Series 980/985

Microprocessor-Based Auto-tuning Control

User's Manual

WATLOW

Watlow Controls, 1241 Bundy Blvd., P.O. 8ox 5580, Winona, MN 55987-5580, Phone: 507/454-5300, Fax: 507/452-4507

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How to Use the Manual

First..

This manua/ will make your job ***easier.*** Reading it and applying the information is a good way to become familiar with the Series 980/985. An overview:

Notes

NOTE:
Details of a *'Note appear here, in the narrow box on the outside of each page.**

The user's manual contains informational notes to alert you to important details. When you see a note icon, look for an explanation in the margin.

Safety Information

CAUTION:
Details of a "Caution" appear here, in the narrow box on the outside of each page.

WARNING:
Details of a "Warning" appear here, in the narrow box on the outside of each page.

This user's manual also has **boldface** safety information notes to protect both you and your equipment. Please be attentive to them. Here are explanations:

The Caution symbol (exclamation point) in the wide text column alerts you to a **"CAUTION,"** a safety or functional hazard which could affect your equipment or its performance. A full explanation is in the narrow column on the outside of the page.

The Warning symbol (lightning bolt) in the wide text column alerts you to a ****WARNING,"** a safety hazard which could affect you and the equipment. A full explanation is in the narrow column on the outside of the page.

Your Feedback

Your comments or suggestions on this manual are welcome, please send them to: Technical Writer, Watlow Winona, Inc., 1241 Bundy Blvd., Winona, MN 55987, or phone 507-454-5300. The Watlow Series 9801985 User's Manual and integral software are copyrighted by Watlow Winona, Inc., ©1988, with all rights reserved. blrO293

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Chapters

Figures, Table, Charts

Chapter 1

Starting Out With The Watlow Series 9801985, A Microprocessor-Based Control

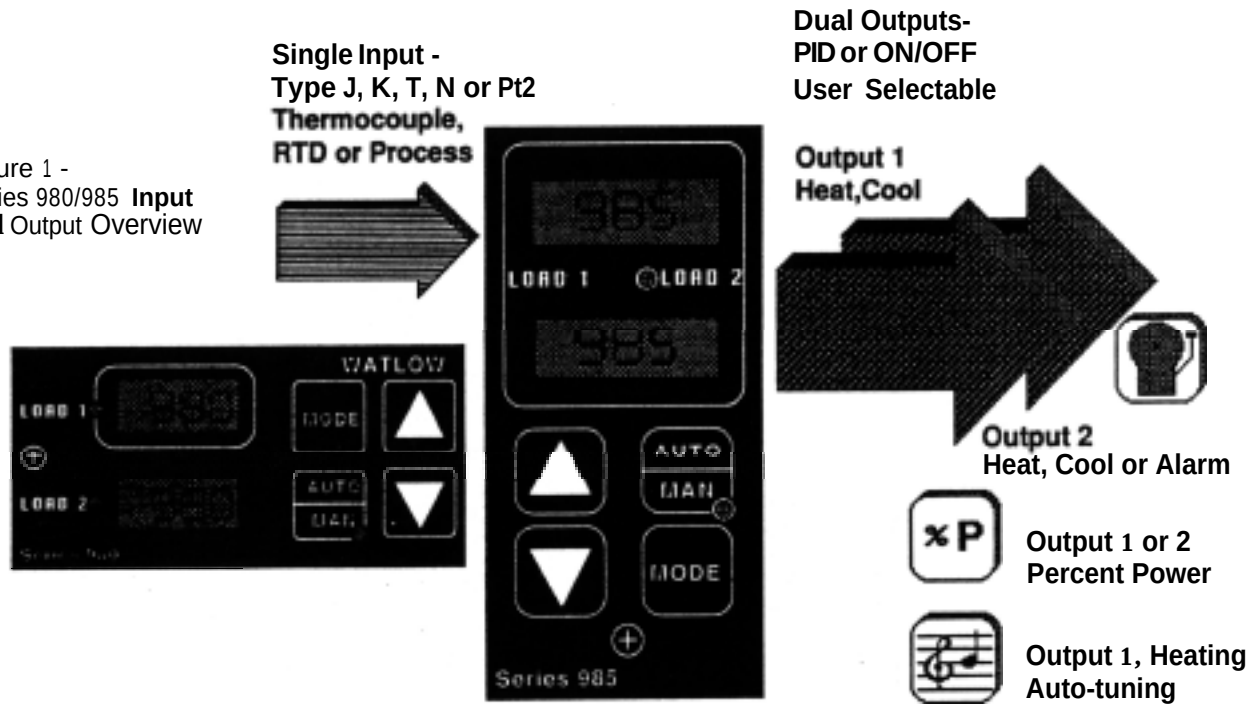


Figure 1 - Series 980/985 **Input and** Output Overview

General Description

Welcome to the Watlow Series 980/985, a dual output, single input, microprocessor-based, 1/8 DIN, auto-tuning temperature control, featuring the Automatic/Manual capability with bumpless transfer. In the Auto mode, the control has closed loop control with sensory feedback, while the Manual mode has open loop control with user defined output power level. The 980/985 accepts a Type J, K, T, N, or Platinel2 thermocouple, RTD, or process input. The primary output is Heating or Cooling, while the secondary output can be Heat, Cool or Alarm.

With the Series 980/985 you can select either PID or ON/OFF for Output 1 or Output 2. You may input a complete set of PID parameters for both outputs, and select automatic tuning for Output 1 from the front panel. This includes proportional band, reset, rate and cycle time. By setting either output's proportional band to zero, the Series 9801985 becomes a simple ON/OFF control with a 3°F or 1.7°C switching differential, 0.3°F or 0.17°C for 0.1 ° RTD.

Operator-friendly features include automatic LED indicators to aid in monitoring and set-up, as well as a calibration offset at the front panel. The Watlow Series 980/985 automatically stores all information in a non-volatile memory.

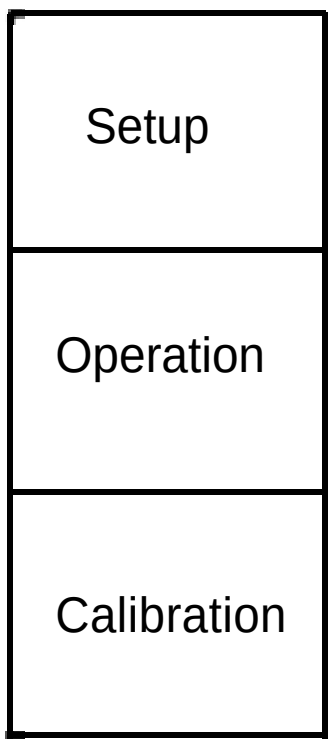
Putting Your Control To Work

To put your Series 980/985 to work, we suggest the following steps:

- Read the User's Manual.
- Plan your installation and wiring.
- Cut the panel mounting hole and install the control.
- Wire your Series 980/985 to the system.
- Start the system and tune the Series 980/985.
- Make final adjustments to the control parameters and record the data.
- That's all there is to it.

Overview of the Series 980/985 Menus

Before getting into the details of installing and wiring the Series 980/985, take a look at Figure 2, and at the three different menus. "Setup", "Operation", and "Calibration". After you feel comfortable with the names and their functions, move on to installation and wiring.



Configure the 980/985's features to your application. Establish levels of operator access, input type, units of measure, low and high range limits, and Output 2 configuration.

Enter the set point and the PID tuning values and alarm set points here. Parameters for proportional band, reset, rate and cycle time for Outputs 1 and 2; alarm low and high; dead-band: calibration offset and auto-tune are here also.

Supply various input signals to the Series 980/985, and it performs auto-calibration. **Calibration procedures should only be attempted with proper equipment and by qualified personnel.**

Figure 2 - Overview of the Series 980/985.

Where To Go From Here

If your Series 980/985 is already installed and wired, go directly to "How to Use the Keys and Displays", Chapter 3. If not, turn the page to Chapter 2, "How to Install and Wire the Series 980/985", and proceed from there.

Chapter 2

How to Install and Wire the Series 9801985

System Planning

This chapter tells you how to install the Series 980/985. All mounting and wiring information is right here. Because Watlow controls are thoroughly tested and "burned in" before leaving the factory, the Series 980/985 is ready to install when you receive it.

But before you begin working, read through this chapter to gain an understanding of the entire installation. Consider sensor installation carefully. You'll need to look at the noise reduction guidelines before making your panel cutout.

Sensor Installation Guidelines

We suggest that you mount the sensor at a location in your process or system where it reads an average temperature. Put the sensor as near as possible to the material or space that you want to control. Air flow past this sensor should be moderate. The sensor should be thermally insulated from the sensor mounting.

Installation Guidelines For Preventing Noise

For improved electrical noise immunity, install the Series 980/985 as far away as possible from motors, relays, and other similar noise generators.

Do not run low power (sensor input) lines in the same bundle as AC power lines. Grouping these lines in the same bundle can create electrical noise interference which may result in error codes in the Series 980/985.

The Culprit

Most noise problems stem from wiring practices. They're the major means of coupling noise from its sources to the control circuit The following information will tell you how to eliminate or decrease noise.

An Information Resource

An outstanding resource for information for wiring guidelines is the IEEE Standard No. 518-1982 and is available from IEEE, Inc. 345 East 47th Street, New York, NY 10017.

Noise Sources

- Switches and relay contacts operating inductive loads such as motor, coils, solenoids, and relays, etc.
- Thyristors or other semiconductor devices which are not zero crossover-fired (randomly-fired or phase angle-fired devices).
- All welding machinery.
- Heavy current carrying conductors.
- Fluorescent and neon lights.

How To Decrease Noise Sensitivity

- Physical separatlon and wire routing must be given careful consideration in planning the layout of the system. For example, A.C. power supply lines should be bundled together and physically kept separate from input signal lines (sensor lines). A 12 inch minimum separatlon is usually effective. Keep all switched output signal lines (high power level) separate from input signal lines (sensor lines). Cross other wiring at 90° angles whenever crossing lines is unavoidable.

- Another important practice is to look at the system layout and identify electrical noise sources such as solenoids, relay contacts, motors, etc., and where they are physically located. Then route the wire bundles and cables as far away as possible from these noise sources. Don't mount relays or switching devices close to a microprocessor control. Don't have phase angle-fired devices in the same electrical enclosure or on the same power line with the control.

- Shielded cables should be used for all low power signal lines to protect from magnetic and electrostatic coupling of noise. Some simple pointers are:

  - Whenever possible, low level signal lines should be run unbroken from signal source to the control circuit.
  - Connect the shield to the control circuit common at the control end only. Never leave the shield unconnected at both ends. Never connect both shield ends to a common or ground.
  - If the shield is broken at some termination point and then continued on, the shield must be connected to maintain shield continuity.
  - If the shield is used as a signal return, no electrostatic shieldlng should be assumed. If this must be done, use a triaxed cable (electrostatically shielded coaxial cable).

- Twisted pair wire should be used any time control circuit signals must travel over two feet or when they are bundled in parallel with other wires.

- The size or gauge of wire should be selected by calculating the maximum circuit current and choosing the gauge meeting that requirement. Using greatly larger wire sizes than required generally will increase the likelihood of electrostatic (capacitance) coupling of noise.

- Ground loops must be eliminated in the entire control system. There are obvious loops which can be spotted by studying the"as-built" wiring diagram. There are also the not-so-obvious ground loops that result from the technique of connecting internal circuit commons in the manufacturer's equipment. An example of this would be if a control circuit is designed to work with a grounded sensor input.

- Do not daisy chain A.C. power (or return) lines, or output signal (or return) lines to multiple control circuits. Use a direct line from the power source to each input requiring A.C. power. Avoid paralleling L1 (power lead) and L2 (return lead) to load power solenoids, contactors, and control circuits. If L1 (power lead) is used to switch a load, L2 (return lead) will have the same switched signal and could couple unwanted noise into a control circuit.

- Grounding the chassis of each piece of equipment in the system is very important. The simple practice of connecting each individuai chassis to the overall equipment chassis immediately adjacent to that piece, and then tie all the major chassis ground terminals together with one lead (usually green wire) to ground at one single point will work best. Don't connect ground to the control case if the control is mounted in grounded enclosure (prevent ground loops).

- Do not confuse chassis grounds (safety ground) with control circuit commons or with AC. supply lines L2 (return or neutral line). Each return system wiring must be kept separate. Be absolutely sure chassis ground (safety) is never used as a conductor to return circuit current

How To Eliminate Noise

- Use "snubbers" ("QUENCHARC™") to filter out noise generated by devices such as relays, relay contacts, solenoids, motors, etc. A snubber is a simple filter device using a 0.1µf, 600 volt, non-polarized capacitor in series with a 100 ohm, 1/2 watt resistor. The device can be used on A.C. or D.C. circuits to effectively dampen noise at its source.

- The general purpose Watlow snubber, described above, is 0804-0147-0000. For other 'QUENCHARC" sizes contact
  PAKTRON
  P.O. Box 5438
  Lynchburg, VA 24502
  Phone: 804-239-6941

- Metal Oxide Varistor (MOV) can be used to limit voltage "spikes" that occur on the A.C. supply lines as a result of lightning strikes, switching large motors, etc. The MOV is available in several varieties and for 115 or 230 volt lines. The device dissipates the voltage "spikes" to ground and in doing so repeatedly, deteriorates its ability to function. MOVs have a limited life.

