PF3100 FARC USER GUIDE v6.0

This user guide contains a general overview of the PF3100 FARC system features and operation. For more specific BMS related operation please review the PF3100 BMS operating manual. This guide is applicable to the NA-42 firmware release only.

Contents

FEATURE OVERVIEW

PERIPHERALS

The PF3100 system can be configured to operate as a parallel positioning fuel/air ratio control system for forced draft applications. In addition to the standard fuel train, the following peripherals are required:

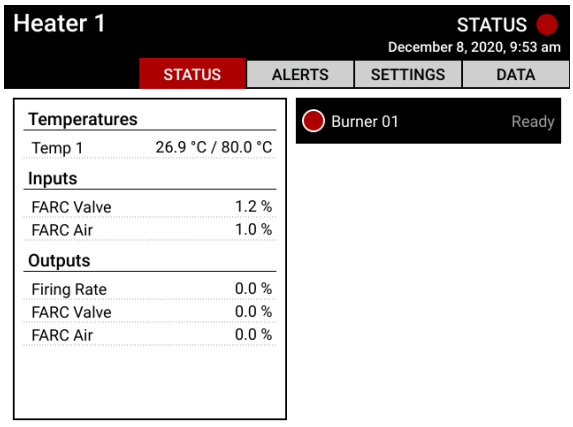
- A fuel gas control valve (TCV) where valve position is controlled by a 4-20 input signal. The valve must have a 4-20 output signal for position feedback.
- An air damper or VFD blower where damper position/VFD speed is controlled by a 4-20 input signal. The damper or blower must have a 4-20 output signal for position/speed feedback.
- A proof of airflow switch or 4-20 transmitter. Airflow must be proven from the blower for the system to start.

Additionally, the following IO are available, but are not required for the system to operate.

- A fault input may be enabled on the IO expansion module. This will take in a digital signal from either a VFD motor driver or air actuator. Often these devices have an output that triggers in the case of a fault event (over-torque, over-heat, etc.). If the signal is high the system will operate normally. If the signal is low or open the BMS will alarm and shutdown.
- The BMS has a powered output that can be used as a signal output to turn a blower on/off. This output will turn the blower on or off accordingly for the system state. It is often used when variable air flow is controlled by a damper.

STATUS SCREEN

Once initial configuration is complete, adjustments to settings can be accessed from the Appliance Status Screen. The Status screen will show the following information. Clicking on any of the FARC labeled items will open the FARC configuration dialog.



Inputs

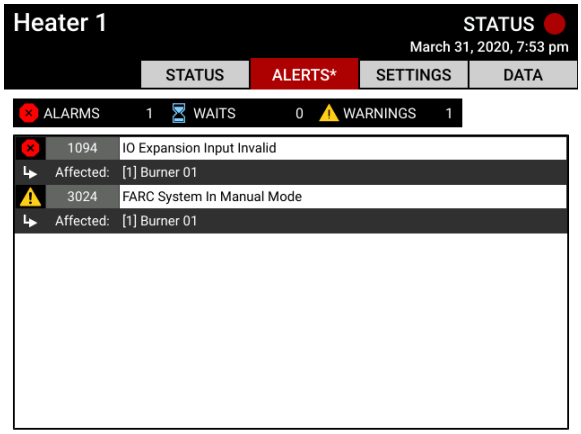
- FARC Valve – This shows the current valve position feedback. An out-of-range input is displayed by an "N/A".
- FARC Air – This shows the current air feedback.
- Proof of Airflow – this shows the proof of air input (from IO Expansion or Aux In)

Outputs

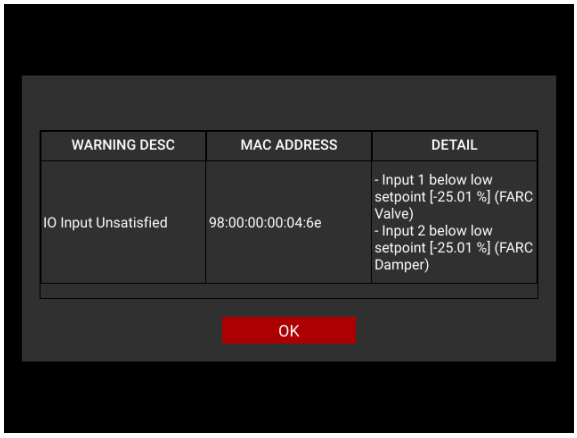
- Firing Rate – This shows the current requested firing rate for the system
- FARC Valve – This shows the BMS's currently requested valve output.
- FARC Air – This shows the BMS's currently requested air output.

ALERTS

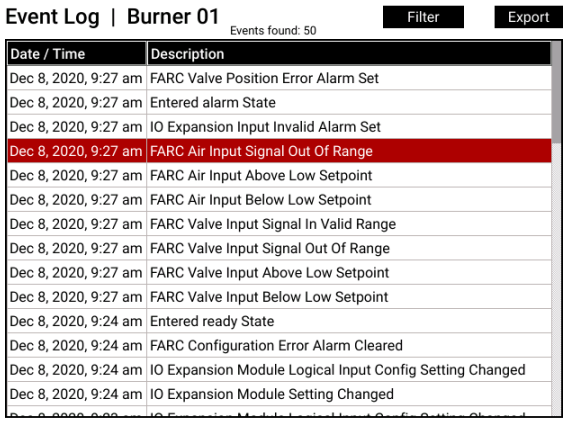
All system alarms including any FARC related alarms are annunciated on the alerts screen. These include any configuration or input faults related to the FARC settings or physical I/O.



