PF2100 USER MANUAL REV 1.8.1
BURNER MANAGEMENT SYSTEM

WARNINGS

THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS 1, DIVISION 2, GROUPS ABCD OR NON-HAZARDOUS LOCATIONS ONLY.

WARNING: EXPLOSION HAZARD
DO NOT DISCONNECT WHILE CIRCUIT IS LIVE UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS OR EQUIVALENT

WARNING: EXPLOSION HAZARD
SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1, DIVISION 2.

DO NOT SERVICE UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS

DO NOT OPEN WHEN ENERGIZED

INSTALLATION & USE MUST CONFORM TO THE DIRECTIONS IN THIS MANUAL

SYSTEM MUST BE PROPERLY CONNECTED TO EARTH-GROUND FOR EFFECTIVE OPERATION OF FLAME DETECTION CIRCUITRY

ELECTRICAL DEVICES CONNECTED TO THE CONTROLLER MUST MEET CERTAIN ELECTRICAL STANDARDS AND BE WITHIN VOLTAGE LIMITS

REPLACEMENT FUSES MUST BE CERAMIC AND OF CORRECT RATING

HW & FW VERSIONING

This version of the manual was written for use with PF2100 systems that have the following hardware and firmware versions.

ITEM	HW VERSION	FW VERSION	
Door Card	v1.71	E1.8.115	
Terminal Card	v1.7	E1.8.101	
4-20mA Card	v3.0	v4.0 / v4.1	
Modbus Card	v2.0	v4.0 / v4.1	

System hardware and firmware versions can be found printed on separate labels inside of the enclosure on each circuit board. (Sections 1.5, 2.4)

Please refer to the Profire Energy Inc. website for the latest documentation.

APPROVALS

CSA 22.2 No. 199-2007
ANSI Z21.20-2007
UL1998-2004

Class 1, Div 2
Grp ABCD
CSA Type 4x

CSA C22.2 No. 0-M91
CSA C22.2 No. 0.4-04
CSA C22.2 No. 94-91
CSA C22.2 No. 142-M1987
CSA C22.2 No. 213-M1987
CSA E60079-0:2007
CSA E60079-15:2005
UL 508, 17th Edition
ANSI-ISA-12.12.01-2007
UL 60079-0:2005
UL 60079-15:2002

C SA US
MC#248705

1 Overview

The PF2100 BMS (Burner Management System) is an electronic control and monitoring system designed for use on a wide array of natural draft burner industrial applications. It provides electronic pilot ignition, flame detection, temperature control, and remote monitoring. In addition to being an extremely useful tool, it improves safety by preventing the flame from being lit under unsafe conditions.

1.1 Available Models

The PF2100 is available in two configurations: **BASE MODEL** and **INTERNAL COIL MODEL**.

The Base Model is for use with externally mounted ignition coils. This is useful when the controller must be mounted more than 5m (15ft) away from the burner. An external ignition coil can be purchased separately from Profire for use with this model.

The Internal Coil model includes a built-in ignition coil and can be used whenever the controller can be mounted less than 5m (15ft) away from the burner.

Both of these models can be further enhanced by adding one of two optional expansion cards:

      4-20mA Expansion Card (**1PS166**)
      Modbus Expansion Card (**1PS167**)

BASE MODELS

E0000   Base Model
E0400   Base Model with 4-20mA Expansion Card
E0M00   Base Model with Modbus Expansion Card
E04M0   Base Model with 4-20mA Expansion Card
            and Modbus Expansion Card

INTERNAL COIL MODELS

EC000   Internal Coil Model
EC400   Internal Coil Model with 4-20mA Expansion Card
ECM00   Internal Coil Model with Modbus Expansion Card
EC4M0   Internal Coil Model with 4-20mA Expansion Card
            and Modbus Expansion Card

1.2 Included Components

The PF2100 comes packaged with the following (varies across models). If any components are missing, contact Profire immediately.

CODE	DESCRIPTION	E0000	E0400	E0M00	E04M0	EC000	EC400	ECM00	EC4M0
A	PF2100	•	•	•	•	•	•	•	•
B	Mounting Brackets & Screws	•	•	•	•	•	•	•	•
C	Instruction Manual (If Requested*)	*	*	*	*	*	*	*	*
D	Internal Coil					•	•	•	•
E	Ferrules (2)					•	•	•	•
F	Straight Silicone Boots (2)					•	•	•	•
G	Ignition Cable (20ft)					•	•	•	•
H	4-20mA Expansion Card		•		•		•		•
I	Modbus Expansion Card			•	•			•	•
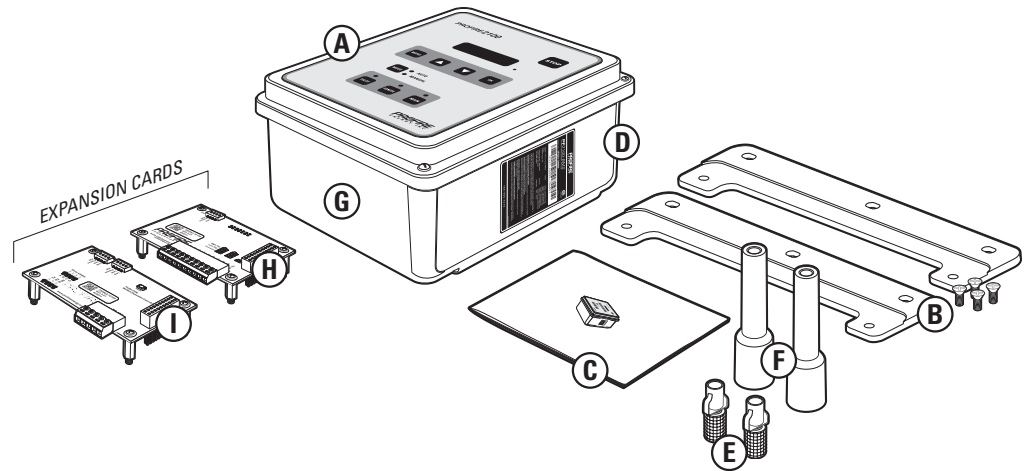
1.3 Optional Components

The following components may be required to install the PF2100 but are not included with the system. Profire offers some of these components for sale individually and also in various kits.

Please contact Profire Sales for further information.

1. **MOUNTING HARDWARE**
   - Channel Bar
   - Conduit Ports
   - Liquid Tight Ports
   - Rubber Grommets

2. **WIRE**
   - Ignition Wire
   - Thermocouple Wire

3. **RODS AND CONNECTORS**
   - Kanthal Ignition Rods (Various Lengths)

4. **VALVES**
   - DC Solenoids
   - Safety Valves with Proof of Closure
   - Proportional Valves

5. **THERMOCOUPLES**
   - Single, Type K
   - Dual Element, Type K

6. **PILOT ASSEMBLY**
   - Nozzles
   - Brackets
   - Mixers
   - Orifices

7. **AUTONOMY**
   - Batteries
   - Solar Chargers
   - Solar Panels

8. **ACCESSORIES**
   - 4-20mA Expansion Cards
   - Modbus Expansion Cards
   - External Ignition Coils

1.4 External Diagram

DOOR & KEYPAD

ENCLOSURE

SERIAL / MODEL LABEL

1.5 Internal Diagram

HW SERIAL / VERSION LABEL

KEYPAD FLEX CABLE

DOOR CARD

TERMINAL CARD

FW VERSION LABEL

RIBBON CABLE
(DOOR TO TERMINAL)

MODBUS CARD
(OPTIONAL)

4-20mA CARD
(OPTIONAL)

INTERNAL COIL
(OPTIONAL)

PROPARE
PF2100-BMS
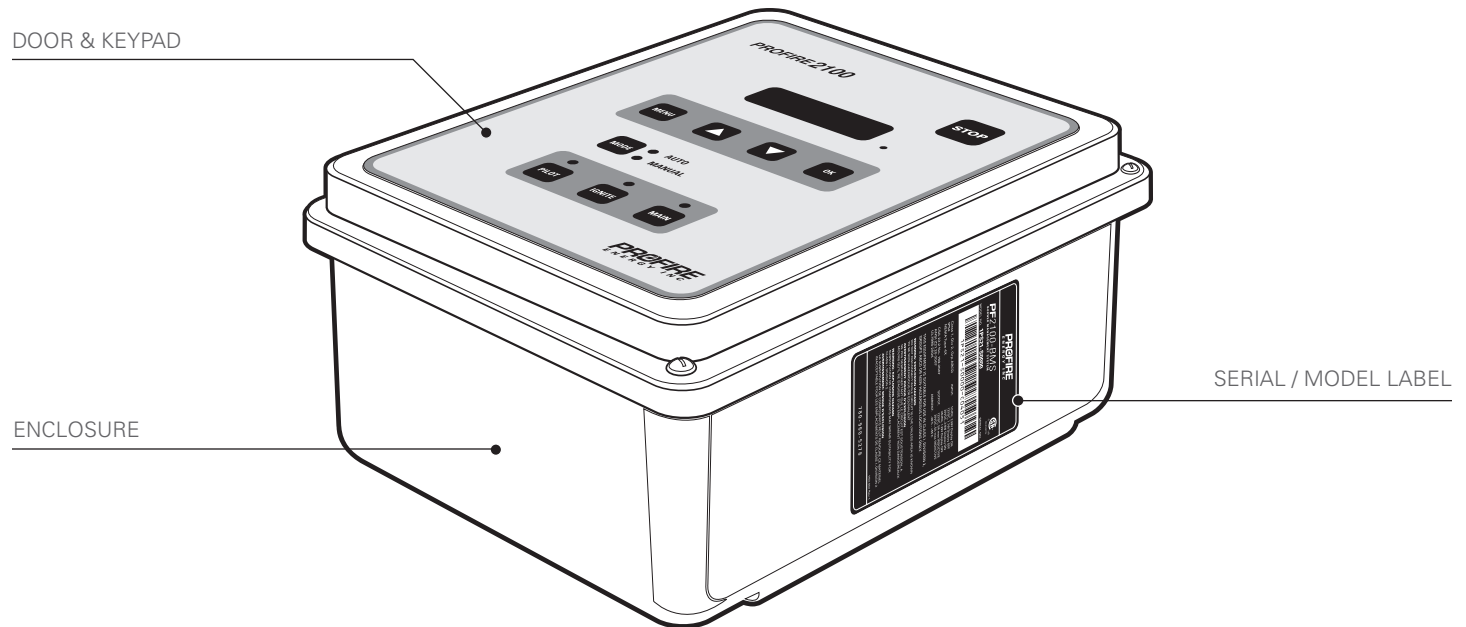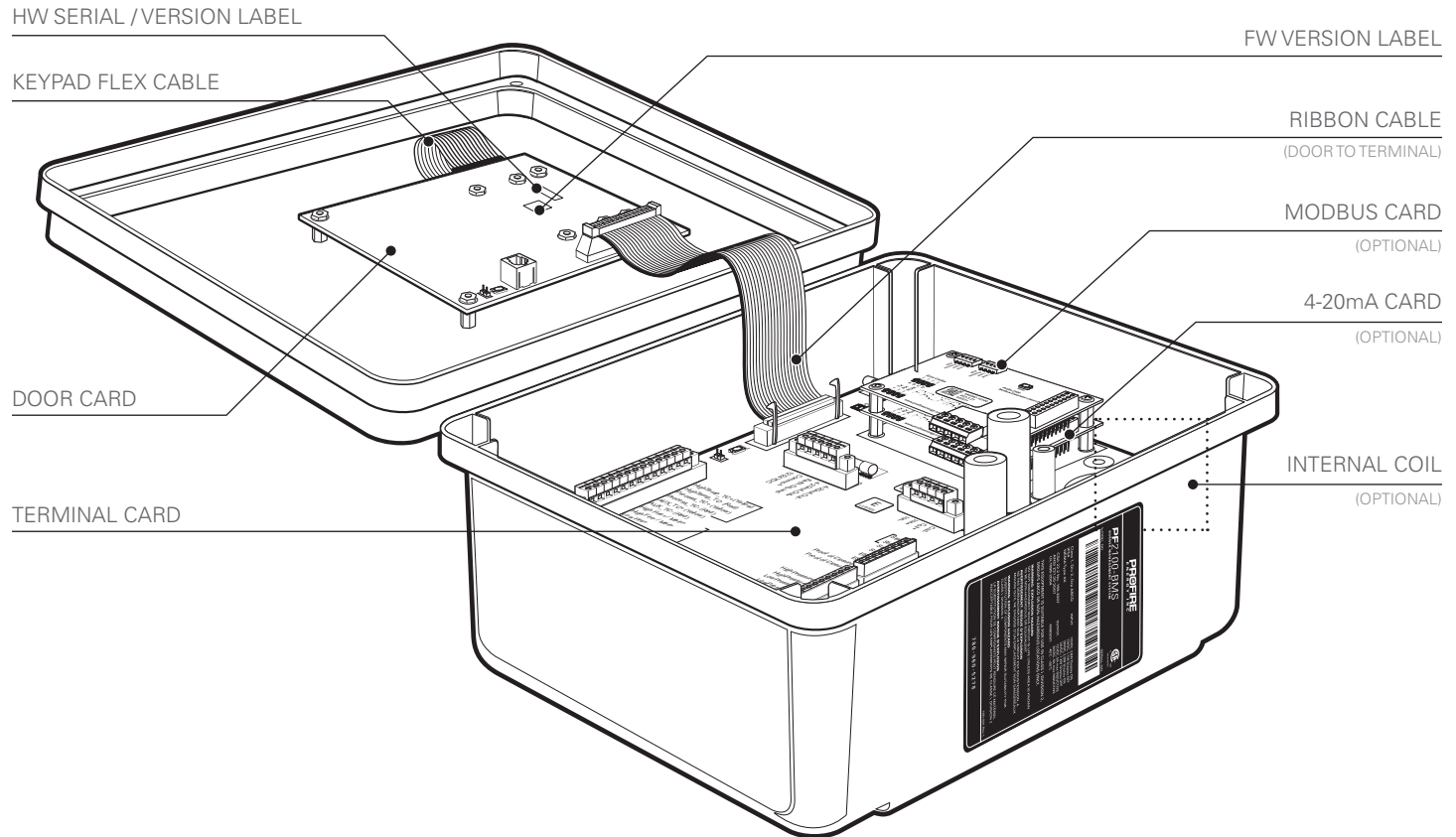
1.6 Installation Types

Below are examples of some of the many applications that the PF2100 can be used in.

1. Line Heater	**4.** Tank Heater	**7.** Gas Production Unit
2. Dehydrator	**5.** Separator	**8.** Amine Reboiler
3. Combustor	**6.** Treater	**9.** Thermal Oxidizer

1.7 Regulatory Requirements

The PF2100 is certified for use in Class I, Division 2, Group ABCD locations. Certain modes of operation or wiring options may be against code in some locations or for burners exceeding a certain heat rating.

Profire makes no assertion as to the suitability of a particular component for a given application. It is up to the customer to examine the local codes and safety requirements to determine if the PF2100 and any other associated components sold by Profire are suitable for use in a given application.

CANADA
The PF2100 is designed to meet CSA B149 requirements which are becoming legislated in Canada. The regulations are not yet finalized. It is expected that compliance of all components of the fuel train will be required (including the BMS, the solenoids, etc.). In addition, field inspection and approval by an accredited inspections group is anticipated to be required.

USA
The PF2100 currently exceeds the requirements for use in the United States.

Other
Consult local codes and safety regulations to determine if the PF2100 can be used in your jurisdiction.

2 Installation

This section includes the steps that should typically be followed when wiring up a PF2100 system in the field. If you are new to the PF2100, you should read this section in its entirety and follow these instructions closely.

STEPS

1. Review Installation Warnings

2. Choose a Mounting Location

3. Mount the System

4. Get Familiar with the Terminal Card

5. Connect the Required Wiring including Power, Valves, Thermocouples, and Ignition Coil / Flame Detection wiring

6. Connect the Optional Wiring including Status Contact, Dry Contact Inputs, 4-20mA Temperature Output, and Expansion Cards

At the end of this section is a table for looking up information about specific terminals and circuits.

Keep in mind that the PF2100 is a versatile system which can be used in many different applications. As such, it is important to know the application for which you are installing the system before you begin your work. The steps provided here are general and will help you to identify questions that need to be answered to complete the installation properly.

To know which options are required, you should consult the engineer or technician who designed the site. You should also consult your local electrical and gas code.

Profire also offers a number of Application Guides for installing the PF2100 in various application and jurisdictions. These include recommended fuel trains, bill of materials, system settings, and P&ID diagrams. These can be found on our website or you can contact a member of the Profire Sales team to discuss your application further.

2.1 Installation Warnings

Before installing the PF2100, please review the following list of warnings.

Failure to observe the following may result in death, electrocution, property damage, product damage, and/or government fines.

1. The PF2100 is not intended for use on burners greater than 12.5 MMBtuh. It is against code in many jurisdictions.

2. To use the PF2100 on burners greater than 5 MMBtuh, it is recommended to use the low fire feature with two safety shutoff valves, at least one of which has Proof of Closure. This is required in many jurisdictions.

3. Failure to properly ground the pilot assembly back to the PF2100's Ion terminal may result in accidental electrocution, product damage, or simply failure to ignite the pilot.

4. The PF2100 generates 20kV- 40kV at its high voltage output terminal which can cause burns or cardiac arrest. Do not touch or place any object near the ignition coil's high voltage terminal or connected ignition wire while the product is operating.
Even without making physical contact with the terminal, it is possible to draw a spark from several inches away, especially if the pilot bracket is not properly grounded.

5. Never leave the PF2100 running unattended without the door screws securely tightened down. This is to prevent moisture from penetrating inside of the enclosure and damaging the product. Moisture damage to the internal circuitry is not covered by the product warranty if the door has been left open.

6. All conduit ports drilled into the PF2100 enclosure must be CSA/NEMA Type 4 rated and have seals poured in them in order to maintain the Type 4 rating

2.2 Mounting Locations

The PF2100 should typically be mounted near the burner it's controlling or in another location that is both safe and easily accessible. The recommended mounting height is 1.5m (5ft) above the ground or platform that the operator will be standing on.

Please consider the following when choosing an install location:

1. **ACCESSIBILITY**
   The operator should be able to easily access the system to observe its operation and change settings. The system should not be mounted facing the sun to make it easier to observe the display and LED indicators on the front panel.

2. **SECURITY**
   In some situations, it may be desirable to mount the system in a location that is not accessible to the general public to prevent accidental and intentional tampering.

3. **OPERATOR SAFETY**
   The system should not be mounted in a dangerous location such as in the path of an open flame, or next to a tank that might overflow, or in any other location where an operator might be placed in undue danger.

4. **PERFORMANCE**
   Choose a mounting location that will allow ground and ignition wires to be kept as short as possible. This will ensure the best ignition and flame detection.

5. **PRODUCT PROTECTION**
   To protect the system from being damaged, it should not be mounted:

   a. Where chemicals may splatter or bubble over from a tank onto the system. Chemicals on the keypad may interfere with an operator's ability to control the product or view the display and LED indicators.

   b. Directly to a heated tank where excessive heat may damage the product. Refer to the maximum operating temperature listed in this document.

   c. To anything that may tip over due to wind or snow. For example, a pole that is not set properly into the ground or a tripod that is not secured with anchor bolts or guy wires.

   d. In locations that may be prone to flooding.

2.3 **Mounting Instructions**

1.   Remove and open the included bag of components taped to the mounting brackets.

2.   Attach the two mounting brackets to the back of the PF2100 enclosure using the 4 screws.

3.   Determine the best location to drill holes in the product enclosure for the wires to enter. It is recommended that these holes be drilled on the bottom of the enclosure (as shown).

4.   Install grommets or conduit ports as required.

5.   Securely mount the enclosure to either a pole, structure or building which satisfies the location requirements previously listed in section 2.2 (Mounting Locations).

DETERMINE DRILL LOCATIONS

CONDUIT AND CABLES
AS REQUIRED
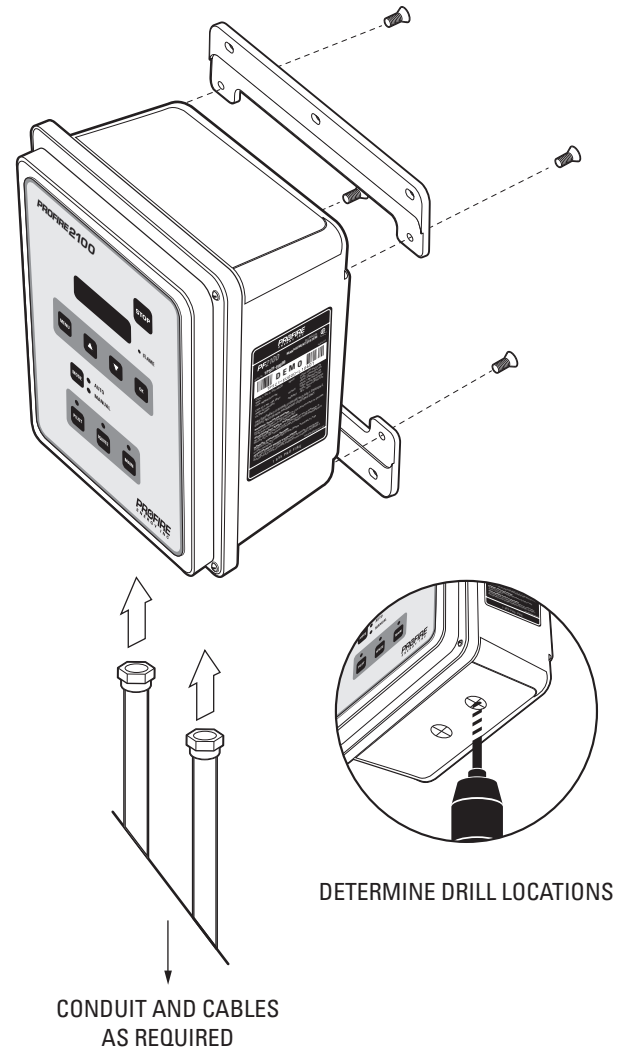
2.4 Terminal Card Diagram

SPARE MAIN FUSE

SPARE STATUS CONTACT FUSE

DOOR CARD CONNECTOR

MAIN FUSE

4-20mA OUTPUT

POWER TERMINALS

FW VERSION LABEL

THERMOCOUPLE INPUTS

VALVE OUTPUTS

INTERNAL COIL
(OPTIONAL EXPANSION)

EXPANSION CARD SLOT

HW SERIAL / VERSION LABEL

IGNITION TERMINALS

FLAME DETECTION TERMINAL

STATUS CONTACT FUSE

STATUS CONTACT OUTPUT

MISC. DRY CONTACT INPUTS

PRESSURE DRY CONTACT INPUTS

LEVEL DRY CONTACT INPUT

SPARE FUSE

RESET

TC FW: E1.8.101

12/24VDC
Common
Earth Ground
4-20mA Out+
4-20mA Out-

Ion-
Ion+
Coil+
Coil-

HighTemp_TC+ (Yellow)
HighTemp_TC- (Red)
Process_TC+ (Yellow)
Process_TC- (Red)
AUX_TC+ (Yellow)
AUX_TC- (Red)
High Fire+ / Main+
High Fire- / Main-
Low Fire+
Low Fire-
Pilot+
Pilot-

Status+
Status-
Start+
Start-
ESD+
ESD-
Proof of Closure+
Proof of Closure-

HighPressure+
HighPressure-
LowPressure+
LowPressure-
Level+
Level-

F2
SPARE FUSE

XXXXXX-XXXXX
XXX-1.75
XXXXXX

PROFIRE
ENERGY INC

2.5 Terminal Descriptions

This table provides a brief description of each terminal and references to further detail.

TERMINAL	EXPECTED CONNECTIONS	DESCRIPTION	SECTION
12/24VDC	Input power from a DC source	Input power 10VDC-28VDC, 5A MAX	2.6.1
Common	Ground back to DC source	Internally connected to EGND	2.6.1
EGND	Earth Ground		2.6.1
4-20mA Out +	Proportional Valve positive terminal or PLC 4-20mA positive input	This output can be used for either Proportional Valve Control or echoing the Process Temperature to a PLC.	2.6.2, 2.7.3
4-20mA Out -	Ground return for the 4-20mA output	A resistance of 120Ω to 250Ω is expected.	
HighTemp_TC + (YELLOW)	High Temp Thermocouple positive lead	A "**TYPE K**" thermocouple must be connected between the "+" and "-" terminals and must not be electrically connected to ground.	2.6.3
HighTemp_TC - (RED)	High Temp Thermocouple negative lead	An uninterrupted connection using "**TYPE K**" thermocouple wire is required for an accurate reading.	
Process_TC + (YELLOW)	Process Thermocouple positive lead		
Process_TC - (RED)	Process Thermocouple negative lead		
AUX_TC + (YELLOW)	Aux Thermocouple positive lead		
AUX_TC - (RED)	Aux Thermocouple negative lead		

2.5 Terminal Description Continued...

TERMINAL	EXPECTED CONNECTIONS	DESCRIPTION	SECTION
High Fire/Main +	High Fire / Main Valve positive terminal	Solenoid valves must be connected between the "+" and "-" terminals. The negative terminal is not directly connected to ground so a common return wire for the High Fire, Low Fire and Pilot valves cannot be used.	2.6.2
High Fire/Main -	High Fire / Main Valve negative terminal. Do not connect to ground.		
Low Fire +	Low Fire Valve positive terminal	2A continuous per valve output. 4A peak per valve output if the corresponding Solenoid PWM Setting is 60% or less.	
Low Fire -	Low Fire Valve negative terminal. Do not connect to ground.		
Pilot +	Pilot Valve positve terminal		
Pilot -	Pilot Valve negative terminal. Do not connect to ground.		
Ion +	Flame Detection positive input. Connect to flame rod or external coil Ion terminal (depending on configuration)	A Kanthal rod should be placed directly in the pilot flame and connected to this input. The pilot assembly must be grounded for the flame detection to function properly. Input is protected from high voltage and can be connected in series with the high voltage terminals of an external ignition coil, allowing a single flame-rod to be used for both ignition and flame detection. A 65VAC signal is applied to the flame rod. The source impedance is very high so there is no danger of sparking.	2.6.4 - 2.6.7
Ion -	Flame Detection negative input. Connect to ground screw on pilot assembly or burner housing.	Ground return for flame detection.	
Coil +	Driver for the low voltage primary of the ignition coil.	The primary of the ignition coil should be connected to this terminal. The 12/24VDC input power will be applied for 1 ms and turned off for 50 ms while sparking. This output is protected by a 250mA thermal fuse.	2.6.4 - 2.6.7
Coil -	Ground return for the ignition coil.		

2.5 Terminal Description Continued...

TERMINAL	EXPECTED CONNECTIONS	DESCRIPTION	SECTION
Status +	Connect to PLC positive input contact or other alarm device.	The status "+" and "-" contacts will be closed when the system is running and opened when the system is shutdown. Dry contact output to indicate system status to an external device. ie. PLC. Note that the contacts are DC only and are not internally connected to power or ground.	2.7.1
Status -	Connect to PLC negative input contact or other alarm device.		
		40VDC, 250mA, 15Ω	
Start +	Remote start input from an external device. ie. PLC.	Dry contact switch is expected. The input is internally pulled up to 9VDC via a 3.75kΩ resistance. Jumper "+" and "-" if not used. All input contacts can use a single common ground return if desired.	2.7.2
Start -	Ground		
ESD +	External Shutdown input, typically plant ESD loop.		
ESD -	Ground		
Proof of Closure +	Proof of Closure from main valve(s).		
Proof of Closure -	Ground		
High Pressure +	Input from a mechanical High Pressure switch.		
High Pressure -	Ground		
Low Pressure +	Input from a mechanical Low Pressure switch.		
Low Pressure -	Ground		
Level +	Input from a float-switch mounted in the bath.		
Level -	Ground		

2.6 Required Wiring

The wiring in this section of the document is required for all PF2100 installations. Skipping or performing any steps in this section incorrectly will likely result in the PF2100 not functioning properly.

2.6.1 Power

The PF2100 can be powered from 12VDC or 24VDC. The maximum current that the PF2100 can safely handle without blowing the main fuse is 5A. The system on its own draws only about 100mA. The rest of the current is drawn by loads on attached circuits such as the valves. Ensure that you select a power supply that is rated appropriately for the total amount of current that will be consumed by all devices attached to it.

WIRING STEPS

1. Wire the Common terminal to the negative terminal of the power supply.

2. Wire the Earth Ground terminal to the shield of all conduit ports installed in the enclosure.

3. Connect the Earth Ground terminal to an actual earth ground connection.

4. Wire the 12/24VDC terminal to the positive terminal of the power supply.

2.6.2 Valves

There are four valve control outputs on the PF2100: Pilot, Low Fire, 4-20mA Output, and High Fire/Main.

WIRING STEPS

1. Wire the Pilot valve to the Pilot +/- terminals

2. Wire the Main valve to the High Fire / Main +/- terminals

3. If Low Fire is required in your application, do one of the following:

    a. Wire the Low Fire valve to the Low Fire +/- terminals
    b. If you want to use a proportional valve, wire the valve to the 4-20mA Out +/- terminals

4. Ensure that each valve has a separate return wire. Multiple valves sharing common return wires will not function properly.

5. Connect valve EGND wires to Earth Ground.

NOTES

1. It is possible to connect multiple valves to the same control output in parallel or series. If you do this, ensure that the configuration you are using meets local codes and also does not exceed the total current rating of the PF2100.

2. The negative valve control wires are NOT connected directly to ground. Therefore, you cannot use a common return wire for all valves.

PILOT VALVE

The Pilot valve is required and must be wired up for all installations.

LOW FIRE VALVE

The Low Fire valve may also be required by local code or for proper operation of your particular application. Low Fire is often used on high Btuh burners (such as those that exceed 5 MM Btuh) to establish a draft before opening the High Fire valve. Failure to do this on high Btuh burners can cause the burner to starve itself of oxygen and snuff out the flame.

4-20mA OUTPUT

The 4-20mA Output can be used to control a proportional valve that is designed for a 4-20mA current loop. Using a proportional valve allows for finer control of the burner's temperature as opposed to the 2 or 3 levels which are possible using normal valves. Typically the 4-20mA Output is used in conjunction with a normal valve. The 4-20mA Output also supports low fire.

HIGH FIRE/MAIN VALVE

The High Fire valve is required and must be wired up for all installations. This valve is sometimes called the Main Valve, especially when Low Fire is not used.

2.6.3 Thermocouples

The High Temp and Process thermocouple inputs are mandatory and must be connected to a Dual Element thermocouple. The Auxiliary thermocouple is only required when a second process temperature (such as the outlet temperature on a line heater) must be monitored. Otherwise, the Auxiliary thermocouple is optional.

All thermocouples are cold junction compensated. For this reason it is important to ensure that Type-k thermocouple wire and connectors are used exclusively. The temperature compensation is done using an ambient temperature sensor located on the terminal card near the thermocouple terminals.

WIRING STEPS

1. Connect a Dual Element, Type-k Thermocouple to the Process and High Temp Thermocouple inputs.

2. If desired, connect a single Type-k Thermocouple to the AUX Thermocouple input.

3. Make sure that all connections are made using Type-k thermocouple wire and connectors.

NOTES

All thermocouples must be:

1. Isolated from ground

2. Isolated from power

3. Type K thermocouples

4. Connected with 20 AWG or larger Type K extension wire

5. Placed a safe distance from high voltage lines and shielded when necessary.

PROCESS THERMOCOUPLE

This thermocouple is normally used on the primary temperature control device. The system will shutdown if an open circuit is detected on this thermocouple. It should be placed in the same thermowell as High Temperature Thermocouple. This is commonly accomplished by using a dual element thermocouple.

HIGH TEMPERATURE THERMOCOUPLE

This thermocouple is used for the high-temp shutdown. The system will shutdown if an open circuit, short-circuit or short-to-ground is detected on this thermocouple. It should be placed in the same thermowell as Process Thermocouple. This is commonly accomplished by using a dual element thermocouple.

