Peerless® *PUREFIRE*® PFA-1 Interface Adapter Installation, Operation and Maintenance Manual

A. OVERVIEW

The PFA-1 Interface Adapter is designed to allow for electronic interface between the *PUREFIRE*® main control and other electronic devices.

1. **Alarm Output:**
    In the event of a blocking or locking error, the PFA-1 Interface adapter will provide a contact closure to signal an external device (alarm bell, phone dialer, etc.) of a problem.

2. **Analog Input:**
    The PFA-1 Interface Adapter will accept an analog input of 0-10VDC. This analog signal can be used to control Setpoint Temperature or Gas Input Rate. This signal is typically provided by a Building Automation system. For Cascade installations, only one PFA-1 Adapter is required per cascade system to control the System Setpoint. If Analog control of Gas Input is required, one InterFace Adapter is required per boiler.

3. **Modbus Interface:**
    The PFA-1 Interface Adapter allows external access to boiler status information using MODBUS RTU protocol. This provides remote access to Temperatures, Operating Status and Error Information as applicable.

    One PFA-1 control is required for each boiler to which Modbus communication is desired. In a multiple boiler cascade control configuration, each boiler must be equipped with a PFA-1 Interface Control to allow full communication.

    a. <u>Temperatures</u>: Supply, Return, DHW and Vent Temperatures can be monitored. In addition, the System Temperature in a multiple boiler (cascade) system can be accessed.

    b. <u>Operating Status</u>: The boiler status can be monitored to determine if the boiler is in Standby, Prepurge, Ignition, Firing, Postpurge or Alarm conditions. It can also indicate if it is satisfying a central heating (CH) or domestic hot water (DHW) demand.

    c. <u>Error Information</u>: If the boiler is in a lockout or blocking error, the interface will allow access to the error code.

B. PRE-INSTALLATION

1. PF-200, PF-210, PF-300, and PF-399 boilers come equipped with pre-wired harnesses to connect to the PFA-1 Interface Adapter. If modbus is required, two additional wires (provided with kit) must be connected as shown below.

2. To connect to the PF-50, PF-80, PF-110 or PF-140 boilers, harnesses (supplied with the PFA-1 Interface Adapter) are required.

3. For stand alone boilers, one PFA-1 Interface Adapter is required for each unit. For multiple boiler installations, one PFA-1 Interface Adapter will provide Alarm information, Setpoint control, and/or Modbus interface for the system. If individual boiler information is required, an interface unit is required for each of them.

4. The PFA-1 Interface Adapter is designed to fit within the *PUREFIRE*® boiler jacket. This manual will provide suggested mounting locations and wiring diagrams.

C. INSTALLATION

1. Figure 1 shows the suggested mounting location for the PFA-1 Interface Adapter on the PF-50, PF-80, PF-110 and PF-140 boilers.

    •   These boilers require a PFA-1 Harness Adapter Kit (provided) to connect to the boiler.
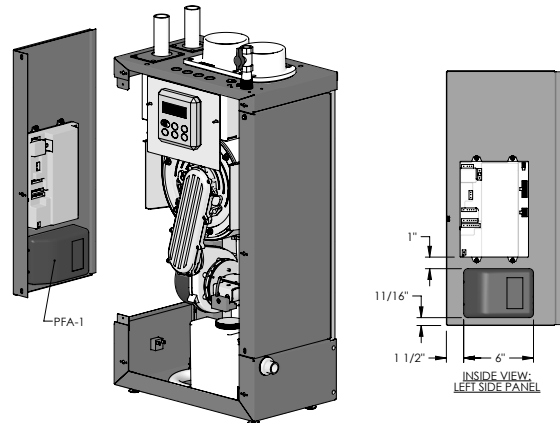

Figure 1

2. Figure 2 shows the suggested mounting location for the PFA-1 Interface Adapter on the PF-200, PF-210, PF-300, and PF-399 boilers.