- Watlow stocks several MOVs. See Table 1.

- "Islatros" and other similar power line filters are designed to carry the power for the control circuit and "buffer" the control circuit from A.C. line noise. Devices like the Islatrol use media (electromagnetic filtering) other than electric circuits to filter out electrical noise. Take care in matching the power capabilities of the filter with power demands of the circuit. Keep line filters as close to the control as possible to minimize the area for interference pick up.

- Islatrols are available from: Control Concepts Corporation
  328 Water Street
  P.O. Box 1360
  Binghamton, NY 13902-1360
  Phone: 607/724-2464

  I - 101 (1A,120VAC)
  I - 105 (5A, 120VAC)
  I - 115 (15A, 120VAC)
  I - 202 (2.5A, 208/240VAC)
  I - 207 (7.5A, 208/240VAC)

- The ultimate protection is an "uninterruptable" power supply. This 'senses' the A.C. power line; when the line fluctuates, a battery powered 60Hz inverted circuit takes over, supplying power within one-half to one cycle of the A.C. line; very expensive.

How To Check For Ground Loops

To check for ground loops, disconnect the ground wire at the ground termination. Measure the resistance from the wire to the point where it was connected. The ohmmeter should read a high ohm value. If you have a low ohm value across this gap, there is at least one ground loop present in your system.

Or check for continuity; your reading should be "open". If you do find continuity, you must now begin looking for the ground loops. Begin disconnecting grounds in the system one at a time, checking for continuity after each disconnection. When continuity reads "open" you have eliminated the ground loop(s). Also, as you reconnect grounds, keep making the continuity test. It is possible to reconnect a ground loop.

Noise Suppression Devices Available From Watlow

Watlow Controls stocks a few key noise suppression parts. You may order these by calling your local Watlow distributor.

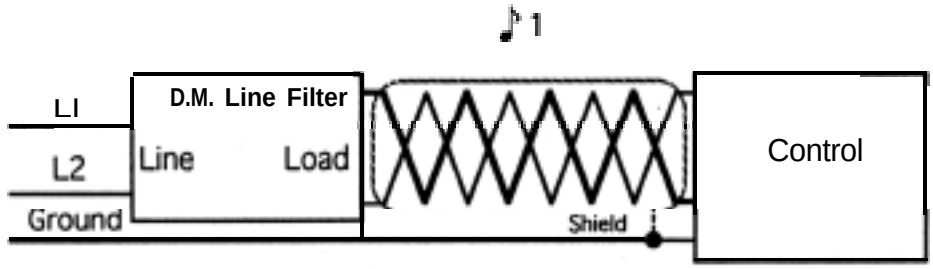
Item	Electrical Ratings	Part Number
Common Mode Line Filter	250V, 3 Amp	0804-0196-0000
Differential Mode Line Filter	Refer to the Islatrol listing above.	
Metal Oxide Varistor	150V, 80 Joule	0802-0273-0000
MOV	130V,38 Joule	0802-0304-0000
MOV	275V, 75 Joule	0802-0266-0000
MOV	275V, 140 Joule	0802-0405-0000

Table 1 - Noise Suppression Device Ratings

Line Filtering Configurations For Controls

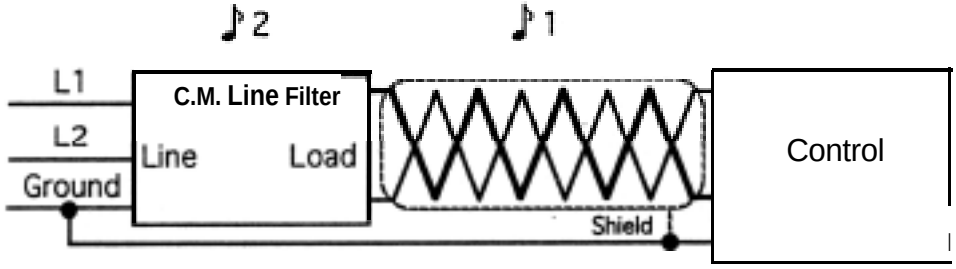
These three diagrams show you filter configurations for removing input power noise. Choose the one best suited for your system. For very dirty or critical applications use a microcomputer-regulated power supply or Uninterruptable Power Supply(U.P.S.) Don't fasten common mode line filters or filters with metal cases to metal that is at ground potential. This prevents ground loops and maintains filter effectiveness.

Figure 3 - **Differential Mode Filter Wiring**



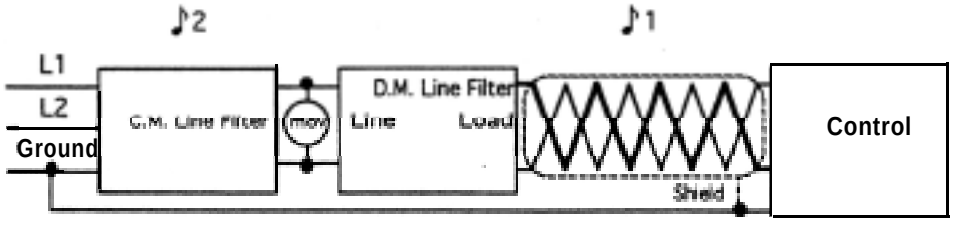
♪1 **NOTE: Keep filters 12 inches or less from the control. Minimize the line distance where noise can be re-introduced to control.**

Figure 4 - Common Mode Filter Wiring



♪2 **NOTE: To prevent ground loops do not fasten common mode line filters or filters with metal cases to metal that is at ground potential. Doing so will reduce filter effectiveness.**

Figure 5 - Combination Differential/ Common Mode Filter Wiring



How to Install the Series 980/985

Figures 6,7 and 8 provide the Series 980/985's panel cutout and dimensions. Do not, however, make your panel cutout until you are sure that you are placing the control in the best location. Read the noise guidelines at the beginning of this chapter before installing and wiring the Series 980/985.

1. Place the panel cutout in the desired location. Figure 6 shows you the panel cutout dimensions.

2. To install, carefully insert the Series 980/985 into the panel cutout. Push the unit in until the bezel is seated securely against the panel.

3. Included with your control are two adjustable mounting brackets; one for the top and one for the bottom of the control case. Installing the mounting brackets requires access to the back side of the panel.

   On the top and bottom of the case are a series of slots running the length of the case. The first two shorter slots are for attaching the mounting brackets. Figure 8 shows a side view with both mounting brackets.

4. Loosen the mounting bracket screws with a Phillips screwdriver far enough to allow for the panel thickness.

5. Make sure that each bracket is placed in the first two slots from the front of the control, with the head of the screw facing the back of the control. Refer to Figure 8 for screw and bracket placement.

6. To attach, place the bracket into the slots (head of the screw facing the back of the control and push backward, securing the brackets to the control case. Do the same for the other side of the control.

7. Make sure the Series 980/985 case is seated properly. Tighten the installation screws firmly against the panel to secure the unit in place.

8. To remove the unit from its enclosure, loosen the captive screw at the bottom of the 980/985's front panel with a Phillips screwdriver. Pull the unit from its case.

9. To release the mounting brackets, push the brackets forward and pull out to release them from the control case.

♪ NOTE:
Removing the Series 980/985 chassis from its case may make mounting easier.

Dimensions

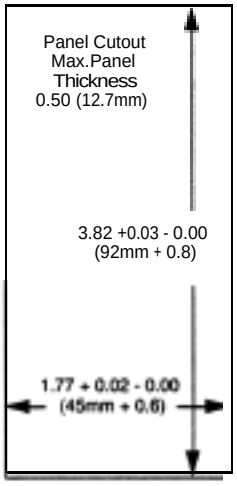


Figure 6 - Series 980/985 Panel Cutout Dimensions

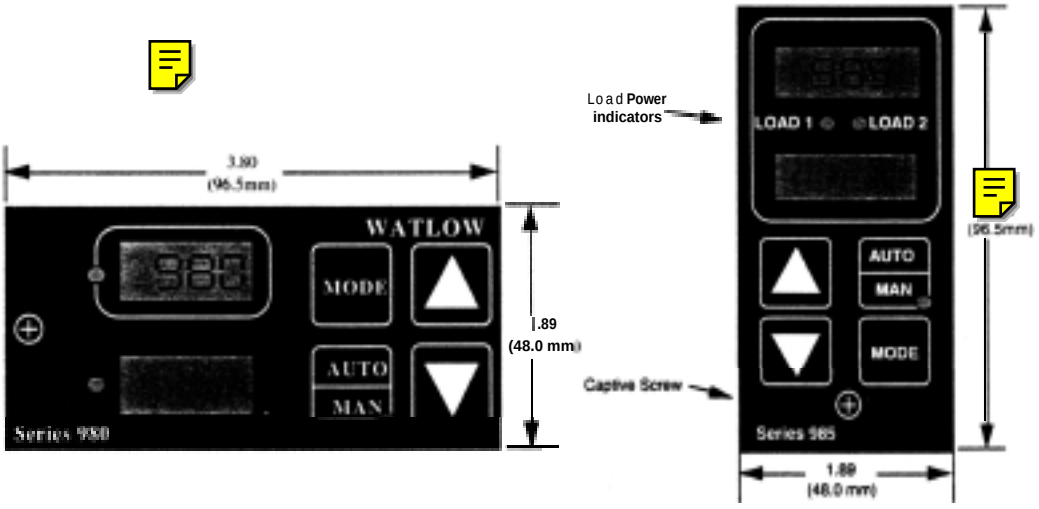
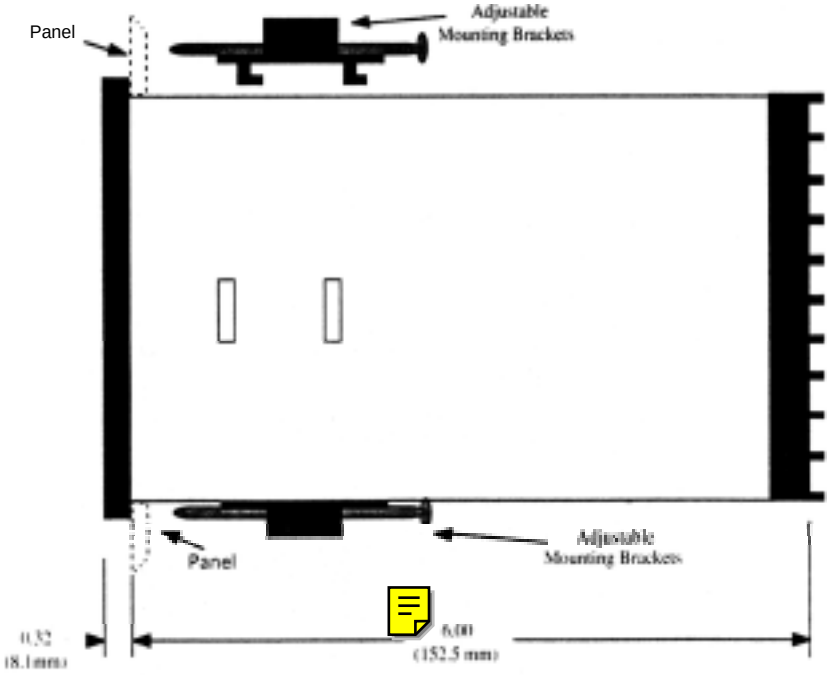


Figure 7 - Series 980/985 Dimensions



How to Wire the Series 980/985

The Series 980/985 wiring is illustrated by model number option. Check the unit sticker on the control and compare your model number to those shown here and also the model number breakdown in the back of this manual.

Series 980/985 internal circuits appear “inside“ the line drawing of the 980/985, while connections and terminal designations appear “outside” the line drawing. All outputs are referenced to a de-energized state. The final wiring figure is a typical system example.

All wiring and fusing should conform to the National Electric Code and to any locally applicable codes as well.

When you apply power without sensor inputs on the terminal strip, the Series 980/985 will display “- - -” in the Upper display, and a "0" in the Lower display. Press the AUTO/MANUAL key twice, and an ER 7 is displayed for one second. This error indicates an open sensor. Remove power to the control and connect the sensor properly, see Page 14.

