Innovative operator interface, measurement, monitoring and control solutions
TEMPERATURE CONTROLLERS

The Trusted Source for Innovative Control Solutions
## Temperature Controllers

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<th>PAXLRT</th>
<th>PAXLTC</th>
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<td>1/8 DIN RTD Temperature Indicator</td>
<td>1/8 DIN Thermocouple Temperature Indicator</td>
<td></td>
</tr>
<tr>
<td>Dimensions (Height) x (Width)</td>
<td>39 mm (H) x 75 mm (W)</td>
<td>39 mm (H) x 75 mm (W)</td>
<td>50 mm (H) x 97 mm (W)</td>
<td>50 mm (H) x 97 mm (W)</td>
</tr>
<tr>
<td>Display</td>
<td>5 Digit, 48” (12mm) Reflective and Red Backlight LCD</td>
<td>5 Digit, 48” (12mm) Reflective and Red Backlight LCD</td>
<td>4 Digit, .56” (14mm) Red LED</td>
<td>4 Digit, .56” (14mm) Red LED</td>
</tr>
<tr>
<td>Control</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Outputs</td>
<td>Single Form C Relay Dual Sinking</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Communications</td>
<td>RS232</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Other Features/Options</td>
<td>User Input Min/Max Memory Custom Units Indicator</td>
<td>Programmable F or C Annunciator</td>
<td>Programmable Offset, Peak/Valley Memory, Custom Units Overlay</td>
<td>Programmable Offset, Peak/Valley Memory, Custom Units Overlay</td>
</tr>
<tr>
<td>Power Source</td>
<td>9 to 28 VDC With Backlighting 65 mA</td>
<td>9 - 26 VDC @ 25 mA</td>
<td>85 to 250 VAC</td>
<td>85 to 250 VAC</td>
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<td>Page 513</td>
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</table>

*See website for product information.
†Field Installable Option Card
## Temperature Controllers

**Description**: RTD and Thermocouple Meter With Setpoint Capability

**Dimensions (Height) x (Width)**: 50 mm (H) x 97mm (W)

**Display**: 5 Digit, .56" (14mm) Red LED

**Input Ranges**: RTD Pt385, Pt392, Ni672, and Cu427 Thermocouple T, E, J, K, R, S, B, N, and mV

### PAXLT DPST PAXT PID T16

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<thead>
<tr>
<th>Control</th>
<th>Outputs</th>
<th>Communications</th>
<th>Other Features/Options</th>
<th>Power Source</th>
<th>Page Number</th>
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</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>User Input Min/Max Memory, Custom Units Overlay</td>
<td>50 to 250 VAC 21.6 to 250 VDC</td>
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<tr>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Min/Max Memory, Integrator/Totalizer, Custom Units Overlay</td>
<td>85 to 250 VAC 11 to 36 VDC 24 VAC</td>
<td>Page 539</td>
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<tr>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Analog Output*, Min/Max Memory, Integrator/Totalizer, Linearizer, Custom Units Overlay</td>
<td>85 to 250 VAC 18 to 36 VDC 24 VAC</td>
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<tr>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Analog Output</td>
<td>85 to 250 VAC 18 to 36 VDC 24 VAC</td>
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*See website for product information.

† Field Installable Option Card
## QUICK Specs

### Temperature Controllers

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<th>TCU</th>
<th>TSC</th>
<th>P16</th>
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</thead>
<tbody>
<tr>
<td><strong>Dimensions</strong></td>
<td>1/16 DIN Temperature Controller</td>
<td>1/8 DIN Temperature Controller</td>
<td>1/8 DIN Temperature Setpoint Controller</td>
<td>1/16 DIN Process Controller</td>
</tr>
<tr>
<td>(Height)x(Width)</td>
<td>48 mm (H) x 48mm (W)</td>
<td>96 mm (H) x 48mm (W)</td>
<td>96 mm (H) x 48mm (W)</td>
<td>48 mm (H) x 48mm (W)</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>2 x 4 Digit, Main Display .4” (10mm) Red Sec. Display .3” (7mm) Green LED</td>
<td>2 x 4 Digit, Main Display .4” (10mm) Red Sec. Display .3” (7mm) Green LED</td>
<td>2 x 4 Digit, Main Display .4” (10mm) Red Sec. Display .3” (7mm) Green LED</td>
<td>2 x 4 Digit, Main Display .3” (7mm) Red Sec. Display .2” (5mm) Green LED</td>
</tr>
<tr>
<td><strong>Input Ranges</strong></td>
<td>Thermocouple T, E, J, K, R, S, B, N, and mV RTD 2, 3, or 4 Wire 100 Ohm (ALPHA = .00385 and .00391)</td>
<td>Thermocouple T, E, J, K, R, S, B, N, and mV RTD 2, 3, or 4 Wire 100 Ohm (ALPHA = .00385 and .00391)</td>
<td>Process Input 0 to 10 VDC or 0 to 20 mA</td>
<td>Process Input 0 to 10 VDC or 0 to 20 mA</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>On/Off, PID</td>
<td>On/Off, PID</td>
<td>On/Off, PID</td>
<td>On/Off, PID</td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
<td>Main Control (Heat/Cool), Cooling Output, Dual Alarms (Relay, SSR Drive, Triac) Field Replaceable</td>
<td>Main Control (Heat/Cool), Cooling Output, Dual Alarms (Relay, SSR Drive, Triac) Field Replaceable</td>
<td>Main Control (Heat/Cool), Cooling Output, Dual Alarms (Relay, SSR Drive, Triac) Field Replaceable</td>
<td>Main Control (Direct/Reverse), Secondary Output, Dual Alarms</td>
</tr>
<tr>
<td><strong>Communications</strong></td>
<td>RS485</td>
<td>RS485</td>
<td>RS485</td>
<td>No</td>
</tr>
<tr>
<td><strong>Other Features/Options</strong></td>
<td>Heater Current Monitor, Analog Output, Remote Setpoint</td>
<td>Heater Current Monitor, Analog Output, Remote Setpoint</td>
<td>Analog Output</td>
<td>Analog Output</td>
</tr>
<tr>
<td><strong>Power Source</strong></td>
<td>85 to 250 VAC 18 to 36 VDC 24 VAC</td>
<td>115/230 VAC</td>
<td>115/230 VAC</td>
<td>85 to 250 VAC 18 to 36 VDC 24 VAC</td>
</tr>
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† Field Installable Option Card
## Temperature Controllers

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<th>Description</th>
<th>PID CONTROL</th>
<th>CONTROL</th>
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<table>
<thead>
<tr>
<th>Dimensions (Height) x (Width)</th>
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<th>CONTROL</th>
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<tbody>
<tr>
<td>48 mm (H) x 48mm (W)</td>
<td>96 mm (H) x 48mm (W)</td>
<td>96 mm (H) x 48mm (W)</td>
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<tr>
<th>Input Ranges</th>
<th>PID CONTROL</th>
<th>CONTROL</th>
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<tbody>
<tr>
<td>Process Input 0 to 10 VDC or 0 to 20 mA</td>
<td>Process Input 0 to 10 VDC or 0 to 20 mA</td>
<td>Thermocouple T, E, J, K, R, S, B, N, and mV RTD 2, or 3 Wire 100 Ohm (ALPHA = .00385 and .00391)</td>
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<th>PID CONTROL</th>
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</thead>
<tbody>
<tr>
<td>On/Off, PID</td>
<td>On/Off, PID</td>
<td>On/Off, PID</td>
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<thead>
<tr>
<th>Outputs</th>
<th>PID CONTROL</th>
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</thead>
<tbody>
<tr>
<td>Main Control (Direct/Reverse), Secondary Output, Dual Alarms (Relay Only)</td>
<td>Main Control (Direct/Reverse), Secondary Output, Dual Alarms (Relay, SSR Drive, Triac) Field Replaceable</td>
<td>Main Control (Direct/Reverse), Secondary Output, Dual Alarms (Relay, SSR Drive, Triac) Field Replaceable</td>
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<tr>
<th>Communications</th>
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<td>RS485</td>
<td>RS485</td>
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<td>Motorized Valve Positioner, Analog Output, Remote Setpoint</td>
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<th>Power Source</th>
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<td>85 to 250 VAC 18 to 36 VDC 24 VAC</td>
<td>115/230 VAC</td>
<td>115/230 VAC</td>
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*See website for product information.

† Field Installable Option Card
### REPLACEMENT Guide

**WHAT YOU’RE USING NOW**

<table>
<thead>
<tr>
<th>MODEL NUMBER</th>
<th>FEATURES</th>
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</table>
| APLTC        | ■ Display: 4 Digit, .56" (14 mm) Red LED  
■ Construction: Metal Front Bezel  
■ Power Source: 115/230 VAC  
■ Measurement: Thermocouple |

| CURRENT PRODUCT |
|-----------------|----------|
| PAXLTC          | ■ Display: 4 Digit, .56" (14 mm) Red LED  
■ Power Source: 85 to 250 VAC  
■ Measurement: Thermocouple |

| IMR            | ■ Display: 4 Digit, .56" (14 mm) Red LED  
■ Construction: Metal Front Bezel  
■ Power Source: 115/230 VAC  
■ Measurement: RTD |

| PAXT           | ■ Display: 6 Digit, .56" (14 mm) Red LED  
■ Power Source: 85 to 250 VAC  
■ Measurement: RTD  
■ Requires Appropriate Option Card |

| IMT            | ■ Display: 4 Digit, .56" (14 mm) Red LED  
■ Construction: Metal Front Bezel  
■ Power Source: 115/230 VAC  
■ Measurement: Thermocouple |

| PAXT           | ■ Display: 6 Digit, .56" (14 mm) Red LED  
■ Power Source: 85 to 250 VAC  
■ Measurement: Thermocouple  
■ Requires Appropriate Option Card |

| CUB4TC         | ■ Display: 5 Digit, .48" (12 mm) Reflective and Red Backlight LCD  
■ Power Source: 9 to 26 VDC  
■ Measurement: Thermocouple |

| CUB5TC         | ■ Display: 5 Digit, .48" (12 mm) Reflective, Green and Red Backlight LCD  
■ Power Source: 9 to 28 VDC  
■ Measurement: Thermocouple |

| CUB4RT         | ■ Display: 5 Digit, .48" (12 mm) Reflective and Red Backlight LCD  
■ Power Source: 9 to 26 VDC  
■ Measurement: RTD |

| CUB5RT         | ■ Display: 5 Digit, .48" (12 mm) Reflective, Green and Red Backlight LCD  
■ Power Source: 9 to 28 VDC  
■ Measurement: RTD |

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Note: Refer to the current product literature, as some differences may exist.
MODEL CUB5TC - MINIATURE ELECTRONIC 5-DIGIT THERMOCOUPLE METER

- CONFORMS TO ITS-90 TEMPERATURE STANDARD
- COLD JUNCTION COMPENSATION (Enable/Disable)
- MINIMUM AND MAXIMUM DISPLAY CAPTURE
- LCD, REFLECTIVE OR GREEN/RED LED BACKLIGHTING
- 0.48" (12.2 mm) HIGH DIGITS
- OPTIONAL SETPOINT OUTPUT MODULES
- OPTIONAL SERIAL COMMUNICATION MODULES (RS232 or RS485)
- OPERATES FROM 9 TO 28 VDC POWER SOURCE
- FRONT PANEL OR CRIMSON PROGRAMMABLE
- DISPLAY COLOR CHANGE CAPABILITY AT SETPOINT OUTPUT
- NEMA 4X/IP65 SEALED FRONT BEZEL

THERMOCOUPLE INPUTS
Thermocouple types T, E, J, K, R, S, B, N, or mV

PROGRAMMABLE TEMPERATURE OFFSET
SELECTABLE °F or °C WITH 1 or 0.1 DEGREE RESOLUTION
°F OR °C DISPLAY ANNUNCIATORS

GENERAL DESCRIPTION
The CUB5 provides the user the ultimate in flexibility, from its complete user programming to the optional setpoint control and communication capability. The CUB5TC accepts a thermocouple input and provides a temperature display in Celsius or Fahrenheit. The meter also features minimum and maximum display capture, display offset, °F or °C indicator, and programmable user input. The display can be toggled either manually or automatically between the selected displays.

The CUB5 display has 0.48" (12.2 mm) high digits. The LCD is available in two versions, reflective and red/green backlight. The backlight version is user selectable for the desired color and also has variable display intensity.

The capability of the CUB5 can be easily expanded with the addition of option modules. Setpoint capability is field installable with the addition of the setpoint output modules. Serial communications capability for RS232 or RS485 is added with a serial option module.

The CUB5 can be powered from an optional Red Lion Micro-Line/Sensor Power Supply (MLPS1000), which attaches directly to the back of a CUB5. The MLPS1 is powered from 85 to 250 VAC and provides up to 400 mA to drive the unit and sensors.

SAFETY SUMMARY
All safety related regulations, local codes and instructions that appear in this literature or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use this meter to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the meter.

CAUTION: Risk of Danger. Read complete instructions prior to installation and operation of the unit.

CAUTION: Risk of electric shock.

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.15" (54.6) H x 3.00" (76.2) W.
**ORDERING INFORMATION**

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<th>MODEL NO.</th>
<th>DESCRIPTION</th>
<th>PART NUMBER</th>
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<td>CUBSTCR0</td>
</tr>
<tr>
<td>CUBSTC0</td>
<td>Thermocouple Meter with Backlight Display</td>
<td>CUBSTC00</td>
</tr>
<tr>
<td>CUB5RLY</td>
<td>Single Relay Output Card</td>
<td>CUB5RLY0</td>
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<tr>
<td>CUB5SNK</td>
<td>Dual Sinking Output Card</td>
<td>CUB5SNK0</td>
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<tr>
<td>CUB5COM</td>
<td>RS485 Serial Communications Card</td>
<td>CUB5COM1</td>
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<tr>
<td>CUB5COM2</td>
<td>RS232 Serial Communications Card</td>
<td>CUB5COM2</td>
</tr>
<tr>
<td>CUB5USB</td>
<td>USB Programming Card for CUB5 Products</td>
<td>CUB5USB0</td>
</tr>
<tr>
<td>MLP51</td>
<td>Micro-Line Power Supply, 85 to 250 VAC</td>
<td>MLP51000</td>
</tr>
<tr>
<td>CBLPROG0</td>
<td>RS232 Programming Cable (DB9-RJ11)</td>
<td>CBLPROG0</td>
</tr>
<tr>
<td>CBPRO0</td>
<td>RS485 Programming Cable (DB9-RJ11)</td>
<td>CBPRO007</td>
</tr>
<tr>
<td>SFCRD0</td>
<td>Crimson 2 PC Configuration Software for Windows 98, ME, 2000, XP</td>
<td>SFCRD200</td>
</tr>
<tr>
<td>CBLSUSB</td>
<td>USB Programming Card</td>
<td>CBLUSB00</td>
</tr>
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</table>

1. **DISPLAY**: 5 digit LCD 0.48" (12.2 mm) high digits
   - **CUB5TCSR0**: Reflective LCD with full viewing angle
   - **CUB5TCSR0**: Transmissive LCD with selectable red or green LED backlight, viewing angle optimized. Display color change capability with output state when using an output module.

2. **POWER**: Input voltage range is +9 to -28 VDC with short circuit and input polarity protection. Must use an RLC model MLP51 or a NEC Class 2 or SELV rated power supply.

3. **READOUT**
   - Resolution: 1 or 0.1 degrees
   - Scale: °F or °C
   - Offset Range: -999 to 9999 display units

4. **THERMOCOUPLE INPUTS**
   - **Isolation**: TC+ and TC- terminals are not electrically isolated from the power supply or optional comms cards.
   - **Response Time**: 500 mSec
   - **Open Sensor Display**:
     - **CUB5TCSR0**: Non-volatilize memory retains all programming
     - **CUB5TCSR0**: Volatilize memory is reset to zero when power is removed.
   - **Remote Meter**: 3 VDC max. with respect to common

5. **USER INPUT (USR)**: Programmable input. Connect terminals to common (USR COMM) to activate function. Internal 10kΩ pull-up resistor to +9 to 28 VDC.

   - **Threshold Levels**:
     - **VIL**: 1.0 V max; **VIH**: 2.4 V min; **VMAX**: 28 VDC
   - **Response Time**: 5 mSec typ.; 50 mSec debounce (activation and release)

6. **CERTIFICATIONS AND COMPLIANCES**
   - **SAFETY**
     - UL Recognized Component, File #E179259, UL61010A-1, CSA C22.2 No. 61010-1, Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
     - UL Listed, File #E173808, UL508, CSA C22.2 No. 14-M95
     - Listed by Underwriters Laboratories, Inc. IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1.
     - IP65 Enclosure rating (Face only), IEC 529

   - **EMC**
     - Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.

7. **ELECTROMAGNETIC COMPATIBILITY**
   - Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.

8. **INTERMODULATION**
   - Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.

9. **INSTRUMENT TO IMMUNITY LOCATIONS**
   - Electrostatic discharge EN 61000-4-2: Criterion A
     - 4 kV contact discharge
     - 8 kV air discharge
   - Electromagnetic RF fields EN 61000-4-3: Criterion A
     - 10 V/m
   - Fast transients (burst) EN 61000-4-4: Criterion A
     - 2 kV power
     - 1 kV signal
   - Surge EN 61000-4-5: Criterion A
     - 1 kV L-N-L
     - 2 kV L-N-E power
   - Power frequency magnetic fields EN 61000-4-8: Criterion A
     - 3 V/m
   - Emissions: EN 55011: Class A

10. **Emissions**
    - Emissions EN 55011: Class A

**Note**

1. **Crimson 2 software is a free download from** http://www.redlion.net/
8. CONNECTIONS: Wire clamping screw terminals
   Wire Strip Length: 0.3” (7.5 mm)
   Wire Gage: 30-14 AWG copper wire
   Torque: 5 inch-lbs (0.565 N-m) max.

9. ENVIRONMENTAL CONDITIONS:
   Operating Temperature Range for CUB5TCR0: -35 to 75°C
   Operating Temperature Range for CUB5TCB0 depends on display color
   and intensity level as per below:

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<thead>
<tr>
<th>INTENSITY LEVEL</th>
<th>TEMPERATURE</th>
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<tbody>
<tr>
<td>Red Display</td>
<td>-35 to 75°C</td>
</tr>
<tr>
<td>1 &amp; 2</td>
<td>-35 to 70°C</td>
</tr>
<tr>
<td>3</td>
<td>-35 to 60°C</td>
</tr>
<tr>
<td>4</td>
<td>-35 to 50°C</td>
</tr>
<tr>
<td>5</td>
<td>-35 to 50°C</td>
</tr>
<tr>
<td>Green Display</td>
<td>-35 to 75°C</td>
</tr>
<tr>
<td>1 &amp; 2</td>
<td>-35 to 65°C</td>
</tr>
<tr>
<td>3</td>
<td>-35 to 65°C</td>
</tr>
<tr>
<td>4</td>
<td>-35 to 55°C</td>
</tr>
<tr>
<td>5</td>
<td>-35 to 55°C</td>
</tr>
</tbody>
</table>

   Storage Temperature: -35 to 85°C
   Operating and Storage Humidity: 0 to 85% max. relative humidity (non-condensing)
   Altitude: Up to 2000 meters

10. CONSTRUCTION: This unit is rated for NEMA 4X/IP65 requirements for indoor use. Installation Category I, Pollution Degree 2. High impact plastic case with clear viewing window. Panel gasket and mounting clip included.

11. WEIGHT: 3.2 oz (100 g)

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**OPTIONAL PLUG-IN CARDS**

**ADDING OPTION CARDS**

The CUB5 meters can be fitted with optional output cards and/or serial communications cards. The details for the plug-in cards can be reviewed in the specification section below. The plug-in cards, that are sold separately, can be installed initially or at a later date.

**WARNING:** Disconnect all power to the unit before installing Plug-in card.

**SINGLE RELAY CARD**

Type: Single FORM-C relay
Isolation To Sensor & User Input Commons: 1400 Vrms for 1 min.
Working Voltage: 150 Vrms
Contact Rating: 1 amp @ 30 VDC resistive; 0.3 amp @ 125 VAC resistive
Life Expectancy: 100,000 minimum operations
Response Time:
   Turn On Time: 4 msec max.
   Turn Off Time: 4 msec max.

**DUAL SINKING OUTPUT CARD**

Type: Non-isolated switched DC, N Channel open drain MOSFET
Current Rating: 100 mA max.
VDS ON: 0.7 V @ 100 mA
VDS MAX: 30 VDC
Offstate Leakage Current: 0.5 mA max.

**RS485 SERIAL COMMUNICATIONS CARD**

Type: RS485 multi-point balanced interface (non-isolated)
   Note: Non-grounded (isolated) thermocouple probes must be used when multiple units are connected in an RS485 network, or measurement errors will occur.
   Band Rate: 300 to 38.4k
   Data Format: 7/8 bits; odd, even, or no parity
   Bus Address: 0 to 99; max 32 meters per line
   Transmit Delay: Selectable (refer to CUB5COM bulletin)

**RS232 SERIAL COMMUNICATIONS CARD**

Type: RS232 half duplex (non-isolated)
   Band Rate: 300 to 38.4k
   Data Format: 7/8 bits; odd, even, or no parity

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**1.0 INSTALLING THE METER**

**INSTALLATION**

The meter meets NEMA 4X/IP65 requirements when properly installed. The unit is intended to be mounted into an enclosed panel. Prepare the panel cutout to the dimensions shown. Remove the panel latch from the unit. Slide the panel gasket over the rear of the unit to the back of the bezel. The unit should be installed fully assembled. Insert the unit into the panel cutout.

While holding the unit in place, push the panel latch over the rear of the unit so that the tabs of the panel latch engage in the slots on the case. The panel latch should be engaged in the farthest forward slot possible. To achieve a proper seal, tighten the latch screws evenly until the unit is snug in the panel (Torque to approx. 28 to 36 in-oz [0.202 to 0.26 N-m]). Do not over-tighten the screws.

**INSTALLATION ENVIRONMENT**

The unit should be installed in a location that does not exceed the operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should only be cleaned with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.

Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.
2.0 Installing Plug-In Cards

**WARNING**: Exposed line voltage exists on the circuit boards. Remove all power to the meter and load circuits before accessing inside of the meter.

**CAUTION**: The Plug-in cards and main circuit board contain static sensitive components. Before handling the cards, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle the cards at a static controlled clean work station. Also, only handle the cards by the edges. Dirt, oil or other contaminants that may contact the cards can adversely affect circuit operation.

**REMOVING THE REAR COVER**

To remove the rear cover, locate the cover locking tab below the 2nd and 3rd input terminals. To release the tab, insert a small, flat blade screwdriver between the tab and the plastic wall below the terminals. Inserting the screwdriver will provide enough pressure to release the tab locks. To replace the cover, align the cover with the input terminals and press down until the cover snaps into place.

The Plug-in cards are separately purchased option cards that perform specific functions. The cards plug into the main circuit board of the meter.

---

3.0 Wiring the Meter

**WIRING OVERVIEW**

Electrical connections are made via screw-clamp terminals located on the back of the meter. All conductors should conform to the meter’s voltage and current ratings. All cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that the power supplied to the meter (DC or AC) be protected by a fuse or circuit breaker.

Strip the wire, leaving approximately 0.3” (7.5 mm) bare lead exposed (stranded wires should be tinned with solder.) Insert the lead under the correct screw-clamp terminal and tighten until the wire is secure. (Pull wire to verify tightness.) Each terminal can accept up to one #14 AWG (2.55 mm) wire, two #18 AWG (1.02 mm), or four #20 AWG (0.61 mm).

**EMC INSTALLATION GUIDELINES**

Although this meter is designed with a high degree of immunity to Electro-Magnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into the meter may be different for various installations. The meter becomes more immune to EMI with fewer I/O connections. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation.

Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The meter should be mounted in a metal enclosure, which is properly connected to protective earth.
2. Use shielded (screened) cables for all Signal and Control inputs. The shield (screen) pigtail connection should be made as short as possible. The connection point for the shield depends somewhat upon the application.

Listed below are the recommended methods of connecting the shield, in order of their effectiveness.

a. Connect the shield only at the panel where the unit is mounted to earth ground (protective earth).

b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is above 1 MHz.

c. Connect the shield to common of the meter and leave the other end of the shield unconnected and insulated from earth ground.

3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be ran in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.

4. Signal or Control cables within an enclosure should be routed as far as possible from contactors, control relays, transformers, and other noisy components.

5. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:

- Ferrite Suppression Cores for signal and control cables:
  - Fair-Rite # 0443167251 (RLC# FCOR0000)
  - TDK # ZCAT3035-1330A
  - Steward # 28B2029-0A0

- Line Filters for input power cables:
  - Schaffner # FN610-1/07 (RLC# LFIL0000)
  - Schaffner # FN670-1-8/07
  - Corcom # 1 VR3

**Note**: Reference manufacturer’s instructions when installing a line filter.

6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.

7. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.

- Snubber: RLC# SNUB0000.
### 3.1 POWER WIRING

**DC Power**

+9 to +28 VDC: +VDC

Power Common: -VDC

![Power Wiring Diagram](image)

### 3.2 USER INPUT WIRING

**Sinking Logic**

USR COMM

Connect external switching device between the User Input terminal and User Input Common.

The user input of the meter is internally pulled up to +9 to +28 V with 10 K resistance. The input is active when it is pulled low (<0.7 V).

![User Input Wiring Diagram](image)

### 3.3 INPUT WIRING

**Thermocouple**

CAUTION: Power input common and sensor input common are NOT isolated from user input common. In order to preserve the safety of the meter application, the power input common and the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

![Thermocouple Wiring Diagram](image)

### 3.4 SETPOINT (OUTPUT) WIRING

**SINGLE SETPOINT RELAY PLUG-IN CARD**

**DUAL SETPOINT N-FET OPEN DRAIN PLUG-IN CARD**

**ELECTRICAL CONNECTIONS**

Output Common is not isolated from DC Power Common. Load must be wired between OSNK terminal and V+ of the load supply.

![Setpoint Wiring Diagram](image)

### 3.5 SERIAL COMMUNICATION WIRING

**SERIAL COMMUNICATIONS PLUG-IN CARD**

**RJ11 CONNECTOR PIN OUTS**

![Serial Communication Wiring Diagram](image)
4.0 REVIEWING THE FRONT BUTTONS AND DISPLAY

It is recommended that all programming changes be made off line, or before installation. The meter normally operates in the Display Mode. No parameters can be programmed in this mode. The Programming Mode is entered by pressing and holding the SEL button. If it is not accessible then it is locked by either a security code, or a hardware lock.

MODULE ENTRY (SEL & RST BUTTONS)
The Programming Menu is organized into separate modules. These modules group together parameters that are related in function. The display will alternate between Pro and the present module. The RST button is used to select the desired module. The displayed module is entered by pressing the SEL button.

MODULE MENU (SEL BUTTON)
Each module has a separate module menu (which is shown at the start of each module discussion). The SEL button is pressed to advance to a particular parameter to be changed, without changing the programming of preceding parameters. After completing a module, the display will return to Pro NO. Programming may continue by accessing additional modules.

SELECTION / VALUE ENTRY
For each parameter, the display alternates between the present parameter and the selections/value for that parameter. The RST button is used to move through the selections/values for that parameter. Pressing the SEL button, stores and activates the displayed selection/value. This also advances the meter to the next parameter.

For numeric values, press the RST button to access the value. The right hand most digit will begin to flash. Pressing the RST button again increments the digit by one or the user can hold the RST button and the digit will automatically scroll. The SEL button will advance to the next digit. Pressing and holding the SEL button will enter the value and move to the next parameter.

PROGRAMMING MODE EXIT (SEL BUTTON)
The Programming Mode is exited by pressing the SEL button with Pro NO displayed. This will commit any stored parameter changes to memory and return the meter to the Display Mode. (If power loss occurs before returning to the Display Mode, verify recent parameter changes.)

PROGRAMMING TIPS
It is recommended to start with Module 1 and proceed through each module in sequence. When programming is complete, it is recommended to record the parameter programming and lock out parameter programming with the user input or programming security code.

FACTORY SETTINGS
Factory Settings may be completely restored in Module 2. This is useful when encountering programming problems.

Pressing both the SEL and the RST button on power-up will also load the factory settings and display rESEt. This allows operation in the event of a memory failure or corrupted data.

ALTERNATING SELECTION DISPLAY
In the explanation of the modules, the following dual display with arrows will appear. This is used to illustrate the display alternating between the parameter on top and the parameter’s Factory Setting on the bottom. In most cases, selections and values for the parameter will be listed on the right.

5.0 PROGRAMMING THE METER

OVERVIEW

PROGRAMMING MENU

- Pr0
- Secondary Function Parameters
- Display and Front Panel Key Parameters
- Setpoint Output Parameters
- Serial Setup Parameters
- MAX - Maximum display capture value
- MIN - Minimum display capture value
- “1” - To the right of the display indicates setpoint 1 output activated.
- “2” - To the right of the display indicates setpoint 2 output activated.

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5.1 MODULE 1 - SIGNAL INPUT PARAMETERS

PARAMETER MENU

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>tYPE</td>
<td>Thermocouple Type</td>
</tr>
<tr>
<td>CJC</td>
<td>Cold Junction Compensation</td>
</tr>
<tr>
<td>SCALE</td>
<td>Temperature Scale</td>
</tr>
<tr>
<td>dECPl</td>
<td>Display Decimal Point</td>
</tr>
<tr>
<td>OFSet</td>
<td>Display Offset Value</td>
</tr>
<tr>
<td>F ILLr</td>
<td>Filter Setting</td>
</tr>
<tr>
<td>bANd</td>
<td>Filter Band</td>
</tr>
<tr>
<td>USr IN</td>
<td>User Input Function</td>
</tr>
<tr>
<td>U-ASn</td>
<td>User Input Assignment</td>
</tr>
</tbody>
</table>

THERMOCOUPLE TYPE

Select the thermocouple type used for the application. The appropriate curve will be automatically loaded for the selected type.

COLD JUNCTION COMPENSATION

This parameter enables or disables internal cold junction compensation. For most applications, cold junction compensation should be enabled (YES). This parameter does not appear if tYPE = VOLt.

TEMPERATURE SCALE

Select the temperature scale. This selection applies for the Input, MAX and MIN displays. This parameter does not appear if tYPE = VOLt.

DISPLAY DECIMAL POINT

Select the decimal point location for the desired display resolution. This selection applies for the Input, MAX and MIN displays. This parameter does not appear if tYPE = VOLt or for types R, S or B thermocouples which have a fixed 1 degree resolution.

DISPLAY OFFSET VALUE

The temperature display can be corrected with an offset value. This can be used to compensate for probe errors, errors due to variances in probe placement or adjusting the readout to a reference thermometer.

FILTER SETTING

If the displayed temperature is difficult to read due to small process variations or noise, increased levels of filtering will help to stabilize the display. Software filtering effectively combines a fraction of the current input reading with a fraction of the previous displayed reading to generate the new display.

FILTER BAND

The filter will adapt to variations in the input signal. When the variation exceeds the input filter band value, the filter disengages. When the variation becomes less than the band value, the filter engages again. This allows for a stable readout, but permits the display to settle rapidly after a large process change. The value of the band is in display units, independent of the Display Decimal Point position. A band setting of ‘0’ keeps the filter permanently engaged at the filter level selected above.

USER INPUT FUNCTION

Select the value(s) to which the User Input Function is assigned. The User Input Assignment only applies if a selection of reset, display hold, or print and reset is selected in the User Input Function menu.

USER INPUT ASSIGNMENT

Select the value(s) to which the User Input Function is assigned. The User Input Assignment only applies if a selection of reset, display hold, or print and reset is selected in the User Input Function menu.
5.2 MODULE 2 - SECONDARY FUNCTION PARAMETERS (2-SEC)

<table>
<thead>
<tr>
<th>Parameter Menu</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SEL</strong></td>
</tr>
<tr>
<td><strong>HI-En</strong></td>
</tr>
<tr>
<td><strong>HI-t</strong></td>
</tr>
<tr>
<td><strong>LO-En</strong></td>
</tr>
<tr>
<td><strong>LO-t</strong></td>
</tr>
<tr>
<td><strong>FCS</strong></td>
</tr>
<tr>
<td><strong>CodE</strong></td>
</tr>
</tbody>
</table>

### MAX DISPLAY ENABLE

Max Display Enable: NO → YES

Enables the Maximum Display Capture capability.

### MAX CAPTURE DELAY TIME

Max Capture Delay Time: 00 to 9999 sec.

When the Input Display is above the present MAX value for the entered delay time, the meter will capture that display value as the new MAX reading. A delay time helps to avoid false captures of sudden short spikes.

### MIN DISPLAY ENABLE

Min Display Enable: NO → YES

Enables the Minimum Display Capture capability.

### MIN CAPTURE DELAY TIME

Min Capture Delay Time: 00 to 9999 sec.

When the Input Display is below the present MIN value for the entered delay time, the meter will capture that display value as the new MIN reading. A delay time helps to avoid false captures of sudden short spikes.

### FACTORY SERVICE OPERATIONS

Factory Service Operations: NO → YES

Select YES to perform either of the Factory Service Operations shown below.

### CALIBRATION

The CUB5TC uses stored voltage calibration and cold junction temperature values to provide accurate temperature and voltage measurements. Over time, the electrical characteristics of the components inside the meter could slowly change. The result is that the stored calibration values may no longer accurately define the input circuit. For most applications, recalibration every 1 to 2 years should be sufficient.

Calibration of the CUB5TC involves a voltage calibration and a cold junction calibration. It is recommended that both calibrations be performed. The voltage calibration MUST precede the cold junction calibration. Allow 30 minute warm up before performing any calibration related procedure. The following procedures should be performed at an ambient temperature of 15 to 35 °C (59 to 95 °F).

Calibration should only be performed by individuals experienced in calibrating electronic equipment.

**CAUTION:** The accuracy of the calibration equipment will directly affect the accuracy of the CUB5TC.

### Input Voltage Calibration

1. Connect a precision DC voltage source with an accuracy of ±0.01% or better to the TC+ (positive) and the TC- (negative) terminals of the CUB5TC. Set the output of the voltage source to zero.
2. With the display at CodE 48, press and hold the SEL button for 2 seconds. Unit will display 0.0. Press RST button. Display reads 0.0.
3. Press the RST button to select 00. Press the SEL button. Display reads 0.0 sec.
4. With the voltage source set to zero, press the SEL button until the display reads 0.0 sec. (Use a reference thermometer with an accuracy of 0.25°C or better.)
5. When display reads 0.0 sec., set the voltage source to the reference temperature indicator (or calibration bath). If a difference of more than ±1.0 °C exists, note the difference (CJ error) and continue with cold junction calibration.

### Cold Junction Calibration

1. Place the thermocouple in close thermal contact to a reference thermometer or invalid results will occur.
2. The ambient temperature must be within 20°C to 30°C.
3. Connect a thermocouple (types T, E, J, K, or N only) with an accuracy of ±1°C or better to the meter.
4. Enter programming mode and verify the following settings in Module 1: TYP = thermocouple type connected to the unit
5. Place the thermocouple in close thermal contact to a reference thermometer probe. (Use a reference thermometer with an accuracy of ±0.25°C or better.)
6. Two probes should be shielded from air movement and allowed sufficient time to equalize in temperature. (A calibration bath of known temperature could be used in place of the thermometer.)
7. Compare the unit display with the reference temperature indicator (or calibration bath). If a difference of more than ±1.0 °C exists, note the difference (CJ error) and continue with cold junction calibration.

### RESTORE FACTORY DEFAULT SETTINGS

Entering Code 66 will overwrite all user settings with the factory settings. The meter will display CodE 00 and then return to CodE 00. Press SEL button to exit the module.

Pressing both the SEL and the RST button on power-up will also load the factory settings and display CodE 66. This allows operation in the event of a memory failure or corrupted data.

### FACTORY SERVICE OPERATIONS

Select YES to perform either of the Factory Service Operations shown below.

1. Boot Code parameter and select CodE 48. Press and hold the SEL button until the display is set to 0.0 sec. Press the RST button to select CodE.
2. Press SEL. Display reads 0.0 sec. followed by the current cold junction value. Calculate a new cold junction value as follows:
   \[
   \text{New cold junction} = \text{Current cold junction} + \text{CJ Error (noted above)}
   \]
3. Press RST and set the display to the new cold junction value. Press and hold SEL. Display reads 0.0 sec. for about four seconds and then returns to 0.0 sec.
4. Press SEL twice to exit calibration and return to the normal display mode. Verify the input reading is correct. If not, repeat steps 6 through 10.
5.3 MODULE 3 - DISPLAY AND FRONT PANEL BUTTON PARAMETERS (3-dSP)

**PARAMETER MENU**

<table>
<thead>
<tr>
<th>3-dSP</th>
<th>SEL</th>
<th>dSP-e</th>
<th>SEL</th>
<th>Fst</th>
<th>Scrl</th>
<th>COLORr</th>
<th>d-LEU</th>
<th>CodE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Display Update Time</td>
<td>Front Panel Display Select Enable</td>
<td>Front Panel Reset Enable</td>
<td>Display Scroll Enable</td>
<td>Display Color</td>
<td>Display Intensity Level</td>
<td>Programming Security Code</td>
</tr>
</tbody>
</table>

**DISPLAY UPDATE TIME**

![dSP-e](image)

This parameter sets the display update time in seconds.

**FRONT PANEL DISPLAY SELECT ENABLE (SEL)**

![SEL](image)

The YES selection allows the SEL button to toggle through the enabled displays.

**FRONT PANEL RESET ENABLE (RST)**

![Fst](image)

This selection allows the RST button to reset the selected value(s).

**DISPLAY SCROLL ENABLE**

![Scrl](image)

The YES selection allows the display to automatically scroll through the enabled displays. The scroll rate is every 4 seconds.

**DISPLAY COLOR (BACKLIGHT UNIT ONLY)**

![COLORr](image)

Enter the desired display color, red or green. This parameter is active for backlight units only.

---

**PROGRAMMING SECURITY CODE**

![CodE](image)

The Security Code determines the programming mode and the accessibility of programming parameters. This code can be used along with the Program Mode Lock-out (P-Loc) in the User Input Function parameter (Module 1).

Two programming modes are available. Full Programming mode allows all parameters to be viewed and modified. Quick Programming mode permits only the Setpoint values to be modified, but allows direct access to these values without having to enter Full Programming mode.

Programming a Security Code other than 0, requires this code to be entered at the CodE prompt in order to access Full Programming mode. Depending on the code value, Quick Programming may be accessible before the CodE prompt appears (see chart).

<table>
<thead>
<tr>
<th>USER INPUT FUNCTION</th>
<th>USER INPUT STATE</th>
<th>SECURITY CODE</th>
<th>MODE WHEN “SEL” BUTTON IS PRESSED</th>
<th>FULL PROGRAMMING MODE ACCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>not P-Loc</td>
<td>—</td>
<td>0</td>
<td>Full Programming</td>
<td>Immediate Access</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-99</td>
<td>Quick Programming</td>
<td>After Quick Programming with correct code entry at CodE prompt *</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100-999</td>
<td>CodE prompt</td>
<td>With correct code entry at CodE prompt *</td>
</tr>
<tr>
<td>P-Loc</td>
<td>Active</td>
<td>0</td>
<td>Programming Lock</td>
<td>No Access</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-99</td>
<td>Quick Programming</td>
<td>No Access</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100-999</td>
<td>CodE prompt</td>
<td>With correct code entry at CodE prompt *</td>
</tr>
<tr>
<td></td>
<td>Not Active</td>
<td>0-999</td>
<td>Full Programming</td>
<td>Immediate Access</td>
</tr>
</tbody>
</table>

* *Entering Code 222 allows access regardless of security code.*
5.4 MODULE 4 - SETPOINT OUTPUT PARAMETERS (4-SPT)

PARAMETER MENU

The Setpoint Output Parameters are only active when an optional output module is installed in the meter.

SETPOINT SELECT

Enter the setpoint (output) to be programmed. The \( n \) in the following parameters will reflect the chosen setpoint number. After the chosen setpoint is completely programmed, the display will return to SPSEL. Repeat steps for each setpoint to be programmed. Select NO to exit the module. The number of setpoints available is setpoint output card dependent.

SETPOINT 2 ENABLE

Select YES to enable Setpoint 2 and access the setup parameters. If NO is selected, the unit returns to SPSEL and setpoint 2 is disabled.

SETPOINT ACTION

Enter the action for the selected setpoint (output). See Setpoint Output Figures for a visual detail of each action.

H1-BL = High Acting, with balanced hysteresis
LO-BL = Low Acting, with balanced hysteresis
H1-UB = High Acting, with unbalanced hysteresis
LO-UB = Low Acting, with unbalanced hysteresis

SETPOINT VALUE

Enter the desired setpoint value. The decimal point position for the setpoint and hysteresis values follow the selection set in Module 1.

HYSTERESIS VALUE

Enter desired hysteresis value. See Setpoint Output Figures for visual explanation of how setpoint output actions (balanced and unbalanced) are affected by the hysteresis. When the setpoint is a control output, usually balanced hysteresis is used. For alarm applications, usually unbalanced hysteresis is used. For unbalanced hysteresis modes, the hysteresis functions on the low side for high acting setpoints and functions on the high side for low acting setpoints.

Note: Hysteresis eliminates output chatter at the switch point, while time delay can be used to prevent false triggering during process transient events.

ON TIME DELAY

Enter the time value in seconds that the output is delayed from turning on after the trigger point is reached. A value of 0.0 allows the meter to update the output status per the response time listed in the Specifications.

OFF TIME DELAY

Enter the time value in seconds that the output is delayed from turning off after the trigger point is reached. A value of 0.0 allows the meter to update the output status per the response time listed in the Specifications.

OUTPUT RESET ACTION

Enter the reset action of the output. See figure for details.

Auto = Automatic action; This action allows the output to automatically reset off at the trigger points per the Setpoint Action shown in Setpoint Output Figures. The “on” output may be manually reset (off) immediately by the front panel RST button or user input. The output remains off until the trigger point is crossed again.

LATCH = Latch with immediate reset action; This action latches the output on at the trigger point per the Setpoint Action shown in Setpoint Output Figures. Latch means that the output can only be turned off by the front panel RST button or user input manual reset, serial reset command or meter power cycle.
When the user input or RST button is activated (momentary action), the corresponding “on” output is reset immediately and remains off until the trigger point is crossed again. (Previously latched alarms will be off if power up Display Value is lower than setpoint value.)

L-dLY = Latch with delay reset action; This action latches the output on at the trigger point per the Setpoint Action shown in Setpoint Output Figures. Latch means that the output can only be turned off by the front panel RST button or user input manual reset, serial reset command or meter power cycle. When the user input or RST button is activated (momentary action), the meter delays the event until the corresponding “on” output crosses the trigger off point. (Previously latched outputs are off if power up Display Value is lower than setpoint value. During a power cycle, the meter erases a previous L-dLY reset if it is not activated at power up.)

This parameter enables the RST button or user input to reset the output when the display is reset.

Note: For this parameter to operate, the RST button or User Input being used must be set to dSP and the Input value must be displayed. If these conditions are not met, the output will not reset.

The Serial Setup Parameters are only active when the optional RS232 or RS485 serial communications module is installed in the meter. Refer to the CUB5COM bulletin for complete details on CUB5 serial communications.
Press and hold SEL button to enter Programming Mode.
MODEL CUB5RT - MINIATURE ELECTRONIC 5-DIGIT RTD METER

- MINIMUM AND MAXIMUM DISPLAY CAPTURE
- LCD, REFLECTIVE OR GREEN/RED LED BACKLITING
- 0.48" (12.2 mm) HIGH DIGITS
- OPTIONAL SETPOINT OUTPUT MODULES
- OPTIONAL SERIAL COMMUNICATION MODULES (RS232 or RS485)
- OPERATES FROM 9 TO 28 VDC POWER SOURCE
- FRONT PANEL OR CRIMSON PROGRAMMABLE
- DISPLAY COLOR CHANGE CAPABILITY AT SETPOINT OUTPUT
- NEMA 4X/IP65 SEALED FRONT BEZEL

GENERAL DESCRIPTION
The CUB5 provides the user the ultimate in flexibility, from its complete user programming to the optional setpoint control and communication capability. The CUB5RT accepts an RTD input and provides a temperature display in Celsius or Fahrenheit. The meter also features minimum and maximum display capture, display offset, °F or °C indicator, and programmable user input. The display can be toggled either manually or automatically between the selected displays.

The CUB5 display has 0.48" (12.2 mm) high digits. The LCD is available in two versions, reflective and red/green backlight. The backlight version is user selectable for the desired color and also has variable display intensity.

The capability of the CUB5 can be easily expanded with the addition of option modules. Setpoint capability is field installable with the addition of the setpoint output modules. Serial communications capability for RS232 or RS485 is added with a serial option module.

The CUB5 can be powered from an optional Red Lion® Micro-Line/Sensor Power Supply (MLPS1000), which attaches directly to the back of a CUB5. The MLPS1 is powered from 85 to 250 VAC and provides up to 400 mA to drive the unit and sensors.

SAFETY SUMMARY
All safety related regulations, local codes and instructions that appear in this literature or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use this meter to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the meter.

CAUTION: Risk of Danger.
Read complete instructions prior to installation and operation of the unit.

CAUTION: Risk of electric shock.

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.15" (54.6) H x 3.00" (76.2) W.
### Ordering Information

<table>
<thead>
<tr>
<th>TYPE</th>
<th>MODEL NO.</th>
<th>DESCRIPTION</th>
<th>PART NUMBER</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CUB5</td>
<td>CUB5RT</td>
<td>RTD Meter with Reflective Display</td>
<td>CUB5RT0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RTD Meter with Backlight Display</td>
<td>CUB5RT0</td>
<td></td>
</tr>
<tr>
<td>Optional Plug-in Cards</td>
<td>CUB5RLY</td>
<td>Single Relay Output Card</td>
<td>CUB5RLY0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CUB5SNK</td>
<td>Dual Sinking Output Card</td>
<td>CUB5SNK0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CUB5COM</td>
<td>RS485 Serial Communications Card</td>
<td>CUB5COM1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CUB5USB</td>
<td>USB Programming Card for CUB5 Products</td>
<td>CUB5USB0</td>
<td></td>
</tr>
<tr>
<td>Accessories</td>
<td>MLPS1</td>
<td>Micro-Line Power Supply, 85 to 250 VAC</td>
<td>MLPS1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CBLFRG</td>
<td>RS232 Programming Cable (DB9-RJ11)</td>
<td>CBLFRG0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CBPRO</td>
<td>Crimson 2 PC Configuration Software for Windows 98, ME, 2000, XP</td>
<td>SFCRD200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CBLUSB</td>
<td>USB Programming Cable</td>
<td>CBLUSB00</td>
<td></td>
</tr>
</tbody>
</table>

1. **DISPLAY:** 5 digit LCD 0.48” (12.2 mm) high digits

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>DISPLAY COLOR</th>
<th>INPUT CURRENT @ 9 VDC WITHOUT CUB5RLY0</th>
<th>INPUT CURRENT @ 9 VDC WITH CUB5RLY0</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CUB5RT0</td>
<td>---</td>
<td>10 mA</td>
<td>40 mA</td>
<td></td>
</tr>
<tr>
<td>CUB5TB0</td>
<td>Red (max intensity)</td>
<td>85 mA</td>
<td>115 mA</td>
<td></td>
</tr>
<tr>
<td>CUB5TB0</td>
<td>Green (max intensity)</td>
<td>95 mA</td>
<td>125 mA</td>
<td></td>
</tr>
</tbody>
</table>

3. **READOUT:**

- Resolution: 1 or 0.1 degrees
- Scale: °F or °C
- Offset Range: -19999 to 19999 display units

4. **RTD INPUTS:**

- **Isolation:** Input and EXC terminals are not electrically isolated from the power supply or optional comms cards.
- **Response Time:** 500 msec.
- **Failed Sensor Display:** LED or Shunt
- **Overrange/Underrange Input:** DL/UL/UL
- **Overrange/Underrange Display:** "....."/-"....."
- **Maximum Input Voltage:** 30 VDC

5. **USER INPUT (USR):** Programmable input. Connect terminal to common (USR COMM) to activate function. Internal 10kΩ pull-up resistor to +9 to 28 VDC.

- **Threshold Levels:** VIL = 1.0 V max; VIH = 2.4 V min; VMAX = 28 VDC
- **Response Time:** 5 msec typ.; 50 msec debounce (activation and release)

6. **CERTIFICATIONS AND COMPLIANCES:**

- **SAFETY**
  - UL Recognized Component, File #E179259, UL61010A-1, CSA 22.2 No. 61010-1
  - Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
  - UL Listed, File # E179259, UL50, CSA C22.2 No. 14-M05
  - Listed by Und. Lab. Inc. to U.S. and Canadian safety standards
  - Type 4X Indoor Enclosure rating (Face only), UL50
  - IECCE CB Scheme Test Certificate #US0257C/UL.
  - CB Scheme Test Report #E179259-V01-S02
  - Issued by Underwriters Laboratories, Inc.
  - IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
  - IP65 Enclosure rating (Face only), IEC 60529

- **ELECTROMAGNETIC COMPATIBILITY**
  - Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.

7. **MEMORY:** Nonvolatile E2PROM memory retains all programming parameters and max/min values when power is removed.

8. **CONNECTIONS:** Wire clamping screw terminals

- **Wire Strip Length:** 0.3” (7.5 mm)
- **Wire Gage:** 30-14 AWG copper wire
- **Torque:** 5 inch-lbs (0.565 N-m) max.

---

1 Crimson 2 software is a free download from http://www.redlion.net/
9. ENVIRONMENTAL CONDITIONS:
Operating Temperature Range for CUB5TCR0: -35 to 75°C
Operating Temperature Range for CUB5TCB0 depends on display color and intensity level as per below:

<table>
<thead>
<tr>
<th>INTENSITY LEVEL</th>
<th>TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Display</td>
<td>-35 to 75°C</td>
</tr>
<tr>
<td>1 &amp; 2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-35 to 100°C</td>
</tr>
<tr>
<td>4</td>
<td>-35 to 60°C</td>
</tr>
<tr>
<td>5</td>
<td>-35 to 50°C</td>
</tr>
<tr>
<td>Green Display</td>
<td>-35 to 75°C</td>
</tr>
<tr>
<td>1 &amp; 2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-35 to 65°C</td>
</tr>
<tr>
<td>4</td>
<td>-35 to 50°C</td>
</tr>
<tr>
<td>5</td>
<td>-35 to 35°C</td>
</tr>
</tbody>
</table>

Storage Temperature: -35 to 75°C
Operating and Storage Humidity: 0 to 85% max. relative humidity (non-condensing)
Vibration According to IEC 68-2-6: Operational 5 to 500 Hz, in X, Y, Z direction for 1.5 hours, 5g’s.
Shock According to IEC 68-2-27: Operational 30 g, 11 msec in 3 directions.
Altitude: Up to 2000 meters

10. CONSTRUCTION: This unit is rated for NEMA 4X/IP65 requirements for indoor use. Installation Category I, Pollution Degree 2. High impact plastic case with clear viewing window. Panel gasket and mounting clip included.

11. WEIGHT: 3.2 oz (100 g)

OPTIONAL PLUG-IN CARDS

ADDING OPTION CARDS
The CUB5 meters can be fitted with optional output cards and/or serial communications cards. The details for the plug-in cards can be reviewed in the specification section below. The plug-in cards, that are sold separately, can be installed initially or at a later date.

WARNING: Disconnect all power to the unit before installing Plug-in card.

SINGLE RELAY CARD
Type: Single FORM-C relay
Isolation To Sensor & User Input Commons: 1400 Vrms for 1 min.
Working Voltage: 150 Vrms
Contact Rating: 1 amp @ 30 VDC resistive; 0.3 amp @ 125 VAC resistive
Life Expectancy: 100,000 minimum operations
Response Time:
  Turn On Time: 4 msec max.
  Turn Off Time: 4 msec max.

DUAL SINKING OUTPUT CARD
Type: Non-isolated switched DC, N Channel open drain MOSFET
Current Rating: 100 mA max.
\( V_{DS \text{ ON}} \): 0.7 V @ 100 mA
\( V_{DS \text{ MAX}} \): 30 VDC
Offset Leakage Current: 0.5 mA max.

RS485 SERIAL COMMUNICATIONS CARD
Type: RS485 multi-point balanced interface (non-isolated)
  Note: Non-grounded (isolated) RTD probes must be used when multiple units are connected in an RS485 network, or measurement errors will occur.
Baud Rate: 300 to 38.4k
Data Format: 7/8 bits; odd, even, or no parity
Bus Address: 0 to 99; max 32 meters per line
Transmit Delay: Selectable (refer to CUB5COM bulletin)

RS232 SERIAL COMMUNICATIONS CARD
Type: RS232 half duplex (non-isolated)
Baud Rate: 300 to 38.4k
Data Format: 7/8 bits; odd, even, or no parity

1.0 INSTALLING THE METER

INSTALLATION
The meter meets NEMA 4X/IP65 requirements when properly installed. The unit is intended to be mounted into an enclosed panel. Prepare the panel cutout to the dimensions shown. Remove the panel latch from the unit. Slide the panel gasket over the rear of the unit to the back of the bezel. The unit should be installed fully assembled. Insert the unit into the panel cutout.

While holding the unit in place, push the panel latch over the rear of the unit so that the tabs of the panel latch engage in the slots on the case. The panel latch should be engaged in the farthest forward slot possible. To achieve a proper seal, tighten the latch screws evenly until the unit is snug in the panel (Torque to approx. 28 to 36 in-oz [0.202 to 0.26 N-m]). Do not over-tighten the screws.

INSTALLATION ENVIRONMENT
The unit should be installed in a location that does not exceed the operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.
The bezel should only be cleaned with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.
Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.

This document provided by Barr-Thorp Electric Co., Inc. 800-473-9123 www.barr-thorp.com
2.0 Setting the Jumpers

**Input Range Jumper**

This jumper is used to select the proper input range. The input range selected in programming must match the jumper setting. Select a range that is high enough to accommodate the maximum input signal to avoid overloads. To access the jumper, remove the rear cover of the meter.

*Warning:* Exposed line voltage exists on the circuit boards. Remove all power to the meter and load circuits before accessing inside of the meter.

**Removing the Rear Cover**

To remove the rear cover, locate the cover locking tab below the 2nd and 3rd input terminals. To release the tab, insert a small, flat blade screwdriver between the tab and the plastic wall below the terminals. Inserting the screwdriver will provide enough pressure to release the tab locks. To replace the cover, align the cover with the input terminals and press down until the cover snaps into place.

2.0 Installing Plug-In Cards

**Warning:** Exposed line voltage exists on the circuit boards. Remove all power to the meter and load circuits before accessing inside of the meter.

**Caution:** The Plug-in cards and main circuit board contain static sensitive components. Before handling the cards, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle the cards at a static controlled clean workstation. Also, only handle the cards by the edges. Dirt, oil or other contaminants that may contact the cards can adversely affect circuit operation.

**Removing the Rear Cover**

To remove the rear cover, locate the cover locking tab below the 2nd and 3rd input terminals. To release the tab, insert a small, flat blade screwdriver between the tab and the plastic wall below the terminals. Inserting the screwdriver will provide enough pressure to release the tab locks. To replace the cover, align the cover with the input terminals and press down until the cover snaps into place.

The Plug-in cards are separately purchased option cards that perform specific functions. The cards plug into the main circuit board of the meter.

3.0 Wiring the Meter

**Wiring Overview**

Electrical connections are made via screw-clamp terminals located on the back of the meter. All conductors should conform to the meter’s voltage and current ratings. All cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that the power supplied to the meter (DC or AC) be protected by a fuse or circuit breaker. Strip the wire, leaving approximately 0.3” (7.5 mm) bare lead exposed (stranded wires should be tinned with solder.) Insert the lead under the correct screw-clamp terminal and tighten until the wire is secure. (Pull wire to verify tightness.) Each terminal can accept up to one #14 AWG (2.55 mm) wire, two #18 AWG (1.02 mm), or four #20 AWG (0.61 mm).

**EMC Installation Guidelines**

Although this meter is designed with a high degree of immunity to Electro-Magnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into the meter may be different for various installations. The meter becomes more immune to EMI with fewer I/O connections. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation. Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The meter should be mounted in a metal enclosure, which is properly connected to protective earth.
2. Use shielded (screened) cables for all Signal and Control inputs. The shield (screen) pigtail connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.
   a. Connect the shield only at the panel where the unit is mounted to earth ground (protective earth).
   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is above 1 MHz.
   c. Connect the shield to the common of the meter and leave the other end of the shield unconnected and insulated from earth ground.
3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
4. Signal or Control cables within an enclosure should be routed as far as possible from contactors, control relays, transformers, and other noisy components.
5. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:
   - Ferrite Suppression Cores for signal and control cables: Fair-Rite # B443167251 (RLC# FCOR0000)
   - Line Filters for input power cables:
     - Schaffner # FN610-1/07 (RLC# LFIL0000)
     - Schaffner # FN670-1.8/07
   - Note: Reference manufacturer’s instructions when installing a line filter.
6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
7. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.
   - Snubber: RLC# SNUB0000.
3.1 POWER WIRING
DC Power
+9 to +28 VDC: +VDC
Power Common: -VDC

3.2 USER INPUT WIRING
Sinking Logic
USR COMM  Connect external switching device between the
USR     User Input terminal and User Input Common.

The user input of the meter is internally pulled up to +9 to +28 V with 10 K resistance. The input is active when it is pulled low (<0.7 V).

3.3 INPUT WIRING

3.4 SETPOINT (OUTPUT) WIRING

CAUTION: Power input common and sensor input common are NOT isolated from user input common. In order to preserve the safety of the meter application, the power input common and the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

3.5 SERIAL COMMUNICATION WIRING

Output Common is not isolated from DC Power Common. Load must be wired between OSNK terminal and V+ of the load supply.
4.0 REVIEWING THE FRONT BUTTONS AND DISPLAY

It is recommended that all programming changes be made off line, or before installation. The meter normally operates in the Display Mode. No parameters can be programmed in this mode. The Programming Mode is entered by pressing and holding the SEL button. If it is not accessible then it is locked by either a security code, or a hardware lock.

MODULE ENTRY (SEL & RST BUTTONS)

The Programming Menu is organized into separate modules. These modules group together parameters that are related in function. The display will alternate between Pro and the present module. The RST button is used to select the desired module. The displayed module is entered by pressing the SEL button.

MODULE MENU (SEL BUTTON)

Each module has a separate module menu (which is shown at the start of each module discussion). The SEL button is pressed to advance to a particular parameter to be changed, without changing the programming of preceding parameters. After completing a module, the display will return to Pro NO. Programming may continue by accessing additional modules.

SELECTION / VALUE ENTRY

For each parameter, the display alternates between the present parameter and the selections/value for that parameter. The RST button is used to move through the selections/values for that parameter. Pressing the SEL button, stores and activates the displayed selection/value. This also advances the meter to the next parameter.

For numeric values, press the RST button to access the value. The right hand most digit will begin to flash. Pressing the RST button again increments the digit by one or the user can hold the RST button and the digit will automatically scroll. The SEL button will advance to the next digit. Pressing and holding the SEL button will enter the value and move to the next parameter.

