SERIES 800, SERIES 850, AND SERIES 860 THERMOELECTRIC COOLER CONTROLLER INSTRUCTION MANUAL

This manual was written for users of either the Series 800 Thermoelectric Cooler Controller or the rack mounted Series 850/860 Thermoelectric Cooler Controller(s). Where differences in the controllers are important to distinguish, those distinctions have been so noted.

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Rev 1.826, August 2014

WARRANTY

Alpha Omega Instruments Corp. warrants the products delivered to be free from defects in material and workmanship at the time of delivery to the Fob point specified in the purchase order, its liability under this warranty being limited to repairing or replacing, at Alpha Omega Instruments' option, items which are returned to it prepaid within two (2) years from the date of shipment and found to Seller's satisfaction to have been so defective. In no event shall Alpha Omega Instruments Corp. be liable for consequential damages.

NO PRODUCT IS WARRANTED AS BEING FIT FOR A PARTICULAR PURPOSE AND THERE IS NO WARRANTY OF MERCHANTABILITY.

This warranty applies only if:

a) **The items are used solely under the operating conditions and manner recommended in this manual, specifications, or other literature;**
b) **The items have not been misused or abused in any manner or repairs attempted thereon;**
c) **Written notice of the failure within the warranty period is forwarded to Alpha Omega Instruments Corp. and, the directions received for properly identifying items returned under warranty are followed;**
d) **The return notice authorizes Alpha Omega Instruments Corp. to examine and disassemble returned products to the extent the Company deems necessary to ascertain the cause of failure.**

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EXPLANATION OF GRAPHIC SYMBOLS

The information listed below is essential to the proper operation of the analyzer. Please review the following safety precautions prior to using the analyzer. Cautionary notes are included throughout this manual.

THIS SYMBOL IS INTENDED TO ALERT THE USER TO THE PRESENCE OF IMPORTANT OPERATING AND MAINTENANCE INSTRUCTIONS

THIS SYMBOL IS INTENDED TO ALERT THE USER TO POTENTIALLY DANGEROUS SITUATIONS OR ITEMS THAT SHOULD BE AVOIDED

IMPORTANT SAFETY INFORMATION

DANGER

POTENTIALLY HAZARDOUS AC VOLTAGES EXIST WITHIN THE ANALYZER, IF NOT AVOIDED, COULD POTENTIALLY RESULT IN SERIOUS INJURY OR DEATH. DISCONNECT ALL SOURCES OF POWER AND EXTERNAL CONNECTIONS BEFORE REMOVING THE COVER TO THE ANALYZER

RISK OF SHOCK

TO AVOID THE RISK OF FIRE OR ELECTRIC SHOCK, DO NOT EXPOSE THE SERIES 8XX THERMOELECTRIC COOLER CONTROLLER TO RAIN, WATER SPRAY, OR ANY OTHER LIQUIDS.

RF DISCLAIMER

This instrument generates and uses small amounts of radio frequency energy, and there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, try to correct the interference by one or more of the following steps:

1. Reorient the receiving antenna.
2. Relocate the instrument with respect to the receiver.
3. Change the AC outlet of the instrument so the instrument and receiver are on different branch circuits.

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1 Overview

1.1 INSTRUMENT DESCRIPTION

The Series 800, 850 and Series 860 Thermoelectric Cooler Controllers represent a significant advance in the state-of-the-art of thermoelectric cooler (TEC) controllers. It is no secret that in the past, TEC controllers required a significant amount of hands-on operation to provide satisfactory performance, particularly when variations in the load and/or environmental conditions existed. The Series 800 / 850 / 860 TEC Controllers utilize advanced control technology in combination with auto-tuning capabilities to provide unprecedented performance.

The Series 800 is designed for bench-top use while the Series 850 and Series 860 are configured for use in a 19ò rack. The Series 800 has a single mini-controller to allow control of a single load up to a maximum of 240W (24V @ 10 Amperes). The Series 850 has a single mini-controller to allow control of a single load up to a maximum of approximately 600 Watts. Whereas the 860 has two mini-controllers that can be used two control two isolated systems. Each isolated system can control a single load up to a maximum of approximately 300 Watts. Essentially, the Series 860 is the equivalent of having two Series 800ôs in one rack mounted configuration.

1.1.1 EASE OF USE

The eloquence of the Series 800 / 850 / 860 TEC Controllers is in their ease of use. The Series 800 / 850 / 860 TEC Controllers feature a user-friendly front panel control containing four (4) switches that allow access to the instrumentôs control settings. In addition, there are two (2) LED digital displays. The upper display shows the temperature, also known as the Process Variable (*PV*). The lower display shows the set point temperature, also known as the Set Variable (*SV*). Both the *PV* and the *SV* are shown simultaneously. Each controller features proportional, integral, and derivative (PID) control that provides exceptionally tight control over a wide temperature range, as well as rapid response to changes in operating conditions.

The user has two options when choosing a control type. The choice of standard PID and also a ñFUZZYò logic control option. Also, an auto-tuning feature is standard to the instrument. The auto-tuning feature helps to insure maximum performance over a broad spectrum of operating conditions. Auto-tuning sets the critical PID terms to match the conditions of the application and provides fast response while minimizing overshoot and undershoot. From the userôs perspective, the need to make frequent manual adjustments has been virtually eliminated. For unique applications, users have the option to manually adjust the instrumentôs control parameters as desired.

1.1.2 MAXIMUM VERSATILITY

The Series 800 / 850 / 860 TEC Controllers accept a variety of temperature sensors including thermistors, semi-conductors sensors, and standard 3-wire, 100 ohm RTDs. Another feature of the Series 800 / 850 / 860 TEC Controllers is that users can choose to operate in either the bipolar (heat AND cool) or unipolar (heat OR cool) mode. Heating and cooling temperature and/or current limits can be set independently of each other, helping to ensure that any limits are not exceeded. These limits can be used to protect the load[1] from damage due to excess current. Current levels for the heat and cool modes can be set independently, thus offering maximum protection to TEC modules and peripheral equipment. Two front panel LEDs will indicate when the instrument is in either the heating or cooling mode.

[1] Load is typically a TEC module or combination of TEC's mounted in series/parallel but could easily be a DC heater element for instance.

1.2 POWER

The following power ratings are standard power ratings and do not reflect all the possible configurations. For instance, other max voltages other than 15V can be accommodated. In some cases the max wattage will still apply, however the 850 can be configured for as high as 600 Watts.

1.2.1 SERIES 800

The Series 800 TEC Controller has five (5) standard output power ratings:

30 Watts	2 A @ 15 VDC
60 Watts	4 A @ 15 VDC
90 Watts	6 A @ 15 VDC
120 Watts	8 A @ 15 VDC
150 Watts	10 A @ 15 VDC

1.2.2 SERIES 850

The Series 850 TEC Controller has six (6) standard output power ratings:

30 Watts	2 A @ 15 VDC
60 Watts	4 A @ 15 VDC
90 Watts	6 A @ 15 VDC
120 Watts	8 A @ 15 VDC
150 Watts	10 A @ 15 VDC
300 Watts	20 A @ 15 VDC

1.2.3 SERIES 860

The Series 860 TEC Controller has five (5) standard output power ratings per channel. Refer to the Series 800 power ratings above to select the power for each channel.

Notes:

- You can select a different power rating for each channel, however the standard units are typically configured identically unless specifically ordered otherwise.
- The 850 and 860 series allow for special modifications where each channel can provide up to 300 Watts for a total of 600 Watts per rack.
- Please contact the factory for any special requirements.

1.3 STANDARD FEATURES

1.3.1 TEMPERATURE ALARM RELAY

The Series 800 / 850 / 860 TEC Controllers are equipped with a temperature alarm that is configurable by the user as a high alarm, low alarm, or both a high and low alarm. This capability is important when the user needs to insure that the temperature of the TEC being controlled does not exceed specific limits. Section 4.2.2 provides details on setting the alarms.

1.3.2 SOFT START

The Series 800 / 850 / 860 TEC Controllers are equipped with a feature called ñsoft startò ñSoft startò helps eliminate potentially dangerous current spikes that could be delivered to the TEC upon powering the controller.

1.4 OPTIONAL EQUIPMENT DESCRIPTIONS

1.4.1 SERIAL COMMUNICATIONS OPTIONS

The Series 800 / 850 / 860 TEC Controllers can be equipped with optional RS-485 Serial Communications. RS485 utilizes the MODBUS protocol.

1.4.2 RAMP AND SOAK

The optional Ramp and Soak function allows up to 16 steps running 7 different pattern types. Ramp and Soak Time units can be set for either minutes/seconds or hours/minutes with a range from 00:00 to 99:59 minutes/seconds or hours/minutes. There are also 16 program operation modes. The guaranteed soak option with adjustable upper and lower guaranteed soak band allows for timing only when the process variable is within a specified range of the desired set point. Continuous mode allows for repeating the ramp and soak process indefinitely.

1.4.2 GPIB INTERFACE OPTIONS (SERIES 850 / 860 CONTROLLERS ONLY)

The Series 850 & 860 TEC Controllers can be equipped with an optional General Purpose Interface Bus (GPIB) that is in accordance with the IEEE-488-2 specification. Standard Commands for Programmable Instruments (SCPI) are also supported.

1.5 GENERAL SPECIFICATIONS

The following pages detail the specifications of the Series 800 / 850 / 860 TEC Controller.

Specification	Model Series 800	Model Series 850	Model Series 860
Control	Uni-polar or Bi-polar, constant current, PID (Proportional, Integral, Derivative) with Auto-tuning. User can select P, or P&I control only.		
Output Voltage	0 to +36 Volts DC. 0 to 15V Standard		
Maximum Output Current	Up to 10 amperes Standard Maximums: 2, 4, 6, 8, or 10 amperes	Up to 20 amperes Standard Maximums: 4, 8, 12, 16, or 20 amperes	Up to 20 amperes per channel for a total of 600W (300W / 2 channels) Standard Maximums per channel: 2, 4, 6, 8, 10 or 20 amperes
Maximum Output Power for Controllers & Power Boost Modules	Up to 150W Standard Maximums: 30W, 60W, 90W, 120W, and 150W	Up to 300 watts Standard Maximums: 60W, 120W, 180W, 240W, and 300W	Up to 300 watts (150W per controller) Standard Maximums per channel: 30W, 60W, 90W, 120W, and 150W
Temperature Sensors	100 ohm RTD, Types E, J, K, N, and T thermocouples, thermistor, AD590/592, and LM35/135/335 as well as external voltage and current inputs.		
Sensor Temperature Ranges for Standard Sensors	Thermistors can operate on one of two ranges (0 to 99.99 Kohms and 0 to 999.9 Kohms). Integrated temperature sensors (AD590/592 and LM35/135/335) operate from: -50ºC to 150ºC. Higher and lower temperatures can be measured depending upon the sensor type. Please refer to section 3.3 for details on the temperature ranges available for each sensor type and an example of a custom sensor type.		
Long Term Stability	< 0.002º C		
Noise and Ripple	< 1 mA		
Front Panel Displays	Two 4 digit LED displays, RED - for actual temperature GREEN - for set point temperature		
Display	Thermoelectric Cooler temperature and set-point temperature in ºC or ºF (user-selectable) with an RTD, thermocouple, AD590/592 and LM135/335. For a thermistor, the display is in Kohms.		

Specification	Model Series 800	Model Series 850	Model Series 860
Display Resolution	Thermistor-100 Kohm range Thermistor-1 Megohm range	0 to 99.99K (10 ohms) 0 to 999.9K (100 ohms)	
	For other sensors, such as RTDs, thermocouples, AD590/592 and LM35/135/335 sensors	0.1 ºC 0.1 ºF	
AC Power	115/230 Volts AC, internally selectable, 47 - 63 Hz		
Internal Cooling	Two (2) Fans		
Weight	12 pounds maximum (150 watt instrument)	18 pounds maximum (300 watt instrument)	18 pounds maximum (300 watt instrument)
Dimensions	4.9ñH X 7.2 W X 10.6ñ L	5.25ñH X 19 W X 15.9ñL (3U chassis height) 5.25ñH X 19 W X 15.9ñL	5.25ñH X 19 W X 15.9ñL (3U chassis height) 5.25ñH X 19 W X 15.9ñL
Standard I/O Connections	Thermoelectric Cooler, Temperature Sensor, AC Power		
Optional I/O Connections	optional EIA/RS-232/485 (using MODBUS[2] protocol)	optional EIA/RS-232/485 (using MODBUS protocol) GPIB	optional EIA/RS-232/485 (using MODBUS protocol) GPIB
Operating Temperature	0°C to 50ºC (32°F - 122°F)		
Warranty	Two years		

[2] MODBUS¡ is a registered trademark of Modicon, Inc., Industrial Automation Systems.

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2 Unpacking / Electrical Installation

Upon opening the shipping container, carefully unpack the instrument to check if the outer surfaces have been damaged. If so, report the findings immediately to Alpha Omega Instruments who will, in turn, provide further instructions.

NOTE: IF DAMAGE HAS BEEN FOUND, DO NOT PROCEED FURTHER, BUT INSTEAD, CONTACT THE FACTORY.

If there is no apparent damage, check the contents to ensure all items were shipped. In some cases, items may be back ordered. **All damage and shortage claims must be made known to Alpha Omega Instruments within 10 days after receipt of shipment.** Carefully rotate the analyzer and check to make sure no components have been loosened or dislodged. **If there are loose or dislodged components (rattling of any kind), contact the factory for further instructions.** If there is no evidence of loose or dislodged components, the installation procedure can begin.

2.1 ELECTRICAL INSTALLATION

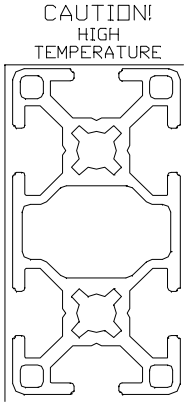
WARNING **ELECTRICAL INSTALLATION SHOULD BE PERFORMED BY A QUALIFIED PERSON AND SHOULD COMPLY WITH APPLICABLE FEDERAL, STATE, OR LOCAL ELECTRICAL SAFETY CODES.**

The Series 800/850/860 Thermoelectric Cooler Controller is shipped with a standard North American power cord NEMA style 5-15P. The mating receptacle on the rear panel of the analyzer is an IEC style 60320 C13/C14. The analyzer accepts a universal power input of 90 to 265VAC @ 50/60 Hz. There is an On/Off switch located on the rear of the Series 800 and on the front of the Series 850/860.

3 Series 800/850/860 TEC Controller Hardware and Connections

The following section explains the hardware and connections on the Series 800 / 850 / 860 TEC Controllers.

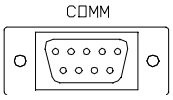
3.1 HEAT SINK



DO NOT BLOCK THE FLOW OF AIR COMING OUT OF THE HOLES IN THE HEAT SINK ON THE REAR OF THE CONTROLLER. HIGH TEMPERATURES MAY RESULT FROM POOR LOAD MATCHING OR A SHORT ON THE OUTPUT. AVOID TOUCHING THE HEAT SINK IN THESE SITUATIONS.

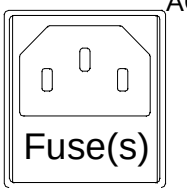
There are two heat sinks on the rack mounted controllers if the power of the instrument exceeds 150 Watts.

3.2 EIA/RS-232/-485



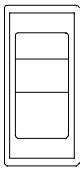
Use this connector to access additional options such as EIA/RS-485 communications. Please refer to Appendix J, Technical Information, for wiring details.

3.3 AC Power Input



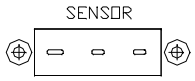
The AC power connector is located on the rear panel with the fuses located in the receptacle. Check the ratings on the fuse for the correct ratings, and only install replacement fuses with the correct rating. A six (6) foot modular power cable is supplied with each instrument

3.4 POWER SWITCHES



The power switch is located on the rear of the Series 800 TEC Controller. The Series 850 TEC Controller has the power switch located on the front panel. The Series 860 has two power switches located on the front panel. One switch for each channel.

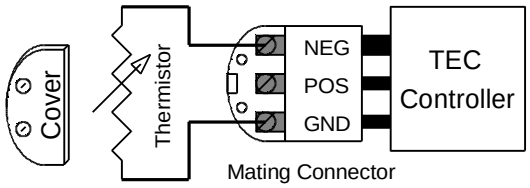
3.5 CONNECTING THE SENSOR INPUT CONNECTOR



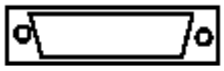
The first connection to make is the sensor mating connector. The wiring and controller setup procedure is detailed in the next section of this manual (Section 4.0).

Locate the sensor input mating connector supplied with the instrument as depicted below. Now locate the sensor input connectore labeled ñSENSORò as depicted above and push the sensor input mating connector into the 3 holes. The connector is polarized (one pin is larger than the other two) and allows three connections to be made between the sensor and the instrument. To access the screw terminals for wiring the sensor, simply remove the sensor input mating connector's cover to expose the terminals of the connector as depicted below.

This is a pictorial of the connector looking down while connected into the SENSOR input connector of the TEC controller. The connector is shown partially engaged to show the larger polarizing terminal. A thermistor is show here as an example.



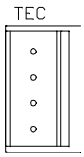
3.6 OPTIONAL GPIB INTERFACE CONNECTOR



See Appendix I for more information on the GPIB Interface.

3.7 TEC POWER OUTPUT CONNECTOR

The Second connection to be made is to the TEC.



	MAKE SURE THAT THE SENSOR IS PROPERLY WIRED, THE CONTROLLER IS PROPERLY PROGRAMMED, AND THE POWER IS OFF BEFORE CONNECTING THE TEC. SEE SECTION 4.0 FOR DETAILS ON THE SENSOR SETUP.

Make sure the Series 800 / 850 / 860 TEC Controller is OFF before connecting the TEC to the TEC power output connector.

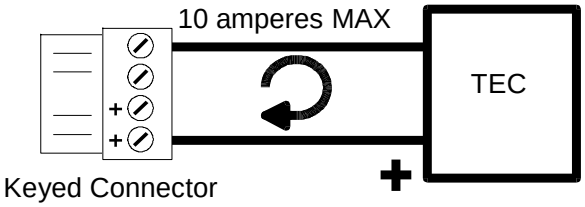
After locating the TEC power output connector on the rear panel of the Series 800 / 850 / 860 TEC Controller, locate the mating connector supplied with the instrument. This mating connector has screw terminals that allow the TEC leads to be clamped down within the connector.

Connect the TEC to the mating connector.

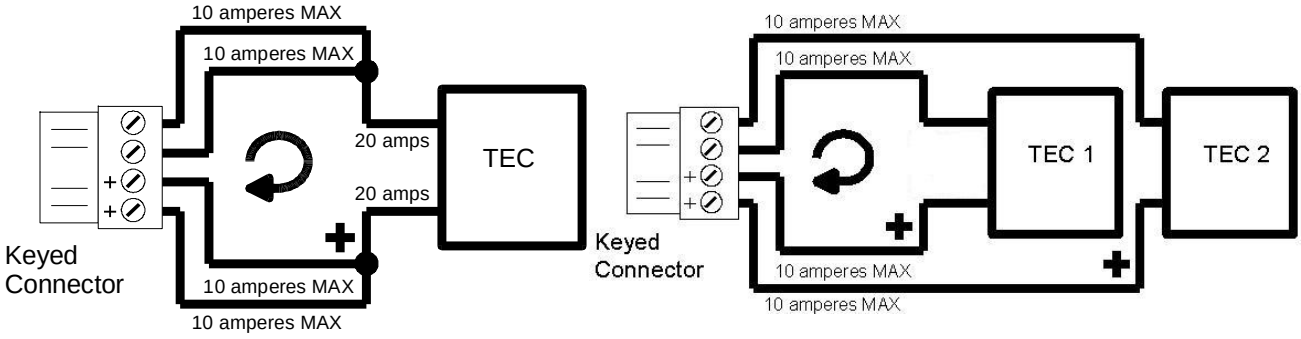
There are two ñ+òs and two ñ-òs. Each pin can carry a maximum of 10 amperes. With the Series 850 TEC Controller, if the current rating is over 10 amperes, then both pins must be used to carry the current (the Series 800 is designed to deliver a maximum of 10 amps and the Series 860 is designed to deliver a maximum of 10 amps per channel). Please remember that for currents over 8 amperes, AWG #14 size wire is recommended. See diagrams below for various configurations:

3.7 TEC POWER OUTPUT CONNECTOR (CONTINUED)

Series 800 and Series 860



Series 850



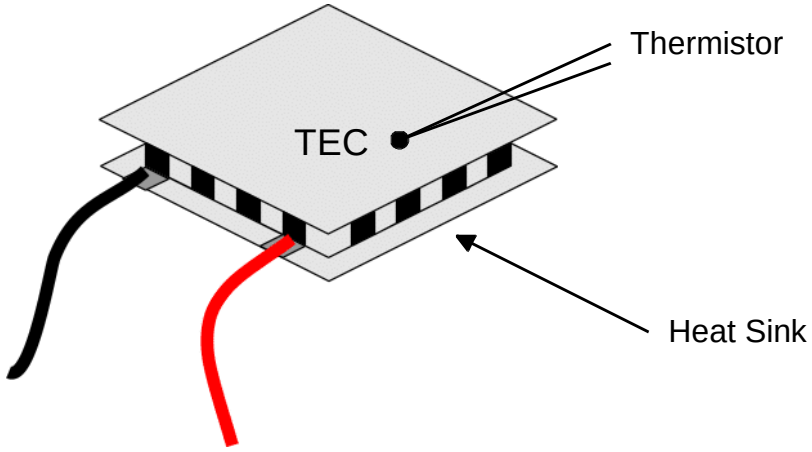
Once the TEC leads are securely fastened into the mating connector, plug this connector into the TEC Power Output connector. If the Sensor is configured according to Section 4.0 and the TEC is properly connected, all that's left is to turn on the Series 800 / 850 / 860 TEC Controller.

Caution: Before applying power to the TEC, the user is responsible for ensuring that the TEC(s) have proper heat sinking. If questions arise regarding heat sinking, it is strongly advised that you contact the supplier of the TEC module for further guidance.

3.9 TEC WIRING

If the temperature should go in the ñwrongòdirection , check to make sure that the TEC is configured as shown below:

Also, if using a thermistor as shown, the Series 800 / 850 / 860 TEC Controller will display Kohms on the display. This means that when the temperature increases, the Kohms will decrease. Hence, the reason they call it a ñNTCò(negative temperature coefficient) thermistor.



