table 52. Alerts. (Continued)

Code	Description
89	RESERVED
90	Modulation output type was invalid
91	Firing rate control parameter was invalid
92	Forced rate was out of range vs. min/max
93	Forced rate was invalid, % vs. RPM
94	Slow start ramp value was invalid
95	Slow start degrees value was invalid
96	Slow start was ended due to outlet sensor fault
97	Slow start was end due to reference setpoint
98	CH max modulation rate was invalid, % vs. RPM
99	CH max modulation rate was > absolute max
100	CH modulation range (max minus min) was too
101	DHW max modulation rate was invalid, % vs.
102	DHW max modulation rate was > absolute max
103	DHW modulation range (max minus min) was too
104	Min modulation rate was < absolute min rate
105	Min modulation rate was invalid, % vs. RPM
106	Manual rate was invalid, % vs. RPM
107	Slow start enabled, but forced rate was invalid
108	Analog output hysteresis was invalid
109	Analog modulation output type was invalid
110	IAS open rate differential was invalid
111	IAS open step rate was invalid
112	MIX max modulation rate was invalid, % vs. RPM
113	MIX max modulation rate was >absolute max or
114	MIX modulation range (max minus min) was too
	Modulation Operation Faults
115	Fan was limited to its minimum duty cycle
116	Manual rate was > CH max modulation rate
117	Manual rate was > DHW max modulation rate
118	Manual rate was < min modulation rate
119	Manual rate in Standby was > absolute max rate
120	Modulation commanded rate was > CH max
121	Modulation commanded rate was > DHW max
122	Modulation commanded rate was < min
123	Modulation rate was limited due to outlet limit
124	Modulation rate was limited due to Delta-T limit
125	Modulation rate was limited due to stack limit
126	Modulation rate was limited due to
127	Fan Speed out of range in RUN
128	Modulation rate was limited due to IAS was open
129	Slow start ramp setting of zero will result in no
130	No forced rate was configured for slow start

Table 52. Alerts. (Continued)

Code	Description
	CH parameter Errors
131	CH demand source was invalid
132	CH P-gain was invalid
133	CH I-gain was invalid
134	CH D-gain was invalid
135	CH OFF hysteresis was invalid
136	CH ON hysteresis was invalid
137	CH sensor type was invalid
138	CH hysteresis step time was invalid
139	CH remote control parameter was invalid
140	CH ODR not allowed with remote control
141	Steam P-gain was invalid
142	Steam I-gain was invalid
143	Steam D-gain was invalid
144	Steam OFF hysteresis was invalid
145	Steam ON hysteresis was invalid
	CH Operation Faults
146	CH control was suspended due to fault
147	CH header temperature was invalid
148	CH outlet temperature was invalid
149	CH steam pressure was invalid
	CH Parameter errors (continued)
150	Steam setpoint source parameter was invalid
151	Minimum water temperature parameter was
152	Minimum water temperature parameter was
153	Minimum pressure parameter was greater than
154	Minimum pressure parameter was greater than
155	CH modulation rate source parameter was
156	Steam modulation rate source parameter was
	DHW Parameter Errors
157	DHW demand source was invalid
158	DHW P-gain was invalid
159	DHW I-gain was invalid
160	DHW D-gain was invalid
161	DHW OFF hysteresis was invalid
162	DHW ON hysteresis was invalid
163	DHW hysteresis step time was invalid
164	DHW sensor type was invalid
165	Inlet sensor type was invalid for DHW
166	Outlet sensor type was invalid for DHW
167	DHW Storage OFF hysteresis was invalid
168	DHW Storage ON hysteresis was invalid
169	DHW modulation sensor type was invalid

Table 52. Alerts. (Continued)

