

# Series 365

ISO 9001



## User's Manual



1/16 DIN Temperature Control



# WATLOW

## Watlow Controls

Watlow Controls, 1241 Bundy Blvd., P.O. Box 5580, Winona, MN 55987-5580, Phone: 507/454-5300, Fax: 507/452-4507

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Supersedes

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**Made in the U.S.A.**



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## Description

The Series 365 is a 1/16 DIN factory-selectable analog latching limit, ON/OFF or PI control. The control operates from a thermocouple or RTD input and is available in several thermocouple ranges including Types J, K, T, R, S or Platinel II thermocouple.

The 365 has an integral setpot with a front panel reset switch, and a front panel LED indicator for output status. In addition to the internal reset switch, a customer supplied remote reset switch can be used with the limit control only.

Factory-selectable options include ON/OFF, PI or latching limit control modes, and auto or manual reset on power loss. In ON/OFF or PI mode, heat or cool operation is user-selectable.

The compact size of the controller allows more flexibility in applications where space is a problem, such as bench top equipment. The 365 is tested to meet NEMA 4X standards for water and corrosion resistance.

## Specifications

### Control Mode

- Heat or cool, user selectable
- **ON/OFF**
  - Switching hysteresis: Typically 3°F/1.7°C
- **PI** (Time proportional with automatic reset)
  - Proportional band adjust: Typically 5 to 50°F/2.8 to 27.8°C
  - Cycle time, fixed: Typically 6 seconds
  - Automatic reset, fixed: Typically 0.25 repeats/minute
- **Limit**
  - Latching
  - High or low, factory selectable
  - Internal reset switch and/or customer supplied remote reset switch. Automatic or manual reset on power loss (factory selectable).

### Operator Interface

- Sealed membrane front panel, NEMA 4X
- LED indication of limit condition or status of load
- Integral Setpot
  - Dial scale calibrated to compensate for sensor non-linearities
  - Dual °F & °C scales

### Input

- Thermocouple or RTD available
- Thermocouple may be grounded or ungrounded
- Thermocouple, automatic cold junction compensation

- RTD input 2 or 3 wire, platinum 100Ω @ 0°C calibrated for #3850 (DIN): 0.003850Ω/Ω°C or #3916 (JIS) 0.003916Ω/Ω°C curve.
- Thermocouple and RTD sensor break protection de-energizes output to protect system.

### Output

- Solid state relay with contact suppression, Form A, 0.5A @ 24VAC min., 264VAC max., opto isolated zero-cross switching. Minimum offstate impedance is 20KΩ. *Only available with ON/OFF or PI control.*
- Open collector, switched DC signal provides a minimum turn ON voltage of 3VDC into a minimum 500Ω load; maximum ON voltage not greater than 32VDC into an infinite load. *Only available with ON/OFF or PI control.*
- Electromechanical relay, Form C, 5A @ 120/240VAC. Minimum offstate impedance is 20KΩ. Warranted to 100,000 cycles.
- Electromechanical relay, Form C, 10A @ 120/240VAC. Minimum offstate impedance is 20KΩ. Warranted to 100,000 cycles.
- Solid state relay without contact suppression, Form A, 0.5A @ 24VAC min., 264VAC max., opto isolated zero-cross switching. Minimum offstate impedance is 31MΩ. *Only available with ON/OFF or PI control.*

### Power

- Factory selectable
- 100VAC, ±10%; 50/60 Hz, ±5%
- 120VAC, -15%, +10%; 50/60 Hz, ±5%
- 208VAC, -15%, +10%; 50/60Hz, ±5%
- 240VAC, -15%, +10%; 50/60 Hz, ±5%
- 4VA power consumption

### Agency Approvals

- UL, CSA and FM pending
- NEMA 4X rating, pending

### Terminals

- #6 compression universal head screw terminals, accepts 20-14 gauge wire

### Accuracy

- Calibration accuracy & sensor conformity: ± 1% of span maximum, at 77°F ± 5°F (25°C ± 3°C) ambient and rated line voltage.
- Accuracy span: 1000°F/540°C minimum
- Set point accuracy: ± 3% of span maximum
- Temperature stability: Typically ± 5μV / °F ambient for thermocouple. Typically < 1°F from 32 to 130°F for RTD.
- Voltage stability: ± 0.01% of span /% of rated line voltage.

