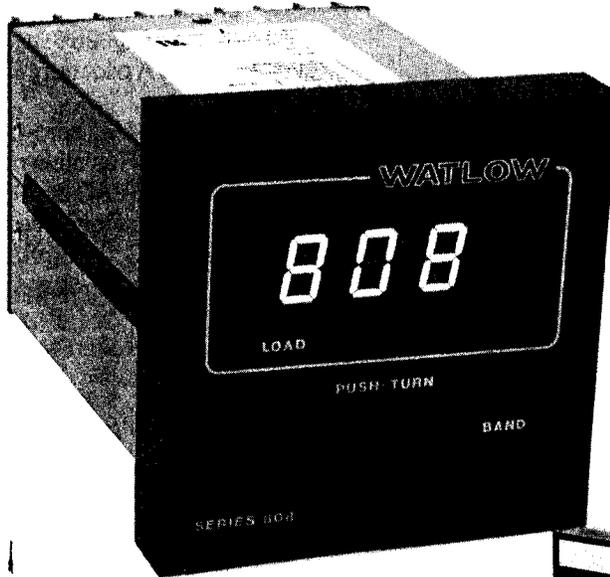


# Series 808



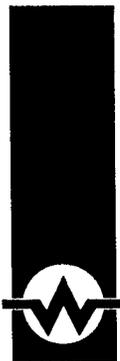
WW Faceplate



00 Faceplate

## 1/4 DIN Digital Temperature Controller

Data Sheet



# WATLOW

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

W808-DA10-8736  
September, 1987  
Supersedes:  
WWM-111

## General Description

The Watlow Series 808 is a 1/4 DIN digital indicating temperature control. The control features a plug-in design to facilitate installation and service. The control mode is PID, with user accessible adjustment to all parameters.

Input options include the selection of thermocouple ranges, RTD ranges, or electrical voltage or current inputs. There are many output options to select from including mechanical relay and solid state output switching devices.

Front panel accessible adjustments include the push-to-set assembly for the main set point, and proportional band adjustments. The front face plate is available in two styles, gray with white bars, or black with white lettering.

## Specifications

### Control Mode

- PID: Proportional with auto reset and rate (integral and derivative).
- Proportional band: 10 to 100°F/°C (3 to 30°F/C for 0.1° RTD range), front panel adjust.
- Reset: 0.05 to 0.5 repeats per minute, internal adjust.
- Rate: 0 to 5 minutes, internal adjust.
- Cycle time: 2 to 30 seconds, internal adjust.

### Operator Interface

- 1/2" LEDs displaying process input value and, when setpot knob is depressed, primary set point value.
- LED indication of output energized (load light).

### Input

- Thermocouple, RTD, and electrical process input available. Refer to the note on Page 5 concerning thermocouples.
- Automatic cold junction compensation for thermocouple.
- RTD input 2 or 3 wire, platinum, 100 ohms @ 0°C calibrated for either of two curves:  
#3916: 0.003916 Ω/Ω°C.  
#3850 (DIN): 0.003850 Ω/Ω°C.
- Electrical process input: 4-20mA and 0-5VDC. User selectable decimal point enable. 100Ω input impedance for 4-20mA.
- MV set point input, (from programmer or another control), 5 mv/digit for 3 digit ranges and 2 mv/digit for 4 digit ranges.
- Sensor break protection de-energizes output to protect system. Display will indicate open sensor.

	<u>3 Digit</u>	<u>4 Digit</u>
Upscale:	EEE	OFL
Downscale:	- - -	OOO

- No sensor break protection is provided when the 0-5V input is used, (Electrical process #701) since 0V is a valid input.

### Output Control

- Relay 10A, SPDT Plug in: 10A @ 120VAC, 5A @ 240VAC, 10A @ 28VDC, 1/3 HP @ 120 or 240VAC, 345VA pilot duty @ 120 or 240VAC. See Figure 1.
- Triac, 1A @ 240VAC zero-crossed switching 50mA min load. Resistive ratings only.
- Triac, 15A @ 240VAC zero-crossed switching 100mA min load. Resistive ratings only.
- 4-20 mA/1-5VDC, 0-20mA/0-5VDC.
- Load impedance for voltage output; 5K minimum.
- Load impedance for current; 600Ω maximum.

### Indication

- Linearized MV output corresponding to input signal,  
5mv/digit for 3 digit ranges.  
2mv/digit for 4 digit ranges.

### Accuracy

- Calibration Accuracy: ±0.25% of span at 77°F±5°F ambient & rated line voltage ± 1%.
- Linearization Accuracy: ±0.25% of span, ±1 digit at 77°F±5°F 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 ambient.
- Voltage Stability: ±0.01% or span % of rated line.

### Agency Approval

- UL recognized, File #E43684, UL 873.
- In UL applications, relay output version is rated 10A @ 120VAC for ambient temperature up to 100°F. Over 100°F, the rating decreases linearly to 6A @ 130°F. See Figure 1.

### Terminals

- #6 screw on barrier strip.

### Power

- 115/230VAC ± 10%, 50/60Hz.
- 6VA power consumption.

### Operating Environment

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

### Dimensions

- Height: 3.8 in.
- Width: 3.8 in.
- Behind panel depth: 4.9 in.
- with 15A triac: 7.6 in.
- Weight: 1.5 lb.

## Ordering Information

Series 808 = **Control**  
 Digital indicating closed loop control with PID; T/C, RTD, or electrical input; interface capability; 1/4 DIN.

8|0|8| - | | | | - |0|0|

- Output**
- A = Relay 10A, SPDT.
  - B = Triac, 1A.
  - C = Triac, 15A.
  - D = 4-20 mA/1-5VDC
  - E = 0-20mA/0-5VDC.

