Series 859

1/4 DIN Digital Indicating Temperature Controller

User's Manual

Watlow Controls, 1241 Bundy Blvd., Winona, MN 55987  507/454-5300, Fax: 507/452-4507

W859-DA30-9015
April, 1990
Supersedes:
W859-DA20-8828

$5.00
Made in the U.S.A.
General Description

The Watlow Series 859, a 1/4 DIN digital indicating temperature controller, features time proportioning with auto-reset and rate as the primary control mode. The secondary output has an ON/OFF control mode. Thermocouple and RTD sensor inputs, plus a wide selection of temperature control ranges, make the Series 859 easily suited to your application.

Specifications

Control Mode

Primary: Proportional with automatic reset and rate.
- Proportional band: Typically 10 to 100°F/C (3 to 30° for 0.1°F RTD range), internal adjustment.
- Reset: Typically 0.05 to 0.5 repeats per minute, internal adjustment.
- Rate: Typically 0 to 5 minutes, internal adjustment.
- Cycle time: 2 to 20 seconds, internal adjustment. (No cycle time on process models).

Secondary: Set point front panel adjustable.
- ON/OFF with 3°F/1.7°C switching hysteresis (0.3°F with 0.1°F RTD ranges).
- Set point options: Independent: (process value) adjustable over entire range. Deviation: Value adjustable (100° max.) either above or below (not both) primary set point depending on secondary output action. Refer to Table 1 on Page 4 for more information.
- Heat/Cool Option: Heat: N.O. output contacts are open above secondary set point. Deviation set point is adjustable below primary set point. Cool: N.O. output contacts are open below secondary set point. Deviation set point is adjustable above primary set point.
- Latching: Manual reset of output required after process temperature has exceeded set point. High Alarm: N.O. output contacts will open above secondary set point. Deviation set point is adjustable above primary set point. Low Alarm: N.O. output contacts will open below secondary set point. Deviation set point is adjustable below primary set point.

Operator Interface

- 1/2" (13 mm) LEDs displaying actual process input value and, when setpoint knob is depressed, primary set point value.
- LED indication of outputs energized (load light)
- With latched option: Secondary LED indicates latched (alarm) condition. Manual reset button is located near the LED.

Input

- Thermocouple and RTD process input available.
- Automatic cold junction compensation for T/C.
- Lead resistance effect for type "J", "K", and "T" thermocouples. 200Ω of lead resistance causes less than 1°F error. Refer to the lead wire manufacturer's specification on ohms per double foot for the type and gauge of wire used.
- RTD input 2 or 3-wire, platinum, 100 ohms @ 0°C calibrated for either of two curves:
  - #3916 (JIS): 0.003916 Ω/°C.
  - #3850 (DIN): 0.003850 Ω/°C.
- MV set point input, (from programmer or another control), 5mV/digit for 3 digit ranges and 2 mV/digit for 4 digit ranges.
- Sensor break protection de-energizes primary output to protect system. Display will indicate open sensor.

  3 Digit 4 Digit

  Upscale: EEE OFL
  Downscale: - - OOO

  Sensor may be grounded or ungrounded.

Output (See Ordering Information for combinations.)

Control

- Relay 5A, SPDT Soldered-in: 5A @ 240VAC, 5A @ 30VDC, 1/6 hp @ 120VAC.
- Triac, 1A @ 240VAC, zero-crossed switching, 1mA min. load. Resistive.
- Triac, 15A @ 240VAC, 100mA, min. load. Resistive.
- 4-20mA into 600 Ω load max.
- 0-20mA into 600 Ω load max.
- Relay 3A, SPST: 3A @ 240VAC.

Indication

- MV output of linearized process input signal, 5mV/digit for 3 digit ranges.
  2mV/digit for 4 digit ranges.

Accuracy

- Calibration Accuracy: ±0.25% of span, ±1 digit at 77°F ±5°F (25°C ±3°C) ambient & rated line voltage ±1%.
- Linearization Accuracy: ±0.25% of span, ±1 digit at 77°F ±5°F (25°C ±3°C) ambient & rated line voltage ±1%.
- MV Signal I/O: ±0.25% of span.
- Accuracy Span: 1000°F or 540°C minimum.
- Temperature Stability: ±2μV/F (±3.6μV/°C) ambient.
- Voltage Stability: ±0.01% of span /% of rated line voltage.