PROGRAMMING MODE EXIT (SEL BUTTON)

The Programming Mode is exited by pressing the SEL button with Pro NO displayed. This will commit any stored parameter changes to memory and return the meter to the Display Mode. (If power loss occurs before returning to the Display Mode, verify recent parameter changes.)

PROGRAMMING TIPS

It is recommended to start with Module 1 and proceed through each module in sequence. When programming is complete, it is recommended to record the parameter programming and lock out parameter programming with the user input or programming security code.

FACTORY SETTINGS

Factory Settings may be completely restored in Module 2. This is useful when encountering programming problems.

Pressing both the SEL and the RST button on power-up will also load the factory settings and display rESEt. This allows operation in the event of a memory failure or corrupted data.

ALTERNATING SELECTION DISPLAY

In the explanation of the modules, the following dual display with arrows will appear. This is used to illustrate the display alternating between the parameter on top and the parameter’s Factory Setting on the bottom. In most cases, selections and values for the parameter will be listed on the right.

5.0 PROGRAMMING THE METER

OVERVIEW

PROGRAMMING MENU

Indicates Program Mode Alternating Display

Parameter  Selection/Value

Factory Settings are shown.
5.1 MODULE 1 - SIGNAL INPUT PARAMETERS (I- INP)

PARAMETER MENU

RTD TYPE

- SELECTION
- TYPE
- RANGE JUMPERS
Pt385  RTD Platinum 385  100 ohm
Pt392  RTD Platinum 392  100 ohm
Ni672  RTD Nickel 672  100 ohm
Cu102  RTD Copper 10Ω  10 ohm

FILTER BAND

- 00 to 199 display units

The filter will adapt to variations in the input signal. When the variation exceeds the input filter band value, the filter disengages. When the variation becomes less than the band value, the filter engages again. This allows for a stable readout, but permits the display to settle rapidly after a large process change. The value of the band is in display units, independent of the Display Decimal Point position. A band setting of '0' keeps the filter permanently engaged at the filter level selected in the previous parameter.

TEMPERATURE SCALE

- °F   °C

Select the temperature scale. This selection applies for the Input, MAX and MIN displays.

DISPLAY DECIMAL POINT

- 0   00

Select the decimal point location for the desired display resolution. This selection applies for the Input, MAX and MIN displays.

DISPLAY OFFSET VALUE

- -19999 to 19999

The temperature display can be corrected with an offset value. This can be used to compensate for probe errors, errors due to variances in probe placement or adjusting the readout to a reference thermometer.

FILTER SETTING

- 0   1   2   3

If the displayed temperature is difficult to read due to small process variations or noise, increased levels of filtering will help to stabilize the display. Software filtering effectively combines a fraction of the current input reading with a fraction of the previous displayed reading to generate the new display.

Filter values represent no filtering (0), up to heavy filtering (3). A value of 1 for the filter uses 1/4 of the new input and 3/4 of the previous display to generate the new display. A filter value of 2 uses 1/8 new and 7/8 previous. A filter value of 3 uses 1/16 new and 15/16 previous.

USER INPUT FUNCTION

DISPLAY MODE

- No Function
- P- Loc Program Mode Lock-out
- rESEt Reset (Edge triggered)
- d-HLd Display Hold
- d-SEL Display Select (Edge triggered)
- d-LEV Display Intensity Level (Edge triggered)
- COLOr Backlight Color (Edge triggered)
- P-Rnt Print Request
- P- rSt-1 Print and Reset
- rSt-2 Setpoint 1 Reset
- rSt-12 Setpoint 1 and 2 Reset
- rSt-1 rSt-2

DESCRIPTION

User Input disabled.
See Programming Mode Access chart (Module 3).
Resets the assigned value(s) to the current input value.
Holds the assigned display, but all other meter functions continue as long as activated (maintained action).
Advance once for each activation.
Increase intensity one level for each activation (backlight version only).
Change backlight color with each activation (backlight version only).
Serial transmit of the active parameters selected in the Print Options menu (Module 5).
Same as Print Request followed by a momentary reset of the assigned value(s).
Resets setpoint 1 output.
Resets setpoint 2 output.
Reset both setpoint 1 and 2 outputs.

USER INPUT ASSIGNMENT

- HI   LO
- dSP

Select the value(s) to which the User Input Function is assigned. The User Input Assignment only applies if a selection of reset, display hold, or print and reset is selected in the User Input Function menu.
### 5.2 MODULE 2 - SECONDARY FUNCTION PARAMETERS (2-SEC)  

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Description</th>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX DISPLAY ENABLE</td>
<td>Enables the Maximum Display Capture capability.</td>
<td></td>
<td>NO/YES</td>
</tr>
<tr>
<td>MAX CAPTURE DELAY TIME</td>
<td>When the Input Display is above the present MAX value for the entered delay time, the meter will capture that display value as the new MAX reading. A delay time helps to avoid false captures of sudden short spikes.</td>
<td></td>
<td>0 to 9999 sec.</td>
</tr>
<tr>
<td>MIN DISPLAY ENABLE</td>
<td>Enables the Minimum Display Capture capability.</td>
<td></td>
<td>NO/YES</td>
</tr>
<tr>
<td>MIN CAPTURE DELAY TIME</td>
<td>When the Input Display is below the present MIN value for the entered delay time, the meter will capture that display value as the new MIN reading. A delay time helps to avoid false captures of sudden short spikes.</td>
<td></td>
<td>0 to 9999 sec.</td>
</tr>
<tr>
<td>FACTORY SERVICE OPERATIONS</td>
<td>Select YES to perform any of the Factory Service Operations shown below.</td>
<td></td>
<td>NO/YES</td>
</tr>
</tbody>
</table>

### CALIBRATION

The CUB5RT uses stored resistance calibration values to provide accurate temperature measurements. Over time, the electrical characteristics of the components inside the meter could slowly change. The result is that the stored calibration values may no longer accurately define the input circuit. For most applications, recalibration every 1 to 2 years should be sufficient.

Calibration of the CUB5RT involves a resistance calibration. Allow 30 minute warm up before performing any calibration related procedure. The following procedures should be performed at an ambient temperature of 15 to 35 °C (59 to 95 °F). Calibration should only be performed by individuals experienced in calibrating electronic equipment.

**CAUTION:** The accuracy of the calibration equipment will directly affect the accuracy of the CUB5RT.

#### 10 OHM RTD Range Calibration

1. Set the Input Range Jumper to 10 ohm.
2. With the display at Code 48, press and hold the SEL button for 2 seconds. Unit will display 00.0.0.00.
3. Press the RST button. Display reads 0.0.0.0.
4. Press the SEL button. Display reads 0.0.
5. Apply a direct short to terminals INP+, EXC, and COMM using a three wire link. Press SEL. Display reads 0.0 for about 15 seconds.
6. When the display reads 0.0, apply a precision resistance of 15 ohms (with an accuracy of 0.01% or better) to terminals INP+, EXC, and COMM using a three wire link. Press SEL. Display reads 0.0 for about 15 seconds.
7. When display reads 0.0.0.0, press the SEL button to exit calibration, or proceed to the 100 ohm RTD Range Calibration.

#### 100 OHM RTD Range Calibration

1. Set the Input Range Jumper to 100 ohm.
2. With the display at Code 85, press and hold the SEL button for 2 seconds. Unit will display 00.0.0.00.
3. Press the RST button until the display reads 0.0.0.0.
4. Press the SEL button. Display reads 0.0.
5. Apply a direct short to terminals INP+, EXC, and COMM using a three wire link. Press SEL. Display reads 0.0 for about 15 seconds.
6. When the display reads 0.0, apply a precision resistance of 300 ohms (with an accuracy of 0.01% or better) to terminals INP+, EXC, and COMM using a three wire link. Press SEL. Display reads 0.0 for about 15 seconds.
7. When display reads 0.0.0.0, press the SEL button to exit calibration.

### RESISTANCE DISPLAY MODE

Entering Code 85 will place the CUB5RT in a resistance display mode. This mode is useful for diagnostic purposes before and after calibration, or to display the measured resistance of a connected RTD probe. If the RTD type is set for Cu100, with the jumper set to the 10 ohm position, the display will read resistance in 1000 ohms resolution. For all other RTD types, with the jumper in the 100 ohm position, the display will read in 500 ohms resolution.

Re-entering code 85 toggles the display back to the temperature display mode without having to remove power from the meter. If power is removed, the display always returns to the temperature display mode when power is reapplied.
5.3 MODULE 3 - DISPLAY AND FRONT PANEL BUTTON PARAMETERS (3-dSP)

**PARAMETER MENU**

<table>
<thead>
<tr>
<th>dSP-t</th>
<th>SEL</th>
<th>Frn</th>
<th>rSt</th>
<th>ScroL</th>
<th>CodE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Display Update Time**
  - dSP-t
  - 0.5 to 2 seconds
  - This parameter sets the display update time in seconds.

- **Display Intensity Level (Backlight Unit Only)**
  - d·LEU
  - 1 to 5
  - Enter the desired Display Intensity Level (1-5). The display will actively dim or brighten as levels are changed. This parameter is active for backlight units only.

- **Front Panel Display Select Enable (SEL)**
  - SEL
  - YES / NO
  - The YES selection allows the SEL button to toggle through the enabled displays.

- **Front Panel Reset Enable (RST)**
  - rSt
  - NO / LO / dSP / HI / HI-LO
  - This selection allows the RST button to reset the selected value(s).

- **Display Scroll Enable**
  - ScroL
  - NO / YES
  - The YES selection allows the display to automatically scroll through the enabled displays. The scroll rate is every 4 seconds.

- **Display Color (Backlight Unit Only)**
  - COLOR
  - rEd / brn
  - Enter the desired display color, red or green. This parameter is active for backlight units only.

**PROGRAMMING SECURITY CODE**

<table>
<thead>
<tr>
<th>CodE</th>
<th>000 to 999</th>
</tr>
</thead>
</table>

- The Security Code determines the programming mode and the accessibility of programming parameters. This code can be used along with the Program Mode Lock-out (P·Loc) in the User Input Function parameter (Module 1).

- Two programming modes are available. Full Programming mode allows all parameters to be viewed and modified. Quick Programming mode permits only the Setpoint values to be modified, but allows direct access to these values without having to enter Full Programming mode.

- Programming a Security Code other than 0, requires this code to be entered at the CodE prompt in order to access Full Programming mode. Depending on the code value, Quick Programming may be accessible before the CodE prompt appears (see chart).

**USER INPUT FUNCTION**

<table>
<thead>
<tr>
<th>USER INPUT FUNCTION</th>
<th>USER INPUT STATE</th>
<th>SECURITY CODE</th>
<th>MODE WHEN “SEL” BUTTON IS PRESSED</th>
<th>FULL PROGRAMMING MODE ACCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>not P·Loc</td>
<td>0</td>
<td>Full Programming</td>
<td>Immediate Access</td>
<td></td>
</tr>
<tr>
<td>1-99</td>
<td>Quick Programming</td>
<td>After Quick Programming with correct code entry at CodE prompt *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100-999</td>
<td>CodE prompt</td>
<td>With correct code entry at CodE prompt *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P·Loc</td>
<td>Active</td>
<td>0</td>
<td>Programming Lock</td>
<td>No Access</td>
</tr>
<tr>
<td>1-99</td>
<td>Quick Programming</td>
<td>No Access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100-999</td>
<td>CodE prompt</td>
<td>With correct code entry at CodE prompt *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Active</td>
<td>0-999</td>
<td>Full Programming</td>
<td>Immediate Access</td>
<td></td>
</tr>
</tbody>
</table>

* Entering Code 222 allows access regardless of security code.
### 5.4 MODULE 4 - SETPOINT OUTPUT PARAMETERS (4-SPt)

#### PARAMETER MENU

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPSEL</td>
<td>Setpoint Select</td>
</tr>
<tr>
<td>Act-n</td>
<td>Setpoint Action</td>
</tr>
<tr>
<td>SP-1</td>
<td>Setpoint Value</td>
</tr>
<tr>
<td>HYS-n</td>
<td>Hysteresis Value</td>
</tr>
<tr>
<td>ED-n</td>
<td>On Time Delay</td>
</tr>
<tr>
<td>EDf-n</td>
<td>Off Time Delay</td>
</tr>
<tr>
<td>Stk-n</td>
<td>Output Action</td>
</tr>
<tr>
<td>En-n</td>
<td>Output Reset</td>
</tr>
<tr>
<td>Sb-n</td>
<td>Standby Operation</td>
</tr>
<tr>
<td>Lc-n</td>
<td>Change Color with Output</td>
</tr>
</tbody>
</table>

The Setpoint Output Parameters are only active when an optional output module is installed in the meter.

#### SETPOINT SELECT

**SPSEL**

<table>
<thead>
<tr>
<th>SPSEL</th>
<th>100</th>
</tr>
</thead>
</table>

Enter the setpoint (output) to be programmed. The parameters will reflect the chosen setpoint number. After the chosen setpoint is completely programmed, the display will return to SPSEL. Repeat steps for each setpoint to be programmed. Select **NO** to exit the module. The number of setpoints available is setpoint output card dependent.

#### SETPOINT 2 ENABLE

**Enb-2**

<table>
<thead>
<tr>
<th>Enb-2</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

Select **YES** to enable Setpoint 2 and access the setup parameters. If **NO** is selected, the unit returns to SPSEL and setpoint 2 is disabled.

#### SETPOINT ACTION

**Act-n**

<table>
<thead>
<tr>
<th>Act-n</th>
<th>HI-bL</th>
<th>LO-bL</th>
<th>HI-Ub</th>
<th>LO-Ub</th>
</tr>
</thead>
</table>

Enter the action for the selected setpoint (output). See Setpoint Output Figures for a visual detail of each action.

- **HI-bL**: High Acting, with balanced hysteresis
- **LO-bL**: Low Acting, with balanced hysteresis
- **HI-Ub**: High Acting, with unbalanced hysteresis
- **LO-Ub**: Low Acting, with unbalanced hysteresis

#### HYSTERESIS VALUE

**HYS-n**

<table>
<thead>
<tr>
<th>HYS-n</th>
<th>2</th>
</tr>
</thead>
</table>

Enter desired hysteresis value. See Setpoint Output Figures for visual explanation of how setpoint output actions (balanced and unbalanced) are affected by the hysteresis. When the setpoint is a control output, usually balanced hysteresis is used. For alarm applications, usually unbalanced hysteresis is used. For unbalanced hysteresis modes, the hysteresis functions on the low side for high acting setpoints and functions on the high side for low acting setpoints.

**Note:** Hysteresis eliminates output chatter at the switch point, while time delay can be used to prevent false triggering during process transient events.

#### ON TIME DELAY

**ED-n**

<table>
<thead>
<tr>
<th>ED-n</th>
<th>0.0</th>
</tr>
</thead>
</table>

Enter the time value in seconds that the output is delayed from turning on after the trigger point is reached. A value of 0.0 allows the meter to update the output status per the response time listed in the Specifications.

#### OFF TIME DELAY

**EDf-n**

<table>
<thead>
<tr>
<th>EDf-n</th>
<th>0.0</th>
</tr>
</thead>
</table>

Enter the time value in seconds that the output is delayed from turning off after the trigger point is reached. A value of 0.0 allows the meter to update the output status per the response time listed in the Specifications.

#### OUTPUT RESET ACTION

<table>
<thead>
<tr>
<th>Auto</th>
<th>Latch</th>
<th>L-dly</th>
</tr>
</thead>
</table>

Enter the reset action of the output. See figure for details.

- **Auto**: Automatic action; This action allows the output to automatically reset off at the trigger points per the Setpoint Action shown in Setpoint Output Figures. The “on” output may be manually reset (off) immediately by the front panel **RST** button or user input. The output remains off until the trigger point is crossed again.

- **Latch**: Latch with immediate reset action; This action latches the output on at the trigger point per the Setpoint Action shown in Setpoint Output Figures. Latch means that the output can only be turned off by the front panel **RST** button or user input manual reset, serial reset command or meter power cycle.
When the user input or RST button is activated (momentary action), the corresponding "on" output is reset immediately and remains off until the trigger point is crossed again. (Previously latched alarms will be off if power up Display Value is lower than setpoint value.)

L·dLY = Latch with delay reset action; This action latches the output on at the trigger point per the Setpoint Action shown in Setpoint Output Figures. Latch means that the output can only be turned off by the front panel RST button or user input manual reset, serial reset command or meter power cycle. When the user input or RST button is activated (momentary action), the meter delays the event until the corresponding "on" output crosses the trigger off point. (Previously latched outputs are off if power up Display Value is lower than setpoint value. During a power cycle, the meter erases a previous L·dLY reset if it is not activated at power up.)

Enter the probe burn-out action. In the event of a temperature probe failure (open or short), the output can be programmed to be on or off.

This parameter enables the backlight CUB5 to switch the backlight color when the output state changes. This parameter is only active for the backlight version.

When YES, the output is disabled (after a power up) until the trigger point is crossed. Once the output is on, the output operates normally per the Setpoint Action and OutputReset Action.

Enter the probe burn-out action. In the event of a temperature probe failure (open or short), the output can be programmed to be on or off.

This parameter enables the backlight CUB5 to switch the backlight color when the output state changes. This parameter is only active for the backlight.

The Serial Setup Parameters are only active when the optional RS232 or RS485 serial communications module is installed in the meter. Refer to the CUB5COM bulletin for complete details on CUB5 serial communications.
Press and hold SEL button to enter Programming Mode.
MODEL PAXLTC - PAX LITE THERMOCOUPLE METER

GENERAL DESCRIPTION
The Pax Lite Thermocouple Meter accepts inputs from standard thermocouples and precisely linearizes them. A full 4-digit display accommodates a wide range of temperature inputs. The unit automatically compensates for cold junction, NBS linearity and the meter’s zero and span.

The meter features a readout choice of either Fahrenheit or Celsius with 0.1 or 1 degree resolution. English Style display prompts and front panel buttons aid the operator through set-up and operation. With a few simple steps the unit can be used as a millivolt meter by selecting “70-U” for thermocouple type. This mode is useful in monitoring and displaying the actual voltage produced at the thermocouple probe junction and as an aid in troubleshooting for a faulty thermocouple probe.

The meter provides a Peak (HI) and Valley (LO) reading memory with selectable capture delay time. The capture delay is used to prevent detection of false Peak or Valley readings that may occur during start-up or unusual process events. The Peak and Valley readings are stored at power-down to allow monitoring the process limits over any length of time (shifts, days, etc.).

Programmable digital filtering enhances the stability of the reading. All set-up data is stored in EEPROM, which will hold data for a minimum of 10 years without power. The meter has several built-in diagnostic functions to alert operators of any malfunction.

Extensive testing of noise interference mechanisms and full burn-in makes the indicator extremely reliable in industrial environments. The front bezel meets NEMA 4X/IP65 requirements for wash down applications.

SAFETY SUMMARY
All safety related regulations, local codes and instructions that appear in the literature or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. Do not use this unit to directly command motors, valves, or other actuators not equipped with safeguards. To do so, can be potentially harmful to persons or equipment in the event of a fault to the unit.

DEFINITION OF TERMS
INSTALLATION CATEGORY (overvoltage category) I:
Signal level, special equipment or parts of equipment, telecommunication, electronic, etc. with smaller transient overvoltages than Installation Category (overvoltage category) II.

INSTALLATION CATEGORY (overvoltage category) II:
Local level, appliances, portable equipment, etc. with smaller transient overvoltages than Installation Category (overvoltage category) III.

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1” (53.4) H x 5” (127) W.
ORDERING INFORMATION

Meter Part Numbers

<table>
<thead>
<tr>
<th>MODEL NO</th>
<th>DESCRIPTION</th>
<th>PART NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAXL</td>
<td>TC</td>
<td>0 0</td>
</tr>
</tbody>
</table>

TC - Thermocouple Temperature Meter

Accessories Part Numbers*

<table>
<thead>
<tr>
<th>TYPE</th>
<th>MODEL NO</th>
<th>DESCRIPTION</th>
<th>PART NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessories</td>
<td>PAXLBK</td>
<td>Units Label Kit Accessory</td>
<td>PAXLBK30</td>
</tr>
</tbody>
</table>

*This meter is shipped with °F and °C overlay labels. The label kit is only needed if another units label is desired.
## General Meter Specifications

1. **DISPLAY**: 4-digit, 0.56” (14.2 mm) high LED, minus sign displayed for negative temperatures.
   - **Overrange/Underrange Input**: Flashing “**UL**” or “**UL**”
   - **Overrange/Underrange Display**: “… | …” or “… | …”

2. **POWER**: 85 to 250 VAC, 50/60 Hz, 6 VA
   - **Isolation**: 2300 Vrms for 1 min. between input and supply (300 V working voltage)

3. **CONTROLS**: Three front panel push buttons for meter set-up. Rear terminal input for disabling the front panel.

4. **THERMOCOUPLE TYPES**: T, E, J, K, R, S, B, N or mV scale

5. **RESOLUTION**: 1 degree for all types, or 0.1 degree for T, E, J, K and N only

6. **THERMOCOUPLE RANGE AND ACCURACY**: All errors include NBS conformity, cold junction effect and A/D conversion errors at 23°C after 60 minutes warm-up. Relative Humidity less than 85%.

<table>
<thead>
<tr>
<th>TC TYPE</th>
<th>RANGE</th>
<th>ACCURACY</th>
<th>WIRE COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>-200 to +400°C</td>
<td>±0.8°C</td>
<td>blue</td>
</tr>
<tr>
<td>E</td>
<td>-200 to +1000°C</td>
<td>±0.8°C</td>
<td>purple</td>
</tr>
<tr>
<td>J</td>
<td>-200 to +760°C</td>
<td>±0.8°C</td>
<td>white</td>
</tr>
<tr>
<td>K</td>
<td>-200 to +1250°C</td>
<td>±0.8°C</td>
<td>yellow</td>
</tr>
<tr>
<td>R</td>
<td>0 to +1768°C</td>
<td>±2.1°C</td>
<td>black</td>
</tr>
<tr>
<td>S</td>
<td>0 to +1768°C</td>
<td>±2.1°C</td>
<td>black</td>
</tr>
<tr>
<td>B</td>
<td>+150 to +1620°C</td>
<td>±2.3°C</td>
<td>grey</td>
</tr>
<tr>
<td>N</td>
<td>-200 to +1300°C</td>
<td>±0.8°C</td>
<td>orange</td>
</tr>
<tr>
<td>mV</td>
<td>-10.00 to +80.00 mV</td>
<td>±0.01%</td>
<td></td>
</tr>
</tbody>
</table>

7. **INPUT IMPEDANCE**: 20 MΩ, all types

8. **LEAD RESISTANCE EFFECT**: 20 µΩ/350 Ω
   - **Max Input Voltage Protection**: 70 VDC continuous

9. **OPEN THERMOCOUPLE DETECTION**: Display flashes; “OPEN”
10. **COLD JUNCTION COMPENSATION**: Automatic, 0.02 degree/degree.

11. **READING RATE**: 2.5 readings/second
12. **RESPONSE TIME**: 2 seconds to settle for step input (increases with programmable digital filtering)

13. **LOW FREQUENCY NOISE REJECTION**:
   - **Normal Mode Rejection**: 45 dB @ 50/60 Hz (may be improved by programmable digital filtering)
   - **Common Mode Rejection**: 120 dB, DC to 50/60 Hz

14. **ENVIRONMENTAL CONDITIONS**:
   - **Operating Temperature Range**: 0 to 50 °C
   - **Storage Temperature Range**: -40 to 80 °C
   - **Operating and Storage Humidity**: 85% max (non-condensing) from 0 to 50 °C
   - **Span Drift**: 40 ppm/°C
   - **Zero Drift**: 1 µV/°C
   - **Altitude**: Up to 2000 meters

15. **CERTIFICATIONS AND COMPLIANCES**:
   - **SAFETY**
     - UL Recognized Component, File # E179259
     - UL3101-1, CSA C22.2 No. 1010-1
   - **EMC**
     - **LISTED by Underwriters Laboratories**: UL508, UL508, CSA C22.2 No. 14-M05

16. **CONSTRUCTION**: This unit is rated for NEMA 4X/IP65 indoor use. One piece bezel/case. Flame resistant. Panel gasket and mounting clip included.

17. **INTERFERENCE**:
   - **Electrostatic discharge**: EN 61000-4-2, Criterion A
   - **Electromagnetic RF fields**: EN 61000-4-3, Criterion A
   - **Fast transients (burst)**: EN 61000-4-4, Criterion A
   - **Surge**: EN 61000-4-5, Criterion A
   - **RF conducted interference**: EN 61000-4-6, Criterion A
   - **Voltage dip/interruptions**: EN 61000-4-11, Criterion A

18. **WEIGHT**: 0.65 lbs. (0.24 Kg)

---

## Accessories

### Units Label Kit (PAXLBK)
- Each meter has a units indicator with backlighting that can be customized using the Units Label Kit. The backlight is controlled in the programming.
- Each meter is shipped with “°F” and “°C” overlay labels which can be installed into the meter’s bezel display assembly.
1.0 INSTALLING THE METER

Installation

The PAX meets NEMA 4X/IP65 requirements when properly installed. The unit is intended to be mounted into an enclosed panel. Prepare the panel cutout to the dimensions shown. Remove the panel latch from the unit. Slide the panel gasket over the rear of the unit to the back of the bezel. The unit should be installed fully assembled. Insert the unit into the panel cutout.

While holding the unit in place, push the panel latch over the rear of the unit so that the tabs of the panel latch engage in the slots on the case. The panel latch should be engaged in the farthest forward slot possible. To achieve a proper seal, tighten the latch screws evenly until the unit is snug in the panel (Torque to approximately 7 in-lbs [79N-cm]). Do not over-tighten the screws.

Installation Environment

The unit should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should be cleaned only with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.

Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.

2.0 WIRING THE METER

POWER WIRING

Primary AC power is connected to Terminals 1 and 2. To reduce the chance of noise spikes entering the AC line and affecting the indicator, the AC power should be relatively “clean” and within the specified limits. Drawing power from heavily loaded circuits or circuits which also power loads that cycle on and off, (contactors, relays, motors, machinery, etc.) should be avoided.

AC Power
Terminal 1: VAC
Terminal 2: VAC

PROGRAM DISABLE INPUT WIRING

PGM.DIS. (Terminal 3) is a digital input that is active when connected to Comm (Terminal 4). Any form of mechanical switch or current sinking logic with less than 0.7 V saturation may be used. The use of shielded cable is recommended. Follow the EMC Installation Guidelines for shield connection.

SIGNAL WIRING (TC SENSOR)

Remove power and connect the negative thermocouple lead (always red) to TC- (Terminal 6) and the positive lead to TC+ (Terminal 5). Be certain that connections are clean and tight. If the thermocouple probe is to be mounted away from the meter, thermocouple extension grade wire must be used (copper wire will not work). Use the correct type and observe the correct polarity. Always refer to the sensor manufacturer’s instructions for probe wiring connections, if available. For multi-probe temperature averaging applications, two or more thermocouple probes may be connected at the meter. (Always use the same type.) In order to minimize the chances of coupling noise into the wires and subsequently causing bouncy and erroneous readings, proper guidelines for thermocouple wire routing must be followed.

Thermocouple

WIRING OVERVIEW

Electrical connections are made via screw-clamp terminals located on the back of the meter. All conductors should conform to the meter’s voltage and current ratings. All cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that the power supplied to the meter be protected by a fuse or circuit breaker.

When wiring the meter, compare the numbers embossed on the back of the meter case against those shown in wiring drawings for proper wire position. Strip the wire, leaving approximately 0.3” (7.5 mm) bare lead exposed (stranded wires should be tinned with solder). Insert the lead under the correct screw-clamp terminal and tighten until the wire is secure. (Pull wire to verify tightness.)
EMC INSTALLATION GUIDELINES

Although this meter is designed with a high degree of immunity to Electro-Magnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into the meter may be different for various installations. The meter becomes more immune to EMI with fewer I/O connections. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation. Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The meter should be mounted in a metal enclosure, which is properly connected to protective earth.
2. Use shielded (screened) cables for all Signal and Control inputs. The shield (screen) pigtail connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness:
   a. Connect the shield only at the panel where the unit is mounted to earth ground (protective earth).
   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is above 1 MHz.
   c. Connect the shield to common of the meter and leave the other end of the shield unconnected and insulated from earth ground.
3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
4. Signal or Control cables within an enclosure should be routed as far as possible from contacts, control relays, transformers, and other noisy components.
5. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:
   - Ferrite Suppression Cores for signal and control cables:
     - Fair-Rite # 0443167251 (RLC# FCOR0000)
     - TDK # ZCAT3035-1330A
     - Steward # 28B2029-0A
   - Line Filters for input power cables:
     - Schaffner # FN610-1/07 (RLC# LFIL0000)
     - Schaffner # FN670-1.8/07
     - Corcom # 1 VR3
   - Note: Reference manufacturer’s instructions when installing a line filter.
6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.

3.0 REVIEWING THE FRONT BUTTONS AND DISPLAY

Display Valley (LO) Reading
Display Peak (HI) Reading
PAR
PROGRAMMING MODE OPERATION
Store selected parameter and index to next parameter
Increment value or change selection
Decrement value or change selection

PEAK/VALLEY DETECTION

The meter will automatically record the highest input reading (peak) and the lowest input reading (valley) for later recall. These values are stored at power-down to allow monitoring the process limits over any length of time (shifts, days, etc.). A selectable capture delay time is used to prevent detection of false peak or valley readings caused by sudden short spikes or unusual process events.

The peak and valley readings can be viewed and reset using the front panel keys as described below.

View Peak, Valley and Input readings:
To view Peak, press ▲. Meter displays $ followed by the Peak reading.
To view Valley, press ▼. Meter displays L followed by the Valley reading.
To view Input, press PAR. Meter displays M followed by the current Input reading.

Note: The decimal point to the right of digit 1 flashes while the peak or valley reading is displayed.

Reset Peak and/or Valley to the current Input reading:
To reset Peak and Valley, press ▲ and ▼ simultaneously.
To reset Peak only, press and hold ▲ then press PAR.
To reset Valley only, press and hold ▼ then press PAR.

In each case, the meter displays $ followed by the current Input reading.
4.0 PROGRAMMING THE METER

PROGRAMMING SEQUENCE

The Thermocouple Meter has up to seven programmable parameters that are entered in the sequence shown above, using the front panel push buttons. Depending on the thermocouple type selected, some parameters are not applicable and are bypassed in the sequence.

The last programming step offers the choice of entering calibration mode. From this mode, the user can restore the meter to factory default settings, or recalibrate the signal input and cold junction temperature if necessary. To prevent inadvertent entries, an access code must be keyed-in to perform any operations in calibration mode.

Note: Programming mode can be locked out using the Program Disable input terminal. With the PGM.DIS. terminal connected to COMM, the meter displays “LOE” when the PAR key is pressed, and will not enter programming mode.

PROGRAMMING MODE ENTRY

Press the PAR key to enter Programming Mode. The meter briefly displays “PGM” followed by the first programming parameter described below.

PROGRAMMING MODE TIMEOUT

The Programming Mode has an automatic time out feature. If no keypad activity is detected for approximately 60 seconds, the meter automatically exits Programming Mode. The meter briefly displays “End” and returns to the normal display mode. When automatic timeout occurs, any changes that were made to the parameter currently being programmed will not be saved.

PROGRAMMING PARAMETERS

In Programming Mode, the display alternates between the parameter and the current selection or value for that parameter. The dual display with arrows is used below to illustrate the alternating display. The selection choices or value range for each parameter is shown to the right of the alternating display.

THERMOCOUPLE TYPE

Select the thermocouple type by pressing the arrow keys (↑ or ↓) to sequence through the selection list. When the desired selection is displayed, press the PAR key to save the selection and advance to the next parameter. Refer to the thermocouple type and accuracy specification for additional TC information.

TEMPERATURE SCALE

Select the desired temperature scale by pressing the up or down arrow keys. This setting does not change the Custom Units Overlay display (if installed). Press the PAR key to save the selection and advance to the next parameter.

DECIMAL POINT POSITION

Select the decimal point position by pressing the up or down arrow keys. This sets the display resolution to 1 or 0.1 degree. This parameter is not available for thermocouple types R, S and B, where the display resolution is always 1 degree. When mV indicator mode is selected for thermocouple type, the display resolution is fixed at 0.01 mV (10 µV).

Press the PAR key to save the selection and advance to the next parameter.

TEMPERATURE DISPLAY OFFSET

The temperature display can be corrected with an offset value. This can be used to compensate for probe errors or errors due to variances in probe placement, or to adjust the readout to a reference thermometer. Set the desired display offset value by pressing (and/or holding) the up or down arrow keys. When the desired offset value is displayed, press the PAR key to save the selection and advance to the next parameter. The display resolution for the offset value is the same as the decimal point position programmed above. The display offset is not available when mV indicator mode is selected for thermocouple type.

DIGITAL FILTERING

This parameter sets the amount of digital filtering applied to the input signal. If the temperature display is difficult to read due to small variations or noise, increased levels of filtering will help to stabilize the display. Although the digital filter features a “moving window” to help minimize response time, higher levels of filtering will result in slightly longer response times.

Set the desired level of input filtering by pressing the up or down arrow keys. Press the PAR key to save the selection and advance to the next parameter.

PEAK (HI)/ VALLEY (LO) CAPTURE DELAY TIME

When the Input display is above the present HI value or below the present LO value for the entered delay time, the meter will capture the Input display as the new HI or LO reading. A delay time helps to avoid false captures of sudden short spikes or Input display variations that may occur during start-up.

Set the desired capture delay time by pressing the up or down arrow keys. Press the PAR key to save the selection and advance to the next parameter.
5.0 CALIBRATING THE METER

CALIBRATION MODE

To enter Calibration Mode, select **CAL** < > **YES** at the end of Programming Mode, and press the **PAR** key. In Calibration Mode, the user can restore the meter to factory default settings or recalibrate the signal input if necessary.

To prevent inadvertent entries, an access code must be entered to perform any operation in Calibration Mode. Upon entering Calibration Mode, the meter initially displays Code 50. Press the up or down arrow keys to select the access code for the desired operation. If an access code other than those shown below is entered, the meter exits Calibration Mode and returns to normal display mode.

FACTORY SETTINGS

The factory settings for the programming parameters are shown in the previous section in the alternating display illustrations. All programming parameters can be restored to the factory default settings by entering the access Code 66 and pressing the **PAR** key. The meter briefly displays **YES** and then returns to Code 50. This procedure resets only parameters that are accessed through Programming Mode. The Calibration Mode settings (input calibration levels) are not affected.

METER INPUT CALIBRATION

The meter has been fully calibrated at the factory. If the meter appears to be indicating incorrectly or inaccurately, refer to the troubleshooting section before attempting this procedure. When re-calibration is required (generally every 2 years), the procedure should only be performed by qualified technicians using appropriate equipment. A precision thermometer (RTD, thermistor or similar type with an accuracy of ±0.3° C) and an accurate voltage source (0.01%) are required. The procedure consists of setting the cold junction temperature and applying accurate voltages to the meter input in a series of three steps. Allow a 60-minute warm-up before starting calibration.

COLD JUNCTION TEMPERATURE CALIBRATION

1. Connect a calibrated thermocouple (types T, E, J, K or N only) to the panel meter. Select the thermocouple type used in programming.

2. Connect the reference thermometer to the measuring end of the thermocouple. Two probes should be shielded from air movement and allowed sufficient time to equalize in temperature. (As an alternative, the PAXLTC thermocouple probe may be placed in a calibration bath of known temperature.)

3. From the normal indicator display mode, compare the display temperature to that of the reference thermometer. Allow 10 minutes for the temperature to equalize. The meter and the reference thermometer should agree to within 1° F (0.6° C).

4. If cold junction re-calibration is necessary (temperature out of tolerance), enter code 48. The meter display will alternate between **CAL** and the old cold junction reading. At this point, key-in the new cold junction temperature according to the formula:

   \[
   \text{New Cold Junction Reading} = \text{Old Cold Junction Reading} + \text{Difference}
   \]

   WHERE:

   \[
   \text{New Cold Junction Reading} = \text{Old Cold Junction Reading} + (\text{Difference} = \text{Reference Thermometer Temperature} - \text{Meter Display Temperature})
   \]

5. Press **PAR**. The meter briefly displays ~ ~ ~ ~ ~ ~ to acknowledge the new cold junction value.

VOLTAGE CALIBRATION

Following cold junction calibration, the display **CAL** < > **YES/NO** appears. Enter **YES** if input voltage calibration is desired. If **NO** is entered, the meter exits calibration and returns to normal display mode.

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>PARAMETERS</th>
<th>DESCRIPTION/COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000 mV</td>
<td>Apply 0.000 mV, wait 20 seconds, press <strong>PAR</strong>.</td>
<td></td>
</tr>
<tr>
<td>30.000 mV</td>
<td>Apply 30.000 mV, wait 20 seconds, press <strong>PAR</strong>.</td>
<td></td>
</tr>
<tr>
<td>60.000 mV</td>
<td>Apply 60.000 mV, wait 20 seconds, press <strong>PAR</strong>.</td>
<td></td>
</tr>
</tbody>
</table>

The meter briefly displays **End** and returns to the normal display mode. Calibration is now complete. It is recommended to check calibration by selecting mV indication mode for thermocouple type (**TYPE** < > **DD**L) and verifying unit accuracy at various points over the range of the meter (-10 to +80 mV).
**TROUBLESHOOTING**

The majority of all problems with the meter can be traced to improper connections or improper programming set-ups. Be sure all connections are clean and tight and check the programming set-ups for correct data.

For further technical assistance, contact technical support at the appropriate company numbers listed.

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>POSSIBLE CAUSE</th>
<th>REMEDIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO DISPLAY</td>
<td>1. Power off, improperly connected, or brown-out.</td>
<td>1a. Check wiring.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1b. Verify power.</td>
</tr>
<tr>
<td>“EEEE” IN DISPLAY</td>
<td>1. Program data error.</td>
<td>1. Press PAR and check data set-ups.</td>
</tr>
<tr>
<td>“...” or “-...-” IN DISPLAY</td>
<td>1. Input display out of range.</td>
<td>1a. Change display resolution to “1” degree.</td>
</tr>
<tr>
<td></td>
<td>2. Loss of data set-ups.</td>
<td>1b. Reduce offset value.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2a. Check data set-ups.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2b. Check for electrical disturbance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2c. Disconnect and reconnect power.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1b. Disconnect and reconnect power.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c. Check for electrical disturbance.</td>
</tr>
<tr>
<td>JITTERY DISPLAY</td>
<td>1. Electrical “Noise” in process or sensor lines.</td>
<td>1a. Increase digital filtering.</td>
</tr>
<tr>
<td></td>
<td>3. Corroded or dirty thermocouple wire connections.</td>
<td>2. Dampen process to eliminate oscillations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Clean and tighten connections.</td>
</tr>
<tr>
<td></td>
<td>2. Broken or burnout probe.</td>
<td>2. Repair or obtain new probe.</td>
</tr>
<tr>
<td>“0-0-” IN DISPLAY</td>
<td>1. Excessive positive probe temperature.</td>
<td>1. Reduce temperature.</td>
</tr>
<tr>
<td>“1L1L” IN DISPLAY</td>
<td>1. Excessive negative probe temperature.</td>
<td>1. Increase temperature.</td>
</tr>
</tbody>
</table>
MODEL PAXLRT - PAX LITE RTD METER

- ACCEPTS STANDARD 3-WIRE 100 Ω RTD SENSORS (ALPHA = 0.00385 or ALPHA = 0.00392)
- CONFORMS TO ITS-90 STANDARDS
- SELECTABLE °F OR °C WITH 0.1 OR 1 DEGREE DISPLAY RESOLUTION
- STATE-OF-THE-ART DIGITAL ELECTRONICS FOR GREATER ACCURACY AND RELIABILITY
- FULL 4-DIGIT, HIGH VISIBILITY, 0.56" (14.2 mm) HIGH RED LED DISPLAY
- PROGRAMMABLE TEMPERATURE OFFSET
- PROGRAMMABLE DIGITAL FILTERING
- PEAK/VALLEY (HI/LO READING) MEMORY
- NEMA 4X/IP65 SEALED FRONT BEZEL
- CUSTOM UNITS OVERLAY WITH BACKLIGHT

GENERAL DESCRIPTION

The Pax Lite RTD Meter accepts standard RTD inputs and precisely linearizes them into temperature readings. A full 4-digit display accommodates a wide range of temperature inputs. State-of-the-art digital circuitry virtually eliminates errors due to drift.

The meter features a readout choice of either Fahrenheit or Celsius with 0.1 or 1 degree resolution. English Style display prompts and front panel buttons aid the operator through set-up and operation. Programmable digital filtering enhances the stability of the reading. All set-up data is stored in EEPROM, which will hold data for a minimum of 10 years without power.

The meter provides a Peak (HI) and Valley (LO) reading memory with selectable capture delay time. The capture delay is used to prevent detection of false Peak or Valley readings that may occur during start-up or unusual process events. The Peak and Valley readings are stored at power-down to allow monitoring the process limits over any length of time (shifts, days, etc.).

The meter has several built-in diagnostic functions to alert operators of any malfunction. Extensive testing of noise interference mechanisms and full burn-in makes the meter extremely reliable in industrial environments. The front bezel meets NEMA 4X/IP65 requirements for wash down applications.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the literature or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. Do not use this unit to directly command motors, valves, or other actuators not equipped with safeguards. To do so, can be potentially harmful to persons or equipment in the event of a fault to the unit.

DEFINITION OF TERMS

INSTALLATION CATEGORY (overvoltage category) I:
Signal level, special equipment or parts of equipment, telecommunication, electronic, etc. with smaller transient overvoltages than Installation Category (overvoltage category) II.

INSTALLATION CATEGORY (overvoltage category) II:
Local level, appliances, portable equipment, etc. with smaller transient overvoltages than Installation Category (overvoltage category) III.

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1" (53.4) H x 5" (127) W.
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**ORDERING INFORMATION**

**Meter Part Numbers**

<table>
<thead>
<tr>
<th>PAXL</th>
<th>RT</th>
<th>0</th>
<th>0</th>
</tr>
</thead>
</table>

RT - RTD Temperature Meter

**Accessories Part Numbers**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>MODEL NO.</th>
<th>DESCRIPTION</th>
<th>PART NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessories</td>
<td>PAXLBK</td>
<td>Units Label Kit Accessory</td>
<td>PAXLBK30</td>
</tr>
</tbody>
</table>

*This meter is shipped with °F and °C overlay labels. The label kit is only needed if another units label is desired.
GENERAL METER SPECIFICATIONS

1. **DISPLAY**: 4-digit, 0.56" (14.2 mm) high LED, minus sign displayed for negative temperatures.
   - Overrange/Underrange Input: Flashing "0.00" or "0.00".
   - Overrange/Underrange Display: "..." or "..."

2. **POWER**: 85 to 250 VAC, 50/60 Hz, 6 VA
   - Isolation: 2300 Vrms for 1 min. between input and supply (300 V working voltage)

3. **CONTROLS**: Three front panel push buttons for meter set-up. Rear terminal input for disabling the front panel.

4. **RESOLUTION**: 0.1 or 1 degree

5. **RANGE**: Decimal Point Dependent
   - 0.1° res: -199.9° to 850.0 °C (-199.9° to 999.9 °F);
   - 1° res: -200° to 850 °C (-328° to 1562 °F)

6. **OPEN/SHORTED RTD DETECTION**: Display flashes: "OPEN" or "SHORT"

7. **LEAD RESISTANCE EFFECT**: 20 Ω max., 2.5 °C/Ω error for V exc. and common lead unbalance

8. **ACCURACY**: 0.3 °C, @ 23 °C and 30 min. warm-up

9. **RESPONSE TIME**: 2 seconds to settle for step input (increases with programmable digital filtering)

10. **LOW FREQUENCY NOISE REJECTION**:
    - Normal Mode Rejection: 40 dB @ 50/60 Hz (may be improved by programmable digital filtering)
    - Common Mode Rejection: 120 dB, DC to 50/60 Hz

11. **CERTIFICATIONS AND COMPLIANCES**:
    - SAFETY
      - UL Recognized Component, File # E179259, UL61010-1, CSA C22.2 No. 61010-1
      - Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
      - UL Listed, File # E137808, UL508, CSA C22.2 No. 14-M95
      - LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
      - Type 4X Enclosure rating (Face only), UL50
      - IECEE CB Scheme Test Certificate # US/8843A/UL
      - CB Scheme Test Report # 04ME11209-20041018
      - Issued by Underwriters Laboratories, Inc.
      - IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
      - IP65 Enclosure rating (Face only), IEC 529

12. **ELECTROMAGNETIC COMPATIBILITY**
    - Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.
    - **Immunity**:
      - Electrostatic discharge: EN 61000-4-2
      - Criterion A
      - 4 kV contact discharge
      - 8 kV air discharge
      - Electromagnetic RF fields: EN 61000-4-3
      - Criterion A
      - 10 V/m
      - Fast transients (burst): EN 61000-4-4
      - Criterion A
      - 2 kV power
      - 2 kV signal
      - Surge: EN 61000-4-5
      - Criterion A
      - 1 kV L-L
      - 2 kV L-N-E power
      - 1 kV signal
      - RF conducted interference: EN 61000-4-6
      - Criterion A
      - 3 V/μs
      - Voltage dip/interruptions: EN 61000-4-11
      - Criterion A
      - 0.5 cycle
      - Emissions:
        - Emissions: EN 55011
        - Class B

Note: 1. Criterion A: Normal operation within specified limits.

13. **ENVIRONMENTAL CONDITIONS**:
    - Operating Temperature Range: 0 to 50 °C
    - Storage Temperature Range: -40 to 80 °C
    - Operating and Storage Humidity: 85% max (non-condensing) from 0 to 50 °C
    - Span Drift: 50 ppm/°C
    - Zero Drift: 0.001 °C/°C
    - Altitude: Up to 2000 meters.

14. **CONSTRUCTION**:
    - This unit is rated for NEMA 4X/IP65 indoor use. One piece bezel/case. Flame resistant. Panel gasket and mounting clip included.

15. **CONNECTIONS**:
    - High compression cage-clamp terminal block
    - Wire Strip Length: 0.3” (7.5 mm)
    - Wire Gage: 30-14 AWG copper wire
    - Torque: 4.5 inch-lbs (0.51 N-m) max.

16. **WEIGHT**: 0.65 lbs. (0.24 Kg)

ACCESSORIES

**UNITS LABEL KIT (PAXLBK)**

Each meter has a units indicator with backlighting that can be customized using the Units Label Kit. The backlight is controlled in the programming.

Each meter is shipped with °F and °C overlay labels which can be installed into the meter’s bezel display assembly.
1.0 Installing the Meter

Installation
The PAX meets NEMA 4X/IP65 requirements when properly installed. The unit is intended to be mounted into an enclosed panel. Prepare the panel cutout to the dimensions shown. Remove the panel latch from the unit. Slide the panel gasket over the rear of the unit to the back of the bezel. The unit should be installed fully assembled. Insert the unit into the panel cutout.

While holding the unit in place, push the panel latch over the rear of the unit so that the tabs of the panel latch engage in the slots on the case. The panel latch should be engaged in the farthest forward slot possible. To achieve a proper seal, tighten the latch screws evenly until the unit is snug in the panel (Torque to approximately 7 in-lbs [79N-cm]). Do not over-tighten the screws.

Installation Environment
The unit should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should be cleaned only with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.

Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.

2.0 Wiring the Meter

Power Wiring
Primary AC power is connected to Terminals 1 and 2. To reduce the chance of noise spikes entering the AC line and affecting the indicator, the AC power should be relatively “clean” and within the specified limits. Drawing power from heavily loaded circuits or circuits that also power loads that cycle on and off (contactors, relays, motors, machinery, etc.) should be avoided.

AC Power
Terminal 1: VAC
Terminal 2: VAC

Signal Wiring (RTD Sensor)
RTD sensors are used in applications where a high degree of accuracy is required. Most RTD sensors available are the 3-wire type. The 3rd additional wire is a sense lead for canceling the effects of lead resistance at the probe. The sense lead connects to Terminal 5 (RTD+), the common lead to Terminal 6 (RTD-), and the excitation lead to Terminal 4 (+ Excitation). The excitation and sense leads are generally the same color because they are functionally the same and may be interchanged at the meter. Four wire sensors have an additional sense lead connected (at the probe) to the common lead. Leave the extra sense lead disconnected when using a four wire probe with the PAXLRT meter. Always refer to the sensor manufacturer’s instructions for probe wiring connections, if available. Two wire RTD sensors may be used with the PAXLRT by shorting Terminal 4 to Terminal 5, if the distance between sensor and meter is less than 30 feet. The total lead resistance can be used to predict the temperature error for 2-wire sensors, according to 2.5°C/Ω of lead resistance.

Note: Extended cable runs can be made provided the lead resistance is less than 20 Ω/lead and the resistance is equal in each lead.

Program Disable Input Wiring
PGM.DIS. (Terminal 3) is a digital input that is active when connected to RTD- (Terminal 6). Any form of mechanical switch or current sinking logic with less than 0.7 V saturation may be used. The use of shielded cable is recommended. Follow the EMC Installation Guidelines for shield connection.

Wiring Overview
Electrical connections are made via screw-clamp terminals located on the back of the meter. All conductors should conform to the meter’s voltage and current ratings. All cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that the power supplied to the meter be protected by a fuse or circuit breaker.

When wiring the meter, compare the numbers embossed on the back of the meter case against those shown in wiring drawings for proper wire position. Strip the wire, leaving approximately 0.3” (7.5 mm) bare lead exposed (stranded wires should be tinned with solder). Insert the lead under the correct screw-clamp terminal and tighten until the wire is secure. (Pull wire to verify tightness.)
EMC INSTALLATION GUIDELINES

Although this meter is designed with a high degree of immunity to Electro-Magnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into the meter may be different for various installations. The meter becomes more immune to EMI with fewer I/O connections. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation. Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The meter should be mounted in a metal enclosure, which is properly connected to protective earth.
2. Use shielded (screened) cables for all Signal and Control inputs. The shield (screen) pigtail connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.
   a. Connect the shield only at the panel where the unit is mounted to earth ground (protective earth).
   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is above 1 MHz.
   c. Connect the shield to common of the meter and leave the other end of the shield unconnected and insulated from earth ground.
3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
4. Signal or Control cables within an enclosure should be routed as far as possible from contactors, control relays, transformers, and other noisy components.
5. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:
   - Ferrite Suppression Cores for signal and control cables:
     - Fair-Rite # 0443167251 (RLC# FCOR0000)
     - TDK # ZCAT3035-1330A
     - Steward # 28B2029-0A0
   - Line Filters for input power cables:
     - Schaffner # FN610-1/07 (RLC# LFI0000)
     - Schaffner # FN670-1.8/07
     - Corcom # 1 VR3
   - Note: Reference manufacturer’s instructions when installing a line filter.
6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.

3.0 REVIEWING THE FRONT BUTTONS AND DISPLAY

Display Valley (LO) Reading
Display Peak (HI) Reading
PAR

PROGRAMMING MODE OPERATION
Store selected parameter and index to next parameter
Increment value or change selection
Decrement value or change selection

PEAK/VALLEY DETECTION
The meter will automatically record the highest input reading (peak) and the lowest input reading (valley) for later recall. These values are stored at power-down to allow monitoring the process limits over any length of time (shifts, days, etc.). A selectable capture delay time is used to prevent detection of false peak or valley readings caused by sudden short spikes or unusual process events.

The peak and valley readings can be viewed and reset using the front panel keys as described below.

View Peak, Valley and Input readings:
To view Peak, press \( \uparrow \). Meter displays \( \text{HI} \) followed by the Peak reading.
To view Valley, press \( \downarrow \). Meter displays \( \text{LO} \) followed by the Valley reading.
To view Input, press PAR. Meter displays \( \text{HI}/\text{LO} \) followed by the current Input reading.

Reset Peak and/or Valley to the current Input reading:
To reset Peak and Valley, press \( \uparrow \) and \( \downarrow \) simultaneously.
To reset Peak only, press and hold \( \uparrow \) then press PAR.
To reset Valley only, press and hold \( \downarrow \) then press PAR.
In each case, the meter displays \( \text{HI}/\text{LO} \) followed by the current Input reading.

Note: The decimal point to the right of digit 1 flashes while the peak or valley reading is displayed.
### 4.0 Programming the Meter

The RTD Meter has seven programmable parameters that are entered in the sequence shown above, using the front panel push buttons.

The last programming step offers the choice of entering calibration mode. From this mode, the user can restore the meter to factory default settings or recalibrate the signal input if necessary. To prevent inadvertent entries, an access code must be keyed-in to perform any operations in calibration mode.

Note: Programming mode can be locked out using the Program Disable input terminal. With the PGM.DIS. terminal connected to RTD-, the meter displays “LOC” when the PAR key is pressed, and will not enter programming mode.

#### PROGRAMMING MODE ENTRY

Press the PAR key to enter Programming Mode. The meter briefly displays Pr a followed by the first programming parameter described below.

#### PROGRAMMING MODE TIMEOUT

The Programming Mode has an automatic timeout feature. If no keypad activity is detected for approximately 60 seconds, the meter automatically exits Programming Mode. The meter briefly displays End and returns to the normal display mode. When automatic timeout occurs, any changes that were made to the parameter currently being programmed will not be saved.

#### PROGRAMMING PARAMETERS

In Programming Mode, the display alternates between the parameter and the current selection or value for that parameter. The dual display with arrows is used below to illustrate the alternating display. The selection choices or value range for each parameter is shown to the right of the alternating display.

#### RTD Type

- rtd

Select the RTD type by pressing the up or down arrow keys (↑ or ↓). When the desired selection is displayed, press the PAR key to save the selection and advance to the next parameter.

#### Temperature Scale

- SCAL

Select the desired temperature scale by pressing the up or down arrow keys. This setting does not change the Custom Units Overlay display (if installed). Press the PAR key to save the selection and advance to the next parameter.

#### Decimal Point Position

- dCP

Select the decimal point position by pressing the up or down arrow keys. This sets the display resolution to 1 or 0.1 degree. Press the PAR key to save the selection and advance to the next parameter.

#### Temperature Display Offset

- OFST

The temperature display can be corrected with an offset value. This can be used to compensate for probe errors or errors due to variances in probe placement, or to adjust the readout to a reference thermometer. Set the desired display offset value by pressing (and/or holding) the up or down arrow keys. When the desired offset value is displayed, press the PAR key to save the selection and advance to the next parameter. The display resolution for the offset value is the same as the decimal point position programmed above.

#### PROGRAMMING SEQUENCE

The setting does not change the Custom Units Overlay display (if installed).

#### Temperature Display Offset

- -1999 to 9999

The temperature display can be corrected with an offset value. This can be used to compensate for probe errors or errors due to variances in probe placement, or to adjust the readout to a reference thermometer. Set the desired display offset value by pressing (and/or holding) the up or down arrow keys. When the desired offset value is displayed, press the PAR key to save the selection and advance to the next parameter. The display resolution for the offset value is the same as the decimal point position programmed above.

#### Digital Filtering

This parameter sets the amount of digital filtering applied to the input signal. If the temperature display is difficult to read due to small variations or noise, increased levels of filtering will help to stabilize the display. Although the digital filter features a “moving window” to help minimize response time, higher levels of filtering will result in slightly longer response times.

- 0 - no digital filtering
- 1 - normal filtering
- 2 - increased filtering
- 3 - maximum filtering

Set the desired level of input filtering by pressing the up or down arrow keys. Press the PAR key to save the selection and advance to the next parameter.

#### PEAK (HI)/ VALLEY (LO) Capture Delay Time

When the Input display is above the present HI value or below the present LO value for the entered delay time, the meter will capture the Input display as the new HI or LO reading. A delay time helps to avoid false captures of sudden short spikes or Input display variations that may occur during start-up.

Set the desired capture delay time by pressing the up or down arrow keys. Press the PAR key to save the selection and advance to the next parameter.

#### Units Label Backlight

The Units Label Kit Accessory contains a sheet of custom unit overlays, which can be installed in the meter bezel display assembly. The unit of measure for the meter display is then visible when the label backlight is illuminated. The two most commonly used temperature unit labels (°F and °C) are supplied with the meter. Press the up or down arrow keys to select whether the units label backlight is illuminated. Press the PAR key to save the selection and advance to the next parameter.

#### Programming Mode Exit

Before exiting Programming Mode, the meter offers the choice of entering Calibration Mode. To exit Programming Mode without entering Calibration Mode, select NO and press the PAR key. The meter briefly displays End and returns to the normal display mode. All programmed selections are now transferred to non-volatile memory and are retained if power is removed from the meter.

(If power loss occurs during Programming Mode, verify parameter changes and reprogram, if necessary, when power is restored.)
5.0 Calibrating the Meter

Calibration Mode

To enter Calibration Mode, select "," at the end of Programming Mode, and press the PAR key. In Calibration Mode, the user can restore the meter to factory default settings or recalibrate the signal input if necessary.

To prevent inadvertent entries, an access code must be entered to perform any operation in Calibration Mode. Upon entering Calibration Mode, the meter initially displays Code 50. Press the up or down arrow keys to select the access code for the desired operation. If an access code other than those shown below is entered, the meter exits Calibration Mode and returns to normal display mode.

Factory Settings

The factory settings for the programming parameters are shown in the previous section in the alternating display illustrations. All programming parameters can be restored to the factory default settings by entering the access Code 66 and pressing the PAR key. The meter briefly displays \( \text{Code} \) and then returns to Code 50. This procedure resets only parameters that are accessed through Programming Mode. The Calibration Mode settings (input calibration levels) are not affected.

Meter Input Calibration

The meter has been fully calibrated at the factory. If the meter appears to be indicating incorrectly or inaccurately, refer to the troubleshooting section before attempting this procedure. When re-calibration is required (generally every 2 years), the procedure should only be performed by qualified technicians using appropriate equipment. Resistance source accuracies of 0.02% or better are required.

The procedure consists of applying accurate signal levels to the meter input in a series of two steps. Allow a 30-minute warm-up period before starting calibration. To begin the input calibration, enter access Code 48 and press the PAR key.

Enter Zero Reference

Meter displays \( \text{S} \). Apply 0 ohms to the meter input by shorting Terminals 4, 5, and 6. Allow the meter to stabilize at least 20 seconds after shorting the terminals, and then press PAR.

Apply Precision Resistance

Meter displays \( \text{S} \). Connect a precision 300 ohm resistor across Terminals 5 and 6. Terminals 4 and 5 remain shorted. (Note: Be certain to short Terminals 4 and 5 at the resistor as shown in the drawing below. Shorting terminals may lead to incorrect calibration.)

Allow the meter to stabilize at least 20 seconds after making the connections, and then press PAR. The meter briefly displays \( \text{End} \) and returns to the normal display mode. Calibration is now complete. It is recommended to check calibration by comparing the displayed temperature with a precision thermometer.

Troubleshooting

The majority of all problems with the meter can be traced to improper connections or improper programming set-ups. Be sure all connections are clean and tight and check the programming set-ups for correct data.

