

# Power Flame Incorporated



## **DIRECTOR SCS LEAD LAG CONTROLLER OPERATING AND MAINTENANCE MANUAL (HW Slate Series PLC)**

### ***THE POWER TO MANAGE ENERGY***

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# 1 Director SCS L/L System Description

The Power Flame Director SCS L/L is a PLC-based lead lag system designed to sequence multiple modulation burners based on the temperature or pressure of the common header mounted 4-20mA sensor. The system will turn the boilers on and off and control the modulation as required to maintain the desired setpoint. Should any burner fail or be disabled, it will be removed from the operation sequence and the next available burner will assume its role. Each system includes a Human-Machine Interface (HMI). This is used to input desired values into the system and to view the status of each burner. Control reverts to the local boiler mounted transmitter when the Burner Control is switched off Lead/Lag or loses communications. An ethernet cable is connected from each burner to the Director SCS L/L. The Director SCS L/L monitors the flame safeguard alarm, fuel valves and the limit string devices over BACnet IP. A writeable BACnet register is modified in the Director SCS burner panel which writes to the demand command, allowing it to start. Systems are available from 2 to 4 burners.

## 2 Boiler Room Overview Screen

Upon power up, the HMI will go to the main screen which is titled “BOILER ROOM OVERVIEW”. Refer to Figure 1 below.

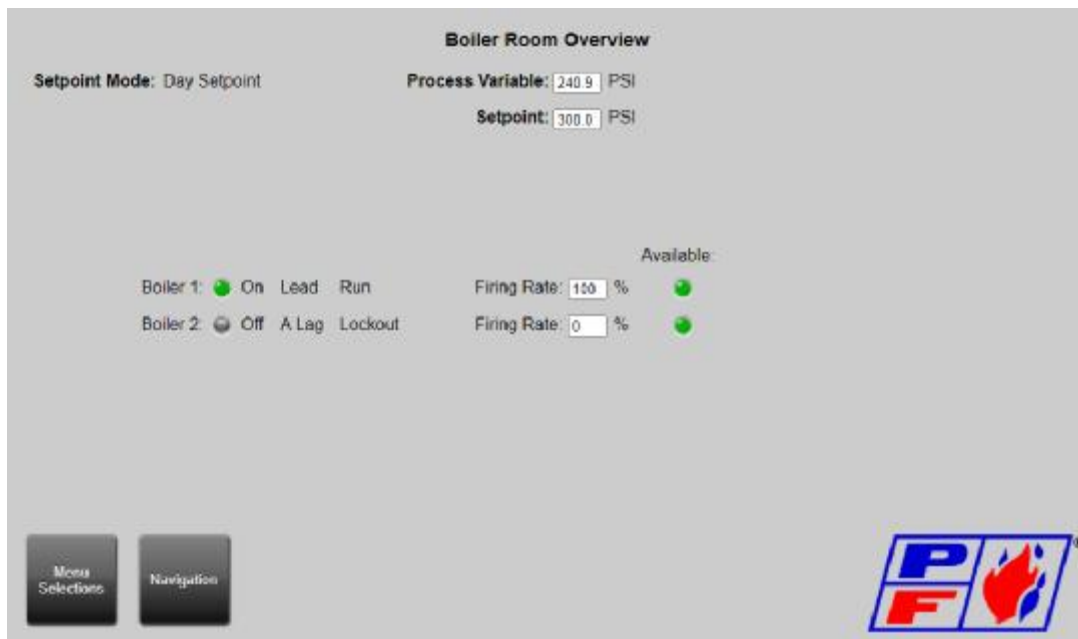


Figure 1: Boiler Room Overview screen

The Boiler Room Overview screen shows the current setpoint (Day, Night, Weekend, or Outdoor Reset), the process variable which is the measured temperature or pressure, each boiler’s position in the lead lag sequence, (Lead, A Lag, B Lag, etc..), the commanded firing rate of each burner as well as a status window for each burner. The

Status window is the box stating each burner's state, such as Baseloading, Unavailable and Lockout that is displayed in Figure 1 above. This window will display the following burner conditions:

Lockout- Burner is in a lockout condition

Unavailable- Burner's limit string devices are not made, the burner is locked out, or the Lead Lag/Bypass switch is in the Bypass position.

Standby- Limit Devices are made and the burner is not locked out. Burner is available for use by the system.

Run- The Burner is in Modulation Mode.

Baseload- This is displayed in Series Modulation mode when the burner is firing according to the entered Baseload percentage.

Ignition Trial- Modulation delay timer in the Director SCS has not timed out from the fuel valve input. Lead Lag/Bypass switch must be in the Lead Lag position.

A battery module is present on the PLC which is required to maintain the system's clock. This clock is used when weekly lead boiler rotation is enabled (see section 11), and when Night or Weekend Setback is enabled (see section 6). The lifespan of the Renata CR 1025 battery is several years under normal use. Power is not drawn from the battery until the system has gone without 120 VAC power for approximately one week. Should the battery fail, a message will pop up on the main screen stating "Battery Failure. Replacement Required." Replacing the battery will clear the message. The system will still be operational with the faulty battery, but the night and weekend setback should be disabled, and the lead boiler select should be changed to a different mode. Yearly replacement of the battery is recommended.