AUX THERMOCOUPLE

This thermocouple is optional and can be enabled in menu 5. It can be used to monitor stack temperature or to control a secondary process temperature. System will shutdown if an open circuit is detected and AUX Thermocouple is enabled.

2.6.4 Ignition Coil / Flame Detection

There are numerous ways to wire the ignition and flame detection circuits correctly but there are also a number of things that must be carefully considered before choosing an approach. The sections after this one contain recommended instructions for wire various configurations.

WIRE LENGTHS AND TYPE

When wiring the ignition and flame detection circuits, wire length must be carefully considered. If the wire lengths are too long, the PF2100 may not be able to deliver enough energy to the ignition rod to ignite the pilot or it may not receive enough signal from the flame rod to be able to detect flame. Generally, Ion+ and Ion- must each be less than 8m (25') when using 16AWG wire. If 7mm diameter ignition wire is used for Ion+, this distance can be increased to 15m (50'). In addition, the 7mm diameter ignition wire from the coil's High Voltage Output terminal to the Ignition Rod must be less than 5m (15').

GROUNDING

Properly grounding the pilot assembly back to the PF2100 is critical for proper ignition and flame detection. This can be accomplished in many ways. It should be noted that the Ion-, COM, and EGND terminals on the PF2100 Terminal Card are all the same electrically. Often times, the pilot assembly is grounded back to the PF2100 through the mechanical connection of the pilot to the piping to the burner housing and then to earth ground which is in turn connected to the PF2100 EGND terminal. If it is not connected in this manner, a ground wire should be run from the Ion- terminal of the PF2100 to the burner housing or even directly to a screw on the pilot assembly. To check the grounding, disconnect the power from the system and use a multimeter to measure the continuity from the pilot assembly to the PF2100 Ion- terminal.

ROD POSITIONING

Rod positioning must also be carefully considered to ensure proper ignition and flame detection. The ignition rod should be positioned (by bending it if necessary) so that there is a 1/8" to ¼" gap between it and the front of the pilot nozzle. The flame rod should be positioned (by bending it if necessary) such that 2" to 3" of its length is positioned within the pilot flame. Care should be taken to ensure that the ignition rod and flame rod are not directly in line with each other. Otherwise, the ignition rod may cast a shadow on the flame rod such that there is no flame present at the flame rod and therefore no flame is detected.

FLAME ANCHORING

The term "Flame Anchoring" refers to how much the flame is in contact with the pilot nozzle. Poor flame anchoring causes poor flame detection. Poor flame anchoring can be caused when there is too much gas pressure resulting in the flame burning primarily outside of the nozzle as opposed to along the inside and outside surfaces of the nozzle. It can also be caused by wind or draft from the main burner.

USING EXTRA RODS TO IMPROVE FLAME DETECTION

In some challenging installations such as non-enclosed or high velocity burners, adding one or two additional rods may be required. A second flame detection rod can help in cases where the flame may blow away from the primary rod from time-to-time. The addition of a ground rod positioned further away from the nozzle tip can assist with

2.6.4 Ignition Coil / Flame Detection Continued...

detecting flames that are not well anchored. Use of additional rods should only be used as a last resort since normally another less costly solution can be found.

INTERNAL VS EXTERNAL COIL

If less than 5m (15ft) of ignition wire are required to connect the PF2100 to the burner housing, the internal coil configuration can be used. Otherwise the external coil configuration must be used.

The Internal Coil Configuration refers to an internal coil included inside the PF2100, while the External Coil Configuration refers to a coil not included with the PF2100 and located in a separate enclosure or inside the burner housing.

SINGLE ROD VS DUAL ROD

A single Kanthal rod can be used for both ignition and flame detection to save cost if desired. This often results in a performance trade-off between ignition and flame detection. This option is only available with external coils. Using two Kanthal rods (one for ignition and one for flame detection) allows for greater flexibility in rod placement and often yields better performance.

WIRING OPTIONS

There are three possible ways to wire the ignition coil and flame detection circuit with the PF2100 as illustrated in the table below. Wiring instructions and diagrams are provided for each.

CONFIGURATION (COIL TYPE)	SINGLE ROD	DUAL ROD
Internal Coil		•
External Coil	•	•

2.6.5 Internal Coil, Dual Rod

Use this configuration when the PF2100 is <5m (15ft) from the burner and you want greater flexibility for rod placement.

WIRING STEPS

1. Connect the Pilot Assembly ground screw to the PF2100's Ion-terminal using a 16 AWG (or thicker) ground wire

2. Connect the Kanthal Flame Detection Rod to the PF2100's Ion+ terminal. Use the included Ferrule and Straight Silicone Boot to ensure that the connection is robust. It is recommended to use 7mm Ignition Wire but 16 AWG may be acceptable for shorter runs.

3. Connect the Kanthal Ignition Rod to the PF2100's Internal Coil Output Terminal using the included ignition wire. Use the included Ferrule and Straight Silicone Boot to ensure that the connection is robust.

4. Adjust the Flame Rod positioning (bend it if necessary) so that 2 to 3" of the rod will be inside the pilot flame.

5. Adjust the Ignition Rod positioning (bend it if necessary) so that there is a 1/8 to 1/4" gap between the rod and the front of the pilot nozzle.

6. Verify that the Coil+ terminal is connected to the black pigtail on the ignition coil.

7. Verify that the Coil- terminal is connected to the white pigtail on the ignition coil.

MAX WIRE LENGTHS

ION +	8m (25ft) if using 16AWG Wire
	15m (50ft) if using 7mm Ignition Wire
Ignition Rod Wire	5m (15ft) must use 7mm Ignition Wire
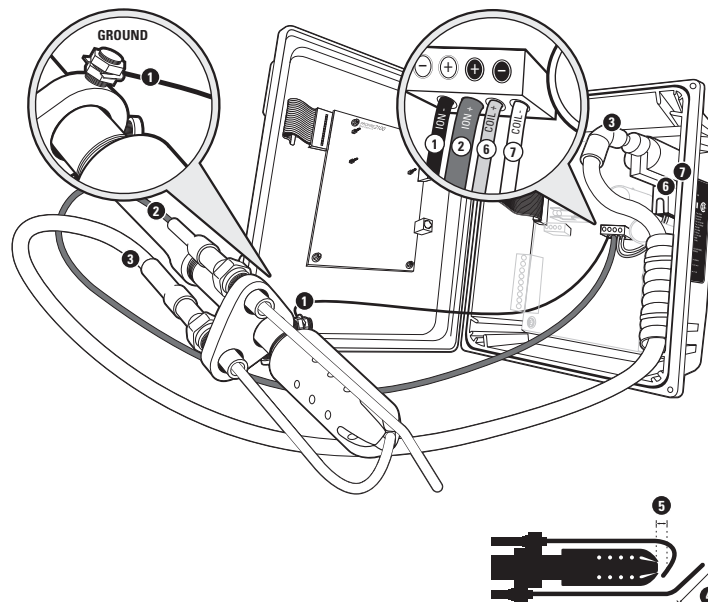
2.6.6 External Coil, Dual Rod

Use this configuration when the PF2100 is >5m (15ft) from the burner and you want greater flexibility for rod placement.

WIRING STEPS

1. Connect Pilot Assembly ground screw to the PF2100's Ion- terminal using a 16 AWG (or thicker) ground wire.

2. Connect the Kanthal Flame Detection Rod to the PF2100's Ion+ terminal. Use the included Ferrule and Straight Silicone Boot to ensure that the connection is robust. It is recommended to use 7mm Ignition Wire but 16 AWG may be acceptable for shorted runs.

3. Connect Coil+ terminal on the External Coil to the Coil+ terminal on the PF2100 using 16 AWG (or thicker) wire.

4. Connect Coil- terminal on the External Coil to the Coil- terminal on the PF2100 using 16 AWG (or thicker) wire.

5. Connect the Kanthal Ignition Rod to the free High Voltage terminal on the External Coil. Use the included 90 degree Bakelite Connector to ensure that the connection is robust. 7mm Ignition Wire must be used.

6. Connect the other High Voltage terminal on the External Coil to one of the mounting screws on another 90 degree Bakelite Connector and 7mm Ignition Wire.

7. Using a multimeter, verify that the coil base plate and the Pilot Assembly are both securely connected to earth ground. If not, you may need to run a ground wire between them.

8. Adjust the Flame Rod positioning (bend it if necessary) so that 2 to 3″ of the rod will be inside the pilot flame.

9. Adjust the Ignition Rod positioning (bend it if necessary) so that there is a 1/8 to 1/4″ gap between the rod and the front of the pilot nozzle.

MAX WIRE LENGTHS

ION +	8m (25ft) if using 16AWG Wire 15m (50ft) if using 7mm Ignition Wire
Ignition Rod Wire	5m (15ft) must use 7mm Ignition Wire

GROUND

BURNER HOUSING
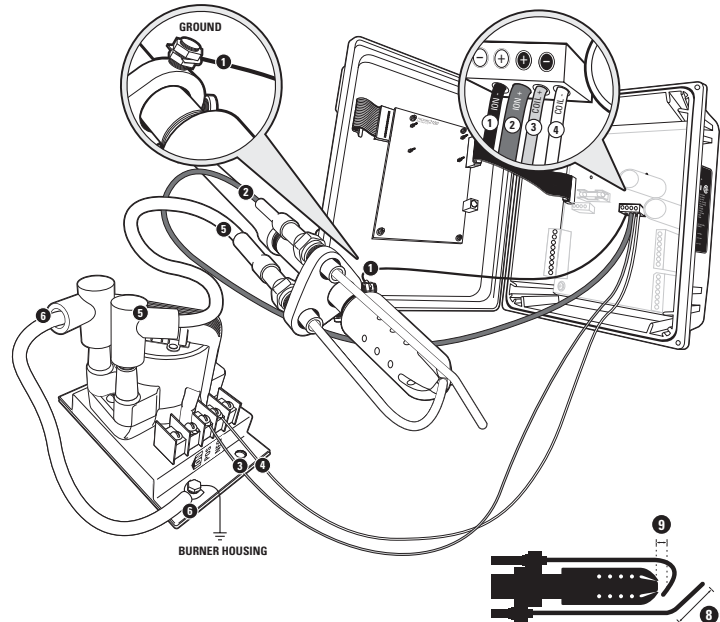
2.6.7 External Coil, Single Rod

Use this configuration when the PF2100 is >5m (15ft) from the burner and you want to save cost by using a single rod.

WIRING STEPS

1. Connect the Pilot Assembly ground screw to the PF2100's Ion-terminal using a 16 AWG (or thicker) ground wire

2. Connect the Ion terminal on the External Coil to the Ion+ terminal on the PF2100. It is recommended to use 7mm Ignition Wire but 16 AWG may be acceptable for shorted runs.

3. Connect the Coil+ terminal on the External Coil to the Coil+ terminal on the PF2100 using 16 AWG (or thicker) wire.

4. Connect the Coil- terminal on the External Coil to the Coil- terminal on the PF2100 using 16 AWG (or thicker) wire.

5. Connect the single Kanthal Rod to the free High Voltage terminal on the External Coil. Use the included 90 degree Bakelite Connector to ensure that the connection is robust. 7mm Ignition Wire must be used.

6. Use a 90˚ Bakelite connector and 7mm Ignition Wire to connect the other High Voltage terminal on the External Coil to the Ion terminal on the coil base plate.

7. Adjust the Kanthal Rod positioning (bend it if necessary) so that 2 to 3″ of the rod will be inside the pilot flame and so that there is a 1/8 to 1/4″ gap between the rod and the front of the pilot nozzle.

MAX WIRE LENGTHS

ION +	8m (25ft) if using 16AWG Wire
	15m (50ft) if using 7mm Ignition Wire
Ignition Rod Wire	5m (15ft) must use 7mm Ignition Wire
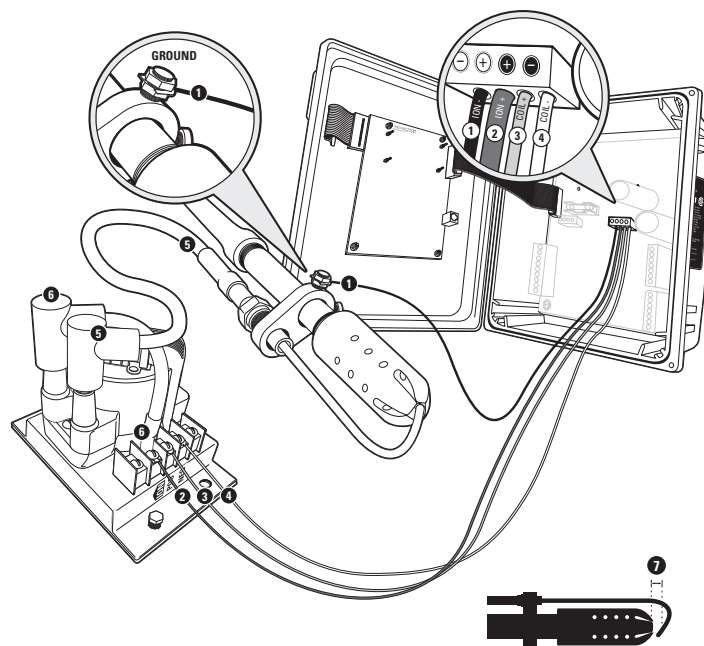
2.7 Optional Wiring

The wiring in this section of the document is optional.

2.7.1 Status Contact

The status contact is a dry contact output comprised of a solid state relay. It can be thought of as a switch which the PF2100 controls. Neither contact is internally connected to power or ground so these connections must be provided externally as required. When the system is running, the contacts are internally connected together and when the system is not running, the contacts are open circuited. These contacts are typically used for remote monitoring of the PF2100's status. An alarm, siren, trouble lamp, or PLC are examples of devices that might be connected to this contact.

The status contacts are rated for DC only so it is important to observe the correct polarity when attaching an external device. The positive status contact terminal should always be at a voltage potential that is greater than or equal to the negative terminal. Be careful not to exceed the voltage and current ratings which are 40VDC, 250mA. The impedance when closed is15Ω. There is a fuse on the status contact to protect it. A spare fuse is also included.

2.7.2 Dry Contact Inputs

There are 6 dry contact inputs on the PF2100. The expected connection to each of these is a switch. These contacts must all be closed (shorted) in order for the system to start. Jumpers are provided for each of these by default. If you need to use a particular contact for your application, simply remove the associated jumper and connect a switch in its place.

START CONTACT

The Start Contact can be used to attach a remote start/stop switch. This is typically connected to a PLC dry contact output.

When the contact is open, the system is stopped. For safety reasons, a double action is required to start the system remotely via this contact. This is accomplished by closing the switch, opening it, and then closing it again. Once the system is running, simply open the switch again to stop it.

ESD CONTACT

The ESD Contact can be used to attach an emergency shutdown switch. This is typically connected to a mushroom switch mounted on a remote panel or to a PLC dry contact output.

When the contact is open, the system is stopped. The system cannot be started via this contact but this contact must be closed in order to start the system.

PROOF OF CLOSURE CONTACT

The Proof of Closure Contact can be used to receive the feedback signal from a Main Valve that has a Proof of Closure output. If multiple main valves with Proof of Closure outputs are used, these can be wired together in series.

Before the system attempts to light the pilot, it will check that the Proof of Closure Contact is closed. If it is open, it will not light the pilot.

HIGH PRESSURE CONTACT

The High Pressure Contact can be connected to a High Pressure Switch installed in the fuel train. Typically, this switch is placed immediately after the Main valve in the fuel train.

When the system initially starts, it will ignore this input. It will light the pilot and open the main valve as it normally would. If the High Pressure Contact remains open 2s after the mains are turned on, the system will then shutdown. This 2s delay is to relieve any pressure that might have built up in the fuel train as a result of regulator leakage. Any time the main valves are open, the system will shutdown if the High Pressure Contact opens and remains open for 2s.

See section 2.7.5 (4-20mA Expansion Card) section for details

2.7.2 Dry Contact Inputs Continued...

LOW PRESSURE CONTACT

The Low Pressure Contact can be connected to a Low Pressure Switch installed in the fuel train. Typically, this switch is placed immediately before the Main valve in the fuel train.

The Low Pressure Contact is time averaged to help reject brief fluctuations in gas pressure. The contact must be open continuously for 2 or 6 seconds (depending on the "Pressure/Level Delay" setting) before the system will shutdown. If "Auto Restart" is enabled, the system will restart automatically when the Low Pressure Contact recloses.

See section 2.7.5 (4-20mA Expansion Card) section for details

LEVEL CONTACT

The Level Contact can be connected to a Level Switch installed right above the fire tube. This is used to signal when the tank level drops below a certain minimum. This is often the point at which the fluid in the tank is no longer covering the fire tube. Running the burner with an empty tank can damage both the fire tube and the tank.

The Level Contact is time averaged to help reject brief fluctuations in tank level which might be a result of vibration. The contact must be open continuously for 2 or 20 seconds (depending on the "Pressure/Level Delay" setting) before the system will shutdown. If "Level Restart" is enabled, the system will restart automatically when the Level Contact recloses.

See section 2.7.5 (4-20mA Expansion Card) section for details

2.7.3 4-20mA Temperature Output

If the 4-20mA Output is not being used to control a proportional valve, it can be configured to output the process temperature encoded as a 4-20mA signal. This is useful if a PLC on site needs to know the process temperature. In this case, wire the PF2100's 4-20mA Output to a PLC's 4-20mA Input. Note that the PF2100 provides the loop power. The PLC resistance is expected to be in the range of 120 Ohms and 250 Ohms.

The 4-20mA output signal will be scaled such that 4mA represents OC and 20mA represents HT ESD Setpoint.

2.7.4 Modbus Expansion Card

An optional Modbus Expansion Card can be installed in the PF2100 which provides the following additional features:

REMOTE MONITORING

This card allows for remote monitoring of the PF2100 status including process temperature, auxiliary temperature, and 4-20mA Input Card status (if installed).

REMOTE START / STOP

This card can also be used to remotely start and stop the system and to adjust some setpoint values.

REMOTE SETPOINT ADJUSTMENT

This card can be used to remotely adjust some setpoints such as High Fire, Low Fire, and Pilot Off setpoints.

Refer to the "Modbus Expansion Card Manual" for further details on installation and operation of this card.
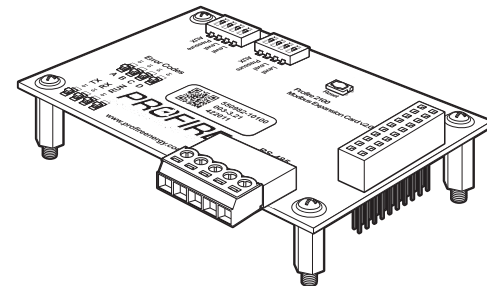
*MODBUS **EXPANSION CARD***

Some PF2100 models come with this card pre-installed.

2.7.5 4-20mA Expansion Card

An optional 4-20mA Expansion Card can be installed in the PF2100 which provides two 4-20mA inputs as well as a pair of complementary dry contact outputs:

4-20mA FUEL TRAIN PRESSURE MEASUREMENT

This card can be used as an alternative to the High and Low Pressure Contacts which are built into the PF2100. This input can be wired to a 4-20mA Pressure Transmitter to obtain an actual reading of the fuel train pressure. The transmitter range and units can be set along with low and high pressure thresholds. The reading can be displayed on the PF2100 display or read remotely via Modbus if the optional Modbus Expansion Card is also installed.

4-20mA TANK LEVEL MEASUREMENT

This can be used as an alternative to the Level Contact which is built into the PF2100. This input can be wired to a 4-20mA Level Transmitter to obtain an actual reading of the tank level. The transmitter range and units can be set along with low and high level thresholds. The reading can be displayed on the PF2100 display or read remotely via Modbus if the optional Modbus Expansion Card is also installed.

TANK HIGH LEVEL DRY CONTACTS

Both Normally Open (NO) and Normally Closed (NC) contacts are provided. When the Level reading is above the High Level Setpoint, the NO contact will close and the NC contact will open. The opposite is true whenever the Level reading is below the High Level Setpoint. This can be used to control auxiliary equipment such as a warning light, an alarm, or the pump that is filling the tank.

Refer to the "4-20mA Expansion Card Manual" for further details on installation and operation of this card.
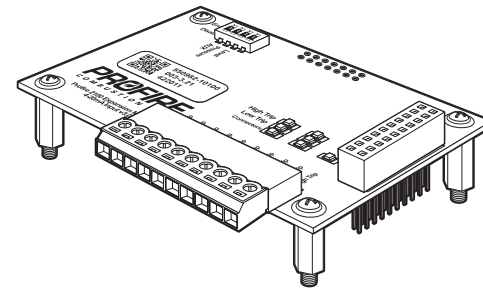
4-20mA **EXPANSION CARD**

Some PF2100 models come with this card pre-installed.

3 User Interface & Settings

The user interface is comprised of two parts: a physical interface (including things such as keys and indicator lights) and a software interface (including things such as menus and status screens).

This section of the manual is organized into four sub-sections. The first two deal with the physical and software interfaces. At the end of the software interface sub-section is a menu map which is useful for quick reference. Following this is a table that provides summary information about each item in the menu map along with the location in the manual where more detailed information can be found. The next sub-section contains detailed information about all of the settings that can be adjusted and is organized alphabetically by topic. The final sub-section contains instructions on how to operate the system.

3.1 Hardware User Interface

The hardware user interface consists of three parts:

1. Indicator lights
2. A Keypad
3. An illuminated display

3.1.1 Keypad Diagram

DISPLAY

STOP KEY

PROFIRE 2100

STOP

FLAME LIGHT

FLAME

OK KEY

MENU KEY

MENU ▲ ▼ OK

DOWN KEY

UP KEY

AUTO LIGHT

MODE KEY

MODE AUTO
MANUAL

MANUAL LIGHT

PILOT LIGHT

MAIN LIGHT

PILOT IGNITE MAIN

PILOT KEY

MAIN KEY

IGNITE KEY

PROFIRE
ENERGY INC

IGNITE LIGHT
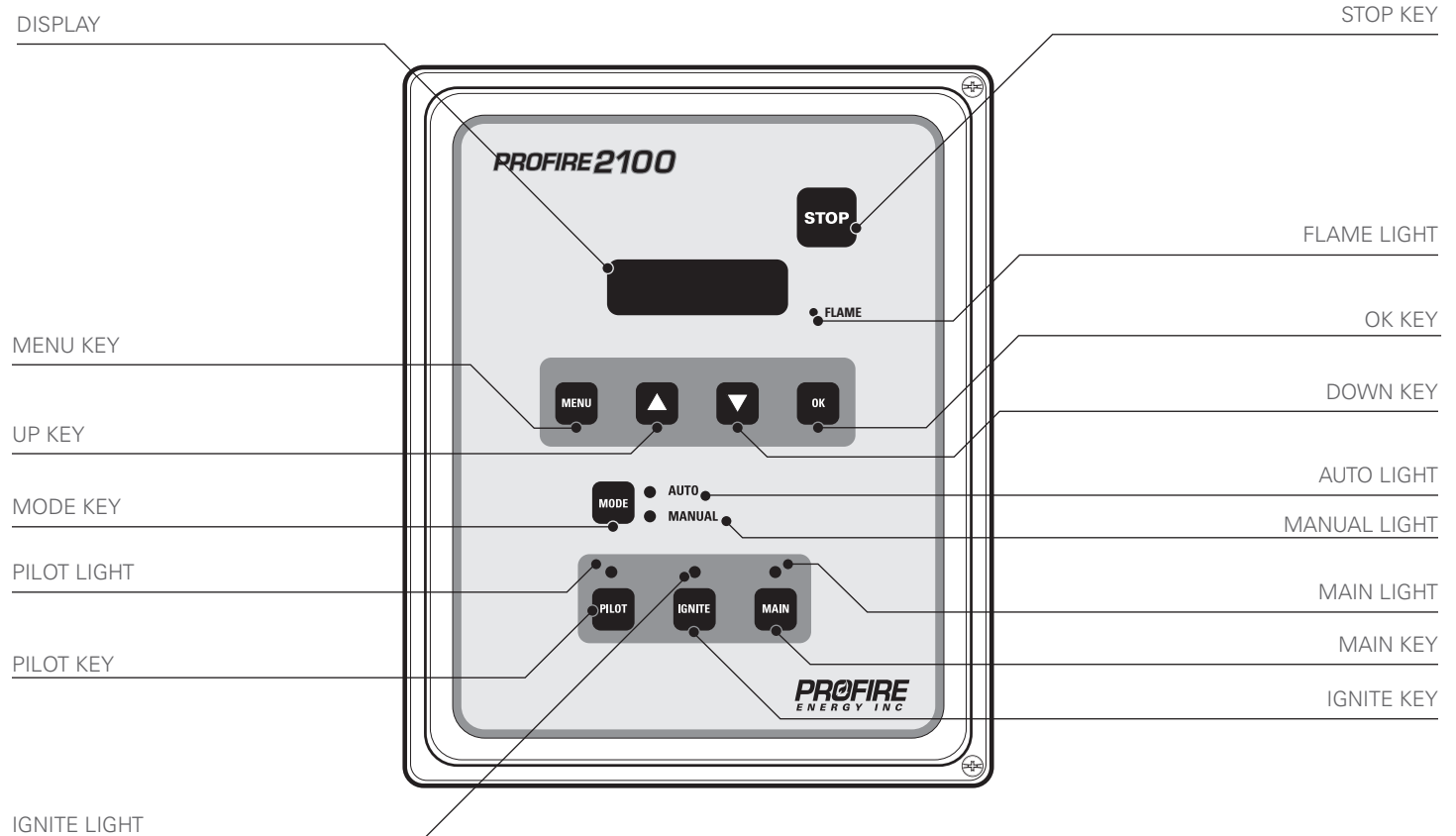
3.1.2 Indicator Lights

FLAME LIGHT

Indicates that the system is detecting the pilot flame.

AUTO LIGHT

Indicates that the system is running in auto mode.

MANUAL LIGHT

Indicates that the system is running in manual mode.

PILOT LIGHT

Indicates that the pilot valve is open.

IGNITE LIGHT

Indicates that the system is sparking to ignite the pilot.

MAIN LIGHT

Indicates that he main valve is open.

3.1.3 Keys

STOP KEY

Used to stop the system immediately or in other words, turn off the burner.

MENU KEY

Used to navigate through the menu.

UP KEY

Used to adjust a setting upwards and to scroll up through lists.

DOWN KEY

Used to adjust a setting downwards and to scroll down through lists.

OK KEY

Used to enter a menu, acknowledge a prompt, save an edited setting, or return to the home screen.

MODE KEY

Used to toggle between Manual and Auto modes of operation.

PILOT KEY

Used in Manual Mode to test the Pilot Valve.

IGNITE KEY

Used in Manual Mode to test the Ignition Circuit.

MAIN KEY

Used in Manual Mode to test the Main Valve.

3.1.4 Display

The display on the PF2100 has two lines of text which are used to show system status, warnings, alarms, prompts, and menus. It is illuminated for ease of reading in both bright sunlight and dark locations. The display is the means through which the software user interface is presented.

When the system first powers on the display will show the system name and firmware version for a few seconds, after this it will show the Home Screen.

3.2 Software User Interface

The software user interface is shown on the PF2100 display. Through it, the state of the system is presented to the user. The user can also change settings via this interface. Below is a diagram showing the various types of information that can be accessed through the interface. Most items are accessed through what is known as the Home Screen whereas others can be accessed from anywhere in the interface. Some items are accessible in all modes whereas others can only be accessed in Manual Mode or only in Auto Mode. Each of these items will be discussed in further detail in the sub-sections that follow.

MANUAL MODE

```
REVIEW
MENU
```
```
HOME SCREEN
System State
Process Temperature
```
```
SYSTEM
MENU
```
```
FW VERSION
SCREEN
```
```
WARNING
MESSAGES
```
```
SHUTDOWN
SCREEN
```

AUTO MODE

```
HOME SCREEN
Process Setpoint/State Transitions
Process Temperature
```
```
QUICK
SETPOINT
ADJUST
```
```
FW VERSION
SCREEN
```
```
WARNING
MESSAGES
```
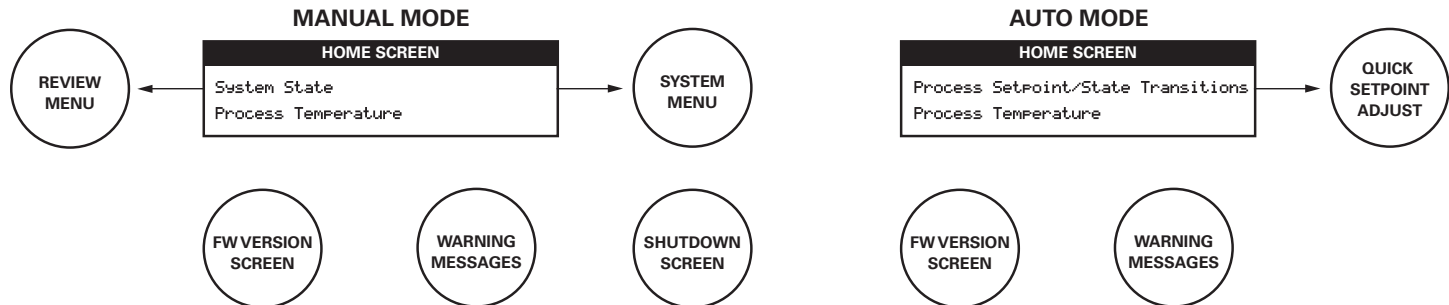
3.2.1 Manual vs. Auto Mode

When the system first powers on, it will normally be in Manual Mode. If the Auto Restart feature is enabled and no alarm conditions are present, it may switch automatically to Auto Mode after power up. Otherwise, the user must manually put the system into Auto Mode by using the Keypad, the Start Contact, or the Modbus Expansion Card. For further details on how to start the system, refer to section 3.5.1 (Starting the System).

The main difference between these two modes is that all settings can be adjusted in Manual Mode whereas they cannot in Auto Mode. The following table illustrates further differences.

ITEM	MANUAL MODE	AUTO MODE
User Can View and Adjust Menu Settings	Yes *	via Quick Setpoint Adjust
User Can Access the Review Menu	Yes	No
Process Control Can Be Running	Yes	Yes
System will try to Relight the Burner if the Pilot is Turned Off Due to Normal Process Control	Yes	Yes
System State Shown on the Home Screen	Always	During State Change
System will Attempt to Relight the Burner if the Flame Goes Out Unexpectedly	No	Yes
Process Setpoint can be Easily Adjusted via the "Quick Setpoint Adjust" feature	No	Yes
The System can be Controlled Manually via the Pilot, Ignite, and Main keys	Yes	No
Manual Indicator Light On	Yes	No
Auto Indicator Light On	No	Yes

* Menus 1-3 only when process control is running, all menus when stopped.

3.2.2 Home Screen

The Home Screen is shown on the display after power up, after waking the display from sleep, and after the user acknowledges a shutdown message. It is the starting point for most user interaction with the menu system. To return to the Home Screen from any point in the user interface, the user can press and hold the OK key for three seconds.

On the Home Screen, the Process Temperature is always shown on the bottom line of the display. The top line differs depending on mode. In Manual Mode, the top line shows the system state. In Auto Mode, it shows the Process Setpoint instead.

The accessibility of other features from the Home Screen also differs depending on mode. For example, the System Menus and Review Menu are only accessible in Manual Mode whereas the Quick Setpoint Adjust feature is only available in Auto Mode. For more information on which features are available in which modes, refer to Sections 3.5.3 (Adjusting Settings & Reviewing Status).

AVAILABLE FEATURES WITHIN OPERATIONAL MODES

MODE	DISPLAY	MENUS	REVIEW	SETPOINT ADJUST
Manual	System State Process Temperature	Yes	Yes	No
Auto	Process Setpoint Process Temperature	No	No	Yes

3.2.3 System State

The System State is the Process Control State of the system. It is shown on the display for a few seconds before and after a state change. In Manual Mode, the top line of the Home Screen always shows the System State. For a complete list of the Process Control States, refer to section 4.2.

