Series 1500

Ramping and Profiling Microprocessor-Based Control

User's Manual

WATLOW

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

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Use The Manual

How to Use the Manual

First...

This manual will make your job easier. Reading it and applying the information is a good way to become familiar with the Series 1500. Here's an overview.

Starting Out — Introduction, Chapter 1, Page 4.

Sample Program — A Sample Program in Action, Chapter 2, Page 16.

Install/Wire — Installation and Wiring, Chapter 3, page 26.

Programming — Technical Reference, Chapter 4, Page 40.

Appendix

Calibration
Specification
Ordering Information
Technical Service
Glossary
Index

Quick Reference — Quick Reference on Back Cover

Notes

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

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

Safety Information

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.

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

(The Stop Sign or Lightning Bolt Sign 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).

!

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

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(The Deer Crossing Sign or Exclamation Point Sign 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).

Technical Assistance

If you encounter a problem with your Watlow control, review all of your configuration information to verify that your selections are consistent with your application...Inputs, Outputs, Alarms, Limits, etc. If the problem persists after checking the above, you can get technical assistance by dialing: 1-507-454-5300

An Application Engineer will discuss your problem with you. Please have the following information available when calling:

- Complete model number
- Serial Number
- All configuration information
- User's Manual

The model and serial numbers can be found on the outside of the case.

Your Feedback

Your comments or suggestions on this manual are welcome, please send them to: Technical Writer, Watlow Controls, 1241 Bundy Blvd., Winona, MN 55987, phone 507/454-5300, fax 507/452-4507.

Contents

Chapter 1

Starting Out with the Watlow Series 1500

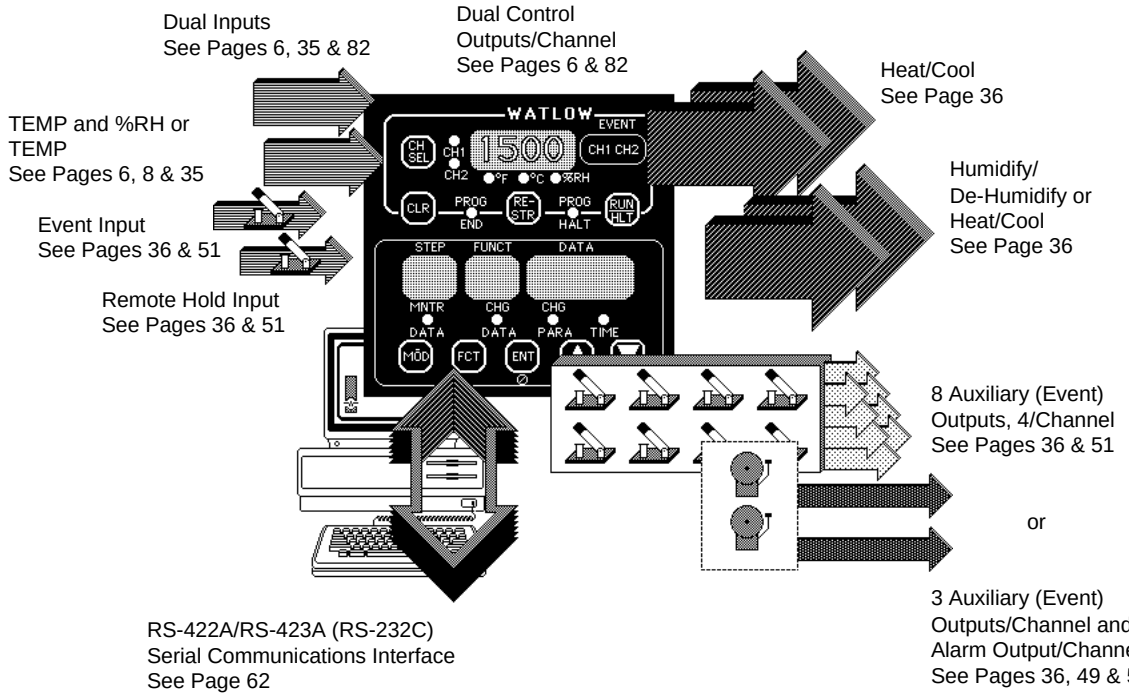
"Read Me First."

Congratulations, you're about to become a fully-qualified user of the Watlow Series 1500! It is a versatile microprocessor-based control; powerful, yet simple to learn. In this chapter of the user's manual, you'll get an overview of the 1500 and its software. You'll "light" the displays and get a feel for moving through the control functions.

Figure 1 is a simplified view of the 1500's capabilities. The control has dual inputs, one per channel, and dual control outputs for each channel. There is a choice of auxiliary (event) or alarm outputs, an event input and remote hold input. An "Event Output" in the Series 1500 is an ON/OFF solid state relay or solid state switch output for activating peripheried equipment or processes. Models with optional communications may be connected to a computer via a serial communications interface.

Figure 1 - Series 1500 Input and Output Overview

The Series 1500 will handle 51 separate control steps. Each step duration is variable from one second to 24 hours, 59 minutes, 59 seconds. The 1500 is a "profiling" control because it will control up to 51 consecutive steps with a single program; the resulting graph of all the steps makes a program "profile." The 1500 is a "ramping"



control because it will move from one process variable to another in a uniform manner.

Operator-friendly features include automatic "prompts," or entry codes, to assist you in programming and monitoring. The Series 1500 has other display codes to indicate a variety of alarm conditions about your process. The 1500 also has a "Jump Loop" option for repeating program steps or segments. A "Wait For" option makes this control responsive to particular process conditions, an external switch conditions or real times of day.

In addition, you can change the three-mode, PID control to a simple ON/OFF control by setting the proportional band parameter in each channel to zero.

When there's a power outage, the 1500 has memory protection provided by an internal Lithium battery and optional battery-backed clock.

The standard RTD version Series 1500 is factory-configured to operate in degrees Centigrade (°C) on Channel One and per cent relative humidity (%RH) on Channel Two. A software selection, the "Temp-Temp" option, is also available for the RTD unit. The Series 1500 Thermocouple version is strictly a "Temp-Temp" control. The 1500 has at least two switches you must set prior to entering your program. Information on how to set these switches follows in this chapter.

When you first apply power, the unit will "come up" with default values for set points, alarm points, control parameters, recycle, events and time. These default values provide minimum operating instructions until you enter your data. The default values are listed in Chapter 4, "Technical Reference."

Remove the Series 1500 carefully from its shipping container. Be sure to set this literature aside where it will not be discarded.

Packing List

Included with your Watlow Series 1500 RTD version are two 107Ω resistors, four jumper wires, two mounting brackets with integral screws, and this manual. The resistors and two jumpers will serve as pseudo-sensors at approximate room conditions while you learn the control. The other jumpers are for power connections.

How to Open the 1500

Before going further, open the Series 1500 and pull the control chassis from its case. Here's how:

The control chassis fastens to the case with a single screw located at the lower front panel. Turn the screw counterclockwise to loosen it. Three strip connector plugs, in the rear of the control chassis, feed power and signals through the back of the case to the triple terminal strip. These plugs will let go as you pull.

!

CAUTION:
Before attempting to open a Series 1500 with data communications (RS-422/423 interface), remove the two screws and DB-15 male connector from the rear of the case.

Pull firmly but gently to remove the Series 1500 from its case. The 1500 chassis will not fit into the case upside down. However, always check to see that it is oriented correctly before returning the chassis to the case. Press the unit in firmly, then turn the front panel screw clockwise to secure it. Do not overtighten the screw.

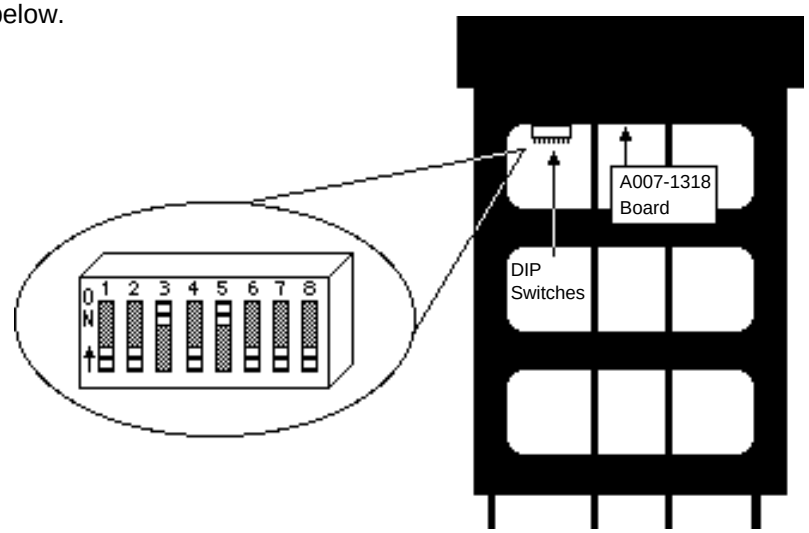
How to Set the DIP Switches

The Watlow Series 1500 has a set of Dual In-Line Package (DIP) switches on circuit board, A007-1318. The location of the board and switches appear in Figure 2. The switches are clearly numbered; the "ON" direction is indicated by an arrow. Look at the DIP switches from the bottom of the control. You'll see them as they appear below.

!

CAUTION: Power must be interrupted before a change in DIP Switch will take effect.

!



Control Chassis - Bottom View

Figure 2 - DIP Switch Location and Setting

Set the DIP switches according to Table 1 below. Make your initial choices now; you may always return to change them later. Set DIP Switch #6 ON for a "Cold Start."

Table 1- DIP Switch Position and Function

Sw	Position	Function
#1	ON	Auxiliary (Event) Output #4 for both Ch-1 and Ch-2 are alarm outputs.
	OFF	Auxiliary (Event) Output #4 for both Ch-1 and Ch-2 are event outputs.
#2	ON	Alarms are latching (displayed until cleared manually).
	OFF	Alarms are non-latching (displayed only as long as alarm condition exists).
RTD Unit Only		
#3	ON	The Ch-2 sensor is an RTD sensor. Jumpers W151 and W153 on the Signal Conditioner board (A007-1316) must be installed.
	OFF	The Ch-2 inputs is a 0-5V signal representing 0-100% RH. Jumpers W150 and W154 on the Signal Conditioner board (A007-1316) must be installed.
T/C Unit Only		
#3	ON	Not Used. Set in the ON position.
#4	ON	Dual PID per channel - #4 OFF Single PID per channel.
		#5 ON Factory use only. Must be in the ON position.
#6	ON	Cold Start on power-up. (Memory cleared, parameters set to default values.)*
	OFF	Warm Start on power up. (Programmed values are retained for all parameters.)*
#7	ON	°C function after a Cold Start.
	OFF	°F function after a Cold Start.
#8	OFF	Not Used. Set in the Off position.

*For further Warm and Cold Start information, see the Technical Reference, Chapter 4.

Quick Wire

You may "power up " the Series 1500 with the following operational check-out. This procedure also prepares you for the Sample Program in Chapter 2. Or, you may skip this section and the sample program, and go directly to Chapter 3, Installation and Wiring.

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

1. Put the 1500 chassis back in its case. Then place the unit on a bench and connect AC power lines and the jumper wires to the Power Supply terminal strip. Use Figure 3 below.

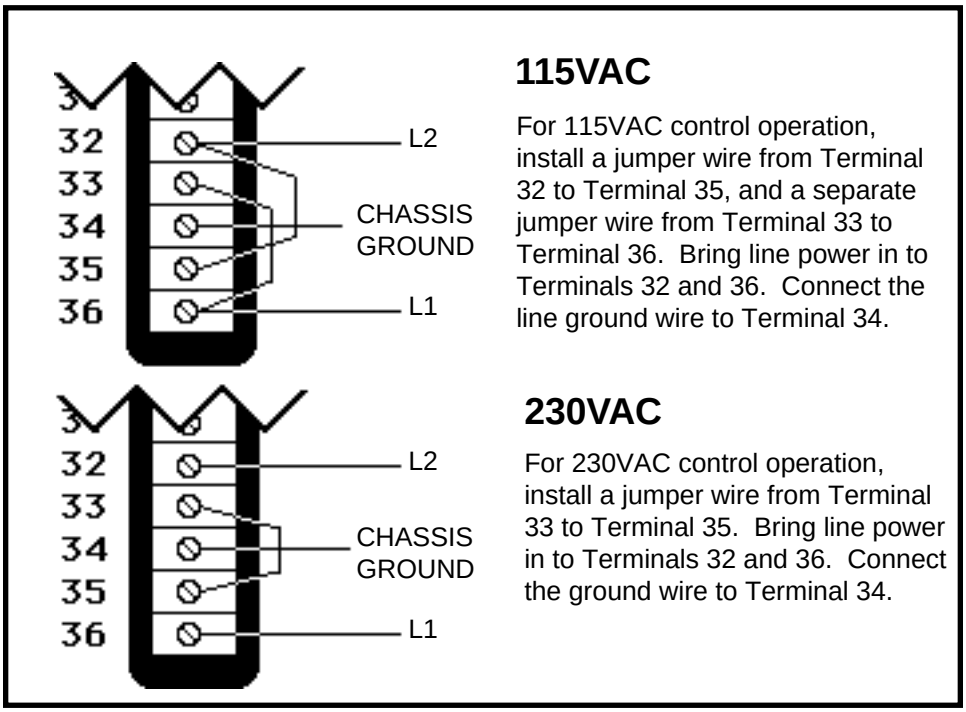
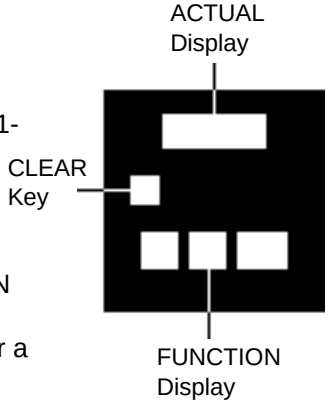


Figure 3 - Quick Wire AC Power Connections

2. As soon as you apply power, the FUNCTION display will alternately flash "A1-C1, A1-C1." Press the CLEAR key to clear the flashing A1. The display will then flash another A-code.



When you apply power without sensor inputs on the Signal Conditioner terminal strip, the Series 1500 will show a flashing "A-digit" in the FUNCTION display. The digit is an alarm code The ACTUAL display will show four steady dashes, "----," meaning "open sensor." These are normal displays for a unit without sensors.

3. If you did not set DIP Switch #6 in the "ON" position before, do that now: Disconnect power from the unit. Open the 1500, set DIP Switch #6 to ON for a Cold Start. Replace the control chassis in the enclosure. Reapply power to the unit. (This clears all previously entered information from the 1500; it is a "clean" or "cold" start).

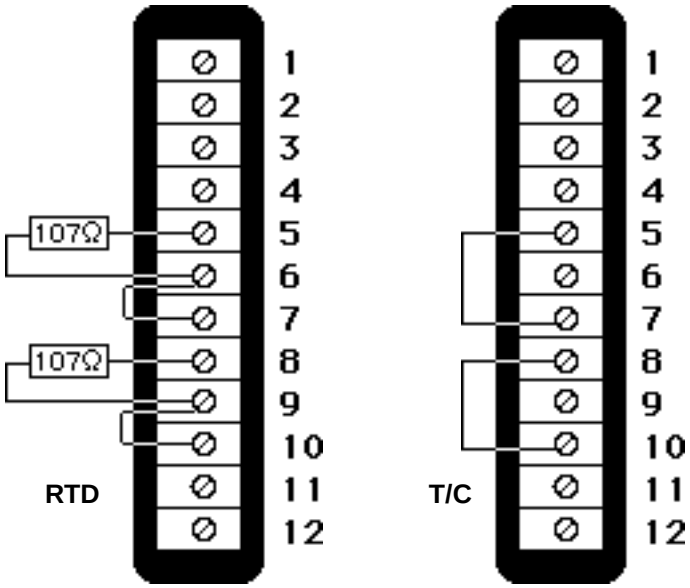
4. Now remove power again, open the unit, and set Switch #6 to OFF. (This will make the next start a "warm" one, retaining all subsequently entered information in the processor's memory). Close the 1500.

5. Locate the Signal Conditioner terminal strip on the back of the Series 1500, it's on the far left as you look at the back of the unit. The resistors, or jumper wires for the T/C version, will simulate input sensors at room temperature for this procedure. Make the correct connections using Figure 4.

   • **For an RTD unit**, connect a 107Ω resistor (provided) across Terminals 5 and 6, and another 107Ω resistor across Terminals 8 and 9. Also connect a jumper wire (provided) across Terminals 6 and 7, and another jumper wire across Terminals 9 and 10. See Figure 4.

   • **For a T/C unit**, connect a jumper wire (provided) across Terminals 5 and 7, and another jumper wire across Terminals 8 and 10.

Figure 4 - Quick Wire Simulated Sensor Wiring



6. Apply power to the unit. With the CLEAR key, clear the "A1" alarm code and any other "A" code that appears after it. The ACTUAL display will be reading Channel 1 at simulated room temperature. Or the ACTUAL display will show Channel 2 at a simulated %RH or temperature reading. Use the CH.SELECT key to switch from one channel to the other.

If your Series 1500 responds this way, continue learning about the control. If your unit does not respond like this, call Watlow at 507/454-5300 and ask for an applications engineer.

Overview of the Three Operating Modes

Before getting into the details of the Series 1500's keys and displays, take a look at Figure 5, showing the three different modes. After you feel comfortable with the names of the modes and their functions, go ahead to learn the keys and displays.

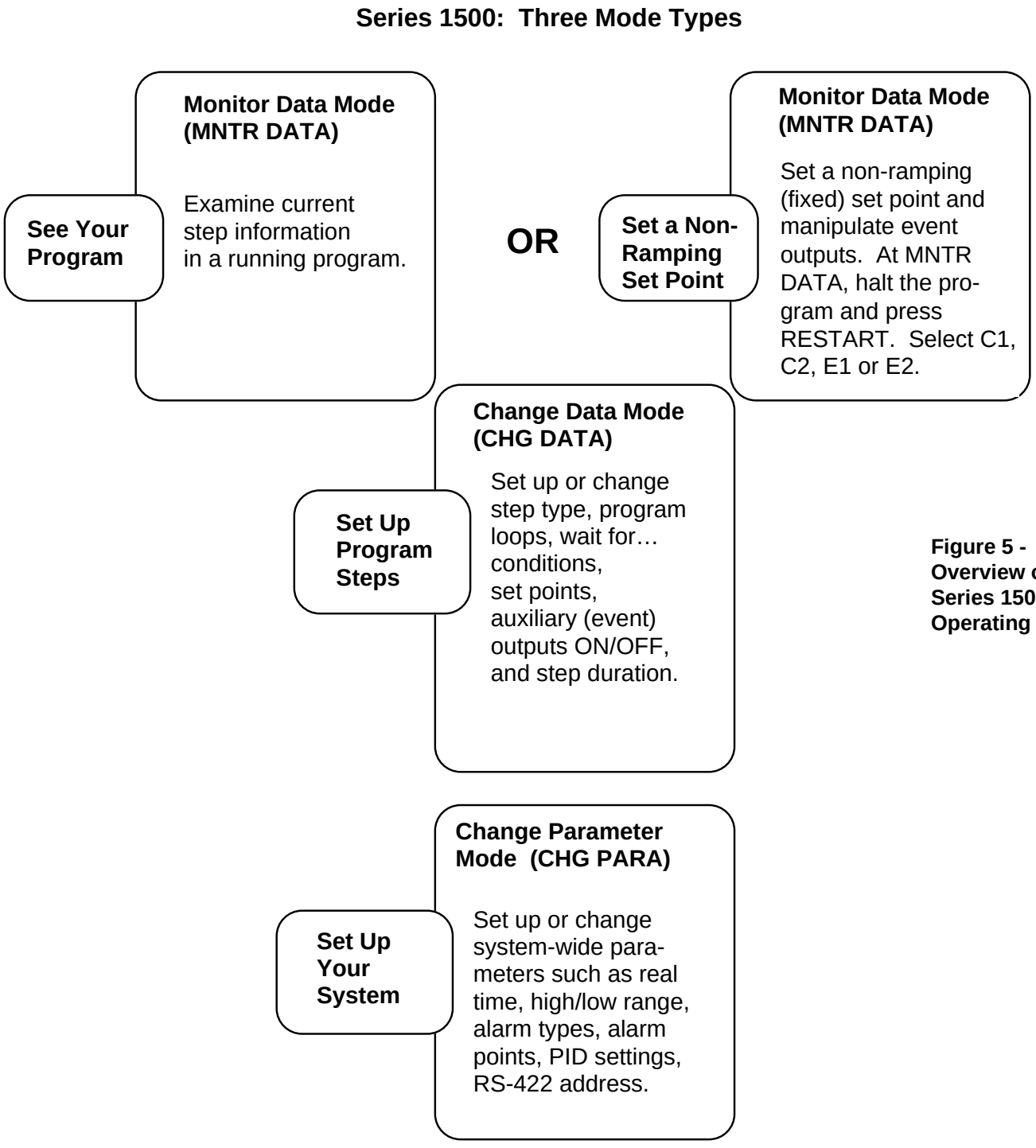
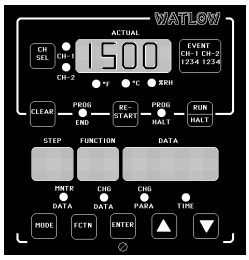


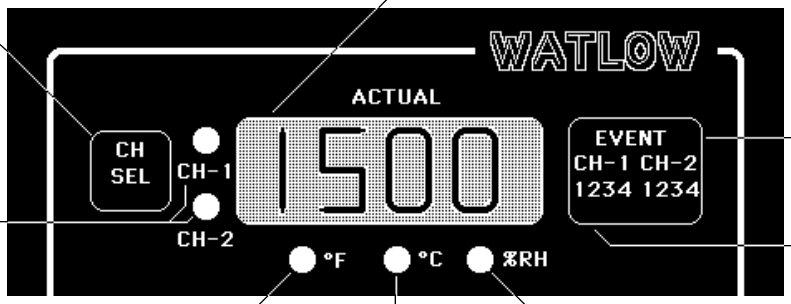
Figure 5 - Overview of the Series 1500 Operating Modes



How to Read the Displays and Use the Keys

Here's an understanding of the Series 1500 displays, keys and LEDs. Use Figure 6 to locate the keys, LEDs and displays described here. Try everything! You'll learn quickly how the 1500 works. The detailed overviews in the next section will further your knowledge.

Figure 6 -
Series 1500 Front Panel Components



CH SEL key: CHANNEL SELECT--Selects either Channel 1 or Channel 2 for the ACTUAL display.

ACTUAL display: Shows the actual value of the variable in Channel 1 or Channel 2, in four digits.

CH-2 EVENT LEDs: Indicates the status of each Channel 2 Event Output with one of four LEDs visible only when the output is energized (ON). An Event Output in the Series 1500 is an ON/OFF solid state relay or switched DC output for activating periphered equipment or processes.

CH-1, CH-2 LEDs: Indicates the channel in the ACTUAL display.

CH-1 EVENT LEDs: Indicates the status of each Channel 1 Event Output with one of four LEDs visible only when the output is energized (ON).

°**F LED**: When lit indicates the value in the ACTUAL display is temperature in degrees Fahrenheit.

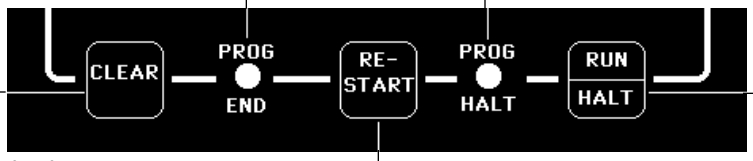
% RH LED: When lit indicates per cent relative humidity in the ACTUAL display.

°**C LED**: When lit, indicates temperature in degrees Celsius in the ACTUAL display.

Figure 6 (Con't) - Series 1500 Front Panel Components

PROG HALT LED: PROGRAM HALT--When lit, indicates that the processor is in the HALT condition. A RUN/HALT key press, or a "Blank Step" in the program causes a HALT. When flashing, indicates that the processor is in "Remote-Hold" condition. See RUN/HALT key.

PROG END LED: PROGRAM END--Indicates that the processor has reached the end of the program.



CLEAR (erase) key:

a. Clears alarm codes from FUNCTION display in MONITOR DATA mode.
b. Clears the step in the STEP display in CHANGE DATA mode when the unit is in the HALT condition.
c. Clears all 51 programmed steps when the unit in the HALT condition, and in GUARDED ACCESS area of the CHANGE PARAMETER mode. (This prevents an operator from accidentally clearing an entire program. The GUARDED ACCESS data is not cleared).

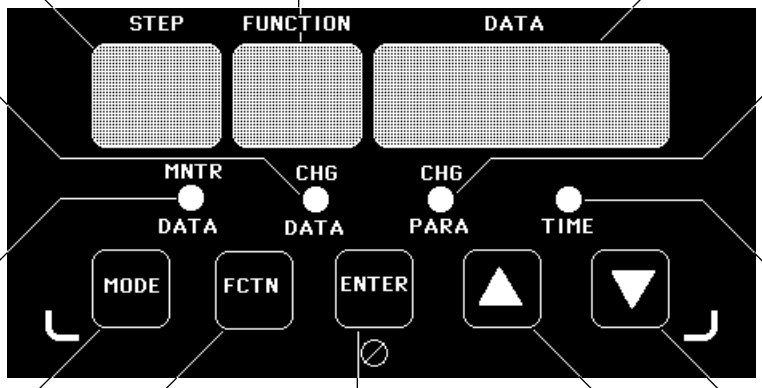
RE-START key: Returns the controller to the initial program step **only** when the 1500 is in the PROGRAM HALT condition. See RUN/HALT key.

