PROLON

FOCUS GUIDE

BOILER CONTROLLER

Configuration Guide for Prolon Focus Software

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1 - Prolon Boiler Controller

This guide will describe in detail the operating sequences and configuration variables used by the Prolon series *Boiler Controllers*.

The Prolon series *Boiler Controller* is designed to control a variety of different boiler units and systems. The on-board microcontroller offers precise digital control to maximize performance. The available control sequences are fully configurable, either locally or remotely, using free software. The controller uses PI (*Proportional / Integral*) control loops to optimize boiler management and offers a variety of functions such as outdoor reset for the supply water temperature, lead-lag sequences for pumps and boiler stages, optional valve and boiler modulation, safety limits and more.

The Prolon series *Boiler Controller* is in essence a collection of highly effective Boiler control sequences designed by Prolon, based on the feedback of our trusted clients and contractors with years of field experience. The sequences offered are highly configurable, allowing for a greater flexibility in the final operation of the controller, but they are not programmable.

1.1 - Hardware Variations

The Prolon series **Boiler Controller** is in essence a collection of highly effective Boiler control sequences designed by Prolon, based on the feedback of our trusted clients and contractors with years of field experience. These sequences are then programmed into various hardware models, offering the user the choice of expanded functionality versus targeted pricing.

The sequences are identical between the various hardware platforms, and are only differentiated by the physical constraints of the chosen hardware. This guide will underline these differences whenever they apply.

The Prolon **Boiler Controller** has been offered on the following hardware platforms. Please see each platform's HARDWARE GUIDE for more information:

M2000 → 9 Analog Inputs / 5 Digital Outputs / 3 Analog Outputs
   The M2000 offers up to four boiler stages.

C1000 → 3 Analog Inputs / 1 Binary Input / 4 Digital Output / 1 Analog Output.
   The C1000 offers up to two boiler stages.

2 - Networking

Prolon's *Boiler Controllers* **can work completely independently, but can also be integrated into a network with other types of Prolon controllers, where they will share and exchange information for a more effective overall system. Prolon's default method of network communication is Modbus RTU over RS485.**

2.1 - Shared Information

When a **Boiler Controller** is networked with a Prolon Master Controller (such as a Rooftop controller), it will automatically be detected and start sharing information. Here is the list of current Prolon Master Controllers:

- ▷ Rooftop Controller (RTU)
- ▷ Heatpump Controller (HP)
- ▷ Make Up Air Controller (MUA)
- ▷ Hydronics Controller (HYD)

The Prolon Network Controller is a special case, as it acts as a link between all Master Controllers, so it will be treated in a class on its own.

The following table summarizes the information shared between **Boiler Controllers**, Prolon Master Controllers, and the Prolon Network Controller. This information is exchanged approximately every three seconds for Master Controllers, and every ten to thirty seconds for the Network Controller. If the information stops being received, it will be declared invalid after 720 seconds.

	Automatically received from Master	Can be received from NC (Configurable)	Can send to NC (Configurable)
Outside Temperature	X	X	X
Occupancy	X	X	
Results of Math Functions	X		

Figure 1 - Shared Information

Note that this table applies to the most recent firmware revision of Prolon controllers, and may not accurately represent all older firmware revisions.

Description

- **Outside Air Temperature**: The outside air temperature will automatically be shared from the Master Controller to the **Boiler Controllers**. A Network Controller can also be configured to share the outside temperature with a **Boiler Controller** should a Master Controller not be present. In the case where both are present, the last received outside temperature value will be used.

  The outside temperature is used for setpoint selection and boiler or pump activation.

- **Occupancy**: The occupancy status will automatically be shared from the Master Controller to the **Boiler Controllers**. A Network Controller can also be configured to

share the occupancy status with **Boiler Controller** should a Master Controller not be present. In the case where both are present, the occupancy status received from the Network Controller will take priority.

  The Occupancy status can be used to offset the setpoint.

- **Results of Math Functions**: A Master Controller is continuously calculating the overall demand of the building using configurable mathematical operations, in a process called Flexi-Zone. The results of these functions can be redistributed to **Boiler Controllers** to offset the supply setpoint.

3 - Adding a Boiler Controller to a Focus Project

Prolon Focus is a free visualization and configuration software for all Prolon controllers. Once the *Boiler Controller* has been physically wired to a Prolon network, it's time to add this controller to your Focus project.

3.1 - Assigning Addresses

The Prolon **Boiler Controller's** address can be assigned using the physical dipswitch found on the controller directly. The address will be encoded in binary. Please see each platform's HARDWARE GUIDE for more information.

3.1.1 - Address Locking

For hardware platforms with physical addressing dipswitches, be aware that Prolon Focus offers a feature that allows a user to lock the address of a controller to a specific value, regardless of what is present on the addressing dipswitch. This allows for protection against unwitting users from changing the addresses by playing with the dipswitches, but can also lead to confusion. Please see Address Management in the Prolon Focus User Guide for more information.

3.2 - Adding the Controller to the Screen

Once the controller has been physically wired to a Prolon network and it has an assigned address, it is time to add it to your Prolon Focus project screen.

3.2.1 - Master Get List

If the **Boiler Controller** is placed under a Master Controller in the network hierarchy, it can be added to your screen simply by performing a GET LIST on the Master. The Master Controller will take charge and scan its network for controllers, and all those that are found will automatically be added to the screen. To perform a GET LIST, right-click on your Master icon and select "Get List":
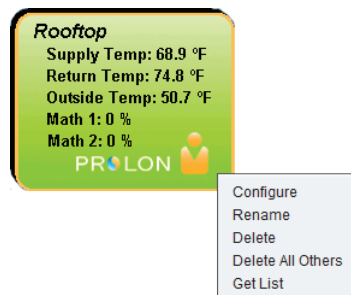
Figure 2 - Master Get List

Note that this step is **crucial**, as no communication will reach your *Boiler Controller* if it has not been added the Master's List. If no Master controller is assigned to the *Boiler Controller*, then this step can be ignored, and the new *Boiler Controller* button can be used instead (see below).

3.2.2 - New Boiler Controller Button

In the event where there is no Master Controller assigned to the *Boiler Controller* in the network hierarchy, then a *Boiler Controller* can be simply added onto the screen by clicking on the "New Boiler Controller" button, found in the Devices Drag and Drop list on the left side of the Focus screen (System View only):

Figure 3 - "New Boiler" Button

Focus will ask for the address of the controller, attempt to locate it, and add it on the screen if successful.

4 - Boiler Controller Icon

Each *Boiler Controller* added to your system has its own icon. Each icon displays data about the *Boiler Controller* device it represents, and this data is updated regularly. You can open the configuration screen for a *Boiler Controller* by double-clicking on its icon. If the *Boiler Controller* is offline, all data values will show "N/A" (not applicable).

Figure 4 - Typical Boiler Controller Icon

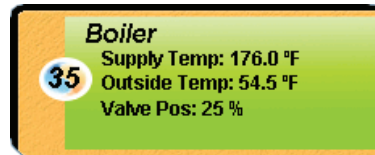*Please note that if the optional Valve Control sequence is not use, the "Valve Pos" will not be shown on the icon.*

4.1 - Icon Data

- **Title**: The name of the *Boiler Controller*. You can change it by right clicking the icon and choosing **Rename**. By default it is set to "Boiler".

