resideo

R7910B SOLA RC (RESIDENTIAL CONTROL)

PRODUCT DATA

APPLICATION

THE R7910B SOLA RC IS A HYDRONIC BOILER CONTROL SYSTEM THAT PROVIDES HEAT CONTROL, FLAME SUPERVISION, CIRCULATION PUMP CONTROL, FAN CONTROL, BOILER CONTROL, AND ELECTRIC IGNITION FUNCTION. IT WILL ALSO PROVIDE BOILER STATUS AND ERROR REPORTING.

MULTIPLE BOILERS CAN BE JOINED TOGETHER TO HEAT A SYSTEM INSTEAD OF A SINGLE, LARGER BURNER OR BOILER. USING BOILERS IN PARALLEL IS MORE EFFICIENT, COSTS LESS, REDUCES EMISSIONS, IMPROVES LOAD CONTROL, AND IS MORE FLEXIBLE THAN THE TRADITIONAL LARGE BOILER. (2008 UPGRADE.)

FEATURES

Safety and Boiler Protection

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

Integrated Control Functions:

- **Primary Control**
- **Internal or external spark generator**
- **Analog Input using 10kohm NTC Sensor**
  - Outlet Limit And Temperature
  - DHW (Domestic Hot Water) Limit and Temperature
  - Stack Temperature Limit and Temperature
  - Inlet Temperature
  - Outdoor Temperature
- **Other Analog Inputs**
  - PWM Feedback
  - Flame Signal from a Flame Rod

SOLA RC System Consists of:

R7910 Control Device
S7999B Touchscreen Display—required for setup and ModBus communication but not required for the system to operate once the R7910B is programmed.
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)
S7910A Local Keyboard Display Module
Fans (VFD)

68-0290-02

- **PID Load Control**
  - CH (Central Heat)
  - DHW (Domestic Hot Water)
- **Digital Inputs**
  - Pre Ignition Interlock
  - LCI (Load [or Limit]Control Input)
  - Airflow Interlock
  - Annunciation (2 Programmable)
  - Remote Reset
- **Digital Outputs**
  - Pump Control (3 outputs, 5 different programmable features)
  - Combustion Blower
  - External Ignition
  - Pilot Valve
  - Main Valve
  - Alarm
- **Algorithm Prioritization**
  - Burner Demand
    - **CH, DHW and Frost Protection**
  - Firing Rate Limiting
    - **Anti-Condensate, Stack Limit, Boiler Delta-T, Boiler Slow Start, Outlet Limit, On and Off Hysteresis**
- **Two Temperature Loops of Control**
  - CH
  - DHW
- **High Limit Control (Meets UL 353)**
- **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**
- **Flame Signal test jacks (Vdc)**
- **Three Status LEDs**
  - Power
  - Flame
  - Alarm
- **Analog NTC Sensor Inputs (10kohm or 12kohm)**

  NOTE: 12kohm sensors cannot be used for Limit Application functions.
- **Flame Sensing**
  - Flame Rod
    - **Single Element (Internal spark generator and flame sense using the same element)**
    - **Dual Element (separate elements for ignition spark and flame sense)**

Approvals:

Underwriters Laboratories, Inc. (UL)(cUL): Component Recognized: File No. MH20613 (MCCZ)

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 a dual 10kohm NTC sensor.

Federal Communications Commission, Part 15, Class B.Emissions.

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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 could include but are not limited to:
  - Read the error log from R7910B.
  - Monitor the input and output variables of the controller.
  - Read parameters from R7910B.
  - 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 R7910B will start up in either the configured or unconfigured condition. In the Configured condition it is ready to operate a burner.

The R7910B is in the unconfigured condition whenever a safety parameter requires editing (Commissioning). The R7910B remains unconfigured and will not operate a burner until all safety parameters have been reviewed and confirmed.

Safety Lockout.

The R7910B 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 always causes a lockout condition to be cleared, and the microcomputer that operates the burner control part of the R7910B to reinitialize and restart.

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

Fault Handling

The R7910B implements three kinds of faults: lockouts, holds, and alerts.

- **Lockout** causes the burner control to shut down and requires manual reset to clear the lockout.
  - It always causes the alarm contact to close.
  - Gets logged into the 15-item lockout/hold history.
- **Hold** causes the burner control to enter a hold condition that lasts until the condition reverts to normal.
- **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 Signal Conditioning

The analog sensor signal processing includes filtering to reduce the effect of noise and spurious read events.

Operating Sensors will not cause a fault condition unless the value is requested for control purposes. The R7910B will trigger an Alert if an operating sensor is malfunctioning.

Safety Sensors (Sensors used as Limits, e.g. High Temp Limit) include a comparison of redundant sensors. A safety sensor mismatch or out-of-range will result in a safety shutdown and Alarm.

Non-Volatile Memory

The R7910B will store the following items in non-volatile memory:

- Factory configuration data
- Parameter Control Blocks
- All configuration parameters
- The 15 item lockout history
- Cycle and Time history

Lockout History

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

- **Burner Lockout/Hold** identifies the cause of the lockout or hold.
- **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, and Stack)

Cycle and Time History

The non-volatile memory will contain 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 R7910B 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

Temperature Settings

All parameters that provide a temperature will have a possible value of "None."

This value will be a special code that is not a legal temperature. Whenever a function requires a temperature parameter it will test this parameter for a legal value, and if the "None" value is found it will respond by generating either an Alarm or a Lockout, as appropriate to the function, and either operate in an alternative manner or suspend operation, as appropriate to the function.

Required Components (not supplied)

Sensor plus Limit (10kohm)

Part Number	Cable Length (inches)
• 50001464-006	6 with Molex in line connector
• 50001464-007	48 without connector

Sensor only (10 kohm)

- 32003971-111 CONTAINS: (2) 118826 ANCHORS; (3) 199624AB MTG. SCREWS; (2) 121958 WIRE NUTS; (1) 32002217-002 SENSOR CLIP; (2) 291125 TIE STRAP (1) 4"x4"x1/2" Insulating Tape
- Pilot Burner Assemblies - Q179A, C, C7005
- Gas Valves - Solenoid V8295 V4730/V4734/V8730 Premix valves with Venturi
- Transformer (for powering R7910 alone 40va minimum) - AT72D (40VA) AT88 (75VA)
- Flame Sensor
- Circulating Pumps 120 Vac

Connectors for field wiring: see Table 1.

Table 1. Connectors For Field Wiring.

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

Accessories:

- S7910A1008 Keyboard Display Module
- S7999B1026 System Display Module
- DSP3944 System Display Programming Tool for system Setup when S7999B is not provided with boiler.
- PM7910 Program Module - Storage module for the R7910 setup parameters, may be written to for storage or used for cloning of replacement controls or multiple systems.

OVERVIEW

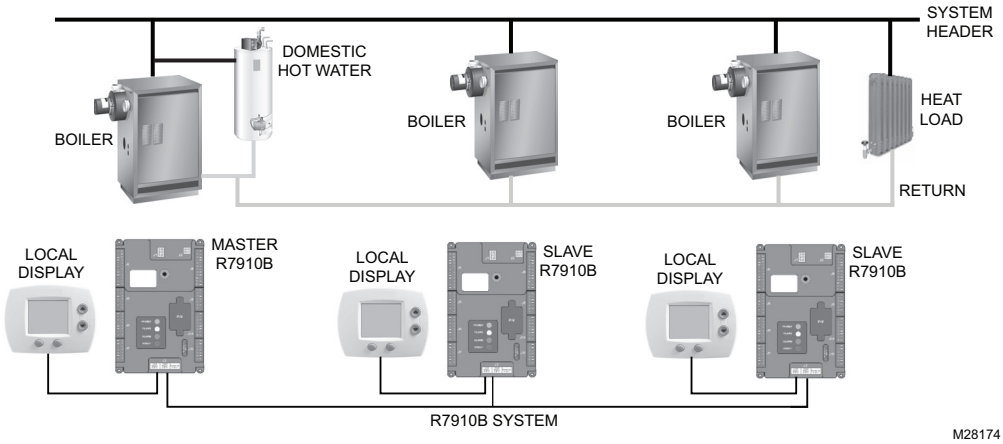


Fig. 1. R7910B System.

Functions provided by the R7910B include automatic boiler sequencing (future upgrade), flame supervision, system status indication, firing rate control, load control, CH/DHW control, limit control, system or self-diagnostics and troubleshooting.

The full versions of the controller offer:

- NTC-temperature sensor for:
  - Primary (CH)
  - Inlet
  - Domestic Hot Water (DHW)
  - Outside temperature sensor (OTS)
  - Stack
- PWM-driven rotation speed controlled DC-fan for optimal modulation control (Fan with display)
- Gas valve 24Vac
- CH circulation pump
- PWM-driven circulation pump for optimal energy consumption
- DHW-pump
- 24Vac inputs for room limit control, high limit control, Air pressure switch, Gas pressure switch (model-specific)
- Optional switches:
  - Summer/winter switch
  - Burner switch
- Optional analogue control input
- Optional analogue output
- Optional filtered input for
  - Storage tank DHW sensor
  - Outdoor temperature sensor
- 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

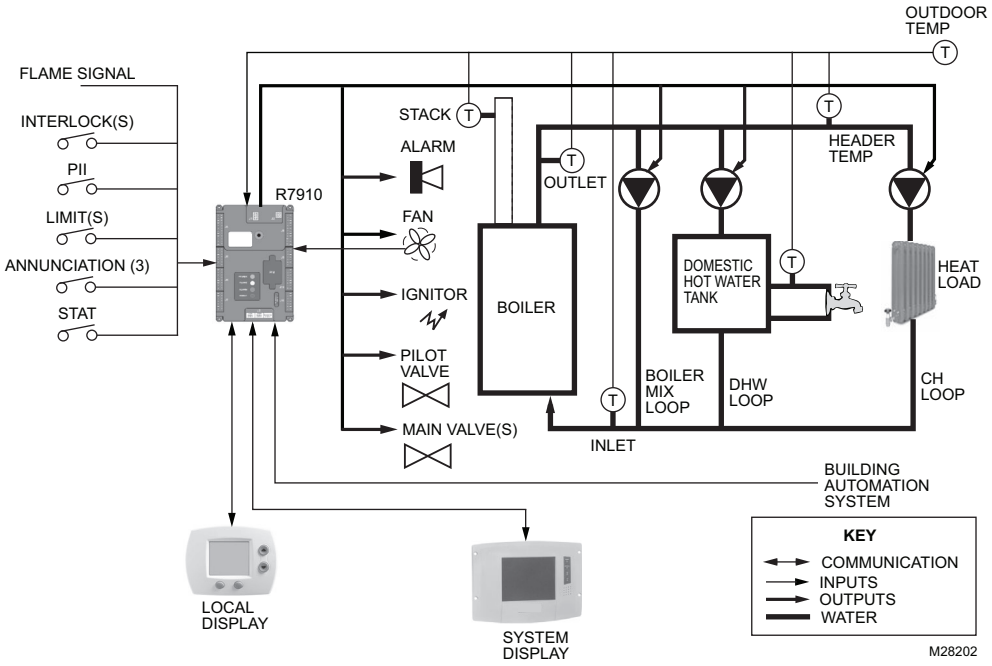


Fig. 2. General hydronic boiler schematic.

Multiple boilers may be joined together (future upgrade) to satisfy the needs to heat a system. Using boilers in parallel improves system efficiency and reduces emissions.

Each boiler has a dedicated R7910B to control the operation of that device. When more than one boiler is needed to heat the system, one of the R7910B may be designated as the Master R7910B to control the operation of the entire system (see Fig. 3). Each R7910B has a local display attached to it to configure parameters and view status specifically for the boiler it controls.

Fig. 2 shows two loops of heat control: Central Heating (CH), and an optional second loop for Domestic Hot Water (DHW) can be configured on each R7910B. 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.

System Display

The System display interfaces to all R7910B in the system and presents them as a group or individually to the user. Configuration and monitoring of the R7910B are permitted from the System display to control operation and display status in both text and graphical modes.

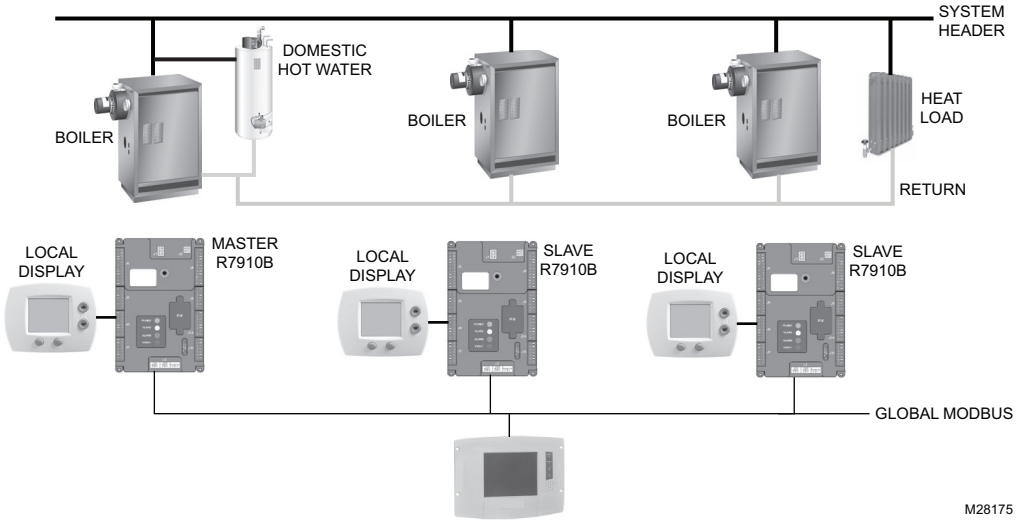


Fig. 3. System display connected to global Modbus networks.

The System display may be connected to the Global RS-485 Modbus network which attaches all of the R7910B together for external control (see the following figure). The System display is the Modbus master on this network, and the R7910B (including the Master R7910B) are Modbus slaves (2008 upgrade).

The System display is optional for the operation of a hydronic heating application with a single R7910B. The System display presents status and permits more configuration than the Local display does, but the System display isn't required. A System display is necessary, however, when multiple R7910B are required in the hydronic system to minimally configure the Lead/Lag algorithm. Once all system configuration is finished it is optional whether the System display remains on the system or not to continue monitoring its operation.

SPECIFICATIONS

Electrical Ratings:
120VAC -15%/+10% (102 to 132 VAC)
Operating voltage
24Vac +10/-15%, 60Hz
Connected Load for Valve and annunciator functions:
24Vac, 60Hz
24VAC -16.6%/+25% (20 to 30 VAC)
Line frequency: 60 Hertz, +/- 5% (57 to 63 Hz)

Corrosion:
R7910B 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:
5 to 95% Relative Humidity, noncondensing. Condensing moisture may cause safety shutdown.

Vibration: 0.0 to 0.5g Continuous (V2 level)

Enclosure: Nema 1/IP40.

Dimensions: See Fig. 4.

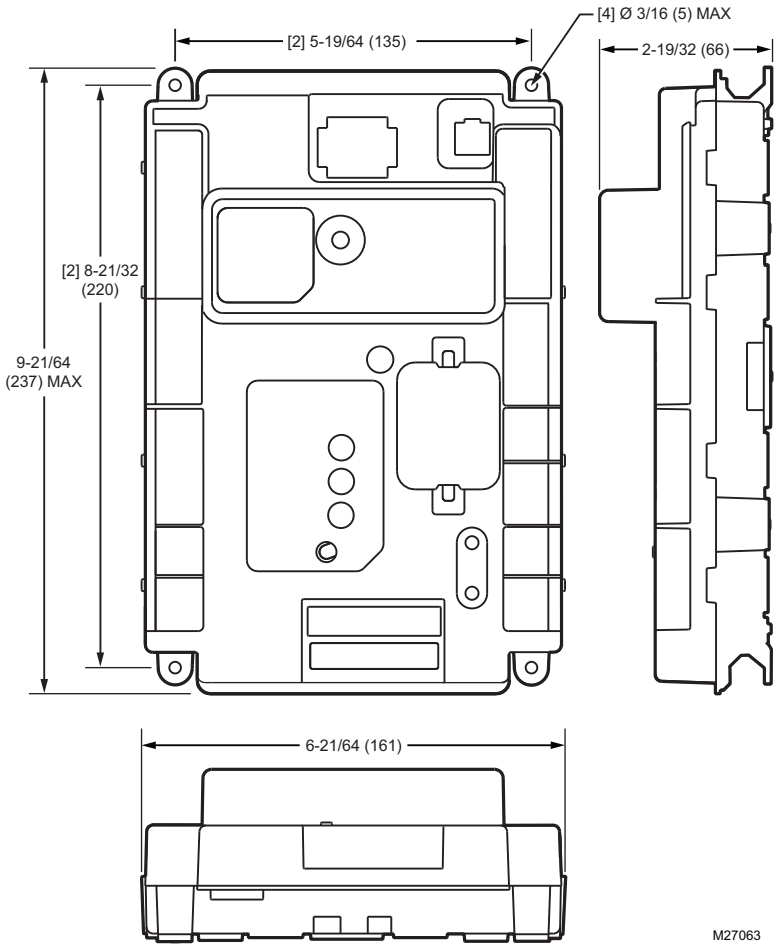


Fig. 4. R7910B dimensions in in. (mm).

Table 2. 50001464* 198799A NTC Sensors

Temp C (F)	12K NTC (kOhm)** Beta of 3750	10K NTC (kOhm)** Beta of 3750
-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

* 50001464 are dual sensors and used as safety sensors.
**All sensors attached to the R7910 MUST be all 12K or 10K sensors (don't mix and match).

The safety mechanism of the R7910B detects drift of the sensor connected to the NTC1 input if:

- the drift is considerable
- this drift is towards lower measured temperatures
- the actual temperature is large

Actual figures depend on the amount of drift and the actual temperature.

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. 5.
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

1. Select a location on a wall, burner or electrical panel. The R7910 can be mounted directly in the control cabinet. Be sure to allow adequate clearance for servicing.
2. Use the R7910 as a template to mark the four screw locations. Drill the pilot holes.
3. Securely mount the R7910 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.

120 Vac Power

During construction, if a temporary generator is used for 120 Vac power, it must be of sufficient quality to provide Vac within 57–63 Hz frequency range and the specific voltage range without significant voltage spikes. Failure to use a generator meeting the voltage, frequency and grounding requirements can result in control operating problems.

Ground Connection

1. Use the common ground terminal next to the controller, close to connector J4-12.
2. Connect the central ground terminal with the connection contact of the controller.
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 J8-1.
2. 24Vac Return to connector J8-2.
3. Ground to central ground terminal, not to Ground on J4-12.

Limit String and Annunciator inputs and Safety Load Outputs

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

Dry Contacts available for:

1. Pump A: Connector J4-6 & 7.
2. Pump B: Connector J4-4 & 5.
3. Pump C: Connector J4-2 & 3.
4. Hot Surface Ignitor: Connector J5-6 & 7.
5. Alarm: Connector J6-7 & 8.

Wiring Connectors J2, J8, J9, and J10 Low Voltage Connections (includes NTC Sensors, current and voltage inputs)

1. Wire according to specifications, following all local ordinances and requirements.
2. Do not bundle the low voltage wires with the ignition cable, CH Pump or DHW Pump, or other 120V wiring.
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 pump control separately.
5. Do not bundle the ionization wire (flame signal) with the high voltage cables, or other 24V wires.

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 R7910B 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 and the high voltage ignition lead and the return path of the current that flows during sparking is an important cause of electromagnetic interference if not properly routed.

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

The following cautions apply:

- A short loop in the ignition wire and the return wire minimizes the electromagnetic field.
- A return path close to the high voltage wire increases the total capacitance of the load connected to the high voltage transformer and will therefore reduce the maximum voltage and make it more difficult to have sparking at the spark plug.
- A return path close to the ignition lead or earth metal increases the changes of flash-over though the isolation of the cable, and with single-sensor systems, reduces the flame signal.

Communications: Connector J3

1. Connect the S7910B Local Display only to connectors J3-1 (C), J3-2 (R), J3-3 (D). **Do not connect the S7999 display to these connectors.**
2. Connect the S7999B System Display to either J3 Local Modbus port, connectors a, b, c or J3 Global ModBus port a, b, c.

Final Wiring Check

1. Check the power supply circuit. The voltage and frequency tolerance must match those of the R7910B. A separate power supply circuit may be required for the R7910B. 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 R7910B 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 14.

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
TOD	22 AWG two-wire twisted pair, insulated for low voltage	Beldon 8443 or equivalent	1000
Temperature (operating) Sensors	22 AWG two-wire twisted pair, insulated for low voltage	Beldon 8443 or equivalent	50
Temperature (Limit) Sensors	22 AWG two-wire twisted pair with ground.	Beldon 8723 shielded cable or equivalent	50
Flame Sensor (Flame Rod/UV)	14, 16, 18 AWG Copper conductor, 600 volt insulations, moisture-resistance wire	TTW60C, THW75C, THHN90C	30
Ignition	Ignition Cable rated for 25kV at 482F(250C)	32004766-001 (2') or -003 (per foot)	3

Table 3. Wire Sizes. (Continued)

Application	Recommended Wire Size	Recommended Part Number(s)	Maximum Leadwire Distance (in feet)
Grounding	Earth ground (subbase and relay module).	**1.** Use to provide a connection between the subbase and the control panel of the equipment. 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.	

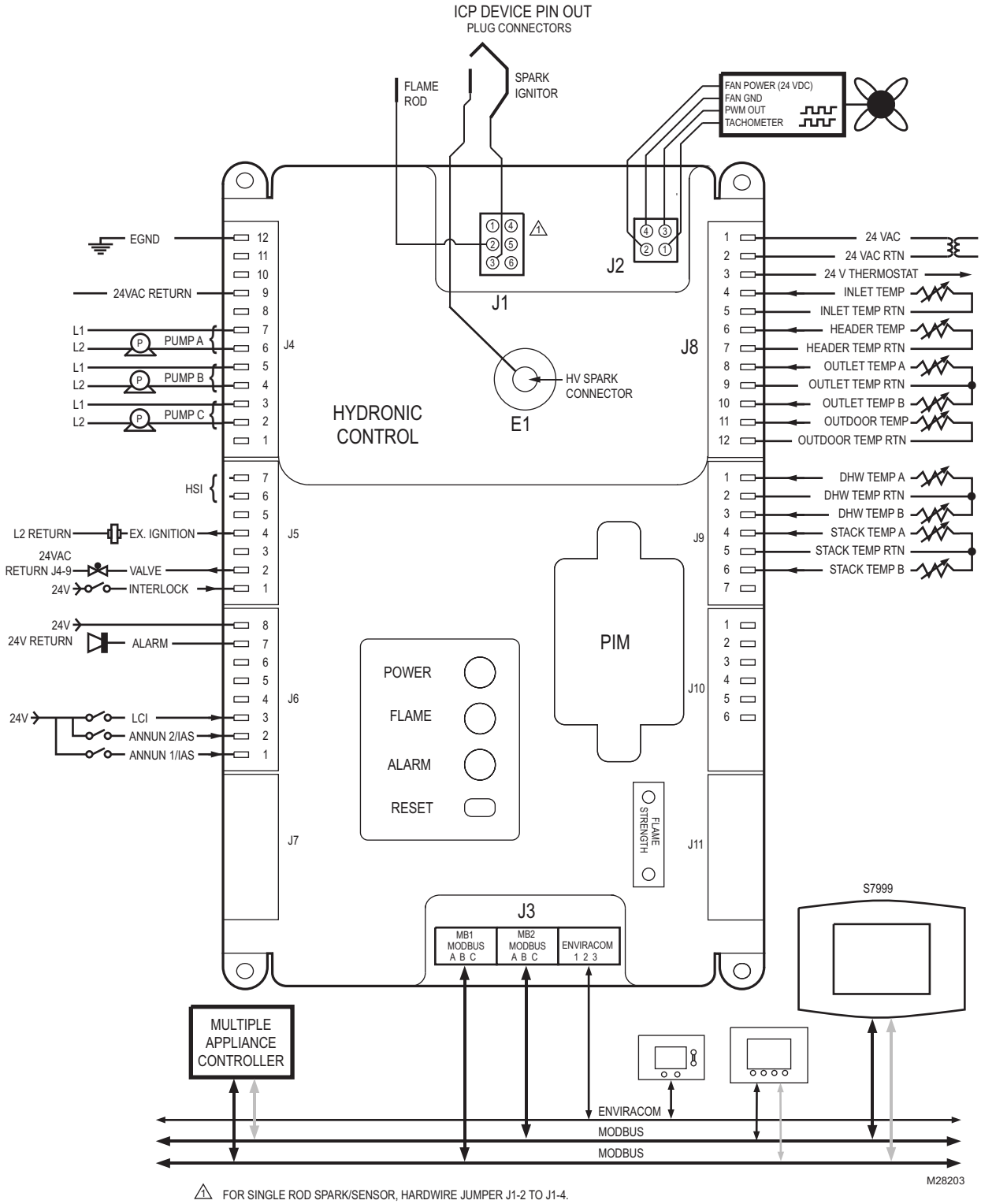


Fig. 5. R7910B device pin out.

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. R7910B Contact Ratings.