### Operating Environment

- 32 to 130°F (0 to 55°C)
- 0 to 90% RH, non-condensing
- Storage temperature: -40° to 158°F (-40° to 70°C)

**3 6 5 - - 0**

**Series 365**

Closed loop control, limit,  
ON/OFF or PI control;  
RTD or thermocouple input;  
5A or 10A relay, DC, solid state;  
1/16 DIN case

**Control Type**

- A = ON/OFF control (heat or cool)
- B = PI control (heat or cool)
- C = High limit with manual reset
- D = High limit with auto reset
- E = Low limit with manual reset
- F = Low limit with auto reset

**Output**

- B = Solid state relay, Form A, 0.5A,  
with contact suppression  
*Only available with ON/OFF or PI control*
- C = Switched DC, open collector, non-isolated  
*Only available with ON/OFF or PI control*
- D = Electromechanical relay, Form C, 5A  
(Warranted to 100,000 cycles)
- E = Electromechanical relay, Form C, 10A  
(Warranted to 100,000 cycles)
- K = Solid state relay, Form A, 0.5A,  
without contact suppression  
*Only available with ON/OFF or PI control*

**Input and Range**

**Thermocouple**

601 = J	32	to	600°F	or	0	to	315°C
602 = J	32	to	1382°F	or	0	to	750°C
603 = K	32	to	2282°F	or	0	to	1250°C
604 = T	150	to	662°F	or	66	to	350C
605 = T	-328	to	150°F	or	-200	to	66°C
606 = Pt2	32	to	2543°F	or	0	to	1395°C
607 = S	32	to	2732°F	or	0	to	1500°C
608 = R	32	to	2732°F	or	0	to	1500°C

**RTD**

101 = RTD	-328	to	1112°F (DIN)
102 = RTD	-328	to	1112°F (JIS)

**Line Voltage**

- 1 = 120VAC
- 2 = 240VAC

**Overlay**

- 00 = Standard
- XX = Custom

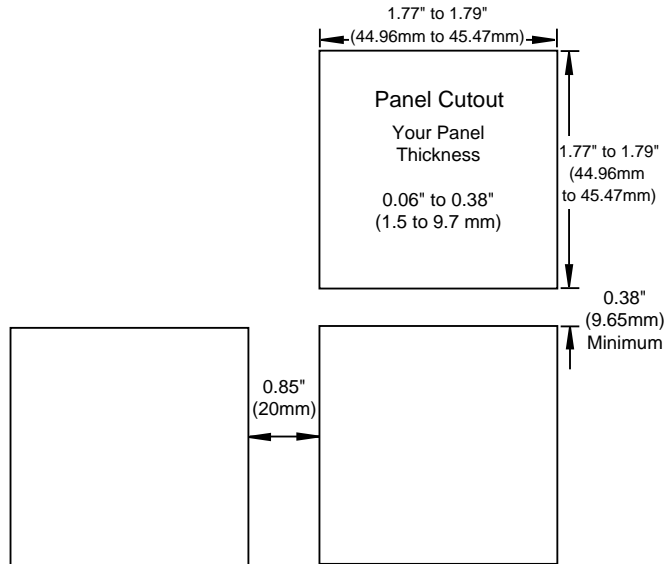
# Installation

**Figure 1 -  
Series 365  
Multiple Panel  
Cutout Dimensions**

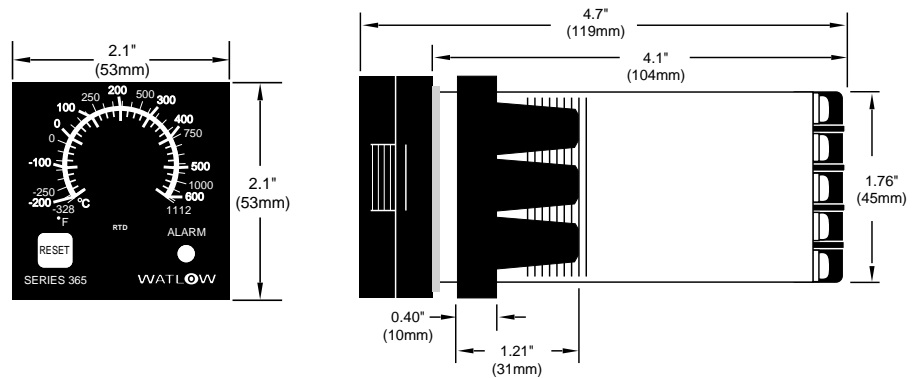


**WARNING:**

The Series 365 Temperature Limit Switch should be mounted in an inconspicuous location to discourage unauthorized changes to the set point. Only approved and appropriate personnel should have the authority to change the set point on the limit switch. Failure to comply with these recommendations could result in damage to equipment and property, and injury to personnel.