- The alerts screen shows any currently annunciated alarms, system waits or warnings.



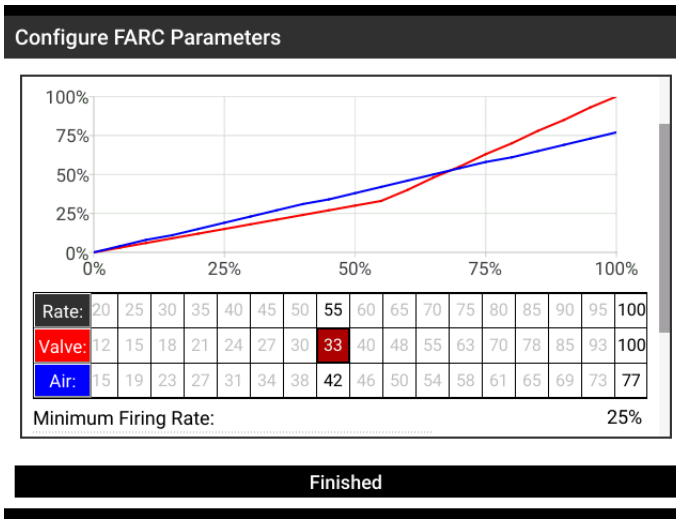
- An alarm may be selected and opened on the alerts screen to show a more detailed description of the related system issue.



- System events including alarms and shutdowns are recorded in the PF3100 event log.

FUEL AIR RATIO TABLE

The fuel air ratio table has a total of 21 points of adjustment for each fuel and air curve. The adjustment points are located at 5% increments across the firing rate 0 to 100% range. The table may be adjusted in 1% increments.



- A minimum of 1 point is required to start the system.
- Points may be added at any 5% interval by highlighting the firing rate column and pressing any of the OK, +, - or number pad buttons.
- All entries must be greater than or equal to the previous point. This enforces an increasing Fuel air slope.
- A user entered point is highlighted in black.
- Values between user added points are linearly interpolated. These values are shown in a grey font.
- Points may be removed by highlighting the column and pressing the OK button, then selecting *remove point* from the pop-up dialog.
- The plus (+) and minus (-) buttons will increase or decrease the highlighted point in 1% increments.

INSTALLATION GUIDE

Installation and commissioning must be performed by a qualified technician with experience in commissioning and tuning Forced draft positioning type FARC systems. Regular maintenance should be performed on the system to verify the tuning and correct system operation.

The PF3100 FARC system uses analog 4-20mA and digital on/off signals to control external devices. The following table outlines IO operation. Connect the BMS IO to the corresponding peripheral. Wiring diagrams for common installations are available from Profire. In addition to this table any IO expansion card inputs may be configured to be used as fault alarms for peripheral equipment. Commonly these will be configured as an additional fault feedback from a motor driver.

IO:	Location:	Signal Type:	Description
FARC Valve Output	PF3101-00 BMS Aux Out	4-20 output	Controls the fuel gas valve position.
FARC Valve Input	PF3113-00 IO Expansion Signal In Input	4-20 input	Confirms the position of the valve.
FARC Air Output	PF3113-00 IO Expansion Signal Out Output	4-20 output	Controls the position of the damper or the blower speed.
FARC Air Input	PF3113-00 IO Expansion Signal In Input	4-20 input	Confirms the position of the damper or the speed/airflow of the blower.
Force Air Fan Output	PF3101-00 BMS HFV output	Digital output	A powered output that can be used to turn the blower enable ON or OFF.
Proof of Airflow (Option 1)	PF3101-00 BMS Aux Input	Digital input	A digital input that when closed confirms airflow. At least 1 proof of airflow input is required for the system to operate.
Proof of Airflow (Option 2)	PF3113-00 IO Expansion Signal In Input	Digital or Analog input	When configured as a digital input the system will confirm airflow when closed. When configured as an analog input the system will confirm airflow when above the configured setpoint. At least 1 proof of airflow input is required for the system to operate.

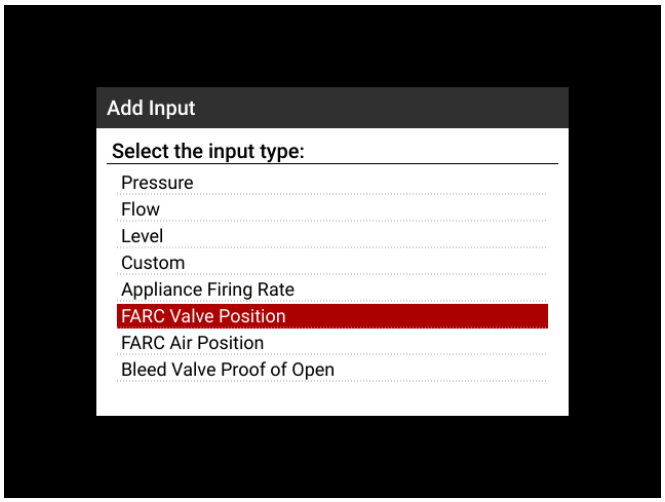
FARC COMMISSIONING

Prior to configuring FARC, make sure the BMS system has been configured per the installation. This may include configuring temperatures, ignition modules, fuel gas pressure transmitters, level transmitters, etc.