- **Address number**: This can be seen in the blue and orange circle (yin/yang) at the left side of the icon.

- **Supply Temperature**: The current water temperature supplied by the boiler. Will display "N/A" if there is no supply temperature sensor attached or if offline.

- **Outside Temperature**: The current outside temperature. Will display "N/A" if there is no outside temperature sensor attached or if offline.

- **Valve Position**: The position of the valve in percentage: 0% means the valve is closed and 100% means the valve is fully opened. Will display "N/A" if the *Boiler Controller* is offline. Only appears if "Staging Boiler with Valve" has been selected as the type of boiler in the system.

4.2 - Icon Colors

The icons also change color depending on the boiler state.

- **Grey**: The icon is grey when working offline or if the communication with that *Boiler Controller* is lost. All data will be seen as "N/A".

- **Green**: The icon is green when the boiler is off, or if no boiler operation can be established using the return temperature *(see section 5.3.2)*.

- **Red**: The icon is red when the boiler is on and boiler operation can be established using the return temperature *(see section 5.3.2)*.

Figure 5 - Grey Icon
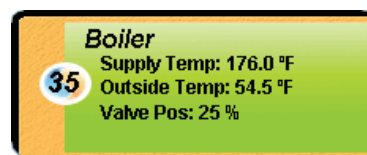
Figure 6 - Green Icon

Figure 7 - Red Icon

4.3 - Icon Right-Click
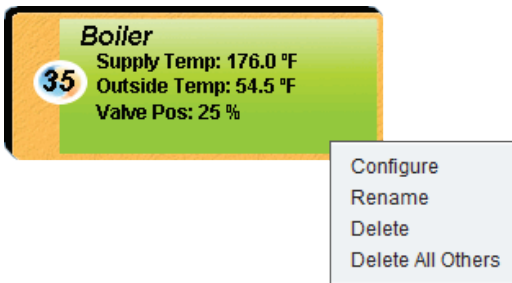
Figure 8 - Icon Right-Click for Boiler

- **Configure**: Opens the configuration screen for this **Boiler Controller**.

- **Rename**: Allows you to rename this **Boiler Controller**. Names are limited to 16 characters.

- **Delete**: Removes this **Boiler Controller** from your Focus Project.

- **Delete All Others**: Removes all other icons from the current system. This is useful for debugging purposes, for example when trying to exclusively establish communication with this controller, and the presence of the other controllers in your project is causing communications to slow down.

5 - Configuration of a Boiler Controller

To view the configuration of a *Boiler Controller* in detail, double-click on its icon to see its configuration screen. Use the menus in the top left corner to navigate between the different sections, or simply double-click any item in the *Boiler Controller Home Screen* to transfer you to its corresponding page. *(See Icon Quick Jumps for more details, p.15.)*

5.1 - Boiler Controller Home Screen
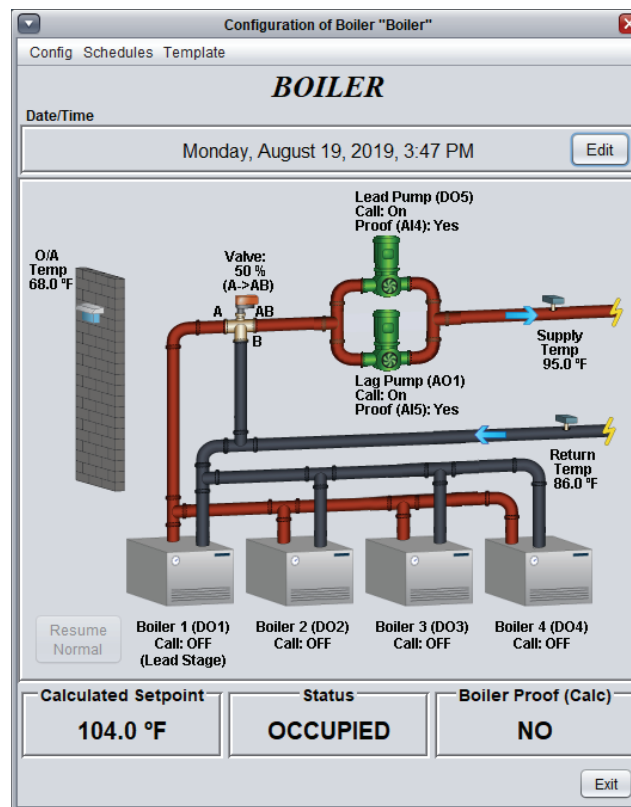
Figure 9 - Boiler Controller Home Screen

This screen shows the status of all inputs and outputs of the **Boiler Controller**, as well as the active setpoint. All values will be "N/A" (Not Applicable) when offline.

Note that this screen will vary **greatly** depending on the sequences and display choices that are selected. The following section lists all possible parameters that can be displayed on the screen, but some are mutually exclusive of others due to hardware constraints or sequence logic. The list below outlines the requirements for each element.

5.1.1 - Displayed Information - Inputs

- **Date/Time**: The current date and time from the real time clock included in the Prolon **Boiler Controller**. This can be edited with the Edit button. (Unavailable for the C1000 hardware platform). The time can be displayed in either 12h or 24h format by changing the setting in the 'Options' menu, under 'Units', then 'Time Format'.

- **O/A Temp**: The current outside air temperature. Will display "N/A" if no outside air temperature sensor is attached, or if none is provided from the network.

- **Return Temp**: The current return water temperature. Will display "N/A" if no sensor is attached. Will not be visible if Return Temp Sensor is not enabled .

- **Supply Temp**: The current supply water temperature. Will be "N/A" if no sensor is attached.

- **Calculated Setpoint**: Displays the current target supply temperature. This setpoint is determined in the Temperature Configuration screen .

- **Status**: The occupancy status of the **Boiler Controller**. The occupancy state can be determined by a number of factors. They are listed here in order of priority:

  ▷ The occupancy status received from a Prolon Network Controller takes first priority.

  ▷ The occupancy status received from a Prolon Master Controller, such as a Rooftop or Heatpump is then used.

  ▷ Finally, the occupancy status determined by the real time clock onboard the **Boiler Controller**, combined with a programmed schedule will be used (only available on M2000). For the C1000 hardware platform, which does not have an onboard real time clock, it will simply default to occupied mode unless indicated otherwise from the network.

- **Boiler Proof (Calc)**: Displays the calculated proof of boiler operation, as long as the Return Temp Sensor is enabled .

  The boiler proof is artificially calculated by comparing the supply and return water temperature readings, and does not stem from a physical input or contact.

  Upon activation of a boiler stage (or when the modulating output is greater than 0%), proof of boiler is automatically assumed. The proof is determined to be lost when there is less than 18°F (10°C) difference between the supply and return temperature for 10 consecutive minutes. If the difference is ever greater than 18°F (10°C), proof is considered obtained again, and the timer restarts.

5.1.2 - Displayed Information - Outputs

Pumps
Pump activity is represented by green pump icons portrayed on the **Home Screen**. Based on the chosen configuration , a single pump or a pair of pumps will be displayed. Each pump icon will display the call for pump from the controller, as well as the proof of pump operation. When call and proof are both confirmed, the pump icon will animate: pump blades will rotate and arrows appear indicating water flow direction.