RUN/HALT key: Starts or stops the program. The processor will resume a program where it was interrupted, unless the RE-START key was pressed, or the step number or set point data at the current step was changed during the HALT condition.

FUNCTION display: Shows the prompts used in the three modes. It also displays hours when TIME is selected in MONITOR DATA, CHANGE PARAMETER or CHANGE DATA modes. The FUNCTION display shows a flashing alarm code if one is activated.

STEP display: Indicates the current step number being programmed in the CHANGE DATA mode, or the current step being monitored in the MONITOR DATA mode.

DATA display: Indicates the entered data or monitored value in four digits.



CHG DATA LED: When lit indicates the processor is in the CHANGE DATA mode.

CHG PARA LED: When lit indicates the processor is in the CHANGE PARAMETER mode.

MNTR DATA LED: When lit, indicates the processor is in the MONITOR DATA mode.

TIME LED: When lit, indicates that the FUNCTION and DATA displays are showing time.

MODE key: Selects either the MONITOR DATA, CHANGE DATA or CHANGE PARAMETER mode.

FCTN key: The FUNCTION key steps through the prompts in each of the three modes.

ENTER key: Enters selected data or NEXT STEP operations in the CHANGE DATA and CHANGE PARAMETER modes.

UP key: Increases the value in the DATA display. A light touch increases the value by one. Holding the key down causes the DATA display to increase rapidly.

DOWN key: Acts opposite the UP key. Ramps the value in the DATA display downward. A light touch decreases the value by one. Holding the key down causes the DATA display to decrease rapidly.

Now that you have a good idea how the 1500's front panel works, look again at the operating modes. This time take a more detailed look.

Overview of the Mode Software

Again, the Series 1500 has three Operating Modes: Monitor Data, Change Data and Change Parameter. These modes change with the MODE key. They make up the basic software routines that run the Series 1500. Each mode has sub-routines and different prompts that appear in the FUNCTION display whenever you press the FCTN key.

Examine the three figures on the next pages, one for each of the modes. Understanding how these modes control the Series 1500 is the key to learning the control.

Figure 7 - Monitor Data (MNTR DATA) Mode Overview

Figure 8 - Change Data (CHG DATA) Mode Overview

Figure 9 - Change Parameter (CHG PARA) Mode Overview

Monitor Data Mode (MNTR DATA):

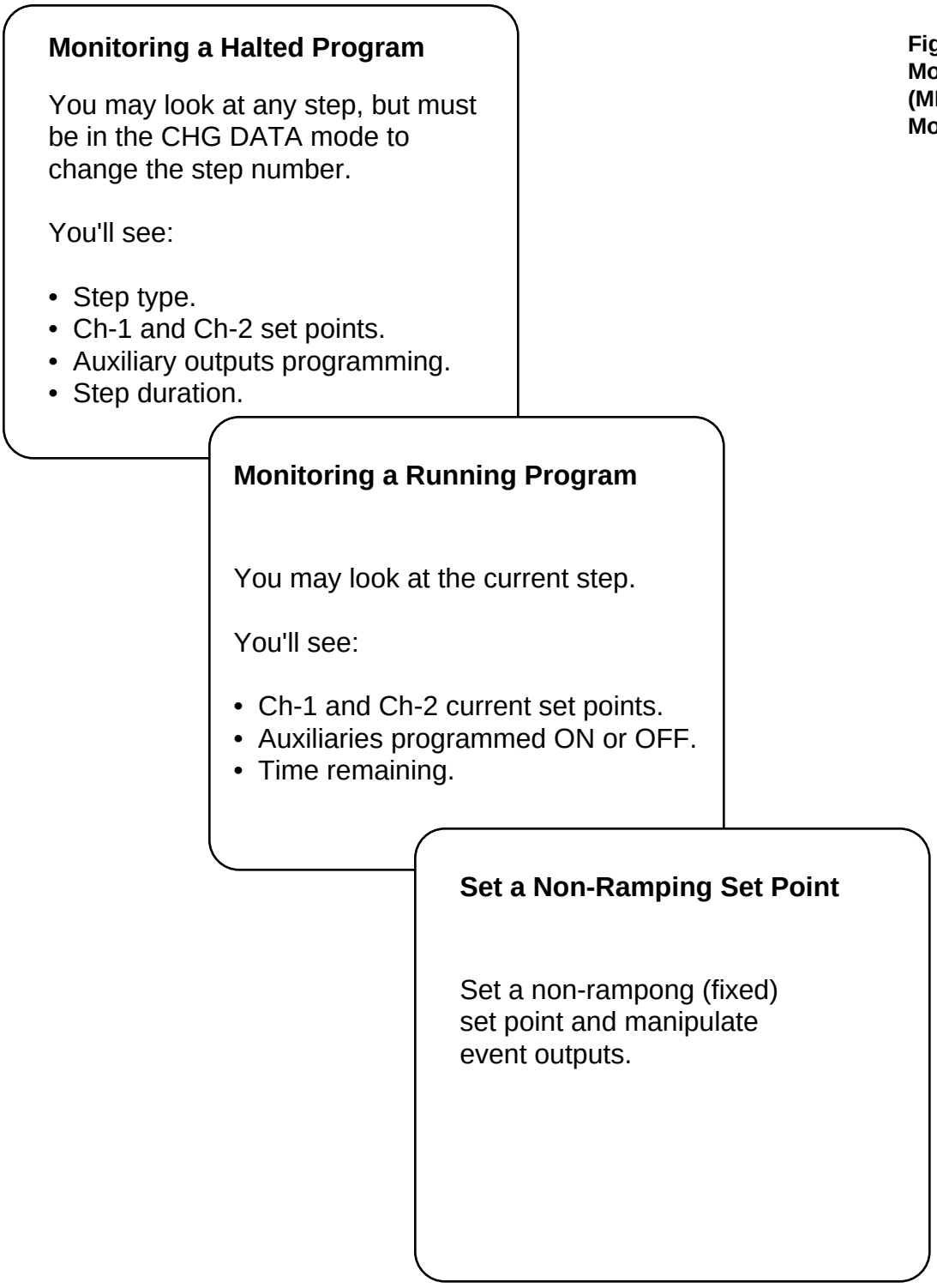
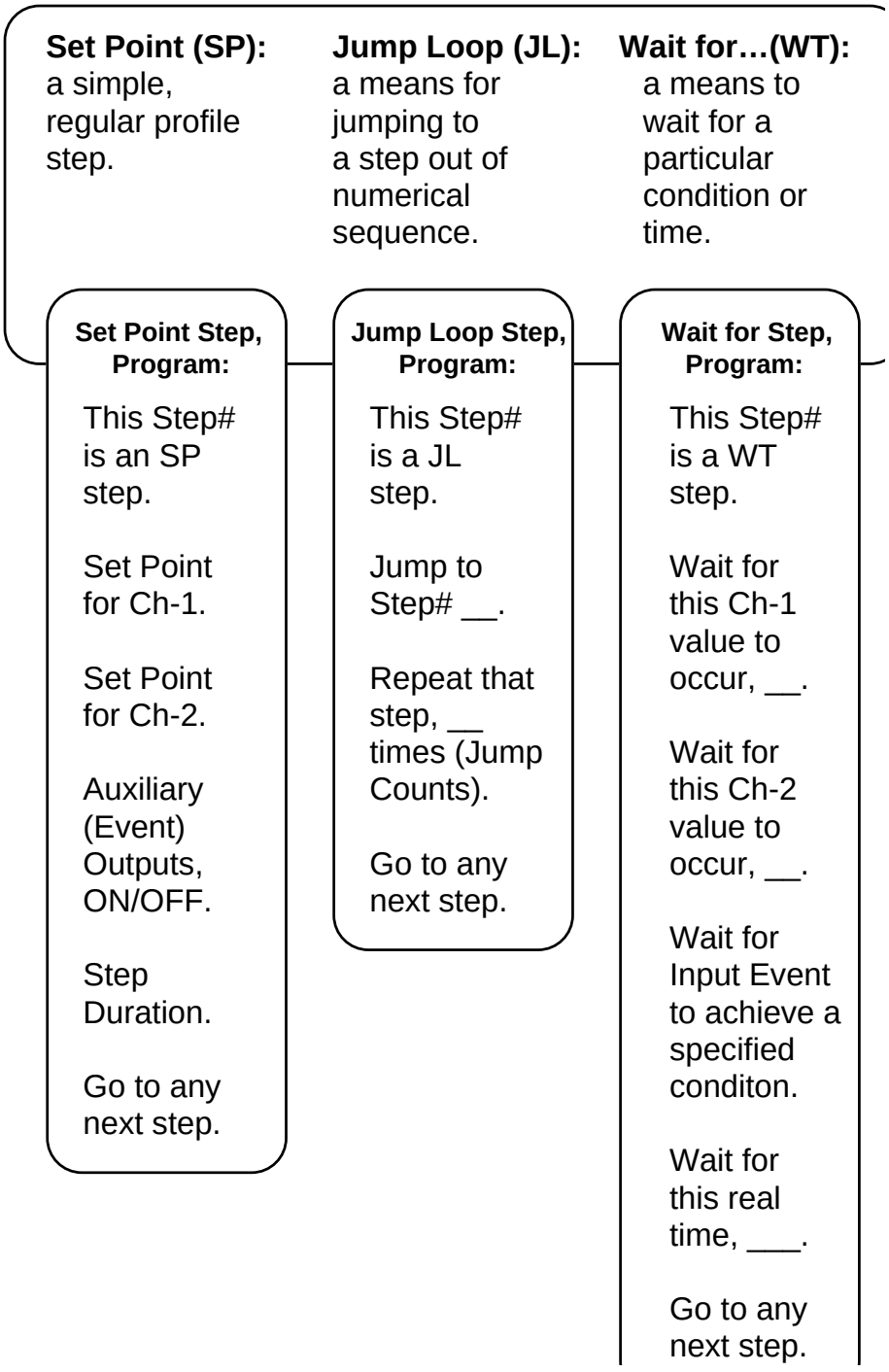


Figure 7 - Monitor Data (MNTR DATA) Mode Overview

Figure 8 - Change Data (CHG DATA) Mode Overview

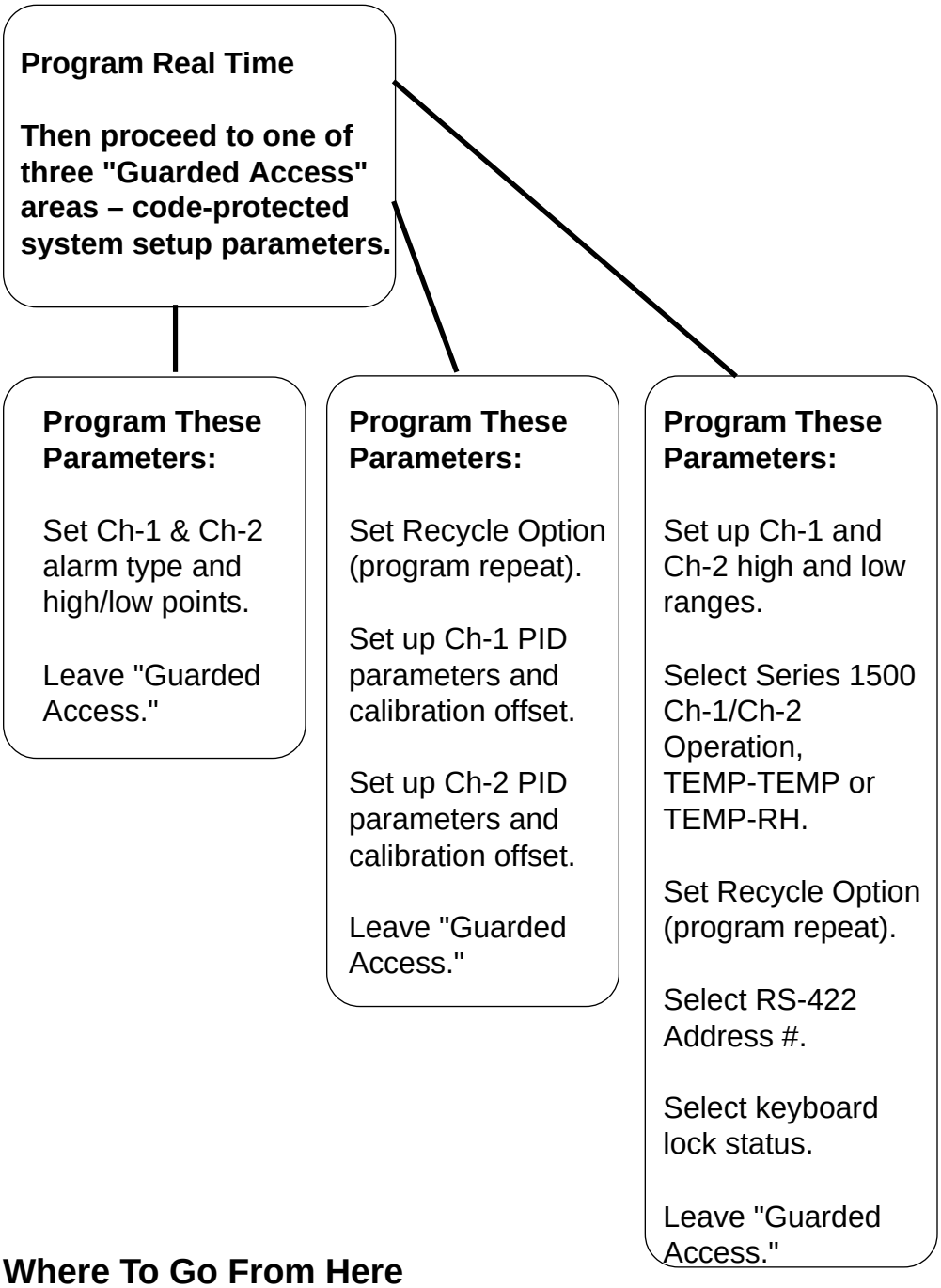
Change Data Mode (CHG DATA):

Three Step Types for Entering Program Data



Change Parameter Mode (CHG PARA) For Entering System-Wide Parameters

Figure 9 - Change Parameter (CHG PARA) Mode Overview



Where To Go From Here

You are now ready to go to the Sample Program, Chapter 2, or to Installation and Wiring, Chapter 3.

If you skip the sample program, do not forget to check the position of DIP Switch 6 before you begin programming your control after installation. With DIP Switch 6 OFF, the 1500 saves your program whenever power is removed (Warm Start). With DIP Switch 6 ON, the 1500 will clear its memory of all programmed information whenever power is removed,substituting default values (Cold Start).

Chapter 2

Learning the Series 1500 — A Sample Program in Action

This chapter will guide you through an easy sample program for the Series 1500. You can quickly grasp the necessary terms and concepts by entering and observing this exercise.

If you feel that your knowledge of programmable controllers does not require a sample program to learn the Series 1500, feel free to skip this chapter. In the Technical Reference section (Chapter 4), you will find details on all material here.

The Series 1500 Wonderful-Apple-Pie Sample Program

Let's assume that Great-Grandma handed down to you her secret recipe for wonderful apple pie. It's not that her ingredients are so different; but she took great care to control baking temperature and humidity, and to add topping ingredients at just the right times in the baking cycle. These really are fantastic apple pies, so you've bought an oven with a Series 1500 control, and you're starting an apple pie business.

IMPORTANT NOTE:

If you have a Series 1500 T/C version, or are using the RTD version for 2 channels of temperature control (TEMP-TEMP), then simply consider all sample program references to relative humidity as a second channel of temperature. Use the sample values as temperatures rather than relative humidities.

Sample Program Chart

The chart here shows the baking process. Grandma's original recipe had Grandpa turn the oven on early in the morning. Grandpa would raise and lower the oven temperature at certain times, too. That is one of Grandma's secrets. With the Series 1500 you'll be able to make your oven "loop" between 275° and 110° three times before a pie is done.

If Great-Grandma was right, this process should turn out a really fine apple pie. Since your bakery will begin baking pies at the same time every morning, you'll want your Series 1500 to automatically start the process each day.

The chart below details the "wonderful-apple-pie" sample program for the Series 1500.

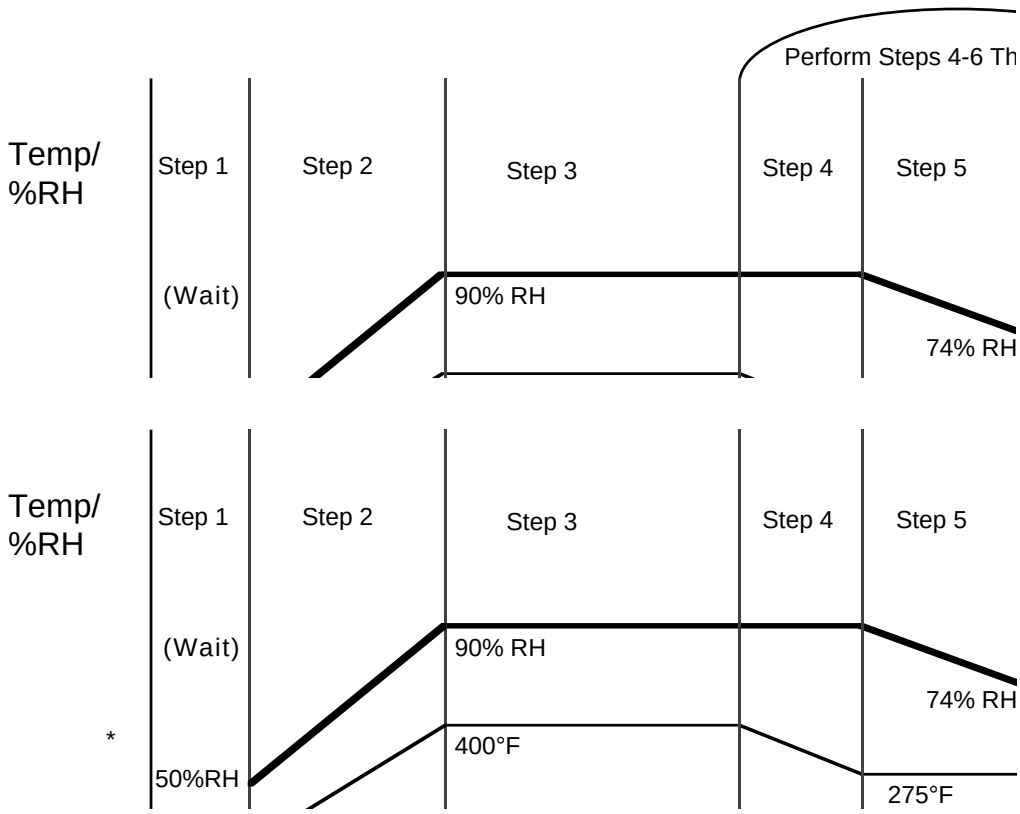


Chart 1 - Series 1500 Sample Program Chart

Setting Event Outputs

To make the pie process even more automated, you have your toppings — sugar, cinnamon and nutmeg—connected to solenoid dispensers controlled by the 1500's "Event Outputs." As you enter the sample program, you'll set the Event Outputs to trigger just when you want them to. You even have an Event Output to put your pies in and take them out of the oven at just the right times. You'll need to turn the Events ON as follows:

Table 2 - Sample Program Event Outputs

STEP	CH #1 EVENTS	CH #2 EVENTS
1	Wait 0	0
2	1, 2, 4	1, 2
3	2	3
4	3, 4	1, 4
5	1	2
6	1, 2, 4	2, 3, 4
8	3, 4	1, 3

Understanding the Modes of Operation

Before you begin entering the program, notice three small lights (LEDs) on the bottom half of the 1500's front panel. They are labeled "MNTR DATA" (Monitor Data), "CHG DATA" (Change Data), and "CHG PARA" (Change Parameters). Press the MODE key to move through these three modes as you read about each one. Another LED, labeled "TIME" indicates when time is being displayed.
"MNTR DATA": While a program is running, you'll want to observe what's happening. Some items can be observed in the "ACTUAL" display and in the nearby top half of the front panel: Actual Temperature or Relative Humidity, Events ON/OFF, etc. But you'll also want to know which step is being performed, and the amount of time remaining in the step.

You can monitor information in a running program by pressing the MODE key until the MNTR DATA LED is ON. Then press the FCTN key until you are observing the data you want. Right now you don't have a program entered, so no meaningful data is available. As soon as you enter the sample program, use this mode to watch things happen.

"CHG DATA": This is the mode where you'll enter program operating DATA (set points, time interval for each step and Event Outputs). In this mode, you can also change data or correct errors in the program. If you want to wait until a specific time before doing something or to set up program loops, you also enter that information in CHG DATA. With the CHG DATA LED on, pressing the FCTN key will move you through the functions you can program.

"CHG PARA": Some Series 1500 information is more applicable to the overall system than to just one specific program. This includes the "real time of day," system maximum/minimum alarm limits and "PID Parameters" which tune the overall system. This system-wide information is entered or changed in this mode.

Again – pressing the FCTN key selects functions while the CHG PARA LED is on. Many of these functions are protected from accidental change by a "Guarded Access" (GA) code before they can be viewed or altered. You'll learn the GA codes soon.

Before You Begin…

Before you begin to enter your Sample Program, take this precaution:

!

CAUTION:
This sample program will activate some of the "Control Outputs" and "Event Outputs" on the Series 1500 terminal strips. To avoid any damage to your equipment while running the sample program, be sure all Event and Control Outputs are disconnected from the Series 1500 terminals. Or remove power from any external loads attached to the Series 1500.

Clear Memory, Set DIP Switches

To clear your Series 1500's memory, do a "Cold Start." Turn the power OFF, open the 1500 and ensure that DIP Switches 2, 3, 5 and 6 are ON and that DIP Switches 1,4,7 and 8 are OFF. If you haven't done so already, attach the provided 107Ω resistor and a jumper (or jumpers for a T/C version) to each sensor input as described in Chapter 1 under "Quick Wire." If you want to use your sensors, refer to Chapter 3, Figure 11 for wiring. Then turn the power ON and press the "CLEAR" key to clear the flashing alarm indication(s).

4. Press the **ENTER key:** the display will flash, then it will change to "MN."

5. **Use the UP/DOWN keys** to place the correct value for minutes into the Data Display; then press ENTER.

6. The display will show "SC" (seconds): again use the UP/DOWN keys to place seconds into the display and then press ENTER.

7. Press the FCTN key several times until the TIME LED is lit **(along with the CHG PARA LED). You** should now see the correct real time on the display, with the seconds counting up.

Set the Recycle Option

Now, while still in the CHG PARA mode, there is one more thing to enter. Remember that you want your program to automatically repeat each day until you decide to halt it. This "Recycle" condition is set within the "Guarded Access" (GA) section of the CHG PARA mode. Do that now:

1. With the CHG PARA LED ON, press **the** FCTN key until "GA" appears in the Function Display. If you pass GA, keep pressing FCTN until GA comes around again.

2. Place **"0006,"** one of the Guarded Access codes, into the Data Display using the UP/DOWN keys.

3. Press ENTER until the "RC," (Recycle) prompt appears in the Function Display.

4. Place a "0001" into the Data Display. Press ENTER.

Begin Entering Data

Now that **you** have entered the real time and the Recycle option, go to the CHG DATA mode to enter actual program data:

1. Press the MODE key until the CHG DATA LED is lit. The display will read "01 SP."

Programming Step 1

Refer back to the sample program chart at the beginning of this section. Remember, that while you'd like to load your program and press the start button now, the first program step must hypothetically wait until early morning before it starts running. To program Step #1 as a Wait Step," do this:

1. Press the FCTN key until "WT" appears in the Function Display.

2. Press the ENTER key, "W1" (Wait for **Ch-1)** appears.

3. Since you are waiting for a specific time, and not for input conditions, press **FCTN** until "WH" (Wait for Hours) appears.

4. We suggest that you enter a time one hour from right now. Changing this time later is a simple matter. You go to the CHG DATA mode with "WH" displayed and then enter the new time. Select hours (0 to 23) and press ENTER.

5. Also enter the "WM" (minutes) and "WS" (seconds). Select minutes, press ENTER. Wait a moment for the display to change, then select seconds and press ENTER.

6. You have completed entering Step #1 as a "Wait Step." The display should now read "01 NX 0002." This indicates that the 1500 is ready to move on to program Step #2 unless you tell it otherwise.

Programming Step 2

1. Since you do indeed want to program Step #2 now, just press ENTER. The display should read "02 SP", and you are ready to begin programming Step #2.

Refer again to the program chart. Note that the values you want to achieve are 400°, 90%RH. You want the 1500 to accomplish this in four minutes. You also want to have Ch-1 Events 1, 2 and 4 ON, and Ch-2 Events 1 and 2 ON during Step #2. We will now program all this data for Step #2:

1. Since the display reads "02 SP," and you do want to enter Set Point Data, first press ENTER. The display changes to "S1" (Set Point for Ch-1).

2. Use the UP/DOWN keys to put "400.0" into the display. Some practice may be necessary to stop at the right value. Then press ENTER. The display changes to "S2" (Set Point for Ch-2).

3. Place "090.0" into the display and press ENTER. The display changes to "E1" (Events for Ch-1). The Data Display is blank right now.

4. In the Data Display, *Event #1 is represented on the right and Event #4 is on the left.* So, for Ch-1 Events #1, 2 and 4 ON, place "1011" into the display and press ENTER. The display will change to "E2" (Events for Ch-2).

5. Likewise, for Ch-2 Events #1 and 2 ON, ENTER the value "0011." The display changes to "HR" (The "hour" portion of the duration of Step #2).