For further technical assistance, contact technical support at the appropriate company numbers listed.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Remedies</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Display</td>
<td>1. Power off, improperly connected, or brown-out.</td>
<td>1a. Check wiring. 1b. Verify power.</td>
</tr>
<tr>
<td>&quot;EEEE&quot; in Display</td>
<td>1. Program data error.</td>
<td>1. Press PAR and check data set-ups.</td>
</tr>
<tr>
<td>&quot;...&quot; or &quot;--&quot; in Display</td>
<td>1. Input display out of range.  2. Loss of data set-ups.</td>
<td>1a. Change display resolution to &quot;1&quot; degree. 1b. Reduce offset value. 2a. Check data set-ups. 2b. Check for electrical disturbance. 2c. Disconnect and reconnect power.</td>
</tr>
<tr>
<td>&quot;OPEN&quot; in Display</td>
<td>1. Probe unconnected. 2. Broken or burnout probe. 3. Excessive probe temperature. 4. Input overload.</td>
<td>1. Connect probe. 2. Repair or obtain new probe. 3. Reduce temperature. 4. Check input levels.</td>
</tr>
<tr>
<td>&quot;$ME&quot; in Display</td>
<td>1. Input shorted.</td>
<td>1. Check input connections.</td>
</tr>
</tbody>
</table>
The PAXLT is a versatile meter that accepts a variety of thermocouple and RTD inputs and provides a temperature display in Celsius or Fahrenheit. The readout conforms to ITS-90 standards, with 1° or 0.1° resolution. The 5-digit display has 0.56" high digits with adjustable intensity. Backlight overlay labels for °F and °C are included.

The meter features a Maximum and Minimum reading memory, with programmable capture time. The capture time is used to prevent detection of false max or min readings which may occur during start-up or unusual process events. Either value can be displayed if desired. The display can be toggled manually or automatically between the selected values.

Other features include thermocouple cold junction compensation, display offset and a programmable user input to perform a variety of meter control functions. Two setpoint outputs are provided, each with a Form C relay. Output modes and setup options are fully programmable to suit a variety of control requirements.

The PAXLT can be universally powered from a wide range of AC or DC voltage. The meter has been specifically designed for harsh industrial environments. With a NEMA 4X/IP65 sealed bezel and extensive testing to meet CE requirements, the meter provides a tough yet reliable application solution.

SPECIFICATIONS

1. DISPLAY: 5 digit, 0.56" (14.2 mm) intensity adjustable Red LED
2. POWER REQUIREMENTS:
   AC POWER: 50 to 250 VAC 50/60 Hz, 12 VA
   Isolation: 2300 Vrms for 1 min. to all inputs and outputs
   DC POWER: 21.6 to 250 VDC, 6 W
   DC Out: +24 VDC @ 100 mA if input voltage is greater than 50 VAC/VDC
           +24 VDC @ 50 mA if input voltage is less than 50 VDC
3. READOUT:
   Display Range: -19999 to 99999
   Scale: °F or °C
   Resolution: 1° or 0.1°
   Response Time: 500 msec min.
   Display Overrange/Underrange Indication: "….." / "-....."
   Input Overrange/Underrange Indication: "OL" / "DL"
4. THERMOCOUPLE INPUTS:
   Input Impedance: 20 MΩ
   Max. Continuous Overvoltage: 30 VDC

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1" (53.4) H x 5.0" (127) W.
Failed Sensor Indication: OPEN

<table>
<thead>
<tr>
<th>TC TYPE</th>
<th>RANGE</th>
<th>ACCURACY @ 23°C</th>
<th>ACCURACY @ 0 to 50°C</th>
<th>WIRE COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>-200 to 400°F</td>
<td>2.3</td>
<td>5.8</td>
<td>(+) blue</td>
</tr>
<tr>
<td>E</td>
<td>-200 to 871°F</td>
<td>2.7</td>
<td>4.9</td>
<td>(+) purple</td>
</tr>
<tr>
<td>J</td>
<td>-200 to 760°F</td>
<td>1.9</td>
<td>4.3</td>
<td>(+) white</td>
</tr>
<tr>
<td>K</td>
<td>-200 to 1372°F</td>
<td>2.3</td>
<td>5.8</td>
<td>(+) yellow</td>
</tr>
<tr>
<td>R</td>
<td>-50 to 1768°C</td>
<td>4.5</td>
<td>15.0</td>
<td>(+) white</td>
</tr>
<tr>
<td>S</td>
<td>-50 to 1768°C</td>
<td>4.5</td>
<td>15.0</td>
<td>(+) white</td>
</tr>
<tr>
<td>B</td>
<td>200 to 1620°C</td>
<td>9.1</td>
<td>15.0</td>
<td>(+) white</td>
</tr>
<tr>
<td>N</td>
<td>-200 to 1300°F</td>
<td>2.8</td>
<td>8.1</td>
<td>(+) orange</td>
</tr>
<tr>
<td>C</td>
<td>0 to 2315°F</td>
<td>1.9</td>
<td>6.1</td>
<td>no standard</td>
</tr>
</tbody>
</table>

*After 20 min. warm-up. Accuracy is specified in two ways: Accuracy at 23°C and 15 to 75% RH environment; and Accuracy from 0 to 50°C and 0 to 85% RH (non-condensing) environment. Accuracy specified over the 0 to 50°C operating range includes meter tempco effects and cold junction tracking errors.

The specification includes the A/D conversion errors, linearization conformity, and thermocouple cold junction compensation. Total system accuracy is the sum of meter and probe errors. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

5. RTD INPUTS:
   - Type: 2, 3 or 4 wire
   - Excitation Current: 100 ohm range: 165 µA; 10 ohm range: 2.5 mA
   - Lead Resistance:
     - 100 ohm range: 10 Ω/lead max.; 10 ohm range: 3 Ω/lead max.
     - Unbalanced Lead Resistance: Automatically compensated up to max per lead
   - Balanced Lead Resistance: Automatically compensated up to max per lead

Max. Continuous Overvoltage: 30 VDC

Failed Sensor Indication: OPEN or Short

<table>
<thead>
<tr>
<th>RTD TYPE</th>
<th>RANGE</th>
<th>ACCURACY @ 23°C</th>
<th>ACCURACY @ 0 to 50°C</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ohm Pt alpha = 0.00385</td>
<td>-200 to 850°C</td>
<td>0.4°C</td>
<td>1.6°C</td>
<td>IEC 751</td>
</tr>
<tr>
<td>100 ohm Pt alpha = 0.00385</td>
<td>-200 to 850°C</td>
<td>0.4°C</td>
<td>1.6°C</td>
<td>no official standard</td>
</tr>
<tr>
<td>120 ohm Nickel alpha = 0.00672</td>
<td>-80 to 260°C</td>
<td>0.2°C</td>
<td>0.5°C</td>
<td>no official standard</td>
</tr>
<tr>
<td>10 ohm Copper alpha = 0.0427</td>
<td>-100 to 260°C</td>
<td>0.4°C</td>
<td>0.9°C</td>
<td>no official standard</td>
</tr>
</tbody>
</table>

*After 20 min. warm-up. Accuracy is specified in two ways: Accuracy at 23°C and 15 to 75% RH environment; and Accuracy from 0 to 50°C and 0 to 85% RH (non-condensing) environment. Accuracy specified over the 0 to 50°C operating range includes meter tempco effects.

The specification includes the A/D conversion errors, linearization conformity. Total system accuracy is the sum of meter and probe errors. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

6. USER INPUT: Programmable input
   - Software selectable for active logic state: active low, pull-up (24.7 kΩ to +5 VDC) or active high, pull-down resistor (20 kΩ)
   - Trigger levels: \( V_{IL} = 1.0 \text{ V max}; V_{IH} = 2.4 \text{ V min}; V_{MAX} = 28 \text{ VDC} \)
   - Response Time: 10 msec typ.; 50 msec debounce (activation and release)

7. MEMORY: Nonvolatile EPROM retains all programming parameters and max/min values when power is removed.

8. OUTPUTS:
   - Type: Dual Form C contacts
   - Isolation to Sensor & User Input Commons: 1400 Vrms for 1 min.
   - Working Voltage: 150 Vrms
   - Contact Rating: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive load)
   - Life Expectancy: 100 K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads.
   - Response Time: Turn On or Off: 4 msec max.

9. ENVIRONMENTAL CONDITIONS:
   - Operating temperature: 0 to 50°C
   - Storage temperature: -40 to 70°C
   - Operating and storage humidity: 0 to 85% RH (non-condensing)
   - Altitude: Up to 2,000 meters

10. CONNECTIONS:
    - High compression cage-clamp terminal block
    - Wire Strip Length: 0.3" (7.5 mm)
    - Wire Gage: 30-14 AWG copper wire
    - Torque: 4.5 inch-lbs (0.51 N-m) max.

11. CONSTRUCTION: This unit is rated for NEMA 4X/IP65 outdoor use. IP20 Touch safe. Installation Category II, Pollution Degree 2. One piece bezel/case. Flame resistant. Synthetic rubber keypad. Panel gasket and mounting clip included.

12. CERTIFICATIONS AND COMPLIANCES:
    - Consult Factory.

13. WEIGHT: 10.4 oz. (295 g)

---

1.0 INSTALLING THE METER

**Installation**

The PAX Lite meets NEMA 4X/IP65 requirements when properly installed. The unit is intended to be mounted into an enclosed panel. Prepare the panel cutout to the dimensions shown. Remove the panel latch from the unit. Slide the panel gasket over the rear of the unit to the back of the bezel. The unit should be installed fully assembled. Insert the unit into the panel cutout.

While holding the unit in place, push the panel latch over the rear of the unit so that the tabs of the panel latch engage in the slots on the case. The panel latch should be engaged in the farthest forward slot possible. To achieve a proper seal, tighten the latch screws evenly until the unit is snug in the panel (Torque to approximately 7 in-lbs [79N-cm]). Do not over-tighten the screws.

**Installation Environment**

The unit should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should be cleaned only with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.

Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.

---

**Panel Cut-Out**

- Panel Dimensions: 3.62 x 2.32" (92 x 58.4 mm)
- Panel Mounting Screws: 1.77 x 0.35" (45 x 8.9 mm)
2.0 Setting the Jumper

INPUT RANGE JUMPER (RTD ONLY)

This jumper is used to select the proper input range for the RTD probe being used (10 ohm or 100 ohm). For thermocouple inputs, this jumper has no effect and can be left in either position.

To access the jumper, remove the meter base from the case by firmly squeezing and pulling back on the side rear finger tabs. This should lower the latch below the case slot (which is located just in front of the finger tabs). It is recommended to release the latch on one side, then start on the other side latch.

3.0 Wiring the Meter

WIRING OVERVIEW

Electrical connections are made via screw-clamp terminals located on the back of the meter. All conductors should conform to the meter’s voltage and current ratings. All cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that the power supplied to the meter (DC or AC) be protected by a fuse or circuit breaker.

When wiring the meter, compare the numbers embossed on the back of the meter case against those shown in wiring drawings for proper wire position. Strip the wire, leaving approximately 0.3” (7.5 mm) bare lead exposed (stranded wires should be tinned with solder.) Insert the lead under the correct screw-clamp terminal and tighten until the wire is secure. (Pull wire to verify tightness.)

EMC INSTALLATION GUIDELINES

Although this meter is designed with a high degree of immunity to Electro-Magnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into the meter may be different for various installations. The meter becomes more immune to EMI with fewer I/O connections. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation. Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The meter should be properly connected to protective earth.
2. Use shielded (screened) cables for all Signal and Control inputs. The shield (screen) pigtail connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.
   a. Connect the shield only at the panel where the unit is mounted to earth ground (protective earth).
   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is above 1 MHz.
   c. Connect the shield to common of the meter and leave the other end of the shield unconnected and insulated from earth ground.
3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be ran in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
4. Signal or Control cables within an enclosure should be routed as far as possible from contactors, control relays, transformers, and other noisy components.
5. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:
   - Ferrite Suppression Cores for signal and control cables:
     Fair-Rite # 043167251 (RLC# FCOR0000)
     TDK # ZCAT3035-1330A
     Steward # 28B2029-0A0
   - Line Filters for input power cables:
     Schaffner # FN610-1/07 (RLC# LFIL0000)
     Schaffner # FN670-1.8/07
     Corcom # 1 VR3
   Note: Reference manufacturer's instructions when installing a line filter.
6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
7. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI. Snubber: RLC# SNUB0000.
3.1 POWER WIRING

Power
Terminal 1: VAC/DC +
Terminal 2: VAC/DC -

3.2 INPUT SIGNAL WIRING

**CAUTION:** Sensor input common (Terminal 7) is NOT isolated from user common (Terminal 9). In order to preserve the safety of the meter application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common and user common must be at protective earth ground potential. If not, hazardous live voltage may be present at the user input and user common terminals. Appropriate considerations must then be given to the potential of the sensor input common and the user common with respect to earth ground.

THERMOCOUPLE

2-WIRE RTD

3-WIRE RTD

3.3 USER INPUT WIRING

Terminal 8: User Input
Terminal 9: User Common

**Current Sinking (Active Low Logic)**

Current Sourcing (Active High Logic)

3.4 SETPOINT (OUTPUT) WIRING

Terminal 10: NC 1
Terminal 11: NO 1
Terminal 12: Relay 1 Common
Terminal 13: NC 2
Terminal 14: NO 2
Terminal 15: Relay 2 Common
4.0 REVIEWING THE FRONT BUTTONS AND DISPLAY

**Display Readout Legends**

- MAX: Maximum display capture value
- MIN: Minimum display capture value

**Operating Mode Display Designators**

- "SP1": Indicates setpoint 1 output activated.
- "SP2": Indicates setpoint 2 output activated.

Pressing the SEL button toggles the meter through the selected displays. If display scroll is enabled, the display will toggle automatically every four seconds between the enabled display values.

5.0 PROGRAMMING THE METER

**Overview Programming Menu**

- **DISPLAY MODE**
  - PAR: Access Programming Mode
  - SEL: Index display through enabled values
  - RST: Resets values (min/max) or outputs

**Programming Mode Operation**

- Store selected parameter and index to next parameter
- Advance through selection list/select digit position in parameter value
- Increment selected digit of parameter value

**Programming Mode Exit (PAR Button)**

The Programming Mode is exited by pressing the PAR button with Prs NO displayed. This will commit any stored parameter changes to memory and return the meter to the Display Mode. (If power loss occurs before returning to the Display Mode, verify recent parameter changes.)

**Programming Tips**

- It is recommended to start with Module 1 and proceed through each module in sequence. When programming is complete, it is recommended to record the parameter programming and lock out parameter programming with the user input or programming security code.

**Factory Settings**

Factory Settings may be completely restored in Module 2. This is useful when encountering programming problems.

**Alternating Selection Display**

In the explanation of the modules, the following dual display with arrows will appear. This is used to illustrate the display alternating between the parameter on top and the parameter’s Factory Setting on the bottom. In most cases, selections and values for the parameter will be listed on the right.
### 5.1 MODULE 1 - INPUT SETUP! PARAMETERS (I- IMP)

<table>
<thead>
<tr>
<th>Parameter Menu</th>
<th>PRO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CJC</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Scale</strong></td>
<td></td>
</tr>
<tr>
<td><strong>dECP</strong></td>
<td></td>
</tr>
<tr>
<td><strong>OFSET</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Filter</strong></td>
<td></td>
</tr>
<tr>
<td><strong>bAnD</strong></td>
<td></td>
</tr>
<tr>
<td><strong>USr IN</strong></td>
<td></td>
</tr>
<tr>
<td><strong>U-ASn</strong></td>
<td></td>
</tr>
<tr>
<td><strong>U-AcT</strong></td>
<td></td>
</tr>
</tbody>
</table>

#### INPUT TYPE

<table>
<thead>
<tr>
<th>Selection</th>
<th>Input Type</th>
<th>Selection</th>
<th>Input Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>tc-k</td>
<td>T</td>
<td>tc-n</td>
<td>N</td>
</tr>
<tr>
<td>tc-e</td>
<td>E</td>
<td>tc-c</td>
<td>C</td>
</tr>
<tr>
<td>tc-j</td>
<td>J</td>
<td>U</td>
<td>mV</td>
</tr>
<tr>
<td>tc-K</td>
<td>Pt 385</td>
<td>Platinum 385 100 Ω</td>
<td></td>
</tr>
<tr>
<td>tc-R</td>
<td>Pt 392</td>
<td>Platinum 392 100 Ω</td>
<td></td>
</tr>
<tr>
<td>tc-S</td>
<td>Ni 672</td>
<td>Nickel 672 100 Ω</td>
<td></td>
</tr>
<tr>
<td>tc-b</td>
<td>Cu 427</td>
<td>Copper 427 10 Ω</td>
<td></td>
</tr>
</tbody>
</table>

Select the thermocouple or RTD type used for the application. For RTDs, position the Input Range Jumper to match the RTD type (10Ω or 100Ω). Selecting U displays a millivolt signal readout with 10 μV resolution.

#### COLD JUNCTION COMPENSATION

<table>
<thead>
<tr>
<th>OFF/ON</th>
<th></th>
</tr>
</thead>
</table>

This parameter enables or disables internal cold junction compensation for thermocouples. For most applications, cold junction compensation should be enabled (ON). This parameter only appears for thermocouple input selections.

#### TEMPERATURE SCALE

<table>
<thead>
<tr>
<th>°F</th>
<th>°C</th>
</tr>
</thead>
</table>

Select the desired temperature scale. This selection applies for the Input, MAX and MIN displays. This parameter does not appear when mV or RTD resistance display is enabled.

#### DISPLAY DECIMAL POINT

<table>
<thead>
<tr>
<th>D0</th>
<th>D1</th>
</tr>
</thead>
</table>

Set the decimal point for the desired display resolution. This selection applies for the Input, MAX and MIN displays, and also affects the Setpoint and Display Offset values. For mV or RTD resistance displays, the decimal point location is fixed and this parameter does not appear.

#### DISPLAY OFFSET VALUE

| -19999 to 19999 |

The temperature display can be corrected with an offset value. This can be used to compensate for probe errors, errors due to variances in probe placement or adjusting the readout to a reference thermometer.

#### FILTER SETTING

| 0 | 1 | 2 | 3 |

If the displayed temperature is difficult to read due to small process variations or noise, increased levels of filtering will help to stabilize the display.

Software filtering effectively combines a fraction of the current input reading with a fraction of the previous displayed reading to generate the new display. Filter values represent no filtering (0), up to heavy filtering (3). A value of 1 for the filter uses 1/4 of the new input and 3/4 of the previous display to generate the new display. A filter value of 2 uses 1/8 new and 7/8 previous. A filter value of 3 uses 1/16 new and 15/16 previous.

#### FILTER BAND

| 0 to 199 display units |

The filter will adapt to variations in the input signal. When the variation exceeds the input filter band value, the filter disengages. When the variation becomes less than the band value, the filter engages again. This allows for a stable readout, but permits the display to settle rapidly after a large process change. The value of the band is in display units, independent of the Display Decimal Point position. A band setting of '0' keeps the filter permanently engaged at the filter level selected above.

#### USER INPUT FUNCTION

<table>
<thead>
<tr>
<th>Display Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>User Input disabled.</td>
</tr>
<tr>
<td>P-Lac</td>
<td>See Programming Mode Access chart (Module 3).</td>
</tr>
<tr>
<td>rESet</td>
<td>Reset the assigned value(s) to the current input value.</td>
</tr>
<tr>
<td>d-Hld</td>
<td>Holds the assigned display, but all other meter functions continue as long as activated (maintained action).</td>
</tr>
<tr>
<td>d-SEL</td>
<td>Advance once for each activation.</td>
</tr>
<tr>
<td>d-LEU</td>
<td>Increase intensity one level for each activation.</td>
</tr>
<tr>
<td>rSt-1</td>
<td>Reset setpoint 1 output.</td>
</tr>
<tr>
<td>rSt-2</td>
<td>Reset setpoint 2 output.</td>
</tr>
<tr>
<td>rSt-1/2</td>
<td>Reset both setpoint 1 and 2 outputs.</td>
</tr>
</tbody>
</table>

* Indicates Edge Triggered function. All others are Level Active functions.

#### USER INPUT ASSIGNMENT

<table>
<thead>
<tr>
<th>HI</th>
<th>HI-LO</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO</td>
<td>dSP</td>
</tr>
</tbody>
</table>

Select the value(s) to which the User Input Function is assigned. The User Input Assignment only applies if a selection of reset or display hold is selected in the User Input Function menu.

#### USER INPUT ACTIVE LEVEL

<table>
<thead>
<tr>
<th>HI</th>
<th>LO</th>
</tr>
</thead>
</table>

Select whether the user input is configured as active low or active high.
5.2 MODULE 2 - SECONDARY FUNCTION PARAMETERS (2-SEC)

MAX DISPLAY ENABLE

Enables the Maximum Display Capture capability.

MAX CAPTURE DELAY TIME

When the Input Display is above the present MAX value for the entered delay time, the meter will capture that display value as the new MAX reading. A delay time helps to avoid false captures of sudden short spikes.

MIN DISPLAY ENABLE

Enables the Minimum Display Capture capability.

MIN CAPTURE DELAY TIME

When the Input Display is below the present MIN value for the entered delay time, the meter will capture that display value as the new MIN reading. A delay time helps to avoid false captures of sudden short spikes.

FACTORY SERVICE OPERATIONS

Select YES to perform any of the Factory Service Operations shown below.

RESTORE FACTORY DEFAULT SETTINGS

Entering Code 66 will overwrite all user settings with the factory settings. The meter will display rESET to indicate the selected display mode between a temperature or resistance readout. The resistance readout is useful for diagnostic purposes before and after calibration, or to display the measured resistance of a connected RTD probe.

For RTD type Cu20 (Input Range Jumper in 10Ω position), resistance is displayed in 2000 ohms resolution. For all other RTD types (100Ω position), resistance is displayed in 200 ohms resolution.

Upon entering Code 85, the meter displays either dSP·t or dSP·r to indicate temperature or resistance readout selected. The display then returns to CodE 00. Press the PAR button to exit the module.

TOGGLE RTD INPUT DISPLAY MODE

Entering Code 85 toggles the selected RTD input display mode between a temperature or resistance readout. The resistance readout is useful for diagnostic purposes before and after calibration, or to display the measured resistance of a connected RTD probe.

CALIBRATION

The PAXLT uses stored calibration values to provide accurate temperature measurements. Over time, the electrical characteristics of the components inside the meter could slowly change, with the result being that the stored calibration values may no longer accurately define the input circuit. For most applications, recalibration every 1 to 2 years should be sufficient.

Calibration for thermocouple inputs involves a voltage calibration and a cold junction calibration. It is recommended that both calibrations be performed. The voltage calibration must precede cold junction calibration.

Calibration of the meter should only be performed by persons experienced in calibrating electronic equipment. Allow a minimum 30 minute warm up before performing any calibration procedures. The following procedures should be performed at an ambient temperature of 15 to 35°C (59 to 95°F).

CAUTION: The accuracy of the calibration equipment will directly affect the accuracy of the meter.

10 OHM RTD Range Calibration

1. Set the Input Range Jumper to 10 ohm position.
2. With the display at CodE 00, press the PAR key. Unit displays CRL NO.
4. Press PAR, Display reads dSP
5. Apply a direct short to terminals RTD (4), TC (6) and COMM (7) using a three wire link. Press PAR, Display reads CRL FOR about 10 seconds.
6. When the display reads CRLr, apply a precision resistance of 15 ohms (with an accuracy of 0.01% or better) to terminals RTD, TC and COMM using a three wire link. Press PAR, Display reads CRL FOR about 10 seconds.
7. When display reads CRL NO, press PAR twice to exit calibration and return to the normal display mode.

100 OHM RTD Range Calibration

1. Set the Input Range Jumper to 100 ohm position.
2. With the display at CodE 00, press the PAR key. Unit displays CRL NO.
3. Press SEL twice to select 100 ohm range. Display reads CRL 100.
4. Press PAR, Display reads dSP
5. Apply a direct short to terminals RTD (4), TC (6) and COMM (7) using a three wire link. Press PAR, Display reads CRL FOR about 10 seconds.
6. When the display reads CRLr, apply a precision resistance of 300 ohms (with an accuracy of 0.01% or better) to terminals RTD, TC and COMM using a three wire link. Press PAR, Display reads CRL FOR about 10 seconds.
7. When display reads CRL NO, press PAR twice to exit calibration and return to the normal display mode.
5.3 MODULE 3 - DISPLAY AND FRONT PANEL KEY

PARAMETERS (3-dSP)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dSP-t</td>
<td>Display Update Time</td>
</tr>
<tr>
<td>SEL</td>
<td>Front Panel Display Select Enable</td>
</tr>
<tr>
<td>rSt</td>
<td>Front Panel Reset Enable</td>
</tr>
<tr>
<td>Scrol</td>
<td>Display Scroll Enable</td>
</tr>
<tr>
<td>b-Lit</td>
<td>Units Label Backlight</td>
</tr>
<tr>
<td>d-LEU</td>
<td>Display Intensity Level</td>
</tr>
<tr>
<td>CodeE</td>
<td>Programming Security Code</td>
</tr>
</tbody>
</table>

**DISPLAY UPDATE TIME**

- **dSP-t**: Displays time in seconds (0.5, 1, 2, or 4 seconds).
- **SEL**: Enables or disables the SEL key.
- **rSt**: Enables or disables the RST button.
- **Scrol**: Enables or disables the display scroll function.
- **b-Lit**: Enables or disables the units label backlight.
- **d-LEU**: Selects a display intensity level (1 to 5).

**PROGRAMMING SECURITY CODE**

- **CodeE**: The Security Code determines the programming mode and the accessibility of programming parameters. This code can be used along with the Program Mode Lock-out (P-Lac) in the User Input Function parameter (Module 1).

Two programming modes are available: Full Programming mode allows all parameters to be viewed and modified, while Quick Programming mode permits only user selected values to be modified, but allows direct access to these values without having to enter Full Programming mode. Entering a Security Code from 1-99 enables Quick Programming mode, and a sublist to select which values appear in the Quick Programming menu. Values set to yes in the sublist are accessible in Quick Programming. Programming any Security Code other than 0, requires this code to be entered at the Code prompt in order to access Full Programming mode. Quick Programming mode, if enabled, is accessed before the Code prompt appears.

<table>
<thead>
<tr>
<th>User Input Function</th>
<th>User Input State</th>
<th>Security Code</th>
<th>Mode When “Par” Button Is Pressed</th>
<th>Full Programming Mode Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>not P-Lac</td>
<td>——</td>
<td>0</td>
<td>Full Programming</td>
<td>Immediate Access</td>
</tr>
<tr>
<td>P-Lac Active</td>
<td>——</td>
<td>1-99</td>
<td>Quick Programming</td>
<td>After Quick Programming with correct code entry at Code prompt *</td>
</tr>
<tr>
<td></td>
<td>100-999</td>
<td>Code prompt</td>
<td>With correct code entry at Code prompt *</td>
<td></td>
</tr>
<tr>
<td>P-Lac Not Active</td>
<td>——</td>
<td>0</td>
<td>Programming Lock</td>
<td>No Access</td>
</tr>
<tr>
<td></td>
<td>1-99</td>
<td>Code prompt</td>
<td>Quick Programming</td>
<td>No Access</td>
</tr>
<tr>
<td></td>
<td>100-999</td>
<td>Code prompt</td>
<td>With correct code entry at Code prompt *</td>
<td></td>
</tr>
</tbody>
</table>

* Entering Code 222 allows access regardless of security code.
5.4 MODULE 4 - SETPOINT OUTPUT PARAMETERS (4-SPk)

PARAMETER MENU

Setpoint Select
Setpoint Enable
Setpoint Action
Setpoint Value
Hysteresis Value
On Time Delay
Off Time Delay
Output Reset Action
Output Reset With Display Reset
Standby Operation
Probe Burn-out Action

SETPOINT SELECT

Select the Setpoint Output to be programmed, starting with Setpoint 1. The "n" in the following parameters reflects the chosen Setpoint number. After the selected setpoint is completely programmed, the display returns to SPSEL. Repeat steps for Setpoint 2 if both Setpoints are being used. Select NO to exit the Setpoint programming module.

SETPOINT ENABLE

Select YES to enable Setpoint n and access the setup parameters. If NO is selected, the unit returns to SPSEL and Setpoint n is disabled.

SETPOINT ACTION

Enter the action for the selected setpoint (output). See Setpoint Output Figures for a visual detail of each action.

HI-bl = High Acting, with balanced hysteresis
LO-bl = Low Acting, with balanced hysteresis
HI-ub = High Acting, with unbalanced hysteresis
LO-ub = Low Acting, with unbalanced hysteresis

SETPOINT VALUE

Enter the desired setpoint value. The decimal point position for the setpoint and hysteresis values follow the selection set in Module 1.

HI-bHys = High Acting, with balanced hysteresis
LO-bHys = Low Acting, with balanced hysteresis
HI-uHys = High Acting, with unbalanced hysteresis
LO-uHys = Low Acting, with unbalanced hysteresis

Hysteresis Value

Enter desired hysteresis value. See Setpoint Output Figures for visual explanation of how setpoint output actions (balanced and unbalanced) are affected by the hysteresis. When the setpoint is a control output, usually balanced hysteresis is used. For alarm applications, usually unbalanced hysteresis is used. For unbalanced hysteresis modes, the hysteresis functions on the low side for high acting setpoints and functions on the high side for low acting setpoints.

Note: Hysteresis eliminates output chatter at the switch point, while time delay can be used to prevent false triggering during process transient events.

ON TIME DELAY

Enter the time value in seconds that the output is delayed from turning on after the trigger point is reached. A value of 0.0 allows the meter to update the output status per the response time listed in the Specifications.

OFF TIME DELAY

Enter the time value in seconds that the output is delayed from turning off after the trigger point is reached. A value of 0.0 allows the meter to update the output status per the response time listed in the Specifications.

OUTPUT RESET ACTION

Enter the reset action of the output. See figure for details.

Auto = Automatic action; This action allows the output to automatically reset off at the trigger points per the Setpoint Action shown in Setpoint Output Figures. The "on" output may be manually reset (off) immediately by the front panel RST button or user input. The output remains off until the trigger point is crossed again.
This parameter enables the RST button or user input to reset the output when the display is reset. Note: For this parameter to operate, the RST button or User Input being used must be set to E41 and the Input value must be displayed. If these conditions are not met, the output will not reset.

**Probe Burn-out Action**

Enter the probe burn-out action. In the event of a temperature probe failure (TC open; RTD open or short), the output can be programmed to be on or off.
Press **PAR** key to enter Programming Mode.

- **PAR**: Press to enter Programming Mode.
- **SEL**: Select menu options.
- **End**: Exit Programming Mode.

### Menu Options:
  - **TYPE**: Input Type
  - **CJC**: Cold Junction Compensation
  - **SCALE**: Temperature Scale
  - **dECPt**: Display Decimal Point
  - **OFSEt**: Display Offset Value
  - **F.Iltr**: Filter Setting
  - **bRNd**: Filter Band
  - **USr IN**: User Input Function
  - **U-RSN**: User Input Assignment
  - **U-Rct**: User Input Active Level

- **2-SEC**: **HI-En**, **HI-t**, **LO-En**, **LO-t**, **FCS**, **CodE**
  - **HI-En**: Max Display Enable
  - **HI-t**: Max Capture Delay Time
  - **LO-En**: Min Display Enable
  - **LO-t**: Min Capture Delay Time
  - **FCS**: Factory Service Operations
  - **CodE**: Access Code For Service Operations

- **3-dSP**: **dSP-t**, **SEL**, **tSt**, **ScrOL**, **b-Lt**, **d-LEU**, **CodE**
  - **dSP-t**: Display Update Time
  - **SEL**: Front Panel Display Select Enable
  - **tSt**: Front Panel Reset Enable
  - **ScrOL**: Display Scroll Enable
  - **b-Lt**: Units Label Backlight
  - **d-LEU**: Display Intensity Level
  - **CodE**: Programming Security Code

- **4-SP**: **SPSEL**, **Enb-n**, **Act-n**, **SPt-n**, **HYS-n**, **tDF-n**, **OFF-n**, **En-n**, **St-n**, **Stb-n**, **brn-n**
  - **SPSEL**: Setpoint Select
  - **Enb-n**: Setpoint Enable
  - **Act-n**: Setpoint Action
  - **SPt-n**: Setpoint Value
  - **HYS-n**: Hysteresis Value
  - **tDF-n**: On Time Delay
  - **OFF-n**: Off Time Delay
  - **En-n**: Output Reset Action
  - **St-n**: Output Reset With Display Reset
  - **Stb-n**: Standby Operation
  - **brn-n**: Probe Burn-out Action
MODEL DP5T - THERMOCOUPLE AND RTD INPUT

This is a brief overview of the DP5T. For complete specifications and programming information, see the DP5 Analog Input Panel Meters Bulletin starting on page 358.

- THERMOCOUPLE AND RTD INPUTS
- CONFORMS TO ITS-90 STANDARDS
- TIME-TEMPERATURE INTEGRATOR
- 5-DIGIT 0.56" HIGH RED LED DISPLAY
- PROGRAMMABLE FUNCTION KEYS/USER INPUT
- 9 DIGIT TOTALIZER (INTEGRATOR) WITH BATCHING

DP5T SPECIFICATIONS

READOUT:
Resolution: Variable: 0.1, 0.2, 0.5, or 1, 2, or 5 degree
Scale: F or C
Offset Range: -19,999 to 99,999 display units

THERMOCOUPLE INPUTS:
Input Impedance: 20 MΩ
Lead Resistance Effect: 0.03 μV/ohm
Max. Continuous Overvoltage: 30 V

RTD INPUTS:
Type: 3 or 4 wire, 2 wire can be compensated for lead wire resistance
Excitation current: 100 ohm range: 165 μA
10 ohm range: 2.6 mA
Lead resistance: 100 ohm range: 10 ohm/lead max.
10 ohm range: 3 ohms/lead max.
Max. continuous overload: 30 V

DIRECT READOUT:
Input range: -10 to 65 mV
0 to 400 ohms, high range
0 to 25 ohms, low range
Display range: -19999 to 99999

<table>
<thead>
<tr>
<th>INPUT TYPE</th>
<th>RANGE</th>
<th>ACURACY* (18 to 28°C)</th>
<th>ACURACY* (0 to 50°C)</th>
<th>STANDARD</th>
<th>WIRE COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>-200 to 400°C</td>
<td>1.2°C</td>
<td>2.1°C</td>
<td>IT90</td>
<td>(+) blue (+) red (+) white (+) blue</td>
</tr>
<tr>
<td>E</td>
<td>-200 to 871°C</td>
<td>1.0°C</td>
<td>2.4°C</td>
<td>IT90</td>
<td>(+) purple (+) red (+) brown (+) blue</td>
</tr>
<tr>
<td>J</td>
<td>-200 to 780°C</td>
<td>1.1°C</td>
<td>2.3°C</td>
<td>IT90</td>
<td>(+) white (+) red (+) yellow (+) blue</td>
</tr>
<tr>
<td>K</td>
<td>-200 to 1372°C</td>
<td>1.3°C</td>
<td>3.4°C</td>
<td>IT90</td>
<td>(+) yellow (+) red (+) brown (+) blue</td>
</tr>
<tr>
<td>R</td>
<td>-50 to 1768°C</td>
<td>1.9°C</td>
<td>4.0°C</td>
<td>B</td>
<td>(+) white (+) red (+) blue</td>
</tr>
<tr>
<td>S</td>
<td>-50 to 1768°C</td>
<td>1.9°C</td>
<td>4.0°C</td>
<td>B</td>
<td>(+) white (+) red (+) blue</td>
</tr>
<tr>
<td>B</td>
<td>100 to 300°C</td>
<td>3.9°C</td>
<td>5.7°C</td>
<td>IT90</td>
<td>(+) white (+) red (+) blue</td>
</tr>
<tr>
<td>N</td>
<td>-200 to 1300°C</td>
<td>1.3°C</td>
<td>3.1°C</td>
<td>IT90</td>
<td>(+) orange (+) red (+) orange (+) blue</td>
</tr>
<tr>
<td>C (W5/W26)</td>
<td>0 to 2315°C</td>
<td>1.9°C</td>
<td>6.1°C</td>
<td>ASTM</td>
<td>no standard no standard</td>
</tr>
</tbody>
</table>

*After 20 min. warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 15 to 75% RH environment; and Accuracy over a 0 to 50°C and 0 to 85% RH (non condensing) environment. Accuracy specified over the 0 to 50°C operating range includes meter tempco and ice point tracking effects. The specification includes the A/D conversion errors, linearization conformity, and thermocouple ice point compensation. Total system accuracy is the sum of meter and probe errors. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

** The accuracy over the interval -270 to -200°C is a function of temperature, ranging from 1°C at -200°C and degrading to 7°C at -270°C. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

*** These curves have been corrected to ITS-90.
MODEL PAXT - THERMOCOUPLE AND RTD INPUT

This is a brief overview of the PAXT. For complete specifications and programming information, see the PAX Analog Input Panel Meters Bulletin starting on page 378.

- THERMOCOUPLE AND RTD INPUTS
- CONFORMS TO ITS-90 STANDARDS
- CUSTOM SCALING FOR NON-STANDARD PROBES
- TIME-TEMPERATURE INTEGRATOR
- 5-DIGIT 0.56" RED SUNLIGHT READABLE OR STANDARD GREEN DISPLAY
- VARIABLE INTENSITY DISPLAY
- OPTIONAL CUSTOM UNITS OVERLAY W/BACKLIGHT
- FOUR SETPOINT ALARM OUTPUTS (W/OPTION CARD)
- COMMUNICATION AND BUS CAPABILITIES (W/OPTION CARD)
- RETRANSMITTED ANALOG OUTPUT (W/OPTION CARD)
- CRIMSON PROGRAMMING SOFTWARE

PAXT SPECIFICATIONS

**READOUT:**
Resolution: Variable: 0.1, 0.2, 0.5, or 1, 2, or 5 degrees
Scale: F or C
Offset Range: -19,999 to 99,999 display units

**THERMOCOUPLE INPUTS:**
Input Impedance: 20 MΩ
Lead Resistance Effect: 0.03 μV/ohm
Max. Continuous Overvoltage: 30 V

<table>
<thead>
<tr>
<th>INPUT TYPE</th>
<th>RANGE</th>
<th>ACCURACY* (18 to 28°C)</th>
<th>ACCURACY* (0 to 59°C)</th>
<th>STANDARD</th>
<th>WIRE COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>-200 to 400°C -270 to -200°C</td>
<td>1.2°C</td>
<td>2.1°C</td>
<td>ITS-90</td>
<td>(+) blue (-) red (+) white (-) blue</td>
</tr>
<tr>
<td>E</td>
<td>-200 to 871°C -270 to -200°C</td>
<td>1.0°C</td>
<td>2.4°C</td>
<td>ITS-90</td>
<td>(+) purple (-) red (+) brown (-) blue</td>
</tr>
<tr>
<td>J</td>
<td>-200 to 760°C</td>
<td>1.1°C</td>
<td>2.3°C</td>
<td>ITS-90</td>
<td>(+) white (-) red (+) yellow (-) blue</td>
</tr>
<tr>
<td>K</td>
<td>-200 to 1372°C -270 to -200°C</td>
<td>1.3°C</td>
<td>3.4°C</td>
<td>ITS-90</td>
<td>(+) yellow (-) red (+) brown (-) blue</td>
</tr>
<tr>
<td>R</td>
<td>-50 to 1768°C</td>
<td>1.9°C</td>
<td>4.0°C</td>
<td>ITS-90</td>
<td>no standard (+) white (-) blue</td>
</tr>
<tr>
<td>S</td>
<td>-50 to 1768°C</td>
<td>1.9°C</td>
<td>4.0°C</td>
<td>ITS-90</td>
<td>no standard (+) white (-) blue</td>
</tr>
<tr>
<td>B</td>
<td>100 to 300°C 300 to 1820°C</td>
<td>3.9°C</td>
<td>5.7°C</td>
<td>ITS-90</td>
<td>no standard no standard</td>
</tr>
<tr>
<td>N</td>
<td>-200 to 1300°C -270 to -200°C</td>
<td>1.3°C</td>
<td>3.1°C</td>
<td>ITS-90</td>
<td>(+) orange (-) red (+) orange (-) blue</td>
</tr>
<tr>
<td>C (W5/W26)</td>
<td>0 to 2315°C</td>
<td>1.9°C</td>
<td>6.1°C</td>
<td>ASTM E988-90***</td>
<td>no standard no standard</td>
</tr>
</tbody>
</table>

*After 20 min. warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 15 to 75% RH environment; and Accuracy over a 0 to 50°C and 0 to 85% RH (non condensing) environment. Accuracy specified over the 0 to 50°C operating range includes meter tempco and ice point tracking effects. The specification includes the A/D conversion errors, linearization conformity, and thermocouple ice point compensation. Total system accuracy is the sum of meter and probe errors. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

** The accuracy over the interval -270 to -200°C is a function of temperature, ranging from 1°C at -200°C and degrading to 7°C at -270°C. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

*** These curves have been corrected to ITS-90.

**RTD INPUTS:**
Type: 3 or 4 wire, 2 wire can be compensated for lead wire resistance
Excitation current: 100 ohm range: 165 μA
10 ohm range: 2.6 mA
Lead resistance: 100 ohm range: 10 ohm/lead max.
10 ohm range: 3 ohms/lead max.
Max. continuous overload: 30 V

<table>
<thead>
<tr>
<th>INPUT TYPE</th>
<th>RANGE</th>
<th>ACCURACY* (18 to 28°C)</th>
<th>ACCURACY* (0 to 59°C)</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ohm Pt</td>
<td>-200 to 850°C</td>
<td>0.4°C</td>
<td>1.6°C</td>
<td>IEC 751</td>
</tr>
<tr>
<td>100 ohm Pt</td>
<td>-200 to 850°C</td>
<td>0.4°C</td>
<td>1.6°C</td>
<td>no official standard</td>
</tr>
<tr>
<td>120 ohm nickel</td>
<td>-80 to 260°C</td>
<td>0.2°C</td>
<td>0.5°C</td>
<td>no official standard</td>
</tr>
<tr>
<td>10 ohm Copper</td>
<td>alpha = .00427</td>
<td>-100 to 260°C</td>
<td>0.4°C</td>
<td>0.9°C</td>
</tr>
</tbody>
</table>

**CUSTOM RANGE:** Up to 16 data point pairs
Input range: -10 to 65 mV
0 to 400 ohms, high range
0 to 25 ohms, low range
Display range: -19999 to 99999

<table>
<thead>
<tr>
<th>INPUT TYPE</th>
<th>RANGE</th>
<th>ACCURACY* (18 to 28°C)</th>
<th>ACCURACY* (0 to 59°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Custom mV range</td>
<td>-10 to 65mV (1 μV res.)</td>
<td>0.02% of reading + 4μV</td>
<td>0.12% of reading + 5μV</td>
</tr>
<tr>
<td>Custom 100 ohm range</td>
<td>0 to 400 Ω (10 MΩ res.)</td>
<td>0.02% of reading + 0.04 Ω</td>
<td>0.12% of reading + 0.05 Ω</td>
</tr>
<tr>
<td>Custom 10 ohm range</td>
<td>0 to 25 Ω (1 MΩ res.)</td>
<td>0.04% of reading + 0.005 Ω</td>
<td>0.20% of reading + 0.007 Ω</td>
</tr>
</tbody>
</table>
GENERAL DESCRIPTION

The Model T16 Controller accepts signals from a variety of temperature sensors (thermocouple or RTD), while the Model P16 Controller accepts either a 0 to 10 VDC or 0/4 to 20 mA DC input signal. Both controllers can provide an accurate output control signal (time proportional or DC Analog Output) to maintain a process at a setpoint value. Dual 4-digit displays allow viewing of the process/temperature and setpoint simultaneously. Front panel indicators inform the operator of the controller and output status. The comprehensive programming allows these controllers to meet a wide variety of application requirements.

MAIN CONTROL

The controller operates in the PID Control Mode for both heating and cooling, with on-demand auto-tune, that establishes the tuning constants. The PID tuning constants may be fine-tuned through the front panel and then locked out from further modification. The controller employs a unique overshoot suppression feature, that allows the quickest response without excessive overshoot. Switching to Manual Mode provides the operator direct control of the output. The controller may also be programmed to operate in On/Off mode with adjustable hysteresis.

ALARMS

Optional alarm(s) can be configured independently for absolute high or low acting with balanced or unbalanced hysteresis. They can also be configured for deviation and band alarm. In these modes, the alarm trigger values track the setpoint value. Adjustable alarm hysteresis can be used for delaying output response. The alarms can be programmed for Automatic or Latching operation. A selectable standby feature suppresses the alarm during power-up until the temperature stabilizes outside the alarm region.

ANALOG OUTPUT OPTION

The optional DC Analog Output (10 V or 20 mA) can be configured and scaled for control or re-transmission purposes. The programmable output update time reduces valve or actuator activity.

PC PROGRAMMING KIT

The optional TP16KIT contains a programming module with a 9 pin RS232 connector, cable and Crimson, a Windows® based configuration software. The software allows downloading, uploading and storage of T16 and P16 program files. All controllers have a communications port that allows configuration by PC even without controller power connected. Controller calibration is also possible using the software when the proper calibration equipment and controller power is connected.

CONSTRUCTION

The controller is constructed of a lightweight, high impact, black plastic textured case and bezel with a clear display window. The front panel meets NEMA 4X/IP65 specifications when properly installed. In applications that do not require protection to NEMA 4X, multiple controllers can be stacked horizontally or vertically. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the controller extremely reliable in industrial environments.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the controller to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller. An independent and redundant temperature limit indicator with alarm outputs is strongly recommended.

DIMENSIONS  In inches (mm)

CAUTION: Risk of Danger.
Read complete instructions prior to installation and operation of the unit.

CAUTION: Risk of electric shock.
**INPUT SPECIFICATIONS**

1. **SENSOR INPUT:**
   - Sample Period: 100 msec (10 Hz rate)
   - Step Response Time: 300 msec typical, 400 msec max to within 99% of final value with step input.
   - Failed Sensor Response:
     - Main Control Output(s): Programmable preset output
     - Display: "OPEN"
     - Alarms: Upscale drive
     - Analog Output: Upscale drive when assigned to retransmitted input.
   - Normal Mode Rejection: >40 dB @ 50/60 Hz
   - Common Mode Rejection: >120 dB, DC to 60 Hz
   - Overvoltage Protection: 120 VAC @ 15 sec max
   - 2. **RTD INPUTS:** (T16 only)
     - Type: 2 or 3 wire
     - Excitation: 150 μA typical
     - Lead Resistance: 15 Ω max per input lead
     - Resolution: 1° or 0.1° for all types

2. **TYPE** | **INPUT TYPE** | **RANGE** | **STANDARD** | **WIRE COLOR** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>385</td>
<td>100 Ω platinum, Alpha = 0.00385</td>
<td>-200 to +600°C -328 to +1112°F</td>
<td>IEC 751</td>
<td>ANSI BS 1843</td>
</tr>
<tr>
<td>392</td>
<td>100 Ω platinum, Alpha = 0.003919</td>
<td>-200 to +600°C -328 to +1112°F</td>
<td>No official standard</td>
<td>Standard (±1°C)</td>
</tr>
<tr>
<td>672</td>
<td>120 Ω nickel, Alpha = 0.00672</td>
<td>-80 to +215°C -112 to +419°F</td>
<td>No official standard</td>
<td>Standard (±1°C)</td>
</tr>
<tr>
<td>Ohms</td>
<td>Linear Resistance</td>
<td>0.0 to 320.0 Ω</td>
<td>N/A</td>
<td>Standard (±1°C)</td>
</tr>
<tr>
<td>mV</td>
<td>-5.00 mV to 56.00 mV</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
INPUT SPECIFICATIONS (Cont’d)

4. SIGNAL INPUT: (P16 only)

<table>
<thead>
<tr>
<th>INPUT RANGE</th>
<th>ACCURACY *</th>
<th>IMPEDANCE</th>
<th>MAX CONTINUOUS OVERLOAD</th>
<th>RESOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 VDC: (-1 to 11)</td>
<td>0.30 % of reading +0.03V</td>
<td>1 MΩ</td>
<td>50 V</td>
<td>10 mA</td>
</tr>
<tr>
<td>20 mA DC: (-2 to 22)</td>
<td>0.30 % of reading +0.04mA</td>
<td>10 Ω</td>
<td>100 mA</td>
<td>10 μA</td>
</tr>
</tbody>
</table>

* Accuracies are expressed as ± percentages over 0 to 50 °C ambient range after 20 minute warm-up.

OUTPUT SPECIFICATIONS

1. CONTROL AND ALARM OUTPUTS:
   - Relay Output:
     - Type: Form A
     - Contact Rating: 3 A @ 250 VAC or 30 VDC; 1/10 HP @ 120 VAC (inductive load)
   - Life Expectancy: 100,000 cycles at max. load rating
   - Logic/SSR Output (main control output only):
     - Rating: 45 mA max @ 4 V min., 7 V nominal

2. MAIN CONTROL:
   - Control: PID or On/Off
   - Output: Time proportioning or DC Analog
   - Cycle Time: Programmable
   - Auto-Tune: When selected, sets proportional band, integral time, derivative time, and output dampening time. Also sets input filter and (if applicable) cooling gain.
   - Probe Break Action: Programmable

3. ALARMS: (optional) 2 relay alarm outputs.
   - Modes:
     - None
     - Absolute High Acting (Balanced or Unbalanced Hysteresis)
     - Absolute Low Acting (Balanced or Unbalanced Hysteresis)
     - Deviation High Acting
     - Deviation Low Acting
     - Inside Band Acting
     - Outside Band Acting
     - Heat (Alarm 1 on Analog Output models only)
     - Cool (Alarm 2)

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>MAIN CONTROL</th>
<th>2 ALARMS &amp; USER INPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relay</td>
<td>—</td>
</tr>
<tr>
<td>T16</td>
<td>Relay</td>
<td>Yes</td>
</tr>
<tr>
<td>P16</td>
<td>Logic/SSR</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Logic/SSR</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Analog Out *</td>
<td>Yes</td>
</tr>
</tbody>
</table>

reset Action: Programmable; automatic or latched
Standby Mode: Programmable; enable or disable
Hysteresis: Programmable
Sensor Fail Response: Upscale
Annunciator: “A1” and “A2” programmable for normal or reverse acting

4. COOLING: Software selectable (overrides Alarm 2).
   - Control: PID or On/Off
   - Output: Time proportioning
   - Cycle Time: Programmable
   - Proportional Gain Adjust: Programmable
   - Heat/Cool Deadband Overlap: Programmable

5. ANALOG DC OUTPUT: (optional)
   - Action: Control or retransmission
   - Update Rate: 0.1 to 250 sec

ACCESSORIES

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>DESCRIPTION</th>
<th>PART NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP16</td>
<td>Programming Kit 1: Includes Software, Comms Module w/ 9-pin connector and cable, and 115 VAC Power Adapter</td>
<td>TP16KIT1</td>
</tr>
<tr>
<td></td>
<td>Programming Kit 2: Includes Software, Comms Module w/ 9-pin connector and cable</td>
<td>TP16KIT2</td>
</tr>
<tr>
<td>RLY</td>
<td>External SSR Power Unit (for Logic/SSR models)</td>
<td>RLY50000</td>
</tr>
<tr>
<td></td>
<td>25 A Single Phase Din Rail Mount Solid State Relay</td>
<td>RLY60000</td>
</tr>
<tr>
<td></td>
<td>40 A Single Phase Din Rail Mount Solid State Relay</td>
<td>RLY64000</td>
</tr>
<tr>
<td></td>
<td>Three Phase Din Rail Mount Solid State Relay</td>
<td>RLY70000</td>
</tr>
</tbody>
</table>

* Analog out may be used for retransmitted signals. When using analog output for retransmitted signals, AL1 becomes main control O1, if selected for heating in the analog out models.

1-717-767-6511

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**EMC INSTALLATION GUIDELINES**

Although this controller is designed with a high degree of immunity to Electromagnetic Interference (EMI), proper installation and wiring methods must be followed to ensure electromagnetic compatibility (EMC) in each application. The type of the electrical noise, source or coupling method into the controller may be different for various installations. The controller becomes more immune to EMI with fewer I/O connections. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation. Listed are some EMC guidelines for successful installation in an industrial environment.

1. The controller should be mounted in a metal enclosure that is properly connected to protective earth.
2. Use shielded (screened) cables for all Signal and Control inputs. The shield (screen) pigtail connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.
   - Connect the shield only at the panel where the controller is mounted to earth ground (protective earth).
   - Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is more than 1 MHz.
   - Connect the shield to common of the controller and leave the other end of the shield unconnected and insulated from earth ground.
3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run through metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
4. Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.
5. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the controller as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the controller to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:
   - Ferrite Suppression Cores for Signal and Control cables:
     - Fair-Rite # 0443167251 (Red Lion Controls # FCOR0000)
     - TDK # ZCAT3035-1330A
     - Steward # 28B2029-0A0
   - Line Filters for input power cables:
     - Schaffner # FN610-1/07 (Red Lion Controls # LFIL0000)
     - Schaffner # FN670-1.8/07
     - Corcom # 1 VR3
   - Note: Reference manufacturer’s instructions when installing a line filter.
6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
7. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.
   - Snubber: Red Lion Controls # SNUB0000.
1.0 Setting the Jumpers (Analog Output Models Only)

To insure proper operation, the Analog Output jumpers must be set to the same range selected in programming Module 2-OP. The default jumper setting is for 20 mA. The default setting in Module 2-OP is 4-20 mA. To access the jumpers, insert a flat-blade screwdriver between the front panel and the side case slot. This should disengage the top and bottom front panel latches from the case grooves. Pull the front panel assembly with the controller boards out of the case. The jumpers are located inside the controller on the left board along the back top section.

2.0 Installing the Controller

The T16 and P16 controllers meet NEMA 4X/IP65 requirements for indoor use to provide a watertight seal in steel panels with a minimum thickness of 0.09”, or aluminum panels with a minimum thickness of 0.12”. The controllers are designed to be mounted into an enclosed panel. The bezel assembly must be in place during installation of the controller.

Instructions:
1. Prepare the panel cutout to the proper dimensions.
2. Remove the panel latch from the controller. Discard the cardboard sleeve.
3. Carefully remove the center section of the panel gasket and discard. Slide the panel gasket over the rear of the controller, seating it against the lip at the front of the case.
4. Insert the controller into the panel cutout. While holding the controller in place, push the panel latch over the rear of the controller, engaging the tabs of the panel latch in the farthest forward slot possible.
5. To achieve a proper seal, tighten the panel latch screws evenly until the controller is snug in the panel, torquing the screws to approximately 7 in-lb (79 N-cm). Overtightening can result in distortion of the controller, and reduce the effectiveness of the seal.

Note: The installation location of the controller is important. Be sure to keep it away from heat sources (ovens, furnaces, etc.) and away from direct contact with caustic vapors, oils, steam, or any other process by-products in which exposure may affect proper operation.

Multiple Controller Stacking

The controller is designed to allow for close spacing of multiple controllers in applications that do not require protection to NEMA 4X. Controllers can be stacked either horizontally or vertically. For vertical stacking, install the panel latch with the screws to the sides of the controller. For horizontal stacking, the panel latch screws should be at the top and bottom of the controller. The minimum spacing from centerline to centerline of controllers is 1.96” (49.8 mm). This spacing is the same for vertical or horizontal stacking.

Note: When stacking controllers, provide adequate panel ventilation to ensure that the maximum operating temperature range is not exceeded.
3.0 WIRING THE CONTROLLER

WIRING CONNECTIONS
All wiring connections are made to the rear screw terminals. When wiring the
controller, use the numbers on the label and those embossed on the back of the
case, to identify the position number with the proper function.
All conductors should meet voltage and current ratings for each terminal.
Also, cabling should conform to appropriate standards of good installation, local
codes and regulations. It is recommended that power (AC or DC) supplied to the
controller be protected by a fuse or circuit breaker. Strip the wire, leaving
approximately 1/4" (6 mm) bare wire exposed (stranded wires should be tinned
with solder). Insert the wire under the clamping washer and tighten the screw
until the wire is clamped tightly.

CONTROLLER POWER CONNECTIONS
For best results, the power should be relatively “clean” and within
the specified limits. Drawing power from heavily loaded circuits or
from circuits that also power loads that cycle on and off should be
avoided. It is recommended that power supplied to the controller be
protected by a fuse or circuit breaker.

INPUT CONNECTIONS
For two wire RTDs, install a copper sense lead of the same gauge and length
as the RTD leads. Attach one end of the wire at the probe and the other end to
input common terminal. Complete lead wire compensation is obtained. This is
the preferred method. If a sense wire is not used, then use a jumper. A
temperature offset error will exist. The error may be compensated by
programming a temperature offset.

RTD and Resistance
COMM 8
TC+ 9
RTD 10

Thermocouple and Millivolt
COMM 8 TC-
TC+ 9 TC+
RTD 10

Voltage and Current
COMM 8 DC-
10V 9 DC+ VOLTAGE
20mA 0 DC+ CURRENT

CONTROL AND ALARM OUTPUT CONNECTIONS
Alarm Models

Main Control Relay Models
(+ ) 01 6 LOAD AC/DC POWER
(- ) 01 7 AC/DC POWER

Main Control Logic/SSR Models
(+ ) 01 6 SSR POWER AC
(- ) 01 7 UNIT AC

ANALOG DC OUTPUT CONNECTIONS
+ V/I 6 CONTROLLER, RECORDER
- V/I 7

USER INPUT CONNECTIONS
USER INPUT 1 COMM. 8
4.0 Reviewing the Front Keys and Display

**Front Panel Keys**

The F1 key is pressed to exit (or escape) directly to the start of the Display Loop. While in the Display Loop, the F1 key can be pressed to activate its programmed function.

The Loop key is pressed to advance to the next parameter, to activate a changed selection/value, and when held for three seconds, enter the Hidden Loop.

**Arrow Keys**

The Arrow keys are used to scroll through parameter selections/values and in the Configuration Loop they are used to scroll to the appropriate Parameter Module.

5.0 Programming: Display Loop

**Display Loop**

At power up, all display segments light, and then the programmed input type and the controller’s software version will flash. Then the Temperature/Process Value is shown in the top display, and the Setpoint Value is shown in the bottom display. This is the Display Loop. If the Setpoint is hidden or locked, the Display Loop will default to Output Power. If Output Power is also hidden or locked out, the bottom display is blank. During programming, the F1 key can be pressed to return the controller to this point. (Only in the Display Loop will the F1 key perform the usual function programmed in Input Module.)

When the Loop key is pressed the controller advances to the next parameter in the Display Loop. Except for Setpoint and % Output Power, the bottom display alternates between the parameter name and its selection/value. The arrow keys are pressed to change the selection/value for the shown parameter. The new selection/value is activated when the Loop key is pressed. Display Loop parameters may be locked out or hidden in Lockout Module. Some parameters are model and programming dependent.
The values shown for the displays are the factory settings.

