PMSTR-4000 Plant Master
Sample Specification

1. GENERAL

1.1. The plant master shall provide sequencing control and automatic rotation of up to eight connected units.

1.1.1. The plant master shall connect to Fireye NXF4000 and/or PPC4000 parallel positioning controls in any combination up to the maximum of eight connected units.

1.1.1.1. The connected Fireye NXF4000 and/or PPC4000 controls shall revert back to local control following a loss of communication with the plant master.

1.1.2. The plant master shall connect to a steam pressure or water temperature sensor using 4-20mA with a freely adjustable span.

1.1.3. The plant master shall be able to connect to an outside air temperature sensor using 4-20mA with a freely adjustable span or to a remote 4-20mA setpoint from BMS for dynamic setpoint control.

1.1.4. The plant master shall be able to connect to a boiler circulating pump when configured for hot water systems, with optional feedback input.

1.1.5. The plant master shall connect to the NXF4000 and/or PPC4000 controls using Modbus RTU via RS485 and the associated wiring methods.

1.2. A communication interface to building automation, PLC or SCADA shall be provided.

1.2.1. Modbus RTU via RS232 shall be provided via a DB9 serial port.

1.2.1.1. Communication settings such as baud rate, node address, data bits, stop bits and parity shall be user adjustable.

1.2.2. Modbus RTU via RS485 shall be provided via a DB9 serial port.

1.2.2.1. Communication settings such as baud rate, node address, data bits, stop bits and parity shall be user adjustable.

1.2.3. Modbus TCP shall be provided via the Ethernet port.

1.2.3.1. The IP address shall be user adjustable.

1.2.4. A hardwired interface shall be provided.

1.2.4.1. A remote disable shall be provided using dry contacts.

1.2.4.2. A setpoint changeover input shall be provided using dry contacts.

1.2.4.3. A remote setpoint shall be possible using an analog input in either 4-20mA or 0-10VDC format.

1.2.4.4. A 24VDC output shall be provided to indicate that the plant master is online.

2. HARDWARE

2.1. The enclosure shall be constructed from an ABS and polycarbonate blend and carry a UL94-5VB flammability rating.

2.1.1. Enclosure ingress rating shall be UL508 types 1, 2, 3, 3R, 4, 4X (indoor), 12 and 13.

2.1.2. Enclosure ingress rating shall be NEMA types 1, 2, 3, 3R, 4, 4X, 12 and 13.

2.1.3. Enclosure ingress rating shall be IEC529-IP66.

2.1.4. Enclosure dimensions shall be 270mm x 370mm (10.64 in. x 14.59 in.) with a depth of 151mm (5.92 in.).

2.2. The controller shall be an HMI/PLC combination unit.

2.2.1. The touchscreen shall have a 7" diagonal screen area with TFT technology and 800x480 pixel resolution.

2.2.2. The PLC shall be fitted with 12 digital inputs at 24VDC.

2.2.3. The PLC shall be fitted with eight relay outputs, split into two groups of four relays sharing a common input.

2.2.4. The PLC shall be fitted with two analog inputs at 4-20mA.

2.2.5. The PLC shall be fitted with one analog output at 4-20mA or 0-10VDC.

2.3. The complete plant master assembly shall be UL508 listed in the United States and Canada as a UL Industrial Control Panel.

2.3.1. As-Built drawings for the panel shall be provided at delivery.

2.4. The incoming voltage range shall be 100VAC-240VAC (45Hz-65Hz) with a nominal power consumption of 125VA.

2.5. The operating temperature range shall be 0°C to 60°C (32°F to 140°F).

2.6. The operating humidity range shall be 10% to 95%, non-condensing.

2.7. The storage temperature range shall be -20°C to 85°C (-4°F to 185°F).

2.8. The plant master shall use screw-type 6mm terminal blocks for any field connections.

3. FIRMWARE

3.1. The application firmware for the plant master shall be preloaded.

3.2. The application firmware shall be field-upgradable via USB drive.

3.3. The basic application firmware shall be available for archival purposes to the end user.

4. FUNCTIONALITY

4.1. The plant master shall be capable of connecting to any quantity between one and eight NXF4000 and/or PPC4000 controls.