3.2.4 Quick Setpoint Adjustment

The Quick Setpoint Adjust feature is only available on the Home Screen while running in Auto Mode. It allows the user to quickly adjust the Process Setpoint using the up and down keys. The change takes effect immediately and does not need to be saved by pressing ok. If password protection is enabled, a password will need to be entered before this feature can be used. If the Pilot Off and/or Low Fire Setpoints are enabled, this feature will also adjust them. In this case, each press of the up or down key will adjust all of these setpoints by 1 degree up or down. All other setpoints are not affected by this feature.

3.2.5 System Menus

The System Menus store all of the system settings in an organized fashion. These menus are also used to show historical and system status information as well as to provide access to calibration features. These menus cannot be accessed while the system is running in Auto Mode. Some menus can only be accessed while the system is stopped. Some menus require a Level 2 password and others require an optional Level 1 password.

3.2.6 Review Menu

The Review Menu provides a quick way for an operator to check key setpoints and system status (accessible only in Manual Mode).

3.2.7 Firmware Version Screen

The Firmware Version Screen shows the firmware version of all cards in the system including the Door Card, Terminal Card, and any installed Expansion Cards.

3.2.8 Warning Messages

When the system detects a warning condition, it will flash a warning message across the bottom line of the Home Screen. Some messages can be dismissed by pressing the OK key (eg, "Unit restarted from LVL event"). Others persist until the warning condition is resolved (eg, "LO Volt Warning").

3.2.9 Shutdown Screen

When the system shuts down as a result of an alarm condition, it will flash the word "SHUTDOWN" in large text on the display alternately with a more detailed message explaining the reason that the system shut down. The Shutdown Screen can always be dismissed by pressing OK, toggling the Start Contact, or sending the Start Command via Modbus.

3.3 Menu Map

The following sections include brief descriptions of each PF2100 Menu, including the valid settings range, default setting, and the location in this document where more detailed information can be found.

HOME SCREEN

System State / Proc SP
Process Temperature

REVIEW MENU

ESD Setpoint
Process Setpoint
Low Fire Setpoint$_5$
Pilot Off Setpoint$_6$
4-20 High Level Setpoint$_2$
4-20 Low Level Setpoint$_2$
4-20 High Pressure Setpoint$_3$
4-20 Low Pressure Setpoint$_3$
Flame
Aux Temp$_1$
4-20 Level Reading$_2$
4-20 Pressure Reading$_3$
TC Debug Screen$_{11}$
Alarms$_4$

SYSTEM MENUS (1-4)

1-SETPOINTS	2-HISTORY	3-SYSTEM INFO	4-SYSTEM SETUP

LEVEL 1 ▲ ▼ ▲ ▲ OR LEVEL 2 ▲ ▼ ▲ ▲ ▼ ▲ PASSWORD MAY BE REQUIRED$_9$

LEVEL 2 PASSWORD$_{10}$

1-SETPOINTS	2-HISTORY	3-SYSTEM INFO	4-SYSTEM SETUP
Pilot Off Setpoint$_6$	Relights	High Temp TC Reading	Auto Restart
Low Fire Setpoint$_5$	Flame Fails	Process TC Reading	Purge Time
Process Setpoint	Resets	4-20mA Output Percent	Pilot to Main Delay
Low Temp Alarm Setpoint	ESDs	Ambient Temp / + Door Card Temp$_{11}$	Restart Attempts
Deadband	High Pressure ESDs	Voltage Reading / + Door Card Voltage$_{11}$	Level Event Restart
AUX Setpoint$_1$	Low Pressure ESDs	Commission Date	Pressure/Level Delay
	Level ESDs	Location	Alarm Mode
	Thermocouple Errors	Control State$_{11}$	Password Enable (menus 1-3)
	Terminal Card Errors	Terminal Card State$_{11}$	Display Sleep
	System Errors		Pilot Valve Power Setting
	View Event Log		Main Valve Power Setting
	Clear History		System Voltage Setting
			Temperature Display Units
			Commission Date Entry$_8$
			Commission Location Entry$_8$
			Reset to Factory Defaults

EVENT LOG

Event 1
Event 2
⋮
Event 31
Event 32

SYSTEM MENUS (5-7)

5 - CONTROL SETUP	**MENU** →	6 - EXPANSION CARDS	**MENU** →	7 - CALIBRATION [11]

OK ↓ ... **OK** ↓ ... **OK** ↓

LEVEL 2 ▲ ▼ ▲ ▲ ▼ ▲ PASSWORD MAY BE REQUIRED [10]

OK ↓ ... **OK** ↓ ... **OK** ↓

High Temp ESD Setpoint	4-20 Expansion Card Enable	Cal Process TC Zero
Process Control Input	4-20 Level Low Setpoint [2]	Cal High Temp TC Zero
Low Fire Enable	4-20 Level High Setpoint [2]	Cal Aux TC Zero
Low to High Fire Delay [3]	4-20 Level Range [2]	Cal Process TC Span
Pilot Off Enable	4-20 Level Units [2]	Cal High Temp TC Span
AUX Temp Mode	4-20 Pressure Low Setpoint [3]	Cal Aux TC Span
4-20 Output Mode	4-20 Pressure High Setpoint [3]	Cal 4-20 Level Zero [2]
4-20 Low Fire Setting [7]	4-20 Pressure Range [3]	Cal 4-20 Level Span [2]
4-20 Gain Setting [7]	4-20 Pressure Units [3]	Cal 4-20 Pressure Zero [3]
	MODBUS Enable/Address	Cal 4-20 Pressure Span [3]
	4-20 Card FW Version	Cal 4-20 Out Zero
	MODBUS Card FW Version	Cal 4-20 Out Span
		Display TC Zero Factors
		Display TC Span Factors
		Display 4-20 PRS Factors
		Display 4-20 LVL Factors
		Clear Cal

SCREEN	NAVIGATION	ADJUSTMENTS
HOME SCREEN (AUTO)	N/A	▲ ▼ TO ADJUST PROCESS SETPOINT IN REAL TIME*
HOME SCREEN (MANUAL)	**MENU** ▲ ▼ TO ENTER REVIEW	N/A
REVIEW	▲ ▼ TO CYCLE **OK** TO RETURN HOME	N/A
EVENT LOG	▲ ▼ TO CYCLE **OK** TO RETURN HOME	N/A
SYSTEM MENUS	**MENU** TO CYCLE **OK** TO RETURN HOME	▲ ▼ TO ADJUST **OK** TO ACCEPT **MENU** TO CANCEL
ANY	**MODE** TOGGLES MODES (AUTO/MANUAL) ▲ + ▼ CHECK FIRMWARE VERSIONS & ENTER DEBUG MODE **OK** PRESS AND HOLD FOR 3s TO EXIT DEBUG MODE, LOCK MENUS AND RETURN HOME	N/A

*Will also adjust Pilot Off and Low Fire Setpoints if enabled.

FOOTNOTES

1 Hidden when Aux Thermocouple is disabled in Menu 5.
2 Hidden when 4-20 Input Card is disabled in Menu 6 or LVL DIP Switch disabled on card.
3 Hidden when 4-20 Input Card is disabled in Menu 6 or PRS DIP Switch disabled on card.
4 Hidden when No Alarms are present.
5 Hidden when Low Fire is disabled in Menu 5.
6 Hidden when Pilot Off is disabled in Menu 5.
7 Hidden when 4-20 Output Mode in Menu 5 = "Temperature Out."
8 Edit fields using arrow keys. Advance fields using OK.
9 Required if enabled in Menu 4, and after password times out.
10 Required after password times out.
11 Viewable in Debug Mode.

3.3.1 Setpoints (MENU 1)

This menu is used to adjust the Process Control Setpoints.

MENU MAP	ON SCREEN	BRIEF DESCRIPTION	RANGE	DEFAULT SETTING	SECTION	
Pilot Off Setpoint	Pilot Off Setpnt	Adjusts the temperature at which the Pilot Valve will turn off when Pilot Off is enabled.	1 to 1349°C (34 to 2460°F)	85°C (185°F)	3.4.10	
Low Fire Setpoint	Low Fire Setpnt	Adjusts the temperature at which the Low Fire Valve will turn off when Low Fire is enabled.	2 to 1349°C (36 to 2460°F)	Hidden, 85°C (185°F)	3.4.10	
Process Setpoint	Proc Setpnt	Adjusts the temperature at which the High Fire/Main Valve will turn off	1 to 1349°C (34 to 2460°F)	80°C (176°F)	3.4.10	
Low Temp Alarm Setpoint	Low Temp Alarm Setpnt	Adjusts the temperature where the Status Contact will close, if enabled.	Disabled, 1 to 1349°C (34 to 2460°F)	Disabled	3.4.10	
Deadband	Deadband	Adjusts the Deadband. Used with the Process Setpoint and sometimes Low Fire and Aux Setpoints.	1 to 150°C (1 to 240°F)	2°C (3°F)	3.4.10	
Aux Setpoint	AUX Setpnt	Adjusts the Auxiliary Setpoint	0 to 1350°C (32 to 2462°F)	Hidden, 20°C (68°F)	3.4.10	

3.3.2 History (MENU 2)

This menu contains read only event counters and the event log.

MENU MAP	ON SCREEN	BRIEF DESRIPTION	RANGE	DEFAULT SETTING	SECTION	
Relights	Re-Lights	Number of Pilot Relight attempts.	0 to 1000	N/A	3.5.4	
Flame Fails	Flame Fails	Number of Shutdowns due to failure to light the pilot.	0 to 1000	N/A	3.5.4	

3.3.2 History (MENU 2) Continued...

MENU MAP	ON SCREEN	BRIEF DESRIPTION	RANGE	DEFAULT SETTING	SECTION
Resets	Resets	Number of power failures or manual resets.	0 to 1000	N/A	3.5.4
ESDs	ESDs	Number of system shutdowns caused by faults.	0 to 1000	N/A	3.5.4
High Pressure ESDs	HPR ESDs	Number of High Pressure Shutdowns.	0 to 1000	N/A	3.5.4
Low Pressure ESDs	LPR ESDs	Number of Low Pressure Shutdowns.	0 to 1000	N/A	3.5.4
Level ESDs	LVL ESDs	Number of Level Contact Shutdowns.	0 to 1000	N/A	3.5.4
Thermocouple Errors	TC Errs	Number of Thermocouple Shutdowns.	0 to 1000	N/A	3.5.4
Terminal Card Errors	Term Errs	Number of Terminal Card Shutdowns.	0 to 1000	N/A	3.5.4
System Errors	Sys Errs	Number of System Errors Shutdowns.	0 to 1000	N/A	3.5.4
View Event Log	View Event Log?	Log of recent events	Yes/No	No	3.5.5
Clear History	Clear History?	Clears all History and logged events	Yes/No	No	3.5.4 - 3.5.5

3.3.3 System Info (MENU 3)

This menu contains read only information about the system.

MENU MAP	ON SCREEN	BRIEF DESCRIPTION	RANGE	DEFAULT SETTING	SECTION
High Temp TC Reading	Hi Temp TC	Current High Temp Thermocouple reading	-50˚C to 1350˚C	N/A	3.4.9 - 3.4.10, 4.2
Process Temp TC Reading	Proc TC	Current Process Thermocouple reading	-50˚C to 1350˚C	N/A	3.4.9 - 3.4.10, 4.2
4-20mA Output Percent	4-20 Output	Current status of the 4-20mA Output	0 to 100%	N/A	3.4.2, 4.2.5

3.3.3 System Info (MENU 3) Continued...

MENU MAP	ON SCREEN	BRIEF DESCRIPTION	RANGE	DEFAULT SETTING	SECTION	
Ambient Temp	Ambient Temp	Current ambient temperature. Used for thermocouple cold junction compensation.	-55°C to 65°C (-70°F to 150°F)	N/A	2.6.3	
Voltage Reading	System Voltage	Current voltage applied to the system	8V to 35V	N/A	3.4.12	
Commision Date	Commission Date	Date that the system was commissioned (if entered by user)	DD-MMM-YYYY	N/A	3.4.5	
Location	Location	The install location of the system (if entered by user)	N/A	N/A	3.4.5	
Control State	Control State	Debug Information	N/A	Hidden		
Terminal Card State	Term Card	Debug Information	N/A	Hidden		

3.3.4 System Setup (MENU 4)

This menu contains various optional system settings. It cannot be accessed while the PF2100 is running.

MENU MAP	ON SCREEN	BRIEF DESCRIPTION	RANGE	DEFAULT SETTING	SECTION	
Auto Restart	Auto Restart	Enables system to restart from a power failure, low pressure, or high voltage event	On/Off	Off	3.4.11	
Purge Time	Purge Time	Adjusts the time from all valves closed to Pilot relight attempts	10- 900 sec	30 sec	3.4.13	
Pilot to Main Delay	Pilot to Main Delay	Adjusts the time from Pilot proven to Main Valve opening	5- 600 sec	15 sec	3.4.13	
Restart Attempts	Restart Attempts	Adjusts the number of Restart Attempts after an unexpected flame failure before a shutdown	0- 3	3	3.4.11	

3.3.4 System Setup (MENU 4) Continued...

MENU MAP	ON SCREEN	BRIEF DESCRIPTION	RANGE	DEFAULT SETTING	SECTION
Level Event Restart	Level Event Restart	Enables recovery from a Low Level event	On/Off	Off	3.4.11
Pressure/Level Delay	PRS/LVL Delay	Pressure and Level shutdown delay	On/Off	Off	3.4.13
Alarm Mode	Alarm Mode	Adjusts the behaviour of Status Contact relative to Start Contact	Alarm when Off, No Alm When Off	No Alm when Off	3.4.3
Password Enable	Password	Enable Password Protection (Menu 1-3)	On/Off	Off	3.4.8
Sleep Mode for the Display	Display Sleep	Enable Sleep Mode for the Display	Never, After 10 Min	Never	3.4.6
Pilot Valve Power Setting	Pilot Solenoid PWM	Adjusts the Pilot Valve PWM duty cycle	Off, 80%, 60%, 40%, 20%	60%	3.4.14
Main Valve Power Setting	Main Solenoid PWM	Adjusts the Main Valve PWM duty cycle	Off, 80%, 60%, 40%, 20%	60%	3.4.14
System Voltage Setting	System Voltage	Configures the expected input voltage for the system	12V, 24V	12V	3.4.12
Temperature Display Units	Temp Units	Configures the temperature units displayed by the system	Fahrenheit, Celsius	Celsius	3.4.6
Commission Date Entry	Commission Date	Set the date that the system was commissioned	DD-MMM-YYYY	01-JUN-2012	3.4.5
Commission Location Entry	Commission Loc	Set the install location of the system. 14 Characters Max.	A-Z, 0-9 -. /		3.4.5
Reset to Factory Defaults	Restore Factory Defaults?	Restore all settings to the factory default	Yes/No	No	3.5.7

3.3.5 Control Setup (MENU 5)

This menu contains various optional Process Control settings. It cannot be accessed while the PF2100 is running.

MENU MAP	ON SCREEN	BRIEF DESCRIPTION	RANGE	DEFAULT SETTING	SECTION
High Temp ESD Setpoint	High Temp ESD Setpoint	Adjusts the High Temperature shut-down setpoint	2 to 1350°C (36 to 2462°F)	90°C (194°F)	3.4.10
Process Control Input	Process Control	Configure the thermocouple used as the Process Temperature	Process TC, AUX TC	Process TC	3.4.9
Low Fire Enable	Low Fire	Enables Low Fire feature and setpoint	Disabled, on at Proc Setpnt, on at Low Fire Setpnt	Disabled	3.4.9
Low to High Fire Delay	Low to High Fire Delay	Adjusts the time from Low Fire Valve opening to High Fire Valve opening, when Low Fire is enabled	30- 600 sec	Hidden, 30 sec	3.4.13
Pilot Off Enable	Pilot Off	Enables Pilot Off feature and setpoint	Disabled, Enabled	Enabled	3.4.9
Aux Temp Mode	AUX Temp Mode	Configures how the Auxiliary Thermo-couple is used.	Disabled, Display Only, Temp Main Ctl, Temp ESD	Disabled	3.4.9
4-20 Output Mode	4-20 Out Mode	Configures 4-20 Output mode	Valve Control, Temperature Out	Valve Control	3.4.2
4-20 Low Fire Setting	4-20 Out Lo Fire Setting	Sets the minimum output for the 4-20mA Output when used for Valve Control.	0 to 70%	40%	3.4.2
4-20 Gain Setting	4-20 Out Cntrl Gain	Sets the adjustment speed of the control loop for the 4-20mA Output when used for Valve Control.	0.1 to 1%/s	0.5%/s	3.4.2

3.3.6 Expansion Cards (MENU 6)

This menu contains settings relating to expansion cards.

MENU MAP	ON SCREEN	BRIEF DESCRIPTION	RANGE	DEFAULT SETTING	MORE INFO
4-20 Input Card Enable	4-20 Input Card Enabled	Enable the 4-20mA Expansion Card and setpoints	No/Yes	No	3.4.1
4-20 Level Low Setpoint	4-20 LVL Low Setpnt	Adjusts 4-20 Low Level trip point	0-Max Volume	Hidden, 60m3	3.4.1
4-20 Level High Setpoint	4-20 LVL High Setpnt	Adjusts 4-20 High Level trip point	0-Max Volume	Hidden, 117m3	3.4.1
4-20 Level Range	4-20 LVL Range	Adjusts Max Level of the tank	0-10000	Hidden, 120m3	3.4.1
4-20 Level Units	4-20 LVL Units	Adjusts the display units for the 4-20mA Level Input	%, m3, BBL, GAL,L	Hidden, m3	3.4.1
4-20 Pressure Low Setpoint	4-20 PRS Low Setpnt	Adjusts 4-20 Low Pressure trip point	0-High Setpoint	Hidden, 3.0 PSI	3.4.1
4-20 Pressure High Setpoint	4-20 PRS High Setpnt	Adjusts 4-20 High Pressure trip point	Low setpoint – Max Pressure	Hidden, 25.0 PSI	3.4.1
4-20 Pressure Range	4-20 PRS Range	Adjusts Max pressure of the fuel train	0-2000	Hidden, 30.0 PSI	3.4.1
4-20 Pressure Units	4-20 PRS Units	Adjusts the display units for the 4-20mA Pressure Input	PSI, kPa, inWC, cmWC, ksc	Hidden, PSI	3.4.1
Enable control and address for the Modbus Module	Modbus Card	Enable control and address for the Modbus Expansion Card	Disabled, 1-128	Disabled	3.4.7
4-20 Card FW Version	4-20 FW	Display Expansion Card FW Version	N/A	N/A	3.4.1, 3.5.6
MODBUS Card FW Version	MBUS FW	Display Expansion Card FW Version	N/A	N/A	3.4.7, 3.5.6

3.3.7 Calibration (MENU 7)

This menu is used to adjust the calibration of thermocouples, 4-20mA Output, and 4-20mA Expansion Card inputs. This menu is hidden by default.

MENU MAP	ON SCREEN	DESCRIPTION	RANGE	DEFAULT SETTING	SECTION
Cal Process TC Zero	Cal Proc TC Zero?	Calibrate Process Thermocouple zero point by shorting the Input	N/A	N/A	3.5.8
Cal High Temp TC Zero	Cal HiTemp TC Zero?	Calibrate High Temp Thermocouple zero point by shorting the Input	N/A	N/A	3.5.8
Cal Aux TC Zero	Cal AUX TC Zero?	Calibrate Aux Thermocouple zero point by shorting the Input	N/A	N/A	3.5.8
Cal Process TC Span	Cal Proc TC Span: xxC	Calibrate Process Thermocouple span point by applying a calibrated reference then adjust the on screen value	N/A	N/A	3.5.8
Cal High Temp TC Span	Cal HiTemp TC Span: xxC	Calibrate High Temp Thermocouple span point by applying a calibrated reference then adjust the on screen value	N/A	N/A	3.5.8
Cal Aux TC Span	Cal AUX TC Span: xxC	Calibrate Aux Thermocouple span point by applying a calibrated reference then adjust the on screen value	N/A	N/A	3.5.8
Cal 4-20 Level Zero	Calibrate 4-20 LVL Zero?	Calibrate 4-20mA Level Input zero point by applying a calibrated 4mA reference	N/A	N/A	3.5.8
Cal 4-20 Level Span	Calibrate 4-20 LVL Span?	Calibrate 4-20mA Level Input span point by applying a calibrated 20mA reference	N/A	N/A	3.5.8
Cal 4-20 Pressure Zero	Calibrate 4-20 PRS Zero?	Calibrate 4-20mA Pressure Input zero point by applying a calibrated 4mA reference	N/A	N/A	3.5.8
Cal 4-20 Pressure Span	Calibrate 4-20 PRS Span?	Calibrate 4-20mA Pressure Input span point by applying a calibrated 20mA reference	N/A	N/A	3.5.8
Cal 4-20 Out Zero	Cal 4-20 Out Zero: x	Calibrate 4-20mA Output zero point by adjusting until a multimeter reads 4mA	N/A	N/A	3.5.8

MENU MAP	ON SCREEN	DESCRIPTION	RANGE	DEFAULT SETTING	SECTION
Cal 4-20 Out Span	Cal 4-20 Out Span: x	Calibrate 4-20mA Output zero point by adjusting until a multimeter reads 20mA	N/A	N/A	3.5.8
Display TC Zero Factors	Cal Factors Zero w x y z	Thermocouple zero point calibration factors for Debug	N/A	N/A	3.5.8
Display TC Span Factors	Cal Factors Span w x y z	Thermocouple span point calibration factors for Debug	N/A	N/A	3.5.8
Display 4-20 PRS Factors	4-20 PRS Factors Z=x S=y	4-20mA Pressure zero point and span point calibration factors for Debug	N/A	N/A	3.5.8
Display 4-20 LVL Factors	4-20 LVL Factors Z=x S=y	4-20mA Level zero point and span point calibration factors for Debug	N/A	N/A	3.5.8
Clear Cal	Clear All Cal Capital Data?	Restore all calibration factors to 0	Yes/No	No	3.5.8

3.3.8 Review Menu

This read only menu allows various commonly needed system settings and status parameters to be reviewed while the system is running.

MENU MAP	ON SCREEN	BRIEF DESCRIPTION	RANGE	DEFAULT SETTING	SECTION
ESD Setpoint	ESD Setpnt	Temp at which system will shutdown			3.4.10
Process Setpoint	ProcSetpnt	Temp at which High Fire / Main Valve will turn off			3.4.10
Low Fire Setpoint	LF Setpnt	Temp at which Low Fire Valve will turn off if Low Fire is enabled			3.4.10
Pilot Off Setpoint	Pilot off	Temp at which Pilot Valve will turn off if Pilot is enabled			3.4.10

3.3.8 Review Menu Continued...

MENU MAP	ON SCREEN	BRIEF DESCRIPTION	RANGE	DEFAULT SETTING	SECTION
4-20 High Level Setpoint	HLV	Level at which 4-20mA Output contacts will toggle			3.4.1
4-20 Low Level Setpoint	LLV	Level below which the system will shutdown or wait if Level Event Restart is enabled			3.4.1
4-20 High Pressure Setpoint	HPR	Pressure above which the system will shutdown after Main			3.4.1
4-20 Low Pressure Setpoint	LPR	Pressure below which the system will shutdown or wait if Auto Restart is enabled			3.4.1
Flame	Flame	Current Flame Quality			5.1, 5.5
Aux Temp	AUX Temp	Current Aux Temp reading			3.4.9, 4.2
4-20 Level Reading	LVL	Current 4-20mA Level input reading			4.4.1
4-20 Pressure Reading	PRS	Current 4-20mA Pressure input reading			4.4.2
TC Debug Screen	DH=ww TH=xx TP=yy TA=zz	Shows the current readings of all temperature sensors simultaneously always in degrees celsius regardless of the display unit setting DH=Door Card High Temp, Thermocouple TH=Termincal Card, High Temp Thermocouple TP=Terminal Card Process Thermocouple TA=Terminal Card Ambient Thermocouple			
Alarms	Alarms	Lists up to 3 simultaneous alarm codes if any are present			5.3

3.4 Settings (Grouped Alphabetically)

This section of the document contains detailed descriptions of all system settings organized alphabetically by topic.

Not all settings need to be modified for a given installation. The settings that need to be modified for every installation are these:

1. Valve Modulation Settings (Pilot and Main)
2. System Storage Setting
3. Process Control Settings
4. Process Setpoints (High Temp ESD, Pilot Off, Process, Low Fire, Low Alarm, Deadband)

3.4.1 4-20mA Expansion Card Settings

These settings all apply to the 4-20mA Expansion Card which must be installed in the PF2100's expansion slot. These settings can all be found in Menu 6. Some of these settings will be hidden if the card is not installed or enabled.

4-20 EXPANSION CARD ENABLE (MENU 6)
For the Tank Level Settings to be visible, the LVL DIP Switch on the
4-20mA Input Card must be enabled.

For the Tank Level Settings to be visible, the LVL DIP Switch on the 4-20mA Input Card must be enabled.

4-20 LOW LEVEL SETPOINT (MENU 6)
If the 4-20mA LVL input drops below this setpoint, the burner will turn off to prevent damage to the tank and fire tube.

4-20 HIGH LEVEL SETPOINT (MENU 6)
If the 4-20mA LVL input exceeds this setpoint, the LVL output contacts on the 4-20mA Input Card will toggle.

4-20 LEVEL RANGE (MENU 6)
Specifies the maximum capacity of the tank's 4-20mA level transmitter.

4-20 LEVEL UNITS (MENU 6)
Specifies the units of measurement. Note that this may have an impact on measurement accuracy.

For the Fuel Train Pressure Settings to be visible, the PRS DIP Switch on the 4-20mA Input Card must be enabled.

4-20 LOW PRESSURE SETPOINT (MENU 6)
If the 4-20mA PRS input drops below this setpoint, the burner will turn off to prevent flame from burning back into the fuel train.

4-20 HIGH PRESSURE SETPOINT (MENU 6)
If the 4-20mA PRS input exceeds this setpoint, the system will shut down.

4-20 PRESSURE RANGE (MENU 6)
Specifies the maximum capacity of the tank's 4-20mA Pressure transmitter.

4-20 PRESSURE UNITS (MENU 6)
Specifies the units of measurement. Note that this may have an impact on measurement accuracy.

3.4.2 4-20mA Output Settings

The 4-20mA Output is built into the Terminal Card (ie, not part of the 4-20mA Expansion Card). It can be used for either of two different purposes. To echo the process temperature to a PLC, or to control a proportional valve.

4-20 OUTPUT MODE (MENU 5)
Set to either "Process Temperature" or "Valve Control" to specify the mode of the 4-20mA Output.

Process Temperature
In this mode, the 4-20mA Output will encode the "Proc Temp" signal as a 4-20mA signal. Note that the "Proc Temp" may correspond to either the Process Thermocouple or the AUX Thermocouple input depending on the Process Control setting. The signal is scaled such that 4mA = 0C and 20mA = the High Temp ESD Setpoint.

Valve Control
In this mode, the 4-20mA Output is intended to drive a proportional valve. The signal is scaled such that 4mA = "Valve Closed" and 20mA = "Valve Fully Open". A temperature feedback system is used to determine how much the valve should be opened at any given point in time. The amount that the proportional valve is open when the main turns on can also be specified. In addition, the speed at which adjustments are made can be adjusted to mitigate undershoot and overshoot.

This feature is always used with a traditional safety solenoid valve connected to the PF2100's Main Valve output. In addition the Low Fire setting must also be enabled by setting it to "On at Proc Setpoint".

4-20 LOW FIRE SETTING (MENU 5)
This setting is only available when the "4-20 Output Mode" is set to "Valve Control". It is used to specify the minimum amount that the proportional valve will ever be open. This is therefore also the starting position of the main valve each time it is turned on. This can be set to any value from 0% to 70%.

4-20 GAIN SETTING (MENU 5)
This setting is only available when the "4-20 Output Mode" is set to "Valve Control". It is used to specify the speed at which valve adjustments are made. It can be set to any value from 0.1%/s to 1.0%/s.

3.4.3 Alarm / Status Contact Settings

The Status Contact will always open if the system is shut down due to an alarm condition. There are two settings that affect the behaviour of the Status Contact: Alarm Mode and Low Temp Alarm Setpoint.

ALARM MODE (MENU 4)
The Alarm Mode is used to select whether the Status Contact will open when the unit is stopped remotely via the Start Contact. It can be set to either of the following two values:

Alarm When Off
In this case, the Status Contact will open when the unit is stopped (turned off) remotely via the Start Contact.

No Alarm When Off
In this case, the Status Contact will remain closed when the unit is stopped (turned off) remotely via the Start Contact.

LOW TEMP ALARM SETPOINT (MENU 1)
When enabled the Status Contact will remain open until the Process Temperature exceeds this setpoint. See section 3.4.10 (Process Setpoints) for more detail.

3.4.4 Auxiliary Temperature Settings

There are two settings that affect the way that the Auxiliary Temperature signal is used by the system: Process Control and Aux Temp Mode.

PROCESS CONTROL (MENU 5)
This setting is used to select the thermocouple input that is associated with the Auxiliary Temperature signal. See section 3.4.9 (Process Control Settings) for more details.

AUX TEMP MODE (MENU 5)
Aux Temp mode can be set to any of the following:

Disabled
The Aux Temp signal is ignored by the system.

Display Only
The Aux Temp signal is only used for display purposes. It can be read on the PF2100 display in manual mode via the Review Menu. It can also be read remotely via the Modbus Expansion Card if it is installed and enabled.

Temp Main Ctl
In this mode, the Aux Temp signal is used as a secondary Process Control input. This modifies the normal Process Control algorithm by adding the additional requirement that the signal be below the Aux Setpoint for the Main Valve(s) to open.
See sections 3.4.9 (Process Control Settings)

Temp ESD
In this mode, the Aux Temp signal is used as an auxiliary ESD input. In addition to the normal process control algorithm, if the Aux Temp signal ever rises above the Aux Setpoint, the system will shut down.

3.4.5 Commissioning Settings

The date and location of commissioning can be stored in the PF2100. This information is optional and is purely for the customer's use. These two settings can be viewed in menu 3 and edited in menu 4.

COMMISSION DATE (MENU 4)
This is the date on which the PF2100 was commissioned. Use the Up and Down keys to edit the date and OK to advance to the next date field.

COMMISSION LOCATION (MENU 4)
This is the location where the PF2100 was installed. Use the Up and Down keys to edit each character and OK to advance to the next character.

3.4.6 Display Settings

There are two settings that affect the behavior of the display: Display Sleep and Temperature Display Units.

DISPLAY SLEEP (MENU 4)
When enabled, the display will turn off to conserve power after 10 minutes of inactivity (no user key presses). Otherwise, the display will always remain on.

TEMPERATURE DISPLAY UNITS (MENU 4)
The PF2100 always operates in Celsius. This includes storage of temperature setpoints, thermocouple measurements, temperature calculations, and modbus communications. This setting only affects the temperature units on the display. This may lead to small rounding errors when operating in Fahrenheit.

3.4.7 Modbus Expansion Card Settings

This setting all applies to the Modbus Expansion Card which must be installed in the PF2100's expansion slot.

MODBUS ENABLE/ADDRESS (MENU 6)
The Modbus Card is disabled by setting the address to zero and enabled by setting the address to any non-zero value. The address is shown on the display as a decimal number which can be set to any value in the range of 1 to 254. This corresponds to hexadecimal values 0x01 to 0xFE.

3.4.8 Password Setting

There are two levels of password protection. Menus 1-3 and the Quick Setpoint Adjust feature may be optionally protected by the Level 1 Password. Menus 4-7 are always protected by the Level 2 Password. These passwords can not be modified.

Level 1 Password △ ▽ △ △ [OK]

Level 2 Password △ ▽ △ △ ▽ △ [OK]

For convenience, once a password has been entered it unlocks all menus that it protects for a period of time. Therefore it does not need to be re-entered again when returning to the menu later. The menus will remain unlocked for 10 minutes or until the user manually locks the menus again. To lock the menus manually, press and hold the OK button for 3 or more seconds. The display will briefly show "Password Logout" to indicate that the menus are now locked again.