For dual pump configurations, additional information will also be available, based on the chosen sequence . For a backup pump configuration, the identity of the lead pump and the lag pump will be displayed. For follower pump configurations, the identity of the primary pump and the secondary pump will be displayed.

For the M2000 hardware platform, the identification of the output responsible for each pump will be displayed (i.e. DO4/AO1), as well as the identification of the input responsible for each proof of pump (i.e. AI4/AI5). This is to help simplify physical setup and troubleshooting.

Finally, if you hover the mouse over any pump icon while online, the Focus software will display the total run time of the associated pump. Also, if the pump is currently ON, it will display how long the pump has been running for. These values are stored in the controller and can be cleared in the Device Properties configuration page .
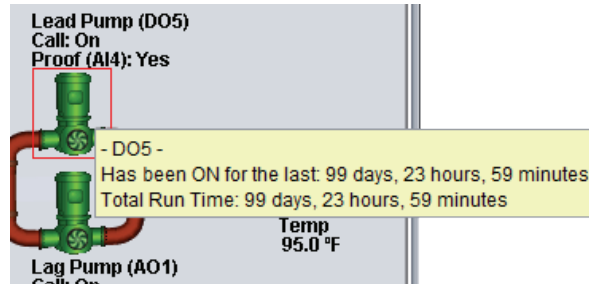
Figure 10 - Pump Display

Note: The C1000 hardware platform only has one input dedicated to proof of pump, so for dual pumps set in a backup pump configuration, the lone proof input will be displayed adjacent to both pumps.

Boiler

Boiler activity is represented by boiler icons portrayed on the **Home Screen**. A variety of boiler setups is possible *(see p.22)*, and up to four individual boiler icons can be displayed at a time. Depending on the setup, a single boiler icon can also have multiple stages. Each individual boiler icon will display the call for boiler stages from the controller, and if boiler proof is determined *(see p.21)*, the active boiler icons will turn red.

For configurations with multiple boilers using lead-lag control, the identity of the lead boiler stage will be also displayed. For modulating boilers, the output percentage will be displayed.

For the M2000 hardware platform, the identification of the output responsible for each boiler will be displayed (i.e. DO1, DO2, etc.).This is to help simplify physical setup and troubleshooting.
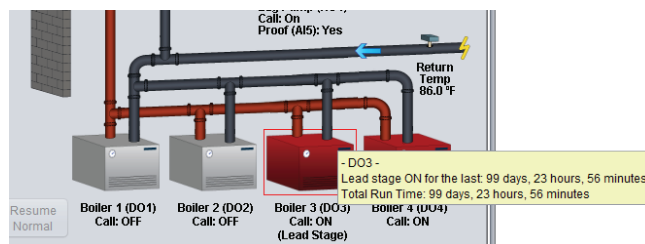

Figure 11 - Boiler Display

Finally, if you hover the mouse over any boiler icon while online, the Focus software will display the total run time of the associated boiler. Also, if the boiler is currently ON and is the lead stage, it will display how long the boiler has been running. These values are stored in the controller and can be cleared in the Device Properties configuration page *(see p.31)*.

Valve

For boilers setups with a mixing valve, a valve icon will be displayed connecting the return and supply lines together. The valve position (in percentage) is shown, with 0% meaning the valve is closed and 100% meaning the valve is opened. The valve opens when there is a need to increase the temperature of the water supplied to the building.

In single pump or backup pump sequences, when less heating is required, the valve closes and diverts the hot supply water (identified as 'B') back towards the boilers ('AB'), instead of towards the main building, with cooler return water taking its place. If more heating is required, it instead opens, sending the cooler return water ('A') back towards the boilers ('AB'), and the hot boiler water towards the building. (See figure 11)

In follower pump sequences, when less heating is required, the valve closes and diverts the cooler return water (identified as 'B') towards the building ('AB'), instead of to the boilers. If more heating is required, it will open, sending the hot boiler water ('A') towards the building ('AB'), and the cool return water back towards the boiler. (See figure 12)
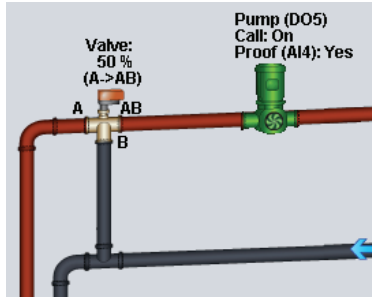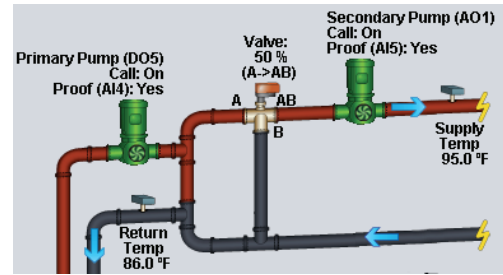
Figure 12 - Valve Position, Single or Backup Pump

Figure 13 - Valve Position, Follower Pump

5.1.3 - Date/Time

The Prolon **Boiler Controller** has an internal real time clock (unavailable on the C1000 hardware platform). The current date and time is displayed at the top of the **Home Screen**. To edit the time, click on the "Edit" button.
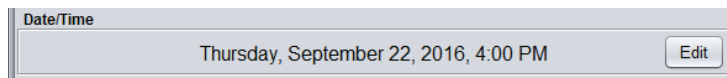
Figure 14 - Edit Time Button

A window appears allowing you to edit the time. Your computer's time is shown at the top of the window. You can copy your computer's time directly into the time of the **Boiler Controller** using the "Copy" button, or simply edit the time yourself by directly typing it in the corresponding text box. A drop down list of time zones is also made available.

The use of daylight savings time can also be configured here. When set to automatic control, daylight savings will be enabled and disabled on Sunday at 2AM on the specified weeks.

Figure 15 - Edit Time Dialog Box

5.1.4 - Icon Quick Jumps

Certain items in the **Home Screen** will direct you to its corresponding configuration screen when they are double-clicked. A red contour will surround the object if this feature is available.
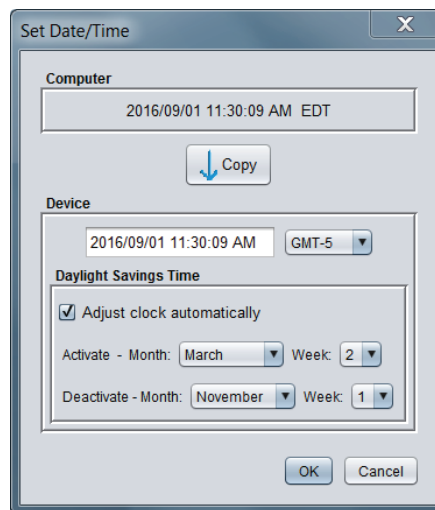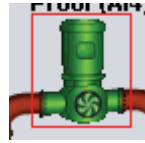

Figure 16 - Icon Quick Jump Example (Pump)

The following is a list of the featured items and their corresponding destination:

ITEMS	QUICK JUMP
Boilers	Boiler Configuration
Pumps	Pumps Configuration
Valve	Boiler Configuration
Calculated Setpoint	Temperature Configuration
Boiler Proof	Temperature Configuration
Outside Temp Sensor	Temperature Configuration
Return Temp Sensor	Temperature Configuration
Supply Temp Sensor	Temperature Configuration
Occupancy Status	Weekly Routines (M2000 only)

Please note that if the advanced password is enabled, you will not be able to double-click on any objects.

