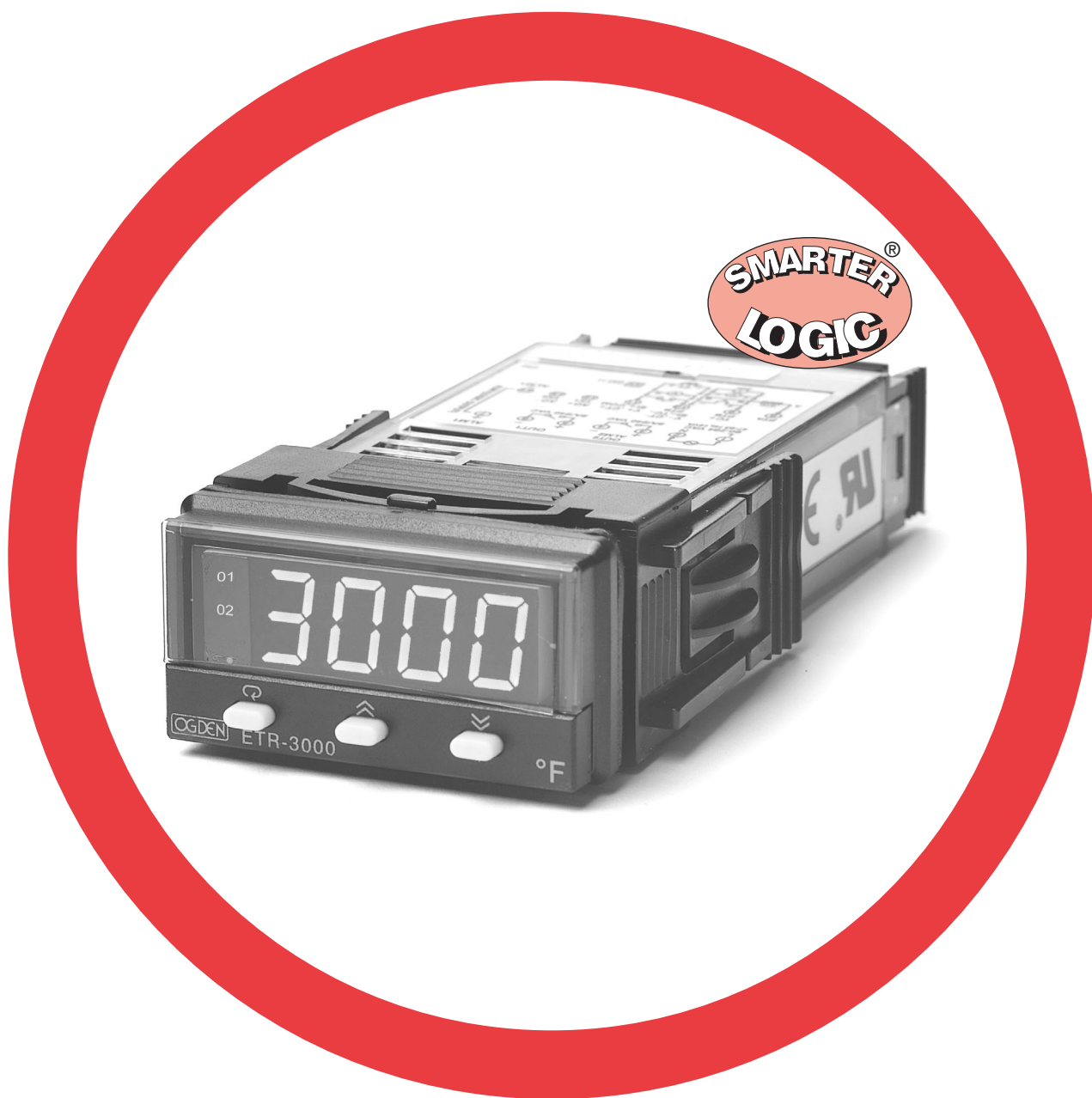




PK486-OMC59
SOFTWARE VERSION
33.16 and HIGHER

Model ETR-3000 AUTOMATIC TUNING 1/32 DIN SMARTER LOGIC[®] Controller



INSTRUCTION MANUAL

Warning Symbol

This Symbol calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury, damage or destruction to part or all of the product and system. Do not proceed beyond a warning symbol until the indicated conditions are fully understood and met.

Using the Manual

- Installer Read Chapter 1, 2
- System Designer Read All Chapters
- Expert User Read Page 9

NOTE:

It is strongly recommended that a process incorporates an FM approved LIMIT CONTROL like the ETR-9040 or ETR-3 which will shut down the equipment at a preset process condition in order to preclude any possible damage to individual components or system.

Information in this user's manual is subject to change without notice.

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Chapter 1 Overview

1-1 General Description

The ETR-3000 Smarter Logic PID microprocessor-based controller incorporates a bright, easy to read 4-digit LED display. The front LED display can be programmed to indicate either the process value or set point value. Smarter Logic technology enables a process to reach a predetermined set point in the shortest possible time, with minimum overshoot during power-up or external load disturbance.

The ETR-3000 is a 1/32 DIN size panel mount controller. These units are powered by an 11-26 or 90-250 VDC/VAC supply, incorporating a 2 amp control output relay as standard. The second output can be used as cooling control, an alarm or dwell timer. Prior to shipment, both outputs can be independently configured as triac, 5V logic output, linear current or linear voltage to drive an external device. There are six independent programmable alarm modes plus a dwell timer that can be configured for the second output. The units are fully programmable for RTD (PT100) and thermocouple types J, K, T, E, B, R, S, N, L without need to physically modify the unit. The input signal is digitized by using a 18-bit A to D converter. A fast sampling rate allows the ETR-3000 unit to control fast processes.

Digital communications RS-485 or RS-232 are available as an additional option. This option allows the units to be integrated with a supervisory control system and/or software.

A programming port is available for automatic configuration, calibration and testing without the need to access the keys on front panel.

By using proprietary Fuzzy modified PID technology(Smarter Logic), the control loop will minimize overshoot and undershoot in the shortest time possible. The following diagram is a comparison of results with and without Fuzzy technology.

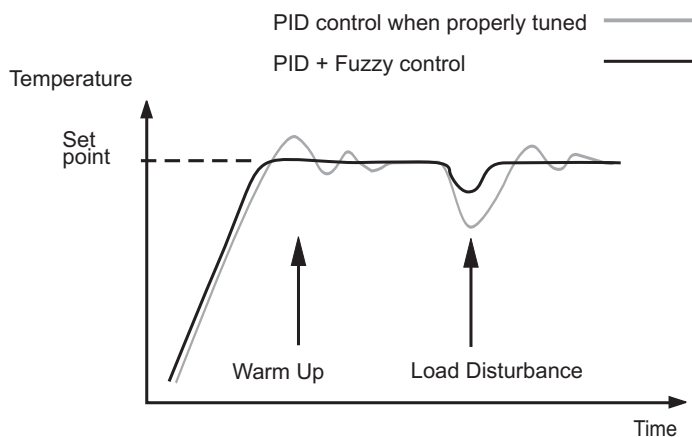


Figure 1.1
Fuzzy Control Advantage

High Accuracy

The ETR-3000 is manufactured with custom designed ASIC(Application Specific Integrated Circuit) technology which contains an 18-bit A to D converter for high resolution measurement (true 0.1 °F resolution for thermocouple and standard Pt100 RTD's) and a 15-bit D to A converter for linear current or voltage control output. The ASIC technology provides improved operating performance, low cost, enhanced reliability and higher density internal storage.

Fast Sampling Rate

The sampling rate of the input A to D converter reaches 5 times/second. This fast sampling rate allows this series to control fast processes.

Smarter Logic Control

The function of Smarter Logic control is to automatically adjust the PID parameters from time to time. These dynamic adjustments are made in order to tune the output value to be more flexible and adaptive to various processes. The result is to enable a process to reach a predetermined set point in the shortest possible time with minimum overshoot and/or undershoot during power-up or external load disturbance.

Digital Communications

The ETR-3000 can be equipped with an RS-485 or RS-232 interface card to provide digital communications. By using shielded twisted pair wire, at most 247 units can be connected together via an RS-485 interface to a host computer. An industry standard Modbus RTU is used for the communication protocol.

Programming Port

A programming port is used to connect the unit to a hand-held programmer or a PC for quick configuration. Additionally, it can be connected to an Automatic Test Equipment (ATE) system for automatic testing & calibration.

Auto-tune

The auto-tune function allows the user to simplify the initial setup for a new system. A clever algorithm is provided to obtain an optimal set of control parameters for the process. The Auto-tune feature can be applied either as the process is warming up (cold start) or as the process is in a steady state (warm start).

Lockout Protection

In order to meet various security requirements, one of four lockout levels can be selected to prevent the unit from being changed without authorization.

Bumpless Transfer

The Bumpless Transfer feature is a unique process protection feature that is employed upon a sensor break condition or input problem. Bumpless transfer allows a controller to continue to proportion it's output based on previous process and control characteristics. Hence, the process can be temporarily controlled just as if running a closed loop control application, making the severe problem of a Thermocouple error temporarily invisible. Bumpless transfer is not to be used for an extended period time as in open loop control, run-away may occur.

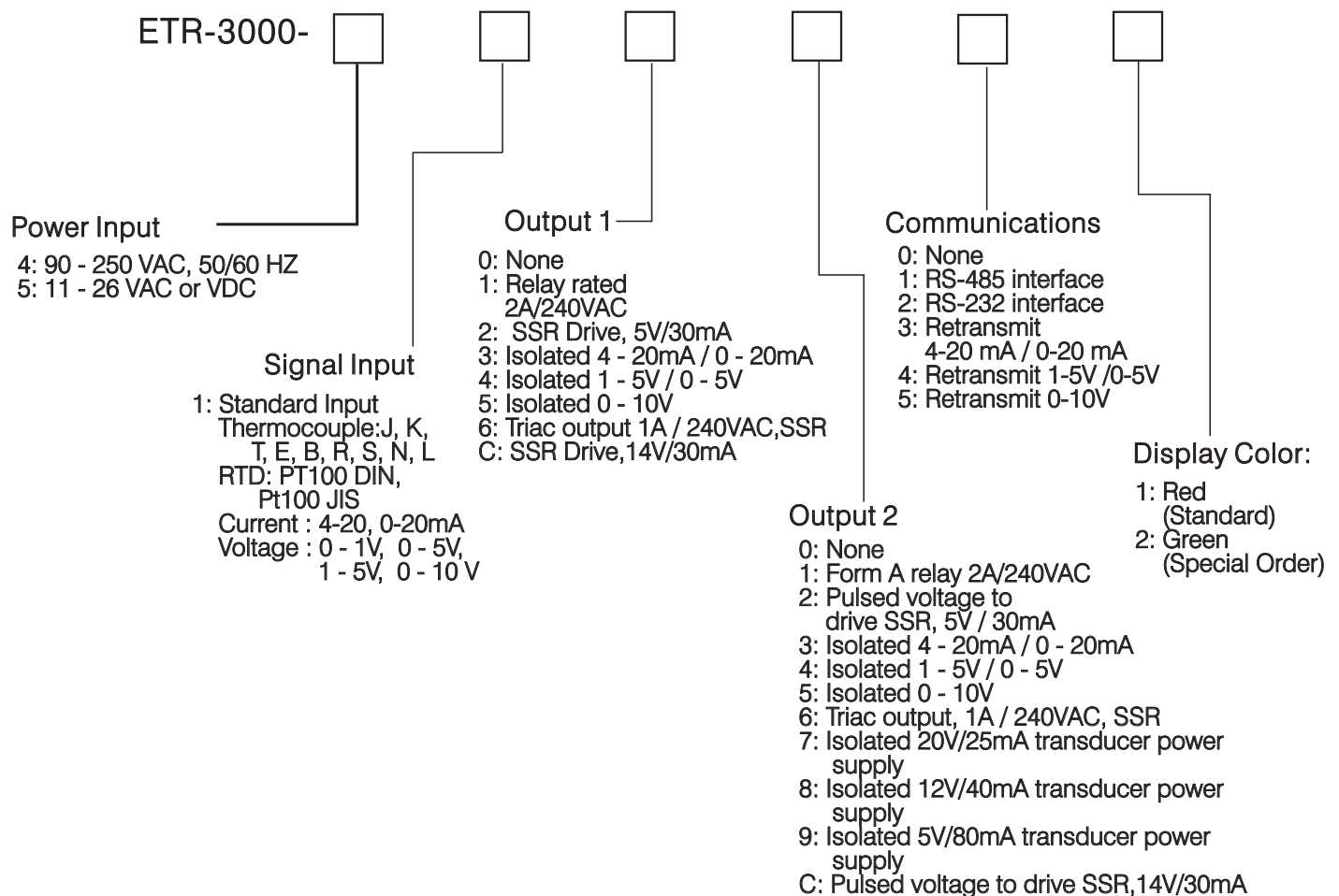
Soft-start Ramp

The ramping function is performed during power up as well as any time the set point is changed. It ramp will control both ramp up and/or ramp down. The process value will reach the set point with a predetermined constant rate.

Digital Filter

A first order low pass filter with a programmable time constant is used to improve the stability of process value. This is particularly useful in certain applications where the process value is too unstable to be read.