**SETPOINT VALUE (SP1)***

```
+ SP 0
```

-999 to 9999

**SETPOINT VALUE (SP2)***

```
+ SP 2
```

-999 to 9999

Typically, the controller is operating with the Setpoint value in the bottom display. There is no annunciator nor parameter indication for Setpoint in the Display Loop. The parameter name alternates with the setpoint value in the Hidden Loop. The Setpoint value can be changed, activated and stored by pressing the arrow keys. This is the only parameter that can be configured as read only in the Display Loop, but read/write in the Hidden Loop. It is possible to store a second Setpoint value that can be selected in the Hidden Loop, by the F1 key or the user input. Both Setpoint values are limited by the Setpoint Low and High Limits in Input Module 1-16.

**% OUTPUT POWER***

```
+ OP 0
```

-100 to 100.0

The % Output Power is shown with the %PW annunciator. The parameter name alternates with the % Output Power value in the Hidden Loop. While the controller is in Automatic Mode, this value is read only. When the controller is placed in Manual Mode, the value can be changed, activated and stored by pressing the arrow keys. For more details on % Output Power, see Control Mode Explanations.

**OUTPUT POWER OFFSET**

```
+ OPF 0
```

-100 to 1000

When the Integral Time is set to zero and the controller is in the Automatic Mode, this parameter will appear after % Output Power. It is also shown with the %PW annunciator illuminated. The power offset is used to shift the proportional band to compensate for errors in the steady state. If Integral Action is later invoked, the controller will re-calculate the internal integral value to provide “bumpless” transfer and Output Power Offset will not be necessary.

**PROPORTIONAL BAND**

```
+ PAP 4.0
```

0.0 to 9999

(% of full input range)

The proportional band should be set to obtain the best response to a process disturbance while minimizing overshoot. A proportional band of 0.0% forces the controller into On/Off Control with its characteristic cycling at Setpoint. For more information, see Control Mode and PID Tuning Explanations.

**INTEGRAL TIME**

```
+ IntT 120
```

0 to 9999 seconds

Integral action shifts the center point position of the proportional band to eliminate error in the steady state. The higher the integral time, the slower the response. The optimal integral time is best determined during PID Tuning. If time is set to zero, the previous Integral output power value is maintained. Offset Power can be used to provide Manual Reset.

**DERIVATIVE TIME**

```
+ dErr 30
```

0 to 9999 seconds per repeat

Derivative time helps to stabilize the response, but too high of a derivative time, coupled with noisy signal processes, may cause the output to fluctuate too greatly, yielding poor control. Setting the time to zero disables derivative action.

**ALARM 1 VALUE**

```
+ AL -1
```

-999 to 9999

On models with alarms, the value for Alarm 1 can be entered here. The value is either absolute (absolute alarm types) or relative to the Setpoint value (deviation and band alarm types.) When Alarm 1 is programmed for \texttt{MIN} or \texttt{MAX}, this parameter is not available. For more details on alarms, see Alarm Module \texttt{AL}.

**ALARM 2 VALUE**

```
+ AL -2
```

-999 to 9999

On models with alarms, the value for Alarm 2 can be entered here. The value is either absolute (absolute alarm types) or relative to the Setpoint value (deviation and band alarm types.) When Alarm 2 is programmed for \texttt{LOW} or \texttt{HIGH}, this parameter is not available. For more details on alarms, see the Alarm Module \texttt{AL}.

* Alternating indication only used in the Hidden Loop.
6.0 PROGRAMMING: HIDDEN LOOP

To enter Hidden Loop, press \( \text{Code} \) for 3 seconds.

HIDDEN LOOP

When \( \text{Code} \) is pressed and held for three seconds, the controller advances to the Hidden Loop. The Temperature/Process Value is shown in the top display. The bottom display alternates between the parameter and its selection/value. \( \text{Setpoint} \) or \( \text{Value} \) is pressed to change the selection/value for the shown parameter. The new selection/value is activated after \( \text{Code} \) is pressed. When \( \text{Code} \) is pressed, the controller returns to the Display Loop and stores changed selection/values to permanent memory. Hidden Loop parameters may be locked out in Lockout Module \( \text{Code} \). Some parameters are model and programming dependent.

**ACCESS CODE**

If the Access Code is set from 1 to 125, in Lockout Module \( \text{Code} \), Access Code will appear here. By entering the proper Code, access to the Hidden Loop is permitted. With the factory setting of 0, Access Code will not appear in the Hidden Loop. A universal code of 111 can be entered to gain access, independent of the programmed code number.

**SETPOINT SELECT**

The SPSL function allows the operator to switch from or to, setpoint 1 and setpoint 2. In the Display Loop, there is no annunciator indicating the selected Setpoint, however, the selected Setpoint value is displayed and activated.

**SETPOINT RAMP RATE**

The setpoint ramp rate can reduce sudden shock to the process and reduce overshoot on startup or after setpoint changes, by ramping the setpoint at a controlled rate. \( \text{R} \) annunciator flashes while ramping. With the T16, the ramp rate is always in tenths of degrees per minute, regardless of the resolution chosen for the process display. With the P16, the ramp rate is in least-significant (display units) digits per minute. A value of 0.0 or 0 disables setpoint ramping. Once the ramping setpoint reaches the target setpoint, the setpoint ramp rate disengages until the setpoint is changed again. If the ramp value is changed during ramping, the new ramp rate takes effect. If the setpoint is ramping prior to starting Auto-Tune, the ramping is suspended during Auto-Tune and then resumed afterward. Deviation and band alarms are relative to the target setpoint, not the ramping setpoint. A slow process may not track the programmed setpoint rate. At power up, the ramping setpoint is initialized at the ambient temperature/process value.

**CONTROL MODE TRANSFER**

In Automatic Mode, the percentage of Output Power is automatically determined by the controller. In Manual/User Mode, the percentage of Output Power is adjusted manually while in the Display Loop. The Control Mode can also be transferred through the \( \text{F1 Key} \) or User Input. For more information, see Control Mode Explanations.
7.0 PROGRAMMING: CONFIGURATION LOOP

- **AUTO-TUNE START**

  The Auto-Tune procedure of the controller sets the Proportional Band, Integral Time, Derivative Time, Digital Filter, Control Output Dampening Time, and Relative Gain (Heat/Cool) values appropriate to the characteristics of the process. This parameter allows front panel starting YES or stopping NO of Auto-Tune. For more information, see PID Tuning Explanations.

- **ALARMS RESET**

  With alarm models, the alarms can be manually reset. The up key resets Alarm 1 and the down key resets Alarm 2.

- **ACCESS CODE**

  If the Access Code is set from -1 to -125, in Lockout Module 3-0L, Access Code will appear here. By entering the proper Code, access to the Configuration Loop is permitted (with a negative Code value, the Hidden Loop can be accessed without the use of a code). With the factory setting of 0 or with an active User Input configured for Program Lock (PLC), Access Code will not appear here. An active user input configured for Program Lock (PLC) always locks out the Configuration Loop, regardless of Access Code.

**CONFIGURATION LOOP**

- **FRONT DISPLAY**

  ENDS AND RETURNS TO START OF DISPLAY LOOP.

  ENTERS MODULE OR AT CONF NO.

  RETURNS TO DISPLAY LOOP.

  ADVANCES TO NEXT MODULE.

  TO access the Configuration Loop, press the up key when CONF NO is displayed in the Hidden Loop. The arrow keys are used to select the parameter module (1-9). To enter a specific module press CONF while the module number is displayed. In the Configuration Loop, CONF will alternate with the parameter number in the bottom display. The Temperature/Process Value is shown in the top display.

  After entering a parameter module, press CONF to advance through the parameter names in the module. To change a parameter's selection/value, press the arrow keys while the parameter is displayed. In the modules, the top display shows the parameter name, and the bottom display shows the selection/value. Use CONF to enter any selection/values that have been changed. The change is not committed to permanent memory until the controller is returned to the Display Loop. If a power loss occurs before returning to the Display Loop, the new values must be entered again.

  At the end of each module, the controller returns to CONF NO. At this location, pressing CONF again returns the display to the the Display Loop. Pressing the Up key allows re-entrance to the Configuration Loop. Whenever CONF is pressed, End momentarily appears as the parameters are stored to permanent memory and the controller returns to the Display Loop.

- **COO Mick Parameters Module**

  TO ACCESS CODE

  0

  -1 to -125

  WITH ALARMS RESET

  WITH AUTO-TUNE START

  WITH ACCESS CODE

  WITH CONFIGURATION LOOP

  WITH FRONT DISPLAY

  WITH TYPE

  WITH BOTTOM DISPLAY

  WITH END

  WITH CONF

  WITH CONF NO

  WITH NEXT PARAMETER

  WITH ACX

  WITH ADVANCES SELECTION/VALUE.
7.1 MODULE 1 - INPUT PARAMETERS (\(t-I\)M) T16 ONLY

### INPUT TYPE

<table>
<thead>
<tr>
<th>TYPE</th>
<th>SELECTION</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(t-\text{C} )</td>
<td>T TC</td>
<td>N TC</td>
</tr>
<tr>
<td>(t-\text{E} )</td>
<td>E TC</td>
<td>C TC</td>
</tr>
<tr>
<td>(t-\text{D} )</td>
<td>J TC</td>
<td>Linear mV</td>
</tr>
<tr>
<td>(t-\text{Y} )</td>
<td>K TC</td>
<td>RTD 385</td>
</tr>
<tr>
<td>(t-\text{R} )</td>
<td>R TC</td>
<td>RTD 392</td>
</tr>
<tr>
<td>(t-\text{S} )</td>
<td>S TC</td>
<td>RTD 672</td>
</tr>
<tr>
<td>(t-\text{B} )</td>
<td>B TC</td>
<td>Linear Ohms</td>
</tr>
</tbody>
</table>

Select the input type that corresponds to the input sensor.

### TEMPERATURE SCALE

- \(^{\circ}\text{F}\) Fahrenheit
- \(^{\circ}\text{C}\) Celsius

Select either degrees Fahrenheit or Celsius. For linear mV and ohms input types, this has no effect. If changed, adjust related parameter values, as the controller does not automatically convert them.

### DECIMAL RESOLUTION

- 0 to 00 for temperature and resistance inputs
- 000 for mV inputs

Select whole degrees, or tenths of degrees for Temperature display, Setpoint values, and related parameters. For Linear Resistance inputs \(t\-\text{in}\), the same parameter selections apply in ohms or tenths of an ohm. For mV inputs \(t\-\text{in}\), only hundredths of a mV resolution is available.

### DIGITAL FILTERING

- 0 = least to 4 = most

The filter is an adaptive digital filter that discriminates between measurement noise and actual process changes. If the signal is varying too greatly due to measurement noise, increase the filter value. If the fastest controller response is needed, decrease the filter value.

### SHIFT/OFFSET

- \(-999\) to \(9999\) degrees

This value offsets the controller’s temperature display value by the entered amount. This is useful in applications in which the sensor cannot provide the actual temperature signal due to mounting constraints, inaccuracy, etc.

### SETPOINT LOW LIMIT

\(-999\) to \(9999\)

The controller has a programmable low setpoint limit value to restrict the setting range of the setpoint. Set the limit so that the setpoint value cannot be set below the safe operating area of the process.

### SETPOINT HIGH LIMIT

\(-999\) to \(9999\)

The controller has a programmable high setpoint limit value to restrict the setting range of the setpoint. Set the limit so that the setpoint value cannot be set above the safe operating area of the process.

### USER INPUT FUNCTION (OPTIONAL)

<table>
<thead>
<tr>
<th>SELECTION</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>NONE</td>
<td>No Function</td>
</tr>
<tr>
<td>PLOC</td>
<td>Program Lock</td>
</tr>
<tr>
<td>LOC</td>
<td>Integral Action Lock</td>
</tr>
<tr>
<td>trnF</td>
<td>Auto/Manual Select</td>
</tr>
</tbody>
</table>

The controller performs the selected User Input function (User Input available only on models with alarms), when the User terminal 1 is connected (pulled low) to Common terminal 8.

- **No Function**: No function is performed.
- **Program Lock**: The Configuration Loop is locked, as long as activated (maintained action).
- **Integral Action Lock**: The integral action of the PID computation is disabled (frozen), as long as activated (maintained action).
- **Auto/Manual Select**: This function selects (maintained action) Automatic (open) or Manual Control (activated).
- **Setpoint 1 or 2 Select**: This function selects (maintained action) Setpoint 1 (open) or Setpoint 2 (activated) as the active setpoint.
- **Setpoint Ramp Disable**: The setpoint ramping feature is disabled, as long as activated (maintained action). Any time the user input is activated with a ramp in process, ramping is aborted.
- **Reset Alarms**: Active alarms are reset, as long as activated (maintained action). Active alarms are reset until the alarm condition is cleared and triggered again (momentary action).

---

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7.1 MODULE 1 - INPUT PARAMETERS (t-in) P16 ONLY

F1 KEY FUNCTION

No Function
Auto/Manual Select
Setpoint 1 or 2 Select

INPUT TYPE

<table>
<thead>
<tr>
<th>Selection</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>$VSS$</td>
</tr>
<tr>
<td>trnF</td>
<td>U:1 &amp;</td>
</tr>
<tr>
<td>SPL</td>
<td>SoE</td>
</tr>
</tbody>
</table>

PARAMETER MENU

INPUT TYPE

<table>
<thead>
<tr>
<th>Selection</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>$VSS$</td>
</tr>
<tr>
<td>trnF</td>
<td>U:1 &amp;</td>
</tr>
<tr>
<td>SPL</td>
<td>SoE</td>
</tr>
</tbody>
</table>

PERCENT ANNUNCIATOR

<table>
<thead>
<tr>
<th>Selection</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>On/Off</td>
</tr>
</tbody>
</table>

DECIMAL RESOLUTION

<table>
<thead>
<tr>
<th>Selection</th>
<th>0.0 - 0.9999</th>
</tr>
</thead>
<tbody>
<tr>
<td>dcPt</td>
<td></td>
</tr>
</tbody>
</table>

ROUNDING INCREMENT

<table>
<thead>
<tr>
<th>Selection</th>
<th>1 to 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>rnd</td>
<td></td>
</tr>
</tbody>
</table>

DIGITAL FILTERING

<table>
<thead>
<tr>
<th>Selection</th>
<th>least to most</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fltr</td>
<td></td>
</tr>
</tbody>
</table>

SCALING

To scale the controller, two scaling points are necessary. Each scaling point has a coordinate pair of Display Values and Input Values. It is recommended that the two scaling points be at the low and high ends of the input signal being measured. Process value scaling will be linear between and continue past the entered points to the limits of the input range. (Factory settings example will display 0.0 at 4.00 mA input and display 100.0 at 20.00 mA input.) Reverse acting indication can be accomplished by reversing the two signal points or the Display value points, but not both. If both are reversed, forward (normal) acting indication will occur. In either case, do not reverse the input wires to change the action.

DISPLAY VALUE SCALING POINT 1

For Key-in Method, enter the first coordinate Display Value by using the arrow keys.

<table>
<thead>
<tr>
<th>Selection</th>
<th>-999 to 9999</th>
</tr>
</thead>
<tbody>
<tr>
<td>dsp1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

INPUT VALUE SCALING POINT 1

For Key-in Method, enter the first coordinate Input Value by using the arrow keys. To allow the P16 to "learn" the signal, use the Applied Method. For Applied Method, press . The ° annunciator is turned on to indicate the applied method. Adjust the applied signal level externally until the appropriate value appears under $imp1$. Using either method, press to store the value for $dsp2$. (The controller can be toggled back to the Key-in Method by pressing before .)

DISPLAY VALUE SCALING POINT 2

Enter the second coordinate Display Value by using the arrow keys.

<table>
<thead>
<tr>
<th>Selection</th>
<th>-999 to 9999</th>
</tr>
</thead>
<tbody>
<tr>
<td>dsp2</td>
<td>1000.0</td>
</tr>
</tbody>
</table>

The controller performs the selected F1 Key Function, when is pressed while in the Display Loop. In any other loop or module location, pressing will perform an escape to the Display Loop.

No Function: No function is performed.
Auto/Manual Select: This function toggles (momentary action) the controller between Automatic and Manual Control.
Setpoint 1 or 2 Select: This function toggles (momentary action) the controller between Setpoint 1 and Setpoint 2.
Reset Alarms: This function can be used to reset one or both of the alarms when activated (momentary action) The alarm will remain reset until the alarm condition is cleared and triggered again.
INPUT VALUE SCALING POINT 2

<table>
<thead>
<tr>
<th>Input</th>
<th>Lower Value</th>
<th>Upper Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INP2</td>
<td>0.000</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>0.000</td>
<td>1000</td>
</tr>
</tbody>
</table>

For Key-in Method, enter the second coordinate Input Value by using the arrow keys. To allow the P16 to "learn" the signal, use the Applied Method. For Applied Method, press \( \text{\textsuperscript{2}} \). The \( \text{\textsuperscript{2}} \) annunciator is turned on to indicate the applied method. Adjust the applied signal level externally until the appropriate value appears under \( \text{\textsuperscript{2}} \). Using either method, press \( \) to store the value for \( \text{\textsuperscript{2}} \). (The controller can be toggled back to the Key-in Method by pressing \( \) before \( \)).

SETPOINT LOW LIMIT

<table>
<thead>
<tr>
<th>Setpoint Low Limit</th>
<th>Lower Value</th>
<th>Upper Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPL1</td>
<td>-999</td>
<td>9999</td>
</tr>
</tbody>
</table>

The controller has a programmable low setpoint limit value to restrict the setting range of the setpoint. Set the limit so that the setpoint value cannot be set below the safe operating area of the process.

SETPOINT HIGH LIMIT

<table>
<thead>
<tr>
<th>Setpoint High Limit</th>
<th>Lower Value</th>
<th>Upper Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPH1</td>
<td>-999</td>
<td>9999</td>
</tr>
</tbody>
</table>

The controller has a programmable high setpoint limit value to restrict the setting range of the setpoint. Set the limit so that the setpoint value cannot be set above the safe operating area of the process.

USER INPUT FUNCTION (OPTIONAL)

<table>
<thead>
<tr>
<th>User Input Function</th>
<th>Lower Value</th>
<th>Upper Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INP2</td>
<td>0.000</td>
<td>2000</td>
</tr>
<tr>
<td>PLOC</td>
<td>0.000</td>
<td>1000</td>
</tr>
</tbody>
</table>

The controller performs the selected User Input function (User Input available only on models with alarms), when the User terminal 1 is connected (pulled low) to Common terminal 8.

No Function: No function is performed.

Program Lock: The Configuration Loop is locked, as long as activated (maintained action).

Integral Action Lock: The integral action of the PID computation is disabled (frozen), as long as activated (maintained action).

Auto/Manual Select: This function selects (maintained action) Automatic (open) or Manual Control (activated).

Setpoint 1 or 2 Select: This function selects (maintained action) Setpoint 1 (open) or Setpoint 2 (activated) as the active setpoint.

Setpoint Ramp Disable: The setpoint ramping feature is disabled, as long as activated (maintained action). Any time the user input is activated with a ramp in process, ramping is aborted.

Reset Alarms: Active alarms are reset, as long as activated (maintained action). Active alarms are reset until the alarm condition is cleared and triggered again (momentary action).

F1 KEY FUNCTION

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>NONE</td>
<td>No Function</td>
<td>SPL1</td>
<td>Setpoint 1 or 2 Select</td>
</tr>
<tr>
<td>PLOC</td>
<td>Program Lock</td>
<td>SPRT</td>
<td>Setpoint Ramp Disable</td>
</tr>
<tr>
<td>ILOC</td>
<td>Integral Action Lock</td>
<td>RLS</td>
<td>Reset Both Alarms</td>
</tr>
<tr>
<td>LRF</td>
<td>Auto/Manual Select</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The controller performs the selected F1 key function, when \( \) is pressed while in the Display Loop. In any other loop or module location, pressing \( \) will perform an escape to the Display Loop.

No Function: No function is performed.

Auto/Manual Select: This function toggles (momentary action) the controller between Automatic and Manual Control.

Setpoint 1 or 2 Selection: This function toggles (momentary action) the controller between Setpoint 1 and Setpoint 2.

Reset Alarms: This function can be used to reset one or both of the alarms when activated (momentary action). The alarm will remain reset until the alarm condition is cleared and triggered again.
When the controller is in Manual Control Mode, this limit does not apply. At 0%, both O1 and O2 are off; at 100%, O1 is on; and at -100%, O2 is on.

The process disturbances or setpoint changes. Enter the safe output power limits for the process. If Alarm 2 is selected for cooling, the range is from -100 to +100%. For heat and cool applications, this is typically set to reverse. This allows O1 or A1 (models with Analog Output) to be used for heating, and A2/O2 to be used for cooling.

CONTROL ACTION

This determines the control action for the PID loop. Programmed for direct action (cooling), the output power will increase if the Process value is above the Setpoint value. Programmed for reverse action (heating), the output power decreases when the Process Value is above the Setpoint Value. For heat and cool applications, this is typically set to reverse. This allows O1 or A1 (models with Analog Output) to be used for heating, and A2/O2 to be used for cooling.

OUTPUT POWER LOWER LIMIT

This parameter may be used to limit controller power at the lower end due to process disturbances or setpoint changes. Enter the safe output power limits for the process. If Alarm 2 is selected for cooling, the range is from -100 to +100%. At 0%, both O1 and O2 are off; at 100%, O1 is on; and at -100%, O2 is on. When the controller is in Manual Control Mode, this limit does not apply.

OUTPUT POWER UPPER LIMIT

This parameter may be used to limit controller power at the upper end due to process disturbances or setpoint changes. Enter the safe output power limits for the process. If Alarm 2 is selected for cooling, the range is from -100 to +100%. At 0%, both O1 and O2 are off; at 100%, O1 is on; and at -100%, O2 is on. When the controller is in Manual Control Mode, this limit does not apply.

SENSOR FAIL POWER LEVEL

This parameter sets the power level for the control outputs in the event of a sensor failure. If Alarm 2 is not selected for cooling, the range is from 0% (O1 output full off) to 100% (O1 output full on). If A2 is selected for cooling, the range is from -100 to +100%. At 0%, both O1 and O2 are off; at 100%, O1 is on; and at -100%, O2 is on. The alarm outputs are upscale drive with an open sensor, and downscale drive with a shorted sensor (RTD only), independent of this setting. Manual Control overrides the sensor fail preset.

OUTPUT POWER DAMPENING

The Dampening Time, entered as a time constant in seconds, dampens the calculated output power. Increasing the value increases the dampening effect. Generally, dampening times in the range of one-twentieth to one-fiftieth of the controller’s integral time (or process time constant) are effective. Dampening times longer than these may cause controller instability due to the added lag effect.

ON/OFF CONTROL HYSTERESIS

The controller can be placed in the On/Off Control Mode by setting the Proportional Band to 0.0%. The On/Off Control Hysteresis (balanced around the setpoint) eliminates output chatter. In heat/cool applications, the control hysteresis value affects both Output O1 and Output O2 control. It is suggested to set the hysteresis band to Factory Setting prior to starting Auto-Tune. After Auto-Tune, the hysteresis band has no effect on PID Control. On/Off Control Hysteresis is illustrated in the On/Off Control Mode section.

AUTO-TUNE CODE

Prior to starting Auto-Tune, this code should be set to achieve the necessary dampening level under PID Control. This value allows customization of the PID values that Auto-Tune will calculate. For the process to be controlled aggressively (fastest process response with possible overshoot), set the Auto-Tune Code to 0. For the process to be controlled conservatively (slowest response with the least amount of overshoot), set this value to 2. If the Auto-Tune Code is changed, Auto-Tune needs to be reinitialized for the changes to affect the PID settings. For more information, see PID Tuning Explanations Section.
ANALOG OUTPUT RANGE (OPTIONAL)

\[ \begin{align*}
\text{OP} & \quad 0-10 \text{ V} \quad 0-20 \text{ mA} \\
\text{OP} & \quad 4-20 \text{ mA}
\end{align*} \]

Select the type of output and range. The Analog output jumpers are factory set to current. They must be changed if voltage output is desired. The Analog output can be calibrated to provide up to approximately 5% over range operation (0 mA current can only go slightly negative).

ANALOG OUTPUT ASSIGNMENT (OPTIONAL)

\[ \begin{align*}
\text{OP} & \quad \text{Main Control % Output Power} \\
\text{inP} & \quad \text{Input Signal Retransmission} \\
\text{SP} & \quad \text{Active Setpoint}
\end{align*} \]

This setting selects the parameter that the Analog Output will retransmit or track.

ANALOG UPDATE TIME (OPTIONAL)

\[ \begin{align*}
\text{ANU} & \quad 0 \text{ to } 250 \text{ seconds} \\
0 & \quad \text{update rate of 0.1 second}
\end{align*} \]

The update time of the Analog Output can be used to reduce excess valve actuator or pen recorder activity.

### 7.3 MODULE 3 - Lockout Parameters (3-1C)

The following parameters can be configured for 

- Lockout (% Output Power)
- Input Signal Retransmission
- Active Setpoint

**Access Code**

\[ \text{Code} = 0 \]

0: Full access to Display, Hidden, and Configuration Loops

1 to 125: Code necessary to access Configuration Loop only.

1 to 125: Code necessary to access Hidden and Configuration Loops.

The following parameters can be configured for Lockout only.
7.4 MODULE 4 - ALARM PARAMETERS (4-AL) (OPTIONAL)

PARAMETER MENU

ALARM 1 ACTION | ALARM 1 ANNUNCIATOR | ALARM 1 RESET MODE | ALARM 1 STANDBY | ALARM 1 VALUE | ALARM 2 ACTION | ALARM 2 ANNUNCIATOR | ALARM 2 RESET MODE | ALARM 2 STANDBY | ALARM 2 VALUE | ALARM 1 & 2 HYSTERESIS

AVAILABLE ALARM ACTIONS

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NONE</strong></td>
<td>No action, the remaining Alarm parameters are not available.</td>
</tr>
<tr>
<td><strong>RbH</strong> (Absolute High)</td>
<td>The alarm energizes when the Process Value exceeds the alarm value + 1/2 the hysteresis value.</td>
</tr>
<tr>
<td><strong>RbL</strong> (Absolute Low)</td>
<td>The alarm energizes when the Process Value falls below the alarm value - 1/2 the hysteresis value.</td>
</tr>
<tr>
<td><strong>RuH</strong> (Absolute High)</td>
<td>The alarm energizes when the Process Value exceeds the alarm value.</td>
</tr>
<tr>
<td><strong>RuL</strong> (Absolute Low)</td>
<td>The alarm energizes when the Process Value falls below the alarm value.</td>
</tr>
<tr>
<td><strong>d-HI</strong> (Deviation High)</td>
<td>Alarm 1 and 2 value tracks the Setpoint value.</td>
</tr>
<tr>
<td><strong>d-LO</strong> (Deviation Low)</td>
<td>Alarm 1 and 2 value tracks the Setpoint value.</td>
</tr>
<tr>
<td><strong>b-IA</strong> (Band Acting) (inside)</td>
<td>Alarm 1 and 2 value tracks the Setpoint value.</td>
</tr>
<tr>
<td><strong>b-OB</strong> (Band Acting) (outside)</td>
<td>Alarm 1 and 2 value tracks the Setpoint value.</td>
</tr>
<tr>
<td><strong>Her</strong> (Heat) (A1 Analog models only)</td>
<td>If heating is selected, the remaining Alarm 1 parameters are not available.</td>
</tr>
<tr>
<td><strong>Cool</strong> (A2 only)</td>
<td>If cooling is selected, the remaining Alarm 2 parameters are not available.</td>
</tr>
</tbody>
</table>

ALARM ACTION FIGURES

*Note: Hys in the above figures refers to the Alarm Hysteresis.*
With normal selection, the alarm annunciator indicates “on” alarm output 1. With reverse selection, the alarm annunciator indicates “off” alarm output.

ALARM STANDBY ALARM 1

Standby prevents nuisance (typically low level) alarms after a power up or setpoint change. After powering up the controller or changing the setpoint, the process must leave the alarm region (enter normal non-alarm area of operation). After this has occurred, the standby is disabled and the alarm responds normally until the next controller power up or setpoint change.

ALARM VALUE ALARM 1

The alarm values are entered as process units or degrees. They can also be entered in the Display or Hidden Loops. When the alarm is configured as deviation or band acting, the associated output tracks the Setpoint as it is changed. The value entered is the offset or difference from the Setpoint.

ALARM ACTION ALARM 2

Select the action for the alarms. See Alarm Action Figures for a visual explanation.

ALARM ANNUNCIATOR ALARM 2

With normal selection, the alarm annunciator indicates “on” alarm output 2. With reverse selection, the alarm annunciator indicates “off” alarm output.

ALARM STANDBY ALARM 2

Standby prevents nuisance (typically low level) alarms after a power up or setpoint change. After powering up the controller or changing the setpoint, the process must leave the alarm region (enter normal non-alarm area of operation). After this has occurred, the standby is disabled and the alarm responds normally until the next controller power up or setpoint change.

ALARM VALUE ALARM 2

The alarm values are entered as process units or degrees. They can also be entered in the Display or Hidden Loops. When the alarm is configured as deviation or band acting, the associated output tracks the Setpoint as it is changed. The value entered is the offset or difference from the Setpoint.

ALARM HYSTERESIS

The Hysteresis Value is either added to or subtracted from the alarm value, depending on the alarm action selected. The same value applies to both alarms. See the Alarm Action Figures for a visual explanation of how alarm actions are affected by the hysteresis.
To enable Cooling in Heat/Cool applications, the Alarm 2 Action must first be set for Cooling. (For P16 Controllers, the cooling output is sometimes referred to as secondary output.) When set to cooling, the output no longer operates as an alarm but operates as a cooling output. The O2 terminals are the same as A2, however a separate O2 annunciator indicates Cooling Operation. Cooling output power ranges from -100% (full cooling) to 0% (no cooling, unless a heat/cool overlap is used). The Power Limits in Output Module 2-01 also limit the cooling power. In applications requiring only a Cooling output, the main O1 output should be used.

**CYCLE TIME**

This cycle time functions like the O1 Output Cycle Time but allows independent cycle time for cooling. A setting of zero will keep output O2 off.

**RELATIVE GAIN**

This defines the gain of the cooling relative to the heating. It is generally set to balance the effects of cooling to that of heating. This is illustrated in the Heat/Cool Relative Gain Figures. A value of 0.0 places the cooling output into On/Off Control.

**HEAT/Cool RELATIVE GAIN FIGURES**

This defines the overlap area in which both heating and cooling are active (negative value) or the deadband area between the bands (positive value). If a heat/cool overlap is specified, the percent output power is the sum of the heat power (O1) and the cool power (O2). If Relative Gain is zero, the cooling output operates in the On/Off Control Mode, with the On/Off Control Hysteresis in Output Module 2-01 becoming the cooling output hysteresis. The function of Deadband is illustrated in the Control Mode Explanations. For most applications, set this parameter to 0.0 prior to starting Auto-Tune. After the completion of Auto-Tune, this parameter may be changed.
7.5 MODULE 9 FACTORY SERVICE OPERATIONS (9-F5)

PARAMETER MENU

CALIBRATION

The controller is fully calibrated from the factory. Recalibration is recommended every two years by qualified technicians using appropriate equipment. Calibration may be performed by using the front panel or with the TP16KIT. The front panel method is explained below. (Refer to the TP16KIT bulletin for calibration instructions using TP16KIT cable and software.) Calibration may be aborted by disconnecting power to the controller before exiting Factory Service Module 9-F5. In this case, the existing calibration settings remain in effect.

Note: Allow the controller to warm up for 30 minutes minimum and follow the manufacturer’s warm-up recommendations for the calibration source or measuring device.

Millivolt Calibration (T16)

Millivolt calibration requires a precision voltage source with an accuracy of 0.03% (or better) connected to terminals 8 (comm.) and 9 (+). When calibrating the input, the millivolt calibration must be performed first, then the Cold Junction or RTD Resistance.

<table>
<thead>
<tr>
<th>PROMPT</th>
<th>APPLY</th>
<th>FRONT PANEL ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CodeE</td>
<td>Press until 4, press .</td>
<td></td>
</tr>
<tr>
<td>CLR</td>
<td>Press 4 for YES, press .</td>
<td></td>
</tr>
<tr>
<td>SLP1</td>
<td>0.0 mV After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLP2</td>
<td>14.0 mV After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLP3</td>
<td>28.0 mV After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLP4</td>
<td>42.0 mV After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLP5</td>
<td>56.0 mV After 5 seconds (minimum), press .</td>
<td></td>
</tr>
</tbody>
</table>

RTD Resistance (T16)

RTD calibration requires a precision 277.0 ohm resistor with an accuracy of 0.1 Ω (or better). Connect a jumper between terminals 9 and 10 with a 0 ohm jumper between 9 and 8 at SP1 and the 277.0 ohm resistor between 9 and 8 at SP2. If using thermocouple only, the RTD calibration need not be performed.

<table>
<thead>
<tr>
<th>PROMPT</th>
<th>APPLY</th>
<th>FRONT PANEL ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CodeE</td>
<td>Press 4 until 4, press .</td>
<td></td>
</tr>
<tr>
<td>CLR</td>
<td>Press .</td>
<td></td>
</tr>
<tr>
<td>CJC</td>
<td>Press .</td>
<td></td>
</tr>
<tr>
<td>rtd</td>
<td>Press 4 for YES, press .</td>
<td></td>
</tr>
<tr>
<td>SLP1</td>
<td>0.0 ohm After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLP2</td>
<td>277.0 ohm After 5 seconds (minimum), press .</td>
<td></td>
</tr>
</tbody>
</table>

Input Calibration (P16)

Process calibration requires a precision signal source with an accuracy of 0.03% (or better) that is capable of generating 10.0 V connected to terminals 8 (COMM) and 9 (+10V) and 20.00 mA connected to terminals 8 (COMM) and 9 (20mA). The current calibration can be skipped by pressing at the not applicable prompts if using the controller for process voltage only.

<table>
<thead>
<tr>
<th>PROMPT</th>
<th>APPLY</th>
<th>FRONT PANEL ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CodeE</td>
<td>Press 4 until 4, press .</td>
<td></td>
</tr>
<tr>
<td>CLR</td>
<td>Press .</td>
<td></td>
</tr>
<tr>
<td>SLP1</td>
<td>0.0 V After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLP2</td>
<td>2.5 V After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLP3</td>
<td>5.0 V After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLP4</td>
<td>7.5 V After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLP5</td>
<td>10.0 V After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLPmA</td>
<td>0.0 mA After 5 seconds (minimum), press .</td>
<td></td>
</tr>
<tr>
<td>SLPmA</td>
<td>20.0 mA After 5 seconds (minimum), press .</td>
<td></td>
</tr>
</tbody>
</table>

Cold Junction (T16)

Cold Junction calibration requires a thermocouple of known accuracy of types T, E, J, K, C or N (connected to terminals 8 and 9) and a calibrated external reference thermocouple probe measuring in °C with resolution to tenths. The two probes should be brought in contact with each other or in some way held at the same temperature. They should be shielded from air movement and allowed sufficient time to equalize in temperature. (As an alternative, the T16 thermocouple may be placed in a calibration bath of known temperature.) If performing the millivolt calibration prior, verify that the correct input type is configured in Input Module 1-4 before performing the following procedure. (After the millivolt calibration the controller will default to type J.) If using RTD only, the cold junction calibration need not be performed.

<table>
<thead>
<tr>
<th>PROMPT</th>
<th>COMPARE</th>
<th>FRONT PANEL ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CodeE</td>
<td>Press 4 until 4, press .</td>
<td></td>
</tr>
<tr>
<td>CLR</td>
<td>Press .</td>
<td></td>
</tr>
<tr>
<td>CJC</td>
<td>Press 4 for YES, press .</td>
<td></td>
</tr>
<tr>
<td>Top display to external reference</td>
<td>Press 4 or 4 to adjust the bottom display until the top process display matches the external reference then press .</td>
<td></td>
</tr>
</tbody>
</table>
Analog Output Calibration (T16 and P16)

Set the controller Analog jumpers to the output type being calibrated. Connect an external meter with an accuracy of 0.05% (or better) that is capable of measuring 10.00 V or 20.00 mA to terminals 6 (+V/I) and 7 (-V/I). The voltage or current calibration that is not being used must be skipped by pressing \( \text{S4} \) until End appears.

<table>
<thead>
<tr>
<th>PROMPT</th>
<th>EXTERNAL METER</th>
<th>FRONT PANEL ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{CodE} )</td>
<td>Press ( \text{F1} ) until ( \text{S4} ), press ( \text{F2} ).</td>
<td></td>
</tr>
<tr>
<td>( \text{CRL} )</td>
<td>Press ( \text{F1} ).</td>
<td></td>
</tr>
<tr>
<td>( \text{CodE} )</td>
<td>Press ( \text{F1} ) (T16 only).</td>
<td></td>
</tr>
<tr>
<td>( \text{RTD} )</td>
<td>Press ( \text{F1} ) (T16 only).</td>
<td></td>
</tr>
<tr>
<td>( \text{ANCL} )</td>
<td>Press ( \text{F1} ) for ( \text{YES} ), press ( \text{F2} ).</td>
<td></td>
</tr>
<tr>
<td>( \text{C 0V} )</td>
<td>Press ( \text{F1} ) or ( \text{F2} ) until external meter matches listing, press ( \text{F2} ).</td>
<td></td>
</tr>
<tr>
<td>( \text{C 10V} )</td>
<td>Press ( \text{F1} ) or ( \text{F2} ) until external meter matches listing, press ( \text{F2} ).</td>
<td></td>
</tr>
<tr>
<td>( \text{C 0m} )</td>
<td>Press ( \text{F1} ) or ( \text{F2} ) until external meter matches listing, press ( \text{F2} ).</td>
<td></td>
</tr>
<tr>
<td>( \text{C 20m} )</td>
<td>Press ( \text{F1} ) or ( \text{F2} ) until external meter matches listing, press ( \text{F2} ).</td>
<td></td>
</tr>
</tbody>
</table>

**TROUBLESHOOTING**

For further technical assistance, contact technical support.

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
<th>REMEDIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NO DISPLAY</strong></td>
<td>1. Power off.</td>
<td>1. Check power.</td>
</tr>
<tr>
<td></td>
<td>3. Loose connection or improperly wired.</td>
<td>3. Check connections.</td>
</tr>
<tr>
<td></td>
<td>4. Bezel assembly not fully seated into rear of controller.</td>
<td>4. Check installation.</td>
</tr>
<tr>
<td><strong>CONTROLLER NOT WORKING</strong></td>
<td>1. Incorrect setup parameters.</td>
<td>1. Check setup parameters.</td>
</tr>
<tr>
<td><strong>E-E2 IN DISPLAY</strong></td>
<td>1. Loss of setup parameters due to noise spike or other EMI event.</td>
<td>1. Press F1 to escape, then check all setup parameters.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Check sensor input and AC line for excessive noise.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. If fault persists, replace controller.</td>
</tr>
<tr>
<td><strong>E-CL IN DISPLAY</strong></td>
<td>1. Loss of calibration parameters due to noise spike or other EMI event.</td>
<td>1. Press F1 to escape, then check controller accuracy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Recalibrate controller. (See Factory Service Module code 77.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Reset parameters to factory default settings.</td>
</tr>
<tr>
<td><strong>dddd or -dd in DISPLAY</strong></td>
<td>1. Display value exceeds 4 digit display range.</td>
<td>1. Change resolution to display whole number and verify reading.</td>
</tr>
<tr>
<td></td>
<td>2. Defective or miscalibrated cold junction circuit.</td>
<td>2. Perform cold junction calibration.</td>
</tr>
<tr>
<td></td>
<td>3. Loss of setup parameters.</td>
<td>3. Check setup parameters.</td>
</tr>
<tr>
<td></td>
<td>4. Internal malfunction.</td>
<td>4. Perform Input calibration.</td>
</tr>
<tr>
<td><strong>OPEN IN DISPLAY (T16)</strong></td>
<td>1. Probe disconnected.</td>
<td>1. Connect probe.</td>
</tr>
<tr>
<td></td>
<td>2. Broken or burned-out probe.</td>
<td>2. Replace probe.</td>
</tr>
<tr>
<td></td>
<td>3. Corroded or broken terminations.</td>
<td>3. Check connections.</td>
</tr>
<tr>
<td></td>
<td>4. Excessive process temperature.</td>
<td>4. Check process parameters.</td>
</tr>
<tr>
<td><strong>SENS IN DISPLAY (P16)</strong></td>
<td>1. Input exceeds range of controller.</td>
<td>1. Check input parameters.</td>
</tr>
<tr>
<td></td>
<td>2. Incorrect input wiring.</td>
<td>2. Change to input sensor with a higher temperature range.</td>
</tr>
<tr>
<td></td>
<td>3. Defective transmitter.</td>
<td>3. Replace transmitter or probe.</td>
</tr>
<tr>
<td></td>
<td>4. Internal malfunction.</td>
<td>4. Reduce temperature.</td>
</tr>
<tr>
<td><strong>DLOL IN TOP DISPLAY</strong></td>
<td>1. Input exceeds range of controller.</td>
<td>1. Check input parameters.</td>
</tr>
<tr>
<td></td>
<td>2. Temperature exceeds range of input probe.</td>
<td>2. Change to input sensor with a higher temperature range.</td>
</tr>
<tr>
<td></td>
<td>3. Defective or incorrect transmitter or probe.</td>
<td>3. Replace transmitter or probe.</td>
</tr>
<tr>
<td></td>
<td>4. Excessive high temperature for probe.</td>
<td>4. Reduce temperature.</td>
</tr>
<tr>
<td></td>
<td>5. Loss of setup parameters.</td>
<td>5. Perform input calibration.</td>
</tr>
<tr>
<td><strong>ULUL IN TOP DISPLAY</strong></td>
<td>1. Input is below range of controller.</td>
<td>1. Check input parameters.</td>
</tr>
<tr>
<td></td>
<td>2. Temperature below range of input probe.</td>
<td>2. Change to input sensor with a lower temperature range.</td>
</tr>
<tr>
<td></td>
<td>3. Defective or incorrect transmitter or probe.</td>
<td>3. Replace transmitter or probe.</td>
</tr>
<tr>
<td></td>
<td>4. Excessive low temperature for probe.</td>
<td>4. Raise temperature.</td>
</tr>
<tr>
<td></td>
<td>5. Loss of setup parameters.</td>
<td>5. Perform input calibration.</td>
</tr>
<tr>
<td><strong>5He k IN DISPLAY (T16)</strong></td>
<td>1. RTD probe shorted.</td>
<td>1. Check wiring and/or replace RTD probe.</td>
</tr>
<tr>
<td><strong>CONTROLLER SLUGGISH OR NOT STABLE</strong></td>
<td>1. Incorrect PID values.</td>
<td>1. See PID control.</td>
</tr>
<tr>
<td></td>
<td>2. Incorrect probe location.</td>
<td>2. Evaluate probe location.</td>
</tr>
</tbody>
</table>
**ON/OFF CONTROL**

The controller operates in On/Off Control when the Proportional Band is set to 0.0%. In this control mode, the process will constantly oscillate around the setpoint value. The On/Off Control Hysteresis (balanced around the setpoint) can be used to eliminate output chatter. Output O1 Control Action can be set to reverse for heating (output on when below the setpoint) or direct for cooling (output on when above the setpoint) applications.

**ON/OFF CONTROL - REVERSE OR DIRECT ACTING FIGURES**

For heat and cool systems, O1 Control Action is set to reverse (heat) and the Alarm 2 Action is set to cooling (O2). The Proportional Band is set to 0.0 and the Relative Gain in Cooling to 0.0. The Deadband in Cooling sets the amount of operational deadband or overlap between the outputs. The setpoint and the On/Off Control Hysteresis applies to both O1 and O2 outputs. The hysteresis is balanced in relationship to the setpoint and deadband value.

**PID CONTROL**

In PID Control, the controller processes the input and then calculates a control output power value by use of a modified Proportional Band, Integral Time, and Derivative Time control algorithm. The system is controlled with the new output power value to keep the process at the setpoint. The Control Action for PID Control can be set to reverse for heating (output on when below the setpoint) or direct for cooling (output on when above the setpoint) applications. For heat and cool systems, the heat (O1) and cool (O2) outputs are both used. The PID parameters can be established by using Auto-Tune, or they can be Manually tuned to the process.

**Note:** CHYS in the On/Off Control Figures refers to the On/Off Control Hysteresis (CHYS) in parameter Module 2.
TIME PROPORTIONAL PID CONTROL

In Time Proportional applications, the output power is converted into output On time using the Cycle Time. For example, with a four second cycle time and 75% power, the output will be on for three seconds \((4 \times 0.75)\) and off for one second.

The cycle time should be no greater than 1/10 of the natural period of oscillation for the process. The natural period is the time it takes for one complete oscillation when the process is in a continuously oscillating state.

LINEAR PID CONTROL

In Linear PID Control applications, the Analog Output Assignment \(\text{AOUA} \) is set to \% Output Power, \(\text{AOUA} \). The Analog Low Scaling, \(\text{AULS} \), is set to 0.0 and the Analog High Scaling, \(\text{AUSH} \), is set to 100.0. The Analog Output will then be proportional to the PID calculated \% output power for Heat or Cooling per the Control Action \(\text{DPC} \). For example, with 0 VDC to 10 VDC (scaled 0 to 100\%) and 75\% power, the analog output will be 7.5 VDC.

MANUAL CONTROL MODE

In Manual Control Mode, the controller operates as an open loop system (does not use the setpoint and process feedback). The user adjusts the percentage of power through the \% Power display to control the power for Output O1. When Alarm 2 is configured for Cooling (O2), Manual operation provides 0 to 100\% power to O1 (heating) and -100 to 0\% power to O2 (Cooling). The Low and High Output Power limits are ignored when the controller is in Manual.

MODE TRANSFER

When transferring the controller mode between Automatic and Manual, the controlling outputs remain constant, exercising true “bumpless” transfer. When transferring from Manual to Automatic, the power initially remains steady, but Integral Action corrects (if necessary) the closed loop power demand at a rate proportional to the Integral Time.

AUTOMATIC CONTROL MODE

In Automatic Control Mode, the percentage of output power is automatically determined by PID or On/Off calculations based on the setpoint and process feedback. For this reason, PID Control and On/Off Control always imply Automatic Control Mode.

PID TUNING EXPLANATIONS

AUTO-TUNE

Auto-Tune is a user-initiated function that allows the controller to automatically determine the Proportional Band, Integral Time, Derivative Time, Digital Filter, Control Output Damping Time, and Relative Gain (Heat/Cool) values based upon the process characteristics. The Auto-Tune operation cycles the controlling output(s) at a control point three-quarters of the distance between the present process value and the setpoint. The nature of these oscillations determines the settings for the controller’s parameters.

Prior to initiating Auto-Tune, it is important that the controller and system be first tested. (This can be accomplished in On/Off Control or Manual Control Mode.) If there is a wiring, system or controller problem, Auto-Tune may give incorrect tuning or may never finish. Auto-Tune may be initiated at start-up, from setpoint or at any other process point. However, ensure normal process conditions (example: minimize unusual external load disturbances) as they will have an effect on the PID calculations.

Start Auto-Tune

Below are the parameters and factory settings that affect Auto-Tune. If these setting are acceptable then Auto-Tune can be started just by performing two steps. If changes are needed, they must be made before starting Auto-Tune.

1. Enter the Setpoint value in the Display Loop.
2. Initiate Auto-Tune by changing Auto-Tune Start \(\text{ATUNE} \) to \(\text{YES} \) in the Hidden Loop.

Auto-Tune Progress

The controller will oscillate the controlling output(s) for four cycles. The bottom display will flash the cycle phase number. Parameter viewing is permitted during Auto-Tune. The time to complete the Auto-Tune cycles is process dependent. The controller should automatically stop Auto-Tune and store the calculated values when the four cycles are complete. If the controller remains in Auto-Tune unusually long, there may be a process problem. Auto-Tune may be stopped by entering \(\text{NO} \) in Auto-Tune Start \(\text{ATUNE} \).
**PID Adjustments**

In some applications, it may be necessary to fine tune the Auto-Tune calculated PID parameters. To do this, a chart recorder or data logging device is needed to provide a visual means of analyzing the process. Compare the actual process response to the PID response figures with a step change to the process. Make changes to the PID parameters in no more than 20% increments from the starting value and allow the process sufficient time to stabilize before evaluating the effects of the new parameter settings.

In some unusual cases, the Auto-Tune function may not yield acceptable control results or induced oscillations may cause system problems. In these applications, Manual Tuning is an alternative.

**PROCESS RESPONSE EXTREMES**

- **Overshoot and Oscillations**
  - To dampen response:
    - Increase proportional band.
    - Increase integral time.
    - Use setpoint ramping.
    - Use output power limits.
    - Reinvoke Auto-Tune with a higher auto-tune code.
    - Increase derivative time.
    - Check cycle time.

- **Slow Response**
  - To quicken response:
    - Decrease proportional band.
    - Decrease integral time.
    - Increase or defeat setpoint ramping.
    - Extend output power limits.
    - Reinvoke Auto-Tune with a lower auto-tune code.
    - Decrease derivative time.

**MANUAL TUNING**

A chart recorder or data logging device is necessary to measure the time between process cycles. This procedure is an alternative to the controller’s Auto-Tune function. It will not provide acceptable results if system problems exist.

1. Set the Proportional Band ($P_{SP}$) to 10.0% for temperature models (T16) and 100.0% for process models (P16).
2. Set both the Integral Time ($I_{INT}$) and Derivative Time ($d_{RT}$) to 0 seconds.
3. Set the Output Dampering Time ($O_{DP}$) in Output Module 2 to 0 seconds.
4. Set the Output Cycle Time ($CYCt$) in Output Module 2 to no higher than one-tenth of the process time constant (when applicable).
5. Place the controller in Manual Control Mode in the Hidden Loop and adjust the % Power to drive the process value to the Setpoint value. Allow the process to stabilize after setting the % Power. Note: $tr_{df}$ must be set to $tr_{df}$ in Parameter Lockouts Module 1.
6. Place the controller in Automatic Control Mode in the Hidden Loop. If the process will not stabilize and starts to oscillate, set the Proportional Band two times higher and go back to Step 5.
7. If the process is stable, decrease Proportional Band setting by two times and change the Setpoint value a small amount to excite the process. Continue with this step until the process oscillates in a continuous nature.
8. Fix the Proportional Band to three times the setting that caused the oscillation in Step 7.
9. Set the Integral Time to two times the period of the oscillation.
10. Set the Derivative Time to 1/8 (0.125) of the Integral Time.
11. Set the Output Dampering Time to 1/40 (0.025) the period of the oscillation.
## PARAMETER VALUE CHART

**Controller Number:**

**Security Code:**

### DISPLAY LOOP

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>PARAMETER</th>
<th>FACTORY SETTING</th>
<th>USER SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>SETPOINT VALUE SP1</td>
<td>T16</td>
<td>P16</td>
</tr>
<tr>
<td>SP</td>
<td>SETPOINT VALUE SP2</td>
<td>T16</td>
<td>P16</td>
</tr>
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<tr>
<td>ProP</td>
<td>PROPORTIONAL BAND</td>
<td>T16</td>
<td>P16</td>
</tr>
<tr>
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<td>INTEGRAL TIME</td>
<td>T16</td>
<td>P16</td>
</tr>
<tr>
<td>dErr</td>
<td>DERIVATIVE TIME</td>
<td>T16</td>
<td>P16</td>
</tr>
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<tr>
<td>RL - 2</td>
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</tbody>
</table>

* Factory Setting places these parameters in the Hidden Loop (set to H.dE in Lockout Module 3-1C).

### HIDDEN LOOP

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>PARAMETER</th>
<th>FACTORY SETTING</th>
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</thead>
<tbody>
<tr>
<td>SPSL</td>
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<tr>
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<td>SETPOINT RAMP RATE</td>
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<td>trnF</td>
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### INPUT MODULE (1-17) T16 ONLY

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<th>FACTORY SETTING</th>
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<td>INPUT TYPE</td>
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<td>P16</td>
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### INPUT MODULE (1-17) P16 ONLY

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### OUTPUT MODULE (2-17)

<table>
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<td>ON/OFF CONTROL DAMPENING</td>
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### LOCKOUT MODULE (3-1C)

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<th>FACTORY SETTING</th>
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<td>SETPOINT RAMP ACCESS</td>
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### ALARM MODULE (4-1L)

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</tr>
<tr>
<td>RSt1</td>
<td>ALARM 1 RESET MODE</td>
<td>Ruh0</td>
<td></td>
</tr>
<tr>
<td>Stb1</td>
<td>ALARM 1 STANDBY</td>
<td>N0</td>
<td></td>
</tr>
<tr>
<td>RL - 1</td>
<td>ALARM 1 VALUE</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>RCy2</td>
<td>ALARM 2 ACTION</td>
<td>Ruh1</td>
<td></td>
</tr>
<tr>
<td>Lb2</td>
<td>ALARM 2 ANNUNCIATOR</td>
<td>nor</td>
<td></td>
</tr>
<tr>
<td>RSt2</td>
<td>ALARM 2 RESET MODE</td>
<td>Ruh0</td>
<td></td>
</tr>
<tr>
<td>Stb2</td>
<td>ALARM 2 STANDBY</td>
<td>N0</td>
<td></td>
</tr>
<tr>
<td>RL - 2</td>
<td>ALARM 2 VALUE</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>RHyS</td>
<td>ALARM 1 &amp; 2 HYSTERESIS</td>
<td>T16, P16</td>
<td></td>
</tr>
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### COOLING MODULE (5-02)

<table>
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<tr>
<th>DISPLAY</th>
<th>PARAMETER</th>
<th>FACTORY SETTING</th>
<th>USER SETTING</th>
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<tr>
<td>CyC</td>
<td>CYCLE TIME</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>GAr</td>
<td>RELATIVE GAIN</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>db - 2</td>
<td>DEADBAND</td>
<td>0</td>
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</tbody>
</table>

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**Parameter availability is model and program dependent.**

- T16 only
- P16 only

1- IM
- Input Type
- Percent Symbol
- Temp Scale
- Decimal Resolution
- Rounding Increment
- Digital Filtering
- Display Value 1
- Input Value 1

2- OP
- Cycle Time
- Control Action
- Output Power Low Limit
- Output Power High Limit
- Sensor Fail Power Preset
- Output Power Dampering
- On/Off Control Hysteresis
- Auto-Tune Code

3- LC
- Setpoint Access
- Output Power Access
- PID Values Access
- Alarm Values Access
- Access Code
- Setpoint Select Access
- Setpoint Ramp Rate Access
- Auto/Manual Transfer Access
- Auto-Tune Off/On Access
- Reset Alarms Access

4- RL
- Alarm 1 Action
- Alarm 1 Annunciator
- Alarm 1 Reset Mode
- Alarm 1 Standby
- Alarm 1 Value
- Alarm 2 Action
- Alarm 2 Annunciator
- Alarm 2 Reset Mode
- Alarm 2 Standby
- Alarm 2 Value
- Alarm 1 & 2 Hysteresis

5- 02
- Cooling Cycle Time
- Cooling Relative Gain
- Heat/Cool Deadband/Overlap

9- FS
- Factory Service Code
MODEL T48 - 1/16 DIN TEMPERATURE CONTROLLER

- PID CONTROL WITH REDUCED OVERSHOOT
- ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS
- NEMA 4X/IP65 BEZEL
- DUAL LED DISPLAYS FOR SIMULTANEOUS INDICATION OF TEMPERATURE AND SETPOINT
- STATUS INDICATORS FOR OUTPUTS AND CONTROL MODES
- ACCEPTS 10 TYPES OF SENSOR INPUTS (Thermocouple or RTD)
- OPTIONAL HEATER CURRENT MONITOR AND HEATER BREAK ALARM
- OPTIONAL DUAL ALARM OUTPUTS
- OPTIONAL TWO LINEAR DC OUTPUTS (0 to 10 V, 0/4 to 20 mA)
- MANUAL/AUTOMATIC CONTROL MODES
- SETPOINT RAMPING FOR PROCESS STARTUP
- PROGRAMMABLE USER INPUT (Digital) FOR ADDED FLEXIBILITY
- SENSOR ERROR COMPENSATION (Offset) AND BREAK DETECTION
- HEATING AND OPTIONAL COOLING OUTPUTS
- PARAMETER SECURITY VIA PROGRAMMABLE LOCKOUTS
- FIELD REPLACEABLE OUTPUT BOARD (Relay or Logic/SSR Drive)
- OPTIONAL TRIAC OUTPUT
- SECOND SETPOINT SETTING
- OPTIONAL REMOTE SETPOINT INPUT (0/4 to 20 mA)
- OPTIONAL RS485 SERIAL COMMUNICATIONS
- PC SOFTWARE AVAILABLE FOR CONTROLLER CONFIGURATION

DESCRIPTION

The T48 Controller accepts signals from a variety of temperature sensors (thermocouple or RTD elements), precisely displays the process temperature, and provides an accurate output control signal (time proportional or linear DC) to maintain the process at the desired temperature. The controller’s comprehensive yet simple programming allows it to meet a wide variety of application requirements.

The controller operates in the PID control mode for both heating and cooling, with on-demand auto-tune, which will establish the tuning constants. The PID tuning constants may be fine-tuned by the operator at any time and then locked out from further modification. The controller employs a unique overshoot suppression feature, which allows the quickest response without excessive overshoot. The unit can be transferred to operate in the manual mode, providing the operator with direct control of the output. The controller may also be programmed to operate in the ON/OFF control mode with adjustable hysteresis. A second setpoint is available on select models to allow quick selection of a different setpoint setting.

Dual 4-digit displays allow viewing of the process temperature and setpoint simultaneously. Front panel indicators inform the operator of the controller and output status. On many models the main control output and the alarm outputs are field replaceable.

Optional alarm(s) can be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, Band IN or OUT, and Heater Current Break) with adjustable hysteresis. A standby feature suppresses the alarm during power-up until the temperature stabilizes outside the alarm region. The second alarm can be configured as a secondary PID output (heat/cool applications).

Optional Main Linear DC output (10 V or 20 mA) can be used for control or temperature re-transmission purposes. Programmable output update time reduces valve or actuator activity. The output range can be scaled independent of the input range.

Optional Second Linear DC output (10 V or 20 mA) provides an independent temperature re-transmission, while the main Linear DC output is being used for control. The output range can be scaled independent of the input range.

Optional Heater Current Monitor provides a direct readout of process heater current. An alarm can be programmed to signal when the heater has failed. This provides early warning of system failure before product quality is affected.

Optional Remote Setpoint input (0/4 to 20 mA) allows for cascade control loops, where tighter control is required; and allows for remotely driven setpoint.

DIMENSIONS In inches (mm)

![Diagram showing dimensions of the T48 Controller](image)
signal from computers or other similar equipment. Straightforward end point scaling with independent filtering and local/remote transfer option expand the controller’s flexibility.

The optional RS485 serial communication interface provides two-way communication between a T48 and other compatible equipment such as a printer, PLC, HMI, or a host computer. In multipoint applications (up to thirty-two), the address number of each T48 on the line can be programmed from 0 to 99. Data from the T48 can be interrogated or changed, and alarm outputs may be reset by sending the proper command code via serial communications. PC software, SFCRM, allows for easy configuration of controller parameters. These settings can be saved to disk for later use or used for multi-controller down loading. On-line help is provided within the software.