Connector		Function	Description and Rating (All Models)
J1	1		
	2	FLAME ROD INPUT	
	3	FLAME ROD COMMON	
	4		
	5		
	6		
J2	1	TACH	Tachometer Input (Tach) Tachometer input.
	2	25V	
	3	PWM	Digital modulation (PWM) Output Digital modulation signal out.
	4	GND	Ground pin for fan interface and power
J3	a	a	Global Modbus RS-485 +
	b	b	Global Modbus RS-485 -
	c	c	Global Modbus RS-485 ground
	a	a	EnviraCOM Data (D)
	b	b	EnviraCOM Receive (R)
	c	c	EnviraCOM ground
J4	12	EARTH GROUND	Earth ground
J4	11	Not Used	
J4	10	Not Used	
J4	9	24 VAC Return	24VAC –15%, +10%; 60Hz, +/-5%
J4	8	Not Used	
J4	7	PUMP A	120VAC: 44.4 ALR, 7.4 Amps run
J4	6	PUMP A	120VAC: 44.4 ALR, 7.4 Amps run
J4	5	PUMP B	120VAC: 44.4 ALR, 7.4 Amps run
J4	4	PUMP B	120VAC: 44.4 ALR, 7.4 Amps run
J4	3	PUMP C	120VAC: 44.4 ALR, 7.4 Amps run
J4	2	PUMP C	120VAC: 44.4 ALR, 7.4 Amps run
J4	1	Conditional spare	
J5	7	Hot Surface Ignitor	120VAC, 7.4 Amp
J5	6	Hot Surface Ignitor	120VAC, 7.4 Amp
J5	3	Conditional spare	
J5	4	EXT. IGNITION	120VAC: 44.4 ALR, 7.4 Amps run
J5	3	Not Used	24VAC: 44.4 ALR, 7.4 Amps run
J5	2	PILOT VALVE	24VAC: 44.4 ALR, 7.4 Amps run
J5	1	INTERLOCK	24VAC: 44.4 ALR, 7.4 Amps run

Table 5. R7910B Contact Ratings. (Continued)

Connector		Function	Description and Rating (All Models)
J6	8	ALARM	24VAC: 6.3 ALR, 0.63 Amps full load
J6	7	ALARM	24VAC: 6.3 ALR, 0.63 Amps full load
J6	6	Not Used	
J6	5	Not Used	
J6	4	Not Used	
J6	3	LCI	24VAC: 2 mA maximum
J6	2	Annunc1 / IAS	24VAC: 2 mA maximum
J6	1	Annunc2	24VAC: 2 mA maximum
J7	7	Not Used	
J7	6	Not Used	
J7	5	Not Used	
J7	4	Not Used	
J7	3	Not Used	
J7	2	Not Used	
J7	1	Not Used	
J8	1	24 VAC	Device Power, 24 VAC, (20 VAC to 30 VAC) (High)
J8	2	24 VAC	24VAC Return (Low)
J8	3	STAT Supply	24 VAC, (20 VAC to 30 VAC) (Connect return to)
J8	4	INLET TEMP	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor.
J8	5	INLET TEMP RTN	Ground reference for the Inlet Temp. Sensor
J8	6	HEADER TEMP	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J8	7	HEADER TEMP RTN	Ground reference for the Header Temp. Sensor
J8	8	OUTLET TEMP A	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J8	9	OUTLET TEMP RTN	Ground reference for the Outlet Temp. Sensor
J8	10	OUTLET TEMP B	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J8	11	OUTDOOR TEMP	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J8	12	OUTDOOR TEMP RTN	Ground reference for the Outdoor Temp. Sensor
J9	1	DHW TEMP A	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J9	2	DHW RTN	Ground reference for the DHW Temp. Sensor
J9	3	DHW TEMP B	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J9	4	STACK TEMP A	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J9	5	STACK RTN	Ground reference for the Stack Temp. Sensor
J9	6	STACK TEMP B	Supply for, and signal input from 10K or 12K Ohm NTC temperature sensor
J9	7	Spare	
J10	1	Not Used	
J10	2	Not Used	
J10	3	Not Used	
J10	4	Not Used	

Table 5. R7910B Contact Ratings. (Continued)

Connector		Function	Description and Rating (All Models)
J10	5	Not Used	
J10	6	Not Used	
J10	7	Not Used	
J10	8	Not Used	
J11	1	Not Used	
J11	2	Not Used	
J11	3	Not Used	
J11	4	Not Used	
J11	5	Not Used	
J11	6	Not Used	
J11	7	Not Used	
SPECIAL CONNECTIONS			
E1	Spark	8kV minimum open circuit voltage; 2.8mJ at the igniter	
PIM	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.	

Table 6. Valve Load Ratings.

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

STARTUP

The R7910B 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 R7910B is ready to operate a boiler.

Commissioning

Passwords

A password level of protection is assigned to all parameters. Three levels, listed here are shown in decreasing order of privilege:

1. **OEM password required**—allows access to all parameters (original password is ICPOEM). The OEM **must** enter a new password for both OEM and Installer.
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 R7910B 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 is shipped, but may be changed later using the S7999 system display, or the programming tool (introduced 2008).

The R7910B must be at an appropriate password level for changes to be effective (OEM password level allows changing either OEM or Installer parameters, installer password level allows changing only the installer parameters).

Parameter Control Blocks (PCB)

The R7910 Parameters are listed in control blocks of parameters. There are three parameter control blocks (PCB) that may be installed into the memory of the R7910B:

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 parameters.

A parameter control block is downloaded using a file-transfer method that operates within the Modbus protocol. The R7910B Global Modbus Interface Specification 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.

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. (A hidden parameter can be read through Modbus, but attempts to write to it return an error response).
- **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.

			via System & Local Display		via Modbus register I/O	
Hidden	Read-only	Password	Shown	Write	Read	Write
0	0	0	Yes	Anytime	Yes	Anytime
0	0	1	Yes	Need Password	Yes	Need Password
0	1	x	Yes	No	Yes	No
1	0	0	No	No	Yes	Anytime
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 alert in this block enables/disables the alert - a disabled alert is never shown.
- An enabled alert has the option of sending an Alarm (should the alarm contacts close or not close 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 not restricted.

⚠ 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 used to change Safety Configuration Parameters is to be done **only** by experienced and/or licensed burner/boiler operators and mechanics.

Programming Safety Parameters

Safety standards require a tool to be used to alter safety parameters. For the Sola RC parameters, this "tool" is the password.

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

The password level assigned during the OEM Parameter PCB process effectively controls the minimum password level of all safety items.

The R7910B will require the Installer password for this item, that is, if the parameter visibility control block indicates that no password is required, the Installer password will be enforced.

The R7910B may be in one of two conditions, configured, and unconfigured. It will run in the configured condition, whereas the setup of safety data is required following the procedure below before it will run when in the configured condition. When unconfigured and idle, all safety loads are off and the burner status is shown as "Safety data setup needed."

To modify and confirm the safety data when the R7910B is in the unconfigured condition requires the following steps: When complete, the R7910 will transition to the configured condition. The R7910B will not run while in the unconfigured state.

To begin, the R7910B needs to be powered in either Standby or a Lockout condition. 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 R7910B 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 R7910B to calculate the modified section of safety data. However it is not yet accepted and written into memory, nor does the R7910B leave the unconfigured state; instead it continues with the confirmation process in the next step.
3. The R7910B 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 R7910B.
4. After all items are confirmed, the R7910B 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 R7910B is in the configured condition, unless some other parameter section also needs setup. If some other section needs setup, the R7910B is again at step 1.

Functional Sub Systems

There are nine functional sub systems to the R7910B. They are:

1. System Operational Settings (Table 8 on page 19)
2. General Configuration Settings (Table 9 on page 19)
3. Demand and Rate
   - Central Heat Parameters (Table 10 on page 23)
   - Domestic Hot Water Params (Table 11 on page 27)
   - CH Frost Protection Params (Table 12 on page 28)
4. Rate Limits and Override (Table 13 on page 31)
5. Burner Control Parameters (Table 20 on page 38)
6. Modulation Output Parameters (Table 22 on page 41)
7. Pump Control (page 42)
8. Lead Lag (still to be defined)
9. Annunciation (page 47)

SYSTEM OPERATIONAL SETTINGS

System settings are those that enable or disable the R7910B 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 This parameter determines whether the CH loop is enabled or disabled. When disabled the demand caused by the CH Sensor is ignored. It may be disabled to turn it off temporarily, or because the application does not use this feature.
DHW enable	Enable, Disable This parameter determines whether the DHW loop is enabled or disabled. When disabled the demand caused by the DHW sensor. It may be disabled to turn it off temporarily, or because the application does not use this feature.
Lead Lag slave enable	(2008 upgrade)
Lead Lag Master enable	(2008 upgrade)
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 is set up as a LL slave, and a LL master is talking on the Local bus, then the CH source is ignored.
DHW priority 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 (ies).
Annunciation enable	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.
Annunciator Mode	Programmable, Fixed The parameter determines whether the Annunciator operates as fully programmable or as a fixed input device See the Annunciator section for details.
Burner Switch	On, Off This parameter enables or disables the burner control. When it is off, the burner will not fire.

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.

Table 9. General Configuration Settings. (Continued)

Parameter	Comment
Burner name	text The Burner Name is a text parameter stored in the R7910B to identify the burner.
OEM ID	text The OEM ID is a text parameter stored in the R7910 intended for use by an OEM to record identification information related to the OEM's configuration and setup of the R7910.
Installation Data	text The Installation Data is a text parameter stored in the R7910. It is intended for use by the installer to record identification information about how the R7910 was setup at the installation time.

Demand and Rate

The Demand and Rate subsystem produces 2 outputs:

- **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 Demand and Rate (CH DR)
- Domestic Hot Water (DHW DR)
- Lead Lag (LL DR)

These are all similar in that:

- Their inputs are a temperature sensor and a setpoint value.
- Their outputs are:
    a. An on/off demand indication that is on if the sub-system wants the burner to fire.
    b. 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 there are 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 R7910B without conversion at one specific maximum modulation fan speed. The chosen fan speed for calibrating these scalers is 5000 RPM, that is, when both the MCBA and the R7910B have a maximum modulation fan speed of 5000 RPM, the user-programmable P, I, and D gains used by the MCBA can be directly copied to the corresponding R7910B parameters, and the behavior of the R7910B control will then be similar to the MCBA.

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

GAINICP = GAINMCBA * Max_modulation_fan_speed / 5000

To prevent integral “wind up,” the R7910B's integrator will be limited to a maximum value (100%, that is, if I were used alone without P and D, the output would be 100%) and integration will be inhibited so that the integrator will not change its value whenever the proportional term (error times P gain) alone would provide 100% output (this is typical of a step-change in setpoint); i.e. values will be added to or subtracted from the integrator only when the operating point is within the proportional band.

The R7910B will also include 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, at the moment the override ends, the integrator will be preloaded with a value that causes the PID output to match the current rate, whenever this is possible within the integrator's limits.

Demand/Rate Selection and Limiting

These sources of demand and modulation rate are processed by a priority selector that determines which of the sources (Central Heating [CH DR], Domestic Hot Water [DHW DR], or Lead Lag Master [LL DR]) 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 overridden by rate limiting, which adjusts the burner firing rate during abnormal conditions.

The descriptions of the parameters shown in Fig. 6 occur elsewhere in this document:

- The enables and the DHW priority timeout are in “Burner Control Operation” on page 50.
- Manual Rate control is in “Modulation Output” on page 40.
- Frost Protection is in “Frost Protection” on page 28.
- Various Rate Limiting inputs are in “Rate Limits and Override” on page 31.

The Demand/Rate Selection subsystem is connected internally in the R7910B as shown in Fig. 6:

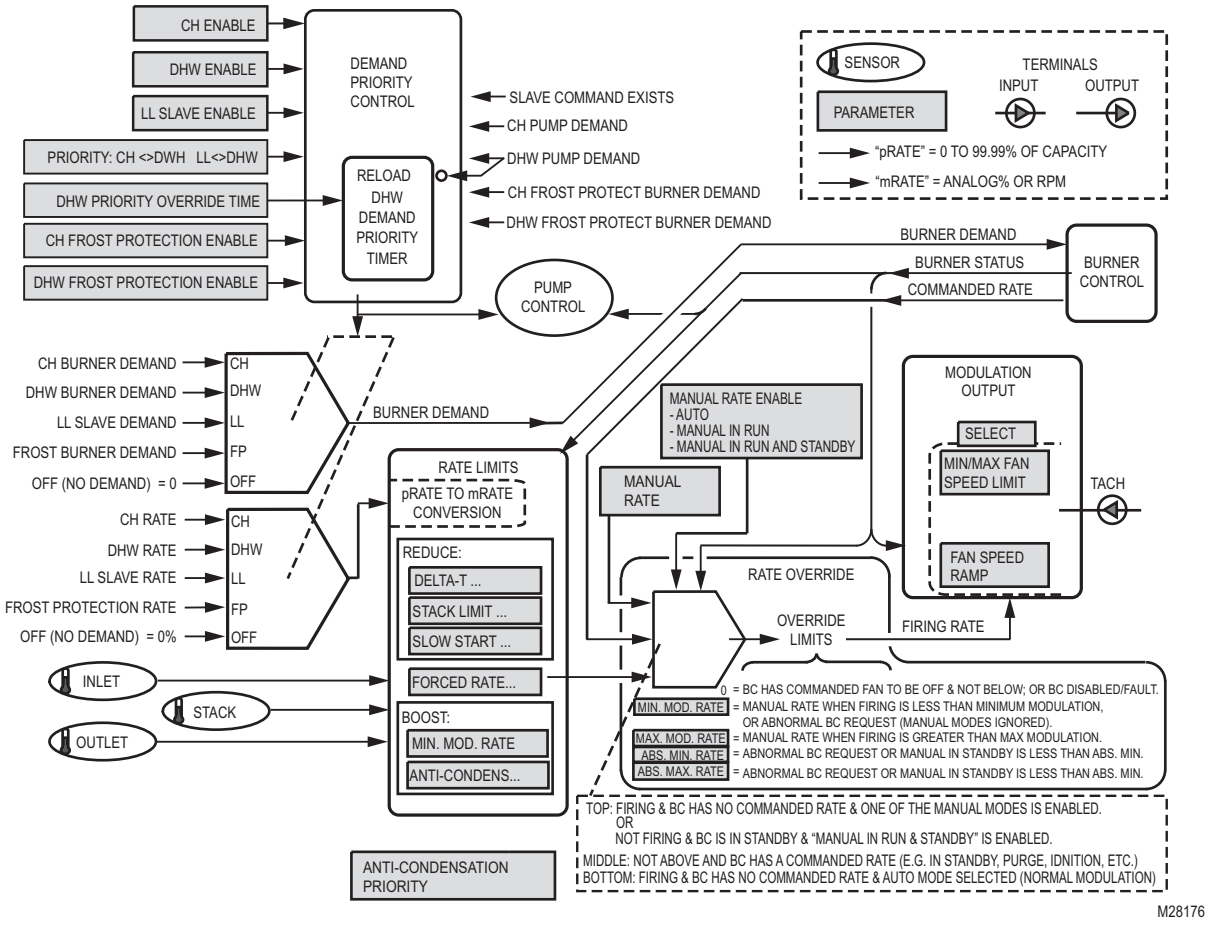


Fig. 6. Demand and rate selection diagram.

The demand priority control block shown in Fig. 6 determines which source of demand has control of the R7910B burner, according to parameters and the logic described below.

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

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

M28204

Fig. 7. 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:

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

IF  DHW Enable is true (selected) AND "DHW Pump Demand" is true (ON)
    IF DHW_priority_timer is greater than zero
        priority = DHW

IF DHW_priority is Off
    IF  CH Enable  is true (selected) AND "CH Pump Demand" is true (ON)
        priority = CH