PASSWORD ENABLE (MENU 4)
When enabled, the Level 1 or Level 2 Password must be entered to access menus 1-3 and the Quick Setpoint Adjust feature.

3.4.9 Process Control Settings

For the PF2100, Process Control means controlling the temperature of a process. The process usually involves heating fluid in a tank or pipe. The Process Control algorithm requires a primary temperature control signal. This is called the Process Temperature or Proc Temp. The control algorithm can optionally accept an auxiliary temperature control signal. This signal is called the Auxiliary Temperature or Aux Temp.

These two signal are not necessarily the same as "Proc TC" and "Aux TC" which are the names of the physical thermocouple inputs on the Terminal Card. The "Aux Temp" signal is only compared to the Aux Setpoint, if enabled.

There are four settings that affect the behaviour of the Process Control Algorithm: Process Control Input, Low Fire Enable, Pilot Off Enable, and Aux Temp Mode.

Note that changing any of these settings may cause the Process setpoints (High Temp ESD, Pilot Off, Low Fire, Process, Low Temp Alarm, Deadband, and Aux) to reset to factory defaults. A warning message will display if this occurs.

PROCESS CONTROL INPUT (MENU 5)
This setting selects which thermocouple inputs will be used as the primary and auxiliary temperature control signals as shown in the following table.

SETTING	PROC TEMP	AUX TEMP
Proc TC	Proc TC	Aux TC
Aux TC	Aux TC	Proc TC

In previous firmware versions this could also be set to "Disabled". In this case the Process Control Algorithm was disabled and the system would ensure the burner was always lit and running. This was useful when it was desired to have an external device, such as a PLC, controlling the process. In this scenario, the PLC would turn the system on and off using the Start contacts. This behaviour can still be achieved by simply setting all Process Setpoints to maximum.

LOW FIRE ENABLE (MENU 5)
This setting is used to enable/disable use of the Low Fire Setpoint in the Primary Process Control Algorithm. Low Fire can be enabled in two different modes: "On at Proc Setpoint" and "On at Low Fire Setpoint". In the first case, the Low Fire Valve will close when it exceeds the Low Fire Setpoint, but will not reopen until it drops below the Process Setpoint minus Deadband. In the second case, the Low Fire Valve will close when it exceeds the Low Fire Setpoint, and will reopen after it drops below the Low Fire Setpoint minus Deadband.

PILOT OFF ENABLE (MENU 5)
This setting is used to enable/disable use of the Pilot Off Setpoint in the Primary Process Control Algorithm.
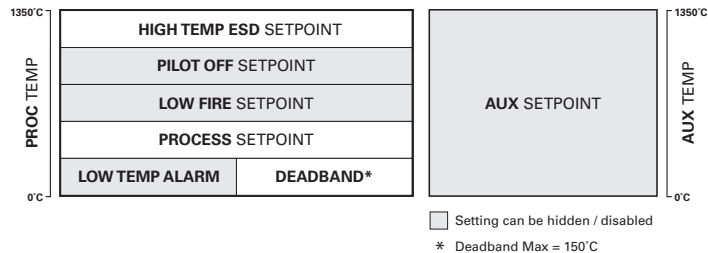
AUX TEMP MODE (MENU 5)
When this setting is set to "Temp Main Ctl", the Auxiliary Process Control Algorithm is enabled. See section 3.4.4 (Auxiliary Temperature Settings) for more details.
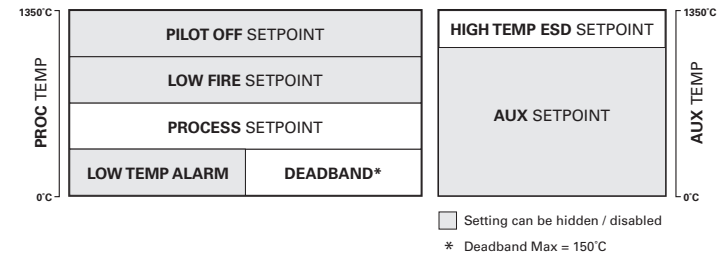
3.4.10 Process Setpoints

There are seven Process Setpoints in total, four of which may be disabled (hidden from menus). The order of the setpoints will vary depending on the value of the Process Control Input setting.

The following diagrams illustrate the upper and lower bounds of each setpoint and their order. Setpoints that are shaded may be disabled. When a setpoint is disabled the upper and lower bounds of the adjacent setpoints are adjusted accordingly.

Process Control Input Setting: Proc TC

1350°C	1350°C
HIGH TEMP ESD SETPOINT	
PILOT OFF SETPOINT	AUX SETPOINT
LOW FIRE SETPOINT	
PROCESS SETPOINT	
LOW TEMP ALARM / DEADBAND*	
0°C	0°C

PROC TEMP / AUX TEMP

☐ Setting can be hidden / disabled
∗ Deadband Max = 150°C

Process Control Input Setting: Aux TC

1350°C	1350°C
PILOT OFF SETPOINT	HIGH TEMP ESD SETPOINT
LOW FIRE SETPOINT	
PROCESS SETPOINT	AUX SETPOINT
LOW TEMP ALARM / DEADBAND*	
0°C	0°C

PROC TEMP / AUX TEMP

☐ Setting can be hidden / disabled
∗ Deadband Max = 150°C

In the Process Control Algorithm, the "Proc Temp" signal is the one that is compared to the Pilot Off, Low Fire, Process, and Deadband setpoints.

HIGH TEMP ESD SETPOINT (MENU 5)
This setting is used to protect the burner and other equipment from overheating. If either the High Temp or Process thermocouple readings exceed this setpoint, the burner will immediately shut down.

This setting can be set to a maximum of 1350°C. The minimum value is 1°C higher than the setpoint below it. Depending on which settings are enabled this will be the Pilot Off, Low Fire, or Process Setpoint.

PILOT OFF SETPOINT (MENU 1)
If the Process Temperature goes above this setting the Pilot Valve will close and the system state will change to "Waiting on Temp". This is often done to conserve pilot gas when it is not needed. This setting is hidden if "Pilot Off" in menu 5 is set to "Disabled".

This setting can be set to a maximum of 1°C below the High Temp ESD Setpoint. The minimum value is the same as the setpoint below it. Depending on which settings are enabled this will be the Low Fire or Process Setpoint.

3.4.10 Process Setpoints Continued...
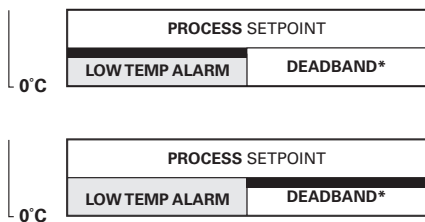
LOW FIRE SETPOINT (MENU 1)
If the Process Temperature goes above this setting the Low Fire Valve will close and the system state will change to "Pilot On". This setting is hidden if "Low Fire" in menu 5 is set to "Disabled".

This setting can be set to a maximum of 1˚C below the High Temp ESD Setpoint or the Pilot Off Setpoint if it is enabled. The minimum value is 1˚C above the Process Setpoint.

PROCESS SETPOINT (MENU 1)
If the Process Temperature goes above this setting the Main Valve will close and the system state will change to "Low Fire".

This setting can be set to a maximum of 1˚C below the High Temp ESD Setpoint, the Pilot Off Setpoint if it is enabled, or 1˚C below the Low Fire Setpoint if it is enabled. The minimum value is the Low Temp Alarm or Deadband (whichever is larger).

PROCESS SETPOINT		
LOW TEMP ALARM	**DEADBAND***	0˚C

PROCESS SETPOINT		
LOW TEMP ALARM	**DEADBAND***	0˚C

LOW TEMP ALARM SETPOINT (MENU 1)
If the Process Temperature goes below this setting the Low Temp Alarm will be asserted and the status contact will open.

This setting can be set to a maximum of the Process Setpoint. The minimum value is 1˚C. Set to 0˚C to disable the Low Temp Alarm.

DEADBAND (MENU 1)
The deadband setting provides temperature hysteresis below the Process Setpoint. For the main valve to open, the temperature must be below Process Setpoint minus the deadband setting. For the main valve to close, the temperature must be above the Process Setpoint.

The deadband setting also provides provides temperature hysteresis below the Low Fire Setpoint when the Low Fire Enable setting is set to "On At Low Fire Setpoint". In this case, the Low Fire valve will open when the Process Temperature is below the Low Fire Setpoint minus the Deadband setting and will close when it is above the Low Fire Setpoint.

The deadband setting also provides provides temperature hysteresis below the Aux Setpoint when the Aux Temp Mode setting is set to "Temp Main Ctl". In this case, the main valve(s) will open when the Auxuliary Temperature is below the Aux Setpoint minus the Deadband setting and will close when it is above the Aux Setpoint.

This setting can be set to a maximum of the 150˚C or the Process Setpoint, whichever is lower. The minimum value is 1˚C.

AUX SETPOINT (MENU 1)
This setpoint is enabled only if "Aux Temp Mode" in Menu 5 is set to "Temp Main Ctl"or "Temp ESD". In the first case, if the Auxiliary Temperature goes above the Aux Setpoint, the Main Valves will close. The pilot will remain on until the Process Temp exceeds the Pilot Off Setpoint (if Pilot Off is enabled). In the second case, the system will shut down if the Auxiliary Temperature goes above the Aux Setpoint.

This setting can be set to a maximum of 1350˚C. The minimum value is 0˚C.

3.4.11 Restart Settings

The PF2100 can be configured to automatically restart after certain alarm conditions clear. The number of restart attempts that the system will make under certain circumstances can be configured. There are three settings that affect restart behaviour: Auto Restart, Level Event Restart, and Restart Attempts.

The number of restart attempts the system will make differs depending on the mode and the reason that the burner is being relit.

MODE	PROCESS CONTROL	FLAME OUT
Manual	3	0
Auto	3	User Configurable

AUTO RESTART (MENU 4)
If this setting is enabled, the system will restart automatically once all alarm conditions are cleared and if the reason that the system stopped running was any of the following:

1. System Input Voltage too low (including power cycle)
2. System Input Voltage too high
3. Low Pressure Contact open
4. 4-20mA Pressure Input below Low Setpoint

LEVEL EVENT RESTART (MENU 4)
If this setting is enabled, the system will restart automatically once all alarm conditions are cleared and if the reason that the system stopped running was any of the following:

1. Level Contact open
2. 4-20mA Level Input below Low Setpoint

RESTART ATTEMPTS (MENU 4)
A restart attempt is an attempt by the system to light the burner. These can occur under two types of circumstances:

1. As a result of normal process control. Examples Include:

   a. The system is started by a user by switching to Auto Mode
   b. The system is started remotely via the Start Contact
   c. The Pilot Turns off as a result of process control and then is automatically turned back on after the temperature drops below the Pilot Off Setpoint
   d. The system automatically restarts after recovering from one of the situations described in the Auto Restart or Level Restart sections

2. As a result of the pilot flame unexpectedly going out. Examples Include:

   a. The gas supply is cut off
   b. Excessive wind blows out the burner flame
   c. Insufficient oxygen supply snuffs out the burner flame
   d. The flame detection rod becomes dirty and unable to detect flame

3.4.12 System Voltage

The PF2100 is designed to operate with a nominal 12VDC or 24VDC Power Supply. It will not be damaged by applying any voltage in or near this range regardless of menu settings. The valves attach to the PF2100 are not designed to accept both 12VDC and 24VDC. They typically only work with one or the other. If the valve voltage ratings are exceeded, the valves may become damaged.

SYSTEM VOLTAGE SETTING (MENU 4)
The purpose of this setting is to select voltage limits to protect and ensure the proper operation of the attached valves. If the PF2100 detects that the input voltage is getting close to these limits, it will present a warning message on the display. If the voltage exceeds these limits, it will shut down which cuts power to the valves to prevent them from being damaged.

The following options are available:

VOLTAGE SETTING	CHOOSE THIS OPTION WHEN...
12V	The Power Supply and all valves are 12VDC
24V	The Power Supply and all valves are 24VDC

The exact limits used are shown in the following table. Note that the high voltage limits also depend on the "Pilot Valve Power Setting" and "Main Valve Power Setting" which can also be found in Menu 4.

VOLTAGE SETTING	PILOT / MAIN VALVE PWM SETTING	LOW VOLT ALARM	LOW VOLT WARNING	HIGH VOLT WARNING	HIGH VOLT ALARM
12V	At least one equal to 100%	<= 8.4V	<= 9.9V	>= 14.6V	>= 15.6V
12V	Both less than 100%	<= 8.4V	<= 9.9V	>= 16.1V	>= 16.8V
24V	At least one equal to 100%	<= 17.9V	<= 19.9V	>= 28.6V	>= 30.0V
24V	Both less than 100%	<= 17.9V	<= 19.9V	>= 33.1V	>= 40.0V

Note that if the system has the "Auto Restart" feature enabled (Menu 4), the system will automatically relight the burner after a high or low voltage alarm clears. Otherwise, the system will remain shut down.

3.4.13 Timing Delay Settings

There are four time delay settings that can be adjusted to match the needs of various applications. These are as follows:

PURGE TIME (MENU 4)
This setting is used to set the minimum amount of time that must elapse between when all valves are known to be closed and the next time that the pilot is lit. This will be the minimum elapsed time between relights and also the minimum amount of time before lighting the burner after a loss of power. The purge time ensures that dangerous amounts of gas are not present in the fire tube before the pilot is lit thus reducing the risk of an explosion. Generally, the larger the burner, the larger the purge time should be. Local codes may dictate the amount of purge time required for a given application. This setting can be set to a minimum of 10s and a maximum of 900s.

PILOT-TO-MAIN DELAY (MENU 4)
This setting is used to set the minimum amount of time that must elapse between the pilot successfully lighting and the main (or low fire) valve opening. The Pilot-to-Main Delay is used to ensure that enough draft is established before opening the main valve. If this is not done, the volume of gas flowing through the main valve can snuff out the flame due to insufficient oxygen supply. Generally, the larger the burner, the larger the delay should be. This setting can be set to a minimum of 5s and a maximum of 600s.

LOW-TO-HIGH FIRE DELAY (MENU 5)
This setting is used to set the minimum amount of time that must elapse between the low fire valve opening and the high fire valve opening. This setting is only available if Low Fire is enabled in Menu 5. The Low-to-High Fire Delay is used to ensure that enough draft is established before switching to high fire. If this is not done, the volume of gas flowing through the high fire valve can snuff out the flame due to insufficient oxygen supply. Generally, the larger the burner, the larger the delay should be. This setting can be set to a minimum of 30s and a maximum of 600s.

PRESSURE/LEVEL DELAY (MENU 4)
This setting is used to reject spurious electrical noise that may be present on the Low Pressure Contact, Level Contact, and the 4-20mA Expansion Card (if installed). This noise can come from electrical interference, mechanical vibration, or small oscillations in gas pressure and tank level. The rejection is accomplished by requiring these contacts to remain open for a continuous period of time (called the "delay") before shutting down. In the case of the 4-20mA Expansion Card, the Pressure and Level readings must remain below their respective low setpoints for the delay time before shutting down. If Auto Restart or Level Event Restart are enabled, the delays are applied before entering a waiting state as opposed to shutting down.

Note that these delays only apply to the contacts opening and the 4-20mA signals dropping below their respective low setpoints. The system does not have a delayed response to the contacts closing or rising above their 4-20mA low setpoints. There is also no delay applied to rising above or falling below the 4-20mA high setpoints.

This setting can be set to either enabled or disabled. When disabled, there is a small delay. When enabled, the delay is lengthened. There are separate delays for Pressure and Level. The following table lists the delays used in all cases.

SETTING	LOW PRESSURE DELAY	LEVEL DELAY
Enabled	6s	20s
Disabled	2s	2s

3.4.14 Valve Modulation Settings

The Pilot and Main Valve outputs can be modulated with a pulsed DC signal to conserve power through a technique known as Pulse Width Modulation (PWM). The duty cycle of the modulation can be adjusted independently for each valve. Each can be set to 100%, 80%, 60%, 40%, or 20%. The 100% setting applies continuous DC voltage (ie, no modulation) to the valve and is the highest power option. The 20% setting applies DC voltage only 20% of the time and is the lowest power option. Only valves that are compatible with modulation should be used with a duty cycle less than 100%. These valves are sometimes called "Low Power" or "Peak-and-Hold" valves since they require only short periodic voltage pulses to hold the valve open. Do not use a duty cycle of 100% with low power valves as this can damage them. Likewise, do not use a duty cycle of 20% with a High Power valve as it will not work properly.

If a multimeter is used to measure the valve power, the measured voltage will be reduced proportionally with the PWM setting.

There are two valve power settings that can be adjusted to match the needs of various applications. These are as follows:

PILOT VALVE POWER SETTING (MENU 4)
Adjusts the PWM Duty Cycle of the Pilot Valve output.

MAIN VALVE POWER SETTING (MENU 4)
Adjusts the PWM Duty Cycle of both the Low Fire and High Fire Valve outputs.

3.5 Operating the System

This section of the manual describes how to operate the system including how to start and stop it in various ways, how to review key system settings, how to adjust setpoints while the system is running, how to check the system firmware versions, how to reset the system settings to defaults, and how to manually calibrate the various inputs and outputs.

3.5.1 Starting the System

There are five different ways to start the system:

MANUALLY VIA THE MODE & OK KEYS
This is the most common way to start the system.

The steps to do this are as follows:

1. Ensure that the system is stopped in Manual Mode with all alarms clear so that the Home Screen displays "Ready".

2. Press the Mode Key and a confirmation prompt will show on the Display.

3. Press the OK Key to confirm that you want to start the system. From this point onward, the system's process control algorithm will take over to turn the valves on and off as required by the systems settings and the current Process Temperature. The system will also be in Auto Mode which will allow the system to automatically restart from faults specified in the system settings.

MANUALLY VIA THE PILOT, IGNITE, AND MAIN KEYS
This method of starting the system is useful primarily during commissioning when it may be desired to test the pilot valve, main valve, ignition circuit, and flame detection circuitry in a slow sequence.

The steps to do this are as follows:

1. Ensure that the system is stopped in Manual Mode with all alarms clear so that the Home Screen displays "Ready".

2. Press and hold the Pilot Key to open the Pilot Valve. Listen to ensure that you can hear the Pilot Valve click open and that you can hear the hiss of gas flowing through it.

3. While continuing to hold the Pilot Key, press and hold the Ignite Key to being sparking. Visually check the Pilot Nozzle for spark and flame. If you cannot see the Pilot Nozzle, listen for the sound of sparking and try to determine if it is coming from the ignition rod or from some other unintended location.

4. Release the Ignite Key and check that the display shows a Flame Quality of 100%.

5. After about 5 seconds, the display will show "Pilot On" if the Pilot was successfully lit.

6. Press the Main Key to open the Main Valve. The system will count down the Pilot-to-Main Delay and then open the Main Valve if the Process Temperature warrants it.

7. From this point on, the system's process control algorithm will take over to turn the valves on and off as required by the system's settings and the current Process Temperature.

8. Press the Mode Key to switch the system fully into Auto Mode which will allow the system to automatically restart from faults specified in the system settings.

AUTOMATICALLY WHEN POWER IS APPLIED
If the Auto Restart feature is enabled, the system will attempt to Automatically Start after a power failure. This will only succeed if all alarms are clear.

REMOTELY VIA THE START CONTACT
This method can be used to start the system from a remote switch mounted elsewhere on the site or via a PLC output contact.

The steps to do this are as follows:

1.   Open the Start Contact and then close it again to acknowledge any Shutdown Message that may be showing on the display. If no Shutdown Message is present, it is not required to do this but it will still work if you do.

2.   Repeat the step above once to remotely start the system in Auto Mode. This will only work if all alarms are clear.

REMOTELY VIA THE MODBUS CARD (IF INSTALLED)
This method can be used to start the system via a remote device over a Modbus RTU network.

The steps to do this are as follows:

1.   The remote device should write "1234" to the 40100 register to place the system into Auto Mode.

2.   The remote device should poll the 40100 register and wait for it to clear to zero which indicates that the system has processed the command.

3.   The remote device should poll the 10001 register and wait for it to become set to one which indicates that process control is running.

3.5.2 Stopping the System

There are five different ways to stop the system:

MANUALLY VIA THE STOP KEY
This is the most common way to stop the system.

The steps to do this are as follows:

1. Press the Stop key. The system will stop immediately.

MANUALLY VIA THE AUTO KEY
This method of stopping the system is useful primarily during commissioning when it may be desired to test the pilot valve, main valve, ignition circuit, and flame detection circuitry in a slow sequence.

The steps to do this are as follows:

1. Press the Mode Key to switch the system into Manual Mode which will prevent the system from automatically restarting from faults specified in the system settings.

2. Press the Main Key to close the Main Valve and disable process control.

3. Press the Pilot Key to close the Pilot Valve and stop the system.

REMOTELY VIA THE START CONTACT
This method can be used to stop the system from a remote switch mounted elsewhere on the site or via a PLC output relay

The steps to do this are as follows:

1. Open the Start Contact and leave it open. The system will stop immediately.

VIA A SHUTDOWN CONDITION
Whenever any shutdown condition is present, the system will stop and will not automatically restart after the condition is removed. Examples of conditions that cause a Shutdown include the Process Temperature rising above the High Temp ESD Setpoint, the High Pressure Contact Opening, or the ESD Contact Opening. Many other conditions can cause shutdowns. Some are dependent on system settings.

REMOTELY VIA THE MODBUS CARD (IF INSTALLED)
This method can be used to stop the system via a remote device over a Modbus RTU network.

The steps to do this are as follows:

1. The remote device should write "4321" to the 40100 register to stop the system.

2. The remote device should poll the 40100 register and wait for it to clear to zero which indicates that the system has processed the command.

3. The remote device should poll the 10001 register and wait for it to become set to zero which indicates that the system is stopped.

3.5.3 Adjusting Settings & Reviewing Status

There are four ways to check and adjust system settings and to view system status:

HOME SCREEN

In Manual Mode, the Home Screen displays the System State and the Process Temperature. In Auto Mode, the Home Screen displays the Process Setpoint and the Process Temperature. The information displayed on the Home Screen is read only except as noted below. The Home Screen is accessible at any time by pressing and holding the OK Key for 3 seconds.

QUICK SETPOINT ADJUST

In Auto Mode, the process setpoints can be adjusted directly from the Home Screen using the Up and Down Keys. This feature allows several setpoints to be adjusted simultaneously by moving them all up or down together as a group. The setpoints that are affected are the Low Fire Setpoint (if enabled), the Process Setpoint, and the Pilot Off Setpoint (if enabled). The adjustments are limited on the high and low side as described in section 3.4.10 (Process Setpoints). Any changes made take effect immediately. This feature is protected by the L1 Password when password protection is enabled in Menu 4.

REVIEW MENU

The Review Menu is used to check key setpoints and to view various real time system measurements such as temperature, pressure, and level. All information in this menu is read only. The Review Menu is only accessible when the system is in Manual Mode. To access it, press the Up or Down Key while on the Home Screen.

SYSTEM MENUS

Menus 1, 4, 5, and 6 are used for checking and adjusting settings. Menus 2 and 3 are used for read only values. Menu 7 is used for calibration and is usually hidden. The System Menus are accessed by pressing the Menu Key from the Home Screen while in Manual Mode. Some menus are not accessible while the system is running.

Menu 3 contains some system status information that is not found elsewhere in the menu system. Refer to section 3.3.3 (System Info) for more details.

When the system is stopped, all settings can be checked and adjusted. When the system is running, only some settings may be checked or adjusted. The following table illustrates the circumstances under which various settings can be checked and adjusted. For more information about the menu system and the user interface, refer to section 3.2 (Software User Interface).

MODE	HOME SCREEN	QUICK SETPOINT CHANGE AVAILABLE	REVIEW MENU AVAILABLE	SYSTEM MENUS AVAILABLE
Manual Mode, System Stopped	System State Process Temperature	No	Yes	1-6 (and sometimes 7)
Manual Mode, System Running	System State Process Temperature	No	Yes	1-3
Auto Mode, System Running	Process Setpoint Process Temperature	Yes	No	None

3.5.4 Viewing Event Counters

Menu 2 contains a series of counters that increment automatically in response to various events. These counters can be used to troubleshoot issues with a particular installation. Each counter will count to a maximum of 1000 and then will stop incrementing. At the bottom of Menu 2 is an option to clear these counters. Clearing the counters also clears the event log.

ESDs

Increments each time the system shuts down as a result of the ESD Contact opening, the High Temp ESD Setpoint being exceeded by either Process Temp or Aux Temp (if enabled), or a high or low voltage alarm.

FLAME FAILS

Increments each time the system shuts down as a result of failing to ignite the pilot within the allocated number of attempts.

HIGH PRESSURE ESDs

Increments each time the system shuts down as a result of the High Pressure Contact opening or the 4-20 Pressure reading exceeding the 4-20 High Pressure Setpoint.

LEVEL ESDs

Increments each time the system shuts down as a result of the Level Contact opening or the 4-20 Level reading dropping below the 4-20 Low Level Setpoint.

LOW PRESSURE ESDs

Increments each time the system shuts down as a result of the Low Pressure Contact opening or the 4-20 Pressure reading dropping below the 4-20 Low Pressure Setpoint.

THERMOCOUPLE ERRORS

Increments each time the system shuts down as a result of a thermocouple issue such as a short circuit, open circuit, or ground short.

RELIGHTS

Increments each time the system attempts to automatically re-ignite the pilot. The first ignition attempt after a manual start is not counted.

RESETS

Increments each time the door card is reset by a power loss or by manually pressing the reset button.

SYSTEM ERRORS

Increments each time the system shuts down as a result of an internal system error.

TERMINAL CARD ERRORS

Increments each time the system shuts down as a result of a terminal card error.

3.5.5 Viewing the Event Log

The Event Log can be accessed from the end of Menu 2. The log contains entries for various types of events such as, System Starts, Stops, Shutdowns, Menu Accesses, etc. The log holds a maximum of 32 events. The first event (#1) is the most recent and the last event (#32) is the oldest.

When the log is full, the oldest event is removed from the list to make room for the next newest event. Navigate through the log using the up and down arrow keys. Press OK to return to the Home Screen. The log can be cleared using the item at the end of Menu 2. Clearing the log also resets all event counters to zero.

The following is an alphabetical list of all possible Event Log entries including a brief description of their meaning and the associated counter which will increment when that event occurs:

ENTRY	DESCRIPTION	ASSOCIATED COUNTER
AUTO	The system switched to Auto Mode because the user pressed the MODE and OK button.	
AUX ESD	The "Aux Temp Mode" setting is set to "Temp ESD" and the Aux Temp signal exceeded the "Aux Setpoint".	ESDs
ESD	The system shut down as a result of the ESD contact being open.	ESDs
FLAME FAIL	The pilot went out and could not be relit automatically within the specified number of attempts (3 attempts on initial start; user defined for other cases).	Flame Fails
HI PRS ESD	The system shut down because the High Pressure Contact was opened or the "4-20mA High Pressure Setpoint" was exceeded.	High Pressure ESDs
HI VOLT	The system input voltage exceeded the High Voltage Alarm threshold.	ESDs
HT ESD	The "High Temp ESD Setpoint" was exceeded by either "Proc Temp" or "Aux Temp" (if enabled) and caused the system to shutdown.	ESDs
LEVEL ESD	The system shut down because the Level Contact was opened or the "4-20mA Low Level Setpoint" was dropped below.	Level ESDs
LO PRS ESD	The system shut down because the Low Pressure Contact was opened or the "4-20mA Low Pressure Setpoint" was dropped below.	Low Pressure ESDs

3.5.5 Viewing Event Log Continued...

ENTRY	DESCRIPTION	ASSOCIATED COUNTER	
LO VOLT	The system input voltage dropped below the Low Voltage Alarm threshold.	ESDs	
LOW ALARM	The "Proc Temp" signal dropped below the "Low Temp Alarm Setpoint".		
MANUAL	The system switched to Manual Mode because the user pressed the MODE button.		
MENU:CTL	Menu 5 "Control" was entered. This will show even if no settings are modified.		
MENU:SETPT	Menu 1 "Setpoints" was entered. This will show even if no settings are modified.		
MENU:SYS	Menu 4 "System" was entered. This will show even if no settings are modified.		
POC STOP	The "Proof of Closure Contact" was open when it should not have been causing the system to shutdown.		
RELIGHT	The pilot was successfully relit after it went out unexpectedly.	Relights	
RESET	The system was reset due to a loss of power or a manual press of the Door Card's reset button.	Resets	
RETRY	The Pilot failed to light and one or more retry attempts were made.		
RUNNING	The system successfully lit the pilot.		
START	The system switched to Auto mode at a point in time when the pilot was not lit.		
STOPPED	The system stopped because the user pressed the STOP button while the Pilot Valve was open.		
SYSTEM ERR	An internal system error has occurred.	System Errors	
TCERR:AUX	The AUX Thermocouple is out of range.	Thermocouple Errors	
TCERR:HT	The High Temp Thermocouple is out of range or grounded.	Thermocouple Errors	
TCERR:PROC	The Process Thermocouple is out of range.	Thermocouple Errors	

3.5.5 Viewing Event Log Continued...

ENTRY	DESCRIPTION	ASSOCIATED COUNTER	
TC NOT EQ	The system detected an unacceptable difference between the Process and High Temp Thermocouple readings. The acceptable difference varies with the HT ESD Setpoint (ESD) as follows: · 15C when ESD < 200C · 25C when 200C <= ESD < 400C · 35C when 400C <= ESD < 800C · 45C when 800C <= ESD		
TERM ERR	Communications between the Terminal Card and the Door Card has been interrupted.	Terminal Card Errors	

3.5.6 Viewing Firmware Versions

From any point in the User Interface press the Up and Down Keys simultaneously. The system will then show four different firmware versions in sequence:

CARD	CURRENT FW VERSION	NOTE
Door Card	DC FW: E1.8.115	
Terminal Card	TC FW: E1.8.101	
4-20mA Expansion Card	4-20 FW: v4.1	Will show "—" if not installed or not enabled in Menu 6
Modbus Expansion Card	MBUS FW: v4.1	Will show "—" if not installed or not enabled in Menu 6

The expansion card firmware versions are only shown if the cards are installed and enabled. They can also be viewed in menu 6.

3.5.7 Resetting to Defaults

The system settings can all be reset to factory defaults by following these instructions:

1. Ensure that the system is stopped

2. Navigate to the "Reset to Factory Defaults" menu item at the bottom of Menu 4

3. Use the Arrow Keys to change the setting to "Yes" and then press the OK Key

4. The system will display "Parameter Saved" and will then reboot

   After rebooting, the system will display the message "CONFIGU-RATION RESET TO DEFAULT" alternating with "Check Settings and Setpoints"

5. Press the OK Key to acknowledge this warning

3.5.7 Resetting to Defaults Continued...

This process only resets the user settings back to factory defaults and does not affect the calibration settings. To reset the calibration settings to defaults, refer to the Field Calibration section below.

Note that older versions of firmware did reset both the user settings and the calibration settings to defaults.

Also note that all settings are stored on the Door Card. If the Door Card is replaced for any reason, the settings will need to be re-entered and calibration may need to be performed.

3.5.8 Field Calibration

It is possible to field calibrate the thermocouples, the 4-20mA Output, and the two 4-20mA Inputs on the 4-20mA Expansion Card. In general, it should not be necessary to do this in the field because the system has already been calibrated at the factory. However, there are circumstances where this may be necessary such as if the door or terminal card was replaced in the field or if the system is very old and has drifted out of calibration. Before recalibrating the system, it is strongly recommended that you explore all other possible solutions first. For example, verify that system settings are correct and that the devices attached to the system are calibrated correctly. If it is deemed necessary to proceed with recalibrating the PF2100, follow the procedures below carefully. Failure to perform the calibration correctly may result in worse performance than if the system had been left alone.