- Control Mode**
- 0 = Heat
  - 1 = Cool (only with output A or D)

**Input & Range**

RTD				
100	=	#3916	-99	to 999°F
101	=	#3916	-99	to 540°C
108	=	#3916	0.0	to 399.9°F
109	=	#3916	0.0	to 399.9°C
120	=	#3850	-99	to 999°F
121	=	#3850	-99	to 540°C
128	=	#3850	0.0	to 399.9°F
129	=	#3850	0.0	to 399.9°C

**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
612	=	T	-99	to 600°F
618	=	K	0	to 1370°C

**Related Devices**

- Extender #Z100-0421-0000 to facilitate installation tuning.
- Relay, 10A, Plug-in: #0003-0073-0000.
- Triac, 1A: #0802-0217-0000.
- Triac, 15A: #0802-0404-0000.

**Electrical**

701	=	4-20 mA / 0-5VDC		
		0	to	999
		0.0	to	99.9

or

- Faceplate**
- 00 = Gray, with white bars
  - WW = Black, with white lettering

## 10A Relay Derating

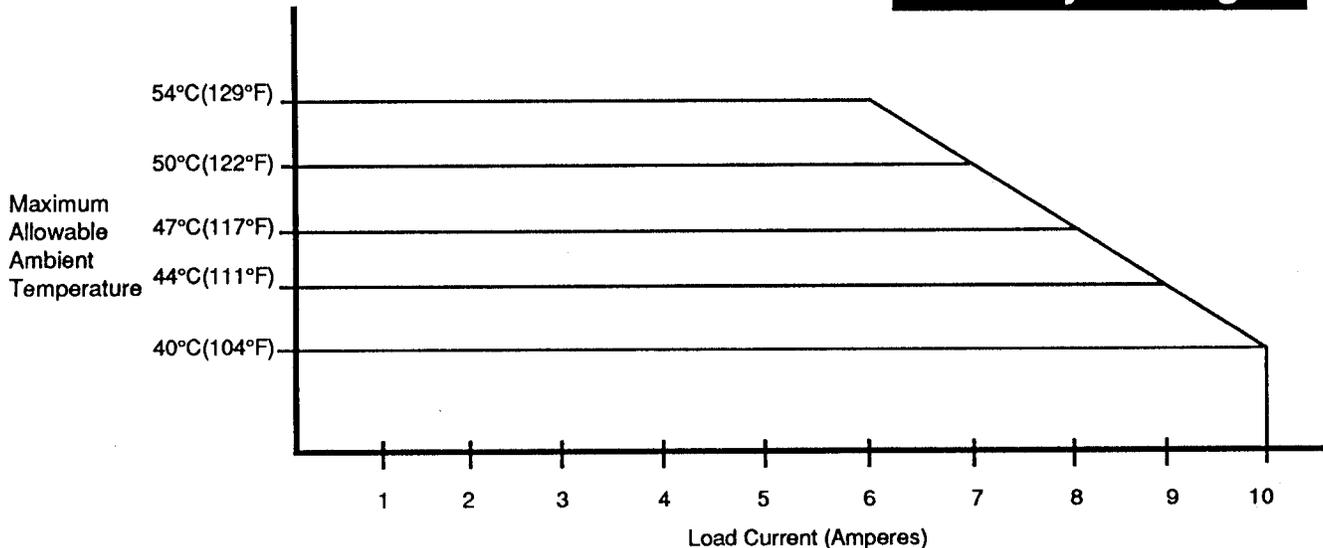


Figure 1 - Temperature Derating Curve for 10A Relay (when used in UL applications)