4.1.1. The connection between the plant master and the NXF4000 and/or PPC4000 controls shall be done using standard Modbus RTU via RS485 wiring methods.

4.1.2. The connection point at the NXF4000 and/or PPC4000 controls shall be to the sequencing bus inputs.

4.1.3. All released firmware revisions of the NXF4000 and/or PPC4000 shall be compatible with the plant master.

4.2. Functions and features of the plant master shall include:

4.2.1. Centralized sensor control shall be utilized, configurable for steam or hot water applications.

4.2.2. Centralized sensor shall be 4-20mA type with a configurable range.

4.2.3. A PID-based load control shall be used to calculate parallel firing rates for enabled controls.

4.2.3.1. The proportional band as well as the integral and derivative times shall be user adjustable.

4.2.4. Lead/lag algorithm shall be used to assign a lead control and sequence lag controls based on time and demand.

4.2.5. Automatic rotation of the lead control shall be based on run time/hours.

4.2.6. Automatic lead alternation shall occur when the assigned lead control is unavailable to run due to open interlocks or lockout.

4.2.7. Failsafe communication protocol shall be used to connected controls to enable local operation upon communication failure with the plant master.

4.2.8. Virtual Hand-Off-Auto switches shall be used to allow quick changeover to local control or manual firing rate control.

4.2.9. Outside air sensor connection shall be available when configured for hot water application.

4.2.9.1. Outside air reset setpoint shall have configurable limits.

4.2.9.2. Warm weather system shutdown shall be configurable based on outside air temperature.

4.2.9.3. Outside air sensor shall be 4-20mA type with a configurable range.

4.2.10. Remote setpoint shall be available via analog input when analog input is not used for outside air sensor.

4.2.10.1. Remote setpoint shall be 4-20mA with a configurable range.

4.2.11. Second setpoint shall be available that can be activated using Modbus or a digital input.

4.2.11.1. Second input shall be assignable for use as a priority setpoint, such as for DHW tanks.

4.2.12. A pump output shall be provided for each control when configured for hot water application.

4.2.12.1. Relay outputs shall be used in groups of four per common voltage connection.

4.2.12.2. Dry contact digital inputs shall be used for connection to pump proving devices such as current sensors, pressure switches or flow switches.

4.2.12.2.1. Pump proving requirement shall be optional.

4.2.12.3. Alarms shall be created, and the control marked as unavailable upon lack of pump proving during operation.

4.2.12.3.1. Pump alarm function shall be optional and maximum allowed time to prove shall be programmable.

4.2.12.4. Pumps shall be commanded to run when a call to run exists for the associated control.

4.2.12.4.1. A programmable start delay for the control shall be included to allow the pump to run before the control begins sequencing on.

4.2.12.4.2. A programmable off delay for the pump shall be included to allow the pump to continue running after the control sequences off.

4.2.12.4.3. An option shall exist to command the pump for the lead control on at all times when it is needed for sensor flow.

4.2.12.5. An output providing 24VDC shall be provided to indicate when the plant master is powered and operating properly.

4.2.12.6. An analog output shall be provided in both 4-20mA and 0-10VDC formats to indicate the current load demand of the plant master.

4.2.12.7. Password levels shall be provided to protect configuration or setpoints from unintended alteration.

4.2.12.7.1. A higher-level password shall be required to modify configuration parameters.

4.2.12.7.2. A lower-level password shall be used for system operators to modify setpoint and alternation settings.

4.2.12.8. A real-time clock shall be provided to allow time to be kept for trending, datalogging and schedule enable/disable and setpoint changes.

4.2.12.9. The audible beep of the touchscreen shall be able to be turned on or off via a setting.

4.2.12.10. The backlight saver function timeout shall be user adjustable.

4.2.12.11. The system units shall be configurable as mBar, PSI, ºC or ºF.

4.2.12.12.   The date format shall be configurable to be displayed as MMDDYYYY or DDMMYYYY.

4.2.12.13.   A trend graph function shall be provided to compare the setpoint against the current steam pressure or hot water temperature.