### 3 Menu Selections Screen

The “Menu Selection” button can be pressed to access the menu screens which are shown in Figure 2.

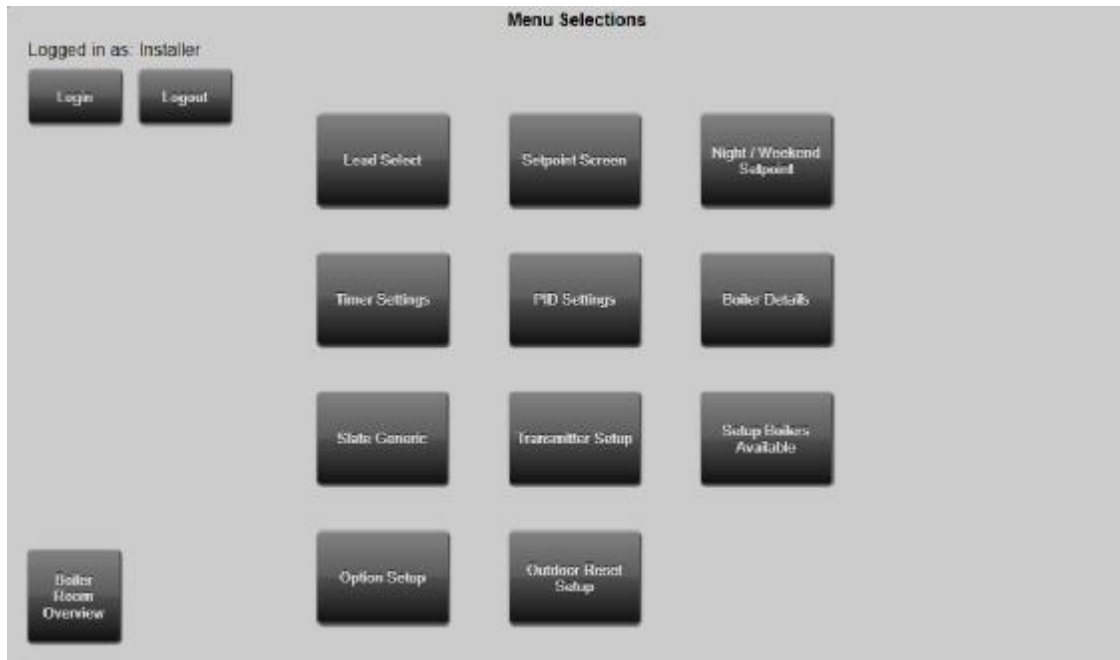


Figure 2: Menu Selection Screen (Logged in)

Each of these menu selections screens include a “Next Screen” button and/or a “Last Screen” button. The “Next Screen” button goes to the next screen in the sub-menu. The “Last Screen” button backs up one screen in the sub-menu. This button will return you to the main screen with repeated presses. A numeric value that is displayed inside of a Blue colored entry field indicates that the value may be changed by the operator. The value is changed by touching the entry field with a finger. A numeric keypad appears on the screen to allow the operator to enter the desired value. The number is read-only if the entry field is not in a blue box.

### 4 Transmitter Settings Screen

The Director SCS system can be configured for either temperature or pressure for proper display on the Header Transmitter. A 4-20mA temperature or pressure transmitter is supplied of the appropriate range for the installation. The minimum and maximum values must be entered correctly for proper system function. They are found under the Transmitter Settings screen as shown in Figure 3B below.