    •   These boilers come with pre-wired harnesses for connection of the adapter. If modbus is required, two additional wires (provided with kit) must be connected as shown below.
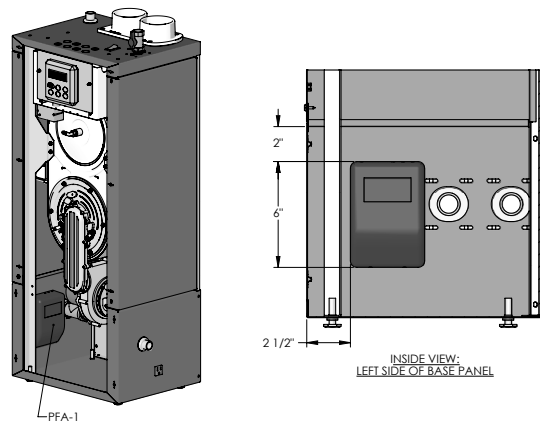

Figure 2

3. Attach PFA-1 Adapter to jacket panel using adhesive-backed Velcro provided with the kit.

D. ELECTRICAL - WIRING

1. Figure 3 shows customer wiring connections for the PFA-1 Interface Board.

2. PF-200, PF-210, PF-300, and PF-399 boilers are equipped with harnesses that provide power and communication to the Interface Board, and alarm contact output to the boiler terminal strip. Connect alarm to boiler terminal strip.

3. **Analog Input (where used):**

   a. For the PF-200, PF-210, PF-300, and PF-399, connect the analog input device to terminals #15 (-) and #16 (+) on the boiler terminal strip located behind the remote control display.

   b. For the PF-50, PF-80, PF-110, and PF-140 boilers, connect the analog input device to the red wires from the J5 connector of the Interface Adapter. Be sure that these wires are connected with the proper polarity.

E. OPERATION - ALARM CONTACTS

Alarm Output:

a. The alarm output is a normally open dry contact. If an error is sensed in one of the attached boilers, the Alarm Output contact closes.

b. This output can be used with either line voltage or 24 volts to power a lamp, buzzer, phone dialer or building management system.

F. OPERATION - ANALOG INPUT

For external control of setpoint temperature or input rate of a *PUREFIRE*® Boiler, a 2-10 volt dc analog signal is to be applied as shown in Figure 3 to the analog input wires.

NOTICE

If the Analog Input is not connected and there is no connection between the red and red/white Analog Input wire, the default input voltage is 2.5 Vdc. Therefore, the boiler will likely run without an Analog Input signal. In this case, all of the standard limits and safety switches will continue to function properly.

