



SERIES C-05830-B0 COMPACT MICRO IV™ LEAD LAG SEQUENCER



Do not operate or service this equipment before reading the operator's manual! Failure to do so could result in serious injury.

All revisions to hardware, wiring, or software must be approved in writing by Hays Cleveland, Division of UniControl Inc.



Instruction Manual Conventions

This manual concentrates on the application of lead-lag sequencing to multiple boiler operation (steam or hot water). However, other applications are possible, including the control of pumps, air conditioning equipment, or other staged devices. Terminology (as defined by ASME CSD-1-1998 "Controls and Safety Devices for Automatically Fired Boilers") that is used in this manual includes the following:

- **Control:** a device designated to regulate the fuel, air, water, steam, or electrical supply to the controlled equipment. It may be automatic, semiautomatic, or manual.
 - **Control, operating:** an automatic control, other than a safety control, to start input, or regulate input upon satisfaction of demand.
 - **Control, primary safety:** a control directly responsive to flame properties, sensing the presence of flame and, in event of ignition failure or loss of flame, causing safety shutdown.
 - **Control, safety (also known as limit):** a control responsive to changes in liquid level, pressure, or temperature, which is set beyond the operating range to prevent operation beyond designed limits.
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Safety Warnings

(Safety symbols and terminology per ANSI Z21.)

Failure to comply in full with the following safety requirements can result in equipment damage and personal injury/death.

1. Read the entire manual to become familiar with the use and operation of this device.
 2. Only qualified personnel should attempt to install, wire, commission, startup, service or operate this device.
 3. This device is not suitable for use in an explosive ambient atmosphere.
 4. Before working on this device, be sure that you understand the processes affected by this device completely.
 5. Before working on this device, be sure that any process affected by this device is secure and safe for servicing.
 6. Take appropriate precautions to avoid electric shock when working with this device near water.
 7. Exercise caution while wiring or working on this device. Multiple voltage sources may be present: take appropriate precautions to avoid electric shock.
 8. RFI (radio frequency interference) can affect adversely the operation of this device and devices that are connected together as a system. Do not use radios near this equipment: examples include, but are not limited to; citizen band radios (CB), walkie-talkies, transceivers, and amateur radios (HAM).
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1.0 INTRODUCTION

1.1 Overview of the Product

Boiler plants today generally use *more* and *smaller* boilers than the plants of the past. These small boilers cost less to install and operate. The **Hays Cleveland Series C-05830 Compact Micro IV™ Lead Lag Sequencer** provides **safe and efficient** coordination of multiple boiler firing rates for maximum plant efficiency. It responds smoothly to changing demand, regulating steam pressure or hot water temperature with speed and flexibility that cannot be achieved using individual boiler controls alone. The **Compact Micro IV™** enables boilers to work together, under any and all operating conditions, eliminating costly, unnecessary boiler cycling.

The **Hays Cleveland Series C-05830 Compact Micro IV™ Lead Lag Sequencer** responds automatically as plant conditions change. Advanced-technology sensors **monitor** steam pressure or water temperature continuously. These variables are displayed continuously, independent of the **programming keypad and alphanumeric display**. Operator controls include **boiler status lights** (to identify which boilers are currently on-line) and **manual/off/auto mode switches**. **Auxiliary loop and monitor displays** are available as options. **On-Off, Low-High-Off and Full-modulating** Compact Micro IV Models are available to provide the appropriate control strategy for any plant. On-off cycling is achieved with output relays. Full modulation is available with a choice of **0-135 ohm, 1-5 VDC, or 4-20 mADC** output, to interface with any type of actuator.

The **Model C-05830 Compact Micro IV™** can control up to six boilers. The **Model C-05810 Micro IV™** is available for controlling up to twelve boilers, and offers additional features including combustion efficiency, flue gas temperature monitoring, and special control loops (such as air compressor loading).

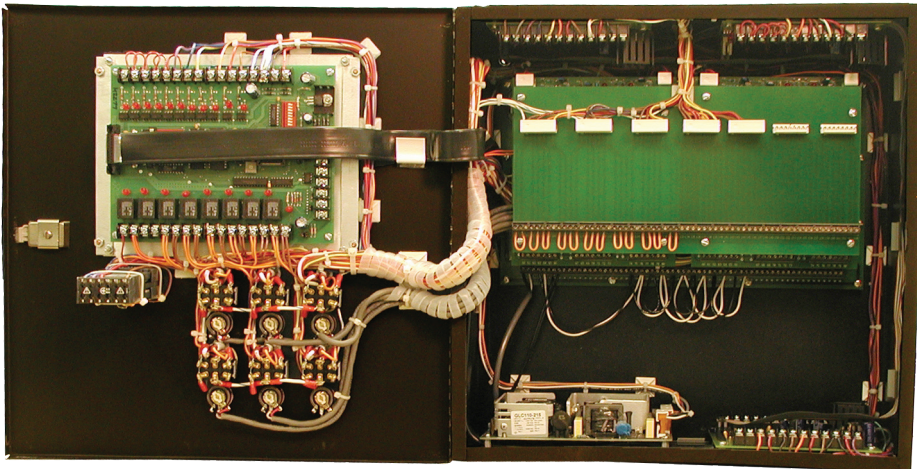
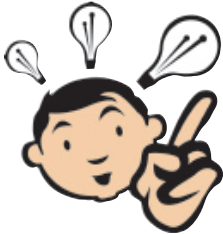


Figure 1: Open view of typical enclosed C-05830 Compact Micro IV™

1.2 Description of Operation

The **Series 5830 Micro IV™** can enable, disable, and modulate the firing rate of multiple boilers automatically in order to maintain a predetermined main header set-point. The fluctuation of main header steam pressure or temperature results from changes in load: this fluctuation provides the control process variable for the system. A remote pressure or temperature transmitter sends the process variable signal to the microprocessor. The process variable is displayed in engineering units on the face of the controller. The microprocessor provides responsive control logic to maintain process temperature or pressure to satisfy demand.

The system is programmed and calibrated to customer specifications at the factory. The field operator can configure system parameters including parallel or series modulation, “cut-in” and “cut-out” pressure set points with night cut back, and the 0-50 minute time delay before the lag boiler starts up. The field operator can configure other timers including assured low fire shutdown and boiler flame failure. The operator can set the time and day for the seven-day timer to automatically rotate the lead boiler or permit lead boiler rotation to occur based on accumulation of lead boiler run time. The operator can also bypass the lead boiler change and manually select the lead boiler and day or night pressure settings.



The **Micro IV™** is a lead lag sequence controller. As such it provides automatic boiler sequencing (parallel or series) and either on-off, low-high-off, or full modulation firing rate control, along with useful control features, monitoring, display, and communication. It does not take the place of either safety (limit) controls or primary safety controls(flame safeguard). **It coordinates with existing** safety limit controls and flame safeguard controls in accordance with boiler and burner manufacturer recommendations.



1.3 Specifications

Line Power: 117 V AC, 50/60 Hz.

Ambient Temperature: 32 to 130F (0 to 55C).

Cabinet Dimensions: 16" x 16" x 6.5".

Cabinet Rating: NEMA 1, with door lock.

Cabinet Mounting: Surface-mounted (on wall) or flush-mounted (in panel) available.

Open-mount Subpanel Size: 13"H x 16"W.

Open-mount Front Panel Size: 13.13"H x 10.63"W.

Process Display (C1): Displays process variable, Temperature (F) or Pressure (psig), in ½" high characters.

Processor-CPU Display: 2-line vacuum fluorescent display, alphanumeric with 20 characters per line. System status LED indicators.

Processor Keypad: 20 keys (membrane).

Boiler Service Switch: MANUAL/OFF/AUTO, one per boiler.

Memory Type/Retention: CMOS RAM with battery.

Comm Ports: RS485 Modbus 19.2K baud, and RS232 ASCII-II.

Inputs, Digital (standard): Eleven; optically isolated.

Inputs, Analog (standard): Eight; 1-5 V DC or 4-20 mA DC into 250 Ω shunt.

Outputs, Digital (standard): Seven; 10A@117 V AC, noninductive, 10A@12 VDC.

Outputs, Analog (standard): Two (up to Eight, optional), 135 Ω or 4-20 mA DC @ 24 V DC.

Expansion Module (digital): Eight DI and six DO relays.

Approvals: Dept. Environmental Protection, NYC DEP approved; Underwriters Laboratory & CUL pending.

System Interface Requirements

- Interface only with printed circuit board style firing rate actuators. **Honeywell Series 90™** electronic models or equivalent.
- Firing rate actuators must have low fire auxiliary switch available.
- 4 - 20 mA DC input signals must be isolated.

Specifications are subject to change without notice.

C - 0 5 8 3 0 - * 0 -

A	B	C	D	E	F	G	H	I
						Options	Options	

1.4 Product Nomenclature

A. Enclosure Style & Processor I/O Capability

The “yy” portion of the suffix code is the I/O capability. It is assigned by **Hays Cleveland**, and varies for the specific options selected. The enclosure will be selected from the following:

- A01yy: **Enclosed Version:** Hot Water Boilers.
- A02yy: **Enclosed Version:** Steam Boilers.
- A11yy: **Open Mount Version:** Steam Boilers.
- A12yy: **Open Mount Version:** Hot Water Boilers.

B__Process Element

- B01: RTD Assembly** for use with hot water service. Platinum 3-wire RTD with 0.5” stainless steel thermowell. The “U” insertion dimension is 2.5”. Temperature range is +40 to +240F, or as specified.
- B02: RTD Assembly**, same as **-B01**, but with a “U” insertion of 4”.
- B24: Steam Pressure Transducer** (stainless steel body) with steam siphon pigtail for steam pressures of 0 to 30 psig; specify set point.
- B25: Steam Pressure Transducer**, same as **-B24** but with range of 0 to 100 psig; specify set point.
- B26: Steam Pressure Transducer**, same as **-B24** but with range of 0 to 300 psig; specify set point.

C __, D __, E __, F __ Control Output & Quantity of Boilers:

Select only one output option. Then fill in the number of boilers in the “xx” value.

Non-Modulating Outputs

- Cxx: ON-OFF Relays only.** Use for boilers equipped with their own modulating control systems.

-Dxx: LOW-HIGH-LOW. Use for boilers that do not modulate, but have only minimum and maximum actuator positions using relay output switching. Includes ON-OFF relays.

Modulating Outputs

(Control selections **-Exx** & **-Fxx** include the standard modulation features (see above) that are unavailable with non-modulating Compact Micro IV™ Models.)

-Exx: ON-OFF with 4-20 mA DC output MODULATION. Boilers may or may not be equipped with control systems. Includes one relay and one isolated 4-20 mA (24 V DC) output per boiler.

-Fxx: ON-OFF with 135 ohm MODULATION. Boilers may or may not be equipped with control systems. One relay and one 135 ohm isolated output per boiler.

G. Common Option Selections

For all control selections (C, D, E & F). Note: Purchase one per system, or one per boiler, as appropriate. Multiple selections are allowed. **Options G16 through G21** are for Hot Water Generators and Boilers only.

-G0100: Outside Air Temperature Reset. Includes RTD Assembly for through-wall mounting and a cabinet-located Indicating Transmitter. One per system.

-G0200: Normal-Manual Night Set-Back Switch. Front cabinet override of the standard night setback feature, without using the keypad. One per system.

-G0300: Dual Set Point Switch. Front cabinet-located switch for selecting either of two operating temperatures or pressures. One per system.

-G0400: Remote Set Point. User supplies a 4-20 mA DC isolated input of temperature or pressure set point. Processor defaults to local set point if input is less than 4 mA DC. One per system.

-G05xx: Remote Lead Boiler Select. User supplies a multiple contact switch input to select the lead boiler. One per boiler.

-G06xx: Assured Low-Fire Warm-Up. Boiler is not released from low-fire until temperature or pressure switch input is opened. Sensing switch by others. One per boiler.

-G07xx: Assured Low-Fire Warm-Up with one Warm Stand-By Boiler. Same as **-G06xx**, plus keeps one boiler warm for immediate use. The assured low-fire warm-up uses one isolated input from a device provided by others (such as Aquastat). Closing of the next available boiler's temperature or pressure switch starts the boiler. The boiler is held at low fire. When the temperature or pressure switch opens, the boiler is taken off line or released to modulate if the boiler is needed.

-G08xx: Assured Low-Fire Shut-Down. Ensures that the boiler is not taken off line until a switch input signals that the burner is in the low-fire position. One per boiler.

- G11xx: Make-Up Air Damper Control.** Provides relay output to open the respective boiler room air damper. Proof-of-open input is required through the boiler burner management system before the boiler is started. One per boiler available.
- G1600: Water Return Temperature Indication.** Includes RTD and 0.5” SS thermowell with a 2.5” (U-dimension insertion) pipe and a cabinet-located indicating transmitter with 4-20 mA DC output. One per system.
- G1700: Water Return Temperature Indication.** Same as -G16xx above, but with a 4-inch insertion RTD & thermowell. One per system.
- G20xx: Boiler Pump ON with Time Delay OFF.** Relay output to turn on boiler’s circulation pump with its boiler. Adjustable time delay OFF after boiler is taken off-line. One per pump.
- G21xx: Boiler Pump ON with Lead Pump Always ON.** Sequences boiler pumps which are used as system circulation pumps. The lead-boiler’s pump is always ON, with adjustable time delay OFF for lag boiler pumps. One per pump.
- G2200: Password Menu Protection.** Prevents unauthorized keyboard entry. The keypad control display is blanked until the proper code is entered to gain access. One per system.
- G2400: Auxiliary Digital I/O Expansion Module:** 8 inputs, 6 outputs. One or more will be included at the factory if needed to accommodate system IO requirements.
- G2500: Second Auxiliary Digital I/O Expansion Module:** 8 inputs, 6 outputs. One or more will be included at the factory if needed to accommodate system requirements.
- G3000: Custom engineered systems are available.** Consult Hays Cleveland for local technical support.