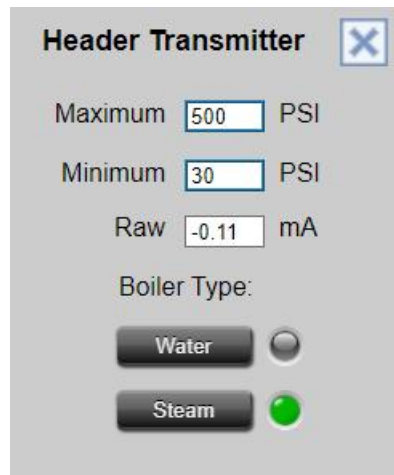


Figure 3A: Header Transmitter Setup Screen

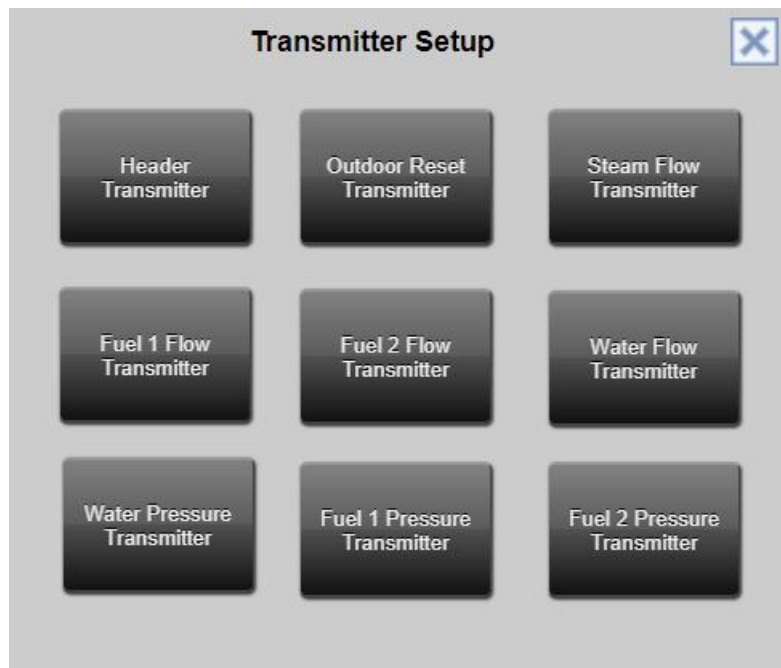


Figure 3B: Transmitter Setup Selection Screen

## 5 Setpoint Adjustment Screen

After the transmitter range has been entered, please go to the Setpoint Screen 1 of 2 as shown in Figure 4 below. Enter the desired Day Setpoint. This is the main header temperature or pressure (process variable or PV) that the system will work to maintain during the day. In this same screen you will find the Time Delayed Cut In value. This is a differential value that is subtracted from the current setpoint. When the PV drops below and stays below the Setpoint minus the Time Delayed Cut In value, the lead burner's start time delay will begin counting. There is an input field for the Instant Cut In. This value is also a differential value that must be larger than the Time Delayed Cut In.

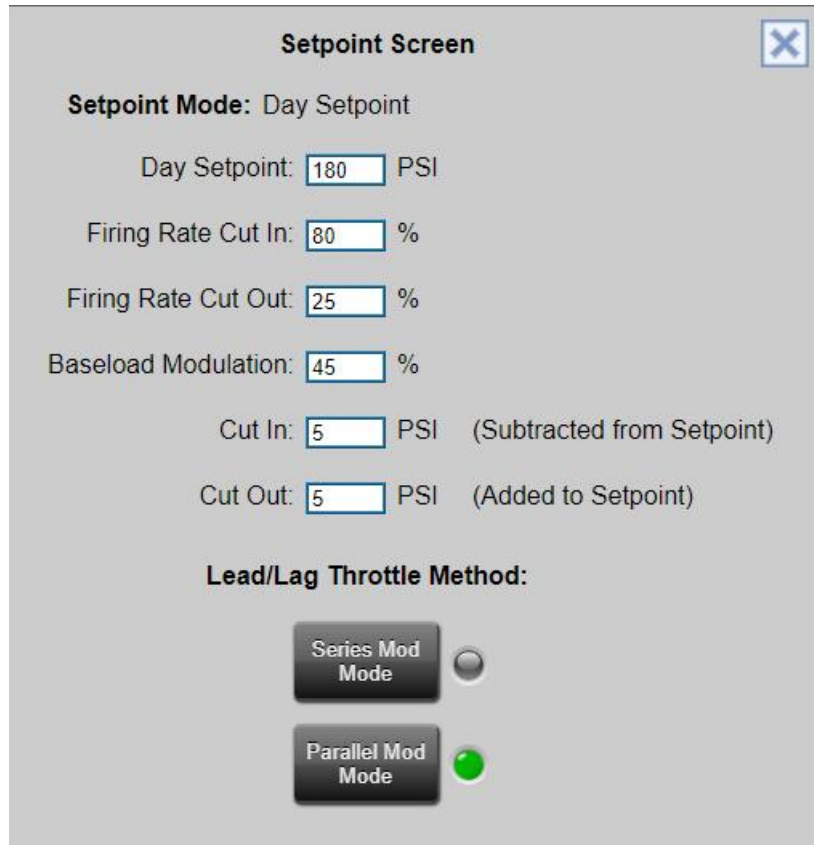


Figure 4: Setpoint Screen

## 6 Night / Weekend Settings Screen

Night / Weekend Settings Screen as shown in Figure 5 below is used to enable the Night and/or Weekend Setback feature. Some facilities like to operate at a lower setpoint during the night, and/or an even lower setpoint on the weekends when demand is low. The Day setpoint mentioned previously in this document is always used if neither night or weekend setback features are enabled. If night setback is enabled, the Night Setpoint is used by the system starting at the hour entered the “Night Setback Hour” and continues until the hour entered into the “Morning Revert Hour”. These values are specified in the 24-hour style. The Weekend Setpoint is used starting on the Weekend start day at the Night setback hour time. The system stops using the weekend setpoint on the weekend end day at the morning revert hour. Should battery failure occur, the clock will display the wrong time which may cause the night and weekend setback modes to occur at the incorrect times.