    4.2.12.13.1.   The graph shall be able to be navigated on the touchscreen to specify the time and range.

    4.2.12.13.2.   The graph data shall be able to be downloaded to USB drive on demand.

4.2.12.14.   When a USB drive is left inserted, a data log shall be taken with samples every 10 seconds. Data shall include the following:

    4.2.12.14.1.   Process variable (steam pressure or hot water temperature)

    4.2.12.14.2.   System setpoint

    4.2.12.14.3.   Assigned lead

    4.2.12.14.4.   Actual lead

    4.2.12.14.5.   Total units online

    4.2.12.14.6.   Total units running

    4.2.12.14.7.   Run status units 1-8

    4.2.12.14.8.   Firing rate units 1-8

4.2.12.15.   Option parameters with numerical indexing shall be used to simplify configuration and reduce the number of configuration pages on the touchscreen.

4.2.12.16.   A timer status screen shall be available to view the status of internal timers such as lag start timers.

4.2.12.17.   A schedule shall be available to allow one action per day of week to be programmed with a start time and end time.

    4.2.12.17.1.   Actions can include enabling the system using the normal setpoint, enabling the system using the second setpoint or disabling the system.

4.2.12.18.   Parameters shall be provided to choose the maximum number of units to run.

    4.2.12.18.1.   A separate set of parameters for each control shall be provided for both the normal setpoint and the second setpoint so that the second setpoint shall be capable of being used to apply a different set of lead/lag parameters as opposed to only providing an alternate setpoint.

4.2.12.19.   Parameters shall be provided to allow skipping individual controls as lead for systems with uneven appliance sizes.

    4.2.12.19.1.   A separate set of parameters for each control shall be provided for both the normal setpoint and the second setpoint so that the second setpoint shall be capable of being used to apply a different set of lead/lag parameters as opposed to only providing an alternate setpoint.

4.2.12.20. Parameters shall be provided to allow choosing a custom alternation order.

> 4.2.12.20.1. A separate set of parameters for each control shall be provided for both the normal setpoint and the second setpoint so that the second setpoint shall be capable of being used to apply a different set of lead/lag parameters as opposed to only providing an alternate setpoint.

4.2.12.21. An option parameter shall exist to allow restoring the default configuration set (as shipped).

4.2.12.22. An option parameter shall exist to clear all data log memory.

4.2.12.23. All Modbus TCP (IP address) settings shall be field configurable.

4.2.12.24. All Modbus RTU settings shall be field configurable.

> 4.2.12.24.1. Baud rates from 4800 to 187500 shall be supported.

4.2.12.25. All operating date shall be readable from the Modbus TCP or Modbus RTU connection.

> 4.2.12.25.1. Communication good units 1-8
>
> 4.2.12.25.2. Enable when in auto units 1-8
>
> 4.2.12.25.3. Run status units 1-8
>
> 4.2.12.25.4. Enable in auto lead
>
> 4.2.12.25.5. Enable in auto lags 1-7
>
> 4.2.12.25.6. Pump enable units 1-8
>
> 4.2.12.25.7. Pump proven units 1-8
>
> 4.2.12.25.8. Pump alarm units 1-8
>
> 4.2.12.25.9. Loop supply or steam header
>
> 4.2.12.25.10. Current active setpoint
>
> 4.2.12.25.11. Source of the current setpoint
>
> 4.2.12.25.12. Outside air temperature
>
> 4.2.12.25.13. Current system load
>
> 4.2.12.25.14. Active lead unit
>
> 4.2.12.25.15. Auto rotation hours until next
>
> 4.2.12.25.16. Auto rotation minutes until next
>
> 4.2.12.25.17. Total units online
>
> 4.2.12.25.18. Total units running
>
> 4.2.12.25.19. Online status of units 1-8
>
> 4.2.12.25.20. Actual firing rate of units 1-8