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

    IF  DHW Enable is true (selected) AND "DHW Pump Demand" is true (ON)
        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 (  CH Frost Protection Enable  is true (selected) AND
         "CH Frost Protect Burner Demand" is true (ON)    )
        priority = FP
    IF (  DHW Frost Protection Enable is true (selected) AND
         "DHW Frost Protect Burner Demand" is true (ON)   )
        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 (not selected) OR DHW priority > CH priority )
                                                    AND
            ( LL Enable is false (not selected) OR DHW priority > LL priority )
          ] )
        ignore ASC = true
```

M28206

Fig. 8. Burner demand priority control.

CH Loop Demand and Rate

The CH (Central Heating) 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 Central Heating function is implemented as shown in Fig. 9.

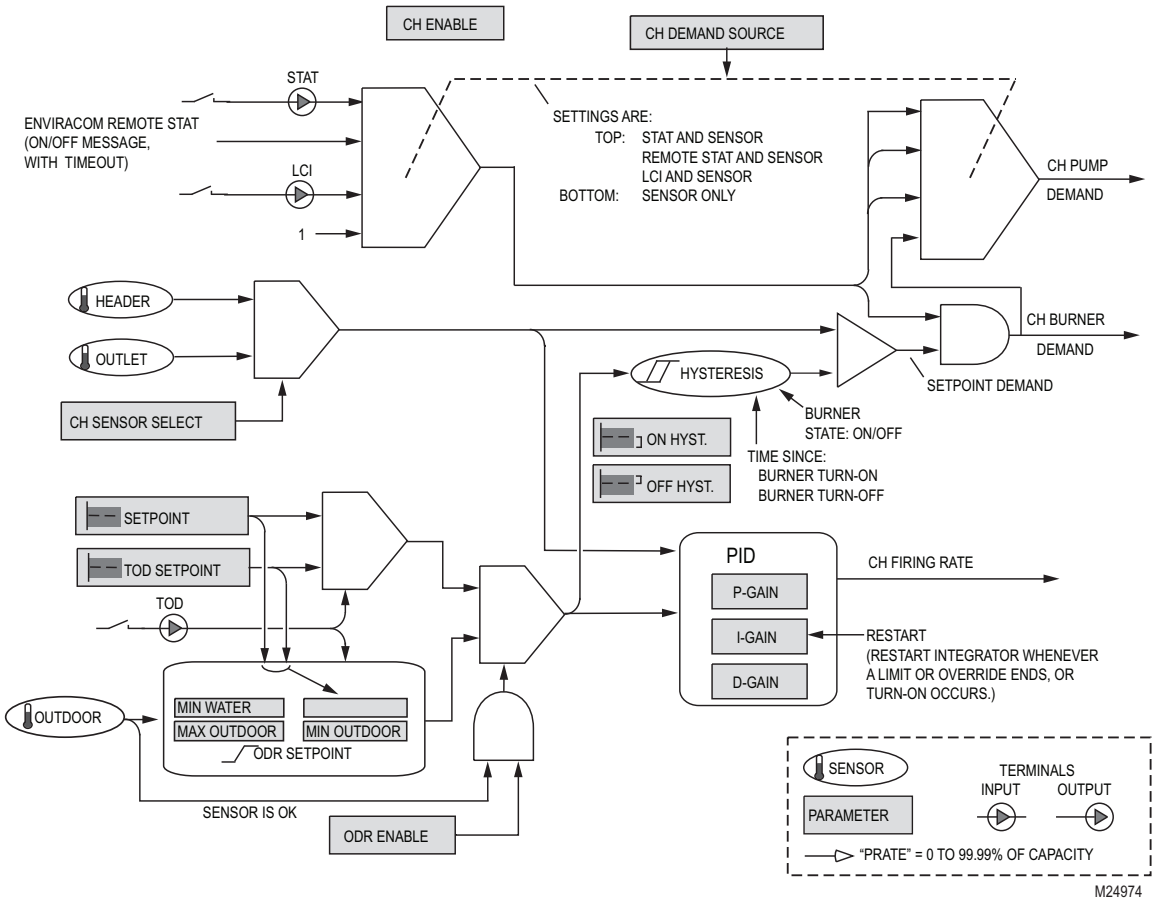


Fig. 9. Central heating diagram.

The function of each parameter and feature is given below.

Table 10. Central Heating Parameters.

Parameter	Comment
CH 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.
CH sensor	Header, Outlet The sensor used for modulation and demand may be either the Outlet sensor or the Header sensor.
CH setpoint	Degrees or None This setpoint is used when the time-of-day input is off. If the ODR function is inactive, the setpoint is used as-is. If the ODR function is active (input on J10-2), this setpoint provides one coordinate for the outdoor reset curve, as described in "CH outdoor reset enable" on page 25.

Table 10. Central Heating Parameters. (Continued)

Parameter	Comment
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 setpoint 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. 10. This gives the PID algorithm some room to be more aggressive in tracking the load, which can result in overshoot (undershoot).
CH hysteresis step time	seconds Time of each step. A step time of zero - diables this feature.

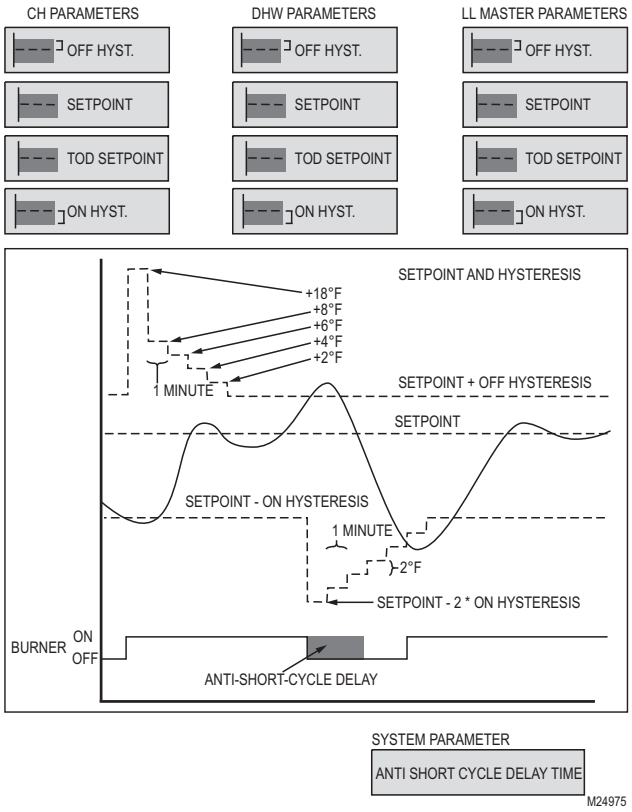


Fig. 10. Setpoint and hysteresis.

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 orignial value:

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

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

* Assuming that on hysteresis is sufficiently large.

Table 10. Central Heating Parameters. (Continued)

Parameter	Comment
CH P-gain CH I-gain CH D-gain	0-100 These parameters are the gains applied to the proportional, integral, and differential terms of the PID equation for the CH loop.
CH outdoor reset enable	Enable, Disable If outdoor reset feature is enabled and the sensor is functioning properly, then the current outdoor temperature is used to determine the setpoint by interpolation. This lookup function uses two X,Y points to determine a line on the graph as shown in Fig. 11. The Y coordinate of the top-right point depends on the time-of-day input (J10-2): • If it is off then the CH setpoint is used. • If it is on the CH TOD setpoint provides the Y coordinate and the lower left point is also re-calculated to shift the graph in a parallel way, as shown in Fig. 11. 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 maximum, a linear interpolation is used to find the setpoint.

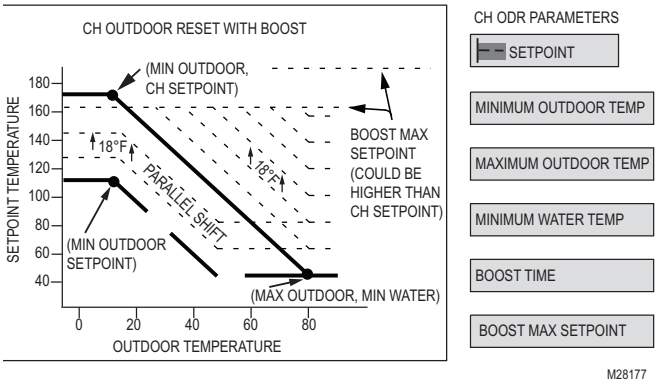


Fig. 11. CH outdoor reset with TOD.

Table 10. Central Heating Parameters. (Continued)

Parameter	Comment
CH ODR minimum water temperature CH ODR maximum outdoor temperature	Degrees or None These two parameters determine the lower left point on the graph.
CH ODR boost time CH ODR boost max setpoint	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 time interval elapses and demand is not satisfied, then the setpoint is increased by 18°F, up to the maximum provided by the CH ODR boost max setpoint. However, if the latter is not a valid temperature for boosting the setpoint, then the boost function is inactive and an alert is issued.

DHW Loop Demand & Rate (DHW DR)

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. 12.

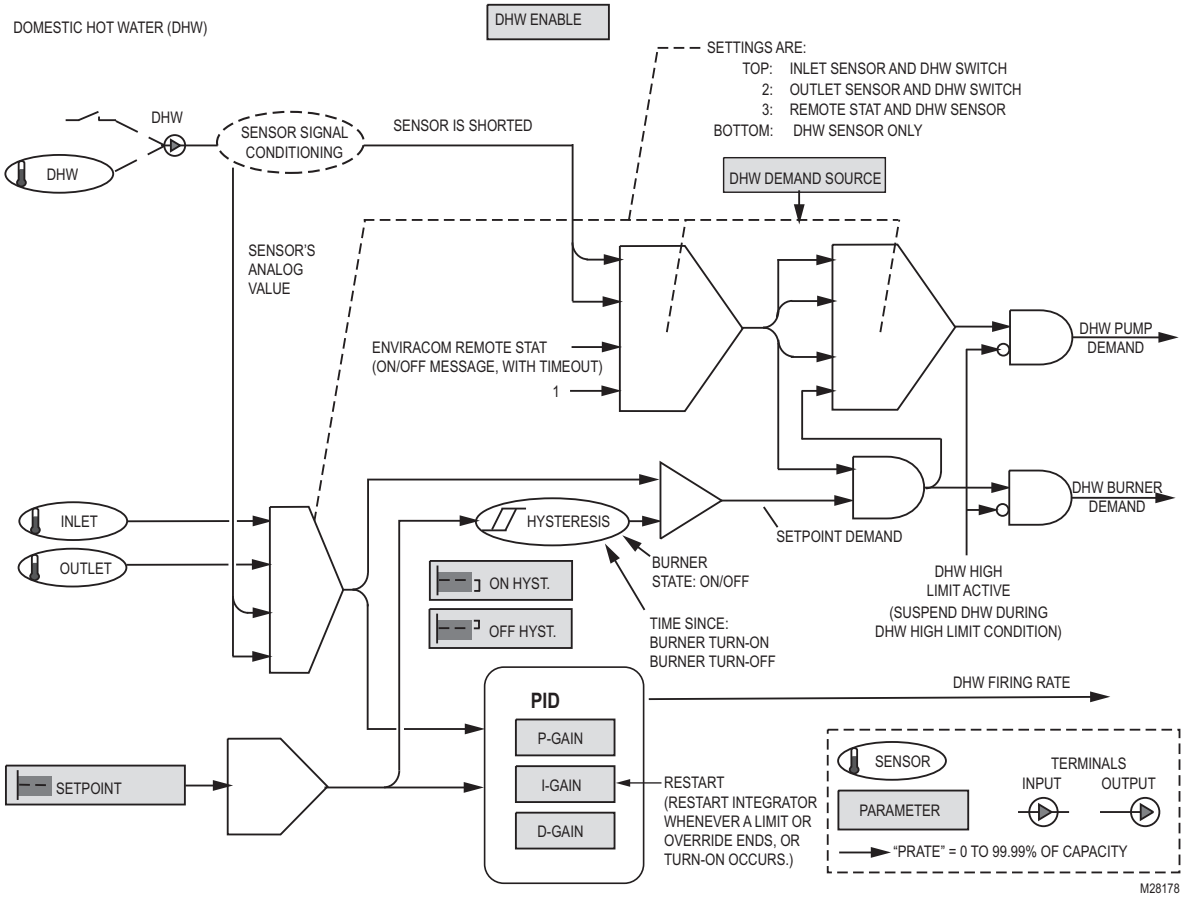


Fig. 12. Domestic hot water function.

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

Table 11. Domestic Hot Water Parameters.

Parameter	Comment
DHW demand source	DHW Sensor Only, Remote Stat and DHW Sensor, DHW Switch and Inlet Sensor, DHW switch and Outlet Sensor The DHW demand source may be selected from four options. In all cases, for burner demand to exist, the selected sensor must be generating a demand as determined by setpoint and hysteresis values. • If **DHW Sensor Only** is chosen, no other input is considered and pump demand is derived from burner demand. • If **DHW Sensor and Remote Stat** 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 for the message timeout time (3–4 minutes), there is no demand. • If **DHW Switch and Inlet Sensor or DHW Switch and Outlet Sensor** is chosen, a switch replaces the DHW sensor, causing this sensor input to appear to be open or shorted when the switch is open or closed. If this option is chosen then the DHW sensor in a shorted condition indicates pump demand, and this condition also must be present for burner demand to exist; if it is open or in-range then there is no demand. When DHW Switch and Inlet Sensor is chosen then the inlet sensor will provide the control temperature. When DHW Switch and Outlet Sensor is chosen then the outlet sensor will provide the control temperature.
DHW setpoint	Degrees or None This setpoint is used whenever the time-of-day switch is off or not connected (unused).
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.
DHW hysteresis step time	seconds The time for each step. A step time of zero disables this feature.
DHW P-gain DHW I-gain DHW D-gain	0-100 These parameters are the gains applied to the proportional, integral, and differential terms of the PID equation for the DHW loop.

Frost Protection

Frost protection is a demand and rate source: it can generate both a demand and a firing rate. It also is a source of pump control.

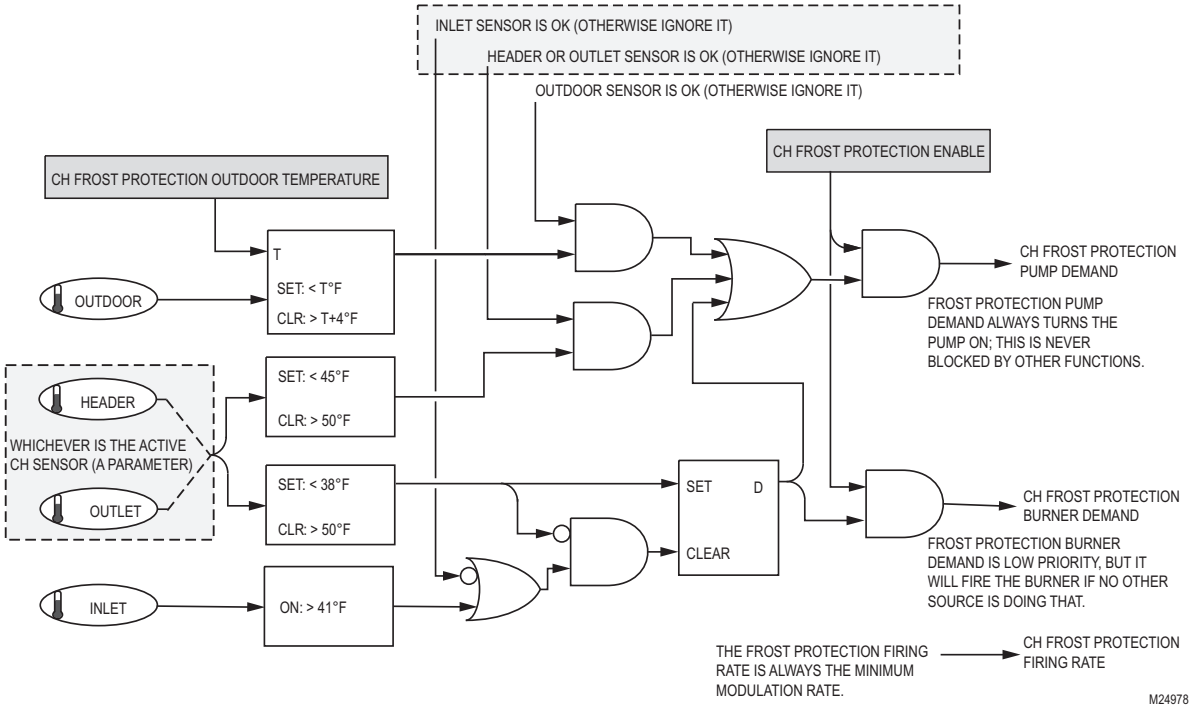


Fig. 13. CH Frost protection.

The behavior of each parameter and feature is given below.

Table 12. CH Frost Protection Parameters.

Parameter	Comment
CH Frost protection enable	Enable, Disable The CH frost protection feature is enabled or disabled by this parameter. If it is enabled then, 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 outlet temperature is below 45°F. Using the Active CH sensor: header or outlet.

Table 12. CH Frost Protection Parameters. (Continued)

Parameter	Comment
CH Frost Protection outdoor setpoint	Degrees or None • The CH pump is turned on if the outdoor sensor is connected and the temperature is below a programmed frost protection level provided by CH frost protection outdoor setpoint. • Once turned on, the CH pump remains on until: a. the outdoor temperature is above the programmed frost protection level + 4°F, and b. the outlet temperature exceeds 50°F. When both of these have occurred, then a CH frost protection overrun timer is started. After the timer expires, the pump reverts to normal operation. This source of pump control has the highest priority and cannot be overridden by any subsystem (e.g. anticondensation) that wants to turn off the CH pump. Additionally, if the burner has no demand from any other source, then the frost protection source generates a demand if the outlet temperature is below 38°F and it requests a firing rate at the minimum modulation rate. It maintains this demand until some other source of demand takes over—frost protection is the lowest priority demand source—or CH frost protection burner demand ends. CH frost protection burner demand ends when both of these occur: a. the outlet temperature exceeds 50°F, and b. the inlet temperature is greater than 41°F. If the CH controls sensor (Outlet or Header) is invalid (e.g. disconnected or defective) then it is ignored by CH frost protection. If the inlet sensor is invalid (e.g. disconnected or defective) 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 FP pump overrun time	MM:SS This time indicates how long the CH pump should continue to run after CH frost protection pump demand ends.
DHW frost protection enable	Enable, Disable The DHW frost protection feature is enabled or disabled by this parameter. See Fig. 14. Additionally, DHW frost protection will use the inlet sensor rather than the DHW sensor, if the DHW demand source parameter selects a switch instead of a sensor. If it is enabled then, regardless of whether the boiler is firing or not, or whether DHW is in control or not: • The DHW pump is turned on if the DHW temperature is below 45°F • Once turned on, the DHW pump remains on until the DHW temperature exceeds 50°F. When this occurs then the DHW overrun timer is started. After the timer expires, the DHW pump reverts to normal operation. This source of pump control has the highest priority and cannot be overridden by any subsystem (e.g., anticondensation) that wants to turn off the DHW pump. Additionally, if the burner has no demand from any other source, then the frost protection source generates a demand if the DHW temperature is below 38°F and it requests a firing rate of 0% which will be converted to be the minimum modulation rate since this is the lowest possible firing rate. It maintains this demand until some other source of demand takes over—frost protection is the lowest priority demand source—or DHW frost protection ends. DHW frost protection ends when the DHW temperature exceeds 50°F. If the DHW Sensor is not valid (eg. disconnected)then it is ignored by DHW Frost Protection.
DHW FP pump overrun time	MM:SS This time indicates how long the DHW pump should continue to run after DHW frost protection pump demand ends.

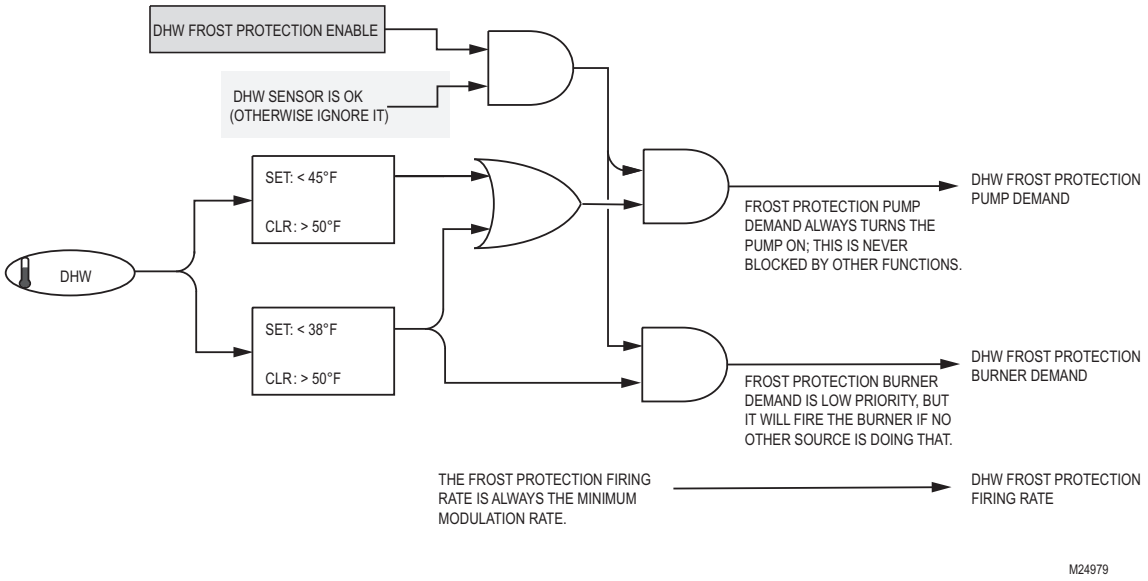


Fig. 14. DHW frost protection.

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
  - Stack limit
  - Slow start
  - Outlet limit
  - 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

Anticondensation has a programmable priority vs. the other rate limits:

The selected programmable priority determines the TRUE or FALSE status for each of the following:

Anticondensation > Delta-T
Anticondensation > Stack limit
Anticondensation > Slow start
Anticondensation > Forced Rate
Anticondensation > 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)

The Delta-T limit function is not a safety function. It is designed to reduce the firing rate in case the difference between the Inlet and the Outlet temperatures is excessive.

Table 13. Limits and Rate Override: Delta-T Limit Parameters.

Parameter	Comment
Delta-T enable	Enable, Disable This parameter enables or disables the entire delta-T limit function.
Delta-T degrees	Degrees or None If the outlet temperature exceeds the inlet temperature and this difference exceeds the temperature given by this parameter, then the response defined below will occur. As the temperature approaches this limit, the Stepped Modulation Limiting function (see “Stepped modulation rate limit” on page 32) is active.
Delta-T response	Lockout, Recycle & Delay If the temperature difference exceeds the limit, 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 with an alert and holds while waiting for a delay (see below) to expire, and after the delay it tries again (assuming that demand is still present).
Delta-T delay	MM:SS This parameter provides the delay time for the Delta-T limit.

Stack limit (Safety limit and Rate limit)

The stack limit is a safety limit. However, the stack rate limit portion which attempts to reduce the firing rate to avoid reaching the stack limit is not.

Table 14. Limits and Rate Override: Stack Limit Parameters.

Parameter	Comment
Stack limit enable	Enable, Disable This parameter enables or disables the entire stack temperature limit 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 safety limit, 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 32) is active.

Outlet high limit (Safety limit and Rate Limit)

The outlet high limit is a safety limit. However, neither the CH pump control nor the outlet rate limit portion that attempts to reduce the firing rate to avoid reaching the outlet high limit are safety functions.

Table 15. Limits and Rate Override: Outlet High Limit Parameters.

Parameter	Comment
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

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

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 32) 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:

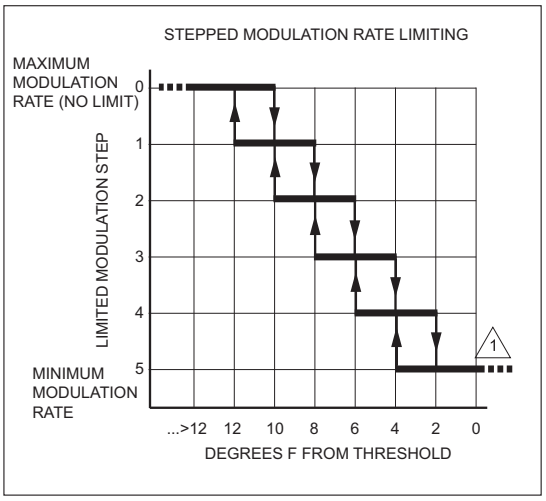
stepsize=range/5

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 shall behave 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.



1 AT THIS POINT A RESPONSE TYPICALLY OCCURS DUE TO A SAFETY LIMIT; HOWEVER, THIS DETECTION AND RESPONSE IS NOT PART OF THE RATE LIMIT FUNCTION.

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Fig. 15. Stepped modulation rate limiting.

Slow Start and Forced Rate limits

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 limit that limits the ramp-up speed of the firing rate when the water is colder than a threshold. These functions are illustrated in the following diagram.

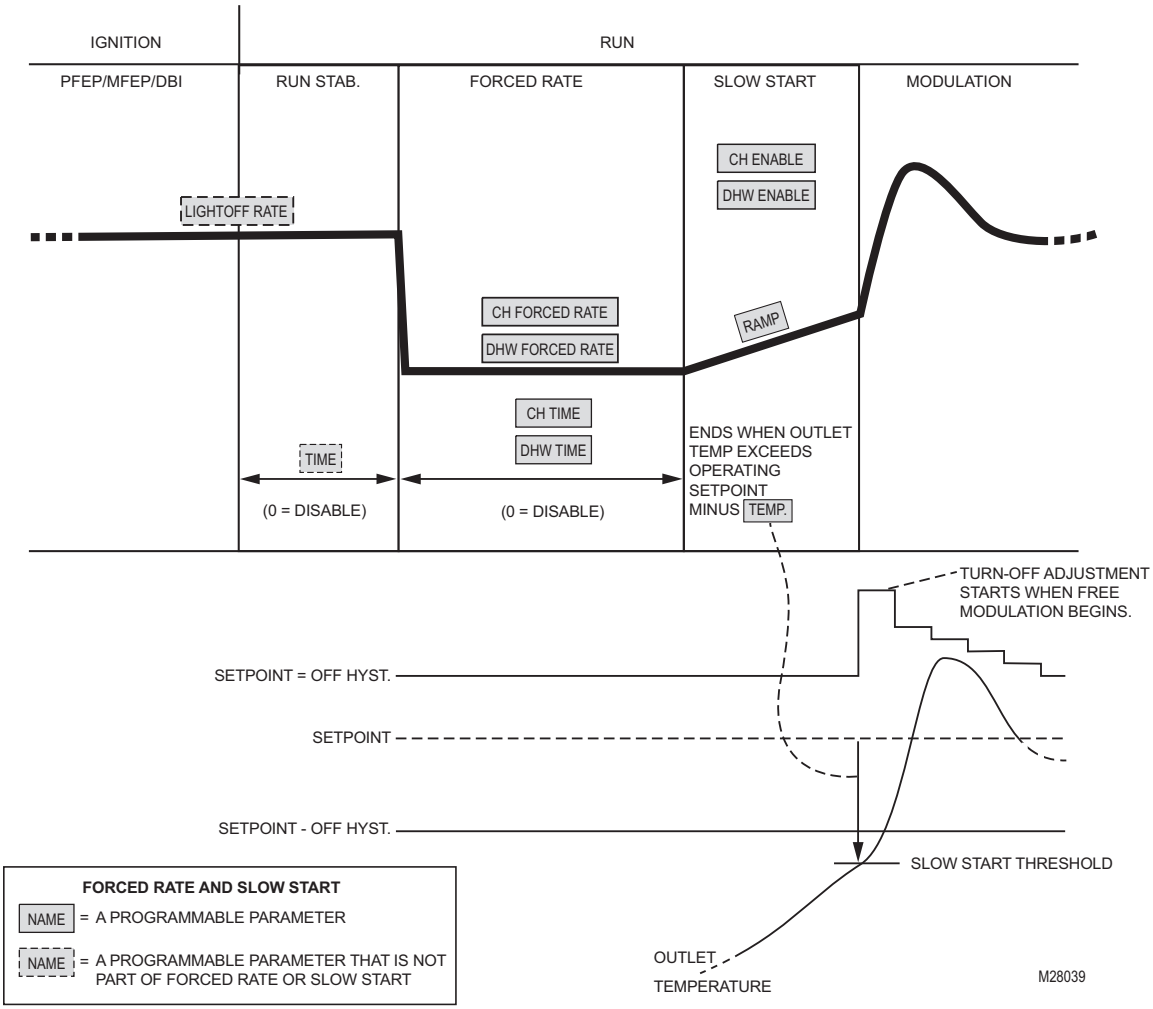

Fig. 16. Slow Start and Forced Rate limits.

Table 16. 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 16. 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 R7910B will calculate and apply this as a stepped function using a step duration of 10 seconds.

DHW high limit

The DHW high limit is a safety limit when Lockout or Recycle & Hold is selected. However, it is not a safety limit when “Suspend DHW” is selected. The DHW pump control is not a safety function.

Table 17. 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.
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.
DHW high limit pump inhibit	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.

Anticondensation

The anticondensation function reduces condensation effects when the temperature is below a threshold by increasing the firing rate and optionally shutting off the pump. This is not a safety function.

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 18. 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 overrides (as described at the beginning of “Rate Limits and Override” on page 31). 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 override ends.
CH anticondensation pump forceoff	Normal, Forced Off If CH anticondensation is in control of the burner as described in the CH anticondensation setpoint section above, and this parameter is forced off, the CH pump is turned off to warm up the heat exchanger more quickly. However, if CH frost protection, outlet high limit, or DHW high limit are active and requesting the pump to be on, then it will remain on—these have higher priority. The pump reverts to its normal condition when anticondensation 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 overrides (as described at the beginning of “Rate Limits and Override” on page 31). • 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 override ends.
DHW anticondensation pump forceoff	Normal, Forced Off If DHW anticondensation setpoint is in control of the burner as described in the DHW anticondensation temperature section above, and this parameter is forced off, the DHW pump is turned off to warm up the heat exchanger more quickly. However, if frost protection is active and requesting the pump to be on, then it will remain on—this has higher priority. The pump reverts to its normal condition when anticondensation ends.

Outlet T-Rise Limit

This limit shuts off the burner if the temperature rise-rate of the outlet sensor is excessive. This is not a safety function.

Table 19. Limits and Rate Override: Slow Start Limit Parameters.

Parameter	Comment
Outlet T-rise degrees enable	Enable, Disable This parameter enables or disables the outlet temperature rise limit function.

Table 19. Limits and Rate Override: Slow Start Limit Parameters. (Continued)

Parameter	Comment
Outlet T-rise degrees	degrees per minute This parameter sets the rate of temperature rise that is tolerated, in degrees per minute. Any temperature increase that exceeds this rate will cause an alert to be issued and the burner will recycle and hold until a delay time expires.
Outlet T-rise delay	MM:SS This parameter provides the delay time for which the burner holds in Standby, whenever the Outlet T-rise rate is exceeded.

Burner Control Setup

Burner performance is defined during the software setup process. The following comments will help to determine the appropriate settings for each burner.

The Setup will include:

Inputs

All digital inputs will be conditioned to eliminate response to spurious noise and transient events while preserving the required response time of 6 line cycles or less.

FLAME
The flame signal will be the flame status after signal conditioning, flame-on timing, and flame-off (FFRT) timing has been performed. The control's response to loss of flame and the abnormal presence of flame is defined by the equipment setup.

LIMIT CONTROL INPUT (LCI) (J6-3)
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 it will be treated as the end of the demand.

INTERLOCK (ILK) (J5-1)
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, and is ignored at other times. An example is an airflow switch. The equipment setup will define the response to this signal.

INTERRUPTED AIR SWITCH (IAS) (J6-2)
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.

STAT, REMOTE STAT, AND LCI AS DEMAND INPUTS (J8-3)
The presence of a 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 may typically cause pump turn-on as a primary effect, but will cause the burner control to fire only if a demand signal is also received from the Demand/Rate Selection subsystem, which is monitoring temperature. If a demand signal is received 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 status of the burner control will be reported in the Burner State and the Burner Lockout/Hold status items. The equipment setup will define the response to demand signals.

DEMAND
A burner control normally will respond to the demand signal from the Demand/Rate Selection subsystem by attempting to light the burner. With success of the purge and ignition sequence, the burner control releases 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.

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

PILOT VALVE (J5-2) AND INTERNAL SAFETY RELAY (EXT. IGN/ PV / MV/ SR)
The burner control turns on the internal safety relay, the load relays and monitors their feedback to ensure that they are in the correct state. These relays provide the electrical power to energize the Pilot Valve terminals. If an output is not in its proper state, the system will respond as defined on initial Setup (typically a lockout or recycle).

FLAME VOLTAGE (TEST JACKS)
This voltage will represent the flame strength using a 0 to 10V 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 17.

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

NOTE: Not all parameters may be visible, depending on model and configuration.

Table 20. Burner Control Safety Parameters.

Parameter	Comment
NTC sensor type	10K dual safety, 12K single non-safety This parameter determines whether 10K or 12K sensors are used for the Inlet, Outlet, Stack, Header, and Outdoor analog sensor inputs. All sensors must be of the same type: 10K or 12K. 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. If "12K single non-safety" is chosen, these three sensors are single 12K sensors and the tracking test is turned off (in this case external safety limits typically are required).
Power up with lockout	Enable, Disable If this parameter is set to disable then a lockout will be cleared by power-cycling the control. However, if enable is chosen, then clearing a lockout requires either: • pressing the reset pushbutton.
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.
Interlock start check	Enable, Disable If the Interlock start check is enabled, 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, 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.
Interlock 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. These responses apply to both the ILK input and the IAS input (unless the Interrupted Air Switch Enable parameter is set to "Disable"). 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.
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 is used by the Annunciator. 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.
Prepurge time	MM:SS This parameter sets the burner control's prepurge time. Setting this parameter to zero disables prepurge.

Table 20. 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 +/- 3% 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 +/- 3% during ignition or MFEP, the burner control will react as specified by the equipment setup (typically by locking out).
Pre-ignition time	Seconds During the preignition time the igniter output is energized and the occurrence of flame is a fault condition. The purpose of this time is to prove that spark does not simulate flame. It may be set to zero if no pre-ignition time is wanted.

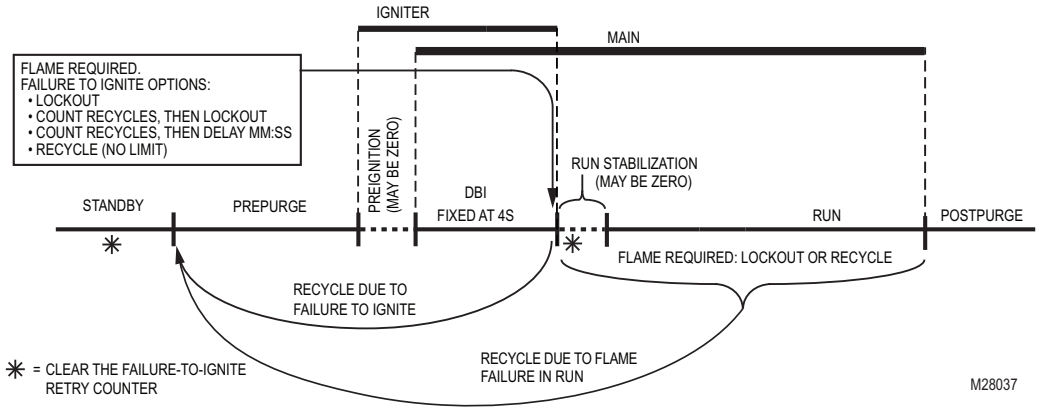

Fig. 17. Direct burner ignition

Table 20. Burner Control Safety Parameters. (Continued)

Parameter	Comment
Main flame establishing period (MFEP)	5, 10, or 15 Seconds 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 40).

Table 20. Burner Control Safety Parameters. (Continued)

Parameter	Comment
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.

Burner Control Non-Safety Parameters

The following parameters may be modified at any time and without using a special process, since they are non-safety parameters.

Table 21. Burner Control Non-Safety Parameters.

Parameter	Comment
Ignition source	Internal, External Ignition The R7910B can use either an internal spark generator, an external ignition source driven via relay contacts that are interlocked and powered through the ILK input terminal. The R7910B operates circuits according to the setting of these parameters; thus if the igniter circuit that is operated differs from the one actually installed, no ignition will occur.
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.
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.

Modulation Output

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

Common Modulation Parameters

These parameters are needed whenever any type of modulation is used. They are listed in the order they would be used in a burner firing sequence.

Table 22. Modulation Output Parameters.

Parameter	Comment
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. However, 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, 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, fan speed for CH, and fan speed for DHW during modulation.
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 23. Fan Speed Modulation Parameters.

Parameter	Comment
Absolute maximum fan speed	RPM The fan will never be proper to operate above the RPM provided by this parameter, regardless of the rate request.
Absolute minimum fan speed	RPM The fan will never be proper to operate below the RPM provided by this parameter, regardless of the rate request, except by commanding it to turn off.
PWM frequency	1000Hz, 2000Hz, 3000Hz, 4000Hz, This parameter provides the frequency used by the PWM output to control the fan.
Fan gain up	1-100 This is the gain for speeding up the fan.
Fan gain down	This is the gain for slowing down the fan.
Fan speed-up ramp	RPM per second Whenever the burner is firing it will be commanded to increase its RPM no faster than the rate provided by this parameter.
Fan slow-down ramp	RPM per second Whenever the burner is firing it 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. During start-up conditions the fan speed is monitored by the burner control which will react if it is not correct. Additionally, during Run if an out-of-range fan speed is reported for more than 3 seconds then the burner control will recycle back to Standby (and try again).

Pump Control

The pump control system operates three pumps identified as Pump A, Pump B, and Pump C. There are multiple pump control functions which may be attached to any of these pump outputs. If a function is not attached to a pump, then it has no effect except that it still will provide input to another pump function.