The PF2100 uses a two-point calibration system to provide readings with greater accuracy than a single-point offset calibration. The first point compensates for any fixed offset in the system and the second point defines the slope. If the calibration fails for any reason, there is an option in the calibration menu to clear all calibration data.

CALIBRATING THE THERMOCOUPLES

For thermocouples, the first calibration point is zero volts which corresponds to the ambient temperature of the terminal block where the thermocouple plugs into the Terminal Card. The second calibration point is referenced to a known temperature that is well above the ambient temperature. This temperature is typically the hottest temperature at which the system will operate but should not be higher than 1350˚C and should not be lower than ambient + 20˚C.

The calibration procedure is as follows:

1. Ensure that the system is stopped.

2. Remove the 3 pairs of thermocouple wires (High Temp, Process, and Aux) from the P8 Pluggable Header on the Terminal Card.

3. Short each pair of thermocouple inputs individually using a jumper or short piece of copper wire (ie, short HT+ to HT-, short Proc+ to Proc-, and short Aux+ to Aux-).

4. Press the UP and Down Keys simultaneously to unlock the Calibration Menu (Menu 7) which is normally hidden.

5. Press the Menu Key repeatedly until Menu 7 is shown.

6. Press OK, enter the L2 Password if prompted △ ▽ △ △ ▽ △ [OK]

7. "Cal Proc TC Zero" will show on the display.

8. Press OK and the message "Calibrating Wait…" will appear on the display for about 5 seconds. Afterwards, the message "Parameter Saved" will show on the display briefly.

9. Press the Menu Key to go to the next item.

10. Repeat steps 8 and 9 for the "Cal HiTemp TC Zero" and "Cal Aux TC Zero" menu items.

11. Reconnect the 3 pairs of thermocouple wires (High Temp, Process, and Aux) to the P8 Pluggable Header on the Terminal Card.

12. Set the High Temp, Process, and Aux thermocouples to a known reference temperature using a dry block or other calibrated reference. The reference temperature should be at least 20C above the ambient temperature and preferably close to the maximum planned operating temperature.

13. "Cal Proc TC Span" will show on the display.

14. Use the Up and Down Keys to adjust the temperature displayed on the PF2100 to match the temperature being applied to the thermocouple. Note that multiple key presses may be required before the temperature value on the display changes. This is because each key press is adjusting a fractional multiplication factor internal to the system.

15. Press OK and the message "Parameter Saved" will show on the display briefly.

16. Press the Menu Key to go to the next item.

17. Repeat steps 14-16 for the "Cal HiTemp TC Span" and "Cal Aux TC Span" menu items.

18. Press and hold the OK key for 3 seconds until the message "Password Logout" is displayed on the screen. The Calibration Menu is now hidden again.

CALIBRATING THE 4-20MA OUTPUT

For the 4-20mA Output, the first calibration point is 4mA and the second calibration point is 20mA. You will need a current meter capable of measuring current to 0.1mA accuracy.

The calibration procedure is as follows:

1. Ensure that the system is stopped.

2. Connect a current meter in series with the 4-20mA Output.

3. Set the current meter to a range setting that covers both 4mA and 20mA.

4. Press the UP and Down Keys simultaneously to unlock the Calibration Menu (Menu 7) which is normally hidden.

5. Press the Menu Key repeatedly until Menu 7 is shown.

6. Press OK, enter the L2 Password if prompted △ ▽ △ △ ▽ △ OK

7. Press the Menu Key repeatedly until "Cal 4-20 Out Zero" is shown on the display.

8. Use the Up and Down Keys to adjust the output current until the current meter reads 4.0mA.

9. Press OK and the message "Parameter Saved" will show on the display briefly.

10. Press the Menu Key repeatedly until "Cal 4-20 Out Span" is shown on the display.

11. Use the Up and Down Keys to adjust the output current until the current meter reads 20.0mA.

12. Press OK and the message "Parameter Saved" will show on the display briefly.

13. Press and hold the OK key for 3 seconds until the message "Password Logout" is displayed on the screen. The Calibration Menu is now hidden again.

CALIBRATING THE 4-20MA INPUTS

For the 4-20mA Output, the first calibration point is 4mA and the second calibration point is 20mA. You will need a handheld process calibrator such as the Fluke 725.

The calibration procedure is as follows:

1. Ensure that the system is stopped.

2. Ensure card is installed and enabled in menu 6. The LVL and PRS DIP switches must also be enabled on the card.

3. Press the UP and DOWN Keys.

4. Press the Menu Key repeatedly until Menu 7 is shown.

5. Press OK, enter the L2 Password if prompted △ ▽ △ △ ▽ △ OK

6. Connect the process calibrator's negative lead to the ground pin on the 4-20mA Input Card.

7. Calibrate the Level Zero

   a. Press the Menu Key repeatedly until "4-20 Level Zero Calibration = No" is shown on the display.

   b. Use the Up or Down key to select "Yes" and begin the calibration process. The display will now read "Apply 4mA then press OK".

   c. Disconnect any wiring that is connected to the Level input and instead attach the process calibrator's positive lead in its place.

   d. Turn on the process calibrator and set it to source a current of 4mA (0%).

   e. Press the OK key and the message "Calibrating Wait…" will appear for several seconds followed by the message "Parameter Set" after the calibration has successfully completed.

8. Calibrate the Level Input's Span point:

   a. Press the Menu Key repeatedly until "Calibrate 4-20 LVL Span?" is shown on the display.

   b. Use the Up or Down key to select "Yes" and begin the calibration process. The display will now read "Apply 20mA then press OK".

   c. Set the process calibrator to source a current of 20mA (100%).

   d. Press the OK key and the message "Calibrating Wait…" will appear for several seconds followed by the message "Parameter Set" after the calibration has successfully completed.

   e. Disconnect the process calibrator from the Level input and reconnect any wiring that was removed from it previously.

9. Calibrate the Pressure Input's Zero point:

   a. Press the Menu Key repeatedly until "Calibrate 4-20 PRS Zero?" is shown on the display.

   b. Use the Up or Down key to select "Yes" and begin the calibration process. The display will now read "Apply 4mA then press OK".

   c. Disconnect any wiring that is connected to the Pressure input and instead attach the process calibrator's positive lead in its place.

3.5.8 Field Calibration Continued...

  d. Turn on the process calibrator and set it to source a current of 4mA (0%).

  e. Press the OK key and the message "Calibrating Wait…" will appear for several seconds followed by the message "Parameter Set" after the calibration has successfully completed.

10. Calibrate the Pressure Input's Span point:

  a. Press the Menu Key repeatedly until "Calibrate 4-20 PRS Span?" is shown on the display.

  b. Use the Up or Down key to select "Yes" and begin the calibration process. The display will now read "Apply 20mA then press OK".

  c. Set the process calibrator to source a current of 20mA (100%).

  d. Press the OK key and the message "Calibrating Wait…" will appear for several seconds followed by the message "Parameter Set" after the calibration has successfully completed.

  e. Disconnect the process calibrator from the Pressure input and reconnect any wiring that was removed from it previously.

11. Disconnect the process calibrator's negative lead from the ground pin on the 4-20mA Input Card.

3.5.8 Field Calibration Continued...

RESETTING CALIBRATION DATA
If you want to reset the calibration settings to default, use the "Cal Data" option at the end of Menu 7.

This process resets the following calibrations to defaults:

- Calibration of the Thermocouples
- Calibration of the 4-20mA Output
- Calibration of the 4-20mA Intput

The procedure to do this is as follows:

1. Ensure that the system is stopped

2. Press the UP and Down Keys simultaneously to unlock the Calibration Menu (Menu 7) which is normally hidden.

3. Press the Menu Key repeatedly until Menu 7 is shown.

4. Press OK, enter the L2 Password if prompted △ ▽ △ △ ▽ △ OK

5. Press the Menu Key repeatedly until "Cal Data" is shown on the display

6. Use the Up or Down keys to select "Yes".

7. Press OK and the message "Parameter Saved" will show on the display briefly.

8. Press and hold the OK key for 3 seconds until the message "Password Logout" is displayed on the screen. The Calibration Menu is now hidden again.
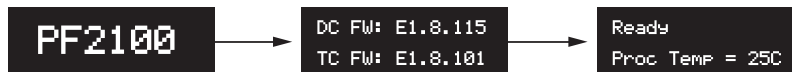
4 Modes & Behaviour

This section of the manual describes the behaviour of the PF2100 when various features are enabled vs disabled. Simplified state diagrams are provided and discussed to give a high level understanding of how the system works. Following this, detailed behaviour descriptions are provided including process charts to illustrate the behaviour of the system when various features are enabled and in response to various external events. These are provided for the Process Control Algorithm, Input/Output Contacts, and Expansion Cards. Finally, examples of common applications are provided including process charts and recommended Process Control settings.

4.1 State Diagrams

The following diagrams illustrate the various states that the PF2100 goes through when the system is powered on, when starting the system in Auto or Manual modes, and once the Process Control algorithm takes over. When the PF2100 changes states while in Auto mode, the new state will be shown momentarily on the display. In Manual Mode, the current state is always shown on the display.

4.1.1 Power On Sequence

When power is applied to the system it will display "PF2100" in large text followed by the firmware versions of the Door and Terminal Card. The system will then display the Home Screen which will show the system state. The system state will be "Ready" if no alarms or present. Otherwise, the state will be "Alarm".

```
┌──────────────┐     ┌──────────────────┐     ┌───────────────────┐
│              │     │ DC FW: E1.8.115  │     │ Ready             │
│   PF2100     │ ──> │ TC FW: E1.8.101  │ ──> │ Proc Temp = 25C   │
│              │     │                  │     │                   │
└──────────────┘     └──────────────────┘     └───────────────────┘
```

4.1.2 Starting in Auto Mode
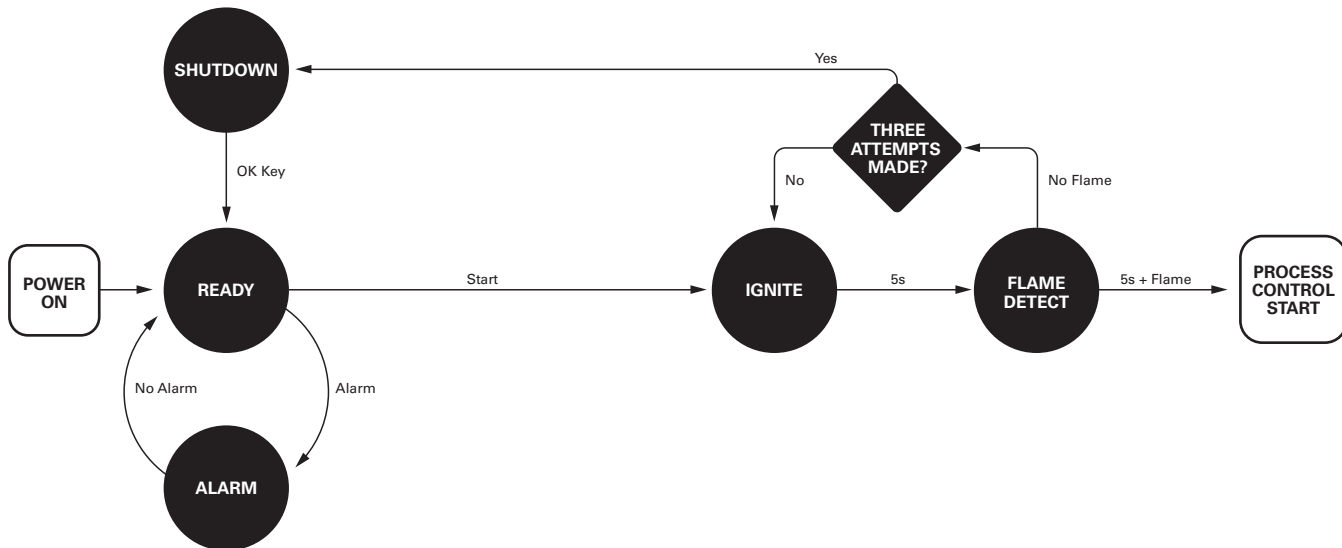
When the system is started in Auto Mode (by pressing the Mode and OK Keys), it will run through the ignition sequence automatically. In Auto Mode, the PF2100 will automatically attempt to relight the pilot if it ever goes out unexpectedly.

NOTE

The "Process Control" state in the diagram is actually a collection of several states that will be explained in more detail later.

4.1.3 Starting in Manual Mode

When the system is started in Manual Mode (using the Pilot, Ignite, and Main Keys), it must be manually moved through the ignition sequence. In Manual Mode, the PF2100 will NOT automatically attempt to relight the pilot if it ever goes out unexpectedly. It will only attempt to relight the pilot if it was turned off by the system as a result of normal process control (ie, Waiting on Temp, Waiting for Level, etc).

NOTE

The "Process Control" state in the diagram is actually a collection of several states that will be explained in more detail later.
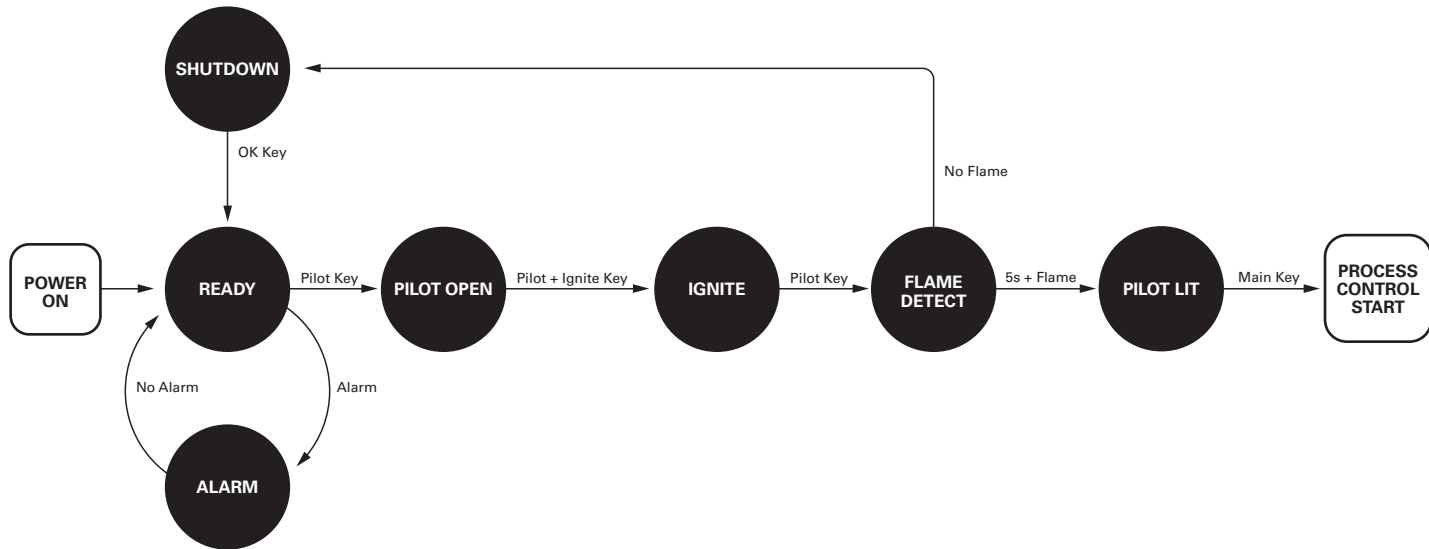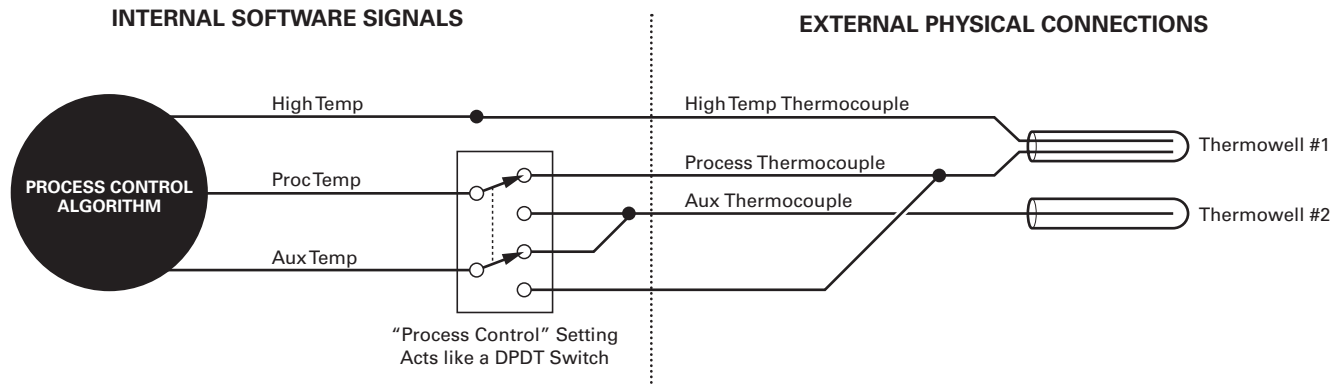
4.1.4 Process Control

The primary function of the PF2100 is to maintain a process at a user specified temperature. It first monitors the temperature and then makes adjustments as required to increase or decrease the temperature. This process of monitoring and controlling forms a closed loop control system that is referred to in this manual as "Process Control". The control is accomplished using a gas fired heater with an electronic ignition circuit and several electronic fuel valves (also called solenoids). The monitoring is accomplished using a flame detection circuit and up to three temperature measuring thermocouples.

The PF2100 implements Process Control using a software algorithm that takes three temperature signals as inputs: "High Temp", "Proc Temp", and "Aux Temp". By default, these signals correspond to the High Temp Thermocouple, the Process Thermocouple, and the Aux Thermocouple respectively. The Process Control setting allows the Process and Aux thermocouples to be swapped. This is useful in circumstances that will be explained later.

4.1.4 Process Control Continued...

In all circumstances the High Temp Thermocouple and the Process Thermocouple are expected to be mounted in a common thermowell. This is usually accomplished by using a duel element thermocouple. The software uses these two thermocouples as a check for each other to ensure that one or the other is not defective. If the readings from these two thermocouples do not agree within a specified amount of error, the system will shutdown.

The "High Temp" signal is used to protect the burner and other process equipment from being damaged from excessive heat. It cannot be disabled through any combination of process control settings.

The "Proc Temp" signal is the primary control signal for the process control algorithm. This signal is compared to the Deadband, Low Temp Alarm Setpoint, Process Setpoint, Low Fire Setpoint, and the Pilot Off Setpoints in order to control the temperature of the process.

The "Aux Temp" signal can be used as a secondary control signal within the process control algorithm. The way that this signal is used will vary depending on the "Aux Temp Mode" setting. Some settings enable an Aux Setpoint which this signal is compared to.
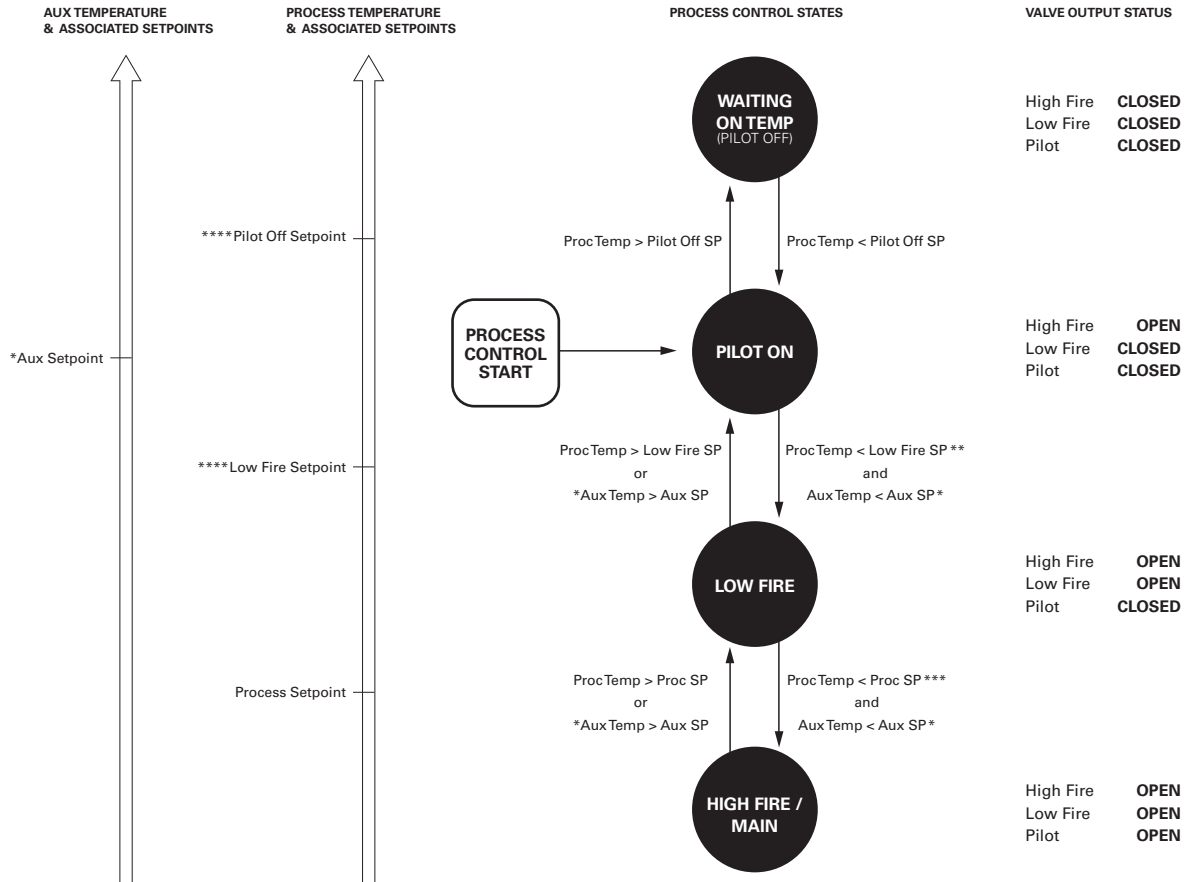
The following diagram illustrates the Process Control states for two different cases. In the one case only the Process Temperature signal is used. In the other case both the Process Temperature and Auxiliary Temperature signals are used. The system will automatically transition between these states in response to the temperature signals.

When the system transitions from the Pilot On state to the Low Fire state, the Pilot-Main-Delay must first elapse. If Low Fire is disabled, this Delay must elapse between the Pilot On state and the High Fire state. Similarily, when the system transitions from the Low Fire state to the High Fire state, the Low-to-High Fire Delay must first elapse. Between all other state transitions a minimum 30 second delay must elapse to prevent oscillation.

The Low Fire setpoint and Low Fire state are only used when Low Fire is enabled in menu 5. The Pilot Off setpoint and Waiting on Temp state are only used when Pilot Off is enabled in menu 5.

When "Aux Temp Mode" is set to "Temp Main Control" the Auxiliary Temperature signal is enabled as a control input as described previously. When the "Aux Temp" signal is above the "Aux Setpoint" the Process Control state is forced to be either "Pilot On" or "Waiting on Temp." The latter occurs only if Pilot Off is enabled and the Process Temp is above the Pilot Off Setpoint.

4.1.4 Process Control Continued...

AUX TEMPERATURE & ASSOCIATED SETPOINTS	PROCESS TEMPERATURE & ASSOCIATED SETPOINTS	PROCESS CONTROL STATES	VALVE OUTPUT STATUS

WAITING ON TEMP (PILOT OFF)

High Fire **CLOSED**
Low Fire **CLOSED**
Pilot **CLOSED**

****Pilot Off Setpoint

Proc Temp > Pilot Off SP   Proc Temp < Pilot Off SP

PROCESS CONTROL START   **PILOT ON**

High Fire **OPEN**
Low Fire **CLOSED**
Pilot **CLOSED**

*Aux Setpoint

Proc Temp > Low Fire SP
or
*Aux Temp > Aux SP

Proc Temp < Low Fire SP **
and
Aux Temp < Aux SP*

****Low Fire Setpoint

LOW FIRE

High Fire **OPEN**
Low Fire **OPEN**
Pilot **CLOSED**

Proc Temp > Proc SP
or
*Aux Temp > Aux SP

Proc Temp < Proc SP ***
and
Aux Temp < Aux SP*

Process Setpoint

HIGH FIRE / MAIN

High Fire **OPEN**
Low Fire **OPEN**
Pilot **OPEN**

* Used when Aux Temp Mode is set to "Temp Main Ctl"

** The Pilot-to-Main Delay must elapse before this transition will occur.

*** The Low-to-High Fire Delay must elapse before this transition will occur.

**** These setpoints may be diabled in menu 5.

4.1.5 Waiting States

In all waiting states, the system turns off the burner and pilot and waits for some event to occur before restarting. The Waiting on Temp state shown in the Process Control state diagram is one example of this. There are two other groups of waiting states which may be optionally enabled: Auto Restart and Level Event Restart. Each of these states can be entered automatically from any other Process Control state if the associated condition is satisfied. Once that condition is cleared, the system will automatically restart via the Relight procedure.

The following waiting states are enabled when the "Auto Restart" feature is enabled.
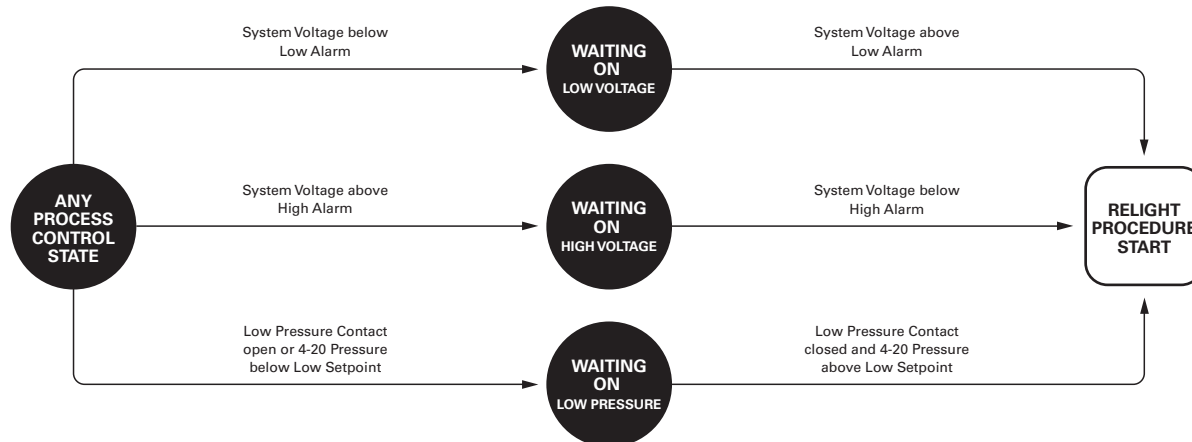
The following waiting state is enabled when the "Level Event Restart" feature is enabled.

4.1.6 Relight Procedure

After the system has been initially started, if it needs to be automatically relit, the procedure below is followed. Note that the number of retries varies depending on the mode and reason for pilot being off.
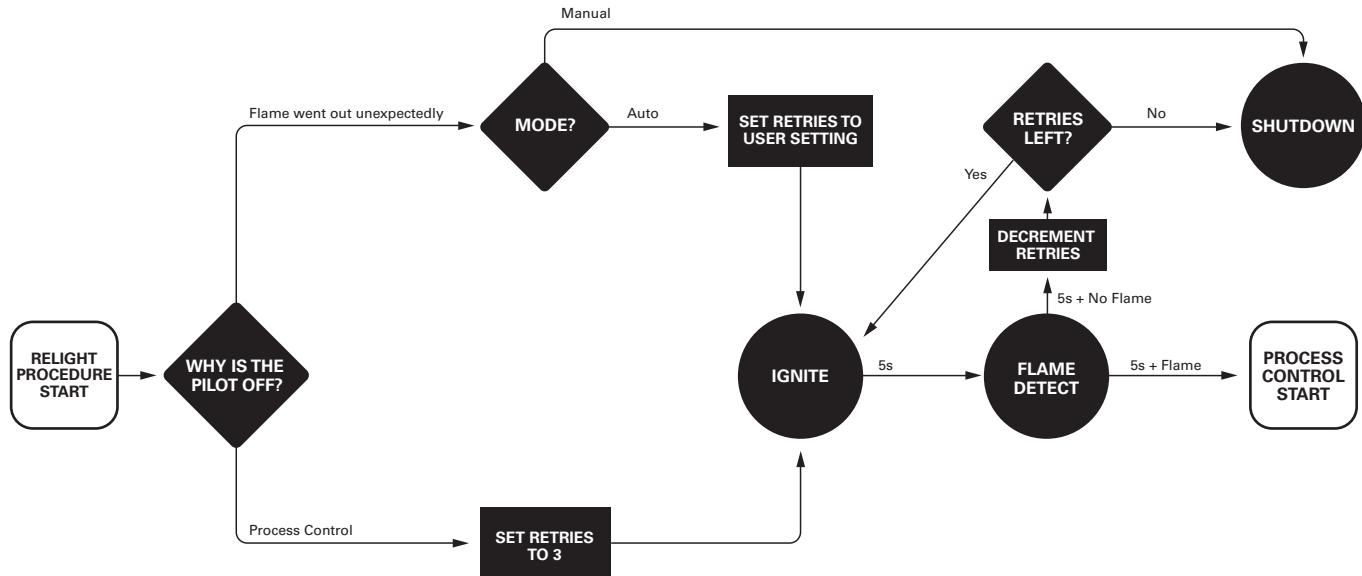
4.2 Process Control Behaviour

This section illustrates the behaviour of the process control algorithm in response to real-world situations.

4.2.1 Basic Process Control

In this scenario the Low Fire, Pilot Off, and Low Temp Alarm features are disabled. This results in the most basic Process Control configuration. If the Process Temperature exceeds the Process Setpoint, the main valve closes until the temperature falls below the Process Setpoint minus the Deadband setting. This setup fires the main fully until the thermocouple reading exceeds the Process Setpoint.

CHART

CHART EVENTS

❶ System is started, Pilot Valve opens, Proc Temp beings to increase slowly.

❷ Pilot-to-Main Delay elapses, Main Valve opens, Proc Temp increases faster.

❸ Proc Temp exceeds Process Setpoint, Main Valve closes, Proc Temp begins to drop.

❹ Proc Temp drops below Process Setpoint minus Deadband, Main Valve opens, Proc Temp begins to increase again.

4.2.2 Low Fire = On at Proc Setpoint

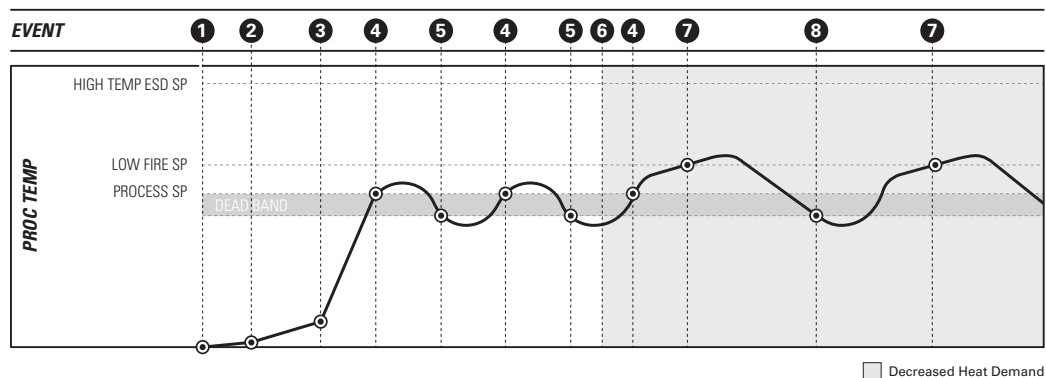This scenario is the same as the basic scenario except that the Low Fire feature has now been enabled. It has been set to turn on at the Process Setpoint. In this case, the Low Fire Valve will close when it exceeds the Low Fire Setpoint, but will not reopen until it drops below the Process Setpoint minus Deadband.