The unit is constructed of a lightweight, high impact plastic case with a tinted front panel. The front panel meets NEMA 4X/IP65 specifications when properly installed. Multiple units can be stacked horizontally or vertically. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the controller extremely reliable in industrial environments.

**SAFETY SUMMARY**

All safety related regulations, local codes and instructions that appear in the manual on or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the T48 to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller. An independent and redundant temperature limit indicator with alarm outputs is strongly recommended.

**SPECIFICATIONS**

1. **DISPLAY:** Dual 4-digit

   **Upper Temperature Display:** 0.4" (10.2 mm) high red LED

   **Lower Auxiliary Display:** 0.3" (7.6 mm) high green LED

   **Display Messages:**
   
   **"OLOL"** - Appears when measurement exceeds + sensor range.
   
   **"ULUL"** - Appears when measurement exceeds - sensor range.
   
   **"OPEN"** - Appears when open sensor is detected.
   
   **"Shrt"** - Appears when shorted sensor is detected (RTD only)
   
   **...** - Appears when display values exceed + display range.
   
   **...** - Appears when display values exceed - display range.

   **LED Status Annunciators:**
   
   **%P** - Lower auxiliary display shows power output in (%).
   
   **MN** - Flashing: Controller is in manual mode.
   
   **O1** - Main control output is active.
   
   **A1** - Alarm #1 is active (for A1 option).
   
   **A2** - Alarm #2 is active OR
   
   **Cooling output (O2) is active**

2. **POWER:**

   **AC Versions:** 85 VAC min. to 250 VAC max., 50 to 60 Hz, 8 VA max.
   
   **DC Versions:**
   
   **DC Power:** 18 to 36 VDC; 7 W
   
   **AC Power:** 24 VAC ± 10%; 50 to 60 Hz, 9 VA

3. **CONTROLS:** Four front panel push buttons for modification and setup of controller functions and one external input user for parameter lockout or other functions.

4. **MEMORY:** Nonvolatile E²PROM retains all programmable parameters and values.

5. **MAIN SENSOR INPUT:**

   **Sample Period:** 100 msec
   
   **Response Time:** Less than 300 msec typ., 400 msec max. (to within 99% of final value w/step input; typically, response is limited to response time of probe)

   **Failed Sensor Response:**
   
   **Main Control Output(s):** Programmable preset output
   
   **Display:** "OPEN"
   
   **Alarms:** Up/Down
   
   **Normal Mode Rejection:** 40 dB @ 50/60 Hz (improves with increased digital filtering.)

   **Common Mode Rejection:** Greater than 120 dB, DC to 60 Hz
   
   **Protection:** Input overload 120 VAC max. for 15 seconds max.

6. **THERMOCOUPLE INPUT:**

   **Types:** T, E, J, K, R, S, B, N. Linear mV, software selectable
   
   **Input Impedance:** 20 MΩ all types
   
   **Lead resistance effect:** 0.25 μΩ/Ω

---

**Cold junction compensation:** Less than ±1°C (±1.5°C max), error over 0 to 50°C max. ambient temperature range. Defeated for Linear mV indication mode.

**Resolution:** 1" for all types, or 0.1" for T, E, J, K, and N only.

---

**TC Type** | **Range** | **Wire Color**
--- | --- | ---
T | -200 to +600°C -328 to +1250°F | blue (+) white (+) red (-) blue (-)
E | -200 to +750°C -328 to +1382°F | violet (+) brown (+) white (+) yellow (+) red (-) blue (-)
J | -200 to +750°C -328 to +1400°F | white (+) red (-) yellow (+) blue (-)
K | -200 to +1250°C -328 to +2282°F | yellow (+) red (-) blue (-)
R | 0 to +1768°C 0 to +3241°F | black (+) white (+) blue (-)
S | 0 to 1768°C 32 to 3214°F | black (+) red (-) blue (-)
N | -200 to +1250°C -328 to +2372°F | orange (+) red (-) blue (-)
| mV | -5.00 to +56.00 | no standard no standard

---

**RTD INPUT:** 2 or 3 wire. 100 Ω platinum, alpha = 0.00385 (DIN 43760), alpha = 0.0039162

**Excitation:** 150 μA typical

**Resolution:** 1 or 0.1 degree

**Lead Resistance:** 15 Ω max. per input lead

---

**RTD Type** | **Range** | **OHMS**
--- | --- | ---
R | -200 to +750°C -328 to +1100°F | 0.4" (10.2 mm)
S | -200 to +600°C -328 to +1250°F | 385
R | -200 to +750°C -328 to +1100°F | 392
OHMS | 1.0 to 320.0

---

**INDICATION ACCURACY:** ±0.3% of Span +1°C.) includes NIST conformity, cold junction effect and A/D conversion errors at 23°C after 20 min. warm-up.

**USER INPUT:** Internally pulled up to +5 VDC (1 Ω).

**VIN:** 5 VDC max., VIN = 0.85 V max., VIN = 3.65 V min., IOFF = 1 μA max.

**Response Time:** 120 msec max.

**Functions:**

- Program Lock
- Integral Action Lock
- Auto/Manual Mode Select
- Ramp Setpoint Enable
- Reset Alarms
- Setpoint 1/2 Select
- Local/Remote Setpoint Select
- Serial block print

10. **CONTROL AND ALARM OUTPUTS:** (Heating, Cooling or Alarm)

**Relay outputs with Form A contacts:**

- Contact Rating: 3 A @ 250 VAC or 30 VDC (resistive load)
- Life Expectancy: 100,000 cycles at max. load rating.
- (Decreasing load and/or increasing cycle time, increases life expectancy.)

**Logic/SSR Drive Outputs:**

- Rating: 45 mA @ 4 V min. 7 V nominal

**Triac Outputs:**

- Type: Isolated, Zero Crossing Detection
- Rating:
  - Voltage: 120/240 VAC
  - Max. Load Current: 1 Amp @ 35°C
  - 0.75 Amp @ 50°C
  - Min Load Current: 10 mA
  - Offset Leakage Current: 7 mA max. @ 60 Hz
- Operating Frequency: 20 to 400 Hz
- Protection: Internal transient snubber

11. **MAIN CONTROL:**

- Control: PID or ON/OFF
- Output: Time proportioning or Linear DC
- Cycle time: Programmable
- Auto-tune: When selected, sets proportional band, integral time, and derivative time values.
- Probe Break Action: Programmable

12. **ALARMS:** 1 or 2 alarms (optional)

**Modes:** Absolute high acting

- Absolute low acting
- Deviation high acting
- Deviation low acting
13. COOLING: Software selectable (overrides alarm 2)
   Control: PID or ON/OFF
   Output: Time Proportional
   Cycle time: Programmable
   Proportional Gain Adjust: Programmable
   Heat/Cool Deadband Overlap: Programmable

14. MAIN AND SECOND LINEAR DC OUTPUT: (optional)
   Main: Control or Re-transmission, programmable update rate from 0.1 sec to 250 sec
   Second: Re-transmission only, fixed update rate of 0.1 sec

<table>
<thead>
<tr>
<th>OUTPUT ** RANGE</th>
<th>ACCURACY * (18 to 28°C)</th>
<th>ACCURACY * (0 to 50°C)</th>
<th>COMPLIANCE</th>
<th>RESOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 10 V</td>
<td>0.10% of FS + 1/2 LSD</td>
<td>0.30% of FS + 1/2 LSD</td>
<td>10k ohm min.</td>
<td>1/3500</td>
</tr>
<tr>
<td>0 to 20 mA</td>
<td>0.10% of FS + 1/2 LSD</td>
<td>0.30% of FS + 1/2 LSD</td>
<td>500 ohm max.</td>
<td>1/3500</td>
</tr>
<tr>
<td>4 to 20 mA</td>
<td>0.10% of FS + 1/2 LSD</td>
<td>0.30% of FS + 1/2 LSD</td>
<td>500 ohm max.</td>
<td>1/2800</td>
</tr>
</tbody>
</table>

* Accuracies are expressed as ± percentages after 20 minutes warm-up. Output accuracy is specified in two ways: Accuracy over an 18 to 28°C range at 0 to 75% RH environment; and accuracy over a 0 to 50°C range at 0 to 85% RH (non-condensing) environment. Accuracy over the wide temperature range reflects the temperature coefficient of the internal circuitry.

** Outputs are independently jumper selectable for either 10 V or 20 mA. The output range may be field calibrated to yield approximately 10% overrange and a small underrange (negative) signal.

15. REMOTE SETPOINT INPUT: (optional)
   Input type: 0/4 to 20 mA
   Input Resistance: 10 Ω
   Overrange: -5% to 105%
   Overload: 100 mA (continuous)
   Scale Range: -999 to 9999 degrees or -99.9 to 999.9 degrees.
   Resolution: 1 part in 10,000.
   Accuracy: ±(0.1% of full scale +1/2 LSD)
   Reading Rate: 10/sec.
   Setpoint Filtering: Programmable Digital
   Setpoint Ramping: Programmable, 0.1 to 999.9 degrees/minute.

16. HEATER CURRENT MONITOR INPUT: (optional)
   Type: Single phase, full wave monitoring of load currents controlled by main output (01).
   Input: 100 mA AC output from current transformer (RLC #CT00401) or any CT with 100 mA AC output.
   Display Scale Range: 1.0 to 999.9 Amps or 0.0 to 100.0%
   Input Resistance: 5 Ω
   Accuracy: ±(0.5% of full scale +1/2 LSD), (5 to 100% of Range)
   Over 0 to 50°C range: ±1.0% of full scale +1/2 LSD, (5 to 100% of Range)
   Frequency: 50 to 400 Hz.
   Alarm Mode: Dual acting; heater element fail detect and control device fail detect.
   Overrange: 105% Capacity
   Overload: 200 mA (continuous).

17. SERIAL COMMUNICATIONS: (optional)
   Type: RS485 multipoint, balanced interface
   Baud Rate: 300 to 9600
   Data Format: 701, 7E1, 7N2, 8N1
   Node Address: 0-99, max of 32 units per line
   Transmit Delay: 2-100 msec or 100-200 msec
   Data Encoding: ASCII
   Isolation w.r.t Main Input Common: 500 Vrms for 1 min. (50 V working)
   Not isolated w.r.t. Remote Setpoint or Heater Current inputs, or Analog Output common
   Note: RS485 and the Analog Output commons are not internally isolated within the controller. The terminating equipment of these outputs must not share the same common (ie. earth ground).

18. ENVIRONMENTAL CONDITIONS:
   Operating Range: 0 to 50°C
   Storage Range: -40 to 80°C
   Span Drift (max.): 130 ppm/°C, main input
   Zero Drift (max.): 1µV/°C, main input
   Operating and Storage Humidity:
   85% max. relative humidity (non-condensing) from 0°C to 50°C.
   Vibration According to IEC 68-2-6: Operational 5 to 150 Hz, in X, Y, Z direction for 1.5 hours, 2g’s.
   Shock According to IEC 68-2-27: Operational 20 g, 11 msec in 3 directions.
   Altitude: Up to 2000 meters

19. ISOLATION BREAKDOWN RATINGS:
   AC line with respect to all Inputs and outputs: 250 V working (2300 V for 1 minute).
   Main input with respect to Analog Outputs, Remote Setpoint Input, Heater Current Input: 50 V working (2300 V for 1 minute).
   All other inputs and outputs with respect to relay contacts: 2000 VAC
   Not isolated between Analog Outputs, Remote Setpoint and Heater Current commons.

20. CERTIFICATIONS AND COMPLIANCES:
   SAFETY
   UL Recognized Component, File #E156876, UL873, CSA 22.2 No. 24
   Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
   Type 4X Enclosure rating (Face only), UL50
   IEC/IEEE CB Scheme Test Certificate # UL1369-156876USA,
   CB Scheme Test Report # 96EM50224-040396
   Issued by Underwriters Laboratories, Inc.
   IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
   IP65 Enclosure rating (Face only), IEC 529

   ELECTROMAGNETIC COMPATIBILITY
   Immunity to EN 50082-2
   Electrostatic discharge EN 61000-4-2 200 Hz, 50% duty cycle
   Level 2; 4 Kv contact Level 3; 8 Kv air
   Level 3: 10 V/m 1 80 MHz - 1 GHz
   Fast transients (burst) EN 61000-4-4 Level 4; 2 Kv I/O
   Level 2; 4 Kv power EN 61000-4-6 Level 3; 10 Vrms 2
   RF conducted interference EN 61000-4-4 150 KHz - 80 MHz
   Power frequency magnetic fields EN 61000-4-8 Level 4; 30 A/m
   Simulation of cordless telephones EN 50204 Level 3; 10 V/m
   Power mains class A
   900 MHz ± 5 MHz
   200 Hz, 50% duty cycle

   Emissions to EN 50081-2
   RF interference EN 55011 Enclosure class A
   Power mains class A

   Notes:
   1. No loss of performance during EMI disturbance at 10 V/m.
   2. Unit is panel mounted in a metal enclosure (Buckeye SM7013-0 or equivalent) that provides at least 20 db shielding effectiveness. Metal panel is connected to earth ground.
   3. For operation without loss of performance:
   Install power line filter, RLC#FLF0000 or equivalent.

   Install 2 ferrite cores, RLC#FCOR0000 or equivalent, to AC lines at unit for frequencies above 5 MHz.
   I/O cables routed in metal conduit connected to earth ground.

   Refer to the EMC Installation Guidelines section of the manual for additional information.

21. CONNECTION: Wire clamping screw terminals

22. CONSTRUCTION: Black plastic alloy case and collar style panel latch. Panel latch can be installed for vertical or horizontal instrument stacking. One piece tinted plastic bezel. Bezel assembly with circuit boards can be removed from the panel or disconnecting wiring. Unit meets NEMA 4X/IP65 requirements for indoor use, when properly installed. Installation Category II, Pollution Degree 2.

23. WEIGHT: 0.38 lbs (0.17 kgs)
**BASIC OPERATION**

The T48 controls a process temperature by measuring the temperature via an input probe, then calculating a control output power value by use of a modified PID control algorithm. The unit controls the system with the new output power value to keep the process temperature at setpoint. The PID control algorithm incorporates features which provide for high control accuracy and low temperature overshoot from process disturbances.

**FRONT PANEL FEATURES**

In the normal operating mode, the unit displays the process temperature in the upper display. One of the following parameters can be viewed in the lower display:

- Setpoint
- % Power Output
- Temperature Deviation
- Heater Current
- Temperature symbol (F or C)
- Blank Display

The user scrolls through these parameters by pressing the D button. If enabled, the control setpoint or power output (manual mode only) can be directly modified in this mode.

In the normal operating mode, parameters are selected by use of the P button and modified by use of the UP and DOWN buttons. Parameters are then entered by the P button, which advances the user to the next parameter. Pressing the D button immediately returns the controller to the normal operating mode without changing the currently selected parameter.

**HARDWARE FEATURES**

A fast 100 msec input sampling rate provides quick controller response to a process disturbance, thus providing excellent temperature control. Measurement accuracy of 0.3% of span ±1°C or better, provides close process control conforming to the desired control setpoint value. The T48 accepts a variety of both thermocouple and RTD temperature probes. An output board contains the Main Control output, Alarm 1 output, Alarm 2/Cooling output, and/or Linear DC output. Since the controller is serviceable from the front of the panel, the output board (on some models) may be easily changed or replaced without disturbing the wiring behind the panel. No re-programming is required when changing or replacing the output board for units without the Linear DC output option. Units with the linear output option require calibration procedure for the new linear output.

Low-drift, highly stable circuitry ensures years of reliable and accurate temperature control. The recommended two year re-calibration interval is easily accomplished via the programming menu.

**REMOTE SETPOINT INPUT**

The remote setpoint input facilitates the use of a remote signal to drive the controller’s setpoint. The remote signal can be scaled independent to that of the controller’s range. The controller’s response to local/remote setpoint transfers can be programmed. Also, the remote signal is filtered by use of an adaptive filter. With this filter, relatively large filtering time constants can be used without suffering from long settling times. The time constant and filter disable band are programmable. Additionally, the remote signal can also be velocity limited (or ramped) to slow the controller’s response to changes in setpoint. This results in a steady control response with no overshoot.

**HEATER CURRENT MONITOR**

The T48 provides a direct readout of process heater current. This provides valuable information regarding single phase heater system integrity. It is especially useful on extruder and large oven applications where adjacent controllers mask the effect of a failed heater. The heater break alarm senses two types of heater system faults:

1) Main control output is “on” and heater current is below alarm value. This indicates failed heater or failed parts of heater, breaker trip, failed power control device, etc.
2) Main control output is “off” and heater current is above 10% of alarm value. This indicates a failed power control device, wiring fault, etc.

**LINEAR DC ANALOG OUTPUTS**

The Main Linear DC output has independent scaling, programmable output update time and filter (damping) time. These parameters permit flexibility in process configuration. The output can be set for 0 to 10 V, 0 to 20 mA or 4 to 20 mA ranges, and can be configured for control or for transmission of temperature or setpoint values.

A Second Linear DC output is dedicated for retransmission of input temperature. The output can be scaled and converted independent of the input and Main Linear DC output. This output is isolated from the input.

**SETPOINT FEATURES**

The controller setpoint can be protected from out of range values by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can be programmed.

A second setpoint value can be programmed which can be made active by a user input and/or through the front panel on selected models.

The setpoint ramp feature ramps the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate. This feature reduces thermal shock to the process and helps to minimize temperature overshoot.

**INPUT FEATURES**

A programmable input filter can be used to stabilize readings from a process with varying or oscillating temperature characteristics, helping to provide better temperature control. A programmable temperature shift function can be used to compensate for probe errors or to have multiple T48 units indicate the same nominal temperature.

The programmable User Input can be used to control a variety of functions, such as auto/manual transfer of the controller, reset alarm output(s), transfer to second setpoint, etc.

**OUTPUT FEATURES**

Programmable output power limits provide protection for processes where excessive power can cause damage. Automatic sensor probe break detection, for fail-safe operation, causes the controller to default to a programmed output power (upscale or downscale burnout). Programmable output cycle time, output hysteresis and dampening can reduce output activity without degrading control accuracy. The main outputs can operate in PID, ON/OFF, or manual control modes.

**CONTROL AND ALARM OUTPUTS**

In addition to the Linear DC outputs, there are up to three types of ON/OFF outputs. These outputs can be relay, logic, or triac for control or alarm purposes. Relay outputs can switch user applied AC or DC voltages. Logic/SSR drive outputs supply power to external SSR power units. One Logic/SSR Drive output can control up to four SSR power units at one time. The Triac output supplies one Amp of AC current for control of an external AC relay or triac device.

**AUTO-TUNE**

The T48 has an auto-tune feature which, on demand, automatically determines the PID control parameters for a particular thermal process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into non-volatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked either at start-up or at setpoint, depending on the process requirements. An auto-tune programmable dampening factor produces various levels of process control and response characteristics.

**RS485 Communications**

The RS485 communications option allows the connection of up to 32 devices on a single pair of wires with a distance of up to 4,000 feet and a maximum baud rate of 9600. Since the same pair of wires are used for both transmit and receive, only one way communication is possible at any given time. The controller has a programmable response time to allow the host device adequate time to release the communication line for a transmission.

Selected parameters from the T48 can be interrogated or changed, and alarm output(s) may be reset by sending the proper command code via serial communications. It is also possible to invoke Auto-tune through the serial port. Serial communications used with SFCRM software allows for easy controller parameter configuration by computer.

**HEATING AND COOLING SYSTEMS**

The T48 is available with dual outputs to provide heating and cooling to those processes that require them. For example, many extruder applications require both heating and cooling to maintain accurate extruder barrel and die temperatures. The T48 is easily configured for these types of applications.
**CONTROLLER PROGRAMMING**

Front Panel Program Disable allows all of the controller’s set-ups to be locked-out from further operator intervention after the initial set-up.

The following four programming modes allow the controller to adapt to any required user-interface level:

- **Unprotected Parameter Mode**
- **Protected Parameter Mode**
- **Hidden Function Mode**
- **Configuration Parameter Mode**

### UNPROTECTED PARAMETERS MODE *

The Unprotected Parameters Mode is accessible from the Normal Display Mode when program disable is inactive or when the proper access code number from the Protected Parameter Mode is entered. The Configuration Parameter Modes can be accessed only from this mode.

- **“SP”** - Enter setpoint
- **“OP”** - Enter output power
- **“Prof”** - Enter proportional band
- **“Intt”** - Enter integral time
- **“dErt”** - Enter derivative time
- **“AL-1”** - Enter value for alarm #1
- **“AL-2”** - Enter value for alarm #2
- **“CNFP”** - Select configuration access point
- **“End”** - Return to normal display mode

### PROTECTED PARAMETERS MODE *

The Protected Parameters Mode is enabled when program disable is active. This mode prevents access to the Configuration Parameter Modes without the proper access code number. Only the parameters that are enabled in the Configuration 3 parameter (lock-out section) can be accessed.

- **“ProP”** - Enter proportional band
- **“Intt”** - Enter integral time
- **“dErt”** - Enter derivative time
- **“AL-1”** - Enter value for alarm #1
- **“AL-2”** - Enter value for alarm #2
- **“CodE”** - Enter value to access unprotected parameters and configuration parameters

### HIDDEN FUNCTION MODE *

The Hidden Function Mode is accessible from the Normal Display Mode. The functions in this mode may be locked-out individually in Configuration 3 parameter (lock-out section).

- **“SPSL”** - Select local (SP1 or SP2) or remote setpoint
- **“ImF”** - Transfer between automatic (PID) control and manual control
- **“tUNE”** - Invoke/cancel PID Auto-tune
- **“bLrS”** - Reset latched alarms

### CONFIGURATION PARAMETER MODE

The Configuration Parameter Mode allows the operator to set-up the basic requirements of the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the Configuration Access Point, allowing the user to return to the Normal Display Mode.

#### Configuration 1, Inputs (1-IN)

- **“TYPE”** - Select input probe type
- **“SCAL”** - Select temperature scale
- **“dCPt”** - Select temperature resolution
- **“FLtr”** - Select level of input filtering
- **“SHFt”** - Enter input correction shift (offset)
- **“SPLO”** - Enter setpoint lower limit
- **“SPHI”** - Enter setpoint higher limit
- **“SPrP”** - Enter setpoint ramp rate
- **“InPt”** - Select user input function

#### Configuration 2, Outputs (2-OP) *

- **“CYCt”** - Enter time proportioning cycle time
- **“dOPT”** - Select output control action
- **“OPLo”** - Enter output power low limit
- **“OPHi”** - Enter output power high limit
- **“OPFL”** - Enter probe fail power preset
- **“OPDP”** - Enter output control dampening
- **“CHYS”** - Enter ON/OFF control hysteresis
- **“tCD”** - Select auto-tuning dampening
- **“ANIP”** - Main Linear DC analog output range
- **“ANAS”** - Main Linear DC analog output source
- **“ANut”** - Main Linear DC analog output update time
- **“ANLO”** - Main Linear DC analog output scaling low
- **“ANHI”** - Main Linear DC analog output scaling high

#### Configuration 3, Parameter Lock-Outs (3-LC) *

- **“SP”** - Select setpoint access level
- **“OP”** - Select power access level
- **“dEv”** - Enable deviation display
- **“Hr”** - Enable heater current display
- **“tSp”** - Enable temperature scale display
- **“CodE”** - Enter parameter access code
- **“Pd”** - Select PID access level
- **“AL”** - Select alarm access level
- **“ALrS”** - Enable alarm reset access
- **“SPSL”** - Enable local/remote selection
- **“ImF”** - Enable auto/manual mode selection
- **“tUNE”** - Enable auto-tune invocation

#### Configuration 4, Alarms (4-AL) *

- **“AC1”** - Select operation mode of alarm #1, or select heat output
- **“ST1”** - Select reset mode of alarm #1
- **“Stb1”** - Enable activation delay of alarm #1
- **“AL-1”** - Enter value for alarm #1
- **“AC2”** - Select operation mode of alarm #2, or select cooling output
- **“ST2”** - Select reset mode of alarm #2
- **“Stb2”** - Enable activation delay of alarm #2
- **“AL-2”** - Enter value for alarm #2
- **“AHYS”** - Enter hysteresis value for both alarms

#### Configuration 5, Cooling (5-O2) *

- **“CYC”** - Enter cooling time proportioning cycle time
- **“GAN”** - Enter cooling relative gain
- **“b2”** - Enter heat/cool deadband or overlap

#### Configuration 6, Serial Communications (6-SC) *

- **“bAUD”** - Select baud rate
- **“Conf”** - Select character frame format
- **“Addr”** - Enter address
- **“Abv”** - Select abbreviated or full transmission
- **“PoP”** - Select print options

#### Configuration 7, Remote Setpoint Input (7-N2) *

- **“dSP1”** - Enter remote setpoint display scaling value #1
- **“INP1”** - Enter remote setpoint process scaling value #1
- **“dSP2”** - Enter remote setpoint display scaling value #2
- **“INP2”** - Enter remote setpoint process scaling value #2
- **“FLtr”** - Enter remote setpoint filter time constant
- **“bAnd”** - Enter remote setpoint filter disable band
- **“bLr”** - Select Local/Remote setpoint transfer response

#### Configuration 7 - Heater Current Parameters (7-N2) *

- **“Hr”** - Enter full scale rating of CT

#### Configuration 8, Second Linear DC Analog Output (8-A2) *

- **“A2P”** - Second linear DC analog range
- **“A2LO”** - Second linear DC analog scaling low
- **“A2HI”** - Second linear DC analog scaling high

#### Configuration 9, Factory Service Operations (9-FS) *

- **“Code 48”** - Calibrate Instrument
- **“Code 66”** - Reset parameters to factory setting

* These parameters may not appear due to option configuration or other programming.
MULTIPLE UNIT STACKING
The T48 is designed for close spacing of multiple units. Units can be stacked either horizontally or vertically. For vertical stacking, install the panel latch with the screws to the sides of the unit. For horizontal stacking, the panel latch screws should be at the top and bottom of the unit. The minimum spacing from center line to center line of units is 1.96" (49.8 mm). This spacing is the same for vertical or horizontal stacking.

Note: When stacking units, provide adequate panel ventilation to ensure that the maximum operating temperature range is not exceeded.

ACCESSORY - CURRENT TRANSFORMER-40 A
The external Current Transformer is used when specifying the T48s equipped with the Heater Current Monitor.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>CT004001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Ratio</td>
<td>40:0.1 (Amperes)</td>
</tr>
<tr>
<td>Operation Frequency</td>
<td>50 to 400 Hz</td>
</tr>
<tr>
<td>Insulation Class</td>
<td>0.6 KV BIL, 10 KV full wave.</td>
</tr>
<tr>
<td>Terminals</td>
<td>Brass studs No. 8-32 UNC with flat washer and hex nuts.</td>
</tr>
<tr>
<td>Window Diameter</td>
<td>1.13&quot; (28.7 mm)</td>
</tr>
<tr>
<td>Weight</td>
<td>8 oz (226.0 g)</td>
</tr>
</tbody>
</table>

ACCESSORY - CURRENT TRANSFORMER-50 A
The external Current Transformer is used when specifying the T48s equipped with the Heater Current Monitor.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>CT005001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Ratio</td>
<td>50:0.1 (Amperes)</td>
</tr>
<tr>
<td>Operation Frequency</td>
<td>50 to 400 Hz</td>
</tr>
<tr>
<td>Insulation Class</td>
<td>0.6 KV BIL, 10 KV full wave.</td>
</tr>
<tr>
<td>Terminals</td>
<td>Brass studs No. 8-32 UNC with flat washer and hex nuts.</td>
</tr>
<tr>
<td>Window Diameter</td>
<td>1.13&quot; (28.7 mm)</td>
</tr>
<tr>
<td>Weight</td>
<td>8 oz (226.0 g)</td>
</tr>
</tbody>
</table>

ACCESSORY - EXTERNAL SSR POWER UNIT
The external SSR Power Unit is used with T48s equipped with Logic/SSR Drive outputs to switch loads up to 240 VAC @ 45 Amps, 25°C ambient. The unit is operated by applying a low level DC control signal to the isolated input. The unit features zero cross detection circuits which reduces radiated RFI when switching load currents. With no contacts to wear out, the SSR Power Unit provides virtually limitless operational life. The unit is supplied with an integral heat sink for immediate installation.

| External SSR Power Unit: |
| Part Number | RLY50000 |
| Switched Voltage Range | 50 to 280 VAC |
| Load Current | 45 Amps max. @ 25°C ambient temperature |
| 35 Amps max. @ 50°C ambient temperature |
| On State Input | 3 to 32 VDC @ 1500 Ω impedance. (isolated) (Use Logic/SSR drive output.) |
| Off State Input | 0.0 to 1.0 VDC |
| Size | 5.5" (14 cm) L x 4.75" (12 cm) W x 2.62" (6.6 cm) H |

Current Transformers:
<table>
<thead>
<tr>
<th>Part Number</th>
<th>CT004001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Ratio</td>
<td>40:0.1 (Amperes)</td>
</tr>
<tr>
<td>Max Heater Current</td>
<td>50 A</td>
</tr>
<tr>
<td>Dielectric Strength</td>
<td>1000 VAC (For 1 minute)</td>
</tr>
<tr>
<td>Vibration Resistance</td>
<td>50 Hz (Approx 10 G)</td>
</tr>
<tr>
<td>Terminals</td>
<td>Solder Type</td>
</tr>
<tr>
<td>Window Diameter</td>
<td>0.228&quot; (5.8 mm)</td>
</tr>
<tr>
<td>Weight</td>
<td>0.406 oz (11.5 g)</td>
</tr>
</tbody>
</table>
MULTIPLE UNIT/REMOTE SETPOINT APPLICATION

Eight T48 controllers are used in a drying oven. Each T48 controls a zone within the oven. Depending upon the material to be dried, and its initial moisture content, the drying setpoint temperature varies. A master T48 controller transmits setpoint via linear DC output. This signal is received as a remote setpoint signal by the other slave controllers.

Whenever the master controller’s setpoint is changed, the slave controller’s setpoint changes automatically.

The remote setpoint input at each slave controller can be scaled independently.

PLASTICS EXTRUDER APPLICATION

Several T48 controllers are employed to control the temperature of a plastics extruder. Each T48 controls a heating element and a cooling water solenoid to maintain each extruder zone at the desired temperature. The Heater Current Monitor option is used to provide a readout of the heater current. The multi-function User Input can be programmed to allow selection of manual operation when connected to common. This allows the user to hold the control output of the controller during abnormal process conditions.

OEM PAINT SPRAYER APPLICATION

An OEM manufacturing spray painting equipment utilizes the T48 to maintain optimum paint temperature. In addition to the low cost, the 1/16 DIN package size permits the OEM to design temperature control into various sized painting equipment, from small hand sprayers to large paint booths. The heating element used to heat the paint, is connected to the Main Control Output (OP1) programmed for On/Off control. Alarm 1 is programmed as Band Inside Acting, so that as long as the paint temperature is within manufacturer’s specifications for temperature, the “GO” light is on. Alarm 2 is programmed as Band Outside acting so that the “NO GO” light is lit when the paint temperature is more than 12° outside the manufacturer’s specifications of 140 to 150°F.
**ORDERING INFORMATION**

Options and Output Boards are factory configured per the part number specified. Part numbers without replacement output boards listed must be returned to the factory for output board replacement.

**MODELS WITHOUT RS485 AND LINEAR DC ANALOG OUTPUT**

<table>
<thead>
<tr>
<th>Option Boards</th>
<th>Part Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic/SSR</td>
<td>RBD48211</td>
</tr>
<tr>
<td>Relay</td>
<td>RBD48211</td>
</tr>
<tr>
<td>Logic/SSR</td>
<td>RBD48211</td>
</tr>
<tr>
<td>Relay</td>
<td>RBD48211</td>
</tr>
<tr>
<td>Logic/SSR</td>
<td>RBD48211</td>
</tr>
<tr>
<td>Relay</td>
<td>RBD48211</td>
</tr>
<tr>
<td>Triac</td>
<td>Logic/SSR</td>
</tr>
<tr>
<td>Logic/SSR</td>
<td>RBD482200</td>
</tr>
<tr>
<td>Relay</td>
<td>RBD48211</td>
</tr>
<tr>
<td>Logic/SSR</td>
<td>RBD48211</td>
</tr>
<tr>
<td>Relay</td>
<td>RBD48211</td>
</tr>
<tr>
<td>Logic/SSR</td>
<td>RBD48211</td>
</tr>
<tr>
<td>Relay</td>
<td>RBD48211</td>
</tr>
</tbody>
</table>

* - This output is programmable as either Control (PID) or as an Alarm.
@ - These part numbers are equipped with a second setpoint.

**MODELS WITH RS485 OR LINEAR DC ANALOG OUTPUT**

<table>
<thead>
<tr>
<th>DEDICATED MAIN CONTROL 01 OUTPUT</th>
<th>DEDICATED ALARM 1 A1 OUTPUT</th>
<th>DEDICATED ALARM 2 (A2 OR 02 (COOL)*</th>
<th>REMOTE SETPOINT INPUT @</th>
<th>HEATER CURRENT INPUT @</th>
<th>REPLACEMENT OUTPUT BOARD</th>
<th>PART NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay</td>
<td>Relay</td>
<td>Relay</td>
<td>YES</td>
<td>YES</td>
<td>RBD48100</td>
<td>T4810010 T4810000</td>
</tr>
<tr>
<td>Relay</td>
<td>Relay</td>
<td>Relay</td>
<td>YES</td>
<td>RBD48111</td>
<td>NA</td>
<td>T4811000</td>
</tr>
<tr>
<td>Relay</td>
<td>Relay</td>
<td>Relay</td>
<td>YES</td>
<td>RBD48111</td>
<td>T4811110 T4811100</td>
<td></td>
</tr>
<tr>
<td>Relay</td>
<td>Relay</td>
<td>Relay</td>
<td>YES</td>
<td>RBD48111</td>
<td>T4811113 T4811103</td>
<td></td>
</tr>
<tr>
<td>Relay</td>
<td>Relay</td>
<td>Relay</td>
<td>YES</td>
<td>RBD48111</td>
<td>T4811114 T4811104</td>
<td></td>
</tr>
<tr>
<td>Logic/SSR</td>
<td>Relay</td>
<td>RBD48200</td>
<td>T4820010 T4820000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logic/SSR</td>
<td>Relay</td>
<td>RBD48211</td>
<td>T4821110 T4821100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logic/SSR</td>
<td>Relay</td>
<td>RBD48211</td>
<td>T4821113 T4821103</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logic/SSR</td>
<td>Relay</td>
<td>RBD48211</td>
<td>T4821114 T4821104</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triac</td>
<td>Logic/SSR</td>
<td>NA</td>
<td>T4832210 T4832200</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* - This output is programmable as either Control (PID) or as an Alarm.
** - This output is jumper and program selectable for either a current or voltage Linear DC output.
@ - These part numbers are equipped with a second setpoint.

1 - Replacement Output Board RBD48100 may be used.
2 - Replacement Output Board RBD48111 may be used.

**ACCESSORIES**

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>DESCRIPTION</th>
<th>PART NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLY</td>
<td>External SSR Power Unit (for Logic/SSR output models)</td>
<td>RLY50000</td>
</tr>
<tr>
<td></td>
<td>Single Phase 25 A DIN Rail Mount SSR</td>
<td>RLY60000</td>
</tr>
<tr>
<td></td>
<td>Single Phase 40 A DIN Rail Mount SSR</td>
<td>RLY6A000</td>
</tr>
<tr>
<td></td>
<td>Three Phase DIN Rail Mount SSR</td>
<td>RLY70000</td>
</tr>
<tr>
<td>CT</td>
<td>40 Ampere Current Transformer (for Heater Current Input models)</td>
<td>CT004001</td>
</tr>
<tr>
<td></td>
<td>50 Ampere Current Transformer (for Heater Current Input models)</td>
<td>CT005001</td>
</tr>
<tr>
<td>SFCRM</td>
<td>Crimson 2 PC Configuration Software for Windows 98, ME, 2000 and XP (for RS485 models)</td>
<td>SFCRM</td>
</tr>
<tr>
<td>ICM4</td>
<td>RS232/RS485 Serial Converter Module</td>
<td>ICM40030</td>
</tr>
<tr>
<td>ICM5</td>
<td>Three way isolated RS232/RS485 Serial Converter</td>
<td>ICM50000</td>
</tr>
</tbody>
</table>

* Crimson software is available for download from http://www.redlion.net
MODEL TCU - TEMPERATURE CONTROL UNIT

DESCRIPTION

The TCU Controller accepts signals from a variety of temperature sensors (thermocouple or RTD elements), precisely displays the process temperature, and provides an accurate output control signal (time proportional or linear) to maintain a process at the desired control point. A comprehensive set of easy to use steps allows the controller to solve various application requirements.

The controller can operate in the PID control mode for both heating and cooling, with on-demand auto-tune, which will establish the tuning constants. The PID tuning constants may be fine-tuned by the operator at any time and then locked out from further modification. The controller employs a unique overshoot suppression feature, which allows the quickest response without excessive overshoot. The unit can be transferred to operate in the manual mode, providing the operator with direct control of the output. The controller may also be programmed to operate in the ON/OFF control mode with adjustable hysteresis.

Dual 4-digit displays allow viewing of the process temperature and setpoint simultaneously. Front panel indicators inform the operator of the controller and output status. Replaceable and interchangeable output modules (relay, SSR drive, or triac) can be installed for the main control output, alarm output(s) and cooling output.

Optional dual alarms can be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, Band IN or OUT, Heater Break and Valve Fail Detect) with adjustable hysteresis. A standby feature suppresses the output during power-up until the temperature stabilizes outside the alarm region. An optional secondary output is available (for processes that require cooling) which provides increased control accuracy and response.

DIMENSIONS  In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 5.5” (140) H x 2.1” (53.4) W.
DESCRIPTION (Cont'd)

**OPTIONS**

A linear 4 to 20 mA or 0 to 10 VDC output signal is available to interface with actuators, chart recorders, indicators, or other controllers. The output signal can be digitally scaled and selected to transmit one of the following: % output power, percent temperature value, process temperature value deviation or setpoint value. For Linear DC control applications, the adjustable output demand dampening, output deadband and output update time parameters expand the versatility of the TCU with final control devices.

The optional Heater Current Monitor serves as a digital ammeter for heater current monitoring. Current transformer accessory (CT05001), is required. An alarm event output, output can be programmed to signal when the heater or heater control devices have failed, before damage to process material occurs. The Heater Break alarm triggers under two conditions:

1) The main output (OP1) is “on” and the heater current is below the heater current alarm value, indicating an aged or failed heater.

2) Output (OP1) is “off” and the heater current is more than 10% of the alarm value, indicating a shorted heater control device or other problem.

The optional Motorized Valve Positioner directly controls the position of a valve by the use of twin outputs (open and close) to control the direction of motor rotation. The motor position defines the opening position of the valve. Two control modes are possible: position control, which makes use of the slidewire feedback signal supplied with the positioner and velocity control, in which no slidewire feedback signal is used. Parameters are provided to adjust the operation of the valve. These include:

- Valve activity hysteresis
- Valve update time
- Variable control dampening
- Slidewire signal fail action
- Adjustable valve position limits.

The valve positioner TCU achieves tight process control, yet minimizes unnecessary valve activity. An alarm event output or display alarm can be programed under loss of slidewire feedback or under valve fail detection. The optional Second Analog Input (0-20 mA DC) can be configured as a remote setpoint signal or as a secondary process signal. Configuration of the second analog input as a remote setpoint signal allows ratio control, master setpoint/multiple slave operation, and the ability to cascade the TCU with another controller (external cascade). Configuration of the second input as a secondary process signal allows operation as a two-process cascade controller within a single unit (internal cascade). In either control mode, parameters are provided to scale, configure, communicate and monitor the activity of both analog inputs. A square law linearizer function can be used to linearize signals derived from flow transmitters.

The optional RS485 multiprotocol serial communication interface provides two-way communication between a TCU unit and other compatible equipment such as a printer, a programmable controller, or a host computer. In multipoint applications the address number of each unit on the line can be programmed from 0-99. Up to thirty-two units can be installed on a single pair of wires. The Setpoint value, % Output Power, Setpoint Ramp Rate, etc. can be interrogated or set. A square law linearizer function can be used to linearize signals derived from flow transmitters.

The optional NEMA 4X/IP65 rated bezel is available for wash down and/or dirty environments, when properly installed. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the controller extremely reliable in industrial environments.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the TCU to directly command motors, valves, or other actuators not equipped with safeguards. To do so, can be potentially harmful to persons or equipment in the event of a fault to the unit. An independent and redundant temperature limit indicator with alarm outputs is strongly recommended. Red Lion Controls model IMT (thermomodule) or model IMR (RTD) units may be used for this purpose. The indicators should have input sensors and AC power feeds independent from other equipment.

SPECIFICATIONS

1. **DISPLAY:** Dual 4-digit

   **Upper Temperature Display:** 0.4” (10.2 mm) high red LED

   **Lower Auxiliary Display:** 0.3” (7.6 mm) high green LED

   **Display Messages (Model dependent):**

   - **“OL”** - Appears when measurement exceeds + sensor range.
   - **“UL”** - Appears when measurement exceeds - sensor range.
   - **“OPEN”** - Appears when open sensor is detected.
   - **“Sht”** - Appears when shorted sensor is detected (RTD only)
   - **“-”** - Appears when display values exceed + display range.
   - **“SLit”** - Appears when display values exceed - display range.
   - **“VALV”** - Appears when valve actuator error is detected.

2. **POWER:** 115/230 VAC (+10%, -15%) no observable line variation effect, 48 to 62 Hz, 10 VA, switch selectable

3. **ANNUNCIATORS:**

   **LED Backlight Status Indicators (Model dependent):**

   - **%PW** - Lower auxiliary display shows power output in (%).
   - **DEV** - Lower auxiliary display shows deviation (error) from temperature setpoint.
   - **OP1** - Main control output is active.
   - **AL1** - Alarm #1 is active.
   - **AL2** - Alarm #2 is active (for Dual Alarm Option).
   - **OP2** - Cooling output is active (for Cooling Option).
   - **OPN** - Valve positioner OPEN output is active (for Valve Positioner option).
   - **CLS** - Valve positioner CLOSE output is active (for Valve Positioner option).
   - **CUR** - Lower auxiliary display shows heater current (for Heater Current Monitor option).
   - **MAN** - Flashing: Controller is in manual mode
   - **REM** - ON: controller is in remote setpoint mode
   - **SEC** - Lower auxiliary display shows second analog input (For Second Analog Input option).
   - **DEV** - Lower auxiliary display shows deviation (for Heater Current Monitor option).

4. **CONTROLS:** Four front panel push buttons for modifying and setup of controller functions and one external input for parameter lockout or other functions.

5. **MAIN SENSOR INPUT:**

   **Sample Period:** 100 msec

   **Response Time:** 300 msec (to within 99% of final value w/step input; typically, response is limited to response time of probe)

   **Failed Sensor Response:**

   - **Main Control Output(s):** Programmable preset output

   **Display:** “OPEN”

   **Alarms:**

   - **Upstate drive**

   **DC Linear:** Programmable preset output

   **Normal Mode Rejection:** 40 dB @ 50/60 Hz (improves with increased digital filtering).

   **Common Mode Rejection:** 100 dB, DC to 60 Hz

   **Protection:** Input overload 120 VAC for 30 seconds.

6. **THERMOCOUPLE:**

   - Types: T, E, J, K, R, S, B, N, Linear mV

   **Input Impedance:** 20 MΩ all types

   **Lead resistance effect:** 20 μV/350 Ω

   **Cold junction compensation:** Less than ±1°C error over 0 - 50°C ambient temperature range. Disabled for Linear type

   **Resolution:** 1/16°C all types, or 0.1°C/°F for T, E, J, K, and N only.

   **RTD:** 2, 3 or 4 wire, 100 Ω platinum, alpha = 0.00385 (DIN 43760),

   **Excitation:** 0.175 mA

   **Resolution:** 1 or 0.1 degree

   **Lead Resistance:** 7 Ω maximum

---

**TC TYPE** | **RANGE** | **ACURACY** | **WIRE COLOR**
---|---|---|---
T | -200 to +400°C | 0.20% + 1.5°C | blue
   -328 to -752°F | 0.20% + 2.7°F |
E | -200 to +750°C | 0.20% + 1.5°C | violet
   -328 to +1382°F | 0.20% + 2.7°F |
J | -200 to +1760°C | 0.15% + 2.7°F | white
   -328 to +1400°F | 0.15% + 2.7°F |
K | -200 to +2250°C | 0.20% + 2.7°F | yellow
   -328 to +2282°F | 0.20% + 2.7°F |
R | 0 to +1768°C | 0.15% + 2.5°C |
   +32 to +3214°F | 0.15% + 4.5°F |
S | 0 to +1768°C | 0.15% + 2.5°C |
   +32 to +3214°F | 0.15% + 4.5°F |
B | +200 to +1820°C | 0.15% + 2.5°C |
   +32 to +3350°F | 0.15% + 4.5°F |
N | 200 to +1000°C | 0.20% + 1.5°C |
   -328 to +2372°F | 0.20% + 2.5°F |
mV | -5.00 to 56.00 | 0.15% + 1 LSD |
RTD (385) | -200 to +600°C | 0.10% + 0.5°C |
   -328 to +1100°F | 0.10% + 0.9°F |
RTD (392) | -200 to +600°C | 0.10% + 0.5°C |
   -328 to +1100°F | 0.10% + 0.9°F |
OHMS | 1.0 to 320.0 | 0.15% + 1 LSD |
8. RANGE AND ACCURACY:
Errors include NIST conformity and A/D conversion errors at 23°C after 20
min. warm-up. Thermocouple errors include cold junction effect. Errors are
expressed as ±% of reading and ±1/2 LSD unless otherwise noted.
9. OUTPUT MODULES [Optional] (For All Output Channels):
Relay:
Type: Form-C (Form-A with some models. See Ordering Information.)
Rating: 5 Amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @
120 VAC (inductive load)
Life Expectancy: 100,000 cycles at max. load rating. (Decreasing load
and/or increasing cycle time, increases life expectancy).
Logic/SSR Drive: Can drive multiple SSR Power Units.
Type: Non-isolated switched DC, 12 VDC typical
Drive: 45 mA max.
Tria:
Type: Isolated, Zero Crossing Detection
Rating:
Voltage: 120/240 VAC
Max. Load Current: 1 Amp @ 35°C
0.75 Amp @ 50°C
Min. Load Current: 10 mA max.
Offstate Leakage Current: 7 mA max. @ 60 Hz
Operating Frequency: 20 to 400 Hz
Protection: Internal Transient Snubber, Fused
10. MAIN CONTROL OUTPUT (Heating or Cooling):
Control: PID or ON/OFF
Output: Time proportioning or linear DC
Hardware: Plug-in, replaceable output modules
Cycle time: Programmable
Auto-tune: When selected, sets proportional band, integral time, and
derivative time values.
Probe Break Action: Programmable
11. COOLING OUTPUT (Optional):
Control: PID or ON/OFF
Output: Time proportioning or linear DC
Hardware: Plug-in, replaceable output modules
Cycle time: Programmable
Proportional Gain Adjust: Programmable
Heat/Cool Deadband Overlap: Programmable
12. LINEAR DC OUTPUT (Optional): With digital scale and offset,
programmable deadband and update time.
4 to 20 mA:
Resolution: 1 part in 3500 typ.
Accuracy: ±0.1% of reading + 25 µA
Compliance: 10 V (500 Ω max. loop impedance)
0 to 10 VDC:
Resolution: 1 part in 3500 typ.
Accuracy: ±0.1% of reading + 35 mV
Min. Load Resistance: 10 KΩ (1 mA max.)
Source: % output power, setpoint, deviation, or temperature
(Available for heat or cool but not both.)
13. HEATER CURRENT MONITOR (Optional):
Type: Single phase, full wave monitoring of load currents controlled by main
output (OP1)
Input: 100 mA AC output from current transformer RLC part number
CT005001 or any current transformer with 100 mA AC output
Display Scale Range: 1.0 to 999.9 amperes or 100.0%
Input resistance: 5 Ω
Accuracy: 1% of full scale ±1 LSD (10 to 100% of range)
Frequency: 50 to 400 Hz
Alarm mode: Dual acting; heater element fail detect and control device fail
detect
Overload: 200 mA (steady state)
Min. output “on” time for Heater break alarm detect: 400 msec
14. MOTORIZED VALVE POSITIONER (Optional):
Two Outputs: Valve open and valve close or Linear DC (optional)
Hardware: Plug-in, replaceable output modules
Three Inputs: Slidewire feedback, signal fail detect (Isolated from main
input)
Slidewire Resistance: 100 to 100 KΩ
Slidewire Exciting Voltage: 0 VDC
Slidewire Fail Action: programmable
Control Mode: Position mode (with slidewire) and velocity mode (w/o
slidewire).
Control Deadband: 1% to 25.0% (position mode)
0.1 to 25.0 seconds (velocity mode)
Update Time: 1 to 250 seconds
Motor Time (open, close): 1 to 9999 seconds
Position Limits: Adjustable 0.0 to 100.0% of valve stroke
Valve Fail Time: Off to 9999 seconds
Alarm mode: Dual acting; loss of slidewire feedback signal and valve fail
detection
15. SECOND ANALOG INPUT:
Range: 0 to 20 mA (Isolated from main input)
Overload: 100 mA (steady state)
Input Resistance: 10 Ω
Voltage Drop (@ 20 mA): 0.2 V
Accuracy: 0.15% of reading ±10 µA ±1 LSD
Scale Range: -999 to 9999
17. USER INPUT (Optional): Internally pulled up to +5 VDC.
Available on all second input (HCM, MVP & ANA) models, and on models
with RS485.
Response Time: 100 msec max.
Functions: Program Lock
Integral Action Lock
Auto/Manual Mode Select
Setpoint Ramp Select
Reset Alarms
Print Request
Local/Remote Setpoint Select
18. ALARMS (Optional):
Hardware: Plug-in, replaceable output module
Modes: Absolute high acting
Absolute low acting
Deviation high acting
Deviation low acting
Inside band acting
Heater break
Valve fail
Second Analog Input monitoring
Reset Action: Programmable; automatic or latched
Standby Mode: Programmable; enable or disable
Hysteresis: Programmable
Probe Break Action: Upscale
 Annunciator: LED backlight for “AL1”, “AL2”, (Alarm #2 not available
with cooling output or motorized valve position option.)
19. ENVIRONMENTAL CONDITIONS:
Operating Temperature Range: 0 to 50°C
Storage Temperature Range: -40 to 80°C
Span Drift (maximum): 100 ppm/°C, main input; 150 ppm/°C, second input
Operating and Storage Humidity:
85% max. (non-condensing) from 0 to 50°C
Zero Drift (maximum): 1 µV/°C, main input;2 µV/°C, second input
Altitude: Up to 2000 meters
20. ISOLATION BREAKDOWN RATINGS:
All inputs and outputs with respect to AC line: 2300 V
Analog Outputs, Second Analog Input, Heater Current Input or
Slidewire Input with respect to main input: 500 V
21. CERTIFICATIONS AND COMPLIANCES:
SAFETY
UL Listed, File #E137808, UL508, CSA C22.2 No. 14-M95
LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
UL Recognized Component, File #E156876, UL873, CSA C22.2 No. 24
Recognized to U.S. and Canadian requirements under the Component
Recognition Program of Underwriters Laboratories, Inc.
Type 2 or 4X Enclosure rating (Face only), UL50
Recognized to U.S. and Canadian requirements under the Component
Recognition Program of Underwriters Laboratories, Inc.
Certified by Underwriters Laboratories, Inc.
UL Recognized Component, File #E156876, UL873
Certified by Underwriters Laboratories, Inc.
IEC 1010-1, EN 61010-1: Safety requirements for electrical equipment
for measurement, control, and laboratory use, Part 1.
IP65 Enclosure rating (Face only), IEC 529

www.redlion.net
EN 61000-4-2
Level 2; 4 kV contact

EN 61000-4-4
Level 3; 10 V/m

EN 55011

EN 61000-4-3
Level 3; 2 kV power

Emissions to EN 60081-2

RF interference
EN 55011
Enclosure class A
Power mains class A

Notes:
1. Self-recoverable loss of performance during EMI disturbance at 10 V/m:
   Analog output signal, Heater Current Monitor input and Motorized Valve Positioner input signal may deviate during EMI disturbance.
   For operation without loss of performance:
   Install power line filter, RLC #LFIL0000 or equivalent.
2. Self-recoverable loss of performance during EMI disturbance at 10 Vrms:
   Analog output signal may deviate during EMI disturbance.
   For operation without loss of performance:
   a. Install power line filter, RLC #LFIL0000 or equivalent.
   b. Install 1 ferrite core 1 turn, RLC #FCOR0000 or equivalent, to cable at unit.

Refer to the EMC Installation Guidelines section of the manual for additional information.

22. CONNECTION: Jaw-type terminal block
   Wire Range: 12-30 AWG copper wire
   Torque: 5-7 inch-lbs (56-79 N-cm)

   Front Panel: Flame and scratch resistant tinted plastic
   Case: High impact black plastic. (Mounting collar included)

24. WEIGHT: 1.3 lbs (0.6 kgs)

ACCESSORIES:
External SSR Power Unit:
   Switched Voltage Range: 50 to 280 VAC (Nominal: 240 VAC)
   Load Current: 45 Amps @ 25°C ambient temperature
   35 Amps @ 50°C ambient temperature
   On State Input: 3 to 32 VDC @ 1500 Ω impedance. (isolated)
   Use Logic/SSR drive output module.
   Off State Input: 0.0 to 1.0 VDC
   Size: 5.5” (14 cm) L x 4.75” (12 cm) W x 2.62” (6.6 cm) H

Current Transformer:
   Current Ratio: 50:0.1 (Amperes)
   Accuracy: ±0.5%
   Operating Frequency: 50 to 400 Hz
   Insulation Class: 0.6 kV BIL 10 kV full wave
   Terminals: Brass studs No. 8-36, (flat washer, washer, nut)
   Weight: 8.0 oz (226 g)
   Approvals: UL recognized component

BASIC OPERATION
The TCU controls a process temperature by measuring the temperature via an input probe, then calculating a control output power value by use of a modified PID control algorithm. The unit controls the system with the new output power value to keep the process temperature at setpoint. The PID control algorithm incorporates features which provide for high control accuracy and low temperature overshoot from process disturbances.

FRONT PANEL FEATURES
In the normal operating mode, the unit will display the process temperature in the upper display. One of six other parameters can be viewed in the lower display:
- Setpoint
- % Power Output
- Temperature Deviation
- Heater Current
- Second Input Process Value
- Temperature Symbol (F or C)

The six parameters can be scrolled through by pressing the DSP button. If enabled, the control setpoint or power output (manual mode only) can be directly modified in this mode.
In the normal operating mode, parameters are selected by use of the PAR button and modified by use of the UP and DOWN buttons. Parameters are then entered by the PAR button, which advances the user to the next parameter. Pressing the DSP button immediately returns the controller to the normal operating mode when making a parameter change. The controller’s configuration and parameter settings are stored in an internal E2PROM device.

HARDWARE FEATURES
The fast 100 msec input sampling rate provides quick controller response to a process disturbance, thus providing excellent temperature control. Measurement accuracy of 0.15% or better, provides closer process control conforming to the desired control setpoint value. One model accepts a variety of both thermocouple or RTD temperature probes. The AC input power is switch selectable, allowing the unit to operate from either 115 VAC or 230 VAC. Since the controller is serviceable from the front of the panel, the output modules may be easily changed or replaced without disturbing the wiring behind the panel. No re-programming is required when changing or replacing modules.

The optional NEMA 4X/IP65 rated model utilizes two bezel securing screws and a neoprene gasket to guarantee a water tight seal, when properly installed. The standard model simply requires pressing a latch to remove the unit.

Low-drift, highly stable circuitry ensures years of reliable and accurate temperature control. The recommended two-year re-calibration interval is easily accomplished via the programming menu.

SETPOINT FEATURES
The controller setpoint can be protected from out of range values by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can be programmed.

The setpoint ramp feature ramps the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate. This feature reduces thermal shock to the process and helps to minimize temperature overshoot. The setpoint may also be transmitted by the optional linear DC output for slave control loops.

The second analog input may be configured as a remote setpoint. As such, the controller is easily switched from local/remote setpoint operation via the front panel or user input. Ratio and bias parameters provide on-line scaling of the remote setpoint. Absolute limit values and maximum rate of change of the remote setpoint further enhance controller flexibility.

INPUT FEATURES
A programmable input filter can be used to stabilize readings from a process with varying or oscillating temperature characteristics, helping to provide better temperature control. A programmable temperature shift and slope function can be used to compensate for probe errors or to have multiple TCU units indicate the same nominal temperature.

The programmable User Input can be used to control a variety of functions, such as auto/manual transfer of the controller, reset alarm output(s), etc.

The second analog input has independent scaling parameters to match the units of other processes or transmitters, or to match the controller’s range.

OUTPUT FEATURES
Programmable output power limits provide protection for processes where excessive power can cause damage. Automatic sensor probe break detection, for fail-safe operation, causes the controller to default to a programmed output power (upscale or downscale burnout). With adjustable time proportioning-cycle time, and programmable DC linear output, the controller can satisfy a wide variety of output requirements.

Programmable dampering output hysteresis and output update time parameters can dramatically reduce actuator activity without degrading control accuracy.

The RS485 Communication option allows the user to access various controller parameters such as the setpoint, % output power, % proportional band, etc. The controller may be setup to transmit various parameters at a programmable automatic print rate.

AUTO-TUNE
The TCU has an auto-tune feature which, on demand, automatically determines the PID control parameters for a particular thermal process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into nonvolatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked either at start-up or at setpoint, depending on the process requirements. An auto-tune programmable dampering factor produces various levels of process control and response characteristics.
OPTIONS
HEATING AND COOLING CONTROL

The TCU has dual outputs for providing heating and cooling to those processes that require them. Many extruder applications require both heating and cooling to maintain accurate extruder barrel and die temperatures. The TCU is easily configured for these applications.

Cooling Configuration Parameters
- "CYC2" - Enter cooling time proportioning cycle time
- "GAN2" - Enter cooling relative gain
- "db-2" - Enter heat/cool deadband or overlap

HEATER CURRENT MONITOR

The Heater Current Monitor serves as a heater element fail sentry, so operators can take corrective action before significant process errors occur in the event of a failure. The actual heater current can be viewed in the secondary display and/or a heater break alarm output can be programmed.

Heater Current Monitor Configuration Parameters
- "HCur" - Enter full scale current of current transformer
- "ACt1", "ACt2" - Program alarm(s) as heater break alarm

MOTORIZED VALVE POSITIONER

The motorized valve positioner controls the position of a valve directly, by use of "open" and "close" control outputs. The slidewire feedback signals of the valve may optionally be connected to the controller. Alternatively, the controller may be configured for linear input valve control using the 4 to 20 mA DC output.

