Series 360

1/4 DIN Limit or Temperature Control

User's Manual

WATLOW

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

W360-DA30-8935
August, 1989
Supersedes:
W360-DB20-8511

$5.00

General Description

The Watlow Series 360 is a 1/4 DIN analog, non-indicating, latching limit or temperature control. The 360 features a plug-in design to facilitate installation and service. It accepts a thermocouple input, and a mechanical relay is offered as the output device. An integral setpot is used, along with a °F and °C dial scale to adjust set point.

The control mode for the temperature control is either ON/OFF or time proportioning with manual reset. High or low limit is user selectable on the latching limit version.

Specifications

Control Mode

Limit, latching
- High or low, user selectable.
- Reset via front panel push button.

ON/OFF Control
- Control with 3°F (1.6°C) switching hysteresis for Type "J" and 4°F (2.2°C) for Type "K" or "T".

Time Proportioning
- Proportional band: 5 to 50°F (3 to 28°C) front panel adjust.
- Manual reset: 100% of proportional band front panel adjust.
- Cycle time: 2 to 20 seconds internal adjust.

Operator Interface

Set Point, Integral
- Dial scale calibrated to compensate for sensor non-linearities.
- Dual °F & °C scales.
- Mechanical clamp to lock setting (limit versions only).

Input
- Thermocouple with automatic cold junction compensation.
- Sensor may be isolated or grounded.

Output
- Relay, 10A, SPDT: 10A @ 120VAC, 5A @ 240VAC, 10A @ 28VDC, 1/3HP @ 120 or 240VAC, 345VA pilot duty @ 120 or 240VAC.
- Plug-in only in proportional control.

Accuracy
- Calibration Accuracy and Sensor Conformity: ± 1% of span, at 77°F ± 5°F (25°C ± 3°C) ambient & rated line voltage ± 1%.
- Set Point Assembly: ± 2% of dial scale.
- Accuracy Span: 1000°F or 540°C minimum.
- Temperature Stability: Typically ± 10µV/°F (18µV/°C) ambient referred to the input.
- Voltage Stability: ± 0.01% of span/% of rated line voltage.

Agency Approvals
- UL recognized, File #E43684, UL 873.
- FM approved (limit version only).

Terminals
- #6 screws on barrier strip.

Power
- 120/240VAC ± 10%, 50/60Hz.
- 4VA.

Power Loss - Output Reset

Operating status when power is restored, if temperature is not beyond set point:
- Automatic: Output relay is automatically re-energized.
- Manual: Manual reset is required to re-energize output relay.

Operating Environment
- 30 to 130°F (0 to 55°C).
- 0 to 90% RH, non-condensing.

UL Recognized, FM Approved Models

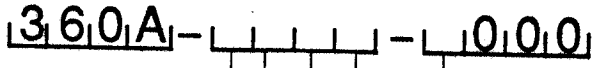
360A-1XXX-X000
360A-3XXX-X000

UL 873 Recognized Only Models

360A-5XXX-X000
360A-6XXX-X000

Dimensions

• Height:	3.80 in.	(96.5mm)
• Width:	3.80 in.	(96.5mm)
• Behind panel depth:	4.90 in.	(124.1mm)
• Weight:	1.3 lb.	(0.6kg)



Control

Series 360 = Temperature limit or closed loop control, latching, ON/OFF or proportioning, integral setpot, 10A relay, 1/4 DIN.

Control Mode

1 = Limit, Manual Reset, UL & FM
3 = Limit, Auto reset, UL & FM
5 = ON/OFF control, UL
6 = Time proportioning control, UL line voltage 120/240VAC required.

Input & Range

Thermocouple

601	=	J	0	to	600°F	or
			-18	to	315°C	
602	=	J	0	to	1000°F	or
			-18	to	528°C	
603	=	K	0	to	2500°F	or
			-18	to	1350°C	
604	=	T	-200	to	600°F	or
			-129	to	538°C	
609	=	T	-125	to	425°F	or
			-87	to	218°C	

Line Voltage

1 = 120VAC (N/A with time proportioning)
2 = 240VAC (N/A with time proportioning)
3 = 120/240VAC (required for time proportioning control)

Related Devices:

- Output relay, ON/OFF and Time Proportioning control: 0003-0073-0000
- Output relay, latching limit: 0003-0071-0000
- Setpot knob: 0821-0064-0000
- Extender card: Z100-0422-0000
- Jumper caps: 0817-0263-0000

This Series Is Obsolete. A More Advanced Series Is Now Available In Same Package Size. For Help In Crossing Over To Newer Version Call Toll Free 1-800-880-3743