1. **Analog Input at Setpoint:**
   Input voltage below 2 volts dc will disable boiler operation. 2 volts corresponds to a boiler setpoint temperature of 60°F and 10 volts corresponds to a boiler setpoint temperature of 200°F. Input voltage between 2 and 10 volts will result in a boiler setpoint temperature proportional to the difference between the 2 volt temperature and the 10 volt temperature. For example, an input of 6 volts will result in a boiler setpoint temperature of 130°F.
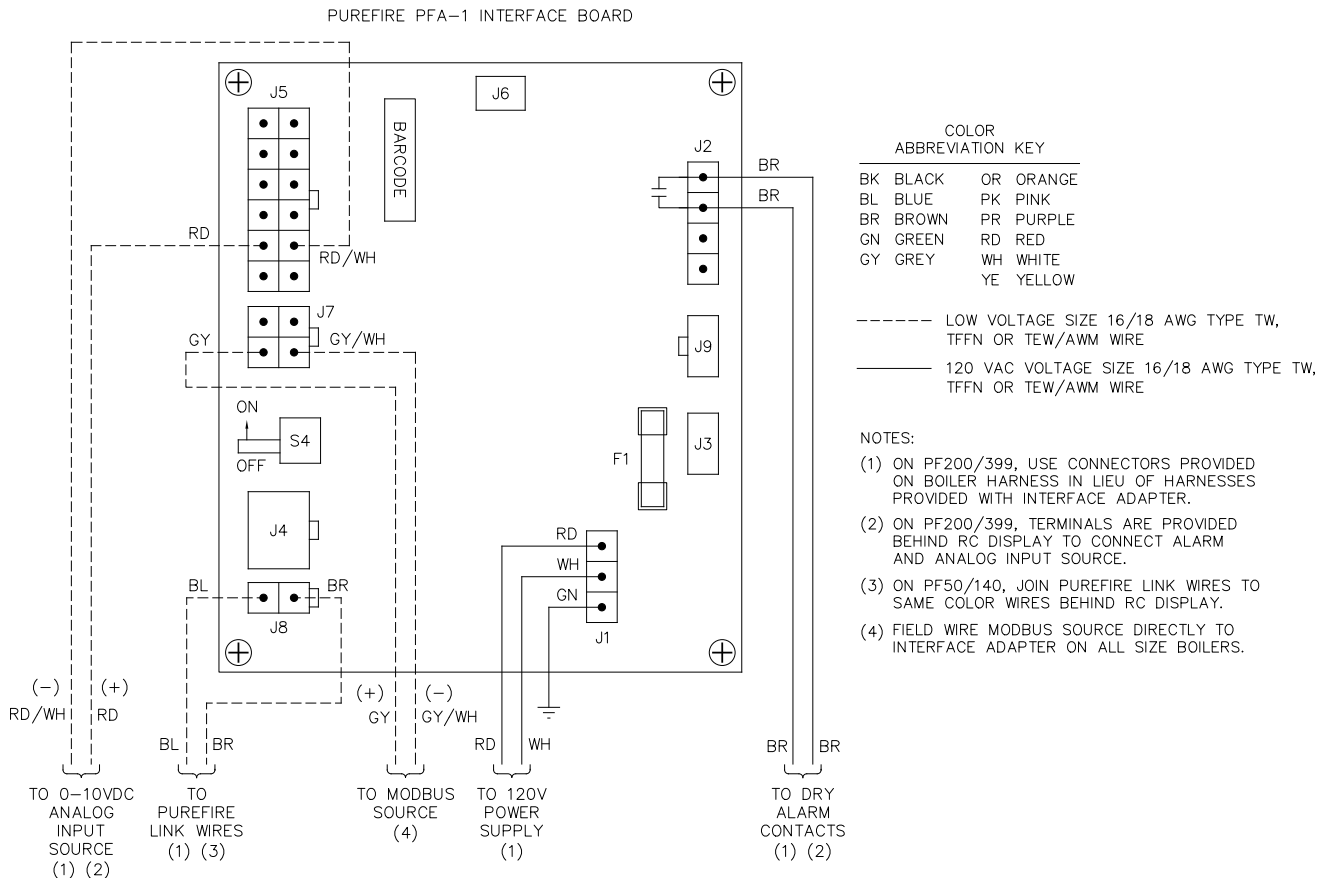

Figure 3: Electrical Wiring

2. **Analog Input of Rate:**
   Input voltage below 2 volts dc will disable boiler operation. 2 volts corresponds to minimum boiler input which will display as 1% Input on the RC Display (see boiler manual for minimum input ratings). 10 volts corresponds to maximum boiler input, and voltages in between will linearly adjust the input rate.

G. OPERATION - MODBUS INTERFACE

1. **Modbus Configuration:**
   The table below summarizes the Modbus configuration details:

2. **Modbus Holding Registers:**
   Modbus communicates using "words" (the contents of 16 bit holding registers). The PFA-1 Interface Adapter organizes the data in read-only holding registers. Table 2 shows the information that is available for reading and the address of the holding registers. Depending on the type of Modbus software used, the holding register addressing range starts at either 0x0000 or 0x0001.

   The values of STATE and ERROR_NUMBER can be used to determine whether the boiler control is operating correctly, not communicating or in an error state.

Table 1

Modbus Configuration Specifications	
Protocol	Modbus RTU
Default Address	0x01 (settable with SiteVision)
Supported Commands	• Read Holding Registers (0x03)* • Write Single Holding Register (0x06)
Baud Rate	9600 bps
Data Length	8 bits
Parity	None
Stop Bits	1
Physical Layer	RS485 (2 wire)
Modbus 1 A Connection	J7-1
Modbus 2 A Connection	J7-3
Buffer Size	8 Registers Per Frame