Terminals

- #6 screws on barrier strips.

Power

- 120/240VAC ±10%, 60Hz ±5%
- 110/220VAC +10% -5%, 50Hz ±5%
- 6VA power consumption.

Operating Environment

- 30 to 130°F/0 to 55°C.
- 0 to 90% RH, non-condensing.

Dimensions

- Height: 3.8 in. (97 mm)
- Width: 3.8 in. (97 mm)
- Behind panel depth: 4.9 in. (125 mm)
  with 15A triac: 7.6 in. (193 mm)
- Weight: 1.3 lb. (0.6 kg)
Ordering Information

Control
Series 859 = Digital indicating closed loop temperature control with PID primary output and ON/OFF secondary output; % or RTD input; interface capability; 1/4 DIN.

Output
(Primary/Secondary)
A = Mechanical Relays, 5A SPDT, Form C/5A SPST, Form A
B = Triac, 1A/1A, Form A
C = Triac, 15A/1A, Form A
*D = Process, 4-20 mA/3A SPST, relay, Form A
*E = Process, 0-20 mA/3A SPST, relay, Form A
* Available only with thermocouple input ranges up to 999°.

Set2 / Output 2 Operation
A = Independent/Heat
B = Independent/Cool
C = Independent/High Alarm**
D = Independent/Low Alarm**
E = Deviation/Heat
F = Deviation/Cool
G = Deviation/High Alarm**
H = Deviation/Low Alarm**

Input & Range
RTD
101 = #3916 -99 to 999°F JIS
103 = #3916 -99 to 500°C JIS
105 = #3916 0.0 to 399.9°C JIS
106 = #3916 0.0 to 399.9°F JIS
121 = #3850 -99 to 999°F DIN
123 = #3850 -99 to 500°C DIN
125 = #3850 0.0 to 399.9°C DIN
126 = #3850 0.0 to 399.9°F DIN

Thermocouple
606 = J -99 to 999°F
608 = J 0 to 1600°F
609 = J 0 to 850°C
610 = K 0 to 999°C
611 = K 0 to 2500°F
615 = T -99 to 600°F

Front Panel
00 = Gray, with white bars
WW = Black, with white lettering
** = WW Front Panel not available with Set 2 Options: C, D, G, H

Related Devices:
* 3A output relay: 0003-0063-0000
* 5A output relay: 0003-0083-0000
* 15A triac: 0802-0291-0000
* Extender Card: Z100-0421-0000
Secondary Output Table

<table>
<thead>
<tr>
<th>Model #</th>
<th>Output 2 Operation</th>
<th>Set 2 Operation (Relative to Set 1)</th>
<th>Contact will Open when Temperature Is:</th>
<th>Output 2 LED is ON when Output 2 Is:</th>
<th>Latching Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>859X-A</td>
<td>Heat</td>
<td>Independent</td>
<td>Above Set 2</td>
<td>Closed</td>
<td>No</td>
</tr>
<tr>
<td>859X-B</td>
<td>Cool</td>
<td>Independent</td>
<td>Below Set 2</td>
<td>Closed</td>
<td>No</td>
</tr>
<tr>
<td>859X-C</td>
<td>High Alarm</td>
<td>Independent</td>
<td>Above Set 2 Alarm*</td>
<td>Open</td>
<td>Yes/Above Set 2</td>
</tr>
<tr>
<td>859X-D</td>
<td>Low Alarm</td>
<td>Independent</td>
<td>Below Set 2 Alarm*</td>
<td>Open</td>
<td>Yes/Below Set 2</td>
</tr>
<tr>
<td>859X-E</td>
<td>Heat</td>
<td>Deviation** Below Set 1</td>
<td>Above Set 2</td>
<td>Closed</td>
<td>No</td>
</tr>
<tr>
<td>859X-F</td>
<td>Cool</td>
<td>Deviation** Above Set 1</td>
<td>Below Set 2</td>
<td>Closed</td>
<td>No</td>
</tr>
<tr>
<td>859X-G</td>
<td>High Alarm</td>
<td>Deviation** Above Set 1</td>
<td>Above Set 2 Alarm*</td>
<td>Open</td>
<td>Yes/Above Set 2</td>
</tr>
<tr>
<td>859X-H</td>
<td>Low Alarm</td>
<td>Deviation** Below Set 1</td>
<td>Below Set 2 Alarm*</td>
<td>Open</td>
<td>Yes/Below Set 2</td>
</tr>
</tbody>
</table>