Installation and Dimensional Information

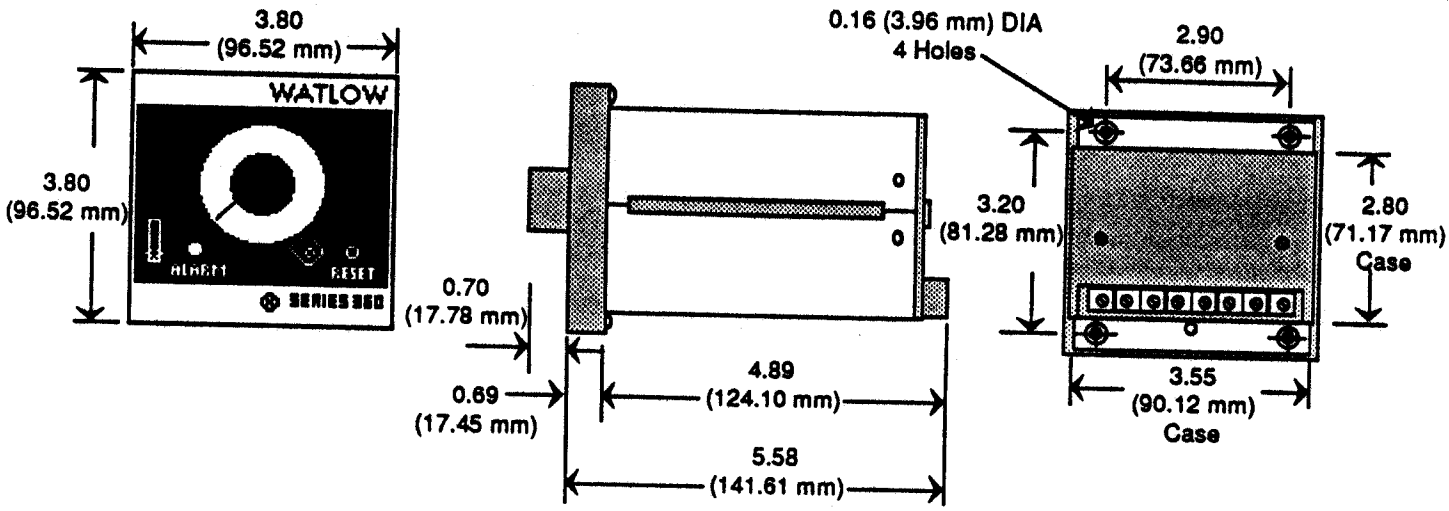


Figure 1 - Series 360 Case Dimensions

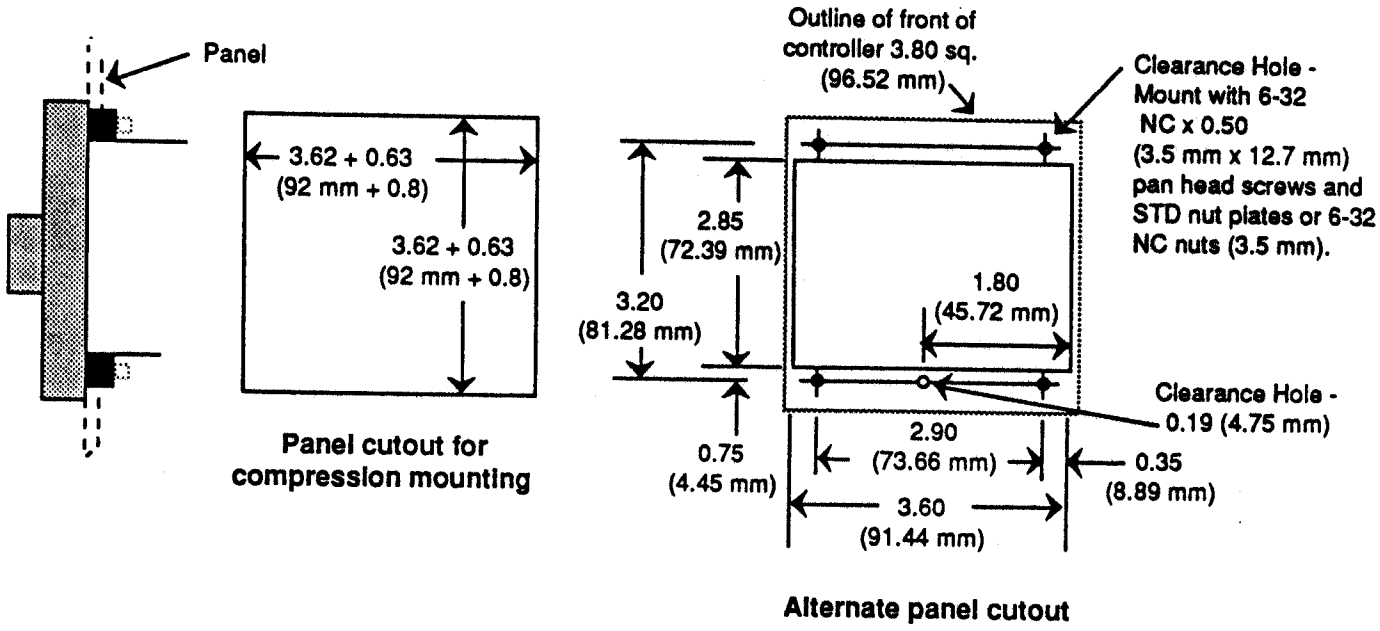


Figure 2 - Mounting Requirements

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 should conform to the National Electric Code NFPA 70 and to any locally applicable codes also.

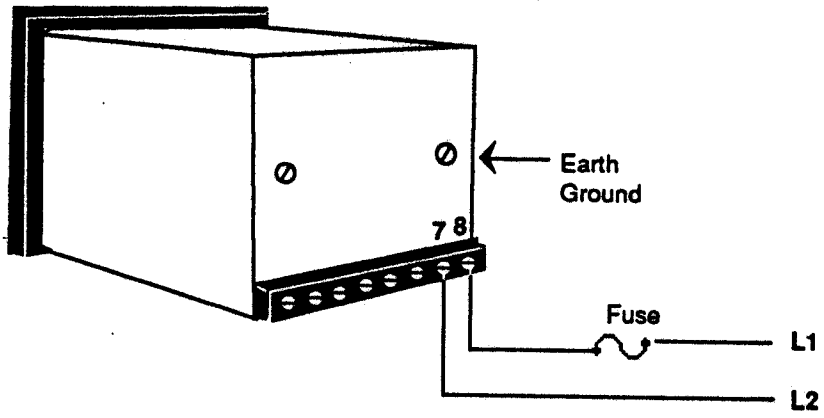


Figure 3 - 120 VAC Power Wiring (360A-XXXX-1000)