It is possible (although not necessarily useful) to attach multiple functions to the same pump. If this occurs then the pump will be on if either function requests the pump to be on (i.e. a logical OR).

Central Heating (CH) Pump

The CH pump function is implemented as shown in Fig. 18.

The CH pump function turns on with overrun time for CH demand and LL slave demand, assuming that the burner is neither locked out nor in an anti short cycle delay, however, these are optionally forced off by CH anticondensation. The CH pump turns on without force-off and using a separate overrun timer for CH frost protection. It turns on with neither force-off nor overrun when outlet high limit is active.

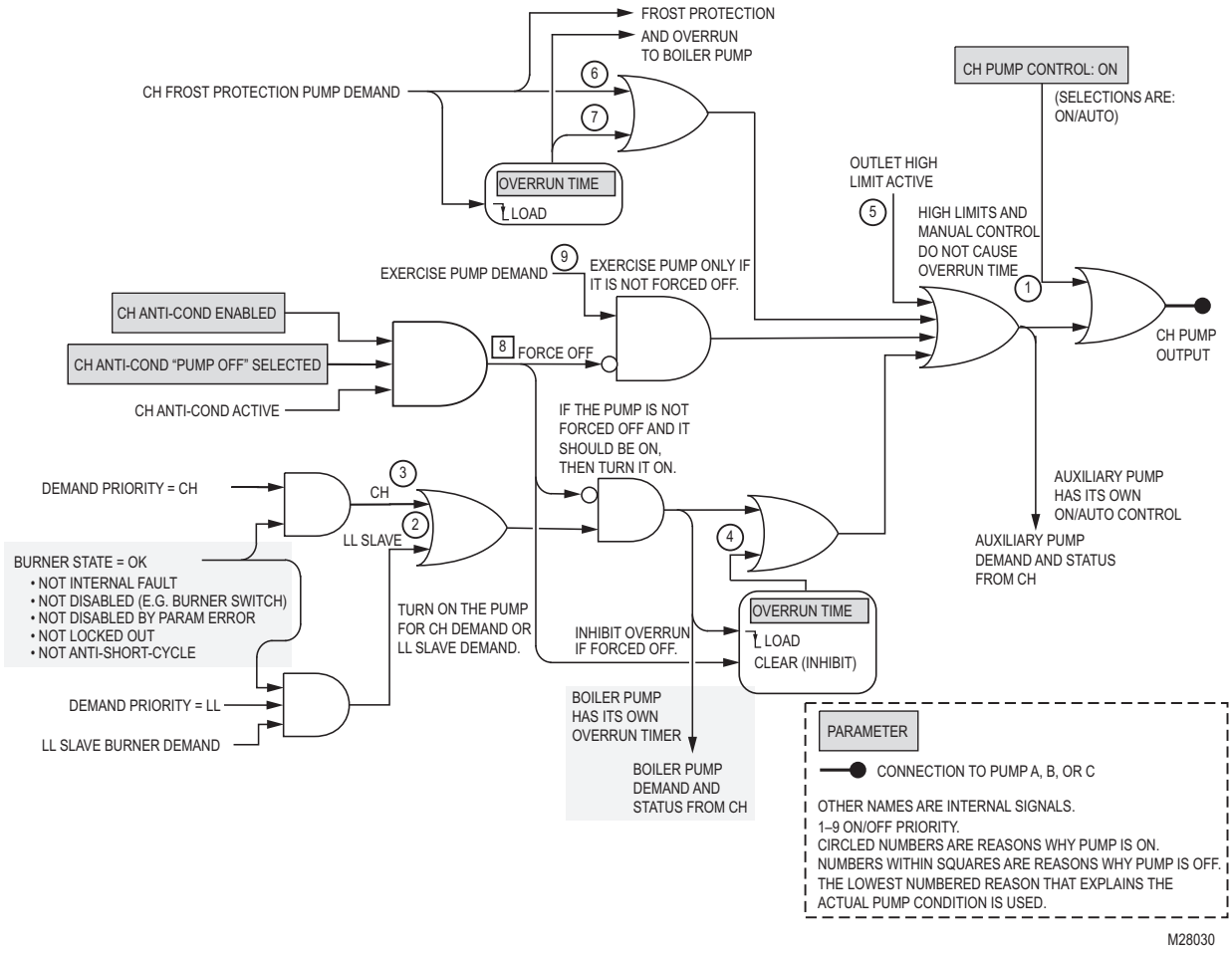

Fig. 18. CH pump implementation.

Table 24. CH Pump Parameters.

Parameter	Comment
CH Pump Output	None, Pump A, Pump B, Pump C This parameter allows the CH pump function to be disconnected or to be attached to any of the pump outputs.
CH Pump Control	On, Auto The CH pump can be turned on manually, or it can be set to operate automatically. If it is turned on, it remains on until changed back to Auto. In Auto mode it operates according to the demand sources listed for CH Pump Output and the overrun time.

Table 24. CH Pump Parameters. (Continued)

Parameter	Comment
CH Pump Overrun Time	MM: SS This time indicates how long the CH pump should continue to run after CH pump demand or LL slave demand ends.

Domestic Hot Water (DHW) Pump

The DWH pump function is implemented as shown in Fig. 19.

The DHW pump function turns on with overrun time for DHW demand, assuming that the burner control is not locked out, although this turn-on is delayed by a start delay time if the burner is not already firing. This turn-on is also optionally forced off by DHW anticondensation. The DHW pump turns on without force-off and using a separate overrun timer for DHW frost protection. It is forced off when DHW high limit is active, except that manual control may still turn it on.

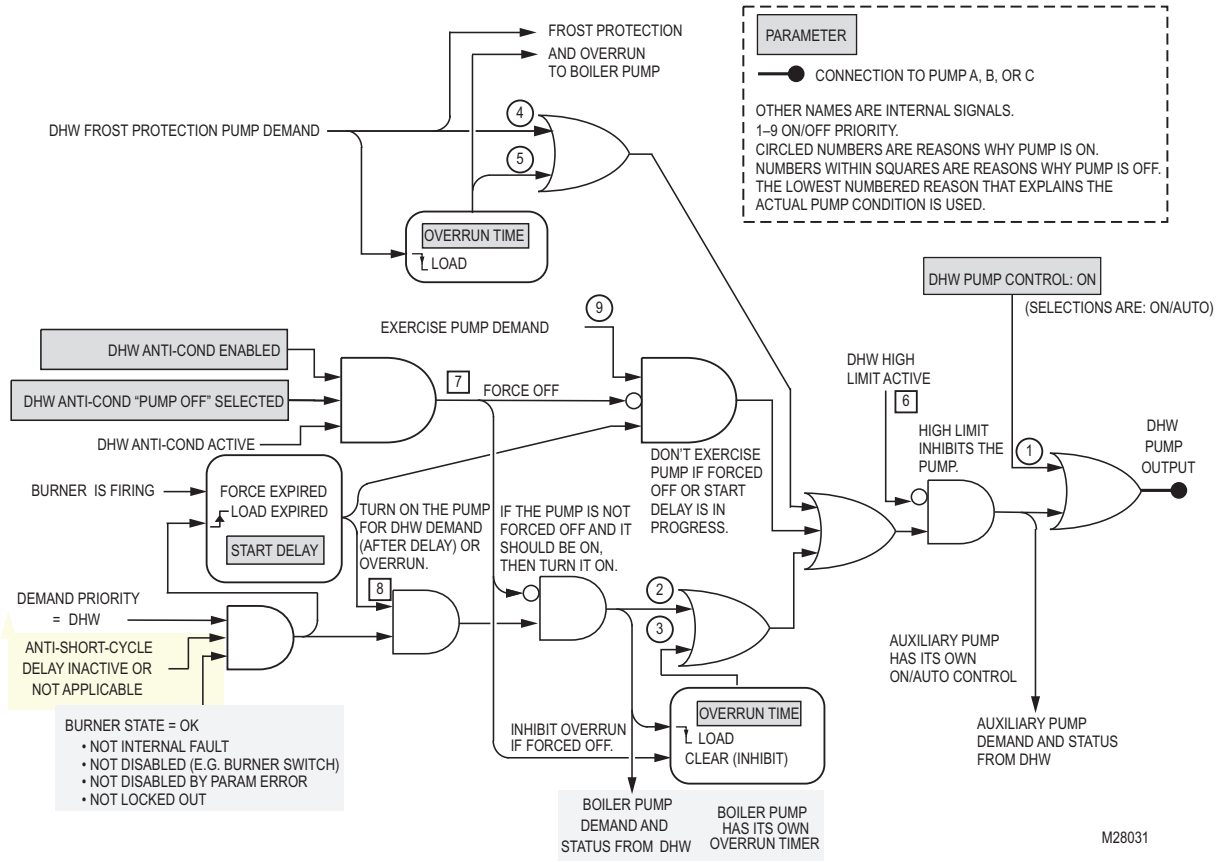

Fig. 19. DHW pump implementation.

Table 25. DHW Pump Parameters.

Parameter	Comment
DHW Pump Output	None, Pump A, Pump B, Pump C This parameter allows the DHW pump function to be disconnected or to be attached to any of the pump outputs.
DHW Pump Control	On, Auto The DHW pump can be turned on manually, or it can be set to operate automatically. If it is turned on, it remains on until changed back to Auto.
DHW Pump Start Delay	MM:SS When DHW demand changes from off to on, this delay time is used to delay the start of the DHW pump. The pump starts after the delay expires, assuming that DHW demand is still present. This delay does not occur, however, if the burner is already firing when DHW gains control of it.

Table 25. DHW Pump Parameters. (Continued)

Parameter	Comment
DHW Pump Overrun Time	MM:SS This time indicates how long the DHW pump should remain on after DHW demand ends.

System Pump

The System pump function is implemented as shown in Fig. 20.

The System pump function turns on with overrun time for LL master pump demand. If the LL master STAT Input Enable parameter is enabled then this demand exists if the Stat input is on and the master has one or more available slaves (firing or not); if disabled then this pump demand exists if the master is sending demand and rate to an available slave (which is firing or preparing to fire). A slave command can also turn on the pump, either with or without overrun time and it can be turned on by the exercise pump function.

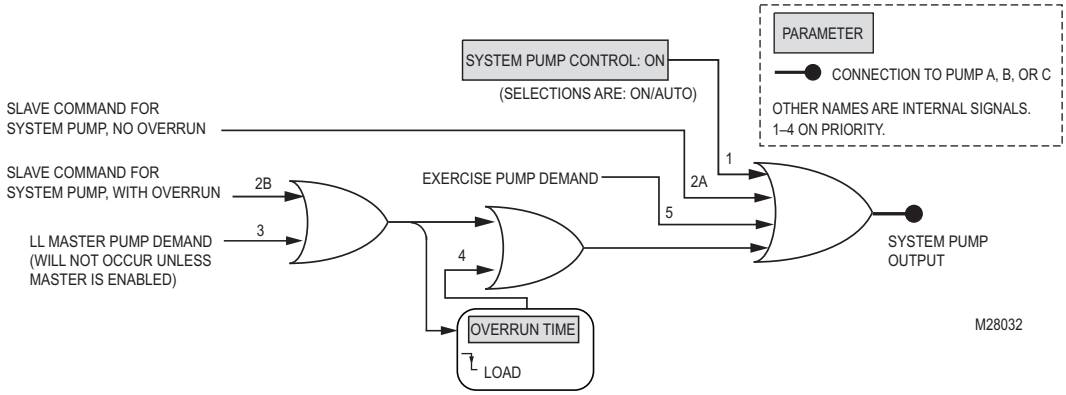

Fig. 20. System pump implementation.

Table 26. System Pump Parameters.

Parameter	Comment
System Pump Output	None, Pump A, Pump B, Pump C This parameter allows the System function to be disconnected or to be attached to any of the pump outputs.
System Pump Control	On, Auto The System pump can be turned on manually, or it can be set to operate automatically. If it is turned on, it remains on until changed back to Auto. In Auto mode it operates according to the LL master and slave demand and overrun time.
System Pump Overrun Time	MM:SS This time indicates how long the System pump should remain on after the LL master or slave pump demand with overrun ends.

Boiler Pump

The Boiler pump function is implemented as shown in Fig. 21.

The Boiler pump function turns on whenever pump demand exists from any source. It has its own overrun time if LL, CH, or DWH is the demand source. For CH frost protection and DHW frost protection it turns on and follows the overrun time provided by those sources. It also turns on with no overrun when the outlet high limit or DHW high limit is active.

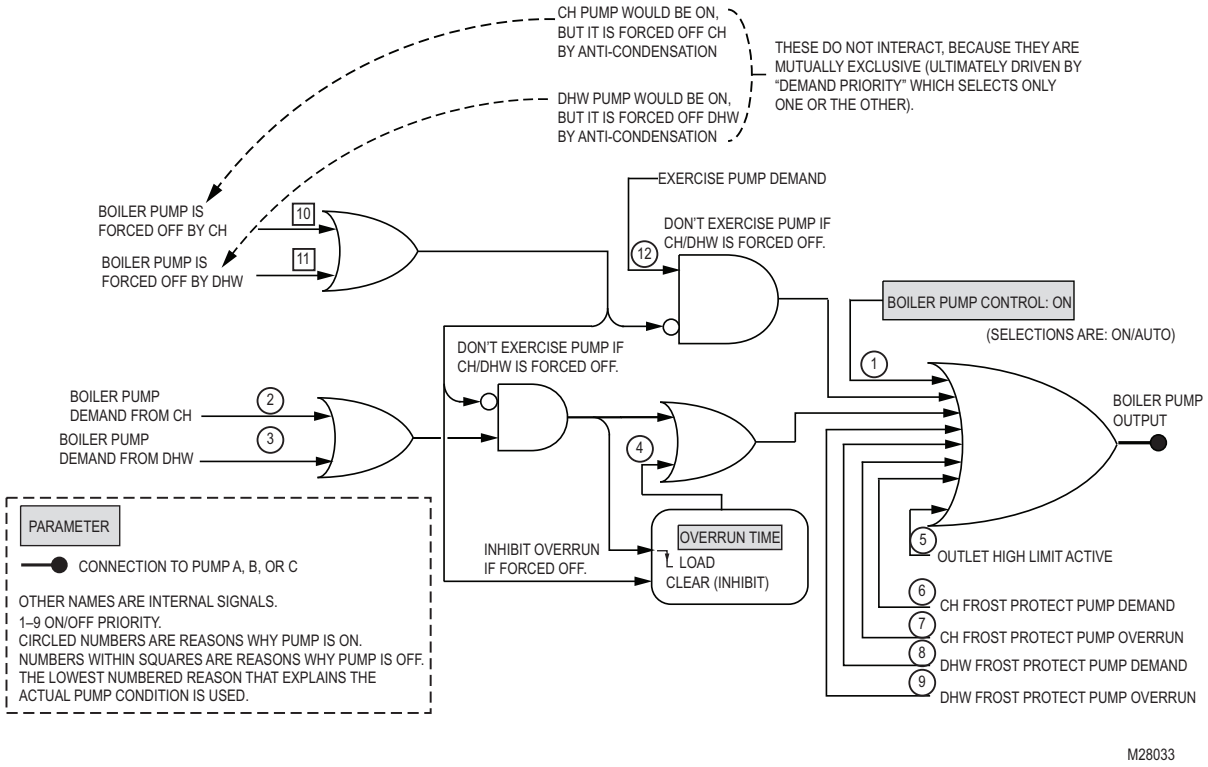

Fig. 21. Boiler pump implementation.

Table 27. Boiler Pump Parameters.

Parameter	Comment
Boiler Pump Output	None, Pump A, Pump B, Pump C This parameter allows the Boiler pump function to be disconnected or to be attached to any of the pump outputs.
Boiler Pump Control	On, Auto The Boiler pump can be turned on manually, or it can be set to operate automatically. If it is turned on, it remains on until changed back to Auto. In Auto mode it operates according to the demand and overrun time.
Boiler Pump Overrun Time	Minutes: Seconds This time indicates how long the Boiler pump should remain on after demand ends.

Auxiliary Pump

The Auxiliary pump function is implemented as shown in Fig. 22.

The Auxiliary pump function turns on whenever the CH or DHW pumps are on. It is off when neither of these is on.

This function has no parameter for overrun time; it inherits all of its behavior related to overrun, frost protection, high limits, and anticondensation by simply following the CH and DHW pumps.

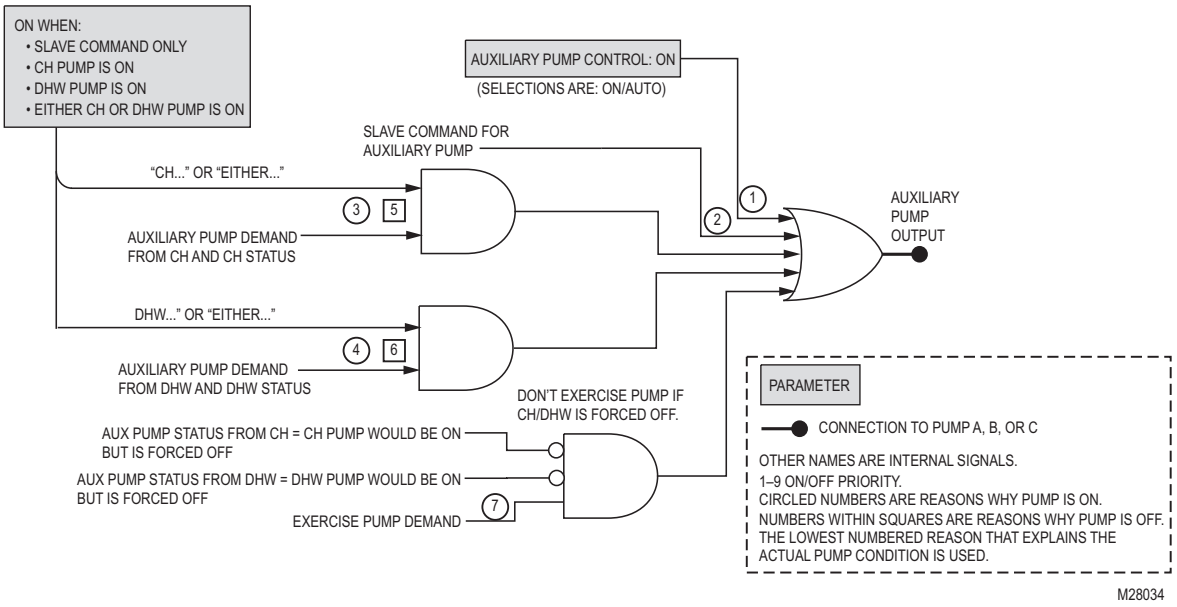

Fig. 22. Auxiliary pump implementation.

Table 28. Auxiliary Pump Parameters.

Parameter	Comment
Auxiliary Pump Output	None, Pump A, Pump B, Pump C This parameter allows the Auxiliary pump function to be disconnected or to be attached to any of the pump outputs.
Auxiliary Pump On When	CH Pump is On, DHW Pump is On, Either CH or DHW Pump is On This parameter determines which pump output is coupled to the Auxiliary pump function: CH, DHW, or either of these. If the latter is selected then the Auxiliary pump is controlled by ORing the two output functions.
Auxiliary Pump Control	On, Auto The Auxiliary pump can be turned on manually, or it can be set to operate automatically. If it is turned on, it remains on until changed back to Auto.

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 29. 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 to exercise. It is common to all three pump outputs (A, B, and C).

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 2 inputs (J6-1,2) along with the Interlock and LCI inputs, provide a total of 4 monitored contact components.

The Annunciator function can be set up as:
- **Disabled:** Not used at all
- **Fully enabled:** Status of all inputs shown, even those designated unused.
- **Enabled with unused designated terminals hidden.**

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:** Monitored after the demand is present throughout the Run period, and following the system action designated by LCI setup parameter (Lockout or Recycle).
  - **ILK:** Monitored with the demand input (LCI) and annunciate which interlock is causing the system to remaining in “Standby”.
  - **Unused:** not used
  - **Other:** Used to Monitor a circuit, not related to any of the above.

The input terminal names Interlock and LCI can be renamed with a long (20 character) and short (3 character) name that describe their purpose. This only applies for monitoring. System demands for annunciation (lockout or standby hold for example) will retrieve the Interlock or LCI name for annunciation.

One Annunciator terminal may already be assigned functions based on the system parameter setup:

- **J1:** Will be Interrupted Air Switch (IAS) if the parameter is enabled.

Annunciator Example

Fig. 23 is an example of wiring to the Annunciator terminals and names that have been assigned for this example.

Note that the assigned terminals (LCI and ILK) are the last interlocks in their category.

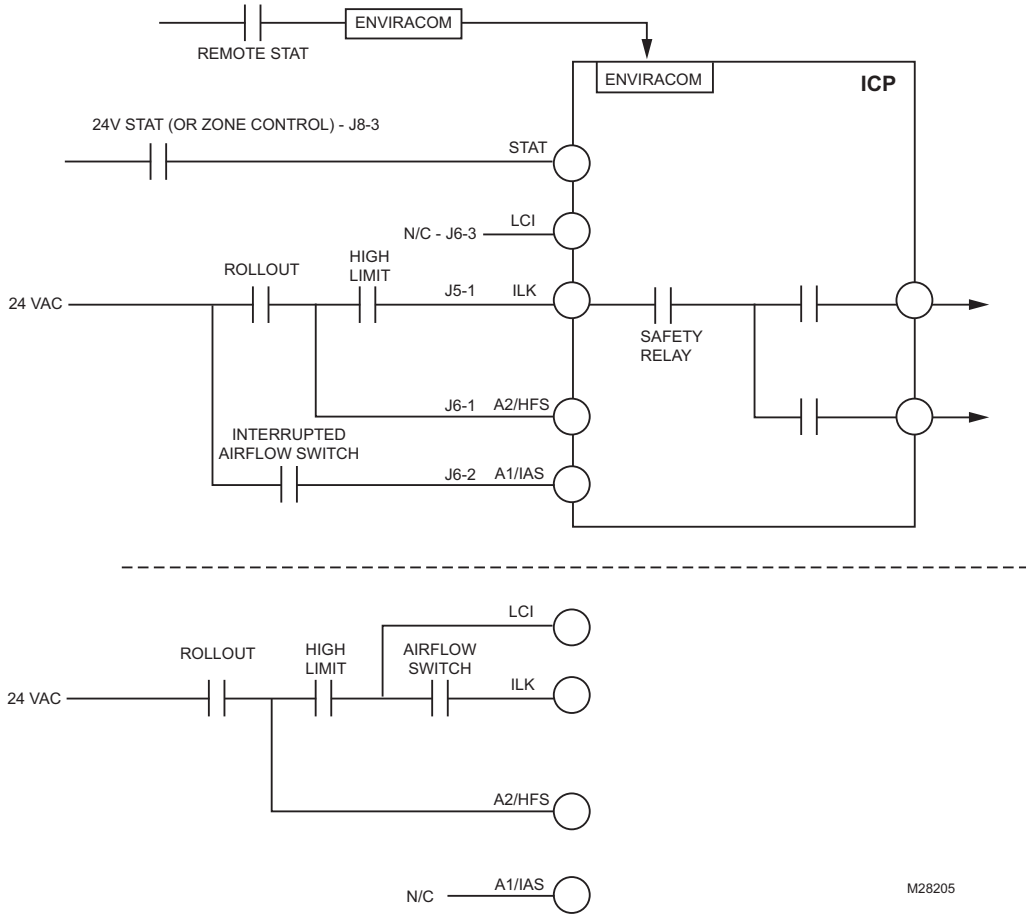

Fig. 23. Example of annunciator inputs and terminal names.

Sorting

Annunciator items are sorted first by their category assignment. The category order is:

LCI, ILK

Viewing the S7999B System Display using the “programmable” annunciator display in this case would resemble Fig. 24.

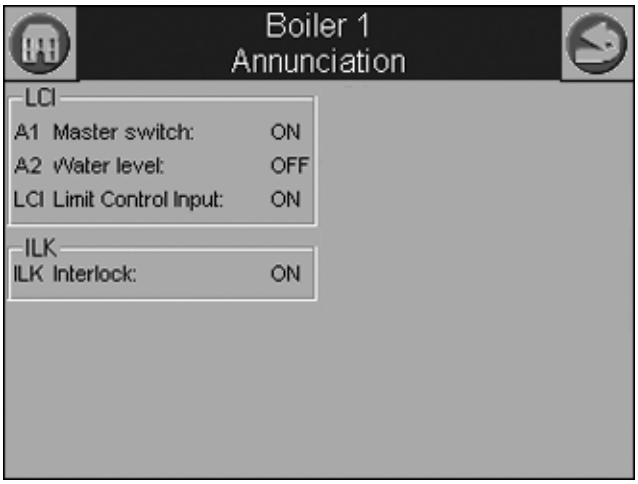

Fig. 24. Annunciator display.

Annunciation of Lockout and Hold Status

The Annunciator will provide an indication in the Annunciator Hold: code parameter of the reason for any Burner Control hold condition whenever the Burner control subsystem reports that it is in a hold condition.

FAULT HANDLING

Lockouts and Alerts

The R7910B implements two kinds of faults: lockouts and alerts.

A list of fault codes with possible troubleshooting tips is provided in Table 45 on page 96.

A list of alerts is provided in Table 39 on page 86.

LOCKOUT
- A lockout causes the boiler control to shutdown and requires manual 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. The R7910B will include alerts for all abnormal events that are relevant to an operator or end user.
- When an alert occurs, it is a one-time event. 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 fault code occurs in the history, corresponding to the most recent occurrence of the alert.

Lockout conditions have a fixed precedence (typically implemented by controlling the order of testing) if they rely on physical constraints (e.g., a typical first-out relationship exists if loss of airflow removes power from valves and the flame goes out: the correct condition to annunciate is the airflow loss and not a valve dropout or a flame failure). In other cases, however, the first condition to declare a lockout will be first. Once a lockout has occurred it persists until reset by the user or, if the Power Up With Lockout parameter allows it, until the power is cycled.

The Burner Control holds do not require a user reset and a new hold may supersede the current hold, if it has a higher precedence. However, there is only one hold condition actually causing a hold—the one with the highest precedence—at any time.

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.

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. The R7910B subsystems implement a startup delay to allow sensors to be read multiple times before they are used, to prime the filtering.

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.

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.

Sensor fault status will include hysteresis to prevent non-persistent events from affecting fault status. This hysteresis will provide a failed sensor response less than 1 second.

BURNER CONTROL OPERATION

Safety Shutdown of Burner Control Functions

Safety Shutdown (Lockout) occurs if any of the following occur during the indicated period (not all periods apply, depending on the model):

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. 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. 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.
5. PILOT FLAME ESTABLISHING PERIOD (PFEP)
   a. Lockout Interlock opens (if enabled).
   b. Pilot Valve terminal is not energized.
   c. No flame is present at the end of the PFEP, or after programmed number of retry attempts.
   d. Internal system fault occurred.
6. MAIN FLAME ESTABLISHING PERIOD (MFEP).
   a. Lockout Interlock opens (if enabled).
   b. Pilot valve terminal is not energized.
   c. No flame present at the end of MFEP.
   d. 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. Internal system fault occurred.
8. POSTPURGE Period.
   a. Pilot Valve terminal is energized.
   b. Internal system fault occurred.
   c. Flame sensed 240 seconds accumulated time after the RUN period.

Standby Hold

State entered when a delay is needed before allowing the Burner Control to be available and for sensor errors.

1. Flame detected for 240 seconds accumulated time in Standby.
2. Internal fault.
3. Pilot valve (main for DSI) energized.

Pre-Ignition Time
1. ILK opens.
2. IAS purge and ignition enabled and interlock open.
3. Flame is detected.
4. P.V. on.

Operational Sequence

Central Heating

INITIATE
The R7910 enters the Initiate sequence on Initial Power up or:
- Voltage fluctuations vary +10%/-15%.
- Frequency fluctuations vary +/-5%.
- If Demand, LCI, or Stat interrupt (open) during the Prepurge Period.

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 exist more than 240 seconds a lockout will occur.

Start-up sequence central heating request (system in standby):
1. Heat request detected (On Setpoint - On Hysteresis).
2. The DHW pump is switched off to prevent the water in the DHW tank from being cooled-down.
3. The Circulating pump is switched on. If the “pump off” function for CH-mode is selected, the pump stays off or will be switched off.
4. After a system Safe Start Check, the Blower (fan) is switched on after a dynamic ILK switch test (if enabled).
5. 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.
6. 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.
7. As soon as the fan-rpm is equal to the light-off rpm (+/- 200 rpm) (or the Low Fire Switch closes), the Trial for Ignition or Pre-Ignition Time is started (depending on hardware selection).
8. Pre-Ignition Time will energize the ignitor and check for flame (model dependent).
9. Trial for Ignition. Fig. 17 on page 39 shows the ignition option. Specifics for timings and device actions were defined by the OEM.
10. The ignition and the gas valve are switched on.

11. The ignition is turned off at 0.3 seconds before the end of the Trial for Ignition period, so the ignition-energy with a combined electrode is released in time.
12. To check the flame signal (at the end of the safety time) the fan is set to start-RPM during the stabilization time.
13. 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.
14. The hysteresis off is increased with 50°F (10°C) during 60 seconds.
15. At the end of the CH-heat request the burner is switched off and the fan stays on until post purge is complete.
16. A new CH-request is blocked for the forced off time set by the Anti Short Cycle (if enabled).
17. The pump stays on during the pump overrun time (if enabled).
18. At the end of the pump overrun time the pump will be switched off.

Domestic Hot Water

INITIATE
The R7910 enters the INITIATE sequence on Initial Power up or:
- Voltage fluctuations vary +10%/-15%.
- Frequency fluctuations vary +/-10%.
- If Demand, LCI, or Stat interrupt (open) during the Prepurge Period.

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 more than 240 seconds a lockout will occur.

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) has verified the ILK is open.
4. After the ILK switch closes and the purge rate proving fan RPM is achieved (or High Fire Switch is closed) - prepurge time is started.
5. When the prepurge 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. At the end of the Prepurge time, the fan-rpm set to the start-rpm +/- 200 rpm or the Low Fire Switch input is proven. Ignition Trials begin.
7. Trial for Ignition. Fig. 17 on page 39 shows the ignition option. Specifics for timings and device actions were defined by the OEM.
8. The ignition and the gas-valve are switched on.
9. The ignition is turned off at 0.3 seconds before ending the PFEP (MFEP), so the ignition-energy with a combined electrode is released in time.
10. Verification of the flame will release R7910B to Run and modulation.
11. A slow start can be present prior to Run, depending on the setting for the DHW Slow Start Enable parameter.
12. The system is now in Run.
13. At the end of the DHW-heat request the burner is switched off and the blower output stays on and the fan is adjusted to postpurge rate to complete post-purge.
14. A new DHW-request is blocked for the time set by the anti short cycle time.
15. The pump stays on during the pump overrun time. At the end of the pump overrun time the pump is switched off.

APPENDIX A: PARAMETER GLOSSARY

All possible parameters are detailed in Table 30. Parameters that are available or present will vary by model.

NOTE: Not all parameters are present in all controls (model dependent).

Table 30. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Absolute max fan speed	The fan will never be commanded to operate above the RPM provided by this parameter, regardless of the rate request.	41
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.	41
Add stage error threshold	If the Lead Lag master is staging by monitoring error, then another stage will be added when more heat is needed and the error exceeds this threshold .	Not available at this time.
Add stage method	To determine when to add a stage the LL master can monitor error (which requires error to exist before a stage is added) or it can monitor rate (which can anticipate the need for a stage and eliminate error).	Not available at this time.
Add stage rate offset	If the Lead Lag master is monitoring rate for staging, then another stage will be added when more heat is needed and the rate of the modulating burner exceeds this threshold .	Not available at this time.
Add stage time	The Lead Lag master waits before adding a stage until the need for another stage has existed for the time given by this parameter.	Not available at this time.
Alarm silence time	Alarms can be silenced for the amount of time given by this parameter.	49
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).	19
Annunciator 1 location	The location of the contacts monitored by the A1 annunciator input.	47
Annunciator 1 long name	The long name (up to 20 characters) of the A1 annunciator input.	47
Annunciator 2 location	The location of the contacts monitored by the A2 annunciator input.	47
Annunciator 2 long name	The long name (up to 20 characters) of the A2 annunciator input.	47
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.	47
Annunciator1 short name	The short (3 letter) name of the contacts monitored by the A1 annunciator input.	47
Annunciator2 short name	The short (3 letter) name of the contacts monitored by the A2 annunciator input.	47
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.	36
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.	36
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.	36
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.	36
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.	36
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.	19
Auxiliary pump control	The Auxiliary 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. In Auto mode it operates according to the pump function that it is assigned to.	45

Table 30. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Auxiliary pump cycle count	Auxiliary pump cycle count. Can be written to a new value (e.g. if the pump or controller is replaced).	5
Auxiliary pump on when	This parameter assigns the Auxiliary pump to a particular function.	45
Auxiliary pump output	This parameter allows the Auxiliary pump function to be disconnected or to be attached to any of the pump outputs.	45
Base load rate	This parameter specifies the preferred (most efficient) firing rate for use by the Lead Lag master, when it is set up to use base load rates.	Not available at this time.
BLR function	This parameter selects either a blower motor function for the BLR output terminal.	37
Boiler pump control	The Boiler 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. In Auto mode it operates according to the demand and overrun time.	44
Boiler pump cycle count	Boiler pump cycle count. Can be written to a new value (e.g. if the pump or controller is replaced).	5
Boiler pump output	This parameter allows the Boiler pump function to be disconnected or to be attached to any of the pump outputs.	44
Boiler pump overrun time	This time indicates how long the Boiler pump should remain on after demand ends.	44
Burner cycle count	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).	5
Burner name	This parameter allows each control to have a unique name.	19
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).	4
Burner switch	This parameter enables or disables the burner control. When it is off, the burner will not fire.	18
CH anticondensation enable	This parameter enables or disables anti-condensation for CH and LL demand.	36
CH anticondensation pump Force Off	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.	36
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.	36
CH D gain	This gain applied to the Differential term of the PID equation for the CH loop.	25
CH demand source	The source of CH loop control can be specified to use different inputs.	23
CH enable	This parameter determines whether the CH loop is enabled or disabled. When disabled the demand caused by the sensor assigned to the CH loop is ignored. It may be disabled to turn it off temporarily, or because the application does not use this feature.	19
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.	34
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.	34
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.	28
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.	24
CH I gain	This gain applied to the Integral term of the PID equation for the CH loop.	25
CH maximum modulation rate	Provides the upper limit of analog output or fan speed during modulation when firing for CH or LL slave mode.	41

Table 30. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
CH ODR boost max setpoint	For CH demand and when outdoor reset is active, the setpoint will be boosted if demand is not met after a period of time. This parameter provides the upper limit for boosting the setpoint.	25
CH ODR boost time	For CH demand and when outdoor reset is active, the setpoint will be boosted if demand is not met after a period of time. This parameter provides the upper limit for boosting the setpoint.	25
CH ODR max 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.	25
CH ODR min 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).	25
CH ODR min water temperature	This parameter provides the CH setpoint when the outdoor reset temperature is at its defined maximum.	25
CH off hysteresis	The off hysteresis is added to the CH setpoint to determine the temperature at which this demand turns off	24
CH on hysteresis	The on hysteresis is subtracted from the Setpoint to determine the temperature at which demand turns on.	24
CH outdoor reset enable	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.	25
CH P gain	This gain applied to the proportional term of the PID equation for the CH loop.	25
CH pump control	The CH 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. In Auto mode it operates according to the demand sources listed above and the overrun time.	42
CH pump cycle count	CH pump cycle count. Can be written to a new value (e.g. if the pump or controller is replaced).	5
CH pump frost protection 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.	29
CH pump output	This parameter allows the CH pump function to be disconnected or to be attached to any of the pump outputs.	42
CH pump overrun time	This time indicates how long the CH pump should remain on after demand from any source ends. That is, whenever the pump has been on, but the last requests for the pump to be on ends, it always continues to run for the time given by this parameter.	43
CH sensor	The sensor used for modulation and demand may be either the Outlet sensor or the Header sensor input.	23
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.	23
CH slow start enable	This parameter enables or disables the slow start limit function for CH (or LL slave) demand.	35
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 approches this limit..	31
Delta-T delay	This parameter provides the delay time for the Delta-T limit.	31
Delta-T enable	This parameter enables or disables the entire delta-T limit function.	31
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.	31
Demand rate interval time	This is the time in milliseconds between iterations of the demand/rate task.	22 (for CH) 25 (for DHW)
DHW anticondensation enable	This parameter enables or disables anti-condensation for the DHW sensor.	36

Table 30. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
DHW anticondensation pump force off	If DHW anti-condensation is in control of the burner and this parameter is Forced off, then the DHW pump is turned off to warm up the heat exchanger more quickly.	36