5.1.5 - Icon Manual Override

Certain components of the **Boiler Controller** can be overridden. To use this feature, right-click on the item of the component you wish to override. A pop-up menu will appear if this feature is available. **Note**: Overrides are unavailable in Offline mode.
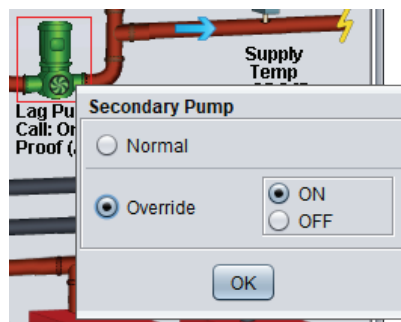

Figure 17 - Manual Override of the Pump

- **Override**: Selecting the "Override" button will allow the user to manually override the selected object until the normal mode is resumed.

  The following is a list of all items that can be overridden:

Boilers
Pumps
Valve
Occupancy

  When an override is applied to an object, a yellow contour appears around its icon and any associated text starts to flash. For example, in the figure below, the boiler has been overridden.
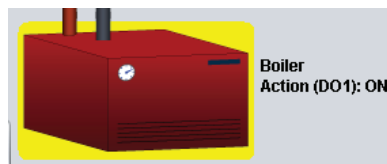
  Figure 18 - Override Example, Boiler

  Please note that if the advanced password is enabled, or if you are offline, you will not be able to override any objects (please review the Prolon Focus User Guide for more information about passwords).

  All overrides are **cancelled** when the *Boiler Controller* is reset or loses power.

- **Normal**: Selecting the "Normal" button will revert the selected item back to its normal automatic behavior. Any override applied to this object will be disabled.

5.1.6 - "Resume Normal" Button

This button allows the *Boiler Controller* to return to its fully automated behaviour. All overrides previously applied to the *Boiler Controller* will be disabled. However, before any action is taken, a dialog box will appear to confirm your choice.

Figure 19 - "Resume Normal" Button

5.2 - Pump Configuration

This screen is used to select and configure the pump sequence. Proof of operation of the pump is required before any boiler stages can activate.
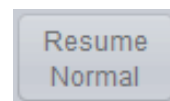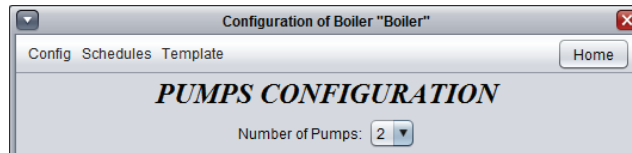

Figure 20 - Pumps Configuration Screen

The number of pumps used in the sequence is the first parameter displayed in this screen and will influence the remaining sections.

5.2.1 - General Sequence

This section defines the pump configuration and general hydronic topology of the system. This section is only available if the number of pumps is set to **two**. There are two different sequences available.
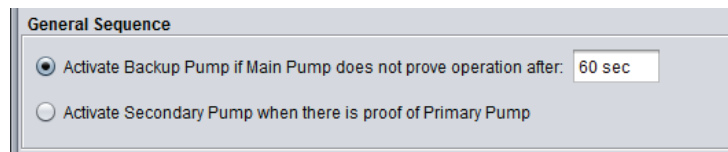

Figure 21 - Pump Sequence

- **Backup Pump Sequence :** The purpose of this sequence is to **activate a backup pump when the main pump does not have proof of operation** for a configurable amount of time. These pumps should be installed in parallel. Their purpose is to circulate water through the boiler, but not necessarily through the building itself (which can be done by another pump or loop).

  The boiler requires proof that a pump is operating before it can be enabled.

  If desired, these two pumps can operate in a lead-lag sequence, evenly distributing the workload between both pumps (see below).

- **Follower Pump Sequence :** The purpose of this sequence is to simply **activate a secondary pump when there is proof of a primary pump**. This sequence is normally used in a primary loop / secondary loop scenarios, where the primary loop feeds the boiler and the secondary loop feeds the building. Lead-lag is not available in this sequence.

  The boiler requires proof that the primary pump is operating before it can be enabled.

5.2.2 - Activation Sequence

This section defines the conditions that will activate the pump. Pump activation is required before the boiler can activate.

Figure 22 - Pump Activation Setup

Pump activity can be enabled based on the outside air temperature, on a call for heating, or on a combination of these two conditions.

A **call for heating** is based on changes to the water supply temperature. When the water supply temperature drops below the activation point of the first boiler stage, a call for heat then occurs. See the Boiler Configuration section for more details on how a call for heat is generated *(see section 5.4)*. It will vary based on the boiler type used.

If the **outside temperature** reading becomes invalid, then that condition is automatically assumed to be met.

5.2.3 - Pump Lead-Lag

The pump lead-lag sequence is only available when the backup pump sequence is selected. The purpose of a lead-lag sequence is to spread the workload more evenly between the two available pumps.

One pump is initially designated as the "lead pump": it will be the one to activate on a call for pump. The lag pump is the backup pump, and will activate if no proof of the lead pump is obtained. As the lead-lag sequence progresses, the role of "lead pump" will be exchanged between the pumps, allowing for a more even distribution of work and wear to the pumps.

This section defines the conditions that will activate the pump. Pump activation is required before the boiler can activate.

Figure 23 - Pump Lead-Lag Setup

There are three available lead-lag sequences:

- **Alternate pumps after each call**: The role of "lead pump" alternates every time the pumps stop operating. The pumps do not exchange roles while a pump is still operating.

- **Alternate pumps with a fixed run time**: The role of "lead pump" alternates automatically based on a configurable interval of uninterrupted time spent in the ON state. When the interval expires, the lead pump will stop and the lag pump will immediately take over, becoming the new lead pump.

- **Equal run time**: Every time the pumps stop operating, the role of "lead pump" is re-evaluated, based on the total run time of each pump. The pump with the lowest run time becomes the lead pump. The pumps do not exchange roles while a pump is operating.

  Please note that the lead-lag sequence can also be **disabled**.

5.2.4 - Pump Setup

This section defines different operational run times and delays for the pump operation.

Figure 24 - Pump Setup

- **Min ON Time**: Once a pump is activated, this is the minimum amount of time it must remain ON, even if the pump is no longer needed to operate. This is used to prevent short-cycling the pump.

- **Min OFF Time**: Once a pump is deactivated, this is the minimum amount of time it must remain OFF, even if the pump is suddenly required again. This is used to prevent short-cycling the pump.

- **Pump Run Time after Boiler Shutdown**: This delay is used to keep the pumps running after the last remaining boiler stage is turned off. The goal is to purge the hot water out of the system.

- **Exercise Pumps**: This function is used to turn on the pump periodically to prevent pump bearing seizure during summer periods due to lime build up.

- **Use SAME proof for BOTH Pumps**: Select this option if both lead pump and backup pump use a common proof (one proof for both pumps). You only need to connect the sensor to Analog Input 4, and the controller will relate any proving signal to whichever pump is currently active. (This setting is automatically used on the C1000 Hardware platform since there is only a single input for proof of pump.)

5.3 - Temperature Configuration

This screen is used to configure the supply water setpoint, as well as define the return water temperature safety limits.