Table 1 - Series 859 Secondary Output Information

* In a normal non-alarm condition, Output 2 contacts are in a closed position. When in an alarm condition, the Output 2 contacts latch open. The temperature must return to a non-alarm condition and the reset button must be depressed before Output 2 contacts close.

** A deviation set point tracks the primary set point. This deviation set point is adjustable 0 to 1000 from the primary set point on all ranges except range codes 105, 106, 125 and 126. These range codes, with tenth of a degree resolution, have a 25°F/13.9°C deviation.

Line Voltage

** WARNING:**

To avoid potential electric shock, use National Electric Code safety practices when wiring and connecting this unit to a power source and to electrical sensors or peripheral devices.

All wiring and fusing must conform to the National Electric Code and to any locally applicable codes also.

Figure 1 - 120 VAC Power Wiring

Figure 2 - 240 VAC Power Wiring
Installation and Dimensional Information

**Figure 3 - Series 859 Case Dimensions**

**Figure 4 - Series 859 Case Dimensions with 15 Amp Triac**

**Figure 5 - Series 859 Mounting Requirements**

Alternate panel cutout
(No panel thickness limit)
Input Wiring

Wire your unit according to the figures showing the correct input.

**Thermocouple Input**
Terminal Designations

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>T.C. (+)</td>
</tr>
<tr>
<td>10</td>
<td>Not used</td>
</tr>
<tr>
<td>11</td>
<td>T.C. (+), Red</td>
</tr>
<tr>
<td>12</td>
<td>Not used</td>
</tr>
<tr>
<td>13</td>
<td>Set point (+) out</td>
</tr>
<tr>
<td>14</td>
<td>Programmer (+) in</td>
</tr>
<tr>
<td>15</td>
<td>Signal conditioner (+) out</td>
</tr>
<tr>
<td>16</td>
<td>Circuit common (-)</td>
</tr>
</tbody>
</table>

For programmer input refer to Page 9, Figures 13 & 14.

🎵 **NOTE:**
You must use a grounded or ungrounded thermocouple if programmer circuit common is not isolated from earth ground. Extension wire for thermocouples must be of the same alloy as the thermocouple itself to limit errors.

**Platinum RTD Input**
Terminal Designations

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>S1</td>
</tr>
<tr>
<td>10</td>
<td>Not used</td>
</tr>
<tr>
<td>11</td>
<td>S2</td>
</tr>
<tr>
<td>12</td>
<td>Not used</td>
</tr>
<tr>
<td>13</td>
<td>Set point (+) out</td>
</tr>
<tr>
<td>14</td>
<td>Programmer (+) in</td>
</tr>
<tr>
<td>15</td>
<td>Signal conditioner (+) out</td>
</tr>
<tr>
<td>16</td>
<td>Circuit common, S3, (-)</td>
</tr>
</tbody>
</table>

For programmer input refer to Page 9, Figures 13 & 14.

🎵 **NOTE:**
Long RTD lead lengths create electrical resistance. There will be approximately +2°C input error for every 1Ω of lead length resistance, when using a two wire RTD. That resistance, when added to the resistance of the RTD element, can result in erroneous input to the instrument. To overcome this problem, use a three wire RTD sensor, which compensates for lead length resistance. When extension wire is used for a three wire RTD, all three extension wires must have the same electrical resistance. (i.e. same gauge, copper stranded wire).
### Terminal Designations

1. N.O. - Load #2 - Contact Rated
2. C. - 240V Max., 5amp R.M.S.
3. N.C.
4. N.O. - Load #1 - Contact Rated
5. C. - 240V Max., 5amp R.M.S.
6. AC line common, L2
7. 120V line, L1
8. 240V line, L1

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### Output - Terminals 1 through 8

**WARNING:**

All wiring and fusing must conform to the National Electric Code NFPA70. Contact your local board for additional information. Failure to observe NEC safety guidelines could result in injury to personnel.