1-2 Ordering Code



Related Products

SNA10A = Smart Network Adaptor for third party software, which converts 255 channels of RS-485 or RS-422 to RS-232 Network.

SNA10B = Smart Network Adaptor for ETR-Net software, which converts 255 channels of RS-485 or RS-422 to RS-232 network.

SNA12A = Smart Network Adaptor for programming port to RS-232 interface

ETR-Set = Configuration Software

CC94-1 = RS-232 Interface Cable (2M)

CETR-9000-1 = Programming port cable for ETR-3000

1-3 Programming Port

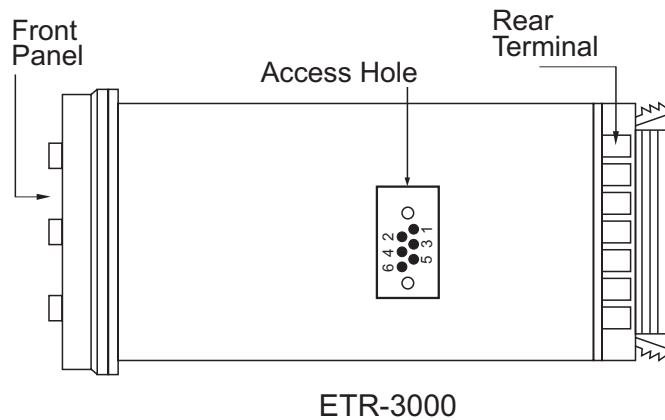


Figure 1.2 Programming Port Overview

A special connector can be used to connect to the programming port which is then connected to a PC for automatic configuration. It can also be connected to an ATE system for automatic calibration and testing.

The programming port is used for off-line automatic setup and testing procedures only. Don't attempt to make any connection to these pins while the unit is powered up and being used for normal control purposes.

1- 4 Keys and Displays

KEYPAD OPERATION

SCROLL KEY :

This key is used to select a parameter to be viewed or adjusted.

UP KEY :

This key is used to increase the value of a selected parameter.

DOWN KEY :

This key is used to decrease the value of a selected parameter.

RESET KEY :

This key is used to:

1. Revert the controllers display back to the process value (or set point value if DISP is set to SP1).
2. Reset the latching alarm, once the alarm condition is removed.
3. Stop the manual control mode, auto-tuning mode and calibration mode.
4. Clear the message of a communications error or auto-tuning error.
5. Restart the dwell timer when the dwell timer has timed out.
6. Enter the manual control menu when a failure condition occurs.

ENTER KEY : Press for 3 seconds or longer .

Press for 3 seconds to:

1. Enter the setup menu. The display will show
2. Enter the manual control mode when the manual control menu, or is displayed.
3. Enter the controller into auto-tuning mode. During auto-tuning mode is displayed.
4. Perform calibration to a selected parameter during the calibration procedure. Press for 5 seconds to select calibration mode.

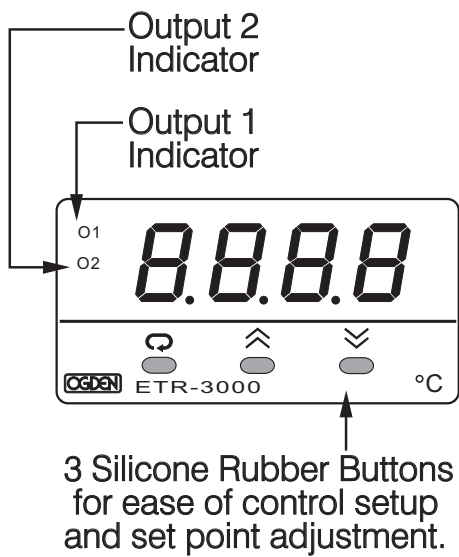
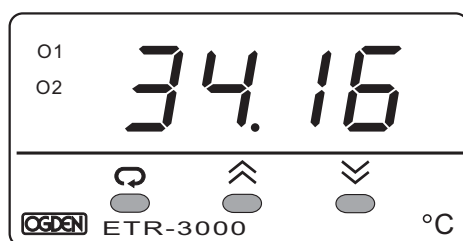


Figure 1.3 Front Panel Description

Table 1.1 Character Legend

A	<i>A</i>	E	<i>E</i>	I	<i>I</i>	N	<i>n</i>	S	<i>S</i>	X	
B	<i>b</i>	F	<i>F</i>	J	<i>J</i>	O	<i>o</i>	T	<i>t</i>	Y	<i>y</i>
C	<i>C</i>	G	<i>G</i>	K	<i>K</i>	P	<i>P</i>	U	<i>u</i>	Z	
c	<i>c</i>	H	<i>H</i>	L	<i>L</i>	Q		V	<i>v</i>	?	<i>?</i>
D	<i>d</i>	h	<i>h</i>	M	<i>m</i>	R	<i>r</i>	W		=	<i>=</i>

▴: Characters Displayed by a Symbol

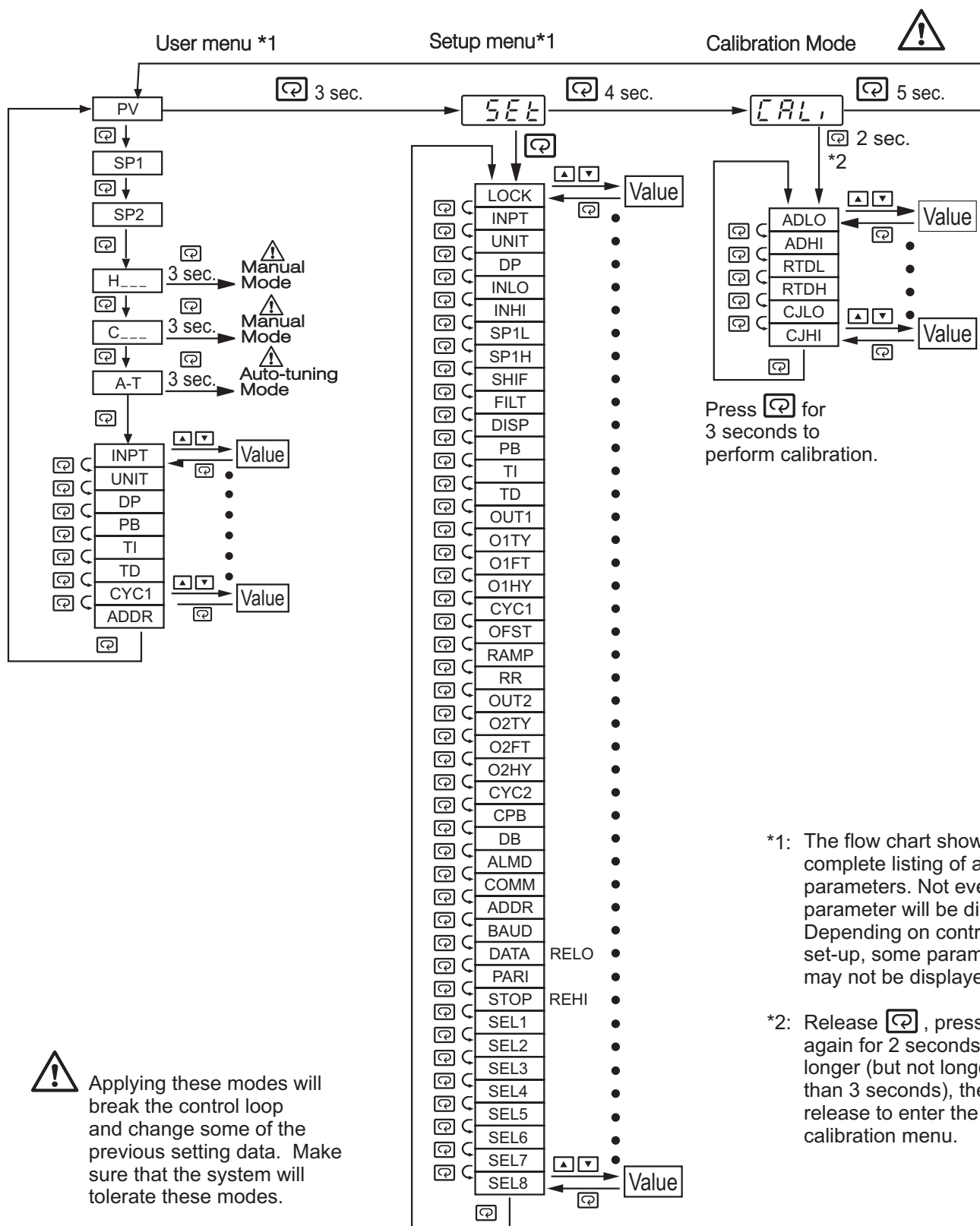


Displays the program code of the product for 2.5 seconds.

The ETR-3000 goes through an initial Power up self test in which it displays the Program code and version of the controller. The left diagram shows program no. 34 for an ETR-3000, version 16.

Figure 1.4
Display at Power-up

1- 5 Menu Overview



1-6 Parameter Descriptions


Parameter Notation	Parameter Description	Range		Default Value
SP1	Set point for output 1	Low: SP1L	High :SP1H	77.0 °F (25.0 °C)
SP2	Set point for output 2 when output 2 performs alarm function or dwell timer	Low: -19999	High :45536	18.0°F (10.0 °C)
LOCK	Select parameters to be locked	0 <i>nonE</i> : No parameters are locked 1 <i>SEt</i> : Setup data is locked 2 <i>uSEr</i> : Setup and User data is locked Set point is un- locked 3 <i>ALL</i> : All data is locked		0
INPT	Input sensor selection	0 <i>J-tC</i> : J type T/C 9 <i>Pt.dn</i> : PT 100 ohms DIN 1 <i>K-tC</i> : K type T/C 10 <i>Pt.JS</i> : PT 100 ohms JIS 2 <i>T-tC</i> : T type T/C 11 <i>4-20</i> : 4 - 20 mA 3 <i>E-tC</i> : E type T/C 12 <i>0-20</i> : 0 - 20 mA 4 <i>B-tC</i> : B type T/C 13 <i>0-60</i> : 0 - 60 mV 5 <i>R-tC</i> : R type T/C 14 <i>0-1V</i> : 0 - 1V 6 <i>S-tC</i> : S type T/C 15 <i>0-5V</i> : 0 - 5V 7 <i>N-tC</i> : N typeT/C 16 <i>1-5V</i> : 1 - 5V 8 <i>L-tC</i> : L type T/C 17 <i>0-10</i> : 0 - 10V		1 (0)
UNIT	Input unit selection	0 <i>C</i> : Degree C unit 2 <i>Pu</i> : Process unit 1 <i>F</i> : Degree F unit		0 (1)
DP	Decimal point selection	0 <i>nodP</i> : No decimal point 2 <i>2-dP</i> : 2 decimal digits 1 <i>1-dP</i> : 1 decimal digit 3 <i>3-dP</i> : 3 decimal digits		1
INLO	Input low scale value	Low: -19999	High: 45486	0°F (-17.8 °C)
INHI	Input high scale value	Low: INLO+50	High: 45536	200.0°F (93.3 °C)
SP1L	Low limit of set point value	Low: -19999	High: 45536	0°F (-17.8 °C)
SP1H	High limit of set point value	Low: SP1L	High: 45536	1000°F (537.8 °C)
SHIF	PV shift (offset) value	Low: -360.0 °C (-200.0 °C)	High: 360.0 °F (200.0 °C)	0.0
FILT	Filter damping time constant of PV (seconds)	0 <i>0</i> : 0 4 <i>2</i> : 2 8 <i>30</i> : 30 1 <i>0.2</i> : 0.2 5 <i>5</i> : 5 9 <i>60</i> : 60 2 <i>0.5</i> : 0.5 6 <i>10</i> : 10 3 <i>1</i> : 1 7 <i>20</i> : 20		2
DISP	Normal display selection	0 <i>PV</i> : Display process value 1 <i>SP 1</i> : Display set point 1 value		0
PB	Proportional band value	Low: 0	High: 932.0 °F (500.0 °C)	18.0 °F (10.0 °C)
TI	Integral time value	Low: 0	High: 1000 sec	100
TD	Derivative time value	Low: 0	High: 360.0 sec	25.0