FARC specific settings have a level 3 authentication. Please contact Profire for the password to modify these settings.

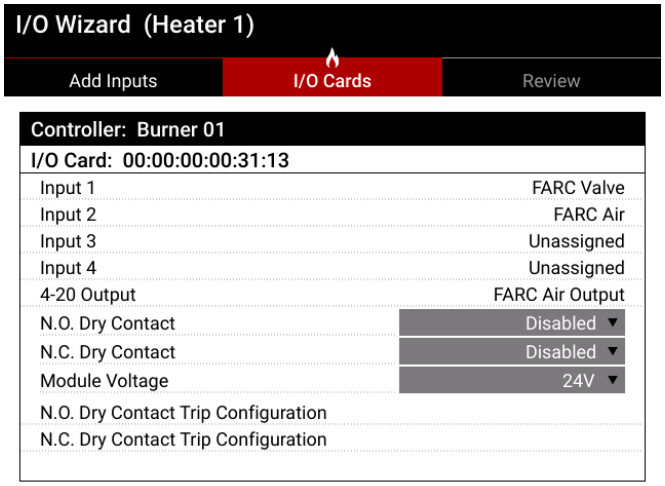
CONFIGURING THE IO EXPANSION MODULE

The following instructions provide an overview of how to configure the IO expansion module required for FARC control.



Open the IO expansion wizard: System Overview Settings > IO Expansion wizard. In the Add Inputs tab:

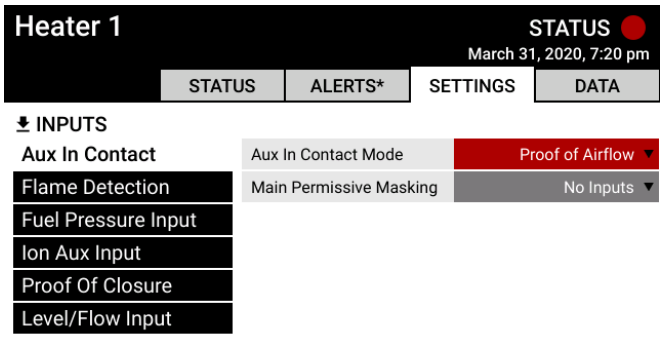
- Add a FARC Valve Position input.
- Add a FARC Air Position input.
- (Optional) Add a custom Proof of Airflow 4-20 or Digital input



- Add the FARC Valve to input 1 and the FARC Air Position to input 2.
- Set the 4-20mA output to Air Position Controlled by FARC. A dialog will appear with additional FARC configuration settings. See the FARC Settings section for a detailed description of setup. The Fuel Air table, light off position and minimum firing rate can be adjusted later. All other settings can only be set in this screen as they should only be configured in commissioning and not during operation.
- (Optional) Proof of Airflow input can be assigned here
- The IO expansion module can be set to a 12V or 24V mode –. If unsure, use 12V mode.
- Go to the review tab and confirm there are no configuration errors.
- Accept the changes and close the wizard

CONFIGURING BMS SETTINGS

The following settings must be configured on the BMS for the system to currently work In the FARC Mode. If any of the settings are not set a FARC configuration alarm will be set. The settings may be configured in the BMS settings tab.



Enable low fire mode

- Process control > Process Temp Control > low Fire Mode on at process setpoint

Enable proof of airflow for the aux input

- Inputs > Aux in Contact > Proof of Airflow

Enable the TCV output

- Outputs > 4-20 Aux Out > PID Control

Enable the Fan Output

- Outputs > Valves > HFV > Force Draft fan

Set the High Fire PWM to max

- Outputs > Valves > High Fire PWM > 100%

HOW TO ADJUST FARC SETTINGS AFTER INITIAL COMMISSIONING

- Open the FARC Configuration Dialog by selecting one of the FARC IO in the appliance status screen. The FARC IO will highlight red, simply press OK to select it.
- All settings are set to a read only state by default. To change them the FARC Mode must be set to Manual.
- Adjust the settings as desired. The changes will take effect immediately. The return or finished button may be used to close the dialog.
- If the system is left in Manual mode a warning will be displayed on the alerts screen.
- Not all settings can be adjusted from this screen. Settings that are read only can be adjusted from the IO wizard. This includes the start up positions of the valve and air actuators and all error configuration.

FARC CONFIGURATION DIALOG SETTINGS

The following settings are available for adjustment in the settings dialog. This is accessible from the appliance status screen by selecting and pressing the OK button on any of the FARC labeled IO. All FARC related settings are level 3 password protected unless otherwise noted.

Some settings such as the manual firing rate, light off position and minimum firing rate are weakly enforced with respect to each other. This means that once the values are within a valid range, they will be prevented from moving outside of that range by the user interface. If the values are outside of a valid range (for example due to a reset to defaults), they can move across the full range until they fall within the valid range. This allows for adjustment of these settings if they are configured incorrectly, but also allows for them to be easier to change by the operator during operation without tripping a configuration error.