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**NOTE:**

Use up to 240VAC, for load power, independent of control power.

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**Figure 9 - 5A/5A Relay (859A-XXXX-00XX)**

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### Terminal Designations

1. T2 - 1 Amp S.S.
2. T1 - Output - Load #2
3. T1 - 1 Amp S.S.
4. T2 - Output - Load #1
5. Not Used
6. A.C. line common, L2
7. 120V line, L1
8. 240V line, L1

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**NOTE:**

Use up to 240VAC, for load power, independent of control power.

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**Figure 10 - 1A/1A Triac (859B-XXXX-00XX)**
Output Wiring (cont.)

**Terminal Designations**

1. T2  1 Amp Solid State
2. T1  Output - Load #2
3. Gate
4. T2  15 Amp Solid State
5. T1  Output - Load #1
6. AC line common, L2
7. 120V line, L1
8. 240V line, L1

![Diagram of output terminals 1 through 8](image)

**NOTE:**
Refer to Page 5, Figure 4 to see an 859 with a 15 Amp triac.

![Diagram of 15A & 1A Triac (859C-XXXX-00XX)](image)

**Terminal Designations**

1. +  Load #1
2. -  Current Output
3. N.C.
4. N.O.  Load #2 - Contact Rated
5. C.  240V Max., 3 Amp R.M.S.
6. A.C. line common, L2
7. 120V line, L1
8. 240V line, L2

![Diagram of 15A & 1A Triac (859C-XXXX-00XX)](image)

**NOTE:**
Use up to 240VAC, for load power, independent of control power.

Figure 11 - 15A & 1A Triac (859C-XXXX-00XX)

![Diagram of 6-20mA or 0-20mA/3A Relay (859D-XXXX-00XX or 859E-XXXX-00XX)](image)

**NOTE:**
Use up to 240VAC, for load power, independent of control power.

Figure 12 - 4-20mA or 0-20mA/3A Relay (859D-XXXX-00XX or 859E-XXXX-00XX)
Programmer Input
Terminal Designations

12. Not Used
13. Set point (+) out
14. Programmer (+) in
15. Signal conditioner (+) out
16. Circuit common

NOTE:
Remove appropriate internal jumper wire if you are using the programmer input. See Page 11, Figure 16 or 17.

NOTE:
Use dry switch for SW1 (SW1 customer-supplied)

Figure 13 - Local/Remote Set Point (With Programmer)

NOTE:
3 digit ranges are scaled 5mV/LSD,
4 digit ranges scaled 2mV/LSD.

Figure 14 - Series 859 Chart Recorder Connection (Optional)
WARNING:
Install high or low temperature limit control protection in systems where an over temperature or under temperature fault condition could present a fire hazard or other hazard. Failure to install temperature limit control protection where a potential hazard exists could result in damage to equipment and property, and injury to personnel.

CAUTION:
With Watlow mercury relays, load must have a unity power factor. For RESISTIVE LOADS ONLY.

NOTE:
All fuses must be selected for proper protection in a given application.

Figure 15 - Series 859 System Wiring Example
For where to get more information on the Watlow products here, see the back cover.

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**CAUTION:**

These jumpers are soldered onto the printed circuit board. They must be removed when using a programmer input or the Series 859 will not function properly. The jumper may be a white insulated wire or a zero ohm resistor with 1 black band.

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### Programmer Input Jumper Locations

**3 Digit Display**

![3 Digit Display Diagram]  
A007-1010-W43

**4 Digit Display**

![4 Digit Display Diagram]  
A007-1195-W85

**Figure 16 - RTD Programmer Input Jumper Removal**

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**3 Digit Display**

![3 Digit Display Diagram]  
A007-1047-W53 or A007-1232-W53
A007-1047 shown here. W53 in same location on both.