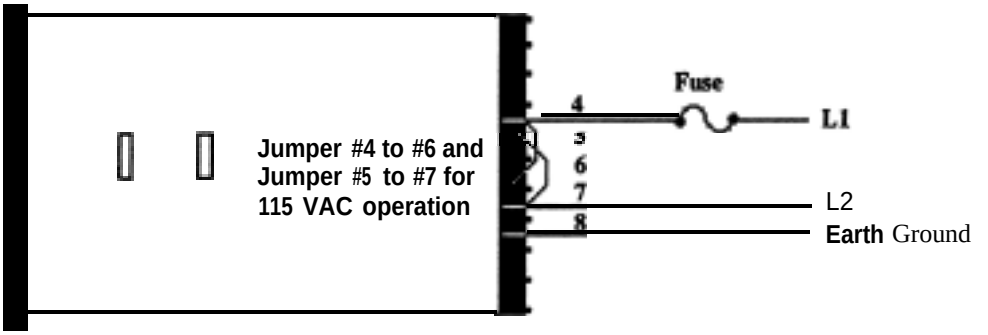


Figure 8 - 115 VAC Power Wiring

CAUTION:

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

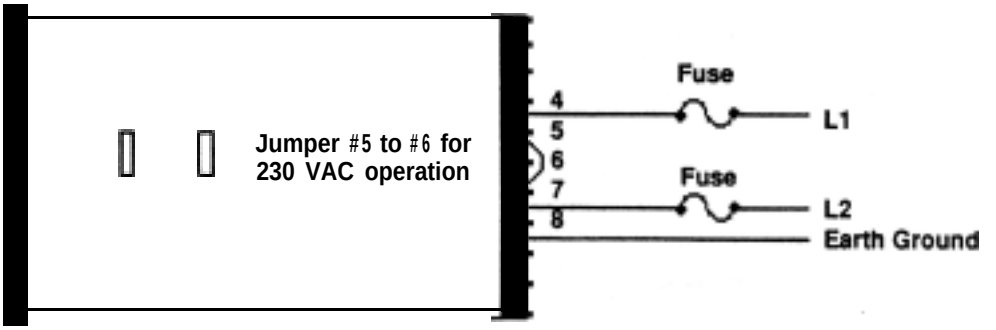
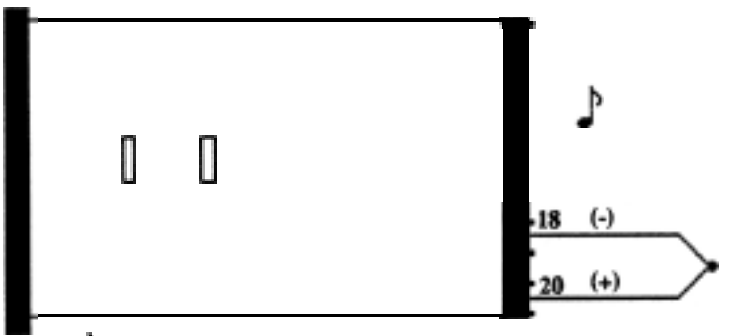


Figure 9 - 230 VAC Power Wiring

Input Options "1", "2" & "3", Thermocouple Input Terminals 18 & 20

Model # 98– A - 1 _ _ - 0-0000
98_A-2 – –0-0000
98_A-3- _ _0-0000

Figure 10 - **Input Options "1", **2* & *3', Thermocouple Wiring Diagram.**



NOTE:

You must use an isolated or ungrounded thermocouple if an external 4-20mA output device with a non-isolated circuit common is connected to the 4-20mA output.

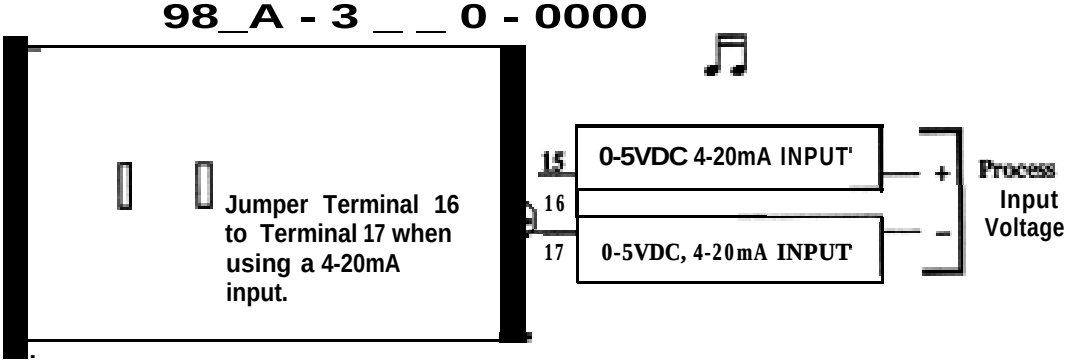
Extenslon wire for thermocouples must be of the same alloy as the thermocouple itself to limit errors.

These input connections are used in conjunction with your units sensor type. (Thermocouple and RTD only)

Input Options "2' & "3", Process or Remote Set Point Input Terminals 15 - 17

Model #98_A - 2 _ _0 - - 0000
98_A - 3 _ _ 0 - 0000

Figure 11 - **Input Options "2" & "3" Process Input Wlring Diagram.**



NOTE:

When using a 4-20mA process Input, the input impedance is 249 ohms

NOTE:

When using a process input such as 0-5VDC or 4-20mA, the rL and rH settings scale the display to match the measured range of the process signal. When using a 0-5VDC process input, the input impedance is 100K ohms.

An example of this is: A pressure transducer operates over a range of 0 - 300 PSI, delivering a 4-20mA output signal for this range. By setting rL = 0 and rH = 300, the Series 980/985 is now displayed as a direct reading of pressure.

Input Options "2" & "3" RTD - 2 Wire
Terminals 12 - 14

Model#98 _ A - 2 _ _0-0000
98_A-3_ _0-0000

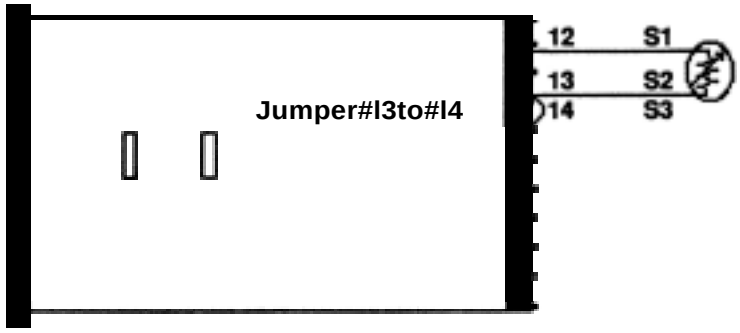


Figure 12 - Input Options "2" & "3", RTD (2 wire) Sensor Wiring.

Input Options "2" & "3" RTD - 3 Wire
Terminals 12 - 14

Model# 98_A-2_ _ 0-0000
98_A-3_ _0-0000

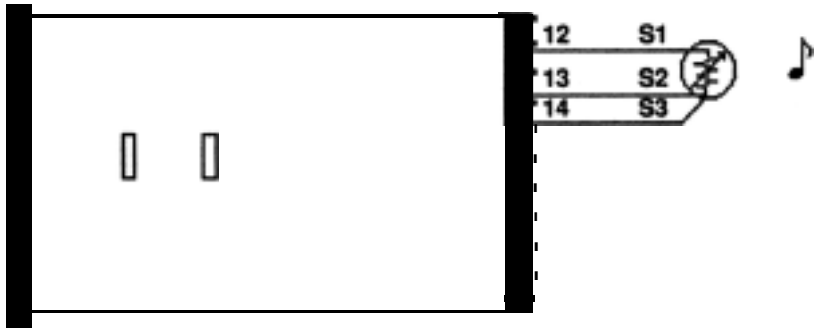


Figure 13 - Input Options "2' & '*3", RTD (3 wire) Sensor Wiring.

NOTE:

Long lead lengths create electrical resistance. There will be a 1° approximate input error for every 1ohm 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 1 Option "B", Solid State Relay

Model# 98_A-_ B _0-0000

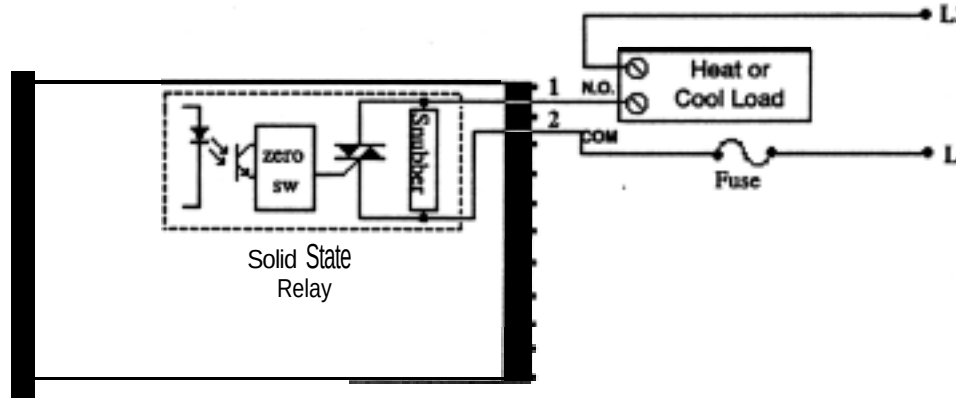


Figure 14 - Solid State Relay, Output 1, Option "B" Wiring Diagram.

Solid State Relay
Watlow's solid state **relays** change state at zero volts, which is *zero-cross switching." They are also optically isolated, which means the output circuitry is energized by infrared light striking a photo-sensitive device. This results in virtual absence of electrically generated noise, plus output to input electrical isolation. Off **state impedance is 20Kohm minimum.**

Output 1 Option "C", DC Output (Open Collector)

Model# 98_A-_C_0-0000

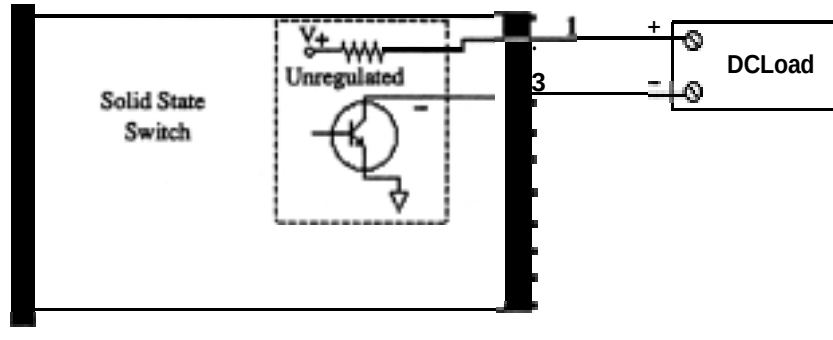


Figure 15 - DC Output 1 (Open Collector), Option 72" Wiring Diagram.

Switched DC
Watlow's solid state switch is **a low current DC output (open collector)** used to switch an external power switching device such as an SSR or an electromechanical relay. The input specifications of the power switching device must those listed for the SS switch output. The power switching device must provide isolation between the SS switch output and load power since the SS switch output is a non-isolated output. Minimum load resistance is 500ohms Available current is minimum 9mA, 22mA maximum.

Output 1 Option “D”, 6 Amp Mechanical Relay

Model#98_A-_D _0-0000

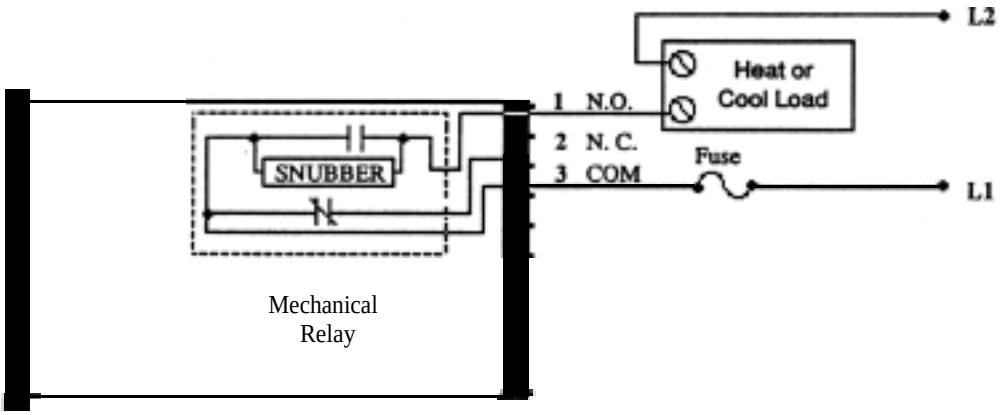


Figure 16 -
6 Amp mechanical Relay, Output 1, Optlon “D” Wlrlng Diagram.

Mechanical Relay

The Electromechanical relay iS an electrical and mechanical device with moving parts. When power is applied to the relay solenoid, Contact closure is Created through movement of the “Common” Contact of the relay. Off **state impedance is 20Kohm minimum.**

Output 1 Option “E”, 0-I0 VDC

Model# 98_A-_E _0-0000

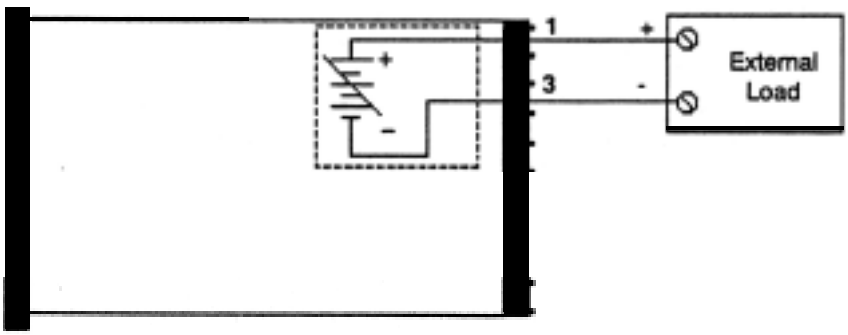


Figure 17 -
0-10VDC, Output 1, Optlon "E" Wiring Diagram.

Process Output,
Proportional value determined by the Control to balance the sensor input and set point. This value will fall between **0-10VDC** depending on your process output type.