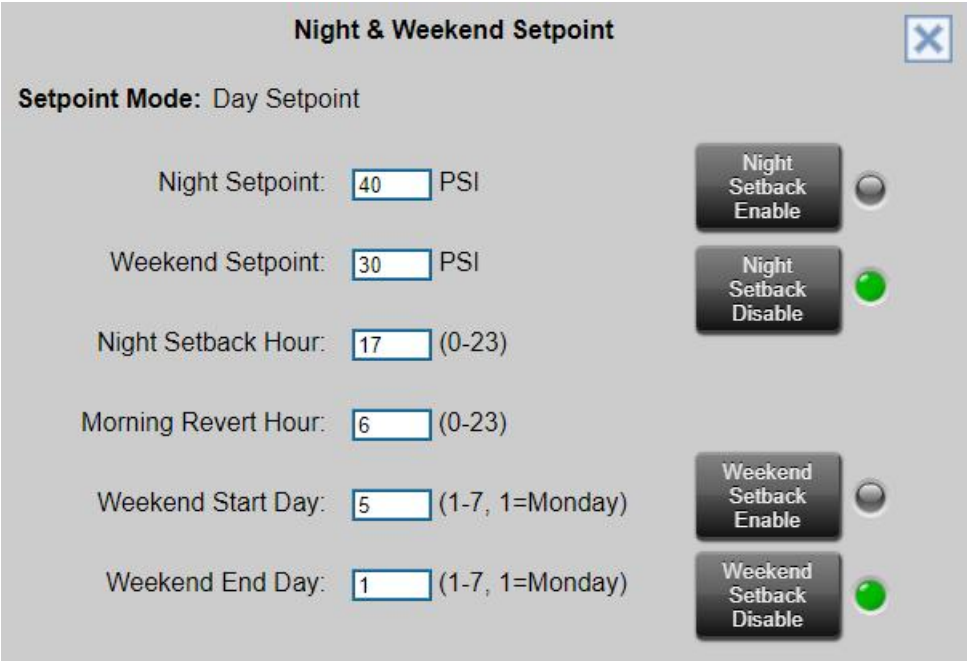
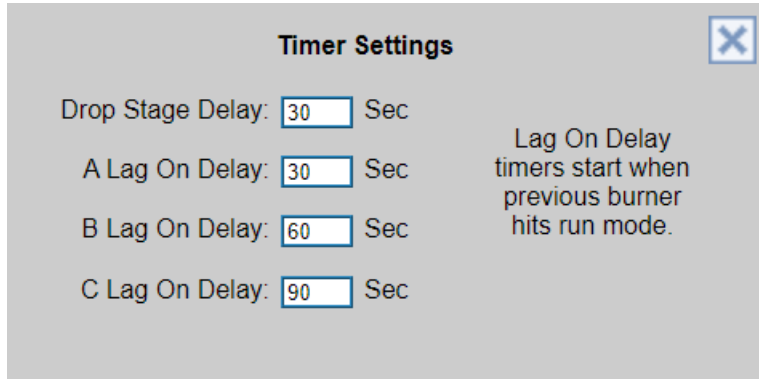


Figure 5: Night / Weekend Setpoint Screen



## 7 Timer Settings Screen

The Lag on-off time delays can be found under the Timer Settings screen as shown in Figure 6 below.



The screenshot shows a window titled "Timer Settings" with a close button (X) in the top right corner. The window contains four input fields for delay times in seconds:

- Drop Stage Delay: 30 Sec
- A Lag On Delay: 30 Sec
- B Lag On Delay: 60 Sec
- C Lag On Delay: 90 Sec

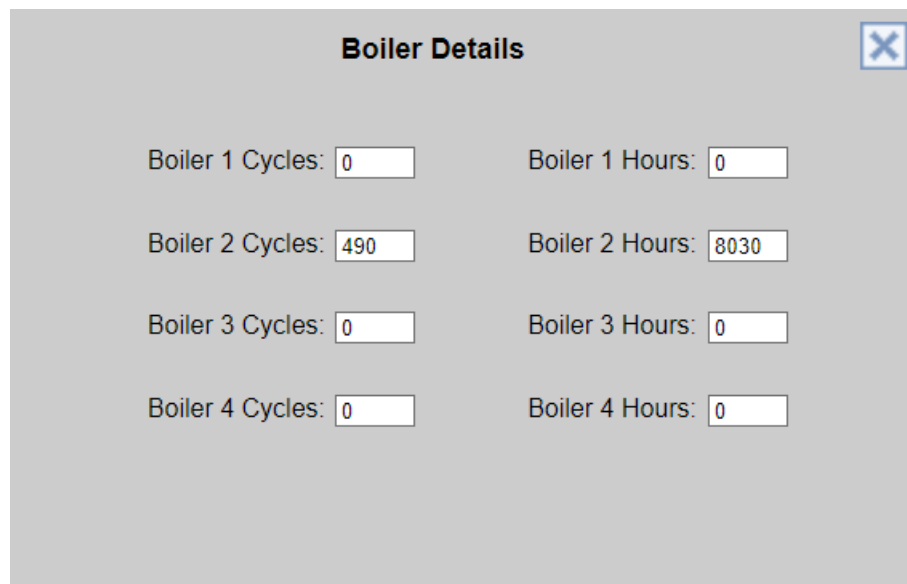
To the right of these fields, there is a note: "Lag On Delay timers start when previous burner hits run mode."