Motorized Valve Positioner Configuration Parameters
Position mode:
- "VPS1" - Enter or measure valve closed position
- "VPS2" - Enter or measure valve open position
- "VdUt" - Enter Valve update time
- "VPdb" - Enter valve control deadband
- "VFAL" - Enter valve fail detect time
- "Act1" - Program alarm as valve fail output

Velocity mode:
- "VdUt" - Enter Valve update time
- "VpOt" - Enter valve open time
- "Vclt" - Enter valve close time
- "Von" - Enter valve control deadband (minimum on time)

INTERNAL CASCADE

Cascade control allows the process to be divided into two control loops: the primary control loop and the secondary control loop. The secondary loop receives its setpoint from the primary loop to control an intermediate variable (steam pressure). The control level of the intermediate variable is the input to the primary process. The primary loop (temperature) controller maintains loop regulation by manipulating the setpoint of the secondary controller. The setpoint of the secondary controller, in turn, changes the intermediate variable. The secondary loop can react faster to disturbances of the intermediate variable, thereby minimizing the effects to the primary control loop. Control loops cascaded in such a manner provide greater control quality than would be possible with single loop control. A single TCU can accomplish two-process cascade control.

Internal Cascade Configuration Parameters
- "OPer" - Select cascade mode
- "root" - Select second input square root linearization
- "dPt2" - Select second input decimal point
- "dSP1", "INP1" - Enter scaling units of second input
- "dSP2", "INP2" - Enter scaling units of second input
- "OFd2" - Output dampening of secondary

Internal Cascade Operational Parameters
- "SPr" - View secondary setpoint value
- "Ph-l", "H-l" - Enter secondary proportional band
- "dt-l" - Enter secondary derivative time

EXTERNAL CASCADE

Similar to internal cascade control, external cascade control differs by the employment of two controllers, one of which is equipped with a second analog input configured as a remote setpoint. A PCU controls the secondary loop, while a TCU controls the primary loop.

External Cascade Configuration Parameters
- "OPEr" - Select ratio mode
- "root" - Select second input square root linearization
- "dPt2" - Select second input decimal point
- "dSP1", "INP1" - Enter scaling units of second input
- "dSP2", "INP2" - Enter scaling units of second input
- "SPtr" - Local/Remote select options

External Cascade Operational Parameters
- "rtio" - Remote setpoint ratio
- "bias" - Remote setpoint bias
Setpoint Master Control

Setpoint Master Control allows automatic setpoint changes to slave controller units (up to 30 units total) from a master TCU controller. The linear DC output of the master is looped with the second analog input of the slave TCU controllers. Each slave unit can have unique remote setpoint ratio and bias values.

Setpoint Slave Configuration Parameters

- "OPER" - Select remote setpoint mode
- "root" - Select second input square root
- "qPq" - Select second input decimal point
- "qSP" - Enter scaling units of second input
- "qINP" - Enter scaling units of second input
- "qSP2" - Enter scaling units of second input
- "INP2" - Enter scaling units of second input
- "SPLQ" - Limit range of remote setpoint
- "bIAS" - Limit rate of change of remote setpoint

Setpoint Slave Operational Parameters

- "rlo" - Second input ratio
- "bIAS" - Second input bias

Controller Programming

The TCU has been designed to reduce the operator interaction with the controller while still maintaining a high degree of control accuracy and user flexibility. Front Panel Program Disable allows all of the controller’s set-ups to be locked-out from further operator intervention after the initial parameter set-up. The configuration parameter mode allows the operator to set-up the basic requirements of the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the configuration selection stage allowing the user to return to the normal display mode.

Protected Parameter Mode

The controller’s parameter modes can be accessed only from this mode.

These parameters may not appear due to option configuration or other programming.

Configuration Parameter Mode

The configuration parameter mode allows the operator to set-up the basic requirements of the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the configuration selection stage allowing the user to return to the normal display mode.
Configuration 6, Serial Communications *

“bAUs” - Select baud rate  
“PArs” - Select parity bit  
“Addr” - Enter unit address number  
“Abbrv” - Select abbreviated or full mnemonic transmissions  
“PrAt” - Enter automatic print rate  
“PoPt” - Select parameters to be included in print-out

Configuration 7, Second Input *

“OPEr” - Select remote setpoint or internal cascade mode  
“root” - Select second input square root linearization  
“OpP2” - Select second input decimal point  
“INP1” - Enter scaling parameters of second input  
“INP2” - Enter scaling parameters of second input  
“SpPr” - Enter local/remote select options  
“Opd2” - Enter Secondary output control dampening

Configuration 8, Motorized Valve Positioner *

Position mode: “VPS1” - Enter or measure valve closed position  
“VPS2” - Enter or measure valve open position  
“VUdt” - Enter valve update time  
“VPdb” - Enter valve control deadband  
“VFAL” - Enter valve fail detect time  
Velocity mode: “VUdt” - Enter valve update time  
“VOPr” - Enter valve open time  
“VCLt” - Enter valve close time  
“VONT” - Enter valve control deadband (minimum on time)

HIDDEN FUNCTION MODE *

The hidden function mode is accessible from the normal operating mode. The four functions in this mode may be locked-out individually in configuration 3 parameter lock-out section.

“SPSL” - Select Local/Remote Setpoint  
“trnF” - Transfer between automatic (PID) control and manual control  
“tUNE” - Invoke/cancel PID Auto-tune  
“ALrS” - Reset latched alarms

PROTECTED PARAMETERS MODE *

The protected parameters mode is enabled when program disable is active. This mode prevents access to the configuration modes without the proper access code number. Only the parameters that are selected in the configuration 3 parameter lock-out section can be accessed.

“ProP” - Enter Proportional band  
“Intt” - Enter integral time  
“dErt” - Enter derivative time  
“rtio” - Enter remote setpoint ratio value  
“bIAS” - Enter remote setpoint bias value  
“SP-2” - Enter internal cascade, secondary setpoint  
“Pb-2” - Enter internal cascade, secondary proportional band  
“It-2” - Enter internal cascade, secondary integral time  
“dt-2” - Enter internal cascade, secondary derivative time  
“AL-1” - Enter value for alarm #1  
“AL-2” - Enter value for alarm #2  
“CodE” - Enter access value to unprotected parameters & configuration parameters

ACCESSORY - EXTERNAL SSR POWER UNIT

The external SSR Power Unit is used with the Logic/SSR Drive Module (OMD00003) to switch loads up to 240 VAC @ 45 amps, 25°C ambient. The unit is operated by applying a low level DC control signal to the isolated input. The unit features zero cross detection circuits which reduces radiated RFI when switching load currents. With no contacts to wear out, the SSR Power Unit provides virtually limitless operational life. The unit is supplied with an integral heat sink for immediate installation.

ACCESSORY - CURRENT TRANSFORMER

The external Current Transformer is used when specifying TCUs equipped with the Heater Current Monitor. The primary current rating is 50 amperes.
OUTPUT MODULES

TYPICAL CONNECTIONS

RELAY MODULE

Type: Form-C (Form-A with some models. See ordering information.)
Rating: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive).
Life Expectancy: 100,000 cycles at maximum load rating.
(Decreasing load and/or increasing cycle time, increases life expectancy).

Logic/SSR Drive: Can drive multiple SSR Power Units.
Type: Non-isolated switched DC, 12 VDC typical
Drive: 45 mA maximum.

TRIAC MODULE

Type: Isolated, Zero Crossing Detection
Rating:
Voltage: 120/240 VAC
Max. Load Current: 1 ampere @ 35°C
0.75 ampere @ 50°C
Min. Load Current: 10 mA
Off State Leakage Current: 7 mA max. @ 60 Hz
Operating Frequency: 20 to 400 Hz
Protection: Internal Transient Snubber, Fused

APPLICATION

Several TCU controllers are employed to control the temperature of a plastics extruder. Each TCU controls a heating element and a cooling water solenoid to maintain each extruder zone at a desired temperature. The heater current monitor of the TCU is used for early detection of heater element failure. The linear DC output is used to retransmit the process temperature to a control computer for data logging purposes.
## ORDERING INFORMATION

### MODELS WITHOUT SECOND INPUT OPTIONS

<table>
<thead>
<tr>
<th>NEMA 4X/IP65 BEZEL</th>
<th>4 to 20 mA ANALOG OUTPUT</th>
<th>0 to 10 VDC ANALOG OUTPUT</th>
<th>ALARM OUTPUTS</th>
<th>COOLING OUTPUT</th>
<th>RS485 COM</th>
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These models have dual alarm outputs, or single alarm with cooling outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

### HEATER CURRENT MONITOR MODELS (HCM)

<table>
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<tr>
<th>NEMA 4X/IP65 BEZEL</th>
<th>4 to 20 mA ANALOG OUTPUT</th>
<th>0 to 10 VDC ANALOG OUTPUT</th>
<th>ALARM OUTPUTS</th>
<th>COOLING OUTPUT</th>
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<td>NO</td>
<td>NO</td>
<td>TCU11208</td>
</tr>
</tbody>
</table>

These models have dual alarm outputs, or single alarm with cooling outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

### SECOND ANALOG INPUT MODELS (ANA)

<table>
<thead>
<tr>
<th>NEMA 4X/IP65 BEZEL</th>
<th>4 to 20 mA ANALOG OUTPUT</th>
<th>0 to 10 VDC ANALOG OUTPUT</th>
<th>ALARM OUTPUTS</th>
<th>COOLING OUTPUT</th>
<th>RS485 COM</th>
<th>PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>2</td>
<td>NO</td>
<td>YES</td>
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<tr>
<td>YES</td>
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<td>NO</td>
<td>2</td>
<td>NO</td>
<td>NO</td>
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<td>YES</td>
<td>2</td>
<td>NO</td>
<td>NO</td>
<td>TCU12108</td>
</tr>
</tbody>
</table>

These models have dual alarm outputs, or single alarm with cooling outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

### MOTORIZED VALVE POSITIONER MODELS (MVP)

<table>
<thead>
<tr>
<th>NEMA 4X/IP65 BEZEL</th>
<th>4 to 20 mA ANALOG OUTPUT</th>
<th>0 to 10 VDC ANALOG OUTPUT</th>
<th>ALARM OUTPUTS</th>
<th>COOLING OUTPUT</th>
<th>RS485 COM</th>
<th>PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>1</td>
<td>NO</td>
<td>YES</td>
<td>TCU10307</td>
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<tr>
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<td>TCU11306</td>
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<td>YES</td>
<td>1</td>
<td>NO</td>
<td>NO</td>
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### ACCESSORIES

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay Module</td>
<td>OMD00000</td>
</tr>
<tr>
<td>Triac Module</td>
<td>OMD00001</td>
</tr>
<tr>
<td>Logic/SSR Drive Module</td>
<td>OMD00003</td>
</tr>
<tr>
<td>SSR Power Unit</td>
<td>RLY50000</td>
</tr>
<tr>
<td>Single Phase 25 A DIN Rail Mount SSR</td>
<td>RLY60000</td>
</tr>
<tr>
<td>Single Phase 40 A DIN Rail Mount SSR</td>
<td>RLY60000</td>
</tr>
<tr>
<td>Three Phase DIN Rail Mount SSR</td>
<td>RLY70000</td>
</tr>
<tr>
<td>50.0.1 Ampere Current Transformer</td>
<td>CT005001</td>
</tr>
<tr>
<td>40.0.1 Ampere Current Transformer</td>
<td>CT004001</td>
</tr>
</tbody>
</table>

Note: Output Modules are NOT supplied with the controller. When specifying the controller, be sure to purchase the appropriate output module for the Main Control Output and if necessary, the alarm output(s), the cooling output, and valve positioner outputs. The controller can be fitted with any combination of output modules.

The Logic/SSR Drive Module is a switched DC source, intended to drive the DC input of an SSR power unit. It should never be connected to line voltage.

All output modules are packaged separately and must be installed by the user.
MODEL TSC - TEMPERATURE SETPOINT CONTROLLER

- SETPOINT PROGRAM CONTROLLER FOR TIME VS. TEMPERATURE (RAMP/SOAK) AND SPECIAL BATCH/RECIPE APPLICATIONS
- ADVANCED PROGRAM PROFILING IN A 1/8 DIN PACKAGE
- ON-LINE MONITORING AND CONTROL OF PROGRAM STATUS, TIME, AND SETPOINT VALUE (Program Run, Pause, Stop, Advance, Modify Time, & Setpoint Value)

AUTOMATIC PROGRAM DELAY FOR PROFILE CONFORMITY, PLUS PROGRAM LINKING, REPEATING AND AUTO POWER-ON FUNCTIONS FOR ENHANCED CAPABILITY

DUAL EVENT OUTPUTS FOR TIMED ACTIVATION OF PROCESS EQUIPMENT SUCH AS STIRRERS, FANS, HEATERS, ETC. (Uses Alarm Output Channels)

FOUR SETPOINT & PID PARAMETER SETS FOR QUICK RECALL OF SETPOINTS AND/OR GAIN VALUES DURING BATCH OR PROCESS CHANGEOVER

PROGRAMMABLE USER INPUT FOR CONTROLLER AND SETPOINT PROGRAM CONTROL

100 MSEC SAMPLING PERIOD WITH 0.15% ACCURACY

ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS

DUAL LED DISPLAYS FOR SIMULTANEOUS INDICATION OF TEMPERATURE AND SETPOINT OR TEMPERATURE AND PROFILE STATUS

ACCEPTS ANY ONE OF 10 DIFFERENT TYPES OF SENSOR INPUTS (Thermocouple or RTD)

FIELD REPLACEABLE AND INTERCHANGEABLE OUTPUT MODULES (Relay, Logic/SSR drive, and Triac)

OPTIONAL DUAL ALARM OUTPUTS (Uses Output Modules)

OPTIONAL COOLING OUTPUT (Uses Output Module)

OPTIONAL LINEAR 4 to 20 mA or 0 to 10 VDC OUTPUT FOR CONTROL OR TEMPERATURE RE-TRANSMISSION

OPTIONAL RS485 SERIAL COMMUNICATIONS INTERFACE

OPTIONAL NEMA 4X/IP65 SEALED FRONT BEZEL

DESCRIPTION

The TSC is a setpoint controller suitable for time vs. temperature, process control applications. The TSC accepts signals from a variety of temperature sensors (thermocouple and RTD elements), precisely displays the process temperature, and provides an accurate output control signal (time proportional or linear) to maintain a process at the desired control point. A comprehensive set of easy to use steps allows the controller to satisfy various applications. The user input can be programmed to perform a variety of controller functions.

Dual 4-digit displays allow viewing of the measured temperature value and setpoint or temperature and profile status simultaneously. Front panel indicators inform the operator of controller status and output states. Replaceable output modules (Relay, logic/SSR drive or Triac) can be fitted to the main control output, alarm output(s) or timed event output(s), and cooling output.

The TSC has been designed to simplify the set-up and operation of a controlled setpoint profile program. The setpoint program is easily entered and controlled through the front panel. Full display capabilities keep the operator informed of the process temperature, profile status, output states, and setpoint value.

Four control points, each having a setpoint and PID parameter set, are available for instant front panel implementation during batch changeover, or for control of multiple processes. The controller can operate in the standard PID control mode for both heating or cooling with on-demand auto-tune which establishes the PID gain set. The PID gain set can be fine tuned by the operator at any time or may be locked from further modification. The unit can be transferred to the manual control mode providing the operator with direct control of the output.

The TSC features four programs or profile recipes, each with up to eight ramp/soak segments, which can be easily stored and executed at any time. Longer profiles can be achieved by linking one or more profiles together, creating a single profile of up to 32 ramp/soak segments. Temperature profile conformity is assured during either soak (hold) phases or both ramp and hold phases by an adjustable error band parameter. The program repeat function cycles the profile either continuously or a set number of times. Power-on options automatically re-start, stop, or resume a running profile. The profile can be controlled via the front panel buttons, the user input, or the optional serial communications port.

Four control points, each having a setpoint and PID parameter set, are available for instant front panel implementation during batch changeover, or

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 5.5" (140) H x 2.1" (53.4) W.
DESCRIPTION (Cont’d)

other process conditions. A control point may have its PID gain set values disabled when implementing the control point.

The optional RS485 multidrop serial communications interface provides the capability of two-way communication between a TSC unit and other compatible equipment such as a printer, a programmable controller, or a host computer. In multipoint applications the address number of each unit on the line can be programmed from 0-99. Up to thirty-two units can be installed on a single pair of wires. The point value, % Output Power, Setpoint Ramp Rate, etc. can be interrogated or changed by sending the proper command code via serial communications. Alarm output(s) may also be reset via the serial communications interface option.

Optional alarm output(s) may be configured to operate as a timed event output or as a standard alarm output. As an alarm output it may be configured to activate according to the variety of actions (Absolute HI or LO, Deviation HI or LO, or Band IN or OUT) with adjustable hysteresis. Also, a standby feature suppresses the output(s) on power-up until the temperature stabilizes outside the alarm region. Timed event output(s) allow the controller to activate another equipment while a programmed profile is running. Each profile can define up to 16 event states (phases), for each output(s).

An optional secondary output is available for processes that require cooling which provides increased control accuracy and response.

The optional linear 4 to 20 mA or 0 to 10 VDC output signal is available to interface with final actuators, chart recorders, indicators, or other controllers. The output signal can be digitally scaled and selected to transmit one of the following: % Output Power, Measurement Value, Measurement Value Deviation, Setpoint Value.

An optional NEMA 4X/IP65 rated bezel is available for washdown and/or dirty environments, when properly installed. Modern surface-mount technology, extensive testing, plus high immunity to noise interference, makes the controller extremely reliable in industrial environments.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the TSC to directly command motors, valves, or other actuators not equipped with safeguards. To do so, can be potentially harmful to persons or equipment in the event of a fault to the unit. An independent and redundant temperature limit indicator with alarm outputs is strongly recommended. Red Lion Controls model IMT (thermocouple) or model IMR (RTD) units may be used for this purpose. The indicators should have input sensors and AC power feeds independent from other equipment.

SPECIFICATIONS

1. DISPLAY: Dual 4-digit

Upper Temperature Display: 0.4” (10.2 mm) Red LED

Lower Auxiliary Display: 0.3” (7.6 mm) Green LED

Display Messages:

“OLLO” - Appears when measurement exceeds + sensor range.

“ULUL” - Appears when measurement exceeds - sensor range.

“OPEN” - Appears when open sensor is detected.

“SHrt” - Appears when shorted sensor is detected (RTD only).

“...” - Appears when display value exceeds + display range.

“...” - Appears when display value exceeds - display range.

2. POWER: 115/230 VAC (+10%, -15%) no observable line variation effect, 48-62 Hz, 10 VA, switch selectable.

3. ANNUNCIATORS:

6 LED Backlight Status Indicators:

%PW - Lower auxiliary display shows power output in (%).

PGM - Lower auxiliary display shows profile status or profile time remaining.

MAN - Controller is in manual mode.

OP1 - Main control output is active.

AL1 - Alarm #1 is active.

AL2 - Alarm #2 is active (for Dual Alarm Option)

OP2 - Cooling output is active (for Cooling Option).

4. CONTROLS: Four front panel push buttons for setup and modification of controller functions and one external input.

5. SETPOINT PROFILE:

Profile: 4

Segments Per Profile: 8 ramp/hold segments (linkable to 32 segments).

Ramp Rate: 0.1 to 999.9 degrees/minute or no ramp.

Hold Time: Off or from 0.1 to 999.9 minutes, can be extended to 500 hours by linking.

Error Band Conformity: Off or from 1 to 9999 degrees deviation, + value for hold phases, - value for both ramp and hold phases.

Power-On Modes: Stop, auto-start, or profile resume.

6. CONTROL POINTS:

Setpoints: 4

PID gain sets: 4

Control: Front panel buttons, user input, or RS485 communications.

7. SENSOR INPUT:

Sample Period: 100 msec

Response Time: 300 msec (to within 99% of final value w/step input; typically, response is limited to response time of probe).

8. THERMOCOUPLE:

Types: T, E, J, K, R, S, B, N or Linear mV.

Input Impedance: 20 MΩ, all types.

Lead Resistance Effect: 20 μV/350 Ω.

Cold Junction Compensation: Less than ±1°C error over 0-50°C ambient temperature range. Disabled for linear mV type.

Resolution: 1°C/All types, or 0.1°C/F for T, E, J, K, and N only.

9. RTD: 2, 3, or 4 wire, 100 Ω platinum, alpha = 0.00385 (DIN 43760), alpha = 0.003916

Excitation: 0.175 mA

Resolution: 1 or 0.1 degree

Lead Resistance: 7 Ω max.

10. RANGE AND ACCURACY:

Errors include NIST conformity and A/D conversion errors at 23°C after 20 minutes warm-up. Thermocouple errors include cold junction effect. Errors are expressed as ±(% of reading) and ±3/4 LSD unless otherwise noted.

<table>
<thead>
<tr>
<th>TC TYPE</th>
<th>RANGE</th>
<th>ACCURACY</th>
<th>WIRE COLOR (ANSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>-200 to +400°C</td>
<td>±0.20% + 1.5°C</td>
<td>blue</td>
</tr>
<tr>
<td>E</td>
<td>-200 to +750°C</td>
<td>±0.20% + 1.5°C</td>
<td>violet</td>
</tr>
<tr>
<td>J</td>
<td>-200 to +760°C</td>
<td>±0.20% + 1.5°C</td>
<td>white</td>
</tr>
<tr>
<td>K</td>
<td>-200 to +1250°C</td>
<td>±0.20% + 1.5°C</td>
<td>yellow</td>
</tr>
<tr>
<td>R</td>
<td>0 to +1768°C</td>
<td>±0.20% + 2.5°C</td>
<td>black</td>
</tr>
<tr>
<td>S</td>
<td>0 to +1768°C</td>
<td>±0.15% + 2.5°C</td>
<td>black</td>
</tr>
<tr>
<td>B</td>
<td>+200 to +1280°C</td>
<td>±0.15% + 2.5°C</td>
<td>grey</td>
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<tr>
<td>N</td>
<td>-200 to +1350°C</td>
<td>±0.20% + 1.5°C</td>
<td>orange</td>
</tr>
<tr>
<td>mV</td>
<td>-5.00 to 55.00</td>
<td>±0.15% + 1 LSD</td>
<td>–</td>
</tr>
<tr>
<td>RTD</td>
<td>-200 to +600°C</td>
<td>±0.10% + 1.6°C</td>
<td>–</td>
</tr>
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<td>(385)</td>
<td>-200 to +600°C</td>
<td>±0.10% + 1.6°C</td>
<td>–</td>
</tr>
<tr>
<td>RTD</td>
<td>-200 to +600°C</td>
<td>±0.10% + 1.6°C</td>
<td>–</td>
</tr>
<tr>
<td>OHMS</td>
<td>1.0 to 320.0</td>
<td>±0.15% + 1 LSD</td>
<td>–</td>
</tr>
</tbody>
</table>

11. OUTPUT MODULES (Optional) (For All Output Channels):

| Relay: | Type: Form-C (Form-A with RS485 option).
| Rating: | 5 Amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive load).
| Life Expectancy: | 100,000 cycles at max. rating. (Decreasing load and/or increasing cycle time, increases life expectancy).
| Logic/SSR Drive: | Can drive multiple SSR Power Units.
| Type: | Non-isolated switched DC, 12 VDC typical.
| Drive: | 45 mA max.
| Triac: | Type: Isolated, Zero Crossing Detection.
| Ratings: | Voltage: 120/240 VAC
| Max Load Current: | 1 AMP @ 35°C
| Min Load Current: | 0.75 AMP @ 50°C
| Off State Leakage Current: | 7 mA max. @ 60 Hz
| Operating Frequency: | 20 to 500 Hz
| Protection: | Internal Transient Snubber, Fused.

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12. MAIN CONTROL OUTPUT (Heating or Cooling):
   - Control: PID or ON/OFF.
   - Output: Time proportioning or linear DC.
   - Hardware: Plug-in, replaceable output modules.
   - Cycle time: Programmable.
   - Auto-tune: When performed, sets proportional band, integral time, and derivative time values.
   - Probe Break Action: Programmable.

13. COOLING OUTPUT (Optional):
   - Control: PID or ON/OFF.
   - Output: Time proportioning or linear DC
   - Hardware: Plug-in, replaceable output modules.
   - Cycle time: Programmable.
   - Proportional Gain Adjust: Programmable.

14. LINEAR DC DRIVE (Optional):
   - With digital scale and offset, programmable deadband and update time.
   - 4 to 20 mA:
     - Resolution: 1 part in 3500 typ.
     - Accuracy: ±0.1% of reading + 25 μA.
     - Compliance: 10 V (500 Ω max. loop impedance).
   - 0 to 10 VDC:
     - Resolution: 1 part in 3500 typ.
     - Accuracy: ±0.1% of reading + 55 mV.
     - Min. Load Resistance: 10 KΩ (1 mA max.)
     - Source: % output power, setpoint, deviation, or temperature.
       (Available for heat or cool, but not both.)

15. ALARMS (Optional):
   - Hardware: Plug-in, replaceable output module.
   - Modes: Absolute high acting
     - Absolute low acting
     - Deviation high acting
     - Deviation low acting
     - Inside band acting
     - Outside band acting
     - Timed event output(s)
   - Reset Action: Programmable; automatic or latched.
   - Delay: Programmable; enable or disable.
   - Hysteresis: Programmable.
   - Probe Break Action: Upscale.
   - Annunciator: LED backlight for “AL1”, “AL2”, (Alarm #2 not available with cooling output).

16. SERIAL COMMUNICATIONS (Optional):
   - Type: RS485 Multi-point, Balanced Interface.
   - Communication Format:
     - Baud Rate: Programmable from 300-9600.
     - Parity: Programmable for odd, even, or no parity.
     - Frame: 1 start bit, 8 data bits, 1 or no parity bit, 1 stop bit.
   - Unit Address: Programmable from 0-99, max. of 32 units per line.
   - Transmit Delay: 100 msec min., 200 msec max.
   - RS485 Common: Isolated from signal input common.
   - Auto Print Time: Off to 9999 seconds between print-outs.

17. USER INPUT:
   - V IN max = 5.25 VDC, V IL = 0.85 V MAX, V IH = 2.0 V MIN
   - Response time 100 msec max.
   - Functions:
     - Program Lock
     - Integral Action Lock
     - Auto/Manual Transfer
     - Setpoint Ramp Select
     - Reset Alarms

18. ENVIRONMENTAL CONDITIONS:
   - Operating Temperature: 0 to 50°C
   - Storage Temperature: -40 to 80°C
   - Operating and Storage Humidity: 85% max. (non-condensing) from 0°C to 50°C
   - Span Drift: ≤ 100 ppm/°C
   - Zero Drift: ≤ 1 μ V/°C
   - Altitude: Up to 2000 meters

19. CERTIFICATIONS AND COMPLIANCES:
   - SAFETY
     - UL Listed, File # E137808, UL508, CSA C22.2 No. 14-M95
     - Listed by Underwriters Laboratories, Inc. to U.S. and Canadian safety standards
     - UL Recognized Component, File # E156876, UL 873, CSA C22.2 No. 24
     - Recognized by U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
     - Type 2 or 4X Enclosure rating (Face only), UL508
     - NEMA 4X/IP65 model only: Sealed bezel utilizing 2 captive mounting screws (panel gasket included). This unit is rated for NEMA 4X/IP65 indoor use. Installation Category II, Pollution Degree 2.

   - SPECIFICATIONS (Cont’d)
     - CERTIFICATIONS AND COMPLIANCES:
       - Hardware:
       - Source:
       - Reset Action:
         - Programmable; enable or disable.
       - RS485 Multi-point, Balanced Interface.
       - Type:
         - Annunciator:
           - LED backlight for “AL1”, “AL2”, (Alarm #2 not available
         - Probe Break Action:
           - Programmable.
         - RS485 Common:
           - Isolated from signal input common.
         - Transmit Delay:
           - Off to 9999 seconds between print-outs.
         - RS485 Common:
           - Isolated from signal input common.
         - Auto Print Time:
           - Off to 9999 seconds between print-outs.

   - ENVIRONMENTAL CONDITIONS:
     - Operating Temperature:
       - 0 to 50°C
     - Storage Temperature:
       - -40 to 80°C
     - Operating and Storage Humidity:
       - 85% max. (non-condensing) from 0°C to 50°C
     - Span Drift:
       - ≤ 100 ppm/°C
     - Zero Drift:
       - ≤ 1 μ V/°C
     - Altitude:
       - Up to 2000 meters

   - ELECTROMAGNETIC COMPATIBILITY
     - Immunity to EN 50082-2
       - Electrostatic discharge
         - EN 61000-4-2
         - Level 2: 4 Kv contact
         - Level 3: 8 Kv air
       - Electromagnetic RF fields
         - EN 61000-4-3
         - Level 3: 10 V/m
         - 150 KHz - 80 MHz
       - Fast transients (burst)
         - EN 61000-4-4
         - Level 4: 2 K V/I
         - Level 3: 2 K V/2Ω
         - 2.2 MHz - 110 MHz
       - RF conducted interference
         - EN 61000-4-6
         - Level 3: 10 V/m2
         - 150 KHz - 80 MHz
     - Emissions to EN 50081-2
       - Radio frequency conducted disturbances
         - EN 61000-4-6
         - Level 3: 2 Kv power
         - 150 KHz - 80 MHz
       - Environments to EN 50082-2
         - Electrostatic discharge
         - EN 61000-4-2
         - Level 2: 4 Kv contact
         - Level 3: 8 Kv air
       - Electromagnetic RF fields
         - EN 61000-4-3
         - Level 3: 10 V/m
         - 150 KHz - 80 MHz
       - Fast transients (burst)
         - EN 61000-4-4
         - Level 4: 2 K V/I
         - Level 3: 2 K V/2Ω
         - 2.2 MHz - 110 MHz
       - RF conducted interference
         - EN 61000-4-6
         - Level 3: 10 V/m2
         - 150 KHz - 80 MHz

   - FRONT PANEL FEATURES
     - In the normal display mode, the unit will display the process temperature in the upper display. One of five other parameters may be selected for viewing in the lower display.
     - Target Setpoint
     - Profile Phase Time Remaining
     - % Output Power
     - Temperature Symbol (F/C)
     - Profile Status

     - The program profile status display indicates the active profile number with the current ramp or hold phase of the profile. The profile can be started, stopped, advanced, etc. from the front panel when the profile status display is viewed, if not locked from access.

     - The phase time remaining display, shows the time remaining in a ramp or hold phase and, if not locked from access, may be changed on-line to effect temporary changes to the program. Additionally, the target setpoint and % output power (manual mode only) may also be changed on-line or locked from operator access.

     - From the normal operating mode, parameters are selected by use of the PAR button and modified by use of the UP and DOWN buttons. Parameters are then entered by the PAR button, which advances the user to the next parameter. Pressing the DSP button immediately returns the controller to the normal operating mode from any parameter module. The controller configuration and parameter settings are stored in an internal EEPROM device.
**HARDWARE FEATURES**

The fast 100 msec input sampling rate provides quick controller response to a process disturbance for excellent temperature control. Measurement accuracy of 0.15% provides closer process control conforming to the desired control setpoint value.

The unit accepts a variety of both thermocouple or RTD temperature probes. The A.C. input power is switch selectable, allowing the unit to operate from either 115 VAC or 230 VAC. Since the controller is serviceable from the front of the panel, the output modules may be easily changed or replaced without disturbing the wiring behind the panel and NO re-programming is required. The standard model simply requires pressing a latch to remove the unit. The NEMA 4X/IP65 rated model utilizes two panel securing screws and a neoprene gasket to guarantee a water tight seal, when properly installed.

Low-drift, highly stable circuit design ensures years of reliable and accurate temperature control. The recommended two year re-calibration interval is easily accomplished via the programming menu.

**SETPOINT FEATURES**

The controller’s setpoint can be protected from out of range values, by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can also be programmed.

The setpoint ramp feature ramps the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate, independent of a setpoint change. This feature reduces thermal shock to the process and inadvertent data entry can also be programmed.

The active setpoint, which can be a running profile, may also be transmitted by the linear DC output for slave control loops.

Four control points are available which can be implemented at any time. Each control point is programmed independently, with each having a setpoint and a PID gain set value. With gain value changes, the output power control signal will not “bump” resulting in a smooth control transition.

**INPUT FEATURES**

A programmable input filter can be used to stabilize readings from a process with varying or oscillating temperature characteristics, helping to provide better temperature control.

A programmable temperature shift and slope function can be used to compensate for probe errors or to have multiple TSC units indicate the same nominal temperature.

A programmable User Input is available to control a variety of controller functions, such as profile control, auto/manual transfer, serial communication print requests, etc.

**CONFIGURATION MODE**

The configuration modules serve to provide the basic set-ups required by the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the configuration selection stage, which allows the user to return to the normal display mode, or advance to a later configuration stage.

**Configuration 1, Inputs**

- **“TYPE”** - Select input probe type
- **“SCAL”** - Select temperature scale
- **“dCpt”** - Select temperature resolution
- **“FLIR”** - Select degree of input filtering
- **“SPAN”** - Select input correction span (slope)
- **“SHFT”** - Enter input correction shift (offset)
- **“SPLO”** - Enter setpoint lower limit
- **“SPHI”** - Enter setpoint higher limit
- **“InPt”** - Select user input function

**Configuration 2, Outputs**

- **“CCY”** - Enter time proportioning cycle time
- **“OPAC”** - Select control action
- **“OPLO”** - Enter output power low limit
- **“OPHI”** - Enter output power high limit
- **“OPFL”** - Enter probe fail power preset
- **“CYS”** - Enter ON/OFF control hysteresis
- **“tcod”** - Select auto-tuning damping
- **“ANAS”** - Select linear DC output assignment
- **“ANLO”** - Enter linear DC low scaling value
- **“ANHI”** - Enter linear DC high scaling value

**Configuration 3, Parameter lock-outs**

- **“SP”** - Select degree of setpoint access
- **“Op”** - Select degree of power access
- **“PS”** - Select degree of profile status access
- **“P-r”** - Select degree of phase time remaining access
- **“Udusp”** - Enable temperature units display
- **“CDE”** - Enter parameter access code
- **“Pig”** - Select degree of PID access
- **“AL”** - Select degree of alarm access
- **“ALRIS”** - Enable manual reset of alarms
- **“CPAC”** - Enable control point access
- **“Apac”** - Enable ramp/hold program access
- **“tMF”** - Enable automatic/manual transfer
- **“tUNc”** - Enable auto-tune invocation

**Configuration 4, Alarms**

- **“Act 1”** - Select operation mode of alarm #1
- **“sr1”** - Select reset mode of alarm #1
- **“Sb”** - Enable activation delay of alarm #1
- **“Sb1”** - Enter value for alarm #1
- **“Ac”** - Select operation mode of alarm #2
- **“sr”** - Select reset mode of alarm #2
- **“Sb2”** - Enable activation delay of alarm #2
- **“Sb2”** - Enter value for alarm #2
- **“Ahys”** - Enter hysteresis value for both alarms

**Configuration 5, Cooling**

- **“CYC2”** - Enter cooling time proportioning cycle time
- **“GAN”** - Enter cooling relative gain
- **“dB”” - Enter heat/cool deadband or overlap

**Configuration 6, Serial Communications**

- **“bAl”** - Select baud rate
- **“Pa”** - Select parity bit
- **“Ad”** - Enter unit address number
- **“Abn”** - Select abbreviated or full mnemonic transmissions
- **“PrA”** - Enter automatic print rate
- **“PoPt”** - Select parameters to be included in print-out

**Configuration 7, Control Points**

- **“CSE”** - Select control point number for set-up 1, 2, 3, & 4
- **“SP-x”** - Enter setpoint value for selected control point
- **“Pd”** - Enter proportional band for selected control point
- **“It-x”** - Enter integral time for selected control point
- **“dx-x”** - Enter derivative time for selected control point

**Configuration 8, Profiles**

- **“PSE”** - Select profile or event output for set-up 1, 2, 3, & 4
- **“Pcc”** - Enter program-repeat cycle count for selected profile
- **“PnL”** - Select ramp rate 1 for selected profile
- **“PnL”** - Enter ramp rate 1 for selected profile
- **“Pnr”** - Enter ramp rate 1 for selected profile
- **“Pnr”** - Enter ramp rate 1 for selected profile
- **“Pnr”** - Enter ramp rate 1 for selected profile
- **“Pn”** - Select event outputs at phase 1 for selected profile
- **“Pn”** - Select event outputs at phase 16 for selected profile

**Configuration 9, Factory Service Operations**

(Detailed in the operator’s manual)

* These parameters may not appear due to option configuration or other programming
OUTPUT FEATURES
Programmable output power limits provide protection for processes where too much power can cause damage. Automatic sensor probe break detection, for fail-safe operation, causes the controller to default to a programmed output power (upscale or downscale burnout). With adjustable time proportioning-cycle time and programmable D.C. Linear output, the controller can satisfy a wide variety of output requirements.

During execution of a profile, two independent, timed event outputs are available to control or signal other equipment. The event outputs use the alarm channels.

The RS485 Communication option allows the user to access various controller parameters such as the setpoint, % output power, % proportional band, etc. The controller may be setup to transmit various parameters at a programmable automatic print rate.

AUTO-TUNE
The model TSC has an auto-tune feature which, on demand, automatically determines the PID control parameters for a particular thermal process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into nonvolatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked at start-up, while ramping, or at setpoint, depending on the process requirements. A programmable auto-tune damping factor produces various levels of process control and response characteristics.

PROFILE PROGRAMMING
Profiles are programmed independently of each other and are separate from the configuration of other controller parameters. Each profile has parameters for error band (profile conformity), linking, auto-start and program repeat cycles. Profiles may be altered during execution, so changes take effect as the programmed profile advances.

CONTROLLER PROGRAMMING
The model TSC has been designed to reduce the operator interaction with the controller while still maintaining a high degree of control accuracy and user flexibility. Front panel program disable allows all of the controller’s set-ups to be locked-out from further operator intervention after the initial parameter set-up.

The programming of the controller is divided into four sections:

- Hidden Mode
- Protected Mode
- Unprotected Mode
- Configuration Mode

These four programming modes allow the controller to adapt to any required user-interface level.

UNPROTECTED PARAMETER MODE
The unprotected mode is accessible when program disable is inactive or when the proper access code number from the protected mode is entered. Only from this mode can the configuration modes be accessed.

- “SP” - Enter setpoint
- “OPOF” - Enter %output power offset
- “OP” - Enter output power
- “ProP” - Enter proportional band
- “Intt” - Enter integral time
- “dErt” - Enter derivative time
- “AL-1” - Enter value for alarm #1
- “AL-2” - Enter value for alarm #2

- “CNFP” - Select basic configuration module
- “End” - Return to normal display mode

PROTECTED PARAMETER MODE *
The protected mode is accessible when program disable is active, also this mode prevents access to the configuration modes without the proper access code number. Only the parameters that are selected in the configuration 3 parameter lock-outs section can be accessed.

- “ProP” - Enter proportional band
- “Intt” - Enter integral time
- “dErt” - Enter derivative time
- “AL-1” - Enter value for alarm #1
- “AL-2” - Enter value for alarm #2
- “CodE” - Enter access code to unprotected mode
- “End” - Return to normal display mode

HIDDEN FUNCTIONS MODE *
The hidden mode is accessible from the normal operating mode by holding the PAR button for 3 seconds. The five functions in this mode may be locked-out individually in configuration 3 parameter lock-outs section.

- “CP” - Load control point
- “Prun” - Control ramp/hold profile state
- “PrunF” - Transfer between automatic (PID) control and Manual control
- “tUNE” - Invoke/Cancel PID auto-tune
- “ALrS” - Reset latched alarms

OUTPUT VARIATIONS WITHOUT RS485 OPTION
The Dual Alarm or the Cooling with Alarm output, without the RS485 option, has independent outputs. Therefore, the cooling output and/or alarm output(s) can be installed with any combination of output modules.

OUTPUT VARIATIONS WITH RS485 OPTION
The Dual Alarm or the Cooling with Alarm output, with RS485 option, does not have independent outputs. In this case, the cooling output and/or alarm output(s) must have the same type of output modules installed since they share the common terminal.

* These parameters may not appear due to option configuration or other programming
OUTPUT MODULES

Units equipped with RS485 option must have the Dual Alarm or Cooling w/alarm options fitted with the same type of output modules. The controller’s main output (OP1) can be fitted with any output module. Output modules are shipped separately and must be installed by the user.

TYPICAL CONNECTIONS

Relay:
- Type: Form-C (Form-A with RS485 option only)
- Rating: 5 Amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive).
- Life Expectancy: 100,000 cycles at maximum load rating. (Decreasing load and/or increasing cycle time, increases life expectancy).

TYPICAL CONNECTIONS

Logic/SSR Drive: can drive multiple SSR Power Units.
- Type: Non-isolated switched DC, 12 VDC typical.
- Drive: 45 mA max.

TRIAC MODULE

Type: Isolated, Zero Crossing Detection.
- Voltage: 120/240 VAC.
- Max. Load Current: 1 Amp @ 35°C
- 0.75 Amp @ 50°C
- Min. Load Current: 10 mA
- Off State Leakage Current: 7 mA max. @ 60 Hz
- Operating Frequency: 20 to 500 Hz.
- Protection: Internal Transient Snubber, Fused.

APPLICATION

TSC GLASS TEMPERING APPLICATION

A manufacturer of glass items needs to anneal (temper) their products to reduce the brittleness of the glass structure. The tempering process requires the glass to be heated and subsequently cooled at a controlled rate to change the structure of the glass. Different tempering profiles are required for different types of glass products.

A TSC is employed to control the temperature profile of the annealing oven. Four different temperature profiles are stored in the controller. The 4 to 20 mA analog output option is utilized to cool the annealing oven during the cool down ramp phases. An event output is used to quickly cool the oven at the end of the batch run (alarm 1). Alarm 2 is used to signal the operator whenever the temperature is outside the prescribed program profile.

Note: Units equipped with the RS485 option have different terminal designators. See "Output Variations with or without the RS485 Option".

The programming for this profile is as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;P1r1&quot;</td>
<td>5.0</td>
<td>Ramp from ambient temp. during heat phase at 5.0°/min.</td>
</tr>
<tr>
<td>&quot;P1L1&quot;</td>
<td>300</td>
<td>Target setpoint level 300°</td>
</tr>
<tr>
<td>&quot;P1H1&quot;</td>
<td>40.0</td>
<td>Heat at 300° for 40.0 minutes</td>
</tr>
<tr>
<td>&quot;P1r2&quot;</td>
<td>3.0</td>
<td>Ramp down 3.0°/min. during cooling phase</td>
</tr>
<tr>
<td>&quot;P1L2&quot;</td>
<td>150</td>
<td>Target Setpoint is 150°</td>
</tr>
<tr>
<td>&quot;P1H2&quot;</td>
<td>0.0</td>
<td>Do not hold at 150° (used as &quot;phantom&quot; hold time for triggering event output for auxiliary cooling)</td>
</tr>
<tr>
<td>&quot;P1r3&quot;</td>
<td>-0.1</td>
<td>End Program</td>
</tr>
<tr>
<td>&quot;P1 1&quot;</td>
<td>1F2F</td>
<td>Turn off output 1 (output 2 is alarm)</td>
</tr>
<tr>
<td>&quot;P1 2&quot;</td>
<td>1F2F</td>
<td>Keep off output 1</td>
</tr>
<tr>
<td>&quot;P1 3&quot;</td>
<td>1F2F</td>
<td>Keep off output 1</td>
</tr>
<tr>
<td>&quot;P1 4&quot;</td>
<td>1N2F</td>
<td>Turn on output 1 for Auxiliary Exhaust Fan</td>
</tr>
</tbody>
</table>

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**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>DESCRIPTION</th>
<th>NEMA 4X/IP65 BEZEL</th>
<th>4 to 20 mA ANALOG OUTPUT</th>
<th>0 to 10 VDC ANALOG OUTPUT</th>
<th>ALARM OUTPUTS</th>
<th>COOLING OUTPUT</th>
<th>RS485 COM</th>
<th>PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSC</td>
<td>Temperature Setpoint Controller</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>2</td>
<td>NO</td>
<td>NO</td>
<td>TSC01001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>YES</td>
<td>YES</td>
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<td>2</td>
<td>NO</td>
<td>NO</td>
<td>TSC11001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>1</td>
<td>YES</td>
<td>NO</td>
<td>TSC11002</td>
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<td>2</td>
<td>NO</td>
<td>YES</td>
<td>TSC11004</td>
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<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>1</td>
<td>YES</td>
<td>YES</td>
<td>TSC11005</td>
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<td>YES</td>
<td>2</td>
<td>NO</td>
<td>YES</td>
<td>TSC12004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
<td>YES</td>
<td>YES</td>
<td>TSC12005</td>
</tr>
</tbody>
</table>

| Relay Module | OMD00000 |
| Triac Module | OMD00001 |
| Logic/SSR Drive Module | OMD00003 |
| Panel Mount Adapter Kit (1/4 DIN to 1/8 DIN) | PMK50000 |
| Single Phase 25 A DIN Rail Mount Solid State Relay | RLY50000 |
| Single Phase 40 A DIN Rail Mount Solid State Relay | RLY60000 |
| Three Phase DIN Rail Mount Solid State Relay | RLY6A000 |
| RLY6A000 |
| Three Phase DIN Rail Mount Solid State Relay | RLY70000 |

These models have dual alarm outputs, or single alarm with cooling outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

*Note: Output Modules are NOT supplied with the controller. When specifying the controller, be sure to purchase the appropriate output module for the Main Control Output and if necessary, the alarm output(s) and cooling output. The controller can be fitted with any combination of output modules that do not have the RS485 option.*

*The Logic/SSR Drive Module is a switched DC source, intended to drive the DC input of an SSR power unit. It should never be connected to a line voltage.*

*All modules are shipped separately and must be installed by the user.*
MODEL P16 - 1/16 DIN PROCESS CONTROLLER

This is a brief overview of the P16. For complete specifications and programming information, see the T16/P16 Temperature/Process Controller Bulletin starting on page 541.

- PID CONTROL WITH REDUCED OVERSHOOT
- ACCEPTS 0-10 V AND 0/4-20 mA SIGNALS
- ON DEMAND AUTO-TUNING OF PID SETTINGS
- DC ANALOG OUTPUT (OPTIONAL)
- USER PROGRAMMABLE FUNCTION BUTTON
- PC OR FRONT PANEL PROGRAMMING
- PC CONFIGURABLE WITH TP16KIT

UL Recognized Component,
File #E156876

INPUT SPECIFICATIONS

1. SENSOR INPUT:
   - Sample Period: 100 msec (10 Hz rate)
   - Step Response Time: 300 msec typical, 400 msec max to within 99% of final value with step input.
   - Failed Sensor Response:
     - Main Control Output(s): Programmable preset output
     - Display: “OPEN”
     - Alarms: Upscale drive
   - Analog Output: Upscale drive when assigned to retransmitted input.
   - Normal Mode Rejection: >40 dB @ 50/60 Hz
   - Common Mode Rejection: >120 dB, DC to 60 Hz
   - Overvoltage Protection: 120 VAC @ 15 sec max

4. SIGNAL INPUT: (P16 only)
   - Accuracies are expressed as ± percentages over 0 to 50 °C ambient range after 20 minute warm-up.

<table>
<thead>
<tr>
<th>INPUT RANGE</th>
<th>ACCURACY</th>
<th>IMPEDANCE</th>
<th>MAX CONTINUOUS OVERLOAD</th>
<th>RESOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 VDC (-1 to 11)</td>
<td>±0.30 % of reading +0.03V</td>
<td>1 MΩ</td>
<td>50 V</td>
<td>10 mV</td>
</tr>
<tr>
<td>20 mA DC (-2 to 22)</td>
<td>±0.30 % of reading +0.04mA</td>
<td>10 Ω</td>
<td>100 mA</td>
<td>10 μA</td>
</tr>
</tbody>
</table>
MODEL P48 - 1/16 DIN PROCESS CONTROLLER

- PID CONTROL WITH REDUCED OVERSHOOT
- ACCEPTS 0 to 10 VDC or 0/4 to 20 mA DC INPUTS
- OPTIONAL TWO LINEAR DC OUTPUTS (0 to 10 V, 0/4 to 20 mA)
- OPTIONAL DUAL ALARM OUTPUTS
- OPTIONAL REMOTE SETPOINT INPUT (0/4 to 20 mA)
- OPTIONAL RS485 SERIAL COMMUNICATIONS
- SECOND SETPOINT SETTING
- SETPOINT RAMPING FOR PROCESS STARTUP
- PROGRAMMABLE USER INPUT (Digital) FOR ADDED FLEXIBILITY
- PARAMETER SECURITY VIA PROGRAMMABLE LOCKOUTS
- MANUAL/AUTOMATIC CONTROL MODES
- ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS
- DUAL LED DISPLAYS FOR SIMULTANEOUS INDICATION OF PROCESS AND SETPOINT
- STATUS INDICATORS FOR OUTPUTS AND CONTROL MODES
- PC SOFTWARE AVAILABLE FOR CONTROLLER CONFIGURATION
- NEMA 4X/IP65 BEZEL

DESCRIPTION

The P48 Controller accepts either a 0 to 10 VDC or a 0/4 to 20 mA DC signal, precisely displays the input process signal according to the programmable scaling points, and provides an accurate output control signal (time proportional or linear DC) to maintain the process at the desired control point. The controller’s comprehensive yet simple programming allows it to meet a wide variety of application requirements.

In the PID control mode the controller operates with on-demand auto-tune, which will establish the tuning constants. The PID tuning constants may be fine-tuned by the operator at any time and then locked out from further modification. The controller employs a unique overshoot suppression feature, which allows the quickest response without excessive overshoot. The unit can be transferred to operate in the manual mode, providing the operator with direct control of the output. The controller may also operate in the ON/OFF control mode with adjustable hysteresis. A second setpoint is available to allow quick selection of a different setpoint setting.

Dual 4-digit displays allow viewing of the process and setpoint simultaneously. Front panel indicators inform the operator of the controller and output status. On some models, the main control output and the alarm outputs are field replaceable.

Optional alarm(s) can be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, and Band IN or OUT) with adjustable hysteresis. A standby feature suppresses the alarm during power-up until the process stabilizes outside the alarm region. The second alarm can be configured as a secondary PID output (heat/cool applications).

Optional Main Linear DC output (10 V or 20 mA) can be used for control or process re-transmission purposes. Programmable output update rate reduces valve or actuator activity. The output range can be scaled independent of the input range.

Optional Second Linear DC output (10 V or 20 mA) provides an independent process re-transmission, while the main Linear DC output is being used for control. The output range can be scaled independent of the input range.

Optional Remote Setpoint input (0/4 to 20 mA) allows for cascade control loops; and allows for remotely driven setpoint signal from computers or other similar equipment. Straightforward end point scaling with independent filtering allows for easy configuration of controller parameters. These settings can be saved to disk for later use or used for multi-controller down loading. On-line help is provided within the software.

The unit is constructed of a lightweight, high impact plastic case with a tinted front panel. The front panel meets NEMA 4X/IP65 specifications when properly installed. Multiple units can be stacked horizontally or vertically. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the controller extremely reliable in industrial environments.
SAFETY SUMMARY
All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the P480 to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller. An independent and redundant process limit indicator with alarm outputs is strongly recommended.

SPECIFICATIONS
1. DISPLAY: Dual 4-digit
   Upper Process Display: 0.4” (10.2 mm) high red LED
   Lower Auxiliary Display: 0.3” (7.6 mm) high green LED
   Display Messages:
   “OLOL” - Appears when measurement exceeds + input range.
   “UULL” - Appears when measurement exceeds - input range.
   “SENS” - Appears when measurement exceeds controller limits.
   “…” - Appears when display values exceed + display range.
   “…” - Appears when display values exceed - display range.
   LED Status Annunciators:
   %P - Lower auxiliary display shows power output in %.
   MN - Flashing: Controller is in manual mode.
   On: Local Setpoint (Remote Setpoint option)
   Off: Remote Setpoint
   DV - Lower auxiliary display shows deviation (error) from setpoint.
   O1 - Main control output is active.
   A1 - Alarm #1 is active (for A1 option).
   A2 - Alarm #2 is active OR Secondary output (02) is active.

2. POWER:
   AC Versions: 85 VAC min. to 250 VAC max., 50 to 60 Hz, 8 VA max.
   DC Versions:
   DC Power: 18 to 36 VDC; 7 W
   DC Power: 24 VAC ±10%; 50 to 60 Hz, 9 VA
3. CONTROLS: Four front panel push buttons for modification and setup of controller functions and one external user input for parameter lockout or other functions.
4. MEMORY: Nonvolatile E2 PROM retains all programmable parameters and values.
5. RANGE AND ACCURACY:

<table>
<thead>
<tr>
<th>INPUT</th>
<th>ACCURACY</th>
<th>IMPEDANCE</th>
<th>MAX CONTINUOUS</th>
<th>RESOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 VDC</td>
<td>(1 to 11)</td>
<td>±0.10% reading +0.02 V</td>
<td>1 M ohm</td>
<td>300 V</td>
</tr>
<tr>
<td>20 mA DC (2 to 22)</td>
<td>±0.10% reading +0.03 mA</td>
<td>±0.30% of reading +0.03 V</td>
<td>10 ohm</td>
<td>100 mA</td>
</tr>
</tbody>
</table>

* Accuracies are expressed as ± percentages after 20 minutes warm-up. The controller’s accuracy is specified in two ways: Accuracy over an 18 to 28°C range at 10 to 75% RH environment; and accuracy over a 0 to 50°C range at 0 to 85% RH (non-condensing) environment. Accuracy over the wide sensor range reflects the coefficient of the internal circuitry.

6. MAIN SIGNAL INPUT:
   Sample Period: 100 msec
   Response Time: Less than 300 msec typ., 400 msec max. (to within 99% of final value w/step input; typically, response is limited to response time of sensor)
   Normal Mode Rejection: 40 dB @ 50/60 Hz (improves with increased digital filtering.)
   Common Mode Rejection: Greater than 120 dB, DC to 60 Hz
   Protection: Input overload 120 VAC max. for 15 sec. max.
7. USER INPUT: Internally pulsed up to +5 VDC (1 MHz).
   Vin, Max = 5.25 VDC, Vin, Min = 0.85 V Min., Eref = 1 V (A) Max.
   Response Time: 120 msec max.
   Functions:
   Program Lock
   Auto/Manual Mode Select
   Reset Alarms
   Local/Remote Setpoint Select
   Setpoint Ramp Enable
   Serial block print
8. CONTROL AND ALARM OUTPUTS:
   Relay outputs with Form A contacts:
   Contact Rating: 3 A @ 250 VAC or 30 VDC (resistive load)
   1/10 HP @ 120 VAC (inductive load)
   Life Expectancy: 100,000 cycles at max. load rating.
   (Decreasing load and/or increasing cycle time, increases life expectancy.)
9. MAIN CONTROL:
   Control: PID or ON/OFF
   Output: Time proportioning or Linear DC
   Cycle time: Programmable
   Auto-tune: When selected, sets proportional band, integral time, and derivative time values.
10. ALARMS: 1 or 2 alarms (optional)
    Modes:
    Absolute high acting
    Absolute low acting
    Deviation high acting
    Deviation low acting
    Inside band acting
    Outside band acting
    Reset Action: Programmable; automatic or latched
    Standby Mode: Programmable; enable or disable
    Hysteresis: Programmable
    Annunciator: LED backlight for “A1”, “A2”
11. SECONDARY OUTPUT: Software selectable (overrides alarm 2)
    Control: PID or ON/OFF
    Output: Time Proportioning
    Cycle time: Programmable
    Proportional Gain Adjust: Programmable
    Deadband /Overlap: Programmable
12. MAIN AND SECOND LINEAR DC OUTPUT: (optional)
    Main: Control or re-transmission, programmable update rate from 0.1 sec to 250 sec
    Second: Re-transmission only, fixed update rate of 0.1 sec

<table>
<thead>
<tr>
<th>OUTPUT ** RANGE</th>
<th>ACCURACY ** (18 to 28°C)</th>
<th>ACCURACY ** (0 to 50°C)</th>
<th>COMPLIANCE</th>
<th>RESOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 20 mA</td>
<td>0.10% of FS</td>
<td>0.30% of FS</td>
<td>10k ohm min.</td>
<td>1/3500</td>
</tr>
<tr>
<td>0 to 10 V</td>
<td>0.10% of FS</td>
<td>0.30% of FS</td>
<td>500 ohm max.</td>
<td>1/3500</td>
</tr>
<tr>
<td>4 to 20 mA</td>
<td>0.10% of FS</td>
<td>0.30% of FS</td>
<td>500 ohm max.</td>
<td>1/2800</td>
</tr>
</tbody>
</table>

* Accuracies are expressed as ± percentages after 20 minutes warm-up. Output accuracy is specified in two ways: Accuracy over an 18 to 28°C range at 10 to 75% RH environment; and accuracy over a 0 to 50°C range at 0 to 85% RH (non-condensing) environment. Accuracy over the wide sensor range reflects the coefficient of the internal circuitry.

** Outputs are independently jumper selectable for either 10 V or 20 mA. The output range may be field calibrated to yield approximately 10% overrange and a small underrange (negative) signal.
13. REMOTE SETPOINT INPUT: (optional)
    Input type: 0/4 to 20 mA
    Input Resistance: 10kΩ
    Overrange: ±5% to 105%
    Overload: 100 mA (continuous)
    Scale Range: -999 to 9999
    Resolution: 1 part in 10,000.
    Accuracy: At 25°C: ±0.1% of full scale ±0.5% LSI
               Over 0 to 50°C range: ±0.2% of full scale ±0.5% LSI
    Reading Rate: 10/sec.
    Setpoint Filtering: Programmable Digital
    Setpoint Ramping: Programmable, 1 to 9999 units/minute.
14. SERIAL COMMUNICATIONS: (optional)
    Type: RS485 multipoint, balanced interface
    Baud Rate: 300 to 9600
    Data Format: 7O1, 7E1, 7N2, 8N1
    Node Address: 0 to 99, max of 32 units per line
    Transmit Delay: 2 to 100 msec or 100 to 200 msec
    Data Encoding: ASCII
    Isolation w.r.t Main Input Common: 500 Vrms for 1 min. (50 V working)
    Not isolated w.r.t. Remote Setpoint or Analog Output common
    Note: RS485 and the Analog Output commons are not internally isolated
15. ENVIRONMENTAL CONDITIONS:
    Operating Range: 0 to 50°C
    Storage Range: -40 to 80°C
    Operating and Storage Humidity: 85% max. relative humidity (non-condensing) from 0°C to 50°C.
    Vibration According to IEC 68-2-6: Operational 2 to 100 Hz, ±1 g
    Shock According to IEC 68-2-27: Operational 20 g, ±1 g
    Altitude: Up to 2000 meters
16. ISOLATION BREAKDOWN RATINGS:
    AC line with respect to all Inputs and outputs: 250 V working (2300 V for 1 minute).
    Main input with respect to Analog Outputs and Remote Setpoint Input: 50 V working (2300 V for 1 minute).
17. CERTIFICATIONS AND COMPLIANCE:

SAFETY
UL Recognized Component, File #E156876, UL573, CSA 22.2 No. 24
Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
Type 4X Enclosure rating (Face only), UL50
IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
IP65 Enclosure rating (Face only), IEC 529.