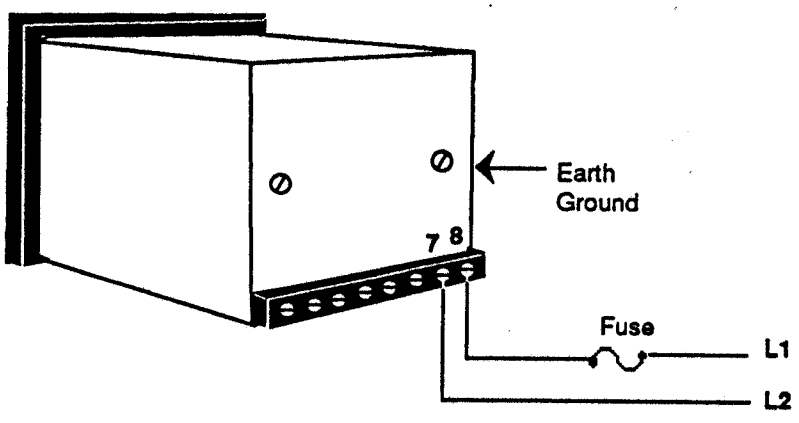


Figure 4- 240 VAC Power Wiring (360A-XXXX-2000)

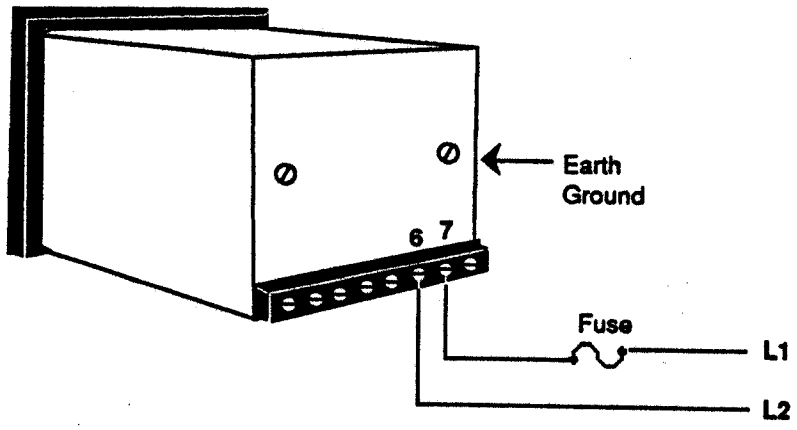


Figure 5 - 120 VAC Power Wiring (360A-XXXX-3000)

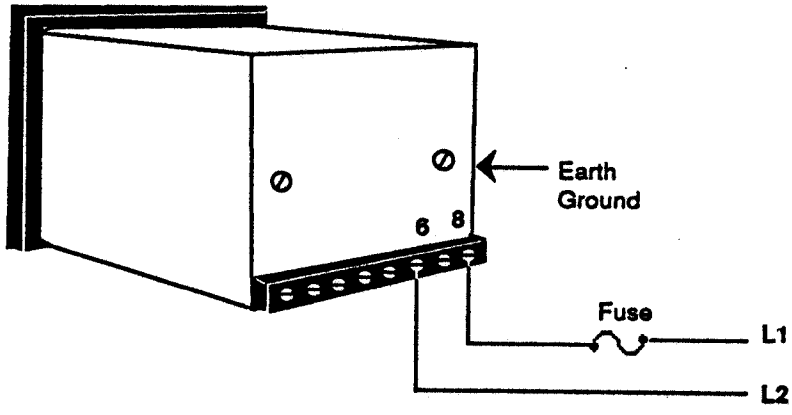


Figure 6- 240 VAC Power Wiring (360A-XXXX-3000)

♪ **NOTE:**

Extension wire for thermocouples must be of the same alloy as the thermocouple itself to limit errors.

Series 360
Temperature Controller

Terminal Designation

1. T.C. (+) ┐ Sensor
2. T.C. (-) ┘

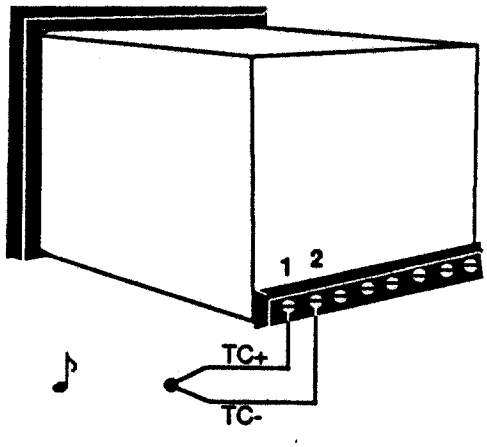


Figure 7 - Thermocouple Input (360A-XXXX-X000)

This Series Is Obsolete. A More Advanced Series Is Now Available In Same Package Size. For Help In Crossing Over To Newer Version Call Toll Free 1-800-880-3743

WARNING:

All wiring and fusing must conform to the National Electric Code NFPA 70. Contact your local board for additional information. Failure to observe NEC safety guidelines could result in injury to personnel.