Figure 6: Timer Settings Screen

If the PV drops below the Instant Cut In, all the available burners will come on immediately. The first lag burner's (A Lag) time delay will start counting if the PV stays below the Time Delayed Cut In and the lead burner's firing rate is above the Firing Rate Cut In value. This prevents the lag burner from turning on if the current burner still has additional firing rate available, even if the PV is below the Time Delayed Cut In value. If applicable, additional lag burners will be brought online in a similar fashion.

The Time Delayed Cut Out is added to the setpoint. If the PV gets above this value and stays above it for the duration of the A Lag Off delay timer and the Modulation signal is below the Firing Rate Cut Out value, then the A Lag burner will shut off. At this time only one burner is on. The lead burner's off delay timer will become active when the PV again, gets above the time delayed cut out plus setpoint value and the firing rate drops below the Firing Rate Cut Out value. If the PV should exceed the setpoint plus instant out value, all of the burners will turn off immediately. The Instant Out value must be greater than the Time Delayed Cut Out value.

## 8 Setup Boiler Available Screen



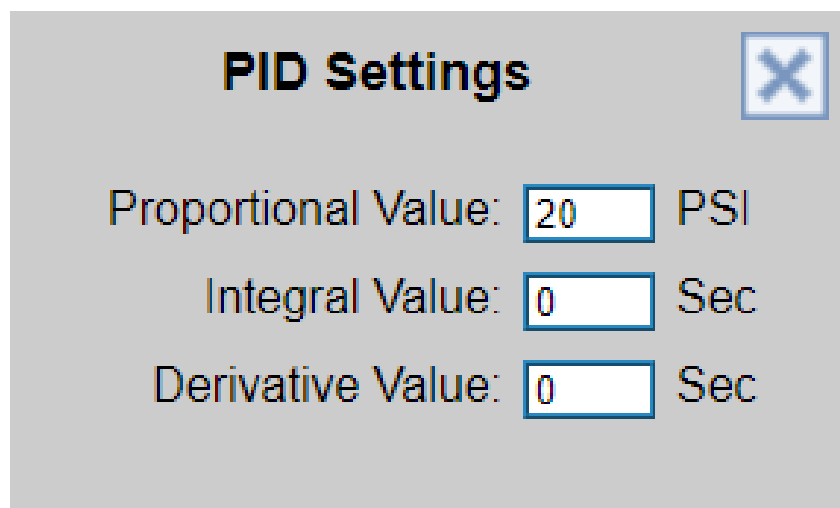
The screenshot shows a window titled "Boiler Details" with a close button in the top right corner. It contains eight input fields arranged in two columns. The left column lists "Boiler 1 Cycles", "Boiler 2 Cycles", "Boiler 3 Cycles", and "Boiler 4 Cycles". The right column lists "Boiler 1 Hours", "Boiler 2 Hours", "Boiler 3 Hours", and "Boiler 4 Hours". The values entered in the fields are: Boiler 1 Cycles: 0, Boiler 1 Hours: 0, Boiler 2 Cycles: 490, Boiler 2 Hours: 8030, Boiler 3 Cycles: 0, Boiler 3 Hours: 0, Boiler 4 Cycles: 0, and Boiler 4 Hours: 0.

| Boiler   | Cycles | Hours |
|----------|--------|-------|
| Boiler 1 | 0      | 0     |
| Boiler 2 | 490    | 8030  |
| Boiler 3 | 0      | 0     |
| Boiler 4 | 0      | 0     |

Figure 7: Setup Boiler Available Screen

## 9 PID Settings Screen

The modulation is controlled by a PID loop. The values for this loop are entered under the PID Settings screen as shown in Figure 8 below.



The screenshot shows a window titled "PID Settings" with a close button in the top right corner. It contains three input fields, each with a unit label to its right. The first field is "Proportional Value" with a value of 20 and the unit "PSI". The second field is "Integral Value" with a value of 0 and the unit "Sec". The third field is "Derivative Value" with a value of 0 and the unit "Sec".

| Parameter          | Value | Unit |
|--------------------|-------|------|
| Proportional Value | 20    | PSI  |
| Integral Value     | 0     | Sec  |
| Derivative Value   | 0     | Sec  |

Figure 8: PID Settings Screen

For proper system operation, refer to PID Settings, Section 8.A in Director SCS Manual.

The Cut in and Cut Out values are added and subtracted to the Setpoint. This threshold starts and stops the Lead Boiler only. (These settings can be found on Setpoint Screen, Figure 3B)

## **10 Lead Burner Selection Screen**

The lead boiler may be selected by six different means on the Lead Select screen as shown in Figure 9 below. Each boiler may be selected manually via the appropriate button. Should any burner be shutoff or locked out on alarm, the failure transfer feature will rotate that burner out of the sequence and immediately bring on the next available burner into the failed/disabled burner's previous role in the sequence.