Output 1 Option "F", 4-20mA

Model# 98_A-_F _0-0000

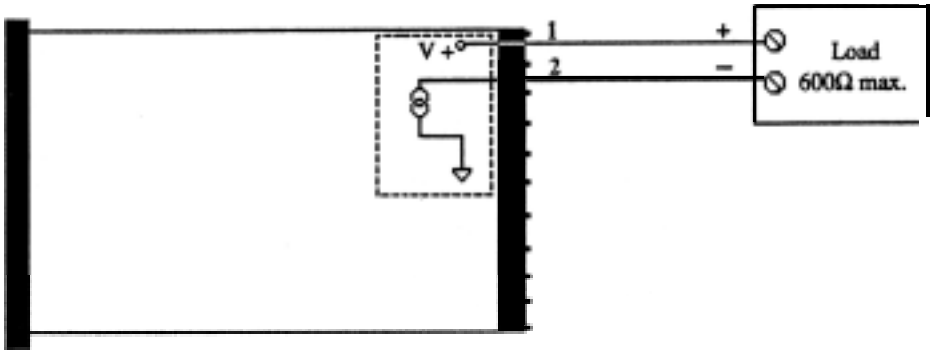


Figure 18 - 4-20mA, Output 1, Option "F" Wiring Diagram.

Process Output
Proportional value determined by the control to balance the sensor input and set point. This value will fall between 4-20mA depending on your process output type.

Output 1 Option "G", 0-20mA

Model# 98_A-_G _0-0000

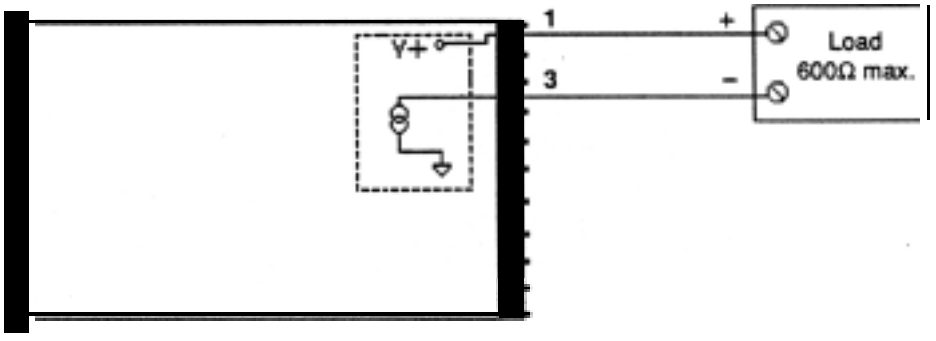


Figure 19 - 0-20mA, Output 1, Option "G" Wiring Diagram.

Process Output
Proportional value determined by the control to balance the sensor input and set point. This value will fall between 0-20mA depending on your process output type.

Output 1 Option “H”, O-5VDC

Model# 98_A-_H _0-0000

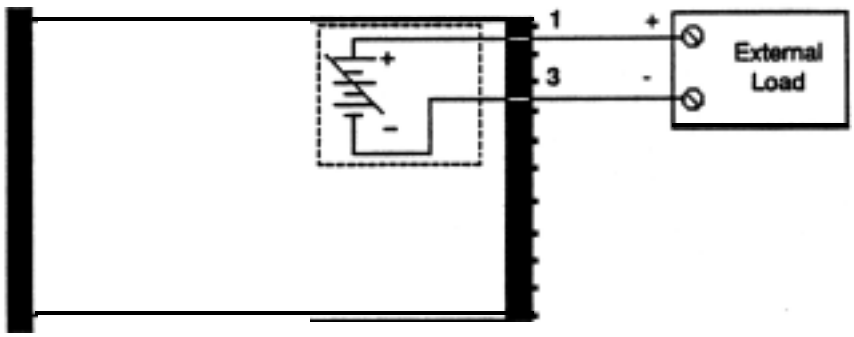


Figure 20 -
O-5VDC, Output 1, Option "H" Wiring Diagram.

Process Output
Proportional value determined by the control to balance the sensor input and set point. This value will fall between O-5VDC depending on your process output type.

Output 2 Option “B”, Solid State Relay

Model# 98_A- . . B 0-0000

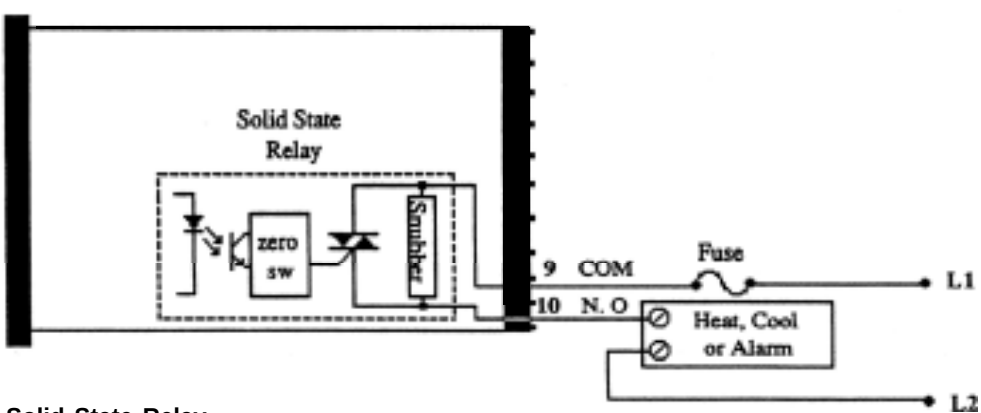


Figure 21 -
S.S. Relay, Output 2, Option "B" Wiring Diagram.

Solid State Relay
Watlow’s solid state relays change state at zero volts, which is zero-cross switching.” They are also optically isolated, which means the output circuitry is energized by infrared light striking a photo-sensitive device. This results in virtual absence of electrically generated noise, plus output to input electrical isolation. Off state impedance is 20Kohms minimum.

Output 2 Option "C", DC Output (Open Collector)

Model# 98_A-___C 0-0000

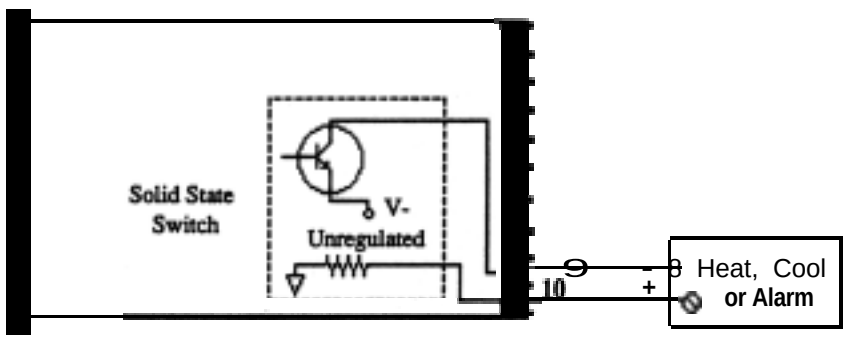


Figure 22 -
DC Output (Open Collector), output 2 Option "C" Wiring Diagram.

Switched DC
Watlow's solid state switch is a low current DC output (open collector) used to switch an external power switching device such as a SSR or an electromechanical relay. The input specifications of the power switching device must match those listed for the SS switch output. The power switching device must provide isolation between the SS switch output **and** load power since the SS switch output is a non-isolated output. Minimum load resistance is 500 ohms. Available current is 9mA minimum and 22mA maximum.

Output 2 Option "D", 6 Amp Mechanical Relay

Model# 98_A-__D 0-0000

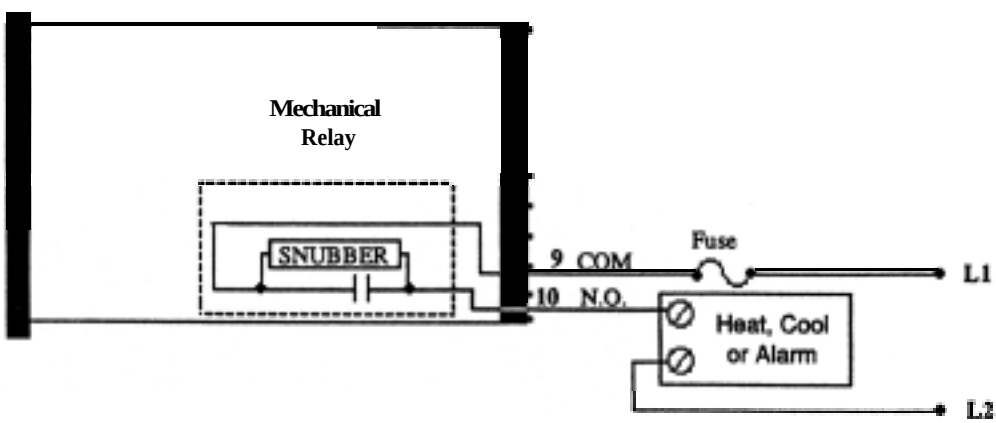


Figure 23 -
6 Amp Mechanical Relay, Output 2, Option "D" Wiring Diagram.

Mechanical Relay
The electromechanical relay is an electrical and mechanical device with moving parts. When power is applied to the relay solenoid, contact closure is created through movement of the "common" contact of the relay. Off state impedance **is 20K ohms minimum.**

WARNING:

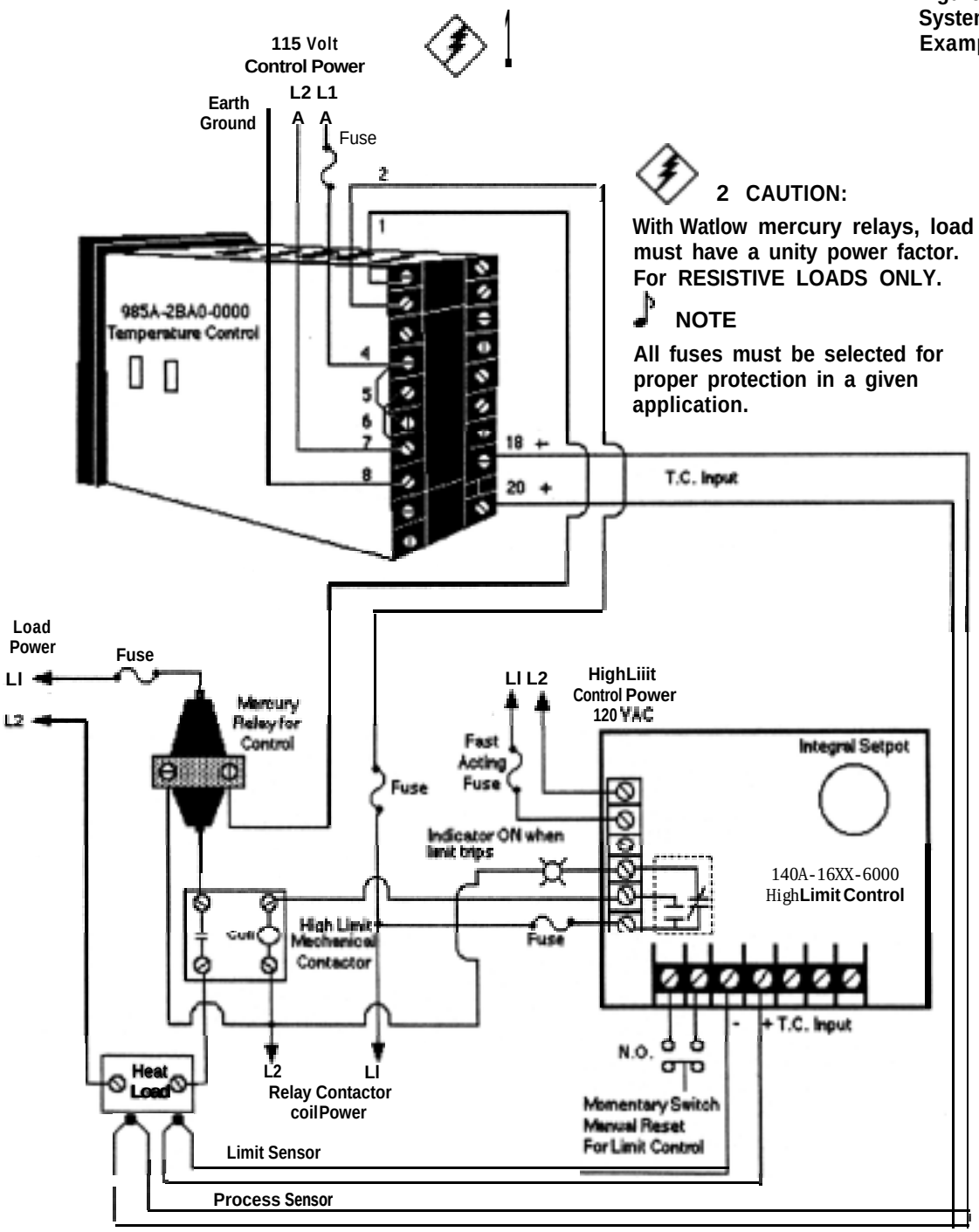
Install high or low temperature limit control protection in systems where an overtemperature fault condition could present a fire hazard or other hazard. Failure to install temperature limit control protection where a potential hazard exists could result in damage to equipment and property, and injury to personnel.

1

CAUTION:

Do not jumper load power from the control power terminals. Doing so will cause your control to be more susceptible to electrical interference from load switching. See Noise Guidelines at the beginning of this chapter.

Figure 24 - System Wiring Example



2 **CAUTION:**

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

NOTE

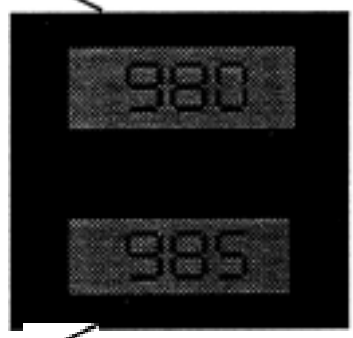
All fuses must be selected for proper protection in a given application.