Parameter Notation	Parameter Description	Range	Default Value
OUT1	Output 1 function	0 <i>rELY</i> : Reverse (heating) control 1 <i>dirct</i> : Direct (cooling) control	0
O1TY	Output 1 signal type	0 <i>rELY</i> : Relay 1 <i>SSrd</i> : Solid state relay drive 2 <i>SSr</i> : Solid state relay 3 <i>4-20</i> : 4-20 mA 4 <i>0-20</i> : 0 - 20 mA 5 <i>0-1V</i> : 0 - 1V 6 <i>0-5V</i> : 0 - 5V 7 <i>1-5V</i> : 1 - 5V 8 <i>0-10</i> : 0 - 10V	0
O1FT	Output 1 failure transfer mode	Select BPLS (bumpless transfer) or 0.0 ~ 100.0 % to continue output 1 control function as the unit fails, or select OFF (0) or ON (1) for ON-OFF control.	0
O1HY	Output 1 ON-OFF control hysteresis	Low: 0.1 High: 90.0°F (50.0°C)	0.2 °F (0.1 °C)
CYC1	Output 1 cycle time	Low: 0.1 High: 90.0 sec.	18.0
OFST	Offset value for P control	Low: 0 High: 100.0 %	25.0
RAMP	Ramp function selection	0 <i>nonE</i> : No Function 1 <i>min</i> : Use unit/minute 2 <i>Hr.r</i> : Use unit/hour	0
RR	Ramp rate	Low: 0 High: 900.0 °F (500.0 °C)	0.0
OUT2	Output 2 function	0 <i>nonE</i> : Output 2 No Function 1 <i>tlr</i> : Dwell timer action 2 <i>dELH</i> : Deviation High Alarm 3 <i>dELo</i> : Deviation Low Alarm 4 <i>dbH</i> : Deviation out of band Alarm 5 <i>dbLo</i> : Deviation in band Alarm 6 <i>PuH</i> : Process High Alarm 7 <i>PuLo</i> : Process Low Alarm 8 <i>CoOL</i> : Cooling PID Function	2
O2TY	Output 2 signal type	0 <i>rELY</i> : Relay output 1 <i>SSrd</i> : Solid state relay drive 2 <i>SSr</i> : Solid state relay 3 <i>4-20</i> : 4 - 20 mA 4 <i>0-20</i> : 0 - 20 mA 5 <i>0-1V</i> : 0 - 1V 6 <i>0-5V</i> : 0 - 5V 7 <i>1-5V</i> : 1 - 5V 8 <i>0-10</i> : 0 - 10V	0
O2FT	Output 2 failure transfer mode	Select BPLS (bumpless transfer) or 0.0 ~ 100.0 % to continue output 2 control function as the unit fails, or select ON (0) or OFF (1) for alarm and dwell timer function.	0
O2HY	Output 2 hysteresis value when output 2 performs alarm function	Low: 0.1 High: 90.0 °F (50.0 °C)	0.2 °F (0.1 °C)
CYC2	Output 2 cycle time	Low: 0.1 High: 90.0 sec.	18.0
CPB	Cooling proportional band value	Low: 50 High: 300 %	100
DB	Heating-cooling dead band (negative value = overlap)	Low: -36.0 High: 36.0 %	0
ALMD	Alarm operation mode	0 <i>norm</i> : Normal alarm action 1 <i>latch</i> : Latching alarm action 2 <i>Hold</i> : Hold alarm action 3 <i>latcho</i> : Latching & Hold action	0

Parameter Notation	Parameter Description	Range	Default Value
COMM	Communication function	0 <i>none</i> : No communication 1 <i>RTU</i> : Modbus RTU mode protocol 2 4-20 : 4-20mA retransmission output 3 0-20 : 0-20mA retransmission output 4 0-5V : 0-5V retransmission output 5 1-5V : 1-5V retransmission output 6 0-10 : 0-10V retransmission output	1
ADDR	Address assignment of digital communication	Low: 1 High: 255	——
BAUD	Baud rate of digital communication	0 24 : 2.4 Kbits/s 4 192 : 19.2 Kbits/s 1 48 : 4.8 Kbits/s 5 288 : 28.8 Kbits/s 2 96 : 9.6 Kbits/s 6 384 : 38.4 Kbits/s 3 144 : 14.4 Kbits/s	2
DATA	Data bit count of digital communication	0 7b, t : 7 data bits 1 8b, t : 8 data bits	1
PARI	Parity bit of digital communication	0 <i>even</i> : Even parity 2 <i>none</i> : No parity bit 1 <i>odd</i> : Odd parity	0
STOP	Stop bit count of digital communication	0 1b, t : One stop bit 1 2b, t : Two stop bits	0
RELO	Retransmission low scale value	Low: -19999 High: 45536	32.0 °F (0.0 °C)
REHI	Retransmission high scale value	Low: -19999 High: 45536	212.0 °F (100.0 °C)
SEL1	Select 1'st parameter for user menu	0 <i>none</i> : No parameter selected 9 <i>01HY</i> : O1HY is put ahead 1 <i>LOCK</i> : LOCK is put ahead 10 <i>CYC1</i> : CYC1 is put ahead 2 <i>INPT</i> : INPT is put ahead 11 <i>OFST</i> : OFST is put ahead 3 <i>UNIT</i> : UNIT is put ahead 12 <i>RR</i> : RR is put ahead 4 <i>DP</i> : DP is put ahead 13 <i>02HY</i> : O2HY is put ahead 5 <i>SHIF</i> : SHIF is put ahead 14 <i>CYC2</i> : CYC2 is put ahead 6 <i>PB</i> : PB is put ahead 15 <i>CPB</i> : CPB is put ahead 7 <i>TI</i> : TI is put ahead 16 <i>DB</i> : DB is put ahead 8 <i>TD</i> : TD is put ahead 17 <i>ADDR</i> : ADDR is put ahead	2
SEL2	Select 2'nd parameter for user menu	Same as SEL1	3
SEL3	Select 3'rd parameter for user menu	Same as SEL1	4
SEL4	Select 4'th parameter for user menu	Same as SEL1	6
SEL5	Select 5'th parameter for user menu	Same as SEL1	7
SEL6	Select 6'th parameter for user menu	Same as SEL1	8
SEL7	Select 7'th parameter for user menu	Same as SEL1	10
SEL8	Select 8'th parameter for user menu	Same as SEL1	17

Chapter 2 Installation

⚠ Dangerous voltages capable of causing death are sometimes present in this instrument. Before installation or beginning any cleaning or troubleshooting procedures the power to all equipment must be switched off and isolated. Units suspected of being faulty must be disconnected and removed to a properly equipped workshop for testing and repair. Component replacement and internal adjustments must be made by a qualified maintenance person only.

⚠ This instrument is protected throughout by Double Insulation . To minimize the possibility of fire or shock hazards, do not expose this instrument to rain or excessive moisture.

⚠ Do not use this instrument in areas under hazardous conditions such as excessive shock, vibration, dirt, moisture, corrosive gases or oil. The ambient temperature of the areas should not exceed the maximum rating specified in Chapter 6.

⚠ Remove stains from this instrument using a soft, dry cloth. Don't use harsh chemicals, volatile solvent such as thinner or strong detergents to clean the instrument in order to avoid deformation or discoloration.

2-1 Unpacking

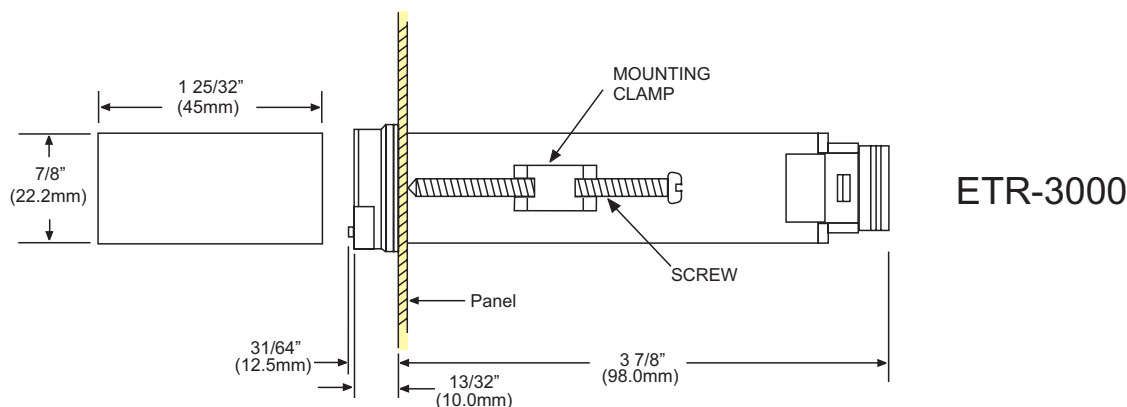
Upon receipt of the shipment remove the unit from the carton and inspect the unit for shipping damage. If any damage due to transit, report and claim with the carrier. Write down the model number, serial number, and date code for future reference when corresponding with our service center. The serial number (S/N) and date code (D/C) are labeled on the box and the housing of control.

2-2 Mounting

Make panel cutout to dimension shown in Figure 2.1.

Take the mounting clamp away and insert the controller into panel cutout. Install the mounting clamp back.

Figure 2.1 Mounting Dimensions



2 - 3 Wiring Precautions

- * Before wiring, verify the label for correct model number and options. Switch off the power while checking.
- * Care must be taken to ensure that maximum voltage rating specified on the label are not exceeded.
- * It is recommended that power of these units to be protected by fuses or circuit breakers rated at the lowest value possible.
- * All units should be installed inside a suitably grounded metal enclosure to prevent live parts being accessible from human hands and metal tools.
- * All wiring must conform to appropriate standards of good practice and local codes and regulations. Wiring must be suitable for voltage, current, and temperature rating of the system.
- * Beware not to over-tighten the terminal screws. The torque should not exceed 1 N-m (8.9 Lb-in or 10.2 KgF-cm)
- * Unused control terminals should not be used as jumper points as they may be internally connected, causing damage to the unit.
- * Verify that the ratings of the output devices and the inputs as specified in Chapter 6 are not exceeded.
- * Except the thermocouple wiring, all wiring should use stranded copper conductor with maximum gauge 18 AWG.

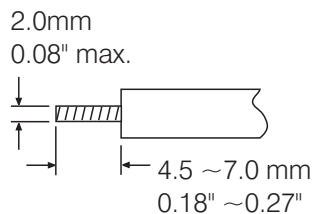


Figure 2.2
Lead Termination

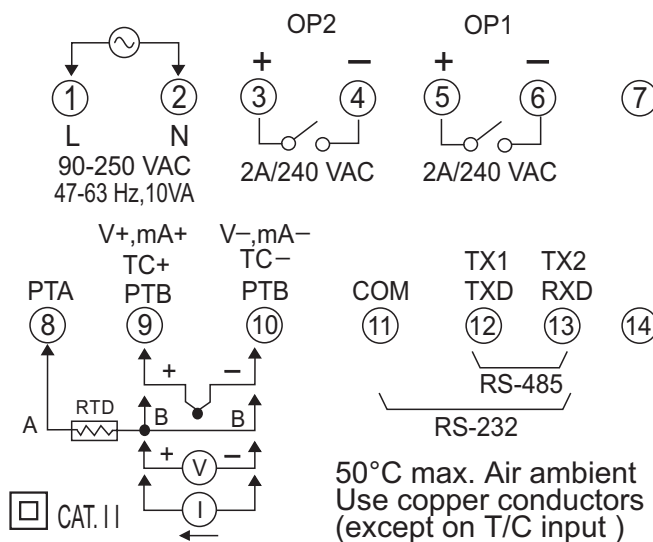


Figure 2.3
Rear Terminal Connection

2-4 Power Wiring

The controller is designed to operate at 11-26 VAC / VDC or 90-250 VAC. Check that the installation voltage corresponds with the power rating indicated on the product label before connecting power to the controller. Near the controller a fuse and a switch rated at 2A/250VAC should be equipped as shown in the following diagram.

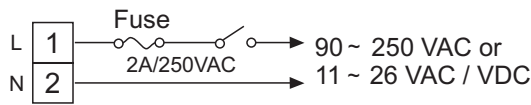


Figure 2.4 Power Supply Connections



This equipment is designed for installation in an enclosure which provides adequate protection against electric shock. The enclosure must be connected to earth ground.

Local requirements regarding electrical installation should be rigidly observed. Consideration should be given to prevent from unauthorized person access to the power terminals.

2-5 Sensor Installation Guidelines

Proper sensor installation can eliminate many problems in a control system. The probe should be placed so that it can detect any temperature change with minimal thermal lag. In a process that requires fairly constant heat output, the probe should be placed close to the heater. In a process where the heat demand is variable, the probe should be closed to the work area. Some experiments with probe location are often required to find this optimum position.

In a liquid process, addition of a stirrer will help to eliminate thermal lag. Since the thermocouple is basically a point measuring device, placing more than one thermocouple in parallel can provide an average temperature readout and produce better results in most air heated processes.

Proper sensor type is also a very important factor to obtain precise measurements. The sensor must have the correct temperature range to meet the process requirements. In special processes the sensor might need to have different requirements such as leak-proof, anti-vibration, antiseptic, etc.

Standard sensor limits of error are ± 4 degrees F (± 2 degrees C) or 0.75% of sensed temperature (half that for special) plus drift caused by improper protection or an over-temperature occurrence. This error is far greater than controller error and cannot be corrected on the sensor except by proper selection and replacement.