Table 2

Modbus Holding Registers (Read Only)					
Item Index		**Parameter Name**	**Address & Holding Registers**		**Notes**
Word	**byte**		**Range Start 0x0000**	**Range Start 0x0001**	
0 High byte	0	STATE	0x0000	0x0001	See Table 3
0 Low byte	1	STATUS	0x0000	0x0001	See Table 4
2 High byte	2	ERROR_NUMBER	0x0002	0x0003	See Table 6A and 6B
2 Low byte	3	WARNING_NUMBER	0x0002	0x0003	See Table 7
4 High byte	4	FLOW_TEMP*	0x0004	0x0005	$^oC = \dfrac{byte\ value}{2} - 10$ $^oF = \dfrac{^oC \times 9}{5} + 32$
4 Low byte	5	RETURN_TEMP	0x0004	0x0005	
6 High byte	6	DHW_TEMP	0x0006	0x0007	
6 Low byte	7	FLUE_TEMP	0x0006	0x0007	
8 High byte	8	NOT USED	0x0008	0x0009	
8 Low byte	9	NOT USED	0x0008	0x0009	
10 High byte	10	APPLIANCE_TYPE	0x000A	0x000B	—
10 Low byte	11	CONTROL_CONFIG_BYTE	0x000A	0x000B	—
12 High byte	12	CH_MODE	0x000C	0x000D	—
12 Low byte	13	DHW_MODE	0x000C	0x000D	—
14 High byte	14	CH_SETPOINT	0x000E	0x000F	—
14 Low byte	15	DHW_SETPOINT	0x000E	0x000F	—
* FLOW_TEMP is the boiler supply (outlet) water temperature.					

To read these values, issue a Modbus command to read a holding register. For example, if a command is issued to read 0x0000 the resulting, unsigned word may read, "0x090F". The high byte for this word is "0x09". Table 3 shows that this value indicates that the burner is on. The low byte for this word is "0x0F". This indicates that the boiler is on as a result of the freeze protection algorithm as shown in Table 4.

Table 3

Control State Descriptions			
STATE		State Name	Description
Decimal	Hexadecimal		
0	0x00	RESET_0	Initialization
1	0x01	RESET_1	Initialization
2	0x02	STANDBY_0	Standby Waiting for Heat Demand
3	0x03	SAFETY_ON	Ignition Sequence
4	0x04	SAFETY_OFF	Ignition Sequence
5	0x05	PRE_PURGE	Ignition Sequence
6	0x06	PRE_PURGE_1	Ignition Sequence
7	0x07	IGNIT_0	Ignition Sequence
8	0x08	IGNIT_1	Ignition Sequence
9	0x09	BURN_0	Folllowing Boiler Demand
10	0x0A	POST_PURGE_0	Purging Combustion Chamber
11	0X0B	POST_PURGE_1	Purging Combustion Chamber
12	0x0C	PUMP_CH_0	Following CH Demand w/o Heat Input
13	0x0D	PUMP_CH_1	Post Purge Pumping after CH Demand
14	0x0E	PUMP_HW_0	Following DHW Demand w/o Heat Input
15	0x0F	PUMP_HW_1	Post Purge Pumping after DHW Demand
16	0x10	ALARM_1	Error Handling
17	0x11	ERROR_CHECK	Error Handling
18	0x12	BURNER_BOOT	Controller (re)start
19	0x13	CLEAR_E2PROM_ERROR	Error Handling
20	0x14	STORE_BLOCK_ERROR	Error Handling
21	0x15	WAIT_A_SECOND	Error Handling

The following example describes how to read the temperature holding registers (byte 4-7 and 14-15). The boiler supply and return temperatures can be read by issuing a Modbus command to read holding register "0x0004". If the word value returned is "0x1D17", then we know that the high byte is "0x1D" and the low byte is "0x17". Converting 1D to decimal, we get 29. Using the formula above to convert to degrees Celsius we get, 4.5°C (40°F). Similarly, the return temperature is found by converting the hexadecimal 17 to decimal 23. Using the formula above, this is equivalent to 1.5°C (35°F).