6. Since Step #2 is only four minutes long, just press ENTER to enter "0000" hours. The display changes to "MN."

7. For Step #2 Minutes, ENTER "0004." The display changes to "SC."

8. For Step #2 Seconds, ENTER "0000." The display changes to "02 00 0400."

9. You have successfully programmed Step #2 as a "Set Point Step." The display is indicating that Step #2 is programmed for a duration of 00 hours, 04 minutes, 00 seconds. Press either ENTER or FCTN; the display changes to "02 NX 0003."

10. Again since you do want to program Step #3 now, press ENTER. The display changes to "03 SP."

Programming Steps 3 through 6

Now that you see how it's done, enter the data for Set Point Steps #3,4,5, & 6. But, be sure to stop and then return to these instructions when the display reaches "07 SP." This is because you will be looping through Steps #4 through #6 three times. Refer to the table below for Steps #3,4,5 and 6.

FCTN	STEP #2	STEP#3	STEP #4	STEP#5	Step#6
S1	400.0	400.0	275.0	275.0	110.0
S2	090.0	090.0	090.0	074.0	065.0
E1	1011	0010	1100	0001	1011
E2	0011	0100	1001	0010	1110
HR	0000	0000	0000	0000	0000
MN	0004	0006	0002	0003	0002
SC	0000	0000	0030	0030	0000

Table 3 - Sample Program Steps

Programming Step 7, a Jump Loop Step

You now have Steps #1-6 programmed. When you run the program, Step #7 will be performed when Step #6 is completed. But, you do not want Step #7 to be a normal "Set Point Step." We want Step #7 to cause the 1500 to JUMP back to Step #4 two times (for a total of 3 times through Steps #4-6). That's why you'll program Step #7 as a"JUMP LOOP Step."

1. With the STEP and FUNCTION displays now reading "07 SP," press the FCTN key until "07 JL" comes up.
2. Press the ENTER key. The display changes to "JS" (Jump to Step #).
3. Enter the number of the step the program will jump to ("0004"). Press ENTER. The display changes to "JC" (Jump Count).
4. Since you want to jump back to Step #4 two times (total of 3 times through the loop), enter "0002." Press ENTER. The display changes to "07 NX 0008."
5. Press ENTER (you do want to program Step #8 now). The diiplay changes to "08 SP."

Programming Step 8

You're ready to enter Step #8. It's a normal Set Point Step, enter the information below (Stop with the display reading "08 NX 0009"):

S1	110.0
S2	065.0
El	**1100**
E2	0101
HR	0000
MN	0006
SC	0000

Recall that you set the Recycle (RC) option to ON, so the program will repeat indefinitely. You have now entered the entire program. You're almost ready to run it.

CAUTION: Notice on the Sample Program Chart (at the beginning of this section) that the Series 1500 holds the Step #8 set points and Step #8 Event Outputs ON as It recycles and waits through Step #1 before beginning the program over.

Almost Ready **to** Run

Remember that Step #1 was a "Wait Step." Even though you press the "RUN" key, you **won't see** any action until the time you programmed into Step #1.

You may want to go back and adjust that time to a different value. There are various ways to get back to Step #1 in CHG DATA mode. Your display is now reading "08 NX 0009"; it is waiting for you to continue programming or monitoring. Use the DOWN key to put "0001" in the Data display and press ENTER. The display will show "01 WI" (Step#l is a Wait Step). Now use the FCTN key to move through "HR," "MN," and "SC;" enter a time real time1 0 minutes from now.

Start Your Program!

The Wonderful Apple Pie Sample Program is all entered and ready. So press the "RE-START' key (upper **front** panel) to set the program to Step #1. Then press the "RUN/HALT' key to start the program.

Monitoring the Action

With the MNTR DATA LED lit, you can now use the FCTN key to check things out. The control doesn't seem to show much happening right now since Step #1 is a "Wait **Step." Press the FCTN key.** In one display you'll see the "WT" (Wait for) time you programmed into Step **#1. The** 1500 **is** watching for its real time to match that programmed time.

Now use the MODE key to move to the CHG PARA mode with the TIME LED also ON. You can watch as real time approaches your programmed time. When the times match, the step number changes to 02. You will also see the Ch-1 and Ch-2 Event lights come ON to coincide with the Events you programmed for Step #2.

As the program runs its course, you can use the MNTR DATA mode and the FCTN key to view the process. As you observe the varying data, the individual functions will become quite clear. After you have observed the program for awhile, read the following information to gain an even more detailed understanding.

CAUTION:
You now have a **basic under-standlng of how the Series 1500 handles** a **control program. Please read and then continue to refer to the following fine points. The "Helpful Hints" sectlon will raise your skills with the Series 1500 to the highest level.**

Helpful Hints

Here are some Series 1500 fine points:

Halt Conditions

A. A Blank Step halts the Series 1500. A "Blank Step" is any step which is not programmed. An "SP" will appear in the Function Display when you select a Blank Step with the MODE key.

B. The Series 1500 can enter the HALT condition in two ways: It encounters a Blank Step in a program, or you press the RUN/HALT key while a program is running.

C. While in the HALT condition, the Series 1500 maintains the Set Points and Event Output conditions from the step it was in when it was halted, or from last step before a "Blank Step" halted the control. If you restart the control, having made no change to the step data, the 1500 will complete the step from the time it stopped. If you change data, the step begins from beginning.

D. Thus, if your sample program did not have "Recycle" activated, it would halt after performing Step #8, but would continue to hold the oven at 110°, 65%RH, and with Ch-1 Events 3 and 4 ON and Ch-2 Events 1 and 3 ON.

E. If you press the RUN/HALT key at 1-1/2 minutes into Step #5, it would Halt with the oven at 275°, 83.2%RH, and have **Ch-1** Event 1 ON and Ch-2 Event 2 ON.

F. However, you may not want the Step #8 conditions to be retained until tomorrow. You could add a step at the end of the program to establish Set Points of 75°, 50%RH, and with all Event Outputs OFF.

2. Ramping Conditions

A. When running **any Set Point step, the Series 1500 notes what the existing starting** conditions are and what the desired ending conditions are. Then it follows a linear path between the two.

B. Although the desired ending conditions are specifically programmed into each step, the beginning conditions depend on the step performed just previously. Know where you are going and where you've been.

C. Step #4 of your Sample Program is an example:

- As the chart on page 17 shows, you expect to start Step #4 at 400°, and ramp uniformly down to 275°. This certainly is what happens on the first time through Step #4.
- But when you "loop back-from Step #6, your starting point is 11 0°. You will be ramping upward from 11 0° to 275°.
- If this is not acceptable to you, you might want to jump loop back to Step #2 to reach a full 400° through Step #3 before you start Step #4.

3. Wait Step

A. A Wait Step maintains the same Set Points that existed at the end of the previous step. With Step #1 as a Wait Step, this means that the 1500 will use the default values for Step #1 (75°, 50%RH, ail events OFF) during its first run. However, when it recycles from Step #6, it will retain the Step #8 values (11 O°, 65%RH, Ch. #1 Events 3 & 4 ON and Ch. #2 Events 1&3 ON).

If you were to halt the program during Step #3 and then "RESTART' and run it, Step #1 would retain the Step #3 values. Since this is not always desirable, you could place a short (1 second) step immediately before the Wait Step to establish different Set Point values.

B. When waiting for "Time," program all three units (HR-MN-SC). If you program "53" for Minutes, but enter nothing for Hours or Seconds, the programmed time will be 53 minutes after midnight.

C. In your sample program's Wait Step, you used "Wait for time" because you aren't connected to a variable oven yet. A more common use of the Wait Step could be as follows:

- In Step #2, you have allowed exactly four minutes to reach 400°, 90%RH. Depending upon your system, this may either be impossible to do, or you may reach the desired conditions much earlier than that. This could result in bad apple pies.

- If you reprogrammed Step #2 as a Wait Step, you could measure how long it takes to achieve the desired conditions, and then react immediately. Much better apple pies.

- But, there is a choice to make here: The Wait Step does not follow the linear ramping path to reach the new conditions as a Set Point Step does. A Wait Step uses the previous step's Set Point. To optimize control (reduce the overshoot and undershoot) a Wait Step uses the "PID Parameters" to satisfy the wait condition. In other words, select the step type which best matches your needs. (The PID parameters are discussed in the Technical Reference Section that follows).

4. Jump Loop Step (JL)

A. In the sample program, you used this capability to jump from Step #6 back to Step #4 two times. Your "Jump Count" (JC) was set to "2." Any value from 1 to 255 can be used in loops of this type.

B. If you program "0" into "JC," the JUMP will occur infinitely. This action could set up a never-ending loop if the jump is backwards. Oryou can set up a one-time "unconditional jump" if the jump is forward. If you use a forward jump, the 0 choice makes no difference. The jump will be performed once.

- But why would you ever want to simply jump forward and skip over some steps, you ask?

  Suppose your overall program has various functional sections, not all of which you want to do every time. By ending each section with a Jump Step, you can easily alter the program to perform various sections in diierent sequences.

  During programming work, you may want to develop and test a program in sections. You can develop the separate sections with unprogrammed Blank Steps between them, then unite the separate sections laterwith Jump Steps.

C. As you learned earlier, jumping or looping into Steps from "different directions" can sometimes cause unexpected results due to different starting conditions as you enter a new step. Watch for such possibilities.

5. Recycle

With the Recycle option active, you might expect to see continuous activity as the **process** repeats the program sequence. This sample program will, in fact, immediately start Step #1 after it completes Step #8.

However, remember that Step #1 is programmed as a "Wait Step," so it will wait until the same time tomorrow. Since you now know what a Wait Step does, you may want to reprogram Step #1 as a simple "Set Point" step so that you can view the Recycle action. If you do decide to reprogram Step #1, then read the following items.

- **You cannot alter data or parameters while the program is running. The 1500 must be in the HALT condition.**

- If you want to move to a different Step #, to see what is programmed there and then modify that step, enter the CHG DATA mode. Then to re-program it from the CHG DATA mode, go to the appropriate step as described above. Then press the CLEAR key. All programmed data (for this step only) will clear, and you can now reprogram it.

6. Interactive Changing of Set Points and Events

When in the halted condition, the Series 1500 actively maintains the current set points and Event Output status. At times, you may wish to change these conditions without actually entering and running a profile step. To do this, you must be in the "MONITOR DATA" mode, halted (PROG HALT LED ON) and "RESTART" key just pressed. Then use the function key to move to the desired prompt ("C1", "C2", "E1" or "E2"), use the INCREMENT/DECREMENT keys to move to the desired data, and press the ENTER key. The Series 1500 will quickly change to controlling at the new condition.

Where To Go From Here

As soon as you feel comfortable with the Series 1500 sample program, move on to Installation and Wiring, Chapter 3. Or if you have already installed and wired your system, go to the Programming Chart in Chapter 4 and begin entering and documenting your Series 1500 program.

Chapter 3

How to Install and Wire the 1500

This chapter tells you how to install and wire the Series 1500. There are also some suggestions for sensor installation. *Also, be sure to look at the noise reduction guidelines before making your panel cutout.*

Sensor Installation Guidelines

Temp-RH

In this 1500 configuration, a dry bulb RTD measures temperature on Channel 1. A wet bulb RTD, in combination with the dry bulb RTD, senses relative humidity on Channel 2. The 1500 calculates the temperature difference between the two bulbs to determine percent relative humidity.

Temp-Temp

For Temp-Temp RTD operation, each dry bulb RTD senses temperature for its channel.

RTDs

The RTDs for the Series 1500 are customer-supplied items. They may be Gordon Part #S001-0133-0000, which is a wire-wound RTD inside a sealed, 18% Nickel-Silver sheath, made for fast temperature response. The detector element is platinum wire 100Ω at 0°C with a temperature coefficient of 0.003916Ω/Ω/°C. The sheath is 0.1875 in. (5 mm) diameter, 2.75 in. (70 mm) long. The three wire leads are 48 in. (1219 mm) long and teflon insulated.

Contact Gordon at:
5710 Kenosha St., Box 500
Richmond, IL 60071
Phone: 815/678-2211

Excessive lead length in a two-wire RTD sensor can create indication errors. To combat this, use a three wire sensor in long lead applications.

RTD - The Dry Bulb Installation

We suggest you mount the dry bulb RTD at a location in your process or system where it reads an average temperature. Air flow past this sensor should be moderate. The sensor should be thermally insulated from the sensor mounting.

RTD - The Wet Bulb Installation

One way to prepare the RTD wet bulb sensor for reading relative humidity on Channel 2 is to slip a cotton wick over the sensor sheath, Watlow Part # 0830-0111-0000 or an equivalent. Put one end of the wick in water. Some systems use a small trough of water with a float valve to replenish the evaporating liquid.

Use distilled water to avoid mineral deposits on the wick that can change the %RH reading. The wicking distance should be as short as practical. The cotton wick must be free of any sizing and starch. The "float valve-trough" systems should also remove the water when the ambient temperature goes below freezing or above boiling.

To obtain valid %RH readings, air flow past the %RH sensor must be sufficient to evaporate the maximum amount of water from the wick without drying it out. Evaporation cools the sensor; the amount of cooling relates directly to the relative humidity present.

Thermally insulate the wet bulb sensor from the sensor mounting. This prevents mounting surface heat from flowing into the sensor sheath and changing the wet bulb temperature. (The result of such heat flow will be a humidity reading higher than actual.)

Thermocouple Installation Guidelines

Locate the thermocouples in your process or system where they read average temperatures. Air flow past these sensors should be moderate. The sensors must be thermally insulated from the sensor mounting. Both thermocouples must be **ungrounded** to obtain correct readings.

Wiring Practices for Preventing Noise

Most noise problems stem from wiring practices, the major means of coupling noise from its sources to the control circuit.

An outstanding information resource 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 motors, 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

1. Our extensive noise testing has shown that the Series 1500 has a good level of noise immunity. In extremely noisy environments, however, the testing has shown that the most effective RFI techniques are:

   a. An RFI filter (such as the Corcom 1ER1) in the power line mounted external to the Series 1500 case. The RFI filter should be an RFI sealed type.

   b. Shielded power cord with the shield terminated to the Series 1500 case

c. Shielded RTD sensor with the shield terminated to the Series 1500 case and to an existing ground plane.

2. Physical separation 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 (very low power level). Keep all switched output signal lines (high power level) separate from current control loop signals (low power level).

3. Excessive lead length in a two-wire RTD sensor can create indication errors. For every 10 feet of lead length, a 1 °C error is typical. To combat this, use a three wire sensor in long lead applications.

4. 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.

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

- 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 end only. Never leave the shield unconnected at both ends. Never connect both shield ends to a common.
- 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 shielding should be assumed. If this must be done, use a triaxed cable (electrostatically shielded coaxial cable).

6. Shielded twisted wire should be used anytime control circuit signals must travel over two feet or when they are bundled in parallel with other signal wires (not line voltage or load wires).

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

8. 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 techniques connecting internal circuit commons in the manufacturers equipment. An example of this would be if a control circuit is designed to work with a grounded sensor input.

9. 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 LI (power lead) and L2 (return lead) to bad power solenoids. Contactors, and control circuits. If LI (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.

10. Grounding the chassis of each piece of equipment in the system is very important. The simple practice of connecting each individual chassis to the overall equipment chassis immediately adjacent to that piece and then tying all the major chassis ground terminals to ether with one lead (usually green wire) to ground at one signle point will work best.

11. Do **not** confuse chassis grounds (safety ground) with control circuit commons or with A.C. supply lines L2 (return or neutral line). Each return system wiring must be kept separate, making absolutely sure chassis ground (Safety) is never used as a conductor to return circuit current.

Microprocessors are in a way like trout…

They require a clean environment to be successful and to prosper. A clean environment means on one level an environment that is free of excessive dust, moisture and other airborne pollutants. But primarily it means a "clean" source of input power from which to base all its operations. What is "clean power?"

Clean power is simply a steady, noise-free line voltage source that meets the rating specifications of the hardware using it. Without clean power to the integrated circuitry, any microprocessor chip is doomed to failure.

Just as the water you get from a tap nowadays may not be acceptable to drink in some locales, so the line voltage coming into your facility may not be acceptable for your microprocessor devices. You may have to filter or "clean" the water or the power. In industrial environments, the potential for pollutants increases, especially electrical noise due to high level power consumption occurring in one place.

The recommendations we are providing for you are ways to achieve a minimum level of clean input power protection. In almost all cases these guidelines will remove the potential for input power problems. If you've applied these measures and still do not get results, please feel free to call us at the factory. We are here to see that our control products work well and do the job they were designed to do.

Definitions

Ground Loop - A condition created when two or more paths for electricity are created in a ground line, or when one or more paths are created in a shield.

Earth Ground - The starting point for safety and computer grounds. It is usually a copper rod driven into the earth.

Safety Ground - A ground line run along with electrical power wiring to protect personnel.

Computer Ground - A ground line for the ground connections to computers or microprocessor-based systems. This line is isolated from safety ground.

Common Mode Line Filter - A device to filter noise signals present on both power lines with respect to ground.

Differential Mode Line Filter - A device to filter noise signals present between the two power lines themselves.

The Dos and Don'ts of Clean Input Power

Do keep line filters as close to the control as possible to minimize the area for interference pick up.

Do use twisted pair wire and possibly shielded wire from line filters to the control

keep the line "clean."

Do keep low power control wires physically separated as far as possible from line voltage wires. Also keep all controller wiring separate from other nearby wiring. Physical separation is extremely effective. A 12 inch minimum separation is usually effective.

Do use common mode, differential mode or a combination of the two filters wherever power may have electrical interferences.

Do cross other wiring at 90° angles whenever crossing lines is unavoidable.

Do have a computer ground line that is separate from all other ground lines. This computer ground line should ideally terminate at the ground rod where the electrical service is grounded.

Don't connect computer ground to safety ground or any other ground points in the electrical system, except at the ground rod.

Don't mount relays or switching devices close to a microprocessor control.

Don't run wires carrying line voltage with signal wires (sensor, communications or other low power lines) going to the control.

Don't use conduit for computer ground.

Don't have phase angle-fired devices in the same electrical enclosure or on the same power line with the control.

Don't connect ground to the control case if the control is mounted in grounded enclosure (prevent ground loops.)

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.

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, that means 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 Winona stocks a few key noise suppression parts. You may order these by calling your local Watlow distributor.

Table 4 - Noise Suppression Device Ratings

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

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 if you are unsure which one to use, see Figure 12.

For very dirty or critical application - use micro-computer-regulated power supply or Uninterruptable Power Supply (U.P.S.)

1

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

2

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.

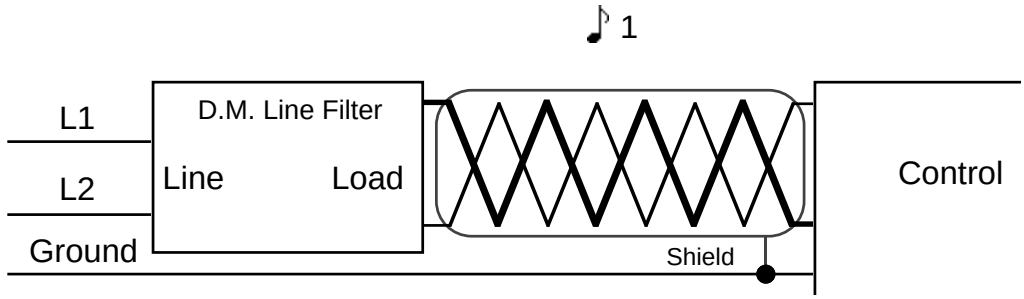


Figure 10 - Differential Mode Filter Diagram

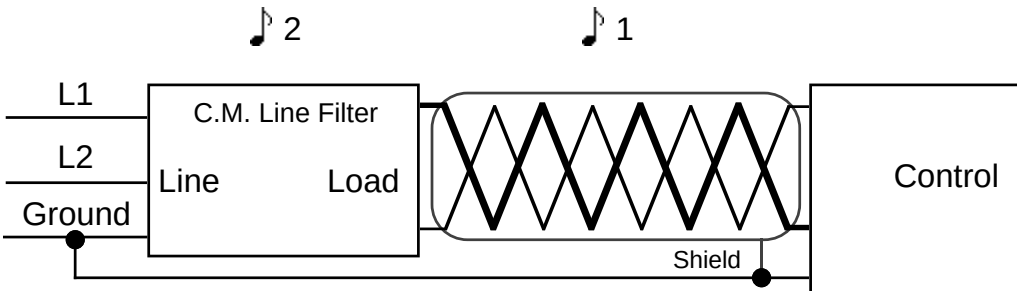


Figure 11 - Common Mode Filter Diagram

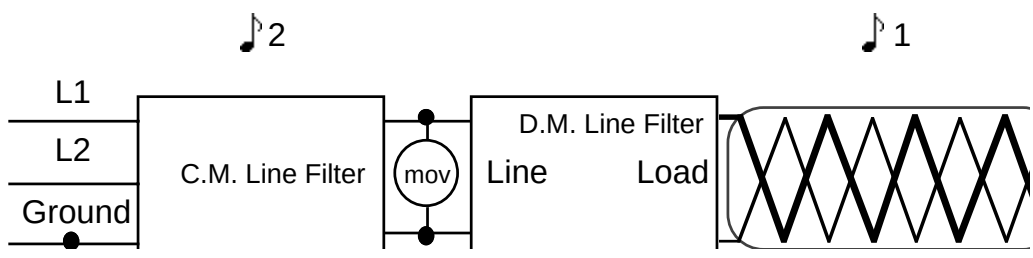


Figure 12 - Combination Differential-Common Mode Filter Diagram

How to Eliminate Noise

Watlow Part Number for Quencharc: 0804-0147-0000

1. Use "Quencharcs" to suppress noise generated by devices such as relays, relay contacts, solenoids, motors, etc. A Quencharc is a simple filter device using a .1µf, 600 volt, non-polar capacitor in series with a 100 ohm, 1/2 watt resistor. The device can be used on an A.C. circuit to effectively dampen noise at its source. For a D.C. circuit, use a diodex across the inductive load coil to dampen noise. This diode must be sized to the coil, having a reverse voltage larger than the coil voltage. The diode forward current must also be larger than the reverse coil current.

Call Watlow Customer Service for MOV Part Number.

2. An "MOV' (Metal Oxide Varistor) 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. "MOV's" have a limited life.

3. A "Corcom IERI" and other similar power line filters are designed to carry the power for the control circuit and at the same time "buffed the control circuit from A.C. line noise. Devices like a Corcom use media (electromagnetic filtering) other than electric circuits to filter out the electrical noise. Care must be taken in matching the power capabilities of the filter in respect to the power demands of the circuit.

4. The ultimate protection is an "uninterrruptable" power supply. This device "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. This is a very expensive solution.

CAUTION: Whenever attempting to open a Series 1500 with data communications (RS-422/423 interface), be sure your system's DB-15 male connector is not connected to the rear of the unit. The DB-l5 male connector may be attached to the 1500 with two screws through the rear of the case to the female DB-15 connector Inside. Attempting to remove the Series 1500 control chassis from its case with the DB-15 male still attached could pull the circuit board from its chassis socket

How to Open the 1500

Here's how to open the Series 1500 and pull the control chassis from its case:

The control chassis fastens to the case with a single screw located at the lower front panel. Turn the screw counterclockwise to loosen it. Three strip connector plugs, in the rear of the control chassis, feed power and signals through the back of the case to the triple terminal strip. These plugs will let go as you pull.

When removing the Series 1500 Control from its case, pull firmly but gently. When returning the control to the case, be sure you have the top UP to match the boards with the case plugs. The 1500 will not fit in to the case upside down. However, always check to see that it is oriented correctly. Press the unit in firmly, then turn the front panel screw clockwise to secure it. Do not overtighten screw.

Pre-Installation Information

The Watlow Series 1500 behind-bezel dimensions are 5.375 in. high by 5.375 in. wide by 7.5 in. deep. The unit weighs 4.5 lbs. For dimensional and mounting information, including the location of mounting holes and size of the front panel cutout, see Figure 10.

The Series 1500 mounts on panels from 0.06 in. to 0.25 in. thick.