**4 Digit Display**

![4 Digit Display Diagram]  
A007-1231-W46

**Figure 17 - Thermocouple Programmer Input Jumper Removal**
1. **Proportional Band** - In a straight time proportional control system, when the actual process temperature is below set point and outside the proportional band limit, 100% power is applied to the load.

   When the actual process temperature is above set point and outside the proportional band limit, 0% power is applied to the load.

   When the actual process temperature is within the proportional band, the controller will proportion the amount of power applied to the load, 0 to 100%.

2. **Temperature Droop** - Phenomenon that occurs in a proportional control system without reset. As the proportional band is increased, the average process temperature may drop to a point that is not the set point temperature. This action takes place even though the load temperature has stabilized.

3. **Automatic Reset (Integral)** - Used in proportional control systems to automatically pick up any system droop.

   Normally this action is adjustable and adjusts the time for reset to obtain agreement between actual process and controller set point.

4. **Rate (Derivative)** - Action that anticipates the rate of actual process temperature rise and automatically widens the proportional band to prevent overshoot. Returns the proportional band to the static adjustment when the set point temperature is stable within the static band boundaries.

5. **Programmer Input** - Control input that accepts a scaled voltage corresponding to the set point temperature.

6. **Temperature Oscillation or Hunting** - Occurs when the proportional band is too narrow or the system is upset by some outside source. The actual load temperature is not controlled within the proportional band on its extreme temperature excursions.

   Load temperature may never stabilize. Control is either full on or full off, not within the proportional band.

7. **Zero -Crossed Switching** - Load is activated only during the time period that the sine wave is going through zero. This eliminates RFI and EMI radiation. (Applies to solid state outputs only.)

8. **Cycle Time** - The rate at which the controller samples load temperature. i.e. At a setting of 2 seconds and 25% power is required to maintain load temperature at set point. Power will be applied for 0.5 second every 2 seconds with a mechanical relay output.

9. **Anti Reset** - Inhibits reset action when the actual process temperature is outside the proportional band.

10. ♩ or ♩ ♩ - Musical Notes are used to alert you to important details.

11. **STOP** - The Stop Sign alerts you to a "WARNING," a safety hazard which could affect you and the equipment.

12. 🐏 - The Deer Crossing Sign alerts you to a "CAUTION," a safety or functional hazard which could affect your equipment or its performance.
RTD Field Calibration Procedure

NOTE: All pots are on the upper board. See Figure 18.

2. Set the decade box to ____ Low ohms. Adjust the SC Lo pot for ____ SC Lo volts on the digital voltmeter. Adjust the Lo pot for ____ Low Temp on the display of the control.

See Table 2 for values that apply to your unit’s range code. Figure 18 below shows you potentiometer locations.

3. Set the decade box to ____ High ohms. Adjust the SC Hi pot for ____ SC Hi volts on the digital voltmeter. Adjust the Hi pot for ____ High Temp on the display of the control.

4. Repeat Steps 2 and 3 until all of the readings are correct with no further adjustment necessary.

5. Check the midpoint of the temperature range.

Table 2 - RTD Input Calibration Values

<table>
<thead>
<tr>
<th>Range</th>
<th>Cal. Curve</th>
<th>Millivolt vs. Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Code</td>
<td>Low/Low</td>
</tr>
<tr>
<td>101 ,99 - 999°F</td>
<td>#3916</td>
<td>92.93Ω</td>
</tr>
<tr>
<td>103 ,99 - 540°C</td>
<td>#3916</td>
<td>100.00Ω</td>
</tr>
<tr>
<td>105 0.0 - 399.9°C</td>
<td>#3916</td>
<td>107.93Ω</td>
</tr>
<tr>
<td>106 0.0 - 399.9°C</td>
<td>#3916</td>
<td>97.35Ω</td>
</tr>
<tr>
<td>120 ,99 - 999°F</td>
<td>#3850</td>
<td>93.03Ω</td>
</tr>
<tr>
<td>123 ,99 - 540°C</td>
<td>#3850</td>
<td>100.00Ω</td>
</tr>
<tr>
<td>125 0.0 - 399.9°C</td>
<td>#3850</td>
<td>107.79Ω</td>
</tr>
<tr>
<td>126 0.0 - 399.9°F</td>
<td>#3850</td>
<td>97.39Ω</td>
</tr>
</tbody>
</table>