Series 360
Temperature Controller

Terminal Designation

1. T.C. (+) ┐ Sensor
2. T.C. (-) ┘
3. C. ┐
4. N.O. ├ Contact Rated 230V, Max 5 Amp RMS
5. N.C. ┘

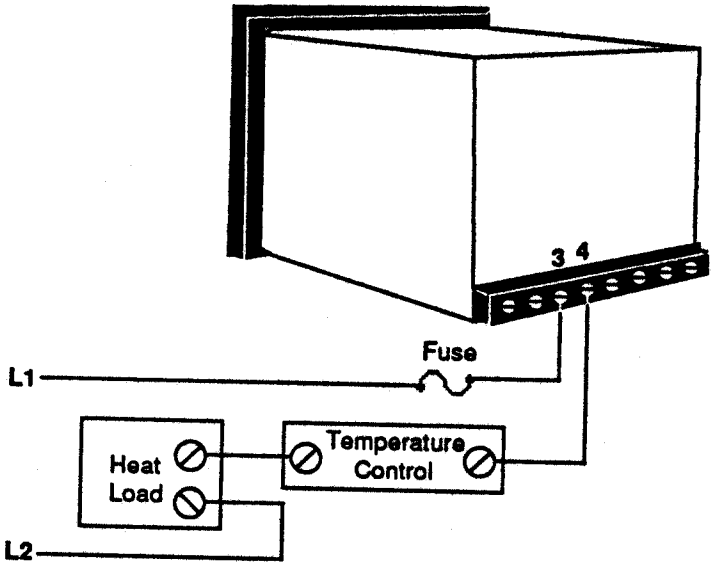


Figure 8 - Limit Output Wiring (360A-[1,3]XXX-X000)

Series 360
Temperature Controller

Terminal Designation

1. T.C. (+) ┐ Sensor
2. T.C. (-) ┘
3. C. ┐
4. N.O. ├ Contact Rated 230V, Max 5 Amp RMS
5. N.C. ┘

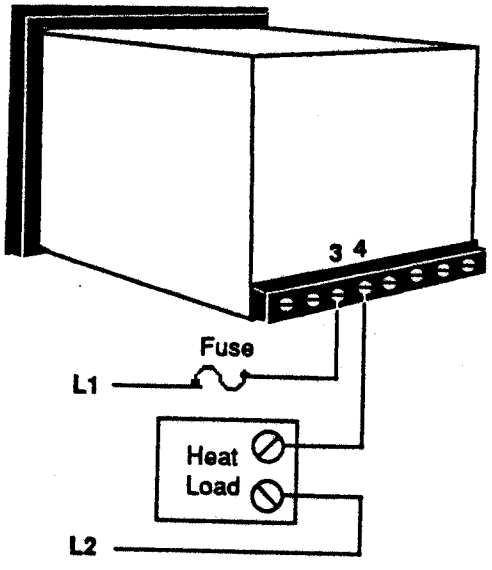


Figure 9 - Time Proportioning or ON/OFF Output Wiring (360A-[5, 6]XXX-X000)

Single Phase 120VAC Application

WARNING:

Install high or low temperature limit control protection in systems where an overtemperature or undertemperature 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.