Chapter 3

How to Use the Keys and Displays

Series 980/985 Displays and Load LED's

Upper Display
Red, 0.3" high LED, seven segment, three or four digit display indicating either process actual temperature, the operating parameter values, or an open sensor.



Lower Display
Red 0.3" high LED, seven segment, three or four digit, display indicating the set point, output value, prompts for data in the upper display, or error and alarm codes.

NOTE:
The Upper display will always show the process value after 1 minute without key strokes.

Figure 25 - Series 980/985 Displays

LOAD 1
When lit, this LED tells you when Output 1 is energized.

LOAD 2
When lit, this LED tells you when Output 2 is energized or the alarm is active.

Series 980/985 Keys

Figure 27 - Series 980/985 Keys

UP/DOWN keys
When pressed simultaneously for **3 seconds**, the Setup Menu appears displaying the LOC parameter. From the LOC parameter, press the UP/DOWN keys again and the Calibration Menu appears.

MODE Key
Steps the control through the Operating menu; also, in the Auto mode, enters new data selected less than 5 seconds previously.

AUTO/MAN Key
Pressed once, it clears any latched alarms. If the key is pressed again within 5 seconds, the control toggles between the Auto and Manual mode. While in the Manual mode, percent power is always displayed in the lower display.

UP Key
Increases the value of the displayed parameter. A light touch increases the value by one. Holding the key down increases the display value at a rapid rate. New data is self entering in 5 seconds.

DOWN Key
Decreases the value of the displayed parameter. A light touch decreases the value by one. Holding the key down decreases the displayed value at a rapid rate. New data is self entering in 5 seconds.

Auto/Manual LED
Lit when the control is in Manual operation. Press the key twice to enter Auto operation. A blinking Auto/Manual LED indicates that pressing the Auto/Manual key toggles between Auto and Manual. After 5 seconds without pressing the Auto/Manual key, the LED stops blinking, and returns to its previous state.

Where To Go From -Here

Now that you know how to read the keys and displays, continue to Chapter 4 to begin entering data and setting up your Series 980/985.

Chapter 4

How To Setup The Series 9801985

NOTE:
While in the Setup menu, all outputs are OFF.

Setting up the Series 980/985 is a simple process. First configure the 980/985's features to your application in the Setup Menu, and then enter values in the Operating Menu. Both tasks use the MODE key to move through the menus and the UP/DOWN keys to select data.

Entering the Setup Menu

Figure 27 - Entering the Setup Menu.

The Setup Menu displays the parameters that configure the Series 980/985's features to your application.

To enter the Setup Menu, press the UP and DOWN keys simultaneously for 3 seconds. See Figure **27.** The Lower display shows the LOC parameter, and the Upper display shows its current level. All keys are inactive until you release both keys. You can get to the LOC parameter from anywhere.

Use the MODE key to cycle through the menu; use the UP/DOWN keys to select Setup data. You may not see all the parameters in this menu, depending on the unit's configuration and model number. After stepping through the menu, you will return to the control set point parameter under the Operation menu.

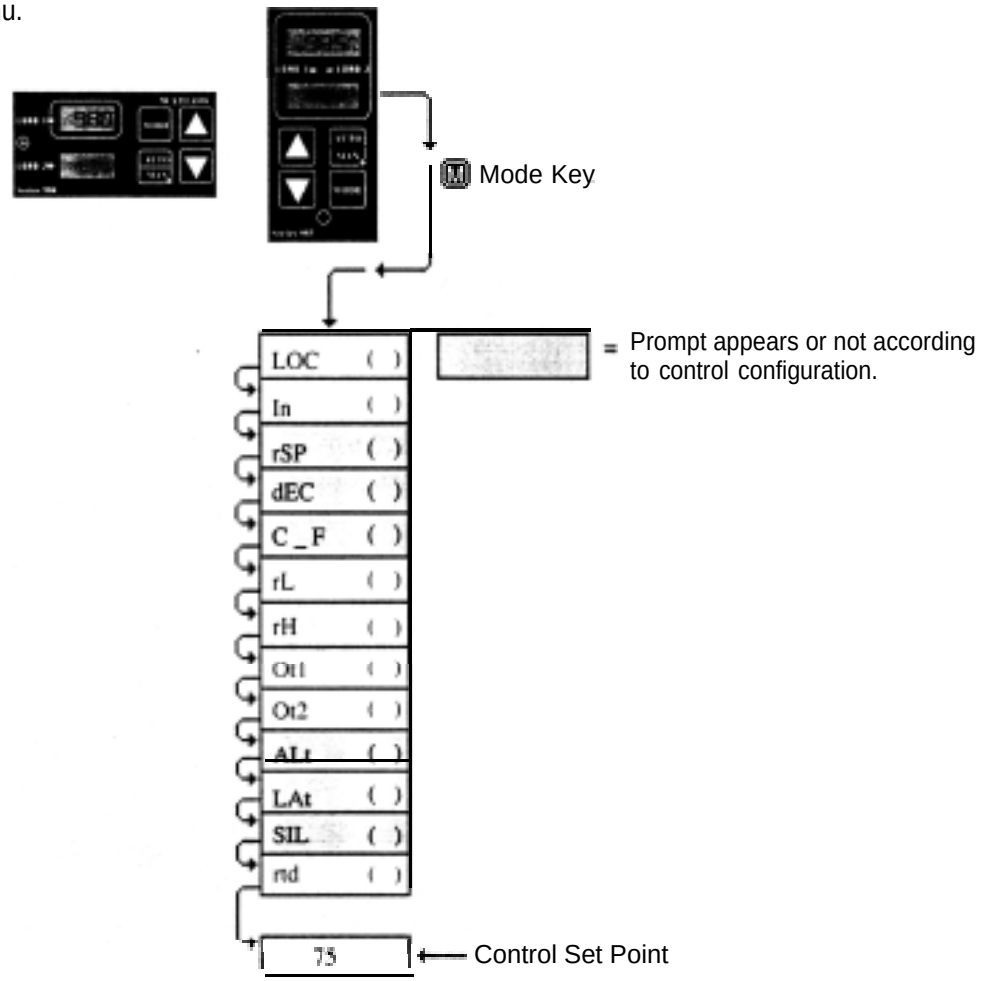
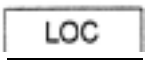


Figure 28 - The Setup Menu.

NOTE:
When using a process input such as O-5VDC or 4-2OmA, the rL and rH settings scale the display to match the measured range of the process signal.

Setup Parameters

At the top of the menu, the Series 980/985 displays the user level of operation in the Upper display, and the LOC parameter in the Lower display. When pressing the MODE key, the value of the next parameter appears in the Upper display, and the parameter itself is in the Lower display.



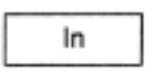
Lock: Selects the level of operator lock-out. This parameter's range is from 0 - 3. The default is 0. The levels of operator lock-out are defined as follows:

LOC 0: All operating parameters may be viewed or changed. Manual operation **is** permitted.

LOC 1: The set point and actual are the only visible parameters, the set point **is** adjustable in this level of lock-out. Manual operation **is** permitted.

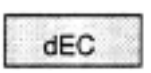
LOC 2: The set point and actual are the only visible parameters, set point is adjustable in this level of lock-out. Manual operation is **not** permitted. Bumpless transfer is defeated.

LOC 3: The set point and actual are the only visible parameters, the set point is **not** adjustable in this level of lock-out. Manual operation is **not** permitted. Bumpless transfer is defeated.



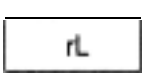
Input: Selects the sensor input type. This parameter's range is J, K, t, n, Pt2, rtd, rt.d, 0-5, and 420. The default is Type "J". Only those input types compatible with your unit appear. See the model number information for your type.

Remote Set Point: Enables the Series 980/985 to accept a remote set point signal from another device. This parameter only appears on models 98XA-2XXX-0000 or 98XA-3XXX-0000 and if In = Thermocouple or RTD input.
Range: OFF, 05,420 **Default:** OFF



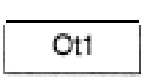
Decimal: Selects the location of the decimal point for ail process related data. The range is 0, 0.0, or 0.00. The default is 0. This parameter only appears if the in parameter is 0-5 or 420.

Celsius _ Fahrenheit: Selects the units of measure for the control. The range of this parameter is C or F. The default is F. This parameter only appears if the In parameter is J, K, t, n, Pt2, rtd, or rt.d.

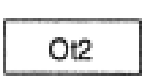


Range Low: Selects the low limit of the operating range. See the model number and specification information in the Appendix for your range values. For units with process input, it determines scaling of the remote set point input. 0.0VDC and 4mA input are equal to Range Low(rL) of your input type. Set point is linearly scaled between rL and rH. See Chart 2 on Page 26.

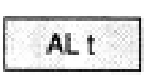
Range High: Selects the high limit of the operating range. See the model number and specification information in the Appendix for your range values. For units with process input, it determines scaling of the remote set point input. The 5.OVDC and 2OmA input are equal to the Range High (rH) of your input type. Set point is linearly scaled between rL and rH. See Chart 2 on Page 26.



Output 1: Selects the output action for the primary output. The range of this parameter is Ht (Heating) or CL (Cooling). Default is Ht.



Output 2: Selects the output action for the secondary output. The range of this parameter is Ht (Heating), CL (Cooling), AL (Alarm) or no (None). Default is AL.



Alarm Type: Selects the alarm type when Output 2 has been selected as an alarm. The range of this parameter is Pr (Process Alarm) or dE (Deviation Alarm). A process alarm is set at an absolute temperature to prevent over/ underrange. Deviation tracks your process set point. The default is Pr. This only appears if the Ot2 parameter is AL.

LAt

Latching: Selects whether the output is latching or non-latching when Output 2 is an alarm. Latching alarms must be cleared before the alarm output will reset. Non-latching automatically resets the alarm output when the condition clears. The range is LAt or nLA, default is nLA. This only appears if the Ot2 = AL.

SIL

Silencing: Selects alarms silencing (alarm inhibit). Appears only when ALt = dE. If LAt, press the Auto/Man key to reset the alarm output. If nLA, alarm automatically resets 5 seconds after power is applied.

rtd

RTD: Selects the RTD calibration curve. JIS = 0.003916 / PC DIN =0.003850 / °C.

Setup Menu

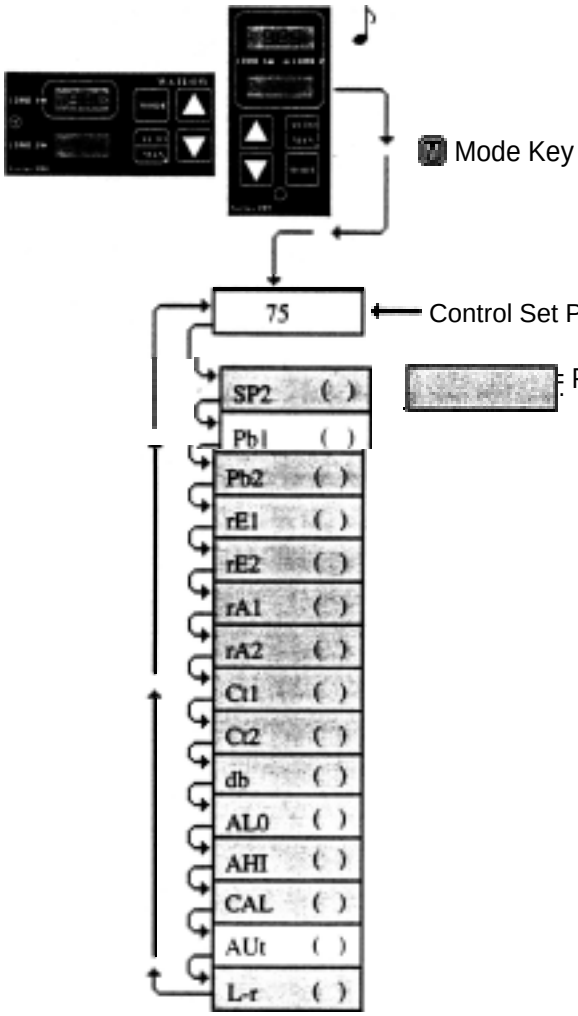
Use this page as a master copy for configuring your Series 980/elects the low limit of the Operating range See the model number and specification informa-

Chart 1- Setup Menu Prompts and Descriptions.

Setup Parameters	Value	Range	Factory Default
LOC		0-3	0
In		J, K (appears as H), t, n, Pt2, rtd, rt.d, 0-5,4-20 Dependent on model number.	J
rSP		OFF, O-5,420	OFF
DEC		0, 0.0, or 0.00 Dependent on input type.	0
C-F		C or F Will not appear if In= 0-5 or 420.	F
rL		rLtorH	Input selection dependent.
rH		rH to rL	Input selection dependent.
Otl		Ht or CL	Ht
ot2		Ht. CL, AL or no	AL
ALt		Pr or dE Dependent on Ot2 = AL.	Pr
LAt		LAt or nLA Dependent on Ot2 =AL.	nLA
SIL		OFF or On Appears if Ot2=AL&ALt=dE.	OFF
rtd		JIS or din Appears if In = rtd or rt.d.	JIS

Chart 2- Input Ranges.