Figure 18 - Series 859 Potentiometer Locations (left side)
T/C Field Calibration Procedure

**NOTE:**
This calibration information is provided as a service. Proper field calibration can be achieved by following this procedure. If your control is in warranty, that warranty will be void if this field calibration is performed improperly.

Thermocouple Input

Equipment Required:
- Precision millivolt source.
- Digital voltmeter (DVM).
- Type _______ reference compensator with reference junction at 32°F/0°C.
- Extender board may be used for ease of servicing, Watlow P/N Z100-0421-0000.

Procedure:
1. Connect the millivolt source to the reference compensator and the compensator leads to the T/C inputs, terminals 9 (+) and 11 (-). Connect the digital voltmeter to terminals 15 (+) and 16 (-). Install the extender board into the control if one is in possession. Connect power to the control. Let the control stabilize before calibration begins.

2. Set the millivolt source to _______Low mV. Adjust the SC Lo pot for _______SC Lo volts on the digital voltmeter. Adjust the Lo pot for _______Low Temp on the display of the control.

See Table 3 for values that apply to your unit's range code. Figure 19 below shows potentiometer locations.

3. Set the millivolt source to _______High mV. Adjust the SC Hi pot for _______SC Hi volts on the digital voltmeter. Adjust the Hi pot for _______High Temp on the display of the control.

4. Repeat Steps 2 and 3 until all of the readings are correct with no further adjustment necessary.

5. Check the midpoint of the temperature range.

Table 3 - T/C Input Calibration Values

<table>
<thead>
<tr>
<th>Range</th>
<th>Low/High</th>
<th>T/C Type</th>
<th>Millivolt vs. Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Low/High</td>
<td>SC Low Volts</td>
<td>Low Temp</td>
</tr>
<tr>
<td>606</td>
<td>-99 - 999°F</td>
<td>.000mV</td>
<td>160V</td>
</tr>
<tr>
<td>608</td>
<td>0 - 160°F</td>
<td>.000mV</td>
<td>.064V</td>
</tr>
<tr>
<td>609</td>
<td>0 - 850°C</td>
<td>.000mV</td>
<td>.000V</td>
</tr>
<tr>
<td>610</td>
<td>0 - 999°C</td>
<td>.000mV</td>
<td>.000V</td>
</tr>
<tr>
<td>611</td>
<td>0 - 2500°F</td>
<td>.000mV</td>
<td>.064V</td>
</tr>
<tr>
<td>615</td>
<td>-99 - 600°F</td>
<td>.000mV</td>
<td>160V</td>
</tr>
</tbody>
</table>

Figure 19 - Series 859 Potentiometer Locations (left side)
Tuning Procedure for PID Controls

Refer to Figure 20 for potentiometer locations.

Initial Settings:
- Cycle time: 2 seconds; turn maximum counter-clockwise; CCW.
- Proportional band: turn maximum clockwise; CW.
- Rate: 0; turn maximum CCW.
- Reset: 0.05 repeats/minutes; turn maximum CW.

Energize the system and allow the process temperature to stabilize. When the system is stable, the load light will cycle at a constant rate. After an adjustment is made, the system may become unstable. Allow sufficient time for the system to stabilize before making another adjustment.

Proportional Band Adjustment:
Rotate the proportional band pot CCW 1/4 turn and observe system stability. Repeat until the load temperature begins to hunt (becomes unstable). When hunting is observed, rotate pot slowly CW until the system becomes stable. Some systems may be stable enough to allow minimum proportional band (maximum CCW).

Rate Adjustment:
Rotate the rate pot 1/4 turn CW. Change the set point temperature 20-30°F/°C, and observe the approach to set point. If the load temperature overshoots, repeat the procedure until optimum approach to set point is achieved.