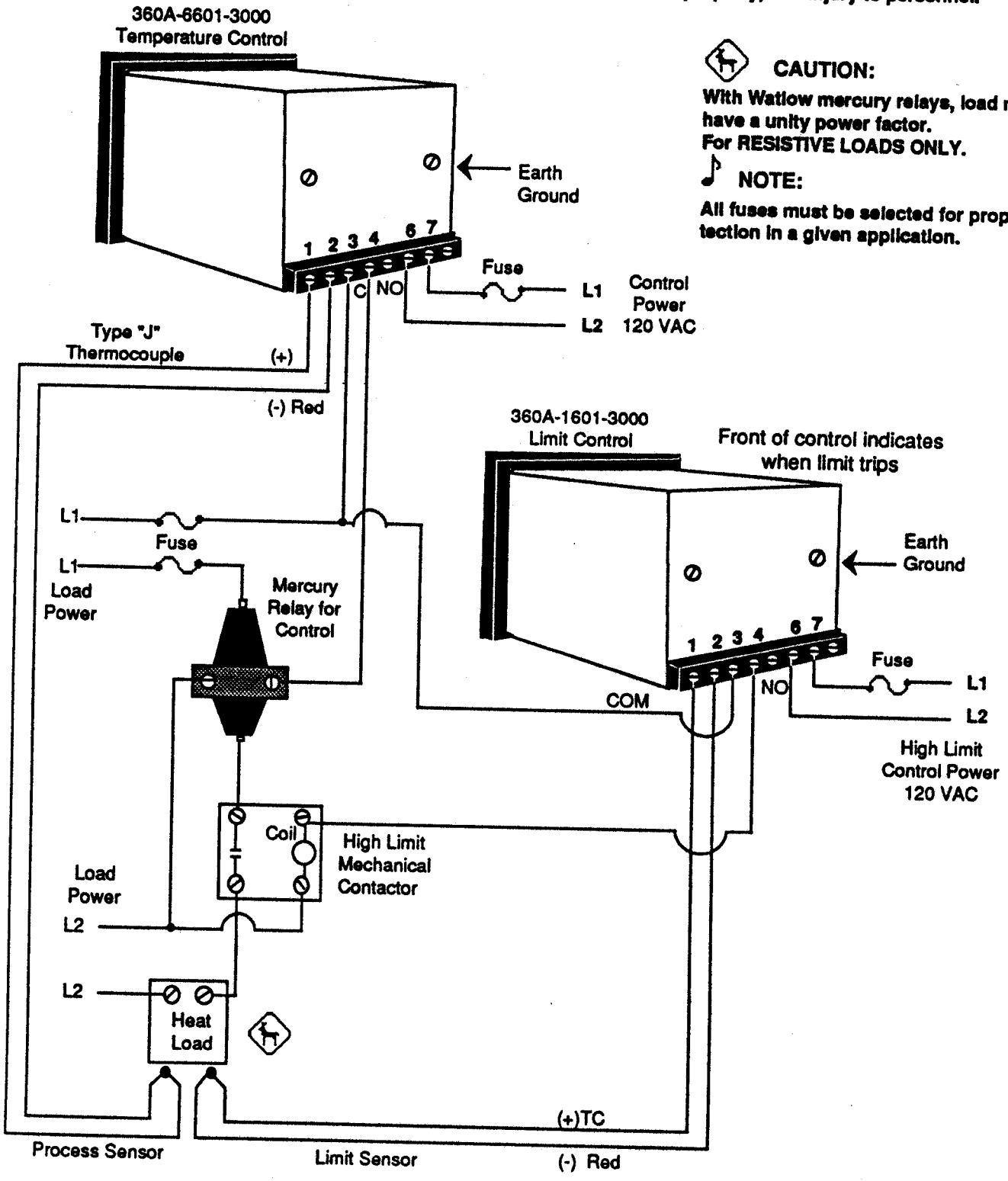


Figure 10 - Series 360 System Wiring Example

Glossary

1. **Cold Junction** - Point of connection between thermocouple metals and the electronic instrument.

2. **Cold Junction Compensation** - Electronic means used to compensate for the effect of temperature at the cold junction.

3. **Cycle Time** - Time interval between consecutive turn ons.

4. **DIN** - Deutsche Industrial Norms, a widely recognized German standard for engineering units.

5. **Limit Control** - Used to remove power to the load whenever the process temperature reaches the limit set point. The unit is manually reset with a front panel-mounted reset switch and a visual alarm indicator. Remote mounted audio or visual alarms may also be utilized to verify alarm/limit status and notify personnel of a limit condition.

6. **Manual Reset or Offset** - Adjustment used in control systems to offset any temperature droop and obtain agreement between actual process temperature and controller set point.

7. **ON/OFF** - Output is turned full ON below set point and stays turned on until process temperature reaches set point, then turns the output full OFF. At this point depending on the design of the thermal system, the process temperature overshoots the set point temperature by some degree.

   As the load cools down below set point (an amount equal to the switching sensitivity or differential) the output is once again turned full ON.

8. **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%.

9. **Set Point** - Intended value of the process variable.

10. **Switching Sensitivity or Differential** - The output will de-energize when the actual temperature reaches the set point temperature. The switching sensitivity or differential is the change in temperature (°F/°C) required to re-energize the output.

11. **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 has stabilized.

12. **Temperature Oscillation or Hunting** - Occurs when proportional band is too narrow or the system is upset by an outside source. Actual process temperature is not controlled within 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.

13. **Thermocouple** - Temperature sensing device that is constructed of two dissimilar metals wherein a measurable, predictable voltage is generated corresponding to temperature.

14. **Thermocouple Break Protection** - Fail-safe operation that assures output shutdown upon an open thermocouple condition.

15. **Time Proportioning with Manual Reset** - The output is turned full ON until the process temperature reaches the proportioning band. In the proportional band, output is cycled ON/OFF in proportion to the degree of difference between actual process temperature and controller set point.

    When process temperature just enters the proportional band, the output may cycle 90% ON and 10% OFF. When the process temperature is near set point the output may cycle 10% ON and 90% OFF. When the process temperature is above the proportional band the output is turned full OFF.

    After the system has stabilized a phenomenon occurs in a proportional control system called droop. This happens in virtually all proportional control systems. The manual reset adjustment is used to compensate for any temperature droop and obtain agreement between set point temperature and desired actual process temperature.

16. ♪ or ♫ - Musical Notes are used to alert you to important details.

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

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

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.

NOTE:

Depending on your unit, the potentiometers on the printed circuit board may be labeled either "Lo" or "Zero," and "HI" or "FS."

Thermocouple Input

Equipment Required:

- Precision Millivolt Source.
- 3 - 1/2 digit, Digital Voltmeter (DVM).
- Reference compensator with reference junction at 32°F/0°C.
- Extender board may be used for ease of servicing, Watlow P/N Z100-0422-0000.

Procedure:

Refer to Table 1 for the values that apply to your unit's range code. Refer to Figure 9 below for potentiometer locations.

1. Connect the millivolt source to the reference compensator, and the compensator leads to the T/C inputs, Terminals 1 (+) and 2 (-).

2. Connect the DVM to Test connector J13, Pin 1 (-), 3 (+) for Limit or ON./OFF units. If you have a Time Proportioning unit, connect the DVM to the bottom side of R26 (+), and the bottom side of VR1 (-). See Figure 9 on the next page for more details.

3. Install the extender board, if one is in possession, into the case, and the control into the extender board.

4. Connect power to the control. Let the control stabilize before calibration begins.

5. Adjust the front panel setpot to _____°F. Set the millivolt source to _____ Low mV. Turn the LO or ZERO pot to _____ VDC on the DVM.

6. Adjust the front panel setpot to _____°F. Set the millivolt source to _____High mV. Turn the HI or FS pot to _____ VDC on the DVM.