2-6 Sensor Input Wiring

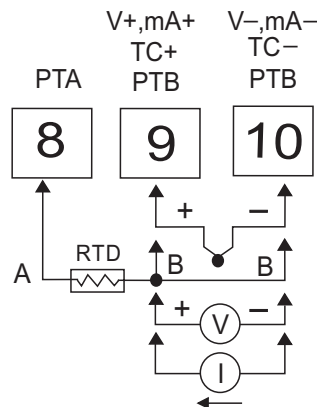


Figure 2.5 Sensor Input Wiring

2-7 Control Output Wiring

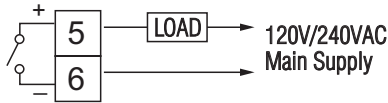


Figure 2.6
Output 1 Relay or Triac (SSR) to Drive Load

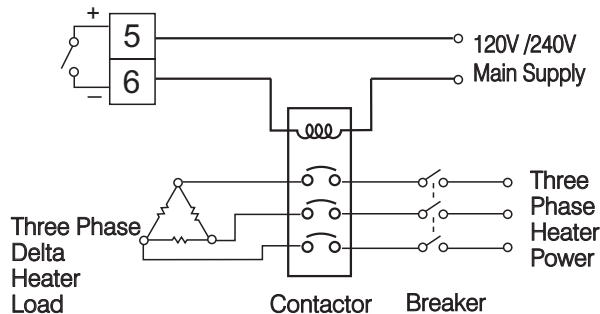


Figure 2.7
Output 1 Relay or Triac (SSR) to Drive Contactor

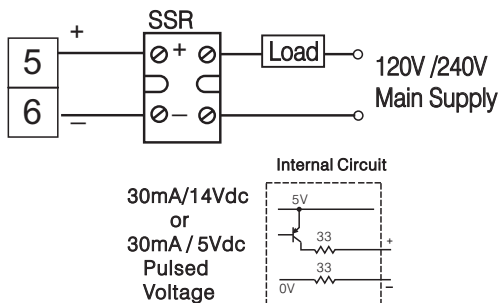


Figure 2.8
Output 1 Pulsed Voltage to Drive SSR

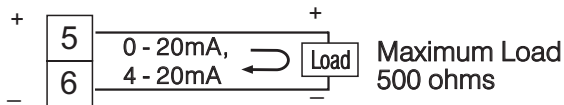


Figure 2.9
Output 1 Linear Current

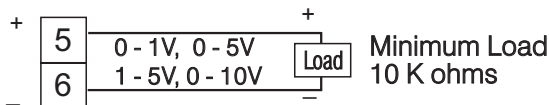


Figure 2.10
Output 1 Linear Voltage

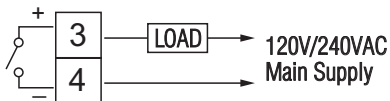


Figure 2.11
Output 2 Relay or Triac (SSR) to Drive Load

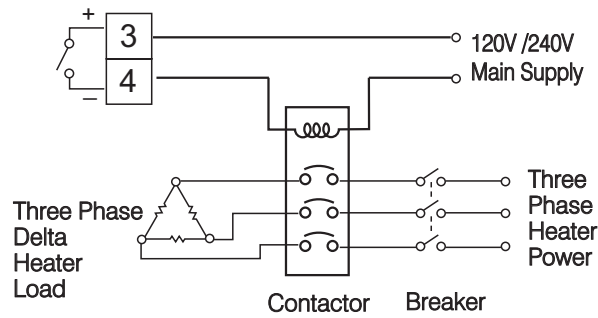
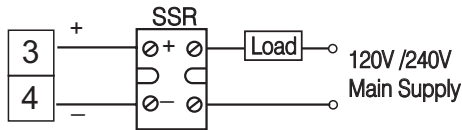


Figure 2.12
Output 2 Relay or Triac (SSR) to Drive
Contactor



30mA / 14Vdc
or
30mA / 5Vdc
Pulsed
Voltage

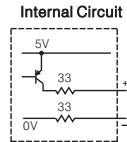


Figure 2.13
Output 2 Pulsed Voltage to Drive SSR

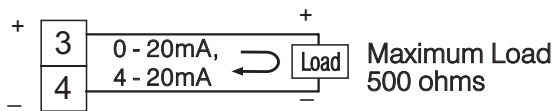


Figure 2.14
Output 2 Linear Current

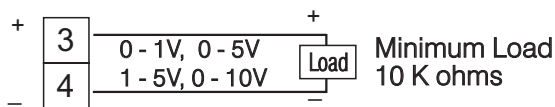


Figure 2.15
Output 2 Linear Voltage

2-8 Alarm Wiring

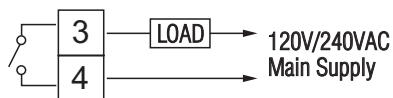


Figure 2.16
Alarm Output to Drive Load

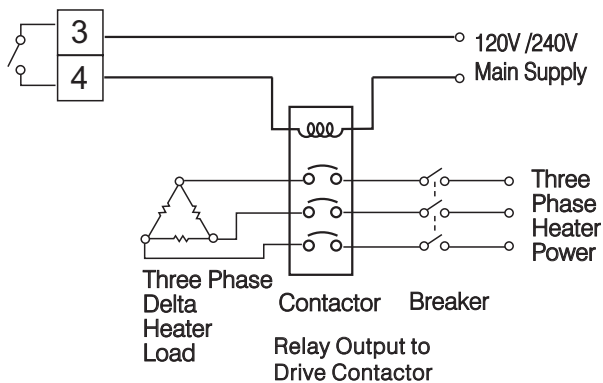


Figure 2.17
Alarm Output to Drive Contactor

2-9 Data Communication

RS-485

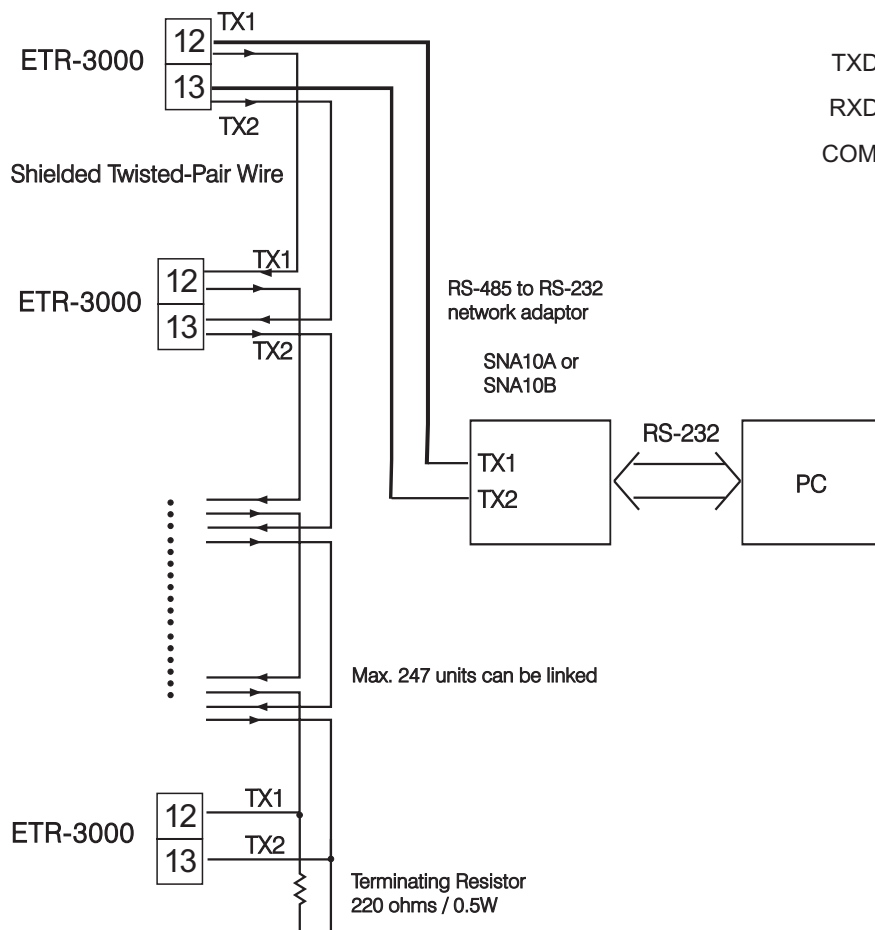


Figure 2.18 RS-485 Wiring

RS-232

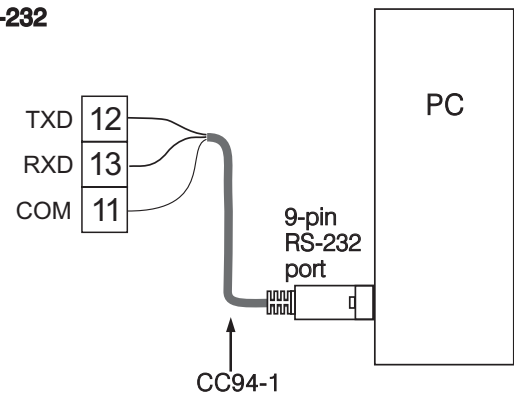


Figure 2.19 RS-232 Wiring

Using RS-232 communications as shown above right, a special cable CC-94-1 should be used. The other option is to configure a 9 pin serial cable as shown below.

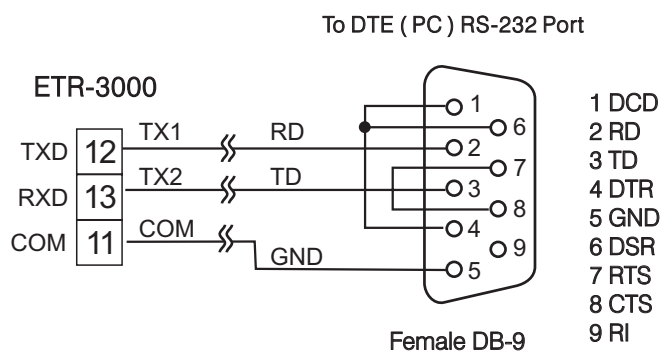


Figure 2.20 Configuration of RS-232 Cable

Chapter 3 Programming

Press \square for 3 seconds and release to enter setup menu. Press \square to select the desired parameter. The display indicates the parameter symbol. Press \triangle or ∇ to view or adjust the value of the selected parameter.

3-1 Lockout

There are four security levels can be selected by using LOCK parameter.

If **NONE** is selected for LOCK, then all parameters are unlocked.

If **SET** is selected for LOCK, then all setup menu parameters are locked.

If **USER** is selected for LOCK, then all setup and user parameters (refer to **section 1-5**) except set point are locked.

If **ALL** is selected for LOCK, then all parameters are locked to prevent any changes.

3-2 Signal Input

INPT: Selects the sensor or signal type for signal input.

Range: (thermocouple) J, K, T, E, B, R, S, N, L

(RTD) PT.DN, PT.JS

(linear) 4-20mA, 0-20mA, 0-60mV, 0-1V, 0-5V, 1-5V, 0-10

UNIT: Selects the process unit

Range: °C, °F, PU (process unit). If the unit is neither °C nor °F, then select PU.

DP: Selects the resolution of process value.

Range: (for T/C and RTD) NO.DP, 1-DP

(for linear) NO.DP, 1-DP, 2-DP, 3-DP

INLO: Selects the low scale value for the linear type input.

INHI : Selects the high scale value for the linear type input.

How to use INLO and INHI :

If 4 - 20 mA is selected for INPT, let SL specifies the input signal low (ie. 4 mA), SH specifies the input signal high (ie. 20 mA), S specifies the current input signal value, the conversion curve of the process value is shown as follows :

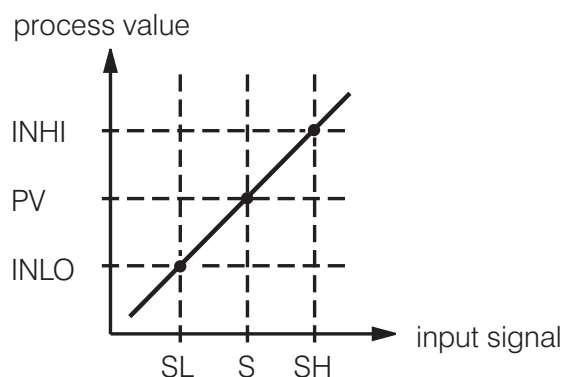


Figure 3.1
Conversion Curve for
Linear Type Process Value

Example : A 4-20 mA current loop pressure transducer with range 0 - 15 kg/cm² is connected to input, then perform the following setup :

Formula : $PV = INLO + (INH - \frac{S-SL}{SH-SL} INLO)$

INPT = 4 - 20 INLO = 0.00

INHI = 15.00 DP = 2-DP

Of course, you may select other value for DP to alter the resolution.