4.2.12.26.   All adjustable parameters and inputs shall be writable from the Modbus TCP or Modbus RTU connection.

    4.2.12.26.1.   Remote disable

    4.2.12.26.2.   Use second setpoint

    4.2.12.26.3.   Reset auto rotate time

    4.2.12.26.4.   Use manual fire rate when in hand units 1-8

    4.2.12.26.5.   Setpoint 1

    4.2.12.26.6.   Setpoint 2

    4.2.12.26.7.   Remote setpoint

    4.2.12.26.8.   Assigned lead unit

    4.2.12.26.9.   Auto rotation hour setpoint

    4.2.12.26.10.   Lag start percent

    4.2.12.26.11.   Lag start delay timer

    4.2.12.26.12.   Lag stop percent

    4.2.12.26.13.   Lag stop delay timer

    4.2.12.26.14.   Hand-off-auto switch state for units 1-8

    4.2.12.26.15.   Manual fire rate when in hand units 1-8

5. OPERATION

5.1. The online status of each NXF4000 and/or PPC4000 relative to the plant master shall be determined.

   5.1.1. A control shall be marked online when sequencing is properly set up on each NXF4000 and/or PPC4000. Each shall have a unique node address.

      5.1.1.1. All connected controls must be properly wired using standard Modbus RTU via RS485 wiring methods.

   5.1.2. A control shall be marked offline if there is a Modbus communication fault.

   5.1.3. A control shall be marked offline if the recycle interlock is not made or the control is locked out.

   5.1.4. A control shall be marked offline if the virtual Hand-Off-Auto switch is not in AUTO.

5.2. A centralized steam pressure or hot water temperature sensor shall be compared against a setpoint to create a system load using a PID calculation.

   5.2.1. At least one control must be online for there to be a valid setpoint.

   5.2.2. If all controls are offline the system shall indicate that there is no system load.

5.3. The lead control shall be enabled whenever there is any system load present.

5.4. The system load shall be calculated based upon the number of controls that are online.

5.5. When calculating individual firing rates, the system shall divide the total system load by the number of units that are online.

   5.5.1. The firing rate applied to the unit shall be scaled appropriately so that 100% system load would equal all online units at 100% firing rate.

5.6. Staging for the lag units shall be done based upon a lag start setpoint and a time delay. When the lead or preceding lag unit firing rate exceeds the lag start setpoint for the full duration of the time delay, the next lag shall be enabled. All firing rates shall be updated to reflect the current total firing units.

5.7. When the system load reduces, lag units shall be disabled in a similar manner to how they are started. When the firing rate drops below the lag stop setpoint for the full duration of the time delay, the last lag unit on shall be disabled. All firing rates shall be updated to reflect the current total firing units.

5.8. When the system load reduces to 0%, a timer shall be activated to delay the shutdown of the system and lead unit. If the system load does remain at 0% for the full duration, the lead unit will shut down and the plant master will indicate that there is no system load.

5.9. The lead/lag (alternation) order shall be determined from the option parameters that specify this for the currently selected setpoint. The system shall use the lead/lag (alternation) order specified for the second setpoint when that setpoint is selected using the digital input or Modbus.

5.10. The maximum number or units that can be enabled shall be determined from the option parameters for the currently selected setpoint. The system shall use the setting

specified for the second setpoint when that setpoint is selected using the digital input or Modbus.

5.11.　A specific unit shall be able to be skipped when set using the option parameter for the currently selected setpoint. The system shall use the setting specified for the second setpoint when that setpoint is selected using the digital input or Modbus.

5.12.　Automatic lead rotation shall occur after the lead unit has been running for the duration of the alternation setpoint. The accumulated hours shall only accrue when the unit is firing.

    5.12.1.　If the lead unit changes status to offline at any point, the first lag shall assume the lead position temporarily until the original lead is placed online again. The original lead unit run hours will continue to accrue.

    5.12.2.　A parameter shall exist to allow automatic lead rotation to be disabled (lead shall then be chosen manually).

    5.12.3.　There shall be an overlap of operation between the former lead unit and new lead unit during changeover. A parameter shall exist to set this overlap time.