Setting		Default	Range	Authentication	Edit While Running	Description
FARC Mode *(Default: Auto)*	Auto	*Auto*		L2	Yes	The system runs normally, the firing rate is determined by the BMS. In this mode FARC table configuration points are locked and cannot be changed.
	Manual					The system runs in a manual mode. The firing rate is provided to the system by the Manual Firing Rate setting. In this mode the fuel air table settings are unlocked so they can be adjusted. This mode is to allow for operator adjustment of the fuel air ratio table while the system is running.
Manual Firing Rate (%)		*0%*	*Minimum Firing Rate to 100%*	L2	Yes	When in manual mode the system will run at this firing rate.
Fuel Air Ratio Table	Firing Rate	*Not adjustable. Available in 5% increments from 0 to 100% firing rate.*		L3	Yes	When this firing rate is used by the controller (or specified by the operator) the valve and air positions will be set to the corresponding outputs in the table.
	Air	*0% for all points*	*0 to 100%*			The % open of the damper or % speed of the VFD at the corresponding firing rate.
	Fuel					The % open of the gas valve at the corresponding firing rate.
Airflow Control Type		*Damper*	*Damper VFD*	L2	No	Damper for Airflow Damper VFD for Fan Motor Control
Air Purge Position (%)		*0%*	*0% to 100%*	L3	No	When in the purge state the air actuator will be at this position.
Air Pilot Position (%)		*0%*	*0% to 100%*	L3	No	When in the pilot state the air actuator will be at this position.
Valve Purge Position (%)		*0%*	*0% to 100%*	L3	No	When in the purge state the valve will be at this position.

Valve Pilot Position (%)	*0%*	*0% to 100%*	L3	No	When in the pilot state the valve will be at this position.
Light Off Position	*20%*	*Minimum Firing Rate to 100%*	L3	Yes	This is the firing rate that the system will ignite the main burner at. This may be higher than the minimum firing rate to assist with light off.
Minimum Firing Rate (%)	*40%*	*0% to Light off position. Maximum of 70%*	L1	Yes	This is the minimum firing rate that the system will use when in the process control state. This must be less than or equal to the light off position. It can be set lower than the light off position for improved burner turndown.
Position Error Timeout (seconds)	*10 Seconds*	*1 to 10 Seconds*	L3	No	This is the amount of time in seconds before the position error alarm will occur if the Position error is not satisfied.
Position Error (%)	*2%*	*0% to 10%*	L3	No	This is the maximum allowable error from the requested valve or air position as compared to the feedback valve or air position. If the error is not satisfied within the Position Error Timeout time, the system will alarm and shutdown.
Cross Limit Error (%)	*1%*	*0% to 15%*	L3	No	This is the maximum allowable difference that the fuel position may exceed the air position. If this difference is exceeded for a time longer than 2 seconds the system will alarm and shutdown. Effectively this is the percentage of excess fuel position that is allowed within the tolerance of the system. In the opposing case where the air position is greater than the fuel position the system will not shutdown as this is not an inherently dangerous situation.

ALARMS

The following alarms are a subset of the burner managements systems alarms that are related to the FARC control system. A general description is offered here. For specific alarm details refer to the PF3100 alarm and shutdown code document.

IO EXPANSION INPUT INVALID

This alarm will appear if an IO expansion input is out of range. The IO expansion inputs are used for the position feedback for the fuel and air devices. More details about the affected IO expansion input such as the input name can be found when the alarm is selected and opened. On the status screen the respective input will display an "N/A" indicating the input is currently invalid. This alarm could mean one or more of the following:

- The input is below 4mA or above 20mA.
- The input is open or shorted.
- The device is damaged, or not responding, or indicating a fault by setting the feedback signal to an out of range value.

FARC CONFIGURATION ERROR

This alarm will appear if any of the FARC settings are not configured correctly. Review the FARC commissioning section for details. This error could mean one or more are not set correctly:

- Proof of airflow input is not enabled.
- Forced draft fan output is not enabled.
- Low fire mode is not enabled.
- System is not in PID or appliance firing rate control.
- The fuel air ratio table has not been configured.
- The fuel air ratio table is invalid. Either the table is corrupt, or the fuel/air slopes are decreasing.

VALVE POSITION ERROR & AIR POSITION ERROR

These alarms will appear if a requested position does not match up to the received valve or air position, respectively. For example, with a position error set to 5%, If the system is requesting 50% output from the valve and the valve only opens to 40%, the system will alarm as the difference between the requested position and the actual position exceeds the 5% position error setting. The following items are examples of what could cause a position error:

- The 4-20 transmitter or receiver is not calibrated.
- The valve or air is stuck, or it has a fault and is not responding.
- The output signal from the BMS controller is open or shorted. Meaning that the valve or air is not receiving the signal.

CROSS LIMIT ERROR

The cross-limit error alarm will occur if fuel position exceeds the desired fuel position requested by the current air position by more than the cross-limit error % setting for a period of 2 seconds or more. The threshold is provided by the cross-limit error % setting. This alarm is only checked in states where the main valves are energized (SSV's).

- The fuel or air system is malfunctioning (it is stuck or has a fault and is not responding) potentially causing an unsafe situation.

FAILED TO PROVE PURGE POSITION

The purge position cannot be achieved within the position error before a timeout of 90 seconds.

- The 4-20 transmitter or receiver is not calibrated.
- The valve or air actuator is stuck, or it has a fault and is not responding.