CHART

Decreased Heat Demand

CHART EVENTS

1 System is started, Pilot Valve opens, Proc Temp beings to increase slowly.

2 Pilot-to-Main Delay elapses, Low Fire Valve opens, Proc Temp increases faster.

3 Low-to-High Fire Delay elapses, High Fire Valve opens, Proc Temp increases even faster.

4 Proc Temp exceeds Proc Setpoint, High Fire Valve closes, Proc Temp begins to drop.

5 Proc Temp drops below Proc Setpoint minus Deadband, High Fire Valve opens again, Proc Temp begins to increase again.

6 The demand for heat decreases and the Proc Temp begins to rise.

7 The Proc Temp exceeds the Low Fire Setpoint, Low Fire Valve closes, and Proc Temp begins to drop.

8 The Proc Temp drops below Proc Setpoint minus Deadband, both Low Fire and High Fire Valves open, and Proc Temp begins to rise again.

4.2.3 Low Fire = On at Low Fire Setpoint

This scenario is the same as the basic scenario except that the Low Fire feature has now been enabled. It has been set to turn on at the Low Fire Setpoint. In this case, the Low Fire Valve will close when it exceeds the Low Fire Setpoint, and will reopen after it drops below the Low Fire Setpoint minus Deadband.
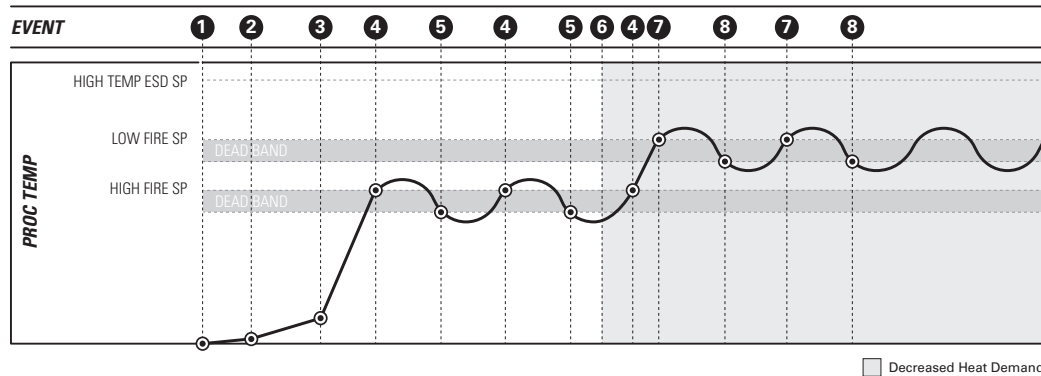
CHART

Decreased Heat Demand

CHART EVENTS

❶ System is started, Pilot Valve opens, Proc Temp beings to increase slowly.

❷ Pilot-to-Main Delay elapses, Low Fire Valve opens, Proc Temp increases faster.

❸ Low-to-High Fire Delay elapses, High Fire Valve opens, Proc Temp increases even faster.

❹ Proc Temp exceeds Proc Setpoint, High Fire Valve closes, Proc Temp begins to drop.

❺ Proc Temp drops below Proc Setpoint minus Deadband, High Fire Valve opens again, Proc Temp begins to increase again.

❻ The demand for heat decreases and the Proc Temp begins to rise.

❼ The Proc Temp exceeds the Low Fire Setpoint, Low Fire Valve closes, and Proc Temp begins to drop.

❽ The Proc Temp drops below Low Fire Setpoint minus Deadband, the Low Fire Valve opens, and Proc Temp begins to rise again.

4.2.4 Pilot Off

This scenario is the same as the basic scenario except that the Pilot Off feature has now been enabled. In this case, when the Proc Temp rises above the Pilot Off Setpoint the Pilot Valve will close and will not re-light until the temperature is below the Process Setpoint minus Deadband.

CHART

4.2.5 Proportional Valve Control

In this scenario, a Proportional Valve is connected to the 4-20mA Output. This is used as a second Main Valve downstream from a traditional safety solenoid valve connected to the Main Valve output.

Proportional Valve Control is always used with the Low Fire set to "On at Proc Setpoint". In this mode both the Process and Low Fire Setpoints are enabled. If the temperature is below the Process Setpoint, the 4-20 mA output slowly ramps up opening the control valve. When the temperature exceeds the Process Setpoint, but is below the Low Fire Setpoint, the 4-20mA output decreases, closing the Proportional Valve. The burner should stabilize at the Process Setpoint. The ringing (swing) on the graph is caused by the balancing of temperature throughout the bath.
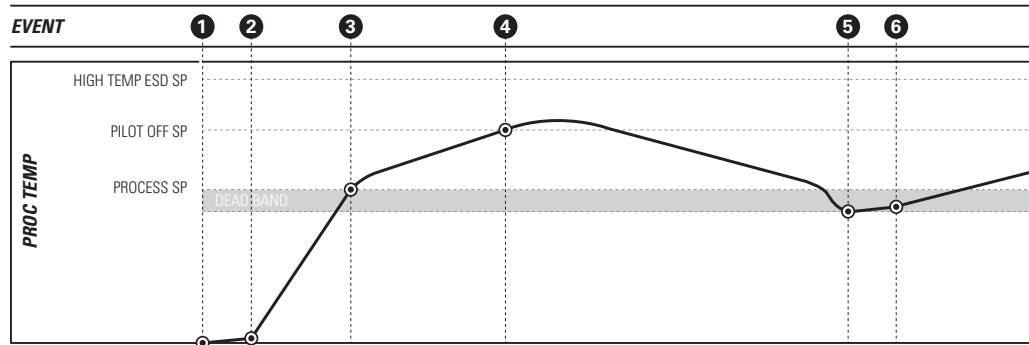
CHART EVENTS
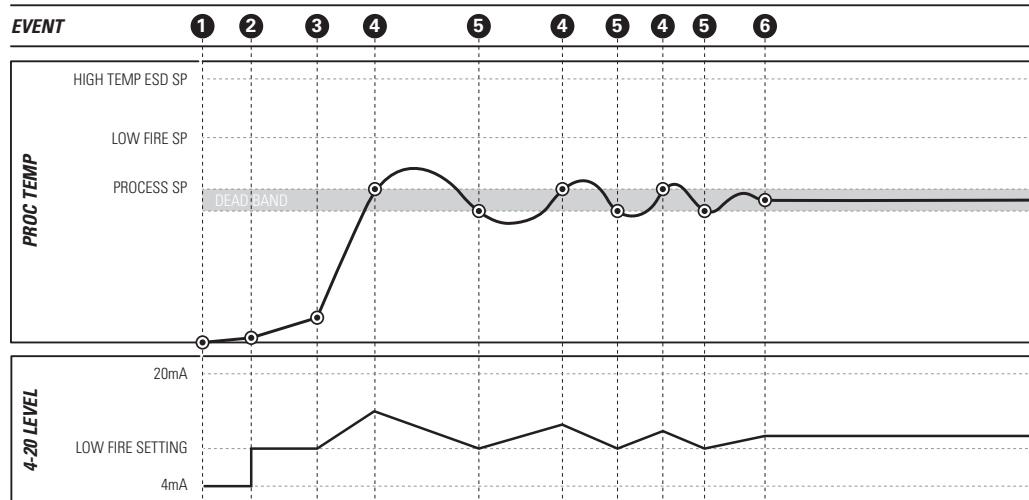
❶ System is started, Pilot Valve opens, Proc Temp beings to increase slowly.

❷ Pilot-to-Main Delay elapses, Low Fire Valve opens, Proc Temp increases faster.

❸ Low-to-High Fire Delay elapses, Main Valve opens, 4-20mA output begins increasing, Proportional Valve begins opening.

❹ Proc Temp exceeds Process Setpoint, 4-20mA output begins to decrease, Proportional Valve begins to close.

❺ Proc Temp drops below Process Setpoint minus Deadband, 4-20mA output begins to increase again, Proportional Valve begins to open again.

❻ Proc Temp stabilizes.

CHART

4.2.6 Aux Temp Mode = Temp Main Ctl

This scenario is the same as the basic scenario except that Aux Temp Mode has been set to "Temp Main Ctl" to enable the Auxiliary Temperature input. The Proc Temp signal measures the outlet temperature of a line heater and the Aux Temp signal measures the bath temperature. If the heat demand increases, the bath temperature may rise quickly. The Aux Setpoint is used to shut off the Main Valves to protect the bath and fire tube in the event of excessive bath temperature.

CHART

EVENT ❶ ❷ ❸ ❹ ❸ ❹ ❸ ❹ ❺ ❻ ❼

AUX TEMP
HIGH TEMP ESD SP
AUX
DEAD BAND

PROC TEMP
LOW FIRE
PROCESS
DEAD BAND

☐ Increased Heat Demand
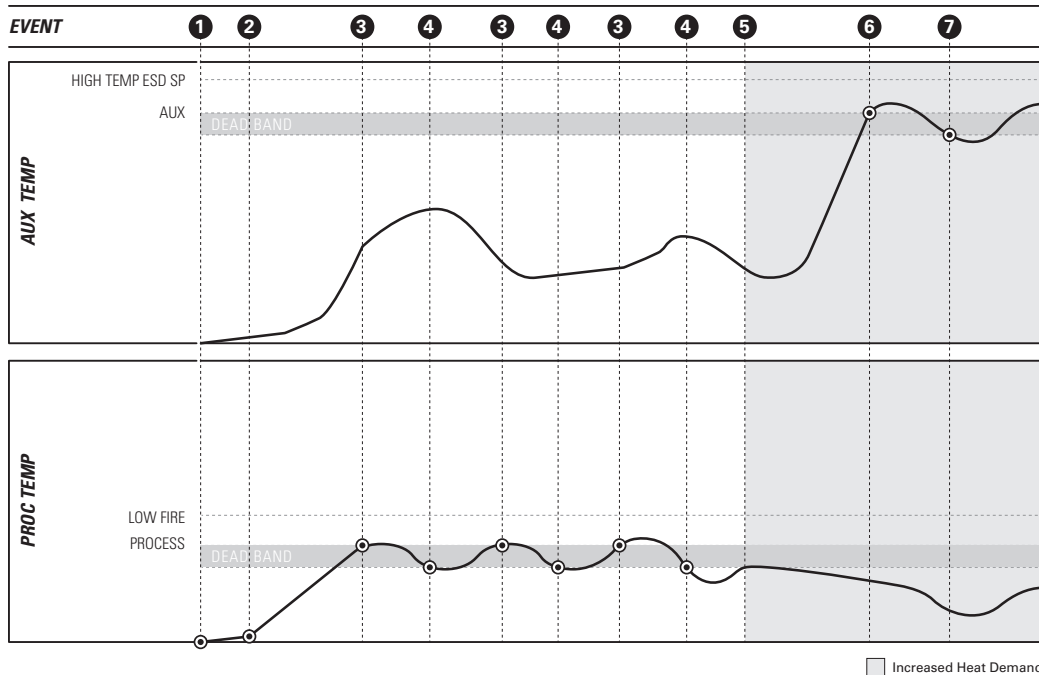
CHART EVENTS

❶ System started. Pilot turns on and temperature begins to increase.

❷ Pilot-to-Main Delay elapses. Low Fire Valve opens and Proc Temp increases faster.

❸ Proc Temp exceeds Process Setpoint. Main Valve closes and the Proc Temp begins to decrease.

❹ Proc Temp drops below Process Setpoint. Main Valve opens and Proc Temp begins to increase.

❺ Heat demand increases because the rate of flow in the pipeline increases or the inlet temp increases. The Aux Temp (bath temp) begins to increase while the Proc Temp (outlet temp) stays low.

❻ Aux Temp rises above the Aux Setpoint and Main Valve closes to protect the bath and fire tube.

❼ Aux Temp drops below Aux Setpoint minus Deadband and Main Valves turn on again.

4.2.7 High Temp ESD

The High Temp ESD Setpoint is always compared against the High Temp Thermocouple regardless of the Process Control setting. The system will immediately shut down if this thermocouple exceeds this setpoint. Becasue the High Temp Thermocouple and Process Thermocouple must always be in the same thermowell, these two thermocouples can be thought of as being the same. Note that the internal signal to which the Process Thermocouple is associated (Proc Temp or Aux Temp) will change depending on the Process Control setting.

This particular graph is a representation of a high temperature shutdown. As shown, the Pilot Off Setpoint is enabled. This means that there is no heat being applied to the fire tube after the Process Temperature exceeds the Pilot Off Setpoint, yet the temperature continues to increase. Once the Process Temperature exceeds the High Temp ESD Setpoint, the system will shut down and require user input to acknowledge the error.
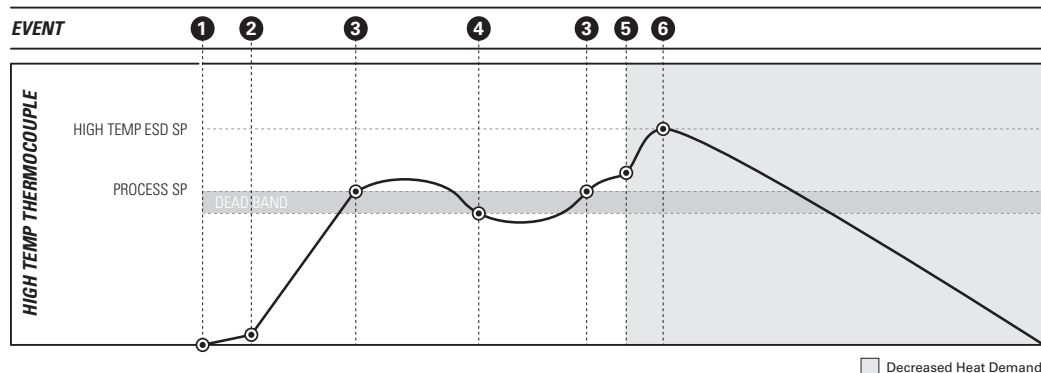
CHART

CHART EVENTS

❶ System is started, Pilot Valve opens, High Temp Thermocouple temperature begins to increase slowly.

❷ Pilot-to-Main Delay elapses, Main Valve opens, High Temp Thermocouple temperature begins to increase faster.

❸ High Temp Thermocouple temperature exceeds Process Setpoint, Main Valve closes, High Temp Thermocouple temperature begins to drop.

❹ High Temp Thermocouple temperature drops below Process Setpoint minus Deadband, Main Valve opens, High Temp Thermocouple temperature begins to increase again.

❺ Heat demand suddenly and substantialy decreases. This could be caused by a rapid decrease in flow by the line heater or a sudden emptying of a tank heater.

❻ The High Temp Thermocouple temperature rises above the High Temp ESD Setpoint, system immediately shuts down, the High Temp Thermocouple temperature begins to decrease slowly.

4.2.8 Aux Temp ESD

If the Aux Temp Mode is set to "Temp ESD", then the Aux Temp signal must be below the Aux Setpoint or the system will shut down. Normally this happens independent of the High Temp ESD previosuly described. However, it is possible for the High Temp ESD Setpoint and the Aux ESD Setpoint to both be applied to the same thermocouple. This happens when Process Control is set to "Aux TC" and Aux Temp Mode is set to "Temp ESD". In this case, whichever setpoint is lower will be used.

In this case, the Aux Setpoint is used as another ESD setpoint. It is always compared against the Auxiliary Temperature signal which depends on the Process Control setting. The system will immediately shut down if this signal exceeds this setpoint.

This particular graph is a representation of an Aux Temp ESD. Process Control is set to "Proc TC" and Aux Temp Mode is set to "Temp ESD". Once the Auxiliary Temperature exceeds the Aux Setpoint, the system will shut down and require user input to acknowledge the error.

CHART EVENTS

❶ System is started, Process Control begins, Aux Temp begins to rise.

❷ Heat demand decreases suddenly and substantialy, Aux Temp begins to rise above normal levels.

❸ Aux Temp rises above the Aux Setpoint, the system shuts down, the Aux Temp begins to decrease slowly.

CHART
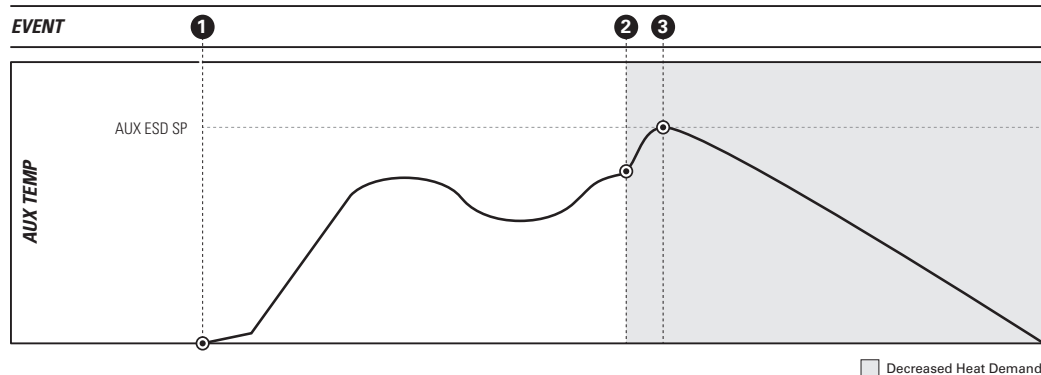
4.3 Contact Behaviour

This section discusses the behaviour of the PF2100's input and output contacts and its response to external signals.

4.3.1 Status Output

The Status Output Contact is generally used to provide a remote indication of whether the system is operating normally. It can be connected to a PLC and used to trigger a remote alarm so that a service technician can be sent to the site in the event of trouble.

In general, the contact will be closed when the system is running and it will be open when the system is not running. Five exceptions to this are as follows:

1. **ON START**
   When the system is first started, the status contact will remain open until after the pilot has been successfully lit.

2. **ALARM MODE**
   If the "Alarm Mode" setting in Menu 4 is "No Alarm When Off", the contact will remain closed if the system is stopped because the Start Contact is open.

3. **LOW TEMP ALARM**
   If the "Low Temp Alarm" feature is enabled in Menu 1 and the Process Temperature is currently below the Low Temp Alarm Setpoint, the Status Contact will be open. The contact will close again as soon as the temperature rises above the Low Temp Alarm Setpoint.

4. **WHILE WAITING**
   If the system is in a waiting state, the status contact will remain closed.

5. **WHILE RESTARTING**
   If the flame blows out and the system is in the process of relighting the pilot, the status contact will remain closed. If the pilot fails to relight within the specified number of Restart Attempts, then the contact will open.

CHART 1: LOW TEMP ALARM = DISABLED, ALARM MODE = ALARM WHEN OFF
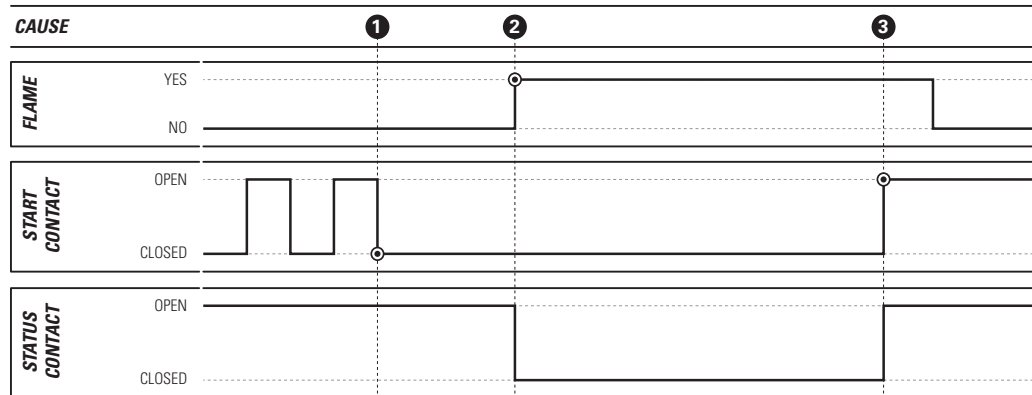
CHART 1 EVENTS

❶ Start Contact toggled twice to start system. System begins running.

❷ Flame is detected by the system. Status contact closes.

❸ Start Contact opens.

CHART 2: LOW TEMP ALARM = DISABLED, ALARM MODE = NO ALM WHEN OFF
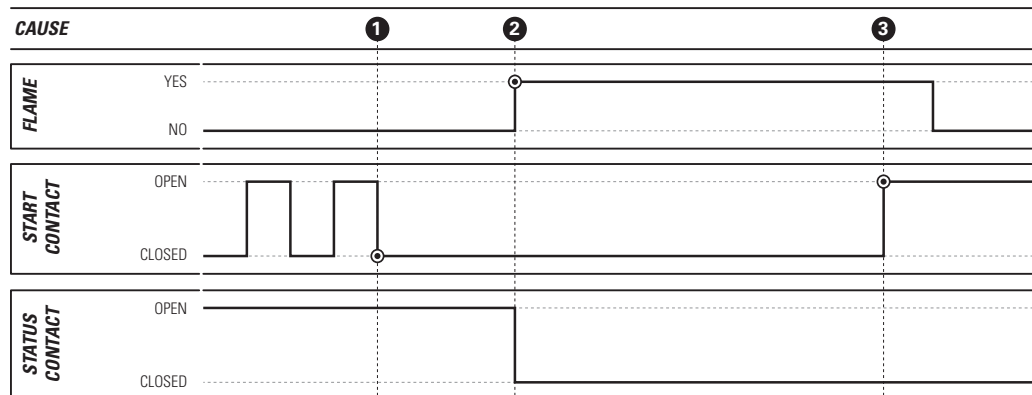
CHART 2 EVENTS

❶ Start Contact toggled twice to start system. System begins running.

❷ Flame is detected by the system. Status contact closes.

❸ Start Contact remains closed.

CHART 3: LOW TEMP ALARM = ENABLED

EVENT ❶ ❷ ❸ ❹ ❺ ❻ ❼

PROC TEMP
PROCESS SP
LOW TEMP ALARM

FLAME
YES
NO

STATUS CONTACT
OPEN
CLOSED

SYSTEM STATE
READY | PURGE | IGNITE | FLAME | DELAY | MAIN

☐ Increased Heat Demand
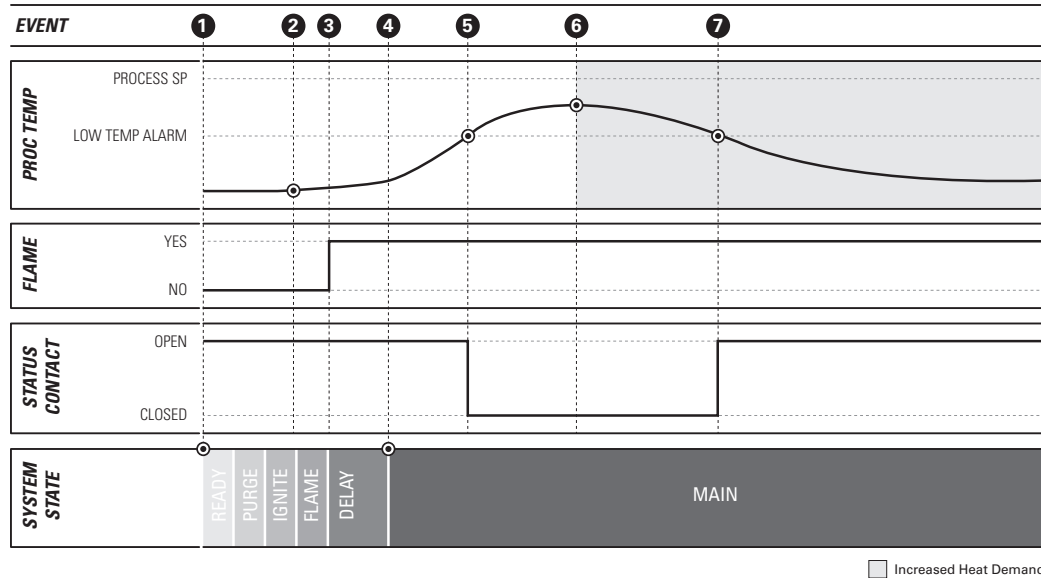
CHART 3 EVENTS

❶ User starts system in Auto Mode. Ignition sequence begins.

❷ System ignites pilot, Proc Temp begins to increase slowly.

❸ Flame was detected, Status Contact remains open.

❹ Pilot-to-Main Delay elapses, Main turns on, Proc Temp begins to increase rapidly.

❺ Proc Temp exceeds Low Temp Alarm Setpoint, Status Contact closes.

❻ Heat demand increases due to the sun going down or a cold front blowing in, Proc Temp begins to drop.

❼ Proc Temp drops below Low Temp Alarm Setpoint, Status Contact opens.

4.3.2 Start Input

The Start Input Contact is used to remotely stop and start the PF2100. This can be done by connecting it to an output relay on a PLC or even to a switch located elsewhere on the site. Generally speaking, the system will begin running when the contact is closed and will stop running when the contact is open. The exception to this is when the system shuts down as a result of an alarm condition. In this case, the contact must be closed to acknowledge the shutdown condition and must then be opened and closed again to restart the system. The status contact can give some idea as to whether the system is shutdown. However, it is not always possible to do so under all circumstances and settings. Therefore, it is recommended to always start the system using the close-open-close sequence described above. This will always work even if the system is not waiting for a shutdown message to be acknowledged. Once the start sequence has been entered, the system will start after the purge time has elapsed. When the start contact is opened, the system will always stop immediately.

CHART EVENTS
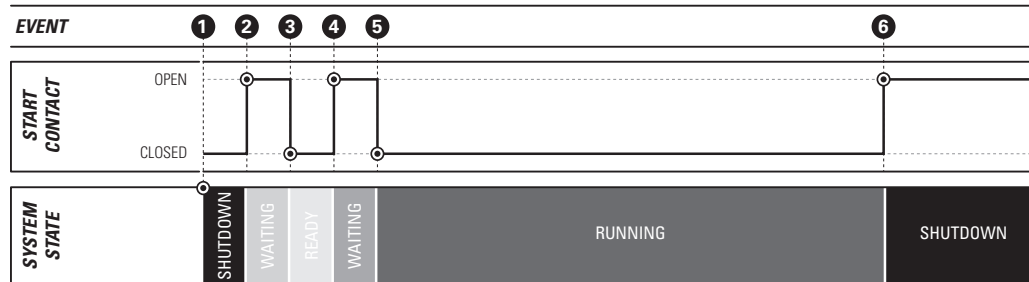
❶ System already in a shutdown state due to some previous alarm.

❷ User opens Start Contact. Shutdown message on display is aknowledged and cleared. System is now waiting for Start Contact to close.

❸ User closes Start Contact. System is now ready to be started.

❹ User opens Start Contact (again). System is now waiting for Start Contact to close again.

❺ User closes Start Contact (again). System begins running.

❻ User opens Start Contact. System shuts down immediately.

CHART

If this contact is not needed, it must be shorted out with the provided jumper or a wire.

4.3.3 ESD Input

The ESD Input Contact is used to stop the PF2100 in the event of an emergency. This is normally done by connecting the contact to the site's ESD Loop. The PF2100 will shutdown immediately when the contact is opened and cannot be restarted until the contact is closed. The PF2100 will not restart automatically if the ESD contact is subsequently reclosed but must instead be restarted via the start contact, the keypad, or the Modbus card.

CHART EVENTS
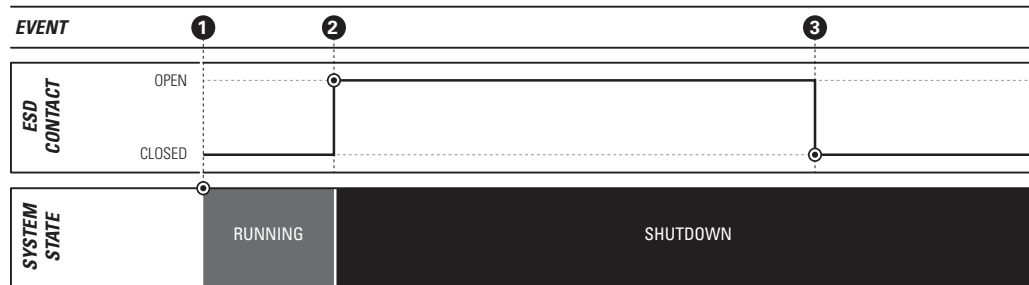
❶ System already running.

❷ ESD Contact opens, system shuts down.

❸ ESD Contact closes, system does not restart automatically and remains shut down.

CHART

EVENT	❶	❷		❸	

ESD CONTACT — OPEN / CLOSED

SYSTEM STATE — RUNNING / SHUTDOWN

If this contact is not needed, it must be shorted out with the provided jumper or a wire.

4.3.4 Proof of Closure Input

When the PF2100 is started, it drives the Main Valves to the closed position. If, for some reason, the valves do not close, a dangerous situation can result. This condition might arise if a valve is mechanically damaged, frozen open, or has been wired incorrectly. If undetected, the PF2100 may attempt to light the burner while a dangerous amount of gas is present resulting in an explosion. To prevent this, the Proof of Closure Input Contact can be used to monitor the mechanical position of the Main Valves. This feature requires the use of valves that have a built-in Proof of Closure output. If more than one Main Valve is used, the Proof of Closure outputs from each valve are wired together in series before being connected to the PF2100's Proof of Closure input.

The Proof of Closure contact must be closed in order for the Purge Timer to count down. If it is ever opened while the system is not running, the Purge Timer is reset and must count down again before the system can be started. In short, the Proof of Closure contact must be closed for the entire duration of the Purge Time or the system will not start. While running, if the Proof of Closure contact ever opens when it is not expected to be open, the system will shutdown.

CHART EVENTS
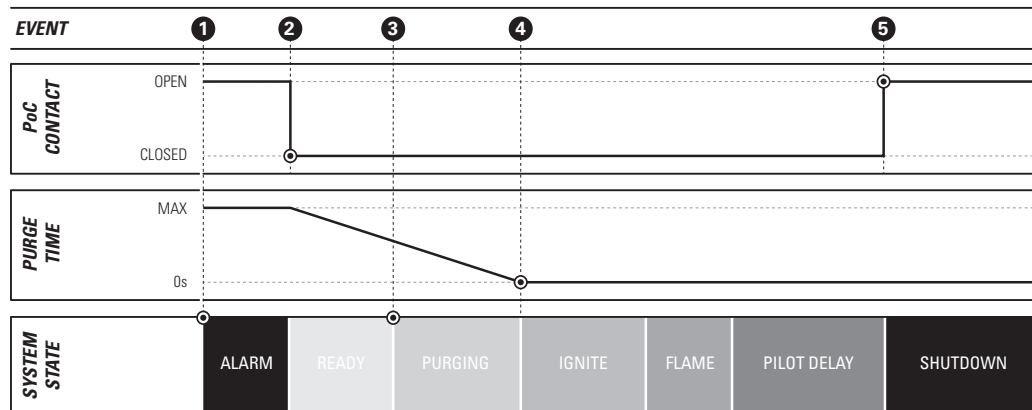
❶ The system begins in the Alarm State because the Proof of Closure (PoC) Contact is open while it is not running.

❷ Proof of Closure closes, purge time begins counting down, system does not start running automatically.

❸ User starts system in Auto Mode. System counts down the remaining purge time on the display.

❹ Purge Time Elapses, system ignites pilot, detects flame and begins counting down the Pilot-to-Main delay.

❺ Proof of Closure opens before Main Valves turn on, the system shuts down due to the incorrect valve state.

CHART

If this contact is not needed, it must be shorted out with the provided jumper or a wire.

4.3.5 Level Input

The Level Input is generally used in tank heater applications. A level switch is installed in the tank to determine when the tank fluid level drops below to position of the fire tube. This switch is then connected to the Level Input Contact on the PF2100. If the fluid level drops below the switch position, the switch opens and the PF2100 will stop heating the tank. This is to prevent damage to the tank and fire tube which may result from applying heat to the empty tank. Generally, this situation arises when a tanker truck arrives on site and empties the tank into the truck. The system can be setup to begin heating the tank again automatically after the level of fluid rises back above the switch position. This is done by enabling the "Level Event Restart" setting in Menu 4.