# Installation and Dimensional Information

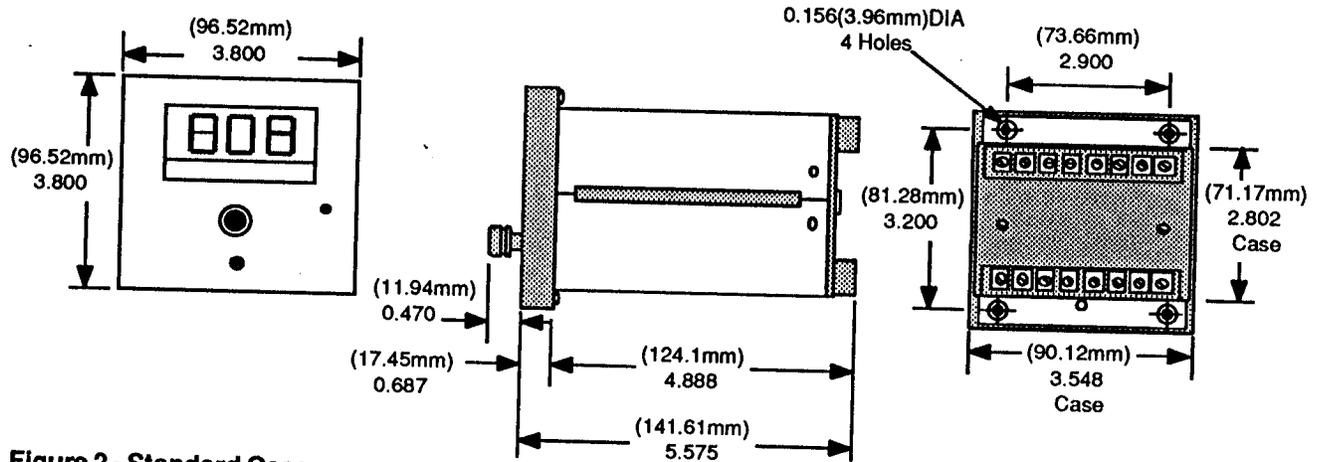


Figure 2 - Standard Case

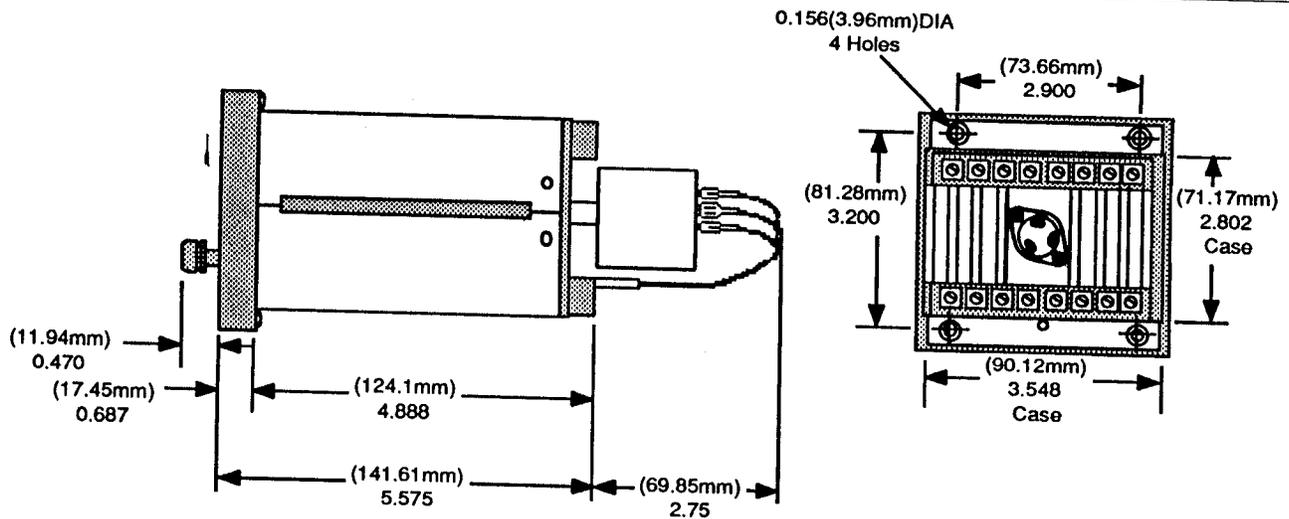


Figure 3 - Standard Case w/15 Amp. Triac

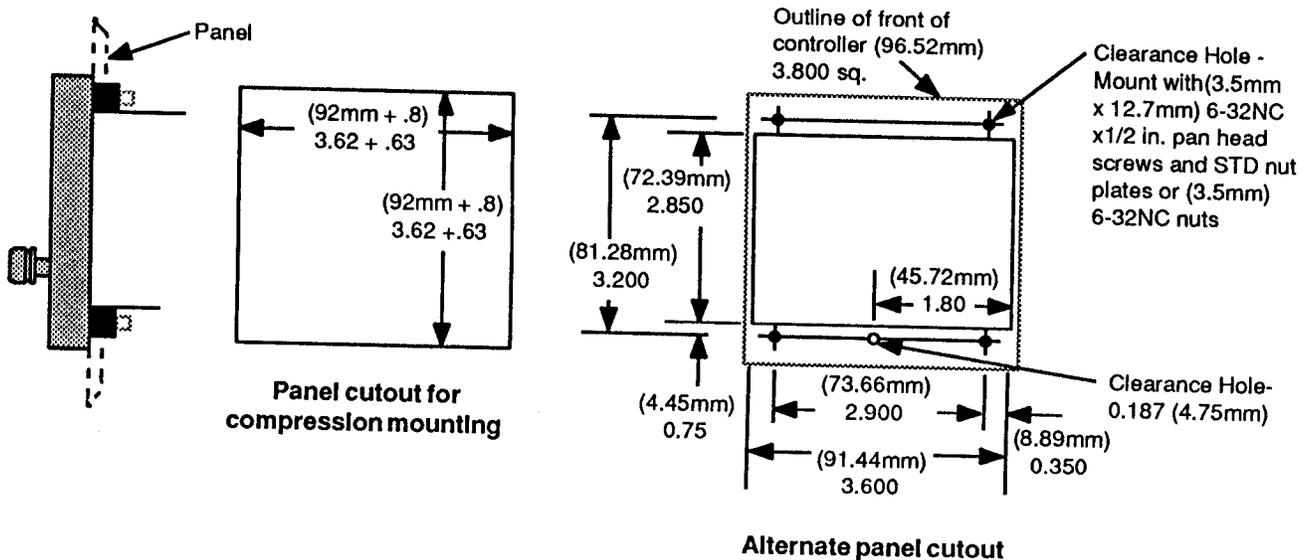


Figure 4 - Mounting Requirements

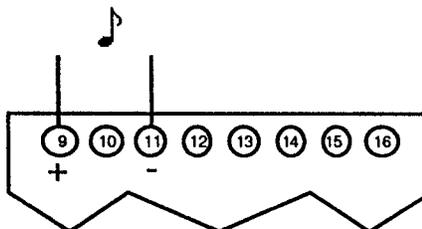
## Input - Terminals 9 through 16

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

For models with **Electrical Process Input** (Range #701) see Page 9.