H. Hardware Options:

- H01xx: Manual Potentiometer (with option Exx or Fxx only).** 135-ohm firing rate potentiometer enables the boiler firing rate to be adjusted when the MAN/OFF/AUTO switch is in the manual position. One per boiler.
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2.0 INSTALLATION

2.1 Mechanical

Install in a convenient location where temperature and vibration are not excessive.

2.2 Electrical



Since each burner circuit is connected to the sequencer through its own 10-amp relay contacts, phasing or different voltages of burner circuits is not a problem. Do not apply power line voltage to any terminals other than H and N, or serious damage may result.

2.3 Wiring

The Micro IV™ continually monitors the limit string and therefore it should be the **last item in the limit string**. This allows the Micro IV™ to respond to a fault in the limit string. When there is a fault in the limit string, the Micro IV™ considers that boiler unavailable for service, and sequences immediately to the next boiler.



When wiring the Micro IV™ to the individual burner safeguard controls, the wire that would normally go to **terminal 6 of the Honeywell 7800** or **terminal 3 of the Fireye YB110 Burner Logix** flame safeguard is rerouted to the “**LIMITS IN**” terminal of the Micro IV™. The “**LIMITS OUT**” is connected to **terminal 6 of the Honeywell 7800** or **terminal 3 of the Fireye YB110 Burner Logix** flame safeguard. The “**LOCKOUT**” terminal is connected to **terminal 3 of the Honeywell 7800**, or **terminal A of the Fireye YB110 Burner Logix** flame safeguard.

Auxiliary digital inputs must be isolated dry contacts. The assured low fire shutdown requires an isolated contact closure from the modulation motor. **It is important that the assured low fire contact remains closed during the entire time the boiler is off-line.**

All remote analog inputs (i.e., remote set point) must be isolated. All 4-20 mA DC outputs have a maximum output voltage of 24 V DC.

2.4 System Interface Requirements

Isolated Inputs: Micro IV™ models with **remote 4 to 20 ma input signals** must be electrically isolated.

3.0 OPERATION & MAINTENANCE



Warning! Only qualified technicians should operate, adjust, or maintain this equipment. 120 V is present in enclosure interior on electrical terminal points.

3.1 Operation

3.1.1 Description of Operation

The **sequencer** accepts an input signal from a **remote pressure or temperature transmitter** mounted in the main header. When **load** (**demand** for steam or hot water) exceeds steam or hot water supply, the **process signal** (header pressure or temperature) drops below the **lead boiler “cut-in” set point** (established during system configuration), prompting the sequencer to call the **lead boiler** on line and release it for modulation. If demand is still not satisfied after the lead boiler modulates to high fire (and the process signal remains below the **first lag boiler “cut-in” set point** throughout an adjustable delay period: see **para. 3.1.3**), the sequencer calls the **first lag boiler** on line. Note that during system configuration, a different process signal *drop* value has been assigned as the “cut-in” point of each subsequent lag boiler (**para 3.2.1.2**). Also, a process signal *increase* value has been assigned as the “cut-out” point of each lag boiler, and an adjustable time delay period has been established for each of these values (**para 3.2.1.4**) so that boilers will not go on and off line unnecessarily due to brief process fluctuations. The method of configuring these values is described in the following paragraphs.

The operation of the system after the first lag boiler has been brought on depends upon whether **parallel** or **series** sequencing mode has been selected.

- In **parallel mode**, all on-line boilers **modulate** in response to demand. If a load remains after all the on-line boilers have modulated to high fire, the sequencer brings another lag boiler on-line and releases it to modulate. As the demand is satisfied, **all** on-line boilers modulate to low fire: the sequencer then signals boilers off line in the reverse of the order they came on line. One after another, the boilers are taken off line after the adjustable time delay period expires, so long as there is no call for heat (i.e., demand remains satisfied).
- When **series modulation** is selected, the lag boilers “cut-in” and “cut-out” points and time delays operate the same as parallel operation. However, **the only modulating boiler is the most recent lag boiler**. When an additional boiler is brought on line the modulating boiler is **locked at high fire**. The new lag boiler is now the modulating boiler. When demand is satisfied, boilers are taken off line in reverse order: as the modulating boiler goes off-line, the previous boiler is released to modulate. The high fire locking point for each boiler is adjustable during configuration: see “throttle back” in para. 3.2.1.1.

3.1.2 Indication

Internal LED capability and door-mounted neon pilot lights indicate “call for heat” for each boiler.

The PLC Scan Light, located on the printed circuit board, indicates the status of the system:

- When it is *on*, the PLC is running.
- When it is *flashing*, **either** the PLC is in “wait” state, **or** there is a user-ladder fault condition. Consult the factory if a user-ladder fault occurs.
- When it is *off*, **either** the power is off, **or** there is a system fault condition. Consult the factory if a system fault occurs.

3.1.3 Lag on/Lag off Adjustable Time Delay

When load increases enough to drop pressure/temperature below the cut-in point, the next boiler in the sequence is brought on-line immediately, and the adjustable time delay relay (0 to 50 minutes, selected during configuration) is energized to prevent the load signal from calling additional boilers on line. This gives the boiler enough time to start producing steam for the load. As long as pressure/temperature remains below the cut-in point, additional boilers will be brought on-line each time the lag-on timer expires and resets itself. This continues until the load has been satisfied. The lag-off adjustment operates the same way, but when the pressure/temperature is above the cut-out points. Note: The timers **must** have a value assigned to them: if either timer is set to 0, **all** boilers will come on-line or go off-line depending on the situation.

3.1.4 EPROM

The EPROM in the PLC holds the program. In the event of a PLC failure, the program has been stored on a disc at the **Hays Cleveland** factory for backup. Call the **Hays Cleveland** sales office where the Compact Micro IV™ was purchased originally to obtain the backup.

3.2 Operator Interface & Configuration

3.2.1 PLC Displays and Configuration

The vacuum fluorescent display consists of two 20-character lines of text (referred to here as **top** and **bottom line** screens). The display is accessed and values are input via the 20-key membrane-type keypad. The keypad includes alphanumeric characters, arrow keys, and several function keys including ENTER, ON, OFF, and CLEAR/DEL, as shown in Figure 1. Seven top line display screens can be accessed to monitor system status and configure settings. Upon initial power-up, the **default screen** displays “Steam Pressure” or “Header Temperature” on the **top line**, and the word “Keys” followed by the *right*, *left*, *up* and *down* arrow characters, and the word “Enter” on the **bottom line**, as shown in Figure 1. If the system is **password protected**, the ENTER sign displays on the **bottom line** instead of the *up/down* arrows, indicating that a password must be input on the keypad and the enter key pressed.

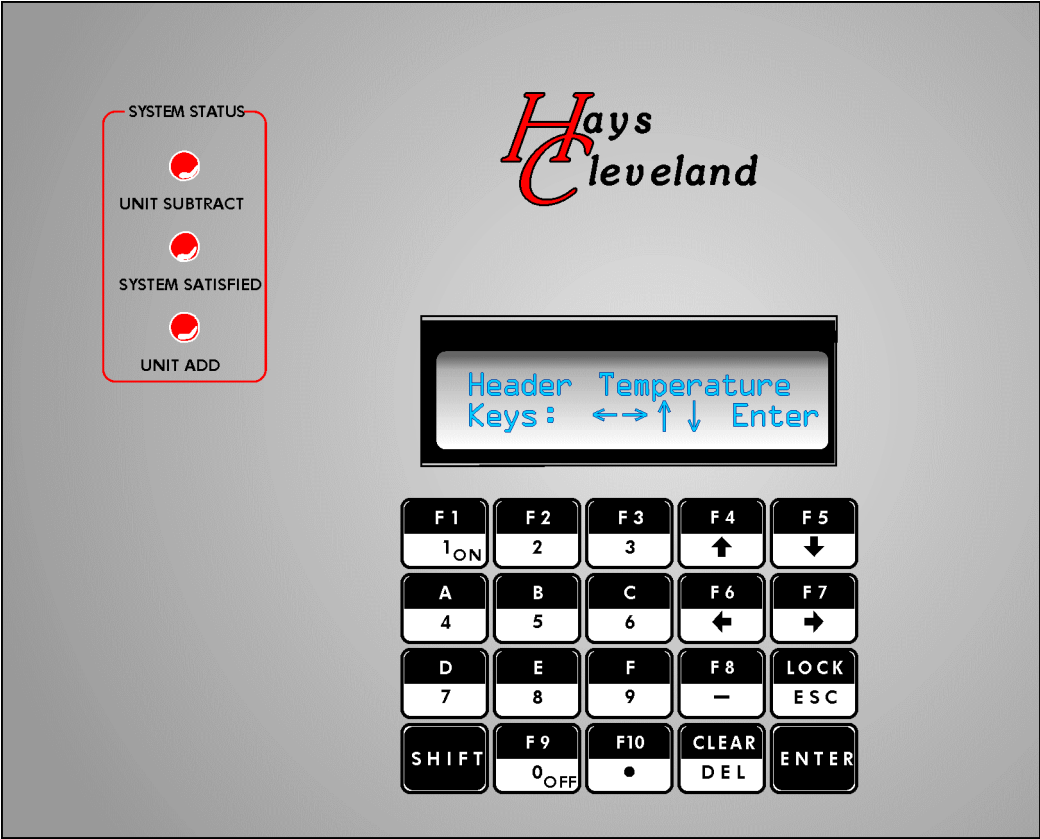


Figure 2: Keypad and display on front panel.

To access **bottom line** messages, press the *down* arrow key on the keypad. To scroll back and forth through the bottom line screens press the *left* or *right* arrow keys. To return to the top line screen, press the *up* arrow key, then scroll through the seven top line screens using the *right* or *left* arrow keys.

The following paragraphs discuss the seven top line display screens: the default **Steam Pressure/Header Temperature** screen, the **Lead Lag Set Points** screen, the **Lead Boiler Select** screen, the **Boiler Time Delay** screen, the **Modulation** screen, the **Night Setback** screen, and the **Outside Temperature Reset** screen. Each top line display has associated bottom line displays accessible only when that top line screen is active. Notice that in the following discussion, settings for the maximum **six boilers** are discussed, even though systems may have from two to six boilers. Notice also that several of the screens are optional: a given Micro IV™ model will have only the screens pertaining to its installed features.

3.2.1.1 Steam Pressure/Header Temperature.

This is the **default** screen which is activated upon system power-up. With this display active, press *down* arrow key on the keypad to access display on bottom line, and then use *left/right* arrow keys to display or reset the following menu items.

- **Process Pressure or Temperature Range:** Press the ENTER key to display the current process range. Compressing the transmitter range results in loss of resolution. This manual assumes that the full available range of the pressure or temperature transmitter is utilized; all system adjustments including Firing Rate Modulation Band and Sequencing Bandwidth adjustments are performed without altering this range.
- **Header PSI/TMP:** the current header pressure (in PSIG) or header temperature (in degrees F), derived from the remote main header transmitter.
- **Parallel Modulation:** Press the ON key and then the ENTER key to enable parallel mode. Press the OFF key and then the ENTER key to disable parallel mode. Note: if both modes are enabled or disabled together, the Compact Micro IV™ defaults to the parallel modulation mode).
- **Series Modulation:** Press the ON key and then the ENTER key to enable series mode. Press the OFF key and then the ENTER key to disable series mode. Note: if both modes are enabled or disabled together, the Compact Micro IV™ will default to the parallel modulation mode).
- **Throttle back:** Press the ENTER key to display the firing rate at which the non-modulating boiler is locked **when in series modulation**. The last boiler on line is the only modulating boiler. To change this setting, use the *numeric* keys on the keypad to enter the desired high fire lock set point as a **percent of firing rate**. Then press the ENTER key.
- **Number of Decimal Places:** Press the ENTER key to select either zero or one decimal place in the process variable and set point values, i.e., 100 (0 decimal places), 10.0 (1 decimal place).
- **Low Range:** Press the ENTER key to display the process variable's low range. If the transmitter minimum output is 0 PSI, enter 0.
- **High Range:** Press the ENTER key to display the process variable's high range. If the transmitter maximum output is 100 PSI, enter 100.

3.2.1.2 Lead/Lag Set Points Screen

The **Series 5830 Micro IV™** accommodates the **lead boiler plus as many as 5 lag boilers**. For each boiler, the cut-in or add value is the process signal **drop from set point** that prompts the Micro IV™ to bring the boiler on-line. For example, if the set point is 100 PSIG, and the lead boiler should be brought on-line if the pressure transmitter signal indicates that 98 PSIG is the actual process value, then the **drop from set point** to enter for that boiler would be “2”. Press the *down* arrow key to access the bottom line and use the *right* and *left* arrow keys to display or reset the cut-in point for each boiler. To change a **Cut-In** or **Cut-Out** setting, use the *numeric* keys on the keypad to enter desired pressure/temperature increase in PSIG/degrees F. Then press the ENTER key.