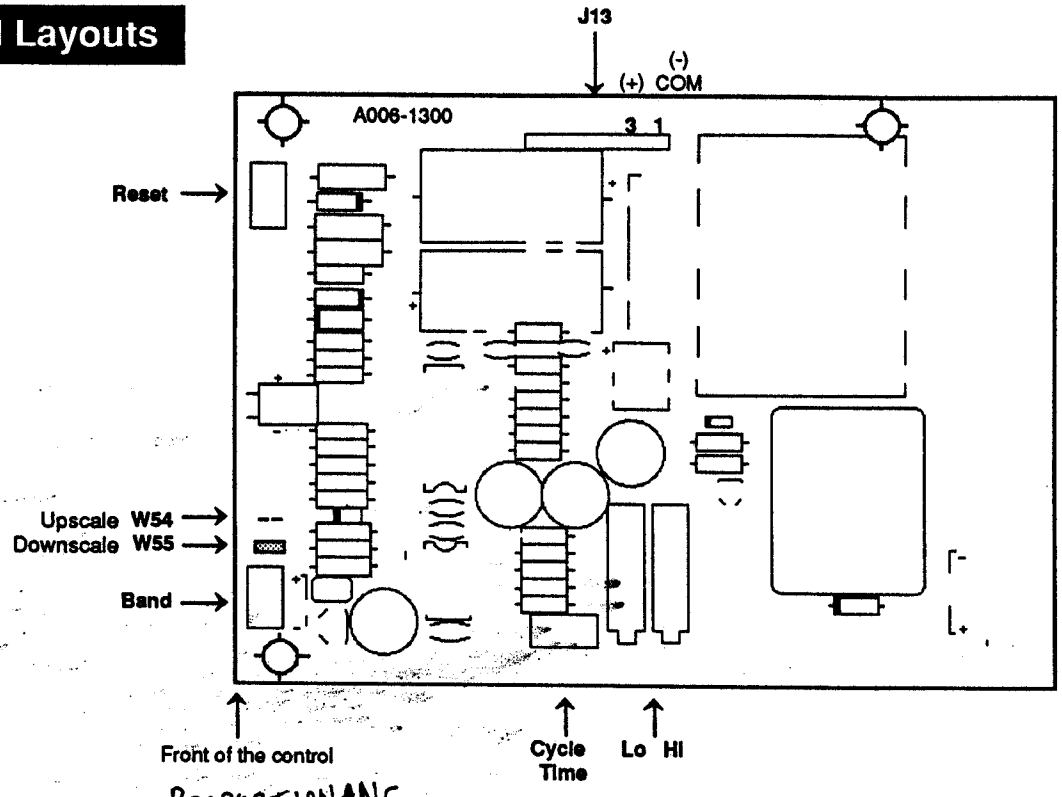
7. Repeat Steps 5 and 6 until all of the readings are correct with no further adjustment necessary.

8. Check the Mid point calibration by setting the mV source to _____ Mid mV. The display should read _____ Mid Temp ± 0.5 minor division on the setpot.

Table 1 - Thermocouple Input Calibration Ranges

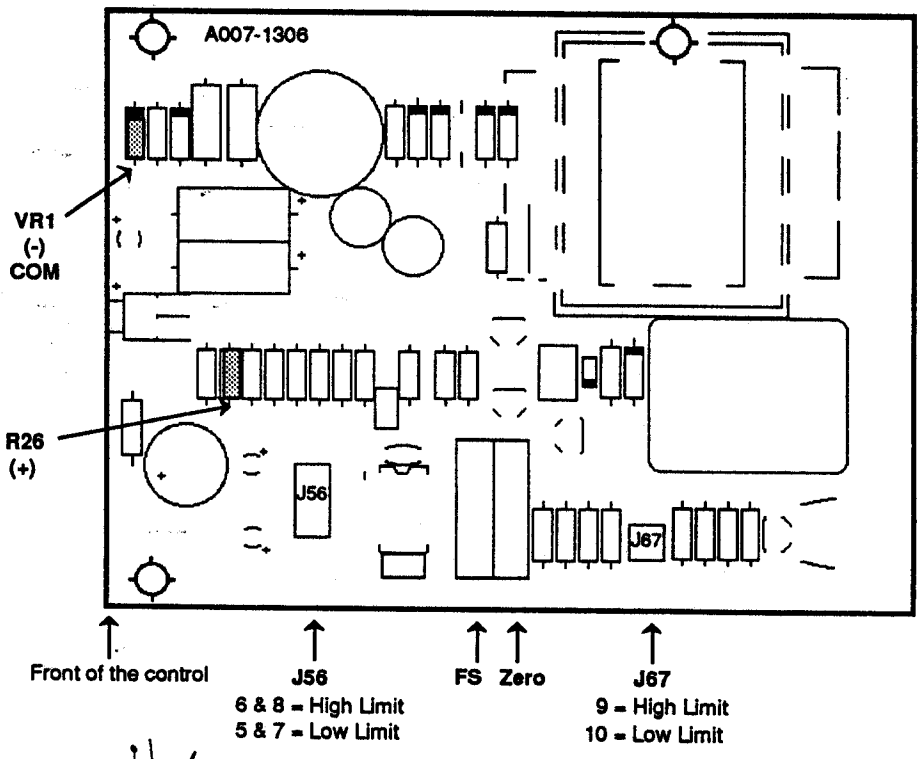
Range			Millivolt vs. Temperature								
Code	Low/High	TC Type	Low Temp	Low mV	Lo Pot	High Temp.	High mV	Hi Pot	Mid Temp	Mid mV	Mid Pot
601	0 to 600°F -18 to 315°C	J	0°F	-0.89	0.00	600°F	17.19	0.00	300°F	7.95	0.00
602	0 to 1000°F -18 to 538°C	J	0°F	-0.89	0.00	1000°F	29.52	0.00	500°F	14.11	0.00
603	0 to 2500°F -18 to 1350°C	K	0°F	0.006	0.00	1350°F	2.66	0.00	675°F	0.62	0.00
604	-200 to 600°F -129 to 538°C	T	-200°F	-4.15	0.00	600°F	15.77	0.00	200°F	3.97	0.00
609	-125 to 425°F -87 to 218°C	T	-125°F	-3.006	0.00	425°F	10.27	0.00	275°F	5.96	0.00