3-3 Control Outputs

There are 4 kinds of control modes that can be configured as shown in **Table 3.1**

Table 3.1 Heat-Cool Control Setup Value

Control Modes	OUT1	OUT2	O1HY	O2HY	CPB	DB
Heat only	REVR	×	☆	×	×	×
Cool only	DIRT	×	☆	×	×	×
Heat: PID Cool: ON-OFF	REVR	DE.HI	×	○	×	×
Heat: PID Cool: PID	REVR	COOL	×	×	○	○

× : Don't care

○ :Adjust to met process requirements

☆:Required if ON-OFF control is configured

Heat Only ON-OFF Control : Select REVR for OUT1, Set PB to 0, O1HY is used to adjust dead band for ON-OFF control, The output 1 hysteresis (O1HY) is enabled in case of PB = 0 . The heat only on-off control function is shown in the following diagram :

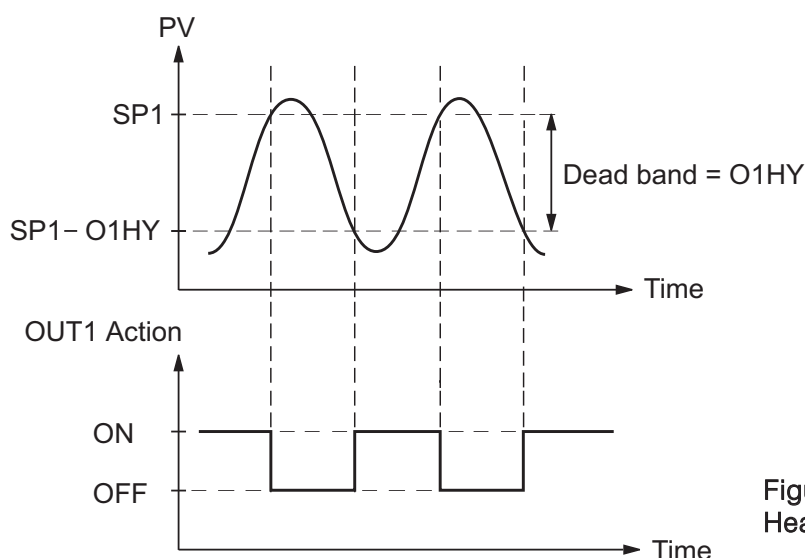


Figure 3.2
Heat Only ON-OFF Control

The ON-OFF control may introduce excessive process oscillation even if hysteresis is minimized. If ON-OFF control is set (ie. PB = 0), TI, TD, CYC1, OFST, CYC2, CPB, DB will be hidden and have no function to the system. The auto-tuning mode and bumpless transfer will be disabled too.

Heat only, P (or PD) control : Select REVR for OUT1, set TI to 0, OFST is used to adjust the control offset (manual reset). **O1HY is hidden** if PB is not equal to 0. **OFST Function** : OFST is measured by % with range 0 - 100.0 %. In the steady state (ie. process has been stabilized) if the process value is lower than the set point by a definite value, say 5 °C, while 20 °C is used for PB, that is lower 25 %, then increase OFST 25 %, and vice versa. After adjusting the OFST value, the process value will be varied and eventually, coincide with the set point. Using the P control (TI set to 0), the auto-tuning is disabled. Refer to section 3-12 " manual tuning " for the adjustment of PB and TD. Manual reset (adjust OFST)is not practical because the load may change from time to time and often need to adjust OFST repeatedly. PID control setup can avoid this situation.

Heat only PID control : Selecting REVR for OUT1, PB and TI should not be zero. Operate auto-tuning for the new process, or set PB, TI and TD with historical values. See section 3-11 for auto-tuning operation. If the control result is still unsatisfactory, then use manual tuning to improve the control . See section 3-12 for manual tuning. The unit contains a **sophisticated PID and Fuzzy algorithm** to achieve a **minimal overshoot and a fast response** to the process if it is properly tuned.

Cool only control: ON-OFF control, P (PD) control and PID control can be used for cooling control. Set OUT1 to DIRT (direct action). The other functions for cool only ON-OFF control, cool only P (PD) control and cool only PID control are the same as the descriptions for heat only control except that the output variable (and action) for the cool control is inverse to the heat control.

NOTE : ON-OFF control may result excessive overshoot and undershoot problems in the process. The P (or PD) control will result in a deviation of process value from the set point. It is recommended to use PID control for the Heat-Cool control to produce a stable and zero offset process value.

Other Setup Required :

Cycle Time: CYC1, CYC2, O1FT, O2FT O1TY & O2TY parameters are set in accordance with the types of OUT1 & OUT2 installed. CYC1 & CYC2 are selected according to the output 1 type (O1TY) & output 2 type (O2TY) Generally, if SSRD or SSR is used for O1TY, select 0.5 ~ 2 sec. for CYC1; if relay is used for O1TY, select 10 ~ 20 sec; and if linear output is used, CYC1 is ignored. Similar settings are applied for CYC2 selection.

You can use the **auto-tuning** program for a new process or directly set the appropriate values for PB, TI & TD according to the historical records for the repeated systems. If the control behavior is still inadequate, then use **manual tuning** to improve the control. See **section 3-12** for manual tuning.

CPB Programming : The cooling proportional band is measured by % of PB with range 50~300. Initially set 100% for CPB and examine the cooling effect. If cooling action should be enhanced then decrease CPB, if cooling action is too strong then increase CPB. The value of CPB is related to PB and its value remains unchanged throughout the auto-tuning procedures. Adjustment of CPB is related to the cooling media used. For air used as a cooling media, adjust CPB to 100(%). For oil is used as a cooling media, adjust CPB to 125(%). For water used as cooling media, adjust CPB to 250(%).

DB Programming: Adjustment of DB is dependent on the system requirements. If more positive value of DB (greater dead band between heating and cooling) is used, an unwanted cooling action can be avoided but an excessive overshoot over the set point will occur. If more negative value of DB (greater overlap) is used, an excessive overshoot over the set point can be minimized but an unwanted cooling action will occur. It is adjustable in the range -36.0% to 36.0 % of PB. A negative DB value shows an overlap area over which both outputs are active. A positive DB value shows a dead band area over which neither output is active.

Output 2 ON-OFF Control (Alarm function): The output 2 can also be configured as alarm function. There are 6 kinds of alarm functions can be selected for output 2, these are: **DE.HI** (deviation high alarm), **DE.LO** (deviation low alarm), **DB.HI** (deviation band out of band alarm), **DB.LO** (deviation band in band alarm), **PV.HI** (process high alarm) and **PV.LO** (process low alarm). Refer to **Figure 3.3** and **Figure 3.4** for the description of deviation alarm and process alarm with normal alarm mode (NORM is set for ALMD).

3-4 Alarm

Output 2 can be selected as an alarm output. There are 6 types of alarm functions and one dwell timer that can be selected. Four separate alarm modes (ALMD) can additionally be applied to each alarm function.

Alarm Failure Transfer is activated as the unit enters **failure mode**. Alarm will go on if **ON** is set for **O2FT** and go off if **OFF** is set for **O2FT**. The unit will enter failure mode when a sensor break occurs or if the A-D converter of the unit fails.

ALARM FUNCTIONS:

A process alarm sets two absolute trigger levels. When the process is higher than $SP2$, a process high alarm (PV.HI) occurs, and the alarm is off as the process is lower than $SP2-O2HY$. When the process is lower than $SP2$, a process low alarm (PV.LO) occurs and the alarm is off as the process is higher than $SP2+O2HY$. A process alarm is independent of set point.

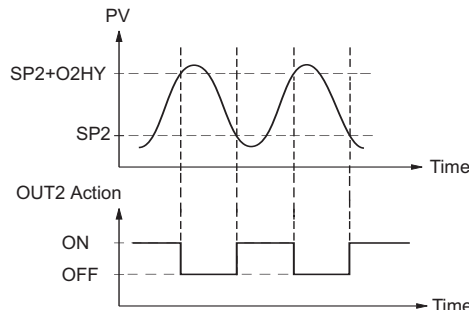


Figure 3.4 Output 2 Process Low Alarm

A deviation alarm alerts the user when the process deviates too far from set point. When the process is higher than $SV+SP2$, a deviation high alarm (DE.HI) occurs and the alarm is off as the process is lower than $SV+SP2-O2HY$. When the process is lower than $SV+SP2$, a deviation low alarm (DE.LO) occurs and the alarm is off as the process is higher than $SV+SP2+O2HY$. Trigger level of deviation alarm is moving with set point.

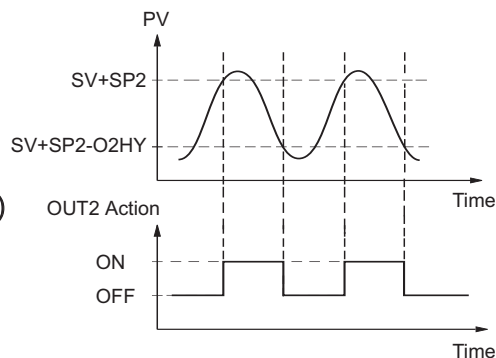


Figure 3.3 Output 2 Deviation High Alarm

A deviation band alarm presets two trigger levels relative to the set point. The two trigger levels are $SV+SP2$ and $SV-SP2$ for alarm. When the process is higher than $(SV+SP2)$ or lower than $(SV-SP2)$, a deviation band high alarm (DB.HI) occurs. When the process is within the trigger levels, a deviation band low alarm (DB.LO) occurs.

Note: In the above descriptions; SV denotes the current set point value for control which is different from SP1 as the ramp function is performed.

ALARM MODES:

Normal Alarm : ALMD = NORM

When a normal alarm is selected, the alarm output is de-energized in the non-alarm condition and energized in an alarm condition.

Latching Alarm : ALMD = LTCH

If a latching alarm is selected, once the alarm output is energized, it will remain unchanged even if the alarm condition is cleared. The latching alarm is reset when the RESET key is pressed, once the alarm condition is removed.

Holding Alarm : ALMD = HOLD

A holding alarm prevents or inhibits an alarm from kicking on during initial controller power up. The alarm is enabled only when the process reaches the set point

Latching / Holding Alarm : ALMD = LT.HO

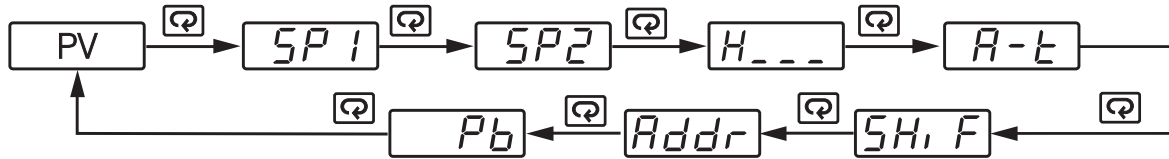
A latching / holding alarm performs both holding and latching function. The latching alarm is reset when the RESET key is pressed, once the alarm condition is removed.

3-5 Display Configuration

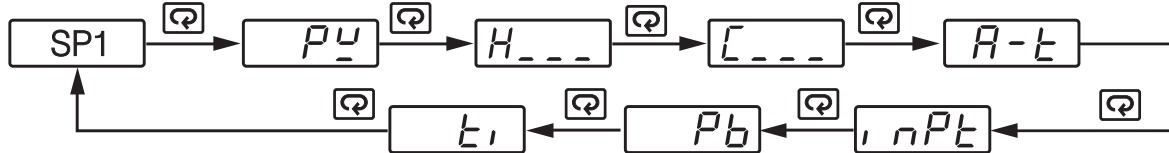
The ETR-3000 can be configured to display the process value by selecting PV for DISP. To display the set point value select SP1 for DISP.

Examples:

If LOCK is set with NONE, OUT2 is set with DEHI, DISP is set with PV, set SEL1=SHIF, SEL2=ADDR, SEL3=PB, SEL4~SEL8=NONE, then the display scrolling for ETR-3000 becomes:



If LOCK is set with NONE, OUT1 is set with REVR, nonzero value is set for PB and TI, OUT2 is set with COOL, DISP is set with SP1, set SEL1=INPT, SEL2=PB, SEL3=TI, SEL4~SEL8=NONE, then the display scrolling for ETR-3000 becomes:



3 - 6 Ramp

The ramping function is performed during power up as well as any time the set point is changed. Choose MINR (units per minute) or HRR (units per hour) for RAMP, the unit will perform the ramping function. The ramp rate is programmed by adjusting RR. The ramping function is disabled as soon as failure mode, manual control mode, the auto-tuning mode or the calibration mode is entered.

Example without Dwell Timer

Select MINR for RAMP, selects °C for UNIT, selects 1-DP for DP, Set RR= 10.0. SV is set to 200 °C initially, and changed to 100 °C after 30 minutes since power up. The starting temperature is 30 °C. After power up the process is running like the curve shown below:

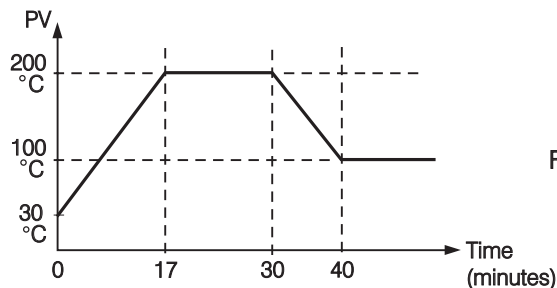


Figure 3.5 RAMP Function

Note: When the ramp function is used, the display will show the current ramping value. However it will revert to show the set point value as soon as the up or down key is touched for adjustment. The ramping value is initiated to process value either as power up or RR and /or set point are changed. Setting RR to zero disables the ramp function.

3-7 Dwell Timer

Output 2 can be configured as dwell timer by selecting TIMR for OUT2. As the dwell timer is configured, the parameter SP2 is used for dwell time adjustment. The dwell time is measured in minute ranging from 0.1 to 4553.6 minutes. Once the process reaches the set point the dwell timer starts to count down until zero (time out). The timer relay will remain unchanged until time out. The dwell timer operation is shown as following diagram. After time out the dwell timer will be restarted by pressing the RESET key. The timer stops to count during the manual control mode, failure mode, calibration period and auto-tuning period.