If the rate pot is advanced too far, the system will be overdamped and approach to set point will be very sluggish.

Reset Adjustment:
A slow setting (0.05 repeats/min.) requires long periods of time for the load temperature to reach set point. If the reset time is set too fast (0.5 repeats/ min.), the system may become unstable and oscillate about set point temperature.

To adjust reset time, rotate the reset pot 1/4 turn CCW and observe stability. Continue adjusting CCW until the system becomes unstable. Rotate CW very slowly to regain stability.

Cycle Time:
Best control is always achieved with faster cycle times. However, if a mechanical contactor or a solenoid is used to switch power to the load, slower cycle times may be desirable to minimize the wear on the mechanical components. Turn cycle time pot CW for longer cycle times.

NOTE: All of the pots are located on the upper board.

NOTE: For ease of adjusting, order extender board - Watlow P/N Z100-0421-0000.

3 Digit Models
(859A, B, & C models)
859D & E are similar to 4 digit models

4 Digit Models

Figure 20 - Series 859 Potentiometer Locations (right side)
Set-Up Instructions for Deviation Set II

1. Connect a jumper for thermocouple input or resistor (approximately 110Ω) for RTD input across the input terminals on the back of the control (terminals #9 and #11, with #11 jumpered to #16 for RTD input).

2. Apply power to the control.

3. Determine the deviation difference you want between Set Point I and Set Point II, such as 20°F.

4. A. For Deviation/Cool and Deviation/High Alarm: Subtract the deviation difference from the temperature that is being displayed.

B. For Deviation/Heat and Deviation/Low Alarm: Add the deviation difference to the temperature that is being displayed.

5. Set the Set I setting to the determined difference in step #5A or B.

6. A. For Heat/Cool and Heat/High Alarm: Turn Set II pot full CCW and push alarm Reset button if Load II LED is still ON. Turn the Set II set screw adjustment clockwise until the Load II indicator LED just turns ON.

B. For Heat/Heat and Heat/Low Alarm: Turn Set II pot full CW and push Alarm Reset button if Load II LED is still ON. Turn the Set II set screw adjustment CCW until the Load II indicator LED turns ON.

7. Remove the jumper or resistor from terminals #9 and #11 and reconnect the process sensor to the control.

Example:
Adjusting deviation on an 859A-F606-0000, a unit with 5A/5A relay, Deviation/Cool, and a type "J" thermocouple.

1. With a jumper connected to terminals #9 and #11, we read an ambient temperature of 70°F. We have already turned the Set II adjustment full CCW.

2. We determine that Set II deviation should be 20°F below Set I. The difference between 70° and 20° is 50°.

3. Pressing in the Set I adjustment knob, we change the setting to 50°F.

4. We then start adjusting the Set II set screw clockwise until the Load II indicator light comes on. Set II is now at a 20°F differential from Set I.