Input Type	Sensor Range Low	Sensor Range High
J	32°F/0°C 32°F/0°C	999*F/750°C (3 digit) 1 382°F/750°C (4 digit)
K	-328°F/-200°C	2282°F/1250°C
t	-328°F/-200°C	662°F/350°C
n	32°F/0°C	2282°F/1 250°C
Pt2	32°F/O°C	2543°F/l395°C
rtd (1°)	-328°F/-200°C	111 2°F/600°C
rt.d (0.1')	-99.9°F/-99.9°C	392.0°F/200.0°C
0-5 (VDC)	-5.00/-50.0/-500	35.00/350.0/3500
420 (mA)	.-5.00/-50.0/-500	35.00/350.0/3500



Prompt appears or not according to control configuration.

NOTE:

The Upper display will always show the process value after 1 minute without key strokes.

Figure 29 - The Operation Menu.

Operation Parameters

Set Point 2: Sets the operating set point for Output 2 when control mode is Ht/Ht or CL/CL. SP2 only appears when Ot1 and 0t2 are the same, and functions as an ON/OFF control.

SP2

Proportional Band: Set the proportional bandwidth for each Output, adjustable from 0° to 999°F or 0 to 555°C for ranges displayed in whole degrees, and 0 to 99.9°F or 0 to 55.5°C for ranges displayed in 0.1°. If set at Pb = 0, the Series 9801985 functions as a simple ON/OFF control with a 3°F or 1.7°C switching differential for ranges displayed in whole degrees, and 0.3°F or 0.17°C for ranges displayed in 0.1°. The default is 25°F/13°C.

Pb1
Pb2

If the input type is 0-5VDC or 4-20mA, the range of Pb1 is 0-999, 0-99.9 or 0-9.99 (determined by the value of DEC). The switching differential is 0.03, 0.3 or 3 units. Pb2 default is 0. Pb2 only appears with Ht/CL or CL/Ht operation.

Reset: Enter Reset for Output 1 or 2, adjustable from 0.00 to 9.99 rpts/min. A value of 2.00 rpts/min. corresponds to an integral time constant of 30 seconds. Selecting 0.00 = no integral action. rE2 only appears with Ht/CL or CL/Ht operation. rA X will not appear if Pb X= 0 respectively.

rE1
rE2

Rate: Adjust Rate function for Output 1 or 2, from 0.00 to 9.99 minutes maximum. Selecting 0.00 = no derivative action. rA2 will only appear with Ht/CL or CL/Ht operation. rA X will not appear if Pb X = 0 respectively.

rA1
rA2

Cycle Time: Enter the Cycle Time for each Output, adjustable from 1 to 60 seconds. The default will be 5 seconds. Ct1 will not appear **if Output 1 is 4-20.** CT2 only appears with Ht/CL or CL/Ht operation..

Ct1
Ct2

Setup

db

Dead Band: Enter the Dead Band between the heating and cooling functions adjustable from ± 99°F/± 55°C. The default is 0°. Appears when Ot2 = CL.

ALO

Alarm Low: Represents the low process alarm or low deviation alarm. Displayed only when 0t2 parameter is AL.

AHI

Alarm High: Represents the high process alarm or high deviation alarm. Displayed only when Ot2 parameter is AL.

CAL

Calibration Offset. The range is ±99°F/±55°C. The default is 0°. Calibration Offset adds or subtracts degrees from the input signal.

AUt

Auto-Tune. The range of this parameter is 0-3, off = 0, slow = 1, medium = 2, and fast = 3. A value other than 0 initiates the auto-tune.

L-r

Local-Remote: Selects a local or remote set point for the Series 980/985. Local set point is adjustable directly from the 980/985, while remote can only be changed from an external device. The signal must be within 0-5V or 4-20mA process input. This parameter appears if the LOC parameter = 0, 1 or 2, and rSP = 0-5 or 420. If L-r = r, the remote set point is displayed in place of the internal set point.

Chart 3 - Operation Menu Prompts and Descriptions.

Use this page as a master copy for your Series 980/985. Operation Parameters. **Do not enter any values here: make photocopies instead.**

Operation Parameters	Value	Range	Factory Default
SP2		rL to rH	Same as primary set point.
Pbl		**0** to 999°F/0 to 555°C or 0 to 99.9°F/0 to 55.5°C 0=ON/OFF control with 3°F or 1.7°C switching differential. 0.3°F or 0.17°C for 0.10 units.	**25°F/l3°C (3 or 4** digit)
Pb2		Same as Pb1. Only appears if Ht/CL or CL/Ht operation.	0°F/0°C (3 or 4 digit)
rE1		**0.00** to 9.99 repeats/min. 0.00 = No Reset Action	0.00 repeats/min.
rE2		Same as rE1. Only appears if Ht/CL or CL/Ht operation. Will not appear if Pb2 = 0.	0.00 repeats/min.
rA1		**0.00** to 9.99 min. 0.00 = No Rate Action	0.00 min.
rA2		Same as rA1. Only appears if Ht/CL or CL/Ht operation. Will not appear if Pb2 = 0.	0.00 min.
AL0 - Deviation **dE** Process **Pr**		**-99°** to **0°** (3 digit display) -999° to 0° (4 digit display) **rL** to AH1	-99° -999° rL
AHI - Deviation dE Process **Pr**		0° to 99° (3 digit display) 0° to 999° (4 digit display) AL0 to **rH**	99° 999° rH
Ctl		1 to 60 seconds	5 seconds
Ct2		1 to 60 seconds Appears if Ht/CL or CL/Ht Will not appear if PB2 = 0	5 seconds
db		±99°F/±55°C. Appears if Ht/CL or CL/Ht	0
CAL		±99°F/±55°C	0
AUt		**0-3** Appears if Ot1 = Ht.	**0**
L-r		L or r. Appears if rSP = 0-5 or 420.	

Chapter 5

How to Tune and Operate

Tuning - Automatic

Auto-tuning: The Series 9801985 gives you the capability to automatically tune the PID parameters to fit the characteristics of your particular thermal system.

The auto-tuning procedure operates on a thermal response value — slow, medium, or fast. A slow thermal response is used when the process temperature is not met too rapidly, or greatly exceeds the set point value. A fast thermal response produces a rapid temperature change over a short period of time.

Once the auto-tune sequence has begun, all PID values for both heat and cool are set to 0 and the control goes into an ON/OFF mode of control at 90% of the established set point. The displayed set point remains unchanged.

The cool output remains off for the duration of the tuning. Once the control has finished "learning" the system, it returns to standard PID control with the heat PID values being automatically established as a result of the auto-tuning. The operator must then establish the cool PID values manually. Tuning is complete within 40 minutes. Any change of the set point, while in auto-tune, re-initiates the auto-tune procedure.

NOTE:
Auto-tuning is only possible in the heat mode. The cool output remains off.

To start auto-tuning:

1. **Press the MODE key** until the **AUt** prompt appears in the data display.

2. **Select a thermal response value,** 1=slow, 2=medium, and 3=fast, using the UP/DOWN keys. A thermal response value of 2 will satisfactorily tune most thermal systems.

3. **Press the MODE key.** While the control is in the tuning mode, the lower display alternately displays the normal information and the prompt **At.** The time between alternations is 1 second.

4. **When the process is complete,** the displays return to their previous state and **AUt** reverts to 0. The appropriate PID tuning parameters are now installed, and retained in the non-volatile memory.

To abort auto-tuning, the operator must reset the **AUt** parameter to 0. This leaves the unit in an ON/OFF heat control state in Auto operation at the displayed set point. The auto-tuning process may also be aborted by pressing the AUTO/MANUAL key twice. In both cases, all PID values are set to 0.

Tuning - Manual

For optimum control performance, tune the Series 985 to the thermal system The tuning settings here are meant for a broad spectrum of applications; your system may have somewhat different requirements.

1. **Apply power to the Series 965** and enter a set point. Begin with these Operation Parameters: **Pbl =** 1, **rE1 = 0.00, rA1 = 0.00, Ct1 = 5, CAL = 0, AUt= 0.**

2. **Proportional Band Adjustment (Output 1):** Gradually increase **Pb1** until the Upper display temperature stabilizes to a constant value. The process temperature will not be right on Set point because the initial reset value is 0.00 repeats per minute. (When **PB1 = 0; rE1** and **rA1** are inoperative, and the 985 functions as a simple ON/OFF control with a 3°F or 1.7°C switching differential.)

3. Reset **Adjustment:** Gradually increase **rE1** until the upper display temperature begins to oscillate or "hunt". Then slowly decrease **rE1** until the Upper display stabilizes again near set point. NOTE: This is a slow procedure, taking from minutes to hours to obtain optimum value.

4. Cycle **Time Adjustment:** Set **Ct1** as required. Optimum system control is sometimes achieved with faster cycle times. However, if a mechanical contactor or solenoid is switching power to the load, a longer cycle time may be desirable to minimize wear on the mechanical components. Experiment until the cycle time is consistent with the quality of control you want.

5. **Rate Adjustment:** Increase **rA1** to 1.00 min. Then raise set point by 20° to 30°F, or 11° to 17°C Observe the system's approach to set point. If the load temperature overshoots set point, increase **rA1** to 2.00 minutes.

   Then raise set point by 20 to 30°F, or 11 to 17°C and watch the approach to the new set point. If **rA1** is advanced too far, approach to the set point will be very sluggish. Repeat as necessary until the system rises to the new set point without overshooting or approaching the set point too slowly.

6. **Calibration Offset Adjustment: You** may want your system to control to a temperature other than the value coming from the input sensor. If so, measure the difference between that temperature, perhaps at another point in the system, and the process value showing in the Upper display. Then enter the amount of **CAL** offset you want. Calibration offset adds or subtracts degrees from the value of the input signal.

Manual and Automatic Operation

To change from manual to auto operation, press the AUTO/MAN key twice.

Manual operation provides direct (time proportioned % power) control of the outputs from -100% to 100%. A negative output value is allowed only with a CI (Cool) selection on either Otl or 0t2. Automatic operation provides closed loop ON/OFF or PID control. When the operation transfers from a closed loop to an open loop, the 985 retains the power level from the closed loop control. When returning to the closed loop control, the previous set point temperature is restored.

Indication of Auto/Manual operation is the LED located on the AUTO/MAN key. When the LED is ON, the control is in the Manual operation, an alarm condition is present, and the output de-energizes. When the LED is OFF, the control is in AUTO operation and the alarm is energized. When the LED flashes, press the key again within five seconds to complete the change in operation. If the sensor is open and LOC = 0 or 1, the Series 985 switches to Manual operation (time proportioned % power), if the output was stable before the break occurred.

When transferring from auto to manual operation, the control output(s) will not change ("bumpless," smooth transition). When transferring from manual to automatic operation, the control output(s) may change significantly. In manual, the output value (% power) appears in the lower display. In automatic operation, the set point appears.

Using Alarms

The Series 985 has two alarms types, Process or Deviation. A **Process alarm** sets an absolute temperature when the process exceeds that absolute temperature limit. The Process alarm points may be independently set high, low, or high/low.

A **Deviation alarm** alerts the operator when the process strays too far from set point. The operator can enter independent high and low alarm settings. The reference for the deviation alarm is the set point. Any change in set point causes a corresponding shift in the deviation alarm. Example: If your set point is 100°F, and you have a deviation alarm set at ±7°F as the high limit, and -5°F as the low limit, the high alarm will trip at 107°F, and the low alarm at 95°F. If you change the set point to 130°F, the alarms will follow the set point and trip at 137°F and 125°F.

Alarm Silencing for alarm output A1 is available with the deviation alarm. This overrides alarm A1 during power up. The non-latching mode automatically enables alarm output A1 on initial power up. In the latching mode, the operator must manually disable the alarm by pressing the AUTO/MAN key once. In both cases alarm silencing disables the A1 alarm output relay, but the A1 LED displays the alarm condition until the process value is within the "safe" region of the deviation alarm band. Once the process value crosses into the "safe" region, both a latching or a non-latching alarm is ready. Any future deviation outside this safe band triggers an alarm.

Both Process and Deviation alarms can be latching or non-latching. The operator must manually reset a latching alarm before the alarm will reset. The operator must also remove the condition that created the alarm. When the operator removes the condition causing the alarm, a non-latching alarm automatically resets the alarm output.

Flashing 'LO" or "HI" in the lower display indicates an alarm.
The Lower display alternately displays information from the current parameter and the "LO" or "HI" alarm message at one second intervals. The alarm output (Output 2) is de-energized and the LOAD 2 LED is lit.

To clear an alarm...

The alarm condition must first be corrected...

- **If the alarm is latching...**

  Clear manually; press the AUTO/MAN key once as soon as the process temperature is inside the alarm limit by 3°F/1.7°C for 1° RTD units, and 0.3°F/0.17°C for 0.1° RTD units.

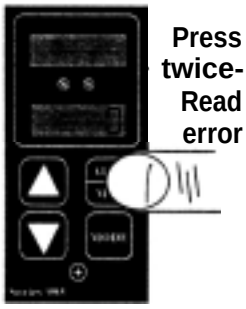
Figure 31 - Alarm Display Examples

Press once - Clear a latched and corrected alarm.

•If the alarm is non-latching...
The alarm will clear itself automatically as soon as the process temperature is inside the alarm limit by 3°F/l.7°C for 1° RTD units, or 0.3°F/0**17°C** for 0.1° RTD units.

CAUTION:
An alarm display will be masked by an error condition or when the control is in the Calibration or Set Up Menus.