ELECTROMAGNETIC COMPATIBILITY

Immunity to EN 50082-2
- Electrostatic discharge: EN 61000-4-2
  - Level 2: 4 kV contact
  - Level 3: 8 kV air
- Electromagnetic RF fields: EN 61000-4-3
  - Level 3: 10 V/m
- Fast transients (burst): EN 61000-4-4
  - Level 4: 2 kV I/O
- RF conducted interference: EN 61000-4-6
  - Level 3: 10 Vrms
- Power frequency magnetic fields: EN 61000-4-8
  - Level 4: 30 A/m
- Simulation of cordless telephones: ENV 50204
  - Level 3: 10 V/m

Emissions to EN 50081-2
- RF interference: EN 55011
  - Enclosure class A
  - Power mains class A

Notes:
1. No loss of performance during EMI disturbance at 10 V/m.
2. Unit is panel mounted in a metal enclosure (Buckeye SM7013-0 or equivalent) that provides at least 20 dB shielding effectiveness. Metal panel is connected to earth ground.
3. Power Line and I/O cables routed in metal conduit connected to earth ground.
4. For operation without loss of performance:
   - Install power line filter, RLC#LFIL0000 or equivalent.
   - OR
   - Install 2 ferrite cores, RLC#FCOR0000 or equivalent, to AC lines at unit for frequencies above 5 MHz.
5. I/O cables routed in metal conduit connected to earth ground.
6. Refer to the EMC Installation Guidelines section of the manual for additional information.

18. CONNECTION:
- Wire clamping screw terminals
19. CONSTRUCTION:
- Black plastic alloy case and collar style panel latch.
- Panel latch can be installed for vertical or horizontal instrument stacking.
- Panel latch can be installed for vertical or horizontal instrument stacking.
- One piece tinted plastic bezel. Bezel assembly with circuit boards can be removed from the case to change the output board without removing the case.
- Panel latch can be installed for vertical or horizontal instrument stacking.
- Unit is panel mounted in a metal enclosure (Buckeye SM7013-0 or equivalent) that provides at least 20 dB shielding effectiveness. Metal panel is connected to earth ground.
- Power Line and I/O cables routed in metal conduit connected to earth ground.

BASIC OPERATION

The P48 controls a process by receiving a linear DC signal representing the process value, then calculating a control output power value by use of a modified PID control algorithm. The unit controls the system with the new output power value to keep the process at setpoint. The PID control algorithm incorporates features which provide for high control accuracy and low overshoot from process disturbances.
**AUTO-TUNE**
The P48 has an auto-tune feature which, on demand, automatically determines the PID control parameters for a particular process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into non-volatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked either at start-up or at setpoint, depending on the process requirements. An auto-tune programmable damping factor produces various levels of process control and response characteristics.

**RS485 SERIAL COMMUNICATIONS**
The RS485 communications option allows the connection of up to 32 devices on a single pair of wires with a distance of up to 4,000 feet and a maximum baud rate of 9600. Since the same pair of wires are used for both transmit and receive, only one way communication is possible at any given time. The controller has a programmable response time to allow the host device adequate time to release the communication line for a transmission.

Selected parameters from the P48 can be interrogated or changed, and alarm output(s) may be reset by sending the proper command code via serial communications. It is also possible to invoke Auto-Tune through the serial port. Serial communications used with SFCRM software allows for easy controller parameter configuration by computer.

**DUAL TIME PROPORTIONAL SYSTEMS**
The P48 is available with dual time proportional outputs. The dual outputs can be used for level or heat/cool applications. The A2 output can be configured for Secondary (cool) control. This allows for dual PID control on ON/OFF control with unbalanced hysteresis.

**CONTROLLER PROGRAMMING**
Front Panel Program Disable allows all of the controller’s set-ups to be locked-out from further operator intervention after the initial set-up.

The following four programming modes allow the operator to adapt to any required user-interface level:

- Unprotected Parameter Mode
- Protected Parameter Mode
- Hidden Function Mode
- Configuration Parameter Mode

**UNPROTECTED PARAMETER MODE**

The Unprotected Parameter Mode is accessible from the Normal Display mode when program disable is inactive or when the proper access code number from the Protected Parameter Mode is entered. The Configuration Parameter Modes can be accessed only from this mode:

- **“SP”** - Enter setpoint
- **“OP”** - Enter output power
- **“ProP”** - Enter proportional band
- **“Intt”** - Enter integral time
- **“dErP”** - Enter derivative time
- **“AL-1”** - Enter value for alarm #1
- **“AL-2”** - Enter value for alarm #2
- **“CNFP”** - Select configuration access point
- **“End”** - Return to normal display mode

**PROTECTED PARAMETERS MODE**

The Protected Parameters Mode is enabled when program disable is active. This mode prevents access to the configuration modes without the proper access code number. Only the parameters that are enabled in the Configuration 3 parameter (lock-out section) can be accessed.

- **“ProP”** - Enter proportional band
- **“Intt”** - Enter integral time
- **“dErP”** - Enter derivative time
- **“AL-1”** - Enter value for alarm #1
- **“AL-2”** - Enter value for alarm #2
- **“CodE”** - Enter value to access unprotected parameters and configuration parameters

**HIDDEN FUNCTION MODE**

The Hidden Function Mode is accessible from the Normal Display Mode. The functions in this mode may be locked-out individually in Configuration 3 parameter (lock-out section).

- **“SPSL”** - Select local (SP1 or SP2) or remote setpoint
- **“tmnF”** - Transfer between automatic (PID) control and manual control
- **“tUNE”** - Invoke/cancel PID Auto-tune
- **“ALSlS”** - Reset latched alarms

**CONFIGURATION PARAMETER MODE**
The Configuration Parameter Mode allows the operator to set-up the basic requirements of the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the Configuration Access Point allowing the user to return to the Normal Display Mode.

**Configuration 1, Inputs (1-IN)**
- **TYPe** - Select input signal type
- **dCPt** - Select scaled display decimal point position
- **”md”** - Enter rounding increment and trailing zeros for scaled display
- **“FLV”** - Select level of input filtering
- **“dSP1”** - Scale main input
- **“dSP2”** - Scale master/remote selection
- **“dSP”** - Enter setpoint lower limit
- **“SPH”** - Enter setpoint higher limit
- **“SP”** - Select setpoint access level
- **“OP”** - Select power access level
- **“SP”** - Select setpoint access level
- **“OP”** - Select output power low limit
- **“OPH”** - Enter output power high limit
- **“OpP”** - Enter output control damping
- **“ChYS”** - Enter ON/OFF control hysteresis
- **“Od”** - Select auto-tuning damping
- **“ANP”** - Main Linear DC analog output range
- **“ANAS”** - Main Linear DC analog output source
- **“AN”** - Main Linear DC analog output update time
- **“ANLO”** - Main Linear DC analog output scaling low
- **“ANHi”** - Main Linear DC analog output scaling high

**Configuration 2, Outputs (2-OP)**
- **“CYC”** - Enter time proportioning cycle time
- **“OPLC”** - Select output control action
- **“OPLO”** - Enter output power low limit
- **“OPHi”** - Enter output power high limit
- **“OPD”** - Select output control damping
- **“CHYS”** - Enter ON/OFF control hysteresis
- **“Od”** - Select auto-tuning damping
- **“ANP”** - Main Linear DC analog output range
- **“ANAS”** - Main Linear DC analog output source
- **“AN”** - Main Linear DC analog output update time
- **“ANLO”** - Main Linear DC analog output scaling low
- **“ANHi”** - Main Linear DC analog output scaling high

**Configuration 3, Parameter Lock-Outs (3-LC)**
- **“SP”** - Select setpoint access level
- **“OP”** - Select power access level
- **“dEv”** - Enable deviation display
- **“OpP”** - Enable blank display
- **“CodE”** - Enter parameter access code
- **“PId”** - Select PID access level
- **“AL”** - Select alarm access level
- **“ALs”** - Enable alarm reset access
- **“SPSL”** - Enable local/remote selection
- **“tmF”** - Enable auto/manual mode selection
- **“tUNE”** - Enable auto-tune invocation

**Configuration 4, Alarms (4-AL)**
- **“AC1”** - Select operation mode of alarm #1, or select main output
- **“AC1h”** - Select reset mode of alarm #1
- **“Ar”** - Enable activation delay of alarm #1
- **“AL-1”** - Enter value for alarm #1
- **“AC2”** - Select operation mode of alarm #2, or select second output
- **“AC2h”** - Select reset mode of alarm #2
- **“Ar2”** - Enable activation delay of alarm #2
- **“AL-2”** - Enter value for alarm #2
- **“AHYS”** - Enter hysteresis value for both alarms

**Configuration 5, Second Output (5-O2)**
- **“CYC”** - Enter time proportioning cycle time
- **“GANZ”** - Enter relative gain
- **“db-2”** - Enter deadband or overlap

**Configuration 6, Serial Communications (6-SC)**
- **“bAUd”** - Select baud rate
- **“ConF”** - Select character frame format
- **“Addr”** - Enter address
- **“Abrv”** - Select abbreviated or full transmission
- **“ProP”** - Select print options

**Configuration 7, Remote Setpoint Input (7-N2)**
- **“dSP1”** - Enter remote setpoint display scaling value #1
- **“dNP1”** - Enter remote setpoint process scaling value #1
- **“dSP2”** - Enter remote setpoint display scaling value #2
- **“dNP2”** - Enter remote setpoint process scaling value #2
- **“FLV”** - Enter remote setpoint filter time constant
- **“bAnd”** - Enter remote setpoint filter disable band
- **“tmF”** - Select Local/Remote setpoint transfer response

**Configuration 8, Second Linear DC Analog Output (8-A2)**
- **“Az2P”** - Second local DC analog range
- **“Az2LO”** - Second local DC analog scaling low
- **“Az2Hi”** - Second local DC analog scaling high

**Configuration 9, Factory Service Operations (9-FS)**
- **“Cod 48”** - Calibrate Instrument
- **“Cod 65”** - Reset parameters to factory setting

*These parameters may not appear due to option configuration or other programming.
MULTIPLE UNIT STACKING

The P48 is designed for close spacing of multiple units. Units can be stacked either horizontally or vertically. For vertical stacking, install the panel latch with the screws to the sides of the unit. For horizontal stacking, the panel latch screws should be at the top and bottom of the unit. The minimum spacing from center line to center line of units is 1.96" (49.8 mm). This spacing is the same for vertical or horizontal stacking.

Note: When stacking units, provide adequate panel ventilation to ensure that the maximum operating temperature range is not exceeded.

ORDERING INFORMATION

Options and Output Boards are factory configured per the part number specified. Part numbers without replacement output boards listed must be returned to the factory for output board replacement.

<table>
<thead>
<tr>
<th>DEDICATED MAIN CONTROL O1 OUTPUT</th>
<th>MAIN CONTROL O1 or A1(Alarm 1)*</th>
<th>DEDICATED ALARM 1 A1 OUTPUT</th>
<th>A2 (ALARM 2) OR A2 (SECONDARY)*</th>
<th>REMOTE SETPOINT INPUT @</th>
<th>RS485 @</th>
<th>MAIN ANALOG OUTPUT** @</th>
<th>SECOND ANALOG OUTPUT** @</th>
<th>REPLACEMENT OUTPUT BOARD</th>
<th>PART NUMBERS</th>
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<tbody>
<tr>
<td>Relay</td>
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* This output is programmable as either Control (PID) or as an Alarm.

** This output is jumper and program selectable for either a current or a voltage Linear DC output.

@ These part numbers are equipped with a second setpoint.

Option Boards are installed at the factory for the appropriate models. These boards are only needed for field replacement.

ACCESSORIES

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>DESCRIPTION</th>
<th>PART NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFCRM</td>
<td>Crimson 2 PC Configuration Software for Windows 98, ME, 2000 and XP (for RS485 models)</td>
<td>SFCRM</td>
</tr>
<tr>
<td>ICM4</td>
<td>RS232/RS485 Serial Converter Module</td>
<td>ICM40030</td>
</tr>
<tr>
<td>ICM5</td>
<td>Three Way Isolated RS232/RS485 Serial Converter Module</td>
<td>ICM50000</td>
</tr>
</tbody>
</table>

*Crimson Software is available for download from http://www.redlion.net

APPLICATION

WATER PROCESSING APPLICATION

A city water company needs to maintain a steady flow of water for their customer needs. They have an existing 0 to 10 VDC flow transmitter to measure the water flow. They need to control the water flow, have a high and low alarm, and keep a recorded chart of the flow for later reference. The Main Linear DC output of the P48 can be used to control the position of water output values per the desired flow setpoint value. The P48 relay outputs can be programmed to give a high flow alarm and a low flow alarm. With the Second Linear DC output model, the flow measurement to the P48 can be converted from 0-10 V to 4-20 mA and retransmitted to a 4-20 mA chart recorder.
**MODEL PCU - PROCESS CONTROL UNIT**

- SELF-DIAGNOSTICS
- FULL PID CONTROL WITH REDUCED OVERSHOOT
- OPTIONAL RS485 SERIAL COMMUNICATIONS INTERFACE
- OPTIONAL DUAL ALARM OUTPUTS (USES OUTPUT MODULES)
- OPTIONAL SECONDARY OUTPUT (USES OUTPUT MODULE)
- OPTIONAL LINEAR 4 to 20 mA OR 0 to 10 VDC OUTPUT FOR CONTROL OR PROCESS VALUE RE-TRANSMISSION
- OPTIONAL MOTORIZED VALVE POSITION CONTROL AND VALVE FAIL ALARM
- OPTIONAL SECOND ANALOG INPUT FOR REMOTE SETPOINT AND CASCADE CONTROL
- OPTIONAL NEMA 4X/IP65 SEALED FRONT BEZEL
- STATUS INDICATORS FOR OUTPUTS AND CONTROL MODES
- PROGRAMMABLE USER INPUT (DIGITAL) FOR ADDED FLEXIBILITY
- MANUAL/AUTOMATIC AND LOCAL/REMOTE SETPOINT CONTROL MODES
- SETPOINT RAMPING FOR PROCESS STARTUP
- PARAMETER SECURITY VIA PROGRAMMABLE LOCKOUTS
- FIELD REPLACEABLE AND INTERCHANGEABLE OUTPUT MODULES (Relay, Logic/SSR Drive and Triac)

**DESCRIPTION**

The PCU Controller accepts either 0 to 10 VDC or a 0 to 20 mA DC input signal, precisely scales the process signal according to programmable scaling points, and provides an accurate output control signal (time proportional, linear, or valve position) to maintain a process at the desired control point. A comprehensive set of easy to use program instructions allows the controller to solve various applications.

The controller can operate in the PID control mode for both the main output and optional secondary output, with on-demand auto-tune, that establishes the tuning constants. The PID tuning constants may be fine-tuned by the operator at any time and then locked-out from further modification. The controller employs a unique overshoot suppression feature, which allows the quickest response without excessive overshoot. The unit can be transferred to operate in the manual mode, providing the operator with direct control of the output. The controller may also be programmed to operate in the ON/OFF control mode with adjustable hysteresis.

Dual 4-digit displays allow viewing of the process value and setpoint simultaneously. Front panel indicators inform the operator of the controller and output status. Replaceable and interchangeable output modules (Relay, Logic/SSR Drive, or Triac) can be installed for the main control output, alarm output(s) and secondary output.
OPTIONS
Optional dual alarms can be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, Band IN or OUT and Valve Fail Detect) with adjustable hysteresis. A standby feature suppresses the output during power-up until the process stabilizes outside the alarm region. An optional secondary output is available (for processes that require cooling) that provides increased control accuracy and response.

A linear 4 to 20 mA or 0 to 10 VDC output signal is available to interface with actuators, chart recorders, indicators, or other controllers. The output signal can be digitally scaled and selected to transmit one of the following: % output power, measurement value, process measurement value deviation or setpoint value. Valve Positioner and Second Analog Input Modules have the adjustable output demand dampening, output deadband and output update time parameters to expand the versatility of the PCU to control devices.

The optional Motorized Valve Positioner directly controls the position of a valve by the use of twin outputs (open and close) to control the direction of motor rotation. The motor position defines the opening position of the valve. Two control modes are possible: position control, that makes use of the slidewire feedback signal supplied with the positioner and velocity control, in which no slidewire feedback signal is used. Parameters are provided to adjust the operation of the valve. These include:
- Valve activity hysteresis
- Valve update time
- Variable control dampening
- Slidewire signal fail action
- Adjustable valve position limits

The Valve Positioner PCU achieves tight process control, yet minimizes unnecessary valve actuator. An alarm event output or display alarm can be programmed under loss of slidewire feedback or under valve fail detection.

The optional Second Analog Input (0 to 20 mA DC) can be configured as a remote setpoint signal or as a secondary process signal. Configuration of the second analog input as a remote setpoint signal allows ratio control, master setpoint/multiple slave operation, and the ability to cascade the PCU with another controller (external cascade). Configuration of the second input as a secondary process signal allows operation as a two-process cascade controller within a single unit (internal cascade). In either control mode, parameters are provided to scale, configure, communicate and monitor the activity of both analog inputs. A square law linearizer function can be used to linearize signals derived from flow transmitters.

The optional RS485 multidrop serial communication interface provides two-way communication between a PCU unit and other compatible equipment such as a printer, a programmable controller, or a host computer. In multipoint applications the address number of each unit on the line can be programmed from zero to ninety-nine. Up to thirty-two units can be installed on a single pair of wires. The Setpoint value, % Output Power, Setpoint Ramp Rate, etc. can be interrogated or changed by sending the proper command code via serial communications. Alarm output(s) may also be reset via the serial communications interface option.

An optional NEMA 4X/IP65 rated bezel is available for wash down and/or dirty environments, when properly installed. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the controller extremely reliable in industrial environments.

SAFETY SUMMARY
All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the PCU to directly command motors, valves, or other actuators not equipped with safeguards. To do so, can be potentially harmful to persons or equipment in the event of a fault to the unit. An independent and redundant limit indicator with alarm outputs is strongly recommended. Red Lion Controls offers various units (such as an IM: IMD1 or IMD2) that may be used for this purpose. The indicators should have input sensors and AC power feeds independent from other equipment.

SPECIFICATIONS
1. DISPLAY: Dual 4-digit
Upper Process Display: 0.4" (10.2 mm) high red LED
Lower Auxiliary Display: 0.3" (7.6 mm) high green LED
Display Messages (Model dependent):
"LOL" - Appears when measurement exceeds +105% input range.
"ULL" - Appears when measurement exceeds -5% input range.
"SENS" - Appears when measurement exceeds "LOL" & "ULL" range.

2. POWER: Switch selectable 115/230 VAC (+10%, -15%) no observable line variation effect, 48 to 62 Hz, 10 VA.

3. ANNUNCIATORS:
LED Backlight Status Indicators (Model dependent):
%PW - Lower auxiliary display shows power output in (%).
DEV - Lower auxiliary display shows deviation (error) from process setpoint.
OP1 - Main control output is active.
AL1 - Alarm #1 is active.
AL2 - Alarm #2 is active (for Dual Alarm Option).
OP2 - Secondary output is active (for Secondary Output Option).
OPN - Valve positioner OPEN output is active (for Valve Positioner Option).
CLS - Valve positioner CLOSE output is active (for Valve Positioner Option).
SEC - Lower auxiliary display shows second analog input (for Second Analog Input Option).
MAN - Flashing: Controller is in Manual control mode.
REM - ON: controller is in remote setpoint mode (Second Analog Input Option).
OFF: controller is in local setpoint mode (Second Analog Input Option).

4. CONTROLS: Four front panel push buttons for modifying and setup of controller functions and one external input for parameter lockout or other functions.

5. SIGNAL INPUT:
Sample Period: 100 msec typ.
Response Time: 300 msec typ. (to within 99% of final value w/step input)

Signal Overdrive Threshold:
10 V Range: 13 V typ.
20 mA Range: 26 mA typ.

Signal Overdrive Response:
Main Control Output: Programmable preset output
Display: "SENS"
Alarms: Upscale drive
CLS: Linear: Programmable preset output
Normal Mode Rejection: 40 dB typ. @ 50/60 Hz (improves with increased digital filtering).
Common Mode Rejection: 100 dB typ., DC to 60 Hz
Protection: Input overload 120 VAC for 30 seconds.

6.

<table>
<thead>
<tr>
<th>SIGNAL RANGE</th>
<th>ACCURACY (% OF UNSCALED READING)</th>
<th>MAXIMUM INPUT</th>
<th>INPUT IMPEDANCE</th>
<th>RESOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 10 VDC</td>
<td>±(0.15% + 3 mV)</td>
<td>300 VDC</td>
<td>1 mA</td>
<td>10 mA</td>
</tr>
<tr>
<td>0 to 20 mA DC</td>
<td>±(0.15% + 6 μA)</td>
<td>200 mA DC</td>
<td>10 Ω</td>
<td>10 μA</td>
</tr>
</tbody>
</table>

OUTPUT MODULES [Optional] (For All Output Channels):
Relay:
Type: Form-C (Form-A with some models. See Ordering Information.)
Rating: 5 Amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive load) max.
Life Expectancy: 100,000 cycles at max. load rating. (Decreasing load and/or increasing cycle time, increases life expectancy).
Logic/SSR Drive: Can drive multiple SSR Power Units.
Type: Non-isolated switched DC, 12 VDC typ.
Drive: 45 mA max.
Triac:
Type: Isolated, Zero Crossing Detection
Rating:
Voltage: 120/240 VAC
Max. Load Current: 1 Amp @ 35°C
0.75 Amp @ 50°C
Min. Load Current: 10 mA
Off State Leakage Current: 7 mA max. @ 60 Hz
Operating Frequency: 20 to 400 Hz
Protection: Internal Transient Snubber, Fused

7. MAIN CONTROL OUTPUT:
Control: PID or ON/OFF
Output: Time proportioning or linear DC
Hardware: Plug-in, replaceable output modules
Cycle time: Programmable
Auto-tune: When selected, sets proportional band, integral time, and derivative time values.
Signal Overdrive Action: Programmable

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1-717-767-6511 597
SPECIFICATIONS (Cont’d)

8. SECONDARY OUTPUT (Optional):
   Control: PID or ON/OFF
   Output: Time proportioning or linear DC
   Hardware: Plug-in, replaceable output modules
   Cycle time: Programmable
   Proportional Gain Adjust: Programmable
   Deadband Overlap: Programmable

9. LINEAR DC OUTPUT (Optional): With digital scale and offset, programmable deadband and update time.
   4 to 20 mA:
   Resolution: 1 part in 3500 typ.
   Accuracy: ±0.1% of reading + 25 µA
   Compliance: 10 V (500 Ω max, loop impedance)
   0 to 10 VDC:
   Resolution: 1 part in 3500 typ.
   Accuracy: ±0.1% of reading + 35 mV
   Min. Load Resistance: 10 KΩ (1 mA max.)
   Source: % output power, setpoint, deviation, or process value
   (Available for OP1 or OP2, but not both)

10. MOTORIZED VALVE POSITIONER (Optional):
    Two Outputs: Valve open and valve close or Linear DC (optional)
    Hardware: Plug-in, replaceable output modules
    Three Inputs: Slidewire feedback, signal fail detect (Isolated from main input)
    Slidewire Resistance: 100 Ω to 100 KΩ
    Slidewire Exciting Voltage: 0.9 VDC typ.
    Slidewire Fail Action: programmable
    Control Mode: Position mode (with slidewire) and velocity mode (w/o slidewire).
    Control Deadband: 1% to 25.0% (position mode)
    0.1 to 25.0 seconds (velocity mode)
    Update Time: 1 to 250 seconds
    Motor Time (open, close): 1 to 9999 seconds
    Position Limits: Adjustable 0.0 to 100.0% of valve stroke
    Valve Fail Time: Off to 9999 seconds
    Alarm mode: Dual acting; loss of slidewire feedback signal and valve fail detection

11. SECOND ANALOG INPUT:
    Range: 0 to 20 mA (Isolated from main input)
    Overload: 100 mA MIN (steady state)
    Input Resistance: 10 Ω typ.
    Voltage Drop (@ 20 mA): 0.2 V typ.
    Accuracy: ±0.15% of reading ±10 µA ±1 LSD
    Scale Range: -999 to 9999

12. SERIAL COMMUNICATION:
    Type: RS485 Multi-point, Balanced Interface
    Communication Format:
      Baud Rate: Programmable from 300 to 9600
      Parity: Programmable for odd, even, or no parity
      Frame: 1 start bit, 7 data bits, 1 or no parity bit, 1 stop bit
      Unit Address: Programmable from 0 to 99, max. of 32 units per line
    Transmit Delay: 100 msec min., 200 msec max.
    RS485 Common: Isolated from signal input common
    Auto Print Time: Off to 9999 seconds between print-outs

13. USER INPUT (Optional):
    Internally pulsed up to +5 VDC. VNI = 5.25 VDC MAX, VIL = 0.85 VMAX; VILH = 3.0 VMIN.
    Available on all second input (MVP & ANA) models, and on models with RS485.
    Response Time: 100 msec max.
    Functions: Program Lock
                Integral Action Lock
                Auto/Manual Mode Select
                Setpoint Ramp Select
                Reset Alarms
                Print Request
                Local/Remote Setpoint Select

14. ALARMS (Optional):
    Hardware: Plug-in, replaceable output module
    Modes: Absolute high acting
            Absolute low acting
            Deviation high acting
            Deviation low acting
            Inside band acting
            Outside band acting
    Valve fail
    Second Analog Input monitoring
    Reset Action: Programmable; automatic or latched
    Standby Mode: Programmable; enable or disable
    Hysteresis: Programmable

Signal Overdrive Action: Upscale
Annunciator: LED backlight for “AL1”, “AL2”, (Alarm #2 not available with secondary output or motorized valve position option.)

15. ENVIRONMENTAL CONDITIONS:
    Operating Temperature Range: 0 to 50°C
    Storage Temperature Range: -40 to 80°C
    Span Drift (maximum): 100 ppm/°C, main input; 150 ppm/°C, second input
    Zero Drift (maximum):
      4 to 20 mA DC Range: 0.5 µA/°C
      0 to 10 VDC Range: 0.2 mV/°C
    Second Input: 2 µA/°C
    Relative Humidity: Less than 85% RH (non-condensing)
    Altitude: Up to 2000 meters

16. ISOLATION BREAKDOWN RATINGS:
    All inputs and outputs with respect to AC line: 2300 VMIN
    Analog Outputs, Second Analog Input or Slidewire Input with respect to main input: 500 VMIN

17. CERTIFICATIONS AND COMPLIANCES:
    SAFETY
    UL Listed, File #E137808, UL508, CSA C22.2 No. 14-M95
    LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
    UL Recognized Component, File # E156876, UL873, CSA C22.2 No. 24
    Recognized to U.S. and Canadian requirements under the Component
    Recognition Program of Underwriters Laboratories, Inc.
    Type 2 or 4X Enclosure rating (Face only), UL50
    IEC/CE CB Scheme Test Certificate #UL1239-156876/USA,
    CB Scheme Test Report #96EM50279-070794
    Issued by Underwriters Laboratories, Inc.
    IEC 1010-1, EN 61010-1; Safety requirements for electrical equipment for
    measurement, control, and laboratory use, Part 1.
    IP65 Enclosure rating (Face only), IEC 529

    ELECTROMAGNETIC COMPATIBILITY:
    Immunity to EN 50082-2
    Electrostatic discharge EN 61000-4-2 Level 2; 4 Kv contact
    EN 61000-4-3 Level 3; 8 Kv air
    Fast transients (burst) EN 61000-4-4 Level 4; 2 Kv I/O
    RF conducted interference EN 61000-4-6 Level 3; 10 V/m²
    Power frequency magnetic fields EN 61000-4-8 Level 4; 30 A/m
    Emissions to EN 50081-2
    RF interference EN 55011 Class A
    Power mains class A

    Notes:
       Process and/or analog output signals may deviate during EMI disturbance.
       For operation without loss of performance:
       Install power line filter, RLC #LFIL0000 or equivalent.
    2. Self-recoverable loss of performance during EMI disturbance at 10 V/mc.
       Process and/or analog output signals may deviate during EMI disturbance.
       For operation without loss of performance:
       Install power line filters, RLC #LFIL0000 or equivalent and 1 ferrite
       core 1 turn, RLC #8FCOR000 or equivalent, to cable at unit.
       Refer to the EMC Installation Guidelines section of the manual for additional
       information.

18. CONNECTION: Jaw-type terminal block
    Wire Range: 12-30 AWG copper wire
    Torque: 5-7 inch-lbs (56-79 N-cm)

19. CONSTRUCTION:
    NEMA 2 For Standard Models.
    Front Panel: Flame and scratch resistant tinted plastic
    Case: High impact black plastic. (Mounting collar included)
    NEMA 4X/IP65 model only: Sealed bezel utilizing two captive mounting
    screws (panel gasket included) This unit is rated for NEMA 4X/IP65
    indoor use. Installation Category II, Pollution Degree 2

20. WEIGHT: 1.3 lbs (0.6 kgs)
BASIC OPERATION

The PCU controls a process by measuring the input signal and then calculating a control output power value by use of a modified PID control algorithm. The unit controls the system with the new output power value to keep the process at setpoint. The PID control algorithm incorporates features that provide for high control accuracy and low overshoot from process disturbances.

FRONT PANEL FEATURES

In the normal operating mode, the unit displays the scaled process value in the upper display. One of four other parameters can be viewed in the lower display:
- % Power Output
- Deviation
- Second Input Process Value

The parameters can be scrolled through by pressing the DSP button. If enabled, the controller setpoint or power output (manual mode only) can be directly modified in this mode.

In the normal operating mode, parameters are selected by use of the PAR button and modified by use of the UP and DOWN buttons. Parameters are then entered by the PAR button, which advances the user to the next parameter. Pressing the DSP button immediately returns the controller to the normal operating mode when making a parameter change. The controller’s configuration and parameter settings are stored in an internal E²PROM device.

HARDWARE FEATURES

The fast 100 msec input sampling rate provides quick controller response to a process disturbance, thus providing excellent process control. Measurement accuracy of 0.15% or better, provides closer process control conforming to the desired control setpoint value. The unit accepts either a 0 to 10 VDC or a 0 to 20 mA DC input signal. The AC input power is switch selectable, allowing the unit to operate from either 115 VAC or 230 VAC. Since the controller is serviceable from the front of the panel, the output modules may be easily changed or replaced without disturbing the wiring behind the panel. No reprogramming is required when changing or replacing modules.

The optional NEMA 4X/IP65 rated model utilizes two bezel securing screws and a neoprene gasket to guarantee a water tight seal, when properly installed.

The standard model simply requires pressing a latch to remove the unit.

Low-drift, highly stable circuitry ensures years of reliable and accurate process control. The recommended two-year re-calibration interval is easily accomplished via the programming menu.

SETPOINT FEATURES

The controller can be protected from out of range values by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can be programmed.

The setpoint ramp feature ramps the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate. This feature reduces shock to the process and helps to minimize overshoot. The setpoint may also be transmitted by the optional linear DC output for slave control loops.

The second analog input may be configured as a remote setpoint. As such, the controller is easily switched from local/remote setpoint operation via the front panel or user input. Ratio and bias parameters provide on-line scaling of the remote setpoint. Absolute limit values and maximum rate of change of the remote setpoint further enhance controller flexibility.

INPUT FEATURES

A programmable input filter can be used to stabilize readings from a process with varying or oscillating characteristics, helping to provide better process control. Programmable scaling points allow the controller to display in any engineering unit; flow, level, pressure, etc. Scaling points are used in conjunction with the programmable rounding increment to stabilize a jittery or otherwise hard to read process signal for better indication.

The programmable User Input can be used to control a variety of functions, such as auto/manual transfer of the controller, reset alarm output(s), etc.

The second analog input has independent scaling parameters to match the units of other processes or transmitters, or to match the controller’s range.

OUTPUT FEATURES

Programmable output power limits provide protection for processes where excessive power can cause damage. Automatic signal overdrive detection, for fail-safe operation, causes the controller to default to a programmed output power (upscale or downscale burnout). With adjustable time proportioning cycle time, and programmable DC linear output, the controller can satisfy a wide variety of output requirements.

Programmable damping output hysteresis and output update time parameters can dramatically reduce actuator activity without degrading control accuracy.

The RS485 Communication option allows the user to access various controller parameters such as the setpoint, % output power, % proportional band, etc. The controller may be set up to transmit various parameters at a programmable automatic print rate.

AUTO-TUNE

The PCU has an auto-tune feature that, on demand, automatically determines the PID control parameters for a particular process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into nonvolatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked either at start-up or at setpoint, depending on the process requirements. An auto-tune programmable damping factor produces various levels of process control and response characteristics.

OPTIONS

**RATIO CONTROL**

The PCU configured for ratio operation controls a process as a ratio of another process or to another variable. Ratio control is commonly used for flow applications, however, any two process variables can be controlled in a ratio mode.

Ratio Control Configuration Parameters

- **OPEr** - Select ratio mode
- **'root'** - Select second input square root linearization
- **dP2** - Select second input decimal point
- **INP1** - Enter scaling units of second input
- **INP2** - Local/Remote Select options
- **SPtr** - Program User Input for Local/Remote Setpoint selection

Ratio Control Operational Parameters

- **'r2tio'** - Remote setpoint ratio
- **'bias'** - Remote setpoint bias

**MOTORIZED VALVE POSITIONER**

The motorized valve positioner controls the position of a valve directly, by use of “open” and “close” control outputs. The slidewire feedback signals of the valve may optionally be connected to the controller. Alternatively, the controller may be configured for linear input valve control using the 4 to 20 mA DC output.
Motorized Valve Positioner Configuration Parameters

**Position mode:**
- "VPS1" - Enter or measure valve closed position
- "VPS2" - Enter or measure valve open position
- "VUdt" - Enter Valve update time
- "VPdb" - Enter valve control deadband
- "VFAL" - Enter valve fail detect time
- "Actt" - Program alarm as valve fail output

**Velocity mode:**
- "VUdt" - Enter Valve update time
- "VOPt" - Enter valve open time
- "VCLt" - Enter valve close time
- "VOnt" - Enter valve control deadband (minimum on time)

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**INTERNAL CASCADE**

Cascade control allows the process to be divided into two control loops: the primary control loop and the secondary control loop. The secondary loop receives its setpoint from the primary loop to control an intermediate variable (steam pressure). The control level of the intermediate variable is the input to the primary process. The primary loop (main input) controller maintains loop regulation by manipulating the setpoint of the secondary controller. The setpoint of the secondary controller, in turn, changes the intermediate variable. The secondary loop can react faster to disturbances of the intermediate variable, thereby minimizing the effects to the primary control loop. Control loops cascaded in such a manner provide greater control quality than would be possible with single loop control. A single PCU can accomplish two-process cascade control.

**Internal Cascade Configuration Parameters**
- "OPEr" - Select cascade mode
- "root" - Select second input square root linearization
- "dP2" - Select second input decimal point
- "dSP1" - Enter scaling units of second input
- "SPLO" - Output dampening of secondary

---

**EXTERNAL CASCADE**

Similar to internal cascade control, external cascade control differs by the employment of two controllers, one of which is equipped with a second analog input configured as a remote setpoint. A PCU controls the secondary loop, while a TCU controls the primary loop.

**External Cascade Configuration Parameters**
- "OPEr" - Select ratio mode
- "root" - Select second input square root linearization
- "dP2" - Select second input decimal point
- "dSP2" - Enter scaling units of second input
- "SPtr" - Local/Remote select options

**External Cascade Operational Parameters**
- "rtio" - Remote setpoint ratio
- "BIAS" - Remote setpoint bias

---

**SETPOINT MASTER CONTROL**

Setpoint Master Control allows automatic setpoint changes to slave controller units (up to 50 units total) from a master PCU controller. The linear DC output of the master is looped with the second analog input of the slave PCU controllers. Each slave unit can have unique remote setpoint ratio and bias values.

**Setpoint Slave Configuration Parameters**
- "OPEr" - Select remote setpoint mode
- "root" - Select second input square root linearization
- "dP2" - Select second input decimal point
- "dSP1" - Enter scaling units of second input
- "SPLO" - Limit range of remote setpoint
- "SPHI" - Limit rate of change of remote setpoint

**Setpoint Slave Operational Parameters**
- "rtio" - Second input ratio
- "BIAS" - Second input bias

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CONTROLLER PROGRAMMING

The PCU has been designed to reduce the operator interaction with the controller while still maintaining a high degree of control accuracy and user flexibility. Front Panel Program Disable allows all of the controller’s set-ups to be locked-out from further operator intervention after the initial parameter set-up.

The programming of the controller is divided into four sections:

Unprotected Parameter Mode
Configuration Parameter Mode
Protected Parameter Mode
Hidden Function Mode

These four programming modes all allow the controller to adapt to any required user-interface level.

UNPROTECTED PARAMETER MODE *

The unprotected parameter mode is accessible when program disable is inactive or when the proper access code number from the protected mode is entered. The configuration parameter modes can be accessed only from this mode.

- **SP** - Enter Setpoint
- **OP** - Enter output power
- **Prop** - Enter proportional band
- **Int** - Enter integral time
- **dErr** - Enter derivative time
- **AS** - Enter or measure alarm demand
- **bAS** - Enter Remote Setpoint bias value
- **bAS** - Enter Remote Setpoint ratio value
- **SP** - View internal cascade secondary setpoint demand
- **Pb** - Enter internal cascade, secondary proportional band
- **It** - Enter integral cascade, secondary integral time
- **dIt** - Enter internal cascade, secondary derivative time
- **AL-1** - Enter value for alarm #1
- **AL-2** - Enter value for alarm #2
- **CNFP** - Select basic configuration mode
- **End** - Return to normal display mode

CONFIGURATION PARAMETER MODE

The configuration parameter mode allows the operator to set up the basic requirements of the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the configuration selection stage allowing the user to return to the normal display mode.

**Configuration 1, Inputs**

- **TYPE** - Select input signal type
- **root** - Select square root linearization of main input *
- **dCPT** - Select scaled display decimal point position
- **rd** - Enter rounding increment and trailing zeroes for scaled display
- **Fltr** - Select level of input filtering
- **dSP1** - Scale main input
- **dSP2** - Scale input lower limit
- **dSN** - Enable deviation display
- **dSP1** - Enable blank display
- **Chys** - Enter ON/OFF control hysteresis
- **tCod** - Select auto-tuning timing
- **ANAS** - Select linear DC output assignment *
- **ANL0** - Enter linear DC output low scaling value *
- **ANHr** - Enter linear DC output high scaling value *
- **ANdB** - Enter linear DC output control deadband *
- **ANuI** - Enter linear DC output update time *

**Configuration 2, Outputs**

- **CYC** - Enter time proportioning cycle time
- **OPAC** - Select control action
- **OpLO** - Enter output power low limit
- **OpPH** - Enter output power high limit
- **OpF** - Enter signal override power preset
- **OpPn** - Enter output control dampening
- **CHYS** - Enter ON/OFF control hysteresis
- **tCod** - Select auto-tuning timing
- **ANAS** - Select linear DC output assignment *
- **ANL0** - Enter linear DC output low scaling value *
- **ANHr** - Enter linear DC output high scaling value *
- **ANdB** - Enter linear DC output control deadband *
- **ANuI** - Enter linear DC output update time *

**Configuration 3, Parameter lock-outs**

- **SP** - Select degree of setpoint access
- **OP** - Select degree of power access
- **dEv** - Enable deviation display *
- **IN-2** - Enable second input display *
- **dMS** - Enable blank display
- **CodE** - Enter parameter access code
- **Pld** - Select degree of PID access
- **PldZ** - Select degree of secondary PID access *
- **nBS** - Select degree of ratio/bias access *
- **AL** - Select degree of alarm access *
- **ALrS** - Enable alarm reset access *
- **SPSL** - Enable local/remote setpoint selection *
- **tFm** - Enable auto/manual mode selection
- **tUme** - Enable auto-tune invocation

**Configuration 4, Alarms**

- **Actl** - Select operation mode of alarm #1
- **rSt1** - Select reset mode of alarm #1
- **Stb** - Enable activation delay of alarm #1
- **AL-1** - Enter value for alarm #1
- **Act2** - Select operation mode of alarm #2
- **rSt2** - Select reset mode of alarm #2
- **Stb2** - Enable activation delay of alarm #2
- **AL-2** - Enter value for alarm #2
- **AHYS** - Enter hysteresis value for both alarms

**Configuration 5, Secondary Output**

- **CyC2** - Enter time proportioning cycle time
- **GAnz2** - Enter relative gain
- **dB** - Enter deadband or overlap
- **OPd2** - Enter secondary output control dampening

**Configuration 6, Serial Communications**

- **bAUC** - Select baud rate
- **Prb** - Select parity bit
- **addr** - Enter unit address number
- **Abv** - Select abbreviated or full mnemonic transcriptions
- **PrAt** - Enter automatic print rate
- **OPPo** - Select parameters to be included in print-out

**Configuration 7, Second Input**

- **OPe** - Select remote setpoint or internal cascade mode
- **root** - Select second input square root linearization
- **dPiZ** - Select second input decimal point
- **INP1** - Enter or measure second input
- **dSP2** - Enter second input scaling parameters
- **INP2** - Select parameters to be included in print-out
- **dSP2** - Enter Secondary output control dampening

**Configuration 8, Motorized Valve Positionner**

- **VPS1** - Enter or measure valve closed position
- **VPS2** - Enter or measure valve open position
- **VUp** - Enter valve update time
- **VPhb** - Enter valve control deadband
- **VFa** - Enter valve fail detect time
- **VOp** - Enter valve open time
- **VCl** - Enter valve close time
- **VOm** - Enter valve control deadband (minimum on time)
- **ALr** - Select local/remote setpoints

**HIDDEN FUNCTION MODE**

The hidden function mode is accessible from the normal operating mode. The four functions in this mode may be locked-out individually in configuration 3 parameter lock-out section.

- **SPSL** - Select Local/Remote Setpoint
- **tFm** - Transfer between automatic (PID) control and manual control
- **tUme** - Invoke/cancel PID Auto-tune
- **ALrS** - Reset latched alarms

* These parameters may not appear due to option configuration or other programming.
PROTECTED PARAMETERS MODE *

The protected parameters mode is enabled when program disable is active. This mode prevents access to the configuration modes without the proper access code number. Only the parameters that are selected in the configuration 3 parameter lock-out section can be accessed.

- "ProP" - Enter proportional band
- "Intt" - Enter integral time
- "dErt" - Enter derivative time
- "rIo" - Enter remote setpoint ratio value
- "SP-2" - Enter internal cascade, secondary setpoint
- "Pb-2" - Enter internal cascade, secondary proportional band
- "rI-2" - Enter internal cascade, secondary integral time
- "dr-2" - Enter internal cascade, secondary derivative time
- "AL-1" - Enter value for alarm #1
- "AL-2" - Enter value for alarm #2
- "Code" - Enter access value to unprotected parameters & configuration parameters

* These parameters may not appear due to option configuration or other programming.

OUTPUT MODULES

TYPICAL CONNECTIONS

Relay: Form-C (Form-A with some models. See ordering information.)
Rating: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive) maximum.
Life Expectancy: 100,000 cycles at maximum load rating. (Decreasing load and/or increasing cycle time, increases life expectancy).

Logic/SSR Drive: Can drive multiple SSR Power Units.
Type: Non-isolated switched DC, 12 VDC typical
Drive: 45 mA maximum.

APPLICATION

A chemical company would like to maintain the level of an acid solution tank to insure constant availability for their process. They have chosen a PCU controller which has a continuous level probe with a 4 to 20 mA output proportional to tank level, connected to the input terminals. The tank is filled by controlling the position of a proportional control valve. The control valve is controlled by a 3 to 15 PSI air signal.

The PCU uses the level control input as its feedback. The 4 to 20 mA input signal is scaled so that 4 mA equals 0% and 20 mA equals 100%.

The 4 to 20 mA output of the PCU is taken to an I/P converter to convert the 4 to 20 mA output to a 3 to 15 PSI signal for the control valve. The relay outputs of the PCU are used for high and low level alarms.
**ORDERING INFORMATION**

**MODELS WITHOUT SECOND INPUT OPTIONS**

<table>
<thead>
<tr>
<th>NEMA 4X/IP65 BEZEL</th>
<th>4 to 20 mA ANALOG OUTPUT</th>
<th>0 to 10 VDC ANALOG OUTPUT</th>
<th>ALARM OUTPUTS</th>
<th>COOLING OUTPUT</th>
<th>RS485 COM</th>
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*Note: These models have dual alarm outputs, or single alarm with secondary outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.*

**SECOND ANALOG INPUT MODELS (RSP)**

<table>
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<th>0 to 10 VDC ANALOG OUTPUT</th>
<th>ALARM OUTPUTS</th>
<th>COOLING OUTPUT</th>
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*Note: These models have dual alarm outputs, or single alarm with secondary outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.*

**MOTORIZED VALVE POSITIONER MODELS (MVP)**

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<th>ALARM OUTPUTS</th>
<th>COOLING OUTPUT</th>
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<td>Single Phase 25 A DIN Rail Mount Solid State Relay</td>
<td>RLY60000</td>
</tr>
<tr>
<td>Single Phase 40 A DIN Rail Mount Solid State Relay</td>
<td>RLY6A000</td>
</tr>
<tr>
<td>Three Phase DIN Rail Mount Solid State Relay</td>
<td>RLY70000</td>
</tr>
</tbody>
</table>

*Note: Output Modules are NOT supplied with the controller. When specifying the controller, be sure to purchase the appropriate output module for the Main Control Output and if necessary, the alarm output(s), the secondary output, and valve positioner outputs.*

The Logic/SSR Drive Module is a switched DC source, intended to drive the DC input of an SSR power unit. It should never be connected to line voltage.

All modules are packaged separately and must be installed by the user.
MODEL PSC - PROCESS SETPOINT CONTROLLER

- AUTOMATIC PROGRAM DELAY FOR PROFILE CONFORMITY, PLUS PROGRAM LINKING, REPEATING AND AUTO POWER-ON FUNCTIONS FOR ENHANCED CAPABILITY
- DUAL EVENT OUTPUTS FOR TIMED ACTIVATION OF PROCESS EQUIPMENT SUCH AS STIRRERS, FANS, HEATERS, ETC. (Uses Alarm Output Channels)
- FOUR SETPOINT & PID PARAMETER SETS FOR QUICK RECALL OF SETPOINTS AND/OR GAIN VALUES DURING BATCH OR PROCESS CHANGEOVER
- PROGRAMMABLE USER INPUT FOR CONTROLLER AND SETPOINT PROGRAM CONTROL
- 100 MSEC SAMPLING PERIOD WITH 0.15% ACCURACY
- ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS
- DUAL LED DISPLAYS FOR SIMULTANEOUS INDICATION OF PROCESS AND SETPOINT STATUS OR PROCESS AND PROFILE STATUS
- ACCEPTS EITHER 0 to 10 VDC OR 4 to 20 mA DC INPUT SIGNAL
- FIELD REPLACEABLE AND INTERCHANGEABLE OUTPUT MODULES (Relay, Logic/SSR drive, and Triac)
- OPTIONAL DUAL ALARM OUTPUTS (Uses Output Modules)
- OPTIONAL SECONDARY OUTPUT (Uses Output Module)
- OPTIONAL LINEAR 4 to 20 mA OR 0 to 10 VDC OUTPUT FOR CONTROL OR PROCESS RE-TRANSMISSION
- OPTIONAL RS485 SERIAL COMMUNICATIONS INTERFACE
- OPTIONAL NEMA 4X/IP65 SEALED FRONT BEZEL

DESCRIPTION

The PSC is a setpoint controller suitable for time vs. process control applications. The PSC Controller accepts either a 0 to 10 VDC or a 4 to 20 mA DC input signal, precisely scales the process signal, according to programmable scaling points, and provides an accurate output control signal (time proportional or linear) to maintain a process at the desired control point. A comprehensive set of easy to use steps allows the controller to satisfy various applications. The user input can be programmed to perform a variety of controller functions.

Dual 4-digit displays allow viewing of the measured process value and setpoint or the process and profile status simultaneously. Front panel indicators inform the operator of controller status and output states. Replaceable output modules (Relay, logic/SSR drive or Triac) can be fitted to the main control output, alarm output(s) or timed event output(s), and secondary output.

The PSC has been designed to simplify the set-up and operation of a controlled setpoint profile program. The setpoint program is easily entered and controlled through the front panel. Full display capabilities keep the operator informed of the process value, profile status, output states, and setpoint value.

The controller can operate in the standard PID control mode for both Output 1 and Output 2 with on-demand auto-tune which establishes the PID gain set. The PID gain set can be fine tuned by the operator at any time or may be locked from further modification. The unit can be transferred to the manual control mode providing the operator with direct control of the output.

The PSC features four programs or profile recipes, each with up to eight ramp/soak segments, which can be easily stored and executed at any time. Longer profiles can be achieved by linking one or more profiles together, creating a single profile of up to 32 ramp/soak segments. Process profile conformity is assured during either soak (hold) phases or both ramp and hold phases by an adjustable error band parameter. The program repeat function cycles the profile either continuously or a set number of times. Power-on options automatically re-start, stop, or resume a running profile. The profile can be controlled via the front panel buttons, the user input, or the optional serial communications port.

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 5.5" (140) H x 2.1" (53.4) W.
DESCRIPTION (Cont’d)

Four control points, each having a setpoint and PID parameter set, are
available for instant front panel implementation during batch changeover,
or other process conditions. A control point may have its PID gain set values
disabled when implementing the control point.

The optional RS485 multidrop serial communications interface provides the
capability of two-way communication between a PSC unit and other compatible
equipment such as a printer, a programmable controller, or a host computer. In
multipoint applications the address number of each unit on the line can be
programmed from 0 to 99. Up to thirty-two units can be installed on a single pair
of wires. The Setpoint value, % Output Power, Setpoint Ramp Rate, etc. can be
interrogated or changed by sending the proper command code via serial
communications. Alarm output(s) may also be reset via the serial
communications interface option.

Optional alarm output(s) may be configured to operate as a timed event
output or as a standard alarm output. As an alarm output it may be configured to
activate according to a variety of actions (Absolute HI or LO, Deviation HI or
LO, or Band IN or OUT) with adjustable hysteresis. Also, a standby feature
suppresses the output(s) on power-up until the process stabilizes outside the
alarm region. Timed event output(s) allow the controller to activate other
equipment while a programmed profile is running. Each profile can define up to
16 event states (phases), for each output(s).

An optional secondary output is available for processes that require cooling
which provides increased control accuracy and response. The output signal can be
digitally scaled and selected to transmit one of the following:

<table>
<thead>
<tr>
<th>% Output Power</th>
<th>Measurement Value</th>
<th>Measurement Value Deviation</th>
<th>Setpoint Value</th>
</tr>
</thead>
</table>

An optional NEMA 4X/IP65 rated bezel is available for washdown and/or
dirty environments, when properly installed. Modern surface-mount technology,
extensive testing, plus high immunity to noise interference, makes the controller
extremely reliable in industrial environments.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the
manual or on equipment must be observed to ensure personal safety and to
prevent damage to either the instrument or equipment connected to it.

The equipment is used in a manner not specified by the manufacturer, the protection
provided by the equipment may be impaired.

Do not use the PSC to directly command motors, valves, or other actuators
not equipped with safeguards. To do so, can be potentially harmful to persons or
communications. Alarm output(s) may also be reset via the serial
communications interface option.

6 LED Backlight Status Indicators:

- %PW: Lower auxiliary display shows power output in (%).
- AL1: Alarm #1 is active.
- AL2: Alarm #2 is active (for Dual Alarm Option).
- OP1: Main control output is active.
- OP2: Secondary output is active (for Secondary Option).

4. CONTROLS: Four front panel push buttons for modifying and setup of
ccontroller functions and one external input.

5. SETPOINT PROFILE:

<table>
<thead>
<tr>
<th>Profiles</th>
<th>Segments Per Profile</th>
<th>Ramp Rate</th>
<th>Hold Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>8 ramp/hold segments (linkable to 32 segments)</td>
<td>0.1 to 999.9 units/minute or no ramp.</td>
<td>Off or from 0.1 to 999.9 minutes, can be extended to 500 hours by linking.</td>
</tr>
</tbody>
</table>

Error Band Conformity: Off or from 1 to 9999 units deviation, + value for hold
phases, - value for both ramp and hold phases.

Power-On Modes: Stop, auto-start, or profile resume.

Start Mode: Ramps from process value.

Program Auto Cycle: 1 to 249, or continuous.

Event Outputs: 2, time activated with profile [uses Alarm output(s)].

Control: Front panel buttons, user input, or RS485 communications.

7. SIGNAL INPUT:

Sample Period: 100 msec

Response Time: 300 msec (to within 99% of final value w/step input).

Signal Overdrive Threshold:

10 V Range: 13 V

20 mA Range: 26 mA

Signal Overdrive Response: Main Control Output: Programmable preset output.

Display: “SENS”

DC Linear: Programmable preset output.

Normal Mode Rejection: 40 dB @ 50/60 Hz (improves with increased
digital filtering)

Common Mode Rejection: 100 db, DC to 50/60 Hz.

8. RANGE AND ACCURACY:

<table>
<thead>
<tr>
<th>Signal Range</th>
<th>Accuracy (% of Unscaled Reading)</th>
<th>Max. Input</th>
<th>Input Impedance</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 10 VDC</td>
<td>±(0.15% + 3 mV)</td>
<td>300 VDC</td>
<td>10 mV</td>
<td>10 mV</td>
</tr>
<tr>
<td>0 to 20 mADC</td>
<td>±(0.15% + 6 μA)</td>
<td>200 mADC</td>
<td>10 μA</td>
<td>10 μA</td>
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</table>

9. OUTPUT MODULES (For All Output Channels):

<table>
<thead>
<tr>
<th>Optional - Must be ordered separately</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay: Type - Form-C (Form-A with RS485 option)</td>
</tr>
<tr>
<td>Rating: 5 Amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive load).</td>
</tr>
<tr>
<td>Life Expectancy: 100,000 cycles at max. rating. (Decreasing load and/or increasing cycle time, increases life expectancy).</td>
</tr>
<tr>
<td>Logic/SSR Drive: Can drive multiple SSR Power Units.</td>
</tr>
<tr>
<td>Type: Non-isolated switched DC, 12 VDC typical</td>
</tr>
<tr>
<td>Drive: 45 mA max.</td>
</tr>
<tr>
<td>Triac: Type - Isolated, Zero Crossing Detection.</td>
</tr>
<tr>
<td>Ratings: Voltage: 120/240 VAC</td>
</tr>
<tr>
<td>Max Load Current: 1 AMP @ 35°C</td>
</tr>
<tr>
<td>0.75 AMP @ 50°C</td>
</tr>
<tr>
<td>Min Load Current: 10 mA</td>
</tr>
<tr>
<td>Off State Leakage Current: 7 mA max. @ 60 Hz</td>
</tr>
<tr>
<td>Operating Frequency: 20 to 500 Hz</td>
</tr>
<tr>
<td>Protection: Internal Transient Snubber, Fused.</td>
</tr>
</tbody>
</table>

10. MAIN CONTROL OUTPUT:

Control: PID or ON/OFF.

Output: Time proportioning or linear DC.

Hardware: Plug-in, replaceable output modules.

Cycle time: Programmable.

Auto-tune: When performed, sets proportional band, integral time, and
derivative time values.

Probe Break Action: Programmable.

11. SECONDARY OUTPUT (Optional):

Control: PID or ON/OFF.

Output: Time proportioning or linear DC

Hardware: Plug-in, replaceable output modules.

Cycle time: Programmable.

Proportional Gain Adjust: Programmable.

DeadBand Overlap: Programmable.

12. LINEAR DC DRIVE (Optional): With digital scale and offset, programmable deadband and update time.

<table>
<thead>
<tr>
<th>Resolution</th>
<th>1 part in 3500 typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy: ±(0.1% of reading + 25 μA).</td>
<td></td>
</tr>
<tr>
<td>Compliance: 10 V (500 Ω max. loop impedance).</td>
<td></td>
</tr>
<tr>
<td>0 to 10 VDC: Resolution: 1 part in 3500 typ.</td>
<td></td>
</tr>
<tr>
<td>Accuracy: ±(0.1% of reading + 35 mV).</td>
<td></td>
</tr>
<tr>
<td>Min. Load Resistance: 10 K Ω (1 mA max.).</td>
<td></td>
</tr>
<tr>
<td>Source: % output power, setpoint, deviation, or process value.</td>
<td></td>
</tr>
<tr>
<td>(Available for OP1 or OP2, but not both.)</td>
<td></td>
</tr>
</tbody>
</table>

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SPECIFICATIONS (Cont’d)

13. ALARMS (Optional):
   Hardware: Plug-in, replaceable output module.
   Modes:
   Absolute high acting
   Absolute low acting
   Deviation high acting
   Deviation low acting
   Inside band acting
   Outside band acting
   Timed event output(s)
   Reset Action: Programmable; automatic or latched.
   Delay: Programmable; enable or disable.
   Hysteresis: Programmable.
   Ammuntiator: LED backlight for “AL1”, “AL2”, (Alarm #2 not available with secondary output).

14. SERIAL COMMUNICATIONS (Optional):
   Type: RS485 Multi-point, Balanced Interface.
   Communication Format:
   Baud Rate: Programmable from 300 to 9600.
   Parity: Programmable for odd, even, or no parity.
   Frame: 1 start bit, 7 data bits, 1 or no parity bit, 1 stop bit.
   Unit Address: Programmable from 0-99, max. of 32 units per line.
   Transmit Delay: 100 msec min., 200 msec max.
   RS485 Common: Isolated from signal input common.
   Auto Print Time: Off to 9999 seconds between print-outs.