5. Remove the jumper from terminals #9 and #11 and replace with the process thermocouple, being certain to connect red (-) to the correct polarity.
<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No display.</td>
<td>Check for presence or proper connection of AC input.</td>
<td>Connect per Line Voltage. See Page 4, Figures 1 &amp; 2.</td>
</tr>
<tr>
<td></td>
<td>A. If not present or proper...</td>
<td>Contact the factory.</td>
</tr>
<tr>
<td></td>
<td>B. If present and proper...</td>
<td></td>
</tr>
<tr>
<td>Display indicates EEE or OFL.</td>
<td>1. An open thermocouple or RTD.</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td></td>
<td>2. If using 2 wire RTD connect jumper wire between S2 and S3.</td>
<td>Connect per Input Figures. See Page 6, Figure 7.</td>
</tr>
<tr>
<td>A display error.</td>
<td>If sensor is connected properly, check for faulty sensor.</td>
<td>Check sensor location, connections and sensing element. Repair or replace sensor as required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A. Thermocouple - Place jumper wire across T/C terminals. If display indicates room temperature, indicator is functioning properly.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. RTD - Place 100 ohm resistor across sensor terminals. If display indicates approximately 32°F/0°C, indicator is functioning properly.</td>
</tr>
<tr>
<td>Poor temperature control.</td>
<td>The load temperature is unstable.</td>
<td>Adjust proportional band, rate, cycle time, auto-reset per PID Adjustments. See Page 15.</td>
</tr>
<tr>
<td>Load will not turn ON.</td>
<td>1. An open thermocouple or RTD.</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td></td>
<td>2. Check fuses, circuit breakers and load.</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td></td>
<td>3. Load LED will not turn ON.</td>
<td>Contact the factory.</td>
</tr>
<tr>
<td>Load will not turn OFF.</td>
<td>1. Polarity reversed on thermocouple.</td>
<td>Connect per Input Figures. See Page 6, Figure 6.</td>
</tr>
<tr>
<td></td>
<td>2. For units with 1 or 15A triacs. Remove power and measure resistance from T1 to T2. (Terminals 3 and 4); if short circuited...</td>
<td>Order P/N 0003-0065-0000 for 1A triac. Order P/N 0802-0291-0000 for 15A triac.</td>
</tr>
<tr>
<td></td>
<td>3. Load LED will not turn OFF.</td>
<td>Contact the factory.</td>
</tr>
<tr>
<td>Cannot control unit w/external programmer</td>
<td>Remove jumper W43, W46 W53 or W85 depending on unit type.</td>
<td>See Jumper Locations. Page 11, Figure 16 or 17.</td>
</tr>
</tbody>
</table>
Shipping Claims

When you receive your Watlow control, examine the package for any signs of external damage it may have sustained enroute. If there is apparent damage either outside the box or to its contents, make a claim with the shipper immediately. Save the original shipping carton and the packing material.

Returning Merchandise

The following procedure applies for any products returned to the factory:

1. Call Watlow Customer Service, 507/454-5300, for a Return Material Authorization (RMA) number before returning any item for repair. We need this information:
   - Ship to address
   - Contact name
   - Ship via
   - Symptoms and/or special instructions
   - Name and phone number of person returning the material.

2. Prior approval and an RMA number, from the Customer Service Department, is needed when returning any unused product for credit. Make sure the RMA number is on the outside of the carton, and on all paper work returned. Ship on a Freight Prepaid basis.

3. After we receive your return, we will examine it to determine the cause for your action.

4. In cases of manufacturing defect, we will enter a repair order, replacement order or issue credit for material. There is a 20% restocking charge on all controls and accessories returned within 120 days after shipment from Watlow. We cannot accept any product after that time period.

5. If the unit is unrepairable, we will return it to you with a letter of explanation. Repair costs will not exceed 50 percent of the original cost.

Warranty

The Watlow Series 859 is warranted to be free of defects in material and workmanship for 18 months after delivery to the first purchaser for use, providing that the units have not been misapplied.

Since Watlow has no control over their use, and sometimes misuse, we cannot guarantee against failure. Watlow's obligations hereunder, at Watlow's option, are limited to replacement, repair or refund of purchase price, and parts which upon examination prove to be defective within the warranty period specified. This warranty does not apply to damage resulting from transportation, alteration, misuse or abuse.

Watlow Controls

Watlow Controls is a division of Watlow Electric Manufacturing Company of St. Louis, Missouri. Watlow is an established manufacturer of industrial electric heating products, in business since 1922. Watlow boasts the ability to begin with a full set of specifications and to complete an industrial product that is manufactured totally in-house, in the U.S.A. Products designed and manufactured by Watlow are electric heating elements, sensors, electronic temperature controls and power switching devices.

The Watlow Controls operation has been designing solid state electronic control devices since 1962, and has earned the reputation as an excellent supplier to original equipment manufacturers. These OEMs depend upon Watlow Controls to provide compatibly engineered controls which they can incorporate into their products with confidence.

Watlow Controls resides in a 100,000 square foot marketing, engineering and manufacturing facility in Winona, Minnesota.
For More Information On Related Products For Your System:

- Watlow MDR's, ask for the Mercury Displacement Relay Brochure
- Other Watlow Products, ask for the Watlow Catalog

Contact us at the address below.