**Cycle Equalize Mode:** Uses the non-resettable counter values that are displayed on the Boiler Detail screen discussed in Figure 12. The boiler with the least number of cycles is selected lead. Once the cycles are all equalized, the system rotates lead.

**Cycle Alternate Mode:** The lead burner is rotated after the chosen number of firing cycles have elapsed. The chosen number of cycles is entered in on Lead Select Screen This screen is shown in Figure 11 below.

**Weekly Rotation Mode:** The selected lead boiler will change on the selected day and hour per the entries on Night Weekend Setpoint Screen (Figure 5). Should battery failure occur, the clock will display the wrong time which cause the weekly lead selection change to occur at the incorrect time.

**Time Equalize Mode:** Uses the non-resettable hour counter values. The boiler with the least amount of run time is selected as the lead.

**Time Alternate Mode:** The lead burner is rotated after the chosen number hours. The chosen number of hours is entered in on Lead Select Screen. This screen is shown in Figure 11 below. The hour timer resets when the mode is changed.

**Modbus Mode:** Lead burner is selected through Modbus. Refer to Section 13 and 15 for additional information.

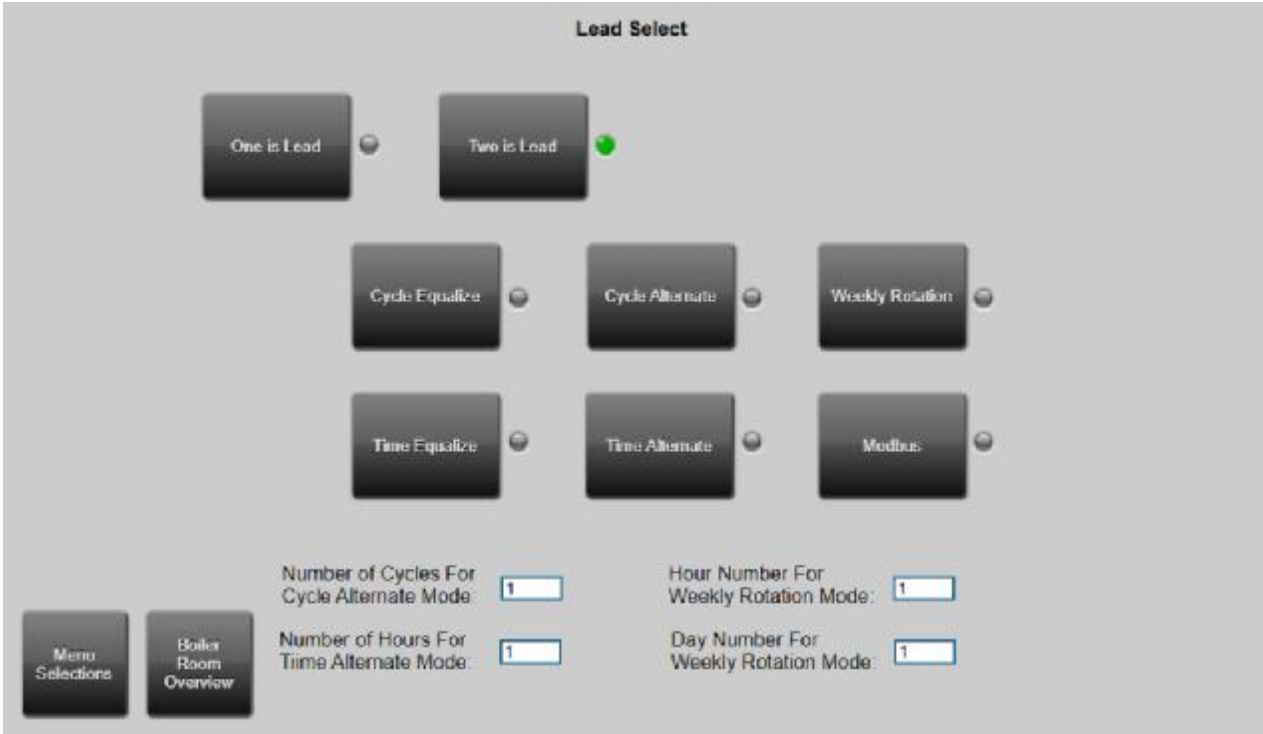


Figure 11: Lead Select Screen

## 11 Boiler Details Information Screen

The Boiler Details screen as shown in Figure 7 previously displays each boiler's number of firing cycles and the total number of run time hours. These values are used in the Time Equalize and Cycle Equalize Lead Selection Modes mentioned in section 10 above.

## 12 Modbus Screen

The Modbus screen 1 of 2 as shown in Figure 13 allows the operator access to set parameters to allow communication with outside systems. The Modbus Address must be set to a unique address on the network. Values 1 to 247 are allowable. The Modbus baud rate must be set to the same speed as the other device on the network. Allowable values are 9600, 19200 and 38400. For the Modbus setpoint write command to take effect, the "Modbus Mode" button must be pressed in Lead Select 1 of 2. See Figure 10.