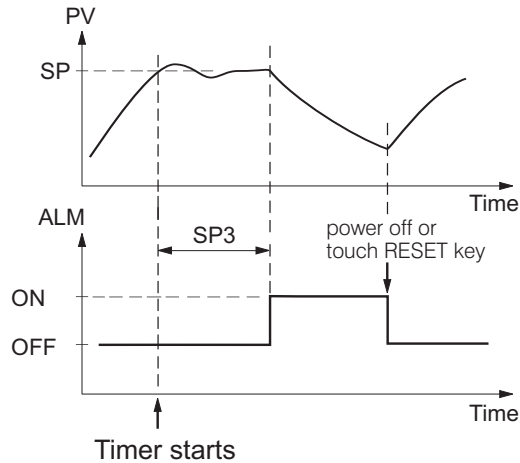


Figure 3.6
Dwell Timer Function

If output 2 is configured as dwell timer, ALMD will be hidden.

3 - 8 PV Shift

In certain applications it is desirable to shift the controller display value from its actual value. This can be easily accomplished by using the PV shift function.

The SHIF function will alter PV only.

Here is an example. A process is equipped with a heater, a sensor and a subject to be warmed up. Due to the design and position of the components in the system, the sensor could not be placed any closer to the part. Thermal gradient (temperature differential) is common in any thermal system when heat is transferred from one point to another. If the difference between the sensor and the subject is 35 °C, and the desired temperature at the subject to be heated is 200 °C, the controlling value or the temperature at the sensor should be 235 °C. You should input -35 °C as to subtract 35 °C from the actual process display. This in turn will cause the controller to energize the load and bring the process display up to the set point value.

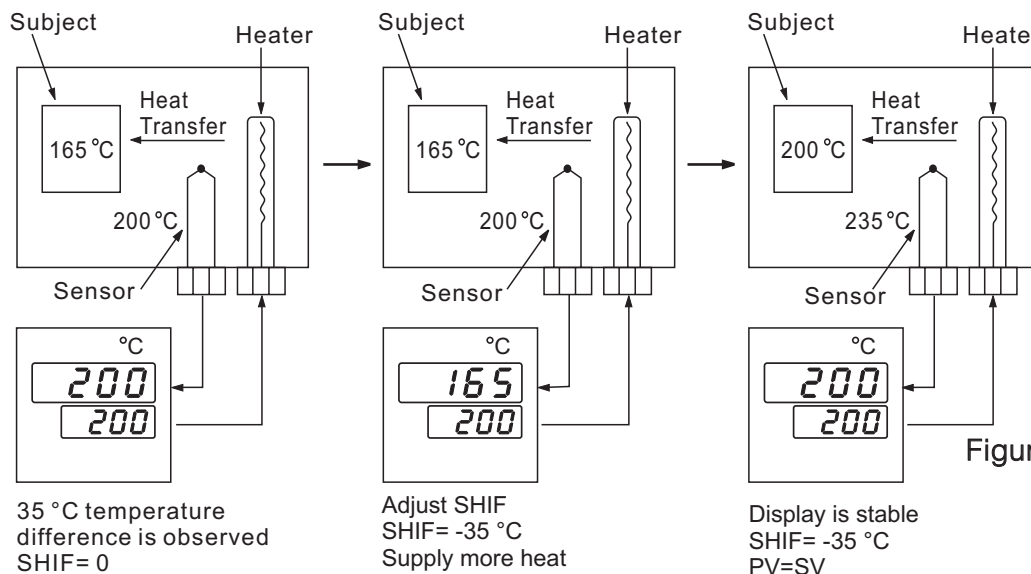


Figure 3.7 PV Shift
Application

3- 9 Digital Filter

In certain applications, the process value is too unstable to be read. To improve this, a programmable low pass filter incorporated in the controller can be used. This is a first order filter with time constant specified by FILT parameter . The default value of FILT is 0.5 sec. before shipping. Adjust FILT to change the time constant from 0 to 60 seconds. 0 seconds represents no filter is applied to the input signal. The filter is characterized by the following diagram.

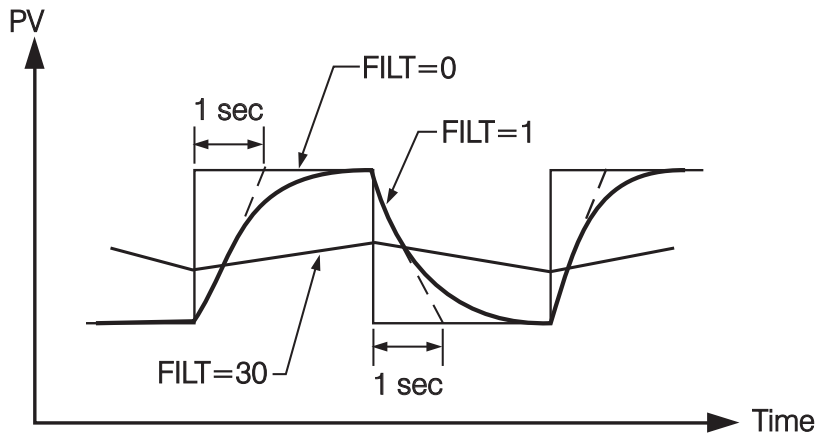


Figure 3.8
Filter Characteristics

Note:

The Filter is available only for PV, and is performed for the displayed value only. The controller is designed to use an unfiltered signal for control even if a Filter is applied. A lagged (filtered) signal, if used for control, may produce an unstable process.

3 -10 Failure Transfer

The controller will enter failure mode as one of the following conditions occurs:

1. SBER occurs due to the input sensor break or input current below 1mA if 4-20 mA is selected or input voltage below 0.25V if 1-5 V is selected .
2. ADER occurs due to the A-D converter of the controller fails.

The output 1 and output 2 will perform the failure transfer function as the controller enters failure mode.

Output 1 Failure Transfer, if activated, will perform :

1. If output 1 is configured as proportional control ($PB \neq 0$), and BPLS is selected for O1FT, then output 1 will perform bumpless transfer. Thereafter the previous control output value (MV1) will be used for controlling output 1.
2. If output 1 is configured as proportional control ($PB \neq 0$), and a value of 0 to 100.0 % is set for O1FT, then output 1 will perform failure transfer. Thereafter the value of O1FT will be used for controlling output 1.
3. If output 1 is configured as ON-OFF control ($PB = 0$), then output 1 will transfer to off state if OFF is set for O1FT and transfer to on state if ON is set for O1FT.

Output 2 Failure Transfer, if activated, will perform :

1. If OUT2 is configured as COOL, and BPLS is selected for O2FT, then output 2 will perform bumpless transfer. Thereafter the previous averaging value of MV2 will be used for controlling output 2.
2. If OUT2 is configured as COOL, and a value of 0 to 100.0 % is set for O2FT, then output 2 will perform failure transfer. Thereafter the value of O2FT will be used for controlling output 2.
3. If OUT2 is configured as alarm function, and OFF is set for O2FT, then output 2 will transfer to off state, otherwise, output 2 will transfer to on state if ON is set for O2FT.

3-11 Auto-tuning




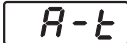

The auto-tuning process is performed at set point.

The process will oscillate around the set point during the tuning process. Set a set point to a lower value if overshooting beyond the normal process value set point is likely to cause damage.

The auto-tuning is applied in cases of :

- ★ Initial setup for a new process
- ★ The set point is changed substantially from the previous auto-tuning value
- ★ The control result is unsatisfactory

Operation :

1. The system has been installed normally.
2. Set the correct values for the setup menu of the unit. But don't use a zero value for PB and TI , otherwise, the auto-tuning program will be disabled.. The LOCK parameter should be set at NONE.
3. Set the set point to a normal operating value or a lower value if overshooting beyond the normal process value is likely to cause damage.
4. Press  several times until  appears on the display.
5. Press  for at least 3 seconds. The display will begin to flash and the auto-tuning procedure will begin.

NOTE :

The ramping function, if used, will be disabled once auto-tuning is initiated.

The auto-tuning mode is disabled as soon as either failure mode or manual control mode occurs.

Procedures:

The auto-tuning can be applied either as the process is warming up (Cold Start) or as the process has been in steady state (Warm Start).




After the auto-tuning procedures are completed, the AT indicator will cease to flash and the unit will revert to PID control by using its new PID values. The PID values obtained are stored in the nonvolatile memory.

Auto-Tuning Error

If auto-tuning fails, an ATER message will appear on the display in cases of :

- If PB exceeds 9000 (9000 PU, 900.0 °F or 500.0 °C).
- or if TI exceeds 1000 seconds.
- or if set point is changed during auto-tuning procedure.

Solutions to

1. Try auto-tuning once again.
2. Do not change the set point value during auto-tuning procedure.
3. Do not set zero value for PB and TI.
4. Use manual tuning instead of auto-tuning. (See section 3-12).
5. Touch RESET key ( or ) to reset  message.

3 - 12 Manual Tuning

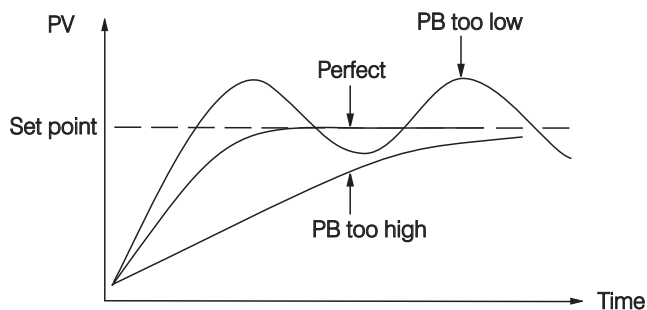
In certain applications (very few) using auto-tuning to tune a process may be inadequate for the control requirement, then you can try manual tuning.

If the control performance by using auto- tuning is still unsatisfactory, the following rules can be applied for further adjustment of PID values :

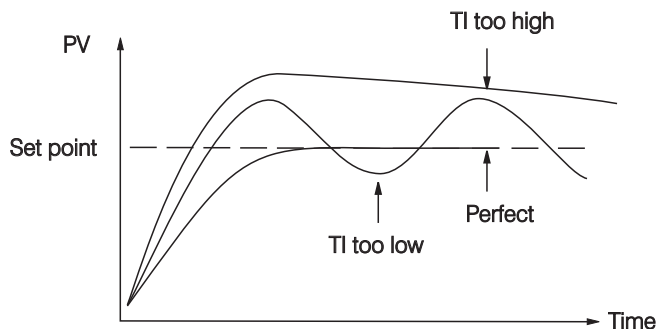
ADJUSTMENT SEQUENCE	SYMPTOM	SOLUTION
(1) Proportional Band (PB)	Slow Response	Decrease PB
	High overshoot or Oscillations	Increase PB
(2) Integral Time (TI)	Slow Response	Decrease TI
	Instability or Oscillations	Increase TI
(3) Derivative Time (TD)	Slow Response or Oscillations	Decrease TD
	High Overshoot	Increase TD

Table 3.2 PID Adjustment Guide

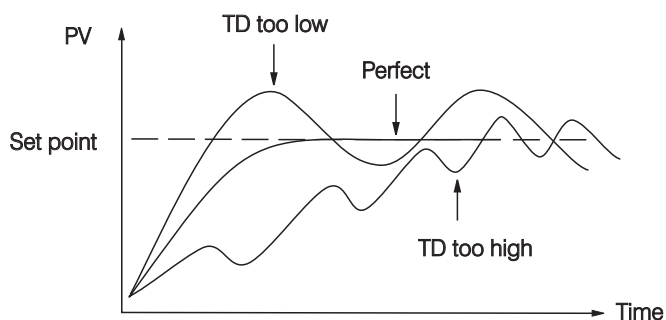
Figure 3.9 shows the effects of PID adjustment on process response.



P action



I action









D action

Figure 3.9
Effects of PID Adjustment

3-13 Manual Control

Operation:

To enable manual control, the LOCK parameter should be set to NONE, then press  several times then  (Heating output) or  (Cooling output) will appear on the display. Press  for 3 seconds then the display will begin to flash. The controller now enters the manual control mode.  indicates output control variable for output 1, and  indicates control variable for output 2. Now you can use up-down key to adjust the percentage values for the heating or cooling output.

The controller performs open loop control as long as it stays in manual control mode.

Exit Manual Control

Press the   keys and the controller will revert to its normal display mode.

3-14 Data Communication

The controllers support RTU mode of Modbus protocol for the data communication. Other protocols are not available for this series.

Two types of interfaces are available for Data Communication. These are RS-485 and RS-232 interface. Since RS-485 uses a differential architecture to drive and sense signal instead of a single ended architecture which is used for RS-232, RS-485 is less sensitive to the noise and suitable for a longer distance communication. RS-485 can communicate without error over 1 km distance while RS-232 is not recommended for a distance over 20 meters.

Using a PC for data communication is the most economic way. The signal is transmitted and received through the PC communication Port (generally RS-232). Since a standard PC can't support RS-485 port, a network adaptor (such as SNA10A, SNA10B) has to be used to convert RS-485 to RS-232 for a PC if RS-485 is required for the data communication. But there is no need to be sad. Many RS-485 units (up to 247 units) can be connected to one RS-232 port, therefore a PC outfitted with 4 comm ports can communicate with up to 988 units. Communications encompass a large scope of applications from single point interface through hundreds of controls to historical trending through endless zones. ETR communications provide for a very powerful and economic solution.

Setup

Enter the setup menu.

Select RTU for COMM. Set individual addresses for each unit which is connected to the same port.