### Thermocouple Input Terminal Designations

- |                                |   |        |
|--------------------------------|---|--------|
| 9. T.C. (+)                    | } | Sensor |
| 10. Not used                   |   |        |
| 11. T.C. (-), Red              |   |        |
| 12. Not used                   |   |        |
| 13. Set point (+) out          |   |        |
| 14. Programmer (+) in          |   |        |
| 15. Signal conditioner (+) out |   |        |
| 16. Circuit common             |   |        |



**Figure 5 - Thermocouple Input**

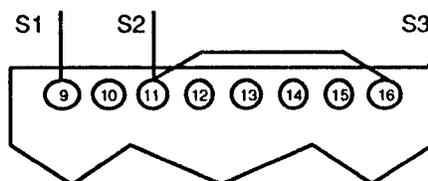
For programmer input refer to Pages 7 & 8, Figures 11, 12, and 13.

### NOTE:

You must use an isolated 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.

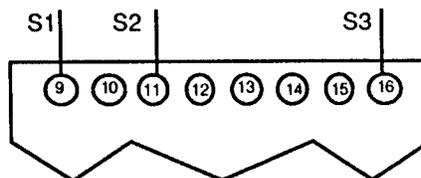
### Platinum RTD Input Terminal Designations

- |                                |
|--------------------------------|
| 9. S1                          |
| 10. Not used                   |
| 11. S2                         |
| 12. Not used                   |
| 13. Set point (+) out          |
| 14. Programmer (+) in          |
| 15. Signal conditioner (+) out |
| 16. Circuit common, S3         |



**Figure 6 - RTD Input (2 wire)**

For programmer input refer to Pages 7 & 8, Figures 11, 12, and 14.



**Figure 7 - RTD Input (3 wire)**

### NOTE:

Long 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).

# Wiring (cont.)

## Output - Terminals 1 through 8

### Terminal Designations

- 1. Not used
- 2. Not used
- 3. N.C. } Contact Rated
- 4. N.O. } 230V Max.,
- 5. C. } 5amp R.M.S.
- 6. AC line common, L2
- 7. 115V line, L1
- 8. 230V line, L1



### 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.

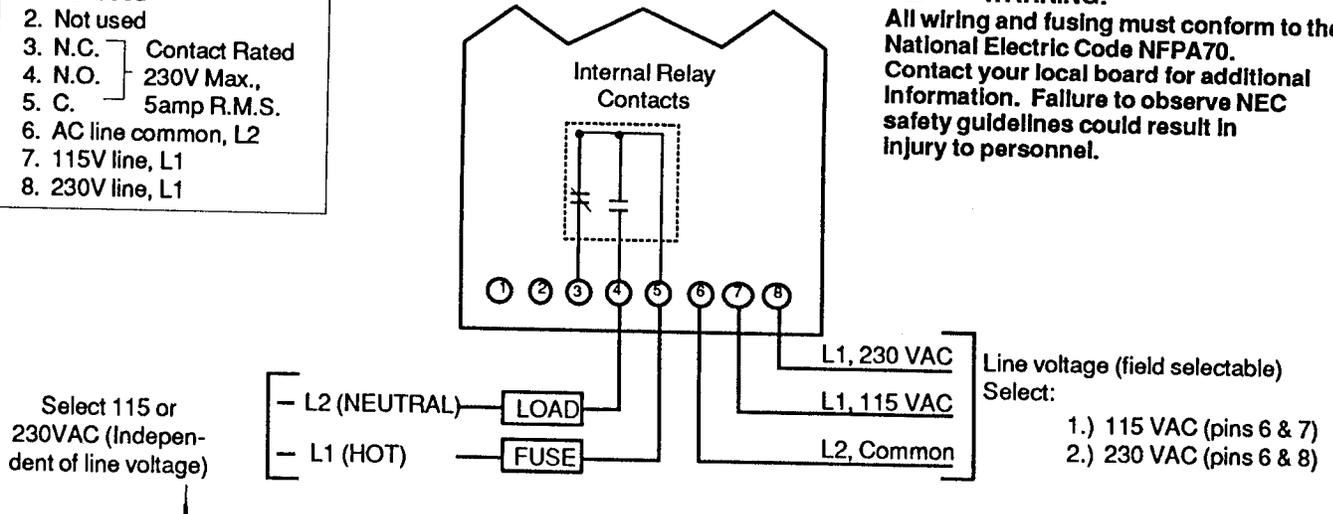


Figure 8 - 808A Relay Output

### Terminal Designations

- 1. Not used
- 2. Not used
- 3. T1 } N.O. Solid State
- 4. T2 } Output
- 5. Gate (for external triac)
- 6. AC line common, L2
- 7. 115V line, L1
- 8. 230V line, L1



### CAUTION:

Terminal 5, Gate (for external triac) is for internal use only. Any external wiring to terminal 5 may damage the control. Consult the factory before using terminal 5.