**Figure 2 -  
Series 365  
Dimensions**



## Installation Procedure

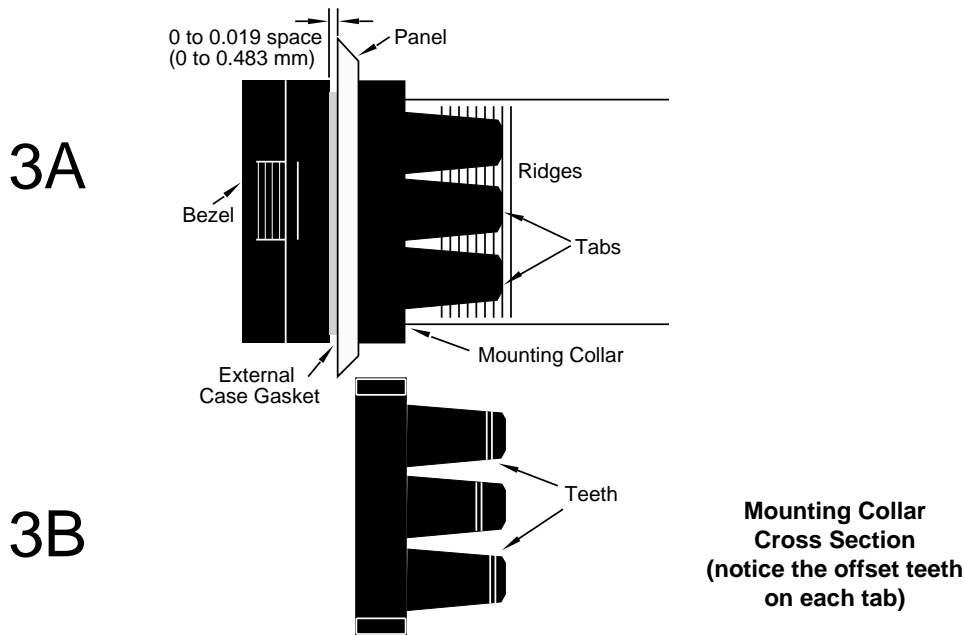
Follow this procedure to mount the Watlow Series 365 temperature control:

1. Make a panel cutout per the dimensions in Figure 1.
2. Remove the 365 chassis from its case. Holding each side of the bezel, press in firmly on the side grips until the tabs release, see Figure 3. Pull the chassis out of the case and set aside for later installation.
3. Make sure the rounded side of the external case gasket is facing the panel surface. Check to see that the gasket is not twisted, and is seated within the case bezel flush with the panel. Place the case in the cutout you just made. Make sure the gasket is between the panel cutout and the case bezel. See Figure 3A.
4. While pressing the front of the case firmly against the panel, slide the mounting collar over the back of the control. The tabs on the collar must line up with the mounting ridges on the case for secure installation. See Figure 3A again. Slide the collar firmly against the back of the panel getting it as tight as possible. Make sure you cannot move the case within the cutout, if you can you do not have a NEMA 4X seal.



**NOTE:**

Removing the Series 365 chassis from its case will make mounting easier.

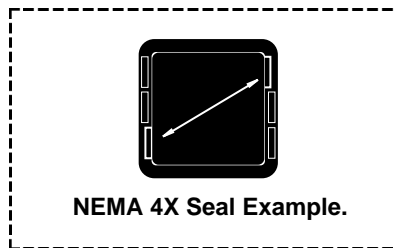
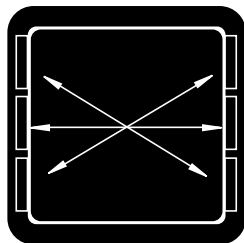


**Figure 3 - Mounting, Case Side View & Collar Cross Section**

Now let's make sure we have a tight seal. Use your thumb to lock the tabs into place while pressing the case from side to side. Don't be afraid to apply enough pressure to install the control. The tabs on each side of the collar have teeth which latch into the ridges. See Figure 3B. Each tooth is staggered at a different height, so only one of the tabs on each side are ever locked into the ridges at any time.