Code	Description
170	DHW modulation sensor was not compatible for
	DHW Operation Faults
171	DHW control was suspended due to fault
172	DHW temperature was invalid
173	DHW inlet temperature was invalid
174	DHW outlet temperature was invalid
175	DHW high limit must be disabled for AUTO mode
176	DHW sensortype was not compatible for AUTO
177	DHW priority source setting was invalid
178	DHW priority method setting was invalid
	CH Operation Faults (continued)
179	CH S5 (J8 terminal 11) sensor was invalid
180	CH inlet temperature was invalid
181	CH S10 (J10 terminal 7) sensor was invalid
182	Lead Lag CH setpoint source was invalid
	Lead Lag Parameter errors
183	Lead Lag P-gain was invalid
184	Lead Lag I-gain was invalid
185	Lead Lag D-gain was invalid
186	Lead Lag OFF hysteresis was invalid
187	Lead Lag ON hysteresis was invalid
188	Lead Lag slave enable was invalid
189	Lead Lag hysteresis step time was invalid
190	No Lead lag Modbus port was assigned
191	Lead Lag base load common setting was invalid
192	Lead Lag DHW demand switch setting was
193	Lead Lag Mix demand switch setting was invalid
194	Lead Lag modulation sensor setting was invalid
195	Lead Lag backup modulation sensor setting was
196	Lead Lag slave mode setting was invalid
197	Lead Lag rate allocation setting was invalid
198	Lead selection setting was invalid
199	Lag selection setting was invalid
200	Lead Lag slave return setting was invalid
201	Lead Lag add stage method setting was invalid
202	STAT may not be a Lead Lag CH demand source
203	Lead Lag base load rate setting was invalid
	Lead Lag Operation Faults
204	Lead Lag master was suspended due to fault
205	Lead Lag slave was suspended due to fault
206	Lead Lag header temperature was invalid
207	Lead Lag was suspended due to no enabled
208	Lead Lag slave session has timed out

Table 52. Alerts. (Continued)

Code	Description
209	Too many Lead Lag slaves were detected
210	Lead Lag slave was discovered
211	Incompatible Lead Lag slave was discovered
212	No base load rate was set for Lead Lag slave
213	Lead Lag slave unable to fire before demand to
214	Adding Lead Lag slave aborted due to add
215	No Lead Lag slaves available to service demand
216	No Lead Lag active service was set due to
217	No Lead Lag add stage method was specified
218	No Lead Lag drop stage method was specified
219	Using backup lead lag header sensor due to
	Frost Protection Faults
220	Lead Lag frost protection rate was invalid
221	Lead Lag drop stage method setting was invalid
222	CH frost protection temperature was invalid
223	CH frost protection inlet temperature was invalid
224	DHW frost protection temperature was invalid
225-226	RESERVED
227	DHW priority override time was not derated due
228	Warm weather shutdown was not checked due
229	Lead Lag slave communication timeout
230	RESERVED
231	Lead Lag CH setpoint was invalid
232	Lead Lag CH time of day setpoint was invalid
233	LL outdoor temperature was invalid
234	Lead Lag ODR time of day setpoint was invalid
235	Lead Lag ODR time of day setpoint exceeded
236	Lead Lag ODR max outdoor temperature was
237	Lead Lag ODR min outdoor temperature was
238	Lead Lag ODR low water temperature was
239	Lead Lag ODR outdoor temperature range was
240	Lead Lag ODR water temperature range was too
241	Lead Lag DHW setpoint was invalid
242	Lead Lag Mix setpoint was invalid
243	Lead Lag CH demand switch was invalid
244	Lead Lag CH setpoint source was invalid
245	RESERVED
246	CH setpoint was invalid
247	CH time of day setpoint was invalid
248	CH outdoor temperature was invalid
249	CH ODR time of day setpoint was invalid
250	CH ODR time of day setpoint exceeds normal
251	CH max outdoor setpoint was invalid

Table 52. Alerts. (Continued)

Code	Description
252	CH min outdoor setpoint was invalid
253	CH min water setpoint was invalid
254	CH outdoor temperature range was too small
255	CH water temperature range was too small
256	Steam setpoint was invalid
257	Steam time of day setpoint was invalid
258	Steam minimum pressure was invalid
259	CH ODR min water temperature was invalid
260	RESERVED
261	DHW setpoint was invalid
262	DHW time of day setpoint was invalid
263	DHW storage setpoint was invalid
264	STAT may not be a DHW demand source when
265-266	RESERVED
267	STAT may not be a CH demand source when
268	CH 4mA water temperature setting was invalid
269	CH 20mA water temperature setting was invalid
270	Steam 4mA water temperature setting was
271	Steam 20mA water temperature setting was
272	Abnormal Recycle: Pressure sensor fault
273	Abnormal Recycle: Safety relay drive test failed
274	Abnormal Recycle: Demand off during Pilot
275	Abnormal Recycle: LCI off during Drive to Purge
276	Abnormal Recycle: LCI off during Measured
277	Abnormal Recycle: LCI off during Drive to
278	Abnormal Recycle: LCI off during Pre-Ignition
279	Abnormal Recycle: LCI off during Pre-Ignition
280	Abnormal Recycle: LCI off during Main Flame
281	Abnormal Recycle: LCI off during Ignition period
282	Abnormal Recycle: Demand off during Drive to
283	Abnormal Recycle: Demand off during Measured
284	Abnormal Recycle: Demand off during Drive to
285	Abnormal Recycle: Demand off during Pre-
286	Abnormal Recycle: Demand off during Pre-
287	Abnormal Recycle: Flame was on during Safe
288	Abnormal Recycle: Flame was on during Drive to
289	Abnormal Recycle: Flame was on during
290	Abnormal Recycle: Flame was on during Drive to
291	Abnormal Recycle: Flame was not on at end of
292	Abnormal Recycle: Flame was lost during Main
293	Abnormal Recycle: Flame was lost early in Run
294	Abnormal Recycle: Flame was lost during Run
295	Abnormal Recycle: Leakage test failed