Figure 25 - Boiler Setpoint Setup

5.3.1 - Boiler Target Setpoint

The final water supply setpoint is determined by a number of factors. It can simply be fixed at a preconfigured value, or it can be calculated based on an outside air temperature reset scale:
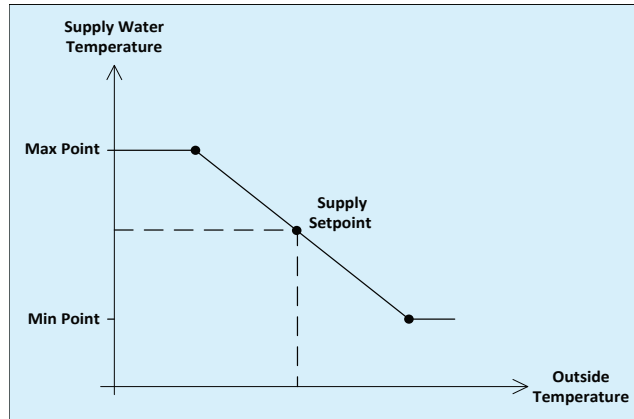

Figure 26 - Outside Temperature Reset Scale

As the outside temperature rises, the supply setpoint drops. *Note* that the supply setpoint stops resetting beyond the outside temperature limits. If the outside temperature becomes invalid, the supply setpoint defaults to the maximum setpoint.

The supply setpoint can then be offset by the following sequences:

- **Lower the setpoint in unoccupied mode by**: The supply setpoint will be reduced by this amount in unoccupied mode only. This setting can help save energy in unoccupied mode.

- **Adjust the setpoint using**: This function is used to increase or decrease the supply water setpoint based on the overall demand of the building, and requires a Prolon Master Controller to work.

  A Prolon Master Controller is continuously calculating the overall demand of the zones in the building in a process called Flexi-Zone (please refer to a Prolon Master Focus Guide, such as an RTU or Heatpump, for more information). Flexi-Zone generates five user-configured math functions for this purpose. Each function results in a number ranging from -100% (cooling demand) to +100% (heating demand).

The supply temperature can be offset by any of these Math functions. For every 10% change, the setpoint will be adjusted by 1.8 °F (1 °C). A Math function at 0% will not offset the supply setpoint.

- **Use maximum supply setpoint upon transition to occupied mode for**: Upon a transition from unoccupied to occupied mode, the *Boiler Controller* can be instructed to only use the maximum supply setpoint for a preconfigured period of time. *Note* that this function is only available when the outside temperature reset scale is used.

5.3.2 - Return Temp

This section defines how the return water temperature reading is incorporated into the Prolon **Boiler Controller** sequence.

Figure 27 - Return Temperature Setup

When enabled, the return water temperature can be used for safety limits, as well as to artificially calculate the proof of boiler status.

- **Enable Return High Limit**: If the return water temperature goes higher than this limit, the boiler will begin to shut down. For a staged boiler sequence (with or without mixing valve) the boiler stages will deactivate while respecting the interstage deactivation delay. If a mixing valve is present, the valve will completely open to allow water to circulate through the boiler. For modulating boilers, the boiler output will turn off. The return water temperature must drop 9 ºF (5 ºC) below this limit before the boiler will be enabled again.

- **Enable Return Low Limit**: This limit is only available for staged boiler sequences with mixing valves. When the return water temperature goes below this value, the mixing valve will close, diverting more of the load' s cooler return water away from the boiler' s path, and back out to the load again. The purpose is to protect gas and oil fired boilers against condensation that can appear in the combustion chamber.

- **Calculate Proof of Boiler**: When the return water temperature sensor is enabled, it can be used to artificially calculate the proof of boiler. The boiler proof is calculated by comparing the supply and return water temperature readings, and does not stem from a physical input or contact.

  Upon activation of a boiler stage (or when the modulating output is greater than 0%), proof of boiler is automatically assumed. The proof is determined to be lost when there is less than 18°F (10°C) difference between the supply and return temperature for 10 consecutive minutes. If the difference is ever greater than 18°F (10°C), proof is considered obtained again, and the timer restarts.

5.4 - Boiler Stages Setup

This screen is used to select and configure the boiler sequence. Proof of operation of the pump is required before any boiler stages can activate. The boiler can also be deactivated due to Return Temperature Limits *(see section 5.3.2)*.

Figure 28 - Boiler Configuration

There are three boiler sequences available, and each is described in their respective section below.

The boiler can be disabled based on outside temperature. Above the prescribed outside temperature, any boiler stages are deactivated. They are re-enabled again when the outside temperature goes 3.6 °F (2 °C) below the limit. If the outside temperature reading is invalid, boiler activation is permitted.

5.4.1 - Boiler Stages Setup

This section is available for both *Staging Boiler* and *Staging Boiler with Valve* sequences. It defines the number of boilers and stages, as well as the operational timing for each stage.

Figure 29 - Boiler Stages Setup

The Prolon M2000 *Boiler Controller* can support up to four boiler stages, and the C1000 can support two. For visualisation purposes, the Home page can display this as:

▷ A single boiler with up to four stages

▷ Up to four individual boilers with a single stage each

▷ Two individual boilers with two stages each

Each boiler stage will respect the minimum ON and OFF times, as well as the interstage delays:

- **Min ON Time**: Once a boiler stage is activated, this is the minimum amount of time it must remain ON, even if the boiler is no longer needed to operate. This is used to prevent short-cycling. *Note*: if proof of pump is lost, all boiler stages will deactivate immediately, regardless of minimum on time.

- **Min OFF Time**: Once a boiler stage is deactivated, this is the minimum amount of time it must remain OFF, even if the boiler stage is suddenly required again. This is used to prevent short-cycling.

- **Interstage Activation Delay**: Once a boiler stage is activated, this is the minimum amount of time that must expire before an additional stage can be turned on.

- **Interstage Deactivation Delay**: Once a boiler stage is deactivated, this is the minimum amount of time that must expire before the next boiler stage can be turned off. *Note*: if proof of pump is lost, all boiler stages will deactivate immediately, regardless of interstage deactivation delay.

5.4.1.1 - Call for Heat

Boiler stages are enabled based on a call for heat. Even pumps can be enabled on a call for heat. A call for heat occurs when the supply temperature falls below the **activation** point. Once the supply temperature rises above the **deactivation** point, the call for heat is cancelled. These activation and deactivation points are determined by the **Differential** band, centered on the current water supply setpoint:
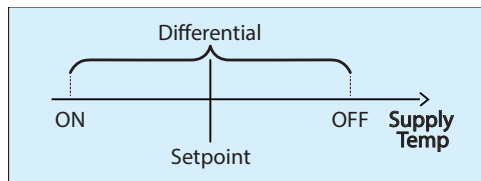

Figure 30 - Staged Boiler Operation Based on Supply Differential

Once the boiler is enabled and proof of pump is obtained, the first boiler stage is activated. If the supply temperature remains below the activation point, subsequent boiler stages (if applicable) will turn on once the interstage activation delay is satisfied for each stage.

When there is no longer any call for heat, the highest boiler stage deactivates. If the supply temperature remains above the deactivation point, subsequent boiler stages (if applicable) will turn off once the interstage deactivation delay is satisfied for each stage.

If the water supply temperature is in the zone between the activation and deactivation points, no additional boiler stages will be activated, nor will they be deactivated (equilibrium).

The water supply setpoint is calculated using the methods detailed in.