3.10 INSTRUMENT FUSES

3.10.1 SERIES 800

The Series 800 TEC Controller is equipped with a 5 Ampere 250 Volt AC Line fuse within the modular AC Input receptacle. If the Instrument does not power up when the power switch is turned ON, or ceases operation while powered ON, place the power switch in the OFF position and remove the modular AC Power Cord. Access the fuse holder by prying the fuse holder open gently with a small screwdriver. Once the fuse is removed, measure the continuity of the fuse with an ohmmeter. If the fuse is failed (open), be sure to replace it only with a fuse of the same rating (5 Ampere 250 Volt, Instrument rating). If the fuse continues to fail in operation, please contact the factory about returning the unit for service.

The Series 800 TEC Controller is also equipped with a fuse mounted at the rear of the analog controller PCB, providing protection for the TEC load. Since each Series 800 TEC Controller can be configured for different amounts of load current, this fuse will also be different depending on the power rating at time of order. If power is not being delivered to the TEC and this fuse is suspected, place the power switch in the OFF position and remove the modular AC Power Cord. Then remove the instrument cover, and access this fuse by rotating the fuse cover 180 degrees with a small straight bladed screwdriver. Please be sure to replace a failed fuse only with a value consistent with the load rating of the instrument and the TEC you are using. Replace the instrument cover, and insert the modular AC power cord into the receptacle. Check your instrument connections, and turn the power ON. If this fuse continues to fail under load, insure that the replacement fuse you insert is equal to or slightly greater than the rated load of the instrument, and check the current limit programming of the instrument controller. If the problem persists, please contact the factory.

3.10.2 SERIES 850 / 860

The Series 850 / 860 TEC Controller is equipped with two (2) 5 Ampere 250 Volt AC Line fuses within the modular AC Input receptacle. If the Instrument does not power up when the power switch is turned ON, or ceases operation while powered ON, place the power switch in the OFF position and remove the modular AC Power Cord. Access the fuse holder by prying the fuse holder open gently with a small screwdriver at each end. Once the fuse holder is removed, measure the continuity of the fuses with an ohmmeter. If the fuses are failed (open), be sure to replace them only with fuses of the same rating (5 Ampere 250 Volt, Instrument rating). If the fuses continue to fail in operation, please contact the factory about returning the unit for service.

The Series 850 / 860 TEC Controller is also equipped with up to two (2) fuses mounted at the rear of each analog controller PCB, providing protection for the TEC load. Since each Series 850 / 860 TEC Controller can be configured for different amounts of load current, these fuses will also be different depending on the power rating at time of order. If power is not being delivered to the TEC and these fuses are suspected, place the power switch in the OFF position and remove the modular AC Power Cord. Then remove the instrument cover, and access these fuses by rotating each fuse cover 180 degrees with a small straight bladed screwdriver. Please be sure to replace a failed fuse only with a value consistent with the load rating of the instrument and the TEC you are using. Replace the instrument cover, and insert the modular AC power cord into the receptacle. Check your instrument connections, and turn the power ON. If these fuses continue to fail under load, insure that the replacement fuses you insert are equal to or slightly greater than the rated load of the instrument, and check the current limit programming of the instrument controller. If the problem persists, please contact the factory.

3.10.3 DEFAULT TEC FUSE RATINGS

The Series 800 TEC Controller has five (5) standard output power ratings:

Power Rating	Current @ Voltage	TEC Fuse Factory Default
30 Watts	2 A @ 15 VDC	5A
60 Watts	4 A @ 15 VDC	5A
90 Watts	6 A @ 15 VDC	10A
120 Watts	8 A @ 15 VDC	10A
150 Watts	10 A @ 15 VDC	15A

The Series 850 TEC Controller has six (6) standard output power ratings

Power Rating	Current @ Voltage	TEC Fuse Factory Default
30 Watts	2 A @ 15 VDC	5A
60 Watts	4 A @ 15 VDC	5A
90 Watts	6 A @ 15 VDC	10A
120 Watts	8 A @ 15 VDC	10A
150 Watts	10 A @ 15 VDC	15A
300 Watts	20 A @ 15 VDC	15A x2

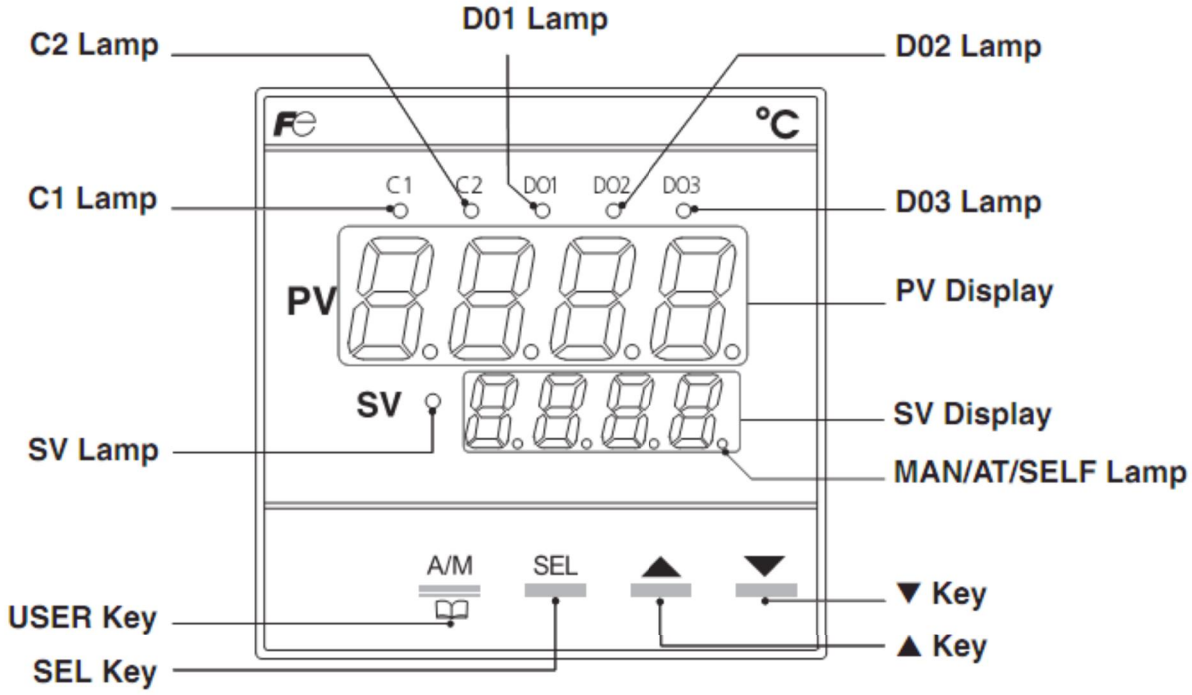
Please note that these fuses are purposely rated ABOVE the maximum rating of the instrument to allow for maximum current to the TEC. Current limits are set from the front panel and should be set according to the specifications of the TEC being used. If operating a TEC that is rated at a substantially lower current, it is recommended that an appropriate fuse be installed to protect the TEC in the unlikely event that the controller should fail.

4 Operation

This section describes how to operate the controller, finding and changing parameters, and interpreting the output that is shown on the various displays.

4.1 INSTRUMENT SETUP AND MENU NAVIGATION

Here you will find the descriptions of the front panel controls. Please reference the diagram below and descriptions on the following page for more information.



Definitions	
PV	Process Variable
SV	Set Point Variable
PV/SV Display	Default display upon power up.
MAN/AT/SELF	Manual / Auto-Tune / Self-Tune
A/M	Auto or Manual mode selection.

Keypad Items	Display Items
***A/M* Key** • Pressing this key in ñmonitoring modeòdisplay or ñsetup modeò display returns you to the PV/SV display. • Holding this key will switch between Auto and Manual mode while displaying the PV	**C1/C2 Lamp** • **C1** or Controller Output 1 is the COOL output for Negative Temperature Coefficient (NTC) sensors. For Positive Temperature Coefficient (PTC) sensors, this output is HEAT. • **C2** or Controller Output 2 is the HEAT output for NTC sensors. For PTC sensors, this output is COOL. • **C1** & **C2** display the condition of the control output. Lamp is on at 100% output and goes off at 0% output. For values between 0% and 100%, the output is indicated by the percentage of time the lamp is on.
***SEL* Key** • Pressing this key switches you to ñmonitoring modeòmode display or setup mode display from PV/SV display. • After switching to parameter mode, this key functions as the select key when changing parameters. • Holding this key down in channel display or parameter display returns you to the PV/SV display. • Pressing this key in PV/SV display shows the manual output value at the bottom of the display.	**DO1/2/3 Lamp** • **DO1** is on when there is an alarm (the process goes higher than the high alarm setting or lower than the low alarm setting.[3] • **DO2** is not used • **DO3** is not used
	PV Display • Displays the value of the process variable (PV) when in operation mode and manual mode. • Displays the name of the parameter when setting them in the parameter menu.
≠ Key • Pressing once will increase the setting value by one. Holding down the key will continue to increase the value. • Changes SV on the PV/SV display. • Moves between items in channel display and parameter display.	**SV Display** • Displays the set point variable (SV). • Displays the output value during manual mode. • Displays current value when changing parameter settings.
Ç Key • Pressing once will decrease the setting value by one. Holding down the key will continue to decrease the value. • Changes SV on the PV/SV display. • Moves between items in channel display and parameter display.	**SV Lamp** • Lamp is on when displaying the SV value. Lamp is off in manual mode. • The lamp blinks while performing ramp/soak or ramp SV operations.
	MAN/AT/SELF Lamp • The lamp stays on during manual mode. • The lamp blinks during auto-tuning and self-tuning.

4.1.1 Definitions

[3] See section 4.2.2 for alarm settings.

The Series 800 / 850 / 860 TEC Controller is designed so that Channel 1[4] output is always supplying cooling power when used with a NTC thermistor. This means that positive voltage will appear at the positive output of the Series 800 / 850 / 860 TEC Controller when cooling. Please note that when using a PTC sensor the outputs are swapped. Please see the next section for details on the sensor programming.

To avoid any misunderstanding or problems, the following terms have been defined.

+ Cooling	Positive voltage is applied to the positive terminal of the thermoelectric cooler (TEC) originating from the positive output terminals of the Series 800 / 850 / 860 TEC Controller. C1 lamp is on or blinking unless the power limit PLC 1 is set to 0.0.
+ Heating	Positive voltage is applied to the negative terminal of the (TEC) originating from the negative output terminals of the Series 800 / 850 / 860 TEC Controller. C2 lamp is on or blinking unless the power limit PLC2 is set to 0.0.
+ Cold Side	The side of the TEC that is opposite the side where the leads are attached to the ceramic plate. This is the controlled side where the temperature sensor should be located.
+ Hot Side	The side of the TEC where the leads are attached to the ceramic plate. This is the side which should be mounted to a heat sink (consult the manufacturer of the thermoelectric cooler if selection of a heat sink is required)

4.1.2 Checklist

☑	*<u>Never</u> connect either of the thermoelectric cooler leads to ground!* This can cause excessive current to flow and possibly damage to the cooler or other grounded systems. Note: slightly overrated fuses have been installed in the Series 800 / 850 / 860 TEC Controllers that should protect the TEC against most faults. However, there is no guarantee. See Chapter 3 for details on the fuse.
☑	*<u>Never</u> put a direct short across the thermoelectric cooler leads when power is applied*. This will cause excessive currents to flow and could generate a significant spark. On some models, damage could result if the short circuit is maintained for a significant amount of time.
☑	*<u>Always</u> set the output Current Limit(s) of the Series 800 / 85 0 / 860 TEC Controllers to approximately 10% less than that specified by the manufacturer of the thermoelectric cooler*.
☑	*<u>Caution:</u> If a thermoelectric cooler melts down due to excess current, in all likelihood it will become a direct short*. Note: Current to the thermoelectric cooler can be adjusted by using the Current Limit settings: See section 5.2 under ñDetailed Parameter Descriptionsòfor details .

[4] Not to be confused with the Series 860 Channel 1/2 sub-system. Channel 1 here refers to the mini-controller LED 1. There are two mini-controllers in the Series 860 TEC Controller. Each TEC Controller Channel has its own mini-controller which has a heat and a cool channel output referred to as Channel 1 and Channel 2. Refer to ñFront Panel Controlsòfor more information.

4.2 SENSOR PROGRAMMING AND CONFIGURATION

The controller is typically shipped ñready for useò and already programmed at the factory for the specific sensor specified at the time of order. However, it is highly recommended that the user complete this section to get acquainted with the controls and verify the configuration for it's proper use as expected.

The following steps detail how to fully configure the controller for use. Please reference the next two pages (with tables) detailing the pertinent information needed for finishing the sensor setup during these steps.

STEP 1) PROCESS VARIABLE TYPE PVT

Upon power up, the instrument enters into ñOperation Modeò where the top display is showing the temperature or actual process value (PV) and the bottom display is showing the set point value (SV)[5]. Typically these values are already configured for the particular sensor that was specified at time of order. KEEP IN MIND THAT ***CHANGING*** THIS PARAMETER WILL RESET THE CONTROLLER TO ACCOMODATE THE NEW SETTINGS.

Follow these steps to configure and/or check your current configuration for the sensor type that you ordered:

a) When the controller is in ñOperation Modeò press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the ñchannel menuò. The upper display shows the channel name (Operations Menu oPE by default). The bottom display shows the channel number 1 Ch 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the ñOperation Modeò screen and try this step again.

b) Press the DOWN key repeatedly until the Settings menu SEt is shown in the upper display. The bottom display will show channel number 6 Ch 6.

c) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the ñparameter menuò. PVT indicating sensor type is shown in the upper display, and the last stored setting for the sensor type PVT is shown in the lower display).

d) Momentarily press the select key ***SEL*** to access the parameter setting of the sensor type. PVT designating sensor type continues to be shown in the upper display, and the last stored setting for the sensor type WILL BLINK in the lower display).

e) Press the UP or DOWN key repeatedly until the correct sensor type PVT value BLINKS in the lower display.

f) Press the select key ***SEL*** to store the sensor type PVT value.

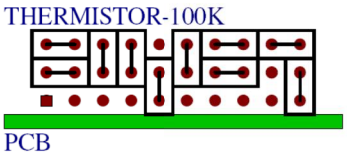
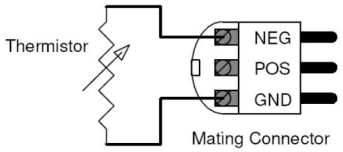
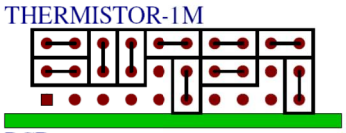
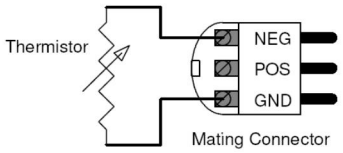
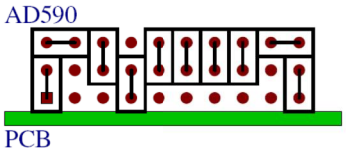
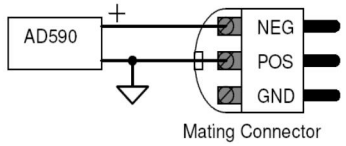
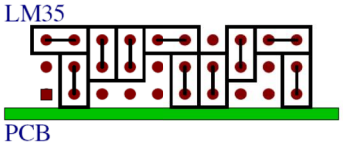
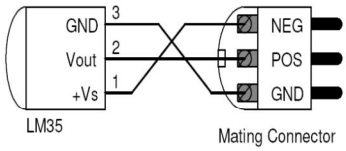
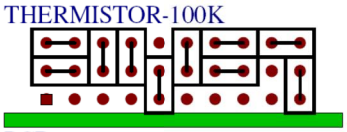
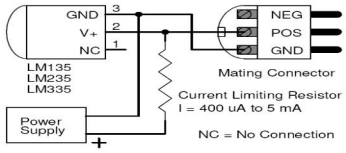
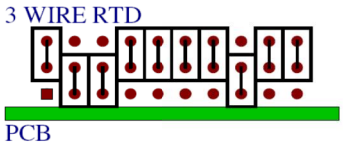
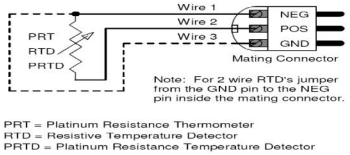
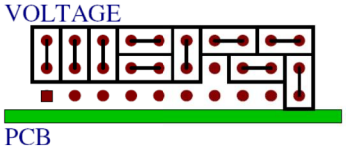
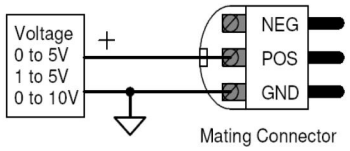
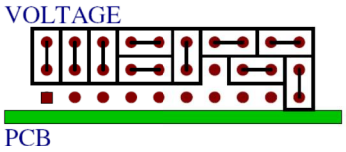
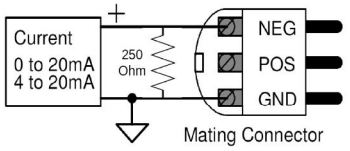
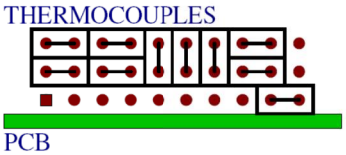
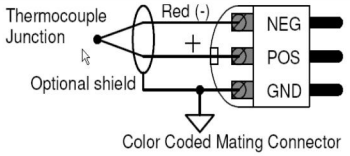
[5] PV and SV are typically a temperature value but may also be K-ohms for thermistors, Voltage, or Current for other applications.

4.2.1 CONTROLLER SETTINGS SENSOR TYPE OVERVIEW

Sensor Configuration		PSr	Pvb (lowest temperature)	PvF (highest temperature)	Pvd decimals	SoL	SoH
Thermistor 0-100 Kohm		17	0.0	99.99	2	Within Pvb and PvF	
Thermistor 0-1 Megohm		17	0.0	999.9	1	Within Pvb and PvF	
AD590		17	-50.0C (-58.0F)	150.0C (302.0F)	1	Within Pvb and PvF	
AD592		17	-25.0C (-13.0F)	105.0C (221.0F)	1	Within Pvb and PvF	
LM35		17	-50.0C (-58.0F)	150.0C (302.0F)	1	Within Pvb and PvF	
LM135/235/335		17	-50.0C (-58.0F)	150.0C (302.0F)	1	Within Pvb and PvF	
100 ohm 3 Wire RTD		1	-200C (-328F) -100.0C (-148.0F)	850C (1562F) 200.0C (392.0F)	0 1	Within Pvb and PvF	
Voltage[6]	0 to 5V 1 to 5V 0 to 10V 2 to 10V 0 to 100mV	15 16 17 18 19	0 1 0 2 0.00	5000 5000 9999 9999 99.99	0 0 0 0 1	Within Pvb and PvF	
Current[7]	0 to 20mA 4 to 20mA	15 16	0.00 4.00	20.00 20.00	2 2	Within Pvb and PvF	
Type J		2	0C (32F) 0.0C (32.0F)	1000C (1832F) 400.0C (752.0F)	0 1	Within Pvb and PvF	
Type K		3	0C (32F) 0.0C (32.0F)	1200C (2192F) 800.0C (999.9F)	0 1	Within Pvb and PvF	
Type R		4	0C (32F)	1600C (2912F)	0	Within Pvb and PvF	
Type B		5	0C (32F)	1800C (3272F)	0	Within Pvb and PvF	
Type S		6	0C (32F)	1600C (2912F)	0	Within Pvb and PvF	
Type T		7	-200.0C (-199.9F)	400.0C (752.0F)	1	Within Pvb and PvF	
Type E		8	0C (32F) -200.0C (-199.9F)	800C (1472F) 800.0C (999.9F)	0 1	Within Pvb and PvF	
Type N		12	0C (32F)	1300C (2372F)	0	Within Pvb and PvF	
Type PL-2		13	0C (32F)	1300C (2372F)	0	Within Pvb and PvF	

[6] Pvb and PvF may be set for engineering units, for example, if the process input of 0 to 10 volts represented 0-50.0 degrees C, Pvb can be set for 0 and PvF can be set for 50.0.

[7] Pvb and PvF may be set for engineering units, for example, if the process input of 0 to 20mA (0 to 5 volts across a 250 ohm resistor) represented 0-50.0 degrees C, Pvb can be set for 0 and PvF can be set for 50.0.

SENSOR TYPE / DISPLAY	*JUMPER SETTINGS*	*REAR PANEL CONNECTIONS*
Thermistor 0.00 to 99.99 K ohms		
Thermistor (1M) 0.00 to 999.9 K ohms		
AD590[8] -50.0 to 150.0 °C -58.0 to 302.0 °F 223.2 to 432.2 °K		
LM35 -50.0 to 150.0 °C -58.0 to 302.0 °F		
LM135, LM235, LM335 -50.0 to 150.0 °C -58.0 to 302.0 °F 223.2 to 432.2 °K		
100 Ohm 3 Wire RTD -199.9 to 800.0 °C -58.0 to 302.0 °F		
Voltage -199.9 to 9999 units (counts)		
Current -199.9 to 9999 units (counts)		
Thermocouple See table at left for fixed ranges		

Note: The setting for ñCURRENTòis shown as ñVOLTAGEòand is due to the external 250 ohm that is to be placed across the sensor input to convert the current to a voltage.

[8] What is this for?

4.2.2 HARDWARE CONFIGURATIONS

NOTE: The jumper configuration for a current input is identical to the configuration for a voltage input. At time of order, if a current input is selected as the input, a precision 250 ohm resistor is shipped with each instrument to allow for current to voltage translation at the input. This translation is provided in the form of a small adapter with the 250 ohm inside. This is assembled and shipped from the factory. Please contact the factory to purchase an adapter if necessary. The part number for the 250 ohm adapter is 8-250A.

STEP 2) PROCESS VARIABLE DECIMAL POINT Pud

Each sensor type has various decimal point settings. KEEP IN MIND THAT *CHANGING* THIS PARAMETER WILL RESET THE CONTROLLER TO ACCOMODATE THE NEW SETTINGS.

Follow these steps to configure and/or check your current configuration for the decimal point. There are basically three choices 0, 1, or 2 decimal places. Some thermocouples have fixed ranges but allow for a tradeoff of maximum range vs. resolution. See the reference table below.

a) When the controller is in ñOperation Modeò press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the ñchannel menuò. The upper display shows the channel name (Operations Menu oPE by default). The bottom display shows the channel number 1 Ch 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the ñOperation Modeò screen and try this step again.

b) Press the DOWN key repeatedly until the Settings menu SEt is shown in the upper display. The bottom display will show Ch 6.

c) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the ñparameter menuò. Pin indicating sensor type is shown in the upper display, and the last stored setting for the sensor type Pin is shown in the lower display.

d) Press the DOWN key repeatedly until the decimal point parameter Pud shows in the upper display.

e) Momentarily press the select key ***SEL*** to access the parameter setting for the decimal point. Pud designating sensor decimal point continues to be shown in the upper display, and the last stored setting for the sensor decimal point WILL BLINK in the lower display).

f) Press the UP or DOWN key repeatedly until the correct decimal point Pud value BLINKS in the lower display.