Looking at Figure 4, you see that the tabs on one side of the collar correspond with those on the opposite side. Make sure that the two corresponding tabs are the only ones locked in the ridges at the same time. If the matching tabs are not holding the case at the same time you will not have a NEMA 4X seal. You can make a visual check, or use your finger nail to pull out on each tab. **Only one on each side is engaged, and they must be corresponding as in Figure 4.** The space between the bezel and panel must be between 0 and 0.019" (0.48mm).

**Make sure that the two corresponding tabs below are locked in the ridges at the same time.**



**NOTE:**  
To guarantee a proper NEMA 4X seal, make sure the gasket between the panel and the rim of the case is not twisted and is seated properly. **PRESS FIRMLY.**

**Figure 4 - Case Rear View and NEMA 4X Seal Example**

When removing the mounting collar, we suggest sliding a thin tool such as a putty knife or screwdriver under all three tabs on each side at once and pulling it back off the case.

5. Insert the control chassis into its case and press the bezel to seat it. Make sure the inside gasket is also seated properly and not twisted. The hardware installation is complete. Proceed to the wiring section from here.

# Power/Switches

## Internal Heat/Cool Switch Location

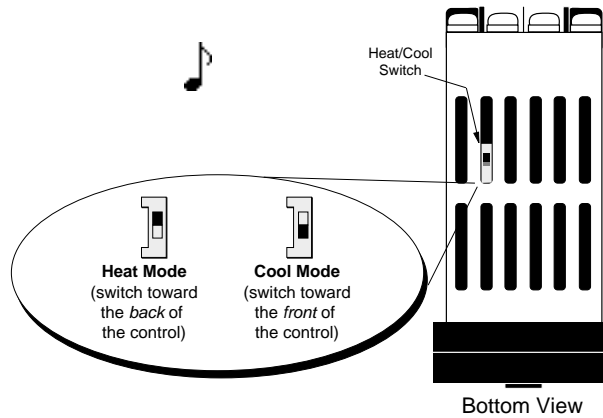
Figure 5 - Heat/Cool Switch Settings

365 A - \_ \_ \_ \_ - 000 and 365 B - \_ \_ \_ \_ - 000



NOTE:

Removing the Series 365 chassis from its case will make changing the Heat/Cool switch easier.



## Power Wiring

100/120VAC 365 \_ \_ \_ \_ - 1000

and

208/240VAC 365 \_ \_ \_ \_ - 2000



NOTE:

The line voltage is determined by your model number.

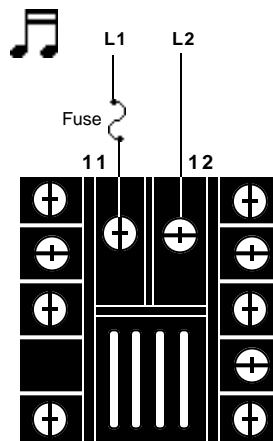
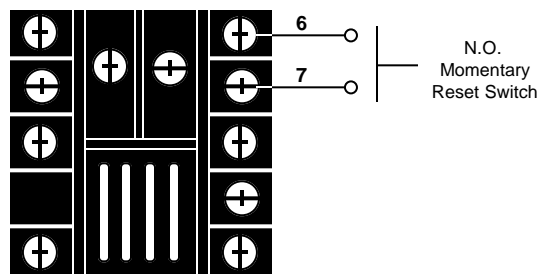


Figure 6 - 120 and 240VAC Power Wiring

## Reset Switch, Customer Supplied

Limit versions only

Figure 7 - Reset Switch Wiring (Customer Supplied)



### Thermocouple

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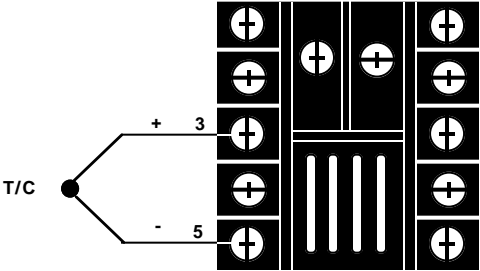


Figure 8 - Thermocouple Wiring

When an external device with a non-isolated circuit common is connected to the DC (open collector) output, you must use an isolated or ungrounded thermocouple.