There is also an option to **Activate stages based on supply temperature offset**. Primarily, the activation and deactivation of boiler stages is regulated solely on interstage delays. This option adds an extra condition to that sequence:
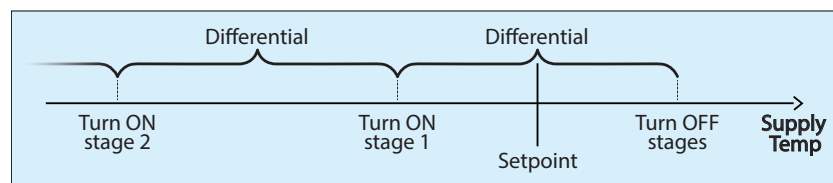

Figure 31 - Staged Boiler Operation Based on Supply Offset

As the supply temperature drops below the Stage 1 Activation Point, only stage 1 is enabled. Stage 2 cannot turn on, regardless of the interstage activation delay. Only once the supply temperature drops below the Stage 2 Activation Point is stage 2 enabled. The interstage activation delay must still be respected. This process is continued for the remaining stages (if applicable).

Once the supply temperature finally rises, any active boiler stages will only be disabled when the supply temperature hits the deactivation point. Unlike the multiple activation points, there is only a single deactivation point, and it is shared among all boiler stages. Boiler stages turn off while respecting the interstage deactivation delay.

If the water supply temperature is in the zone between the first activation and deactivation points, no additional boiler stages will be activated, nor will they be deactivated (equilibrium).

5.4.1.2 - Boiler Lead-Lag

The purpose of a lead-lag sequence is to spread the workload more evenly between the available boiler stages.

One stage is initially designated as the "lead stage": it will be the one to activate on a call for heat. As the lead-lag sequence progresses, the role of "lead stage" will be exchanged, allowing for a more even distribution of work and wear to the boilers.

There are three available lead-lag sequences:

- **Alternate boilers after each call**: The role of "lead stage" alternates every time the boilers stop operating. The boilers do not exchange roles while a stage is still operating.

- **Alternate boilers with a fixed run time**: The role of "lead stage" alternates automatically based on a configurable interval of uninterrupted time spent in the ON state. This may imply that stages will suddenly turn on or off to satisfy the conditions of their new roles.

- **Equal run time**: Every time the boilers stop operating, the role of "lead stage" is re-evaluated, based on the total run time of each stage. The stage with the lowest run time becomes the lead stage. The boilers do not exchange roles while a stage is still operating.

  Please note that the lead-lag sequence can also be **disabled**.

IMPORTANT: Regardless of the chosen lead lag-sequence or boiler setup, boiler stages always operate in a FILO (First In, Last Out) sequence. The lead stage is always the first one to turn on in response to a call for heat, and the last on to turn off once the call for heat is satisfied.

5.4.2 - Valve Setup

This section defines how a mixing valve is incorporated into the Prolon boiler sequence. For safety concerns, the valve sequence requires a valid supply temperature reading to operate; otherwise it will cut the boiler stages and move the valve to a fully open position. The valve will also fully open in the event that the pump stops or proof of pump is lost.

Figure 32 - Valve Setup

The valve's purpose is to accurately control the supply water temperature being sent to the building (load) so that it matches the supply setpoint. It achieves this by mixing the hot water supplied by the boiler with the colder return water coming back from the building.

When the supply temperature is too low, the valve **OPENS** to let in more water from the boilers. If the supply is too high, the valve **CLOSES**, sending the cooler return water back to the building.

The controller uses a PI (**Proportional** / **Integral**) loop to regulate the valve position. The **Proportional** component of the loop is determined as follows:
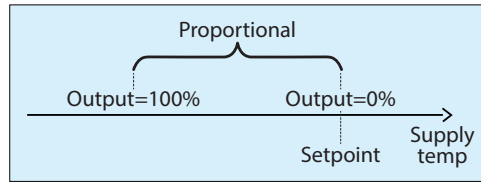
Figure 33 - Valve Proportional Band

As the supply temperature drifts below the setpoint, the ***Proportional*** component ramps up to compensate.

The ***Integral*** component is defined as the amount of time required to increase the valve's position by 100% due to a constant error of 1.8°F/1°C. Its purpose is to correct small errors over time.

The ***Proportional*** component is then added to the ***Integral*** component to calculate the final valve position. When properly tuned, this PI loop will efficiently maintain the supply water setpoint.

The valve's output voltage will be directly proportional to the calculated valve position.

- **Reverse Acting**: The output voltage will be inversely proportional to the calculated valve position. For example, in a range of 0-10VDC, if the valve position is calculated to be at 30%, it will output 7 volts at the terminals.

- **Range**: This option selects the voltage range provided by the ***Boiler Controller*** at the terminals of the Valve Output. The range always corresponds to a full 0-100% output scale. For example, in the 2-10V range, a 0% output corresponds to 2V, and a 50% output corresponds to 6V.

- **Minimum Valve Position**: This is the minimum position to which the valve is allowed to close. This setting is used to protect the boiler by ensuring that there is always a minimum flow of water passing through it.

5.4.2.1 - Call for Heat

Boiler stages are enabled based on a call for heat. Even pumps can be enabled on a call for heat. In a staged boiler sequence with a mixing valve, a call for heat is generated by first calculating the desired valve position using the PI loop as described above.

If the calculated valve position is greater than the Minimum Valve Position, then a call for heat is generated and the first boiler stage is authorized. The valve will modulate its position to obtain the supply setpoint.

If the valve's position reaches 100% and supply setpoint is still not obtained, the next boiler stage is enabled. Boiler stages are continuously enabled so long as the valve position is 100% and the interstage activation delay for each stage is respected.

If the supply temperature rises too high, the valve will begin to close. If the calculated valve position drops below the point defined by **"Disable boiler stages when calculated valve position is less than"** then the boiler stages begin turning off in succession, while still respecting the interstage deactivation delay. ***Note*** that the actual valve position will never drop below the **Minimum Valve Position**, regardless of its calculated value.

In summary, if the calculated valve position is anywhere in between the "**Disable**" point and **100%**, no additional boiler stages will be activated or deactivated, since the valve is successfully maintaining the supply setpoint using the currently active boiler stages.

There is an additional sequence that can influence the valve position based on the **Return Water** temperature *(see section 5.3.2)*.

5.4.3 - Modulating Boiler

This section defines the operation of the modulating boiler(s) sequence. It defines the number of modulating boiler stages and optional backup stage, as well as operational timing for each stage. For safety concerns, the modulating boiler sequence requires a valid supply temperature reading to operate; otherwise it will cut power to the modulating boiler output. The output will also turn off in the event that the pump stops or proof of pump is lost, or if the return water temperature limit is tripped *(see section 5.3.2)*.

Figure 34 - Modulating Boiler Setup

The ProLon M2000 **Boiler Controller** can support up to two modulating boilers, and the C1000 can support one. Each modulating signal is accompanied by a Boiler Enable signal (see Hardware Guide for more details). Both C1000 and M2000 **Boiler Controllers** also support an optional backup stage. For visualization purposes, the Home page will display this as:

▷ A single modulating boiler

▷ A single modulating boiler with backup stage

▷ Two individual modulating boilers

▷ Two individual modulating boilers with backup stage

Each modulating boiler will respect the minimum ON and OFF times, as well as the interstage delays:

- **Min ON Time**: Once a modulating boiler is activated, this is the minimum amount of time it must remain ON, even if the boiler is no longer needed to operate. This is used to prevent short cycling. **Note**: if proof of pump is lost, all boiler stages will deactivate immediately, regardless of minimum on time.