SENSOR	Pud
Thermistor 10K (0-100K)	2
Thermistor 100K (0-1M)	1
AD590	1
LM35	1
LM135/235/335	1
100ohm 3 Wire RTD	1
Voltage	0
Current	0

SENSOR	Pud
Type J	0/1
Type K	0
Type R	0
Type B	0
Type S	0
Type T	0/1
Type E	0/1
Type N	0

g) Press the select key ***SEL*** to store the decimal point Pud position.

STEP 3) PROCESS VARIABLE BOTTOM LIMIT Pub

KEEP IN MIND THAT *CHANGING* THIS PARAMETER WILL RESET THE CONTROLLER TO ACCOMODATE THE NEW SETTINGS.

Follow these steps to configure and/or check your current configuration for the sensors lower limit.

a) When the controller is in "Operation Mode" press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the "channel menu". The upper display shows the channel name (Operations Menu oPE by default). The bottom display shows the channel number 1 Ch 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the "Operation Mode" screen and try this step again.

b) Press the DOWN key repeatedly until the Settings menu SEt is shown in the upper display. The bottom display will show Ch 6.

c) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the "parameter menu" Snr indicating sensor type is shown in the upper display, and the last stored setting for the sensor type Snr is shown in the lower display).

d) Press the DOWN key repeatedly until the sensor lower range limit parameter Pub shows in the upper display.

e) Momentarily press the select key ***SEL*** to access the parameter setting for the sensor lower range limit. Pub designating sensor lower range limit continues to be shown in the upper display, and the last stored setting for the sensor lower range limit WILL BLINK in the lower display.

f) Press the UP or DOWN key repeatedly until the correct sensor lower range limit Pub value BLINKS in the lower display.

g) Press the select key ***SEL*** to store the sensor lower range limit Pub value.

SENSOR	Pub (DP)
Thermistor 10K (0-100K)	0.0K
Thermistor 100K (0-1M)	0.0K
AD590	-50.0C / -58.0F
AD592	-25.0C / -13.0F
LM35	-50.0C / -58.0F
LM135/235/335	-50.0C / -58.0F
100ohm 3 Wire RTD	-199.9 (1), -200.0 (0)
Voltage	0
Current	0

SENSOR	Pub (DP)
Type J	0C (32F) 0.0C (32.0F)
Type K	0C (32F) 0.0C (32.0F)
Type R	0C (32F)
Type B	0C (32F)
Type S	0C (32F)
Type T	-200C (-328F) / -199.9C (-199.9F)
Type E	-200C (-328F) / -199.9C (-199.9F
Type N	0C (32F)

NOTE: When using thermocouple sensors and setting the decimal point to a value of 1 the entire sensor range is limited to 1000 degrees full scale and a minimum value of -199.9. For example, -199.9 to 800.1 or -50.0 to 950.0.

STEP 4) PROCESS VARIABLE FULL SCALE LIMIT PUF

KEEP IN MIND THAT *CHANGING* THIS PARAMETER WILL RESET THE CONTROLLER TO ACCOMODATE THE NEW SETTINGS.

Follow these steps to configure and/or check your current configuration for the sensors full scale input limit.

a) When the controller is in "Operation Mode" press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the "channel menu". The upper display shows the channel name (Operations Menu OPE by default). The bottom display shows the channel number 1 Ch 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the "Operation Mode" screen and try this step again.

b) Press the DOWN key repeatedly until the Settings menu SET is shown in the upper display. The bottom display will show channel number 6 Ch 6.

c) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the "parameter menu". PUI indicating sensor type is shown in the upper display, and the last stored setting for the sensor type PUI is shown in the lower display.

d) Press the DOWN key repeatedly until the sensor upper range limit parameter PUF shows in the upper display.

e) Momentarily press the select key ***SEL*** to access the parameter setting for the sensor upper range limit. PUF designating sensor upper range limit continues to be shown in the upper display, and the last stored setting for the sensor upper range limit WILL BLINK in the lower display.

f) Press the UP or DOWN key repeatedly until the correct sensor upper range PUF value BLINKS in the lower display.

g) Press the select key ***SEL*** to store the sensor upper range limit PUF value.

SENSOR	PUF
Thermistor 10K (0-100K)	99.99
Thermistor 100K (0-1M)	999.9
AD590	150.0C (302.0F)
AD590	105.0C (221.0F)
LM35	150.0C (302.0F)
LM135/235/335	150.0C (302.0F)
100ohm 3 Wire RTD	850C (1562F) 200.0C (392.0F)
Voltage	9999
Current	9999

SENSOR	PUF
Type J	1000C (1832F) 400.0C (752.0F)
Type K	1200C (2192F) 800.0C (1472.0)
Type R	1600C (2912F)
Type B	1800C (3272F)
Type S	1600C (2912F)
Type T	400.0C (752.0F)
Type E	800C (1472F) 800.0C (1472.0F)
Type N	1300C (2372F)
Type PL-2	1300C (2372F)

NOTE: When using thermocouple sensors and setting the decimal point to a value of 1 the entire sensor range is limited to 1000 degrees full scale and a minimum value of -199.9. For example, -199.9 to 800.1 or -50.0 to 950.0.

4.2.3 TEMPERATURE SET POINT LIMITS

When setting target temperatures, the set point being entered by the operator can be limited to any value within the sensors lower range limit PLb and upper range limit PLF discussed earlier. This can avoid operator errors that may result in undesired temperature settings. As an example, the range of a Type T thermocouple sensor may include -200 to 350 degrees Celcius using one 0 decimal points, however the process is limited to 10.0 to +40.0. In this example, the decimal point could be increased to 1 instead of zero for better resolution with a max range of -199.9 to 350.0 and also the users input range of 10.0 to 40.0 could be programmed into SuL and SuH respectively.

The factory defaults to the maximum range possible.

STEP 5) TARGET SETPOINT LOWER LIMIT SuL

Note: SuL must be less then SuH and be within PLb and PLF

a) When the controller is in ñOperation Modeò press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the ñchannel menuò. The upper display shows the channel name (Operations Menu oPE by default). The bottom display shows the channel number 1 Ch 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the ñOperation Modeò screen and try this step again.
b) Press the DOWN key repeatedly until the PID menu PId is shown in the upper display. The bottom display will show channel number 2 Ch 2.
c) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the ñparameter menuò. P indicating the proportional band is shown in the upper display, and the last stored setting for the proportional band P is shown in the lower display.
d) Press the DOWN key repeatedly until the set point lower limit parameter SuL shows in the upper display.
e) Momentarily press the select key ***SEL*** to access the parameter setting for the set point lower limit. SuL designating set point lower limit continues to be shown in the upper display, and the last stored setting for the set point lower limit WILL BLINK in the lower display).
f) Press the UP or DOWN key repeatedly until the desired set point lower limit SuL value BLINKS in the lower display.
a) Press the select key ***SEL*** to store the set point lower limit SuL value.

STEP 6) TARGET SETPOINT UPPER LIMIT SUH

Note: SUH must be greater than SUL and be within PUB and PUF

a) When the controller is in ñOperation Modeò press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the ñchannel menuò. The upper display shows the channel name (Operations Menu OPE by default). The bottom display shows the channel number 1 CH 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the ñOperation Modeò screen and try this step again.

b) Press the DOWN key repeatedly until the PID menu PID is shown in the upper display. The bottom display will show channel number 2 CH 2.

c) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the ñparameter menuò. P indicating the proportional band is shown in the upper display, and the last stored setting for the proportional band P is shown in the lower display).

d) Press the DOWN key repeatedly until the set point upper limit parameter SUH shows in the upper display.

e) Momentarily press the select key ***SEL*** to access the parameter setting for the set point upper limit. SUH designating set point upper limit continues to be shown in the upper display, and the last stored setting for the set point upper limit WILL BLINK in the lower display.

f) Press the UP or DOWN key repeatedly until the desired set point upper limit SUH value BLINKS in the lower display.

g) Press the select key ***SEL*** to store the set point upper limit SUH value.

4.2.2 TEMPERATURE DEPENDENT OPERATIONAL LIMITS (ALARM 1)

The controller can be setup to disable power when the temperature is beyond an end user defined value. This setting has both a high and low value and can cover any temperature within the sensor lower range limit and upper range limit discussed earlier.

STEP 7) THE TEMPERATURE ALARM LOW LIMIT AL 1L

Note: AL 1L must be less than AL 1H and within SdL and SdH

a) When the controller is in ñOperation Modeò press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the ñchannel menuò The upper display shows the channel name (Operations Menu oPE by default). The bottom display shows the channel number 1 Ch 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the ñOperation Modeò screen and try this step again.
b) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the ñparameter menuò nAn indicating the manual or automatic control option is shown in the upper display, and the last stored setting for the manual or automatic control nAn is shown in the lower display.
c) Press the DOWN key repeatedly until the alarm low limit parameter AL 1L shows in the upper display.
d) Momentarily press the select key ***SEL*** to access the parameter setting for the alarm low limit. AL 1L designating alarm low limit continues to be shown in the upper display, and the last stored setting for the alarm low limit WILL BLINK in the lower display).
e) Press the UP or DOWN key repeatedly until the desired alarm low limit AL 1L value BLINKS in the lower display.
f) Press the select key ***SEL*** to store the alarm low limit AL 1L value.

STEP 8) THE TEMPERATURE ALARM HIGH LIMIT AL 1H

Note: AL 1H must be greater than AL 1L and within SoL and SoH.

a) When the controller is in ñOperation Modeò press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the ñchannel menuò The upper display shows the channel name (Operations Menu oPE by default). The bottom display shows the channel number 1 Ch 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the ñOperation Modeò screen and try this step again.
b) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the ñparameter menuò nAn indicating the manual or automatic control option is shown in the upper display, and the last stored setting for the manual or automatic control nAn is shown in the lower display).
c) Press the DOWN key repeatedly until the alarm high limit parameter AL 1H shows in the upper display.
d) Momentarily press the select key ***SEL*** to access the parameter setting for the alarm high limit. AL 1H designating alarm high limit continues to be shown in the upper display, and the last stored setting for the alarm high limit WILL BLINK in the lower display.
e) Press the UP or DOWN key repeatedly until the desired alarm high limit AL 1H value BLINKS in the lower display.
f) Press the select key ***SEL*** to store the alarm high limit AL 1H value.

4.2.3 POSITIVE AND NEGATIVE TEMPERATURE COEFFICIENT INVERSION

The instrument must be configured to match the temperature coefficient of the selected sensor type. This is accomplished using the Aor option in the SEr Ch6 menu. See section 7 for more details. Refer to section 4.1 for menu navigation and the software map.

5 Controller Modes

The controller has four modes: operation mode, manual mode, monitoring mode, and setup mode. This section outlines each mode and explains their key functions.

Refer to the following diagram for information about key functions and changing modes.

"Press and hold" means to press a key and hold it for about one to two seconds.

5.1 OPERATION MODE

Operation mode is the regular mode of operation. PV and SV values are displayed. Control output and alarm output are suspended during standby, but the PV value is displayed as normal and the SV value blinks. The controller starts in this mode when the power is turned on.

5.2 MANUAL MODE

Manual mode allows you to set the output manually (MV). The actual temperature or process value (PV) is displayed, as in operation mode. Use the up and down keys to change the MV value, displayed as a percentage from -3% to 103%.

Manual display mode only appears when the controller is set to manual mode.

5.3 MONITORING MODE

Monitoring mode allows you to conýrm the status of the controller by checking each value.

To enter monitoring mode from operation mode or manual display mode, press and hold the select key ***SEL***. The device will enter monitoring mode with MV1 selected. Use the up and down keys to scroll through the information. A table is shown below with the descriptions of the items in this menu.

FAIL	Error Source Display
MV1	MV1 (%) - Output 1 (internal)
MV2	MV2 (%) - Output 2 (internal)
PASS	Password

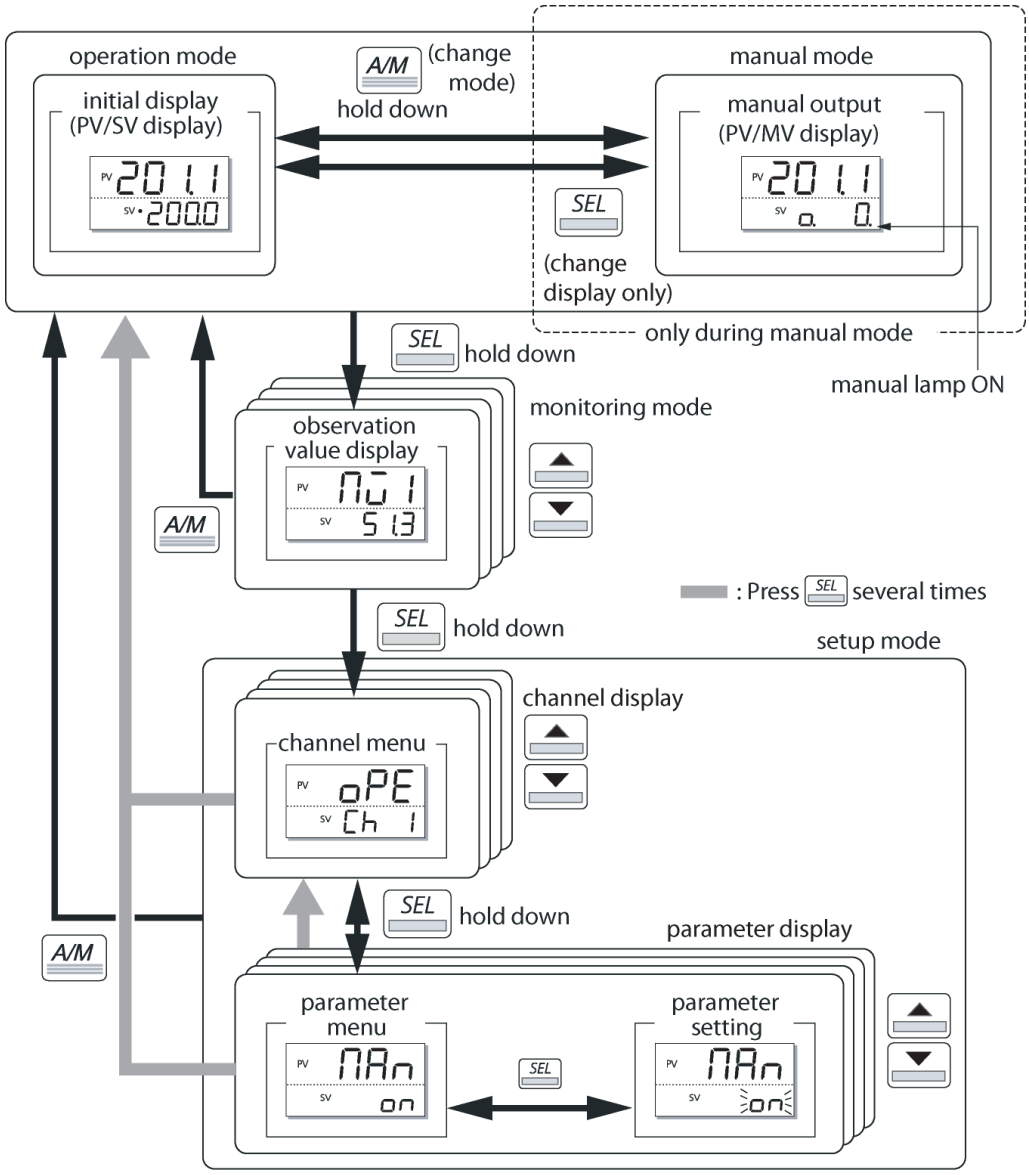
The parameters are divided into channels. Each channel contains one series of parameters. The following is an overview of the channels.

5.4 SETUP MODE

Setup mode allows you to set the parameters for the device. To enter setup mode, ýrst press and hold the ***SEL*** key when in operation mode or manual display mode to enter "monitoring mode" with [MV1] selected. Then press and hold the ***SEL*** key to enter the channel menu in setup mode. Use the up and down keys to select the channel that includes the parameter you wish to change. Press and hold the ***SEL*** key, then use the up and down keys to check the parameters and their values. To change the value of a parameter, press the ***SEL*** key when the value of the parameter you wish to change is being displayed. The parameter value will blink and can be changed with the up and down keys. Press the ***SEL*** key again to set the parameter to your desired value. The value will then stop blinking.

5.5 SOFTWARE MAP

Below is the software map for navigating the controller. Shown on the map are the 4 modes described in the previous section and how to navigate between them.



SEE SECTION 9 FOR PARAMETER DESCRIPTIONS

6 Hardware Concepts of the Series 800 / 850 / 860 TEC Controller

If all the previous steps have been followed, at this stage, the Series 800 / 850 / 860 TEC Controller should be properly configured for the desired sensor type and the TEC module should be connected in the correct fashion.

6.1 TEMPERATURE LIMIT ALARM 1 (DO1)

Alarm 1 is associated with DO1 and operates an internal relay that allows shutting down the output. Alarm 1 has a high and low temperature limit setting which if exceeded, will result in the output to the TEC(s) to be turned off.

6.1.1ALARM 1 HIGH

Alarm 1 ñhighò alarm allows the setting of a high temperature limit which if exceeded, will result in the output to the TEC(s) to be shut down. DO1 will light indicating this alarm.

6.1.2ALARM 1 LOW

Alarm 1 ñlowò alarm allows the setting of a low temperature limit which if exceeded, will result in the output to the TEC(s) to be shut down. DO1 will light indicating this alarm.

Using Alarm 1 high and Alarm 1 low temperature limit alarms (section 4.2 Steps 7 and 8) provides the means to shut down power to the TEC(s) should user set temperature limits be exceeded, thus protecting the TEC(s) from potential damage.

6.2 POWER LIMITS (CURRENT LIMITS)

The controller is equipped to limit both Output 1 and Output 2. These limits can be set from 0% up to 100% of the output. The power limit is based on the maximum current. For instance, when using a 150W controller rated at 15V and 10A, then the power limit at 100% would be 10A * 100% = 10A * 15V = 150W. Likewise, at 50%, the power limit would be (10A * 50%) = 5A * 15V = 75W. These limits are accessible from Ch 2 PId as PHC 1 and PHC2 as Power Limit High Channel 1 and Power Limit High Channel 2 High respectively. Another example, if the controller has a maximum output of 10A, but the connected TEC can only handle 6A, setting both PHC 1 and PHC2 to 60.0% will limit both the heating and cooling currents to 6A. These can be set independently if different current limits for heating and cooling are desired. This is typical as the TEC will tend to heat up much faster than it cools down in most applications. Be aware that these current limits also apply during an Auto-Tuning sequence.

6.3 CONTROL TYPE OVERVIEW

The controller has two types of temperature control. ñPIDò and ñFUZZYò

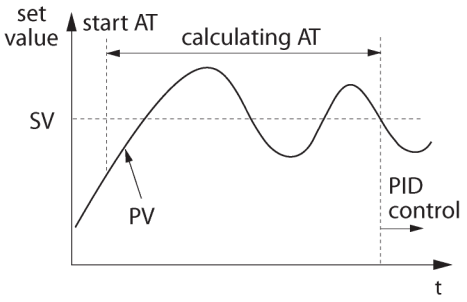
Control Type	Parameter(s)	Description
PID Controls	P > 0 I d AT	PID calculation and controls proceed according to the previously set PID parameters. PID parameters can be set manually or through auto-tuning (AT).
Fuzzy PID Control	FuZY AT	Reduces the amount of overshoot during control. It is effective when you want to suppress overshoot while changing SV, even during processes where it may take a long time to reach the target value.

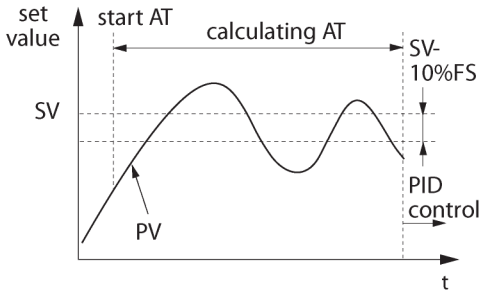
6.4 AUTO-TUNING

When initiated, the Auto-Tune function will automatically calculate the ideal PID parameters needed for controlling the TEC[9]. There are three (3) types of Auto-Tuning options in the operation channel menu oPE Ch1.

Auto-Tune Parameter	Operation	Function
On	Normal Type	Standard auto-tuning. Choose this option under normal circumstances.
Lo	Low PV Type	Auto-tuning that runs at SV-10%. Use this to minimize overshoot.
OFF	Stop/Finish	Stops or finishes auto-tuning

The PID values will be calculated after the Process Variable (PV) has crossed the Set point Variable (SV) 4 times. This is true for both Normal (SV) and Low (SV-10%) type Auto-Tuning. The figures below show the control for ñNormalò auto-tuning and ñLoò auto-tuning respectively.





If auto-tuning has not finished in a reasonable amount of time, please check the following:

- Input/output connections

[9] This assumes that the controller is able to produce sufficient output to control above and below the set point. In the event that the controller cannot complete the auto-tuning process, it may be necessary to cancel this mode of operation. ...

- Control output operation (see section 7)
- Sensor input type

Note: if it becomes necessary to cancel the auto-tuning simply turn the AT parameter off. The AT parameter is located in the operation parameters menu oPE Ch 1.

If there are any significant changes in the operating environment, such as those below, auto-tuning must be restarted.

- Large change in the set point (SV)
- Change in input range (see section 4.2.2 and 4.2.3)
- Large change in controlled device (load)

Please note the following:

- The PID parameters after auto-tuning has ýnished will be saved even if power is removed. If power is removed before auto-tuning is ýnished, PID parameters will not be changed and auto-tuning will need to be restarted.
- Control reverts to ON/OFF during auto-tuning, so some processes may experience large changes in PV. If you are running a process that cannot accommodate large changes in PV, do not use auto-tuning. Auto-tuning is also not suitable for processes requiring rapid response.
- Restart auto-tuning if SV changes drastically, PV input type changes or the control object conditions change. Auto-tuning can be activated even when the control type is in fuzzy mode.

Caution: Auto-tuning is not performed in manual mode or standby mode.

5.5 TIMING OUT

If no input commands (keys pressed) are received by the controller while in monitor or setup mode (channel or parameter display) for a period of 30 seconds, the controller will revert back to the PV/SV display.

7 Sensor Coefficient and Power Modes

7.1 POSITIVE OR NEGATIVE TEMPERATURE COEFFICIENTS

For positive temperature coefficient (PTC) sensors **AoF = Pu**, output 1 (C1) indicates the HEAT channel and output 2 (C2) indicates the COOL channel.