Table 52. Alerts. (Continued)

Code	Description
296	Abnormal Recycle: Interrupted air flow switch
297	Abnormal Recycle: Interrupted air flow switch
298	Abnormal Recycle: Interrupted air flow switch
299	Abnormal Recycle: Interrupted air flow switch
300	Abnormal Recycle: Interrupted air flow switch
301	Abnormal Recycle: Interrupted air flow switch
302	Abnormal Recycle: Ignition failed due to
303	Abnormal Recycle: ILK off during Drive to Purge
304	Abnormal Recycle: ILK off during Measured
305	Abnormal Recycle: ILK off during Drive to
306	Abnormal Recycle: ILK off during Pre-Ignition
307	Abnormal Recycle: ILK off during Pre-Ignition
308	Abnormal Recycle: ILK off during Main Flame
309	Abnormal Recycle: ILK off during Ignition period
310	Run was terminated due to ILK was off
311	Run was terminated due to interrupted air flow
312	Stuck reset switch
313	Run was terminated due to fan failure
314	Abnormal Recycle: Fan failed during Drive to
315	Abnormal Recycle: Fan failed during Measured
316	Abnormal Recycle: Fan failed during Drive to
317	Abnormal Recycle: Fan failed during Pre-Ignition
318	Abnormal Recycle: Fan failed during Pre-Ignition
319	Abnormal Recycle: Fan failed during Ignition
320	Abnormal Recycle: Fan failed during Main Flame
321	Abnormal Recycle: Main Valve off after 10
322	Abnormal Recycle: Pilot Valve off after 10
323	Abnormal Recycle: Safety Relay off after 10
324	Abnormal Recycle: Hardware flame bias
325	Abnormal Recycle: Hardware static flame
326	Abnormal Recycle: Hardware flame current
327	Abnormal Recycle: Hardware flame rod short
328	Abnormal Recycle: Hardware invalid power
329	Abnormal Recycle: Hardware invalid AC line
330	Abnormal Recycle: Hardware SLO flame ripple
331	Abnormal Recycle: Hardware SLO flame sample
332	Abnormal Recycle: Hardware SLO flame bias
333	Abnormal Recycle: Hardware SLO flame bias
334	Abnormal Recycle: Hardware SLO spark stuck
335	Abnormal Recycle: Hardware SLO spark
336	Abnormal Recycle: Hardware SLO static flame
337	Abnormal Recycle: Hardware SLO rod shorted
338	Abnormal Recycle: Hardware SLO AD linearity

Table 52. Alerts. (Continued)