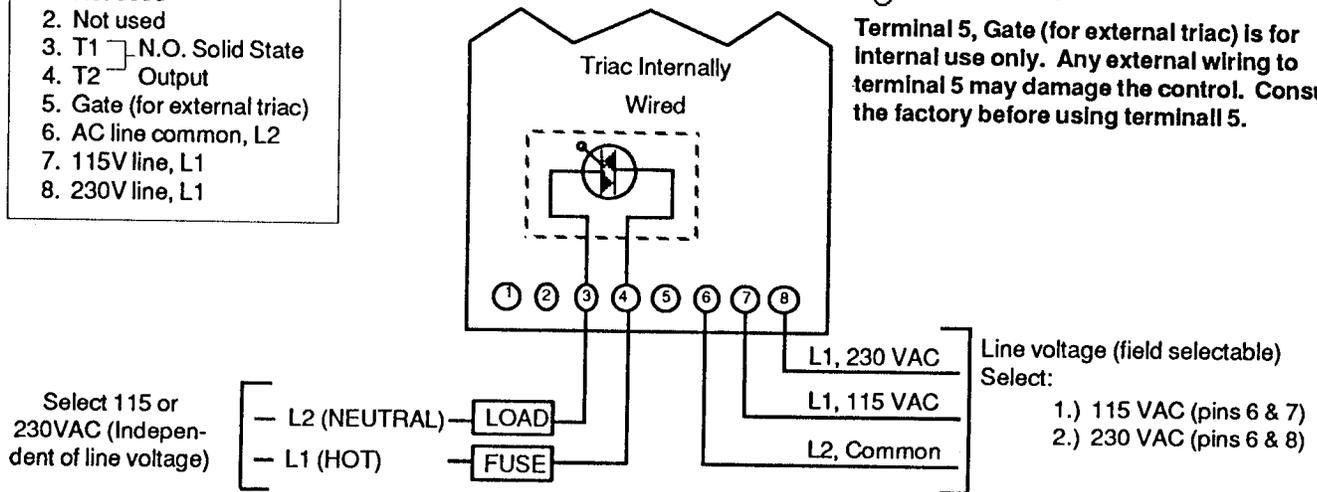
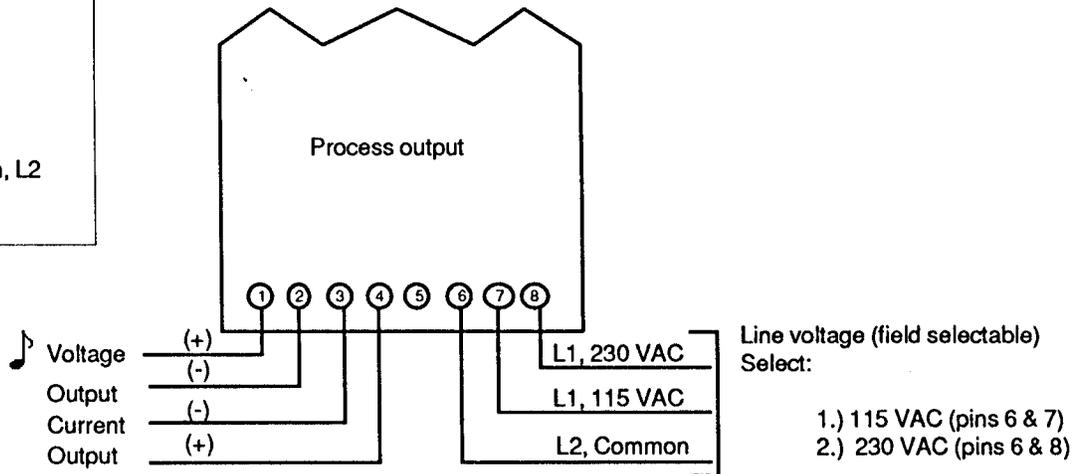


Figure 9 - 808B & 808C 1 & 15A Triac Output

## Wiring (cont.)

Terminal Designations	
1. +	Voltage
2. -	(Out)
3. -	Current
4. +	(Out)
5.	Not used
6.	AC line common, L2
7.	115V line, L1
8.	230V line, L1



🎵 You must jumper current output (Terminal 3 to 4) if using voltage output only.

Figure 10 - 808D- 4/20mA/1-5VDC & 808E- 0-20mA/0-5VDC

## Programmer Input

🎵 NOTE:

Remove appropriate internal jumper wire if you are using the programmer input. See Pages 8 and 9, Figures 13, 14, or 17.

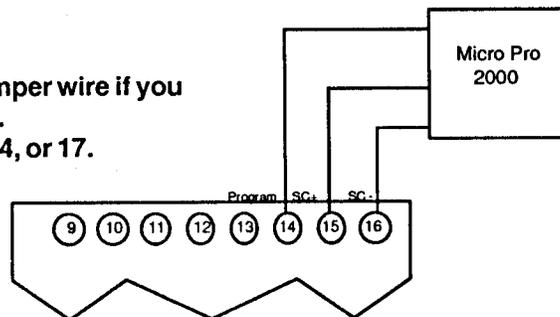
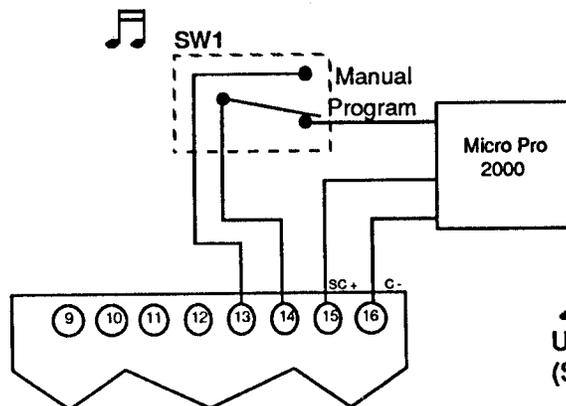


Figure 11 - Remote set point (w/programmer)



🎵 NOTE:  
Use dry circuit for SW1  
(SW1 customer supplied)

Figure 12 - Local/remote set point (w/programmer)

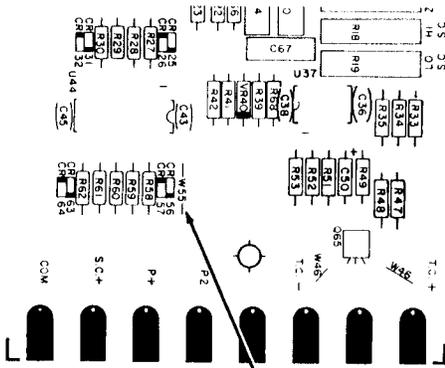
# Jumper Locations



**CAUTION:**

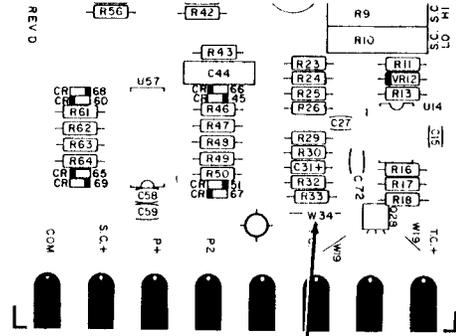
These jumpers are soldered onto the printed circuit board. They must be removed when using a programmer input, or the 808 will not function correctly.