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 this by 4 degrees F.	36
DHW D gain	This gain applied to the Differential term of the PID equation for the DHW loop.	27
DHW demand source	The source of DHW loop control can be specified to use different inputs.	27
DHW enable	This parameter determines whether the DHW loop is enabled or disabled. When disabled the demand caused by the DHW sensor is ignored. It may be disabled to turn it off temporarily or because the application does not use this feature.	19
DHW forced rate	For DHW demand, if the DHW forced rate time is non-zero, then the firing rate will be held at the rate specified here during that time. This parameter is also needed as the starting point for Slow State, even if the forced rate time is zero.	34
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.	34
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.	29
DHW has priority over CH	This parameters determines the priority of DHW vs. 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 Time paremeter.)	19
DHW has priority over LL	This parameters determines the priority of DHW vs. the LL slave 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 Time paremeter.)	Not available at this time.
DHW high limit enable	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.	35
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.	35
DHW high limit setpoint	If the DHW temperature reaches the value given by this parameter then a response will occur.	35
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.	27
DHW I gain	This gain applied to the Integral term of the PID equation for the DHW loop.	27
DHW maximum modulation rate	Provides the upper limit of analog output or fan speed during modulation when firing for DHW.	41
DHW off hysteresis	The off hysteresis is added to the DHW Setpoint to determine the temperature at which DHW demand turns off	27
DHW on hysteresis	The on hysteresis is subtracted from the DHW Setpoint to determine the temperature at which DHW demand turns on.	27
DHW P gain	This gain applied to the Proportional term of the PID equation for the DHW loop.	27
DHW priority 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.	19
DHW pump control	The DHW 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. In Auto mode it operates according to the DHW demand, the start delay timer and the overrun time.	43
DHW pump cycle count	Can be written to a new value (e.g. if the pump or controller is replaced).	5
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.	29

Table 30. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
DHW pump output	This parameter allows the DHW pump function to be disconnected or to be attached to any of the pump outputs.	43
DHW pump overrun time	This time indicates how long the DHW pump should remain on after demand from any source ends. That is, whenever the pump has been on, but the last requests for the pump to be on ends, it continues to run for the time given by this parameter.	44
DHW pump start delay	When DHW demand changes from off to on, this parameter delays the start of the DHW pump. No delay occurs when DHW demand acquires control (due to priority) of a burner that is already firing for CH or LL slave demand.	43
DHW setpoint	This Setpoint is used whenever the time-of-day switch is off or not connected (unused).	27
DHW slow start enable	This parameter enables or disables the slow start limit function for DHW demand.	35
Drop stage rate offset	If the Lead Lag master is monitoring rate for staging, then a stage will be dropped when less heat is needed and the rate of the modulating burner drops below this threshold .	Not available at this time.
Drop stage time	The Lead Lag master waits before dropping a stage until the need to drop a stage has existed for the time given by this parameter.	Not available at this time.
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).	41
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).	41
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.	41
Fan 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.	41
Fan 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.	41
Firing rate control	If one of the manual modes is chosen then the Manual Rate parameter controls the firing rate during the specified states.	41
Flame sensor type	Different kinds of flame detectors may be used. This parameter tells the control what type of sensor is installed.	
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.	
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..	38
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.	40
Ignite failure response	If ignition fails then several responses are possible. This parameter selects one of these responses.	40
Ignite failure retries	This parameter provides the number of retries for an ignition failure, if the response to failure of ignition includes retries.	40
Ignition source	Several outputs may be selected as the ignition source. This parameter selects one of these.	40
ILK long name	The long name (up to 20 characters) of the ILK annunciator input.	47
ILK short name	The short (3 letter) name of the contacts monitored by the ILK annunciator input.	47
Installation data	The installer may edit this parameter to provide installation information.	20
Interlock 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.	38

Table 30. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
Interlock 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.	38
Interrupted air switch 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.	38
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.)	38
LCI long name	The long name (up to 20 characters) of the LCI annunciator input.	47
LCI short name	The short (3 letter) name of the contacts monitored by the LCI annunciator input.	47
Lead lag D gain	Gain applied to the differential term of the PID equation for the LL master.	Not available at this time.
Lead lag 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.	Not available at this time.
Lead lag I gain	Gain applied to the integral term of the PID equation for the LL master.	Not available at this time.
Lead lag master enable	This parameter determines whether the R7910 will operate as a lead lag master on the local Modbus.	Not available at this time.
Lead lag master stat input enable	If enabled then the STAT input provides an overall demand input for the LL master. When STAT is off then the LL master will operate the slave burners, but when it is off the master will turn off all slave burners.	Not available at this time.
Lead lag off hysteresis	The off hysteresis is added to the LL master's setpoint to determine the temperature at which this demand turns off	Not available at this time.
Lead lag on hysteresis	The on hysteresis is subtracted from the LL master's setpoint to determine the temperature at which this demand turns on.	Not available at this time.
Lead lag outdoor reset enable	If outdoor reset is enabled then the current outdoor temperature is used to determine the Setpoint by interpolation using LL Setpoint (or LL Time-Of-Day Setpoint if TOD is on), the min water temperature, and the min and max outdoor temperatures.	Not available at this time.
Lead lag P gain	Gain applied to the proportional term of the PID equation for the LL master.	Not available at this time.
Lead lag sequence type	The Lead Lag master may operate according to several sequencing algorithms. This parameter selects one of these.	Not available at this time.
Lead lag 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 LL Outdoor Reset parameter.	Not available at this time.
Lead lag slave enable	This parameter determines whether the R7910 will operate as a lead lag slave.	Not available at this time.
Lead lag 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 LL Outdoor Reset parameter.	Not available at this time.
Lightoff rate	This parameter specifies the analog output or fan speed used during Ignition.	41
Lightoff rate proving	This parameter specifies the input used to confirm the Prepurge rate has been reached.	39
LL ODR boost max setpoint	For LL demand and when outdoor reset is active, the setpoint will be boosted if demand is not met after a period of time. This parameter provides the upper limit for boosting the setpoint.	Not available at this time.
LL ODR boost time	For LL demand and when outdoor reset is active, the setpoint will be boosted if demand is not met after a period of time. This parameter provides the upper limit for boosting the setpoint.	Not available at this time.
LL ODR max outdoor temperature	This parameter determines the maximum outdoor temperature for the LL outdoor reset graph. At the maximum outdoor temperature the setpoint will be the minimum water temperature.	Not available at this time.
LL ODR min outdoor temperature	This parameter determines the X coordinate of one point on the ODR graph. At this outdoor temperature the setpoint will be the LL setpoint (or the LL TOD setpoint, if TOD is on).	Not available at this time.

Table 30. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
LL ODR min water temperature	This parameter provides the LL setpoint when the outdoor reset temperature is at its defined maximum.	Not available at this time.
Manual firing rate	This parameter specifies the analog output or fan speed during burner modulation, when the Firing rate control parameter specifies Manual mode.	41
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.	39
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.	40
Minimum modulation rate	Provides the lower limit of analog output or fan speed during modulation.	41
Minimum stage off time	Whenever the LL master turns off a stage, it will remain off for at least the amount of time specified here, before it is requested to turn on again.	Not available at this time.
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.	38
OEM identification	The OEM may provide identification information here.	20
Outdoor frost protection setpoint	This parameter provides the setpoint for frost protection based on outdoor temperature. When the outdoor temperature falls below this threshold then frost protection will be active.	
Outlet 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.	32
Outlet high limit setpoint	If the outlet temperature reaches the value given by this parameter, a response will occur.	32
Outlet T-rise degrees	If the T-Rise limit is active and the outlet temperature rises faster than this number of degrees per minute, then the burner will recycle and delay for a specified time.	36
Outlet T-rise delay	This parameter provides the delay time before the burner will again attempt to fire, when an outlet T-rise limit has occurred.	37
Outlet T-rise limit enable	This parameter enables or disables the outlet T-rise limit.	37
PID iteration frequency	PID iteration frequency. This parameter determines how many executions of the demand/rate task occur between executions of the PID control algorithm.	
Postpurge rate	This parameter specifies the analog output or fan speed used during Postpurge.	41
Postpurge time	This parameter sets the burner control's postpurge time. Setting this parameter to zero disables prepurge.	40
Power up with lockout	If Enable is chosen, then if the control is in the lockout condition when it powers up, it will remain that way. Disable means that power cycling the control will clear a lockout.	38
Preignition time	During the Preignition time the igniter output is energized and the occurrence of flame is a fault condition. It can be used to heat up a hot-surface igniter or to prove that spark does not simulate flame. Set to zero to disable.	39
Prepurge rate	This parameter specifies the analog output or fan speed used during Prepurge.	41
Prepurge time	This parameter sets the burner control's prepurge time. Setting this parameter to zero disables prepurge.	38
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.)	
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.	46
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.	46
Purge rate proving	This parameter specifies the input used to confirm the Prepurge rate has been reached.	39

Table 30. Parameter Glossary.

Parameter Name	Short Description	Ref. Page
PWM frequency	This parameter provides the frequency of the pulse-width modulation for variable speed fan control.	41
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.	40
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.	40
Slave mode	Each slave burner can specify how it should be handled by the Lead Lag master's sequencer. This parameter selects one of those methods.	Not available at this time.
Slave priority	When a slave burner is Used First or Used Last, it's order of use vs. other burners also having the same slave mode can be set using this parameter, to give each slave a different priority.	Not available at this time.
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.	35
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.	35
Spark Voltage	Spark voltage configuration for Safety uC	
Stack limit delay	This parameter provides the delay time for the Stack limit.	32
Stack limit enable	This parameter enables or disables the entire stack temperature limit function.	32
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.	32
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.	32
System pump control	The Boiler 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. In Auto mode it operates according to the demand and overrun time.	44
System pump cycle count	System pump cycle count. Can be written to a new value (e.g. if the pump or controller is replaced).	5
System pump output	This parameter allows the System pump function to be disconnected or to be attached to any of the pump outputs.	44
System pump overrun time	This time indicates how long the System pump should remain on after demand ends.	44
Temperature units	This parameter determines whether temperature is represented in units of Fahrenheit or Celsius degrees.	19

APPENDIX B: DEVICE PARAMETER WORKSHEET EXAMPLE

Table 31 is an example of a completed parameter worksheet, which is recommended as a way to record and track parameter selections made for a specific boiler model.

Table 31. Example of a Completed Device Parameter Worksheet.

Parameter Name	Customer Display Screen Visibility	Minimum Range	Default Setting	Maximum Range	Parameter Units
Burner cycle count	Visible		0		Cycles
Burner run time	Visible		0		Hours
CH pump cycle count	Visible		0		Cycles
DHW pump cycle count	Visible		0		Cycles
System pump cycle count	Visible		0		Cycles
Boiler pump cycle count	Visible		0		Cycles
Auxiliary pump cycle count	Visible		0		Cycles
Temperature units	Visible		A:Fahrenheit		
Antishort cycle time	Visible		1m 0s		mmm:ss
Alarm silence time	Visible		5m 0s		mmm:ss
Power up with lockout	not Visible		Enabled		
Burner name	Visible				20 chars
Installation data	Visible				20 chars
OEM identification	Visible				20 chars
Modulation output	not Visible		B:Demand rate is in % units		
CH maximum modulation rate	Visible		100%		% | RPM
DHW maximum modulation rate	Visible		100%		% | RPM
Minimum modulation rate	Visible		0%		% | RPM
Prepurge rate	Visible		100%		% | RPM
Lightoff rate	Visible		25%		% | RPM
Postpurge rate	Visible		25%		% | RPM
CH forced rate	Visible		25%		% | RPM
CH forced rate time	Visible		1m 0s		mmm:ss
DHW forced rate	Visible		25%		% | RPM
DHW forced rate time	Visible		120m 0s		mmm:ss
Burner switch	Visible		Yes/True/On		
Firing rate control	Visible		A:Automatic firing		
Manual firing rate	Visible		25%		% | RPM
Analog output hysteresis	Visible		0	20	1 to 10
CH enable	Visible		Enabled		
CH demand source	Visible		D:Sensor & LCI		
CH sensor	Visible		A:Outlet sensor		
CH setpoint	Visible	32°F 0°C	180°F 82°C	240°F 116°C	
CH tod setpoint	Visible	32°F 0°C	160°F 71°C	240°F 116°C	
CH on hysteresis	Visible	2°F 1°C	15°F 8°C	100°F 56°C	
CH off hysteresis	Visible	2°F 1°C	15°F 8°C	100°F 56°C	

Table 31. Example of a Completed Device Parameter Worksheet. (Continued)

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

Table 31. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Display Screen Visibility	Minimum Range	Default Setting	Maximum Range	Parameter Units
CH pump output	Visible		A:No pump assignment		
CH pump control	Visible		A:Automatic pump control		
CH pump overrun time	Visible		1m 0s		mmm:ss
CH pump frost protection overrun time	Visible		1m 0s		mmm:ss
DHW pump output	Visible		A:No pump assignment		
DHW pump control	Visible		A:Automatic pump control		
DHW pump overrun time	Visible		1m 0s		mmm:ss
DHW pump frost protection overrun time	Visible		1m 0s		mmm:ss
DHW pump start delay	Visible		0m 0s		mmm:ss
Boiler pump output	Visible		A:No pump assignment		
Boiler pump control	Visible		A:Automatic pump control		
Boiler pump overrun time	Visible		1m 0s		mmm:ss
Auxiliary pump output	Visible		A:No pump assignment		
Auxiliary pump control	Visible		A:Automatic pump control		
Auxiliary pump on when	Visible		A:Auxiliary ON when CH pump is ON		
System pump output	Visible		A:No pump assignment		
System pump control	Visible		A:Automatic pump control		
System pump overrun time	Visible		1m 0s		mmm:ss
Pump exercise interval	Visible		0		Days
Pump exercise time	Visible		0m 0s		mmm:ss
Annunciation enable	Visible		Enabled		
Annunciator mode	not Visible		B:Programmable annunciator		
Annunciator 1 location	Visible		E:No annunciation for this terminal		
Annunciator1 short name	Visible		A1		3 chars
Annunciator 1 long name	Visible		Annunciator 1		20 chars
Annunciator 2 location	Visible		E:No annunciation for this terminal		
Annunciator2 short name	Visible		A2		3 chars
Annunciator 2 long name	Visible		Annunciator2		20 chars
LCI short name	Visible		LCI		3 chars
LCI long name	Visible		Load Control Input		20 chars
ILK short name	Visible		ILK		3 chars
ILK long name	Visible		Interlock		20 chars

Table 31. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Display Screen Visibility	Minimum Range	Default Setting	Maximum Range	Parameter Units
DHW enable	Visible		Disabled		
DHW demand source	Visible		A:DHW sensor only		
DHW has priority over CH	Visible		No/False/Off		
DHW has priority over LL	Visible		No/False/Off		
DHW priority time	Visible		30m 0s		mmm:ss
DHW setpoint	Visible	32°F 0°C	140°F 60°C	240°F 116°C	
DHW tod setpoint	Visible	32°F 0°C	120°F 49°C	240°F 116°C	
DHW on hysteresis	Visible	2°F 1°C	5°F 3°C	100°F 56°C	
DHW off hysteresis	Visible	2°F 1°C	5°F 3°C	100°F 56°C	
DHW P gain	Visible	0	50	400	
DHW I gain	Visible	0	50	400	
DHW D gain	Visible	0	50	400	
DHW hysteresis step time	Visible		0m 0s		mmm:ss
Outlet high limit setpoint	Visible	32°F 0°C	220°F 104°C	240°F 116°C	
Outlet high limit response	Visible	[A B #c #d]	A:Lockout		
Stack limit enable	Visible		Disabled		
Stack limit setpoint	Visible	32°F 0°C	200°F 93°C	500°F 260°C	
Stack limit response	Visible	[A #b C #d]	A:Lockout		
Stack limit delay	Visible		5m 0s		mmm:ss
Delta-T enable	Visible		Disabled		
Delta-T degrees	Visible		30°F 17°C		
Delta-T response	Visible	[A #b C #d]	A:Lockout		
Delta-T delay	Visible		5m 0s		mmm:ss
DHW high limit enable	Visible		Enabled		
DHW high limit setpoint	Visible	32°F 0°C	150°F 66°C	240°F 116°C	
DHW high limit response	Visible	[A B #c D]	D:Suspend DHW		
CH slow start enable	Visible		Disabled		
DHW slow start enable	Visible		Disabled		
Slow start ramp	Visible		10%		% | RPM per minute
Slow start setpoint	Visible	0°F -18°C	20°F -7°C	180°F 82°C	
Outlet T-rise limit enable	not Visible		Disabled		
Outlet T-rise degrees	not Visible	0°F 0°C	30°F 17°C	180°F 100°C	
Outlet T-rise delay	not Visible		5m 0s		mmm:ss
CH anticondensation enable	Visible		Disabled		
CH anticondensation setpoint	Visible	32°F 0°C	135°F 57°C	240°F 116°C	
CH anticondensation pump Force Off	Visible		Disabled		
DHW anticondensation enable	Visible		Disabled		
DHW anticondensation setpoint	Visible	32°F 0°C	135°F 57°C	240°F 116°C	
DHW anticondensation pump force off	Visible		Disabled		

Table 31. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Display Screen Visibility	Minimum Range	Default Setting	Maximum Range	Parameter Units
Anticondensation > Outlet limit	Visible		No/False/Off		
Anticondensation > Delta-T	Visible		No/False/Off		
Anticondensation > Stack limit	Visible		No/False/Off		
Anticondensation > Slow start	Visible		Yes/True/On		
Anticondensation > Forced rate	Visible		Yes/True/On		
CH ODR max outdoor temperature	Visible		80°F 27°C		
CH ODR min outdoor temperature	Visible		0°F -18°C		
CH ODR min water temperature	Visible	32°F 0°C	50°F 10°C	240°F 116°C	
CH ODR boost time	not Visible		30m 0s		mmm:ss
CH ODR boost max setpoint	not Visible	32°F 0°C	200°F 93°C	240°F 116°C	
LL ODR max outdoor temperature	not Visible		80°F 27°C		
LL ODR min outdoor temperature	not Visible		0°F -18°C		
LL ODR min water temperature	not Visible	32°F 0°C	50°F 10°C	240°F 116°C	
LL ODR boost time	not Visible	1m 0s	1m 0s	9m 0s	mmm:ss
LL ODR boost max setpoint	not Visible	32°F 0°C	200°F 93°C	240°F 116°C	
CH frost protection enable	Visible		Disabled		
DHW frost protection enable	Visible		Disabled		
Outdoor frost protection setpoint	Visible		32°F 0°C		
Lead lag slave enable	Visible		Disabled		
Lead lag master enable	not Visible		Disabled		
Lead lag sequence type	not Visible		C:Base-loaded sequencing		
Lead lag setpoint	not Visible	32°F 0°C	180°F 82°C	240°F 116°C	
Lead lag tod setpoint	not Visible	32°F 0°C	160°F 71°C	240°F 116°C	
Lead lag outdoor reset enable	not Visible		Disabled		
Lead lag on hysteresis	not Visible	2°F 1°C	15°F 8°C	100°F 56°C	
Lead lag off hysteresis	not Visible	2°F 1°C	15°F 8°C	100°F 56°C	
Lead lag P gain	not Visible		50	400	
Lead lag I gain	not Visible		50	400	
Lead lag D gain	not Visible		0	400	
Lead lag master stat input enable	not Visible		Disabled		
Add stage method	not Visible		0		TBD
Add stage error threshold	not Visible		0		TBD
Add stage rate offset	not Visible		0%		% | RPM
Add stage time	not Visible		1m 0s		mmm:ss
Drop stage rate offset	not Visible		0%		% | RPM

Table 31. Example of a Completed Device Parameter Worksheet. (Continued)

Parameter Name	Customer Display Screen Visibility	Minimum Range	Default Setting	Maximum Range	Parameter Units
Drop stage time	not Visible		1m 0s		mmm:ss
Minimum stage off time	not Visible		1m 0s		mmm:ss
Slave mode	not Visible		A:Do not use this burner as a slave		
Slave priority	not Visible		1		1 to 8
Base load rate	not Visible		50%		% | RPM
Fan during off cycle rate	not Visible		25%		% | RPM
Lead lag hysteresis step time	not Visible		1m 0s		mmm:ss

R7910B GLOBAL MODBUS

The following definitions are used in this section:

Modbus: Application layer communication protocol standard adopted by the Modbus-IDA trade association. Recognized as an industry standard protocol for RS-485 serial communication.

PCB: Parameter Control Block. Files that customize the user interface with the R7910B. PCBs reside in the non-volatile storage in the R7910B and are uploaded from the R7910B into the user interface.

PIM: Plug In Module. Plug that can be inserted into the R7910B to enable Lead Lag and to backup and restore parameter settings in the R7910B.

RTU: Remote Terminal Unit serial transmission mode. Mode used to encode data for Modbus where each 8-bit byte is sent as two 4-bit hexadecimal characters.

The R7910B Global Modbus port is a 3-pin connector that interfaces to the following RS-485 signals:

Table 32. RS-485 Signals.

Signal	Terminal
Data + (a)	1
Data - (b)	2
Common (c)	3

Serial transmission mode on the Global Modbus network is RTU mode. Message format has the following characteristics::

Coding system	8-bit binary
Number of data bits per character	10 = 1 start bit 8 data bits No parity bit 1 stop bit
Bit transfer rate	38400 bps
Duplex	Half duplex
Error checking	2 byte CRC-16 polynomial
Bit transfer order	LSB first
End of message	Idle line for 3.5 or more characters

The R7910B Global Modbus interface supports the following function codes:

- 03 (0x03) Read Holding Registers
- 06 (0x06) Write Single Register
- 16 (0x10) Write Multiple Registers
- 17 (0x11) Report Slave ID

All of the configuration and status data are accessed as 16-bit holding registers in this interface. Since all R7910B digital signals accessed in this interface are read-only, these digital signals are mapped to bits within holding registers instead of coils or discrete inputs to simplify the interface. Variable length data are also represented by holding registers, and therefore, must be accessed individually and not as part of a group. The length of the variable length data is returned in the response. All 32-bit data items are accessed as two consecutive 16-bit holding registers, i.e., each item uses 2 register address spaces.