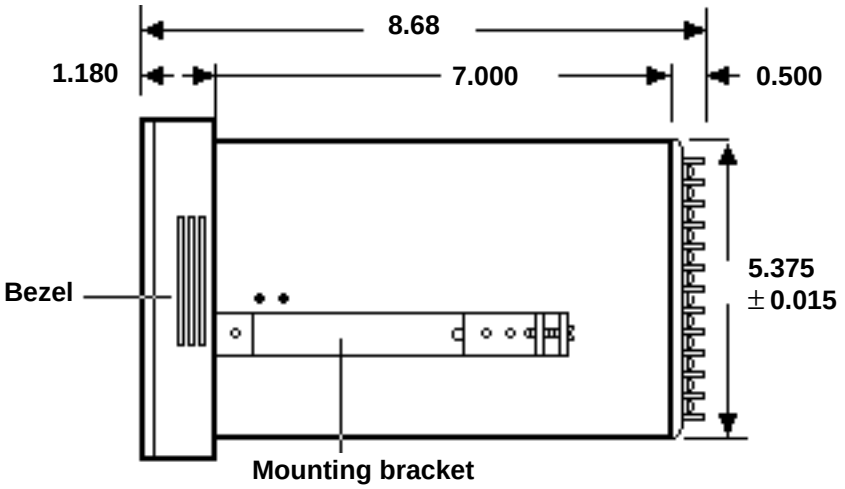
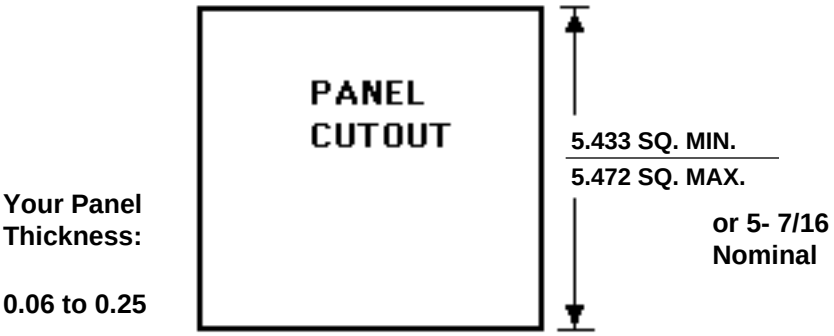
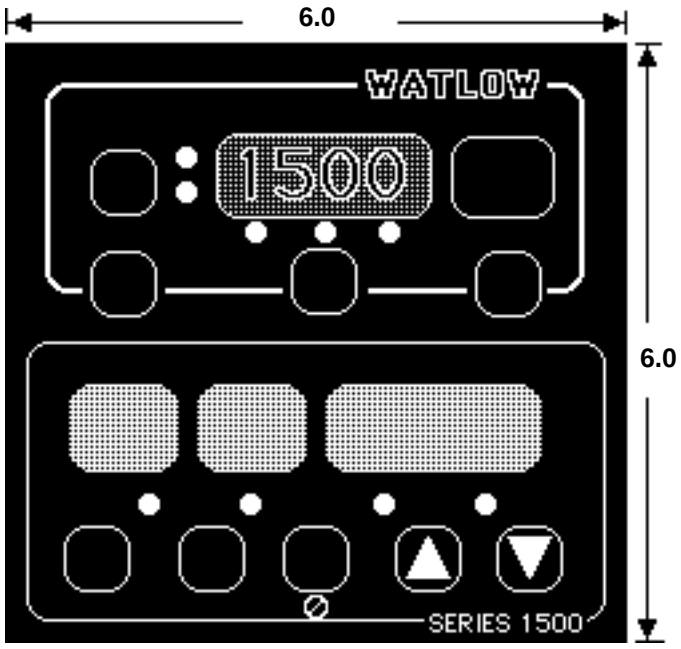


**Figure 13 -
Unit and Panel
Cutout Dimensions**

Note: All dimensions in inches.



Note: All dimensions in inches.



Installation Procedure

O

WARNING:
To avoid electric shock, make all connections on the terminal strips on the back of this control before connecting power to the unit. Also disconnect power before opening the Watlow Series 1500.

To mount the Watlow Series 1500:

1. Make a panel cutout per the dimensions in Figure 10.
2. Remove the Series 1500 chassis from its case by turning the front panel screw CCW. Grip the bezel firmly and pull the control from the case.
3. Place the case in the cutout you just made.
4. Attach the mounting brackets either to the top and bottom, or to both sides of the unit.
5. Tighten the screws on the ends of the mounting brackets to hold the case securely against the back of the panel.
6. Insert the control chassis into its case and turn the front panel screw CW to hold the chassis in place. *If you have a Series 1500 with data communications:* Fasten your DB-15 male connector with two 4-40 brass screws to the 1500's DB-15 female on the rear of the unit. Do not overtighten screws.

Electrical Connections and Wiring

! **1**

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

O

Figures 14 and 15, on the following two pages, show you how to connect the Watlow Series 1500 to your load or system. Study the strip connections carefully before beginning the hook-up. Be sure to use these jumpers on the Power Supply terminals: For 115VAC, jumper 32 to 35 and jumper 33 to 36. For 230 VAC, jumper 33 to 35. Attach Chassis Ground to 34.

! **2**

CAUTION:
Before connecting the Series 1500 to a data communications network, remove power from all devices on the network.

If you wish to disable Channel 2, Figure 18 will show you how to do that.

Figure 19 provides the pin configuration for units equipped with RS-422/RS-423 data communications. On these models the serial communications interface is through a DB-15, D-Type, female connector located on the 1500's backplane. This connector is tapped to accept two 4-40 brass screws for attaching the male plug.

! **1**

! **2**

! **3**

! **3**

CAUTION:
Add external noise isolators to any unisolated power supply components in devices on an RS-422 network to prevent noise from entering the network.

Figures 14 & 15 - Signal Conditioners, Jumper Selection, p. 35, 36

Figures 16 & 17 - Power Supply Input, CH-1 & CH-2 Output Connections, p. 36, 37

Figure 18 - Wiring To Disable Channel 2, p. 37

Figure 19 - RS-422/423 Interface, Pin Designations, Jumper Selection, p. 38

Once you have the Watlow Series 1500 Control securely mounted and correctly wired, you may apply power to the system.

SIGNAL CONDITIONER RTD Version

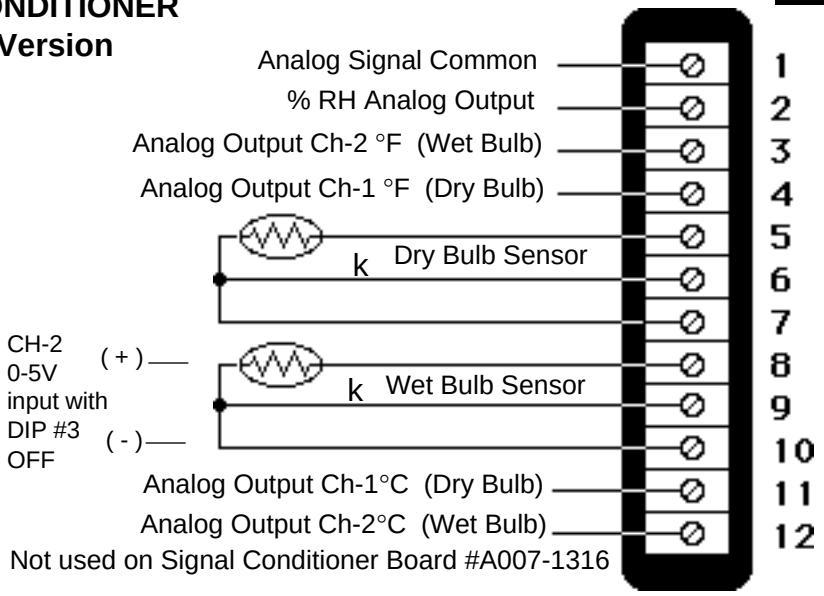
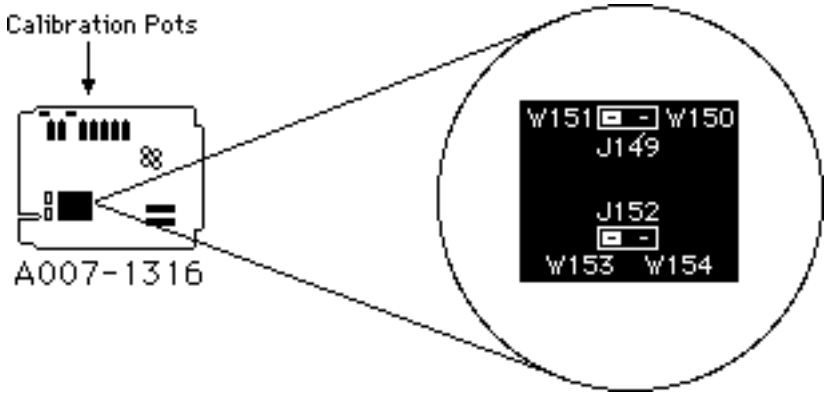


Figure 14 - Signal Conditioner Connections and Jumpers.

NOTE:

For a two-wire sensor on Channel 1, attach the leads to Terminals 5 and 6 with a jumper wire from Terminal 6 to Terminal 7. For Channel 2, attach the leads to Terminals 8 and 9 with a jumper wire from Terminal 9 to

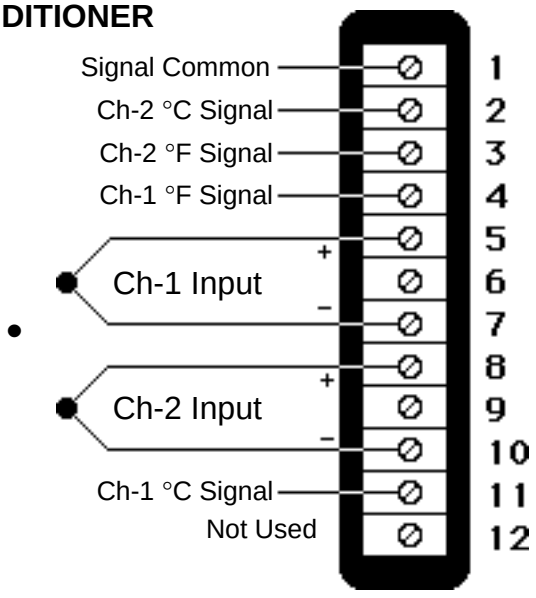


RTD Version Jumper Selection with DIP Switch #3.

#3 ON = Jumpers on W151 and W153 for RTD sensor.

#3 OFF = Jumpers on W150 and W154 for 0-5V signal.

SIGNAL CONDITIONER T/C Version



NOTE:

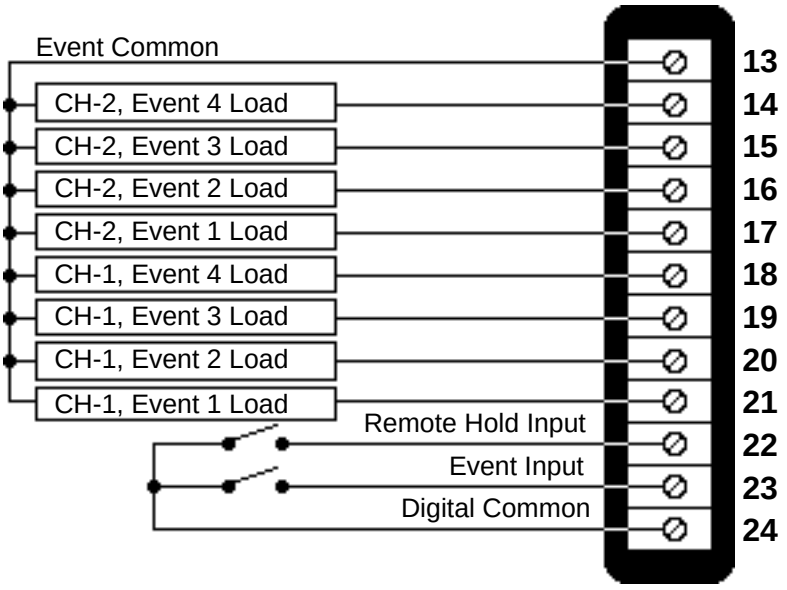
Terminals 1-4, 11-12 provide analog signals for a chart recorder.

CAUTION: Thermocouples must be ungrounded. Grounded thermocouples will generate erroneous temperature indication and can develop communication errors.

Event Input/Output, 0.5 Amp Solid State Relay

Model # 150_ - _ _ _ 1 - _ _ _0

Fig. 15 - Event Output, Remote Hold Input and Event Input Connections for Dual Solid State Relay Version



NOTE:

Event outputs can be powered by a line (up to 240VAC) independent of the control input. The event outputs can conduct up to 0.5A each.

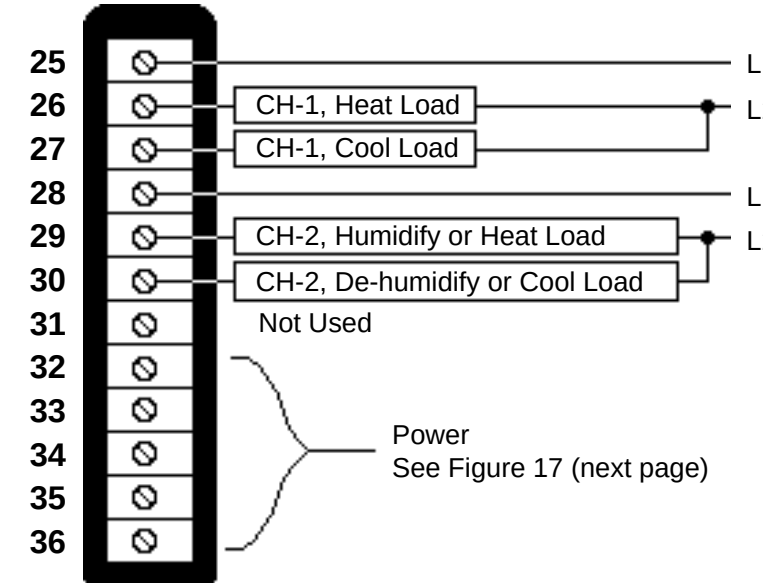
! **CAUTION:**

Fuse event outputs properly. Failure to do so could cause damage to your equipment and property.

Temp & RH Control Output, Power Supply Input, 0.5 Amp Solid State Relay

Model # 150_ - _ AA _ - _ _ _0

Figure 16 - Power Supply Input, Temp. & RH Output Connections for Dual Solid State Relay Version



NOTE:

The control power outputs for each channel can be powered by independent 115VAC or 230VAC lines.

Event Input/Output, Open Collector

Model # 150_ - _ _ _ 2 - _ _ _0

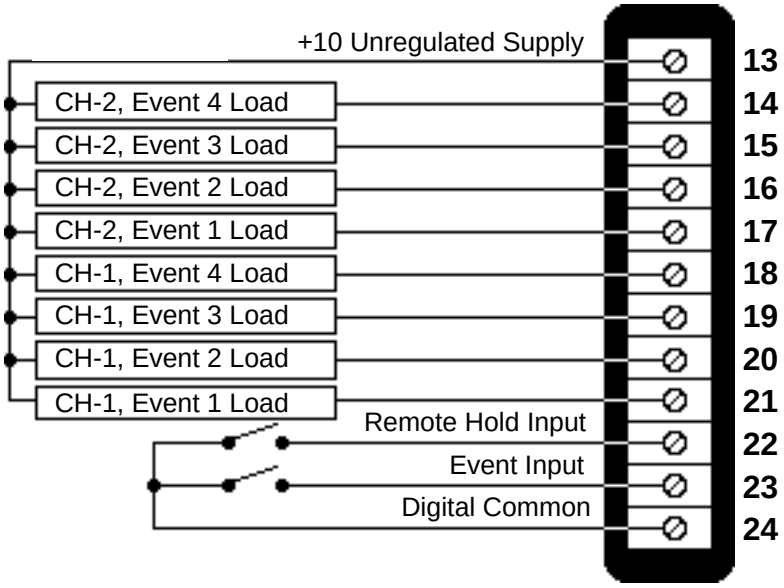


Fig. 15A - Event Output, Remote Hold Input and Event Input Connections for Dual Solid State Switch Version

Temp & RH Control Output, Power Supply Input, Open Collector

Model # 150_ - _ BB _ - _ _ _0

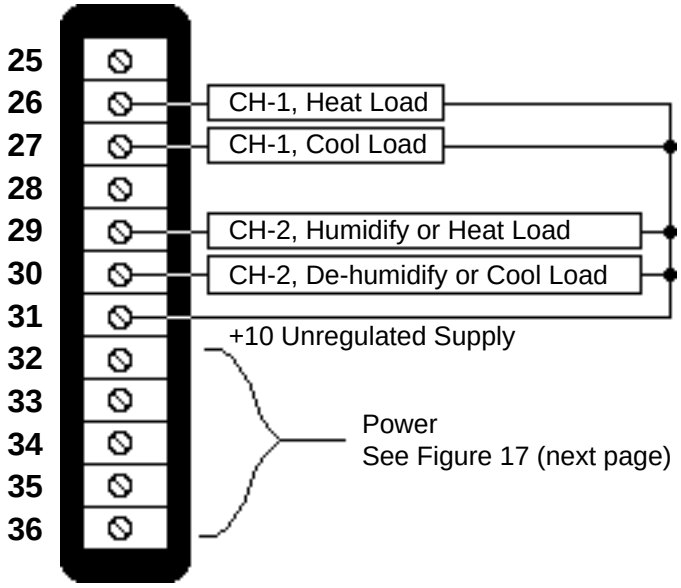
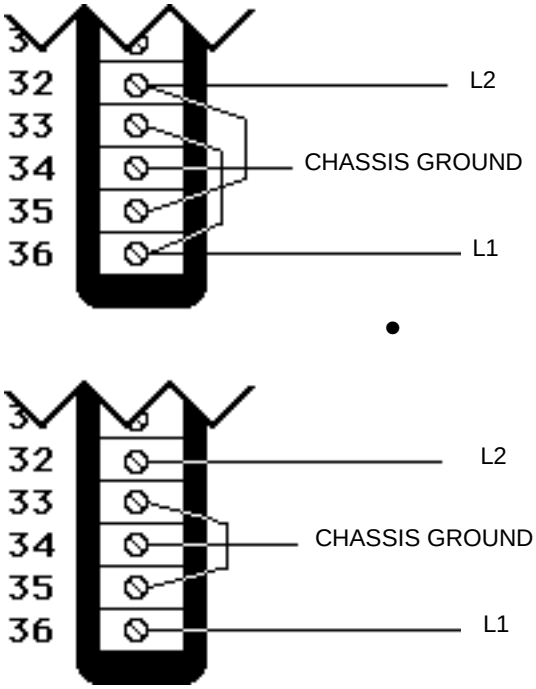


Figure 16A - Power Supply Input, Temp. & RH Output Connections for Dual Solid State Switch Version.

Power Supply Input, Temp & RH Control Output

Figure 17 - Power Supply Input, CH-1 & CH-2 Output Connections



115VAC

For 115VAC control operation, install a jumper wire from Terminal 32 to Terminal 35, and a separate jumper wire from Terminal 33 to Terminal 36. Bring line power in to Terminals 32 (L2B) and 36 (L1A). Connect the line ground wire to Terminal 34.

230VAC

For 230VAC control operation, install a jumper wire from Terminal 33 to Terminal 35. Bring line power in to Terminals 32 (L2B) and 36 (L1A). Connect the line ground wire to Terminal 34.

- **CAUTON:**

Fuse load and power outputs properly. Failure to do so could cause damage to your equipment and property.

Figure 18 - Wiring to Disable Channel 2

To Disable Channel 2

Required when running Ch-1 TEMP control without Ch-2.

RTD

1. Select TT=1 for TEMP-TEMP operation. Refer to Page 46, Figure 21.
2. Install a 107Ω resistor between Terminals 8 and 9, plus a jumper wire between Terminals 9 and 10.

T/C

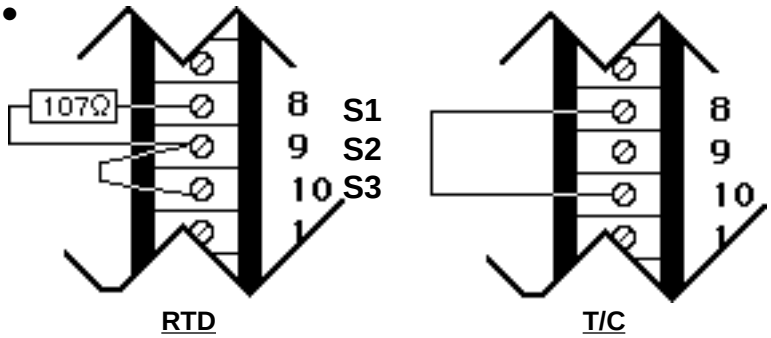
1. Put a jumper between Terminals 8 and 10.

- **CAUTON:**

Total absence of connections on Terminals 8, 9, and 10 will create an alarm condition.

NOTE:

For thermocouple inputs, the 107Ω resistor can be used in place of the jumper.



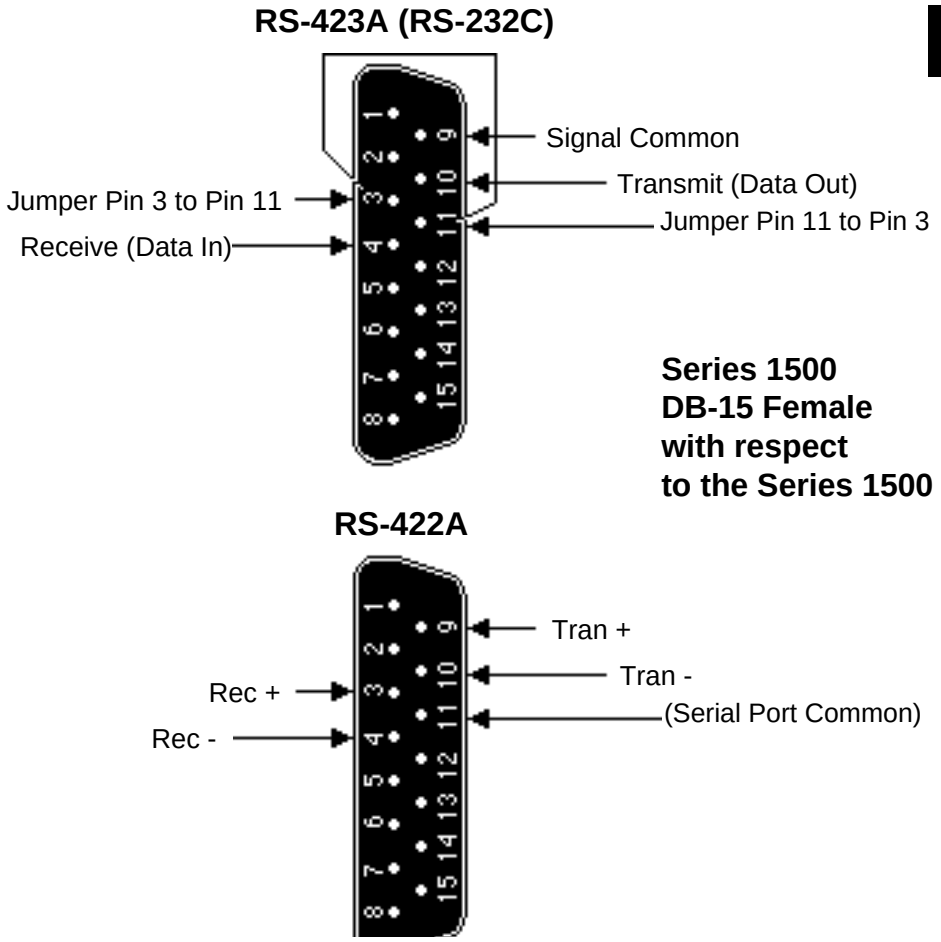
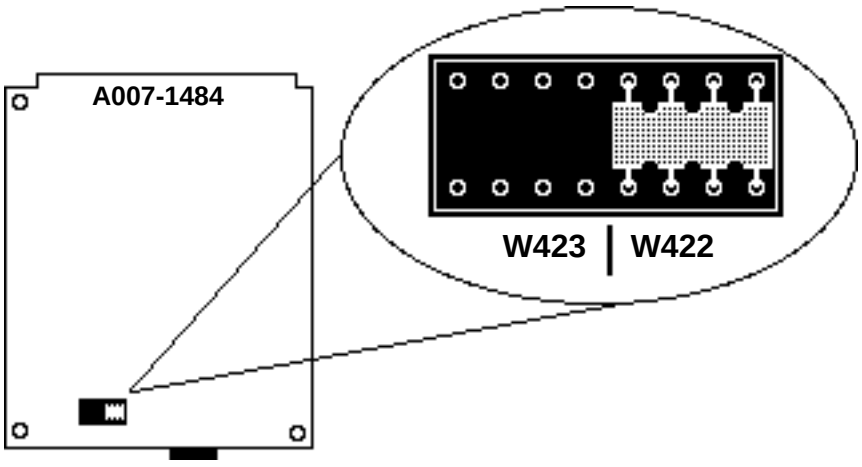


Figure 19 - RS-422/423 Interface, Pin Designations and Jumper.

You must also set the RS-423/RS-422 Jumper for a communications interface. Put the jumper on W423 for RS-423, or on W422 for RS-422.



DB-15 Connector

NOTE:

The RS-423/RS-422 Selection Jumper is located on the logic (A007-1484) board, on the side opposite the DB-15 connector.

Where To Go From Here

Now you are ready to program and tune your Series 1500. If you haven't read the sample program information in Chapter 2, please do so now. Or if you already understand how to program the Series 1500, go ahead and enter your program.

You'll find a Programming Chart in the Technical Reference section, Chapter 4, that is particularly helpful in recording your program.

Chapter 4

Technical Reference

This section of the Series 1500 manual is compiled for easy reference and rapid information retrieval. Notice the page headings as you thumb through the section; they will assist you in finding what you need.

How to Program the Series 1500

Here's how to enter a program into the Series 1500 through the front panel. If you haven't already read it, you'll find a good sample program in Chapter 2 which will also teach you the programming process.

Write Out Your Program

The Watlow Series 1500 controls temperature or relative humidity for a specific heating and/or cooling process in a controlled series of individually programmed steps. Those programmed steps are valuable information. Your program, when it's entered, gives the Series 1500 orders for the work you want it to perform.

Since the number of steps in the program may be as many as 51, we suggest that you write it out on **copies** of the three charts located in this section. This will enable you to program the Series 1500 quickly and without mistakes. Together, the Series 1500 Programming Chart, the Guarded Access Chart and the General Parameter Chart will provide you with a back-up copy of your entire program.

Select the Proper DIP Switch Settings

Prior to programming and operating the Series 1500, you must set DIP Switches #1, 2, 6, and 7 for the conditions you want. Write your choices on a copy of the General Chart, found in this section.

DIP Switch #1 selects whether Event 4 output will be used as an event output, or as an alarm output for each channel.

DIP Switch #2 selects whether the alarm output will be a latching or a non-latching output.