## 3 Digit Display



A007-1233-W55

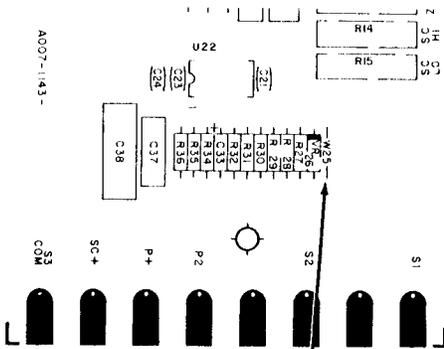
## 4 Digit Display



A007-1215-W34

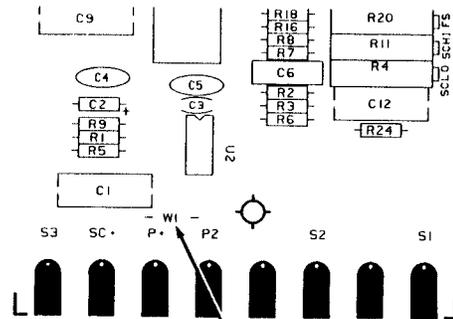
Figure 13 - Thermocouple Unit

## 3 Digit Display



A007-1143-W25

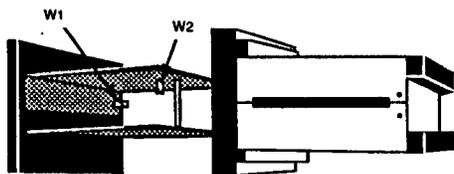
## 4 Digit Display



A007-1602-W1

Figure 14 - RTD Unit

# Electrical Process Input



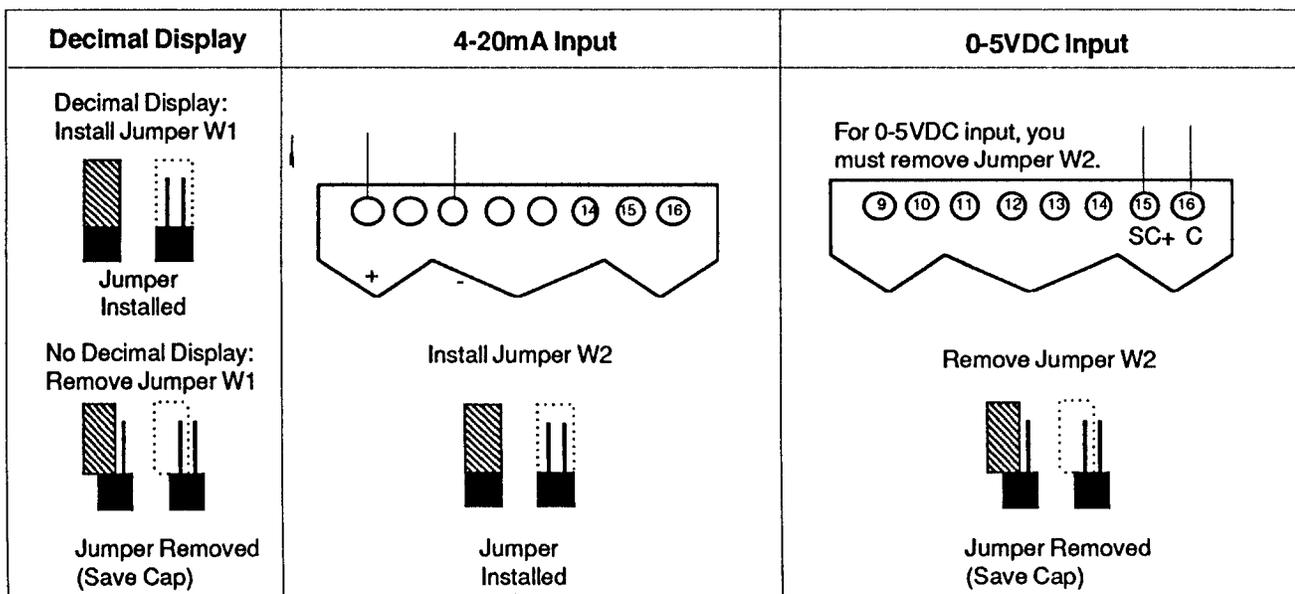
Three dimensional drawing of Range #701 removable jumper block positioning.