For negative temperature coefficient (NTC) sensors **AoF = nu** the opposite is true and (C1) indicates the COOL channel and output 2 (C2) indicates the HEAT channel.

7.2 POWER MODES

There are typically three power modes. Bi-Polar, COOL ONLY, and HEAT ONLY. However, due to the inversion based on the sensor type, the controller's output is dependent upon the **AoF** parameter as shown in the table below:

MODE	*DESCRIPTION*	*PARAMETERS*
Negative Temperature Coefficient Sensor Type (NTC). Example: NTC Thermistor AoF = nu		
Bi-Polar COOL or HEAT[10]	Standard operation with cooling (C1) and heating (C2) capabilities. Standard control mode for thermistors.	PtC1 = Cool Limit PtC2 = Heat Limit
COOL ONLY	By setting the C2 output limit (PtC2) to 0.0, the controller will only drive the C1 output resulting in a COOL ONLY mode of operation.	PtC1 = Cool Limit PtC2 = 0.0
HEAT ONLY	By setting the C1 output limit (PtC1) to 0.0, the controller will only drive the C2 output resulting in a HEAT ONLY mode of operation.	PtC1 = 0.0 PtC2 = Heat Limit
Positive Temperature Coefficient Sensor Type (PTC). Example: RTD or Thermocouple AoF = Pu		
Bi-Polar COOL or HEAT	Standard operation with cooling (C2) and heating (C1) capabilities. Used with most PTC sensors like RTD, Thermocouple, etc.	PtC1 = Heat Limit PtC2 = Cool Limit
COOL ONLY	By setting the C1 output limit (PtC1) to 0.0, the controller will only drive the C2 output resulting in a COOL ONLY mode of operation.	PtC1 = 0.0 PtC2 = Cool Limit
HEAT ONLY	By setting the C2 output limit (PtC2) to 0.0, the controller will only drive the C1 output resulting in a HEAT ONLY mode of operation.	PtC1 = Heat Limit PtC2 = 0.0

Please note that should the TEC be wired backwards, the **AoF** parameter could be used to swap the output and correct the problem. Be careful not to turn the TEC upside down and then control with an inverted output as the efficiency of the TEC will be dramatically reduced.

[10] The output is a switched bi-polar output. Therefore it is necessary to avoid ZERO current control to avoid excessive switching at the output. A simple fan or offset temperature will alleviate this.

8 Control Introduction

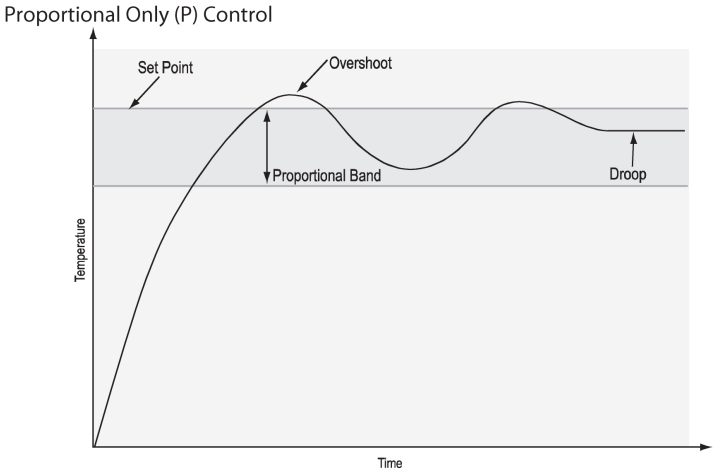
The Series 800 / 850 / 860 TEC Controllers have been designed to provide a great deal of flexibility with respect to the instrumentõs control parameters.

Temperature control can be accomplished in one of three ways as listed below:

a) Proportional only (P)
b) Proportional + Integral (PI)
c) Proportional + Integral + Derivative (PID)

PID stands for **P**roportional, **I**ntegral, and **D**erivative terms.

8.1 PROPORTIONAL ONLY (P) CONTROL



Some processes need to maintain a temperature or process value better than an on/off control can provide. Proportional control provides better control by adjusting the output when the temperature or process value is within a proportional band. This band is simply a window around the desired set point. As an example, if the desired temperature set point is 10°C and the proportional band was 5°C, then the proportional band window would be 10°C ±5°C. When the actual process value (temperature) is within this band, the controller adjusts the output based on how close the process value is to the set point: the closer to the set point to the actual, the lower the proportional output. This is similar to backing off on the gas pedal of a car as you approach a stop sign. It keeps the temperature or process value from swinging as widely as it would with a simple on/off control. However, when a system settles down, the temperature or process value tends to ñdroopò short of the set point. With proportional control the output current level equals (set point minus process value) divided by the proportional band. The PID proportional band can be viewed or changed with Proportional band **P** in the Channel 2 **Ch2** PID **PID**.

8.2 THE PROPORTIONAL BAND SETUP

The Proportional Band P is used to control the gain of the controller.

Proportional Band

The proportional band is set as a percentage of input sensor range. (value can be set from 0 to 999.9%).

Example: Proportional Band = 20%

With the input sensor set for a range of 0-100 degrees PUb, PUF and the proportional band P set for a value of 20%, the proportional band will represent a span of 20 degrees from the set point. For example, if the set point (SV) is 55 degrees, then proportional band will operate outputs from 45 to 65 degrees.

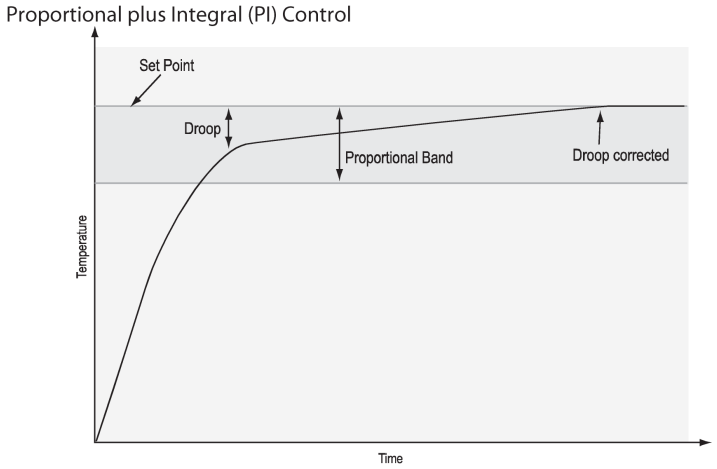
Setting Proportional Band P

a) When the controller is in ñOperation Modeò press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the ñchannel menuò. The upper display shows the channel name (Operations Menu oPE by default). The bottom display shows the channel number 1 Ch 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the ñOperation Modeò screen and try this step again.
b) Press the DOWN key repeatedly until the PID menu PId is shown in the upper display. The bottom display will show channel number 2 Ch 2.
c) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the ñparameter menuò P indicating the proportional band is shown in the upper display, and the last stored setting for the proportional band P is shown in the lower display.
d) Momentarily press the select key ***SEL*** to access the parameter setting for the proportional band. P designating proportional band continues to be shown in the upper display, and the last stored setting for the proportional band WILL BLINK in the lower display).
e) Press the UP or DOWN key repeatedly until the desired proportional band P value BLINKS in the lower display.
f) Press the select key ***SEL*** to store the proportional P value.

Note: Should the P term be set to zero, it will automatically revert to a default setting of 10.0%.

8.3 PROPORTIONAL PLUS INTEGRAL (PI) CONTROL

The droop inherent while using proportional only control can be corrected by adding integral or ñresetò control to the system. When the system has settled down the integral/reset value is tuned to bring the temperature or process value closer to the set point. The integral determines the speed of the correction. However, this may increase the overshoot that occurs at when the instrument turns on or when the set point is changed. Too much integral action will make the system unstable. Integral is cleared when the process value is outside of the Anti-reset Windup **Ar** setting. Integral is measured in seconds per repeat. A low integral value causes a fast integrating action. View or change the integral value with Integration time **I** under the **Ch 2** menu item labeled **PId**.



Setting Integral Term

a) When the controller is in ñOperation Modeò press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the ñchannel menuò. The upper display shows the channel name (Operations Menu **oPE** by default). The bottom display shows the channel number 1 **Ch 1**. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the ñOperation Modeò screen and try this step again.

b) Press the DOWN key repeatedly until the PID menu **PId** is shown in the upper display. The bottom display will show channel number 2 **Ch 2**.

c) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the ñparameter menuò **P** indicating the proportional band is shown in the upper display, and the last stored setting for the proportional band **P** is shown in the lower display).

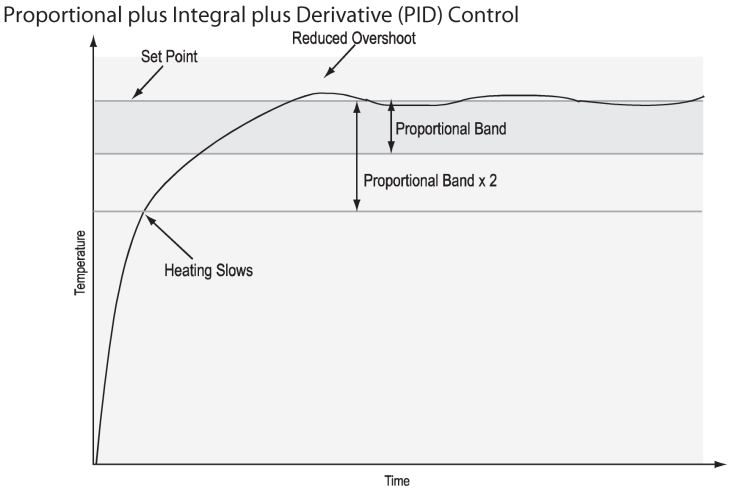
d) Press the DOWN key repeatedly until the integrator parameter **I** shows in the upper display.

e) Momentarily press the select key ***SEL*** to access the parameter setting for the integrator. **I** designating integrator continues to be shown in the upper display, and the last stored setting for the integrator WILL BLINK in the lower display.

f) Press the UP or DOWN key repeatedly until the desired integrator **I** value BLINKS in the lower display.

g) Press the select key ***SEL*** to store the integrator **I** value.

8.4 PROPORTIONAL PLUS INTEGRAL PLUS DERIVATIVE (PID) CONTROL



Use derivative or ñrateòcontrol to minimize the overshoot in a PI-controlled system. The derivative adjusts the output based on the rate of change in the temperature or process value. Too much derivative will make the system sluggish.

Set The Initial Controller Derivative

a) When the controller is in ñOperation Modeòpress and hold the select key ***SEL*** for approximately four (4) seconds, this will access the ñchannel menuò. The upper display shows the channel name (Operations Menu oPE by default). The bottom display shows the channel number 1 Ch 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the ñOperation Modeòscreen and try this step again.

b) Press the DOWN key repeatedly until the PID menu PID is shown in the upper display. The bottom display will show Ch 2.

c) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the ñparameter menuò. P indicating the proportional band is shown in the upper display, and the last stored setting for the proportional band P is shown in the lower display).

d) Press the DOWN key repeatedly until the derivative parameter (d) shows in the upper display.

e) Momentarily press the select key ***SEL*** to access the parameter setting for the derivative. d designating derivative continues to be shown in the upper display, and the last stored setting for the derivative WILL BLINK in the lower display.

f) Press the UP or DOWN key repeatedly until the desired derivative d value BLINKS in the lower display.

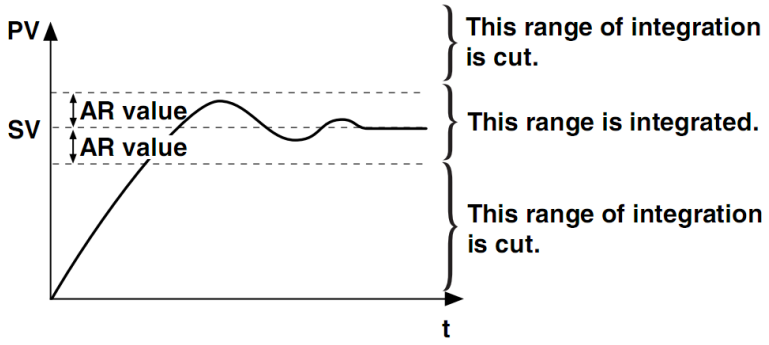
g) Press the select key ***SEL*** to store the derivative d value.

8.5 ANTI-RESET WINDUP

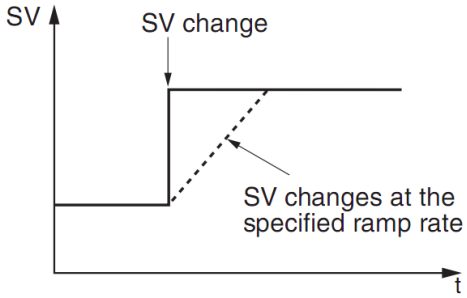
Anti-reset windup Ar is a function that limits the range of valid integration to control overshooting.

Range of Ar: 0 to 100% FS

The anti-reset windup function Ar cuts integration that falls outside of the Ar set range that is centered around SV. It is automatically set to the optimum value when auto-tuning is activated. View or change the Anti-reset windup with the Ar under Ch 2 PId setting.



8.6 RAMP TO SET POINT



The picture shown above illustrates a typical control situation where NO ramping is involved. The dotted line illustrates the difference when applying a Ramp to Set Point.

Ramping protects materials and systems that cannot tolerate rapid temperature changes. The value of the ramp rate is the maximum degrees per minute or hour that the system temperature can change. Select when ramping is active with Ramping Mode rMP (Ch 7 SYS). The options are on/off.

Select whether the rate is in degrees per minute or hour with Ramp SV Slope time units rMPU (Ch 7 SYS). Set the ramping incline rate with Ramp SV Incline rMPh (Ch 7 SYS). Set the ramping decline rate with Ramp SV Decline rMPL Ch 7 SYS.

8.7 FUZZY PID CONTROL

Fuzzy control is used to minimize overshoot compared to normal PID. ***Fuzzy control can only be used after auto-tuning has been activated and PID values have been set.***

To turn on Fuzzy control perform the following steps:

a) When the controller is in ñOperation Modeò press and hold the select key ***SEL*** for approximately four (4) seconds, this will access the ñchannel menuò. The upper display shows the channel name (Operations Menu oPE by default). The bottom display shows the channel number 1 Ch 1. NOTE: If the select key ***SEL*** is held too long it this will enter into the Operations Menu channel) simply press the auto/manual key(*A/M*) to return to the ñOperation Modeò screen and try this step again.

b) Press the DOWN key repeatedly until the Settings menu SEt is shown in the upper display. The bottom display will show Ch 1.

c) Press and hold the select key ***SEL*** key for approximately two (2) seconds. (Note: holding down too long will go back to the channel menu). This will access the ñparameter menuò with rMP indicating Ramp and Soak mode is shown in the upper display, and the last stored setting for the sensor type rMP is shown in the lower display).

d) Press the DOWN key repeatedly until the control type parameter CtrL shows in the upper display.

e) Momentarily press the select key ***SEL*** to access the parameter setting for the control type. CtrL designating control type continues to be shown in the upper display, and the last stored setting for the sensor decimal point WILL BLINK in the lower display).

f) Press the UP or DOWN key repeatedly until the correct control type FUZY value BLINKS in the lower display.

g) Press the select key ***SEL*** to store the control type FUZY.

9 Parameter Descriptions

Listed below are the important operating parameters found within the various menu channels of the controller, become familiar with their function in operating the controller.:

9.1 AUTO TUNE.....AT

Use Auto Tune to automatically set the PID parameters. Options allow setting either Cooling or Heating individually, OR using both simultaneously.

Function	Description
On	This will output full heat and full cool and monitor the response times to calculate the best settings for the PID parameters.
Lo	This will function the same as ñOnò but will control to (SV ï 10%) to prevent overshoot.

Note: This auto tune process when initiated will attempt to work around the set point temperature that is programmed into the bottom display when at the Operation mode display.

9.2 AUTO / MANUAL OPERATION MODE.....AMn

Setting AMn to ñoffò(default) will allow the output to be controlled by the settings of the PID parameters. Setting AMn to ñonòwill cause the output to be controlled by the up and down arrow keys via the Operation Mode display. The MAN/AT/SELF LED will illuminate indicating that the lower display will show the % current being output to the load. LED C1 will indicate Output 1 current & LED C2 will indicate Output 2 current.

Note: holding down on the A/M key for a few seconds will also enter the manual mode. Holding down again will go back to the Monitor mode.

IMPORTANT: The set point will now be in the range of -3% to 103% to allow for heating or cooling. 50.0% IS THE ZERO OUTPUT POINT. -3% to 50.0% is Output 2 (Heating), 50.0 to 103.0% is Output 1 (Cooling).

9.3 SOFTWARE MAP TABLE

The table below shows the available channels of the channel menu when operating in setup mode.

Channel	Display	Channel Name	Overview
Ch 1	oPE	Operation	Sets the parameters for operation.
Ch 2	PId	Control (PID)	Sets the parameters concerning controls.
Ch 4	PrG	Ramp/Soak	Sets the parameters concerning ramp/soak. **Purchased separately.**
Ch 5	Mon	Monitor	Allows you to conýrm the status of the controller by checking each value. (Cannot be set.)
Ch 6	SEt	Setup	Sets the parameters concerning input/output.
Ch 7	SYS	System	Sets the parameters concerning system deýnitions for the controller.
Ch 9	CoM	Communication	Sets communication parameters such as the communication station number. **Purchased separately.**

Please see the next page for details on the options available in each channel.

Please note that items that are only available if purchased separately are still documented throughout the manual but may not be available.

The table below shows the parameters available within each of the channel menu items.

Chan.	Name	Description	Chan.	Name	Description	Chan.	Name	Description
oPE			PrG[11]			SYS		
	MAn	Manual Mode Switch		Ptn	Ramp/soak operation pattern		rMP	Ramp SV effect/no effect
	StbY	RUN/Standby switch		rtMU	Ramp/soak time		rMPL	Ramp SV - decline
	PrG	Ramp/soak control command[11]		SU- 1.. 16	SV Set Value X		rMPH	Ramp SV - Incline
	AT	Auto-Tuning run command		rM 1.. 16r	Ramp Time X		rMPU	Ramp SV slope time units
	SUn	Currently Selected SV no.		rM 1.. 16S	Soak Time X		SUr	Ramp SV display mode selection
	AL 1L	Alarm 1 Low setting		Mod	Ramp/soak mode		CtrL	Control methods
	AL 1H	Alarm 1 High setting		GSoE	Guaranteed soak ON/OFF		SrMd	Mode at statup
	LoC	Key Lock		GS-L	Guaranteed soak band lower	CoM[11]		
Pid				GS-h	Guaranteed soak band upper		Sno	Station No. setting
	P	Proportional Band		Conr	Continue mode		CoM	Parity Setting
	I	Integration Time	Non				PCoL	Protocol
	d	Derivation Time		SrAt[11]	Ramp/soak progress		SCC	Communications permissions
	Ar	Anti-reset windup		MV1	MV1 ï Output 1 (internal)			
	SuL	SV lower limit		MV2	MV2 ï Output 2 (internal)			
	SuH	SV upper limit		FALt	Error Source Display			
	PhC1	Output 1 upper limit		Pno[11]	Pattern No. Display			
	PhC2	Output 2 upper limit						
			SEr					
				PiT	PV Input type			
				PiL	PV input lower limit			
				PiH	PV input upper limit			
				Pid	Decimal position			
				PiU	Unit display			
				AdJ0	PV value input zero adjust			
				AdJS	PV value input span adjust			
				rF	PV temperature input filter			

[11] Ordered separately

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10 Optional Ramp and Soak Features

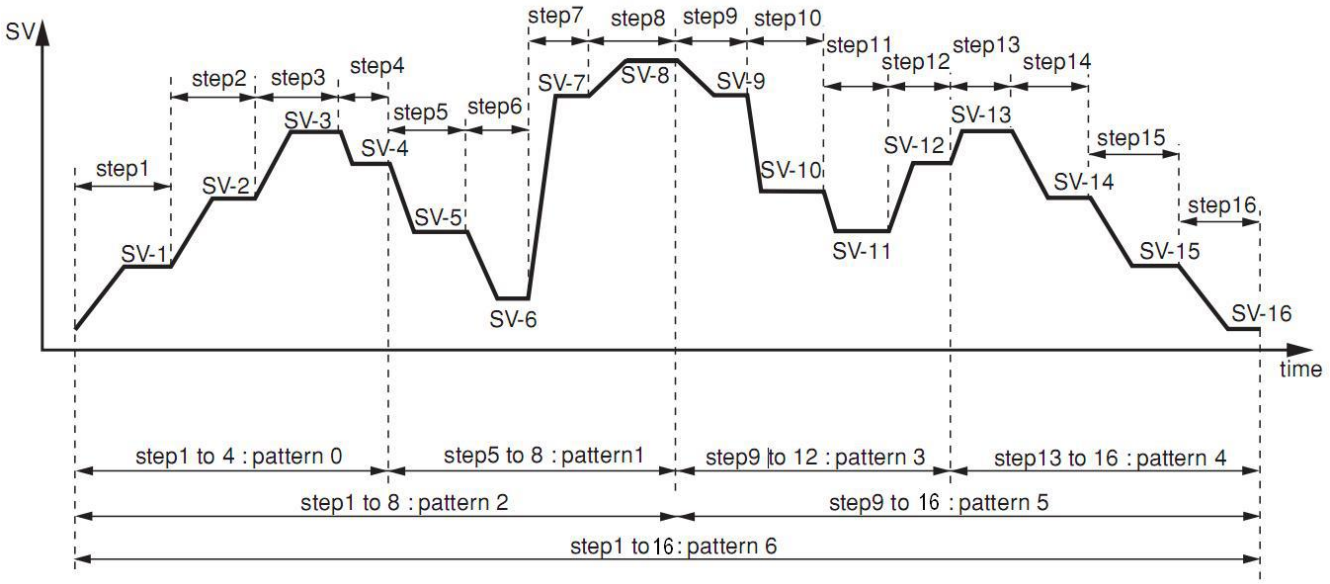
The optional Ramp and Soak function allows up to 16 steps running 7 different pattern types. Ramp and Soak Time units can be set for either minutes/seconds or hours/minutes with a range from 00:00 to 99:59 minutes/seconds or hours/minutes. There are also 16 program operation modes. The guaranteed soak option with adjustable upper and lower guaranteed soak band allows for timing only when the process variable is within a specified range of the desired set point. Continuous mode allows for repeating the ramp and soak process indefinitely.