FAILED TO PROVE PILOT POSITION

The pilot position cannot be achieved within the position error before a timeout of 90 seconds.

- The 4-20 transmitter or receiver is not calibrated.
- The valve or air is stuck, or it has a fault and is not responding.

FAILED TO PROVE LOW FIRE POSITION

The low fire (main light off) position cannot be achieved before a timeout of 90 seconds.

- The 4-20 transmitter or receiver is not calibrated.
- The valve or air actuator is stuck, or it has a fault and is not responding.

FAILED TO PROVE AIRFLOW

The PF3100 is in a purging state or has requested air flow in a running state and the proof of airflow input has not been satisfied.

- The proof of airflow signal is open.
- The air actuator is in the correct position, but the fan may not be running to produce enough air flow.
- The fan may have an obstruction.
- A proof of airflow switch may be stuck.
- A proof of airflow transmitter may not be calibrated correctly.
- The proof of airflow setpoint setting may not be configured correctly.

OPERATING OVERVIEW

The PF3100 system can be configured as a FARC system to regulate the ratio of fuel to air. The FARC control system requests the valve and air positions and compares them to the feedback positions.

The FARC system works in conjunction with the burner management controller where requests for the FARC pilot, light off, purge and process control positioning are sequenced between the two. A fuel control valve and air control are required.

The following items describe a few key details of the operation of the FARC system.

- The proof of airflow switch or sensor is proven deenergized before starting the system. This is done by removing or reducing airflow enough during the startup sequence to deenergize the input and verify the loss of air flow. In the event the airflow switch is not proven, the system will shut down.
- The manual firing rate can be changed to a desired position before changing the system over from auto to manual. Where all other FARC related settings require the system to first be in manual mode before adjustment. This is so that the operator can select a desired firing rate before manually overriding the system.
- Position monitoring is used to verify the position feedback against requested positions.
- The position error alarm has a selectable alarm time. This allows for an alarm time to be selected that is appropriate for the appliance's operating limits.
- The cross-limiting control system is designed in such a way that airflow must always be greater than the gas flow for all operating events and firing rate transitions. A maximum cross limit error is used to prevent the gas position from exceeding the air position during operation. If the gas flow exceeds the airflow by more than the cross-limit error and for longer than 2 seconds the system will shut down. The cross-limit error is not the primary method of control to prevent a fuel rich condition. It is a secondary alarm in the event of a malfunction of the actuators. In normal use this tolerance can compensate for positioning deadband in actuators, while preventing operation outside of the appliances safe operating region.
- When the firing rate is decreased the gas valve will close then the air position will follow the gas valve position. The gas valve leads, and the air position lags.
- When the firing rate is increased the air position will increase then the gas valve will follow the air position feedback. The air position leads and the gas lags.
- If the fuel or air actuator becomes stuck during transition the system will alarm and shutdown after the position error timeout.
- The fuel air ratio table must not allow for a contradiction in firing rate and fuel/air positioning. Hence, an increase in firing rate must either increase fuel/air positions or keep them the same. A decrease in firing rate must either decrease fuel/air positions or keep them the same. The fuel/air positioning is not allowed to decrease if the firing rate is increasing.

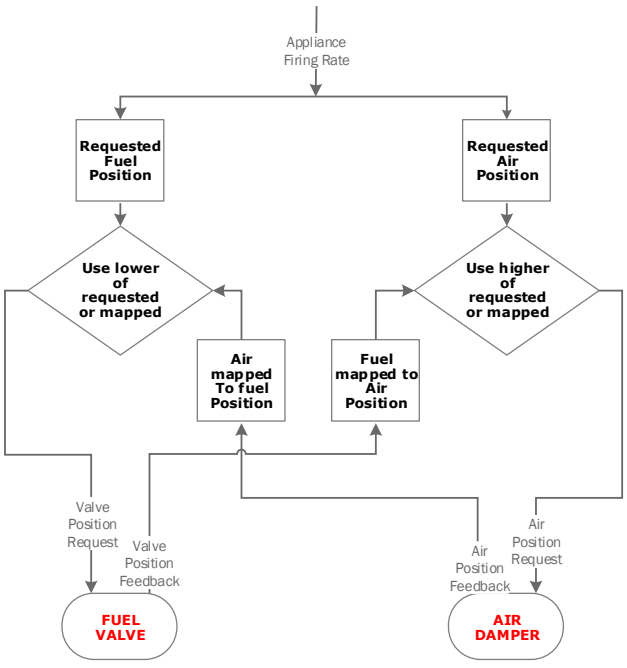
CROSS LIMITING AND POSITION ERROR

FARC systems often have a position error that is used to define the allowable operating limits of the system. The PF3100 system uses a position error (the allowable difference between requested and feedback position) to define the limit of tolerance in each individual peripheral device.

The maximum difference with position error alone between the air and the fuel gas position is 2 * position error. As an example, with a 5% position error - the valve can be 5% high while the air position is 5% low. While each is within the 5% position error threshold, the difference between the two actuators is 10%.

For this reason, it is recommended that the cross-limit error is set at a value below the position error. The cross-limit error sets the limit on the maximum amount that the fuel can be in excess of the air regardless of their position error. For example, if the position error is 5% and the cross-limit error is 3% - the fuel and the air can both deviate up to 5% from their requested positions, but the fuel cannot be more than 3% higher than the air feedback.