- **Lead Cut-In (Add):** current “cut-in” pressure/temperature drop from set point in PSIG or degrees F. This is the pressure/temperature drop from set point at which the lead boiler is brought on-line. Be sure that the lead cut in is equal to or below the high fire pressure/temperature setting of the boiler firing rate modulation controller.
- **First Lag Cut-In:** current “cut-in” pressure/temperature drop from set point in PSIG/degrees F. This is the pressure/temperature drop at which the first lag boiler is called on line. Be sure that the first lag cut-in setting is equal or below the lead cut-in pressure/temperature drop (for example, lead cut-in = 2; first lag cut-in = 4; second lag cut-in = 6, etc.).
- **Second Lag Cut-In:** current “cut-in” pressure/temperature drop from set point in PSIG/degrees F. This is the pressure/temperature drop at which the second lag boiler is called on line. Be sure that the second lag cut-in setting is equal or below the first lag cut-in pressure/temperature drop.
- **Third Lag Cut-In:** current “cut-in” pressure/temperature drop from set point in PSIG/degrees F. This is the pressure/temperature drop at which the third lag boiler is called on line. Be sure that the third lag cut-in setting is equal or below the second lag cut-in pressure/temperature drop.
- **Fourth Lag Cut-In:** current “cut-in” pressure/temperature drop from set point in PSIG/degrees F. This is the pressure/temperature drop at which the fourth lag boiler is called on line. Be sure that the fourth lag cut-in setting is equal or below the third lag cut-in pressure/temperature drop.
- **Fifth Lag Cut-In:** current “cut-in” pressure/temperature drop from set point in PSIG/degrees F. This is the pressure/temperature drop at which the fifth lag boiler is called on line. Be sure that the fifth lag cut-in setting is equal or below the fourth lag cut-in pressure/temperature drop.
- **Lead Cut-Out (Remove):** current “cut-out” pressure/temperature increase from set point in PSIG/degrees F. This is the pressure/temperature increase at which the lead boiler is taken off line. Be sure that the lead cut-out setting is equal to or above the first lag boiler cut-out pressure/temperature increase.
- **First Lag Cut-Out:** current “cut-out” pressure/temperature increase from set point in PSIG/degrees F. This is the pressure/temperature increase at which the first lag boiler is taken off line. Be sure that the first lag cut-out setting is equal to or above the second lag boiler cut-out pressure/temperature increase.

- **Second Lag Cut-Out:** current “cut-out” pressure/temperature increase from set point in PSIG/degrees F. This is the pressure/temperature increase at which the second lag boiler is taken off line. Be sure that the second lag cut-out setting is equal to or above the third lag boiler cut-out pressure/temperature increase.
- **Third Lag Cut-Out:** current “cut-out” pressure/temperature increase from set point in PSIG/degrees F. This is the pressure/temperature increase at which the third lag boiler is taken off line. Be sure that the third lag cut-out setting is equal to or above the fourth lag boiler cut-out pressure/temperature increase.
- **Fourth Lag Cut-Out:** current “cut-out” pressure/temperature increase from set point in PSIG/degrees F. This is the pressure/temperature increase at which the fourth lag boiler is taken off line. Be sure that the fourth lag cut-out setting is equal to or above the fifth lag boiler cut-out pressure/temperature increase.
- **Fifth Lag Cut-Out:** current “cut-out” pressure/temperature increase from set point in PSIG/degrees F. This is the pressure/temperature increase at which the fifth lag boiler is taken off line. Be sure that the fifth (**or final** if there are fewer than five lag boilers) lag cut-out setting is equal to or above the low fire pressure setting of the boiler firing rate modulation controller.

3.2.1.3 Lead Boiler Select Screen: Press *down* arrow key to access bottom line and use the *right* and *left* arrow keys to display or reset the following parameters:

- **Present Lead:** displays the present lead boiler.
- **Accumulated Run Time Mode:** Press the ON key and then the ENTER key to **enable** the Accumulated run time mode. Press the OFF key and then the ENTER key to **disable** the accumulated run time mode. (*Note:* Compact Micro IV™ **defaults** to the Accumulated run time mode if *neither or both* “Accumulated Run Time” and “Day/Hr Change” are selected.)
- **Day / Hr Change Mode:** Press the ON key and then the ENTER key to **enable** the Day/Hour Change mode. Press the OFF key and then the ENTER key to **disable** the Day/Hour Change mode. (*Note:* Compact Micro IV™ **defaults** to the Accumulated run time mode if *neither or both* “Accumulated Run Time” and “Day/Hr Change” are selected.)
- **Hours Lead Change:** Press the ENTER key to display the number of hours of run time that must accumulate to prompt a lead boiler change. To change this setting, use the *numeric* keys on the keypad to enter the desired number of lead boiler run hours before lead boiler change. Then press the ENTER key.
- **Lead Run Hours:** Displays the accumulated run time of the current lead boiler.
- **Day (1-7):** Press the ENTER key to display the day on which the lead boiler is changed. To change this setting, use the *numeric* keys on the keypad to enter the desired day (Monday = 1, Sunday = 7). Then press the ENTER key.
- **Hour (0 - 23):** Press the ENTER key to display the hour at which the lead boiler is changed. To change this setting, use the *numeric* keys on the keypad to enter the desired hour at which the lead boiler is to change. (12AM = 0, 11PM = 23). Then press the ENTER key.

- **Manual Override:** To bypass automatic boiler rotation control, press the ON key, then press the ENTER key. To resume automatic boiler rotation, press the OFF key, then press the ENTER key.
- **Select Lead:** Press the ENTER key to display the lead boiler **when in manual override**. Using the alphanumeric keypad, press *1,2,3,4,5, or 6* to select the desired lead boiler, then press the ENTER key.
- **Remote Lead Selection:** To enable this function, press the ON key, then the ENTER key. To resume automatic boiler rotation, press the OFF key, then the ENTER key.

3.2.1.4 Boiler Time Delay Display Screen: press *down* arrow key to access the bottom line and use the *right* and *left* arrow keys to display or reset the following messages. (Set times in seconds, 0-32,760, equals 0-546 minutes.)

- **Lag ON Delay:** This delay is adjusted to allow the last boiler brought on-line enough time to attain operating temperature before another boiler is brought on-line because of the continuing demand signal (see **para 3.1.3**). Press the ENTER key to display the current lag on time delay. To change the setting, use *numeric* keys to enter the desired timer set point and then press ENTER.
- **Lag OFF Delay:** This delay is usually adjusted to a minimal setting so that boilers can be taken off line quickly--but not all at once--as soon as demand for heat is satisfied. Press ENTER key to display the current lag off time delay. To change the setting, use *numeric* keys to enter desired timer set point and then press ENTER.

A boiler may not be at low fire when it is sent off line, but it should be allowed to modulate down to low fire before turning it off. The following Low Fire delays provide this time allowance.

- **Low Fire Boiler #1 Delay:** Press the ENTER key to display the **assured low fire time delay** for boiler 1. To change the setting, use the *numeric* keys to enter the desired time delay value. Then press the ENTER key.
- **Low Fire Boiler #2 Delay:** Press the ENTER key to display the assured low fire time delay for boiler 2. To change the setting, use the *numeric* keys to enter the desired time delay value. Then press the ENTER key.
- **Low Fire Boiler #3 Delay:** Press the ENTER key to display the assured low fire time delay for boiler 3. To change the setting, use the *numeric* keys to enter the desired time delay value. Then press the ENTER key.
- **Low Fire Boiler #4 Delay:** Press the ENTER key to display the assured low fire time delay for boiler 4. To change the setting, use the *numeric* keys to enter the desired time delay value. Then press the ENTER key.
- **Low Fire Boiler #5 Delay:** Press the ENTER key to display the assured low fire time delay for boiler 5. To change the setting, use the *numeric* keys to enter the desired time delay value. Then press the ENTER key.

- **Low Fire Boiler #6 Delay:** Press the ENTER key to display the assured low fire time delay for boiler 6. To change the setting, use the *numeric* keys to enter the desired time delay value. Then press the ENTER key.
- **Circulation pump Delay:** Press the ENTER key to display the current value for the delay in shutting off the circulation pump after a boiler is taken off line. This delayed shut off permits the pump to remove residual heat from the boiler. To change the setting, use the *numeric* keys to enter the desired time delay value. Then press the ENTER key.

3.2.1.5 Modulation Screen:

- **Local Set Point:** This is the set point value **as selected during configuration**. Press the ENTER key to display the current local set point in PSIG or Degrees F. To change the setting, use the *numeric* keys to enter the desired set point. Then press the ENTER key.
- **Operating Set Point:** This is the local set point value **as affected by any other features** that have been configured, such as night set back, remote lead selection, or outdoor temperature reset. Press the ENTER key to display the current operating set point in PSIG or Degrees F.
- **Header PSI - TEMP:** Press the ENTER key to display the current header pressure or temperature from the remote master transmitter.
- **Firing Rate Modulation Band (Gain Adjustment):** This adjustment controls the responsiveness of the lead lag control system to process fluctuations by varying the ratio of the transmitter range to the firing rate modulation range. This ratio, referred to as **firing rate gain** is displayed numerically from 1 to 100. Press the ENTER key to display the current gain setting. To change the setting, use the *numeric* keys to enter the desired gain value. Then press the ENTER key. (Setting the gain is a simple procedure once its relationship to the **set point**, the **process signal**, the **firing rate control band*** and the transmitter output range is clearly understood; see set aside block, “**Additional Information on Gain.**”)
- **Firing Rate Integral:** The integral adjustment is made only after the modulation band has been properly set. The integral corrects the “droop” effect of the gain adjustment. This adjustment should be made in small increments until the “droop” effect has been reduced to a desired level. Should the modulated output start to oscillate, the integral adjustment should be reduced until the oscillation stops. Integral settings are in “repeats per second” engineering units.
- **Firing Rate Boiler #1:** This displays from 0 to 100% the current firing rate of the boiler.
- **Firing Rate Boiler #2:** This displays from 0 to 100% the current firing rate of the boiler.
- **Firing Rate Boiler #3:** This displays from 0 to 100% the current firing rate of the boiler.
- **Firing Rate Boiler #4:** This displays from 0 to 100% the current firing rate of the boiler.
- **Firing Rate Boiler #5:** This displays from 0 to 100% the current firing rate of the boiler.
- **Firing Rate Boiler #6:** This displays from 0 to 100% the current firing rate of the boiler.

3.2.1.6 Night Setback Display Screen:

- ***PSI or Temp Setback:*** Press the ENTER key to display the current night pressure or temperature setback. To change this setting, use the *numeric* keys on the keypad to enter the desired night pressure setback in PSIG, or the night temperature setback in Degrees F. Then press the ENTER key.
 - ***Sunday Day (1):*** Press the ENTER key to display the current hour at which the day time operating set point is to initiate. To change this setting, use the *numeric* keys on the key pad to enter the desired hour. Then press the ENTER key.
 - ***Sunday Night (2):*** Press the ENTER key to display the current hour at which the night time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
 - ***Monday Day (1):*** Press the ENTER key to display the current hour at which the day time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
 - ***Monday Night (2):*** Press the ENTER key to display the current hour at which the night time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
 - ***Tuesday Day (1):*** Press the ENTER key to display the current hour at which the day time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
 - ***Tuesday Night (2):*** Press the ENTER key to display the current hour at which the night time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
 - ***Wednesday Day (1):*** Press the ENTER key to display the current hour at which the day time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
 - ***Wednesday Night (2):*** Press the ENTER key to display the current hour at which the night time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
 - ***Thursday Day (1):*** Press the ENTER key to display the current hour at which the day time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
 - ***Thursday Night (2):*** Press the ENTER key to display the current hour at which the night time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
-

- **Friday Day (1):** Press the ENTER key to display the current hour at which the day time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
- **Friday Night (2):** Press the ENTER key to display the current hour at which the night time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
- **Saturday Day (1):** Press the ENTER key to display the current hour at which the day time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
- **Saturday Night (2):** Press the ENTER key to display the current hour at which the night time operating set point is to initiate. To change this setting, use the *numeric* keys on the keypad to enter the desired hour. Then press the ENTER key.
- **Present:** Press the ENTER key to display the setting currently in use; 1= day, 2= night.
- **Man Override:** To bypass the clock control using the keypad, press the ON key, then the ENTER key. To resume clock control, press OFF, and then ENTER, on the keypad.
- **Select Setting:** When manual override is ON, use the numeric keys to select 1 (day) or 2 (night) to maintain day or night setting. Then press the ENTER key.

3.2.1.7 Outside Temperature Reset (Optional Feature):

- **Maximum Outside Temperature:** Displays in degrees Fahrenheit the maximum outside temperature that will affect the local set point. To change the setting, use the numeric keys to enter the desired temperature value. Then press the ENTER key. Factory preset is 60F.
- **Minimum Outside Temperature:** Displays in degrees Fahrenheit the minimum outside temperature that will affect the local set point. To change the setting, use the numeric keys to enter the desired temperature value. Then press the ENTER key. Factory preset is 0 F.
- **Influence:** Displays the influence setting, adjustable from 0 to 32,700. This is similar to a gain setting, in which the higher the influence the more responsive it is to changes in the outside temperature. To change the setting, use the numeric keys to enter the desired influence value. Then press the ENTER key. Factory preset is 1.
- **Maximum Set Point:** Displays the maximum operating set point of the Compact Micro IV™. To change the setting, use the numeric keys to enter the desired maximum set point value. Then press the ENTER key.
- **Note:** Equation for outside temperature reset is:

$$\text{Operating Set Point} = (\text{Maximum outside temperature} - A) * \text{Influence} + \text{Local Set Point}$$
 where A = Actual Outside Temperature or Minimum Outside Temperature whichever is greater.