10.1 PATTERN TYPES

The 16-step ramp/soak patterns are divided into seven types, any one of which can be used. The pattern selection is accessible from PTn CHY PrG

Pattern Number	Steps
0	1 to 4
1	5 to 8
2	1 to 8
3	9 to 12
4	13 to 16
5	9 to 16
6	1 to 16

Example



10.2 RAMP/SOAK TIME UNITS

Can be set for either minutes/seconds or hours/minutes. For minutes and seconds, select MM.SS under the rCnU parameter Ch4 PrG. For hours/minutes, select hh.MM under the rCnU parameter Ch4 PrG. Note: Time units cannot be set separately for each step. All steps use the same unit of time.

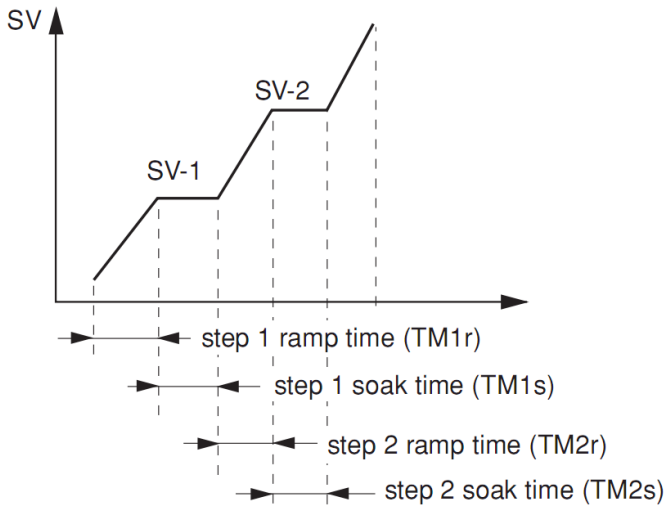
10.3 RAMP/SOAK SV SELECT (STEP 1 TO STEP 16)

Set the parameters SU-1 through SU16 for the Set point value for each corresponding step #. These parameters are accessible from the Ch4 PrG menu. These values can be set within the limits of the SUL (set point lower limit) and SUH (set point upper limit).

10.4 RAMP TIME (STEP 1 TO 16)

Set the parameters rN1r to r16r for the Ramp time for each corresponding step #. These parameters are accessible from the Ch4 PrG menu. Ramp time can be set from 00:00 to 99:59 (hour:min/minute:sec).

10.5 SOAK TIME (STEP 1 TO 16)

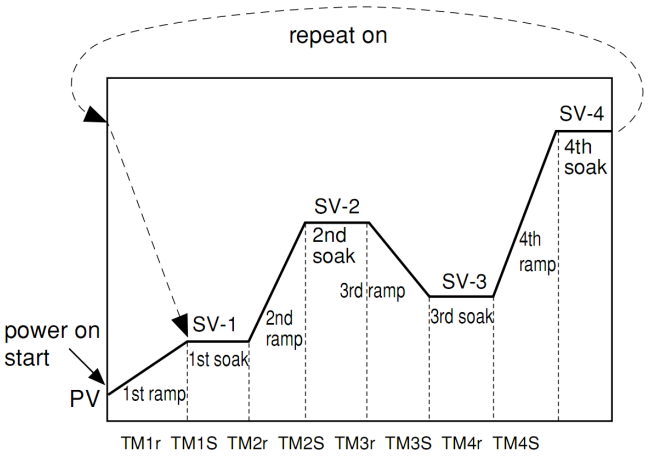


Set the parameters rN1S to r16S for the Ramp time for each corresponding step #. These parameters are accessible from the Ch4 PrG menu. Soak time can be set from 00:00 to 99:59 (hour:min/minute:sec).

10.6 RAMP/SOAK MODE

Ramp/Soak Mode sets the method of ramp/soak operation. The following items can be set:

Power On Start	Starts the ramp/soak from the current PV value when the controller is turned on.
END time output	Maintains the same state as at the end of the ramp/soak when ramp/soak is complete.
OFF Time output	Switches to the OFF state when ramp/soak is complete.
Repeat operation	Repeats ramp/soak from step 1 when the last step finishes.



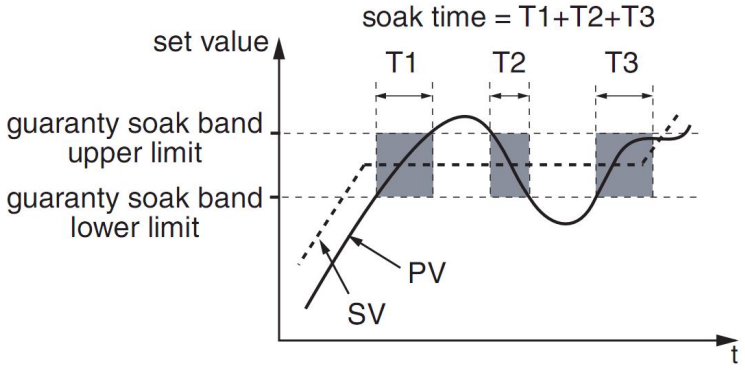
10.6 RAMP/SOAK MODE (CONTINUED)

Mode	Power On Start	Ending Output	OFF Output	Repeat Behavior
0	None	Maintain Control	Maintain Control	None
1	None	Maintain Control	Maintain Control	On
2	None	Maintain Control	Standby Mode	None
3	None	Maintain Control	Standby Mode	On
4	None	Standby Mode	Maintain Control	None
5	None	Standby Mode	Maintain Control	On
6	None	Standby Mode	Standby Mode	None
7	None	Standby Mode	Standby Mode	On
8	On	Maintain Control	Maintain Control	None
9	On	Maintain Control	Maintain Control	On
10	On	Maintain Control	Standby Mode	None
11	On	Maintain Control	Standby Mode	On
12	On	Standby Mode	Maintain Control	None
13	On	Standby Mode	Maintain Control	On
14	On	Standby Mode	Standby Mode	None
15	On	Standby Mode	Standby Mode	On

Note: When not in repeat operation, the last SV value is held when ramp/soak finishes.

10.7 GUARANTEED SOAK

This function guarantees soak time. Soak time only counts down when the PV is within the temperature range defined by the Guaranteed Soak Lower Limit and the Guaranteed Soak Upper Limit. The diagram below illustrates the process variable entering and exiting the Guaranteed Soak Band. Only when the process variable is within the shaded areas is the Soak Time counted down. When the Soak time has been reached the cycle proceeds to the next step.



Guaranteed Soak GSot in Ch4 PrG	On, Off
Guaranteed Soak Upper Limit GS-H in Ch4 PrG	0-50% FS
Guaranteed Soak Lower Limit GS-L in Ch4 PrG	0-50% FS

*note ï The numbers for the guaranteed soak upper and lower limit are in degrees (or units of measure specified) The value limitation for these numbers is 50% of the entire sensor range specified by PUb and PUF. For example, a type K thermocouple with a range of 0 to 400 degrees C will have a value limitation of 200 degrees for the guaranteed soak upper limit and guaranteed soak lower limit. A control set point of 100 degrees C with an upper limit of 30C and a lower limit of 20C will have the guaranteed soak time accumulated while the process value is between 80C and 130C.

10.8 CONTINUE MODE

This function allows the controller to continue the ramp and soak operation in the event of a power interruption to the controller.

Continue mode can be set for the following:

Reset rES	Does not operate ramp and soak upon power being restored.
Continue Con	Continues ramp and soak operation at the point where the power was turned off upon power being restored.
Restart rnL	Resumes ramp and soak operation from the first step upon power being restored.

11 Optional Serial Communications

11.1 RS485 CONNECTIONS

Wire the Series 8XX RS485 communications using the table below as a reference.

Item	**Specifications**	
Electrical Specifications	EIA RS-485 compliant	
Communication method	Two wire system, half double-bit serial	
Synchronous method	Asynchonous	
Connection status	1:N	
Max. no. of connections	255 Units	
Communication distance	Max 500m (total length)	
Data Format	**Data length**	8 bits
	Stop bit	1 bit
	Parity	None/Even/Odd (selectable)
Transmission code	Hex value (MODBUS RTU Mode)	
Error detection	CRC-16	
Insulation	Functional insulation for the transmission area and other areas (withstanding AC 500V)	

Show below are the connections for RS485.

RS485 CONNECTIONS	DB9 PIN OUT
R+ / T+	Pin 2
R- / T-	Pin 3
GND (optional)	Pin 5 (optional)

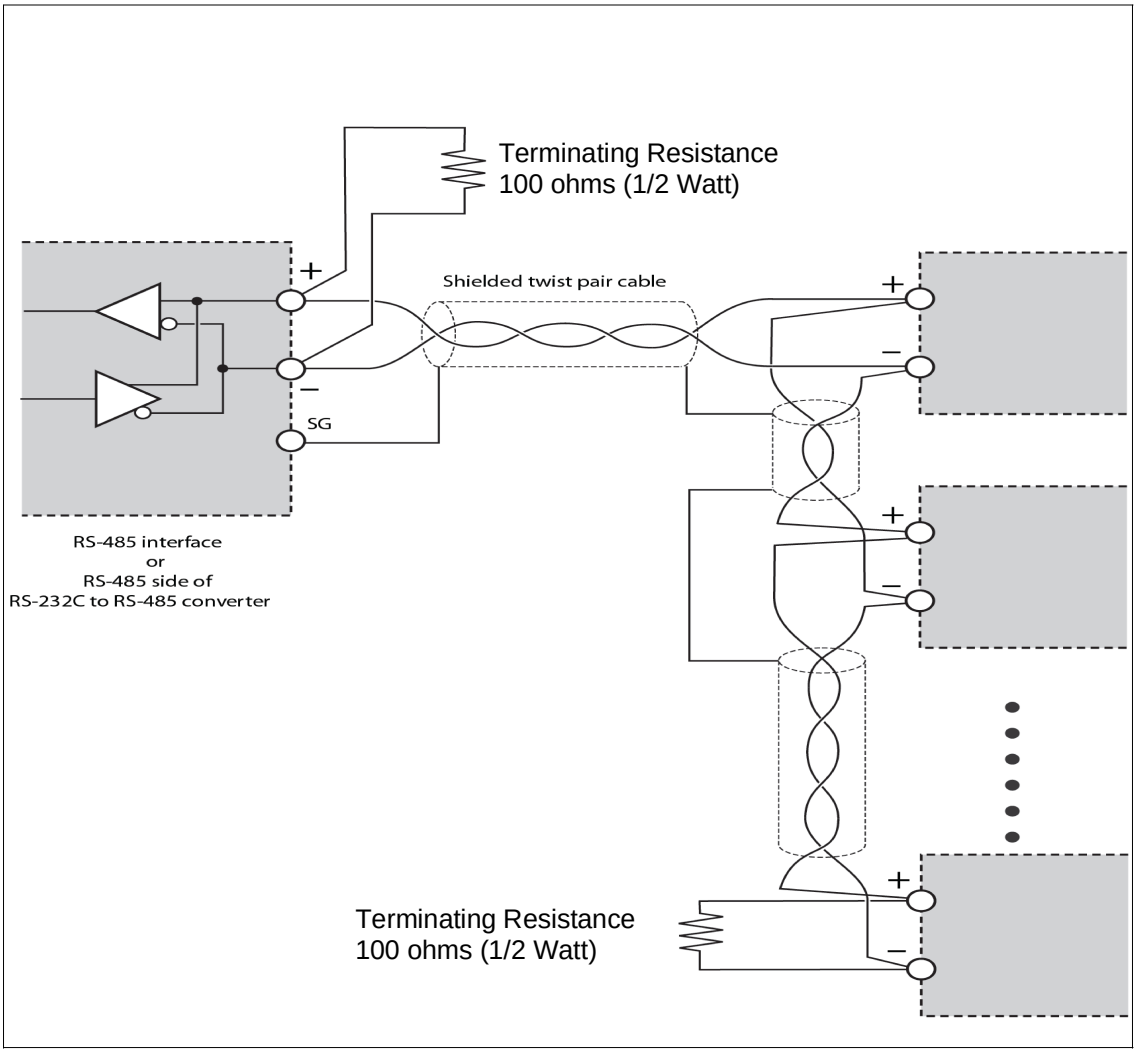
Note: the COM or ground pin is not necessary and connecting it is optional.

11.2 RS232 CONNECTIONS

RS232 CONNECTIONS	DB9 PIN OUT
TxD	Pin 2
RxD	Pin 3
GND	Pin 5

Note: If you have trouble communicating, try swapping over the input and output lines. Some are called T+ / T- or maybe A / B. Whatever the case, the communications link will not work unless these are correct.

Typical Connections for RS485 Communications.



11.2 COMMUNICATION SETTINGS

The communications settings listed below are accessed via the channel 9 Communications menu.

Display	Parameter Name	Function	Setting Range	Initial Value
STno	ST No. Setting	Station (Address) Number	0 to 255	1
bAU	Baud rate/Parity Setting	Communications speed and parity check	96od (9600 bps/odd) 96ev (9600 bps/even) 96no 9600 bps/none) 19od (19200 bps/odd) 19ev (19200 bps/even) 19no (19200 bps/none)	96od
SCC	Communications Permissions	Read-Only setting	r (read only) rW (read and write)	rW

Note: changing the baud rate requires a power cycle to continue at the new baud setting.

11.3 MODBUS RTU

The communication system with the MODBUS protocol always operates using a method where the master first sends a command message and the applicable slave replies with a response message.

11.4 MESSAGE COMPOSITION

The command message and response message are composed of four parts: the station number, function code, data part, and error check code. These four parts are sent in that order.

Field Name	No. of bytes
Station No. (address)	1 byte
Function Code	1 byte
Data part	2 to 125 bytes
Error Check Code (CRC-16)	2 bytes

The following describes each part of the message.

Station No.

This is the number specifying the slave. Commands can only be processed by slaves that have the same value set in the Stno parameter.

Function Code

This code specifies the function for the slave to perform.

Data Part

This data is required to run the function code. The composition of the data part is different depending on the function code.

The data in the micro controller is assigned a coil number or resistor number[12]. This coil number or resistor number is specified when the data is read or written through communication.

The coil number or resistor number used by the message employs a relative address.

The relative address is calculated using the following formula.

Relative address = (last four digits of the coil number or resistor number) – 1

Example: When a function code specifies resistor number "40003"

Relative address = (the last four digits of 40003) ï 1 = 0002

Error Check Code

This code detects whether there are errors (changes in the bits) during the signal transmission processes. MODBUS protocol (RTU mode) use CRC-16 (Cyclic Redundancy Check).

[12] ñCoilsò and ñResistorsò simply refer to digital and analog values and have no meaning relative to the controller. This naming convention is part of the MODBUS communications specification only.

11.5 SLAVE RESPONSE

Normal Slave Response

The slave creates and replies with a response message for each command message. The response message has the same format as the command message.

The contents of the data part are different depending on the function code.

Irregular Slave Response

If there are problems (such as specification of a nonexistent function code) with the contents of the command message other than transmission error, the slave creates and replies with an error response message without following the command.

The composition of the error response message uses the value of the function code in the command message plus 80H, as seen below.

Field Name	No. of bytes
Station No. (address)	1 byte
Function Code + 80H	1 byte
Error Code	1 byte
Error Check Code (CRC-16)	2 bytes

The error code is shown as follows.

Error Code	Contents	Explanation
01H	Faulty function code	A nonexistent function code was specified. Please check the function code.
02H	Faulty address for coil or register	The Specified relative address for the code number or resistor number cannot be used by the specified function code.
03H	Fault code or resistor number	The specified number is too large and specified a range that does not contain coil numbers or resistors number

No Response

In the following situations, the slave will ignore the command message and not send a response message.

ÅThe station number specified by the command message is not the same as the slaveôs specified station number.

ÅThe error check code does not correspond, or a transmission error (such as parity error) is detected.

ÅThe interval between the data comprising the message is empty for more than 24 bit time.

ÅThe slave station number is set to "0".

11.6 FUNCTION CODE

For MODBUS protocol, coil numbers or resistor numbers are assigned by the function code, and each functional code only works for the assigned coil number or resistor number.

The correspondence between the function code and the coil number or resistor number is as follows:

Function Code			Coil Number, Resistor Number	
Code	Function	Target	Number	Contents
02H	Read (continuous)	Input relay	1xxxx	Read bit data
03H	Read (continuous)	Hold resistor	3xxxx	Read word data
04H	Read (continuous)	Input resistor	4xxxx	Read/write word data
06H	Write	Hold resistor		
10H	Write (continuous)	Retention resistor		

The message length for each function is as follows.

[unit: byte]

Code	Contents	Assignable Data Number	Command Message		Response Message	
			Minimum	Maximum	Minimum	Maximum
02H	Read bit data (read-only)	8 bit*1	8	8	6	6
03H	Read word data	60 words*1	8	8	7	125
04H	Read word data (read-only)	37 words*1	8	8	7	79
06H	Write word data	1 word	8	8	8	8
10H	Continuously write word data	60 words*1	11	129	8	8

*1Assignable Data Numbers are Internal controller settings only.

11.7 CALCULATING ERROR CHECK CODE (CRC-16)

CRC-16 is a 2-byte (16-bit) error check code. The calculation range extends from the start of the message (station number) to the end of the data part.

The slave calculates the CRC of the received message and ignores the message if this value is not the same as the received CRC code.

CRC-16 is calculated as follows:

```
This C routine, calc_crc(), calculates the cyclical redundancy checksum, CRC, for a
string of characters. The CRC is the result of dividing the string by 0xA001.
Modbus applications calculate the packet's CRC, then append it to the packet.

#define POLYNOMIAL 0xA001;
unsigned int calc_crc(unsigned char *start_of_packet, unsigned char
*end_of_packet)
{
unsigned int crc;
unsigned char bit_count;
unsigned char *char_ptr;
/* Start at the beginning of the packet */
char_ptr = start_of_packet;
/* Initialize CRC */
crc = 0xffff;
/* Loop through the entire packet */
do{
/* Exclusive-OR the byte with the CRC */
crc ^= (unsigned int)*char_ptr;
/* Loop through all 8 data bits */
bit_count = 0;
do{
/* If the LSB is 1, shift the CRC and XOR the polynomial mask with the CRC */
if(crc & 0x0001){
crc >>= 1;
crc ^= POLYNOMIAL;
}
/* If the LSB is 0, shift the CRC only */
Else{
crc >>= 1;
}
} while(bit_count++ < 7);
} while(char_ptr++ < end_of_packet);
Return(crc);
}
```

11.8 TRANSMISSION CONTROL STEPS

11.8.1 MASTER COMMUNICATIONS METHOD

Start communication from the master while following the rules below.

1. The command message, must be sent after an empty space of at least 48 bit time.
2. The interval between each byte in a command message should be less than 24 bit time.
3. After sending a command message, for less than 24 bit time the master will enter receiving standby.
4. After receiving the response message, the next command message must be sent after at least 48 bit time. (Similar to #1.)
5. For safety reasons, create a framework where the master checks the response message, and if there is no response or an error occurs, retry at least three times.

CAUTION: The definitions written above are for the minimum required value. For safety reasons, we recommend creating a master side program that keeps margins two to three times as large. For a concrete example, with 9600 bps, we recommend programming a blank state (#1 above) of at least 10ms, and the interval between bytes (#2 above) and switching time from sending to receiving (#3 above) within 1 ms.

11.8.2 EXPLANATION

Frame Detection

This communication system uses a two-wire RS-485 interface, and the circuit can therefore enter one of the following two states.

ÅEmpty state (no data on the circuit)

ÅCommunication state (data running on the circuit)

The units connected on the circuit start in receiving state and monitor the circuit. When a blank state appears on the circuit for at least 24 bit time, the unit detects the end of the previous frame, and within the next 24 bit time, enters receiving standby. When data appears on the circuit, the unit begins receiving data, and once another blank state of at least 24 bit time is detected, that frame is ended. In other words, the data on the circuit from the first time that a 24 bit time blank state appears to the second time one appears is loaded as one frame (a bundle of data). Therefore, one frame (command message) must be sent while following the rules below.

ÅBefore sending the command message, leave an empty space of at least 48 bit time.

ÅThe interval between each byte in a command message should be less than 24 bit time.

Micro controller Response

After the micro controller detects the frame (detects blank states at least 24 bit time long), that frame is used to send a command message. When a command message is sent locally, the response message is returned, but the processing time is about 1 to 30 ms. (The time may change depending on the contents of the command message.) Therefore, one frame (command message) must be sent while following the rules below.

ÅAfter sending a command message, for less than 24 seconds the master will enter receiving standby.

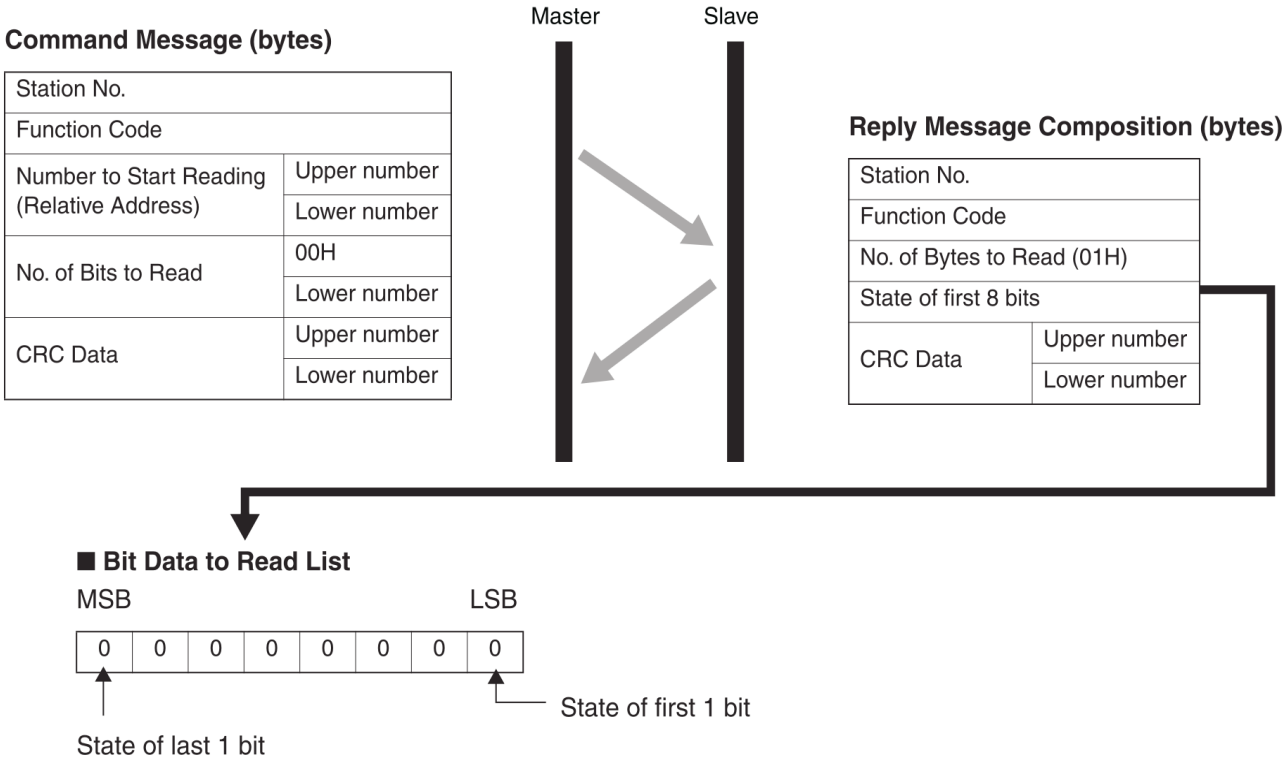
11.9 READING READ-ONLY BIT DATA (FUNCTION CODE: 02H)

The unit reads bit data continuously for the specified number of bits from the first number to start reading from. The salves systematically send the read data in 8-bit units.