DIP Switch #3 selects an RTD sensor for Ch-2, or a 0 to 5v signal for Ch-2.
DIP Switch #3 for a T/C unit must be ON.

DIP Switch #4 single/dual PID.

DIP Switch #5 is for factory test and calibration, it must be ON.

DIP Switch #6 sets a "warm" or "cold" start following power removal from the 1500. With "Warm Start" the microprocessor uses previously programmed information as if power had not been removed. A Cold Start is when the 1500 starts "clean" or completely cleared of all programmed information. All parameters will be empty or set to the default limits.

Normally, the 1500 should be in the Warm Start condition. In Cold Start, all program information will be lost when power is applied to the unit.

DIP Switch #7 sets the temperature scale at °C or °F.

DIP Switch #8 is not used, set it to the OFF position.

Recycle Option

You may request that your program repeat indefinitely by selecting RC=1 in the GA = 6 area of the CHG PARA mode.

With the Recycle option active, you may expect to see continuous activity as the program sequence repeats. However, if your Step #1 is programmed as a "Wait Step," the processor will be waiting for a time or actual condition and no action will be taking place.

Programming in General

The programming method is simple. Press the MODE key to get to the mode you want to program. Then use the FCTN key to move from one prompt to the next for each of the displays.

- When you want to enter data at any given FUNCTION display prompt, press the UP or DOWN key to select the data for the DATA display. Then, press the ENTER key to enter the data. The display will momentarily blank, then the entered data will re-appear for a short duration and then self-prompt to the next parameter. Whenever you press the MODE key, you'll get an immediate exit from any mode the 1500 is in.

The flow diagrams, Figures 15 and 16, will aid you in understanding the programming process for CHG DATA and CHG PARA, respectively.

- **CAUTION: Be sure DIP SW-6 is in the OFF (Warm Start) position before you begin programming; all your entries will be saved when power**

Programming the Change Data Mode (CHG DATA)

Press the MODE key to select the CHANGE DATA mode. The processor will automatically branch to one of three submodes or Step Types: SP-Set Point, JL-Jump Loop, WT-Wait. See Figure 15**.**

When SP is in the FUNCTION window and the DATA window is blank, the 1500 is displaying a "blank step." A blank step is simply an unprogrammed step.

1. For SP (Set Point) submode, press ENTER. The display responds with S1 and the DATA window is blank. This means the set point for Channel 1 on this particular step is not programmed. If you want to ENTER a set point for Channel 1, select a value and press ENTER. Or, if you do not want to program S1, just press FCTN, and display shows S2. The DATA window is again blank.

2. For the JL (Jump Loop) submode, press FCTN until JL appears in the FUNC TION window. Then press ENTER. JS-Jump Step, and JC-Jump Count are the parameters to be entered next.

CHG DATA Flow Diagram

MODE — Press to light CHG DATA LED.

FCTN — Press to select the Step Type you want: SP, JL, WT or NX. Press enter to select individual prompts.

▲ ▼ — Press to select values.

ENTER — Press to enter data into memory.

Series 1500 Displays

STEP
FUNCTION
DATA
I
= Blank Display
= Step Number
NX [*+1] = Next Step in Sequence

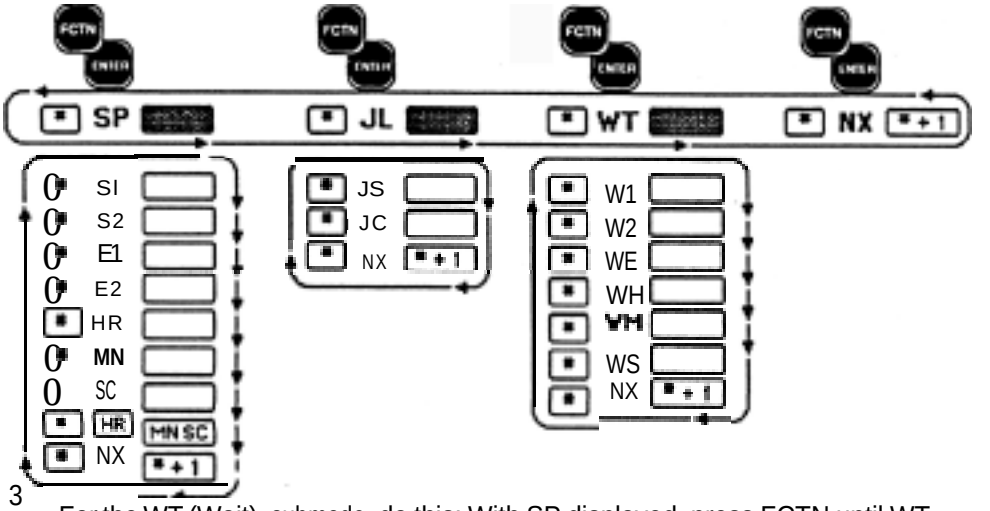


Figure 20 - CHG DATA Mode Flow Diagram

3 For the WT (Wait) submode, do this: With SP displayed, press FCTN until WT appears. Press ENTER and Wl comes up requesting a wait condition for the Ch-1 set point. Enter a value and press ENTER. If no wait for Ch-1 set point is needed, press FCTN. Now, W2 appears requesting a wait for Ch-2 set point. After W2, WE, WH (Wait **for** Real Hours), then WM (Wait for Real Minutes), then WS (Wait for Real Seconds) will appear in sequence. Select actual time-of-day values for each and press ENTER.

The Blank Step

Any unprogrammed step is first a Blank Step before information entered makes it a Set Point, Jump Loop, or Wait Step.

A Blank Step halts the processor. When it encounters a Blank Step at the end of a program, the processor will always halt unless you selected the RECYCLE option in the CHG PARA mode. In that case, the program returns to Step 01 and repeats. The 0001 entry option at the RC prompt in Guarded Access selects the recycle option.

In normal programming, only the last step in the program remains a Blank step. Therefore, you retain a Blank Step simply by not programming the step.

Halt Conditions

The Series 1500 can HALT in three ways. It encounters a Blank Step in a program (a Blank Step hatts the Series 1500) you press the RUN/HALT key while a program is running, or the remote hold input is shorted.

While in the HALT condition, the Series 1500 actively maintains the Set Points and Event Output conditions which existed at the time it hatted.

At the end of a program, or in a hatted condition, the Series 1500 will continue to hold set points and Event Outputs at the same states they were in at the end of the final step or when the program was halted.

Example: If you press the RUN/HALT key at 1-1/2 minutes into a step, the control would hold an oven at that step's set points and Event states.

If you do not want the "final" step conditions to be retained at the end of a program, add a step to establish stand-by set points with all Event Outputs OFF.

SP (Set Point) Step Programming

Enter set point data for both channels in this submode. The SP prompt sequence, appearing in the FUNCTION display and listed below, will receive data in the DATA display. Use the UP or DOWN key, then press ENTER. The processor advances automatically to the next prompt.

To advance to the next prompt without entering data, press the FCTN key. The CHG DATA flow diagram will assist you in the programming process.

1. Sl (Channel 1 Set Point) Select the Channel 1 set point and press ENTER.

2. S2 (Channel 2 Set Point) Select the Channel 2 set point. Then press ENTER.

3. El (Channel 1 Event Outputs) Select a 1, or a 0 for each the four available events (1 = ON, 0 = OFF). The DATA display shows the 1 or 0 entry for Events 4 through 1, from left to right. Press ENTER.

4. E2 (Channel 2 Event Outputs) Again, select a 1, or a 0 for each of the four available events (1 = ON, 0 = OFF). The DATA display shows the 1 or 0 entry for Events 4 through 1, from left to right. Press ENTER.

Note: If you've set DIP Switch #1 ON, then there are only three events available for each channel. In that case each Event 4 is an alarm.

5. HR (Step Duration) Select hours, press ENTER. The prompt MN will appear. Select minutes, press ENTER. The prompt SC will appear. Select seconds, press ENTER. The step duration in hours, minutes and seconds will appear in the FUNCTION and DATA displays. The TIME LED will be ON. Press FCTN to proceed to the next prompt, NX.

6. NX (Next Step) This prompt will automatically take you to the next step in sequence when you press ENTER. If, however, you want to go to a different step, simply enter that Step # with the UP and DOWN keys and press ENTER.

7. Return to the SP, JL, WT, NX loop. The process begins over again; you must choose the Step type before programming the step.

Set Point Ramping Conditions

When remembering any Set Point step, the Series 1500 notes what the existing starting conditions are and what the desired ending conditions are. Then it follows a linear path between the two.

Although the desired ending conditions are specifically programmed into each step, the beginning conditions depend on the step the 1500 performed just previously. Know where you are going and where you've been.

Here's an example:

- You start a Step #4 at 400° (Step #3's set point), and ramp uniformly down to 275° (Step 4's set point).

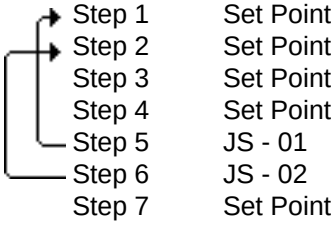
- If you "loop back" from Step #6, your starting point will be the Step #6 set point and not the Step #3 set point. You will be ramping to 275° from a different starting point.

- You might want to jump back to an earlier step to reach a full 400° through Step #3 before you start Step #4. Read on for more about Jump Steps…

JL (Jump Loop) Step Programming

In this submode you'll program the step # to be jumped to (JS) and the number of jumps to be performed (JC). The most common Jump Loops are backward jumps, that is, jumping to steps already performed. You can also program a forward jump, but from there you cannot loop back.

"Nested loops" or "intertwined loops" are **not** acceptable. An example of an intertwined loop is a sequence with Steps 1, 2 , 3, 4 and 7 programmed as regular Set Point steps; Step 5 as a jump to Step 1 and Step 6 as a jump to Step 2. The processor never reaches Step 7. See the example below.



Use simple loops in your programs. You'll find hints to programming below.
- **JS** (Jump Step) selects the step to jump to, press ENTER.
- **JC** (Jump Count) selects the number of times this loop is to run, press ENTER.
- For **NX** (Next Step), press ENTER to go to the next step, or select any step.

Any value from 1 to 255 can be used in loops of this type.

If you program "0" into "JC," the JUMP is **always** performed. If the jump is backwards, this will be a never-ending loop. Or set up a one-time "unconditional jump" with a forward jump. By ending each section with a Jump Step, you can easily alter a program to perform various sections in different sequences.

- During programming work, you may want to develop and test a program in sections. Develop the separate sections with unprogrammed Blank Steps between them, then unite the separate sections later with Jump Steps.

As you learned earlier, jumping or looping into Steps from "different directions" can sometimes cause unexpected results due to different starting conditions as you enter a new step. Watch for such possibilities.

WT (Wait) Step Programming

This submode allows the Series 1500 to wait for Channel 1 and/or Channel 2 actual process inputs and/or the real time of day. You can wait for one or two of these conditions, or all of them. If you don't need one wait condition, just press the FCTN key, and the next Wait prompt will appear.

- With **W1** (Channel 1 Actual) select the Ch-1 Wait set point and press ENTER.
- With **W2** (Channel 2 Actual) select the Ch-2 Wait set point and press ENTER.
- With **WE** (Wait for Event) Enter a "1" to wait for a closed switch condition or a "0" to wait for an open switch condition at the Event Input.
- With **WH, WM, WS** (Real Time of Day) select each component of the real time of day set point and press ENTER.

A Wait Step maintains the same Set Points and Event Output conditions that existed at the end of the previous step.

If Step #1 is a Wait Step and the program is halted on Step #3 a set point step. If "RE-START" is pressed and you run again, the 1500 will wait for the Step #1 conditions maintaining the set points from Step #3. Since this is not always desirable, you could place a short (1 second) step immediately before the Wait Step to establish new set point values.

Enter "0" by pressing the ENTER key when the Data Display is blank, or when a "0" is in the display.

When waiting for Time, program all three units (HR-MN-SC). If you program only "53" for Minutes, but enter nothing for Hours or Seconds, the programmed time will be 53 minutes after midnight, 00 53 00.

The Wait Step does not follow the linear ramping path to reach the new conditions, as a Set Point Step does. A Wait Step uses the previous step's set point. To optimize control (reduce the overshoot and undershoot), a Wait Step uses the "PID Parameters" to satisfy the wait condition. In other words, select the step type which best matches your needs.

NX (Next Step) Programming

After the final prompt in each of the step types (SP, JL, or WT), pressing ENTER advances the processor to **NX**, which selects the next program step. At the same time the STEP display will advance by one.

Pressing ENTER again will bring up SP, JL or WT if the next step has no programmed information. Or, if there is data in the subsequent step, the processor will move to the first prompt in that submode. For example, if the step is an SP step, S1 will come up; if a WT step, W1 appears in the FUNCTION display, and so on.

If you want a different step from **NX**, select the number of the step you want in the DATA display with the UP and DOWN keys, then press ENTER. Again, the processor will move to one of the three step types if the step is blank, or to the first prompt in the the step type loop: S1, JS or W1.

Pressing FCTN at **NX** instead of ENTER will send the processor back to the initial prompt in the current step.

Altering **a** Program

NOTE:

If you have the opt ional battery backed clock, the time may already be correct.

- You cannot alter data or parameters while the program is running. The 1500 must be in the HALT condition.
- If you want to move to a diierent Step # to see what is programmed there and then modify that step, enter the CHG DATA mode. Then press the FCTN key **until** the "NX" appears in the Function Display. Place the Step # into the Data Display and press ENTER.
- If you want to completely clear a Step of all programmed data to re-program it, go to the CHG DATA mode and to the appropriate Step # as described above. Then press the CLEAR key. All programmed data (for this step only) will clear, and you can now re-program it.

Figure 21 - Change Parameter (CHG PARA) Mode Flow Diagram

Programming the Change Parameter Mode (CHG PARA)

Press the mode key to select the Change Parameter (CHG PARA) mode. The TIME LED will be ON. The FUNCTION and DATA displays will show the real time of day.

Press FCTN to produce the time prompt, HR, in the FUNCTION display. You'll enter the real time of day here, beginning with hours. See Change Parameter Fig. 16.

MODE

Selects MNTR DATA, CHG DATA or CHG PARA Mode.

FCTN

Selects any **prompt** in a mode.

Select values for the DATA display.

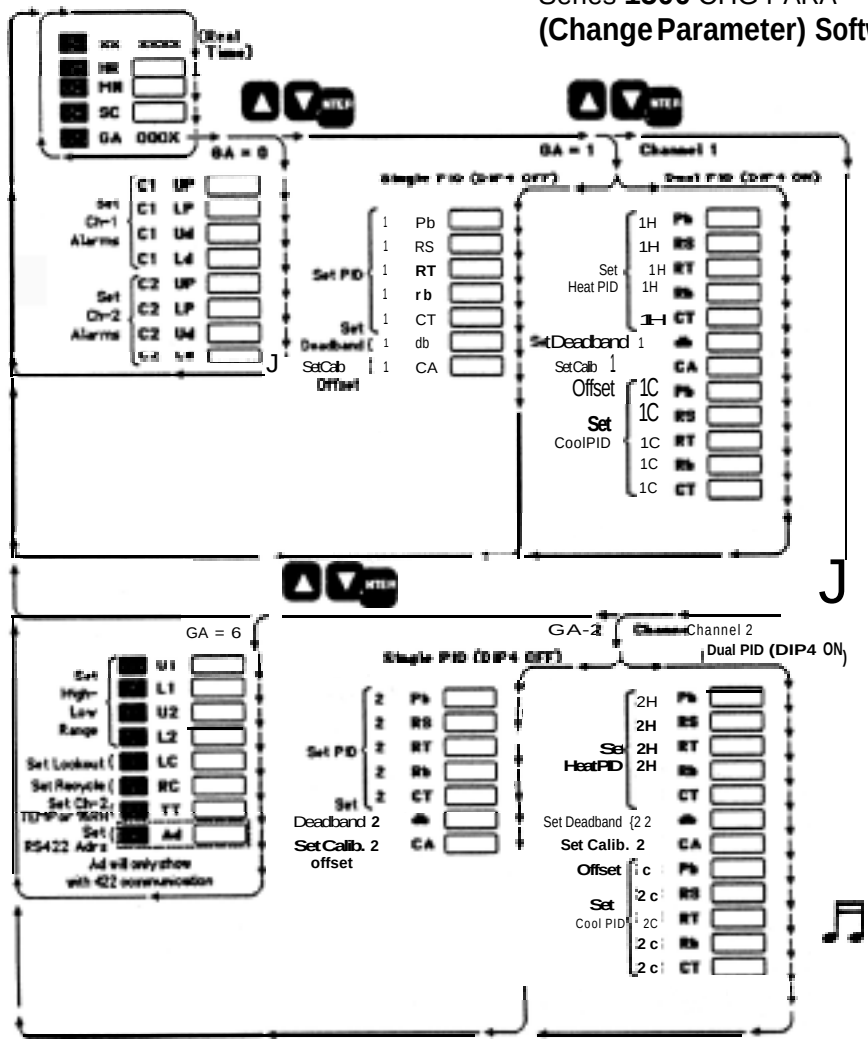
ENTER

Places values from the DATA display into memory.

NOTE:

Only RTD version 1500s **have the** TT prompt (2-channel temperature control.

Series **1500** CHG PARA **(Change Parameter) Software**



minutes with the UP/DOWN keys. Press ENTER. The prompt SC will appear. Select correct seconds with the UP/DOWN keys. Press ENTER; GA will appear.

GA (Guarded Access) Programming

The Guarded Access parameters control the process limits. The three GA parameter loops are restricted to operators by special codes. The Guarded Access codes prevent inexperienced or unauthorized operators from changing the parameters.

The GA prompts appear in the Guarded Access Charts (p. 49 or 50) and in the CHG PARA flow diagram. You may alter any one of them by changing the DATA display with the UP and DOWN keys. Then press ENTER. Guarded Access parameters will not self prompt. To proceed to the next prompt, press FCTN.

- **GA (Guarded Access)** Select a GA code with the UP and DOWN keys. Then press ENTER. The first prompt in the loop appears.

  GA Code = 0000. Prompts appear for Ch-1, then repeat for Ch-2. These parameters are more fully explained in the "Alarm" reference section, p. 46. Ranges for your particular unit are in the charts on pages 49 or 50.

- **UP (Upper Process Type Alarm)** Select an alarm point of this type for Ch-1. Press ENTER; press FCTN. If you do not want this alarm set to highest value.

- **LP (Lower Process Type Alarm)** Select an alarm point of this type for Ch-1. Press ENTER; press FCTN. If you do not want this alarm set to lowest value.

- **Ud (Upper Deviation Type Alarm)** Select an alarm point of this type for Ch-1. Press ENTER; press FCTN. If you do not want this alarm set to highest value.

- **Ld (Lower Deviation Type Alarm)** Select an alarm point of this type for Ch-1. Press ENTER; press FCTN. If you do not want this alarm set to lowest value.

- Sequence repeats for Channel 2 and then leaves the guarded area, returning to real time.

  GA Codes = 0001 and 0002. Prompts appear for Ch-1 with Code 0001, and then repeat for Ch-2 with Code 0002. Except for CA, these parameters pertain directly to tuning your control to the system. See the "Tuning" reference section on p. 60. Ranges and default values are listed on pp. 49 or 50.

  This section will also vary according to the flow chart depending upon DIP Switch #4 (single or dual PID).

- **Pb (Proportional Band)** Select a proportional band value with the UP/DOWN keys. Then press ENTER; press FCTN.

- **RS (Reset)** Select a reset value with the UP/DOWN keys. Then press ENTER; press FCTN.

Guarded Access

- **RT (Rate)** Select a rate value with the UP/DOWN keys. Then press ENTER; press FCTN.
- **Rb (Rate Band)** Rate band defines where the rate function will occur. The Rate Band will occur at one to seven times the proportional band. With a "0" entry, rate is always in effect. Select a rate band value with the UP/DOWN keys. Then press ENTER; press FCTN.
- **CT (Cycle Time)** Enter a cycle time value with the UP/DOWN keys. Then press ENTER; press FCTN.
- **db (Dead Band)** The dead band defines an area on either side of set point where no switching action will occur. Select a dead band value with the UP/DOWN keys. Then press ENTER; press FCTN.
- **CA (Calibration Offset)** Calibration offest enables you to offset the input value from -10° to 10°C or °F. Enter a calibration offset value with the UP/DOWN keys. Then press ENTER; press FCTN.

GA Code = 0006. These parameters are high and low display and scroll limits, and for some units, two channel control type and device address. Ranges and default values are listed for your particular unit in the charts on pages 49 or 50.

- **U1 (Ch-1 Upper Set Point Limit)** Place the Channel 1 upper set point limit into the DATA display with the UP and DOWN keys. Press ENTER; press FCTN.
- **L1 (Ch-1 Lower Set Point Limit)** Place the Channel 1 lower set point limit into the DATA display with the UP and DOWN keys. Press ENTER; press FCTN.
- **U2 (Ch-2 Upper Set Point Limit)** Place the Channel 2 upper set point limit into the DATA display with the UP and DOWN keys. Press ENTER; press FCTN.
- **L2 (Ch-2 Low Set Point Limit)** Place the Channel 2 lower set point limit in the DATA display with the UP and DOWN keys. Press ENTER; press FCTN.
- **LC (Front Panel Keyboard Lockout)** Enter a "1" to lock the entire front panel, or a "0" to unlock it.
- **RC (Recycle)** Select "1" to activate the recycle option (begin again at Step #1 after completing a profile). Or, select "0" to deactivate the recycle option. Then press ENTER; press FCTN.
- **TT (Temp-Temp, 2-channel temperature control)** This prompt will not appear on thermocouple units. Select 0000 for Temp-RH control, or 0001 for Temp-Temp control. Press ENTER; press FCTN.
- **Ad (RS-422 Address for the 1500)** This prompt appears only on units with data communications. It applies only for a RS-422 interface. Each device on the network must have its own address. Choose an address for your Series 1500 with the UP/DOWN keys. Press ENTER; press FCTN.
- Sequence then leaves the guarded area, returning to real time.

! 1

CAUTION: Don't press the CLEAR key while you are in the Guarded Access 0006 area. If you press the CLEAR key, you will clear all programmed information for all steps. The GA information will remain, but all programmed steps, and any information you have entered for them, will clear.

! 2

CAUTION: The U1, L1, U2, L2 parameters are simple scrolling and display limits, not alarms.

Where To Go From Here

For more Series 1500 programming experience, you may want to turn to the sample program in Chapter 2, if you haven't already done so. However, once you have the control installed and programmed, you need to tune it to your thermal system for optimum performance. Turn now to "Tuning," in this chapter, for a general description.

Alarm Codes

Alarms

The 1500 system provides four basic alarm conditions in each of the two control channels. They are, with mnemonic abbreviations:

Upper Process - UP	Upper Deviation - Ud
Lower Process - LP	Lower Deviation - Ld

A "process" alarm, you will recall, is available at an absolute process level.

A **"deviation" alarm, on the other hand, is linked to the process set point. It "deviates" with a fixed value in** either a positive or negative direction from the main set **point: If** the process set point changes, the deviation alarm will shift with it while maintaining the fixed deviation.

Alarm Options

There are two specific options for the 1500 alarms. Both are set in hardware:

Event Output Option -	DIP **Switch #1 ON**
Latching Alarm Option -	DIP Switch #2 ON

(See Chapter 1 for information on how to set the DIP switches.)

Event - Alarm Output Option

The Event Output option uses Event #4, the most significant (furthest left in the DATA display) channel event output as an alarm indicator. With this option, any of the four alarm conditions (listed above) on a channel will activate the alarm event output.

You may use the Event #4 output signal to control your alarm device or indicator. When any one of a channel's alarms is triggered, the Event #4 indicator on the Series 1500 front panel for that channel will light.

If the Event Output Alarm Option is selected, the number **of events per channel** in a program step is reduced from four to three.

Latching Option

The latching option allows alarms to be "latched," so that momentary alarms are saved for the operator. An alarm code will flash until the operator clears it **with** the CLEAR key.

In the unlatched option state (DIP Switch #2 = OFF), if an alarm condition is no longer present, it is not displayed for the operator. If you press the CLEAR key and the alarm indication remains, that means that the alarm condition is still present in the system.

Alarm Entry

Enter alarm points in the CHG PARA Mode, and in the Guarded Access (GA) submode. The alarm ranges and defautts appear in the Guarded Access Chart for your particular unit in this section of the manual.

WARNING: The Series 1500 alarms are not designed as system "safety limits." These alarms do not meet the minimum separate power supply requirements for the safety limit function. Using them as such could result in damage to your equlpment and injury to personnel. Watlow recommends one Series 140 per channel in dual output temperature applications. The Series 140 is an **FM-approved and UL recognized latching limit control.**

Alarm Display **Codes**

h in the FUNCTION display, indicating the type of alarm. These alarm messages are listed below. The first two are operational alarms that have no effect on alarm/event outputs.

A0 - Low RAM back up battery
AI - Power intenupt
A2 - Ch - 1 Upper Process exceeded
A3 - Ch - 1 Lower Process exceeded
A4 - Ch - 1 Upper deviation exceeded
A5 - Ch - 1 Lower deviation exceeded
A6 - Ch - 2Upper Process exceeded
A7 - Ch -2 Lower Process exceeded
A8 - Ch - 2 Upper deviation exceeded
A9 - Ch - 2 Lower deviation exceeded

If more than one alarm condition is present, the lowest numbered alarm code will take precedence. That is, if alarms Al and A6 are present, only Al will flash. If you clear Al, then A6 will flash.