3.2.2 Real Time Clock Display

- To display the real-time clock calendar, enter the following keypad sequence:

[esc] [shift] [F9] [shift] [C]

- If no changes are necessary, the real-time clock display can be exited quickly (i.e., without having to scroll through all the settings), and the previous display resumed, by entering the following keypad sequence: [shift] [F9]
- To change the real-time clock calendar, display it first, then enter the following additional keypad sequence: [shift] [C]
- The cursor will flash at the year entry. If no change is desired, just press ENTER. Otherwise, use the keypad numeric keys to enter a new year value, then press enter. The cursor will begin to flash at the *month* entry. It will then flash at the day, hour, minute, and second entries in turn.
- **Saving the changes:** when all desired changes have been made, press the following keypad sequence to save the new settings, exit the real-time clock calendar display, and return to the previous display: [shift] [F10]
- **The clock does not compensate for the change from daylight saving time to standard time. It must be reset to the proper time.**

3.2.3 Switches and Pilot Lights

3.2.3.1 The Off/Auto/Manual selector switches are used to define the availability status of each boiler:

- In the *off* position, the respective boiler is off line and not available to contribute to steam supply.
- In the *auto* position, the respective boiler is available and will be brought on and off line as directed by the lead lag sequencer.
- In the *manual* (“*man*”) position, the respective boiler can contribute to steam supply as directed from its own operating and limit controls, but is not subject to sequence logic from the lead lag sequencer. A boiler in the manual mode is skipped in the sequence whether or not it is the selected lead boiler

3.2.3.2 A separate “Boiler ON” neon pilot light is provided for each boiler (i.e., Boiler #1 ON, Boiler #2 ON, Boiler #3 ON).

3.2.4 Series C1 Indicator Display & Configuration

The **Micro IV™** sequencer uses a **Series C1 Indicator/Transmitter** to display header pressure (or temperature) continuously. This component is mounted in the front panel. It accepts input from the pressure transmitter or thermocouple, and displays and retransmits the process signal. The **Series C1** is factory-configured and wired

to display the measured header variable based upon engineering data provided at order entry. If, however, **the type or range of the header transmitter** is changed from the factory-configured settings, it is necessary to reconfigure the scale of the **Series C1** in order to accurately display the transmitted value. The following outline describes the reconfiguration procedure:

- Press the parameter menu selection key (left-most key) repeatedly to scroll through the parameter menu until “Pass” is displayed.
- Press the *up/down* values modification keys repeatedly to display the configuration menu password “33”.
- Enter sensor/transmitter configuration code: press the up/down buttons to set the required code. For pressure transmitter input, it is “8400”. For RTD input it is “1400”. Press the reenter key.
- Configure engineering units: Press the right key until “unit” is displayed. Press the up/down buttons until required unit (degree F, PSI, etc.) is displayed. Press the enter key.
- Configure display resolution (number of decimal places): Press enter key until “Sc.d.d” is displayed. Press the up/down arrow to select setting: for high range applications above 30 engineering units, set for “0” decimal places; for 30 and below set for “1”. Press the enter key.
- Configure the low range: Press ENTER key until “Sc.Lo.” is displayed. Press the up/down key to select proper low range or zero. Press the enter key.
- Configure the high range: Press enter key until Sc.Hi. is displayed, use the up/down key to select the proper transmitter high range. Press the enter key.
- Press the parameter menu selection key to return to operator mode.
- Please refer to the enclosed Hays Cleveland Instruction Manual C1.00 for additional information on the Series C1 Transmitting Indicator/Controller.

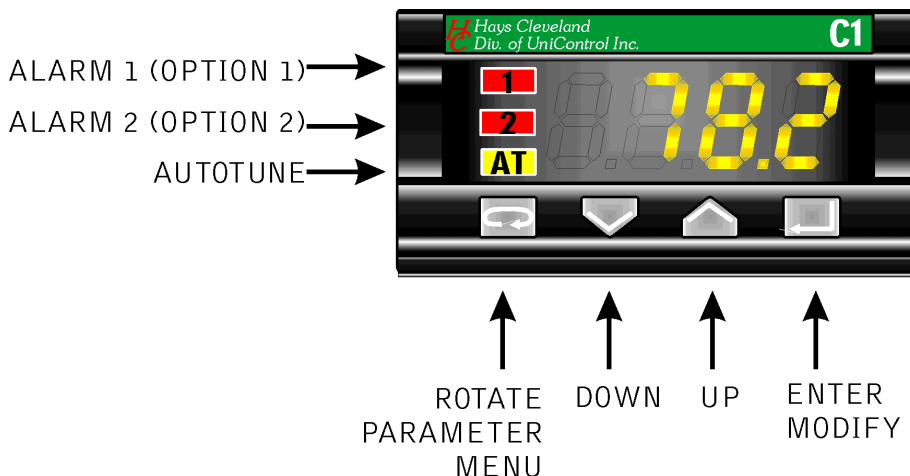


Figure 3: Model C1 Digital Panel Meter and Indicator/Transmitter.

3.3 Battery

The PLC has a 3-volt lithium battery backup (Part Number CR 2430) with a five-year life span. If the battery fails, the program remains in the EPROM and only the current settings are lost.

3.4 PLC I/O Board

The I/O board contains the microprocessor, along with terminals for eleven 24-VDC inputs and seven 10-amp relay outputs.

3.5 PLC Analog Board

The analog board accepts eight inputs and provides up to 8 outputs, including the PI output for modulation.

3.6 Steam Pressure Transmitter or Header Temperature RTD

The steam pressure transmitter or header temperature RTD provides an analog signal to the PLC.

3.7 Modulation Control

A 4-20 mA DC input with a 0–135 ohm output control is provided for each boiler to position the modulation actuator. Each control has a fail-safe function in that if the PLC fails, the modulation for each boiler reverts to the boiler-mounted modulation control.

3.8 Modbus Communications

The RS485 uses the Modbus – RTU Protocol. The communications port is set at 19,200 baud, 1 start, 8 data, 1 stop, and no parity. Cable for communications must be Belden 9841 or equal. The Modbus address may be set from 0 – 63 by using the dip switches as shown on Table 7, page 33.

3.9 Troubleshooting

Symptom	Possible Cause	Recommended Solution
Boiler will not start, and the associated LED on the Micro IV™ CPU board is lit. (LED 0)	Is the auto/off/man switch in the auto position?	Change switch position to auto.
	Is there a lockout condition?	Correct the lockout condition.
	Is the limit string complete?	Check all limit string devices.
Boiler will not shut off.	Assured low fire contact is not closed at low fire.	Verify that the low fire end switch is closed at the low fire position.
	The low fire LED is not lit when the actuator is at low fire? The LED is located on the CPU board or the auxiliary input board.	Check low fire shut down circuit for proper termination wiring.
Boiler cycles on and off.	Low fire end switch is used to energize a relay for multiple low fire contact closures. The relay is powered from the blower motor.	Change the relay power source to a terminal that is constantly powered.
Boiler starts and stays at low fire.	Low fire warm up temperature switch is set too high.	Lower the set point of the temperature switch.
	The temperature switch contacts are the incorrect type: they are remaining closed upon temperature increase.	Change to temperature switch contacts that open on temperature increase
	Is the Auto/off/man switch in the auto position?	Change switch position to Auto.
The actuator runs backwards	Actuator is wired backwards.	Swap the B and W wires on the actuator.

For assistance in commissioning or troubleshooting your Micro-IV™ lead/lag sequencer, please contact your local Hays Cleveland representative or call Hays Cleveland at 216.398.4414.

3.10 Commissioning Tips

Tables 1 through 7 below list only the most important control parameters requiring field adjustment, in the order in which they can be accessed on the front display. All parameters are factory preset, but field configuration is necessary. Section 3.2 of this manual provides comprehensive parameter information.

Pressure/ Temperature Settings		Range	Factory Preset	Importance	Commissioning Tip
Modulation	Parallel	On/ Off	Off	★ ★	Turn “on” for fastest system response to disturbances. Often used for process applications with wide load swings . “Series” must be turned off.
	Series	On/ Off	On	★ ★	Often used for heating applications with minimal load swings . “Parallel” must be turned off.
Throttle Back (% of firing rate)	Boiler #1	0 to 100	60	★ ★ ★	For Series Modulation only : adjust to suit point of optimal firing rate efficiency or to base-load a boiler to minimize next lag boiler nuisance cycling.
	Boiler #2				
	Boiler #3				
	Boiler #4				
	Boiler #5				
	Boiler #6				
Process Variables: Decimal Places		0 or 1	Job Specific	★	Determines resolution of process variables: header pressure/temperature, cut-in and cut-out points, throttle back settings etc.
Low Range of Transmitter (psi or deg F)		-32000 to +32000		★ ★	Must span entire expected operating range of the pressure or temperature sensor.
High Range of Transmitter (psi or deg F)		0 to +32000			

Table 1: Default Screen (Pressure/Temperature) Settings

Table 2: Boiler Time Delay Screen Settings

Timer Settings		Range	Factory Preset	Importance	Commissioning Tip
Lag ON Delay		0 to 32,760 sec. = 0 to 546 min.	100	★★★	Adjust to allow leading boilers sufficient time to produce heat and reduce demand before additional lag boiler is started. Set delay long enough to minimize nuisance cycling of lag boilers.
Lag OFF Delay			10	★★	Adjust to allow excess boiler capacity to be removed quickly, but allowing enough time so that needed boilers are not turned off. Set delay long enough for load to settle out after each lag boiler is taken off line in order to minimize nuisance cycling of lag boilers.
Low Fire Delay	Boiler #1		0	★★	Adjust to allow sufficient time for firing rate actuator to move to low fire position before sequencer takes boiler off-line.
	Boiler #2				
	Boiler #3				
	Boiler #4				
	Boiler #5				
	Boiler #6				
Circulation Pump Delay	Boiler #1	0	★★	Adjust to allow sufficient time for pump to remove residual heat from the boiler before the sequencer shuts the pump off.	
	Boiler #2				
	Boiler #3				
	Boiler #4				
	Boiler #5				
	Boiler #6				

Table 3: Boiler Cut-in and Cut-out Settings

Lead/Lag Set Point Settings		Range	Preset	Importance	Commissioning Tip
Cut-In	Lead Blr.	0 to 100	5	★★★	Cut-in parameter is the acceptable amount of variation in header pressure or temperature below set point .. If the process variable drops below a particular cut-in value, the associated boiler is brought on line.
	1 st Lag		10		
	2 nd Lag		15		
	3 rd Lag		20		
	4 th Lag		25		
	5 th Lag		30		
Cut-Out	Lead Blr.	0 to 100	10	★★★	Cut-out parameter is the acceptable amount of variation in header pressure or temperature above set point . If the process variable exceeds a particular cut-in value, the associated boiler is taken off line.
	1 st Lag				
	2 nd Lag				
	3 rd Lag				
	4 th Lag				
	5 th Lag				

Table 4: Lead Boiler Select Screen Settings

Lead Boiler Change	Range	Preset	Importance	Commissioning Tip
Accumulated Time Mode	On/Off	On	★ ★	Disable (set to OFF) if runtime-based lead boiler automatic rotation is undesirable.
Hours for Lead Change	0 to 32000 (hours)	100		
Day & Hour Lead Mode	On/Off	Off	★ ★	Enable (set to ON) if day-of-the-week-based lead boiler automatic rotation is desirable.
Day	1 to 7 (days)	7		
Hour	0 to 23 (military hour)	23		
Manual Override Mode	On/Off	On	★ ★ ★	"ON" disables all other boiler rotation features (accumulated time mode, day and hour lead mode, and optional remote lead select.)
Select Lead	Job Specific	1	★ ★	Selects the lead boiler when manual override is enabled.

Table 5: Modulation Screen Settings

Modulation Settings	Range	Preset	Importance	Commissioning Tip
Local Set Point	Job Specific		★★★	Set to desired header set point.
Gain (as per cent of firing rate)	0 to 100	20	★★★	Adjust to optimize the response magnitude of the automatic control system to header disturbances. The optimal gain value is a function of the physical dynamics of the system and changes as lead boiler rotation alters the system capacity and physical hardware response times. A balance between quick response time, and nuisance cycling is the goal. Typical gain settings are between 15 and 20.
Integral (repeats per second)	0 to 100	Job Specific	★★	Adjust to optimize the response time of the automatic control system to header disturbance ("droop").

Table 6: Pressure/Temperature Set Back Screen Settings

Night Setback		Range	Preset	Importance	Commissioning Tip
Pressure/ Temperature Setback		0 to 100 (°F or psi)	10	★ ★ ★ ★	Select the night set point as a setback from the day set point.
Sunday Monday Tuesday Wednesday Thursday Friday Saturday	Day (1)	0 to 23	7	★ ★ ★ ★	Select time (military hours) that night setback ends (day set point restored).
	Night (2)		19		Select time (military hours) that night setback commences.
Manual Override		On/Off	On	★ ★ ★ ★	Disable if automatic day-time, night setback cycling is desired.
Select (1,2)		1,2	1	★ ★ ★ ★	This selection is used to toggle between the primary set point or the night-setback set point, but then maintain that set point continuously . A setting of 1 selects the primary set-point 24 hours a day. A setting of 2 selects the night setback set point 24 hours a day.