An example of this is if the fuel and air feedback positions are both 5% high from their requested positions (perhaps due to calibration). They both may respectively be at the correct fuel/air ratio so there is no need for the system to shut down. However, if at this point the air now drops by 3% the fuel/air ratio will be out of specification and the system must shutdown. The position error is also used to limit the amount of excess air during firing rate transitions by limiting the requested airflow to a maximum of the position error for each of the actuators. This helps to improve system efficiency during transitions.



- Firing rate can be requested by the internal PID, manual override or external request.
- The fuel and air position are gathered from the fuel air ratio table.
- The air position is mapped back to the fuel air ratio table to get the corresponding fuel position. The fuel valve is requested to be set to the lower of the firing rate or the air limited value.
- The fuel position is mapped back to the fuel air ratio table to get the corresponding air position. The air position is requested to be set to the higher of the firing rate or the air limited value.
- Not shown here is the position error and the cross-limiting error which ensure the operation of the system is within the appliance limits.
- During process control the firing rate is gated to the minimum firing rate setting.

FIRING RATE TRANSITIONS

As the firing rate changes, the internal FARC control system will step the fuel/air outputs in 0.5% increments up to the maximum excess air limit. In some systems positioning to the maximum excess air may not be enough of a change to affect a movement of the actuator/fan, etc., possibly due to a deadband. To compensate for this, the requested position will increment/decrement by 0.5% every 1 second until reaching the desired firing rate.

When at the excess air limit the system will wait for the actuators to catch up to the request before continuing to increment/decrement the requested position. This control method is transparent at the system level, and acts to smoothly transition both the fuel and air positions through the firing range while compensating for any system deadband. This also tightens the actuation between the fuel and air positioning and limits the amount of excess air during transitions to improve efficiency.

START SEQUENCE

The following is a summarized overview of the startup sequence of the PF3100 system when in FARC mode. All timeouts listed below will exit immediately if the condition that is being checked is satisfied. This is to speed up the startup process and minimize down time between any shutdown cycles.

READY

Ready is the default state for the system to wait in standby until an interaction starts the system. Upon receiving a command to start, the system will turn the fan OFF and move to the *Startup Checks* state.

STARTUP CHECKS

The *Startup Checks* state proves the absence of airflow. The system waits in this state until the proof of airflow input is de-energized (if using a switch) or until the airflow sensor is reading no airflow (if using a transmitter). Once verified the system will turn the fan ON and continue to the *Request Purge Position* state. If the absence of airflow cannot be proven within 90 seconds, the system will shut down on a *Failed to Prove No Airflow* alarm.

REQUEST PURGE POSITION

When purge position is requested, a command is sent to the FARC system to enable the FAN output and request the air and fuel actuators to the purge position. A timer begins to count down from 90 seconds. Once elapsed and the position has not been satisfied, the system will shut down on a *Failed to Prove Purge Position* alarm. If the purge position is achieved before the timer elapses the system will immediately move to the *Prove Airflow* state.

PROVE AIRFLOW

The system holds on a 90s timeout, continually checking for airflow from the proof of airflow input. Once achieved, the system will move to the *Purging* state. If the timer elapses, the system will shut down on a *Failed to Prove Airflow* alarm.

PURGING

Once in purging, the purge timer (operator selected setting) will count down. When it has elapsed, the system will move to *Request Pilot Position*. During purging if the proof of airflow or purge position is not satisfied it will shut down on a *Failed to Prove Airflow* alarm. During the request pilot position, pilot ignition, request main light off and process control states the purge position does not need to be proven, but the proof of airflow is required to always be satisfied or the system will shut down on a *Failed to Prove Airflow* alarm.

REQUEST PILOT POSITION

Once requested, a 90s timer counts down. If the pilot position is not achieved before the timer elapses, the system will shut down on a *Failed to Prove Pilot Position* alarm. If the position is achieved, the system will move to *Pilot Ignition*.

PILOT IGNITION

After the purging sequence has been completed and the air actuator is at the pilot light off position, the pilot trial for ignition will begin. The pilot position must be maintained during this state or the system will shut down on a position failure alarm. After a successful pilot light off, the system will move to the *Request Main Light Off Position.*

REQUEST MAIN LIGHT OFF POSITION

Once requested, a 90s timer counts down. If the main light off position is not achieved before the timer elapses, the system will shut down on a *Failed to Prove Main Light Off Position* alarm. If the position is achieved, the system will move to light off the main burner and enter *Process control*.

PROCESS CONTROL

Once in the process control state, the system is now allowed to run in auto mode via the internal PID or via an external appliance firing rate request. Alternatively, the operator may put the system into manual mode to override the firing rate manually. In all cases, the FARC system will modulate the fuel and air positions according to the fuel air ratio table and the requested firing rate. All transitions (auto and manual) use cross limiting control to provide excess air on firing rate changes.

STOP SEQUENCE

The system may shutdown via an alarm or user stop. When this occurs the stop sequence will begin. The stop sequence may occur from any running state.

POST PURGE POSITION

Once initiated, the fan output is turned ON if not already, and the purge position is requested. In this case the proving of the position is not required (the system does not care if it achieved the purge position or not as it is already moving towards a shutdown and needs to *purge* regardless). The system will immediately move to *post-purge*.