NOTE:

An Al power interrupt alarm will **always** flash until an operator presses the CLEAR key (or sends ALMOO), regardless if alarms are latched or unlatched.

Alarm Results

What happens when an alarm occurs depends on how you have the auxiliary output (Event #4) wired. The alarms by themselves don't stop the Series 1500 program or shut down the outputs.

The only alarm that has an effect on the Series 1500 program is "Al" - power interrupt. If your unit has a battery-backed real time clock, and a short power interruption occurs, the 1500 will pick up the program where it left off. The program however, will be running behind the real time clock (correct time) by the duration of the power outage. A "Waitfor" time step in the program would correct that time lag in the next 24 hour period.

If your 1500 does not have a battery-backed clock and a short power outage occurs, the 1500 still picks up on the step it left off, but both the real time clock and the program will be running behind by the duration of the power outage. A Waitfor time step will not re-synchronize the program and correct real time in this case.

Clearing Alarms

To clear the power intenupt alarm (Al, and alarms with the "latch" option, press the CLEAR key in the MNTR DATA mode.

If an alarm condition is no longer present, the alarm will remain cleared. If the condition is still present, the alarm message will reappear. In that case, you must correct the condition that caused the alarm before it will clear.

Upper and Lower Set Point Limits are Display and Scroll Limits, Not Alarms

The upper and lower set point limits, U1/L1 and U2/L2, are not alarms. They are configured to limit the range of display and the scrolling capability of the Series 1500. It is possible to have alarm points beyond the upper and lower limits of the control's set points.

Event Outputs

One of the most versatile features of the Series 1500 is its capability for event outputs. An “event output” is simply a preprogrammed ON/OFF event. There are eight total, four for each channel during each individual step. The event may turn any number of peripheral devices ON or OFF to assist you in controlling your process, system or environment.

For instance, in a closed environmental chamber, you might wish to circulate air at a given time in your program for one or more steps. You might want to turn lights ON or OFF, or signals, or lock out your humidifier, or you could activate a video recorder.

If the events are programmed for one step and left unprogrammed for the next step, the events will repeat the last programmed sequence. The Output Event LEDs, to the right of the ACTUAL display, are visible only when the outputs are active during a program run.

These event outputs have solid-state switching rated at 0.5 amps up to 115VAC or 240VAC.

Program the Events in the CHG DATA Mode, entering them in a 1=ON, O=OFF manner for each step. The four place DATA display shows the ON/OFF status (reading from left to right) beginning with Event Output # 4 on the left and so on. Thus, with the El or E2 prompts, the DATA display will read “1001” or "0011," or any other combination of 1 's and/or 0's. You program Event Outputs in. the Change Data Mode.

When DIP Switch #1 is ON, Event #4 is an alarm output and is not available to program as an event.

When these Event Outputs are actually ON during a running program, you can see them displayed in the EVENT box in the upper righthand corner of the front panel.

Event Input

The event input allows the Series 1500 to be programmed to wait at that point in the profile until the external condition occurs. It can be programmed to wait for a switch closure or opening.

Remote Hold Input

Closing the remote hold input switch will cause the Series 1500 to pause until the switch opens. This is indicated by a flashing “RUN/HALT" LED. While in this condition, the Series 1500 will actively maintain the set point and event output conditions which exist.

Analog Retransmit Outputs

Each sensor input signal level is made available at an "Analog Retransmit" output for chart recording or other uses. See Terminals 1,2,3,4 and 11, page 35. The scaling of these outputs varies with sensor type and function. The following is a summary of. the **scaling:**

RTD Units

		°F Output
-0500VDC	=	-100.0°F
0.000VDC	=	0.0°F
+5.000VDC	=	1000.0°F

		°C Output
O.OOOVDC	=	0°C
1.250VDC	=	250°C
2.500VDC	=	500°C

If using %RH

		Output	
0.000VDC	=	0.0%RH	
0.500VDC	=	l00.0%RH	(If using 0 - 0.500V option)
5.000VDC	=	1 00.0%RH	(If using 0 - 5.000V option)

T/C Units

		°F Output
-0.500VDC	=	-100°F
0.000VDC	=	0°F
5.000VDC	=	3200°F

		°C Output
0.l00VDC	=	-64°C
0.000VDC	=	0°C
2.750VDC	=	1760°C

Thermocouple types which use only parts of the -100 to +3200 degree range will have a corresponding part of the retransmit voltage range.

RTD Guarded Access Chart

Make a copy of this chart to document the Series 1500 Guarded Access for each program you use.

Program # _____ System _____ Programmer _____ Date _____

GA Code	Ch	Pmpt	Parameter	Default	Range Low	Range High	Units	Your Setting
0000	C1	UP	Ch - 1 Upper Process Alarm	999 538	-99 -99	999 538	°F °C	
	C1	LP	Ch - 1 Lower Process Alarm	-99 -99	-99 -99	999 538	°F °C	
	Cl	Ud	Ch - 1 Upper Deviation Alarm	999 538	0 0	999 538	°F °C	
	C I	Ld	Ch - 1 Lower Deviation Alarm	-999 -538	-999 -538	0 0	°F °C	
	C 2	UP	Ch - 2 Upper Process Alarm	101 999 538	-001 -99 -99	101 999 538	%RH °F °C	
	C 2	LP	Ch - 2 Lower Process Alarm	-001 -99 -99	-001 -99 -99	101 999 538	%RH °F °C	
	C2	Ud	Ch - 2 Upper Deviation Alarm	101 999 538	000 0 0	101 999 538	%RH °F °C	
	C2	Ld	Ch - 2 Lower Deviation Alarm	-101 -999 -538	000 -999 -538	-101 0 0	%RH °F °C	
0001	1H	Pb	Ch - 1 Prop. Band	0004	0	500	°C or °F	
	1H	RS	Ch - 1 Reset	0001	00.00	20.00	repeats/min.	
	1H	RT	Ch1 - Rate	0001	00.00	05.00	min.	
	1H	Rb	Ch - 1 Rate Band	0010	0	3	times Pb	
	1H	CT	Ch - 1 Cycle Time	0005	1	60	sec.	
	1	db	Ch - 1 Dead Band	0000	-20.0	20.0	°C or °F	
	1	CA	Ch 1 Calib rationAdjust	0000	-10.0	10.0	°C 0r °F	
Dual PID	1C	Pb	Ch - 1 Prop. Band	-99	0	500	°C or °F	
	1C	RS	CH - 1 Reset	0001	00.00	20.00	repeats/min.	
	1C	RT	Ch - 1 Rate	0001	00.00	05.00	min.	
	1C	Rb	Ch - 1 Rate Band	0000	0	3	times Pb	
	1C	CT	Ch - 1 Cycle Time	0005	1	60	sec.	
0002	2H	Pb	Ch - 2 Prop. Band	0004 0004	0 0	500 60	°C or °F %RH	
	2H	RS	Ch - 2 Reset	0001	00.00	20.00	repeats/min.	
	2H	RT	Ch-2Rate	0001	00.00	5.00	min.	
	2H	Rb	Ch - 2 Rate Band	0000	0	3	times Pb	
	2H	CT	Ch - 2 Cycle Time	0005	1	60	sec.	
	2	db	Ch - 2 Dead Band	0000	-20.0	20.0	%RH, °C or °F	
	2	CA	CH - 2 Calibration Adjust	0000	-10.0	10.0	°C or °F	
Dual PID	2C	Pb	Ch - Prop. Band	0004 0004	0 0	500 60	°C or °F %RH	
	2 C	RS	Ch - 2 Reset	0001	00.00	20.00	repeats/min.	
	2C	Rt	Ch-2 Rate	0001	00.00	5.00	min.	
	2 C	Rb	Ch 2Rate Band	0000	0	3	Times Pb	
	2C	CT	Ch - 2 Cycle Time	0005	1	60	sec.	
0006		U1	Ch-1 Upper Set Point Limit	999.9 538.0	-99.9 -99.9	999.9 538.0	°F °C	
		L1	Ch-1 Lower Set Point Limit	-99.9 -99.9	-99.9 -99.9	999.9 538.0	°F °C	
		U2	Ch-2 Upper Set Point Limit	999.9 538.0 100.0	-99.9 -99.9 0.0	999.9 538.0 100.0	°F °C %RH	
		L2	Ch-2 Lower Set Point Limit	-99.9 -99.9 0	-99.9 -99.9 0.0	999.9 538.0 100.0	°F °C %RH	
		RC	Recycle: ON=1 , OFF =0	0	0	1	—	
		TT	T-RH=OOOO, T-T=0001	0000	0	1	—	
		Ad	Address number RS-422	0	0	9	Device #	
		LC	Keyboard Lock	0	0	1	—	

T/C Guarded Access Chart

Use this chart to determine parameter ranges, limits and default settings. Then enter your setting for each parameter. Make a photocopy of the chart and enter values for each program you use.

Program # _____ System _____ Programmer _____ Date_____

GA Code	Ch	Pmpt	Parameter	Default	Range			Your Setting
					Low	High	Units	
0000	C1	UP	Ch - 1 Upper Process Alarm	3200 1760	-99 -99	3200 1760	°F °C	
	C1	LP	Ch - 1 Lower Process Alarm	-99 -99	-99 -99	3200 1760	°F °C	
	C1	Ud	Ch - 1 Upper Deviation Alarm	3200 1760	0 0	3200 1760	°F °C	
	C1	Ld	Ch - 1 Lower Deviation Alarm	-999 -999	-999 -999	0 0	°F °C	
	c2	UP	Ch - 2 Upper Process Alarm	3200 1760	-99 -99	3200 1760	°F °C	
	C2	LP	Ch - 2 Lower Process Alarm	-99 -99	-99 -99	3200 1760	°F °C	
	C2	Ud	Ch - 2 Upper Deviation Alarm	3200 1760	0 0	3200 1760	°F °C	
	C2	Ld	Ch - 2 Lower Deviation Alarm	-999 -999	-999 -999	0 0	°F °C	
0001	1H	Pb	Ch - 1 Prop. Band	0004	0	500	°C or F	
	1H	RS	Ch - 1 Reset	0001	0	20.00	repeats/min.	
	1H	RT	Ch - 1 Rate	0001	0	5.00	min.	
	1H	Rb	Ch - 1 Rate Band	0000	0	3	times Pb	
	1H	CT	Ch - 1 Cycle Time	0005	1	60	sec.	
	1	db	Ch - 1 Dead Band	0000	-20	20	°C or F	
	1	CA	Ch - 1 Calibration Adjust	0000	-10	10	°C or F	
Dual PID	1C	Pb	Ch - 1 Prop. Band	0004	0	500	°C or F	
	1C	RS	Ch - 1 Reset	0001	0	20.00	repeats/min.	
	1C	RT	Ch - 1 Rate	0001	0	5.00	min.	
	1C	Rb	Ch - 1 Rate Band	0000	0	3	times Pb	
	1C	CT	Ch - 1 Cycle Time	0005	1	60	sec.	
0002	2H	Pb	Ch - 2 Prop. Band	0004	0	500	°C or F	
	2H	RS	Ch - 2 Reset	0001	0	20.00	repeats/min.	
	2H	RT	Ch - 2 Rate	0001	0	5.00	min.	
	2H	Rb	Ch - 2 Rate Band	0000	0	3	times Pb	
	2H	CT	Ch - 2 Cycle Time	0005	1	60	sec.	
	2	db	Ch - 2 Dead Band	0000	-20	20	°C or F	
	2	CA	Ch - 2 Calibration Adjust	0000	-10	10	°C or F	
Dual PID	2C	Pb	Ch - 2 Prop. Band	0004	0	500	°C or F	
	2C	RS	Ch - 2 Reset	0001	0	20.00	repeats/min.	
	2C	RT	Ch - 2 Rate	0001	0	5.00	min.	
	2C	Rb	Ch - 2 Rate Band	0000	0	3	times Pb	
	2C	CT	Ch - 2 Cycle Time	0005	1	60	sec.	
0006	C1	U1	Ch-1 Upper Set Point Limit	3200 1760	-99 -99	3200 1760	°F °C	
	C1	L1	Ch-1 Lower Set Point Limit	-99 -99	-99 -99	3200 1760	°F °C	
	C2	U2	Ch-2 Upper Set Point Limit	3200 1760	-99 -99	3200 1760	°F °C	
	C2	L2	Ch-2 Lower Set Point Limit	-99 -99	-99 -99	3200 1760	°F °C	
		RC	Recycle: ON=1 OFF =0	0	0	1	—	
		Ad	Address number RS-422	0	0	9	Device	
		LC	Keyboard Lock	0	0	1	—	

RTD General Parameter Chart

Use this chart to determine parameter **ranges, limits and default** settings. Then enter your setting for each parameter. Make a photocopy of the chart and enter values for each program you use.

Program # _____ System _____ Programmer _____ Date_____

Series 1500 DIP Switch Settings

Sw-Position	Function	Setting
#1 -ON	Event Output #4 for both Ch-1 and Ch-2 are alarm outputs.	
#1 - OFF	Event Output #4 for both Ch-1 and Ch-2 are event outputs.	
##2 - ON	Alarms are latching (displayed until cleared manually).	
#2- OFF	Alarms are non-latching (displayed only as tong as alarm condition exists).	
#3-ON	The Ch-2 sensor is an RTD sensor. On the (A007-1316) board, Jumper J149 must be on Wl51, Jumper J152 must be on W153.	
#3-OFF	The Ch-2 input is a 0-5V signal for 0-l 00% RH. On the (A007-1316) board, Jumper J149 must be on W150, Jumper J152 must be on Wl54.	
#4-ON	Dual PID	
#4 - OFF	Single PID	
#5 - ON	Factory use only. Must be in the ON position.	ON
#6 - ON	Cold Start on power-up. (Memory cleared, parameters set to default values)	
#6 - OFF	Warm Start on power-up. (Programmed values are retained for all parameters):	
#7-ON	°C function after a Cold Start.	
#7 - OFF	°F function after a Cold Start.	
#&OFF	Not Used. Set in the OFF position	OFF

RTD Series 1500 Parameter Ranges

Prompt	Parameter	Range		
		Low	High	Units
	Number of Steps	1	51	Steps
	Step Type (Data Comm.)	0	3	Type
S1	Ch-1 Set Point	LI	U1	°F/°C
S 2	Ch-2 Set Point	L2	u2	
EI	ON (DIP 1 ON) Dec. Equiv	0	15	binary total ON
E2	ON (DIP 1=ON) Dec. Equiv.	0	15	binary total ON
EI	ON (DIP 1=OFF) Dec. Equiv.	0	7	binary total ON
E2	ON (DIP l=OFF) Dec. Equiv.	0	7	binary total ON
HR	Step Duration-Hours	0	24	hours
MN	Step Duration-Minutes	0	59	minutes
SC	Step Duration-Seconds	0	59	seconds
JC	Jump Step	1	51	Step#
JC	Jump Counts	0	255	counts
W1	Wait or Ch-1 Actual	11	U1	°F/°C
w2	Wait for Ch-2 Actual	L2	U2	%RH/°F/°C
WE	Wait for Event	0	1	—
WH	Wait for Real Hour	0	23	hours
WM	Wait for Real Minute	0	59	minutes
WS	Wait for Real Second	0	59	seconds

Programming Chart

Make photocopies of this page and the previous page, then record your parameters and entire program step by-step.

Prog. No. _______ System _______ Programmer _______ Date _______ Page _______ of _______

Step #	√ Step Type	Step Type	Set Value		Event Outputs		
					4 3 2 1	4 3 2 1	HR
		Set Point SP	S1	S2			HR
		Jump Loop JL	JS	JC			
		Wait For WT	W1	W2	WE		WH
		Set Point SP	S1	S2			HR
		Jump Loop JL	JS	JC			
		Wait For WT	W1	W2	WE		WH
		Set Point SP	S1	S2			HR
		Jump Loop JL	JS	JC			
		Wait For WT	W1	W2	WE		WH
		Set Point SP	S1	S2			HR
		Jump Loop JL	JS	JC			
		Wait For WT	W1	W2	WE		WH
		Set Point SP	S1	S2			HR
		Jump Loop JL	JS	JC			
		Wait For WT	W1	W2	WE		WH
		Set Point SP	S1	S2			HR
		Jump Loop JL	JS	JC			
		Wait For WT	W1	W2	WE		WH
		Set Point SP	S1	S2			HR
		Jump Loop JL	JS	JC			
		Wait For WT	W1	W2	WE		WH

Programming Chart

Make photocopies of this page and the previous page, then record your parameters and entire program step by-step.

Prog. No. ________ System ________ Programmer ________ Date ________ Page ________ of ________

JL							
Wait For WT	W1	W2	WE		WH	WM	
Set Point SP	S1	S2			HR	MN	
Jump Loop JL	JS	JC					
Wait For WT	W1	W2	WE		WH	WM	
Set Point SP	S1	S2			HR	MN	
Jump Loop JL	JS	JC					
Wait For WT	W1	W2	WE		WH	WM	
Set Point SP	S1	S2			HR	MN	
Jump Loop JL	JS	JC					
Wait For WT	W1	W2	WE		WH	WM	
Set Point SP	S1	S2			HR	MN	
Jump Loop JL	JS	JC					
			WE		WH		
Set Point SP					HR		
			WE		WH		
Set Point SP					HR		
			WE		WH		

Tuning

For optimum control performance, it is necessary to tune the Series 1500 to your thermal system. At this point you should already have a program profile entered into the 1500. This profile needs to be as nearly typical of your system requirements as you are able to predict.

Recommended Tuning Reference

There are a number of quality references on the art of tuning electronic controllers to the systems they control. If you are not an instrument technician qualified to tune thermal systems, we suggest that you obtain and become familiar with the reference below before attempting to tune your system. Remember that the time you spend tuning your system is relative to the quality of control you need.

Process Control Instrumentation Technology - Third Edition
by **Curtis D. Johnson Hardcover, 1982, 497** pp.
ISBN: 0-471-05789-4 approx. $37.00

"Its overall objective is to provide instructional material for a general understanding of process control characteristics such as elements, modes, and stability along with detailed knowledge of measurement technique, control mode implementation, and final control element functions." Johnson

Using a Chart Recorder

The tuning procedure will be greatly simplified if you use a chart recorder to assist in tuning the Series 1500. See Page 35 for analog retransmit outputs to connect to a chart recorder. Refer to Page 52 for signal conditioner output scaling.

CAUTION: Be sure the Series 1500 is in a Warm Start condition (DIP Switch #6 OFF) In order to save your tunlng entrles. Also record your experimental, and then final settlngs on a copy of the Guarded Access Chart available In this sectlon of the manual.

The analog retransmit output provides a chart recorder output for both temperature and humidity.

If you don't have a chart recorder available, you can still plat the time vs. temperature system response. Record the 1500's ACTUAL display readings on graph paper with an x, y axis to accomplish the same thing.

How to Make the 1500 a Simple ON/OFF Control

If you want your 1500 to function as a simple ON/OFF control in either channel, just set the Proportional Band (Pb) for that channel to zero.

Manual Tuning

For optimum control performance, tune the 1500 to the themal system. The tuning settings here are meant for a broad spectrum of applications; your system may have somewhat different requirements. Refer to the key flow charts, diagrams and definitions on Pages 42 - 61 for prompt location and description. Repeat this tuning procedure for both Channel 1 and 2.

NOTE:

When tuning in the Heat mode, use H where X appears.
When tuning In the Cool mode, use C where X appears.

1. Apply power to the Series 1500 and enter a set point in the Change Data Mode (CHG DATA). Next, go into the Change Parameter Mode (CHG PARA), and enter (1) at the GA parameter. Using the MODE, UP/DOWN and ENTER keys, set the operating parameters initially:

Proportional Band:	1X P b = O	Cycle Time:	1X CT = 5
Reset:	1X RS = 0.00	Dead Band:	1X d b = O
Rate:	1X RT = 0.00	Caiibration Offset:	1X CA = 0
Rate Band:	1X Rb = 3.00		

To tune a parameter relating to heat, set the set point above ambient temperature, for cooling, set the set point below ambient temperature. Allow actual process temperature to stabilize at or near set point. The ACTUAL display indicates when the load is stabilized near set point.

2. Proportional Band Adjustment: Gradually increase Pb until the ACTUAL display temperature stabilizes to a constant value. The temperature will not be right on set point because the initial reset value is 0.00 repeats per minute. The ACTUAL temperature will stabilize below the desired set point. (When Pb = 0, RS, Rb, RT, and Ct are inoperative, and the 1500 functions as a simple ON/OFF control with a 3°F/1.7°C switching differential.

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

4. Rate Adjustment: Increase RT to 1 .OO min. Then raise set point by 20° to 30°F/ 11° to 17°C. Observe the system's approach to set point. If the bad temperature overshoots set point, increase RT to 2.00 minutes.

5. Cycle Time Adjustment: Set CT as required. Optimum system controls is always 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.

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 (as much as ±90°F/±50°C) between that temperature, perhaps at another point in the system, and the process value showing in the alphanumeric display. Then enter the amount of CAL Offset YOU want Calibration offset adds or subtracts degrees from the value of the input signal.

How to Run and Halt A Program

Here is how to run and halt Series 1500 programs.

How to Run a Program

When you have all program steps defined and entered, press RESTART to return the processor to Step 01. Then press RUN/HALT to begin the program.

How to Halt a Program

To stop the program, press RUN/HALT. The PROG HALT LED will light. The program stops in the current step.

The processor holds all values for the outputs as they were at the moment the program stopped. That means the controller is controlling to a fixed value, the set point at the instant of termination.

How to Restart a Program

Press the RUN/HALT key to restart the program. The PROGRAM HALT LED goes out. If you entered no new data or did not change steps during the halt, the program resumes where it left off, completing the time remaining in the current step.

If, however, you changed the step data or the step number during the halt, the processor starts at the beginning of the step in progress when you hatted the program.

Remote Hold Input

Closing the remote hold input switch causes the Series 1500 to pause until the switch opens. Remote hold is indicated by a flashing “RUN/HALT” LED. The Series 1500 actively maintains the set point and event output conditions which exist at the time when remote hold occurs.

Data Communications, Commands and Syntax

In this section you'll learn the Series 1500 data communications. See Figure 14 in Chapter 1 for RS422 and RS423 pin designations, and also for locating and making the required RS422/423 jumper selection.

The Series 1500 data communications package provides you with a foundation for a sophisticated communications system based on your system needs and your software development. Your Watlow Sales Engineer has available, upon request, a Series 1500 data communications sample computer program with sample profiles.

Communication Parameters

The Series 1500 with data communications operates with these parameters.

Baud Rate:	1200 Baud
Character Format:	7 Data Bits
Stop Bits:	1 Stop Bit
Parity:	Odd Parity

Protocol

You can select one of two hardware interfaces:
1) RS422A for a "multidrop" or (multiple device) network, up to ten devices total; with 4000' network length limit, or
2) RS-423A (RS-232C compatible) for one on one communication on a 50' network you **need, you must use the correct combination of interface and protocol.**

We use ANSI X3.28 Protocol, based on ANSI X3.28 - 1976 Subcategories 2.2, and A3, with the RS-422A **interface to run a multiple devicenetwork We also use XON/** XOFF Protocol, a simpler protocol, to run a two device network with an RS-423A interface. XON/XOFF Protocol requires no **responses** to messages like the ANSI X3.28 Protocol does. **XON/XOFF will also work with theRS422A interface, but the** network is limited to two devices. Likewise, ANSI X3.28 Protocol, which provides a response to every message, will work with the RS-423 interface. But again you are limited to two devices.

Command Rules

The following listing shows the command and the typical Series 1500's response string. The labels beneath each parameter in a command or response string are here for your information only: they will not appear on your computer screen.

- A command word with a question mark is a direct request for a response, a query.
- The __'s in the pages that follow are the number of character positions in a parameter available for entry or response.
- Each parameter in a string must have at least one digit or an asterisk entered.
- To avoid making any entry for a given parameter, enter an asterisk in the string.
- Each parameter in a string must be separated by at least one space.
- Decimal points shown in the typical string must be understood; they are not transmitted or received.
- The Series 1500 responds to and sends the minus sign, indicating a negative value.
- Whenever you send an STP command (to enter step parameters) the Series 1500 is automatically halted.
- The correct protocol must be applied to each command string for the communications to function.
- Parameter limits are listed in the Guarded Access and General Parameter Charts located in this section.
- An operator at the Series 1500 front panel and an operator at a computer remotely-linked to the same Series 1500 both have equal access to the controller. Priority is on a first in, first out basis.
- Communications are not affected in any way by the keyboard lockout status.
- RS-422, STX-ETX.
- In RS-423 a *CR' (carriage return) is the required line terminator.
- With the RS-422 interface, the Series 1500 sends an "ACK" or "NAK" after each command. For a "NAK," you may use "ERR?" to determine the cause of the error.
- With the RS-423 interface there is no automatic indication of a successful command. You may query "ERR?" after each command to determine if the Series 1500 accepted it.

Command Words

The Series 1500 **recognizes** and responds to the following list of syntactical command words through a serial communication interface.

ACT? Requests actual process inputs.

MTR? Requests information on **the current step.**

ST?? Requests programmed information for a step.

STP Enter step information.

PTR? Request real time of day, and high and low set point limits.

PTR Enter real time of day, and high and low set point limits.

GAI? Request the Guarded Access information for Ch-1.

GA1 Enter the Guarded **Access** parameters **for Ch1.**

GA2? Request the **Guarded Access information for Ch-2.**

GA2 **Enter the Guarded Access parameters for Ch-2.**

STS? Request the program Run/Halt and End status information_

STS Enter the program Run/Halt and End status.

ALM? Request any current alarm code infonnation.