CAUTION: When the number of bits to be read is not a multiple of eight, unrelated bits (on the MSB side) all become ñ0ò

Function Code	02H
Max. No. of Bits to Read in One Message	8 bits
Relative Address	0000H to 000CH
Coil Number	10001H to 10013H

Message Composition

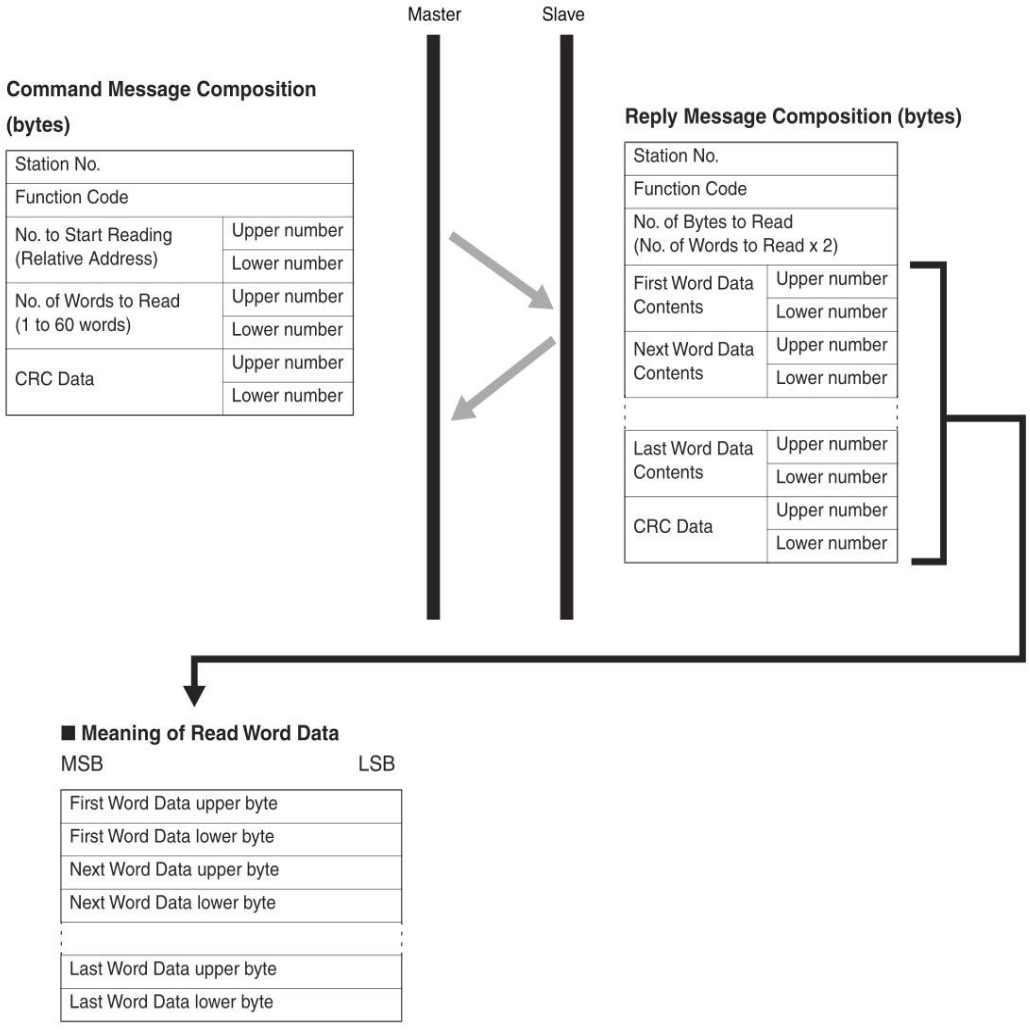


11.10 READING WORD DATA (FUNCTION CODE: 03H)

The unit reads word data continuously for the specified number of words from the first number to start reading from. The slave forwards the read word data from the upper number of bytes to the lower number.

Function Code	03H	
Max. No. of Bits to Read in One Message	60 words	
Relative Address	0000H to 0276H	03E8H to 065EH
Resistor Number	40001 to 40628	41001 to 41628
Contents	Internal Calculation Value	Engineering Unit

Message Composition:

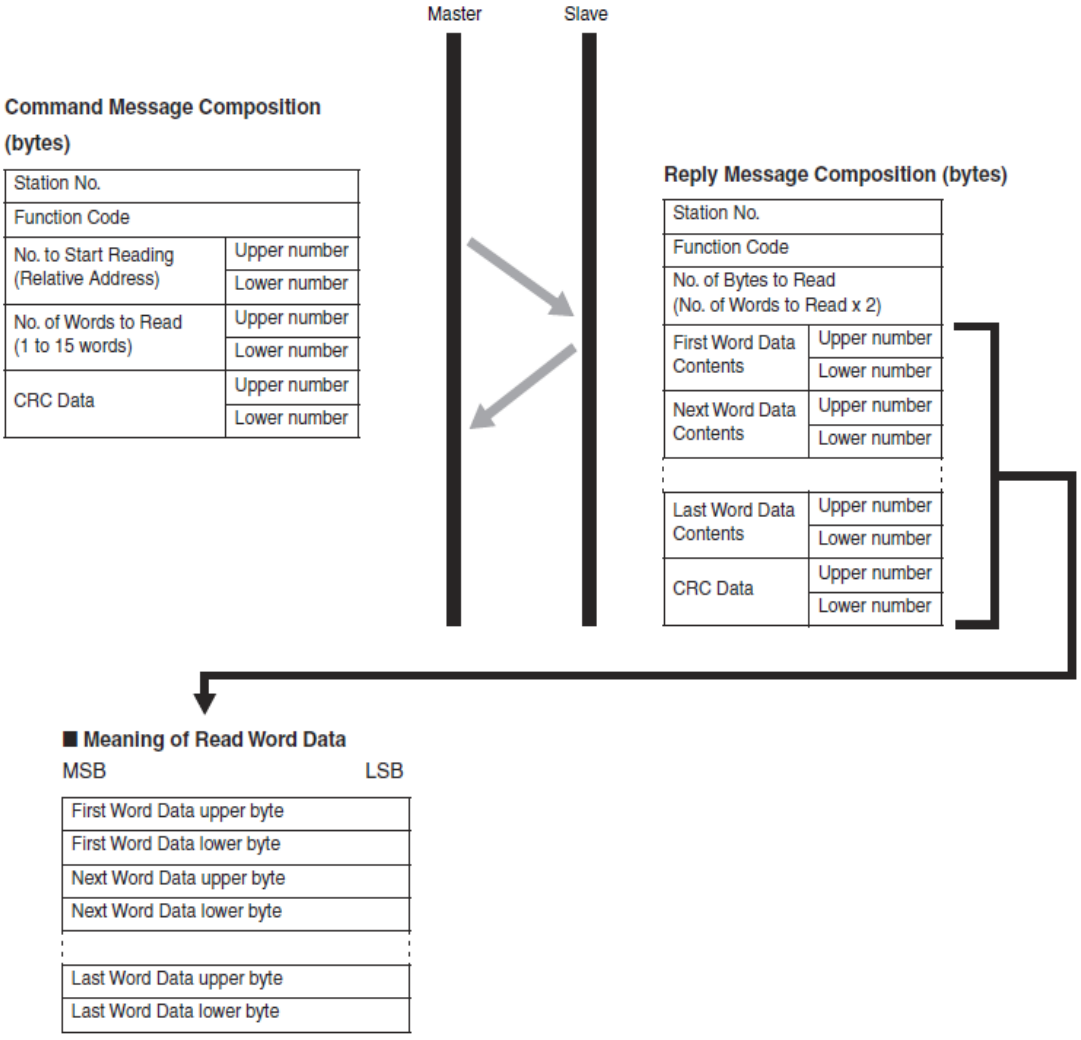


11.11 READING READ-ONLY WORD DATA (FUNCTION CODE: 04H)

The unit reads word data continuously for the specified number of words from the first number to start reading from. The slave forwards the read word data from the upper number of bytes to the lower number.

Function Code	04H	
Max. No. of Bits to Read in One Message	37 bytes	
Relative Address	0000H to 0064H	03E8H to 044CH
Resistor Number	30001 to 30100	31001 to 31100
Contents	Internal Calculation Value	Engineering Unit

Message Composition:



11.12 WRITING WORD DATA (1 WORD, FUNCTION CODE: 06H)

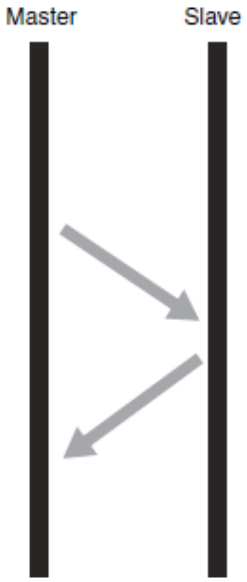
This writes the specified data to the specified number for word data. The master sends the data to be written from the upper number of bytes to the lower number.

Function Code	06H	
Max. No. of Bits to Read in One Message	1 word	
Relative Address	0001H to 0274H	03E9H to 065CH
Resistor Number	40002 to 40628	41002 to 41628
Contents	Internal Calculation Value	Engineering Unit

Message Composition:

Command Message Composition (bytes)

Station No.	
Function Code	
Specified Write Number (Relative Address)	Upper number
	Lower number
Word Data to Write	Upper number
	Lower number
CRC Data	Upper number
	Lower number



Response Message Composition (bytes)

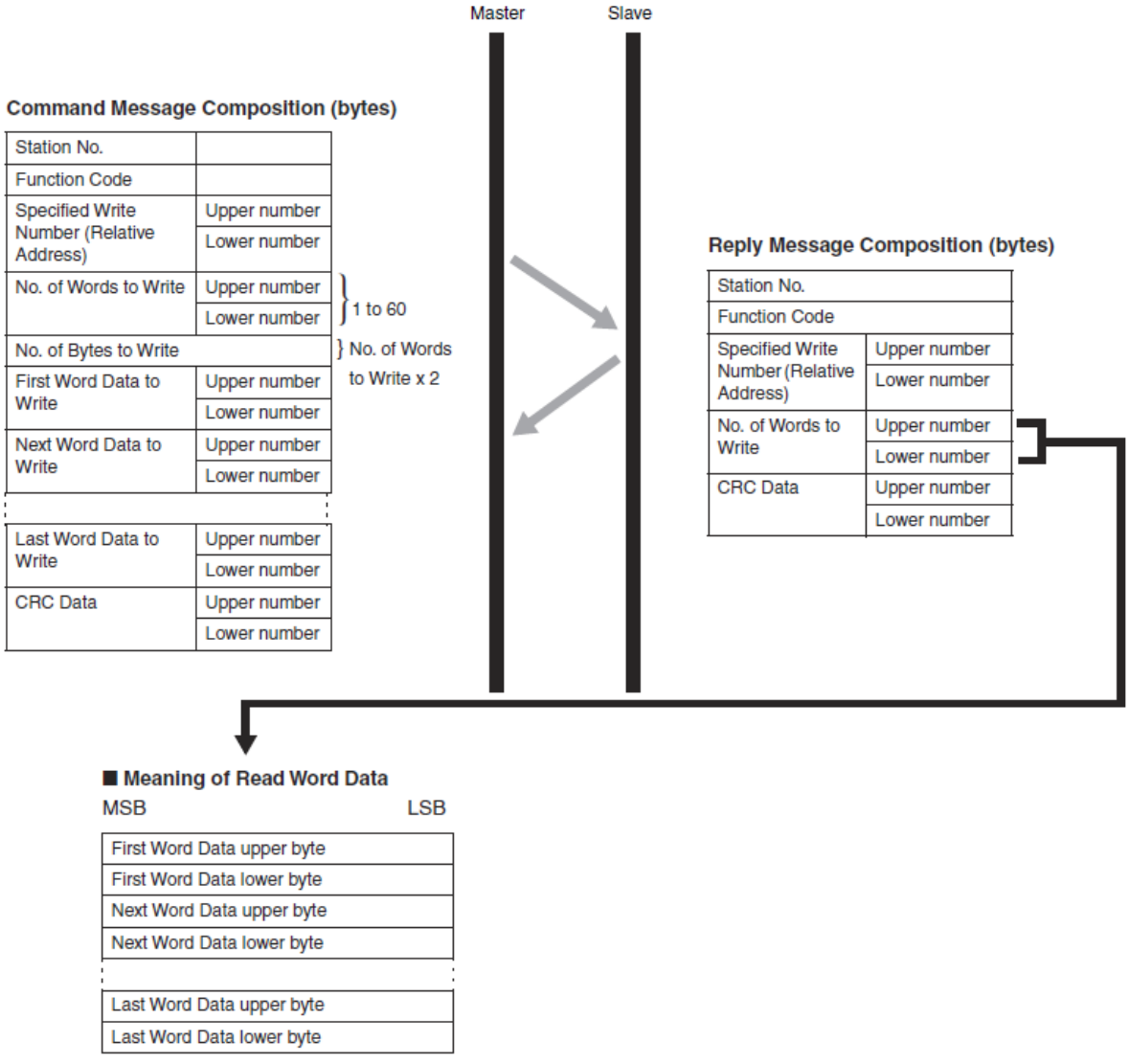
Station No.	
Function Code	
Specified Write Number (Relative Address)	Upper number
	Lower number
Word Data to Write	Upper number
	Lower number
CRC Data	Upper number
	Lower number

11.13 WRITING CONTINUOUS WORD DATA (FUNCTION CODE: 10H)

This writes continuous word information for a number of written words from the first number for writing. The master sends the data to be written from the upper number of bytes to the lower number.

Function Code	10H	
Max. No. of Bits to Read in One Message	60 words	
Relative Address	0000H to 0077H	03E8H to 045FH
Resistor Number	40001 to 40120	41001 to 41120
Contents	Internal Calculation Value	Engineering Unit

Message Composition:



11.14 DATA FORMAT

11.14.1 SENT DATA FORMAT

The MODBUS protocol used by this equipment employs RTU (Remote Terminal Unit) mode. The data is sent as "numerical value", not as ASCII code.

11.14.2 INTERNAL CALCULATION VALUE AND ENGINEERING UNIT

In this unit, parameter data and data dependent on an input range can handle the following two types of data. Internal Calculation Value: Values listed as percentages of the input range (0.00 to 100.00, without decimal point)

Engineering Unit: Values subjected to scaling to actual values depending on the input range

"Engineering Unit" data is handled as the address (resister number) of 1000 added to the address (resister number) for "Internal Calculation Value".

(Ex.) The value is calculated as follows when the full scale is 400°C and the PV value is "150".

Class	Resistor Number	Data (HEX)		Data
Internal Calculation Value	30001	0EA6 (H)	→	3750 (37.5%)
Engineering unit	31001	0096 (H)		150

The PV value is received as follows.

37.50 (%) x 400 (full scale °C) = 150 °C

Data not dependent on an input range the same data in both addresses.

Also, bit data cannot be handled in this manner. (Not effective for addresses with 1,000 added.)

CAUTION: Pay attention to the position of the decimal point when changing the input range by writing with communication. When changing the position of the decimal point by writing with communication, change the lower limit and upper limit of the input range at the same time.

(Ex.) When changing the input range from 0 to 400 to 0.0 to 400.0

Operating the keys on the front of the equipment

Change the position of the decimal point ("Pvd") in the setup menu ("SET Ch 6").

"Pvd" = 0 Ÿ 1 (or 2)

Changing by communication

Set the decimal position parameter ("Pvd"), as well as the corresponding values for PF input lower limit ("Pvb") and PV input upper limit ("PvF").

"Pvd" = 0 Ÿ 1

"Pvb" = 0 Ÿ 0

"PvF" = 400 Ÿ 400

11.14.3 MANAGING THE DECIMAL POINT

Some of the internally stored data may contain may digits lower than the decimal point on the front display. Also, the decimal point is not added to sent data.

Carry out processes for the decimal point position (erasing the decimal point when sending data and adding the decimal point when receiving data).

Attention must be paid to the position of the decimal point for data where the parameters are dependent on a range.

11.14.4 DATA DURING INPUT ERROR

For situations such as over-range, under-range, and input breaks where UUUU or LLLL display on the front, read PV value becomes 105% or -5% of the input range.

Input errors can be detected via communication using "resistor number 30008 (or 31008): Input/Unit Error Status".

11.14.5 WRITTEN DATA

When writing data to each parameter, set that written data within the range for the data. PXG can accept written data outside of the range, but do so with care as correct operations are not guaranteed.

11.14.6 ADDRESSES NOT WRITTEN

Do not write to addresses that are not public. Doing so may cause damage to the controller.

11.15 GENERAL PURPOSE INTERFACE BUS (GPIB)

GPIB control of the Series 850 / 860 TEC Controller is accomplished through a GPIB to Modbus converter. Please reference the Modbus section of the Manual in Appendix K for more information on the MODBUS protocol. Follow these simple steps to start communicating with the Series 850 / 860 TEC Controller via GPIB.

1.)	*Verify that the default address of —04“ is appropriate for the GPIB bus that the Series 850 / 860 TEC Controller will be connected to. If not, please refer to section 4.3.4 “Changing the GPIB address“.*
2.)	Connect the Series 850 / 860 TEC Controller to the GPIB bus with an appropriate GPIB controller set up to ð talkñto the address currently assigned to the Series 850 / 860 TEC. Default address is ð 04ñ
3.)	Turn on the Series 850 / 860 TEC Controller and verify that the controller is operational by sending the ð *IDN?ñquery. The Series 850 / 860 TEC Controller should respond with the controllerós IDN message.
4.)	The Series 850 / 860 TEC Controller should be ready to communicate at this point. Basically, only two commands are needed to communicate with the Series 850 / 860 TEC Controller. Reading and writing to the controller uses two simple commands: See Modbus command syntax section 4.3.1.
5.)	Get familiar with the MODBUS commands listed later in this chapter. The most frequently used commands are on the following page:

11.16 MODBUS COMMAND SYNTAX

These are two commands used to read and write to the Series 850/860 TEC Controller.

Syntax	Meaning
R[?] reg, num	Read Register Command. Reads one or multiple Modbus device registers. User specifies starting register *reg* and number of registers to be read *num*. The [?] is an optional symbol. Values for *reg* are 0 to 32767. Values for *num* are 1 to 64. Responses are returned as 16 bit decimal or HEX values separated by commas. Output format selected with the Format command. Examples: R? 1130,1 reads the set point R? 0000,1 reads the actual process temperature. R? 1024,4 reads the current limit registers 1024, 1025, 1026, & 1027.
W reg, w	Meaning
	Write Register Command. Writes a 16 bit value, *w* to a single Modbus device register, *reg*. Values for *reg* are 0 to 32767. Values for *w* are 0 to 65535. Example: W 1130,55 writes the decimal value 55 to register 1130 (Set point temperature).
	Notes
	WARNING Writing continuously to a register within a program loop can cause premature failure of the EEPROM inside the <power field here>. Only write to a register after first reading it to check whether or not it should be changed.

11.17 EXAMPLE COMMANDS

Below are the MODBUS registers for common settings. The complete list of registers is located on the web.

Be sure to use the proper function code and relative address for accessing these registers. (Relative address is last 4 digits of Register number ï 1).

Name	Description	Register(s)
Process	Actual Temperature, Read Only (PV)	30001
Set Point	Desired Temperature (Sv)	41131
PID	Proportional, Integral, and Derivative Settings (P, I, D)	41006, 41007, 41008
Temperature Alarms	Low and High Temperature Alarms (AL1L, AL1h)	41163, 41164
Current Limits	Output 1 Limit Low and High (PLC1, PhC1) Output 2 Limit Low and High (PLC2, PhC2)	41025, 41026, 41027, 41028

11.18 MODBUS COMMANDS OVER GPIB

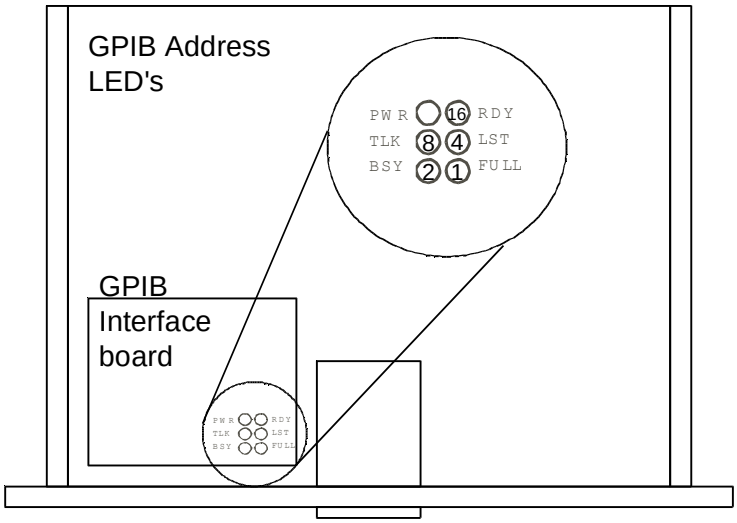
Syntax	Default	Meaning
C addr	1	Modbus Address Command. This must match the setting programmed at the front panel of the controller. Default=1.
L [?] w	-	Loopback Command.
R[?] reg, num	-	Read Register Command. Reads one or multiple Modbus device registers. User specifies starting register *reg* and number of registers to be read *num*. The [?] is an optional symbol. Values for *reg* are 0 to 32767. Values for *num* are 1 to 64. Responses are returned as 16 bit decimal or HEX values separated by commas. Output format selected with the Format command. I.e. R? 1130,1 reads the set point R? 0000,1 reads the actual process temperature. R? 1024,4 reads the current limit registers 1024, 1025, 1026, & 1027.
W reg, w	-	Write Register Command. Writes a 16 bit value, *w* to a single Modbus device register, *reg*. Values for *reg* are 0 to 32767. Values for *w* are 0 to 65535. An example is: W 1130, 55 writes the decimal value 55 to 1130. Recommended write command. Check for proper write by reading back
WB reg, num, w(0)..w(n)	-	Write Block command. Writes multiple 16 bit words, *w(i)* to multiple registers. Starting register, *reg*. Number, *num* specifies how many words are to be written. Values for *reg* are 0 to 32767. Values for *num* are 1 to 64. Values for w are 0 to 65535.
D time	200	Timeout Command. Sets timeout value of Modbus response message in milliseconds. Timeout is the total *time* for the message to be received by the controller. Value for *time* is 1 to 65535 milliseconds. Leave this at the default of 200.
D?	-	Queries the current timeout setting.
E?	-	Read Error Command. Reads the Modbus Error Register. Returns an error code whose value is 0 to 255. 0 = No errors. 1,2,3 = Exception code #. 100 = CRC error. 101 = Timeout error (no characters received) 2nn = Partial or corrupted with nn bytes received.