The screenshot displays the 'SLATE Base - Communications' configuration screen. It is divided into several sections:

- Navigation:** A back arrow and '< Base Status' on the left, and a 'None' button on the right.
- Ethernet Configuration:** A list of fields including Source (Static IP address), Address (192.168.92.21), Subnet Mask (255.255.255.0), Router Address (192.168.92.1), DNS Address (192.168.92.1), and MAC Address (00:40:84:51:0A:96).
- RS-485 Configuration:** Fields for Protocol (Modbus), Baud Rate (38400), and Parity (None).
- Communication Setup:** A tabbed interface with 'Modbus', 'BACnet', and 'Router and Foreign Device' tabs. The 'Modbus' tab is active, showing:
  - BACnet Configuration Status:** Configuration OK
  - RS-485 Slave Address:** 1
  - Modbus/TCP Configuration:** Modbus/TCP
  - Modbus/TCP Port:** 502

Figure 12: Modbus Setting Screen

The Modbus setting screen shown in Figure 12 displays the data that is being transmitted from the Modbus master device. These fields can be used in troubleshooting to ensure that the data is being transmitted from the master device. Refer to Section 15 for detailed information on the available points.

# 13 System Time Screen

< Base Status
**SLATE Base - General Setup**

None

SLATE Device Name

Date/Time

Displays

Auto Logout

Aux V

Options

Notes

**Reported Date/Time**

**Reported Day Name**

Friday

**Set Date/Time**

**Date/Time Format**

Four items separated by semicolons or spaces:  
 1) ymd, mdy, dmy, or 8601 (ISO 8601 standard form).  
 2) 24 or 12, for 24 hour time or 12 hour time with am/pm  
 3) s or ns, to include or omit seconds  
 4) ddd, dayname or empty, to include the dayname as a 3 letter abbreviation a full word, or omit the dayname

**Daylight Savings Setting**

Two pairs of numbers separated by semicolon or space. Each pair is: 1 through 4 corresponding to the 1st through the 4th Sunday or the letter L corresponding to the last Sunday, then a comma, then a month number. If empty then DST changes are disabled.

**Time Zone**

Irrelevant unless/until network time sync is enabled.  
 UTC offset from GMT. GMT is 0, Eastern is -5, Pacific is -8, etc. Fractional values are OK e.g. India should be 5.5.

Figure 13: System Time Screen

The correct time and date must be entered by the operator into the time and date field. Correct time and date must be used when in Night or Weekend Rotation Modes

# 14 BACnet Binding Configuration

Configuring Device Object Instance:

From the Main Overview page go to Main Menu – Login as Installer – go to Slate Generic – BASE – Communication Setup – BACnet. Ethernet Configuration needs to be selected as “Plain BACnet/IP”. The Device Object number is 1-4 for burners 1-4 and 10 for the master lead lag. These values can differ due to site preferences but must match the Device=number in the BACnet Binding.