### RTD, 2 or 3 Wire

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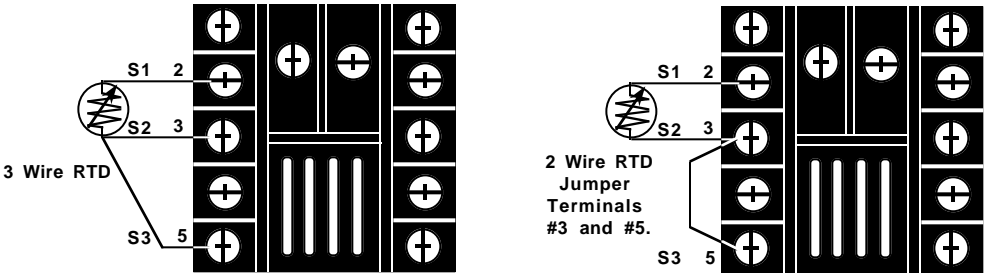


Figure 9 - RTD Wiring

Long lead lengths create electrical resistance. There will be approximately + 2°F 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)

# Output Wiring

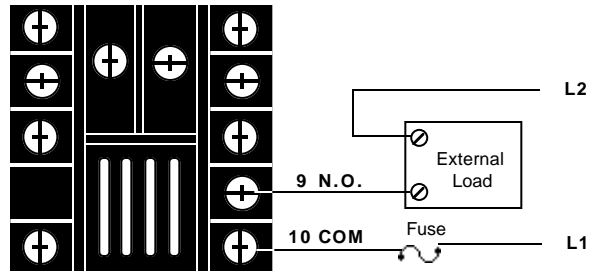
## Solid State Relay, 0.5A

With Contact Suppression: 3 6 5 \_ - **B** \_ \_ \_ - \_ 0 0 0

Without Contact Suppression: 3 6 5 \_ - **K** \_ \_ \_ - \_ 0 0 0

Only available on units with ON/OFF or PI control

Figure 10 - Solid State Relay Wiring

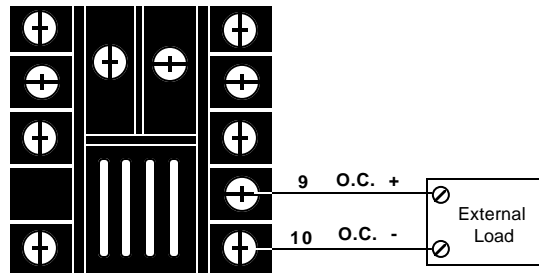


## Switched DC, Open Collector

Non-Isolated 3 6 5 \_ - **C** \_ \_ \_ - \_ 0 0 0

Only available on units with ON/OFF or PI control

Figure 11 - Switched DC Wiring