Table 7: Modbus Configuration

Card Address	Position					
	1	2	3	4	5	6
00	OFF	OFF	OFF	OFF	OFF	OFF
01	ON	OFF	OFF	OFF	OFF	OFF
02	OFF	ON	OFF	OFF	OFF	OFF
03	ON	ON	OFF	OFF	OFF	OFF
04	OFF	OFF	ON	OFF	OFF	OFF
05	ON	OFF	ON	OFF	OFF	OFF
06	OFF	ON	ON	OFF	OFF	OFF
07	ON	ON	ON	OFF	OFF	OFF
08	OFF	OFF	OFF	ON	OFF	OFF
09	ON	OFF	OFF	ON	OFF	OFF
10	OFF	ON	OFF	ON	OFF	OFF
11	ON	ON	OFF	ON	OFF	OFF
12	OFF	OFF	ON	ON	OFF	OFF
13	ON	OFF	ON	ON	OFF	OFF
14	OFF	ON	ON	ON	OFF	OFF
15	ON	ON	ON	ON	OFF	OFF
16	OFF	OFF	OFF	OFF	ON	OFF
17	ON	OFF	OFF	OFF	ON	OFF
18	OFF	ON	OFF	OFF	ON	OFF
19	ON	ON	OFF	OFF	ON	OFF
20	OFF	OFF	ON	OFF	ON	OFF
21	ON	OFF	ON	OFF	ON	OFF
22	OFF	ON	ON	OFF	ON	OFF
23	ON	ON	ON	OFF	ON	OFF
24	OFF	OFF	OFF	ON	ON	OFF
25	ON	OFF	OFF	ON	ON	OFF
26	OFF	ON	OFF	ON	ON	OFF
27	ON	ON	OFF	ON	ON	OFF
28	OFF	OFF	ON	ON	ON	OFF
29	ON	OFF	ON	ON	ON	OFF
30	OFF	ON	ON	ON	ON	OFF
31	ON	ON	ON	ON	ON	OFF
32	OFF	OFF	OFF	OFF	OFF	ON
33	OFF	OFF	OFF	OFF	OFF	ON
34	OFF	ON	OFF	OFF	OFF	ON
35	ON	ON	OFF	OFF	OFF	ON
36	OFF	OFF	ON	OFF	OFF	ON
37	ON	OFF	ON	OFF	OFF	ON
38	OFF	ON	ON	OFF	OFF	ON
39	ON	ON	ON	OFF	OFF	ON
40	OFF	OFF	OFF	ON	OFF	ON
41	ON	OFF	OFF	ON	OFF	ON
42	OFF	ON	OFF	ON	OFF	ON
43	ON	ON	OFF	ON	OFF	ON
44	OFF	OFF	ON	ON	OFF	ON
45	ON	OFF	ON	ON	OFF	ON
46	OFF	ON	ON	ON	OFF	ON
47	ON	ON	ON	ON	OFF	ON
48	OFF	OFF	OFF	OFF	ON	ON
49	ON	OFF	OFF	OFF	ON	ON
50	OFF	ON	OFF	OFF	ON	ON
51	ON	ON	OFF	OFF	ON	ON
52	OFF	OFF	ON	OFF	ON	ON
53	ON	OFF	ON	OFF	ON	ON
54	OFF	ON	ON	OFF	ON	ON
55	ON	ON	ON	OFF	ON	ON
56	OFF	OFF	OFF	ON	ON	ON
57	ON	OFF	OFF	ON	ON	ON
58	OFF	ON	OFF	ON	ON	ON
59	ON	ON	OFF	ON	ON	ON
60	OFF	OFF	ON	ON	ON	ON
61	ON	OFF	ON	ON	ON	ON
62	OFF	ON	ON	ON	ON	ON
63	ON	ON	ON	ON	ON	ON

Additional Information on Gain

The factory default gain setting has been set at 20. This has been found to be the figure that is most commonly used on systems using Micro IV and Hays Cleveland pressure or temperature transmitters. Using this figure, if the system becomes unstable or does not respond fast enough, we recommend adding “five” to the default number for a faster response, or subtracting “five” for a slower response. Below, additional technical and fine-tuning information is provided.

The **set point** is the desired steam pressure or water temperature which the lead lag system will maintain by bringing boilers on-line, allowing them to modulate, and taking them off-line in response to changes in load. The process signal is the actual steam pressure or water temperature: the **process signal** is the output of the pressure or temperature transmitter.

The **firing rate control bandwidth** is the range of process signal values on either side of the set point within which the firing rate modulates but *lead lag sequencing* is not permitted: the system cannot initiate boiler cut-in or cut-out within the modulation band. The **control bandwidth** is positioned so that the set point is its midpoint. The maximum process deviation from set point is therefore equal to one half the firing rate control bandwidth: this distance above the set point is the **low fire point**; the same distance below the set point is the **high fire point**. These points are set when the operating control bandwidth is set (see paragraph). On a **sequencing lead-lag system**, the maximum process deviation below set point (the high fire endpoint of the firing rate control bandwidth) should coincide with the **boiler cut-in point**.

The maximum process deviation above set point (the low fire endpoint of the firing rate control bandwidth) should coincide with the **boiler cut-outpoint**.

When the control bandwidth equals 100% of the transmitter range, the system **gain** equals one ($Gain = 1$) because:

$$100\% \text{ transmitter range} / 100\% \text{ modulation band} = 1.$$

This gain setting is usually too wide: the lead lag system would permit the process signal to fluctuate freely across the entire transmitter range without initiating a corrective sequencing response (bringing on or taking off a boiler). At the other extreme ($Gain = 100$), the modulation band is effectively restricted to the set point value (1% of transmitter range): even the slightest process deviation would signal the control system to respond by bringing on or taking off a boiler. A gain setting this narrow usually causes system instability because the lead lag controller cannot keep up with the continual process changes. In adjusting the gain setting of a sequencing lead lag control system, the operator's goal should be to ensure that the control system is as responsive as

possible to process fluctuations without creating instability. This is best accomplished by selecting the desired boiler cut-in and boiler cut-out points (which are the endpoints of the sequencing bandwidth) and then adjusting the gain so that the modulation band falls within the sequencing bandwidth.

Example: If the operator wants to maintain a process set point of 100 PSI, with a deviation of no more than 5 pounds tolerated, then (placing the set point in the middle of the modulation band), 105 PSI is the selected cut-outsetting and 95 PSI is the selected cut in setting. The width of the modulation band is 10 pounds. In this example, let's say the pressure transmitter has a range of 0 PSI to 300 PSI. The transmitter output range is 300 PSI wide. $100\% \text{ of transmitter range} / 100\% \text{ of modulation band} = 300 / 10 = \text{Gain of } 30$

The inverse of this expression reveals the relationship between gain and controller output: converting the modulation band to a percent of the transmitter range yields: $10 / 300 = 1 / 30 = .03 = 3.3\%$. Half of the modulation band value is equal to the maximum process deviation from set point: 1.65%. Whenever the process is at the maximum deviation below set point, the controller output should be 100% (because at a process pressure reading of 95 PSI we want to bring another boiler on line). At the maximum deviation above set point, the controller output should be 0% (because at a process pressure reading of 105 PSI we want to take the last boiler off line). At set point, the controller output is 50%, or neutral. 0-100% of the Controller output range equals just 3.3% of the transmitter range when the gain is 30.

At a gain of 1, the controller output range was equal to 100% of the transmitter range. The system responsiveness to process fluctuations has been increased by setting the gain at 30. Increasing the gain reduces the modulation band. When making any adjustments to the gain, the operator should do so in small increments, pausing to observe system response after each small change.

Notes: The general formula for % Controller Output is:

$$[(\text{Set point} - \text{Process deviation from set point}) \times \text{Gain}] + 50\% = \% \text{ Output.}$$

4.0 CUSTOMER SERVICE INFORMATION

4.1 Contacts

Hays Cleveland Sales Office

1903 South Congress Avenue

Boynton Beach FL 33426

Telephone: 561.734.9400

Fax: 561.734.8060

email: salescombustion@unicontrolinc.com

Hays Cleveland Customer Service Department

1111 Brookpark Road

Cleveland OH 44109

Telephone: 216.398.4414

Fax: 216.398.8558

email: customerservice@unicontrolinc.com

Visit us on the WEB!

<http://www.hayscleveland.com>

4.2 Repairs

Damaged or defective units may be returned to the factory for repair. However, factory authorization must be obtained before shipping whether warranty or non-warranty service is required, and all units must be shipped prepaid.

A letter of transmittal that includes the following information should accompany the returned instrument:

1. Location, type of service, and length of time in service of the unit.
 2. Description of the faulty operation of the device and the circumstances of the failure.
-

3. Name and telephone number of the person to contact if there are questions about the unit.
4. Indicate whether warranty or non-warranty service is requested.
5. Attach Purchase Order for all out-of-warranty repairs.
6. Complete shipping instructions for the return of the repaired instrument.
7. Original purchase order number and date of purchase.
8. Return Goods Authorization number provided by the factory when you called.

Clearly label the shipping container:

RETURN FOR REPAIR

Model _____

RG # _____

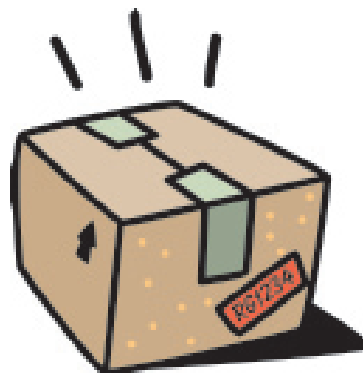
Ship prepaid to:

HAYS CLEVELAND

1111 Brookpark Road

Cleveland OH 44109-5869

216-398-4414



Please follow this procedure. It expedites handling of the returned item, and avoids unnecessary additional charges for inspection and testing to determine the problem before repairing it.

4.3 Service

A **Maintenance and Service Contract** can ensure trouble-free, economical operation of **Hays Cleveland** equipment for many years. One-time on-site service by a factory-trained service engineer can also be provided as needed. Contact Hays Cleveland for information on these service options.

4.4 Standard Terms and Conditions of Sale

AGREEMENT OF SALE: Acceptance by Seller of any order placed for the good described on the reverse side hereof shall be subject to Seller's Standard Terms and Conditions of Sale and is conditioned upon the Buyer's acceptance of these Standard Terms and Conditions.

TERMS OF CONTRACT: Any terms or conditions of the Buyer's order which are inconsistent with these Standard Terms and Conditions shall not be binding on the Seller and shall not be considered applicable to the sale or shipment of goods covered by this Acknowledgment or Sales Contract. Unless Buyer shall notify Seller in writing to the contrary within ten (10) days after the mailing of this Acknowledgment or Sales Contract by Seller, acceptance of these Standard Terms and Conditions by Buyer shall be indicated and, in the absence of such notification, the sale and shipment by Seller of the goods covered hereby shall be subject to these Standard Terms and Conditions.

PRICES: Prices are subject to change to the extent permissible under applicable federal law. Sales contracts which call for delivery in the future will be billed at prices in effect at the time of shipment. Shipping weights shown are approximate and subject to change without notice. Prices of products do not include supervision of erection or adjustment after installation by Buyer. MINIMUM BILLING ON ANY ORDER IS \$150.00 U.S. FUNDS.

SHIPMENT AND PAYMENTS: All prices and shipments are F.O.B. the Seller's factory such that the risk of loss and risk of liability during shipment passes to the Buyer upon delivery of the equipment to the carrier. As discussed under the section, "Title and Ownership," the Seller shall retain title to the equipment. No freight is allowed on any shipments. Shipments and deliveries hereunder shall at all times be subject to the approval of Seller's Credit Department, and at any time Seller may require payment in advance or satisfactory security or guarantee that invoices will be promptly paid when due. If Buyer fails to comply with any terms of payment, Seller, in addition to its rights and remedies but not in limitation thereof, reserves the right to withhold further deliveries or terminate this Agreement, and any unpaid amount thereon shall become due immediately. Standard terms of payment are 1% 10 – Net 30 days unless otherwise negotiated prior to placement of order. Special terms of payment shall be as set forth on the quotation, or acknowledgment for order.

Pro rata payments shall become due as shipments are made. If shipments are delayed by the Buyer, payments shall become due on the date when the Seller is prepared to make shipment. If, in the judgment of the Seller, the financial condition of the Buyer at any time does not justify continuance of production or shipment on the terms of payment specified, the Seller may require full or partial payment in advance. Where the Buyer of the plant equipped is outside the territory of the United States of America, all remittances shall be made in U.S.A. funds. If the order is placed with complete specifications and instructions to fabricate, and then shipment is postponed by buyer, the order will be invoiced on date of shipment which was originally scheduled. If held for shipment, a charge may be made for storage in excess of four weeks after scheduled shipping date at the discretion of the Seller.

PARTIAL SHIPMENTS: The Seller reserves the right to ship and invoice units as manufacture of unit items is completed. Alternately, invoices may be rendered on net 30 day terms as unit items are completed, the equipment then being held for release by Buyer. It is sometimes necessary for certain instruments and/or controllers, etc., to be specially packed or for other reasons shipped separately, and therefore must be mounted in the panel at the job site. The Seller reserves the right to make exceptions to mounting such equipment in the panel before shipment, even though the Proposal is based on a completely assembled, piped and /or wired panel. The Seller will not accept any charges for labor and/or material required to unpack, mount in the panel, pipe and/or wire equipment shipped separately.

TITLE AND OWNERSHIP: The Seller shall retain title, and hold a lien against, the equipment furnished under the terms and conditions of this proposal until the full and final payment shall have been made to the Seller, by the Buyer. In the event of a default by the Buyer on any of the terms, payments or conditions which are on his part to be performed, then the Seller shall have the right, without notice, to repossess any or all of the above mentioned equipment wherever the same may be found, and in doing so, shall not be held as a trespasser.

DELAYS AND DEFAULTS: Where date of delivery is given, we will endeavor to make shipments as near the date as possible, but we cannot be held responsible for any loss or inconvenience caused by delay or failure to deliver. Delays or defaults in delivery by Seller of the goods covered by this Sales Contract shall be excused so far as the same is caused by fire, strikes, accident, governmental regulation, or any delays unavoidable or beyond reasonable control of Seller. In no event shall Seller be liable for any consequential, special, or contingent damages on account of any default or delay in delivery.

ACCELERATED OR DELAYED PAYMENTS: There will be no reduction in price for payments more favorable to UniControl Inc. than the standard terms. If payments are not made in conformance with the standard terms, the quoted price shall, without prejudice to the right of UniControl Inc. to immediate payment, be increased by an amount equal to the lesser of 1 ½ percent per month or fraction thereof on the unpaid balance or the highest legal rate.