Code	Description
339	Abnormal Recycle: Hardware SLO bias not set
340	Abnormal Recycle: Hardware SLO bias shorted
341	Abnormal Recycle: Hardware SLO electronics
342	Abnormal Recycle: Hardware processor clock
343	Abnormal Recycle: Hardware AC phase
344	Abnormal Recycle: Hardware A2D mismatch
345	Abnormal Recycle: Hardware VSNSR A2D
346	Abnormal Recycle: Hardware 28V A2D
347	Abnormal Recycle: Hardware HFS IAS shorted
348	Abnormal Recycle: Hardware PII INTLK shorted
349	Abnormal Recycle: Hardware HFS LCI shorted
350	Abnormal Recycle: Hardware HFS LFS shorted
351	Abnormal Recycle: Invalid zero crossing
352	Abnormal Recycle: fault stack sensor
353	Abnormal Recycle: stack limit
354	Abnormal Recycle: delta T limit
355	Abnormal Recycle: fault outlet sensor
356	Abnormal Recycle: outlet high limit
357	Abnormal Recycle: fault DHW sensor
358	Abnormal Recycle: DHW high limit
359	Abnormal Recycle: fault inlet sensor
360	Abnormal Recycle: Check Parameters Failed
	Internal Errors
361	Internal error: No factory parameters were
362	Internal error: PID iteration frequency was invalid
363	Internal error: Demand-Rate interval time was
364	Internal error: Factory calibration parameter for
365	Internal error: CH PID P-scaler was invalid
366	Internal error: CH PID I-scaler was invalid
367	Internal error: CH PID D-scaler was invalid
368	Internal error: DHW PID P-scaler was invalid
369	Internal error: DHW PID I-scaler was invalid
370	Internal error: DHW PID D-scaler was invalid
371	Internal error: Lead Lag master PID P-scaler was
372	Internal error: Lead Lag master PID I-scaler was
373	Internal error: Lead Lag master PID D-scaler was
374	Abnormal Recycle: Hardware flame bias high
375	Abnormal Recycle: Hardware flame bias low
376	Abnormal Recycle: Hardware flame bias delta
377	Abnormal Recycle: Hardware flame bias delta
378	Abnormal Recycle: Hardware flame bias
379	Abnormal Recycle: Hardware flame bias
380	Abnormal Recycle: Fan Speed Not Proven

Table 52. Alerts. (Continued)

Code	Description
381	Abnormal Recycle: Fan Speed Range Low
382	Abnormal Recycle: Fan Speed Range High
383-450	RESERVED
	Circulator Errors
451	Circulator control was invalid
452	Circulator P-gain was invalid
453	Circulator I-gain was invalid
454	Circulator temperature was invalid
455	Circulator outlet temperature was invalid
456	Circulator inlet temperature was invalid
457	Circulator outdoor temperature was invalid
458	Circulator sensor choice was invalid
459	Circulator PID setpoint was invalid
	Debug Faults
460	LCI lost in run
461	Abnormal Recycle: Demand lost in run from
462	Abnormal Recycle: Demand lost in run due to
463	Abnormal Recycle: Demand lost in run due to no
464	LCI lost in Combustion Pressure Establishing
465	LCI lost in Combustion Pressure Stabilization
466	RESERVED
	Internal Data Faults
467	Internal error: EEPROM write was attempted
468	Internal error: EEPROM cycle count address
469	Internal error: EEPROM days count address was
470	Internal error: EEPROM hours count address
471	Internal error: Lockout record EEPROM index
472	Internal error: Request to write PM status was
473	Internal error: PM parameter address was invalid
474	Internal error: PM safety parameter address was
475	Internal error: Invalid record in lockout history
476	Internal error: EEPROM write buffer was full
477	Internal error: Data too large was not written to
478	Internal error: Safety key bit 0 was incorrect
479	Internal error: Safety key bit 1 was incorrect
480	Internal error: Safety key bit 2 was incorrect
481	Internal error: Safety key bit 3 was incorrect
482	Internal error: Safety key bit 4 was incorrect
483	Internal error: Safety key bit 5 was incorrect
484	Internal error: Safety key bit 6 was incorrect
485	Internal error: Safety key bit 7 was incorrect
486	Internal error: Safety key bit 8 was incorrect
487	Internal error: Safety key bit 9 was incorrect

Table 52. Alerts. (Continued)