How To Deal With Error Codes



Press twice- Read error

Figure 32 - Error Code Display Examples

NOTE:
Electrical noise or a noise event, vibration or excess environmental moisture or temperature may cause Series 985 errors to occur. **If the cause of an error is not otherwise apparent, check for these.**

Three dashes, "- - -", in the upper display indicate a Series 985 **error.**

- **If operator access is LOC 0 or** 1 . . .

  Press the AUTO/MAN key twice to see the error code for one second.

- **If operator access is LOC 2 or 3...**

  The error code is already in the lowerdisplay.

- **Error code definitions and actions...**

Er 1- Sensor overrange error
The sensor input is generating **a value** that is higher than that allowed for the range of this sensor, or the A/D circuitry is not functioning properly. Enter a valid input.

Er 2 - Sensor underrange error
The sensor input is generating a **value** that is lower than that allowed for the range of this sensor, or the A/D circuitry is not functioning properly. Enter a valid input.

Er 3 - Ambient error
Check the specification for the ambient temperature range.

Er 4 - Configuration error
The unit's microprocessor is faulty; call the factory.

Er 5 - Non volatile checksum error
The nonvolatile memory checksum has discovered a checksum error. Unless a momentary power interruption occurred while the unit was storing data, the nonvolatile memory is bad. Call the factory.

Er 7 - A/D overflow error
The A/D circuit is over- or under-range. An open or reversed polarity sensor is the most likely cause. Check the sensor; if it is connected and functioning properly, then call the factory.

- **To clear a corrected error...**

  Cycle power to the control.

Er 1, 2, 3 & 7 Errors - Control Outputs May Be ON

If operator access is LOC 0 or 1 . . .

. ..and the control was in AUTO operation when the error occurred, it will go into MANUAL (% power) operation. If the output power is less than 70%±5% change within the last two minutes, the 985 will switch into Manual operation at the last Automatic power level. If the control was in MANUAL operation, it will remain there. (You must press the AUTO/ MAN key twice to see the error code.) The alarm output (if present) will be in its alarm state (LED lit). The Upper display will read "- - -". The Lower display will indicate the error code.

If the control was operating with stable output values when the error occurred, it will continue to operate at those levels on a % power basis. If output values were not stable, the control outputs will go to 0% power (OFF).

If operator access is LOC 2 or 3. . .

The control will remain in AUTO operation. The control outputs will go OFF. The AUTO/MAN and MODE keys are disabled. The UP/DOWN keys may be used together to enter the Set Up Menu. The alarm output (if present) will be in its alarm state (LED lit). The Upper display will read - - -". The Lower display will indicate the error code.

To clear a corrected error...

Cycle power to the control.

Er 4 & 5 Errors - Control Outputs Will Be OFF

Error codes Er 4 and Er 5 will result in these conditions:

- The control is in AUTO operation with both Outputs OFF.
- The alarm output (Output **2),** if present, is in its alarm state (de-energized with the LED lit).
- The Upper display will indicate the process value#.
- The Lower display will indicate the error code.
- All Keys are inactive.
- All Set Up Menu parameters are reset to default values. Calibration values 4AO and 2AO are set to default values. All other Calibration Menu values remain unchanged.
- These conditions will occur regardless of the value of LOC, or the presence of the Set Up or Calibration Menus.

To clear a corrected error. . .

Cycle power to the control.

Recalibrate the 4-20mA output, if applicable (see the unit's model #).

Appendix

Control Mode

- Single set point, non-ramping.
- Single input, dual outputs.
- Control outputs: User selectable as: Heat, Heat/Heat, Heat/Cool, Cool, Cool/Cool, Heat/Alarm, Cool/Alarm
  - Outputs independent, or related via deadband for Heat/Cool.
  - ON/OFF: 3°F or 1.7°C switching hysteresis or 0.3°F or 0.l7°C for 0.10 Units.
  - PID parameters:
    - Proportional band: 0 to 999°F/0 to 555°C(3 digit only)
    - 0 to 999°F/0 to 555°C or 0 to 99.9°F/0 to 55.5°C (3 or 4 digit)
    - Reset: 0.00 to 9.99 repeats per minute.
    - Rate: 0.00 to 9.99 minutes.
    - Cycle time: 1 to 60 seconds.
  - Deadband: ±99°F, ±99 units or ±55°C
    ±9.9°F, ±9.9 units or ±5.5°C for 0.1 decimal units)

Operator Interface

- Membrane front panel.
- Three or four digit 0.3" (8mm) LED diiplays.
- MODE, AUTO/MANUAL, UP, and DOWN keys.
- Dual digital displays.

Input

- Thermocouple, RTD, and electrical process input.
- Automatic cold junction compensation for thermocouple.
- RTD input 2 or 3 wire, platinum, 100 ohm @ 0°C user selectable, calibrate to JIS curve #3916 (0.003916(0.003916ohm/ohm/°C or DIN curve #3850(0.003850ohm/ohm°C
- Sensor break protection de-energizes control output to protect system or selectable bumpless transfer to manual operation.
- Grounded or ungrounded sensors.
- °F/°C or process variable units are user selectable.
- Operating ranges user selectable.

Jt/c:	32 to 999°F or	0 to 750°C (3 Digit)
	32 to 1382°F or	0 to 750°C (4 Digit)
Kt/c:	-328 to 2282°F or	-200 to 1250°C
Tt/c:	-328 to 662°F or	-200 to 350°C
Nt/c:	32 to 2282°F or	0 to 1250°C
PT 2 (Platinel2)	32 to 2543°F or	0 to 1395°C
1° RTD:	-328 to 1112°F or	-200 to 600°C
0.1° RTD:	-99.9 to 392.0°F or	-99.9 to 200.0°C
0-5VDC:	-500 to 3500 units	
4-20mA:	-500 to 3500 units	

Primary Output (Heating or Cooling)

- Solid state relay, 0.5A @ 24VAC minimum, 253VAC maximum, opto-isolated, zero cross switching.
- Electromechanical relay, Form C, 6A @ 115/230VAC, 6A @ 28VDC, 1/8 hp. @ 115VAC 125VA @ 115VAC. Warranted to 100,000 cycles.
- Open collector, switched DC signal provides a minimum turn ON voltage of 3VDC into a minimum 500 ohm load, maximum ON voltage not greater than 32VDC into an infinite load.
- 4-20mA reverse acting into a 600 ohm maximum load.

Secondary Output (Heat, Cool or Alarm)

- Solid state relay, 0.5A @ 24VAC minimum, 253VAC maximum, opto-isolated, zero cross switching.
- Electromechanical relay, Form A, 6A @ 115/230VAC, 6A @ 28VDC, 1/8 hp. @ 115VAC, 125VA @ 115VAC. Warranted to 100,000 cycles.
- Open collector, switched DC signal provides a minimum turn ON voltage of 3VDC into a minimum 500 ohm load; maximum ON voltage not greater than 32VDC into an infinite load.

Accuracy

- Calibration Accuracy: ± 0.1% of span, ± 1 LSD, 77°F ± 5°F (25°C ±3°C) ambient & rated line voltage ± 10%.
- Accuracy Span: 1000°F or 540°C minimum.
- Temperature Stability: 0.1 °F/°F (0.1 °C/°C) change in ambient.
- Voltage Stability: ± 0.01% of span per percent of rated line voltage.

Agency Approvals

- UL recognized, File #E43684, UL873
- CSA file #LR30586

Terminals

- #6 compression type screw terminals

Power

- 115/230VAC +10%, -15%, 50/60Hz, ± 5%
- 10VA maximum
- Data retention upon power failure via nonvolatile memory

Operating Environment

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

Dimensions

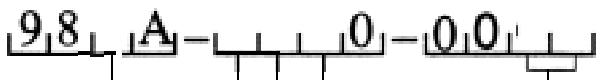
(985 orientation) For 980 units, switch height and width measurements.

Height:	3.8 in.	(96.5 mm)
Width:	1.9 in.	(48.0 mm)
Overall depth:	6.3 in.	(160.5 mm)
Behind panel depth:	6.0 in.	(152.5 mm)
Weight:	0.9 lb.	(0.4 kg)

Model No.

Series 980/985 Model Number Information

The Series **980/985** Model Number, listed on **your** unit sticker, is defined below.



Control
Series 980/985
= Dual output,
microprocessor-based
I/8 DIN

Mounting
0 = Horizontal
5 = Vertical

Input
1 = Type J thermocouple (3 digit only)
2 = Type J, K, T, N, PT 2 thermocouple;
RTD 1°, 420mA, 0-5VDC (4 digit)
3 = Type J, K, T, N, PT 2 thermocouple;
RTD 0.1°, 4-20mA, 0-5VDC (4 digit)

#1 output
B = Solid state relay, Form A, 0.5A, RC suppression
c = Switched DC, open collector, non-isolated
D = Electromechanical relay, Form C, 6A
(Warranted to 100,000 cycles)
E = Process, 0-10VDC, non-isolated
F = Process, 4-20mA, non-isolated
G = Process, 0-20mA, non-isolated
H = Process, 0-5VDC, non-isolated
K = Solid state relay, Form A, 0.5A,
without contact suppression

#2 **output Type**
A = None
B = Solid state relay, Form A, 0.5A, RC suppressed
c = Switched DC, open collector, non-isolated
D = Electromechanical relay, Form A, 6A
(Warranted to 100,000 cycles)
K = Solid state relay, Form A, 0.5A
without contact suppression
L = Electromechanical relay, Form B, 6A
(Warranted to 100,000 cycles)

Front Panel
00 = Standard
xx = Special label, consult Watlow representative

Calibration Menu

In the Calibration Menu, various input signals must be supplied in order for the control to go through its auto calibration. The calibration menu can only be entered from the LOC parameter in the Setup menu. Press the UP/DOWN keys simultaneously for 3 seconds (± 1 second). The CAL parameter appears.

CAUTION:

Incorrect calibration will affect the accuracy and should only be attempted with proper equipment and by qualified personnel.

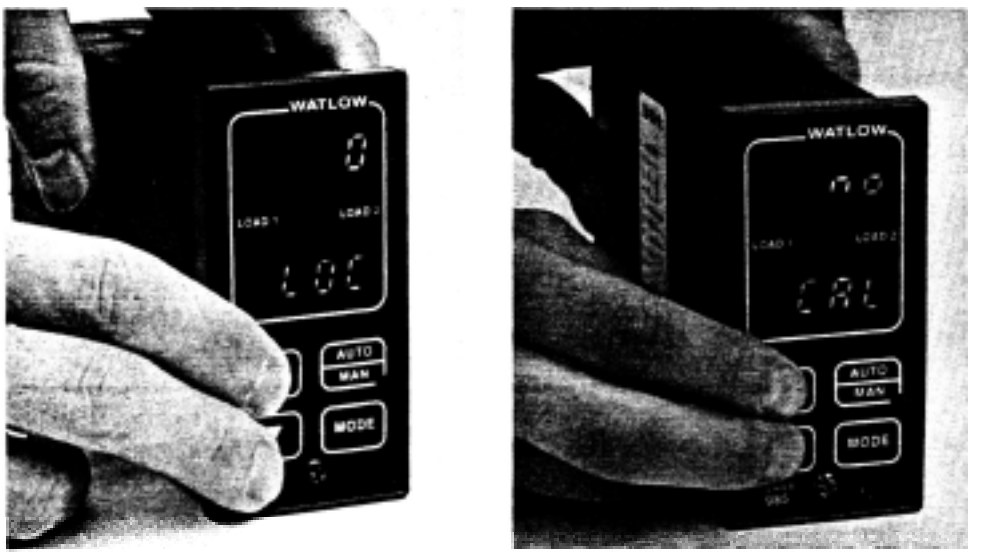


Figure 33 - Entering the Calibration Menu.

NOTE:

Calibration values are not retained unless you are In the MANUAL mode.

Any inadvertent change in displayed data when pressing UP & DOWN, is ignored. At the CAL parameter, press the AUTO/MANUAL key twice to enter the MANUAL mode. Calibration values are not retained unless in MANUAL mode.

Upon entering the calibration menu, the top display window indicates CAL and keys are inactive until all keys are released. The upper display continues to indicate CAL (with the exception of calibration of the 4-20mA output) while the operator walks through the entire calibration parameter list. While calibrating the 4-20mA output, the upper display contains a numeric value that is slewed up or down until the output value is correct. The control uses the lower display to prompt the user as to what the input should be.

NOTE:

While in the Calibration Menu, all outputs are OFF, except the 4-20mA output.

Once the input has been properly established and maintained for at least 10 seconds, the MODE key may then be used to display the next prompt. After the final input is established, another press of the MODE key returns the unit to the configuration menu at the top of the parameter list.

Cal Restore

If you make a mistake in calibrating your control, the rSt prompt at the end of the calibration menu restores the original factory calibration settings. Simply select yes and press the MODE key. The original factory calibration values are restored. Figure 34 on the next pages shows the calibration prompt.

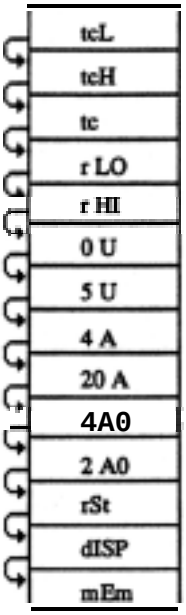


Figure 34 - **The Calibration Menu.**

Thermocouple, low end uncompensated. 0 mV
Thermocouple, high **end uncompensated.** 50mV
Thermocouple compensated value reference.
RTD low end resistance, see Table 2 on Page 39.
RTD high end resistance, see Table 2 on Page 39.
Process input. 0V
Process input. 5V
Process input. 4mA
Process input. 20mA
Process output. 4mA
Process output. 20mA
Restore factory calibration values. See Page 37.
Factory use only.
Factory use only.