The holding register map is defined in the following table. Except for variable length data items the registers can be accessed as a single register or up to 20 registers for writes and 125 registers for reads. Data is mapped into logical groups with room for future expansion so some gaps exist in the register map.

Data organization is intended to allow for efficient register access. Status data is organized into register blocks by application function and a function status change indicator is used to denote when any data has changed within the register block since the last time the registers were read (see the following figure). The R7910B sets the status change indicator bit when at least one of the registers in the functional block has changed value since it was last read. The Global Modbus master can read the status change register and determine which functional register blocks have changed value since it's last access and only read those register blocks. The Global Modbus master can ignore the status change register and poll status data as it deems fit.

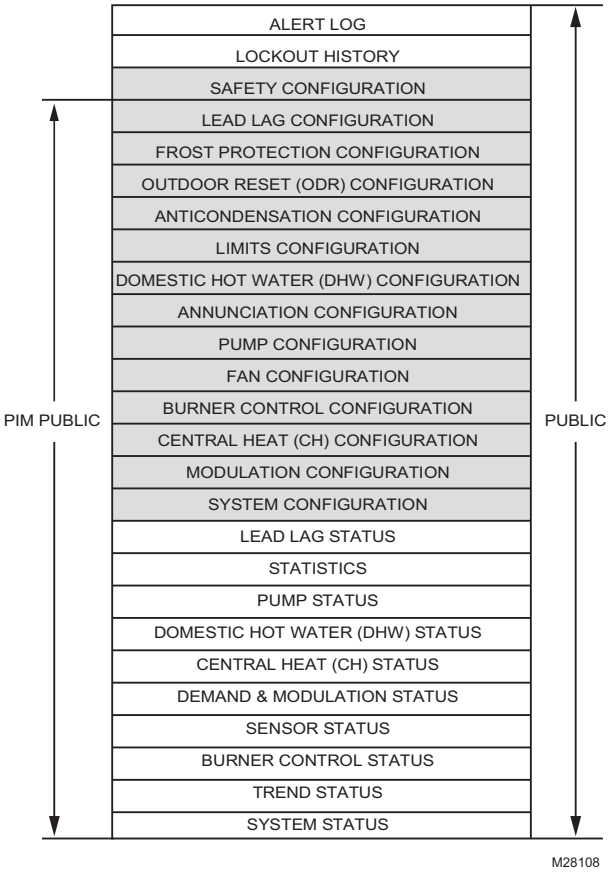

Fig. 25. Register map.

Table 33. R7910B Global Modbus Register Map.

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
		SYSTEM STATUS			
0000	0000	Status Change	R	U16	Register is cleared (all bits zeroed) after read. Identifies register groups that have new status in them. Bit map: 15-11=Reserved (always 1) 10=Alert log 9=Lockout history 8=Lead Lag status 7=Statistics 6=Pump status 5=DHW status 4=CH status 3=Demand&Modulation status 2=Sensor status 1=Burner control status 0=Active Lockout

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
0001	0001	Configuration Change	R	U16	Register is cleared (all bits zeroed) after read. Identifies register groups that have new data in them. Bit map: 15=PCB configuration 14=PIM configuration 13=Safety configuration 12=Lead Lag configuration 11=Frost protection configuration 10=Outdoor reset configuration 9=Anticondensation configuration 8=Limits configuration 7=DHW configuration 6=Annunciation configuration 5=Pump configuration 4=Fan configuration 3=Burner control configuration 2=CH configuration 1=Modulation configuration 0=System configuration
0002	0002	Digital I/O	R	U16	Bit map: 15=Safety relay 14=Time of Day 13=STAT (Demand) 12=High Fire Switch (HFS) 11=Low Fire Switch (LFS) 10=Load Control Input (LCI) 9=Pre-ignition interlock (PII) 8=Interlock (ILK) 7=Alarm 6=Main valve 5=Pilot valve 4=External ignition 3=Blower motor/HSI 2=Pump C 1=Pump B 0=Pump A
0003	0003	Annunciation I/O	R	U16	Only applicable when Annunciation is enabled Bit map: 15-3=Reserved (always 0) 2=Annunciator 3/LFS 1=Annunciator 2/HFS 0=Annunciator 1/IAS
0004	0004	Limits	R	U16	Bitmap: 15-4=Reserved (always 0) 3=Delta T limit 2=Stack limit 1=DHW high limit 0=Outlet high limit
0005	0005	PIM status	R	U16	Bit map: 15-11=Reserved 10=OEM alert PCB stored in PIM 9=OEM range PCB stored in PIM 8=OEM parameter PCB stored in PIM 7-2=Reserved 1=Lead/Lag enabled 0=PIM installed
		TREND STATUS			

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
0006	0006	Demand source	R	U16	Current demand source: 0=Unknown 1=No source demand 2=CH 3=DHW, 4=Lead Lag 5=CH frost protection 6=DHW frost protection 7=No demand due to burner switch (register 199) turned off
0007	0007	Outlet temperature	R	U16	-40°-130° (0.1°C precision)[1]
0008	0008	Firing rate	R	U16	Actual firing rate (%[2] or RPM[3]).
0009	0009	Fan speed	R	U16	RPM
000A	0010	Flame signal	R	U16	0.01V or 0.01μA precision (0.00-15.00V)
000B	0011	Inlet temperature	R	U16	-40°-130° (0.1°C precision)[1]
000C	0012	DHW temperature	R	U16	-40°-130° (0.1°C precision)[1]
000D	0013	Outdoor temperature	R	U16	-40°-130° (0.1°C precision)[1]
000E	0014	Stack temperature	R	U16	-40°-130° (0.1°C precision)[1]
000F	0015	Header temperature	R	U16	-40°-130° (0.1°C precision)[1]
0010	0016	Active CH setpoint	R	U16	-40°-130° (0.1°C precision)[1] Setpoint determined by CH setpoint source (register 65).
0011	0017	Active DHW setpoint	R	U16	-40°-130° (0.1°C precision)[1] Setpoint determined by DHW setpoint source (register 81).
0012	0018	Active LL setpoint	R	U16	-40°-130° (0.1°C precision)[1] Setpoint determined by LL setpoint source (register 161).
0013-001F	0019-0031	RESERVED			
		BURNER CONTROL STATUS			
0020	0032	Burner control status	R	U16	0=Disabled 1=Locked out 2=Standby Hold 3=Unconfigured safety data 4-15=Reserved 16=Normal Standby 17=Preparing 18=Firing 19=Postpurge
0021	0033	Burner control state	R	U16	Burner control sequence (I/O) state. Different states exist between residential & commercial models (see Table 40 & 41). Model type determined by register 176.
0022	0034	Lockout code	R	U16	0=No lockout, 1-4096 (see Table 37)
0023	0035	Alarm reason	R	U16	0=None 1=Lockout (see Lockout code, register 34) 2=Other (alert)

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
0024	0036	Annunciator first out	R	U16	Source for annunciator first out: 0=None or undetermined 1=ILK 2=PII 11=Annunciator 1 12=Annunciator 2 13=unused 14=unused 15=unused 16=unused 17=unused 18=unused
0025	0037	Annunciator Hold	R	U16	Source for burner control hold condition (see Hold code): 0=None or undetermined 1=ILK 2=unused 3=LCI 11=Annunciator 1 12=Annunciator 2 13=unused 14=unused 15=unused 16=unused 17=unused 18=unused
0026	0038	Sequence time	R	U16	Running time for timed burner control operation (seconds)
0027	0039	Delay time	R	U16	Running delay time (seconds). Applicable when burner control in delayed or hold state.
0028	0040	Hold code	R	U16	Source/reason for burner hold (same codes as lockout, see Table 37)
0029	0041	Burner control flags	R	U16	Bit map: 15-1=Reserved (always 0) 0= Flame detected
002A	0042	Remote Stat	R/W	U16	0=No remote STAT demand, 1=remote STAT demand indicated
002B-002F	0043-0047	RESERVED			
		SENSOR STATUS			
0030	0048	Outlet sensor state	R	U16	0=None, 1=Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0031	0049	Inlet sensor state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0032	0050	DHW sensor state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0033	0051	Stack sensor state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0034	0052	Outdoor sensor state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0035	0053	Header sensor state	R	U16	0=None, 1= Normal, 2=Open, 3=Shorted, 4=Outside high range, 5=Outside low range, 6=Not reliable
0036-0037	0054-0055	RESERVED			Reserved for new sensors.
		DEMAND & MODULATION STATUS			

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
0038	0056	Active rate limiter	R	U16	0=None 1=Outlet high limit 2=Delta T limit 3=Stack limit 4=Slow start limit 5=Anti-condensation 6=Minimum modulation 7=Forced rate
0039	0057	Limited rate	R	U16	RPM or %[2]
003A	0058	Active rate override	R	U16	0=None 1=Burner control default 2=Burner control 3=Manual firing rate 4=Manual firing rate off
003B	0059	Override rate	R	U16	RPM or %[3]
003C	0060	Demand rate	R	U16	RPM or %[3]
003D-003F	0061-0063	RESERVED			
		CENTRAL HEATING (CH) STATUS			
0040	0064	CH status	R	U16	0=Unknown 1=Disabled 2=Normal 3=Suspended
0041	0065	CH setpoint source	R	U16	0=Unknown 1=Normal setpoint 2=TOD setpoint 3=Outdoor reset
0042	0066	CH pump demand	R	U16	0=Off 1=On
0043	0067	CH burner demand	R	U16	0=Off 1=On
0044	0068	CH requested rate	R	U16	RPM or %[3]
0045	0069	CH frost pump demand	R	U16	0=Off 1=On
0046	0070	CH frost burner demand	R	U16	0=Off 1=On
0047	0071	Active CH on hysteresis	R	U16	-40°-130° (0.1°C precision)[1]
0048	0072	Active CH off hysteresis	R	U16	-40°-130° (0.1°C precision)[1]
0049-004F	0073-0079	RESERVED			
		DOMESTIC HOT WATER (DHW) STATUS			
0050	0080	DHW status	R	U16	0=Unknown 1=Disabled 2=Normal 3=Suspended
0051	0081	DHW setpoint source	R	U16	0=Unknown 1=Normal setpoint 2=TOD setpoint 3=Outdoor reset

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
0052	0082	DHW priority count	R	U16	Countdown of time when DHW has priority over CH (secs). Applicable when DHW priority time is enabled (see register 452).
0053	0083	DHW pump demand	R	U16	0=Off 1=On
0054	0084	DHW burner demand	R	U16	0=Off 1=On
0055	0085	DHW requested rate	R	U16	RPM or %[3]
0056	0086	DHW frost pump demand	R	U16	0=Off 1=On
0057	0087	DHW frost burner demand	R	U16	0=Off 1=On
0058	0088	Active DHW on hysteresis	R	U16	-40°-130° (0.1°C precision)[1]
0059	0089	Active DHW off hysteresis	R	U16	-40°-130° (0.1°C precision)[1]
005A-005F	0090-0095	RESERVED			
		PUMP STATUS			
0060	0096	CH pump status	R	U16	See Table 42.
0061	0097	CH pump overrun time	R	U16	Running overrun time for CH pump (seconds)
0062	0098	CH FP overrun time	R	U16	Running overrun time for CH pump due to frost protection (seconds)
0063	0099	CH pump idle days count	R	U16	Number of days that CH pump has not run (sat idle).
0064	0100	DHW pump status	R	U16	See Table 42.
0065	0101	DHW pump start delay time	R	U16	Count down (seconds) when DHW pump is delayed from starting.
0066	0102	DHW pump overrun time	R	U16	Running overrun time for DHW pump (seconds).
0067	0103	DHW FP overrun time	R	U16	Running overrun time for DHW pump due to frost protection (seconds).
0068	0104	DHW pump idle days count	R	U16	Number of days that DHW pump has not run (sat idle).
0069	0105	System pump status	R	U16	See Table 42.
006A	0106	System pump overrun time	R	U16	Running overrun time for Lead Lag pump (seconds).
006B	0107	System pump idle days count	R	U16	Number of days that LL pump has not run (sat idle).
006C	0108	Boiler pump status	R	U16	See Table 42.
006D	0109	Boiler pump overrun time	R	U16	Running overrun time for Boiler pump (seconds)
006E	0110	Boiler pump idle days count	R	U16	Number of days that boiler pump has not run (sat idle).
006F	0111	Auxiliary pump status	R	U16	See Table 42.
0070	0112	Auxiliary pump idle days count	R	U16	Number of days that auxiliary pump has not run (sat idle).
0071-007F	0113-0127	RESERVED			
		STATISTICS			
0080-0081	0128-0129	Burner cycle count	R/W	U32	0-999,999
0082-0083	0130-0131	Burner run time	R/W	U32	Hours
0084-0085	0132-0133	CH pump cycle count	R/W	U32	0-999,999

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
0086-0087	0134-0135	DHW pump cycle count	R/W	U32	0-999,999
0088-0089	0136-0137	System pump cycle count	R/W	U32	0-999,999
008A-008B	0138-0139	Boiler pump cycle count	R/W	U32	0-999,999
008C-008D	0140-0141	Auxiliary pump cycle count	R/W	U32	0-999,999
008E-008F	0142-0143	Controller cycle count	R	U32	0-999,999
0090-0091	0144-0145	Controller run time	R	U32	Hours
0092-009F	0146-0159	RESERVED			
		LEAD LAG STATUS			
00A0	0160	RESERVED			
00A1	0161	Lead Lag slave status	R	U16	Bit map: 15=Slave command received 14=Slave mode has priority over CH & DHW 13=Slave is modulating 12-11=Reserved (always 0) 10=R7910B master controlling slave (full slave mode) 9=Modbus master controlling slave (simple slave mode) 8=EnviraCOM controlling slave (simple slave mode) 7-0=Burner control status (see register 32)
00A2	0162	Lead Lag master setpoint source	R	U16	0=Unknown 1=Normal setpoint 2=TOD setpoint 3=Outdoor reset
00A3	0163	Lead Lag master pump demand	R	U16	0=Off 1=On
00A4	0164	Lead Lag slave burner demand	R	U16	0=Off 1=On
00A5	0165	Lead Lag slave requested rate	R	U16	RPM or %[3]
00A6-00AF	0166-0175	RESERVED			
		SYSTEM CONFIGURATION			
00B0	0176	Product type	R	U16	Product family (MSB): 0=Unknown product 1=Hydronic boiler control Product ID (LSB): 0=Residential control 1=Commercial control
00B1	0177	Password	W		Variable length password string (up to 20 characters) requesting R7910B permission to write registers.
00B2	0178	Register Access Status	R	U16	Register data write access status: 0=No register writes allowed 1=Installer register writes allowed 2=OEM register writes allowed 3=All register writes allowed

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
00B3	0179	Temperature units	R/W	U16	Display format for temperature at user interface: 0=°F (Fahrenheit), 1=°C (Celsius)
00B4	0180	Antishort cycle time	R/W	U16	0-600 seconds
00B5	0181	Alarm silence time	R/W	U16	0-600 minutes
00B6	0182	Power up with lockout	R/W	U16	0=Clear lockout on power-up (reset), 1=Do not clear lockout on power-up (preserve)
00B7	0183	Reset and restart	W	U16	Force soft reset of R7910B subsystems: 0=None 1=Burner control 2=Application 3=Burner control and application 4=Clear lockout start 5=Clear lockout confirm
00B8	0184	Burner Name	R/W		Variable length string (up to 20 characters)
00B9	0185	Installation data	R/W		Variable length string (up to 20 characters)
00BA	0186	OEM ID	R/W		Variable length string (up to 20 characters)
00BB	0187	Safety revision	R	U16	Safety parameter revision (1-65535)
00BC	0188	Application revision	R	U16	Application parameter revision (1-65535)
00BD	0189	Installer password	W		To set new installer password (up to 20 characters). Requires register access status (register 178) set to Installer or higher.
00BE	0190	OEM password	W		To set new OEM password (up to 20 characters). Requires register access status (register 178) set to OEM or higher.
00BF	0191	RESERVED			
		MODULATION CONFIGURATION			
00C0	0192	Modulation output	R/W	U16	0=Fan PWM 1=0-10V 2=4-20mA
00C1	0193	CH Maximum modulation rate	R/W	U16	RPM or %[3]
00C2	0194	DHW Maximum modulation rate	R/W	U16	RPM or %[3]
00C3	0195	Minimum modulation rate	R/W	U16	RPM or %[3]
00C4	0196	Prepurge rate	R/W	U16	RPM or %[3]
00C5	0197	Lightoff rate	R/W	U16	RPM or %[3]
00C6	0198	Postpurge rate	R/W	U16	RPM or %[3]
00C7	0199	CH forced rate	R/W	U16	RPM or %[3]
00C8	0200	CH forced rate time	R/W	U16	0-600 seconds
00C9	0201	DHW forced rate	R/W	U16	RPM or %[3]
00CA	0202	DHW forced rate time	R/W	U16	0-600 seconds
00CB	0203	Burner switch	R/W	U16	0=Off, 1=On. Used to enable/disable burner control.
00CC	0204	Firing rate control	R/W	U16	0=Auto 1=Manual in Run 2=Manual in Run & Standby
00CD	0205	Manual firing rate	R/W	U16	Firing rate used when control is set to manual (% or RPM[3])

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
00CE	0206	Analog output hysteresis	R/W	U16	0-10V/4-20mA modulation output hysteresis. Setting of 0-10.
00CF	0207	RESERVED			
		CH CONFIGURATION			
00D0	0208	CH enable	R/W	U16	0=Disable Central Heating 1=Enable Central Heating
00D1	0209	CH demand source	R/W	U16	0=Sensor only 1=Sensor & STAT terminal 2=Sensor & Remote Stat 3=LCI & Sensor
00D2	0210	CH sensor	R/W	U16	0=Outlet sensor 1=Header sensor
00D3	0211	CH setpoint	R/W	U16	-40°-130° (0.1°C precision)[1]
00D4	0212	CH time of day setpoint	R/W	U16	-40°-130° (0.1°C precision)[1] Setpoint when Time Of Day switch is on.
00D5	0213	CH on hysteresis	R/W	U16	0°-130° (0.1°C precision)[1]
00D6	0214	CH off hysteresis	R/W	U16	0°-130° (0.1°C precision)[1]
00D7	0215	CH outdoor reset enable	R/W	U16	0=Disable outdoor reset 1=Enable outdoor reset
00D8	0216	CH P-gain	R/W	U16	0-100
00D9	0217	CH I-gain	R/W	U16	0-100
00DA	0218	CH D-gain	R/W	U16	0-100
00DB-00DF	0219-0223	RESERVED			
		BURNER CONTROL CONFIGURATION			
00E0	0224	Ignition source	R/W	U16	0=Internal ignition, 1=External ignition, 2=Hot Surface Igniter (HSI)
00E1	0225	BLR/HSI function	R/W	U16	BLR/HSI terminal function: 0=blower motor, 1=Hot Surface Igniter (HSI)
00E2	0226	Igniter on during	R/W	U16	0=Pilot Flame Establishing Period (PFEP), 1=First 1/2 of PFEP
00E3	0227	Pilot type	R/W	U16	0=Interrupted, 1=Intermittent, 2=Direct burner ignition
00E4	0228	Flame sensor type	R/W	U16	0=None (no sensor) 1=Flame rod, 2=UV power tube
00E5	0229	Purge rate proving	R/W	U16	0=None, 1=HFS, 2=Fan speed
00E6	0230	Lightoff rate proving	R/W	U16	0=None, 1=LFS, 2=Fan speed
00E7	0231	Prepurge time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
00E8	0232	Pre-ignition time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
00E9	0233	Pilot flame establishing period (PFEP)	R/W	U16	4, 10, or 15 seconds
00EA	0234	Main flame establishing period (MFEP)	R/W	U16	5, 10, or 15 seconds
00EB	0235	Run stabilization time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
00EC	0236	Postpurge time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
00ED	0237	Interlock start check	R/W	U16	0=No ILK check, 1=ILK check

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
00EE	0238	Interlock open response	R/W	U16	0=Lockout, 1=Recycle
00EF	0239	Ignite failure response	R/W	U16	0=Lockout 1=Continuous recycle 2=Retry, recycle & hold? 3=Retry, recycle & lockout
00F0	0240	Ignite failure retries	R/W	U16	3 or 5
00F1	0241	Ignite failure delay	R/W	U16	0-600 seconds, 0xFFFF=Not configured
00F2	0242	MFEP flame failure response	R/W	U16	0=Lockout, 1=Recycle
00F3	0243	Run flame failure response	R/W	U16	0=Lockout, 1=Recycle
00F4	0244	Pilot test hold	R/W	U16	0=Disable, 1=Enable
00F5	0245	NTC sensor type	R/W	U16	0=10K dual safety 1=12K single non-safety
00F6	0246	Interrupted air switch (IAS) enable	R/W	U16	0=Disable 1=Enable during purge 2=Enable during purge & ignition
00F7	0247	IAS start check enable	R/W	U16	0=Disable 1=Enable
00F8	0248	LCI enable	R/W	U16	0=Disable 1=Enable
00F9	0249	PII enable	R/W	U16	0=Disable 1=Enable
00FA	0250	Flame threshold	R/W	U16	Minimum microamps needed to declare flame presence (0.1μA precision). Default value is 0.8 μA (8).
0FB	0251	Lockout reset	W	U16	1=Reset (clear) current lockout
00FC-00FF	0252-0255	RESERVED			
		FAN CONFIGURATION			
0100	0256	Absolute maximum fan speed	R/W	U16	RPM
0101	0257	Absolute minimum fan speed	R/W	U16	RPM
0102	0258	Fan PWM frequency	R/W	U16	1000, 2000, 3000, 4000Hz
0103	0259	Fan pulses per revolution	R/W	U16	1-10
0104	0260	Fan speed-up ramp	R/W	U16	0-7000 RPM/sec
0105	0261	Fan slow-down ramp	R/W	U16	0-7000 RPM/sec
0106	0262	Fan gain up	R/W	U16	0-65535
0107	0263	Fan gain down	R/W	U16	0-65535
0108	0264	Fan minimum duty cycle	R/W	U16	1-100%
0109-010F	0265-0271	RESERVED			
		PUMP CONFIGURATION			
0110	0272	CH pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
0111	0273	CH pump control	R/W	U16	0=Auto, 1=On
0112	0274	CH pump overrun time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
0113	0275	CH FP pump overrun time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
0114	0276	DHW pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
0115	0277	DHW pump control	R/W	U16	0=Auto, 1=On

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
0116	0278	DHW pump overrun time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
0117	0279	DHW FP pump overrun time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
0118	0280	DHW pump start delay	R/W	U16	0-600 seconds, 0xFFFF=Not configured
0119	0281	Boiler pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
011A	0282	Boiler pump control	R/W	U16	0=Auto, 1=On
011B	0283	Boiler pump overrun time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
011C	0284	Auxiliary pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
011D	0285	Auxiliary pump control	R/W	U16	0=Auto, 1=On
011E	0286	Auxiliary pump is on when	R/W	U16	0=CH pump is ON 1=DHW pump is ON 2=Either CH or DHW pump is ON 3=Slave command only
011F	0287	System pump output	R/W	U16	0=None, 1=Pump A, 2=Pump B, 3=Pump C
0120	0288	System pump control	R/W	U16	0=Auto, 1=On
0121	0289	System pump overrun time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
0122	0290	Pump exercise interval	R/W	U16	Days
0123	0291	Pump exercise time	R/W	U16	0-600 seconds, 0xFFFF=Not configured
0124-012F	0292-0303	RESERVED			
		ANNUNCIATION CONFIGURATION			
0130	0304	Annunciation enable	R/W	U16	0=Annunciation disabled 1=Annunciation enabled
0131	0305	Annunciator mode	R/W	U16	0=Fixed 1=Programmable
0132-013E	0306-0318	Annunciator 1 configuration	R/W		See Table 36.
013F-014B	0319-0331	Annunciator 2 configuration	R/W		See Table 36.
014C-0158	0332-0344	unused			
0159-0165	0345-0357	unused			
0166-0172	0358-0370	unused			
0173-017F	0371-0383	unused			
0180-018C	0384-0396	unused			
018D-0199	0397-0409	unused			
019A-01A5	0410-0421	unused			
01A6-01B1	0422-0433	LCI configuration	R/W		See Table 42.
01B2-01BD	0434-0445	ILK configuration	R/W		See Table 42t‘g6yv.
01BE-01BF	0446-0447	RESERVED			
		DHW CONFIGURATION			

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
01C0	0448	DHW enable	R/W	U16	0=DHW disabled 1=DHW enabled
01C1	0449	DHW demand source	R/W	U16	0=DHW sensor only 1=DHW sensor & Remote Stat 2=DHW switch & inlet sensor 3=DHW switch & outlet sensor
01C2	0450	DHW priority vs CH	R/W	U16	0=CH > DHW, 1=DHW > CH
01C3	0451	DHW priority vs LL	R/W	U16	0=LL > DHW, 1=DHW > LL
01C4	0452	DHW priority time	R/W	U16	0=No DHW priority time, >0=DHW priority time (min)
01C5	0453	DHW setpoint	R/W	U16	-40°-130° (0.1°C precision)[1]
01C6	0454	DHW time of day setpoint	R/W	U16	-40°-130° (0.1°C precision)[1] Setpoint when Time Of Day switch is on.
01C7	0455	DHW on hysteresis	R/W	U16	-40°-130° (0.1°C precision)[1]
01C8	0456	DHW off hysteresis	R/W	U16	-40°-130° (0.1°C precision)[1]
01C9	0457	DHW P-gain	R/W	U16	0-100
01CA	0458	DHW I-gain	R/W	U16	0-100
01CB	0459	DHW D-gain	R/W	U16	0-100
01CC-01CF	0460-0463	RESERVED			
		LIMITS CONFIGURATION			
01D0	0464	Outlet high limit setpoint	R/W	U16	-40°-130° (0.1°C precision)[1]
01D1	0465	Outlet high limit response	R/W	U16	0=Lockout 1=Recycle & hold
01D2	0466	Stack limit enable	R/W	U16	0=Disable stack limit 1=Enable stack limit
01D3	0467	Stack limit setpoint	R/W	U16	-40°-130° (0.1°C precision)[1]
01D4	0468	Stack limit response	R/W	U16	0=Lockout 2=Recycle & delay
01D5	0469	Stack limit delay	R/W	U16	0-600 seconds
01D6	0470	Delta T enable	R/W	U16	0=Disable Delta T limit 1=Enable Delta T limit
01D7	0471	Delta T degrees	R/W	U16	0°-130° (0.1°C precision)[1]
01D8	0472	Delta T response	R/W	U16	0=Lockout 2=Recycle & delay
01D9	0473	Delta T delay	R/W	U16	0-600 seconds, 0xFFFF=Not configured
01DA	0474	DHW high limit enable	R/W	U16	0=Disable DHW high limit 1=Enable DHW high limit
01DB	0475	DHW high limit setpoint	R/W	U16	-40°-130° (0.1°C precision)[1]
01DC	0476	DHW high limit response	R/W	U16	0=Lockout 2=Recycle & hold 3=Suspend DHW
01DD	0477	CH slow start enable	R/W	U16	0=Disable CH slow start limit 1=Enable CH slow start limit
01DE	0478	DHW slow start enable	R/W	U16	0=Disable DHW slow start limit, 1=Enable DHW slow start limit
01DF	0479	Slow start ramp	R/W	U16	RPM/min or %/min[3]

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
01E0	0480	Slow start setpoint	R/W	U16	-40°-130° (0.1°C precision)[1]
01E1	0481	Outlet T-rise limit enable	R/W	U16	0=Disable Outlet T-rise limit 1=Enable Outlet T-rise limit
01E2	0482	Outlet T-rise degrees	R/W	U16	Degrees/min (0.1°C precision)[1]
01E3	0483	Outlet T-rise delay	R/W	U16	0-600 seconds, 0xFFFF=Not configured
01E4-01EF	0484-0495	RESERVED			
		ANTICONDENSATION CONFIGURATION			
01F0	0496	CH anticondensation enable	R/W	U16	0=Disable CH anticondensation 1=Enable CH anticondensation
01F1	0497	CH anticondensation setpoint	R/W	U16	-40°-130° (0.1°C precision)[1]
01F2	0498	CH anticondensation pump force off	R/W	U16	0=Normal (no change to CH pump) 1=CH pump forced off
01F3	0499	DHW anticondensation enable	R/W	U16	0=Disable DHW anticondensation 1=Enable DHW anticondensation
01F4	0500	DHW anticondensation setpoint	R/W	U16	-40°-130° (0.1°C precision)[1]
01F5	0501	DHW anticondensation pump force off	R/W	U16	0=Normal (no change to DHW pump) 1=DHW pump forced off
01F6	0502	Anticondensation priority	R/W	U16	Is anticondensation more important than (0=No, 1=Yes)? Bit map: 15-5=Reserved (always 0) 4=Outlet high limit 3=Forced rate 2=Slow start 1=Delta T limit 0=Stack limit
01F7-01FF	0503-0511	RESERVED			
		OUTDOOR RESET CONFIGURATION			
0200	0512	CH ODR maximum outdoor temperature	R/W	U16	-40°-130° (0.1°C precision)[1]
0201	0513	CH ODR minimum outdoor temperature	R/W	U16	-40°-130° (0.1°C precision)[1]
0202	0514	CH ODR minimum water temperature	R/W	U16	-40°-130° (0.1°C precision)[1]
0203	0515	CH ODR boost time	R/W	U16	0-600 seconds
0204	0516	CH ODR boost maximum setpoint	R/W	U16	-40°-130° (0.1°C precision)[1]
0205	0517	Lead Lag ODR maximum outdoor temperature	R/W	U16	-40°-130° (0.1°C precision)[1]
0206	0518	Lead Lag ODR minimum outdoor temperature	R/W	U16	-40°-130° (0.1°C precision)[1]
0207	0519	Lead Lag ODR minimum water temperature	R/W	U16	-40°-130° (0.1°C precision)[1]
0208-020F	0520-0527	RESERVED			
		FROST PROTECTION CONFIGURATION			

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
0210	0528	CH frost protection enable	R/W	U16	0=Disable CH frost protection 1=Enable CH frost protection
0211	0529	DHW frost protection enable	R/W	U16	0=Disable DHW frost protection 1=Enable DHW frost protection
0212	0530	Outdoor frost protection setpoint	R/W	U16	-40°-130° (0.1°C precision)[1] (applicable for CH only)
0213-021F	0531-0543	RESERVED			
		LEAD LAG CONFIGURATION			
0220	0544	Lead Lag slave enable	R/W	U16	0=Lead/Lag slave disabled 1=Lead/Lag simple slave enabled for EnviraCom master 2=Lead/Lag simple slave enabled for Global Modbus master 3=Lead/Lag full slave enabled for Global Modbus master