The response to the contact opening is delayed by 2s to reject electrical noise that is common on some sites. If long periods of severe noise are common on a particular site, the delay can be increased to 20s by enabling the "Pressure/Level Delay" feature in Menu 4.

If this contact is not needed, it must be shorted out with the provided jumper or a wire.

4.3.5 Level Input Continued...

CHART 1: LEVEL EVENT RESTART = DISABLED
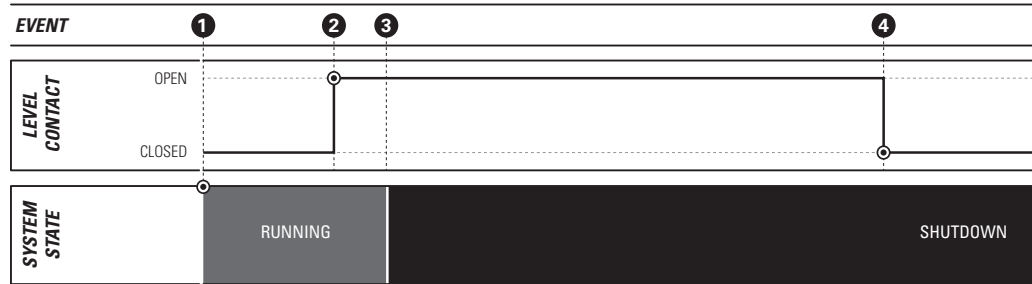
EVENT   ❶   ❷   ❸   ❹

| LEVEL CONTACT | OPEN |
| | CLOSED |

| SYSTEM STATE | RUNNING | SHUTDOWN |

CHART 1 EVENTS

❶ System already running with Level Contact closed.

❷ Level Contact opens, timer begins counting down.

❸ Timer expires, System shuts down.

❹ Level Contact closes, system does not restart automatically.

CHART 2: LEVEL EVENT RESTART = ENABLED
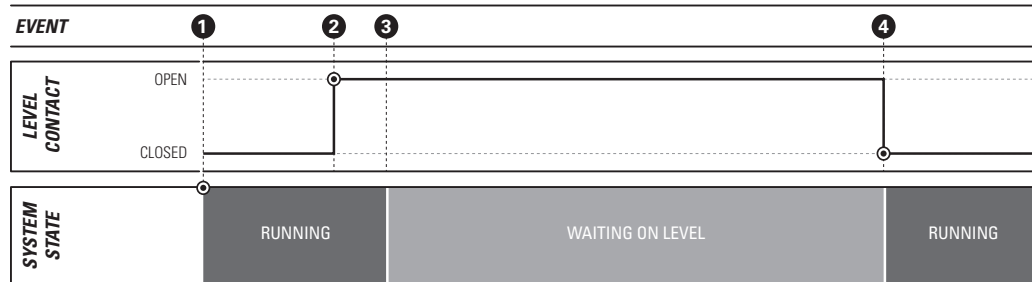
EVENT   ❶   ❷   ❸   ❹

| LEVEL CONTACT | OPEN |
| | CLOSED |

| SYSTEM STATE | RUNNING | WAITING ON LEVEL | RUNNING |

CHART 2 EVENTS

❶ System already running with Level Contact closed.

❷ Level Contact opens, timer begins counting down.

❸ Timer expires. System waits for Level to close.

❹ Level Contact closes, system starts running again.

4.3.6 Low Pressure Input

The Low Pressure Input is used to monitor fuel train pressure. Insufficient fuel pressure may result in the flame burning back into the fuel train causing damage or improper operation. A low pressure switch is installed on the fuel train and then connected to the Low Pressure Input Contact on the PF2100. If the fuel pressure drops below the switch's mechanically set pressure setting, the switch opens and the PF2100 will close all valves and stop running. The system can be setup to begin running again automatically after the pressure returns above the switch's pressure setting. This is done by enabling the Auto Restart feature in Menu 4.

The response to the contact opening is delayed by 2s to reject electrical noise that is common on some sites. If long periods of severe noise are common on a particular site, the delay can be increased to 6s by enabling the "Pressure/Level Delay" feature in Menu 4.

If this contact is not needed, it must be shorted out with the provided jumper or a wire.

4.3.6 Low Pressure Input Continued...

CHART 1: LOW PRESSURE RESTART = DISABLED
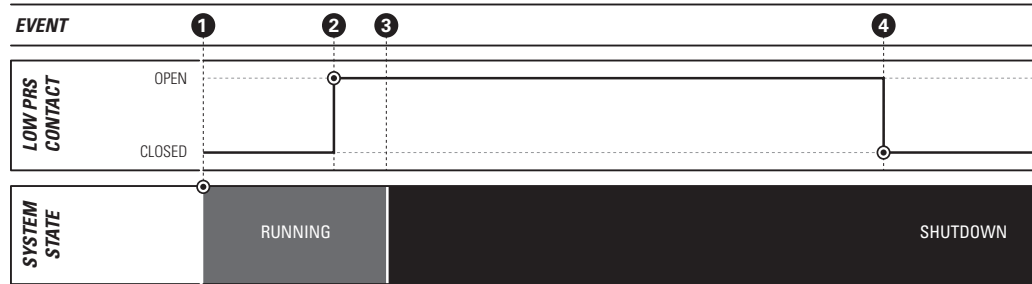
EVENT ❶ ❷ ❸ ❹

LOW PRS CONTACT — OPEN / CLOSED

SYSTEM STATE — RUNNING / SHUTDOWN

CHART 1 EVENTS

❶ System already running with Low Pressure contact closed.

❷ Low Pressure contact opens, timer begins counting down.

❸ Timer expires, system shuts down.

❹ Low Pressure contact closes, system does not restart automatically.

CHART 2: LOW PRESSURE RESTART = ENABLED
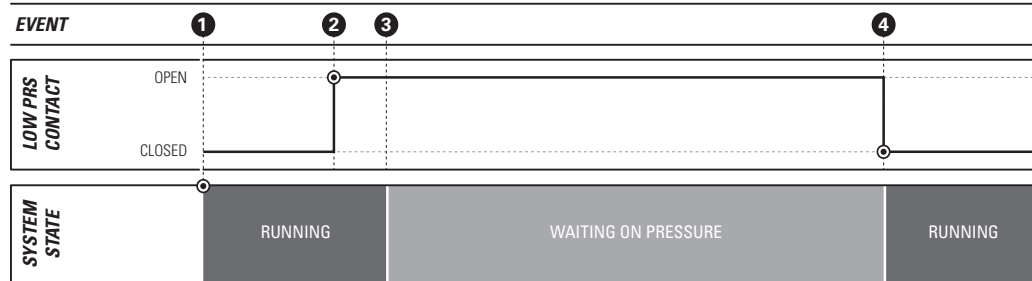
EVENT ❶ ❷ ❸ ❹

LOW PRS CONTACT — OPEN / CLOSED

SYSTEM STATE — RUNNING / WAITING ON PRESSURE / RUNNING

CHART 2 EVENTS

❶ System already running with Low Pressure contact closed.

❷ Low Pressure contact opens, timer begins counting down.

❸ Timer expires, system waits for Low Pressure contact to close.

❹ Low Pressure contact closes, system starts running again.

4.3.7 High Pressure Input

The High Pressure Input Contact is used to monitor fuel train pressure when excess fuel pressure may result in damage to the pilot nozzle or otherwise cause improper operation. A high pressure switch is installed on the fuel train and then connected to the High Pressure Input Contact on the PF2100. If the fuel pressure increases above the switch's mechanically set pressure setting, the switch opens and the PF2100 will close all valves and stop running. The system always shuts down from a High Pressure Event and cannot be programmed to automatically restart if the event clears.

The system can be started when the High Pressure Contact is open. This is to allow for easy recovery from the common issue of leaky regulators. If the regulator upstream from the high pressure switch is leaky, it can allow pressure to accumulate at the switch's position over time while the system is not running. Since there is no way to relieve this pressure other than to open a downstream valve, the system must be allowed to start running under this condition. So the system will start, light the pilot, and open the main valve to allow the built-up pressure to be relieved. If the pressure does not drop low enough to close the High Pressure Contact within 2s after the main valve has been opened, the system will shutdown. Otherwise, it will continue running.

The response to the contact opening is always immediate and cannot be configured.

If this contact is not needed, it must be shorted out with the provided jumper or a wire.

CHART 1: HIGH PRESSURE CONTACT OPENS WHILE RUNNING
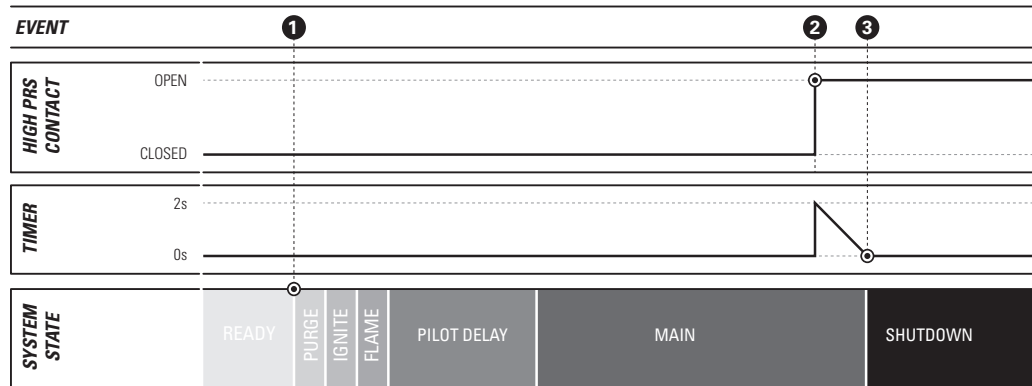
CHART 1 EVENTS

❶ System started by user with High Pressure Contact closed.

❷ High Pressure Contact opens while the system is running with the mains open and starts counting down 2s.

❸ Timer expires with High Pressure Contact still open, system shuts down.

CHART 2: HIGH PRESSURE CONTACT OPEN ON START; DOES NOT CLOSE
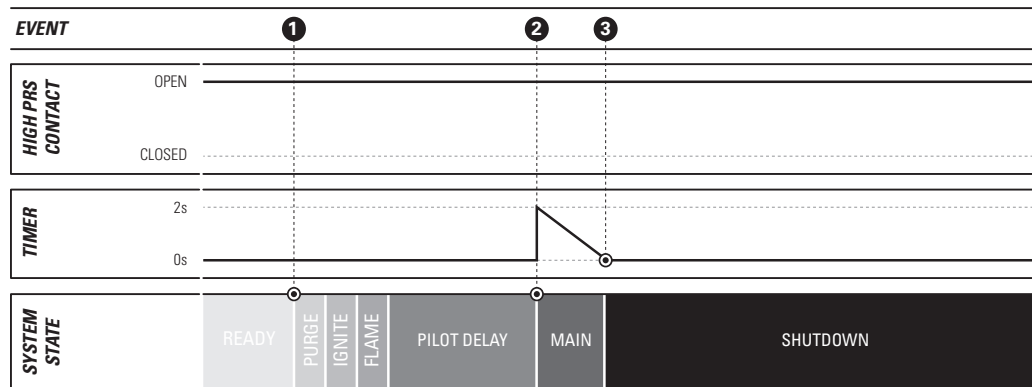
CHART 2 EVENTS

❶ System started by user with High Pressure Contact open.

❷ Main valve opens and timer starts counting down 2s.

❸ Timer expires, High Pressure Contact still open, and the system shuts down.

CHART 3: HIGH PRESSURE CONTACT OPEN ON START; DOES CLOSE
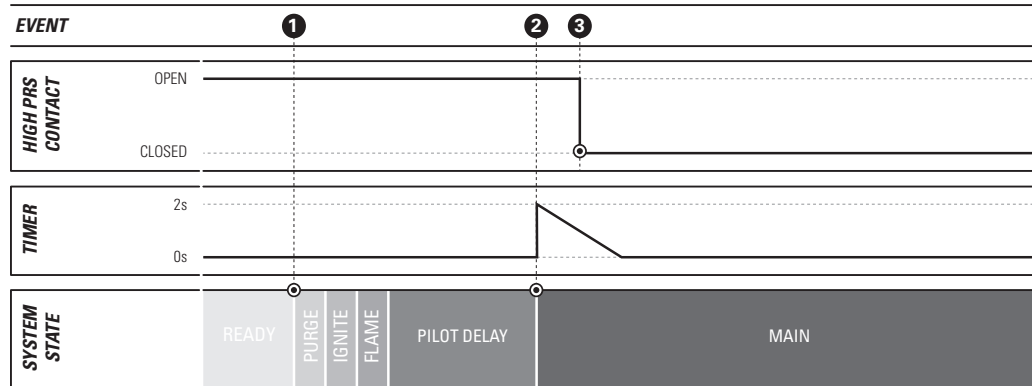
CHART 3 EVENTS

❶ System started by user with High Pressure Contact open.

❷ Main Valve opens and timer starts counting down 2s.

❸ High Pressure Contact closes within 2s of the main valves opening and the system continues to run.

EVENT	❶	❷ ❸

HIGH PRS CONTACT — OPEN / CLOSED

TIMER — 2s / 0s

SYSTEM STATE — READY | PURGE | IGNITE | FLAME | PILOT DELAY | MAIN

4.4 4-20mA Expansion Card Behaviour

The 4-20mA Expansion Card provides an alternate method of monitoring tank level and fuel train pressure. This is via 4-20mA loop transmitters. These devices can be used in place of the switches attached to the level and pressure contacts on the PF2100. Using transmitters allows actual measurements of the level and pressure to be shown on the PF2100's display or read remotely via Modbus (if the Modbus Card is installed).

4.4.1 4-20mA Level Input & Output Contacts

The 4-20mA Level Input is used to monitor tank level in the same way that the Level Contact is. The behaviour and features are identical to those described in the previous Level Contact section. The difference is that a Level Transmitter is used instead of a Level Switch and the Low Level setpoint is set via a menu instead of the physical position of the switch on the tank. When the 4-20mA signal is below the Low Level setpoint, the system will stop. When it is above the setpoint, it will run.

The 4-20mA expansion card also has a pair of High Level Output Contacts which toggle when the Level Input exceeds the Level High Setpoint. One contact is normally open and the other is normally closed. "Normally", in this case, means "when the level is below the high setpoint". The normally closed contact could be used to turn off the pump that is filling the tank and the normally open contact could be used to sound a remote alarm to signal that the tank is full.

To use the 4-20mA Level Input, it must be setup as follows:

1. Attach a properly calibrated Level Transmitter to the 4-20 Level Input
2. Enable the Level DIP Switch on the 4-20 Card
3. Enable the 4-20 Card in Menu 6
4. Set the Level Low Setpoint, High Setpoint, Range, and Units in Menu 6
5. Disable the Level Contact by installing a jumper in it

CHART

| EVENT | ❶ | ❷ | ❸ | ❹ | ❺❻❼ |
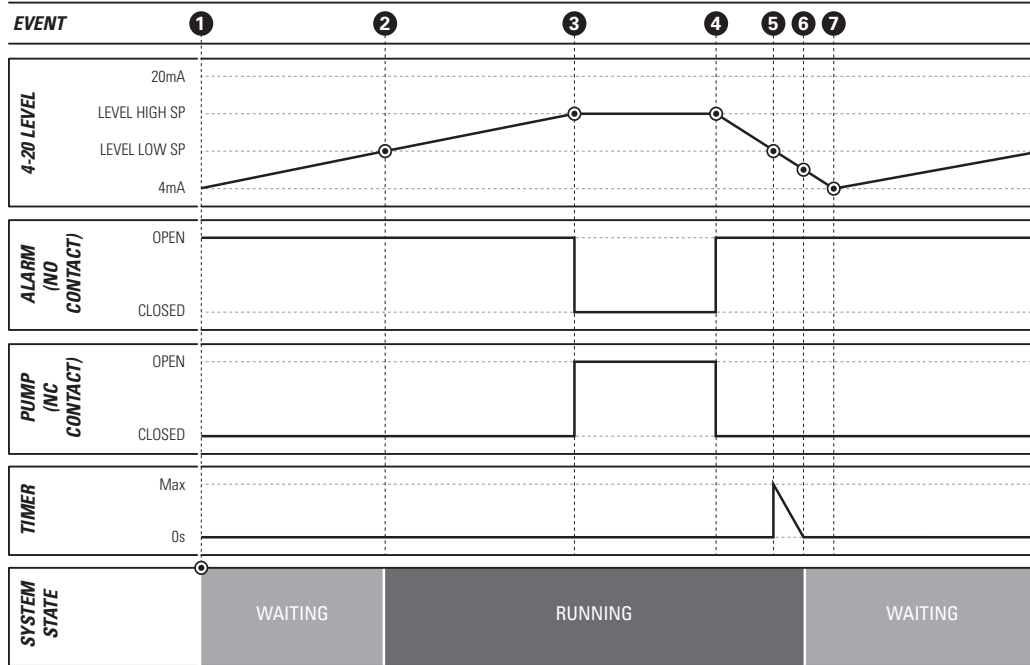
CHART EVENTS

❶ System started with tank empty. Pump starts filling tank. Burner is off and system is waiting on level input because 4-20mA level input is below the low setpoint.

❷ Tank level rises above low setpoint. System begins running (heating tank).

❸ Tank level rises above the high set-point, the pump turns off and the remote alarm turns on to signal a truck to come and empty the tank.

❹ An operater arives on site and begins emptying the tank into a tanker truck. The pump turns back on and the alarm turns off.

❺ The tank level drops below the low setpoint and the level delay timer begins counting down.

❻ The level delay timer reaches zero after 2 or 20s (depending on the "Pressure/Level Delay" setting) and the system stops heating the tank and returns to the "Waiting on Level" state.

❼ The tank is empty and the tanker truck leaves the site. The tank level begins rising again.

4.4.2 4-20mA Pressure Input

The 4-20 Pressure Input is used to monitor fuel train pressure in the same way that the Pressure Contacts are. The behaviour and features are identical to those described in the previous Low Pressure Contact and High Pressure Contact sections. The difference is that a Pressure Transmitter is used instead of a pair of Pressure Switches and the setpoints are set via a menu instead of mechanically on the switches. When the 4-20 signal is below the low setpoint or above the high setpoint, the system will stop. When it is between the two setpoints, it will run. It can be setup to restart from a low event but not from a high event.

To use the 4-20 Pressure Input, it must be setup as follows:

1. Attach a properly calibrated Pressure Transmitter to the 4-20 Pressure Input
2. Enable the Pressure DIP Switch on the 4-20 Card
3. Enable the 4-20 Card in Menu 6
4. Set the Pressure Low Setpoint, High Setpoint, Range, and Units in Menu 6
5. Disable the Low Pressure and High Pressure Contacts by installing a jumper in each of them

CHART 1 EVENTS

❶ System started by user with pressure between low and high setpoints.

❷ Pressure regulator fails while the mains are turned on. Pressure begins increasing.

❸ Pressure exceeds High Setpoint and system shuts down.

CHART 1: PRESSURE INCREASES WHILE RUNNING

EVENT	❶		❷ ❸

4-20 PRESSURE		
20mA		
PRESSURE HIGH SP		
PRESSURE LOW SP		
4mA		

SYSTEM STATE	READY	PURGE	IGNITE	FLAME	PILOT DELAY	MAIN	SHUTDOWN
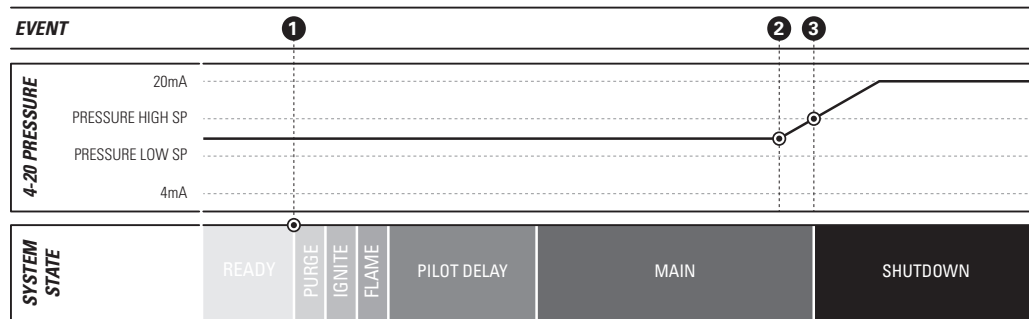
CHART 2: PRESSURE HIGH FROM START
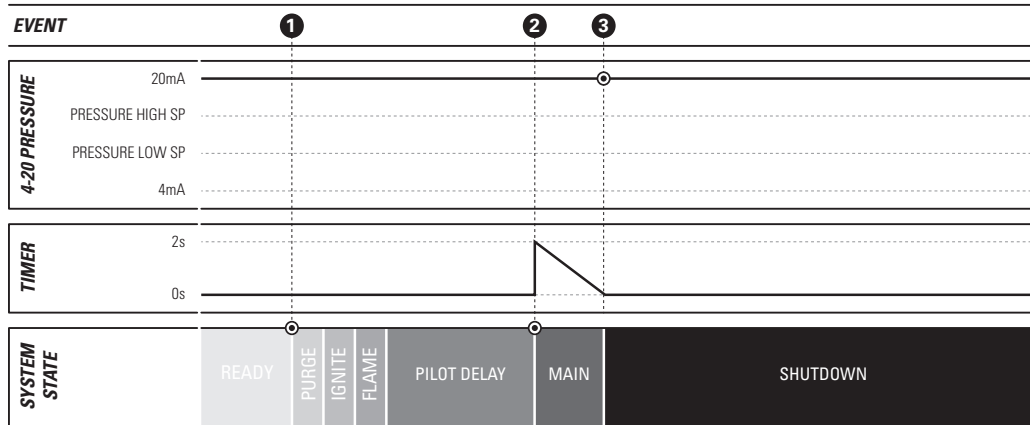
EVENT ❶ ❷ ❸

4-20 PRESSURE
- 20mA
- PRESSURE HIGH SP
- PRESSURE LOW SP
- 4mA

TIMER
- 2s
- 0s

SYSTEM STATE
READY | PURGE | IGNITE | FLAME | PILOT DELAY | MAIN | SHUTDOWN

CHART 2 EVENTS

❶ System started by user with pressure above high setpoint.

❷ Main turns on and timer starts counting down 2s.

❸ The timer expires and the pressure signal does not drop below the high setpoint. The system shuts down.

CHART 3: PRESSURE HIGH ON START BUT CLEARS WHEN MAIN OPENS

EVENT ❶ ❷ ❸

4-20 PRESSURE
- 20mA
- PRESSURE HIGH SP
- PRESSURE LOW SP
- 4mA

TIMER
- 2s
- 0s

SYSTEM STATE
READY | PURGE | IGNITE | FLAME | PILOT DELAY | MAIN
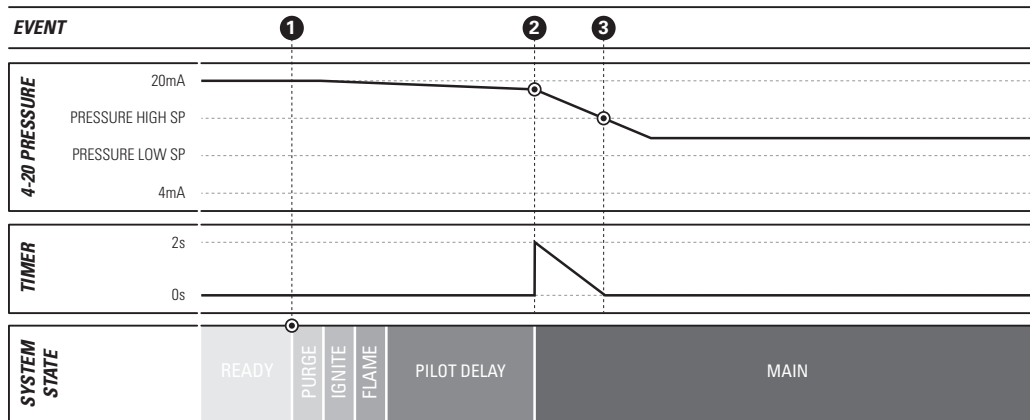
CHART 3 EVENTS

❶ System started by user with pressure above high setpoint due to a slow leak in the regulator. Pressure begins to drop slowly through pilot valve.

❷ Main valve opens and pressure begins to drop faster through main valves.

❸ The pressure drops below the high setpoint within 2s of the main valves opening and the system continues running.

CHART 4: AUTO RESTART = ENABLED
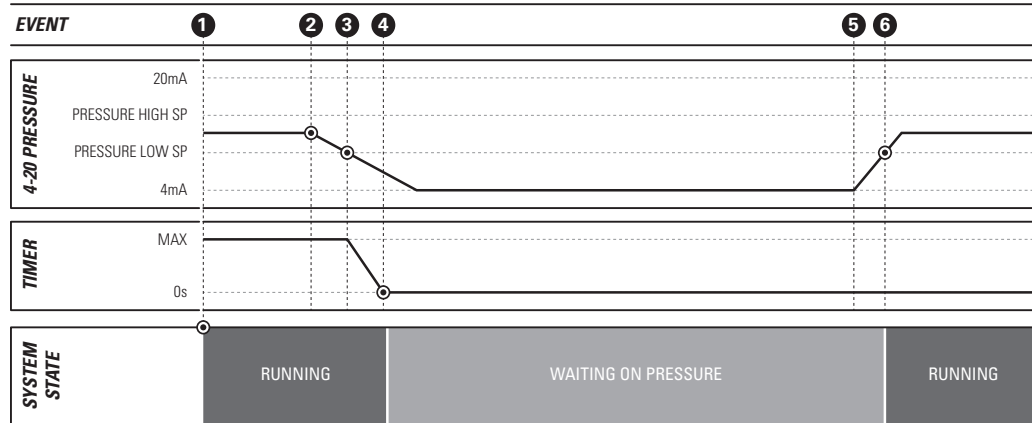
CHART 4 EVENTS

EVENT ❶ ❷ ❸ ❹ ❺ ❻

4-20 PRESSURE		
	20mA	
	PRESSURE HIGH SP	
	PRESSURE LOW SP	
	4mA	

TIMER	
	MAX
	0s

SYSTEM STATE	
RUNNING	WAITING ON PRESSURE	RUNNING

❶ System already running with pressure between High and Low setpoints.

❷ Hand valve on fuel train closed. Pressure begins to drop.

❸ Pressure falls below the low set point. Delay timer starts counting down. (max valve depends on the Level/Pressure Delay setting)

❹ Delay timer expires and burner turns off. System state is now "Waiting on Pressure."

❺ Hand valve is opened and pressure increases quickly.

❻ Pressure rises above low setpoint and system begins running again.

CHART 5: LEVEL EVENT RESTART = DISABLED
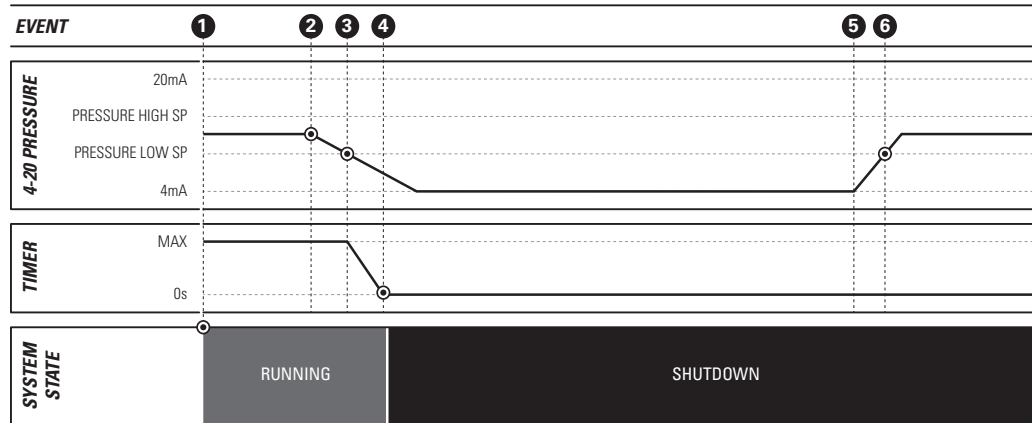
CAUSE & EFFECT

❶ System already running with pressure between High and Low setpoints.

❷ Hand valve on fuel train closed. Pressure begins to drop.

❸ Pressure falls below the low set point. Delay timer starts counting down. (max valve depends on the Level/Pressure Delay setting)

❹ Delay timer expires and system shuts down.

❺ Hand valve is opened and pressure increases quickly.

❻ Pressure rises above low setpoint but system does not restart and remains shut down.

4.5 Example Applications

The following section gives examples of common applications. The recommended process control settings for that application are provided as well as instructions on the placement of the thermocouples.

4.5.1 Simple Heater

For a simple heater such as a tank heater, the process being controlled is the temperature of the liquid in the tank. Only a single thermowell is required to measure this. The Process and High Temp Thermocouples are both placed inside of this thermowell. The Aux Thermocouple is not needed and is therefore not connected. The default settings for both Process Control and Aux Temp Mode are used.

Recommended Settings:

SETTING	USER SETTING
Process Control	Process TC
Aux Temp Mode	Disabled

	THERMOCOUPLE	LOCATION
A	Process + High Temp	Bath
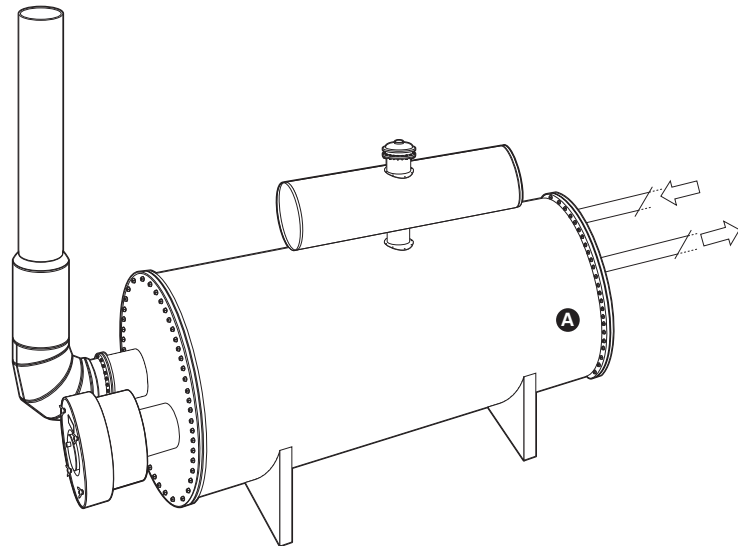
4.5.2 Stack Protection

For any application where it is desired to monitor and protect the stack from overheating, two thermowells are required: One for the process being controlled and one for the stack. The illustration below portrays a Tank Heater as an example. The Process and High Temp Thermocouples are both placed inside of the thermowell in the tank. The Aux Thermocouple is placed in a separate thermowell inside of the stack. The default setting for Process Control is used and Aux Temp Mode is set to "Temp ESD". This allows the system to shutdown the burner if the stack temperature rises above the Aux Setpoint.