Thermocouple Field Calibration Procedure

Equipment Required

- Type "J" Reference Compensator with reference junction at 320F/0°C, or Type "J" Thermocouple Calibrator set at 320F/0°C.
- Precision millivolt source, 0-50mV min. range, 0.01 mV resolution

NOTE

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Charts, Pages 26 and 28.

Setup And Calibration

1. Connect the AC line voltage Ll to Terminal #4, L2 to Terminal #7, and Ground to Terminal #8. Jumper for correct line voltage. See Chapter 2.
2. Connect the millivolt source to Terminal #18 Negative and Terminal #20 Positive on the 980/985 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Figure 33 on Page 37.

IMPORTANT:

When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

NOTE:

Not all parameters will appear. They are dependent on your unit type. Use only the steps that apply to your unit.

4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON.
5. At the "tcL" prompt, enter 0.00 millivolts from the millivolt source to the control. Allow at least 10 seconds to stabilize. Press the MODE key.
6. At the "tcH" prompt, enter 50.00 millivolts from the millivolt source to the 9801985. Allow at least 10 seconds to stabilize. Press the MODE key.
7. At the "tc" prompt, disconnect the millivolt source, and connect the reference compensator or T/C calibrator to Terminal #18 Negative, and Terminal #20 Positive on the Series 980/985 terminal strip. Allow 10 seconds for the control to stabilize. Press the AUTO/MAN key twice to exit the MANUAL mode. This pauses calibration to allow you to exit the CAL mode.

RTD Field Calibration Procedure

Equipment Required

1K ohm precision decade resistance box with 0.01 ohms resolution.

Setup And Calibration

NOTE

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Charts, Pages 26 and 28.

1. Connect the AC line voltage L1 to Terminal #4, L2 to Terminal #7, and Ground to Terminal #8. Jumper for correct line voltage. See Chapter 2.

2. Connect the decade resistance box to Terminal #12,13 and 14 on the terminal strip. Use regular 20 - 24 gauge wire of the same length and type.

3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Figure 33 on Page 37. Press the MODE key until the **rL0** prompt is displayed.

NOTE:
Not all parameters will appear. They are dependent on **your unit type. Use only** the steps that **apply to your unit.**

IMPORTANT:

When the MANUAL LED is ON the unit is automatlcally calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON.

5. At the **rL0** prompt, set the decade resistance box to the correct low setting- See the table below. Allow at least 10 seconds to stabilize. Press the MODE key.

	Calibration	Low	High
985A-2XX0-0X00	1°	17.31	317.33
985A-3XX0-0X00	0.1°	59.57	177.13

Table 2-
RTD Settings.

6. At the **rHI** prompt, set the decade resistance box to the correct high setting. Allow at least 10 seconds to stabilize. Press the AUTO/MAN key twice to exit the MANUAL mode. This pauses calibration to allow you to exit the CAL mode.

0 - 5 Volt Field Calibration Procedure

Equipment Required

- Precision voltage source 0-5 volt minimum range with 0.001 volt resolution.

Setup And Calibration

NOTE:
Not all parameters will appear. They are dependent on your unit type. Use only the steps that apply to your unit.

NOTE

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Charts, Pages 26 and 28.

1. Connect the AC line voltage Ll to Terminal #14, L2 to Terminal #7, and Ground to Terminal #8. Jumper for correct line voltage. See Chapter **2.**

2. Connect the voltage/current source to Terminal #15 and #17 on the Series 980/985 terminal strip. Use regular 20 - 24 gauge wire.

3. Apply power to the unit and allow it to warm up for 15 minutes. After **warm-up** put the unit in the CAL menu. See Figure **33** on Page **37.** Press the MODE key until the **OU** prompt is displayed.

IIMPORTANT:

When the MANUAL LED Is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON.

5. At the OU prompt, set the voltage/current source to 0.00 volts. Allow at least 10 seconds to stabilize. Press the MODE key.

6. At the **5U** prompt, set the voltage/current source to 5.00 volts. Allow at least 10 seconds to stabilize. Press the AUTO/MAN key twice to exit the MANUAL mode. This pauses calibration to allow you to exit the CAL mode.

4-20mA Input Field Calibration Procedure

Equipment Required

- Precision current source 0-20mA minimum range with 0.01 mA resolution.

Setup And Calibration

NOTE

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Charts, Pages 26 and 26.

NOTE:

Not all parameters will appear. They are dependent on your unit type. Use only the steps that apply to your unit.

1. Connect the AC line voltage Ll to Terminal #4, L2 to Terminal #7, and Ground to Terminal **#8.** Jumper for correct line voltage. See Chapter **2.**

2. Connect the voltage/current source to Terminal #15 and #17. Jumper Terminal #16 to #17 on the Series 980/985 terminal strip. Use regular 20 - 24 gauge wire.

3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Figure 33 on Page 37. Press, the MODE key until the **4A** prompt is displayed.

IMPORTANT:

When the MANUAL LED is ON the-unit is automatlcally calibratlng. Your sequence is VERY Important. Always move to the next prompt before changing the calibration equlpment.

4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON.

5. At the **4A** prompt, set the mA source to 4.00mA. Allow at least 10 seconds to stabilize. Press the MODE key.

6. At the 20A prompt, set the voltage/current source to 20.00mA. Allow at least 10 seconds to stabilize. Press the AUTO/MAN key twice to exit the MANUAL mode. This pauses calibration to allow you to exit the CAL mode.

0-20/4-20mA Output Field Calibration Procedure

NOTE
Not all parameters will **appear. They** ***are*** **dependent on your unit type. Use only the steps that apply to your unit.**

Equipment Required

- 470 ohm 1/2 watt 10% resistor.
- 4 - 1/2 digit Digital Multimeter.

Setup And Calibration

NOTE

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Charts, Pages 26 **and 28.**

1. Connect the AC line voltage LI **,** L2, and ground to the proper terminals of the 980/985. See Chapter 2.
2. Connect the multimeter in series with the 470 ohm resistor to Terminal #1 (+) and #3 (-) for 0-20mA units, on the Series 980/985 terminal strip. Use Terminal #I (+) and #2 (-) for 4-20mA units. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Figure 33 on Page 37. Press the MODE key until the 4A0 prompt is displayed.

IMPORTANT:

When the MANUAL LED 's ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON.
5. At the 4A0 prompt, the multimeter should read approximately 0mA for 0-20mA units and 4mA for 4-20mA units. Allow at least 10 seconds to stabilize.
6. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 0.0mA ±0.1 **OmA** on 0-20mA units and 4.0mA+/-0.2mA on 4-20mA units. Press the MODE key.
7. At the 2AO prompt, the multimeter should read approximately 20mA. Allow at least 10 seconds to stabilize.
8. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 20.0mA ±0.10mA on 0-20mA units and 20.0mA+/-0.2mA on 4-20mA units.
9. Press the AUTO/MAN key twice to exit the MANUAL mode. This pauses calibration to exit the CAL mode.

0-5/0-10 Volt Output Field Calibration Procedure

Equipment Required

- 20K ohm, 1/4 watt, 10% resistor
- 4 - 1/2 digit Digital Multimeter.

Setup And Calibration

NOTE

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Charts, Pages 26 and 26.

1. Connect the AC line voltage LI , L2, and ground to the proper terminals of the 980/985. See Chapter 2.
2. Connect the multimeter across the 20K ohm resistor to Terminai #1 (+) and #3 (-) for 0-5VDC or 0-10VDC units, on the Series 980/985 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Figure 33 on Page 37. Press the MODE key until the 4A0 prompt is displayed.

IMPORTANT:

When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON.
5. At the 4A0 prompt, the multimeter should read approximately 0.000V. Allow at least 10 seconds to stabilize.
6. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 0.0V±0.10V. Press the MODE key.
7. At the 2AO prompt, the multimeter should read approximately 5.000V for 0-5 volt units, or 1 0.000V for 0-10 volt units. Allow at least 10 seconds to stabilize.
8. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 5.0V ±0.10V on 0-5V units and 10.0V+/-0.1 OV on 0-1 OV units.
9. Press the AUTO/MAN key twice to exit the MANUAL mode. This pauses calibration to exit the CAL mode.

NOTE:

Not all parameters will appear. They are dependent on your unit type. Use only the steps that apply to your unit.

Glossary, A-P

Alarm: A condition, generated by a controller, indicating that the process has exceeded or fallen below the set or limit point.

Anti-reset: Control feature that inhibits automatic reset action outside of the proportional band.

Automatic prompts: Data entry points where a microprocessor-based control "prompts" or asks the operator/programmer for information input.

Bumpless transfer: When transferring from auto to manual operation, the control output(s) will not change ("bumpless," smooth transition).

Closed loop: Control system that has a sensing device for process variable feedback.

Cold junction: Point of connection between thermocouple metals and the electronic instrument.

Cold junction compensation: Electronic means used to compensate for the effect of temperature at the cold junction.

Cycle time: The time necessary to complete a full ON-through-OFF period in a time proportioning control system.

Dead band: A temperature band between heating and cooling functions.

Derivative: Anticipatory action that senses the rate of change of temperature, and compensates to minimize overshoot and undershoot. Also "rate."

Deviation: The difference between the value of the controlled variable and the value at which it is being controlled.

Default parameters: The parameters, or programmed instructions, which are permanently stored in microprocessor software to provide a data base.

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

Display **capability:** In a digital indicating instrument, the entire span that can be indicated if fully utilized.

Droop: Difference in temperature between set point and stabilized process temperature.

Duty cycle: Percentage of "load ON time" relative to total cycle time.

Hysteresis: In ON/OFF control, the temperature change necessary to change the output from full ON to full OFF.

Hunting: Oscillation or fluctuation of process temperature between set point and process variable.

input: Process variable information being supplied to the instrument.

integral: Control action that automatically eliminates offset, or "droop", between set point and actual process temperature. Also "reset."

Isolation: Electrical separation of sensor from high voltage circuitry. Allows for application of grounded or ungrounded sensing element.

JIS: Japanese Industrial Standards. Also Japanese Industrial Standards Committee (JISC). Establishes standards on equipment and components.

Offset: Adjustment to actual input temperature and to the temperature values the Series 985 uses for display and control.

ON/OFF control: Control of temperature about a set point by turning the output full ON below set point and full OFF above set point in the heat mode.

Open loop: Control system with no sensory feedback. The Series 980/985 uses closed loop.

Output: Action in response to difference between set point and process variable.

Overshoot: Condition where temperature exceeds setpoint due to initial power up or process changes.

P control: Proportioning control.

Parameter: A physical property whose value determines the response of an electronic control to given inputs.

PD control: Proportioning control with rate action.

PI control: Proportioning control with auto-reset.

PID control: Proportioning control with auto-reset and rate.

Process varlable: Thermal system element to be regulated, such as time, temperature, relative humidity, etc.

Programmed display data: Displayed information which gives the operator/programmer the "programmed" or intended process information, i.e., intended set point, intended alarm limit, etc. See "Actual displayed data."

Proportlonal band: Span of temperature about the set point where time proportional control action takes place.

Proportloning control: See Time Proportioning Control.

Rate: Anticipatory action that senses the rate of change of temperature and compensates to minimize overshoot. Also "derivative."

Rate Band: A thermal control band that defines where the rate (derivative) function begins. A Watlow rate band occurs centered on set point at one or more times the width of the proportional band.

Reference junction: Synonymous with cold junction. See "Cold junction."

Reset: Control action that automatically eliminates offset, or "droop", between set point and actual process temperature. Also "integral."

Reset windup inhibit: Synonymous with anti-reset. See "Anti-reset."

RTD: Resistance Temperature Detector. Resistive sensing device displaying resistance versus temperature characteristics. Displays positive temperature coefficient.

Set point: Intended value of the process variable.

Switching sensitivity: In ON/OFF control, the temperature change necessary to change the output from full ON to full OFF.

Thermal System: A regulated environment consisting of a heat source, heat transfer medium, sensing device and a process variable control instrument.

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

Thermocouple break protection: Fail-safe operation that assures output shutdown upon an open thermocouple condition.

Three mode control: Proportioning control with reset and rate.

Time Proportioning Control: Action which varies the amount of ON and OFF time when "close" to the set point, i.e., in the proportional band. This variance is proportional to the difference between the set point and the actual process temperature. In other words, the amount of time the output relay is energized depends on the system temperature.

Triac: Solid state switching device.

Upper display data: Displayed information which gives the operator/programmer real or "actual" data, i.e., actual process temperature. See "Programmed display data."

Warm Start: Start-up condition where all program information is remembered by the instrument's memory back-up protection.

Zero switching: Action that provides output switching only at the zero voltage crossing points of the AC line.

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Warranty

The Watlow Series 980/985 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, 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.

Returns

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.

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.

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.

Watlow Controls

Watlow Controls is a division of Watlow Electric Mfg. Co., St. Louis, MO, a manufacturer of industrial electric heating products, since 1922. Watlow begins with a full set of specifications and completes an industrial product that is manufactured totally in-house, in the U.S.A. Watlow products include electric heaters, sensors, controls and switching devices. The Winona 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.