0221-0231	0545-0561	RESERVED			
0232	0562	Slave command	R/W	U16	Bit map: 15=Slave demand request 14=Slave suspend startup 13=Slave run fan request 12=Turn on System pump with overrun 11=Turn on System pump with no overrun 10=Turn on Auxiliary pump 9=Reserved (always 0) 8=Commanded rate is binary fraction %[4] 7-0=Commanded rate[5]
0233-023F	0563-0575	RESERVED			
		SAFETY CONFIGURATION			
0240-025F	0576-0607	RESERVED			
		LOCKOUT HISTORY			
0260-0270	0608-0624	Lockout history record 1	R		Most recent lockout. See Table 34.
0271-0281	0625-0641	Lockout history record 2	R		2nd newest lockout. See Table 34.
0282-0292	0642-0658	Lockout history record 3	R		3rd newest lockout. See Table 34.
0293-02A3	0659-0675	Lockout history record 4	R		4th newest lockout. See Table 34.
02A4-02B4	0676-0692	Lockout history record 5	R		5th newest lockout. See Table 34.
02B5-02C5	0693-0709	Lockout history record 6	R		6th newest lockout. See Table 34.
02C6-02D6	0710-0726	Lockout history record 7	R		7th newest lockout. See Table 34.
02D7-02E7	0727-0743	Lockout history record 8	R		8th newest lockout. See Table 34.
02E8-02F8	0744-0760	Lockout history record 9	R		9th newest lockout. See Table 34.
02F9-0309	0761-0777	Lockout history record 10	R		10th newest lockout. See Table 34.

Table 33. R7910B Global Modbus Register Map. (Continued)

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
030A-031A	0778-0794	Lockout history record 11	R		11th newest lockout. See Table 34.
031B-032B	0795-0811	Lockout history record 12	R		12th newest lockout. See Table 34.
032C-033C	0812-0828	Lockout history record 13	R		13th newest lockout. See Table 34.
033D-034D	0829-0845	Lockout history record 14	R		14th newest lockout. See Table 34.
034E-035E	0846-0862	Lockout history record 15	R		Oldest lockout
034F	0863	RESERVED			
		ALERT LOG			
0360-0365	0864-0869	Alert log record 1	R	U16	Most recent alert (see Table 38).
0366-036B	0870-0875	Alert log record 2	R	U16	2nd newest alert.
036C-0371	0876-0881	Alert log record 3	R	U16	3rd newest alert.
0372-0377	0882-0887	Alert log record 4	R	U16	4th newest alert.
0378-037D	0888-0893	Alert log record 5	R	U16	5th newest alert.
037E-0383	0894-0899	Alert log record 6	R	U16	6th newest alert.
0384-0389	0900-0905	Alert log record 7	R	U16	7th newest alert.
038A-038F	0906-0911	Alert log record 8	R	U16	8th newest alert.
0390-0395	0912-0917	Alert log record 9	R	U16	9th newest alert.
0396-039B	0918-0923	Alert log record 10	R	U16	10th newest alert.
039C-03A1	0924-0929	Alert log record 11	R	U16	11th newest alert.
03A2-03A7	0930-0935	Alert log record 12	R	U16	12th newest alert.
03A8-03AD	0936-0941	Alert log record 13	R	U16	13th newest alert.
03AE-03B3	0942-0947	Alert log record 14	R	U16	14th newest alert.
03B4-03B9	0948-0953	Alert log record 15	R	U16	Oldest alert.
03BA-0FFF	0954-4095	RESERVED			

Each lockout history record has the format described in Table 34.

Table 34. R7910B Lockout History Record.

Byte Offset	Parameter	Read/Write	Format	Note
0-1	Lockout code	R	U16	See register 34 (decimal).
2-3	Annunciator first out	R	U16	See register 36 (decimal).
4-5	Burner control state	R	U16	See register 33 (decimal).
6-7	Sequence time	R	U16	See register 37 (decimal).
8-11	Cycle	R	U32	See registers 128-129 (decimal).
12-15	Hours	R	U32	See registers 130-131 (decimal).
16-17	I/O	R	U16	See register 2 (decimal).
18-19	Annunciator	R	U16	See register 3 (decimal).
20-21	Outlet temperature	R	U16	See register 7 (decimal).
22-23	Inlet temperature	R	U16	See register 11 (decimal).
24-25	DHW temperature	R	U16	See register 12 (decimal).
26-27	Outdoor temperature	R	U16	See register 13 (decimal).
28-29	Stack temperature	R	U16	See register 14 (decimal).
30-31	Header temperature	R	U16	See register 15 (decimal).
32-33	Fault data	R	U8	Fault dependent data (U8 x 2).

Each annunciator configuration record has the format described in Table 35.

Table 35. Annunciator Configuration.

Byte Offset	Parameter	Read/Write	Format	Note
0-1	Location	R/W	U16	0=Unused, 1=PII, 2=LCI, 3=ILK, 4=Other
2-4	Annunciator short name	R/W	U8	
5	Unused	--	U8	
6-25	Annunciator name	R/W	U8	

The PII, LCI, and ILK terminals are named with configuration records that have a format described in Table 36.

Table 36. LCI, ILK Terminal Configuration.

Byte Offset	Parameter	Read/Write	Format	Note
0-2	Interlock short name	R/W	U8	
3	Unused	--	U8	
4-23	Interlock name	R/W	U8	

R7910B lockout and hold codes are contained in Table 37.

Table 37. R7910B Lockout/Hold Codes.

Code	Description	Note
0	None	No Lockout/hold
1	Unconfigured safety data	Lockout
2	RESERVED	
3	Hardware fault	Hold
4	Safety MFO error	Hold
5	Unstable power (DCDC) output	Hold
6	Invalid processor clock	Hold

Table 37. R7910B Lockout/Hold Codes. (Continued)

Code	Description	Note
7	Safety relay drive error	Hold
8	SLO electronics unknown error	Hold
9	Zero crossing not detected	Hold
10	Flame bias out of range	Hold
11	Invalid Burner control state	Lockout
12	Invalid Burner control state flag	Lockout
13	Safety relay drive cap short	Hold
14-20	RESERVED	
21	Flame rod to ground leakage	Hold
22	Static flame (not flickering)	Hold
23	24VAC voltage low/high	Hold
24	Modulation fault	Hold
25	Pump fault	Hold
26	Motor tachometer fault	Hold
27-34	RESERVED	
35	Anti short cycle	Hold
36	Fan speed not proved	Hold
37	LCI off	Hold
38	PII off	Hold/Lockout
39	Interrupted Airflow Switch off	Hold/Lockout
40	Interrupted Airflow Switch on	Hold/Lockout
41	ILK off	Hold/Lockout
42	ILK on	Hold/Lockout
43	Pilot test hold	Hold
44	Wait for leakage test completion	Hold
45-52	RESERVED	
53	Outlet high limit	Hold/Lockout
54	DHW high limit	Hold/Lockout
55	Delta T limit	Hold/Lockout
56	Stack limit	Hold/Lockout
57-60	RESERVED	
61	Inlet sensor fault	Hold
62	Outlet sensor fault	Hold
63	DHW sensor fault	Hold
64	Header sensor fault	Hold
65	Stack sensor fault	Hold
66	Outdoor sensor fault	Hold
67-74	RESERVED	
75	Flame detected out of sequence	Hold/Lockout
76	Flame lost in MFEP	Lockout
77	Flame lost early in run	Lockout
78	Flame lost in run	Lockout
79	Ignition failed	Lockout
80	Ignition failure occurred	Hold
81	Flame current lower than WEAK threshold	Hold
82	Pilot test flame timeout	Lockout

Table 37. R7910B Lockout/Hold Codes. (Continued)

Code	Description	Note
83	Flame circuit timeout	Lockout
84-91	RESERVED	
92	Lightoff rate proving failed	Lockout
93	Purge rate proving failed	Lockout
94-97	RESERVED	
98	Flame detected	Hold
99	High fire switch	Hold
100	High fire switch on	Hold
101	Combustion pressure on	Hold
102	Standby purge fan switch	Hold
103	Hold purge fan switch	Hold
104	Combustion pressure/flame	Hold
105	Combustion pressure on	Hold
106	High fire switch off	Hold
107	High fire switch stuck on	Hold
108	Low fire switch off	Hold
109	Low fire switch stuck on	Hold
110	High limit	Hold
111-116	RESERVED	
117	Interrupted Airflow Switch failed to close	Hold
118	ILK failed to close	Hold
119-122	RESERVED	
123	Invalid BLOWER/HSI output setting	Lockout
124	Invalid Delta T limit enable setting	Lockout
125	Invalid Delta T limit response	Lockout
126	Invalid DHW high limit enable setting	Lockout
127	Invalid DHW high limit response	Lockout
128	Invalid Flame sensor type	Lockout
129	Invalid interrupted air switch enable setting	Lockout
130	Invalid interrupted air switch start check enable setting	Lockout
131	Invalid Igniter on during setting	Lockout
132	Invalid Ignite failure delay setting	Lockout
133	Invalid Ignite failure response setting	Lockout
134	Invalid Ignite failure retries setting	Lockout
135	Invalid Ignition source	Lockout
136	Invalid Interlock open response setting	Lockout
137	Invalid Interlock start check setting	Lockout
138	Invalid LCI enable setting	Lockout
139	Invalid lightoff rate	Lockout
140	Invalid Lightoff rate proving setting	Lockout
141	Invalid Main Flame Establishing Period time	Lockout
142	Invalid MFEP flame failure response setting	Lockout
143	Invalid NTC sensor type setting	Lockout
144	Invalid Outlet high limit response	Lockout

Table 37. R7910B Lockout/Hold Codes. (Continued)

Code	Description	Note
145	Invalid Pilot Flame Establishing Period setting	Lockout
146	Invalid PII enable setting	Lockout
147	Invalid pilot test hold settings	Lockout
148	Invalid Pilot type setting	Lockout
149	Invalid Postpurge time setting	Lockout
150	Invalid Power up with lockout settings	Lockout
151	Invalid Preignition time setting	Lockout
152	Invalid Prepurge rate	Lockout
153	Invalid Prepurge time setting	Lockout
154	Invalid Purge rate proving setting	Lockout
155	Invalid Run flame failure response setting	Lockout
156	Invalid Run stabilization time setting	Lockout
157	Invalid Stack limit enable setting	Lockout
158	Invalid Stack limit response	Lockout
159-174	RESERVED	
175	High fire switch	Lockout
176	Flame detected	Lockout
177	Main flame ignition	Lockout
178	Main valve off	Lockout
179	Ignition off	Lockout
180	Main valve on	Lockout
181	Pilot valve on	Lockout
182	Ignition on	Lockout
183	Combustion pressure	Lockout
184	No flame	Lockout
185	Purge fan switch on	Lockout
186	Block intake	Lockout
187	Purge fan switch off	Lockout
188	Combustion pressure/flame	Lockout
189	Flame detected	Lockout
190-195	RESERVED	
196	Main relay feedback	Lockout
197	Pilot relay feedback	Lockout
198	Safety relay feedback	Lockout
199	Safety relay open	Lockout
200-207	RESERVED	
208	Unconfigured BLOWER/HSI output setting	Lockout
209	Unconfigured Delta T limit enable setting	Lockout
210	Unconfigured Delta T limit response	Lockout
211	Unconfigured DHW high limit enable setting	Lockout
212	Unconfigured DHW high limit response	Lockout
213	Unconfigured Flame sensor type	Lockout
214	Unconfigured interrupted air switch enable setting	Lockout

Table 37. R7910B Lockout/Hold Codes. (Continued)

Code	Description	Note
215	Unconfigured interrupted air switch start check enable setting	Lockout
216	Unconfigured Igniter on during setting	Lockout
217	Unconfigured Ignite failure delay setting	Lockout
218	Unconfigured Ignite failure response setting	Lockout
219	Unconfigured Ignite failure retries setting	Lockout
220	Unconfigured Ignition source	Lockout
221	Unconfigured Interlock open response setting	Lockout
222	Unconfigured Interlock start check setting	Lockout
223	Unconfigured LCI enable setting	Lockout
224	Unconfigured Lightoff rate proving setting	Lockout
225	Unconfigured Main Flame Establishing Period setting	Lockout
226	Unconfigured MFEP flame failure response setting	Lockout
227	Unconfigured NTC sensor type setting	Lockout
228	Unconfigured Outlet high limit response	Lockout
229	Unconfigured Pilot Flame Establishing Period setting	Lockout
230	Unconfigured PII enable setting	Lockout
231	Unconfigured Pilot type setting	Lockout
232	Unconfigured Postpurge time setting	Lockout
233	Unconfigured Power up with lockout settings	Lockout
234	Unconfigured Preignition time setting	Lockout
235	Unconfigured Prepurge time setting	Lockout
236	Unconfigured Purge rate proving setting	Lockout
237	Unconfigured Run flame failure response setting	Lockout
238	Unconfigured Run stabilization time setting	Lockout
239	Unconfigured Stack limit enable setting	Lockout
240	Unconfigured Stack limit response	Lockout
241-244	RESERVED	
245	Flame ripple and overflow	Hold
246	Flame number of sample mismatch	Hold
247	Flame bias out of range	Hold
248	Bias changed since heating cycle starts	Hold
249	Spark voltage stuck low or high	Hold
250	Spark voltage changed too much during flame sensing time	Hold
251	Static flame ripple	Hold
252	Rod shorted to ground detected	Hold
253	A/D linearity test fails	Hold
254	flame bias can not be set in range	Hold
255	flame bias shorted to adjacent pin	Hold

Each alert log record has the format described in Table 38.

Table 38. R7910B Alert Log Record.

Byte Offset	Parameter	Read/Write	Format	Note
0-1	Alert code	R	U16	See Table 39.
2-5	Cycle	R	U32	See registers 128-129 (decimal).
6-9	Hours	R	U32	See registers 130-131 (decimal).
10	--	R	U8	Unused
11	Occurrence count	R	U8	Number of occurrences of most recent alert.

R7910B alert codes are contained in Table 39.

Table 39. R7910B Alert Codes.

Code	Description	Note
0	None	No alert
1	Alert PCB was restored from factory defaults	
2	Safety configuration parameters were restored from factory defaults	
3	Configuration parameters were restored from factory defaults	
4	Invalid Factory Invisibility PCB was detected	
5	Invalid Factory Range PCB was detected	
6	Invalid range PCB record has been dropped	
7	EEPROM lockout history was initialized	
8	Switched application annunciation data blocks	
9	Switched application configuration data blocks	
10	Configuration was restored from factory defaults	
11	Backup configuration settings was restored from active configuration	
12	Annunciation configuration was restored from factory defaults	
13	Annunciation configuration was restored from backup	
14-17	RESERVED	
18	Alarm silence time exceeded maximum	
19-26	RESERVED	
27	Safety processor was reset	
28	Application processor was reset	
29	Burner switch was turned OFF	
30	Burner switch was turned ON	
31	PIM was inserted into socket	
32	PIM was removed from socket	
33	Alert PCB was configured	
34	Parameter PCB was configured	
35	Range PCB was configured	
36	PIM incompatible with product was inserted into socket	
37	PIM application parameter revision differs from application processor	
38	PIM safety parameter revision differs from safety processor	
39	PCB incompatible with product contained in PIM	
40	Parameter PCB in PIM is too large for product	
41	Range PCB in PIM is too large for product	
42	Alert PCB in PIM is too large for product	
43	RESERVED	
44	Low voltage was detected in safety processor	

Table 39. R7910B Alert Codes. (Continued)

Code	Description	Note
45	High line frequency occurred	
46	Low line frequency occurred	
47	Invalid subsystem reset request occurred	
48	Write large enumerated Modbus register value was not allowed	
49	Maximum cycle count was reached	
50	Maximum hours count was reached	
51-58	RESERVED	
59	Burner control firing rate was > absolute max rate	
60	Burner control firing rate was < absolute min rate	
61	Burner control firing rate was invalid, % vs. RPM	
62	Burner control was firing with no fan request	
63	Burner control rate (nonfiring) was > absolute max rate	
64	Burner control rate (nonfiring) was < absolute min rate	
65	Burner control rate (nonfiring) was absent	
66	Burner control rate (nonfiring) was invalid, % vs. RPM	
67-74	RESERVED	
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	
82-89	RESERVED	
90	Modulation output type was invalid	
91	Firing rate control parameter was invalid	
92	Forced rate was out of range vs. min/max modulation	
93	Forced rate was invalid, % vs. RPM	
94	Slow start ramp value was invalid	
95	Slow start degrees value was invalid	
96	Slow start was ended due to outlet sensor fault	
97	Slow start was end due to reference setpoint fault	
98	CH max modulation rate was invalid, % vs. RPM	
99	CH max modulation rate was > absolute max rate	
100	CH Modulation range (max minus min) was too small	
101	DHW max modulation rate was invalid, % vs. RPM	
102	DHW max modulation rate was > absolute max rate	
103	DHW modulation range (max minus min) was too small	
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	
108-114	RESERVED	
115	Fan was limited to its Minimum Duty Cycle	
116	Manual rate was > CH max modulation rate	
118	Manual rate was < min modulation rate	

Table 39. R7910B Alert Codes. (Continued)

Code	Description	Note
119	Manual rate in Standby was > absolute max rate	
120	Modulation commanded rate was > CH max modulation rate	
121	Modulation commanded rate was > DHW max modulation rate	
122	Modulation commanded rate was < min modulation rate	
123-130	RESERVED	
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	
138-145	RESERVED	
146	CH control was suspended due to fault	
147	CH Header temperature was invalid	
148	CH Outlet temperature was invalid	
149-156	RESERVED	
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	
163-170	RESERVED	
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	
175-182	RESERVED	
183	LL P-gain was invalid	
184	LL I-gain was invalid	
185	LL D-gain was invalid	
186	LL OFF hysteresis was invalid	
187	LL ON hysteresis was invalid	
188	LL Slave enable was invalid	
189-203	RESERVED	
204	Lead Lag master was suspended due to fault	
205	Lead Lag slave was suspended due to fault	
206	LL header temperature was invalid	
207	Lead Lag was suspended due to no enabled PIM installed	
208-221	RESERVED	
222	CH frost protection temperature was invalid	
223	CH frost protection inlet temperature was invalid	
224	DHW frost protection temperature was invalid	
225-230	RESERVED	
231	LL setpoint was invalid	

Table 39. R7910B Alert Codes. (Continued)

Code	Description	Note
232	LL time of day setpoint was invalid	
233	LL outdoor temperature was invalid	
234	LL ODR time of day setpoint was invalid	
235	LL ODR time of day setpoint exceeded normal setpoint	
236	LL max outdoor setpoint was invalid	
237	LL min outdoor setpoint was invalid	
238	LL min water setpoint was invalid	
239	LL outdoor temperature range was too small	
240	LL water temperature range was too small	
241-245	RESERVED	
246	CH setpoint was invalid	
247	CH time of day setpoint was invalid	
248	CH outdoor temperature was invalid	
249	CH ODR time of day setpoint was invalid	
250	CH ODR time of day setpoint exceeds normal	
setpoint		
251	CH max outdoor setpoint was invalid	
252	CH min outdoor setpoint was invalid	
253	CH min water setpoint was invalid	
254	CH outdoor temperature range was too small	
255	CH water temperature range was too small	
256-260	RESERVED	
261	DHW setpoint was invalid	
262	DHW time of day setpoint was invalid	
263-274	RESERVED	
275	Abnormal Recycle: LCI off during Drive to Purge Rate	
276	Abnormal Recycle: LCI off during Measured Purge Time	
277	Abnormal Recycle: LCI off during Drive to Lightoff Rate	
278	Abnormal Recycle: LCI off during Pre-Ignition test	
279	Abnormal Recycle: LCI off during Pre-Ignition time	
280	Abnormal Recycle: LCI off during Main Flame Establishing Period	
281	Abnormal Recycle: LCI off during Ignition period	
282	Abnormal Recycle: Demand off during Drive to Purge Rate	
283	Abnormal Recycle: Demand off during Measured Purge Time	
284	Abnormal Recycle: Demand off during Drive to Lightoff Rate	
285	Abnormal Recycle: Demand off during Pre-Ignition test	
286	Abnormal Recycle: Demand off during Pre-Ignition time	
287	Abnormal Recycle: Flame was on during Safe Start check	
288	Abnormal Recycle: Flame was on during Drive to Purge Rate	
289	Abnormal Recycle: Flame was on during Measured Purge Time	
290	Abnormal Recycle: Flame was on during Drive to Lightoff Rate	
291	Abnormal Recycle: Flame was not on at end of Ignition period	
292	Abnormal Recycle: Flame was lost during Main Flame Establishing Period	
293	Abnormal Recycle: Flame was lost early in Run	
294	Abnormal Recycle: Flame was lost during Run	
295	Abnormal Recycle: Leakage test failed	

Table 39. R7910B Alert Codes. (Continued)

Code	Description	Note
296	Abnormal Recycle: Interrupted air flow switch was off during Drive to Lightoff Rate	
297	Abnormal Recycle: Interrupted air flow switch was off during Pre-Ignition test	
298	Abnormal Recycle: Interrupted air flow switch was off during Pre-Ignition time	
299	Abnormal Recycle: Interrupted air flow switch was off during Main Flame Establishing Period	
300	Abnormal Recycle: Ignition failed due to interrupted air flow switch was off	
301	Abnormal Recycle: ILK off during Drive to Lightoff Rate	
302	Abnormal Recycle: ILK off during Pre-Ignition test	
303	Abnormal Recycle: ILK off during Pre-Ignition time	
304	Abnormal Recycle: ILK off during Main Flame Establishing Period	
305	Abnormal Recycle: ILK off during Ignition period	
306-307	RESERVED	
308	Run was terminated due to interrupted air flow switch was off	
309	Not safe to start due to high limit	
310	Drive to Purge Rate failed due to high limit	
311	Measured Purge Time failed due to high limit	
312	Drive to Lightoff Rate failed due to high limit	
313	Pre-Ignition test failed due to high limit	
314	Pre-Ignition time failed due to high limit	
315	Main Flame Establishing Period failed due to high limit	
316	Ignition failed due to high limit	
317	Run was terminated due to high limit	
318	Stuck reset switch	
319-360	RESERVED	
361	Internal error: No factory parameters were detected in control	
362	Internal error: PID iteration frequency was invalid	
363	Internal error: Demand-Rate interval time was invalid	
364	Internal error: Factory calibration parameter for modulation was invalid	
365	Internal error: CH PID P-scaler was invalid	
366	Internal error: CH PID I-scaler was invalid	
367	Internal error: CH PID D-scaler was invalid	
368	Internal error: DHW PID P-scaler was invalid	
369	Internal error: DHW PID I-scaler was invalid	
370	Internal error: DHW PID D-scaler was invalid	
371	Internal error: Lead Lag master PID P-scaler was invalid	
372	Internal error: Lead Lag master PID I-scaler was invalid	
373	Internal error: Lead Lag master PID D-scaler was invalid	
374-466	RESERVED	
467	Internal error: EEPROM write was attempted before EEPROM was initialized	
468	Internal error: EEPROM cycle count address was invalid	
469	Internal error: EEPROM days count address was invalid	
470	Internal error: EEPROM hours count address was invalid	
471	Internal error: Lockout record EEPROM index was invalid	
472	Internal error: Request to write PIM status was invalid	
473	Internal error: PIM parameter address was invalid	

Table 39. R7910B Alert Codes. (Continued)

Code	Description	Note
474	Internal error: PIM safety parameter address was invalid	
475	Internal error: Invalid record in lockout history was removed	
476	Internal error: EEPROM write buffer was full	
477	Internal error: Data too large was not written to EEPROM	
478	Internal error: Safety key bit 0 was incorrect	
479	Internal error: Safety key bit 1 was incorrect	
480	Internal error: Safety key bit 2 was incorrect	
481	Internal error: Safety key bit 3 was incorrect	
482	Internal error: Safety key bit 4 was incorrect	
483	Internal error: Safety key bit 5 was incorrect	
484	Internal error: Safety key bit 6 was incorrect	
485	Internal error: Safety key bit 7 was incorrect	
486	Internal error: Safety key bit 8 was incorrect	
487	Internal error: Safety key bit 9 was incorrect	
488	Internal error: Safety key bit 10 was incorrect	
489	Internal error: Safety key bit 11 was incorrect	
490	Internal error: Safety key bit 12 was incorrect	
491	Internal error: Safety key bit 13 was incorrect	
492	Internal error: Safety key bit 14 was incorrect	
493	Internal error: Safety key bit 15 was incorrect	
494	Internal error: Safety relay timeout	
495	Internal error: Safety relay commanded off	
496	Internal error: Unknown safety error occurred	
497	Internal error: Safety timer was corrupt	
498	Internal error: Safety timer was expired	
499	Internal error: Safety timings	
500	Internal error: Safety shutdown	

Burner control states are contained in Table 40. Note that depending on selected burner performance characteristics, not all states will apply to a specific application.

Table 40. Burner Control States.

State	Name
0	Initiate
1	Standby Delay
2	Standby
3	Safe Startup
4	Prepurge - Drive to Purge Rate
5	Prepurge - Measured Purge Time
6	Prepurge - Drive to Lightoff Rate
7	Preignition Test
8	Preignition Time
9	Pilot Flame Establishing Period
10	Main Flame Establishing Period
11	Direct Burner Ignition

Table 40. Burner Control States. (Continued)

State	Name
12	Run
13	Postpurge
14	Lockout
255	Safety Processor Offline

R7910B pump status codes are contained in Table 41.

Table 41. Pump Status Codes.

Status	Description	Note
0	Unknown	
1	Not connected	
2	Not Lead Lag master	
3	Pump A Off	
4	Pump B Off	
5	Pump C Off	
6	Pump A Off - Anticondensation (CH demand)	
7	Pump B Off - Anticondensation (CH demand)	
8	Pump C Off - Anticondensation (CH demand)	
9	Pump A Off - Anticondensation (DHW demand)	
10	Pump B Off - Anticondensation (DHW demand)	
11	Pump C Off - Anticondensation (DHW demand)	
12	Pump A Off - Anticondensation (LL demand)	
13	Pump B Off - Anticondensation (LL demand)	
14	Pump C Off - Anticondensation (LL demand)	
15	Pump A On - Slave overrun	
16	Pump B On - Slave overrun	
17	Pump C On - Slave overrun	
18	Pump A On - LL master overrun	
19	Pump B On - LL master overrun	
20	Pump C On - LL master overrun	
21	Pump A Off - Start delay (DHW demand)	
22	Pump B Off - Start delay (DHW demand)	
23	Pump C Off - Start delay (DHW demand)	
24	Pump A On - CH demand	
25	Pump B On - CH demand	
26	Pump C On - CH demand	
27	Pump A On - CH frost protection	
28	Pump B On - CH frost protection	
29	Pump C On - CH frost protection	
30	Pump A On - DHW demand	
31	Pump B On - DHW demand	
32	Pump C On - DHW demand	