POST PURGE

The system will transition to the *Lockout* state and continue the purge countdown (user selectable time). The post purge and lockout events are asynchronous. The purge will occur regardless of whether there is an alarm and regardless of whether airflow is proven or not. Any subsequent starting of the system will require a proven pre-purge regardless of the post purge because there is no guarantee of the post-purge air changes (fan may have faulted, or a damper may be stuck causing the system to shutdown). Once the post purge is complete, the fan output is de-energized. The post purge countdown may begin before the air actuator is at purge position, hence if a full post purge time is required the purge time may need to be increased to compensate for the time the air actuator may require to get to the purge position.

LOCKOUT

After the purge is complete, the system will remain in a lockout state. Lockout state requires user acknowledgment before the system can move to another state. If all alarm conditions have been cleared, the acknowledgment will transition the system to the ready state where it may be started again. Otherwise, a Lockout acknowledgment will transition the system to the *alarm* state.

ALARM

The system will remain in the alarm state if there are persistent alarms. Once cleared, the system will move back to the *ready* state. For additional details on alarm handling refer to the PF3100 BMS user guide.

WAIT TRANSITION

The system may enter a waiting state while running. This can be from several wait events including low fuel pressure, or a low voltage restart or others. When entering wait from a flame state the system will perform a post purge sequence. Proof of purge position and proof of airflow are not required as the system must do this during the startup sequence before any valves are opened. The post purge sequence may be exited before completion if a startup sequence has been initiated and no other wait bits are set.

REQUEST PURGE POSITION

The fan output is turned ON and the purge position is requested. The system then immediately moves to the *Purging* state. Note that proof of purge position is NOT required (see above).

PURGING

Once in purging the purge timer (operator selected setting) will count down. When it has elapsed, the system will move to the *Wait* state. Note that proof of airflow is NOT required (see above). The system is free to exit the purge state if the start sequence is initiated and there are no other wait bits set.

WAIT

Once in the wait state the air actuator will remain in the purge position, however the fan output will be deenergized. The system will remain in the wait state until all wait conditions are cleared. Once all wait conditions are cleared the system will perform the start sequence to start the appliance.

CANADIAN FIELD APPROVAL REQUIREMENTS

FARC systems in Canada must comply with the requirements found in CSA B149.3-20 Annex D. Canadian regulations generally require gas fired equipment to be field approved by an inspector prior to commissioning. The following table provides a summary of the Annex D requirements which Canadian inspectors will refer to and a corresponding explanation of how the PF3100 system meets each of those requirements. Note that some requirements are addressed inherently by the PF3100, others must be addressed through the engineering design of the overall system, and yet others must be addressed at the time of commissioning of the equipment. These requirements are labelled in the table below as being addressed by "PF3100", "System Design", and "Commissioning" respectively.

The standards requirements have been summarized, please refer to the applicable document for interpretation.

Summarized Requirement		Implementation	Addressed by:
D.2	**Option to certify to ISO 23552-1.**	The PF3100 is not currently certified to this standard.	
	Option to use a microprocessor-based system compliant with clause 12.7.	The PF3100 does comply with this requirement.	PF3100
	Option to integrate FARC with the BMS.	The PF3100 does integrate these features. The PF3101-00 BMS Controller card runs the FARC control algorithm and may be configured to use IO on additional PF3100 family cards.	PF3100
	Option to use a non-certified system compliant with the following additional requirements.	The PF3100 FARC feature set is not certified (as per ISO 23552-1) and does comply with the following requirements.	PF3100
D.2 a	**The FARC system shall be evaluated as a closed loop system.**	Control of the FARC system is based on positioning according to the fuel air ratio table and the appliance firing rate and relies on a closed loop feedback to verify correct operation.	PF3100, System Design
D.2.b.i	**Continuous feedback of actuator/fan positions to ensure requested position has been achieved.**	Feedback is provided via 4-20 analog input signals. If the position feedback is lost or the signal goes out of the 4 – 20mA range the system will alarm. If the end device has a fault available as a digital output, it can be connected as a system alarm.	PF3100, System Design
D.2.b.ii	**The inability of any actuator/fan to achieve the requested position shall be detected and the corresponding actuator/fan**	The requested position is compared to the feedback position. If this difference is larger than the position error setting for a duration greater than the Position Error Timeout setting the system will alarm.	PF3100, System Design

	shall be prevented from traveling past the corresponding position.	The corresponding actuator cannot travel past the corresponding position due to the cross limiting between the two positions.	
D.2.b.iii	**The actuator/fan error tolerance shall be within the appliances safe operating range.**	The error tolerance between the requested position and the feedback position can be adjusted to be within the safe operating range of the appliance. Positioning that is outside of the tolerance will cause a system alarm.	PF3100, System Design, Commissioning
D.2.b.iv	**Cross limiting shall be used to be ensure the error tolerance is not exceeded.**	Cross limiting is used to enforce a safe fuel/air ratio. When the firing rate is increased the air position will increase first with the fuel position following behind it. On air position increase the air position will only be adjusted to a maximum of the position error limit before waiting for the fuel flow to increase. It will step up to the requested position while maintaining its limit within the position error. When the firing rate is decreased the fuel will decrease first with the air position following behind it. On fuel decrease the fuel flow will only be adjusted to a minimum of the position error limit before waiting for the air position to decrease. It will step down to the requested position while maintaining its limit within the position error.	PF3100
D.2.b.v	**Upon detection of a position fault or any other unsafe condition the system shall revert to a risk adverse state or shutdown.**	If a position fault is detected or any other unsafe condition the system will alarm and shutdown.	PF3100
D.2.b.vi	**The valve or air position must be accurately measured. This may be done by using a shaft position sensor. Any linkages between the position sensor and the actual air actuator must be fully secured.**	This requirement must be met via the installation method and equipment used.	System Design
D.2.b.vii	**The actuator assembly must have indication of position.**	This requirement must be met via the equipment used.	System Design