## Electrical Process Input Terminal Designations

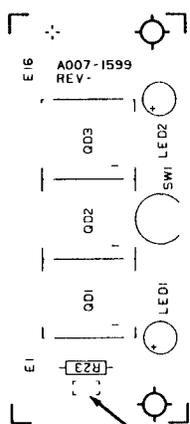
- 9. 4-20mA, (+) in
- 10. Not used
- 11. (-) in
- 12. Not used
- 13. Set point (+) out
- 14. Programmer (+) in
- 15. Signal conditioner (+) 0-5VDC
- 16. Circuit common

**Figure 15 - Decimal Display Jumper Positioning**

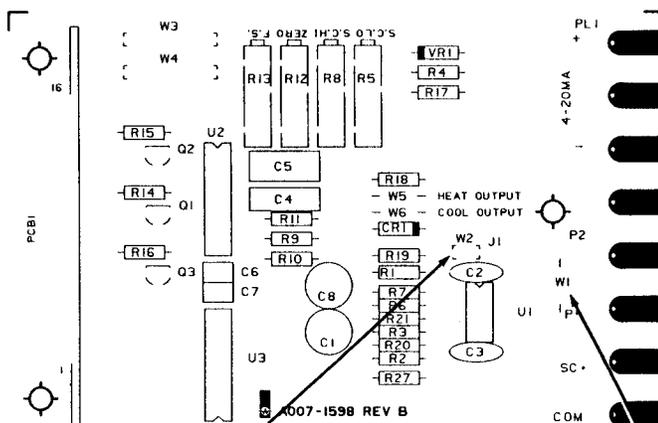
To use the Electrical Process Input, you must set jumper W1 for decimal display or no decimal display, and you must set Jumper W2 for 4-20mA input or 0-5VDC input. Figure 16 shows you how to place the jumpers. Figure 17 shows you where its jumpers are.



**Figure 16 - Electrical Process Input**



**A007-1599-W1**  
Decimal  
Removable jumper block



**A007-1598-W2**  
4-20mA/0-5VDC  
Removable jumper block

**A007-1598-W1**  
Programmable  
Soldered in

**Figure 17 - Electrical Process Range #701 Jumper Locations**

# RTD Field Calibration Procedure

 NOTE: All pots are on the upper board.

## Platinum RTD Input

### Equipment Required:

- A. 100Ω decade resistance box.
- B. Digital voltmeter (DVM).
- C. Extender board may be used for ease of servicing, Watlow P/N Z100-0421-0000.

### Procedure:

1. Connect decade resistance box to input terminals 9 and 11, with 11 jumpered to 16. Connect digital voltmeter to terminals 15 (+) and 16 (-). Install control into extender board, if one is in possession. Connect power to the control. Let the control stabilize before calibration begins.
2. Set the decade box to \_\_\_\_\_ Lo ohms. Adjust SC Lo pot for \_\_\_\_\_ SC Lo volts on the digital voltmeter. Adjust the Zero pot for \_\_\_\_\_ Lo Temp on the display of the control.
3. Set the decade box to \_\_\_\_\_ Hi ohms. Adjust SC Hi pot for volts on the digital voltmeter. Adjust the FS pot for \_\_\_\_\_ Hi 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 1 - RTD Input Calibration Values**

Range				Millivolt vs. Temperature							
Code	Low/High	Cal. Curve		Lo Ohms	SC Lo Pot	Lo Temp	Mid Ohms	Mid Temp	Hi Ohms	SC Hi Pot	Hi Temp
100	-99 - 999°F	#3916		92.93Ω	.000V	0°	199.37Ω	500°	294.91Ω	4.95V	990°
101	-99 - 540°C	#3916		100.00Ω	.000V	0°	195.70Ω	250°	297.50Ω	2.70V	540°
108	0.0 - 399.9°F	#3916		97.35Ω	.40V	20°	136.59Ω	200°	176.73Ω	7.80V	390°
109	0.0 - 399.9°C	#3916		107.93Ω	.40V	20°	177.14Ω	200°	246.08Ω	7.80V	390°
120	-99 - 999°F	#3850		93.03Ω	.000V	0°	197.69Ω	550°	291.56Ω	4.95V	990°
121	-99 - 540°C	#3850		100.00Ω	.000V	0°	195.70Ω	250°	297.50Ω	2.70V	540°
128	0.0 - 399.9°F	#3850		92.93Ω	.000V	0°	135.97Ω	200°	175.43Ω	7.80V	390°
129	0.0 - 399.9°C	#3850		107.79Ω	.40V	20°	175.84Ω	200°	243.59Ω	7.80V	390°

## T/C Field Calibration Procedure

### Thermocouple Input

#### Equipment Required:

1. Precision millivolt source.
2. Digital voltmeter (DVM).
3. Type \_\_\_\_\_ reference compensator with reference junction at 32°F/0°C.
4. Extender board may be used for ease of servicing, Watlow P/N Z100-0421-0000.

#### Procedure:

1. Connect millivolt source to reference compensator and compensator leads to T/C inputs, terminals 9 (+) and 11 (-). Connect digital voltmeter to terminals 15 (+) and 16 (-). Install control into extender board, if one is in possession. Connect power to the control. Let the control stabilize before calibration begins.
2. Set the millivolt source to \_\_\_\_\_ Lo mV. Adjust SC Lo pot for \_\_\_\_\_ SC Lo volts on the digital voltmeter. Adjust the Zero pot for \_\_\_\_\_ Lo Temp on the display of the control.
3. Set the millivolt source to \_\_\_\_\_ Hi mV. Adjust the SC Hi pot for \_\_\_\_\_ SC Hi volts on the digital voltmeter. Adjust the FS pot for \_\_\_\_\_ Hi 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 - T/C Input Calibration Values**

Range			Millivolt vs. Temperature							
Code	Low/High	TC Type	Lo mV	SC Lo Pot	Lo Temp	Mid mV	Mid Temp	Hi mV	SC Hi Pot	Hi Temp
606	0 - 1370°C	"K"	2.02mV	.100V	50°	29.13mV	700°	54.13mV	2.70V	990°
608	0 - 1600°F	"J"	.000mV	.064V	31°	23.32mV	800°	50.05mV	3.20V	1600°
609	0 - 850°F	"J"	.000mV	.000V	0°	21.85mV	400°	42.28mV	3.75V	750°
610	0 - 999°F	"K"	.000mV	.000V	0°	20.64mV	500°	40.88mV	4.95V	990°
611	0 - 2500°F	"K"	.000mV	.064V	32°	26.96mV	1250°	54.85mV	5.00V	2500°
612	-99 - 600°F	"T"	.000mV	.160V	32°	6.647mV	300°	15.77mV	3.000V	600°
618	0 - 1370°F	"K"	2.02mV	.100V	50°	29.13mV	700°	54.13mV	2.70V	1350°

## Glossary

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 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 temperature 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. **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.
6. **Zero 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.)
7. **Cycle Time** - The rate at which the controller samples load temperature. At a setting of 2 seconds, 25 % power is required to maintain load temperature at set point, power will be applied for 1/2 second every 2 seconds.
8. **Anti Reset** - Inhibits reset action when the actual process temperature is outside the proportional band.