NON-CANCELLATION: Orders are not subject to suspension, reduction, or cancellation, except on terms that will indemnify Seller against loss.

RENEGOTIATION: Unless advised by Buyer in writing, Seller understands that Buyer's order and this Sales Contract are not renegotiable under the Renegotiation Act of 1951.

SPECIFICATIONS: Seller relies on specifications and other data furnished by the Buyer, an architect, contractor, or consulting engineer in all phases of the work covered by this Sales Contract. Seller shall be responsible to check quantities only. Alterations to or changes in specifications, approval of samples, changes in delivery instructions and all other instructions must be submitted in writing to Seller.

In the event Seller performs design or engineering work at the request of Buyer, an architect, contractor, consulting engineer, or representative in any phase of the work covered by this Sales Contract, Seller shall not be responsible for any damages claimed by Buyer as a result of alleged errors or defects in such design or engineering work.

WARRANTY AND LIMITATION OF LIABILITY: The warranty applies to all components except those components which may be destroyed by negligence or abnormal use. Seller warrants that the goods supplied by it have been manufactured in accordance with its standard manufacturing practices and conform to the contract or catalog description for such goods. Seller further warrants that the goods supplied by it are fit for the ordinary purpose or purposes specified in its catalog for which such goods are used when installed in accordance with Seller's recommended installation procedures. Except as stated herein, Seller makes no express warranty with respect to goods supplied by it and Seller makes no warranty that the goods are fit for any particular purpose. When the use of materials not manufactured by Seller is suggested by Seller's recommended installation procedures or otherwise, Seller makes no express warranty with respect to such materials nor that such materials are merchantable or fit for any particular purpose. Seller will, at its sole option, credit, repair or replace, any goods supplied by it which its examination shall disclose to its satisfaction are defective in workmanship or material and are returned to it within one year from the date of shipment and any claim not made within this period shall conclusively be deemed waived by Buyer. Credit, repair, or replacement will be preconditioned upon examination of the goods by Seller, and, if requested by Seller, return of the goods to Seller at its direction and expense. In those instances in which a part or product is returned to the Seller, all transportation charges are to be paid by the Buyer. No goods are to be returned to Seller without its written consent. Seller shall not be liable for any expense incurred by Buyer in order to remedy any defect in its goods. Seller shall not be liable for any consequential, special, or contingent damage or expense, arising directly or indirectly from any defect in its goods or from the use of any defective goods. The remedies set forth herein shall constitute the exclusive remedies available to Buyer and are in lieu of all other remedies.

The responsibility for the performance and service of equipment included in this proposal which is not manufactured by the Seller and is not a part of equipment manufactured by the Seller will be the responsibility of the manufacturer of that equipment.

CLAIMS: Claims for shortage of goods or for mistakes or errors in billing must be presented within forty-five (45) days from the date of shipment of goods and must state the packing slip number and container number applicable to the claim. Any claim not so presented will be conclusively deemed waived.

TAXES: Any federal, state, local or other government tax or charge on the sale, shipment, or installation of the goods covered by this Sales Contract shall be added to the price and paid by Buyer or, in lieu thereof, the Buyer shall furnish Seller with tax-exemption certificates acceptable to the taxing authority. Buyer agrees to reimburse and save Seller harmless from all such state and local taxes, including interest and penalties thereon, which may at any time be payable to any governmental unit with respect to the sale of any goods covered by this Sales Contract.

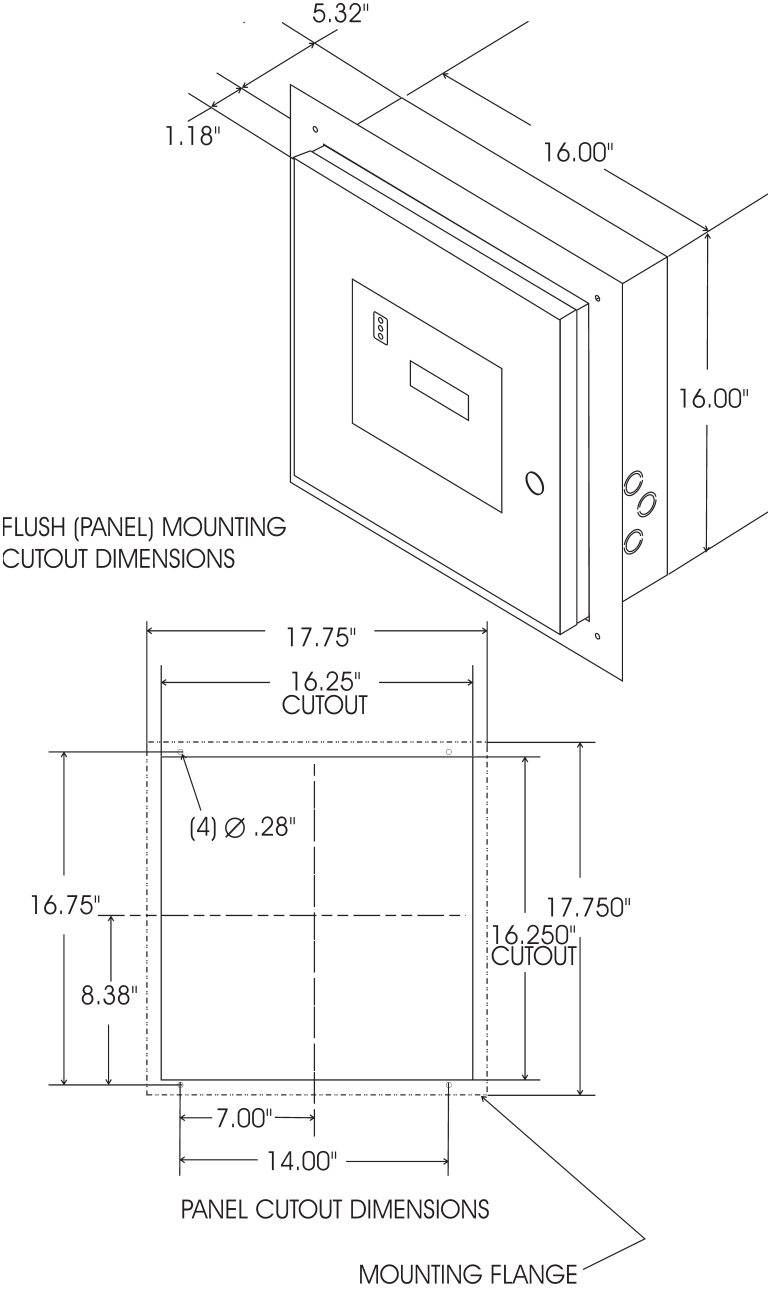
CORRECTIONS: Typographical or clerical errors contained in this Sales Contract, including prices, are subject to correction by Seller.

FAIR LABOR STANDARDS: These goods were produced in compliance with all applicable requirements of sections 6, 7, and 12 of the Fair Labor Standards Act, as amended and of the regulations and orders of the United States Department of Labor issued under Section 14 thereof.

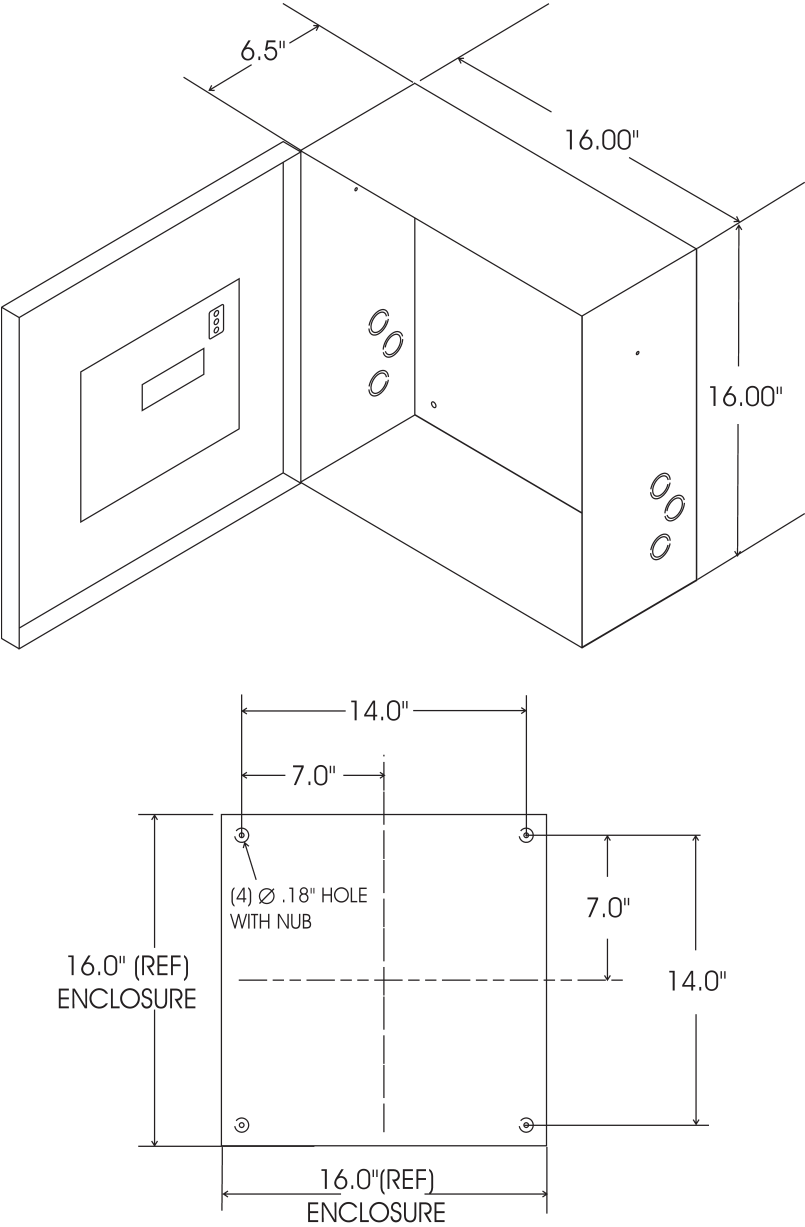
APPLICABLE LAW: All questions arising out of this Sales Contract, which shall be deemed an Ohio Contract, shall be governed by the laws of the State of Ohio.

EXCLUSIVE TERMS: All proposals are based on, and all products are sold on, the terms and conditions contained herein. No other representation by the Seller or its representatives is valid. This Sales Contract shall constitute the complete contract between the parties. No one has authority to depart from the terms and conditions set forth herein, nor to make any representations or arrangements other than those printed hereon unless the same are written on the face of this Sales Contract or are given in writing with it or in pursuance of it, and are fully approved in writing by an officer or authorized employee of the Seller. Others made thereon, or contracts resulting therefrom, are not binding until and unless so accepted.