Board Layouts



PROPORTIONING

Figure 11 - A007-1300 ~~Limit/ON/OFF Board~~



Limit/ON/OFF

Figure 12 - A007-1306 ~~Time Proportioning Board~~

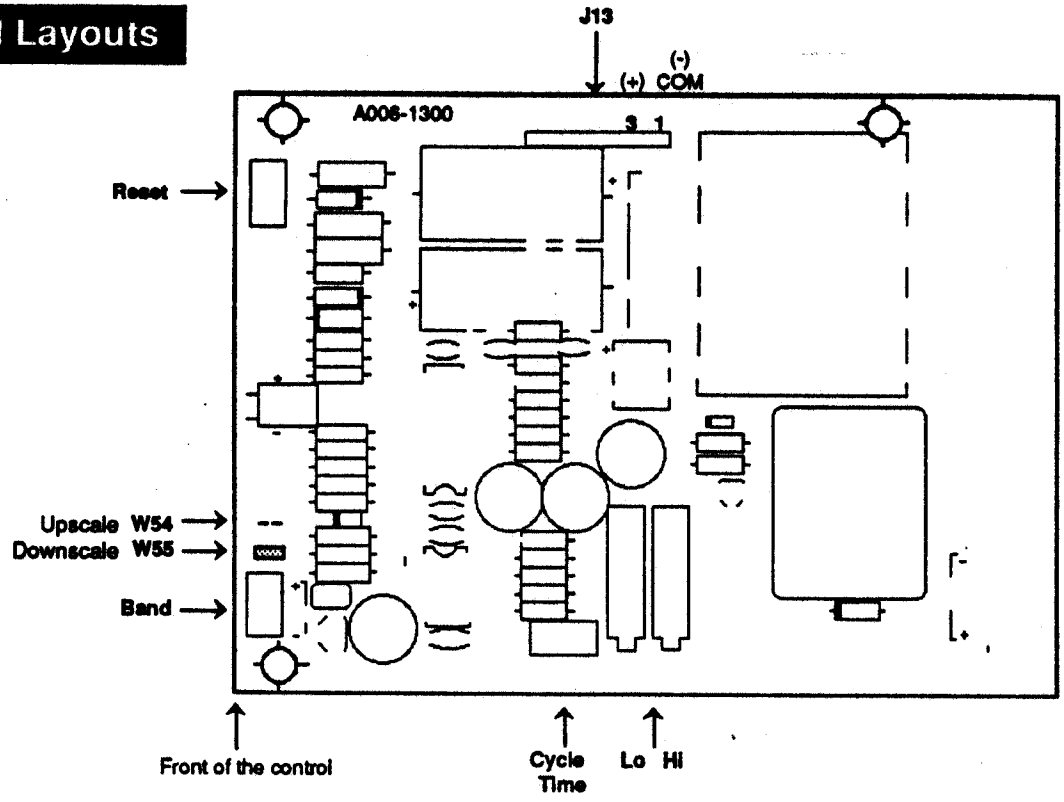


Figure 11 - A007-1300 Limit/ON/OFF Board

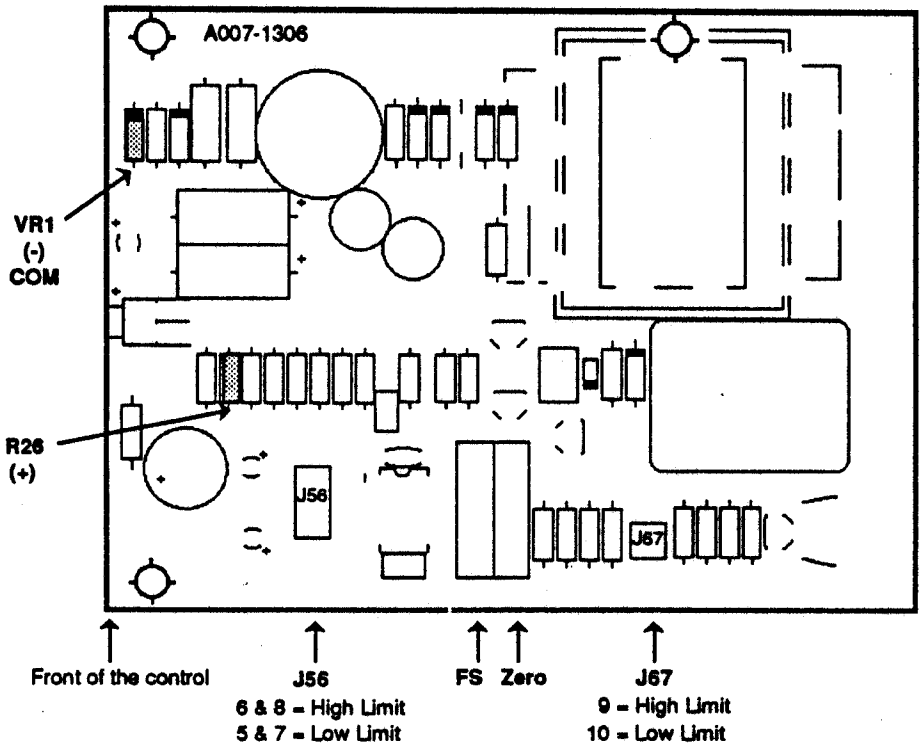


Figure 12 - A007-1306 Time Proportioning Board

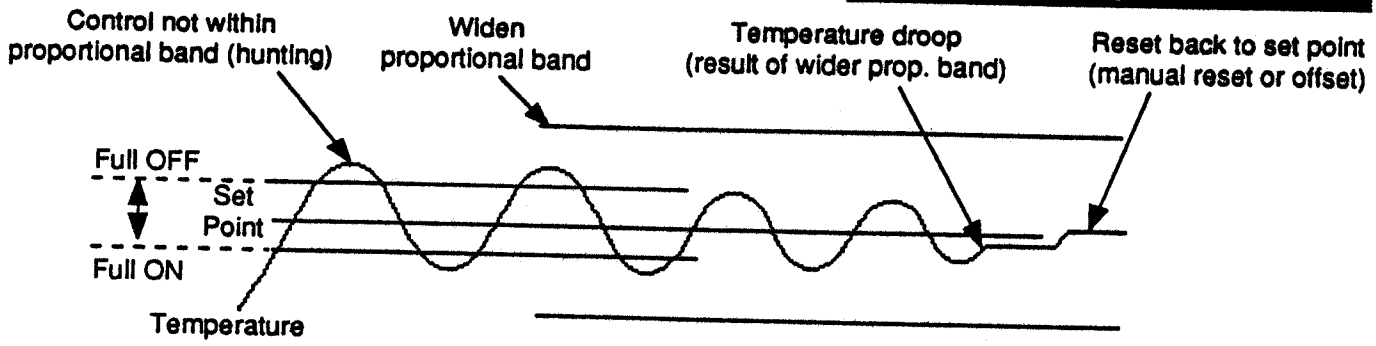


Figure 13 - Adjustment Graph

Tuning Procedure for Time Proportioning Controls with Manual Reset

Initial Settings:

1. Proportional Band: Turn maximum clockwise; CW (widest setting).
2. Manual Reset: Turn to mid-range.
3. Cycle Time: Turn maximum counterclockwise; CCW (fastest time).

Proportional Band Adjustment:
Rotate the proportional band pot (located on the front of the control) CCW 1/4 turn and observe system stability. Repeat until the process temperature begins to hunt (becomes unstable). When hunting is observed, rotate pot CW, in small increments, until the system becomes stable. Some systems may be stable enough to allow minimum proportional band setting (maximum CCW).

Manual Reset:
In virtually all proportional control systems the average process temperature may drop to a point that is not the set point temperature. This action takes place even though the process temperature has stabilized.

Monitor the actual process temperature on the digital indicator and adjust the manual reset pot (located on the front of the control) slowly CW if the process temperature stabilized below set point temperature. If large changes in set point temperature are made, readjustment of the manual reset may be required.

Cycle Time:
Set as required. Best control is always achieved with faster cycle times. However, if a mechanical contactor or solenoid is used to switch power to the load, slower cycle times may be desirable to minimize the wear on the mechanical components.

Cycle time pot is located internally on the printed circuit board. See Figure 12 on Page 12 for location.

♫ **NOTE:**

For ease of adjusting, order extender board - Watlow P/N Z100-0422-0000.

Field Selectable Limit Operations