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

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

11.  - The Deer Crossing Sign alerts you to a "CAUTION," a safety or functional hazard which could affect your equipment or its performance.

## Tuning Procedure for PID Controls

## Tuning

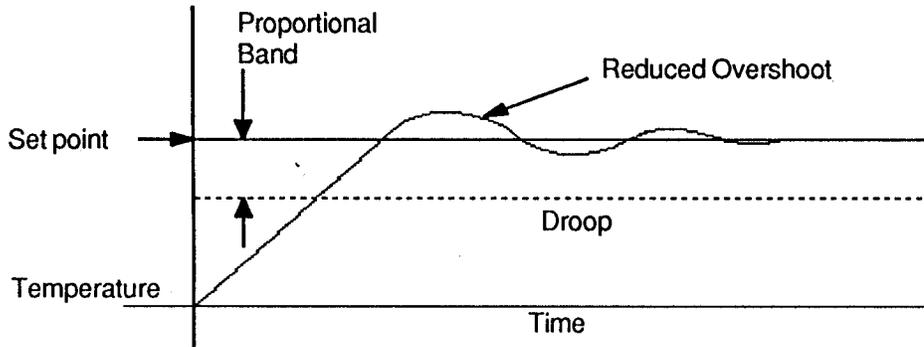


Figure 18 - Adjustment Graph

### Initial Settings:

1. Cycle time: 2 seconds; turn maximum counter-clockwise; CCW.
2. Proportional band: Turn maximum clockwise; CW.
3. Rate: 0; turn maximum CCW.
4. 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.

### Proportional Band Adjustment:

Rotate the proportional band pot CCW 1/4 turn and observe system stability. Repeat until the process 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:

The rate adjustment controls overshoot as load temperature approaches set point temperature by limiting the rate of change of load temperature. Rotate the rate pot 1/4 turn CW. Change the set point temperature 20 to 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:

The reset adjustment controls the time required to drive the error signal to zero. A slow setting (0.05 repeats/mins.) requires long periods of time for the load temperature to reach set point. If the reset time is set too fast (0.5 repeats/ mins.) 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:

Cycle time is the time base used in proportioning power to the load. At a setting of 2 seconds, if 25% power is required to maintain load temperature at set point, power will be applied for 0.5 second every 2 seconds. At 10 second cycle time, power would be applied for 2.5 seconds every 10 seconds.

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.

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

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

## Troubleshooting Chart

Problem	Cause	Action
No display	The A.C. input is not connected or is connected improperly.	<p>Check the A.C. input connections. If not present or correct, connect per Wiring outputs. See Pages 6 &amp; 7, Figures 8-10.</p> <p>If present and correct, return the unit to the factory.</p>
The display indicates EEE or OFL	1. An open thermocouple or RTD.	Repair or replace.
	2. For a 2 wire RTD - A jumper is not being used between S2 and S3.	Connect per Wiring inputs. See Page 5, Figure 6.
A display error	The sensor is connected improperly.	<p>Check the sensor location, connections, and the sensing element. Repair or replace the sensor as required.</p> <p>A. Thermocouple - Place a jumper wire across the T/C terminals. The Indicator is functioning correctly if the display indicates room temperature.</p> <p>B. RTD - Place a 100 ohm resistor across the sensor terminals. The indicator is functioning properly if the display indicates approximately 0°C/32°F.</p>
Poor temperature control	The control parameters are not adjusted properly.	Adjust the proportional band, cycle time and the manual reset per Tuning. See Page 13.
The load will not turn ON	1. An open thermocouple or RTD.	Repair or replace.
	2. The load circuit is open.	Check the fuses, circuit breakers and the load.
	3. A faulty unit.	Return the unit to the factory.
The load will not turn OFF	1. The polarity is reversed on the T/C.	Connect per the Wiring inputs. See Page 5, Figure 5.
	2. A short circuit between T1 and T2.	With the power OFF, measure the resistance from T1 to T2 (Pins 3 & 4); if it is short circuited, order P/N 0802-0217-0000 for a 1A triac. Order P/N 0802-0404-0000 for a 15A triac.
Cannot control the unit with an external programmer	The internal jumper wires are not removed.	Remove the proper jumper wires depending on your unit. See Jumper Locations, Pages 8 or 9, Figures 13, 14, or 17.

## Returns

The Watlow Series 808 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, any 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.

## Warranty

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

1. You must 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      • Bill to address
  - Contact name        • Phone number
  - Ship via              • Your P.O. number
  - Symptoms and/or special instructions
  - Name and phone number of person returning the material.

We will not accept a return without an RMA number. The RMA number must appear on the outside of the carton and on all paperwork. Cartons without RMA numbers will be returned. Ship on a Freight Prepaid basis.

2. You need prior approval and an RMA number from the Customer Service Department when you are returning an unused product for credit. Also, we must apply a 20 percent restocking charge for all returned stock controls and accessories.
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.
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.