D.2.b.viii	**Purge and light off position must be interlocked with the system.**	The purge position is verified before beginning the purge state. The light off position is verified before lighting off the main burner. The position tolerance is continually monitored to be within the position error in all states. If the error is out of tolerance the system will not start due to an alarm or shutdown if already running.	PF3100
D.2.b.ix	**If a variable speed fan is used, secondary feedback must be used from the fan including current, fan speed, or flow sensor.**	Feedback is provided via the 4-20mA analog feedback input. The feedback must match the requested position within the position error.	PF3100, System Design
D.2.c	**Meter type system**	The PF3100 is a positioning type system, so this condition does not apply.	
D.2.d	**A checker system may optionally provide redundant confirmation of valve/air/fan positions, airflow, pressures and temperatures.**	No additional checker system is implemented. The FARC and BMS control are integrated into one solution. The BMS side of the system will verify the airflow (airflow switch), fuel pressure limits and temperature limits.	PF3100
D.2.e	**If O2 Trim is used its control range must be limited to +/- 10% of combustion airflow.**	This solution does not use O2 trim.	
D.2.f	**The FARC system must be interlocked with the BMS controller to ensure proper operation. The following must be proven before starting the system: All communication links, Confirmation of purge position, Low fire position, and fail-safe trip in the case the FARC system detects a fault.**	The FARC system is fully interlocked with the BMS controller. The communication links are continually verified, if they are lost then the system will alarm and shut down. Purge position is verified before beginning the purge state. If an airflow transmitter is used, it is verified to indicate no airflow before starting the fan. If an airflow switch is used it is verified to be open before starting the fan. Proof of light off position is verified before lighting off the mains.	PF3100
D.2.g	**The combustion control microprocessor may be independent from the BMS or incorporated into a PLC**	The BMS and FARC control system is incorporated on the same platform and is SIL certified as a safety system according to IEC 61508.	PF3100

	based burner management system.		
D.2.h	**FARC tables and related settings are password protected.**	All fuel air ratio table adjustments and FARC settings require a level 3 operator password to be adjusted.	PF3100
D.2.i	**The system shall shutdown (or annunciate a warning depending on application) if a sensor or an actuator has a fault or if the FARC system has a fault.**	The system will alarm and shutdown if a sensor such as a position sensor or an actuator has a fault. Additional device faults can be connected into the system as an alarm. All alarms are annunciated.	PF3100
D.2.j	**The system must shutdown if readings exceed a safe limit as declared by the appliance manufacturer.**	The safe limit of operation for the FARC system is defined by the position error and the cross-limit error. If the system exceeds these limits it will alarm and shutdown. This tolerance should be set by a qualified professional that is familiar with the appliance requirements.	PF3100, System Design, Commissioning
D.2.k	**The system must be protected from RF interference.**	The system meets noise immunity levels and has been tested against the applicable standard FCC Part 15 Subpart B and IEC 60730-2-5.	PF3100
D.2.l	**The system must be commissioned by a qualified technician along with regularly maintained.**	This requirement must be met via the commissioning party. The requirement for regular maintenance and for the system to be commissioned by a qualified technician is stated in the user manual.	Commissioning

VERSION HISTORY

Document Version	Release date	Changes
V1.0	April 2, 2020	Initial release
V2.0	April 4, 2020	Internal Release
V3.0	April 17, 2020	Internal Release
V4.0	June 11, 2020	Updated for NA-41 firmware release: - Changed references to fuel flow and air flow to fuel position and air position where related to the positioning of the actuators. - Added additional details to explain cross limit and position errors. - Added light off position. - Added defaults and ranges for FARC settings. - Position error default changed to 2%. - Cross limit error default changed to 1%. - Improved description of light off firing rate. - Improved description of the effect the position error has on excess air during firing rate transitions. The cross limit error does not have any control over modulating excess air. - Updated description of start/stop and wait sequences. - Positioning timeouts and airflow timeouts have now been extended to 90 seconds. - Startup purging section has an extended description of purge positioning requirements in this state. - Pilot ignition section now refers to maintaining the pilot position throughout this state. - Position error timeout minimum has been changed from 0 to 1 second. - Fuel Air table firing rate description updated. - Cross limiting description clarified regarding excess fuel shutdown. - Updated settings table to show authentication level and if editable while running. - Updated description of post purge not requiring position proving and the effect this has on purge time.
V5.0	November 26, 2020	Updated for NA-41.1 firmware release: - Changed the cross limit maximum value from 5% to 15%
V6.0	March 12, 2021	Updated for NA-42.0 firmware release: - Added new “Airflow Control Type” setting. - Updated to reflect changing of “Damper” references to “Air” for new VFD feature