Table 4

Control State Descriptions			
STATE		State Name	Description
Decimal	Hexadecimal		
0	0x00	STANDBY	Standby Waiting for Heat Demand
14	0x0E	BLOCK	Error Handling
10	0x0A	ALARM	Error Handling
15	0x0F	FROST_PROTECT	Freeze Protection Demand
16	0x10	CH	Central Heating Demand
17	0x11	RESET_STATE	Initializing
18	0x12	STORAGE	DHW Demand
19	0x13	Not Applicable	Not Applicable
20	0x14	Not Applicable	Not Applicable
21	0x15	STORE_WARM_HOLD	DHW Demand (Store Warm Hold)

Table 5

Determination of General Control Status		
Control Status	STATE Value	ERROR_NUMBER Value
Control is not Communicating Properly	0x00	0x00
Control is Operating Correctly with No Errors	Not 0x00	0xFF
Control is Operating Correctly with Errors	Not 0x00	Not 0xFF

Table 6A describes the ERROR_NUMBER values for Lockout Errors. These are errors that require a manual reset to continue boiler operation. Table 6B describes the ERROR_NUMBER values for Blocking Errors. Blocking errors are conditions that allow the boiler to continue operation as soon as the condition is corrected.

Table 7 shows values for the WARNING_NUMBER holding register. These conditions primarily concern the operation of sensors.

If multiple errors are present, the lowest number error will be communicated.

Table 6A

ERROR_NUMBER (Lockout Errors)			
Error Number		Error Designation	Description
Decimal	Hexadecimal		
0	0x00	E2PROM_READ_ERROR	Internal Software Error
1	0x01	IGNIT+ERROR	3 Consecutive Failed Ignition Attempts
5	0x05	GV_RELAY_ERROR	Gas Valve Relay Problems
6	0x06	SAFETY_RELAY_ERROR	Internal Control Error
8	0x08	FAN_ERROR	Incorrect Fan Speed
9	0x09	RAM_ERROR	Internal Control Error
10	0x0A	WRONG_EEPROM_SIGNATURE	Internal Control Error
11	0x0B	RETURN_HIGHER_THAN_SUPPLY	Boiler Return Tempurature Higher Than Supply
12	0x0C	E2PROM_ERROR	Internal Control Error
13	0x0D	STATE_ERROR	Internal Control Error
14	0x0E	ROM_ERROR	Internal Control Error
15	0X0F	AIR_SWITCH_NOT_OPEN	Internal Control Error
16	0x10	15MS_XRL_ERROR	Internal Control Error
17	0x11	AIR_SWITCH_NOT_OPEN	Internal Control Error
18	0x12	T_MAX_LOCK_ERROR	High Temperature Limit Open
19	0x13	STACK_ERROR	Internal Control Error
20	0x14	FLAME_OUT_TOO_LATE_ERROR	False Flame Detected After Shutdown
21	0x15	FLAME_ERROR_1	False Flame Detected Before Ignition
22	0x16	20MS_XRL_ERROR	Internal Control Error
23	0x17	41MS_ERROR	Internal Control Error
24	0x18	TOO_MANY_FLAME_FAILURES	3 Consecutive Flame Failures
25	0x19	FLOW_SWITCH_NOT_CLOSED	Flow Switch Open / Circulator Off
26	0x1A	FLOW_SWITCH_NOT_OPEN	Flow Switch Closed / Circulator On
27	0x1B	FLAG_BYTE_INTEGRITY_ERROR	Internal Control Error
28	0x1C	AD_HI_CPL_ERROR	Internal Control Error
29	0x1D	AD_LO_CPL_ERROR	Internal Control Error
30	0x1E	REGISTER_ERROR	Internal Control Error