33	Pump A On - DHW frost protection	
34	Pump B On - DHW frost protection	
35	Pump C On - DHW frost protection	
36	Pump A Off - DHW high limit	

Table 41. Pump Status Codes. (Continued)

Status	Description	Note
37	Pump B Off - DHW high limit	
38	Pump C Off - DHW high limit	
39	Pump A On - Exercise	
40	Pump B On - Exercise	
41	Pump C On - Exercise	
42	Pump A On - Frost protection	
43	Pump B On - Frost protection	
44	Pump C On - Frost protection	
45	Pump A On - Lead Lag master demand	
46	Pump B On - Lead Lag master demand	
47	Pump C On - Lead Lag master demand	
48	Pump A On - Slave demand	
49	Pump B On - Slave demand	
50	Pump C On - Slave demand	
51	Pump A On - Manual	
52	Pump B On - Manual	
53	Pump C On - Manual	
54	Pump A On - Outlet high limit	
55	Pump B On - Outlet high limit	
56	Pump C On - Outlet high limit	
57	Pump A On - Overrun	
58	Pump B On - Overrun	
59	Pump C On - Overrun	
60	Pump A On - Frost protection overrun	
61	Pump B On - Frost protection overrun	
62	Pump C On - Frost protection overrun	

Register Writes

Writing to any data register may require an access level password. For those data registers requiring access security a password matching the one contained in the R7910B must be provided before the R7910B allows the data to be changed. A valid password login remains in effect for 10 minutes before another login is required (R7910B timeout for password login).

Two Modbus registers are defined to manage the register data access login:

- (0x00B1) Password
- (0x00B2) Register Access Status

The Modbus master writes a password into the Password register to request write access to the data registers. Even though this register is a holding register, and therefore should normally only accept a 16-bit value, it accepts alphanumeric text up to 30 characters in length. Due to this length change, this register must be written individually and not as part of a group register write.

Results of the login are reported by the R7910B in the Register Access Status register. If the Modbus master writes the correct installer password, the status register indicates this result and all data with installer access level and below can be changed. If the Modbus master writes the correct OEM password, the status register indicates this result and all data with OEM access level and below can be changed.

03 (0x03) Read Holding Registers

This function is used to read one or more consecutive data registers in the R7910B. The register address of the first register (see Table 33) in the range is included in the request along with the number of registers to read. R7910B returns a response with the starting register address, the number of bytes returned, followed by the register data contents in register address order (lowest register address first, etc.).

Normally, the number of bytes returned is 2 times the number of registers requested, because each register usually contains a 16-bit value. An exception to this rule is that registers representing variable length text data return the length of the text data, which can exceed 2 bytes.

06 (0x06) Write Single Register

This function is used to write data to a single register in the R7910B. The R7910B register address and 16-bit data value to write into the register are sent to the R7910B, and the R7910B returns an acknowledged response.

NOTE: This function (command) cannot be used for variable length text data registers.

16 (0x10) Write Multiple Registers

This function is used to write data into multiple R7910B registers with a single request. The R7910B registers must be located consecutively in the register map because only a base address is provided. The Modbus master provides the starting register address, the number of registers to write, the total number of bytes, followed by the actual data itself. The R7910B writes the data into each register and acknowledges the completion with a response echoing the number of registers written.

When writing text data to a register representing variable length text, the number of registers should be specified as one and the byte count be the number of bytes in the text data.

17 (0x11) Report Slave ID

This function is used to locate and identify the R7910Bs connected on the Global Modbus network. The Modbus master issues a Report Slave ID request for a specific Modbus address onto the Global Modbus network, and if an R7910B exists with the requested Modbus address, it responds to the request. If no R7910B exists, the Modbus master times out and concludes that no R7910B is present with that Modbus address.

Included in the R7910B response is the following data to further identify it:

- OS number
- Burner name

Format of the R7910B response message is depicted in Table 42.

Table 42. Report Slave ID Response

Byte: 0	1	2	3	4	5-20	21-40	41-42
Slave Address	**Function Code**	**Byte Count**	**Slave ID**	**Run Indicator**	**OS Number**	**Burner Name**	**CRC**
0x01-0xF0	0x11	0x30	0x79	0x00=OFF 0xFF=ON			

The OS number (up to 16 characters) and burner name (up to 20 characters) fields are NULL filled text strings. They have a fixed field length so that the boundaries of each field are known. These same R7910B parameters can be obtained with the Read Holding Register function.

The Run Indicator status contains an OFF status when the R7910B is in a lockout or unconfigured state. In any other case the status indicates an ON condition.

NOTE: A slave ID of 0x79 is reserved for all R7910B hydronic boiler control models at this time.

Exception Codes

The Modbus exception codes in Table 43 may be given by the R7910B in response to function code requests.

Table 43. Modbus Exception Codes.

Code	Name	Comment
0x01	ILLEGAL_FUNCTION	Illegal function code or action requested
0x02	ILLEGAL_DATA_ADDRESS	Register address out of bounds
0x03	ILLEGAL_DATA_VALUE	Data in register write is invalid for register
0x10	READ_MULTIPLE_NOT_OK	Exceeded maximum registers allowed in read
0x11	ACCESS_FAILURE	Invalid password access level for register
0x12	LOGIN_FAILURE	Unrecognized password given for login

Block Data Transfer

An internal Modbus interface exists to transfer blocks of data to/from the R7910B. This interface uses a bank of 16-bit holding registers on the Global Modbus port for the transfer. Holding registers are used to keep the Modbus interface simple on the Global Modbus port (limit the number of function codes supported).

Uses for this block data transfer is to move the following type of data:

- OEM Parameter PCB
- OEM Range PCB
- OEM Alert PCB

Data is transferred with 16-bit holding registers defined in Table 44. Data is transferred in blocks up to 32 bytes at a time. Sixteen consecutive holding registers are used as a data buffer to contain the data transferred. The holding register with the least significant Modbus address, 0x2004, contains the first 2 bytes of data with the first byte in the high order (most significant) bits (16-31), and the second byte in the low order (least significant) bits (0-15). The next 2 bytes of data are placed in Modbus address 0x2005, the next 2 bytes in 0x2006, etc. For example, see Fig. 26.

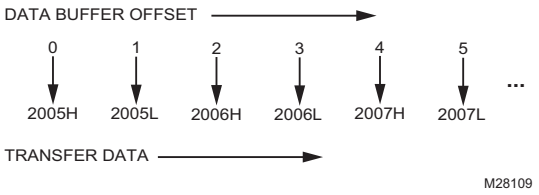

Fig. 26. Transfer data buffer.

Table 44. R7910B Block Data Transfer Register Map.

Address (hex)	Register (dec)	Parameter	Read/Write	Format	Note
2000	8192	Transfer Direction	R/W	U16	0=Download data into R7910B 1=Upload data from R7910B 2=Cancel transfer
2001	8193	Transfer Status	R	U16	0=No transfer 1=Transfer in progress 2=Transfer complete 3=Transfer failed 4=Illegal direction 5=Illegal transfer type 6=Illegal transfer size 7=Illegal transfer address
2002	8194	Transfer Type	R/W	U16	7=OEM Visibility PCB 8=OEM Range PCB 9=OEM Alarm PCB
2003	8195	Transfer Base Address	R/W	U16	Destination or source address for first data transfered
2004	8196	Transfer Size	R/W	U16	0-32
2005-2014	8197-8212	Transfer Data	R/W	U16	

Only 32 bytes can be transferred at a time because the R7910B keeps an internal buffer in application RAM to hold the data while the transfer is occurring.

The procedure to transfer data *to* the R7910B is:

1. Ensure that no transfer is currently in progress by the R7910B (look at Transfer Status). If so, cancel the transfer or wait.
2. Buffer first 2 bytes of data into 16-bit data with first byte in most significant 8 bits and next byte in least significant 8 bits.
3. Write 16-bit data into first Transfer Data register (address 0x2005).
4. Repeat steps 2 and 3 with next data pair written to next Transfer Data register (address 0x2006, etc.) until all data is written for this block.
5. Write number of bytes in this block to Transfer Size register.
6. Write destination address for first byte in block into Transfer Base Address register.
7. Write data type into Transfer Type register.
8. Write 0 (Download) to Transfer Direction register. This write starts actual download to begin (Transfer Status register should change to transfer in progress).
9. Read Transfer Status register until status indicates transfer is complete (or failed).
10. Repeat steps 2-8 for next block of data.

The procedure to transfer data *from* the R7910B is:

1. Ensure that no transfer is currently in progress by the R7910B (look at Transfer Status). If so, cancel the transfer or wait.
2. Write source address for first byte in R7910B into Transfer Base Address register.
3. Write total number of bytes to transfer into Transfer Size register (number must be less than 33).
4. Write data type into Transfer Type register.
5. Write 1 (Upload) to Transfer Direction register. This write starts actual upload to begin (Transfer Status register should change to transfer in progress).
6. Read Transfer Status register until status indicates transfer is complete (or failed).
7. Read Transfer Size register to get the actual number of data bytes transferred by the R7910B. Fewer data bytes may transfer than requested (end of block).
8. Read all Transfer Data registers starting with first one (address 0x2005) until enough have been read to get number of bytes transferred.

PARAMETER CONTROL BLOCK (PCB)

Parameter Control Block (PCB) files are used in the R7910B to customize the interface that the user has with the R7910B. Several PCB file types are defined for different customization purposes. The PCB files are maintained outside of the

R7910B and transferred to the R7910B using the download procedure defined above. The PCB files can be retrieved from the R7910B using the upload procedure defined above.

Each PCB specifies attributes for the public Modbus holding registers. These attributes differ from actually specifying the value of the registers, i.e., configuration parameter settings, but instead define how the register is used in the R7910B installation. These same attributes are uploaded into the Local and System displays when they initially communicate with the R7910B.

NOTE: Not all registers in the Modbus register map (see Table 33) are included in the PCB "public" register context. The status and configuration parameter registers from the beginning of the register map up to the end of the Lead Lag configuration group are within the PCB public context. Registers defined above them, e.g., Lockout History, Alert Log, etc., are outside the context of PCB files.

The PCB files are downloaded and uploaded using the Global Modbus block data transfer procedure. A PCB file is transferred in blocks up to 32 bytes at a time. For example, see Fig. 27.

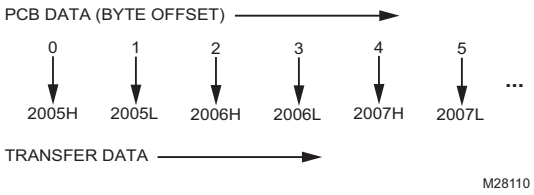

Fig. 27. PCB data transfer.

The PCB data is written to the Transfer Data registers, the number of bytes written is written into the Transfer Size register, and the relative byte offset into the PCB file is written into the Transfer Base Address register. The R7910B adds the byte offset onto an internal base address where it places the PCB file. A download data command is written into the Transfer Direction register to begin the PCB data transfer. Once the transfer is complete the next block in the PCB file is transferred until the complete PCB file is transferred.

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.

Fault codes and suggestions for troubleshooting are found in Table 45. Note that all potential faults may not apply to all models depending on features of the specific OS.

Table 45. Fault Code and Troubleshooting.

Code	Description	Recommended Troubleshooting of Lockout Codes
0	None	
1	Unconfigured safety data	1. Setup error, return to program mode and recheck. 2. If fault repeats, replace module.
2	Waiting for safety data verification	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.
3	Internal fault: Hardware fault	
4	Internal fault: Safety Relay key feedback error	
5	Internal fault: Unstable power (DCDC) output	
6	Internal fault: Invalid processor clock	
7	Internal fault: Safety relay drive error	
8	Internal fault: Zero crossing not detected	
9	Internal fault: Flame bias out of range	
10	Internal fault: Invalid Burner control state	
11	Internal fault: Invalid Burner control state flag	
12	Internal fault: Safety relay drive cap short	
13	Internal fault: PII shorted to ILK	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.
14	Internal fault: HFS shorted to LCI	
15	Internal fault: Safety Relay Test FB ON	
16	Internal fault: Safety Relay Test SR OFF	
17	Internal fault: Safety Relay Test SR not OFF	
18	Internal fault: Safety Relay Test FB not ON	
19	RESERVED	

Table 45. Fault Code and Troubleshooting. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes
20	Internal fault: Flame ripple and overflow	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.
21	Internal fault: Flame number of sample mismatch	
22	Internal fault: Flame bias out of range	
23	Internal fault: Bias changed since heating cycle starts	
24	Internal fault: Spark voltage stuck low or high	
25	Internal fault: Spark voltage changed too much during flame sensing time	
26	Internal fault: Static flame ripple	
27	Internal fault: Flame rod shorted to ground detected	
28	Internal fault: A/D linearity test fails	
29	Internal fault: Flame bias cannot be set in range	
30	Internal fault: Flame bias shorted to adjacent pin	
31	Internal fault: SLO electronics unknown error	
32-46	RESERVED	
47	Flame rod to ground leakage	1. Check the flame rod insulator for cracks. 2. Check for potential short of the flame rod to nearby ground or burner surface. 3. Check the leadwire for the potential of shorting to ground. 4. If steps 1-3 are correct and the fault persists, replace the module.
48	Static flame (not flickering)	1. Check the flame rod position to the flame - should be in outer area 2/3 of the flame. 2. Check for potential of other flame simulating conditions. 3. Check the leadwire for the potential of being pinched. 4. If steps 1-3 are correct and the fault persists, replace the module.
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.
50	Modulation fault	Internal sub-system fault. 1. Review alert messages for possible trends. 2. Correct possible problems. 3. If fault persists, replace module.
51	Pump fault	
52	Motor tachometer fault	
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.
54-60	RESERVED	
61	Anti short cycle	Will not be a lockout fault. Hold Only.
62	Fan speed not proved	
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.
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.

Table 45. Fault Code and Troubleshooting. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes
65	Interrupted Airflow Switch OFF	1. Check wiring and correct any faults. 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."
66	Interrupted Airflow Switch ON	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.
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 module."
68	ILK ON	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.
69	Pilot test hold	1. Verify Run/Test is changed to Run. 2. Reset Module. 3. If fault repeats, replace module.
70	Wait for leakage test completion	1. Internal Fault. Reset Module. 2. If fault repeats, replace module.
71-78	RESERVED	
	Outlet high limit	1. Check system pumps and valves to ensure proper water flow. 2. Check wiring and correct any possible errors. 3. Replace the Outlet high limit sensor. 4. Check Outlet high limit setting. 5. If previous steps are correct and fault persists, replace the module.
80	DHW high limit	1. Check system pumps and valves to ensure proper water flow. 2. Check wiring and correct any possible errors. 3. Replace the DHW high limit sensor. 4. Check DHW high limit setting. 5. If previous steps are correct and fault persists, replace the module.
81	Delta T limit	1. Check system pumps and valves to ensure proper water flow.
82	Stack limit	1. Check for blocked stack. 2. Check for proper water flow and boiler water temperature. 3. Check wiring and correct any possible errors. 4. Replace the Stack high limit. 5. If previous steps are correct and fault persists, replace the module.
83-90	RESERVED	
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.

Table 45. Fault Code and Troubleshooting. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes
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.
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.
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.
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.
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.
97-104	RESERVED	
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.
106	Flame lost in MFEP	1. Inspect the main fuel valve (s) and connection (s). 2. Make sure that the fuel pressure is high enough to supply fuel to the combustion chamber. 3. Make sure the flame detector is positioned to obtain the required flame signal strength. 4. Reset the module and recycle. 5. If fault persists, replace the module.
107	Flame lost early in run	1. Inspect the main fuel valve (s) and connection (s). 2. Make sure that the fuel pressure is high enough to supply fuel to the combustion chamber. 3. Make sure the flame detector is positioned to obtain the required flame signal strength. 4. Reset the module and recycle. 5. If fault persists, replace the module.
108	Flame lost in run	1. Inspect the main fuel valve (s) and connection (s). 2. Make sure that the fuel pressure is high enough to supply fuel to the combustion chamber. 3. Make sure the flame detector is positioned to obtain the required flame signal strength. 4. Reset the module and recycle. 5. If fault persists, replace the module.
109	Ignition failed	1. Check pilot valve (Main Valve for DSI) wiring and operation - correct any errors. 2. Check the fuel supply. 3. Check furl 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.

Table 45. Fault Code and Troubleshooting. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes
110	Ignition failure occurred	Will not be a lockout fault. Hold Only.
111	RESERVED	
112	Pilot test flame timeout	Interrupted Pilot or DSI application and flame lost when system in “test” mode. 1. Reset the module to restart.
113	Flame circuit timeout	Will not be a lockout fault. Hold Only.
114-121	RESERVED	
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.
123	Purge 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.
124	High fire switch OFF	1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function. 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.
125	High fire switch stuck ON	1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function. 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.
126	Low fire switch OFF	1. Check wiring and correct any potential wiring errors. 2. Check Low Fire Switch to assure proper function. 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.
127	Low fire switch stuck ON	1. Check wiring and correct any potential wiring errors. 2. Check Low Fire Switch to assure proper function. 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.
128-135	RESERVED	
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.
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.

Table 45. Fault Code and Troubleshooting. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes
138-148	RESERVED	
149	Flame detected	
150	High fire switch	1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function. 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.
151	High fire switch ON	1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function. 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.
152	Combustion pressure ON	
153	Standby purge fan switch	
154	Hold purge fan switch	
155	Combustion pressure/flame	
156	Combustion pressure ON	
157	High fire switch	1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function. 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.
158	Flame detected	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.
159	Main flame ignition	1. Inspect the main fuel valve (s) and connection (s). 2. Make sure that the fuel pressure is high enough to supply fuel to the combustion chamber. 3. Make sure the flame detector is positioned to obtain the required flame signal strength. 4. Reset the module, if fault persists, replace the module.
160	Main valve OFF	1. Check Main Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.
161	Ignition OFF	1. Check Ignition terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.
162	Main valve ON	1. Check Main Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.

Table 45. Fault Code and Troubleshooting. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes
163	Pilot valve ON	1. Check Pilot Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.
164	Ignition ON	1. Check Ignition terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.
165	Combustion pressure	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 module. 4. During Standby and Purge, measure the voltage across the switch. Supply voltage should be present. If not, the Combustion Pressure Switch is defective and needs replacing. 5. If the fault persists, replace the relay module.
166	No flame	
167	Purge fan switch ON	
168	Block intake	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.
169	Purge fan switch OFF	
170	Combustion pressure/flame	
171	Flame detected	
172	Main relay feedback incorrect	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.
173	Pilot relay feedback incorrect	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.
174	Safety relay feedback incorrect	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.
175	Safety relay open	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.
176-183	RESERVED	

Table 45. Fault Code and Troubleshooting. (Continued)

Code	Description	Recommended Troubleshooting of Lockout Codes
184	Invalid BLOWER/HSI output setting	1. Return to program mode and recheck. 2. If fault repeats, verify electrical grounding. 3. If fault repeats, replace module.
185	Invalid Delta T limit enable setting	
186	Invalid Delta T limit response setting	
187	Invalid DHW high limit enable setting	
188	Invalid DHW high limit response setting	
189	Invalid Flame sensor type setting	
190	Invalid interrupted air switch enable setting	
191	Invalid interrupted air switch start check enable setting	
192	Invalid Igniter on during setting	
193	Invalid Ignite failure delay setting	
194	Invalid Ignite failure response setting	
195	Invalid Ignite failure retries setting	
196	Invalid Ignition source setting	
197	Invalid Interlock open response setting	
198	Invalid Interlock start check setting	1. Return to program mode and recheck. 2. If fault repeats, verify electrical grounding. 3. If fault repeats, replace module.
199	Invalid LCI enable setting	
200	Invalid lightoff rate setting	
201	Invalid Lightoff rate proving setting	
202	Invalid Main Flame Establishing Period time setting	
203	Invalid MFEP flame failure response setting	
204	Invalid NTC sensor type setting	
205	Invalid Outlet high limit response setting	
206	Invalid Pilot Flame Establishing Period setting	
207	Invalid PII enable setting	
208	Invalid pilot test hold setting	
209	Invalid Pilot type setting	
210	Invalid Postpurge time setting	
211	Invalid Power up with lockout setting	
212	Invalid Preignition time setting	
213	Invalid Prepurge rate setting	
214	Invalid Prepurge time setting	
215	Invalid Purge rate proving setting	
216	Invalid Run flame failure response setting	
217	Invalid Run stabilization time setting	
218	Invalid Stack limit enable setting	
219	Invalid Stack limit response setting	
220	Unconfigured Delta T limit setpoint setting	
221	Unconfigured DHW high limit setpoint setting	
222	Unconfigured Outlet high limit setpoint setting	
223	Unconfigured Stack limit setpoint setting	
224-255	RESERVED	

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