Set the Baud Rate (BAUD), Data Bit (DATA), Parity Bit (PARI) and Stop Bit (STOP) such that these values are accordant with PC setup conditions.

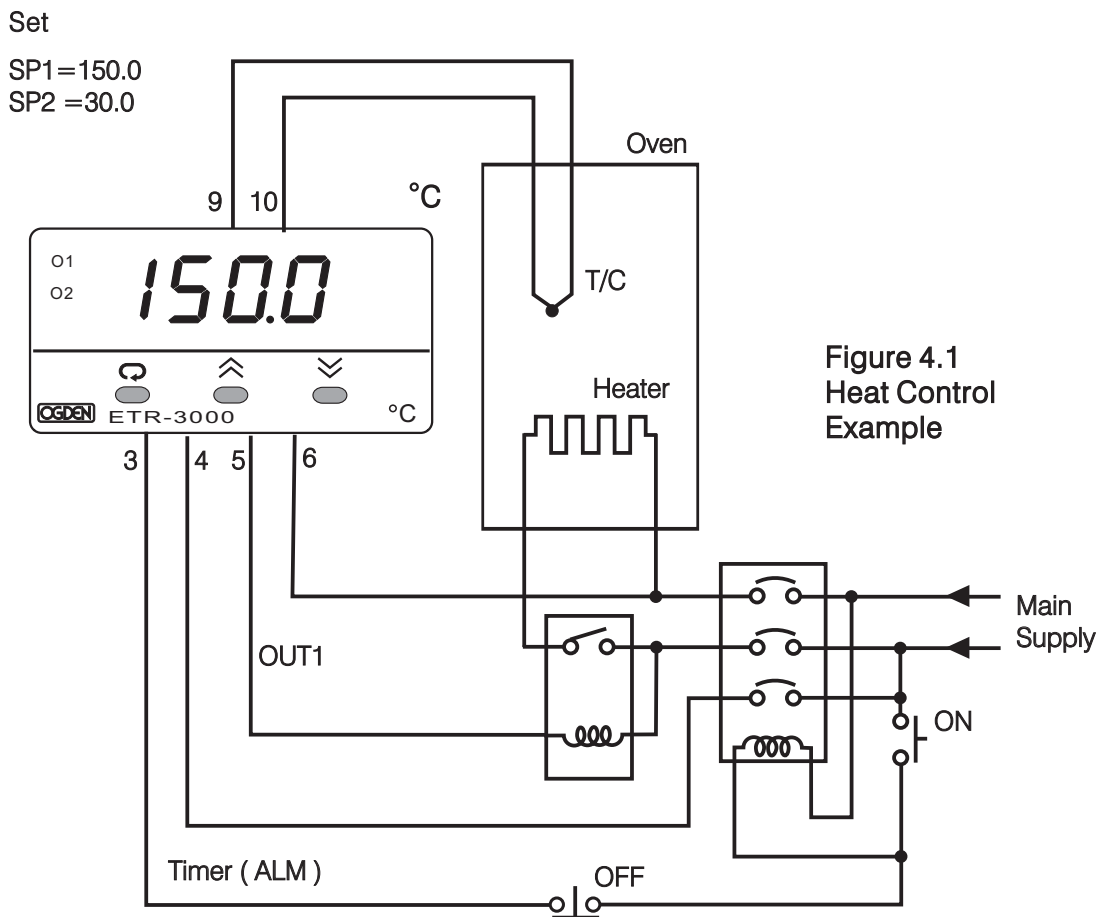
If you use a conventional 9-pin RS-232 cable instead of CC94-1, the cable should be modified for proper operation of RS-232 communication according to Section 2-9.

Please see the communications supplement for more detailed information.

Chapter 4 Applications

4-1 Heat Only Control with Dwell Timer

An oven is designed to dry products at 150 degrees C for 30 minutes and then stay unpowered until the next batch is ready for baking. An ETR-3000 equipped with a dwell timer is used for this purpose. A single phase system diagram is shown as follows :



To achieve this function set the following parameters in the setup menu.

INPT=K_TC	UNIT= °C	DP=1_DP
OUT1=REVR	O1TY=RELY	CYC1=18.0
O1FT=BPLS	OUT2=TIMR	O2FT=ON

Auto-Tuning is performed at 150 °C for this new oven.

4-2 Cool Only Control

An ETR-3000 is used to control a refrigerator at a temperature below 0 °C. The temperature is lower than the ambient, therefore a cooling action is required. Select DIRT for OUT1. Since output 1 is used to drive a magnetic contactor, O1TY should be set to RELY. A small temperature oscillation is tolerable, hence use ON-OFF control to reduce wear and tear on the mechanical parts and resulting over-all cost. To achieve ON-OFF control, the PB is set to zero and O1HY is set at 0.1 °C.

Setup Summary:

INPT=PT.DN
UNIT= °C
DP=1-DP
OUT1=DIRT
O1TY=RELY

User Menu:

PB = 0 (°C)
O1HY=0.1 (°C)

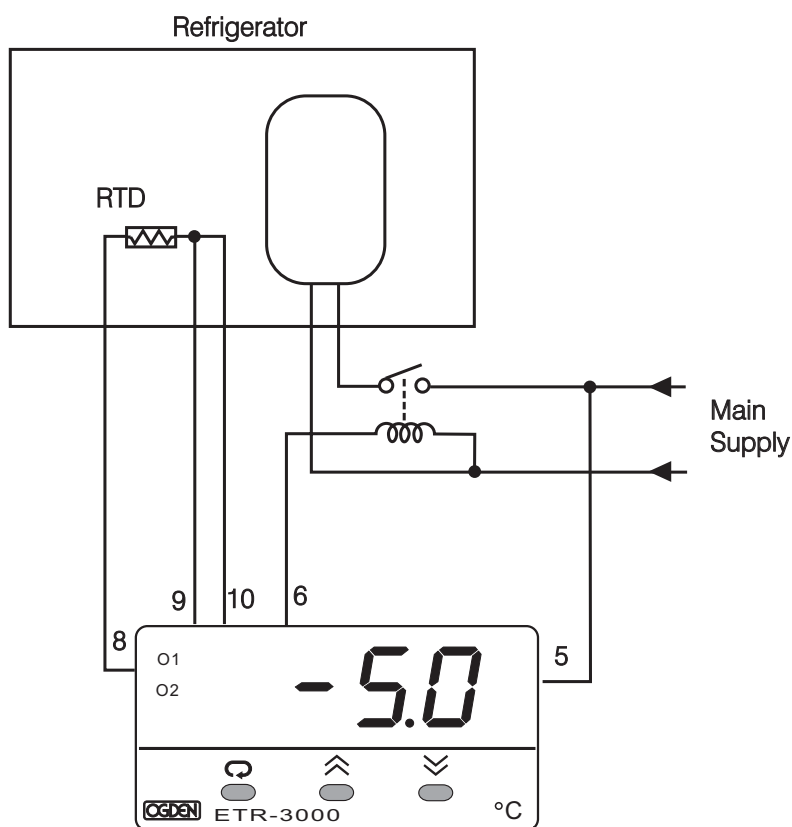


Figure 4.2 Cooling Control Example

4-3 Heat-Cool Control

An injection mold required to be controlled at 120 °C to ensure a consistent quality for the parts. An oil pipe is buried in the mold. Since plastics are injected at higher temperatures (e.g. 250 °C), the circulation oil needs to be cooled as its temperature rises. Here is an example:

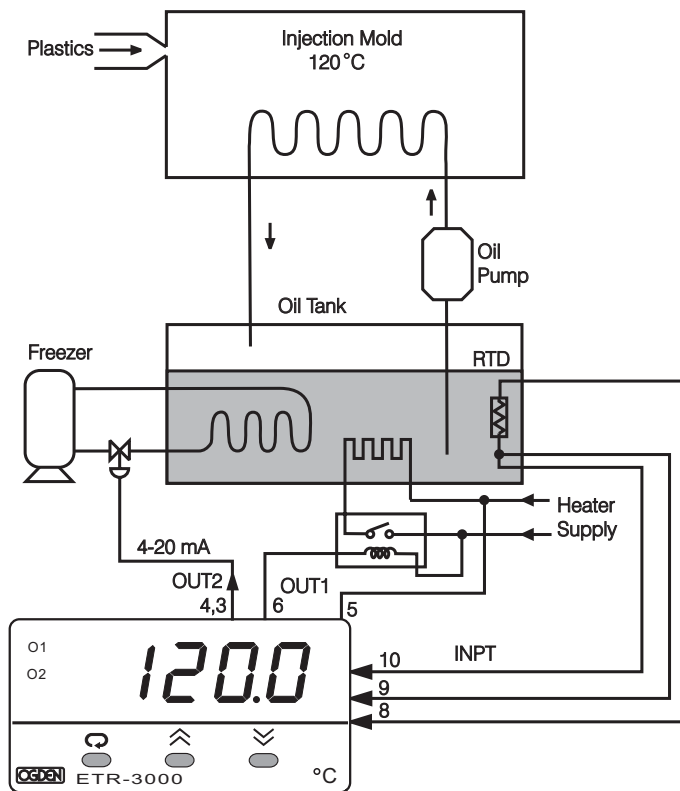


Figure 4.3
Heat-Cool Control Example

The PID Heat-Cool is used for the above example.
To achieve this set the following parameters in the Setup Menu:

```
INPT=PT.DN
UNIT= °C
DP= 1-DP
OUT1=REVR
O1TY=RELY
CYC1=18.0 (sec.)
O1FT=BPLS
OUT2=COOL
O2TY=4-20
O2FT=BPLS
```

Adjust SV at 120.0 °C , CPB at 125 (%) and DB at -4.0 (%).

Apply Auto-tuning at 120 °C for a new system to get an optimal PID values. See Section 3-11.

Adjustment of CPB is related to the cooling media used. If water is used as cooling media instead of oil, the CPB is set at 250 (%). If air is used as cooling media instead of oil, the CPB is set at 100 (%).

Adjustment of DB is dependent on the system requirements. More positive value of DB will prevent unwanted cooling action, but will increase the temperature overshoot, while more negative value of DB will achieve less temperature overshoot, but will increase unwanted cooling action.

Chapter 5 Calibration



Do not proceed through this section unless there is a definite need to re-calibrate the controller. Otherwise, all previous calibration data will be lost. Do not attempt recalibration unless you have appropriate calibration equipment. If calibration data is lost, you will need to return the controller to your supplier who may charge you a service fee to re-calibrate the controller.



Entering calibration mode will break the control loop. Make sure that if the system is allowable to apply calibration mode.

Equipment needed before calibration:

- (1) A high accuracy calibrator maintained at NIST standards (Fluke 5520A Calibrator recommended) with following functions:
 - 0 - 100 mV millivolt source with ± 0.005 % accuracy
 - 0 - 10 V voltage source with ± 0.005 % accuracy
 - 0 - 20 mA current source with ± 0.005 % accuracy
 - 0 - 300 ohm resistant source with ± 0.005 % accuracy
- (2) A test chamber providing 25 °C - 50 °C temperature range
- (3) A switching network (SWU16K, optional for automatic calibration)
- (4) A calibration fixture equipped with programming units (optional for automatic calibration)
- (5) A PC installed with calibration software ETR -Net and Smart Network Adaptor SNA10B (optional for automatic calibration)

The calibration procedures described in the following section are a step by step manual procedures.

Since the controller needs 30 minutes to warm up an unit before calibration, calibrating the unit one by one is quite inefficient. An automatic calibration system for numerous quantities is available upon request.

Manual Calibration Procedures

★ Perform step 1 to enter calibration mode.

Step 1. Set the Lock parameter to the unlocked condition (LOCK=NONE).

Press and hold the scroll key until **Cal** appears on the display, then release the scroll key.

Press the scroll key for 2 seconds then release, the display will show **AdLo** and the unit enters calibration mode .

★ Perform step 2 to calibrate Zero of A to D converter and step 3 to calibrate gain of A to D converter.

Step 2. Short the thermocouple inpt terminals , then press scroll key for at least 3 seconds. The display will blink a moment and a new value is obtained. Otherwise, if the display didn't blink or if the obtained value is equal to -199.9 or 199.9, then the calibration fails.

Step 3. Press scroll key until the display shows **AdHi** . Send a 60mV signal to the thermocouple input terminals in correct polarity . Press scroll key for at least 3 seconds . The display will blink a moment and a new value is obtained . Otherwise , if the display didn't blink or if the obtained value is equal to -199.9 or 199.9, then the calibration fails.

★ Perform both steps 4 and 5 to calibrate RTD function (if required) for input.

Step 4. Press scroll key until the display shows r t d L . Send a 100 ohms signal to the RTD input terminals according to the connection shown below:

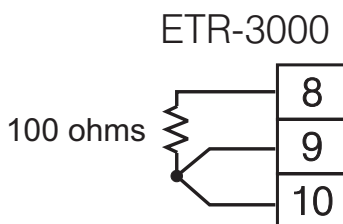


Figure 5.1 RTD Calibration

Press scroll key for at least 3 seconds . The display will blink a moment, otherwise the calibration fails.

Step 5. Press scroll key and the display will show r t d H . Change the ohm's value to 300 ohms .Press scroll key for at least 3 seconds. The display will blink a moment and two values are obtained for RTDH and RTDL (step 4). Otherwise, if the display didn't blink or if any value obtained for RTDH and RTDL is equal to -199.9 or 199.9 , then the calibration fails.