5.13.　An outside air temperature setpoint shall be used when configured for hot water systems and there is a valid outside air temperature sensor connected.

    5.13.1.　The outside air reset setpoint shall be calculated from configurable parameters for minimum and maximum outside temperature as well as minimum and maximum system setpoints. The calculation shall only be performed once every five minutes to avoid a fluctuating setpoint.

    5.13.2.　If the outside temperature sensor fails during operation the system shall revert to the locally entered setpoint.

    5.13.3.　If configured with priority, the second setpoint shall supersede the outside air setpoint when enabled.

    5.13.4.　A parameter shall exist to shut the system down (no system load) when the outside air temperature is too high (warm weather shutdown).

5.14.　Pump control shall be provided for hot water systems.

    5.14.1.　When a unit starts, the pump output shall be enabled and the unit itself is delayed for an adjustable start delay period. This start delay gives time for the pump to circulate before the unit starts.

    5.14.2.　When the unit shuts down, the pump shall continue to run for an adjustable off delay period. This also allows any latent heat to circulate before the pump shuts off.

    5.14.3.　There shall be an option to connect pump feedback. When enabled, the status of the pump monitoring device shall be shown on the interface.

    5.14.4.　There shall be an option to enable a pump alarm, which is triggered if the feedback is not received within a set allowed amount of time. If a pump alarm is created, the unit shall be marked offline until the pump alarm is resolved.

5.15.　When a unit changes to the run state there shall be an adjustable delay applied before the unit can modulate. The unit shall be kept at low fire during this delay.

6. INTERFACE

6.1. There shall be an overview screen capable of showing the operating status of four units. If the plant master is configured for more than four units, there shall be a second overview screen available for units 5+ that contains the same basic information as the main overview screen.

6.2. The overview screen of the user interface shall display the following:

6.2.1. Steam header pressure or loop supply temperature.

6.2.2. The current setpoint and the source. The source shall derive from the following options:

6.2.2.1. Setpoint 1

6.2.2.2. Setpoint 2

6.2.2.3. Outside air

6.2.2.4. Remote

6.2.2.5. System disabled

6.2.3. System load in percent.

6.2.4. The outside air temperature sensor reading (if configured).

6.2.5. The operating status of each unit. The status shall derive from the following options:

6.2.5.1. Offline

6.2.5.2. Standby (unit is online but commanded off)

6.2.5.3. Starting (unit is online and in the process of firing)

6.2.5.4. Running (unit is running)

6.2.6. The current lead or lag assignment of the unit.

6.2.7. Bar graph for the actual firing rate.

6.2.8. The current pump command and feedback status.

6.2.9. Virtual Hand-Off-Auto switch.

6.3. Icons shall be used as buttons to navigate to other screens.

6.4. A passcode screen shall automatically display when a screen has security requirements.

6.5. All settings shall be done using numerically indexed option parameters.

6.5.1. Option parameters shall be grouped by type.

6.5.2. Access to the option parameters shall require the highest level of passcode.

6.6. A timer status screen shall be accessible from the settings screen to view the current status of any timer used for start/stop delays, modulation delays or pump delays.

6.7. A setpoint screen shall be provided to allow operating user the ability to make changes.

6.7.1. Access to the option parameters shall only require the lower level of passcode.

6.7.2. Setpoints that shall be adjustable from the setpoint screen:

    6.7.2.1. Setpoint 1

    6.7.2.2. Setpoint 2

    6.7.2.3. Lag start percent

    6.7.2.4. Lag start delay time

    6.7.2.5. Lag stop percent

    6.7.2.6. Lag stop delay time

    6.7.2.7. Auto rotation time

    6.7.2.8. Current assigned lead unit

    6.7.2.9. Current alternation timer remaining with manual timer reset button

6.7.3. A trend graph screen shall be provided to view the setpoint against the process variable.

    6.7.3.1. The trend graph shall be able to be navigated by time period.

    6.7.3.2. The data shall be able to be exported to USB drive.

    6.7.3.3. The current state of log memory used shall be displayed. Log memory shall be resettable from an option parameter.