ALM 00 Clear all alarm codes.

NXS-- **Put the Series 1500 into Step# - - .**

ERR? Request the last communication error, and then clear the error code to 0.

PDA? Request the process and/or deviation alarm set points.

PDA Enter the process and/or deviation alarm set points.

TIM? Requests real time of day.

TIM Enter real time of day.

LIM? Requests high and low set point limits

LIM Enter high and low setpoint limits

LOC? Requests keyboard lockout status

LOC Enter keyboard lockout status

RCY? Request the Recycle option

RCY Enter the Recycle option

WARNING: Take all necessary precautions to ensure that BOTH the Series 1500 front panel and a remote computer Interface are prevented from Initiating output actlon from the Series 1500 when maintenance personnel are working on the system. Failure to do so **could result In damage to equipment** and/or **injury to personnel.**

Command Words and Syntax

Here is a list of the command words with the syntax. **Limits for all parameters** are in the Guarded Access and General Parameters Charts located in this section of the Series 1500 manual. NOTE: Decimal points in general are not available for the Series 1500 T/C version. See the T/C charts on pp. 50 and 52.

ACT? **Requests the current ACTUAL process Inputs.**

Sample Response: 2050 0820

Ch-1 *Actual* *Ch2 Actual*

MTR? Monitors information on the current step.

Step#	Step Type	Ch-1 Set Point	*Ch2* Set Point	Ch-1 Events	Ch-2 Events	Hr.	Mn.	Sec.
						Time Remaining In Step		

Sample Response:
0501 23400840150811 3200

Note: Event (Auxiliary) Outputs ON or OFF for Ch-1 and Ch-2

- Monitoring and entry requires the decimal equivalent of the binary number totaling the states of the events for each channel.
- Each of the event outputs has a "1" state for ON or a "0" state for OFF.
- If DIP SW-1 is ON, there are 4 events per channel, 8 total.
  If DIP SW-1 is OFF, Event #4 for each channel is an alarm, and thus there are only 3 events per channel, 6 total.
- Event #4 (or 3) holds the most significant digit position in the binary number denoting the states of the events.
- To find the decimal equivalent, add the integers representing the ON state for each event:
  (Event 4=8, Event 3=4, Event 2=2, Event 1=1)

0000=0	0001 =l	0010=2	0011=3
0100=4	0101=5	0110=6	0111-7
1000-8	1001=9	1010=10	1011 = 11
1100=12	1101=13	1110=14	1111 = 15

000=0	001=1	010=2	011=3
100=4	101=5	110=6	111=7

- The individual events are programmed to a "1" or "0" state when a step is entered; they remain in the same state until a different step changes them.

STP? -- **Requests.the programmed informatlon for Step# – – .**

The first response parameter is the Step Type:
0000 = Blank Step
0001 = Set Point Step
0002 = Jump Loop Step
0003 = Wait For Step

Sample Transmission:
STP? 22

Blank Step - STP?

ı=Unprogrammed parameter

0000	****	****	****	****	****	****	****
Step Type	Ch-1 set Point	Ch-2 set Point	Ch-1 Events	Ch-2 Events	Hr. Duradon Of The Step	Mn.	Sec.

Sample Response:
0000 **** **** **** **** **** **** ****

Set Point Step - STP?

0001	— — —.—	— — — . —	— — — —	— — — —	— — — —	— — — —	— —
Step Type	Ch-1 Set Point	Ch-2 Set Point	Ch-1 Events	aI-2 Events	Hr. Duration Of The Step	Mn.	Sec.

Sample Response:
00011234084000050011 00020030 0000

Jump Loop Step - STP?

ı= Unprogrammed parameter

0002	— — — —	— — — —	****	****	****	****	****
Step Type	Jump Step	Jump Count					

Sample Response:
0002 0004 0010 **** **** **** **** ****

Wait Step- STP?

***=Unprogrammed parameter**

-99	-99	3200	°F	— — — —	— — — —	— — — —
Step Type	Wait For Ch-1	Wait_ Ch-2	Wait For Event	Wait For Hours	Wait For Minutes	wait For Seconds
				Real Time		

Sample Response:
0003 1234 0840 0001 ** 0015 0010 0030**

STP **Program a step.**

The first parameter entered after the step number is the Step Type.

00 = Blank Step
01 = Set Point Step
02 = Jump Loop Step
03 = Wait For Step

Note: **Whenever you send an STP** command (to enter Step parameters) the Series 1500 halts automatically.

Blank Step - STP

. = Unprogrammed parameter

— —	00	0001	— — — .—	— — — . —	— — — —	— —
Step #	Step Type	Ch1-Set Point	Ch-2 Set Point	Ch-1 Events	Ch-2 Events	Hr. Mn. Sec. Duration of the step

Sample Transmission:
STP2200*******
or
STP 22 00

Set Point Step - STP

****	****	****	****	****				
Step I	Step Type	Ch-1 Set Point	Ch-2 set Point	Ch-1 Events	Ch-2 Events	Hr. Mn. Sec. Duration Of The step		

Sample **Transmission:**
STP 1201 1234 0820 00 03 01 25 00

Note: **Enter** Event (Auxiliary) Outputs ON/OFF for Ch-1 and Ch-2 per NOTE with "MNTR?" on p. 60.

Jump Loop Step - STP

___	02	___	_____
Step No.	Step Type	Jump Step	Jump Counts

Sample Transmission:
STPI202100004

Wait Step - STP

= Unprogrammed parameter

999.9	03	___.__	___.__	_____	*	__	__	__
Step #	**Step Type**	**Ch-1 set** Point	**Ch-2 set Point**	**Wait For Event**		**Hf.**	**Mn.**	**Sec.**
						Wait For Real Time **of Day**		

Sample Transmission:
STP 14 03 2100 0900 1*08 30 00

PTR?

Requests real time of day, and upper and lower set point limits.

__	__	__	____	___.__	___.__	___.__
HR	**MN**	**SC**	**Ch-1 upper** Limit	**Ch-1 Lower Limit**	**Ch-2 Upper Limit**	**Ch-2 Lower Limit**
RealTme Clock						

Sample Response:
08 25 00 9999 -999 9999 -999

PTR

Enter real time of day, and upper and lower set point limits.

__	__	__	____	____	____	____
HR	**MN**	**SC**	**Ch-1 Pref** Limit	**Ch-1 Lower** Limit	**Ch-2 Upper** Limit	**c2 Lower** Limit

Sample Transmission:
PTR 08 25 00 9999 -999 9999 -999

TIM? LIM Syntax

TIM? Requests real time of day only

HR MN SC

Sample Response
12 34 56

TIM Enter real time of day only

HR MN SC

SampleTransmission:
TIM 23 59 59

LIM? Requests upper and lower set point limits

CH-1 Upper Limit Ch-1 **Lower Limit** **CH-2 Upper Limit** **CH-2 Lower Limit**

Sample Response:
8765 4321 1234 -123

LIM Enter upper and lower set point limits

Ch-1 Upper Limit **Ch-1 Lower Limit** **CH-2 Upper Limit** **CH-2 Lower Limit**

SampleTransmission:
LIM 8765 4321 1234 -123

LOC? Requests keyboard lockout status

0001

SampleTransmission:
LOC 0001

LOC Enter keyboard lockout status

0001

SampleResponse
0001

RCY? Request the Recycle option

Recycle

Sample Response:
01

RCY Enter the Recycle option

Recycle

Sample Transmission:
RCY O1

GAI?

Single PID:

Ch1 Prop. Band	Ch1 Reset	Ch1 Rate	Ch1 Rate Band	Ch1 Rate Time	Ch1 Cycle Time Heat	Ch1 Calibration Offset

Sample Response:
0048 0012 0034 0003 0029 0021 0012

Dual **PID:**

Ch1 Prop. Band Heat	Ch1 Reset Heat	Ch1n Rate Heat	Ch1 Rate Band Heat	Time Heat	Ch1 Dead Band	Ch1 Calib. Offset	Ch1 Prop. Band Cool	Ch1 Reset Cool	Ch1 Rate Cool	Ch1 Rate Band Cool	Ch1 W e lime Cool

Sample Response:
0048 0012 0034 0003 0029 0021 0012 0084 0021 0043 0000 0020

GA1

Single PID:

Ch1 Prop. Band	Ch1 Reset	Ch1 Rate	Ch1 Rate Band	Ch1 Cycle Time	Ch1 Dead Band	Ch1 Calib. Offset

SampleCommand:
GA1 0048 0012 0034 0003 0029 0021 0012

Dual PID:

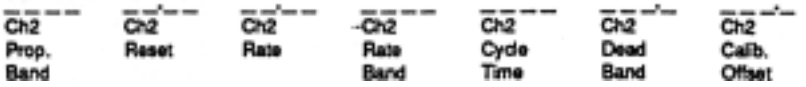
Ch1 Prop Band Heat	Ch1 Reset Heat	Ch1 Rate Heat	Ch1 Rate Band Heat	Ch1 Cycle Time Heat	Ch1 Dead Band Calib. Offset	Ch1 t	Ch1 Reset Cool	Ch1 Rate Cool	Ch1 Rate Band Cool	Ch1 Cycle Time Cool

Sample Response:
GA1 0048 0012 0034 0003 0029 0021 0012 0084 0021 0043 0000 0020

GA2? STS Syntax

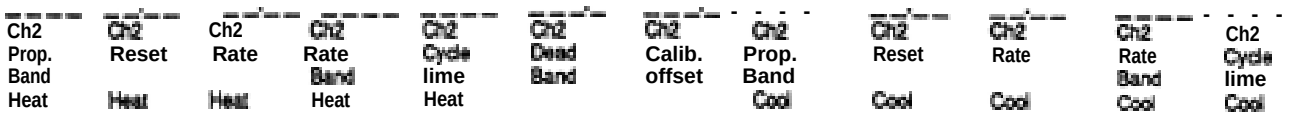
GA2?

Single PID:



Sample Response:
00480012003400030029 **00210012**

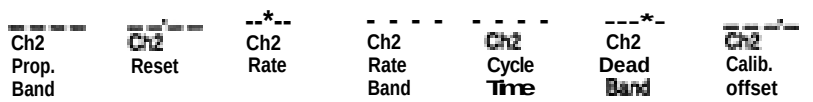
Dual PID:



Sample Response:
0048 0012 0034 0003 0029 0021 0012 0058 0021 0043 0000 0020

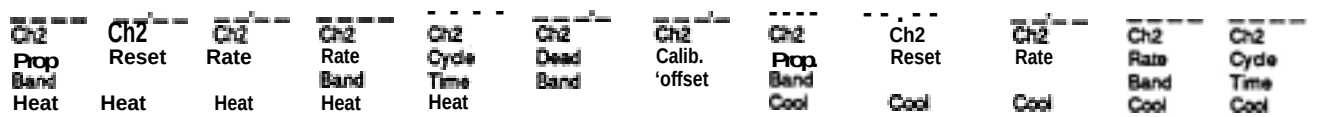
GA2

Single **PID:**



SampleCommand:
GA2 0048 0012 0034 0003 0029 0021 0012

Dual PID:



SampleCommand:
GA2 0048 0012 0034 0003 0029 0021 0012 0058 0021 0043 0000 0020

STS? **Request the program Run/Halt and End status.**

1=Run,O=Halt, 2 = Remote Hold
1 = Program ended, 0 = Program not ended

Run/Halt Program End

Sample Response:
01 00

STS **Send Run or Halt to the Series 1500**

1= Run,O=Halt

Run/Halt

Sample Transmission:
STS O1

Note: STS = 00 maintains all Event and **Control** Outputs at **levels** existing when the program halts.

ALM? **Request current alarm code information.**

Alarm Code

Sample Response:
0018

Note: These alarms are additive and may occur in any combination. To decode, use the following list. Subtract out the largest possible integer first, then the next largest possible integer, and so on.

The integer 16 is the largest possible integer to subtract out, leaving a remainder of 2.
The integer 2 stands alone. Thus Alarm Codes **16** and 2 are now present in the system.

Alarm Code		
1	=	Low RAM back-up battery.
2	=	Power interrupt.
4	=	Ch-1 Actual has exceeded UP, the upper process alarm value.
8	=	CH-1 Actual has exceeded LP, the lower process alarm value.
16	=	Ch-1 Actual has exceeded Ud, the upper deviation alarm value.
32	=	Ch-1 Actual has exceeded Ld, the lower deviation alarm value.
64	=	Ch-2 Actual has exceeded UP, the upper process alarm value.
128	=	Ch-2 Actual has exceeded LP, the **lower** process alarm value.
256	=	Ch-2 Actual has exceeded Ud, the upper deviation alarm value.
512	=	Ch-2 Actual has exceeded Ld, the lower deviation alarm value.

ALM 00 **Clear all alarm conditions now occurring.**

Sample Transmission:
ALM 00

NXS -- Put **the Series 1500** into **Step - - now.**

Sample Transmission:
NXS 25

ERR? **Request the last communcation error code and clear the error code register to 0.**

Error codes are listed in the Error Code section following this one.

Error Code

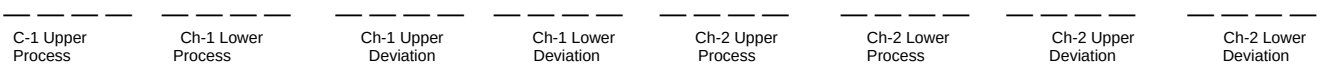
Sample Response:
0111

PDA? PDA Syntax

PDA? Request values for the process and deviation alarm set points.

Sample Response:
0999 -099 0555 -555 0101-001 0999 -099 0999 -999

PDA Enter values for the process and deviation alarm set points.



Sample Transmission:
PDA 0999 499 0555 -555 0101-0010999 -099 0999 -999

Where **To Go** From Here

As soon as you gain an understanding of Series1500 communications, we recommend that you put the capability to wok You may write computer programs based on this command syntax. You will also be able to build and store profiles for the Series 1500.

Data Communication Error Codes

When you query "ERR?" using the correct protocol, a Series 1500 linked to a computer will respond with these 3-digit **data** communications error codes. The code will appear **on your computer** screen. A **definition listing for each code is in the right-hand columns below.**

1	**Parity error**
2	**Framing error**
3	**Over** run error
10	Talking while should be listening
11	Transmit buffer overflow
12	Receive buffer overflow
50	No command word match
51	Invalid character or too few command parameters; not recognizable
90	**LOC** value out of limit
100	Step # or step type entered was out of limit
101	Ch-1 Set Point for any step was out of limit
102	Ch-2 Set Point for any step was out of limit
103	Ch-1 Event Output for any step is out of limit
104	Ch-2 Event Output for any step is out of limit
105	HR for any step was out of limit
106	MN for any step was out of limit
107	SC for **any step was** out of limit
108	JS **for any step was out of limit**
109	JC for any step was out of limit
110	Real time hours are out of limit
111	Real time minutes are out of limit
112	Real time seconds are out of limit
113	Ch-1 Upper Limit is out of limit
114	Ch-1 Lower Limit is out of limit
115	Ch-2 Upper Limit is out of limit
116	Ch-2 Lower Limit is out of limit
117	Proportional Band for Ch-1 is out of limit
118	Reset for Ch-1 is out of limit
119	Rate for Ch-1 is out of limit
120	Cycle time for Ch-1 is out of limit
121	Dead Band for Ch-1 is out of limit
122	Proportional Band for Ch-2 is out of limit
123	Reset for Ch-2 **is out** of limit
124	Rate for Ch-2 is out of limit
125	Cycle time for Ch-2 is out of limit
126	Dead Band for C h-2 is out of limit
127	Run/Halt command is out of limit
126	Alarm clear command is out of limit
129	Step # being forced to is out of limit
130	**Recycle command is out of limit**
131	**Rate Band for Ch-1 is out of limit**
132	Rate Band **for Ch-2** is **out of limit**
133	**Calibration adjustable for Ch-1 is out of limit**
134	**Calibration adjustable for Ch-2 is out of limit**
135	**Lower deviation for Ch-1 is out of limit**
136	**Upper deviation for Ch-1 is out of limit**
137	**Lower process for Ch-1 is out of limit**
138	**Upper process for Ch-1 is out of limit**
139	**Lower deviation** for Ch-2 is out of limit
140	Upper deviation **for Ch-2 is out of limit**
141	**Lower process for Ch-2 is out of limit**
142	**Upper process for Ch-2 is out of limit**

Bad Sensor Indication and Troubleshooting

Indication

When a bad (open or shorted) sensor occurs for Ch-1 or Ch-2, the ACTUAL display will show "- - - - ". The Series 1500 control outputs in both channels de-energize when a bad sensor occurs. The events outputs remain energized. Bad sensor on Ch-1 will produce alarm codes A2 and A4. Bad sensor on Ch-2 will produce alarm codes A6 and A8.

Troubleshooting

Follow this procedure to troubleshoot a suspected bad sensor:

!

CAUTION: Use National Electric Code standard safety procedures when troubleshooting an electronic controller. Use grounded test equipment, non-conductive tools and floor safety mats.

1. Remove power from the unit.
2. Check each sensor input with an ohmmeter at the terminals with the sensor installed. Use the Connection Label pasted on the right side of the Series 1500 case to locate the correct terminals. With an open sensor, the resistance will read greater than 330 ohms. A shorted sensor will have a resistance less than 70 ohms.
3. Replace the bad sensor.
4. Apply power to the Series 1500.

Field Calibration Procedure

— RTD Calibration —

The Series 1500 is shipped totally calibrated from the factory; it does not need field calibration, and will not except in unusual circumstances. This calibration procedure will enable you to calibrate the Series 1500 low voltage analog input and output signals for accuracy.

O 1

Equipment Needed

1. Two 100 ohm decade boxes.
2. Two board connectors, Watlow P/N Z100-0285-0000.
3. Digital voltmeter.

O 1 **WARNING**

Use National Electric Code standard safety procedures when calibrating an electronic controller. Use grounded test equipment, non-conductive tools and floor safety mats. Carelessness could result in electric shock.

Wiring

1. Remove the Series 1500 from its case and attach the two Watlow board connectors to the power supply board (A007-1313 or A007-1714) and the signal conditioner board (A007-1316 or A007-1719).

   • Power supply board is on the right looking at the rear of the unit.
   • Signal conditioner board is on the left looking at the rear of the unit.

O 2

2. Wire correct line voltage per wiring diagrams on page 37.

3. Connect decade box for Channel 1: S1 to Term. 5, S2 to Term. 6, and S3 to Term. 7. Short S2 to S3 at decade box.

4. Connect decade box for Channel 2: S1 to Term. 8, S2 to Term. 9, and S3 to Term. 10. Short S2 to S3 at decade box.

O 2 **WARNING**

Use care to avoid electric shock when working with the Series 1500 control chassis outside of its case. Line voltage is present on both the power supply and signal conditioner circuit boards. Carelessness could result in electric shock.

Calibration

1. Document DIP Switch positions and all values in Guarded Access, pp. 53 & 55.

2. Check DIP Switches if #7 is OFF use °F values, #7 is ON, use °C values.

3. Set Ch-1 and Ch-2 inputs to (136.59) [135.97] ohms.

4. Connect DVM, (-) minus to Term. 1, (+) plus to test point E-120 on signal conditioner board.

5. Power up control. It will power up with Ch-1, °F or °C and Monitor Data LED lit. Step flashes A1, hit CLEAR to stop. If the program halt LED is not lit, press RUN/HALT key.

6. Adjust span pot for 5.000VDC on DVM.

NOTE:

Use the regular resistance values (in parenthesis) for calibrating JIS Curve #3916. Use the resistance values in brackets for calibrating DIN Curve #3850.

Calibrate Channel 1 °F Output

7. Remove (+) plus lead from E-120 and connect to Term. 4. Set Ch-1 input to (92.93) [93.03] ohms. Adjust Ch-1 SC-Lo pot for 0.000V on DVM. Ch-1 Actual should be 000.0 ± 0.5°F (-18°C).

8. Set Ch-1 input to (294.91) [291.56] ohms and adjust Ch-1 SC-Hi pot for 4.950VDC. Actual should read 990.0° ± 0.5°F (532°C).

9. Repeat Steps 7 and 8 until all the readings are correct with no further adjustment necessary.

10. Set Ch-1 input to (199.37) [197.69] ohms. DVM should read 2.50VDC. Actual should read 500° ± 1.0°F (260°C).

Calibrate Channel 2 °F Output

11. Remove DVM (+) plus lead from Term. 4 and connect to Term. 3. Set Ch-2 input to (92.93) [93.03] ohms. Adjust Ch-2 SC-Lo pot for 0.000V on DVM.

12. Set Ch-2 input to (294.91) [291.56] ohms and adjust Ch-2 SC-Hi pot for 4.950VDC on DVM.

13. Repeat Steps 11 and 12 until all the readings are correct with no further adjustment necessary.

NOTE:

#13 thru #16 required only if %RH analog output is used.

Calibrate %RH Output

14. Remove DVM (+) plus lead from Term. 3 and connect to Term. 2. Set Ch-1 and Ch-2 inputs to (136.59) [135.97] ohms. Adjust F.S. pot for 0.500VDC on DVM. Ch-2 Actual should read 100.0 ± 1.0.

15. Set Ch-2 input to (112.75) [112.53] ohms. Adjust zero pot for 0.000VDC on DVM. Ch-2 should read 00.0 ± 1.0.

16. Repeat Steps 14 and 15 until readings are correct.

%RH analog output does not work with a voltage input on Channel 2

17. Set Ch-2 input to (132.28) [131.74]. DVM should read 0.325± 0.005VDC and Ch-2 Actual should read 64.4 ±1.0.

NOTE:

#17 thru #21 required only if °C analog output is used.

Calibrate Channel 1 °C Output

18. Power down control. Set DIP Switch #7 ON.

19. Disconnect DVM (+) plus from Term. 2 and connect to Term. 11. Power up control. Set Ch-1 input to (100.00) [100.00] ohms. Ch-1 Actual should read 000.0°C. Adjust °C Lo pot for 0.00V on DVM.

20. Set Ch-1 input to (284.04) [280.90] ohms. Ch-1 Actual should read 500.0°C. Adjust °C Hi pot for 2.500VDC on DVM.

21. Repeat Steps 19 and 20 until readings are correct.

22. Set Ch-1 input for (195.70) [194.07] ohms. Actual should read 250.0°C. DVM should read 1.25VDC.

Field Calibration Procedure

— Thermocouple Calibration —

The Series 1500 is shipped totally calibrated from the factory; it does not need field calibration, and will not except in unusual circumstances. This calibration procedure

Equipment Needed

1. One Millivolt Source (two if doing both channels simutaneously).
2. Two board connectors, Watlow P/N Z100-0285-0000.
3. One C/J (Cold-Junction) Compensator (Omega "MCJ" Series) for the T/C (Thermocouple) type being calibrated (two if doing both channels simultane ously).
4. T/C Extension Wire.

WARNING

Use National Electric Code standard safety procedures when calibrating an electronic controller. Use grounded test equipment, non-conductive tools and floor safety mats. Carelessness could result in electric shock.

Wiring

1. Remove the Series 1500 from its case and attach the two Watlow board connectors to the power supply board (A007-1313 or A007-1714) and the Signal Conditioner board (A007-1316 or A007-1720).

   - Power supply board is on the right looking at the rear of the unit.
   - Signal conditioner board is on the left looking at the rear of the unit.

WARNING

Use care to avoid electric shock when working with the Series 1500 control chassis outside of its case. Line voltage is present on both the power supply and signal conditioner circuit boards. Carelessness could result in electric shock.

2. Wire correct line voltage per wiring diagrams on page 37.

3. Connect the "INPUT" terminals of the C/J Compensator (via appropriate connector & copper T/C extension wire) to the Ch-1 Signal Conditioner CH-1 Input Terminals (observe proper polarity) per diagram on page 35.

4. If calibrating both channels at the same time, also connect a C/J Compansator to the CH-2 terminals.

5. If calibrating one channel at a time, connect the CH-2 Signal Conditioner Input Terminals (8 & 10) together with a short piece of wire to avoid an "Open T/C" alarm.

6. Connect the "OUTPUT" terminals of the CJ Compensator to the mV (millivolt) source, observing proper polarity.

Calibration

NOTE:

The following procedure applies to all three T/C types, although the Input/Output values may differ between types. Use the values corresponding to

1. Document DIP Switch settings and values in Guarded Access, pages 54 & 56.

2. Set Series 1500 DIP Switches 3 & 6 ON, all others OFF.

3. Set mV Source as follows.

Type	Setting
J	-0.885 mV, (0°F)
K	-0.692 mV, (0°F)
R	+2.282 mV, (550°F)

4. Connect DVM, (-) minus to Signal Conditioner connector terminal 1 and (+) plus to test point TP-10 on the Signal Conditioner Board.

5. Power up Series 1500 Control. Will power up in deg. F. Press "CLEAR" to stop flashing. Allow atleast 15 minutes for the control to stabilize.

6. With mV Source set as follows, adjust "SPAN POT" for 5.000VDC on DVM.

Type	Setting
J	-0.885 mV, (0°F)
K	-0.692 mV, (0°F)
R	+2.282 mV, (550°F)

7. Connect DVM, (+) plus to TP100 (TP99 for CH-2) and adjust "Zero Adjust Pot" for the following DVM reading at TP-100 (TP99 for CH-2). Then verify that Actual reads as follows.

Type	DVM Reading	Actual Reading
J	0.0VDC ± 0.003	0°F ± 3
K	0.0VDC ± 0.003	0°F ± 3
R	0.8594VDC ± 0.003	550°F ± 3

8. Set mV Source as follows, and adjust "F.S. POT" for the corresponding DVM reading. Actual should read the value shown.