11.19 CHANGING THE GPIB ADDRESS

Default address of 04. Configuring the controller for a new address:

1. Connect the Series 850 / 860 TEC Controller to the GPIB bus controller. Note: disconnect other equipment that may conflict with the existing address!
2. You can verify the address by simply turning the Series 850 / 860 TEC Controller OFF and then back ON. As the Series 850 / 860 TEC Controller powers up, look at the interface board from the top. The address will be displayed by blinking LEDs on the interface board.
3. Simply add the numbers in the circles that are blinking while powering up to determine the address currently stored in memory.
4. Verify communication to the controller by sending the "*IDN?" query and read back the controller's IDN message.
5. To set or query the GPIB address simply use the SCPI command:
   SYST:COMM:GPIB:ADDR

Save the configuration using standard IEEE-488.2 command:
*SAV 0



11.20 IEEE 488.2 COMMANDS

COMMAND	NAME	DESCRIPTION
*CLS	Clear Status	
*ESE<value>	Event Status Enable	<value> integer 0 to 255.
*ESE?	Event Status Enable Query	Returns state (integer 0 to 255) of the ESE register.
*ESR?	Event Status Register Query	Reads then clears the Event Status Register.
*IDN	Identification Query	Returns four fields separated by commas. Fields are: Manufacturer,Model,6 digit Serial Number, and Version of Firmware.
*OPC	Operation Complete Command	
*OPC?	Iperation Complete Query	Places an ASCII charater ñ1ò into the Output Queue when all pending selected operations have finished.
*RCL 0	Recall	Restores the state stored in memory by the *SAV command (see below)
*RST	Reset	Restores the power up state except that the state of the IEEE-488 interface is unchanged.
*SAV 0	Save	Saves the current configuration in nonvolatile memory. *SAV 0 saves the current settins as the new power on setting.
*SRE<value>	Service Request Enable	<value> integer 0 to 255. Bit 6 is ignored.
*SRE?	Service Request Enable Query	Returns state (integer 0 to 255) of the SRE register.
*STB?	Read Status Byte	
*TST?	Self Test Query	Returs last power on status byte. All 0ôs indicate no self test failures.
*WAI	Wait to continue	Prevents any further execution of commands or queries until the No-Operation-Pending flag is TRUE.

11.21 SCPI COMMANDS

Standard SCPI Commands

Command (Capitals are shortcuts)	Function	Options	Factory Setting
SYSTem:**COMM**unicate:**GPIB**:**ADDR**ess	Sets GPIB bus address	0 to 30	4
SYSTem:**COMM**unicate:**SER**ial:**BAUD**	Sets transmit/receive baud rate	300 to 19200	9,600
SYSTem:**COMM**unicate:**SER**ial:**RS485**	Tristate transmitter enabled	ON / OFF	ON
SYSTem:**ERR**or**?**	Requests next entry in error/event queue. 000 = No error -100 = Command error -200 = Execution error -300 = Query error	N/A	N/A
SYSTem:**VERS**ion	Returns the SCPI version number		
FORMat:[**DATA**]:**TALK** **FT**	Sets talk string and data query response format. ASCII expresses a words input bit pattern as a decimal value equal to the binary som of the data. Multiple words are separated by commas. HEXL converts each four bit nibble into the ASCII characters 0 to 9 and A to F. TABLE allows the user to define his own character set. All talk strings end with a linefeed. ASCII example = 128,5,255 HEXL example = 8000,05FF	ASCII / HEXL	ASCII

- [ ] denotes optional
- BOLD denotes short format (see example below)

Example:

FORM:DATA:TALK HEXL Allow communication in HEXL instead of the default ASCII

FT HEXL Allow communication in HEXL instead of the default ASCII

11.22 FACTORY SETTINGS

Hardware Check	Instructions	Notes
Jumpers W4 & W5	Set to EIA/RS-485 (defaults to EIA/RS-232)	
Communications Check		
SYST:COMM:GPIB:ADDR	defaults to ñ4ò	
SYST:COMM:SER:RS485	defaults to ñOFFòfor EIA/RS-232	Should be ñONòfor EIA/RS-485
AOIC Settings		
CAL:IDN <string>	Sets the identification string	ñManufacturer,Model,6 digit Serial Number, and Version of Firmwareò
CAL:LOCK ON	Disables configuration commands	ñOFFòor ñ0òfor changes. ñON or ñ1òto protect.

12 MODBUS Data Address Map

12.1 BIT DATA (READ ONLY): FUNCTION CODE [02 (H)]

Relative address	Coil Number	Type	Memory contents	Read data	Dependent on range	Remarks/ related parameters
0000H	10001	bit	ALM1 ON/OFF	0: Alarm OFF 1: Alarm ON		

12.2 WORD DATA (READ/WRITE): FUNCTION CODE [03H, 06H, 10H]

12.2.1 OPERATION [EH1]

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read data	Written data range	Factory Setting	Dependent on range
				Internal	Engineering unit					
"MAn"	MAn	Switches to manual mode	0088H	40121	41121	Word	0: oFF (during auto) 1: on (during manual)	0: oFF (auto) 1: on (manual)	oFF	
"StbY"	STbY	Switches between RUN and standby	0003H	40004	41004	Word	0: oFF (during RUN) 1: on (during standby)		oFF	
"PrG"	PrG	Ramp/soak controls Command	0061H	40082	41082	Word	0: oFF (during stop) 1: rUn (during run) 2: hLd (during hold)	0: oFF (stop) 1: rUn (run) 2: hLd (hold)	oFF	
"AT"	AT	Auto-tuning run command	0004H	40005	41005	Word	0: oFF 1: rUn 2: Low		oFF	
"AL 1L"	AL1L	AL1L set value	00B2H	40163	41163	Word	0% to 100% FS (absolute alarm) -100% to 100 % FS (deviation alarm)			X
"AL 1h"	AL1h	AL1h set value	00B3H	40164	41164	Word	0% to 100% FS (absolute alarm) -100% to 100 % FS (deviation alarm)			X
"LoC"	LoC	Key lock	0037H	40040	41040	Word	0 : no lock 1 : all lock 2 : All but SV locked			

12.2.2 PID [Ch2]

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read data	Written data range	Factory Setting	Dependent on range
				Internal	Engineering unit					
"P"	P	Proportional band	0005H	40006	41006	Word	0 to 9999 (0.0% to 999.9%)		5.0%	
"I"	I	Integration time	0006H	40007	41007	Word	0 to 32000 (0 to 3200 sec)		240 sec	
"d"	D	Derivation time	0007H	40008	41008	Word	0 to 9999 (0.0 to 999.9sec)		60.0 sec	
"Ar"	Ar	Anti-reset windup	000BH	40012	41012	Word	0% to 100% FS		100%	X
"SvL"	SvL	SV limit (lower)	002EH	40031	41031	Word	0% to 100% FS		0% FS	X
"Svh"	Svh	SV limit (high)	002FH	40032	41032	Word	0% to 100% FS		100% FS	X
"PhC1"	PhC1	C1 (Cool output) limit (high)	0029H	40026	41026	Word	-3.00 to 103.00%		103.0%	
"PhC2"	PhC2	C2 (Heat output) limit (high)	002BH	40028	41028	Word	-3.00 to 103.00%		103.0%	

12.2.4 RAMP/SOAK (rh4)

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read data	Written data range	Factory Setting	Dependent on range
				Internal	Engineering unit					
"PTn"	PTn	Ramp/Soak Activation Pattern	0231H	40561	41561	Word	0 (uses steps 1 to 4) 1 (uses steps 5 to 8) 2 (uses steps 1 to 8) 3 (uses steps 9 to 12) 4 (uses steps 13 to 16) 5 (uses steps 9 to 16) 6 (uses steps 1 to 16)		6	
"TIMU"	TIMU	Ramp/soak time units	029DH	40562	41562	Word	0 : hh.MM (hour: min) 1 : MM.SS (min: sec)		hh.MM	
"SU-1"	SV-1	Ramp/Soak 1 seg/SV Set Value	02B6H	40581	41581	Word	0% to 100% FS		0% FS	**X**
"TM1r"	TM1R	Ramp/Soak 1 seg ramp time	02B7H	40582	41582	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"TM1S"	TM1S	Ramp/Soak 1 seg soak time	02B8H	40583	41583	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SU-2"	SV-2	Ramp/Soak 2 seg/SV Set Value	02B9H	40584	41584	Word	0% to 100% FS		0% FS	**X**
"TM2r"	TM2R	Ramp/Soak 2 seg ramp time	02BAH	40585	41585	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"TM2S"	TM2S	Ramp/Soak 2 seg soak time	02BBH	40586	41586	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SU-3"	SV-3	Ramp/Soak 3 seg/SV Set Value	02BCH	40587	41587	Word	0% to 100% FS		0% FS	**X**
"TM3r"	TM3R	Ramp/Soak 3 seg ramp time	02BDH	40588	41588	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"TM3S"	TM3S	Ramp/Soak 3 seg soak time	02BEH	40589	41589	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SU-4"	SV-4	Ramp/Soak 4 seg/SV Set Value	02BFH	40590	41590	Word	0% to 100% FS		0% FS	**X**
"TM4r"	TM4R	Ramp/Soak 4 seg ramp time	02C0H	40591	41591	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"TM4S"	TM4S	Ramp/Soak 4 seg soak time	02C1H	40592	41592	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SU-5"	SV-5	Ramp/Soak 5 seg/SV Set Value	02C2H	40593	41593	Word	0% to 100% FS		0% FS	**X**
"TM5r"	TM5R	Ramp/Soak 5 seg ramp time	02C3H	40594	41594	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"TM5S"	TM5S	Ramp/Soak 5 seg soak time	02C4H	40595	41595	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SU-6"	SV-6	Ramp/Soak 6 seg/SV Set Value	02C5H	40596	41596	Word	0% to 100% FS		0% FS	**X**
"TM6r"	TM6R	Ramp/Soak 6 seg ramp time	02C6H	40597	41597	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"TM6S"	TM6S	Ramp/Soak 6 seg soak time	02C7H	40598	41598	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SU-7"	SV-7	Ramp/Soak 7 seg/SV Set Value	02C8H	40599	41599	Word	0% to 100% FS		0% FS	**X**
"TM7r"	TM7R	Ramp/Soak 7 seg ramp time	02C9H	40600	41600	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read data	Written data range	Factory Setting	Dependent on range
				Internal	Engineering unit					
"rTM7S"	TM7S	Ramp/Soak 7 seg soak time	02CAH	40601	41601	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SV-8"	SV-8	Ramp/Soak 8 seg/SV Set Value	02CBH	40602	41602	Word	0% to 100% FS		0% FS	**X**
"rTM8r"	TM8R	Ramp/Soak 8 seg ramp time	02CCH	40603	41603	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"rTM8S"	TM8S	Ramp/Soak 8 seg soak time	02CDH	40604	41604	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SV-9"	SV-9	Ramp/Soak 9 seg/SV Set Value	02CEH	40605	41605	Word	0% to 100% FS		0% FS	**X**
"rTM9r"	TM9R	Ramp/Soak 9 seg ramp time	02CFH	40606	41606	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"rTM9S"	TM9S	Ramp/Soak 9 seg soak time	02D0H	40607	41607	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SV 10"	SV10	Ramp/Soak 10 seg/SV Set Value	02D1H	40608	41608	Word	0% to 100% FS		0% FS	**X**
"r 10r"	T10R	Ramp/Soak 10 seg ramp time	02D2H	40609	41609	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"rTM10S"	T10S	Ramp/Soak 10 seg soak time	02D3H	40610	41610	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SV 11"	SV11	Ramp/Soak 11 seg/SV Set Value	02D4H	40611	41611	Word	0% to 100% FS		0% FS	**X**
"r 11r"	T11R	Ramp/Soak 11 seg ramp time	02D5H	40612	41612	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"r 11S"	T11S	Ramp/Soak 11 seg soak time	02D6H	40613	41613	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SV 12"	SV12	Ramp/Soak 12 seg/SV Set Value	02D7H	40614	41614	Word	0% to 100% FS		0% FS	**X**
"r 12r"	T12R	Ramp/Soak 12 seg ramp time	02D8H	40615	41615	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"r 12S"	T12S	Ramp/Soak 12 seg soak time	02D9H	40616	41616	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SV 13"	SV13	Ramp/Soak 13 seg/SV Set Value	02DAH	40617	41617	Word	0% to 100% FS		0% FS	**X**
"r 13r"	T13R	Ramp/Soak 13 seg ramp time	02DBH	40618	41618	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"r 13S"	T13S	Ramp/Soak 13 seg soak time	02DCH	40619	41619	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SV 14"	SV14	Ramp/Soak 14 seg/SV Set Value	02DDH	40620	41620	Word	0% to 100% FS		0% FS	**X**
"r 14r"	T14R	Ramp/Soak 14 seg ramp time	02DEH	40621	41621	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"r 14S"	T14S	Ramp/Soak 14 seg soak time	02DFH	40622	41622	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"SV 15"	SV15	(Ramp/Soak 15 seg/SV Set Value)	02E0H	40623	41623	Word	0% to 100% FS		0% FS	**X**
"r 15r"	T15R	Ramp/Soak 15 seg ramp time	02E1H	40624	41624	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"r 15S"	T15S	Ramp/Soak 15 seg soak time	02E2H	40625	41625	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read data	Written data range	Factory Setting	Dependent on range
				Internal	Engineering unit					
"SU 16"	SV16	Ramp/Soak 16 seg/SV Set Value	02E3H	40626	41626	Word	0% to 100% FS		0% FS	**X**
"r 16r"	T16R	Ramp/Soak 16 seg ramp time	02E4H	40627	41627	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"r 16S"	T16S	Ramp/Soak 16 seg soak time	02E5H	40628	41628	Word	00.00-99.59 (hour:min/min: sec)		00.00 (hour:min)	
"Mod"	Mod	Ramp/soak mode	0060H	40081	41081	Word	0 to 15		0	
"GSoK"	GSoK	Guaranty soak ON/OFF	02A6H	40571	41571	Word	0:oFF (guaranty soak off) 1:on (guaranty soak on)		oFF	
"GS-L"	GS-L	Guaranty soak (lower limit)	02A7H	40572	41572	Word	0% to 50% FS		5°C	**X**
"GS-h"	GS-h	Guaranty soak (upper limit)	02A8H	40573	41573	Word	0% to 50% FS		5°C	**X**

12.2.5 MONITOR (CHS)

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read data
				Internal	Engineering unit		
STAT	STAT	Ramp/soak progress	029CH	40561	41561	Word	0: oFF 1: 1-rP 2: 1-Sk 3: 2-rP 4: 2-Sk é 5: 3-rP 6: 3-Sk . . . 31 rP 32 Sk 33 End
no1		Controllers Calculated Output for C1					
no2		Controllers Calculated Output for C2					
FALt		Falt diagnostic					
Pno[11]		Ramp/soak Pattern #					

12.2.6 SETUP (Ch6)

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read data	Written data range	Factory Setting	Dependent on range
				Internal	Engineering unit					
"PvT"	PvT	PV input type	000FH	40016	41016	Word	0 (JPT 100'3f) 1 (PT 100'3f) 2 (J) 3 (K) 4 (R) 5 (B) 6 (S) 7 (T) 8 (E) 9 (no function) 10 (no function) 11 (no function) 12 (N) 13 (PL- 2) 14 (no function) 15 (0V to 5V / 0mA to 20mA 16 (1V to 5V/4mA to 20mA) 17 (0mV to 10V) 18 (2V to 10V) 19 (0mV to 100mV)		3 (K)	
"Pvb"	Pvb	PV input lower limit	0021H	40018	41018	Word	-1999-9999		0°C	
"PvF"	PvF	PV input upper limit	0022H	40019	41019	Word	-1999-9999		400°C	
"Pvd"	Pvd	Decimal position	0023H	40020	41020	Word	0 (no decimal point) 1 (one decimal place) 2 (two decimal places)		0	
"PvU"	PvU	Unit display	016EH	40345	41345	Word	0: °C 1: °F		0	
"tF"	TF	PV input filter	0025H	40022	41022	Word	0 to 1200 (0.0 to 120.0 sec)		5 sec	
"AdJ0"	ADJ0	PV display zero adjustment	0072H	40099	41099	Word	-50% to 50% FS			X
"AdJS"	ADJS	PV display Span adjustment	0073H	40100	41100	Word	-50% to 50% FS			X
"rCJ"	RCJ	Cold Junction Compensation	0026H	40023	41023	Word	0: oFF (off) 1: on (on)		on	
"Sfo1"	Sfo1	Soft start OUT1 set value	01A3H	40392	41392	Word	-300 to 10300 (-3.00 to 103.00%)			
"SFtF"	SFTM	Soft start set time	01A5H	40394	41394	Word	00:00 to 99:59 (hour:min)		00:00 (hour:min)	
"Sbo1"	Sbo1	During standby, OUT1 set value	01A9H	40398	41398	Word	-300 to 10300 (-3.00 to 103.00%)			
"Sbo2"	Sbo2	During standby, OUT2 set value	01AAH	40399	41399	Word	-300 to 10300 (-3.00 to 103.00%)			
"SbMd"	SBMD	Standby mode setting	01ABH	40400	41400	Word	0 to 3		0	
"AoT"	AoT	Analog Output Type	01ACH	40401	41401	Word	0: Positive Temperature Coefficient 2: Negative Temperature Coefficient		0	

12.2.7 SYSTEM (CH7)

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read data	Written data range	Factory Setting	Dependent on range
				Internal	Engineering unit					
"rMPL"	rMPL	Ramp SV - Decline	01C9H	40430	41430	Word	0% to 100% FS/°C		0°C	X
"rMPh"	rMPh	Ramp SV ñ Incline	01CAH	40431	41431	Word	0% to 100% FS/°C		0°C	X
"rMPU"	rMPU	Ramp SV slope time unit	01CBH	40432	41432	Word	0: hour (slope temperature/hour) 1: Min (slope temperature/min)		hoUr	
"SUT"	SvT	Ramp SV - SV display mode selection	01CCH	40433	41433	Word	0: rMP (Ramp SV HOLD) 1: TrG (target SV)		rMP	
"CTrL"	CTrL	Control methods	0001H	40002	41002	Word	0: PiD (PID control) 1: FUZY (Fuzzy Pid control)			
"STMd"	STMd	Startup mode	01CDH	40434	41434	Word	0: Auto (starts up in auto mode) 1: MAn (starts up in manual mode)		Auto	

12.2.8 OTHER

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read data	Written data range	Factory Setting	Dependent on range
				Internal	Engineering unit					
SV	Front SV set value	Front SV set value	0002H	40003	41003	Word	0 to 10000 (in the 0% to 100% FS set value limit)			X
			0092H	40131	41131	Word				
MV	Front MV set value	Front MV set value	0089H	40122	41122	Word	-300 to 10300 (3.0 to 103.0%)			

12.3 Resistor Number Order Read/Write Parameter List

Relative address	Resistor Number		Parameter contents
	Internal	Engineering unit	
0001 H	40002	41002	CTrL (control method)
0002H	40003	41003	Front SV set value
0003H	40004	41004	STbY (Switches between RUN and standby)
0004H	40005	41005	AT (Auto-tuning run command)
0005H	40006	41006	P (Proportional band)
0006H	40007	41007	I (Integration time)
0007H	40008	41008	D (Derivation time)
0009H	40010	41010	CoL (Cooling proportional band coefficient)
000BH	40012	41012	Ar (Anti-reset windup)
000CH	40013	41013	BAL (output convergence value)
000DH	40014	41014	PvoF (PV input shift)
000EH	40015	41015	SvoF (SV input shift)
000FH	40016	41016	PvT (PV input types)
0020H	40017	41017	P-F (Unit display)
0021H	40018	41018	Pvb (PV input lower limit)
0022H	40019	41019	Pvb (PV input upper limit)
0023H	40020	41020	Pvd (decimal position)
0024H	40021	41021	-

Relative address	Resistor Number		Parameter contents
	Internal	Engineering unit	
0025H	40022	41022	TF (PV input filter)
0026H	40023	41023	rCJ (Cold junction compensation)
0029H	40026	41026	PHC1 Cool output limit (high)
002BH	40028	41028	PHC2 Heat output limit (high)
002EH	40031	41031	SvL SV limit (lower)
002FH	40032	41032	SvH SV limit (upper)
0037H	40040	41040	LoC (Key lock)
003BH	40044	41044	AL1 (ALM1 set value) or A1-L
003EH	40047	41047	A1-H (Alarm 1 upper limit set value)
0048H	40057	41057	Sv-1 (Ramp/soak 1 seg/SV set value)
0049H	40058	41058	Sv-2 (Ramp/soak 2 seg/SV set value)
004AH	40059	41059	Sv-3 (Ramp/soak 3 seg/SV set value)
004BH	40060	41060	Sv-4 (Ramp/soak 4 seg/SV set value)
004CH	40061	41061	Sv-5 (Ramp/soak 5 seg/SV set value)
004DH	40062	41062	Sv-6 (Ramp/soak 6 seg/SV set value)
004EH	40063	41063	Sv-7 (Ramp/soak 7 seg/SV set value)
004FH	40064	41064	Sv-8 (Ramp/soak 8 seg/SV set value)
0050H	40065	41065	TM1r (Ramp/soak 1 seg ramp time)
0051H	40066	41066	TM1S (Ramp/soak 1 seg soak time)
0052H	40067	41067	TM2r (Ramp/soak 2 seg ramp time)
0053H	40068	41068	TM2S (Ramp/soak 2 seg soak time)
0054H	40069	41069	TM3r (Ramp/soak 3 seg ramp time)
0055H	40070	41070	TM3S (Ramp/soak 3 seg soak time)
0056H	40071	41071	TM4r (Ramp/soak 4 seg ramp time)
0057H	40072	41072	TM4S (Ramp/soak 4 seg soak time)
0058H	40073	41073	TM5r (Ramp/soak 5 seg ramp time)
0059H	40074	41074	TM5S (Ramp/soak 5 seg soak time)
005AH	40075	41075	TM6r (Ramp/soak 6 seg ramp time)
005BH	40076	41076	TM6S (Ramp/soak 6 seg soak time)
005CH	40077	41077	TM7r (Ramp/soak 7 seg ramp time)
005DH	40078	41078	TM7S (Ramp/soak 7 seg soak time)
005EH	40079	41079	TM8r (Ramp/soak 8 seg ramp time)
005FH	40080	41080	TM8S (Ramp/soak 8 seg soak time)
0060H	40081	41081	Mod (Ramp/soak mode)
0061 H	40082	41082	PrG (PROG) (Ramp/soak control command)
0062H	40083	41083	PTn (Ramp/soak activation pattern)
0064H	40085	41085	SLFb (Pv stable width during self-tuning)
0072H	40099	41099	AdJ0 (PV display zero adjustment)
0073H	40100	41100	AdJS (PV display Splan adjustment)
0088H	40121	41121	Man (switching manual mode)
0089H	40122	41122	Front MV set value
0092H	40131	41131	Front SV set value
0093H	40132	41132	Front MV set value