## Electromechanical Relay, Form C

With Contact Suppression

5 Amps 3 6 5 \_ - **D** \_ \_ \_ - \_ 0 0 0

10 Amps 3 6 5 \_ - **E** \_ \_ \_ - \_ 0 0 0

Figure 12 - Electromechanical Relay Wiring

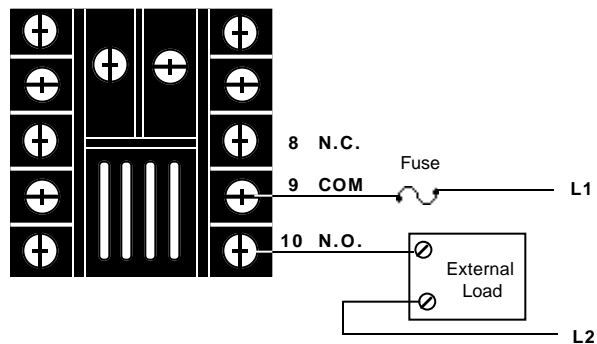
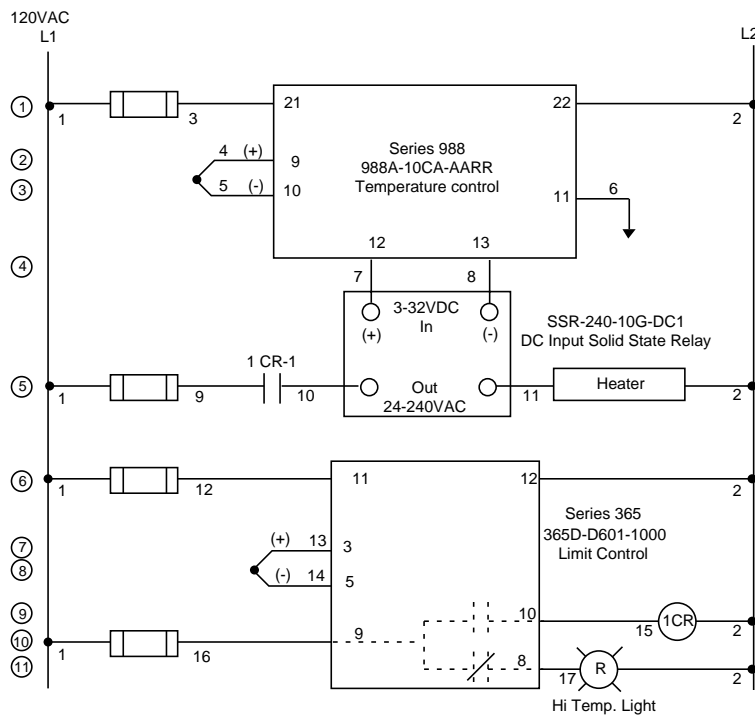
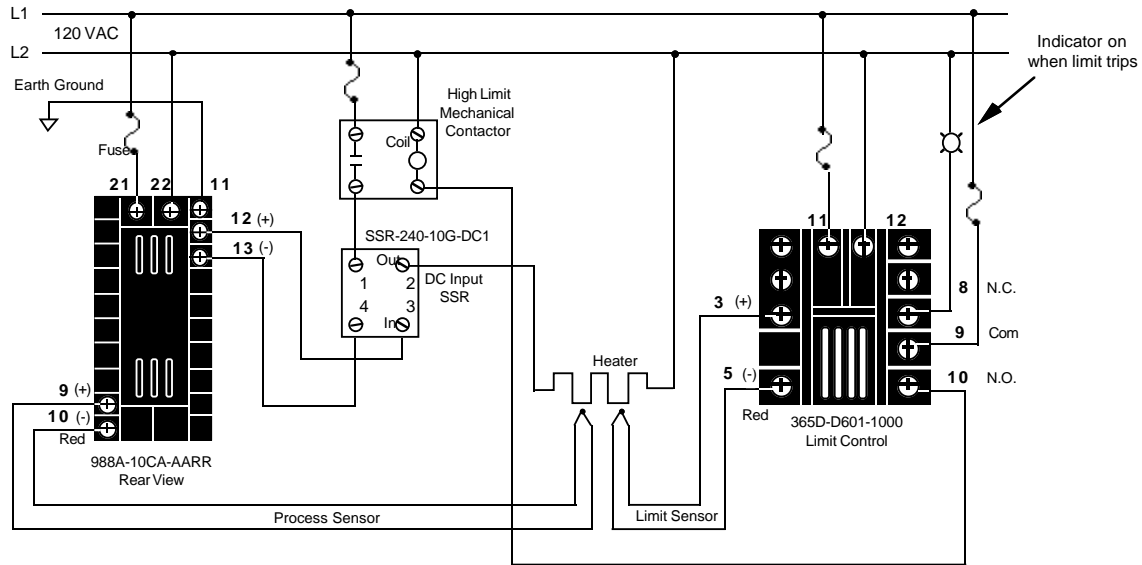




Figure 13 -  
System Wiring  
Example



# Tuning



## NOTE:

The tuning procedure must be performed with the control chassis in the case. Make any potentiometer adjustments through the slots in the case.

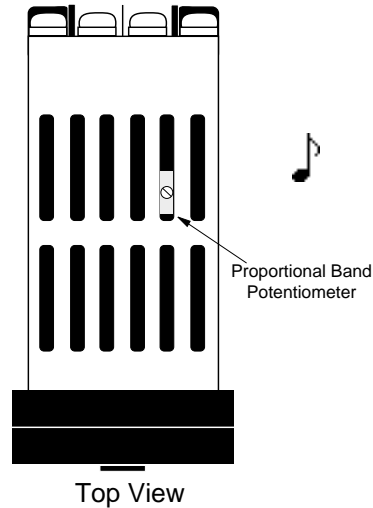
Figure 14 - Proportional Band Potentiometer Location

## Tuning Procedure for PI Controls

365B - XXXX-X0XX

### Initial Settings:

- Proportional band: 5 to 50°F/2.8 to 27.8°C  
Maximum proportional band is clockwise (CW), the minimum is counter clockwise (CCW). See Figure 14.