* Perform step 6 to calibrate offset of cold junction compensation, if required.

Step 6. Setup the equipments according to the following diagram for calibrating the cold junction compensation. Note that a K type thermocouple must be used.

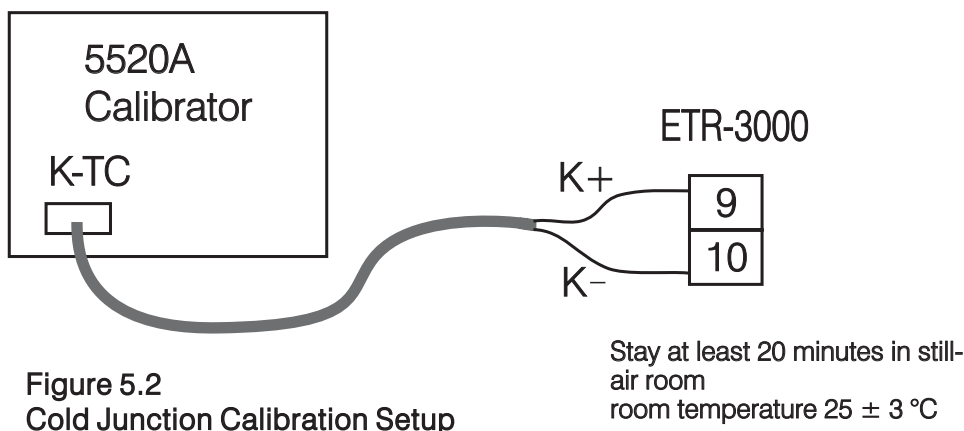


Figure 5.2
Cold Junction Calibration Setup

The 5520A calibrator is configured as K type thermocouple output with internal compensation. Send a 0.00 °C signal to the unit under calibration.

The unit under calibration is powered in a still-air room with temperature 25 ± 3 °C. Stay at least 20 minutes for warming up. Perform step 1 stated above, then press scroll key until the display shows C J L 0 . Press up/down key to obtain 40.00. Press scroll key for at least 3 seconds. The display will blink a moment and a new value is obtained . Otherwise , if the display didn't blink or if the obtained value is equal to -5.00 or 40.00, then the calibration fails.

★ Perform step 7 to calibrate gain of cold junction compensation if required.

Step 7. Setup the equipments same as step 6. The unit under calibration is powered in a still-air room with temperature 50 ± 3 °C. Stay at least 20 minutes for warming up . The calibrator source is set at 0.00 °C with internal compensation mode.

Perform step 1 stated above , then press scroll key until the display shows C JH₁ . Press scroll key for at least 3 seconds. The display will blink a moment and a new value is obtained. Otherwise , if the display didn't blink or if the obtained value is equal to -199.9 or 199.9, then the calibration fails.

This setup is performed in a high temperature chamber, hence it is recommended to use a computer to perform the procedures.

★ Input modification and recalibration procedures for a linear voltage or a linear current input:

1. Remove R60(3.3K) and install two 1/4 W resistors RA and RB on the control board with the recommended values specified in the following table.

The low temperature coefficient resistors should be used for RA and RB.

Input Function	RA	RB	R60
T/C, RTD, 0~60mV	X	X	3.3K
0 ~ 1 V	61.9K	3.92K	X
0 ~ 5V, 1 ~ 5V	324K	3.92K	X
0 ~ 10 V	649K	3.92K	X
0~20mA, 4~20mA	39Ω	3.01Ω	X

2. Perform Step 1 and Step 2 to calibrate the linear input zero.
3. Perform Step 3 but send a span signal to the input terminals instead of 60mV. The span signal is 1V for 0~1V input, 5V for 0~5V or 1~5V input, 10V for 0~10V input and 20mA for 0~20mA or 4~20mA input.

★ Final step

Step 8. Set the LOCK value to your desired function.

Chapter 6 Specifications

Power

90 ~ 250 VAC, 47 ~ 63 Hz, 10VA, 5W maximum
11 ~ 26 VAC / VDC, 10VA, 5W maximum

Input

Resolution : 18 bits
Sampling Rate : 5 times / second
Maximum Rating : -2 VDC minimum, 12 VDC maximum (1 minute for mA input)
Temperature Effect : $\pm 1.5\mu\text{V}/^{\circ}\text{C}$ for all inputs except mA input
 $\pm 3.0\mu\text{V}/^{\circ}\text{C}$ for mA input
Sensor Lead Resistance Effect :
T/C: $0.2\mu\text{V}/\text{ohm}$
3-wire RTD: $2.6^{\circ}\text{C}/\text{ohm}$ of resistance difference of two leads
2-wire RTD: $2.6^{\circ}\text{C}/\text{ohm}$ of resistance sum of two leads 200 nA
Common Mode Rejection Ratio (CMRR): 120dB

Burn-out Current :

Normal Mode Rejection Ratio (NMRR): 55dB

Sensor Break Detection :

Sensor open for TC, RTD and mV inputs,
Sensor short for RTD input
below 1 mA for 4-20 mA input,
below 0.25V for 1 - 5 V input,
unavailable for other inputs.

Sensor Break Responding Time :

Within 4 seconds for TC, RTD and mV inputs, 0.1 second for 4-20 mA and 1 - 5 V inputs.

Characteristics:

Type	Range	Accuracy@ 25AC	Input Impedance
J	-120 °C~1000 °C (-184 °F~1832 °F)	±2 °C	2.2 MΩ
K	-200 °C~1370 °C (-328 °F~2498 °F)	±2 °C	2.2 MΩ
T	-250 °C~400 °C (-418 °F~752 °F)	±2 °C	2.2 MΩ
E	-100 °C~900 °C (-148 °F~1652 °F)	±2 °C	2.2 MΩ
B	0 °C~1800 °C (32 °F~3272 °F)	(±200 °C~1800 °C)	2.2 MΩ
R	0 °C~1767.8 °C (32 °F~3214 °F)	±2 °C	2.2 MΩ
S	0 °C~1767.8 °C (32 °F~3214 °F)	±2 °C	2.2 MΩ
N	-250 °C~1300 °C (-418 °F~2372 °F)	±2 °C	2.2 MΩ
L	-200 °C~900 °C (-328 °F~1652 °F)	±2 °C	2.2 MΩ
PT100 (DIN)	-210 °C~700 °C (-346 °F~1292 °F)	±0.4 °C	1.3 KΩ
PT100 (JIS)	-200 °C~600 °C (-328 °F~1112 °F)	±0.4 °C	1.3 KΩ
mV	-8mV~70mV	±0.05 %	1.3 KΩ
mA	-3mA~27mA	±0.05 %	70.5 Ω
V	-1.3V~11.5V	±0.05 %	650 KΩ

Output 1 / Output 2

Relay Rating : 2A/240 VAC, life cycles 200,000 for resistive load
Pulsed Voltage : Source Voltage 5V, current limiting resistance 66 Ω.

Linear Output Characteristics

Type	Zero Tolerance	Span Tolerance	Load Capacity
4~20 mA	3.6~4 mA	20~21 mA	500Ω max.
0~20 mA	0 mA	20~21 mA	500Ω max.
0 ~ 5 V	0 V	5 ~ 5.25 V	10 KΩ min.
1 ~ 5 V	0.9 ~ 1 V	5 ~ 5.25 V	10 KΩ min.
0 ~ 10 V	0 V	10 ~10.5 V	10 KΩ min.

Linear Output

Resolution : 15 bits

Output Regulation : 0.02 % for full load change

Output Settling Time : 0.1 sec. (stable to 99.9 %)

Isolation Breakdown Voltage : 1000 VAC

Temperature Effect : ± 0.01 % of SPAN / °C

Triac (SSR) Output

Rating : 1A / 240 VAC

Inrush Current : 20A for 1 cycle

Min. Load Current : 50 mA rms

Max. Off-state Leakage : 3 mA rms

Max. On-state Voltage : 1.5 V rms

Insulation Resistance : 1000 Mohms min. at 500 VDC

Dielectric Strength : 2500 VAC for 1 minute

DC Voltage Supply Characteristics (Installed at Output 2)

Type	Tolerance	Max. Output Current	Ripple Voltage	Isolation Barrier
20 V	± 0.5 V	25 mA	0.2 Vp-p	500 VAC
12 V	± 0.3 V	40 mA	0.1 Vp-p	500 VAC
5 V	± 0.15 V	80 mA	0.05 Vp-p	500 VAC

Output 2 Functions : Dwell timer,

Deviation High / Low Alarm,

Deviation Band High / Low Alarm,

PV High / Low Alarm,

PID cooling control

Alarm Mode : Normal, Latching, Hold, Latching / Hold.

Dwell Timer : 0.1 - 4553.6 minutes

Data Communication

Interface : RS-232 (1 unit), RS-485 (up to 247 units)

Protocol : Modbus Protocol RTU mode

Address : 1 - 247

Baud Rate : 2.4 ~ 38.4 Kbits/sec

Data Bits : 7 or 8 bits

Parity Bit : None, Even or Odd

Stop Bit : 1 or 2 bits

Communication Buffer : 160 bytes

User Interface

Single 4-digit LED Display

Keypad : 3 keys

Programming Port : For automatic setup, calibration and testing

Communication Port : Connection to PC for supervisory control

Control Mode

Output 1 : Reverse (heating) or direct (cooling) action

Output 2 : PID cooling control, cooling P band 50~300% of PB, dead band -36.0 ~ 36.0 % of PB

ON-OFF : 0.1 - 90.0 (°F) hysteresis control (P band = 0)

P or PD : 0 - 100.0 % offset adjustment

PID : Fuzzy logic modified

Proportional band 0.1 ~ 900.0 °F.

Integral time 0 - 1000 seconds

Derivative time 0 - 360.0 seconds

Cycle Time : 0.1 - 90.0 seconds

Manual Control : Heat (MV1) and Cool (MV2)

Auto-tuning : Cold start and warm start

Failure Mode : Auto-transfer to manual mode while sensor break or A-D converter damage

Ramping Control : 0 - 900.0 °F/minute or 0 - 900.0 °F/hour ramp rate

Digital Filter

Function : First order

Time Constant : 0, 0.2, 0.5, 1, 2, 5, 10, 20, 30, 60 seconds programmable

Environmental & Physical

Operating Temperature : -10 °C to 50 °C

Storage Temperature : -40 °C to 60 °C

Humidity : 0 to 90 % RH (non-condensing)

Altitude: 2000m maximum

Pollution: Degree 2

Insulation Resistance : 20 Mohms min. (at 500 VDC)

Dielectric Strength : 2000 VAC, 50/60 Hz for 1 minute

Vibration Resistance : 10 - 55 Hz, 10 m/s² for 2 hours

Shock Resistance : 200 m/s² (20 g)

Moldings : Flame retardant polycarbonate

Dimensions :

ETR-3000-----50mm(W) X 26.5mm(H) X 110.5mm(D), 98 mm depth behind panel

Weight :

ETR-3000----- 120 grams

Approval Standards

Safety : UL61010C-1

CSA C22.2 No. 24-93

CE EN61010-1 (IEC1010-1)

Protective Class :

Ip65 front panel

EMC: CE En61326

Table A.1 Error Codes and Corrective Actions

Error Code	Display Symbol	Error Description	Corrective Action
4	<i>Er 04</i>	Illegal setup values been used: Before COOL is used for OUT2, DIRT (cooling action) has already been used for OUT1, or PID mode is not used for OUT1 (that is PB = 0, and / or TI = 0)	Check and correct setup values of OUT2, PB, TI and OUT1. IF OUT2 is required for cooling control, the control should use PID mode (PB \neq 0, TI \neq 0) and OUT1 should use reverse mode (heating action), otherwise, don't use OUT2 for cooling control.
10	<i>Er 10</i>	Communication error: bad function code	Correct the communication software to meet the protocol requirements.
11	<i>Er 11</i>	Communication error: register address out of range	Don't issue an over-range register address to the slave.
14	<i>Er 14</i>	Communication error: attempt to write a read-only data or a protected data	Don't write a read-only data or a protected data to the slave.
15	<i>Er 15</i>	Communication error: write a value which is out of range to a register	Don't write an over-range data to the slave register.
26	<i>AtEr</i>	Fail to perform auto-tuning function	<ol style="list-style-type: none"> 1.The PID values obtained after auto-tuning procedure are out of range. Retry auto-tuning. 2.Don't change set point value during auto-tuning procedure. 3.Use manual tuning instead of auto-tuning. 4. Don't set a zero value for PB. 5. Don't set a zero value for TI. 6. Touch RESET key
29	<i>EEPE</i>	EEPROM can't be written correctly	Return to factory for repair.
30	<i>CJEr</i>	Cold junction compensation for thermocouple malfunction	Return to factory for repair.
39	<i>SbEr</i>	Input sensor break, or input current below 1 mA if 4-20 mA is selected, or input voltage below 0.25V if 1 - 5V is selected	Replace input sensor.
40	<i>AdEr</i>	A to D converter or related component(s) malfunction	Return to factory for repair.

A.2 WARRANTY AND LIMITATION OF REMEDY AND LIABILITY

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