Recommended Settings:

SETTING	USER SETTING
Process Control	Process TC
Aux Temp Mode	Temp ESD
Aux Setpoint	Maximum Tolerable Stack Temperature

	THERMOCOUPLE	LOCATION
A	Process + High Temp	Bath
B	Aux	Stack
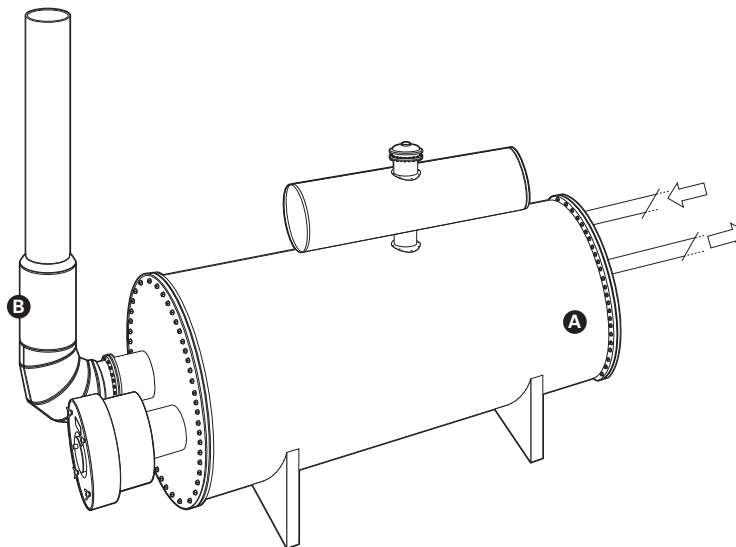
4.5.3 Outlet Temperature Control

For any application where it is desired to control the outlet temperature indirectly via the temperature of a bath, two thermowells are required: One for the bath and one for the outlet. The illustration below portrays a Line Heater as an example. The Process and High Temp Thermocouples are both placed inside of the thermowell in the bath. The Aux Thermocouple is placed in a separate thermowell inside of the outlet pipe. Process Control is set to "Aux TC" and Aux Temp Mode is set to "Temp Main Ctl". This allows the system to apply as much heat as is necessary to maintain the desired outlet temperature up to the maximum allowable bath temperature as specified using the Aux Setpoint.

Recommended Settings:

SETTING	USER SETTING
Process Control	Aux TC
Aux Temp Mode	Temp Main Ctl
Aux Setpoint	Maximum Bath Temperature

	THERMOCOUPLE	LOCATION
A	Process + High Temp	Bath
B	Aux	Outlet
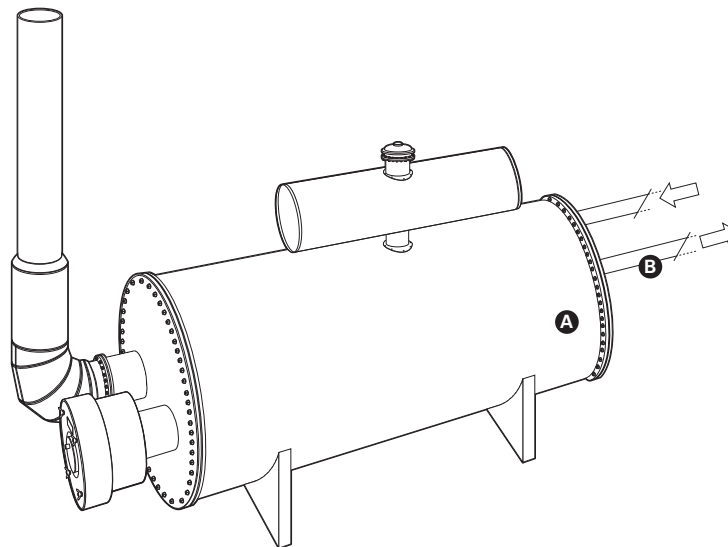
4.5.4 Remote Temperature Monitor

For any application where it is desired to remotely monitor a temperature other than the process, two thermowells are required: One for the process and one for the temperature that you want to remotely monitor. The illustration below portrays a Dehydrator as an example. In this case, the operator wants to remotely monitor the inlet temperature for information purposes. The Process and High Temp Thermocouples are both placed inside of the thermowell in the bath. The Aux Thermocouple is placed in a separate thermowell inside of the inlet pipe. Process Control is set to "Process TC" and Aux Temp Mode is set to "Display Only". This allows the system to run process control using the Process Thermocouple while using the Aux Thermocouple only for display only purposes. The Aux Thermocouple reading can be displayed on the PF2100's display in Manual Mode or read remotely via the Modbus Card (if installed).

Recommended Settings:

SETTING	USER SETTING
Process Control	Process TC
Aux Temp Mode	Display Only

	THERMOCOUPLE	LOCATION
A	Process + High Temp	Bath
B	Aux	Inlet
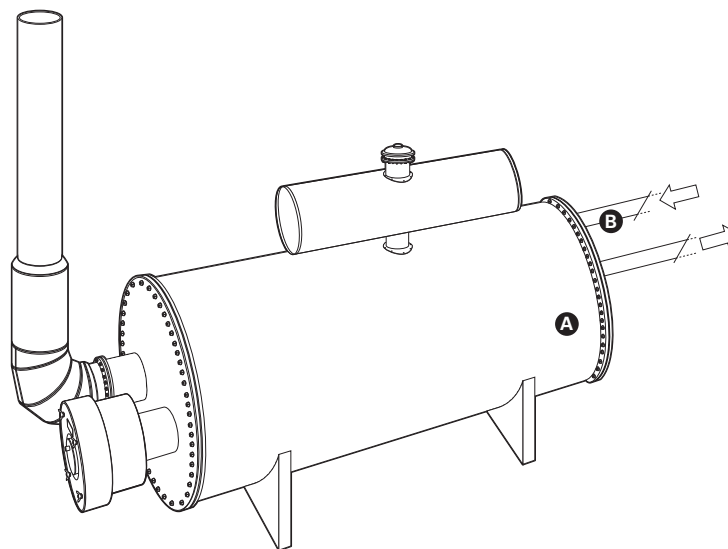
5 Troubleshooting

This section of the manual is designed to aid you in troubleshooting the PF2100. It begins with a list of Common Issues and Solutions. Following this are reference tables containing Shutdown Messages, Alarm Codes, and Warning Messages. This section concludes with a pair of step-by-step guides for troubleshooting issues with Flame Detection and thermocouples.

If you are having trouble with your PF2100 System, please consult the following resources in this order:

- Consult this section for solutions to see if one matches your needs.
- Consult the support section of our website at **www.profireenergy.com.**
- Contact us on our support line at **1-855-PRO-FIRE** (776-3473).

5.1 Common Issues & Solutions

The following list of issues is organized alphabetically by topic. Under each issue is a list of possible solutions.

EXPANSION CARDS

1. Cannot Write Setpoints via Modbus

    a. Check that the system has the latest firmware.
        Firmware older than v1.8.005 did not support this feature.

    b. Check that the Modbus Card has the latest firmware.
        Firmware older than v4.0 did not support this feature.

FLAME DETECTION

1. System Has Visible Flame But Cannot Detect It

    a. The flame rod, pilot assembly and the gap between them should be fully engulfed in flame. If not, adjust the rod positioning.

    b. Check that the flame detection wiring does not exceed the recommended maximum length.

    c. Check that the Ion+ wire is securely connected as per the appropriate wiring diagram.

    d. Check that the ground connection between the PF2100 and the pilot assembly is present and secure.

    e. Put the PF2100 into Manual Mode and use the Review Menu to check the flame quality level.

    f. Consult the instructions in the section 5.5 (Flame Detection Troubleshooting Guide) for further details on Flame Detection.

SHUTDOWN

1. System shuts down with a High/Low Voltage message shutdown

    a. Ensure that the system voltage setting is set to match the power supply's nominal voltage.

    b. Check that the system has the latest firmware. Firmware older than v1.8.005 was prone to shutdown on transient voltage spikes and dips.

    c. Ensure that some other load is not causing the supply to droop periodically. This can be done by simply removing other devices from the supply or if that is not an option, monitor the supply voltage with a data logger.

    d. Ensure that the power supply is rated appropriately for the valves and other peripheral devices attached to the PF2100. Refer section 2.6.1 (Power) for details.

2. System shuts down on High Temperature ESD

    a. Check that the HT ESD setpoint is not set too close to the operating temperature of the system. Measurement accuracy and process control overshoot can cause the system to shutdown if they are too close.

3. System shuts down on an Open TC Error

    a. Check if one of the thermocouples is not connected inside of the PF2100. Note that both the Process and High Temp thermocouples are required.

    b. Check that there are no breaks in the thermocouple wiring.

SOLAR POWER

1. Solar output voltage is 12V when 24V is expected

    a. Check if the solar panels are incorrectly wired in parallel rather than series

2. Expected battery life is not achieved

    a. The PF2100 is not setup to use low power valves with a PWM setting of 20%

    b. The PF2100 is not setup to put the display to sleep when not being used

    c. The solar panel is undersized

    d. The solar panel is shaded or not located in full sun

3. The battery is not being charged at all

    a. Check if the Solar Charger is damaged or defective. Look for flashing error codes on the controller's LEDs.

    b. The solar panel is undersized

    c. The solar panel is shaded or not located in full sun

    d. The battery is defective

SOLENOIDS

1. Valves are not opening

    a. Check if the positive and negative wires are reversed.

    b. Ensure that each valve has a separate negative return wire connected to the correct terminal. A common ground wire

5.1 Common Issues & Solutions Continued...

cannot be used and will not work.

    c.   Check if the proper PWM setting is used for each valve.

    d.   Check if the valve voltage ratings match the system voltage (12V or 24V).

2. System shuts down with terminal card command refused, master power, solenoid feedback.

    a.   Check solenoid wiring to ensure that no wires are crossed and separate return wires are used for each valve.

STATUS CONTACT
1. Status Contact Opens But System Continues to Run

    a.   Check that the system has the latest firmware. Some firmware versions older than v1.8.005 had a bug that might lead to this under certain circumstances. If you can't update your firmware immediately, repositioning the flame rod so that it is more fully immersed in the flame can lessen the occurrence of this issue.

2. Status Contact Never Closes

    a.   The current or voltage ratings on the status contact may have been exceeded. Verify that you are not exceeding these ratings. If the ratings were exceeded, check the terminal Card HW version to determine the appropriate solution.

        i.   v1.6: Replace the Terminal Card.
        ii.   v1.7: Replace the Status Contact Fuse on the Terminal Card.

THERMOCOUPLES
1. Thermocouple Readings are Bouncing

    a.   Verify that the Valve PWM Settings are correct for the valves that are being used. Using incorrect settings for a valve can result in more noise than necessary. The lowest noise will result when the PWM setting is set to 20% for low power valves and 100% for regular valves.

    b.   Verify that proper system grounding is being observed. Especially check that all solenoids are properly connected to earth ground.

2. Thermocouple Readings are Incorrect

    a.   Check if the thermocouple wiring polarity is reversed. Yellow should be connected to positive, and red to negative.

    b.   Check that no thermocouple pairs are crossed (ie, positive from one TC paired with negative from another TC).

    c.   Ensure that only type-k thermocouple wire and connectors are used. Even small sections of other types of wire can significantly disrupt the measurement.

    d.   If a head connection is used, verify that none of the above wiring issues exist there either.

    e.   Check if the thermocouple is defective by trying a different thermocouple that is known to be good or by connecting the suspect thermocouple to a process calibrator.

    f.   Check that the PF2100 is in proper calibration using a process calibrator. If not, recalibrate the system.

5.2 Shutdown Messages

The following is a list of messages that may flash on the PF2100 display after the system has shutdown. Typically, the word "SHUTDOWN" in large text will flash alternately with one of the messages below. These messages indicate the reason that the system last shutdown and can be cleared by pressing the OK key (except where noted). Use the table below to determine the meaning of these messages. This table is organized alphabetically.

ON SCREEN	DESCRIPTION
Ambient Temps Not Equal	The Ambient Temperature read by the Door Card does not match the one reported by the Terminal Card.
Aux High Temp	Aux Temp Mode is set to "Temp ESD" and the Auxiliary Temperature exceeded the High Temp ESD Setpoint.
Aux Thermocouple Error	The Auxiliary Thermocouple is open or shorted.
Comparison Setpoints	One of the Setpoints in the Door Card does not match the corresponding value in the Terminal Card.
Comparison: C_byte x y	The Door Card's internal control byte (x) did not match the Terminal Card's internal status byte (y).
Comparison: ESD DC:xxx TC:xxx	The Door Card and Terminal Card do not agree on the state of the ESD Contact. "xxx" will be either "ON" or "OFF".
Comparison: LVL DC:xxx TC:xxx	The Door Card and Terminal Card do not agree on the state of the Level Contact. "xxx" will be either "ON" or "OFF".
Comparison: MAN DC:xxx TC:xxx	The Door Card and Terminal Card do not agree on the state of the Main Valve Output. "xxx" will be either "ON" or "OFF".
Comparison: PLT DC:xxx TC:xxx	The Door Card and Terminal Card do not agree on the state of the Pilot Valve Output. "xxx" will be either "ON" or "OFF".
Comparison: PoC DC:xxx TC:xxx	The Door Card and Terminal Card do not agree on the state of the Proof of Closure Contact. "xxx" will be either "ON" or "OFF".
Comparison: PRH DC:xxx TC:xxx	The Door Card and Terminal Card do not agree on the state of the High Pressure Contact. "xxx" will be either "ON" or "OFF".
Comparison: PRL DC:xxx TC:xxx	The Door Card and Terminal Card do not agree on the state of the Low Pressure Contact. "xxx" will be either "ON" or "OFF".

5.2 Shutdown Messages Continued...

ON SCREEN	DESCRIPTION
Comparison: STRT DC:xxx TC:xxx	The Door Card and Terminal Card do not agree on the state of the Start Contact. "xxx" will be either "ON" or "OFF".
Control Error	The Internal Control State is not valid.
DC MSP430 No Communications	The TC430 Temperature chip on the Door Card is not responding.
EEPROM Error	The EEPROM settings are corrupted.
ESD Input	The ESD Input was open while the system was running or attempting to start.
Expansion Card Error / 4-20 Exp Card: 4-20 Level Low	The 4-20mA Level Input was below the Level Low Setpoint while the system was running with the Level Event Restart feature disabled.
Expansion Card Error / 4-20 Exp Card: 4-20 Level Open	The 4-20mA Level Input is open (reading below ~ 3.75mA)
Expansion Card Error / 4-20 Exp Card: 4-20 PRS High	The 4-20mA Pressure Input was above the Pressure High Setpoint while the system was running with the Main Valve open.
Expansion Card Error / 4-20 Exp Card: 4-20 PRS Low	The 4-20mA Pressure Input was below the Pressure Low Setpoint while the system was running with the Auto Restart feature disabled.
Expansion Card Error / 4-20 Exp Card: 4-20 PRS Open	The 4-20mA Pressure Input is open (reading below ~ 3.75mA)
Expansion Card Error / 4-20 Exp Card: Card Fail	The 4-20mA Expansion Card is not responding. This may indicate that it is not installed correctly or that it is enabled when not present at all.
Expansion Card Error / Modbus Card: Card Fail	The Modbus Expansion Card is not responding. This may indicate that it is not installed correctly or that it is enabled when not present at all.
Flame detected before start	Flame was detected prior to the system igniting the pilot. This may indicate a leaky valve, inadequate purge time, or a faulty Terminal Card.
Flame Fail	The system failed to ignite the pilot within the allocated number of retry attempts.

5.2 Shutdown Messages Continued...

ON SCREEN	DESCRIPTION
Flame Rod Test Error / Adjust Flame Rod Position	The Flame Rod or associated wiring may be shorted to ground thus preventing it from properly detecting flame.
High Pressure	The High Pressure Contact remained open for more than 2s after the main valve opened. This error can also be triggered by the 4-20 Input Card if the Pressure reading remains above the 4-20 Pressure High Setpoint for 2s after the main valve opened.
High Temp	The Process Temperature rose above the High Temp ESD Setpoint.
High Temp Setpnt Mismatch	The Door Card and Terminal Card do not agree on the value of the High Temp ESD Setpoint.
High Voltage xx.x Volts	The system voltage remained above the High Voltage Alarm point for 20s or more and Auto Restart is disabled. "xx.x" is the voltage reading at the point in time when the shutdown occurred. See section 3.4.12 (System Voltage) for a description of these alarm points.
HT Thermocouple Error	The High Temp Thermocouple is open or shorted.
Ignite Key Stuck	The Ignite Key was held for more than 30s while in manual mode.
KEY STUCK ERROR / DOWN	Down Key Stuck at System Startup. This may indicate a defective keypad. This error must be resolved in order to continue using the system.
KEY STUCK ERROR / IGN	Ignite Key Stuck at System Startup. This may indicate a defective keypad. This error must be resolved in order to continue using the system.
KEY STUCK ERROR / MAIN	Main Key Stuck at System Startup. This may indicate a defective keypad. This error must be resolved in order to continue using the system.
KEY STUCK ERROR / MODE	Mode Key Stuck at System Startup. This may indicate a defective keypad. This error must be resolved in order to continue using the system.
KEY STUCK ERROR / OK	OK Key Stuck at System Startup. This may indicate a defective keypad. This error must be resolved in order to continue using the system.
KEY STUCK ERROR / PLT	Pilot Key Stuck at System Startup. This may indicate a defective keypad. This error must be resolved in order to continue using the system.
KEY STUCK ERROR / MENU	Menu Key Stuck at System Startup. This may indicate a defective keypad. This error must be resolved in order to continue using the system.

5.2 Shutdown Messages Continued...

ON SCREEN	DESCRIPTION
KEY STUCK ERROR / STOP	Stop Key Stuck at System Startup. This may indicate a defective keypad. This error must be resolved in order to continue using the system.
KEY STUCK ERROR / UP	Up Key Stuck at System Startup. This may indicate a defective keypad. This error must be resolved in order to continue using the system.
Level Input	The Level Contact is open and "Level Event Restart" is set to "Off". This error can also be triggered by the 4-20 Input Card if the Level reading is below the 4-20 Level Low Setpoint and "Level Event Restart" is set to "Off".
Low Pressure	The Low Pressure Contact is open and "Auto Restart" is set to "Off". This error can also be triggered by the 4-20 Input Card if the Pressure reading is below the 4-20 Pressure Low Setpoint and "Auto Restart" is set to "Off".
Low Voltage xx.x Volts	The system voltage remained below the Low Voltage Alarm point for 20s or more and "Auto Restart" is set to "Off". "xx.x" is the voltage reading at the point in time when the shutdown occurred. See section 3.4.12 (System Voltage) for a description of these alarm points.
Master Power Error	The Master Power switch to the powered valve outputs was in the wrong state. This may indicate a Terminal Cards hardware failure.
Modbus Card: Shutdown	The system shut down because a remote shutdown command was recieved via Modbus.
Modbus Card: Shutdown / Remote Cmd Error	The system recieved an undefined command from the Modbus Expansion Card.
Pilot Key Stuck	The Pilot Key was held for more than 30s while in manual mode.
Pro Thermocouple Error	The Process Thermocouple is open or shorted.
Proof of Closure / Should be Closed	The Proof of Closure Contact was detected to be Open when it was not expected to be. This may indicate a faulty valve or wiring.
Purge Values Mismatch	The Door Card and Terminal Card do not agree on the value of the Purge Time Setting.
Run CRC Error	Main Program Memory CRC Error
Solenoid Feedback Error / Check Solenoid Wiring	The solenoids were observed to have a state opposite to the one being driven by the PF2100. Check that the wiring is correct and not shorted to power or ground.

5.2 Shutdown Messages Continued...

ON SCREEN	DESCRIPTION
System Error	Illegal Process Control or Display State
Terminal Card Ambient Fail	The Terminal Card could not measure the ambient temperature. The Door Card failed to detect this.
Terminal Card Command Refused	The Terminal Card recieved a valid command from the Door Card but the command was refused because it would result in an invalid or unsafe state. The Door Card failed to detect this.
Terminal Card Communication	The Termincal Card is not communicating with the Door Card. This may indicate a faulty ribbon cable or incompatible firmware. The Door Card failed to detect this.
Terminal Card High TC Grounded	The Terminal Card detected that the High Temp Thermocouple was shorted to ground. The Door Card failed to detect this.
Terminal Card High Temp Alarm	The Terminal Card detected that the High Temp Thermocouple exceeded the High Temp ESD Setpoint. The Door Card failed to detect this.
Terminal Card Reciprocal Comp	The Terminal Card detected that the Door Card status or High Temp ESD Setpoint did not match. The Door Card failed to detect this.
Terminal Card Shutdown Detect	The Terminal Card detected an alarm condition. The Door Card failed to detect this.
Terminal Card Voltage Sense	The Terminal Card detected that the system voltage was outside of allowable limits. The Door Card failed to detect this. See section 3.4.12 (System Voltage) for a description of these alarm points.
Thermocouples Not Equal / Check Wiring	The High Temp and Process Thermocouples are reading temperatures that are too far apart. This may indicate a failed thermocouple or improper wiring.
User Stop	The user pressed the Stop key on the keypad.

5.3 Alarm Codes

The following is a list of alarm codes that may show on the Alarm screen of the PF2100 display. These codes indicate a persistent problem that must be cleared before the system can be restarted. Use the table below to determine the meaning of these codes.

ON SCREEN	DESCRIPTION
4-20Lvl	The 4-20 Input Card's Level Input is reading a value below the 4-20 Level Low Setpoint and "Level Event Restart" is set to "Off".
4-20Prs	The 4-20 Input Card's Pressure Input is reading a value below the 4-20 Pressure Low Setpoint and "Auto Restart" is set to "Off".
AuxTC	The system is in a mode that requires the Aux Thermocouple and the Aux Thermocouple is open or otherwise wired incorrectly.
DC_TC	The TC430 temperature sensor on the Door Card is not responding.
ESD_Inp	The ESD Contact is Open.
FlmTest	There is a problem with the Flame Detection wiring or circuitry.
PoC_Inp	The Proof of Closure contact is open.
HiVolt	The system voltage is above the High Voltage Alarm point.
HT_ESD	The Process Temperature is above the High Temp ESD Setpoint.
HT_TC	The High Temp Thermocouple is open or otherwise wired incorrectly.
LoVolt	The system voltage is below the Low Voltage Alarm point.
LowPrs	The Low Pressure Contact is Open or the 4-20mA Expansion Card's Pressure Input is reading a value below the 4-20 Pressure Low Setpoint. In either case, "Auto Restart" is set to "Off".
Lvl_Inp	The Low Level Contact is Open or the 4-20mA Expansion Card's Level Input is reading a value below the 4-20 Level Low Setpoint. In either case, "Level Event Restart" is set to "Off".
MbusErr	The Modbus Card is not responding. This may indicate that it is not installed correctly or that it is enabled when not present at all.

5.3 Alarm Codes Continued...

ON SCREEN	DESCRIPTION
ProcTC	The Process Thermocouple is open or otherwise wired incorrectly.
RemShut	Modbus Shutdown Command Received
Sys_Err	System Error – The Terminal Card is not communicating with the Door Card. This may indicate a faulty ribbon cable or incompatible firmware.
TC_MM	The High Temp and Process Thermocouples are reading temperatures that are too far apart. This may indicate a failed thermocouple, improper wiring, or a damaged Door or Terminal Card.
Val_MM	The Door and Terminal Card's setpoints do not match.

5.4 Warning Messages

The following is a list of warning messages that may flash periodically on the PF2100 display. These messages indicate a problem that may be developing or a condition from which the system may automatically restart once cleared. Use the table below to determine the meaning of these messages.

ON SCREEN	DESCRIPTION
Check all settings / Other settings have changed	A major process control setting was changed and the process control setpoints were reset to factory defaults. This includes the High Temp ESD Setpoint, the Pilot Off Setpoint, the Low Fire Setpoint, the Process Setpoint, the Low Temp Alarm Setpoint, the Deadband setting, and the Aux Setpoint.
HI Volt Warning	The system voltage is getting close to the High Voltage Alarm threshold and may stop or shutdown soon.
High Prs Warning	The High Pressure Contact is open or the 4-20 Pressure Input is above the 4-20 Pressure High Setpoint. Shortly after the main valve opens, the contact must be closed and the 4-20 Pressure must be below the setpoint or the system will shutdown.
LO Volt Warning	The system voltage is getting close to the Low Voltage Alarm threshold and may stop or shutdown soon.
Low Temp Alarm	The process temperature is below the Low Temp Alarm Setpoint and the Status Contact is Open.

5.4 Warning Messages Continued...

ON SCREEN	DESCRIPTION
Unit restarted from LVL event	The system has recently restarted from a Level event. Press OK to clear this message.
Unit restarted from PRS event	The system has recently restarted from a Low Pressure event. Press OK to clear this message.
Unit restarted from VLT event	The system has recently restarted from a Low or High Voltage event. Press OK to clear this message.
Waiting: 420 LVL	The system will automatically restart once the 4-20 Input Card's Level Input rises above the Low Setpoint.
Waiting: 420 PRS	The system will automatically restart once the 4-20 Input Card's Pressure Input drops below the High Setpoint.
Waiting: HiVolt	The system will automatically restart once the system voltage falls below the High Voltage Alarm Threshold.
Waiting: LoVolt	The system will automatically restart once the system voltage rises above the Low Voltage Alarm Threshold.
Waiting: Low PRS	The system will automatically restart once the Low Pressure Contact is closed.
Waiting: LVL	The system will automatically restart once the Level Contact is closed.
Waiting:STRT Inp	The system will automatically restart once the Start Contact is closed.

5.5 Flame Detection Troubleshooting Guide

System is not detecting flame.

1 Does the flame quality drop from 100% (Pilot) when the main comes on?

NO

2 Ensure that the pilot orifice is correct for the gas used. (#54 for natural gas)

3 Ensure that there is a metal-on-metal connection from the pilot nozzle to the housing and a ground wire from the housing to the 2100

4 Ensure that the ignition rod is fully immersed in the flame

With the system powered and in idle mode, set a Multi-Meter to read AC voltage and measure across the ION + and ION - terminals. The voltage will fluctuate a bit due to the flame test.

Take note of the maximum voltage

YES

Does the system stay running with the flame arrestor open?

NO

The draft from the main could be pulling the pilot flame away from the flame rod.
Reposition the flame rod.

YES

Clean the arrestor and look for other air restrictions

Is the voltage greater than 25VAC?

NO

Remove the wire from ION + and measure the AC voltage between the ION + and ION - terminals again.

Is the voltage above 35VAC?

NO

It is possible that the terminal card is faulty

YES

Is the wire run length from the burner to the PF2100 longer than 25'

NO

Something is loading the signal. Ensure that the wire type is not shielded. Look for partial ground shorts or nicked wires.

YES

The length loading on the wire is too high. Using ignition wire for ION + will allow the signal to be run up to 50'. Using separate rods for flame detection and ignition can also reduce the ION + load by bypassing the coil.

YES

5 Measure the AC volatage from the flame rod to ground if the rod is accessible. If it is not accesible remove the wire from the flame rod and measure on the connector.

THERE ARE TWO RODS

Is the voltage measured at the rod close to the voltage measured across the ION + and ION - terminals?

NO

Is the same rod being used for both flame detection and ignition?

NO

Check the ION + wire for shorts to ground or nicks.

YES

Measure the AC voltage on the ION + wire where it connects to the coil.

Is it close to the same voltage that was measured across the ION + and ION - terminals?

NO

Check the ION + wire for shorts to ground or nicks.

YES

Replace the coil.

YES

NEXT PAGE

QUESTION ARE IN WHITE RECTANGLES

?

NO

NO, ALWAYS MOVES TO THE RIGHT

YES

YES, ALWAYS MOVES DOWN

PREVIOUS PAGE

6 Set the Multi-Meter to measure DC voltage across ION + and ION - with the system in manual mode.

Is the reading across ION + and ION - around +5VDC? **NO** → Remove the wire from ION + and measure the DC voltage between the ION + and ION - terminals again.

Is the voltage across the ION + and ION - terminals around +5VDC? **NO** → It is possible that the terminal card is faulty

YES ↓

YES → Check the ION + wire for nicks or other faults.

7 Put the system into Auto Mode and monitor the voltage on the Multi-Meter. While sparking the voltage will jump around, ignore this.

Take note of the voltage after the sparking while the flame is present.

Did the voltage drop below +5V when the flame was present? **NO** → The system is not seeing the flame at all. The circuit from the rod through the flame to the nozzle to ground is not being completed.

Check the grounding to the pilot nozzle.

Check for cracked ceramic on the flame rod.

YES ↓

8 The system is sensing flame, just not enough. The DC voltage should drop to -5VDC or lower (-8VDC is better) for stable flame detection.

9 Adjust the flame rod positioning to try to decrease the voltage while the flame is present.

The problem could be related to flame anchoring. To verify this place a grounded rod in the flame.

Did placing the grounded rod in the flame improve the DC voltage reading? **NO** → Recheck the orifice size and increase the pilot pressure

YES ↓

Try replacing the pilot nozzle

YES ↓

Set the system up to use separate rods for flame detection and ignition

5.6 Thermocouple Troubleshooting Guide

Problem with Thermocouples.

QUESTION ARE IN WHITE RECTANGLES

? → **NO** NO, ALWAYS MOVES TO THE RIGHT

YES YES, ALWAYS MOVES DOWN

1 Ensure that both the High Temp and Process thermocouples are connected.

A ───── **B**

2 System reading Process TC, ProcTC, HH Thermocouple or ProcH TC

3 Check the thermocouple wiring, ensure that the thermocouples are paired correctly and not reversed.

4 The thermocouple indicated by the system may be faulty. Install a jumper across HighTemp_TC+ and HighTemp_TC-. Also install a jumper across Process_TC+ and Process_TC-.

Did the error clear? — **NO** → One of the circuit boards may be faulty

YES

There is likely a problem with the thermocouple or the wiring

Verify that there is continuity between the red and yellow for each thermocouple

2 System reading TC's not equal or TC Mismatch

3 Set a Multi-Meter to read mili-volts DC (mVDC) and measure across HighTemp_TC+ and HighTemp_TC-

4 Also measure across Process_TC-

Are the voltages measured across the two thermocouples within 0.1mVDC? — **NO** → The system is likely reading correctly. Set the meter to read continuity and check that the thermocouples are paired correctly and not reversed.

YES

The system is likely out of calibration

Re calibrate the HighTemp_TC and Process_TC

If the calibration did not resolve the problem it is possible that one of the circuit boards will need to be replaced

If the thermocouples are paired correctly and not reversed it is possible that one of the thermocouples is faulty and will need to be replaced

GENERAL FEATURES

- Designed for use with natural draft fire tube heaters
- Meets or exceeds all relevant codes and standards
- Easy installation with clearly marked component I/O
- Easily accessible removable terminal connections
- Rapid 3 second shut-down on flame-out
- Electronic spark ignition
- Low-power operating mode to accommodate solar panel or TEG applications
- Auto-relight or manual operation
- Transient protected and fail-safe circuits
- All solid state circuit components
- CSA compliant for Class I, Division 2 locations
- Certified for use on B.149 compliant valve trains
- Optional internal or external ignition coil

INPUTS & OUTPUTS

(6) Digital inputs for safety interlock device connections
(5) Digital outputs
(1) 4-20mA output
(1) Flame-rod input
(3) Thermocouple inputs

TECHNICAL SPECIFICATIONS

TEMPERATURE RATINGS	MIN	MAX
Operating Range	-40°C (-40°F)	+55°C (+130°F)
Storage Range	-40°C (-40°F)	+80°C (176°F)

POWER CONSUMPTION	12V	24V
Controller only, display ON	2.6 W	2.9 W
Controller only, display OFF	1.1 W	1.2 W
Maximum Total Current Draw	5A	5A
Maximum Valve Current Draw	2A	2A
Ignition Voltage (Internal Coil)	up to 20 kV	up to 40 kV

TERMINAL BLOCKS	VALUE
Maximum Wire Gauge	12 AWG

STATUS CONTACT	VALUE
Type	Dry
MAX Voltage	40VDC
MAX Continuous Current	250mA
Impedance (When Closed)	15Ω

PHYSICAL DIMENSIONS	VALUE
Width	30.9 cm (12.15 in)
Height	23.4 cm (9.23 in)
Depth	13.4 cm (5.28 in)

WEIGHT	VALUE
E0000 Model	4.0lbs / 1.8kg
E0400 Model	4.5lbs / 2.0kg
E0M00 Model	4.5lbs / 2.0kg
EC000 Model	6.0lbs / 2.6kg

FUSES	VALUE
Main Fuse Rating	5A / 250V Ceramic, Fast Blow
Status Contact Fuse Rating	250mA / 125V Ceramic, Fast Blow
Replacement Main Fuse	LittelFuse 0314005.HXP
Replacement Status Contact Fuse	LittelFuse 0453.250 or 0451.250