Relative address	Resistor Number		Parameter contents
	Internal	Engineering unit	
0094H	40133	41133	Man (switching manual mode)
0095H	40134	41134	STbY (Switches between RUN and standby)
0096H	40135	41135	AT (Auto-tuning run command)
00B2H	40163	41163	AL1L (AL1 set value)
00B3H	40164	41164	AL1h (AL1h set value)
00F2H	40221	41221	SvN (Selectable SV numbers)
00F3H	40222	41222	PLn1 (Currently selected PID No.)
00FCH	40231	41231	Front SV set value
00FDH	40232	41232	P (Proportional band)
00FEH	40233	41233	I (Integration time)
00FFH	40234	41234	d (Derivation time)
0101H	40236	41236	CoL (Cooling proportional band coefficient)
0104H	40239	41239	Ar (Anti-reset windup)
0105H	40240	41240	Rev (sets normal/reverse operations)
0106H	40241	41241	Sv1 (SV set value 1)
0107H	40242	41242	P1 (Proportional band 1)
016AH	40341	41341	PvT (PV input types)
016BH	40342	41342	PvB (PV input lower limit)
016CH	40343	41343	PvF (PV input upper limit)
016DH	40344	41344	Pvd (decimal position)
016EH	40345	41345	PvU (Unit display)
0170H	40347	41347	PvOF (PV input shift)
0171H	40348	41348	SVOF (SV input shift)
0172H	40349	41349	SVL (SV limit (lower))
0173H	40350	41350	SVH (SV limit (upper))
0174H	40351	41351	TF (PV input filter)
0175H	40352	41352	ADJ0 (PV display zero adjustment)
0176H	40353	41353	ADJS (PV display Splan adjustment)
0177H	40354	41354	rCJ (Cold junction compensation)
0183H	40360	41360	-
019CH	40385	41385	-
019DH	40386	41386	PHC1 Cool output limit (high)
019EH	40387	41387	-
019FH	40388	41388	PHC2 Heat output limit (high)
01A3H	40392	41392	SFo1 (Soft start output 1)
01A5H	40394	41394	SFTM (Soft start set time)
01C0H	40421	41421	CTRL (control method)
01C1H	40422	41422	ONOF (ON/OFF control hysteresis)
01C2H	40423	41423	SLFB (Pv stable width during self-tuning)
01C9H	40430	41430	rMPL (Ramp SV - decline)
01CAH	40431	41431	rMPH (Ramp SV - incline)
01CBH	40432	41432	rMPU (Ramp SV slope time unit)
01CCH	40433	41433	SvT (Ramp SV - SV display mode selection)

Relative address	Resistor Number		Parameter contents
	Internal	Engineering unit	
01CDH	40434	41434	STMd (Startup mode)
0224H	40521	41521	PASS (Password input)
0225H	40522	41522	PAS1 (Password 1 setup)
0226H	40523	41523	PAS2 (Password 2 setup)
0227H	40524	41524	PAS3 (Password 3 setup)
022EH	40531	41531	ToUT (Display timeout setting)
0233H	40536	41536	rST (Reset main unit)
029CH	40561	41561	PTN (Ramp/soak progress)
029DH	40562	41562	TiMU (Ramp/soak time units)
029EH	40563	41563	Mod (Ramp/soak mode)
02A6H	40571	41571	Gsok (Guaranty soak ON/OFF)
02A7H	40572	41572	GS-L (Guaranty soak (lower limit))
02A8H	40573	41573	GS-H (Guaranty soak (upper limit))
02B6H	40581	41581	Sv-1 (Ramp/soak 1 seg/SV set value)
02B7H	40582	41582	TM1r (Ramp/soak 1 seg ramp time)
02B8H	40583	41583	TM1S (Ramp/soak 1 seg soak time)
02B9H	40584	41584	SV-2 (Ramp/soak 2 seg/SV set value)
02BAH	40585	41585	TM2r (Ramp/soak 2 seg ramp time)
02BBH	40586	41586	TM2S (Ramp/soak 2 seg soak time)
02BCH	40587	41587	Sv-3 (Ramp/soak 3 seg/SV set value)
02BDH	40588	41588	TM3r (Ramp/soak 3 seg ramp time)
02BEH	40589	41589	TM3S (Ramp/soak 3 seg soak time)
02BFH	40590	41590	Sv-4 (Ramp/soak 4 seg/SV set value)
02C0H	40591	41591	TM4r (Ramp/soak 4 seg ramp time)
02C1H	40592	41592	TM4S (Ramp/soak 4 seg soak time)
02C2H	40593	41593	Sv-5 (Ramp/soak 5 seg/SV set value)
02C3H	40594	41594	TM5r (Ramp/soak 5 seg ramp time)
02C4H	40595	41595	TM5S (Ramp/soak 5 seg soak time)
02C5H	40596	41596	Sv-6 (Ramp/soak 6 seg/SV set value)
02C6H	40597	41597	TM6r (Ramp/soak 6 seg ramp time)
02C7H	40598	41598	TM6S (Ramp/soak 6 seg soak time)
02C8H	40599	41599	Sv-7 (Ramp/soak 7 seg/SV set value)
02C9H	40600	41600	TM7r (Ramp/soak 7 seg ramp time)
02CAH	40601	41601	TM7S (Ramp/soak 7 seg soak time)
02CBH	40602	41602	Sv-8 (Ramp/soak 8 seg/SV set value)
02CCH	40603	41603	TM8r (Ramp/soak 8 seg ramp time)
02CDH	40604	41604	TM8S (Ramp/soak 8 seg soak time)
02CEH	40605	41605	Sv-9 (Ramp/soak 9 seg/SV set value)
02CFH	40606	41606	TM9r (Ramp/soak 9 seg ramp time)
02D0H	40607	41607	TM9S (Ramp/soak 9 seg soak time)
02D1H	40608	41608	Sv10 (Ramp/soak 10 seg/SV set value)
02D2H	40609	41609	T10r (Ramp/soak 10 seg ramp time)
02D3H	40610	41610	T10S (Ramp/soak 10 seg soak time)

Relative address	Resistor Number		Parameter contents
	Internal	Engineering unit	
02D4H	40611	41611	Sv11 (Ramp/soak 11 seg/SV set value)
02D5H	40612	41612	T11r (Ramp/soak 11 seg ramp time)
02D6H	40613	41613	T11S (Ramp/soak 11 seg soak time)
02D7H	40614	41614	Sv12 (Ramp/soak 12 seg/SV set value)
02D8H	40615	41615	T12r (Ramp/soak 12 seg ramp time)
02D9H	40616	41616	T12S (Ramp/soak 12 seg soak time)
02DAH	40617	41617	Sv13 (Ramp/soak 13 seg/SV set value)
02DBH	40618	41618	T13R (Ramp/soak 13 seg ramp time)
02DCH	40619	41619	T13S (Ramp/soak 13 seg soak time)
02DDH	40620	41620	Sv14 (Ramp/soak 14 seg/SV set value)
02DEH	40621	41621	T14r (Ramp/soak 14 seg ramp time)
02DFH	40622	41622	T14S (Ramp/soak 14 seg soak time)
02E0H	40623	41623	Sv15 (Ramp/soak 15 seg/SV set value)
02E1H	40624	41624	T15r (Ramp/soak 15 seg ramp time)
02E2H	40625	41625	T15S (Ramp/soak 15 seg soak time)
02E3H	40626	41626	Sv16 (Ramp/soak 16 seg/SV set value)
02E4H	40627	41627	T16r (Ramp/soak 16 seg ramp time)
02E5H	40628	41628	T16S (Ramp/soak 16 seg soak time)

12.4 WORD DATA (READ ONLY): FUNCTION CODE [04 (H)]

12.4.1 MONITOR (CH5)

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read data	Dependent on range
				Internal	Engineering unit			
"STAT"	STAT	Ramp/soak progress	0028H	30041	31041	Word	oFF (ramp/soak is stopped) 1rP (Step 1 Ramp) 1Sk (soak is in step 1) ... 16rP (Step 16 Ramp) 16Sk (soak is in step 16) End (ramp/soak is finished)	
"Mv1"	Mv1	Control output 1	0029H	30042	31042	Word	-300 to 10300 (-3.00 to 103.00%FS)	
"Mv2"	Mv2	Control output 2	002AH	30043	31043	Word	-300 to 10300 (-3.00 to 103.00%FS)	
"TM1"	TM1	Remaining time on timer 1	0031 H	30050	31050	Word	0 sec to 9999 sec / 0 min to 9999 min	
"TM2"	TM2	Remaining time on timer 2	0032H	30051	31051	Word	0 sec to 9999 sec / 0 min to 9999 min	
"TM3"	TM3	Remaining time on timer 3	0033H	30052	31052	Word	0 sec to 9999 sec / 0 min to 9999 min	
"TM4"	TM4	Remaining time on timer 4	0034H	30053	31053	Word	0 sec to 9999 sec / 0 min to 9999 min	
"TM5"	TM5	Remaining time on timer 5	0035H	30054	31054	Word	0 sec to 9999 sec / 0 min to 9999 min	
"FALT"	FALT	Error source display	0036H	30055	31055	Word	0000 to 1100	

12.4.2 OTHER

Parameter display	Parameter name	Contents	Relative address	Resistor Number		Type	Read Data	Dependent On Range
				Internal	Engineering unit			
Display PV value	Pv (measurement)		0000H	30001	31001	Word	0 to 10000 (0.00 to 100.00%FS)	
Display SV Value	Sv (Currently used set value)		0001 H	30002	31002	Word	0 to 10000 (0.00 to 100.01%FS)	
	DV (Currently used deviation)		0002H	30003	31003	Word	-10000 to 10000 (-100.00 to 100.00%FS)	
"oUT 1"	MV1	Output 1	0003H	30004	31004	Word	-300 to 10300 (-3.00 to 103.00%FS)	
"oUT2"	MV2	Output 2	0004H	30005	31005	Word	-300 to 10300 (-3.00 to 103.00%FS)	
"St no"	STNo	STATION No.	0005H	30006	31006	Word	0 to 255	
	ALM STATUS		0006H	30007	31007	Word		
"FALT"	FALT	FALT STATUS	0007H	30008	31008	Word	0000 to 1100	
"STAT"	STAT	Ramp/Soak progress	0008H	30009	31009	Word		
"TM1"	TM1	Remaining time on timer 1	000AH	30011	31011	Word	0 sec to 9999 sec / 0 min to 9999 min	
"TM2"	TM2	Remaining time on timer 2	000BH	30012	31012	Word	0 sec to 9999 sec / 0 min to 9999 min	
"TM3"	TM3	Remaining time on timer 3	000CH	30013	31013	Word	0 sec to 9999 sec / 0 min to 9999 min	
"CNdt"	DI		000EH	30015	31015	Word		
	RJC (Cold junction compensation)		000FH	30016	31016	Word	FF (off) on (on)	
	ALM STATUS		003BH	30060	31060	Word		
	DI STATUS		003CH	30061	31061	Word		
	STAT		003DH	30062	31062	Word		

12.4.3 RESISTOR NUMBER ORDER READ PARAMETER LIST

Relative address	Resistor Number		Type	Memory contents
	Internal	Engineering unit		
0000H	30001	31001	Word	PV (measurement)
0001 H	30002	31002	Word	SV (Currently used set value)
0002H	30003	31003	Word	DV (Currently used deviation)
0003H	30004	31004	Word	Mv1 (output 1)
0004H	30005	31005	Word	Mv2 (output 2)
0005H	30006	31006	Word	STATION No.
0006H	30007	31007	Word	ALM STATUS
0007H	30008	31008	Word	FALT STATUS
0008H	30009	31009	Word	STAT (Ramp/soak progress)
000AH	30011	31011	Word	TM1 (Remaining time on timer 1)
000BH	30012	31012	Word	TM2 (Remaining time on timer 2)
000CH	30013	31013	Word	TM3 (Remaining time on timer 3)
000EH	30015	31015	Word	DI STATUS
000FH	30016	31016	Word	rJC (Cold junction compensation)
0028H	30041	31041	Word	STAT (Ramp/soak progress)
0029H	30042	31042	Word	Mv1 (output 1)
002AH	30043	31043	Word	Mv2 (output 2)
0031H	30050	31050	Word	TM1 (Remaining time on timer 1)
0032H	30051	31051	Word	TM2 (Remaining time on timer 2)
0033H	30052	31052	Word	TM3 (Remaining time on timer 3)
0034H	30053	31053	Word	TM4 (Remaining time on timer 4)
0035H	30054	31054	Word	TM5 (Remaining time on timer 5)
0036H	30055	31055	Word	FALT STATUS
003BH	30060	31060	Word	ALM STATUS
003CH	30061	31061	Word	DI STATUS

12.5 ENGINEERING UNIT DATA ADDRESS MAP

Handles data dependent on an input range as scaled vale (engineering unit).

12.5.1 BIT DATA (READ ONLY): FUNCTION CODE [02 (H)]

Relative address	Coil Number	Type	Memory contents	Read data	Dependent on range	Remarks/ related parameters
0000H	10001	bit	ALM1 ON/OFF	0: Alarm OFF 1: Alarm ON		

13 Technical Information

This section contains a reference to information that may be useful in certain configurations.

13.1 TEMPERATURE SENSOR CONFIGURATIONS

The Series 800 / 850 / 860 TEC Controllers were designed to allow the user to select from a wide range of temperature sensors. Should it become necessary to change the sensor interface to a different input other than the one that was shipped from the factory, then follow the steps below.

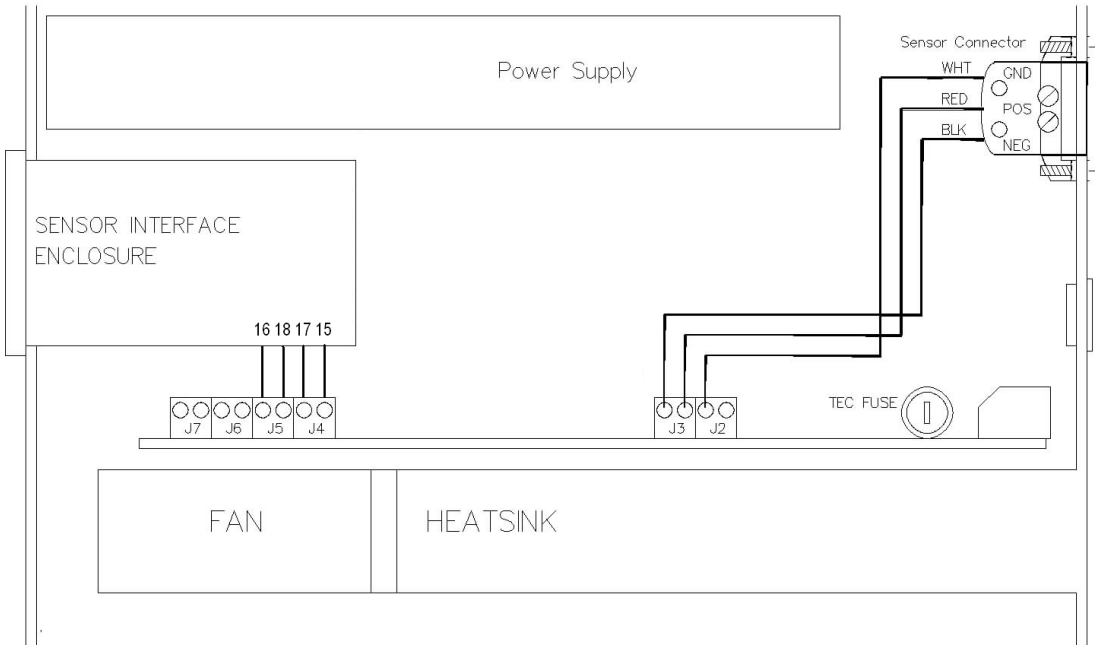
NOTE: If changing to/from a standard configuration to/from a thermocouple configuration, please contact the factory.

13.1.1 STANDARD CONFIGURATION

This configuration allows the most flexibility to interface to all temperature sensors except thermocouples (see thermocouple configuration below). By simply changing jumpers internally on the printed circuit board, the Series 800 / 850 / 860 TEC Controllers can accommodate a wide range of sensors. (See Jumper Settings on page 20)

The drawing below shows the Standard Configuration for the Series 800 / 850 / 860 TEC Controllers. This configuration will allow ALL sensors EXCEPT Thermocouples to be used via the rear panel connector.

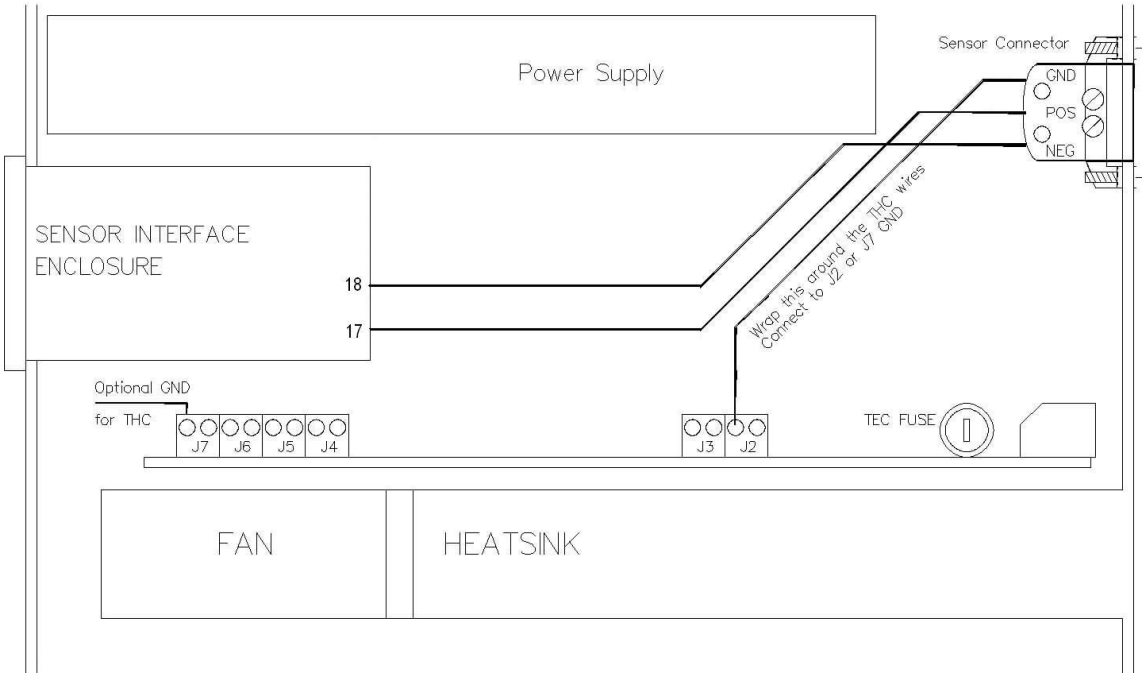
Standard Interface Connections



13.1.2 THERMOCOUPLE CONFIGURATION

The drawing below shows the thermocouple configuration for the Series 800 / 850 / 860 TEC Controllers. In this configuration only the thermocouple Type specified at time of order can be used. To use any other type sensor, contact the factory.

Thermocouple Interface Connections



13.2 THERMISTOR CURVES

Please see the web page for our standard Alpha Omega thermistor curves.

13.3 SPECIAL CONFIGURATIONS

Please contact factory for special requirements. Also see web page for special applications.

14 Maintenance and Troubleshooting

14.1 USER MAINTENANCE / SERVICEABLE ITEMS

The Series 800/850/860 TEC controllers contain few serviceable items. Those items include fuses as well as jumper and wire configurations based on the type of temperature sensor being used.

WARNING: The controller should never be operated or powered without the cover on. Remove all AC power, TEC, and sensor connections before opening the enclosure or servicing any items on or within the controller.

14.2 FUSES

The Series 800 contains one (1) 5A slow blow fuse on the AC inlet. There is a fuse for the TEC output located on the printed circuit board inside the controller.

The Series 850/860 contains two (2) 5A slow blow fuses on the AC inlet. There is a fuse for the TEC output located on each of the printed circuit boards inside the controller.

See the table below for the fuse ratings (See section 3.10 for more information):

Controller Board Wattage	Fuse Rating
30W	3.15A
60W	5A
90W	8A
120W	10A
150W	15A

Contact the factory if controller was custom ordered or if board wattage is not listed above.

14.3 TROUBLESHOOTING

Trouble	Cause	Solution	Reference
Cannot communicate with the host	Parity does not agree.	Make the parity on the host and the unit the same.	Ch9
	Communication speed does not agree.	Make the communication speed on the host and the unit the same.	
Parameters you want to view do not appear	A Password is set	Release the password with SUPER pass	Ch11
Control output is not output even with the power turned on	Soft start is set.	Check the soft start settings.	Ch6
	The ramp/soak settings have the output turned OFF.	Check the ramp/soak settings.	Ch4
	Standby mode is on.	Check the output settings during standby mode.	Ch6
Manual mode cannot be changed	Manual mode is not assigned to the user key	Check the USER key assignments	Ch7
	The DI function is not set to manual mode.	Check the DI function settings	Ch1
Keys do not work	Key lock is set to ON.	Check the key lock settings	Ch1
	SV Limit value is set	Check the SV limit value settings	Ch2
	The USER key settings have changed	Check the USER key settings	Ch7
SV blinks when power Is turned on	Standby is turned on	Release standby	Ch1
	Ramp.soak status is ñENDò	Changes the ramp/soak settings	Ch1
Control does not start even if power is turned on	STMD mode is set to manual output	Check the STMD settings	Ch7