For jumper location, see Page 12.

Select either high or low limit operation

High Limit Operation -
For high limit operation, make these connections:

1. Install a blue connector on J56-6 and J56-8. See Page 11 for locations.
2. Upscale thermocouple break protection (if the T/C opens, the output relay will de-energize and the alarm condition will come on): Install a blue connector on J67-9.

Low Limit Operation -
For low limit operation, make these connections:

1. Install a blue connector on J56-5 and J56-7.
2. Downscale thermocouple break protection (if the T/C opens, the output relay will de-energize and the alarm condition will come on): Install a blue connector on J67-10.

Troubleshooting Chart

Problem	Probable Cause	Action
Control will not operate.	Check for presence or proper connection of AC input. 1. If not present or proper ...	A. Check fuses or circuit breakers.
		B. Check power to the load.
		C. Connect per Line Voltage. See Pages 5 and 6.
	2. If present and proper ...	Contact the factory.
Poor temperature control.	Load temperature is unstable.	Adjust the proportional band, cycle time and manual reset.
Load will not turn ON.	1. An open thermocouple.	Check the input wiring, see Page 7. 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.
Load will not turn OFF.	The polarity is reversed on the T/C.	Connect per the Input Wiring. See Page 7.
The Limit control will not operate.	Hi or Lo jumpers are not installed correctly.	Install per Jumper Selection, See. Pages 12 - 13.
Thermocouple Break Protection is not functioning properly.	Installation jumpers are not installed correctly.	Install per Jumper Selection, See Pages 12 - 13.

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.

Returns

The following procedure must be used on any returns of product 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 enter a repair order, replacement order, or issue credit for material.

4. In cases of manufacturing defect, 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 360 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.