- **Min OFF Time**: Once a modulating boiler is deactivated, this is the minimum amount of time it must remain OFF, even if the boiler is suddenly required again. This is used to prevent short cycling.

- **Interstage Activation Delay**: Once a boiler is activated, this is the minimum amount of time that must expire before an additional boiler can be turned on.

- **Interstage Deactivation Delay**: Once a boiler is deactivated, this is the minimum amount of time that must expire before the next boiler can be turned off. **Note**: if proof of pump is lost, all boilers will deactivate immediately, regardless of interstage deactivation delay.

Boiler Lead-Lag

The purpose of a lead-lag sequence is to spread the workload more evenly between the available boiler stages. One stage is initially designated as the "lead stage": it will be the one to activate on a call for heat. As the lead-lag sequence progresses, the role of "lead stage" will be exchanged, allowing for a more even distribution of work and wear to the boilers.

There are three available lead-lag sequences:

- **Alternate boilers after each call**: The role of "lead stage" alternates every time the boilers stop operating. The boilers do not exchange roles while a stage is still operating.

- **Alternate boilers with a fixed run time**: The role of "lead stage" alternates automatically based on a configurable interval of time spent in the ON state. This may imply that stages will suddenly turn on or off to satisfy the conditions of their new roles.

- **Equal run time**: Every time the boilers stop operating, the role of "lead stage" is re-evaluated, based on the total run time of each stage. The stage with the lowest run time becomes the lead stage. The boilers do not exchange roles while a stage is still operating.

Please note that the lead-lag sequence can also be **disabled**.

IMPORTANT: Regardless of the chosen lead lag-sequence or boiler setup, boiler stages always operate in a FILO (First In, Last Out) sequence. The lead stage is always the first one to turn on in response to a call for heat, and the last on to turn off once the call for heat is satisfied.

Enable Staged Backup Boiler with differential

Select this checkbox if there is a Backup Boiler stage. This Backup stage will turn on if all modulating boiler outputs have reached 100%, the interstage activation delay has elapsed and the supply temperature still remains less than the setpoint **minus** half the backup differential.

Note that the Backup Boiler Stage does not participate in the lead/lag sequence and will always be the last Boiler stage to activate.

When the backup is ON, the supply must rise above the setpoint **plus** half the backup differential before it will deactivate. Any modulating boiler stages will remain at 100% until the backup stage deactivates.

The controller uses a PI (**Proportional / Integral**) loop to regulate the boiler value.

The **Proportional** component of the loop is determined as follows: As the supply temperature drifts below the setpoint, the Proportional component ramps up to compensate.

The **Integral** component is defined as the amount of time required to increase the boiler's value by 100% due to a constant error of 1.8°F/1°C. Its purpose is to correct small errors over time.

The **Proportional** component is then added to the **Integral** component to calculate the final boiler value. When properly tuned, this PI loop will efficiently maintain the supply water setpoint. The boiler's modulating output voltage will be directly proportional to the calculated boiler value.

- **Reverse Acting**: The output voltage will be inversely proportional to the calculated boiler value. For example in a range of 0-10VDC, if the calculated value is 30%, it will output 7 volts at the terminals.

- **Range**: This option selects the voltage range provided by the **Boiler Controller** at the terminals of the Modulating Output. The range always corresponds to a full 0-100% output scale. For example, in the 2-10V range, a 0% output corresponds to 2V, and a 50% output corresponds to 6V.
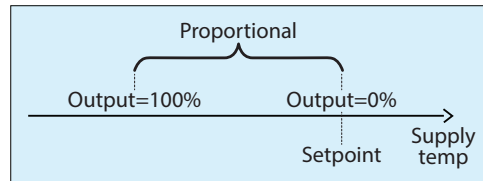

Figure 35 - Modulating Boiler Proportional Band

5.4.3.1 - Call for Heat

As seen in **section 5.2.2** , Pump activity can be dependent on a call for heat. In the case of the modulating boiler sequence, which constantly calculates the output value using a PI loop as described above, it is not suitable to activate the pumps simply when the desired boiler output is greater than 0%. The supply setpoint and supply temperature readings can fluctuate naturally near the 0% mark, resulting in unnecessary activation of the pumps.

Instead, the Prolon **Boiler Controller** has a configurable pump activation point. When the calculated boiler value is greater than the **Minimum Boiler Activation**, a call for pump is requested. Once proof of pump is obtained, the boiler will begin modulating its output to obtain the supply setpoint.

Similarly, if the calculated boiler value drops below the **Deactivation Point**, the pump request is cancelled and the pump starts its "**Pump Run Time after Boiler Shutdown**" counter . During this time, the boiler is still enabled and modulating, but should the calculated boiler value rise back **above** the Calculated Pump Deactivation Point, the pump shutdown timer is cancelled. Only when the pump shutdown timer completes it countdown will the pump finally shut off, along with the modulating boiler output.

Note that if instead the pump is being controlled based on outside temperature, the Pump Activation and Deactivation points are not used, and the modulating boiler will turn on and off as needed.

5.5 - Calibration Configuration

This screen allows the user to adjust the controller's various input readings, in case a noticeable offset is observed. Positive or negative values can be entered.

Figure 36 - Calibration Screen

The return calibration only takes place if a return sensor is used *(see section 5.3.2)*.
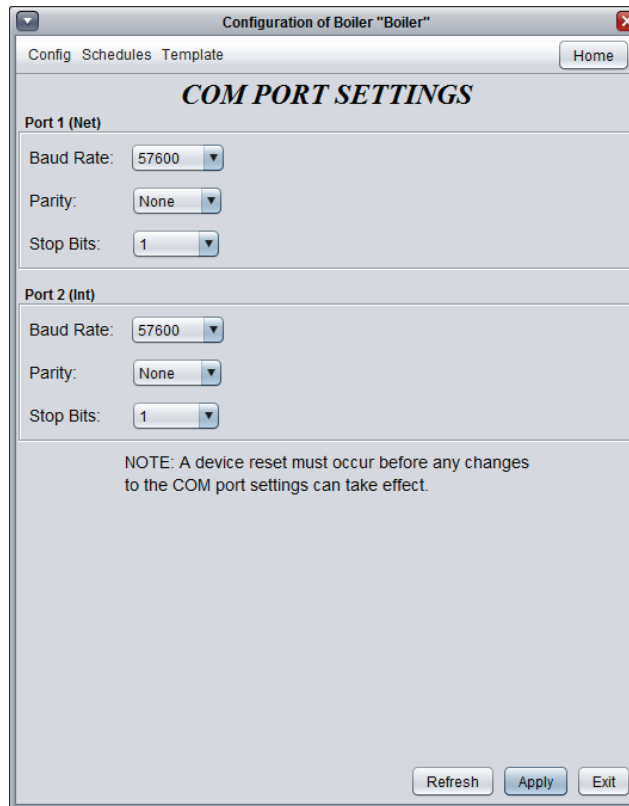
5.6 - COM Port Settings

Figure 37 - COM Port Configuration Screen

Changes to the settings in this section will only take effect once the **Boiler Controller** is reset or has power cycled. Each port on the **Boiler Controller** has the same options. Please refer to each platform's hardware guide for more details on the COM ports.