Table 6B

ERROR_NUMBER (Blocking Errors)			
Error Number		Error Designation	Description
Decimal	Hexadecimal		
31	0x1F	REFHI_TOO_LO_ERROR	Internal Software Error
32	0x20	REFHI_TOO_HI_ERROR	Internal Software Error
33	0x21	REFLO_TOO_LO_ERROR	Internal Software Error
34	0x22	REFLO_TOO_HI_ERROR	Internal Software Error
35	0x23	FLAME_ERROR_2	False Flame Detected
36	0x24	LOW_WATER_CUTOFF_ERROR	Low Water Cutoff
39	0x27	FLUE_GAS_ERROR	High Vent Temperature
40	0x28	RETURN_TEMP_ERROR	High Return Temperature (>194°F; >90°C)
41	0x29	BLOCKED_DRAIN_ERROR	Blocked Condensate Drain
43	0x2B	WD_50HZ_ERROR	Poor Ground Connection
44	0x2C	PHASE_ERROR	Hot & Neutral Legs Reversed
45	0x2D	NET_FREQ_ERROR	Frequency ? 60 Hz ? 1.2 Hz
46	0x2E	FAULTY_EARTH_ERROR	Poor Ground Connection
47	0x2F	WD_COMMUNICATION_ERROR	Internal Hardware Error
51	0x33	T_SUPPLY_OPEN	Supply Sensor Not Connected
52	0x34	T_RETURN_OPEN	Return Sensor Not Connected
55	0x37	T_DHW_OUT_OPEN	DHW Sensor Not Connected
56	0x38	T_SYSTEM_OPEN	System Sensor Not Connected
57	0x39	T_FLUE_OPEN	Flue Sensor Not Connected
59	0x3B	T_SUPPLY_SHORTED	Supply Sensor Shorted
60	0x3C	T_RETURN_SHORTED	Return Sensor Shorted
63	0x3F	T_DHW_OUT_SHORTED	DHW Sensor Shorted
64	0x40	T_SYSTEM_SHORTED	System Sensor Shorted
65	0x41	T_FLUE_SHORTED	Flue Sensor Shorted
66	0x42	RESET_BUTTON_ERROR	Reset Button Activated 7 Times in 1 Minute

Table 7

WARNING_NUMBER			
Decimal	Hexadecimal	Error Designation	Description
1	0X01	T_OUTDOOR_SHORTED_WARNING	Outdoor Sensor Shorted
2	0X02	T_DHW_OUT_OPEN_WARNING	DHW Sensor Not Contected
3	0X03	T_DHW_OUT_SHORTED_WARNING	DHW Sensor Shorted
4	0X04	FLUE_SENSOR_OPEN	Flue Sensor Not Connected
255	0XFF	NO_WARNING	All Sensors Operating Correctly

3. **Modbus Holding Registers (Read/Write):**
The PFA-1 control has holding registers that allow CH and DHW Setpoints to be written using Modbus commands. Table 8 shows the Modbus Holding Registers for Read/Write Control.

4. **Controlling Main Board Parameters:**
a. To change the CH setpoint:

- Boiler must be set to CH Mode 0 or 3.
Issue a Modbus Write single holding register command that writes 0x0002 to the R/W control register located at 0x001A to switch the CH setpoint reading to writing.

- Calculate the scaled setpoint as follows:
(°C+10)x2x256=scaled value

- Issue a Modbus Write single holding register command to rite the scaled temperature setpoint value to the 0x001E holding register.

b. To change the DHW setpoint:

- Issue a Modbus Write single holding register command that writes 0x0001 to the R/W control register located at 0x001A to switch the CH setpoint reading to writing.

- Calculate the scaled setpoint as follows:
(°C+10) x 2 = scaled value

- Issue a Modbus Write single holding register command to write the scaled temperature setpoint value to the 0x001E holding register.

Table 8

Modbus Holding Registers (Read/Write)					
Item Index		Parameter Name	Address & Holding Registers		Notes
Word	byte		Range Start 0x0000	Range Start 0x0001	
10 High byte	10	R/W control	0x001A	0x001B	(°C + 10) x 2 = byte value
10 Low byte	11	R/W control	0x001A	0x001B	
14 High byte	14	CH_SETPOINT	0x001E	0x001F	$(°F - 32) \times \frac{5}{9} = °C$
14 Low byte	15	DHW_SETPOINT	0x001E	0x001F	

NOTICE

If no Modbus command is sensed for more than 4.25 seconds after the Write Command is issued, the control resets and the command must be re-issued to change the setpoint.

NOTICE

If an invalid value is written after the Write Command is issued, the control resets and the command must be re-issued to change the setpoint.

NOTICE

Modbus setpoints are maintained in volatile memory. Therefore, if the control must be reset due to an lockout error, a new value for CH and DHW must be written through Modbus. If this is not done, the control will default to the last value saved for each of these parameters.

NOTICE

The *PUREFIRE®* main control resets automatically every 24 hours. This will reset the CH and DHW setpoint values to the last value saved for each of these parameters. A new Modbus command should be issued periodically for each setpoint to be sure that the control is targeting the correct temperature.

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