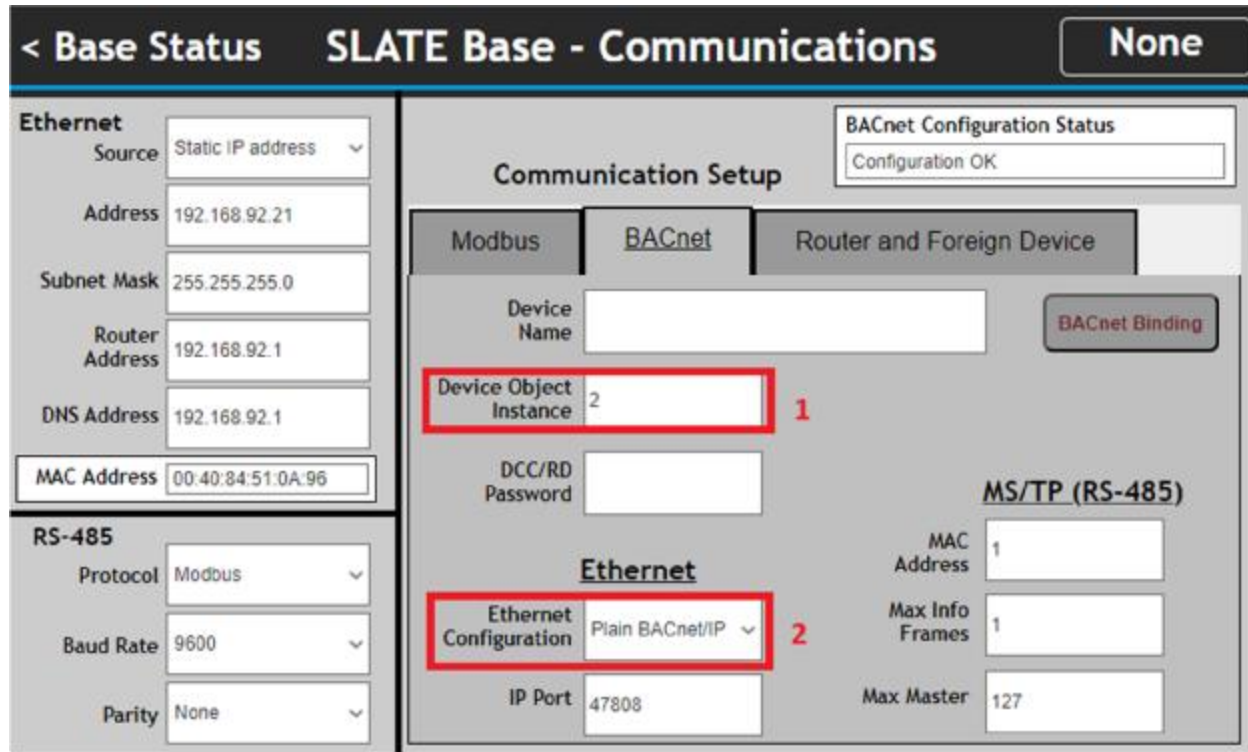


Figure 14

Item #1 is the Device Object Instance. In this example it is 2 as this is burner number 2.

Item #2 turns on the BACnet communications between the master and burner panels for lead lag operation.

## Setting up BACnet bindings.

Burner control setup:

From the Main Overview page go to Main Menu – Login as Installer – go to Slate Generic – BASE – Communication Setup – BACnet – BACnet Binding.

Enter in the following strings in the Setup box for each burner control.

| Bind Register # | 17              | 18              | 19              | 20              |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Burner # 1      | Device=10 AV-5  | Device=10 AV-6  | Device=10 AV-7  | Device=10 AV-17 |
| Burner # 2      | Device=10 AV-8  | Device=10 AV-9  | Device=10 AV-10 | Device=10 AV-17 |
| Burner # 3      | Device=10 AV-11 | Device=10 AV-12 | Device=10 AV-13 | Device=10 AV-17 |
| Burner # 4      | Device=10 AV-14 | Device=10 AV-15 | Device=10 AV-16 | Device=10 AV-17 |

**SLATE Base - BACnet Binding** None

**Register Select:** Bind Register 20 1

**Live status:**

BACnet bind 20 data = 262.597 2 Data read from device

BACnet bind 20 status = Access - Normal 3 Status code: 1  
Status message

**Setup:** Device=10|AV-17 4

The binding registers can be used to pull (read) data from any BACnet device, such as another SLATE control. Each register has an associated setup register and a status register with a code that identifies a status message. Status messages include reporting of any syntax errors in the setup register.

The setup register contains keyword=value pairs that are separated by the vertical bar character. Spaces are allowed, but optional.

Example setup strings to identify the device, object instance, and property that is read:  
 Device = 12 | AO-123  
 Device = 12 | AO-123 | propid = present-value (Same as above)  
 Device = 12 | objtype = 1 | instance = 123 | propid = 85 (Same as above using numeric objtype: 1 is AO, 85 is present value)  
 Device = 48 | BO-456 | propid=persent-value [ 3 ] (Indexed item: use square brackets.)  
 Device omitted means this device. objtype omitted means the device object. objtype may be AO, AI, AV, BO, BI, BV, MI, MO, MV with a dash and an instance number, or the keyword objtype= and a BACnet numeric code. If the numeric code is used then the instance keyword is required. propid if omitted means present-value. propid may use a BACnet property name or number. May be indexed.

Figure 15

Item #1 is the Bind Register number. Each burner control will need Bind Registers 17-20 filled out.

Item #2 is the BACnet data from that register.

Item #3 is the communication status, a Status code of 1 here is Access – Normal (means valid data transfer) and a Status code of 3 means no response.

Item #4 is Setup box for the data string. In this example the “Device=10” is referring to the BACnet Device Object



Instance number of the master lead lag panel. If the BACnet Device Object Instance number of the master lead lag panel changes from the default value of 10 then the Device=number needs to match in each burner control.

#### Master Lead Lag Setup:

From the Main Overview page go to Main Menu – Login as Installer – go to Slate Generic – BASE – Communication Setup – BACnet – BACnet Binding.

Enter in the following strings in the Setup box for the master lead lag panel.

| Bind Register # | Bind String     |
|-----------------|-----------------|
| 1               | Device=1   AV-1 |
| 2               | Device=2   AV-1 |
| 3               | Device=3   AV-1 |
| 4               | Device=4   AV-1 |
| 5               | Device=1   AV-2 |
| 6               | Device=2   AV-2 |
| 7               | Device=3   AV-2 |
| 8               | Device=4   AV-2 |
| 9               | Device=1   AV-3 |
| 10              | Device=2   AV-3 |
| 11              | Device=3   AV-3 |
| 12              | Device=4   AV-3 |
| 13              | Device=1   AV-4 |
| 14              | Device=2   AV-4 |
| 15              | Device=3   AV-4 |
| 16              | Device=4   AV-4 |

## Notes