Code	Description
488	Internal error: Safety key bit 10 was incorrect
489	Internal error: Safety key bit 11 was incorrect
490	Internal error: Safety key bit 12 was incorrect
491	Internal error: Safety key bit 13 was incorrect
492	Internal error: Safety key bit 14 was incorrect
493	Internal error: Safety key bit 15 was incorrect
494	Internal error: Safety relay timeout
495	Internal error: Safety relay commanded off
496	Internal error: Unknown safety error occurred
497	Internal error: Safety timer was corrupt
498	Internal error: Safety timer was expired
499	Internal error: Safety timings
500	Internal error: Safety shutdown
501	RESERVED
	MIX Errors
502	Mix setpoint was invalid
503	Mix time of day setpoint was invalid
504	Mix outdoor temperature was invalid
505	Mix ODR time of day setpoint was invalid
506	Mix ODR time of day setpoint exceeds normal setpoint
507	Mix ODR max outdoor temperature was invalid
508	Mix ODR min outdoor temperature was invalid
509	Mix ODR low water temperature was invalid
510	Mix ODR outdoor temperature range was invalid
511	Mix ODR water temperature range was invalid
512	Mix demand switch was invalid
513	Mix ON hysteresis was invalid
514	Mix OFF hysteresis was invalid
515	Mix ODR min water temperature was invalid
516	Mix hysteresis step time was invalid
517	Mix P-gain was invalid
518	Mix I-gain was invalid
519	Mix D-gain was invalid
520	Mix control was suspended due to fault
521	Mix S10 (J10-7) temperature was invalid
522	Mix outlet temperature was invalid
523	Mix inlet temperature was invalid
524	Mix S5 (J8-11) temperature was invalid
525	Mix modulation sensor type was invalid
526	Mix ODR min water temperature setpoint was invalid
527	Mix circulator sensor was invalid
528	Mix flow control was invalid
529	Mix temperature was invalid
530	Mix sensor was invalid

Table 52. Alerts. (Continued)

Code	Description
531	Mix PID setpoint was invalid
532	STAT may not be a Mix demand source when Remote Stat is enabled
533-539	RESERVED
540	Delta T inlet/outlet enable was invalid
541	Delta T exchanger/outlet enable was invalid
542	Delta T inlet/exchanger enable was invalid
543	Delta T inlet/outlet degrees was out of range
544	Delta T exchanger/outlet degrees was out of range
545	Delta T inlet/exchanger degrees was out of range
546	Delta T response was invalid
547	Delta T inversion limit response was invalid
548	Delta T rate limit enable was invalid
549	Delta T exchanger/outlet wasn't allowed due to stack limit setting
550	Delta T inlet/outlet limit was exceeded
551	Delta T exchanger/outlet limit was exceeded
552	Delta T inlet/exchanger limit was exceeded
553	Inlet/outlet inversion occurred
554	Exchanger/outlet inversion occurred
555	Inlet/exchanger inversion occurred
556	Delta T exchanger/outlet wasn't allowed due to stack connector setting
557	Delta T inlet/exchanger wasn't allowed due to stack limit setting
558	Delta T inlet/exchanger wasn't allowed due to stack connector setting
559	Delta T delay was not configured for recycle response
	T Rise Errors
560	Outlet T-rise enable was invalid
561	Heat exchanger T-rise enable was invalid
562	T-rise degrees was out of range
563	T-rise response was invalid
564	Outlet T-rise limit was exceeded
565	Heat exchanger T-rise limit was exceeded
566	Heat exchanger T-rise wasn't allowed due to stack limit setting
567	Heat exchanger T-rise wasn't allowed due to stack connector setting
568	Outlet T-rise wasn't allowed due to outlet connector setting
569	T-rise delay was not configured for recycle response
	Heat Exchanger High Limit Errors
570	Heat exchanger high limit setpoint was out of range
571	Heat exchanger high limit response was invalid

Table 52. Alerts. (Continued)

Code	Description
572	Heat exchanger high limit was exceeded
573	Heat exchanger high limit wasn't allowed due to stack limit setting
574	Heat exchanger high limit wasn't allowed due to stack connector setting
575	Heat exchanger high limit delay was not configured for recycle response
	Pump Errors
576	CH pump output was invalid
577	DHW pump output was invalid
578	Boiler pump output was invalid
579	Auxiliary pump output was invalid
580	System pump output was invalid
581	Mix pump output was invalid
582-589	RESERVED
	DHW Plate Heat Exchanger Errors
590	DHW plate preheat setpoint was invalid
591	DHW plate preheat ON hysteresis was invalid
592	DHW plate preheat OFF hysteresis was invalid
593	Tap detect degrees was out of range
594	Tap detect ON hysteresis was invalid
595	Inlet - DHW tap stop degrees was out of range
596	Outlet - Inlet tap stop degrees was out of range
597	DHW tap detect on threshold was invalid
598	DHW plate preheat detect on threshold was invalid
599	DHW plate preheat detect off threshold was invalid

Automation and Control Solutions
Honeywell International Inc.
1985 Douglas Drive North
Golden Valley, MN 55422

Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Toronto, Ontario M1V 4Z9
customer.honeywell.com

66-1171—03 M.S. Rev. 11-09
Printed in U.S.A.

Honeywell