- Cycle time, fixed. Typically 6 seconds.
- Automatic reset, fixed. Typically 0.25 repeats/minute.

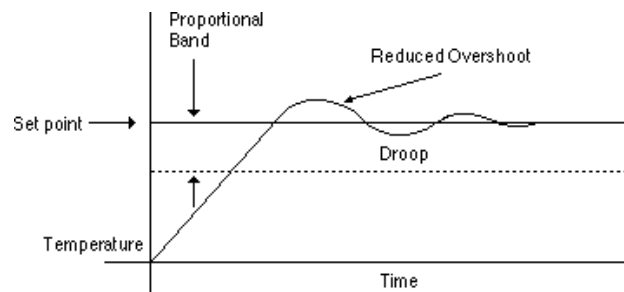
Energize the system and allow the process temperature to stabilize. When the system is stable, the load will cycle at a constant rate.

Once 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 process temperature begins to hunt (becomes unstable). When hunting is observed, rotate the pot CW, in small increments, until the system becomes stable. Some systems may be stable enough to allow minimum proportional band (maximum CCW).

Figure 15 - PI Adjustment Graph



The Series 365 is calibrated and tested before leaving the factory.

## Thermocouple Calibration

365X-X6XX-X000

### Equipment required:

- Precision millivolt source (mV source).
- Appropriate type reference compensator with reference junction at 32°F/0°C.

### Setup:

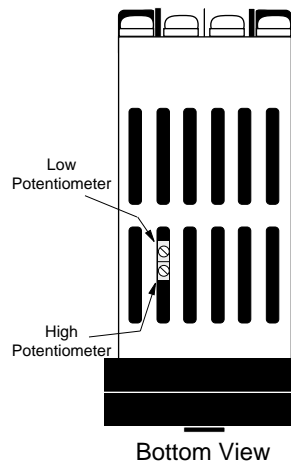
1. Wire your control for the correct line voltage. See power wiring on Page 6, Figure 6.
2. Connect the millivolt source to the thermocouple reference compensator, and the compensator to the thermocouple input terminals on the Series 365 (Terminals 3 and 5). See Page 7, Figure 8.
3. Make sure the heat/cool switch is in the correct position for your application. See Page 6, Figure 5. Apply power.
4. Refer to Table 1 below for values that apply to your unit's range code.

Code	Range		T/C Type	Millivolt	
	Low	High		Low mV	High mV
601	32 to 600°F/	0 to 315°C	"J"	0.000	17.186
602	32 to 1382°F/	0 to 750°C	"J"	0.000	42.283
603	32 to 2282°F/	0 to 1250°C	"K"	0.000	50.633
604	150 to 662°F/	66 to 350°C	"T"	3.711	17.816
605	-328 to 150°F/	-200 to 66°C	"T"	-5.603	2.711
606	32 to 2543°F/	0 to 1395°C	"Pt2"	0.000	55.246
607	32 to 2732°F/	0 to 1500°C	"S"	0.000	15.576
608	32 to 2732°F/	0 to 1500°C	"R"	0.000	17.445

Table 1 - Thermocouple Input Calibration Values

### Procedure:

1. Set the mV source to \_\_\_\_\_, the Low mV value. Turn the setpot fully CCW. Adjust the Low pot until the unit just fully de-energizes.
2. Set the mV source to \_\_\_\_\_, the High mV value. Turn the setpot fully CW. Adjust the High pot until the unit just fully de-energizes.
3. Repeat Steps 1 and 2 as necessary until no further adjustment is needed.



# RTD Calibration

The Series 365 is calibrated and tested before leaving the factory.