15. USER INPUT:
   VIN MAX = 5.25 VDC, VIL = 0.85 VMAX; VIH = 2.0 VMIN
   Response time: 100 msec max.
   Functions:
   Program Lock
   Integral Action Lock
   Auto/Manual Transfer
   Setpoint Ramp Select
   Reset Alarms

16. ENVIRONMENTAL CONDITIONS:
   Operating Temperature Range: 0° to 50°C
   Storage Temperature Range: -40° to 80°C
   Span Drift: 0 to 10 VDC Range - 0.2 mV/°C
   90 ppm/°C
   -40° to 80°C
   Zero Drift:
   4 to 20 mA DC Range - 0.5 µA/°C
   Relative Humidity: Less than 85% RH (non-condensing)
   Altitude: Up to 2000 meters

17. CERTIFICATIONS AND COMPLIANCES:
   SAFETY
   UL Listed, File #E137808, UL508, CSA C22.2 No. 14-M95
   LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
   UL Recognized Component, File #E156876, UL873, CSA C22.2 No. 24
   Recognized to U.S. and Canadian requirements under the Component
   Recognition Program of Underwriters Laboratories, Inc.
   Type 2 or 4X Enclosure rating (Face only), UL50
   IEC/IEC CB Scheme Test Certificate #UL1239-156876/USA,
   CB Scheme Test Report #96ME50279-070794
   Issued by Underwriters Laboratories, Inc.
   IEC 1010-1, EN 61010-1: Safety requirements for electrical equipment
   for measurement, control, and laboratory use, Part 1.
   IP65 Enclosure rating (Face only), IEC 529

   ELECTROMAGNETIC COMPATIBILITY:
   Immunity to EN 50082-2
   Electrostatic discharge
   EN 61000-4-2
   Level 2; 4 Kv contact
   Level 3; 8 Kv air
   Level 3; 10 V/m
   80 MHz - 1 GHz
   Fast transients (burst)
   EN 61000-4-4
   Level 4; 2 Kv I/O
   Level 3; 2 Kv power
   RF conducted interference
   EN 61000-4-6
   Level 3; 10 V/m
   150 kHz - 80 MHz
   Emissions to EN 50081-2
   RF interference
   EN 55011
   Enclosure class A
   Power mains class A

   Notes:
   1. Self-recoverable loss of performance during EMI disturbance at 10 V/m:
      Measurement input and/or analog output signal may deviate during
      EMI disturbance.
      For operation without loss of performance:
      Install power line filter, RLC #LFIL0000 or equivalent.
   2. Self-recoverable loss of performance during EMI disturbance at 10 V/m:
      Measurement input and/or analog output signal may deviate during
      EMI disturbance.
      For operation without loss of performance:
      Install power line filter, RLC #LFIL0000 or equivalent.
      Refer to the EMC Installation Guidelines section of the manual for additional
      information.

   18. CONNECTION:
      J-type terminal block.
   19. CONSTRUCTION:
      Front Panel: Flame and scratch resistant tinted plastic.
      Case: High impact black plastic. (Mounting collar included).
      NEMA 4X/IP65 model only:
      Sealed bezel utilizing 2 captive mounting screws (panel gasket included).
      This unit is rated for NEMA 4X/IP65 indoor use. Installation Category II, Pollution Degree 2.
   20. WEIGHT:
      1.3 lbs. (0.6 kgs)

BASIC OPERATION

The PSC controls the process profile of a system by measuring the input signal,
comparing it to the setpoint value of the profile in progress, and
calculates the new output power value by use of a modified PID control
algorithm. The unit controls the system with the new output power value so the
process value conforms to the profile. The PID control algorithm incorporates
features which provide high control accuracy and low disturbance overshoot.

FRONT PANEL FEATURES

In the normal display mode, the unit will display the scaled process value in
the upper display. One of five other parameters may be selected for viewing in
the lower display:
   Target setpoint
   % Output Power
   Profile Status
   Profile phase time remaining
   Blank the lower display.

The profile status display indicates the active program number with the
current ramp or hold phase of the program. The profile can be started, stopped,
advanced, etc., from the front panel when the profile status display is viewed, if
not locked from access.

The phase time remaining display, shows the time remaining in a ramp or hold
phase and, if not locked from access, may be changed on-line to effect temporary
changes to the profile. Additionally, the target setpoint and % output power
(manual mode only) may also be changed on-line or locked from operator access.

From the normal operating mode, parameters are selected by use of the PAR
button and modified by use of the UP and DOWN buttons. Parameters are then
entered by the PAR button, which advances the user to the next parameter.
Pressing the DSP button immediately returns the controller to the normal
operating mode from any parameter module. The controller configuration and
parameter settings are stored in an internal EEPROM device.

HARDWARE FEATURES

The fast 100 msec input sampling rate provides quick controller response to a
process disturbance for excellent process control. Measurement accuracy of 0.15%
provides closer process control conforming to the desired control setpoint value.

The unit will accept either a 0 to 10 VDC or a 4 to 20 mA DC input signal. The A.C.
input power is switch selectable, allowing the unit to operate from either 115 VAC
or 230 VAC. Since the controller is serviceable from the front of the panel, the
output modules may be easily changed or replaced without disturbing the wiring
behind the panel and NO re-programming is required. The standard model simply
requires pressing a latch to remove the unit. The NEMA 4X/IP65 rated model utilizes
two panel securing screws and a neoprene gasket to guarantee a water tight seal, when
properly installed.

Low-drift, highly stable circuit design ensures years of reliable and accurate
process control. The recommended two year re-calibration interval is easily
accomplished via the programming menu.
SETPOINT FEATURES
The controller’s setpoint can be protected from out of range values, by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can also be programmed.

The setpoint ramp feature ramps the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate, independent of a programmed profile. This feature reduces shock to the process and also helps to minimize overshoot.

The active setpoint, which can be a running profile, may also be transmitted and loaded into nonvolatile memory. The operator may view and modify the active setpoint, which can be a running profile, at any time.

INPUT FEATURES
A programmable input filter can be used to stabilize readings from a process with varying or oscillating characteristics, helping to provide better process control.

Scaling points allow the controller to display in any engineering unit; flow, level, pressure, temperature, etc. Scaling points are used in conjunction with the programmable rounding increment to stabilize a jittery or otherwise hard to read process signal for better indication.

A programmable User Input is available to control a variety of controller functions, such as profile control, auto/manual transfer, serial communication and print requests, etc.

OUTPUT FEATURES
Programmable output power limits provide protection for processes where too much power can cause damage. Automatic signal overdrive detection can be used to detect if the output of the channels, when this situation occurs. With adjustable time proportioning-cycle time and programmable D.C. Linear output, the controller can satisfy a wide variety of output requirements.

During execution of a profile, two independent timed event output channels are available to control or signal other equipment. The event outputs use the alarm channels.

The RS485 Communication option allows the user to access various controller parameters such as the setpoint, % output power, % proportional band, etc. The controller may be setup to transmit various parameters at a programmable automatic print rate.

AUTO-TUNE
The model PSC has an auto-tune feature which, on demand, automatically determines the PID control parameters for a particular process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into nonvolatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked at start-up, while ramping, or at setpoint, depending on the process requirements. A programmable auto-tune damping factor produces various levels of process control and response characteristics.

PROFILE PROGRAMMING
Profiles are programmed independently of each other and are separate from the configuration of other controller parameters. Each profile has parameters for error band (profile conformity), linking, auto-start and program repeat cycles. Profiles may be altered during execution, so changes take effect as the profile advances.
CONTROLLER PROGRAMMING

The model PSC has been designed to reduce the operator interaction with the controller while still maintaining a high degree of control accuracy and user flexibility. The programming of the controller is divided into four sections:

- Hidden Mode
- Protected Mode
- Unprotected Mode
- Configuration Mode

These four programming modes allow the controller to adapt to any required user-interface level.

UNPROTECTED PARAMETER MODE

The unprotected mode is accessible when program disable is inactive or when the proper access code number from the protected mode is entered. Only from this mode can the configuration modes be accessed.

- "SP" - Enter setpoint
- "OPOF" - Enter output power offset
- "OP" - Enter output power
- "ProP" - Enter proportional band
- "Intt" - Enter integral time
- "dErt" - Enter derivative time
- "AL-1" - Enter value for alarm #1
- "AL-2" - Enter value for alarm #2
- "CNFP" - Select basic configuration module
- "End" - Return to normal display mode

PROTECTED PARAMETER MODE

The protected mode is accessible when program disable is active, also this mode prevents access to the configuration modes without the proper access code number. Only the parameters that are selected in the configuration 3 parameter lock-outs section can be accessed.

- "ProP" - Enter proportional band
- "Intt" - Enter integral time
- "dErt" - Enter derivative time
- "AL-1" - Enter value for alarm #1
- "AL-2" - Enter value for alarm #2
- "CodE" - Enter access value to unprotected mode

HIDDEN FUNCTIONS MODE

The hidden mode is accessible from the normal operating mode by holding the PAR button for 3 seconds. The five functions in this mode may be locked-out individually in configuration 3 parameter lock-outs section.

- "CP" - Invoke control point x
- "Prun" - Control ramp/hold profile state
- "tmF" - Transfer between automatic (PID) control and Manual control
- "tUNE" - Invoke/Cancel PID auto-tune
- "ALrS" - Reset latched alarms

OUTPUT VARIATIONS WITHOUT RS485 OPTION

The Dual Alarm or the Secondary with Alarm output, without the RS485 option, has independent outputs. Therefore, the secondary output and/or alarm output(s) can be installed with any combination of output modules.

OUTPUT VARIATIONS WITH RS485 OPTION

The Dual Alarm or the Secondary with Alarm output, with RS485 option, does not have independent outputs. In this case, the secondary output and alarm output(s) must have the same type of output modules installed since they share the common terminal.

OUTPUT MODULES

Units equipped with RS485 option must have the Dual Alarm or Secondary w/alarm options fitted with the same type of output modules. The controller’s main output (OP1) can be fitted with any output module. Output modules are shipped separately and must be installed by the user.

TYPICAL CONNECTIONS

Relay:
- Type: Form - C (Form-A with RS485 option only)
- Rating: 5 Amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive).
- Life Expectancy: 100,000 cycles at maximum load rating.

Logic/SSR Drive:
- Type: Non-isolated switched DC, 12 VDC typical.
- Drive: 45 mA max.

Triac:
- Type: Isolated, Zero Crossing Detection.
- Rating:
  - Voltage: 120/240 VAC.
  - Max. Load Current: 1 Amp @ 35°C
  - 0.75 Amp @ 50°C
  - Min. Load Current: 10 mA
  - Off State Leakage Current: 7 mA max @ 60 Hz.
  - Operating Frequency: 20 to 500 Hz.
  - Protection: Internal Transient Snubber, Fused.
APPLICATION

A chemical treatment process requires the PH level of a solution be ramped at staged levels over specific time periods during start-up. The PSC unit is installed to meet this requirement.

After the tank is filled, the PSC’s user input is triggered to run profile 1 to start the process. Alarm output 2 signals the operator if the PH level deviates outside the running profile. The error band (profile conformance) is programmed to the desired value to prevent the PH level from deviating from the programmed setpoint profile. Timed event output 1 signals that the profile process is complete.
### Ordering Information

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Description</th>
<th>Nema 4X/IP65 Bezel</th>
<th>4 to 20 mA Analog Output</th>
<th>0 to 10 VDC Analog Output</th>
<th>Alarm Outputs</th>
<th>Secondary Output</th>
<th>Rs485 Com</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSC</td>
<td>Process Setpoint Controller</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>2</td>
<td>NO</td>
<td>NO</td>
<td>PSC11001</td>
</tr>
<tr>
<td></td>
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<td>NO</td>
<td>1</td>
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<td>YES</td>
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<td>YES</td>
<td>1</td>
<td>YES</td>
<td>YES</td>
<td>PSC12005</td>
</tr>
</tbody>
</table>

| Relay Module | OMD00000 |
| Triac Module | OMD00001 |
| Logic/SSR Drive Module | OMD00003 |

| PMK5       | Panel Mount Adapter Kit (1/4 DIN to 1/8 DIN) | PMK50000 |

| RLY        | SSR Power Unit                              | RLY50000 |
|           | Single Phase 25 A DIN Rail Mount Solid State Relay | RLY60000 |
|           | Single Phase 40 A DIN Rail Mount Solid State Relay | RLY6A000 |
|           | Three Phase DIN Rail Mount Solid State Relay | RLY70000 |

These models have dual alarm outputs, or single alarm with secondary outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

**Note:** Output Modules are NOT supplied with the controller. When specifying the controller, be sure to purchase the appropriate output module for the Main Control Output and if necessary, the alarm output(s) and secondary output. The controller can be fitted with any combination of output modules that do not have the RS485 option.

The Logic/SSR Drive Module is a switched DC source, intended to drive the DC input of an SSR power unit. It should never be connected to a line voltage.

All modules are shipped separately and must be installed by the user.
MODEL TLA - TEMPERATURE LIMIT ALARM

GENERAL DESCRIPTION

The TLA is a Factory Mutual approved temperature limit alarm, intended to provide an independent shutdown for thermal processes. The TLA accepts signals from a variety of temperature sensors (thermocouple or RTD elements), and its comprehensive programming allows it to meet a wide variety of application requirements.

Dual 4-digit displays allow viewing of the process temperature and limit setpoint simultaneously. Front panel indicators inform the operator of the process and output status. The main limit output and alarm outputs are field replaceable.

The limit output is selectable for high or low trip activation. If the process temperature goes above the limit setpoint for a high trip, or below the limit setpoint for a low trip, the limit relay will de-energize to initiate a process shutdown. The limit output cannot be reset until the process temperature returns to the proper operating range; manual reset is required (local or remote). Sensor failure will initiate a process shutdown.

Relay alarm(s) can be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, and Band IN or OUT) with adjustable hysteresis. A standby feature suppresses the alarm during power-up until the process stabilizes outside the alarm region.

The unit is constructed of a lightweight, high impact plastic case with a tinted front panel. The front panel meets NEMA 4X/IP65 specifications when properly installed. Multiple units can be stacked horizontally or vertically. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the TLA extremely reliable in industrial environments.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the TLA to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the unit.

DIMENSIONS  In inches (mm)

![Dimensions Diagram]

1-717-767-6511
GENERAL SPECIFICATIONS

1. DISPLAY: 2 line by 4-digit LED
   Upper (Main) Display: 0.4" (10.2 mm) high red LED
   Lower (Secondary) Display: 0.3" (7.6 mm) high green LED

Display Messages:
- "OLOL" - Appears when measurement exceeds - sensor range.
- "ULUL" - Appears when measurement exceeds - sensor range.
- "OPEN" - Appears when sensor is detected.
- "SHT" - Appears when shorted sensor is detected (RTD only)
- "..." - Appears when display values exceed + display range.
- "..." - Appears when display values exceed - display range.

2. POWER:
   - Line Voltage Models: 85 to 250 VAC, 50/60 Hz, 8 VA.
   - Low Voltage Models:
     - DC Power: 18 to 36 VDC, 7 W.
     - AC Power: 24 VAC +/-10%, 50/60 Hz, 9 VA

3. CONTROLS: Four rubber push buttons: R, P, Up, Down
4. MEMORY: Nonvolatile E2PROM retains all programmable parameters and values.

5. ENVIRONMENTAL CONDITIONS:
   - Operating Range: FM rated @ 0 to 65°C, UL rated @ 0 to 55°C
   - Storage Range: -40 to 80°C
   - Operating and Storage Humidity: 85% max. relative humidity (non-condensing) from 0°C to 65°C.
   - Altitude: Up to 2000 meters

6. ISOLATION BREAKDOWN RATINGS:
   - AC line with respect to all inputs and outputs: 2300 V for 1 minute (250 V working)
   - Relay contacts to all other inputs and outputs: 2300 VAC
   - DC Power with respect to sensor input: 50 V working (500 V for 1 minute)

7. CERTIFICATIONS AND COMPLIANCEs:
   - SAFETY
     Factory Mutual Approved, Report #3014646, FM 3545, FM 3810
     UL Recognized Component, File #E156876, UL 873, CSA C22.2 No. 24
     Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
     Type 4X Enclosure rating (Face only), UL 50
     IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
     IP65 Enclosure rating (Face only), IEC 529

INPUT SPECIFICATIONS

1. SENSOR INPUT:
   - Sample Period: 100 msec
   - Step Response Time: Less than 300 msec typ., 400 msec max. (to within 99% of final value)
   - Normal Mode Rejection: Greater than 40 dB @ 50/60 Hz
   - Common Mode Rejection: Greater than 120 dB, DC to 60 Hz
   - Overvoltage Protection: Input overload 120 VAC for 15 seconds max.
   - Failing Sensor Response: Main Output: Sensor failure will initiate a process shutdown
     Display: “OPEN”
     Alarms: Upscale

3. INDICATION ACCURACY:
   ±(0.3% of Span +1°C) at 23°C ambient after 20 minute warm-up. (Includes NIST conformity, cold junction effect, A/D conversion errors and linearization conformity)

4. RTD INPUT:
   - 2 or 3 wire, 100 Ω platinum, alpha = 0.00385 (DIN 43760), alpha = 0.0039162
   - Excitation: 150 μA typical
   - Resolution: 1 or 0.1 degree
   - Lead Resistance: 15 Ω max. per input lead

5. THERMOCOUPLE INPUT:
   - Types: T, E, J, K, R, S, B, N, Linear mV, software selectable
   - Input Impedance: 20 MΩ all types
   - Lead resistance effect: 0.25 μV/Ω
   - Cold junction compensation: Less than ±1°C typ., (±1.5°C max), error over 0 to 65°C max. ambient temperature range. Defeated for Linear mV indication mode.

   Resolution: 1° for all types, or 0.1° for T, E, J, K, and N only.

<table>
<thead>
<tr>
<th>TC TYPE</th>
<th>RANGE</th>
<th>WIRE COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>-200 to +400°C</td>
<td>blue (+)</td>
</tr>
<tr>
<td></td>
<td>-328 to +752°F</td>
<td>red (-)</td>
</tr>
<tr>
<td>E</td>
<td>-200 to +750°C</td>
<td>violet (+)</td>
</tr>
<tr>
<td></td>
<td>-328 to +1382°F</td>
<td>red (+)</td>
</tr>
<tr>
<td>J</td>
<td>-200 to +700°C</td>
<td>white (+)</td>
</tr>
<tr>
<td></td>
<td>-328 to +1400°F</td>
<td>red (-)</td>
</tr>
<tr>
<td>K</td>
<td>-200 to +1250°C</td>
<td>yellow (+)</td>
</tr>
<tr>
<td></td>
<td>-328 to +2282°F</td>
<td>red (-)</td>
</tr>
<tr>
<td>R</td>
<td>0 to +1768°C</td>
<td>black (+)</td>
</tr>
<tr>
<td></td>
<td>+32 to +3214°F</td>
<td>red (-)</td>
</tr>
<tr>
<td>S</td>
<td>0 to +1768°C</td>
<td>black (+)</td>
</tr>
<tr>
<td></td>
<td>+32 to +3214°F</td>
<td>red (-)</td>
</tr>
<tr>
<td>B</td>
<td>+140 to +1820°C</td>
<td>grey (+)</td>
</tr>
<tr>
<td></td>
<td>+300 to +3308°F</td>
<td>red (-)</td>
</tr>
<tr>
<td>mV</td>
<td>-200 to +1300°C</td>
<td>orange (+)</td>
</tr>
<tr>
<td></td>
<td>+328 to +2372°F</td>
<td>red (-)</td>
</tr>
</tbody>
</table>

6. REMOTE RESET INPUT: Internally pulled up to +5 VDC (1MΩ).
   - VHI: 0.85 V max., VHI: 3.65 V min., VIN MAX: 5.25 VDC, IOFF: 1μA max.
OUTPUT SPECIFICATIONS

1. LIMIT AND ALARM OUTPUT RELAYS:
   Contact Rating: 5 A @ 250 V AC or 30 V DC (resistive load) 1/10 HP @ 120 V AC (inductive load)
   Life Expectancy: 100,000 cycles at max. load rating. (Decreasing load increases life expectancy.)

2. LIMIT OUTPUT: TLA21000: Form-C relay; TLA11100: Form-A relay. Selectable for high or low trip activation. If the process temperature goes above the limit setpoint for a high trip, or below the limit setpoint for a low trip, the limit relay will de-energize to initiate a process shutdown. The limit output cannot be reset until the process temperature returns to the proper operating range; manual reset is required (local or remote).

   Annunciators:
   “EX” - Lit when the process temperature exceeds the limit setpoint.
   “OUT” - Lit when the limit output is de-energized.

3. ALARM OUTPUTS (Optional): One or two Form-A relays.
   Modes:
   - Absolute High Acting
   - Absolute Low Acting
   - Deviation High Acting
   - Deviation Low Acting
   - Inside Band Acting
   - Outside Band Acting

   Reset Action: Programmable; automatic or latched. Latched alarms can be reset regardless of limit exceed condition.

   Standby Mode: Programmable; enable or disable.

   Hysteresis: Programmable.

   Annunciator: “A1” and “A2” programmable for normal or reverse acting.

ORDERING INFORMATION

85 to 250 VAC

<table>
<thead>
<tr>
<th>LIMIT OUTPUT</th>
<th>ALARM 1 OUTPUT</th>
<th>ALARM 2 OUTPUT</th>
<th>REPLACEMENT OUTPUT BOARD</th>
<th>PART NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form-C Relay</td>
<td>Form-A Relay</td>
<td></td>
<td>RBDLA210</td>
<td>TLA21000</td>
</tr>
<tr>
<td>Form-A Relay</td>
<td>Form-A Relay</td>
<td></td>
<td>RBD48111</td>
<td>TLA11100</td>
</tr>
</tbody>
</table>

18 to 36 VDC / 24 VAC

<table>
<thead>
<tr>
<th>LIMIT OUTPUT</th>
<th>ALARM 1 OUTPUT</th>
<th>ALARM 2 OUTPUT</th>
<th>REPLACEMENT OUTPUT BOARD</th>
<th>PART NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form-C Relay</td>
<td>Form-A Relay</td>
<td></td>
<td>RBDLA210</td>
<td>TLA21010</td>
</tr>
<tr>
<td>Form-A Relay</td>
<td>Form-A Relay</td>
<td></td>
<td>RBD48111</td>
<td>TLA11110</td>
</tr>
</tbody>
</table>

EMC INSTALLATION GUIDELINES

Although this unit is designed with a high degree of immunity to Electro Magnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into the unit may be different for various installations. Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The unit should be mounted in a metal enclosure, which is properly connected to protective earth. Use shielded (screened) cables for all Signal and Control inputs. The shield (screen) pigtail connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.
   a. Connect the shield only at the panel where the unit is mounted to earth ground (protective earth).
   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is above 1 MHz.
   c. Connect the shield to common of the unit and leave the other end of the shield unconnected and insulated from earth ground.

2. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.

3. Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.

4. In very electrically noisy environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure.

   The following EMI suppression devices (or equivalent) are recommended:
   - Ferrite Suppression Cores for signal and control cables:
     - Fair-Rite # 0443167251 (RLC #FCOR0000)
     - TDK # ZCAT3035-1330A
     - Steward #28B2029-0A0
   - Line Filters for input power cables:
     - Schaffner # FN610-1/07 (RLC #LFIL0000)
     - Schaffner # FN670-1.8/07
     - Corcom #1VR3
   - Note: Reference manufacturer’s instructions when installing a line filter.

5. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.

6. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.

   Snubbers:
   - RLC #SNUB0000

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1.0 INSTALLING THE TLA

The TLA meets NEMA 4X/IP65 requirements for indoor use to provide a watertight seal in steel panels with a minimum thickness of 0.09 inch, or aluminum panels with a minimum thickness of 0.12 inch. The units are intended to be mounted into an enclosed panel. It is designed so that the units can be stacked horizontally or vertically. The bezel assembly MUST be in place during installation of the unit.

Instructions:

1. Prepare the panel cutout to the dimensions.
2. Remove the panel latch from the unit. Discard the cardboard sleeve.
3. Carefully remove the center section of the panel gasket and discard. Slide the panel gasket over the unit from the rear, seating it against the lip at the front of the case.
4. Insert the unit into the panel cutout. While holding the unit in place, push the panel latch over the rear of the unit, engaging the tabs of the panel latch in the farthest forward slot possible.
5. To achieve a proper seal, tighten the panel latch screws evenly until the unit is snug in the panel, torquing the screws to approximately 7 in-lbs (79 N-cm). Over tightening can result in distortion of the panel, and reduce the effectiveness of the seal.

Note: The installation location of the TLA is important. Be sure to keep it away from heat sources (ovens, furnaces, etc.), and away from direct contact with caustic vapors, oils, steam, or any other process byproducts in which exposure may affect proper operation.

Multiple Unit Stacking

The TLA is designed for close spacing of multiple units. Units can be stacked either horizontally or vertically. For vertical stacking, install the panel latch with the screws to the sides of the unit. For horizontal stacking, the panel latch screws should be at the top and bottom of the unit. The minimum spacing from center line to center line of units is 1.96" (49.8 mm). This spacing is the same for vertical or horizontal stacking.

Caution: When stacking units, provide adequate panel ventilation to ensure that the maximum operating temperature range is not exceeded.

Caution: Disconnect power to the unit and to the output control circuits to eliminate the potential shock hazard when removing the bezel assembly.

Unit Removal Procedure

To remove a unit from the panel, first loosen the panel latch screws. Insert flat blade screwdrivers between the latch and the case on either side of the unit, so that the latches disengage from the grooves in the case. Push the unit through the panel from the rear.

Removing Bezel Assembly

The bezel assembly must be removed from the case to replace the output board. To remove the bezel assembly, insert a flat blade screwdriver into the pry slot on either side of the unit. Twist the screwdriver handle until the unit is ejected enough to allow removal.

Caution: The bezel assembly contains electronic circuits that can be damaged by static electricity. Before removing the assembly, discharge static charge on your body by touching an earth ground point. It is also important that the bezel assembly be handled only by the bezel itself. Additionally, if it is necessary to handle a circuit board, be certain that hands are free from dirt, oil, etc., to avoid circuit contamination that may lead to malfunction. If it becomes necessary to ship the unit for repairs, place the unit in its case before shipping.

Installing Bezel Assembly

To install the bezel assembly, insert the assembly into the case until the bezel is fully seated against the lip of the case. Properly installing the bezel assembly is necessary for watertight sealing.
2.0 WIRING THE TLA

After the unit has been mechanically mounted, it is ready to be wired. All wiring connections are made to the rear screw terminals. When wiring the unit, use the numbers on the label and those embossed on the back of the case, to identify the position number with the proper function.

All conductors should meet voltage and current ratings for each terminal. Also cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that power supplied to the unit (AC or DC) be protected by a fuse or circuit breaker. Strip the wire, leaving approximately 1/4” (6 mm) bare wire exposed (stranded wires should be tinned with solder). Insert the wire under the clamping washer and tighten the screw until the wire is clamped tightly.

Caution: Unused terminals are NOT to be used as tie points. Damage to the TLA may result if these terminals are used.

POWER WIRING

AC Power
Primary AC power is connected to terminals #11 and #12, labeled AC. To reduce the chance of noise spikes entering the AC line and affecting the TLA, an AC feed separate from that of the load should be used to power the TLA. Be certain that the AC power to the TLA is relatively “clean” and within the variation limit. Connecting power from heavily loaded circuits or circuits that also power loads that cycle on and off (contacts, relays, motors, etc.), should be avoided.

DC Power
DC Power (18 to 36 VDC) is connected to terminals #11 and #12 labeled DC+ and DC- respectively.

CAUTION: Observe proper polarity when connecting DC voltages. Damage to the unit may occur if polarity is reversed.

SIGNAL WIRING

Thermocouple
When connecting the thermocouple, be certain that the connections are clean and tight. If the thermocouple probe cannot be connected directly to the TLA, thermocouple wire or thermocouple extension-grade wire must be used to extend the connection points (copper wire does not work). Always refer to the thermocouple manufacturer’s recommendations for mounting, temperature range, shielding, etc. For multi-probe temperature averaging applications, two or more thermocouple probes may be connected to the TLA (always use the same type). Paralleling a single thermocouple to more than one TLA is not recommended. Generally, the red wire from the thermocouple is negative and connected to the TLA’s common.

RTD
When connecting the RTD, be certain that the connections are clean and tight. RTD sensors have a higher degree of accuracy and stability than thermocouple sensors. Most RTD sensors available are the three wire type. The third wire is a sense lead for canceling the effects of lead resistance of the probe. Four wire RTD elements may be used by leaving one of the sense leads disconnected. Two wire RTD sensors may be used in either of two ways:
A) Attach the RTD to terminals #8 and #10. Install a copper sense wire of the same wire gauge as the RTD leads. Attach one end of the wire at the probe and the other end to terminal #9. Complete lead wire compensation is obtained. This is the preferred method.
B) Attach the RTD to terminals #8 and #10. Install a shorting wire between terminals #9 and #10. A temperature offset error of 2.5°C/ohm of lead resistance exists. The error may be compensated by programming a temperature offset.

Note: With extended cable runs, be sure the lead resistance is less than 15 ohms/lead.

RELAY CONNECTIONS

To prolong contact life and suppress electrical noise interference due to the switching of inductive loads, it is good installation practice to install a snubber across the contactor. Follow the manufacturer’s instructions for installation.

REMOTE RESET WIRING

The use of shielded cable is recommended. Follow the EMC installation guidelines for shield connection.

Terminal #6 is the Remote Reset. Any form of mechanical switch may be connected to terminal #6 (REMOTE RESET) and terminal #8 (COMM.). Sinking open collector logic with less than 0.7 V saturation and off-state leakage current of less than 1 μA may also be used.

Note: Snubber leakage current can cause some electromechanical devices to be held ON.

*Terminal numbers are model dependent. See Terminal Configurations for description.
### 3.0 FRONT PANEL DESCRIPTION

The front panel bezel material is flame and scratch resistant, tinted plastic that meets NEMA 4X/IP65 requirements, when properly installed. Continuous exposure to direct sunlight may accelerate the aging process of the bezel. The bezel should be cleaned only with a soft cloth and neutral soap product. Do NOT use solvents. There are two 4-digit LED displays, a red upper Main Display and a lower green Secondary Display.

There are up to four panel annunciators, with red backlighting, that illuminate to inform the operator of the TLA and output status. See the front panel diagram for a description of the annunciators. Four front panel buttons are used to access different modes and parameters. The following is a description of each button.

- **R** - The Reset (R) button is used to reset the limit and alarm relays. The limit output cannot be reset until the process temperature returns to the proper operating range. Latched alarms can be reset regardless of limit exceed condition.
- **P** - The Parameter (P) button is used to access programming, enter the change, and scroll through the available parameters in any mode. When changes to the parameter are accessed, the new values must be re-entered.
- **UP, DN** - The Up/Down buttons are used to modify parameters.

### Button Functions

**R** - The Reset (R) button is used to reset the limit and alarm relays. The limit output cannot be reset until the process temperature returns to the proper operating range. Latched alarms can be reset regardless of limit exceed condition.

**P** - The Parameter (P) button is used to access programming, enter the change, and scroll through the available parameters in any mode. When changes to the parameter are accessed, the new values must be re-entered.

**UP, DN** - The Up/Down buttons are used to modify parameters.

### TLA CONFIGURATION OVERVIEW

The TLA is programmed with certain parameter settings from the factory. Factory settings are listed in parentheses in the various Configuration of Parameters tables. In many cases, these settings must be changed to the particulars of the application before proper operation can be started.

The TLA is typically in the Normal Display Mode. In this mode, the process temperature is displayed in the main (top) display, and the limit setpoint is displayed in the secondary (bottom) display. When changes to the parameter configurations are needed, the P button is pressed, and the TLA will enter into the Parameter Mode.

### PARAMETER CONFIGURATION BASIC STARTUP

For basic start-up, it is important to verify or change Input Parameter Module (1-IN) parameters (YPE and SCAL, and Output Parameter Module (2-OP) parameter LiAC (Limit Trip Action). For alarm set-up, it is important to verify or change Alarms Parameter Module (4-AL) parameters AC1, AL-1, AC2, and AL-2.

If the above Input parameters or the input wiring connections are not correct, then the main (top) display may display an error message or incorrect value. Verify the input programming and wiring. (If incorrect display continues, refer to the Troubleshooting section.) All other parameter configurations are important but will not prevent the TLA from showing a correct display.

### 4.0 PARAMETER MODE

The Parameter Mode is accessed by pressing the P Button from the Normal Display Mode. While in the Parameter Mode, the temperature is displayed in the main (top) display, and the parameter is displayed in the secondary (bottom) display. The correct password must be entered before any parameters can be accessed. To modify values, use the UP or DOWN button while the parameter is displayed. Use the P button to accept the new value, and to scroll through the parameters. The TLA will automatically return to the normal display mode if no action is taken. The TLA responds to the new values immediately, but the change is not committed to non-volatile memory until the TLA is returned to the Normal Display Mode. If power loss occurs before returning to the normal display mode, the new values must be re-entered.

To gain access to the Configuration Parameter Modules continue to CNFP and press the UP button. These modules allow access to the fundamental set-up parameters of the TLA. If the setpoint or alarm values are modified, the CNFP step will be skipped.

### Parameter Mode Reference Table

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>PARAMETER</th>
<th>RANGE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PASS</td>
<td>Password to access parameters</td>
<td>0 to 250</td>
<td>If an incorrect value is entered, the TLA will display &quot;End&quot; momentarily, and then return to the normal display mode. The default password is 10. The wildcard password is 222 (in case the password is forgotten).</td>
</tr>
<tr>
<td>SP</td>
<td>Limit setpoint</td>
<td>-999 to 9999</td>
<td>Range limited by SPLO &amp; SPHI.</td>
</tr>
<tr>
<td>AL-1 *</td>
<td>Alarm #1</td>
<td>-999 to 9999</td>
<td>The Alarm parameters can be independently locked out from appearing. See Configuration Module 3, Parameter Lock-outs.</td>
</tr>
<tr>
<td>AL-2 *</td>
<td>Alarm #2</td>
<td>-999 to 9999</td>
<td></td>
</tr>
<tr>
<td>CNFP</td>
<td>Configuration parameter modules</td>
<td>&quot;Up&quot; button: enter configuration modules.</td>
<td>These modules allow access to the fundamental set-up parameters of the TLA. The modules are grouped into related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each module, the program returns to &quot;CNFP&quot;.</td>
</tr>
<tr>
<td>End</td>
<td>End of Parameter Mode</td>
<td></td>
<td>When the parameter list has been scrolled through, the TLA will display &quot;End&quot; momentarily, and then return to the normal display mode.</td>
</tr>
</tbody>
</table>

* Model Number Dependent.
CONFIGURATION PARAMETER MODULES

The Configuration Parameter modules are accessed by pressing the UP button from CNFP in the Parameter Mode. The UP or DOWN buttons can be pressed to move to the desired Parameter Module. The P button is then pressed to enter into that module. The main (top) display will be the parameter, and the secondary (bottom) display will be the parameter value. The UP or DOWN buttons are used to modify the desired parameter value, and the P button enters the new value, and moves to the next parameter. The TLA responds to the new values after the P button is pressed, however, the change is not committed to permanent memory until the TLA is returned to the Normal Display Mode. If power loss occurs before returning to the Normal Display Mode, the new values must be entered again. At the end of each module, the TLA will go back to CNFP. Other Parameter Modules can be accessed by pressing the UP or DOWN buttons, or pressing P will return to the Normal Display Mode.

Parameters that are model number, or program dependent will only be displayed when the appropriate options are installed or programmed.

### CONFIGURE MODULE 1 - INPUT PARAMETERS (1-IN)

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>PARAMETER</th>
<th>RANGE (FACTORY SETTING)</th>
<th>DESCRIPTION/ COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE</td>
<td>Input Type</td>
<td>tc-t - Type T TC</td>
<td>Select from the list of various thermocouple and RTD sensors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tc-E - Type E TC</td>
<td>TC types and various linear scales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tc-J - Type J TC</td>
<td>TC types and various linear scales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tc-K - Type K TC</td>
<td>TC types and various linear scales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tc-R - Type R TC</td>
<td>TC types and various linear scales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tc-S - Type S TC</td>
<td>TC types and various linear scales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tc-B - Type B TC</td>
<td>TC types and various linear scales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tc-N - Type N TC</td>
<td>TC types and various linear scales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LIN - Linear mV</td>
<td>TC types and various linear scales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>r385 - 385 curve RTD</td>
<td>TC types and various linear scales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>r392 - 392 curve RTD</td>
<td>TC types and various linear scales.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rLIN - Linear ohms</td>
<td>TC types and various linear scales.</td>
</tr>
</tbody>
</table>

| SCAL    | Temperature Scale | °F or °C                  | Select either degrees Fahrenheit (F) or degrees Celsius (C). If changed, be sure to check all parameters. |
| dCPt    | Temperature Resolution | 0 or 0.0 (0)            | Select either 1 or 0.1 degree resolution. If changed, be sure to check all parameters. |
| FLtr    | Digital Input Filtering and Display Update | 0 to 4 0 - least input filtering 3 - most input filtering 4 - most input filtering and slower 500 msec display update rate (outputs still update at 100 msec rate) (1) | Select the relative degree of input signal filtering and display update rate. The filter is an adaptive digital filter that discriminates between measurement noise and actual process changes. Therefore, the influence on step response time is minimal. If the signal is varying too greatly due to measurement noise, increase the filter value. Conversely, if the fastest TLA response is desired, decrease the filter value. |
| SHFI    | Input Signal Shift (correction offset) | -999 to 9999 1 or 0.1 degree (0) | If the TLA temperature disagrees with a reference temperature instrument or if the temperature sensor has a known calibration, the TLA temperature can be compensated by a correction offset. The following equation expresses the relationship: Desired Display Temp = (TLA Temp) + SHFI. Normally set to 0. |
| SPLO    | Limit Setpoint Lower Limit | -999 to 9999 1 or 0.1 degree (0) | The TLA has programmable high and low setpoint limit values to restrict the setting range of the limit setpoint. Set the limit values so that the temperature setpoint value cannot be set outside the safe operating area of the process. SPHI must be above SPLO. |
| SPHI    | Limit Setpoint Upper Limit | -999 to 9999 1 or 0.1 degree (9999) | The TLA has programmable high and low setpoint limit values to restrict the setting range of the limit setpoint. Set the limit values so that the temperature setpoint value cannot be set outside the safe operating area of the process. SPHI must be above SPLO. |

### CONFIGURE MODULE 2 - OUTPUT PARAMETERS (2-OP)

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>PARAMETER</th>
<th>RANGE (FACTORY SETTING)</th>
<th>DESCRIPTION/ COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LiAc</td>
<td>Limit Output Trip Action</td>
<td>LO - Low Acting Hi - High Acting (HI)</td>
<td>The limit output is selectable for high or low trip activation. If the process temperature goes above the limit setpoint for a high trip, or below the limit setpoint for a low trip, the limit relay will de-energize to initiate a process shutdown. See the Limit Output Action section for details.</td>
</tr>
</tbody>
</table>
### Configure Module 3 - Lockout Parameters (3-LC)

<table>
<thead>
<tr>
<th>Display</th>
<th>Parameter</th>
<th>Range (Factory Setting)</th>
<th>Description/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PASS</td>
<td>Password</td>
<td>0 to 250 (10)</td>
<td>The password is required to access all parameters. The password can be set to any value between 0 and 250. A wildcard password, 222, can be used as an alternative to the programmed password.</td>
</tr>
<tr>
<td>AL *</td>
<td>Alarms #1 and #2 access level</td>
<td>LOC - lockout, prevents the alarms from appearing rEd - read only, alarms appear, but cannot be modified Ent - enter, alarms appear, and can be modified (Ent)</td>
<td>The alarm(s) parameter in the Parameter Mode can be configured to be completely locked out, read only, or fully accessible.</td>
</tr>
<tr>
<td>FPrS</td>
<td>Front panel reset</td>
<td>NO - disabled YES - active (YES)</td>
<td>The front panel R button can be enabled or disabled. The Remote Reset input is not affected by this setting.</td>
</tr>
</tbody>
</table>

* Model Number Dependent.

### Configure Module 4 - Alarms Parameters (4-AL)

<table>
<thead>
<tr>
<th>Display</th>
<th>Parameter</th>
<th>Range (Factory Setting)</th>
<th>Description/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Act1</td>
<td>Alarm 1 action mode</td>
<td>A-HI - absolute high A-LO - absolute low d-HI - deviation high d-LO - deviation low b-IN - band inside b-OT - band outside (A-HI)</td>
<td>When deviation low-acting with positive alarm value (d-LO), deviation high-acting with negative value (d-HI), or band inside-acting (b-IN) is selected for the alarm action, the indicator is OFF when the alarm output is ON. See the Alarms section for complete details of each action. If changed, check alarm values.</td>
</tr>
<tr>
<td>rSt1</td>
<td>Alarm 1 reset mode</td>
<td>Auto - automatic LATC - manual reset (Auto)</td>
<td>Automatic reset alarms are reset by the TLA when the alarm condition clears. Latched alarms require operator action to reset the alarm condition. The front panel R button, if enabled, can be used to reset a latched alarm (see FPrS in Configure Module 3). A latched alarm condition may also be reset via the Remote Reset input. See the Reset Action diagram in the Alarms section.</td>
</tr>
<tr>
<td>Stb1</td>
<td>Alarm 1 standby function (delay)</td>
<td>NO or YES (NO)</td>
<td>The alarm(s) may be independently configured to exhibit a power-on, standby delay which suppresses the alarm output from turning ON until the temperature first stabilizes outside the alarm region. After this condition is satisfied, the alarm standby delay is canceled and the alarm triggers normally, until the next TLA power-on. This feature also works for deviation and band alarms when the setpoint is changed via keypad. This action suppresses “nuisance” alarms. See the Alarm Standby diagram in the Alarms section.</td>
</tr>
<tr>
<td>AL-1</td>
<td>Alarm 1 value</td>
<td>-999 to 9999 (0)</td>
<td>The alarm values are either absolute values, or relative to the limit setpoint value (deviation and band alarms). An absolute alarm value is the value that is entered for the alarm. A relative alarm value is the mathematical sum of the temperature limit setpoint value and the alarm value (positive or negative), thus a relative alarm tracks the limit setpoint value as it is changed. If the alarm action is set as a Band Alarm, then only a positive alarm value can be entered.</td>
</tr>
<tr>
<td>rSt2 *</td>
<td>Alarm 2 reset mode</td>
<td>Auto - automatic LATC - manual reset (Auto)</td>
<td></td>
</tr>
<tr>
<td>Stb2 *</td>
<td>Alarm 2 standby function (delay)</td>
<td>NO or YES (NO)</td>
<td></td>
</tr>
<tr>
<td>AL-2 *</td>
<td>Alarm 2 value</td>
<td>-999 to 9999 (0)</td>
<td></td>
</tr>
<tr>
<td>AHYS</td>
<td>Alarm hysteresis value</td>
<td>1 to 250 (1)</td>
<td>The alarm value(s) have a programmable hysteresis band to prevent alarm output chatter near the alarm trigger point. The hysteresis value should be set to eliminate this effect. A value of 2 to 5 is usually sufficient for most applications. A single alarm hysteresis value applies to both alarms. See the Alarm Action Figures, in the Alarms section, for the effect of hysteresis on the various alarm types.</td>
</tr>
</tbody>
</table>

* Model Number Dependent.
CONFIGURE MODULE 9 - FACTORY SERVICE OPERATIONS (9-FS)

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>PARAMETER</th>
<th>RANGE</th>
<th>DESCRIPTION/ COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CodE</td>
<td>Factory service function code</td>
<td>48 - Calibrate instrument</td>
<td>TLA calibration. Refer to the Calibration section for details.</td>
</tr>
<tr>
<td></td>
<td>66 - Reset parameters to factory settings</td>
<td>Entering code 66 restores all parameters to factory settings. The unit indicates the operation after the P button is pressed, by displaying &quot;rSEt&quot; in the lower display momentarily.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>77 (twice in succession) - Reset TLA calibration to nominal values</td>
<td>Caution: this operation erases the TLA calibration values and defaults the values to nominal settings. Reading errors of ±10% may result. Do not perform this operation unless the TLA has lost calibration. Loss of calibration is signaled by an &quot;E-CL&quot; error flag at power-up. To clear this flag, perform calibration procedure as noted in the Calibration section. Alternatively, &quot;stepping&quot; through one of the calibration procedures clears the error flag, but does NOT validate the calibration accuracy in any manner.</td>
<td></td>
</tr>
</tbody>
</table>

USER PARAMETER VALUE CHART
TLA Number _____________

<table>
<thead>
<tr>
<th>MNEMONIC</th>
<th>PARAMETER</th>
<th>USER SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR5S</td>
<td>Password</td>
<td>_____________</td>
</tr>
<tr>
<td>SP</td>
<td>Limit Setpoint</td>
<td>_____________</td>
</tr>
<tr>
<td>RL - 1</td>
<td>Alarm 1 Value</td>
<td>_____________</td>
</tr>
<tr>
<td>RL - 2</td>
<td>Alarm 2 Value</td>
<td>_____________</td>
</tr>
</tbody>
</table>

3 - LC Lockout Parameters

<table>
<thead>
<tr>
<th>MNEMONIC</th>
<th>PARAMETER</th>
<th>USER SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR5S</td>
<td>Password</td>
<td>_____________</td>
</tr>
<tr>
<td>RL</td>
<td>Alarm(s) Access Level</td>
<td>_____________</td>
</tr>
<tr>
<td>FP, S</td>
<td>Front Panel Reset</td>
<td>_____________</td>
</tr>
</tbody>
</table>

4 - RL Configure Alarm Parameters

<table>
<thead>
<tr>
<th>MNEMONIC</th>
<th>PARAMETER</th>
<th>USER SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC1</td>
<td>Alarm 1 Action Mode</td>
<td>_____________</td>
</tr>
<tr>
<td>RS1</td>
<td>Alarm 1 Reset Mode</td>
<td>_____________</td>
</tr>
<tr>
<td>SKb1</td>
<td>Alarm 1 Standby Enabled</td>
<td>_____________</td>
</tr>
<tr>
<td>RL - 1</td>
<td>Alarm 1 Value</td>
<td>_____________</td>
</tr>
<tr>
<td>RC2</td>
<td>Alarm 2 Action Mode</td>
<td>_____________</td>
</tr>
<tr>
<td>RS2</td>
<td>Alarm 2 Reset Mode</td>
<td>_____________</td>
</tr>
<tr>
<td>SKb2</td>
<td>Alarm 2 Standby Enabled</td>
<td>_____________</td>
</tr>
<tr>
<td>RL - 2</td>
<td>Alarm 2 Value</td>
<td>_____________</td>
</tr>
<tr>
<td>RHYS</td>
<td>Alarm Hysteresis Value</td>
<td>_____________</td>
</tr>
</tbody>
</table>

2 - OP Output Parameters

<table>
<thead>
<tr>
<th>MNEMONIC</th>
<th>PARAMETER</th>
<th>USER SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>L , RC</td>
<td>Limit Output Trip Action</td>
<td>_____________</td>
</tr>
</tbody>
</table>
LIMIT OUTPUT ACTION

The limit output is selectable for high or low trip activation. If the process temperature goes above the limit setpoint for a high trip, or below the limit setpoint for a low trip, the limit relay will de-energize to initiate a process shutdown. The limit output cannot be reset until the process temperature returns to the proper operating range; manual reset is required. The following action figures describe the status of the limit output and the front panel indicators for various over/under setpoint, and reset conditions. Reset is either by the front panel R button, if enabled, or by the Remote Reset input, terminal #6. Refer to Configure Module 2 - Output Parameters for details of configuring the limit output. Refer to Configure Module 3 - Lockout Parameters for details of configuring the front panel Reset button.

5.0 ALARMS (OPTIONAL)

The alarm action figures describe the status of the alarm output and the front panel indicator for various over/under temperature conditions. The alarm output waveform is shown with the output in the automatic reset mode. Select the alarm action with care -- in some configurations, the front panel indicator (LED) might be OFF while the output is ON. Refer to Configure Module 4 - Alarm Parameters for details of configuring the alarms.
CALIBRATION CHECKS

The instrument has been fully calibrated at the factory for all input types. If the unit appears to be indicating or controlling incorrectly, see the Troubleshooting section before attempting this procedure.

If the TLA is suspected of reading incorrectly, the instrument may be checked for indication accuracy without disturbing the factory calibration. The following procedures may be used for this purpose.

Note: Allow ½ hour warm-up before checking these parameters.

mV Reading Check
1. Connect a DC mV source with an accuracy of 0.03% or better to terminal #8 (-) & #9 (+).
2. Configure Input Parameters Module 1 for linear mV (Lin) input, under TYPE.
3. Compare the TLA read-out to the standard at various points over the range (-5.00 mV to 56.00 mV). The tolerance is ±(0.15% of reading + 1 LSD).
4. Calibrate the TLA if the readings are out of tolerance.

Thermocouple Cold Junction Temperature Check
1. Connect a thermocouple probe of known accuracy (Types T, E, J, K, N only) to TLA. Select the probe used in Configure Module 1.
2. Connect a reference temperature probe to measuring end of thermocouple to monitor temperature. Allow sufficient time for temperatures to equalize.
3. Compare TLA display with reference temperature probe. The TLA display should equal the calibrated probe temperature. (Tolerance is ±1°C.)
4. Calibrate the cold junction temperature if out of tolerance.

Error Flag E-CL
If error flag “E-CL” appears at power-up, a loss of calibration parameters due to noise spikes has occurred. Entering code 77 twice in Factory Service Operations Module (9-FS) erases the TLA calibration values and defaults the values to nominal settings. Reading errors of ±10% may result. It is recommended that the TLA be fully recalibrated. If using thermocouple only, the RTD calibration need not be performed.

Note: the “E-CL” flag may be cleared by “stepping” through cold junction calibration procedure without the need to change any calibration values. A ±10% reading error will still exist.
6.0 Calibration

When re-calibration is required (generally every two years), this procedure should be performed by qualified technicians using appropriate equipment. Equipment source accuracy of 0.03% or better is required.

The procedure consists of: applying accurate mV signals, setting the thermocouple cold junction temperature, and applying precision resistance, among others. Allow a 30 minute warm-up period before starting this procedure. Do not use thermocouple wire for the millivolt or RTD ohms calibration.

Factory Service Operations - Calibration (9-FS)

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>PARAMETER</th>
<th>RANGE</th>
<th>DESCRIPTION/ COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CodE</td>
<td>Enter function code</td>
<td>48</td>
<td>Calibrate instrument.</td>
</tr>
<tr>
<td>CAL</td>
<td>Millivolt calibration</td>
<td>yes/no</td>
<td>Calibration required for both RTD and TC input. If this procedure is performed, the cold junction temp or RTD ohms calibration procedures in turn must be completed.</td>
</tr>
<tr>
<td>CJC</td>
<td>Thermocouple cold junction temperature calibration</td>
<td>yes/no</td>
<td>Not required if only using RTD input. This procedure can only be performed AFTER an accurate mV calibration.</td>
</tr>
<tr>
<td>rtd</td>
<td>RTD resistance calibration</td>
<td>yes/no</td>
<td>Not required if only using TC input. This procedure can only be performed AFTER an accurate mV calibration.</td>
</tr>
</tbody>
</table>

Millivolt Calibration (CAL)

Connect precision millivolt source with an accuracy of 0.03% to terminals #8 (-) & #9 (+). Cold Junction or RTD ohms calibration MUST be performed after millivolt calibration.

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>ACTION</th>
<th>DESCRIPTION/ COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>StP1</td>
<td>Apply 0.0 mV</td>
<td>Wait 10 seconds, press P.</td>
</tr>
<tr>
<td>StP2</td>
<td>Apply 14.0 mV</td>
<td>Wait 10 seconds, press P.</td>
</tr>
<tr>
<td>StP3</td>
<td>Apply 28.0 mV</td>
<td>Wait 10 seconds, press P.</td>
</tr>
<tr>
<td>StP4</td>
<td>Apply 42.0 mV</td>
<td>Wait 10 seconds, press P.</td>
</tr>
<tr>
<td>StP5</td>
<td>Apply 56.0 mV</td>
<td>Wait 10 seconds, press P.</td>
</tr>
</tbody>
</table>

Thermocouple Cold Junction Calibration (CJC)

This procedure must be performed AFTER an accurate mV calibration.
2. Connect a thermocouple probe of known accuracy to the TLA (Types T, E, J, K, and N only). Select the probe type used in Configure Module 1.
3. Connect a reference temperature probe to the measuring end of the TLA thermocouple probe. The two probes should be shielded from air movement and allowed sufficient time to equalize in temperature. (As an alternative, the TLA thermocouple probe may be placed in a calibration bath of known temperature.)
4. Compare TLA display with reference temperature probe (or calibration bath).
   If the displayed TLA temperature does not equal the reference probe temperature, calculate the CJC error as follows:
   $$\text{CJC Error} = \text{reference probe temperature} - \text{displayed TLA temperature}$$
5. Enter Factory Service Operations Module (9-FS).

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>PARAMETER</th>
<th>DESCRIPTION/ COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CJC</td>
<td>Cold Junction Temperature</td>
<td>Observe the indicated cold junction temperature. Add the calculated CJC Error to the displayed value. Enter the sum as the new value for CJC. Exit 9-FS and repeat step 4.</td>
</tr>
</tbody>
</table>

Note: If the initial value for CJC is not within the range of 15°C to 40°C, enter 25.0°C for CJC and repeat the Cold Junction Calibration procedure.

RTD Ohms Calibration (RTD)

This procedure must be performed AFTER an accurate mV calibration. Connect one leg of precision resistance (accuracy of 0.1 ohm) to terminals #9 and #10 together, and the other leg to #8.

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>ACTION</th>
<th>DESCRIPTION/ COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rtd1</td>
<td>Connect 0.0 ohm (jumper wire)</td>
<td>Wait 10 seconds, press P.</td>
</tr>
<tr>
<td>Rtd2</td>
<td>Connect 277.0 ohm</td>
<td>Wait 10 seconds, press P.</td>
</tr>
</tbody>
</table>
7.0 **TROUBLESHOOTING**

The majority of problems can be traced to improper connections or incorrect set-up parameters. Be sure all connections are clean and tight, that the correct output board is fitted, and that the set-up parameters are correct. For further technical assistance, contact technical support at the appropriate company numbers listed.

<table>
<thead>
<tr>
<th>PROBLEMS</th>
<th>POSSIBLE CAUSE</th>
<th>REMEDIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NO DISPLAY</strong></td>
<td>1. Power off. 2. Brown-out condition. 3. Loose connection or improperly wired. 4. Bezel assembly not fully seated into rear of TLA.</td>
<td>1. Check power. 2. Verify power reading. 3. Check connections. 4. Check installation.</td>
</tr>
<tr>
<td><strong>TLA NOT WORKING</strong></td>
<td>1. Incorrect parameter set-up.</td>
<td>1. Check set-up parameters.</td>
</tr>
<tr>
<td><strong>“E-FP” IN DISPLAY</strong></td>
<td>1. Defective front panel button.</td>
<td>1. Press R to escape, then check all buttons for proper operation. 2. Replace unit.</td>
</tr>
<tr>
<td><strong>“E-UP” IN DISPLAY</strong></td>
<td>1. Internal problem with TLA.</td>
<td>1. Replace unit.</td>
</tr>
<tr>
<td><strong>“E-E2” IN DISPLAY</strong></td>
<td>1. Loss of setup parameters due to noise spike or other EMI event.</td>
<td>1. Press R to escape, then check all setup parameters. a. Check sensor input and AC line for excessive noise. b. If fault persists, replace TLA.</td>
</tr>
<tr>
<td><strong>“E-CL” IN DISPLAY</strong></td>
<td>1. Loss of calibration parameters due to noise spike or other EMI event.</td>
<td>1. Press R to escape, then check TLA accuracy. a. Recalibrate TLA. (See Factory Service Module code 77.) b. Reset parameters to factory default settings.</td>
</tr>
<tr>
<td><strong>“...” or “-..” IN DISPLAY</strong></td>
<td>1. Display value exceeds display range. 2. Defective or mis-calibrated cold junction circuit. 3. Loss of set-up parameters. 4. Internal malfunction.</td>
<td>1. Change resolution to display whole number and verify reading. 2. Perform cold junction calibration. 3. Check set-up parameters. 4. Perform Input calibration.</td>
</tr>
<tr>
<td><strong>“OPEN” IN DISPLAY</strong></td>
<td>1. Probe disconnected. 2. Broken or burned-out probe. 3. Corroded or broken terminations. 4. Excessive process temperature.</td>
<td>1. Connect probe. 2. Replace probe. 3. Check connections. 4. Check process parameters.</td>
</tr>
<tr>
<td><strong>“OLOL” IN UPPER DISPLAY</strong></td>
<td>1. Check input parameters. 2. Change to input sensor with a higher temperature range. 3. Replace transmitter or probe. 4. Reduce temperature. 5. Perform input calibration.</td>
<td>1. Input exceeds range of TLA. 2. Temperature exceeds range of input probe. 3. Defective or incorrect transmitter or probe. 4. Excessive high temperature for probe. 5. Loss of setup parameters.</td>
</tr>
<tr>
<td><strong>“ULUL” IN UPPER DISPLAY</strong></td>
<td>1. Input is below range of TLA. 2. Temperature below range of input probe. 3. Defective or incorrect transmitter or probe. 4. Excessive low temperature for probe. 5. Loss of setup parameters.</td>
<td>1. Check input parameters. 2. Change to input sensor with a lower temperature range. 3. Replace transmitter or probe. 4. Raise temperature. 5. Perform input calibration.</td>
</tr>
<tr>
<td><strong>“OLOL” OR “ULUL” IN LOWER DISPLAY</strong></td>
<td>1. Signal input exceeds allowable range by 5%.</td>
<td>1. Check remote signal source.</td>
</tr>
</tbody>
</table>
8.0 Installing an Output Board

The TLA is supplied with an output board installed.

Replacing Output Board

1. Remove the bezel assembly.
2. Lift up on the top bezel board latch while gently pulling out on the bezel/display board assembly. Do NOT remove the display board from the bezel.
3. Remove the output board by pulling it away from the other boards. Replace the output board by aligning the board to board connector. Be certain the connector is fully mated.
4. Connect the bezel/display board assembly by guiding the board ends into the bezel latches. Slide the assembly on evenly until the display board connector is completely engaged and bezel latches are fully seated onto the boards.

9.0 Terminal Configurations

AC Models

Form-A Limit Relay with 2 Alarms

<table>
<thead>
<tr>
<th>A2</th>
<th>N.O.</th>
<th>REMOTE</th>
<th>A1</th>
<th>N.O.</th>
<th>LIMIT</th>
<th>A2</th>
<th>N.O.</th>
<th>REMOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13</td>
<td>14</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>2</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Form-C Limit Relay with 1 Alarm

<table>
<thead>
<tr>
<th>N.O.</th>
<th>LIMIT</th>
<th>N.O.</th>
<th>LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 12</td>
<td>11</td>
<td>2 11</td>
<td>12</td>
</tr>
<tr>
<td>1 13</td>
<td>14</td>
<td>2 13</td>
<td>14</td>
</tr>
<tr>
<td>1 13</td>
<td>14</td>
<td>2 13</td>
<td>14</td>
</tr>
</tbody>
</table>

DC Models

Form-A Limit Relay with 2 Alarms

<table>
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<tr>
<th>A2</th>
<th>N.O.</th>
<th>REMOTE</th>
<th>A1</th>
<th>N.O.</th>
<th>LIMIT</th>
<th>A2</th>
<th>N.O.</th>
<th>REMOTE</th>
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<tbody>
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<td>14</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>2</td>
<td>13</td>
<td>14</td>
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</table>

Form-C Limit Relay with 1 Alarm

<table>
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<th>LIMIT</th>
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<td>12</td>
</tr>
<tr>
<td>1 13</td>
<td>14</td>
<td>2 13</td>
<td>14</td>
</tr>
<tr>
<td>1 13</td>
<td>14</td>
<td>2 13</td>
<td>14</td>
</tr>
</tbody>
</table>

AC ~AC 85–250 VAC 50/60 HZ 8VA

POWER (+)(−)
DC 18–36V 7W AC 24V ±10%
50/60 HZ 9VA