- **Baud Rate**: This sets the baud rate value for the COM port. The default baud rate used by the **Boiler Controller** is 57600bps but may be set to any of these standard values:
  - ▷ 9600 bps
  - ▷ 19200 bps
  - ▷ 38400 bps
  - ▷ 57600 bps
  - ▷ 76800 bps
  - ▷ 115200 bps

- **Parity**: This sets the parity for communication on the COM port. The default parity used by the **Boiler Controller** is "None" but may be set to any of these standard values:
  - ▷ None
  - ▷ Odd
  - ▷ Even

- **Stop Bits**: Sets the number of stop bits used by the COM port. By default, it is set to 1, but can also be set to 2.

5.7 - Device Properties

Figure 38 - Device Properties Screen

This screen shows all the intrinsic properties of the device you are configuring. This helps you determine its capabilities without having to visually inspect the device.

- **Device Type**: The type of controller you are configuring.

- **Software version**: The current software in the controller. The greater the software version, the more advanced the device is. Devices can be upgraded by reprogramming them (see "Reprogram" below).

- **Hardware version**: This is the physical nature of the controller. Different hardware has different features. The hardware can only be changed by replacing it physically.
- **Device Number**: The network address of the controller, which is configured manually using the dipswitches, or even through software.

- **Device Name**: This field indicates the current name of the controller, which you can modify. Alternatively, you can just right-click on the icon and select the rename option.

- **Reset Device**: Causes the device to perform a reset. All configuration properties REMAIN SAVED. However, resetting the controller removes all active overrides. This function is useful for debugging purposes.

- **Reprogram**: This function is used to upgrade the controller to a new software version. Focus will begin by asking you for the HEX file that contains the software

update. Software update HEX files can only be provided by Prolon. At the end of the procedure, Focus will automatically reapply all the parameters you have previously configured into the device.

Should there be any interruption during the programming procedure (due to intermittent communication or other), the procedure is halted to allow time for the problem to be fixed. When ready, the whole upgrade procedure can be resumed at any time by pressing this button again. It is normal for the icon to turn grey and become unresponsive during this period. Simply continue with the procedure anyways.

- **Clear Timers**: This function is used to clear and restart the various run time counters for the pumps and boiler stages. Any single timer can be cleared without affecting the others.
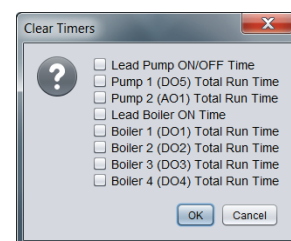

Figure 39 - Clear Timers Pop Up

5.8 - Weekly Schedule

This screen is used to configure weekly occupancy schedules (M2000 hardware platform only).

Figure 40 – Weekly Routines Screen

- **Weekly Schedule Grid**: The Weekly Schedule Grid defines the weekly occupancy routine of the controller. Double-click a cell on the grid to edit it.

  The occupancy status only changes when a valid time is encountered on the weekly schedule grid. For example in the routine above, on Monday the device will be set to "Occupied" at 7:00 AM. At 6:00 PM, the device will be set to "Unoccupied" and remain so until the next valid time is encountered (7:00 AM the next day), where it becomes occupied again. The "Holiday" column will replace a normal weekday anytime the current date has been set as a holiday (see the next section).

  The time can be displayed in either 12h or 24h format by changing the setting in the 'Options' menu, under 'Units', then 'Time Format'.

Note that if a Network Controller is present on the network and it has been configured to send a schedule to this **Boiler Controller**, the schedule sent by the Network Scheduler will take precedence over the one set here.

- **Copy/Paste**: The Copy/Paste function makes it easy to copy a particular day's schedule and apply it to other days of the week. Simply choose a day to copy from the drop down list, select one or more days to paste to then click the "Paste" button.

5.9 - Holiday Calendar

This screen is used to define which dates count as holidays, so that the normal daily schedule can be replaced by an alternate, special holiday schedule. The calendar has no pre-defined holiday marked, allowing for complete customization of the holiday calendar upon initial configuration. The holiday calendar does not automatically recognize floating holidays (Labor Day, Memorial Day, etc.) and thus must be adjusted annually.
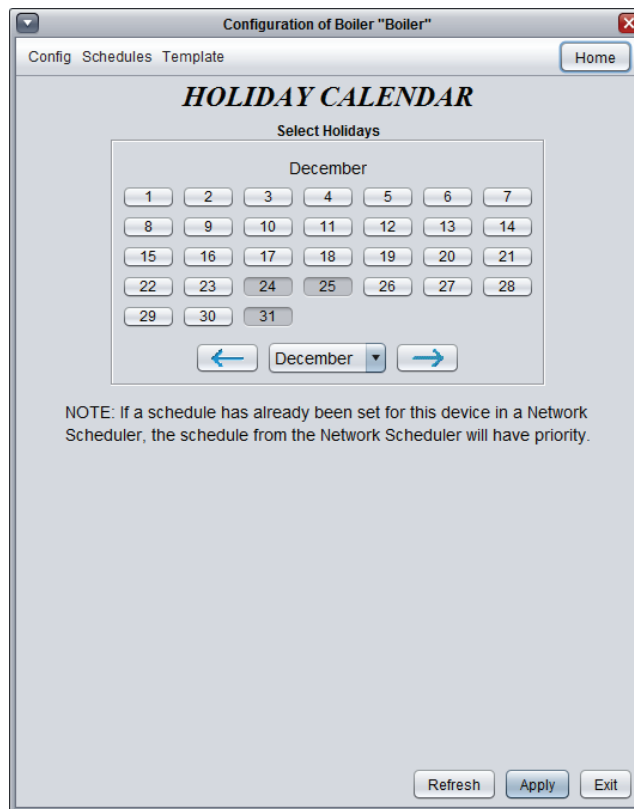

Figure 41 - Holiday Calendar Screen

Calendar Dates
On the selected days, the holiday occupancy routine defined in the Weekly Routines screen will replace the normal occupancy schedule of that day. After the day is over, the next day follows the standard schedule again.

• To select or unselect a date, simply click on it. You can flip through the different months by clicking on the arrows at the bottom or by simply choosing the desired month from the drop down list of months.

5.10 - Template Menu

5.10.1 - Save as Template

The template function gives you the ability to save the configuration of a particular **Boiler Controller** for future use, which can then be applied to any other **Boiler Controller**, regardless of hardware platform. Each configurable property of the **Boiler Controller** is saved into this template file, except for its name. This function is very useful if you have many **Boiler Controllers** with the same or very similar configurations. You will be able to quickly copy and paste the configuration from **Boiler Controller** to **Boiler Controller**.

5.10.2 - Load Template...

After saving a **Boiler Controller** configuration in a template, you can load this template into another **Boiler Controller** by selecting this menu item in the configuration screen of the **Boiler Controller** you wish to change. All configuration properties found in the template are then copied into the configuration screen for your viewing or possible modification. Once you are satisfied with the set of properties, click the "Apply" button.

Note: The template configuration will not be applied to the **Boiler Controller** until you click on the "Apply" button. If you do not wish to use the configuration properties of a loaded template, click on the "Refresh" or "Exit" buttons.