## RTD Calibration

365X-X1XX-X000

### Equipment required:

- 1K $\Omega$  Decade Box

### Setup:

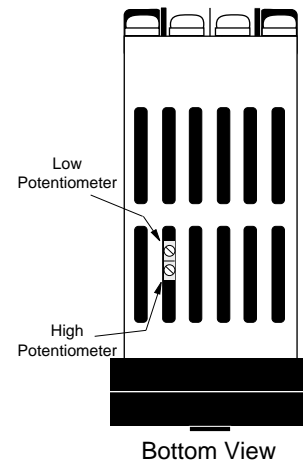
1. Wire your control for the correct line voltage. See power wiring on Page 6, Figure 6.
2. Connect the decade box to the S1 and S2 terminals on the Series 365 (Terminals 2 and 3). See Page 7, Figure 9.
3. Make sure the heat/cool switch is in the correct position for your application. See Page 6, Figure 5. Apply power.
4. Refer to Table 2 below for values that apply to your unit's range code.

Table 2 -  
RTD Input  
Calibration Values

Code	Range		Ohms	
	Low/High	RTD Curve	Low Ohms	High Ohms
101	-328 to 1112°F	DIN	18.49	313.59
102	-328 to 1112°F	JIS	17.14	317.28

### Procedure:

1. Set the decade box to \_\_\_\_\_, the Low Ohms value. Turn the setpot fully CCW. Adjust the Low pot until the unit just fully de-energizes.
2. Set the decade box to \_\_\_\_\_, the High Ohms value. Turn the setpot fully CW. Adjust the High pot until the unit just fully de-energizes.
3. Repeat Steps 1 and 2 as necessary until no further adjustment is needed.



<b>Problem</b>	<b>Probable Cause</b>	<b>Action</b>
Poor temperature control.	The proportional band is not adjusted properly.	Adjust the proportional band per <i>Tuning</i> . See Page 10.
The load will not turn ON.	1. An open sensor.	Repair or replace.
	2. The load circuit is open.	Check the fuses, circuit breakers, load, and wiring. See <i>Output Wiring</i> , Page 8.
	3. The AC input is not connected or is connected improperly.	Check the AC input connections. If not present or proper, connect per <i>Power Wiring</i> . See Page 6.
	4. A faulty unit.	Contact the factory.
The load will not turn OFF.	1. The polarity is reversed on the T/C.	Connect per <i>Input Wiring</i> . See Page 7.
	2. A faulty unit.	Remove power to the control and the control from the system. Apply power to the system with the control removed. If the load turns OFF, return the control to the factory. If the load remains ON, there are other problems in the system that must be resolved. Consult the factory.
The unit is not controlling to set point.	The unit is out of calibration.	Refer to the calibration procedure which applies to your control. See Page 11 or 12.

# Glossary

**Automatic Reset (Integral)** - Used in proportional control systems to automatically pick up any system droop. This action may be adjustable or fixed, and adjusts the output level to obtain agreement between actual process temperature and controller set point.

**Automatic Reset on Power Loss** - The limit control does not recognize the power outage as a limit condition. When power is restored, the output will energize automatically as long as a temperature limit condition does not exist.

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

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

**ON/OFF** - In a heating application, the output is turned full ON below set point and stays turned on until the process temperature reaches set point, then the controller 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.

**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%.

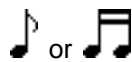
**Switching Sensitivity or Differential** - In a heating application, the output will de-energize when the actual temperature reaches the set point temperature. The switching sensitivity or differential is the drop in temperature required to re-energize the output.

**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.

**Temperature Oscillation or Hunting** - Occurs when the proportional band is too narrow or the system is upset by some outside source. The actual process 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.

**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.



- Musical notes are used to alert you to important details.



The Warning symbol (lightning bolt) alerts you to a "WARNING", a safety hazard which could affect *you and the equipment*.



The Caution symbol (exclamation point) alerts you to a "CAUTION", a safety or functional hazard which could affect *your equipment* or its performance.

## Returns

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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
  - Bill-to address
  - Phone number
  - P.O. number
2. Prior approval and an RMA number is needed when returning any unused product for credit. Make sure the RMA number is on the outside of the carton, and on all paperwork returned. Ship on a Freight Prepaid basis.
3. After we receive your return, we will examine it and 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. A 20 percent restocking charge is applied for all returned stock controls and accessories.
5. If the unit is unrepairable, it will be returned to you with a letter of explanation. Repair costs will not exceed 50 percent of the original cost.

## Shipping Claims

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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 packing material.

## Warranty

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The Watlow Series 365 is warranted to be free of defects in material and workmanship for 36 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. This excludes mechanical relays which are warranted to 100,000 cycles.

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