APPENDICES

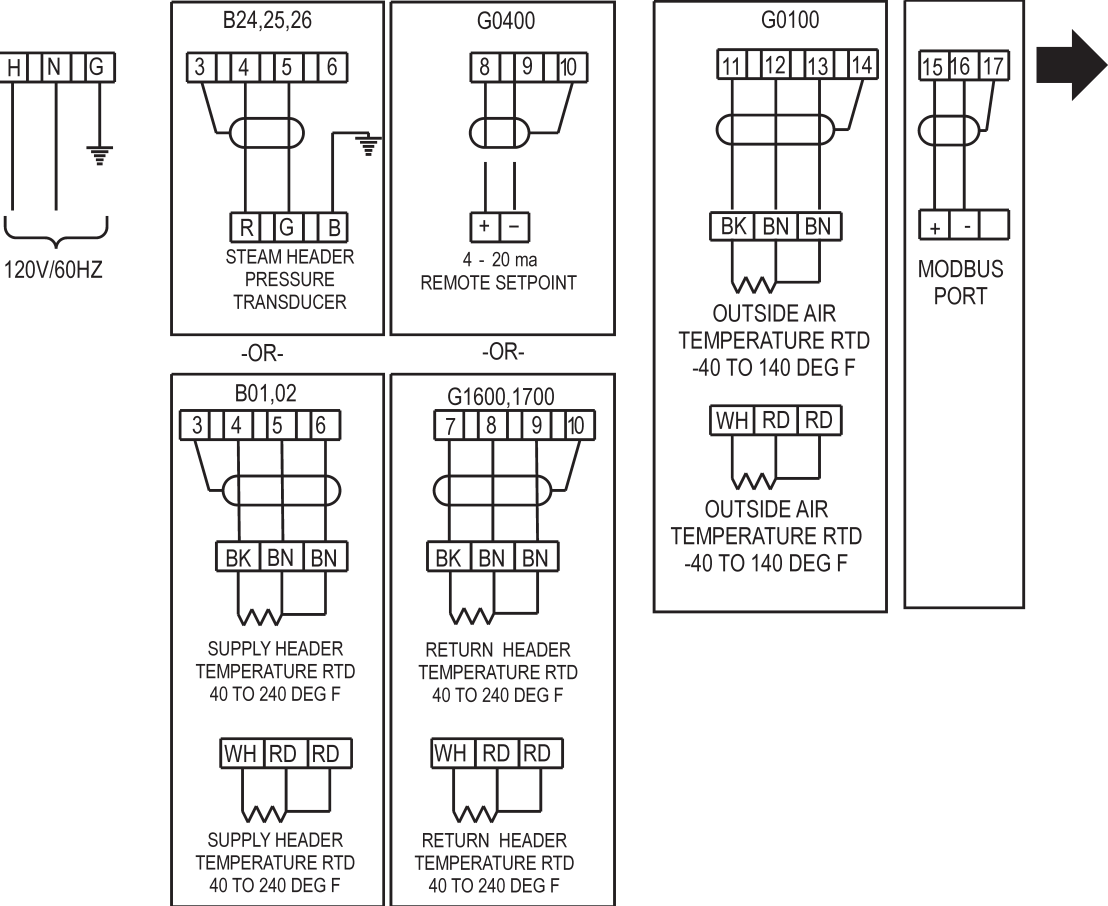


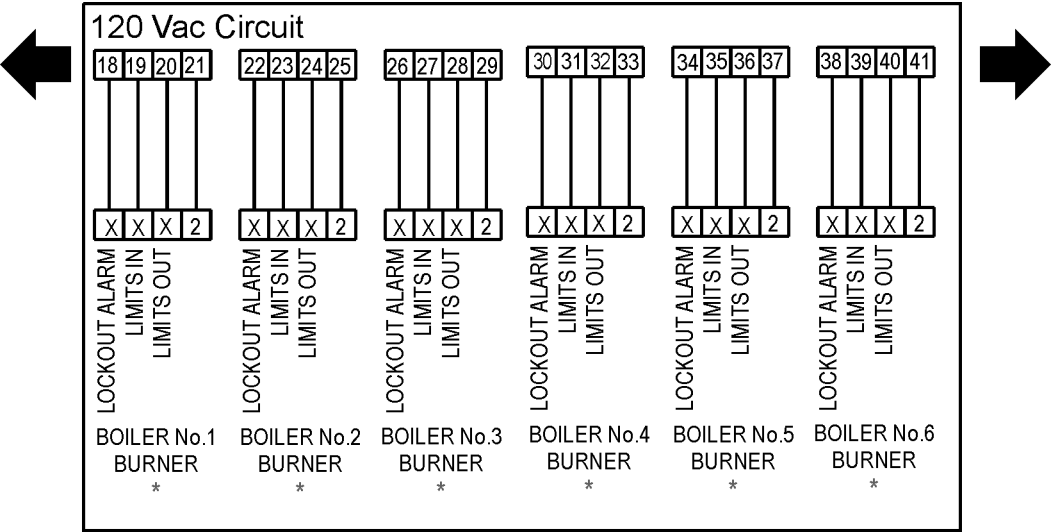
Drawing 1: Flush-mounting Dimensions.





SURFACE (WALL) MOUNTING DIMENSIONS

Drawing 2: Surface-mounting Dimensions.

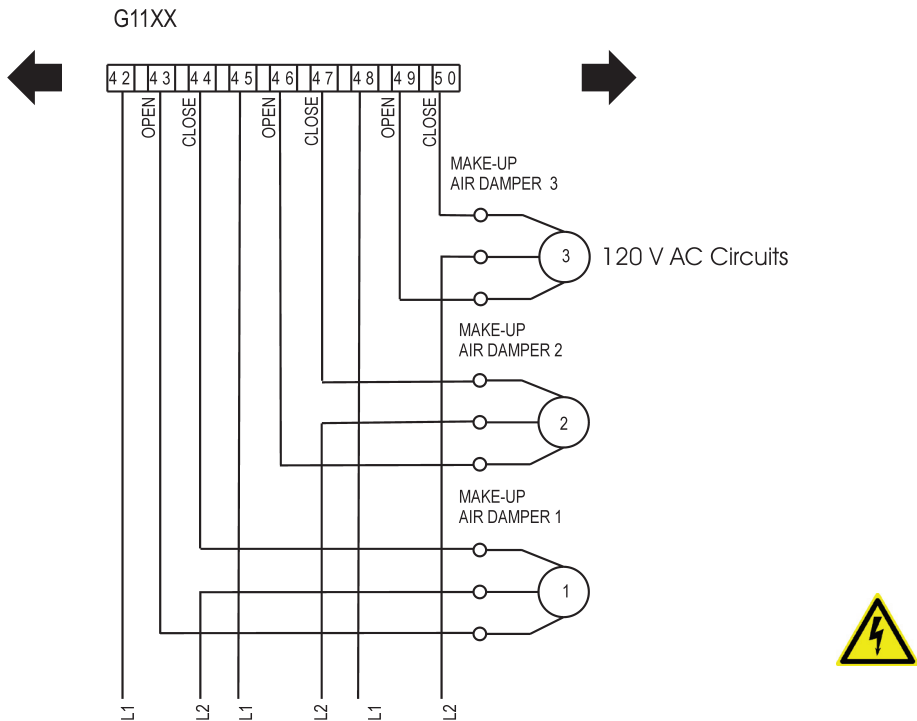




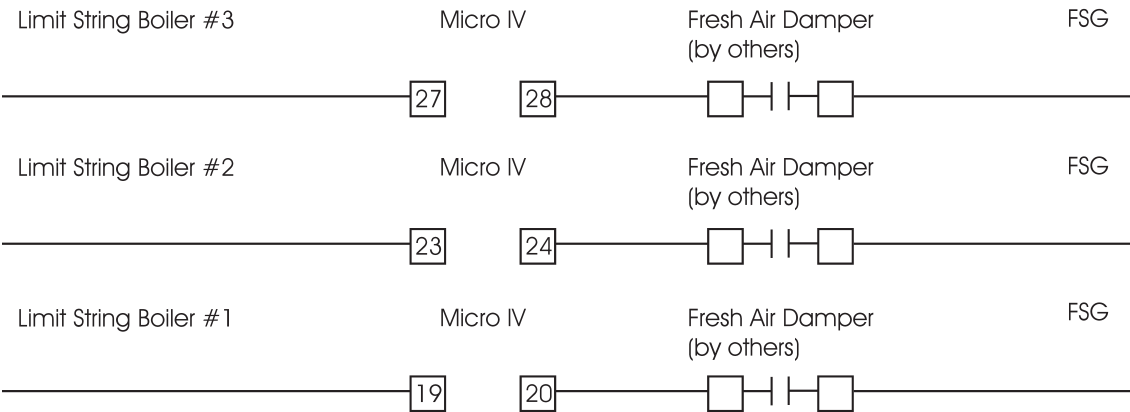
- NOTES:
- 1.  = EXTERNAL WIRING.
 - 2.  = USE BELDEN No. 8618 SHIELDED CABLE OR EQUAL.
 - 3. ALL INTERNAL WIRING TO 18 GA. EXCEPT AS NOTED.
 - 4. * = GENERALLY THE LAST DEVICE IN THE LIMIT STRING.
 - 5. ALL INPUT SIGNAL LINES ARE REQUIRED TO BE ISOLATED.
 - 6. SIGNAL LINES ARE TO BE RUN IN SEPARATE CONDUIT FROM CONTROL LOGIC.
 - 7. USE BELDEN No. 9841 CABLE OR EQUAL FOR COMMUNICATIONS.



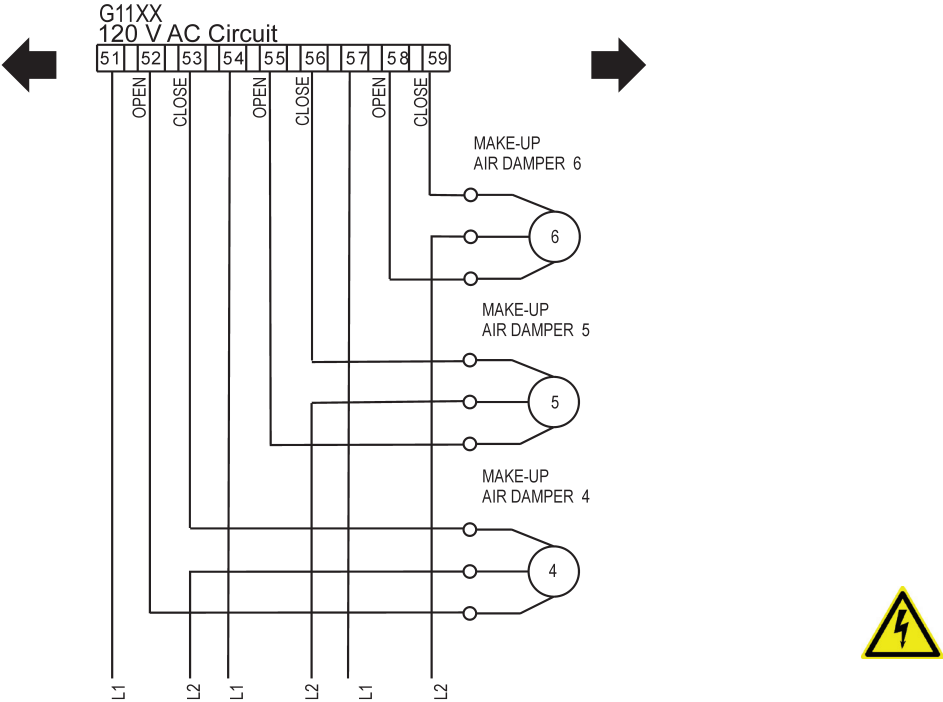
PRELIMINARY: FOR CONSTRUCTION REFERENCE ONLY. SUBJECT TO CHANGE IN FINAL ASSEMBLY AND TEST. CONFIRM WIRING WITH HAYS CLEVELAND BEFORE INSTALLATION. HAYS CLEVELAND STRONGLY SUGGESTS THAT ONLY COMPETENT ELECTRICIANS INSTALL WIRING. TEST ALL WIRING BEFORE APPLYING POWER AND OPERATING EQUIPMENT. EVERY EFFORT HAS BEEN MADE TO PROVIDE AN ACCURATE DRAWING. OCCASIONALLY ERRORS OCCUR. IN SUCH A CASE, PROVIDE MARKED-UP DRAWINGS TO HAYS CLEVELAND FOR DOCUMENTATION BACKUP. HAYS CLEVELAND DOES NOT ACCEPT LIABILITY FOR ANY ERRORS OR OMISSIONS OF THIS DRAWING.



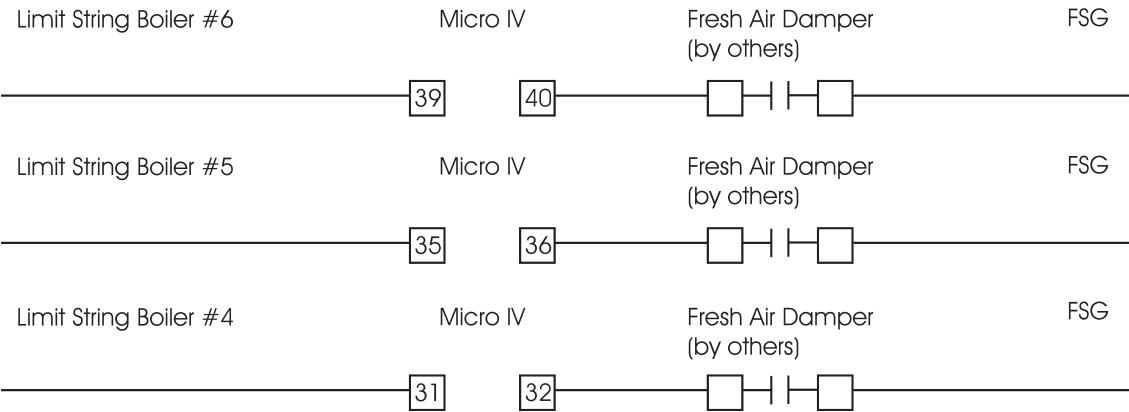
External Wiring Connections
120 V AC Circuit



Drawing 5: External Wiring Diagram 3 of 10.

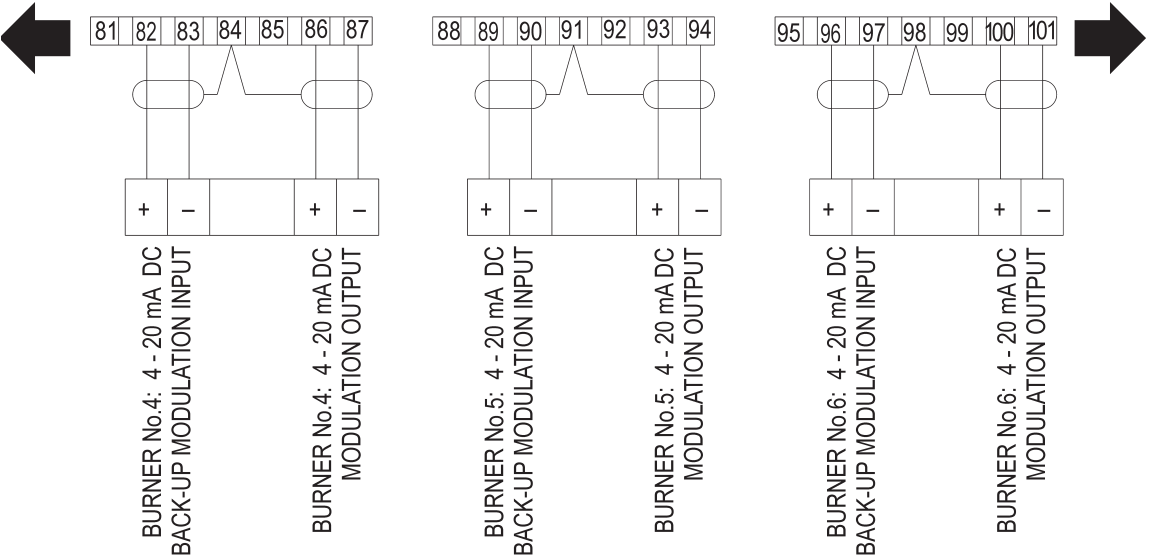


External Wiring Connections
120 V AC Circuit

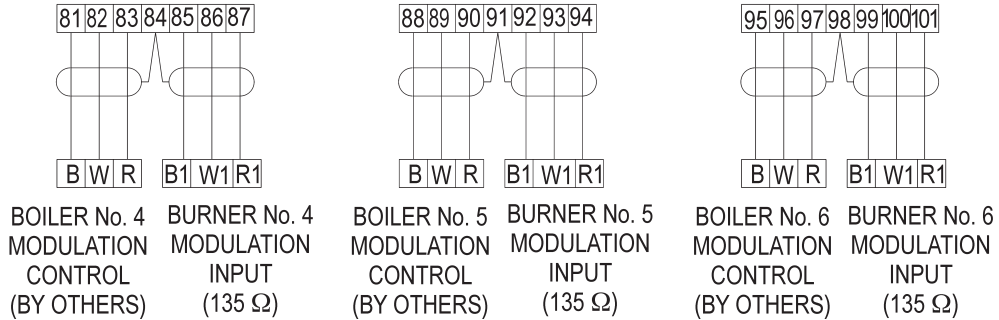


Drawing 6: External Wiring Diagram 4 of 10.