Type	mV Source	DVM Reading	Actual Reading
J	39.40mV, (1300°F)	2.031VDC ± 0.003	1300°F ± 3
K	52.93mV, (2400°F)	3.750VDC ± 0.003	2400°F ± 3
R	20.28mV, (3100°F)	4.884VDC ± 0.003	3100°F ± 3

9. Set mV Source as follows. DVM and Actual readings should be as shown.

Type	mV Source	DVM Reading	Actual Reading
J	17.19mV, (600°F)	0.9375VDC ± 0.005	600°F ± 5
K	26.97mV, (1200°F)	1.875VDC ± 0.009	1200°F ± 6
R	10.27mV, (1800°F)	2.812VDC ± 0.005	1800°F ± 5

10. Repeat Steps 5-8 until all the readings are correct with no further adjustments necessary.

11. Turn power OFF. Set DIP Switch #7 ON (deg. C). Move DVM (+) plus lead to Signal conditioner connector terminal 11 (terminal 4 for CH-2). Turn power back ON.

12. Set mV Source as follows, and adjust "Deg. C Lo Pot" for the corresponding DVM reading. Actual should read the value shown.

Type	mV Source	DVM Reading	Actual Reading
J	-0.885mV, (0°F)	-0.028VDC ± 0.003	- 18°C ± 3
K	-0.692mV, (0°F)	-0.028VDC ± 0.003	- 18°C ± 3
R	2.282mV, (550°F)	+0.448VDC ± 0.003	287°C ± 3

13. Set mV Source as follows, and adjust "Deg. C Hi Pot" for the corresponding DVM reading. Actual should read the value shown.

Type	mV Source	DVM Reading	Actual Reading
J	39.40mV, (1300°F)	1.100VDC ± 0.003	704°C 3
K	52.93mV, (2400°F)	2.055VDC ± 0.003	1315°C ± 3
R	20.28mV, (3100°F)	2.662VDC ± 0.003	1704°C ± 3

14. Set mV Source as follows. DVM and Actual Readings should be as shown.

Type	mV Source	DVM Reading	Actual Reading
J	17.19mV, (600°F)	0.4922VDC ± 0.003	315°C ± 3
K	26.97mV, (1200°F)	1.014VDC ± 0.003	649°C ± 3
R	10.27mV, (1800°F)	1.534VDC ± 0.003	982°C ± 3

15. Repeat Steps 12-14 until all the readings are correct with no further adjustments necessary.

16. If calibrating one channel at a time, power-down the Series 1500 and mV Source. Move the C/J Compensator from the CH-1 connector terminals to the CH-2 terminals, and move the shorting wiring to the CH-1 terminals. Then perform Steps 6-14 for CH-2.

NOTE

Steps 10-14 only required if the deg. C Analog Output is used.

Specifications

General Features

- Dual channel closed loop control.
- Temperature and relative humidii.
- 51 time-based steps for ramping.
- 8 event outputs per step.
- 1 **event input.**
- 1 remote hold input.
- Data communications interface optional.
- Fully programmable parameters.
- Membrane faceplate.
- User-friendly, 1/2 DIN plug in chassis.
- Three year warranty.

Control Mode

- Microprocessor-based user selectable modes.
  - Dual channel with dual control outputs per channel.
- Control parameters user selectable.
  - Channels 1 & 2 as Temp & Temp **or** Temp & RH.
  - On/Off switching hysteresis: 0.3°F or 0.3% RH with RTD or 0-5VDC **inputs.**
  - **On/Off** switching hysteresis: 3.0°F for T/C.
  - PID parameters per channel or per output.
    Proportional band: 0-500°F or 060% RH.
    Reset: 0.00-20.00 repeats per minute.
    Rate: 0.00-5.00 minutes.
    Rate band: 0-3 times proportional band.
    Cycle time: 0-60 seconds.
  - Deadband: +20° On/Off or ±20° with PID.
- Alarm parameters user selectable.
  - Latching or non-latching, both channels.
  - Process high & low and deviation high & **low per** channel.
- 51 steps each selectable as:
  - Set point value.
  - Ramping, value and time.
  - Wait For, time or value
  - Jump/Loop to another step.

Operator Interface

- Membrane front panel user-friendly I/2 DIN size.
- Four digit 1/2" LED's displaying actual **process input value.**
- **-Eight** character alphanumeric 1/2" LED's displaying set point, step number, and various prompts and values **for the 1500.**
- Nineteen LED's to indicate various status conditions.
- Nine keys **for** control and value entry.

Input

. Thermocouple, RTD, **and electrical % RH** input.

- Automatic cold junction compensation for thermocouples.
- RTD input 2 or 3 wire, platinum, 100ohms Ω @ 25°C, calibrated to curve #3916 (0.003916ohms/ohms/°CΩ Ω Ω Ω
  DIN curve calibration ##3850 (0.003850ohms/ohms/°C available upon request.
- Sensor break protection de-energizes output to protect system.
- **°F, °C** or % **RH is** user selectable, RTD version.

Specifications

- Temperature ranges:
  S: -100 1400°F or **-73 to 760°C**
  K t/c: -100 to 2500°F or **-73 to 1371 °C**
  R t/c: 500 to 3200°F **or 260 to 1760°C**
  RTD: -99.9 to 9999°F **or -99.9 to 537.7%**
- T/C inputs must be ungrounded.
- %RH ranges (on channel #2 only) and user selectable. Range limits are 0.0 to 100.0% RH Input types:
  - RTD: % RH is based **upon Channel #1 RTD** as **dry** bulb and Channel #2 **RTD as** -99 .
  - **0-5/DC:' Direct** % RH signal on Channel #2.
- Dual RTD input includes analog retransmit of input signal levels: -0.5 to 5.0VDC for Temp and 0 to 0.5VDC for %RH.
- Dual T/C input includes analog **retransmit of input signal levels: 1.5625mV per** LSD. 0° = 0 Volts.
- Calibration offset of input signals.
  - RTD: ±10.0°F or °C.:
  - T/C: ±10° or °C.

Outputs

- Control outputs are two per channel: heat & cool (humidify & de-humidify) action.
  - Solid state relay, 0.5A @ 24VAC **min,** 253VAC max. opto-isolated, zero cross switching or,
  - DC switched open collector solid state switches, 10VDC, 5mA.
- Auxiliary discrete ouputs are displayed **as** Event **#1 thru** #4 for each channel and are user selectable as:
  - Solid state relay, 0.5A @ 24VAC min, 253VAC max, opto-isolated, zero cross switching or,
  - DC switched open collector solid state switches, 10VDC, 5mA.
  - Eight event outputs programmed per step, **or**
  - Six event outputs programmed per step, an1 alarm output per channel.

Accuracy

- Calibration Accuracy and Sensor Conformity: ± 0.25% of span, ± 1 digit (± 1% wet/dry % RH) at 77°F ± 5°F ambient rated line voltage ± 1%.
- Accuracy Span: 1000°F or 540°C minimum.
- Temperature Stability: ±2µV / °F ambient.
- Voltage Stability: ± 0.01% of span / % of rated line voltage.

Communlcatlons

- Serial data communications.
- RS422A or RS-423A (RS232C Compatible) 1200 Baud.
- Electrically isolated.
- All operator indications and controls.
- RS-422 with ANSI X3.28 subparagraph 2.2-A.3 protocol, RS-423 with XON/XOFF protocol.

Terminals

- 36 each #6 screws on **3 barrier** strips.
- Communications: DB-15 female receptacle.

Power

- 115/230VAC ±10%, 50/60Hz.

- Data retention upon power failure via Lithuim battery.
- Optional battery backup real time clock.

Operating Environment

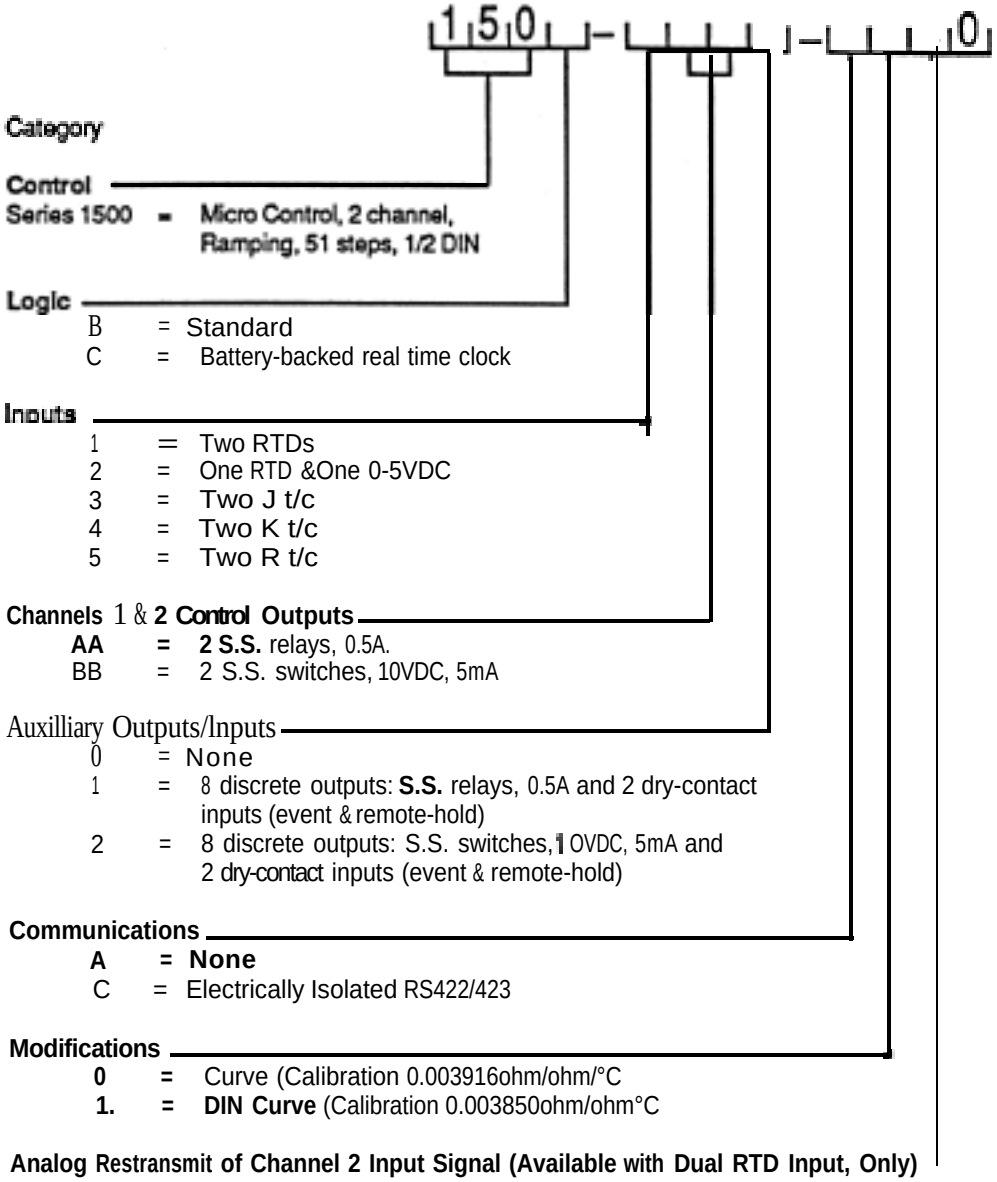
30 to 130°F/0-55°C.

- 0-90% RH, non-condensing.

Dimensions

- Height: 6.0 in.
- Width: 6.0 in.
- Overall depth: 8.8 in:
- Behind panel depth: 7.5 in.
- Weight: 4.5 lb.

Series 1500


1 5 0 - - - 0
Category
Control
Series 1500 = Micro Control, 2 channel, Ramping, 51 steps, 1/2 DIN
Logic
B = Standard
C = Battery-backed real time clock
Inputs
1 = Two RTDs
2 = One RTD &One 0-5VDC
3 = Two J t/c
4 = Two K t/c
5 = Two R t/c
Channels 1 & 2 Control Outputs
AA = 2 S.S. relays, 0.5A.
BB = 2 S.S. switches, 10VDC, 5mA
Auxilliary Outputs/Inputs
0 = None
1 = 8 discrete outputs: S.S. relays, 0.5A and 2 dry-contact inputs (event & remote-hold)
2 = 8 discrete outputs: S.S. switches, 10VDC, 5mA and 2 dry-contact inputs (event & remote-hold)
Communications
A = None
C = Electrically Isolated RS422/423
Modifications
0 = Curve (Calibration 0.003916ohm/ohm/°C
1. = DIN Curve (Calibration 0.003850ohm/ohm°C
Analog Restransmit of Channel 2 Input Signal (Available with Dual RTD Input, Only)
0 = 0 - 0.5V out on Channel 2
1 = 0-5V out on Channel2

Technical Service

If Something Goes Wrong

The Series 1500 is a **designed for long life and durable service. If,** however, something should go wrong, call Watlow **at** 507-454-5300, and ask for an application engineer. We'll help you with the problem right on the phone.

Warranty Information

The Watlow Series 1500 is warranted to be free of defects in material and workmanship for 18 months after delivery to the first purchaser for use, providing that the unit has not been misapplied.

Watlow cannot guarantee against failure, since Watlow has no control over use, and sometimes misuse. Watlow's obligations hereunder, at Watlow's option, are limited to replacement, repair, or refund of purchase price, on 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.

Returning Merchandise

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

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

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

4. In cases of manufacturing defect, we will enter a repair order, replacement order or issue credit **for material.** A **20 percent restocking charge is applied for all** returned stock controls and accessories.

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.

Shipping Claims

When you receive your Watlow Series 1500, 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. Always save the original shipping carton and the packing material.

Watlow Winona, Inc.

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

The **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 Winona to provide compatibly engineered **controls which they can incorporate into their** products with confidence.

Glossary

This glossary includes general thermal system control terms; not all are used with the Series 1500.

Actual display data: Displayed information which gives the operator/programmer real or "actual" data, i.e., actual time of day, actual process temperature, or actual process relative humidity, etc. See "Programmed display data."

Alarm: A signal, generated by the Series 1500, warning the operator that the process has exceeded or fallen below the alarm setpoint.

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. A Series 1500 prompt has two letters.

Auxiliary outputs: ON/OFF outputs per channel, one of which may be designated as an alarm. An unprogrammed step will take auxiliary output status from the programmed step to that just prior to it.

Auto-reset: Same as "reset" and "integal." Control action that automatically eliminates offset, or "droop," between set point and actual process temperature.

Change Data Mode: (CHG DATA) - Set up the program step information for the Serles 1500, including step type, set points, step duration, "wait for" or "jump loop" conditions, and auxiliary output status.

Change Parameter Mode: (CHG PARA) - Set up the system step information for the Series 1500, including real time, high and low range limits, alarm types, alarm points, PID parameters, and RS-422 address.

Channel: A distinct electronic control bop or path for reading input data and communicating information to an output device or devices.

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

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

Cold junction compensation: Electronic means used to subtract the effect of the cold, or reference junction temperature from a thermocouple's electro-chemical circuit.

Cold start: A "clean," or completely cleared-of-user-programmed information, start-up condition. In the Series 1500, powering up with DIP Switch #6 in the "ON" position gives a "Cold Start."

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

DATA: Values (for a specific Series 1500 parameter) which appear in the control's DATA display. DATA may be changed in the CHG DATA mode with the UP/DOWN keys.

Dead Band: Represents the area where no heating or cooling takes place in a heat/cool proportional control.

Derivative:	Same as "rate." Anticipatory action that senses the rate of change of temperature, and compensates to minimize overshoot.
Deviation:	The difference between the value of the controlled variable and the value at **which it** is being controlled.
DIP switch:	**Dual In-line** Package (ON/OFF) switch.
Displaycapability:	In a digital indicating instrument, the entire span that can be indiiated 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.
Event Output:	A programmable, ON/OFF output used **for triggering peripheral devices or processes** from a specific Series 1500 program **step. When events for a step are** unprogrammed, they retain the ON/OFF status from the last programmed step.
Guarded Access:	(GA) -A set of Series 1500 parameters in the CHG **PARA (change parameter) mode** which are "guarded" by access codes. The GA parameters include alarm types, PID parameters, dead band, cycle times, calibration offset, recycle option, 2-channel temperature control, device address, and the front panel bck.
HALT condition:	Indicated by a steadily ON "PROG HALT" LED caused **by a RUN/HALT key** press during a running program, or by the program reaching a "Blank" (unprogrammed) step." See "Remote-Hold".
Hysteresis:	In ON/OFF control, the temperature change necessary to re-energize the output after it was de-energized at set point.
Hunting:	Oscillation of process temperature above and below set point.
Input:	Process variable information being supplied to the instrument.
Integral:	Same as "auto-reset" and "reset."
Isolation:	Electrical separation of functional circuits, such as the sensor circuit, or the data communications circuits, from control power sources and ground.
Manualreset:	Manual adjustment made to provide coincidence between set point and process temperature, thereby eliminating droop.
Monitor Data Mode:	**(MTR DATA) - Examines** the currently running step information.
off set:	**A** value added to or subtracted from the input signal.
ON/OFF control:	**Control of temperature about** a set point by turning the output full ON or full OFF at set point.
Open loop:	Control system with no sensoryfeedback-
output:	A **signal or value going** out from a control.

Overshoot: Condition whereby temperature **exceeds** set point due to initial **power** up or process changes.

P control: Proportioning control.

Parameter: Any of a set of physical properties whose values determine 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 variable: Signal or value reflecting the status of the process, such as 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 time-in-step, intended process relative humidity, etc. See "Actual displayed data."

Proportional band: The span of temperature about the set point where proportional control action takes place.

Profiling: Executing several adjacent program steps where each step defines a ramp, or a sloping control graph.

Program Step: A numbered step in a process control program which contains its own specific parameters for causing a predictable response by the control.

Ramping: Progressing from one set point to another set point over a periid of time.

Range: Minimum and maximum operating limits of a sensor or controller.

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

Rate Band: The area above and below set point where the rate (derivative) function occurs. Available in certain WWattow controls at a value of 1 to n times the proportional band.

Recycle: Program option in some microprocessor-based temperature controls to repeat the entire program indefinitely. Also "continuous loop."

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

Remote - Hold: The Remote - Hold input from a user-supplied switch closure will halt a Series 1500 program and cause the PROG HALT LED to flash. Opening the switch causes the 1500 to resume the program where it left off.

Reset: Same as "auto-reset" and "integral."

Reset wind-up Inhibit: Synonymous with anti-reset. See "Anti-reset."

Restart: To **begin to control a thermal system again, after stopping control and holding** the **process variable at a fixed value.** A "restart" **may occur with newly-programmed information in microprocessor-based controls.**

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

Set point: Intended value of the process variable.

Signal conditioner: An **electronic circuit that provides sensor compatibility of the input signal for use in the control.** Includes linearization and/or sensor excitiation.

Single .mode cont rol : Proportioning control.

Span: Distance in degrees or other **units between the minimum and maximum operating limits** of a sensor or controller.

Switching sensltlvlty: See "Hysteresis."

Thermalsystem: 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.

Threemodecontrol: Proportioning control with auto-reset and rate.

Time-In-step: Time remaining in any given program step.

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 the result of the control **algorithm.** In other words, the amount of time the output relay is energized depends on the system control requirement.

Trlac: Solid state switching device.

Twoposltlon control: An ON/OFF control.

Warm Start: Start-up condition **where** all program information is remembered by the **instrument's** memory back-up protection. **In the Series 1500, powering up** with **Dip** Switch #6 in the OFF position gives a "Warm Start."

WetBulb: Half of a **wet** bulb/dry bulb **%RH sensor** system, i.e., an RTD with a wet sock.

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

Index

Series 1500 Quick Reference

How to Get Around in the Series 1500 Software

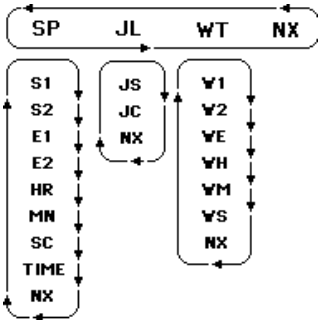
MODE — Selects MNTR DATA, CHG DATA or CHG PARA Mode.

FCTN — Selects any prompt in a mode.

Selects values for the DATA display.

ENTER — Places values from the DATA display into memory.

Change Data Mode (CHG DATA)



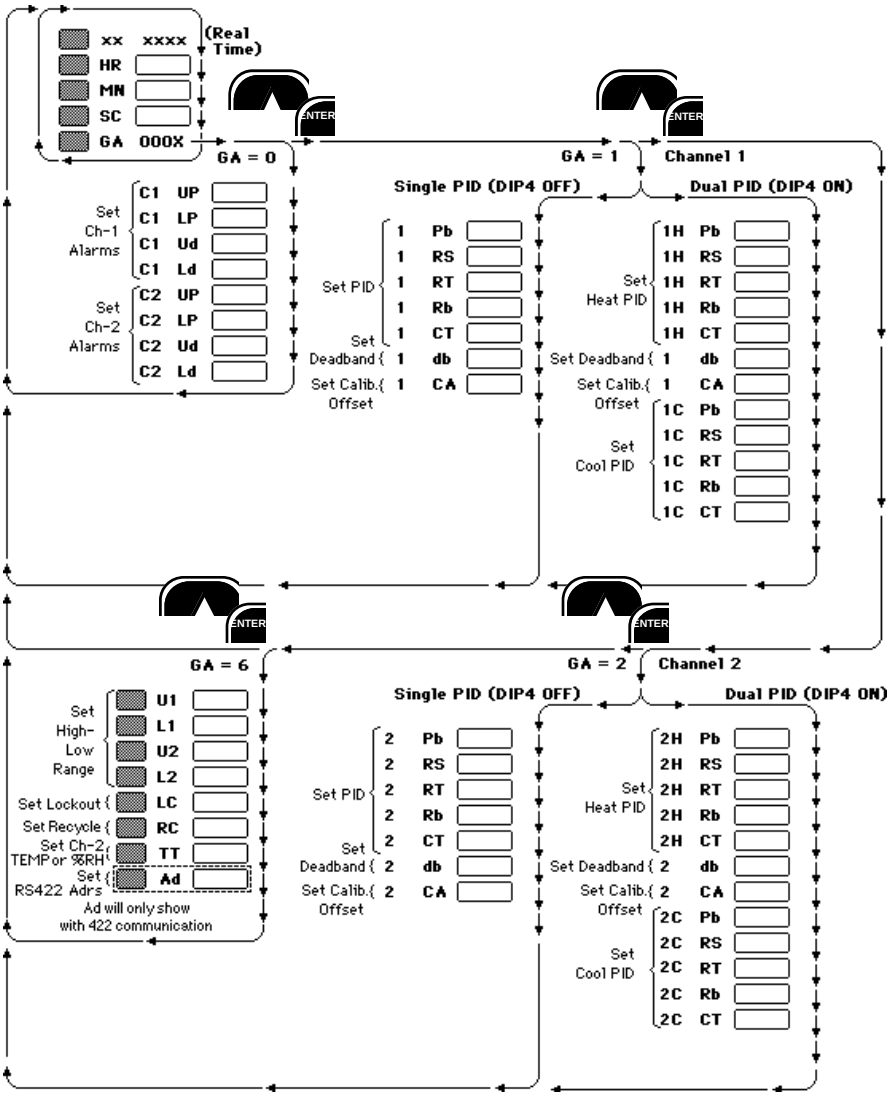
SP = Set Point Step: Program set points, events and time.

JL=Jump Loop Step: Program step # to jump to, and # of times to repeat that step.

WT=Wait Step: Program a step to wait for… Ch-1 condition, and/or CH-2 condition, and/or an event, and/or a real time (hr, min, sec).

NX= Next Step: In sequence or any next step.

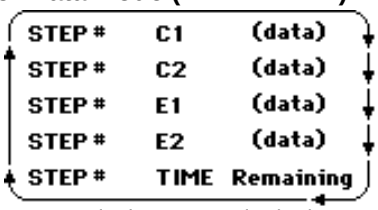
Change Parameter Mode (CHG PARA)



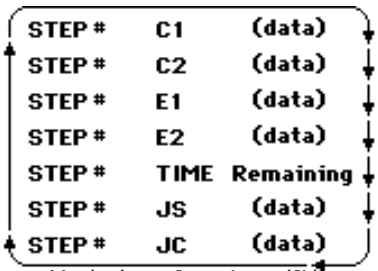
Prompt Key

U1=Ch-1 Upper Set Point Limit
L1=Ch-1 Lower Set Point Limit
U2=Ch-2 Upper Set Point Limit
L2=Ch-2 Lower Set Point Limit
GA=Guarded Access
RC=Recycle Option
Pb=Proportional Band
RS=Reset
RT=Rate
Rb=Rate Band
db=Dead Band
CT=Cycle Time
CA=Calibration Offset
TT=Temp-Temp (Ch-1/Ch-2)
UP=Upper Process Alarm Point
LP=Lower Process Alarm Point
Ld=Lower Deviation Alarm Point
Ad=Adress #, RS-422 only
HR=Hours
MN=Minutes
SC=Seconds
C1=Channel 1
C2=Channel 2

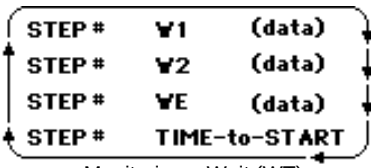
Monitor Data Mode (MNTR DATA)



Monitoring a Set Point (SP) Step in a running program.



Monitoring a Jump Loop (JL) Step in a running program.



Monitoring a Wait (WT) Step in a running program.