EXX



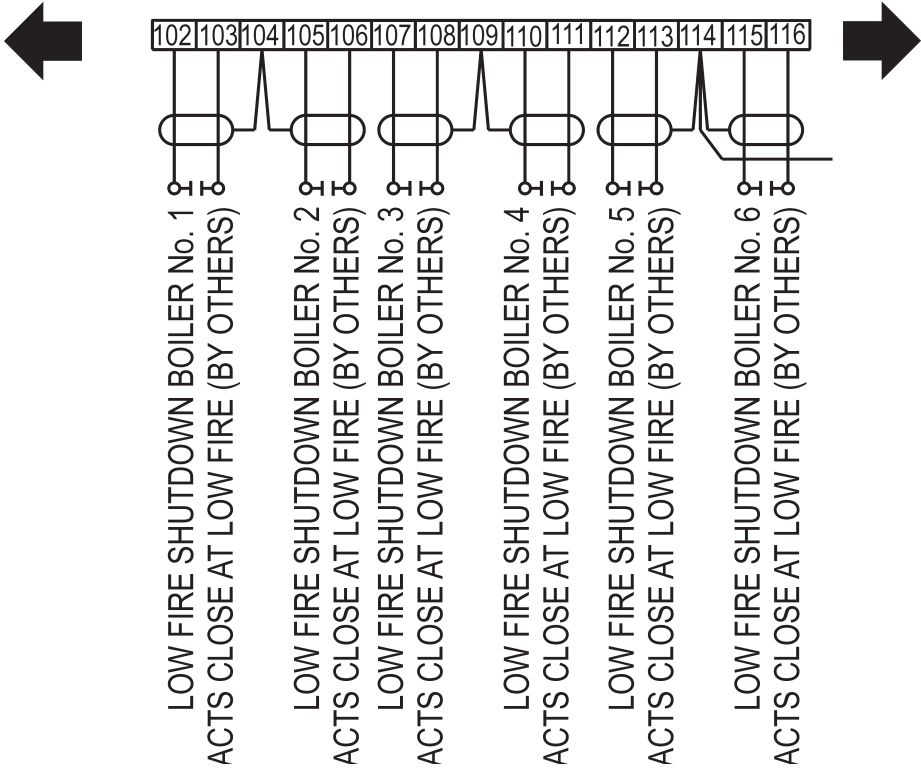
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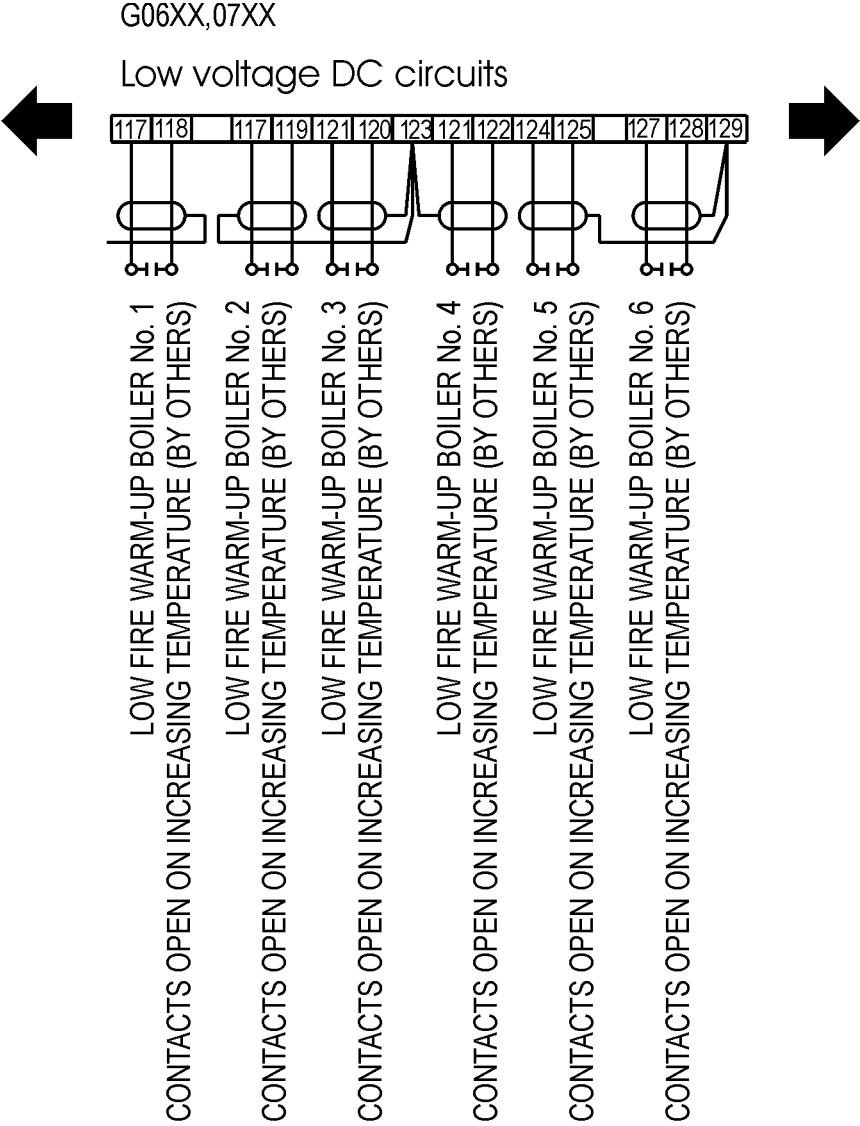
Drawing 8: External Wiring Diagram 6 of 10.

G08XX

Low voltage DC circuits

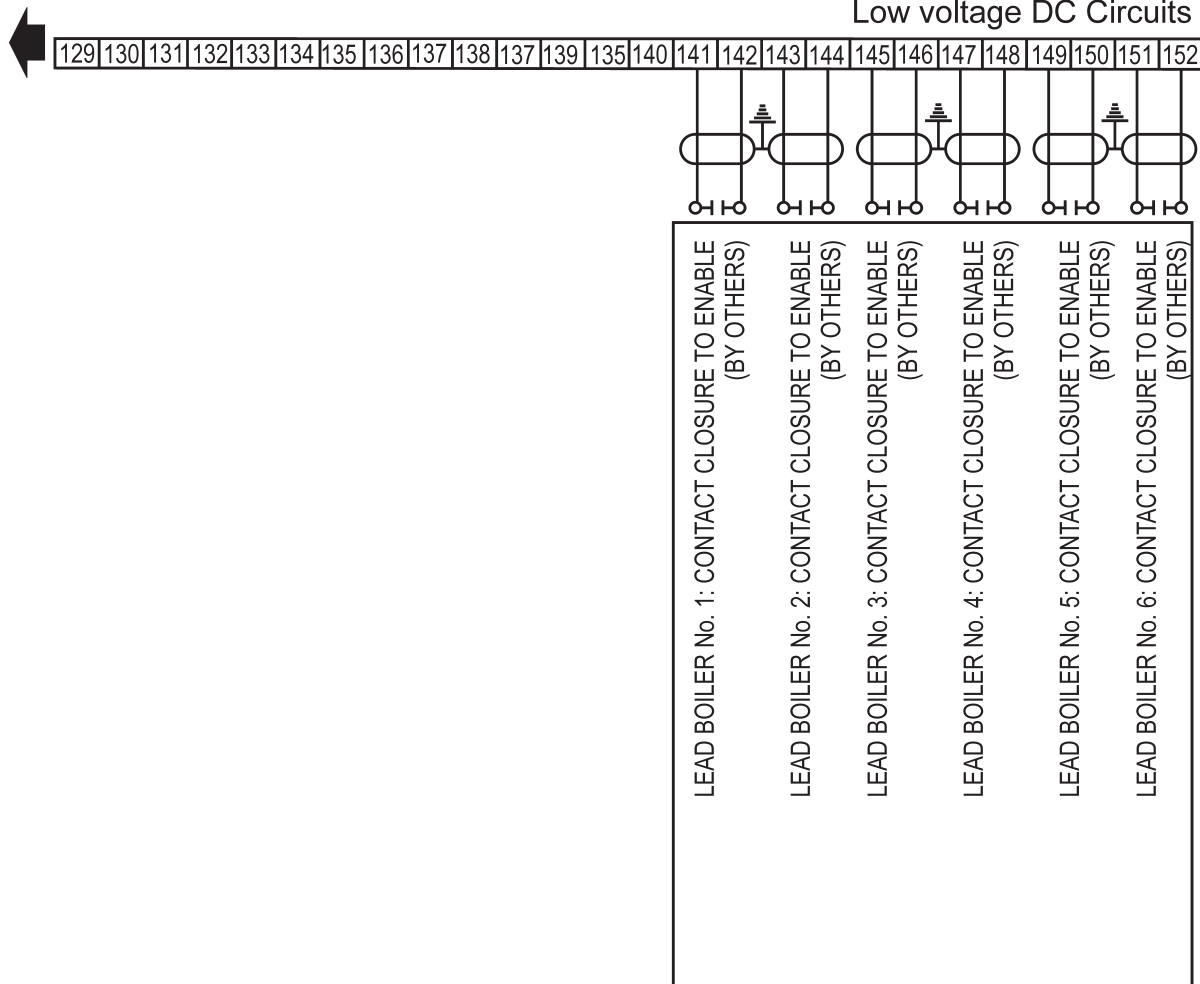


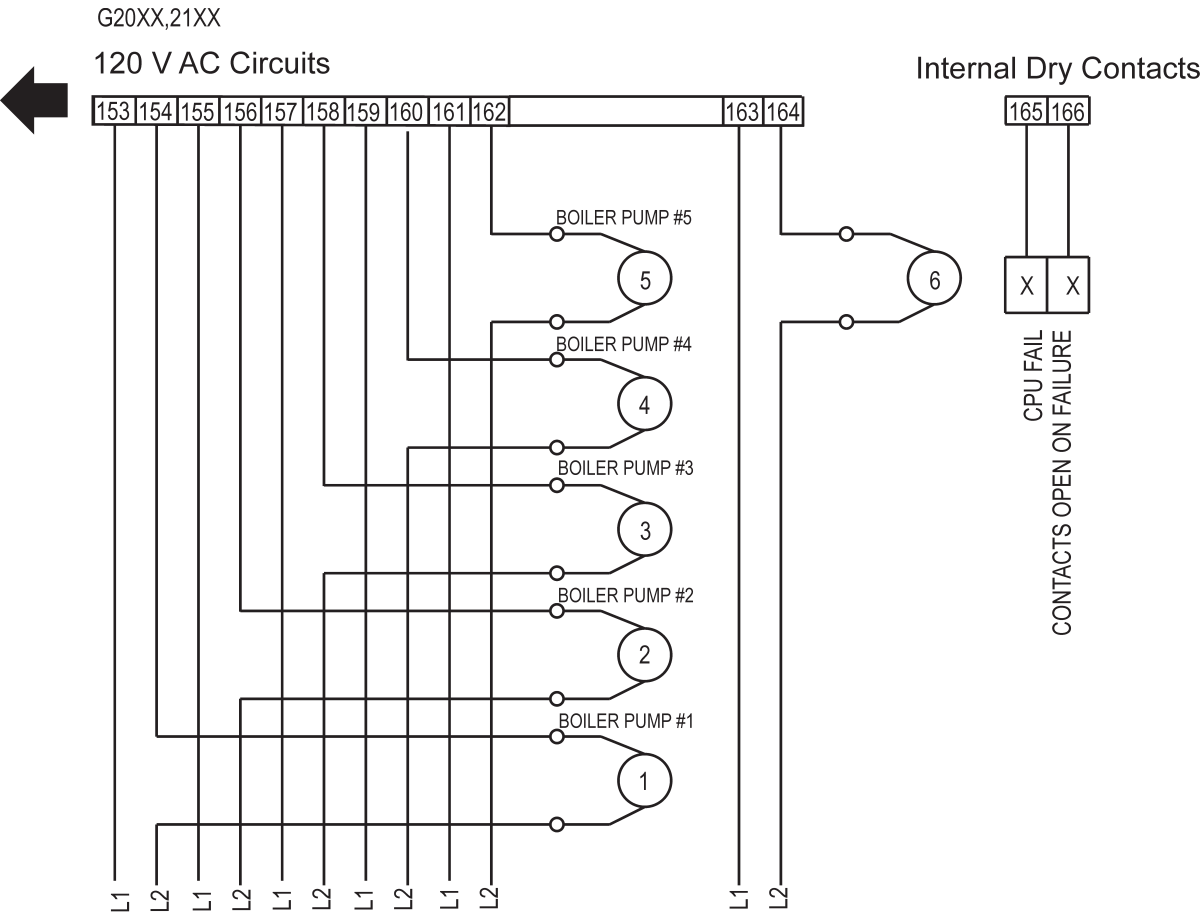
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Low voltage DC Circuits





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